clean water PROGRAM

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Hayward, CA
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Protecting Alameda County Creeks, Wetlands & the Bay

September 15, 2011

Mr. Bruce Wolfe
Executive Officer
Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland CA 94612

Dear Bruce:

SUBJECT: **SUBMITTAL OF FY 2010-2011 CLEAN WATER PROGRAM AND BASMAA REPORTS PURSUANT TO PROVISION C.16**

As you know, various submission and reporting provisions of the Municipal Regional Stormwater Permit (MRP) authorize Permittee implementation and compliance through coordination of the countywide stormwater program or in a regional collaborative effort. The member agency Permittees of the Alameda Countywide Clean Water Program (Clean Water Program) through their Management Committee, and in conformance with the Memorandum of Agreement signed by their governing bodies, have authorized and directed me to prepare and submit certain reports as part of their compliance with submission of their Annual Reports pursuant to Provision C.16.

Therefore with this letter, I am submitting this Clean Water Program Annual Report along with two Bay Area Stormwater Management Agencies Association regional collaborative reports attached as appendices on behalf of and for the benefit of the Clean Water Program member agency Permittees. By signing this letter on behalf of the Clean Water Program, I certify under penalty of law that these documents and all attachments are prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who managed the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine imprisonment of knowing violations. [40 CFR 122.22(d)].

Sincerely,

James Scanlin
Program Manager

Attachment: Clean Water Program Fiscal Year 2010/2011 Annual Report

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cleanwater
PROGRAM
alameda county

Fiscal Year 2010/11
Annual Report

July 2010 through June 2011

September 15, 2011

Credits

This report is being submitted by the participating agencies in the Alameda Countywide Clean Water Program.

City of Alameda
City of Albany
City of Berkeley
City of Dublin
City of Emeryville
City of Fremont
City of Hayward
City of Livermore
City of Newark
City of Oakland
City of Piedmont
City of Pleasanton
City of San Leandro
City of Union City
Alameda County

Alameda County Flood Control and Water Conservation District
Zone 7 Water Agency

Implementation of the Program coordinated by:

Alameda County Public Works Agency
Alameda County Flood Control and Water Conservation District
951 Turner Court, Room 300, Hayward, California 94545

Report Prepared by:

ACCWP Program Staff
Jim Scanlin, Program Manager
Arleen Feng

and

EOA, Inc.
1410 Jackson Street
Oakland, California 94612

TABLE OF CONTENTS

APPENDICES

- BASMAA Model Bioretention Soil Media Specifications Transmittal Letter and Report Cover
- BASMAA Green Roof Minimum Specifications Transmittal Letter and Report Cover
- BASMAA Special Projects Proposal/LID Treatment Reduction Credits Transmittal Letter and Report Cover
- Standard Stormwater Treatment BMP Inspection Report Form
- Model Stormwater Treatment Measures and Hydromodification Management Controls Maintenance Agreement
- C.3 Stormwater Technical Guidance Manual excerpts
- New Development Workshop Flyer, Agenda, Sign-in and Evaluation Summary

APPENDIX C Provision C.4

- FY 2010/11 I&IDC Subcommittee Attendance
- List of I&IDC Related Educational Outreach Materials Downloaded from the Clean Water Program's Website
- Survey to Determine I&IDC Subcommittee's Priorities for Revising Outreach Materials
- Stormwater Business Inspectors Workshop Flyer, Agenda, Evaluations and Sign-in

APPENDIX D Provision C.5

- Enhancement of BASMAA Surface Cleaner Training and Recognition Program Regional Project Profile

APPENDIX E Provision C.6

- Pollution Prevention – It's Part of the Plan Outreach Piece
- Inspection Checklist for Construction Stormwater Controls
- Wet Season Notification Model Letter
- Construction Inspection Workshop Flyer, Agenda, Sign-in and Evaluations

APPENDIX F Provision C.7

- BASMAA Implementation Plan for Litter Outreach
- Summer Reeds Newspaper Insert
- Bay-Friendly Garden Tour 2011 Final Report
- Bringing Back the Natives Garden Tour Final Report
- Educational Services Annual Reports FY2010/2011
- BASMAA *Training and Outreach for FY10-11 Regional Supplement* (with *BASMAA Five-Year Strategic Advertising Plan "Our Water, Our World" Pesticides Program* Report, *BASMAA Five-Year Strategic Outreach Plan: Litter* Report and *BASMAA Media Relations Campaign Annual Report* as attachments)

APPENDIX G Provision C.8

- January 31, 2011 Bay Area Macroinvertebrate Bioassessment Information (BAMBI) Network Meeting Agenda

APPENDIX H Provision C.9

- Our Water, Our World (OWOW) IPM Store Partnership Program Final Report July 2011

APPENDIX I Regional Supplemental Report

- BASMAA *Regional Pollutants of Concern Report for FY2010-2011 and Monitoring Status Report for January – June 2011* Supplemental Report

LIST OF TABLES

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ACCWP:	Alameda Countywide Clean Water Program
ACFC&WCD	Alameda County Flood Control and Water Conservation District
ACPWA:	Alameda County Public Works Agency
BASMAA:	Bay Area Stormwater Management Agencies Association
BMP(s):	Best Management Practices
CASQA:	California Stormwater Quality Association
CEQA:	California Environmental Quality Act
CRMP:	Coordinated Resource Management Plan(ning)
CSG:	Community Stewardship Grant
DCIA:	Directly Connected Impervious Areas
EBMUD:	East Bay Municipal Utility District
EBRPD:	East Bay Regional Parks District
EOA:	Eisenberg, Olivieri, & Associates
FY:	Fiscal year (July through June)
GP:	General Plan
haz.:	Hazardous
HMBP:	Hazardous Materials Business Plan
HM:	Hydromodification Management
I&IDC:	Industrial and Illicit Discharge Control
IBI	Index of Biotic Integrity
MRP:	Municipal Regional Stormwater Permit
MSS:	Monitoring and Special Studies
ND:	New Development
NDS:	New Development Subcommittee
NOI:	Notice of Intent
N/P/K:	Nitrogen/Phosphorus/ Potassium
NPDES:	National Pollutant Discharge Elimination System
O&M:	Operation and Maintenance
PCBs:	Polychlorinated Biphenyls
PI/P:	Public Information and Participation
POTW:	Publicly Owned Treatment Works
Protocols:	ACCWP Minimum Enforcement Reporting Protocols (adopted by subcommittee Feb 1996)
QA/QC:	Quality Assurance/ Quality Control
RCD:	Resource Conservation District
RMP:	Regional Monitoring Program
RWQCB:	Regional Water Quality Control Board (San Francisco Bay Region)
SFEI	San Francisco Estuary Institute
SWPPP:	Stormwater Pollution Prevention Plan

GLOSSARY OF ABBREVIATIONS AND ACRONYMS (cont.)

SWMP:	Stormwater Management Plan
TMDL:	Total Maximum Daily Load
TPH:	Total Petroleum Hydrocarbon
TSS:	Total Suspended Solids
US E.P.A.:	United States Environmental Protection Agency
WAMS	Watershed Assessment and Monitoring/Special Studies
Water Board:	San Francisco Bay Regional Water Quality Control Board

1: Executive Summary

Introduction

This report describes the Alameda Countywide Clean Water Program's (Clean Water Program) stormwater pollution prevention and control activities in FY 2010/11 and its activities conducted to assist the Clean Water Program's member agencies to comply with the municipal regional stormwater permit (MRP) adopted in October 2009.

Clean Water Program accomplishments are listed for each of the MRP's Provisions from Provision C.2 through C.15. Similar to previous years, a summary of the technical studies and informational, educational, and promotional products developed during FY 2010/11 is contained in Table 1-1. Table 1-2 briefly describes each component's work in progress. Finally, Table 1-3 summarizes each agency's participation in the Management Committee and its subcommittees.

The executive summary is organized by MRP Provision from C.2 through C.10 and C.15; a Regional Pollutants of Concern section covers Provisions C.11, C.12 and C.14, as well as parts of Provisions C.9, C.10 and C.13.

Summary of MRP Provision Implementation

Provision C.2 Municipal Operations

Most MRP Provision C.2 tasks need to be implemented by each of the Clean Water Program's member agencies. The Clean Water Program helps member agency staff understand the MRP's requirements, and it develops various tools needed to effectively plan, implement, and report on the activities completed.

During this reporting period the following activities were conducted:

- Conducted a workshop on June 2, 2011 on integrated pest management solutions for structural and landscape related pest control. (See Appendix A for workshop material.)
- Compiled guidance memo and reporting templates from member agencies and posted them to the Program's new website: cleanwaterprogram.org.
- Reviewed Program's existing rural roads guidance and assessed opportunities for future updates.

- Held a Municipal Maintenance Subcommittee meeting on March 3, 2011 and reviewed all municipal operations related requirements from provisions C.2, C.5, C.9, C.10, and C.15.

Provision C.3 New Development and Redevelopment

In FY 2010/11, the Clean Water Program undertook a variety of activities to help its member agencies comply with MRP Provision C.3, New Development and Redevelopment. These activities emphasized providing guidance and model documents for use by the member agencies to meet Provision C.3 requirements. Bimonthly meetings of the New Development Subcommittee provide important opportunities for member agencies to communicate their needs to the Program and obtain information and tools they need for MRP compliance. The Subcommittee forms work groups for focused effort on specific work products and sponsors training sessions for municipal agency staffs.

Provision C.3 accomplishments of the Program are summarized below:

- Assisted with agency implementation of the C.3.a.i(7) and C.3.c.i(1) requirements to implement source control measures in development projects by updating the Program's Source Control Model List, which agencies use as a model for their local source control lists.
- Helped member agencies prepare to implement Provisions C.3.b (Regulated Projects) and C.3.c (Low Impact Development - LID) requirements that go into effect December 1, 2011, by completing an update the Program's C.3 Technical Guidance. Member agencies use the technical guidance as a guide to help project applicants incorporate post-construction stormwater controls in new and redevelopment projects.
- Assisted with regional efforts to implement Provisions C.3.b (Pilot Green Streets), C.3.c (LID Feasibility, Soil Specifications, and Green Roof Specifications), and C.3.e (Special Projects) by participating in the Bay Area Stormwater Management Agencies Association's preparation of the following documents:
    - Draft data collection procedures for pilot green streets
    - LID feasibility/Infeasibility Report, submitted to the Water Board on April 29, 2011
    - Biotreatment soil specifications, submitted to the Water Board on December 1, 2010
    - Green Roof Specifications, submitted to the Water Board on April 29, 2011
    - Special Projects Proposal for LID reduction credits, submitted to the Water Board on December 1, 2010
- Updated the Program's Operation and Maintenance Verification Inspection Form, in collaboration with the Industrial and Illicit Discharge Subcommittee, to help local inspectors capture new inspection data required in Provision C.3.h.

- Updated the Program's model maintenance agreement to help local agencies meet the C.3.h requirements for long-term maintenance assurance for stormwater treatment measures and hydromodification management controls.
- Held a new development workshop on September 29, 2010, to train agency staff on Provision C.3. The workshop helped the agencies comply with various C.3 requirements, including Provision C.3.b and C.3.c requirements that go into effect on December 1, 2011, and the C.3.a(4) requirements to provide training to agency staff.
- Helped agency staff prepare to implement Provision C.3.c LID requirements, and to meet C.3.a.(4) training requirements, by holding a field trip on February 8, 2011, for the New Development Subcommittee to view rainwater harvesting systems and a green roof at Mills College in Oakland.

Provision C.4 Industrial and Commercial Site Controls

This section of the report describes the countywide activities conducted to implement the MRP's Provision C.4 Industrial and Commercial Site Controls. Activities summarized in this section were implemented jointly for the benefit of the Clean Water Program's member agencies. The Clean Water Program's role is to help municipal staff to develop and use various tools, templates, reporting forms, and other MRP compliance support materials and participate in countywide inspector training workshops.

During this reporting period the following activities were completed with input and assistance from the Industrial & Illicit Discharge Control (I&IDC) Subcommittee.

- Identified priorities for updating educational outreach materials as part of the process of branding materials with the new Clean Water Program name, logo and tagline.
- Initiated work with the Public Information and Participation Subcommittee to update the Vehicle Facilities BMPs booklet and to create a new restaurant BMPs booklet.
- Conducted a training workshop that focused on improving inspection skills and understanding about how to handle priority pollutants of concern.

Provision C.5 Illicit Discharge Detection and Elimination

This section of the report describes the countywide activities conducted to help the Clean Water Program's member agencies to implement the MRP's Provision C.5 Illicit Discharge Detection and Elimination. The Clean Water Program's role is to help municipal staff to develop and use MRP compliance support materials. This includes acting as a liaison with BASMAA on its continued development of a mobile business educational outreach program and enforcement strategy.

During this reporting period the following materials and activities were completed with input and assistance from the I&IDC Subcommittee.

- Continued to track the progress of BASMAA's Maintenance Operations Committee's expansion of BASMAA's surface cleaner training and recognition program to include fleet washers and carpet cleaners.
- Shared information at I&IDC Subcommittee meetings about illicit discharge incidents that provide useful case study type of information.

Provision C.6 Construction Site Control

This section summarizes the accomplishments of the Clean Water Program in helping its member agencies comply with MRP Provisions C.6, Construction Site Control. Through the New Development Subcommittee (NDS), the Program accomplished the following activities.

- Made minor updates to the Alameda County Flood Control District's construction BMP plan-sheet-size outreach piece, to help member agencies throughout the county implement Provision C.6.c requirements for Best Management Practice Categories.
- Updated the Program's existing construction site inspection checklist, to help agencies meet the C.6.e requirements for construction, clarifying the role of member agencies in verifying that projects disturbing one acre or more of land have obtained coverage under the statewide Construction General Permit.
- Provided a model letter to assist the member agencies in meeting the Provision C.6.e.ii(1) requirement to remind, by September 1st of each year, all site developers and/or owners disturbing one acre or more of soil to prepare for the upcoming wet season.
- Conducted two sessions of a training workshop, on May 25th and 26th, to train construction site inspection staff throughout the county. The workshop addressed various Provision C.6 requirements and helped member agencies and meet the Provision C.6.f requirement to provide training or access to training for staff conducting construction stormwater inspections.

Provision C.7 Public Information and Outreach

Stormwater pollution results from the collective and incremental activities of each person within Alameda County. Thousands of routine, seemingly inconsequential decisions result in the unintended and unanticipated generation of stormwater pollutants. Public Information and Participation (PIP) is essential to minimizing stormwater pollution.

The Provision C.7 implementation actions performed by the Clean Water Program during FY 2010/11 are summarized below:

- Through the BASMAA Regional Media Relations project, conducted six pitches – automotive maintenance, holiday gift wrap, reusable lunch boxes/water bottles, hiring an IPM certified PCO, ant control, and litter. In all, the six pitches resulted in thirty-five media placements: 23 on the radio; and 12 online.

- Ordered the following outreach and promotional items for distribution at public outreach events in fiscal year 2010/11:
    - 5,000 seed packets
    - 21,000 stickers for kids
    - 5,000 labels featuring "less-toxic" pest control recipes for spray bottles
    - 20 banners for outreach events
    - 19,000 Less-Toxic Pest Management Fact Sheets
- Updated the Program website www.cleanwaterprogram.org to provide better navigation and improved look.
- Hosted booths at the Alameda County Fair that was held from June 22, 2011 to July 10, 2011 in Pleasanton.
- Promoted Watershed Stewardship Collaborative Efforts by awarding funds totaling $5,000 to the Bay Friendly Gardening Tours and the Bringing Back the Natives Garden Tours through the Event Partnership program.
- Promoted Citizen Involvement Events by awarding grants to fund five projects in the amount of $18,000.
- Promoted outreach to school age children by providing $100,000 to five educational programs.

Provision C.8 Water Quality Monitoring

Provision C.8 of the MRP requires Permittees to conduct water quality monitoring and associated projects during the permit term. All water quality monitoring activities required by Provision C.8 are coordinated regionally through the Regional Monitoring Coalition (RMC), a collaborative effort of MRP Permittees under the auspices of the Bay Area Stormwater Management Agencies Association (BASMAA). Clean Water Program Permittees notified the Water Board in writing of their agreement to participate in the RMC, and water quality data collection conducted through the RMC will commence by October 2011. The RMC and FY10-11 regional activities for its implementation are described in the BASMAA *Regional Monitoring Status Report for January – June 2011* (Appendix I) prepared on behalf of all MRP Permittees by representatives of the Clean Water Program and other BASMAA member programs, and submitted under separate cover to the Water Board.

The Program also continued active participation in the Regional Monitoring Program, and staff participated in the RMP's Small Tributaries Loading Strategy Workgroup. Additional General Program accomplishments achieved during this reporting period, not described in the Regional Supplement, include co-sponsoring the tenth annual meeting of the Bay Area Macroinvertebrate Bioassessment Information network (BAMBI).

Regional Pollutants of Concern

MRP Provisions C.9 through C.14 address pollutants that have been identified as being of regulatory concern for San Francisco Bay and/or local waterbodies. Most of Provisions C.11, C.12 and C.14, as well as parts of C.9, C.10 and C.13, are implemented through BASMAA Regional Projects that are reported in the Regional POC/Monitoring Supplement.

Provision C.9 Pesticides Toxicity Control

Provisions in C.9 reflect the implementation actions incorporated in the Basin Plan through the Total Maximum Daily Load and Water Quality Attainment Strategy for diazinon and pesticide–related toxicity in urban creeks throughout the Bay Area.

Program accomplishments in FY 2010/11 related to Provision C.9 include the following:

- Program staff participated in regional and statewide workshops, meetings and conference calls to track pesticide regulatory processes (Provision C.9.e).
- Communicated with the County Agricultural Department's Integrated Pest Management Coordinator.
- Promoted Integrated Pest Management (IPM) methods at the point-of-purchase. The Clean Water Program's contractor, Anne Joseph Consulting, implemented the region-wide *Our Water, Our World* (OWOW) *Integrated Pest Management (IPM) Store Partnership Program* in Alameda County. Currently, six Orchard Supply Hardware (OSH) stores, four Ace Hardware stores, three Home Depot stores and 20 independent stores in Alameda County participate in the partnership. To train store employees on IPM methods and promote the *OWOW IPM Store Partnership Program*, Annie Joseph conducted the following training and outreach events:
    - Fifteen IPM training workshops for employees of participating stores. A total of 113 staffs were trained.
    - Two weekend customer tabling events.
- Held a workshop on Landscape and Structural IPM for municipal employees. Distributed a newspaper insert that included information on less toxic pest control methods, IPM, Our Water Our World, and Ecowise and Green Pro IPM certification programs to 137,000 homes.

Provision C.10 Trash Load Reduction

In FY 2010/11 the Program assisted the member agencies in complying with Provision C.10 of the MRP. This assistance has been provided through the Trash Load Reduction Work Group of the Policy-Level Subcommittee.

- The Program funded the installation and maintenance of 20 full trash capture inlet filters that will be included in the development of the baseline trash loading estimate.

- Program staff worked with SFEP staff to facilitate implementation of a grant to fund purchase and installation of full trash capture devices.

Provisions C.11, C.12, C.13, and C.14
Mercury, PCBs, Copper, and Legacy Pollutants

The following highlights accomplishments achieved during this reporting period with active participation by Clean Water Program staff:

- Program staff participated in regional Project Team meetings to implement pilot projects for controlling mercury and PCB discharges to stormwater from a variety of sources (Provisions C.12.b and C.11/12.c,d,e,f and i).
- Program staff represented BASMAA at meetings of RMP workgroups planning and conducting studies to address the requirements of Provisions C.11.h, C.12.h and C.13.e.
- Program Staff developed a conceptual plan for the pilot project at the Ettie Street Pump Station for Diversion of Dry Weather and First Flush Flows to POTWs (C11/12.f).

Provision C.15 Exempted and Conditionally Exempted Discharges

This section of the report describes the countywide activities conducted to help the Clean Water Program's member agencies to implement the requirements of the MRP's Provision C.15 Exempted and Conditionally Exempted Discharges. The Clean Water Program's role is to help municipal staff to understand the MRP's requirements and to make available for their use various MRP compliance support materials.

The MRP describes a variety of different types of non-stormwater discharges that may be conditionally exempted. The most extensive tracking, monitoring, and reporting requirements are for planned and unplanned potable water discharges by water purveyors. The only Clean Water Program's member agencies that are water purveyors are the cities of Hayward, Livermore, and Pleasanton and the Zone 7 Water Agency. Because there are so few water purveyors covered by the MRP, this MRP provision has had a low priority for countywide implementation.

During this reporting period, an administrative civil liability issued to EBMUD for a planned and unplanned potable water discharge was discussed as a case study with input and assistance from the I&IDC Subcommittee.

TABLE 1-1. CLEAN WATER PROGRAM PROJECTS COMPLETED, TRAINING EVENTS, AND INFORMATIONAL/EDUCATIONAL/PROMOTIONAL PRODUCTS PRODUCED DURING FY 2010/11

Component	Product/Event	Intended Audience	Contact for Obtaining Additional Copies/ Items/Information
Provision C.2	Integrated Pest Management Workshop	Municipal Staff	See Appendix A for the report.
Provision C.3	Update of Source Control Model List	Agency staff	Laura Prickett, EOA, Inc. (510) 832-2852 x 123
	LID Feasibility/Infeasibility Criteria Report	Agency staff	Laura Prickett, EOA, Inc. (510) 832-2852 x 123
	Biotreatment Soil Specifications	Agency staff	Laura Prickett, EOA, Inc. (510) 832-2852 x 123
	Proposal of Special Projects Criteria and Procedures	Agency staff	Laura Prickett, EOA, Inc. (510) 832-2852 x 123
	Update of Stormwater Treatment Measure Operation and Maintenance Verification Inspection Checklist	Agency staff	Laura Prickett, EOA, Inc. (510) 832-2852 x 123
	Update of Model Maintenance Agreement	Agency staff	Laura Prickett, EOA, Inc. (510) 832-2852 x 123
	Update of C.3 Technical Guidance	Project applicants and Agency staff	Laura Prickett, EOA, Inc. (510) 832-2852 x 123
	New Development Workshop, September 29	Agency staff	Laura Prickett, EOA, Inc. (510) 832-2852 x 123
	Field trip to view Mills College rainwater harvesting systems and green roof	Agency staff	Laura Prickett, EOA, Inc. (510) 832-2852 x 123
Provision C.4	Survey to Determine Priorities for Revising Educational Outreach Materials	Agency staff	Appendix C
	Table with Number of Downloads from Website of Educational Outreach Materials	Agency staff	Appendix C
	Stormwater Inspectors' Workshop: Pollutants of Concern & Inspection Skills	Agency's business inspection staff	Appendix C
Provision C.6	Adaptation of Alameda County's construction BMP plan sheet for agency use	Agency staff and construction project contractors	Laura Prickett, EOA, Inc. (510) 832-2852 x 123
	Update of Construction Site Inspection Checklist	Agency staff	Laura Prickett, EOA, Inc. (510) 832-2852 x 123

Component	Product/Event	Intended Audience	Contact for Obtaining Additional Copies/ Items/Information
Provision C.6 (continued)	Model Wet Season Notification Letter	Agency staff	Laura Prickett, EOA, Inc. (510) 832-2852 x 123
	Construction Site Inspection Workshop, May 25 and 26	Agency staff	Sandy Matthews, LWA (510) 625-1580 x 12
Provision C.7	Promotional Items (stickers, seed packets, labels, banners, and fact sheets)	Kids, General Public	Jim Scanlin, Clean Water Program Program Manager (510) 670-6548
	Awarded $100,000 in educational services contracts	Students K-12	Jim Scanlin, Clean Water Program Program Manager (510) 670-6548
	Funded five Community Stewardship projects for a total of $18,000	Educators, friends groups, and other community groups	Jim Scanlin, Clean Water Program Program Manager (510) 670-6548
	Awarded $5,000 for Event Partnerships	Educators, friends groups, and other community groups	Jim Scanlin, Clean Water Program Program Manager (510) 670-6548
Provision C.8	Bay Area Macroinvertebrate Bioassessment Workshop, 1/31/11 (BASMAA Task of Regional Benefit)	Agency watershed monitoring staff, Water Board SWAMP staff, scientists and creek groups working on local bioassessment projects	Arleen Feng ACPWA (510) 670-5575 www.cleanwaterprogram.org
Provision C.9	Integrated Pest Management Workshop	Municipal Staff	See Appendix A for the report.
	15 IPM training workshops for store employees.	Employees of stores participating in the OWOW program.	Jim Scanlin, Clean Water Program Program Manager (510) 670-6548
	Two IPM tabling events held at garden centers in Alameda County.	Customers of stores participating in the OWOW program.	Jim Scanlin, Clean Water Program Program Manager (510) 670-6548

TABLE 1-2. GENERAL PROGRAM WORK IN PROGRESS AS OF JULY 2011

Component	Project Name	Status
Provision C.3	Update of C.3 Technical Guidance	Information regarding the LID Feasibility Report and Special Projects to be incorporated by October 2011.
	Green street data collection and reporting	Program staff will continue working with BASMAA to develop data collection procedures.
Provision C.4	Updated version of Vehicle Service Facility booklet	Scheduled for completion in 2011.
	New retail food facility booklet	Scheduled for completion in 2011.
Provision C.7	Educational Services Program	Awarded $100,000 (through RFP process) to fund five educational services programs during FY 2011/12. In FY 2009-10, the Program issued a RFP and selected these five organizations for conducting school outreach programs from 2010-11 through 2013-14.
	Event Services Program	Awarded $5,000 to fund Bringing Back the Natives Garden Tours and Bay Friendly Gardening Tours during FY 2011/12.
	Community Services Grants	Sent out RFP for FY 2011-12 CSGs. Contracts expected to be awarded in November 2011.
Provision C.8	Creek Status Monitoring	Will conduct Creek Status Monitoring using Regional Monitoring Coalition guidance and standards.
	Small Tributaries Loading Strategy	Will continue collaborating with RMP in planning and implementation of sampling design and guidance for POC Loads Monitoring.
	POC Loads Monitoring	Will assist RMP staff with installation and setup of monitoring station in San Leandro Creek.
Provision C.9	Regional Monitoring Coalition	Will continue participating in planning and development of monitoring designs and guidance.

Component	Project Name	Status
Provision C.9 (continued)	Creek Status Monitoring	Will conduct Creek Status Monitoring using Regional Monitoring Coalition guidance and standards.
	Small Tributaries Loading Strategy	Will continue collaborating with RMP in planning and implementation of sampling design and guidance for POC Loads Monitoring.
	POC Loads Monitoring	Will assist RMP staff with installation and setup of monitoring station in San Leandro Creek.
Provision C.10	Trash Load Reduction	Work through BASMAA's Trash Committee to develop estimates of baseline trash loading and methods for assigning trash load reductions to various trash load reduction methods.
Provision C.11/C.12 Regional Mercury and PCB projects	Clean Watersheds for a Clean Bay (C.11/12.c,d,e,i)	Will continue participating in BASMAA grant project, including planning and implementation of pilot projects in the Ettie Street Pump Station.
	Pilot Diversion to POTWs (C.11/12.f)	Will continue participating in regional coordination, and implement pilot project at the Ettie Street Pump Station.
Provision C.12.b PCBs Managing PCB-Containing Materials and Wastes during Building Demolition and Renovation	PCBs in Caulk Project	Will continue working with SFEP contractors to develop BMPs, refine Model Implementation Plan, and evaluate potential effectiveness of potential control measures.

TABLE 1-3. MANAGEMENT COMMITTEE AND SUBCOMMITTEE PARTICIPATION[1]

Agency (No. of Meetings)	Management Committee (9)	Policy Level (9)	PIP (5)	Maintenance (1)	New Development (6)	I&IDC (5)	WAMS (3)
Alameda	8	8	3	1	5	4	3
Albany	6	6	0	0	3	0	
Berkeley	8	8	4	0	2	4	3
Dublin	9	9	5	1	6	4	3
Emeryville	7	7	4	1	5	4	
Fremont	7	7	3	0	6	3	3
Hayward	8	8	5	1	5	5	3
Livermore	8	8	2	1	5	5	1
Newark	8	8	1	0	4	2	
Oakland	9	9	5	1	4	5	3
Piedmont	8	8	2	1	1	0	
Pleasanton	8	8	2	0	6	0	3
San Leandro	9	9	0	0	6	4	
Union City	4	4	2	0	4	1	
Unincorporated Alameda County	9	9	4	1	6	5	
Flood Control District	9	9	4	1	6	5	
Zone 7	6	6	4	0	0	0	

Notes:
[1]Total number of meetings for the Management Committee and each subcommittee is indicated in parentheses in the column headings.

Key: PIP Public Information Participation
I&IDC Industrial & Illicit Discharge Control
WAM Watershed Assessment and Monitoring/Special Studies

2: Provision C.2 Municipal Operations

Introduction

Most MRP-required maintenance tasks need to be implemented by each of the Program's member agencies. The Program helps municipal staff understand the MRP's requirements through Municipal Maintenance Subcommittee meeting and workshops, and develops various tools, such as templates, reporting forms, and other materials, needed to effectively plan, implement, and report on the activities completed.

Implementation

During this reporting period the following activities were conducted:

- Conducted a workshop on June 2, 2011 on integrated pest management solutions for structural and landscape related pest control. (See Appendix A for workshop material.)
- Compiled guidance memo and reporting templates from member agencies and posted them to the Program's new website.
- Reviewed Program's existing rural roads guidance and assessed opportunities for future updates.
- Began planning for the Annual Maintenance Workshop scheduled for September 29, 2011.
- Held a Municipal Maintenance Subcommittee meeting on March 3, 2011 and reviewed all municipal operations related requirements from provisions C.2, C.5, C.9, C.10, and C.15.
- Participated in the BASMAA Municipal Operations Committee.

Future Actions

1. The Annual Municipal Maintenance Subcommittee Workshop is scheduled for September 29, 2011.

2. Improve member agencies' staff understanding and provide staff training and guidance materials where needed regarding:

   - BMPs for street and road repair maintenance activities, such as asphalt / concrete removal, cutting, installation and repair;
   - BMPs for sidewalk/plaza maintenance and pavement washing;
   - Graffiti removal conducted in a way that prevents non-stormwater and wash water discharges from reaching storm drains;
   - Corporation yard BMPs and inspection practices to assure implementation of stormwater pollution prevention plans for corporation yards; and
   - Stormwater pump station dissolved oxygen monitoring and inspections.

3: Provision C.3
New Development & Redevelopment

Introduction

In FY 2010/11 the Program assisted the member agencies in complying with Provision C.3 of the MRP, and preparing for the December 1, 2011, implementation of low impact development (LID) requirements, in which projects regulated by Provision C.3 will need to meet stormwater treatment requirements using evapotranspiration, infiltration, or rainwater harvesting and use. Where this is infeasible, biotreatment measures may be used.

This assistance has been provided through the New Development Subcommittee (Subcommittee), which has been chaired by Mark Lander, of the City of Dublin, since January 2010. Through this Subcommittee, the Program has conducted tasks such as providing training, and updating and preparing model documents and guidance for member agency use. This chapter describes the Provision C.3 implementation actions during FY 2010/11, as well as planned future actions.

Implementation

The primary accomplishments of the Program related to Provision C.3 implementation during the past fiscal year are listed below, according to applicable MRP provision numbers.

Provision C.3.a New Development & Redevelopment Performance Standard Implementation

Source Control Model List

The Program's Source Control Model List of pollutant source control measures for projects with potential sources of pollutants (such as pesticide application in landscaping, swimming pool discharges, car wash discharges, etc.) was updated for consistency with the specific source control measures required in MRP Provisions

C.3.c.i(1) and C.3.a.i(7), as well as swimming pool discharge requirements in Provision C.15. The member agencies have agency-specific Source Control Measure Lists based on the Program's Model List. The updated Source Control Model List is in Appendix B.

Provision C.3.b Regulated Projects

Green Streets Coordination

The New Development Subcommittee held discussions of the Provision C.3.b.iii requirement for the completion, by December 1, 2014, of 10 green streets pilot projects within the region. Among the 10 pilot green street projects, at least two must be located within Alameda County. Some of the member agencies are evaluating possibilities for green street pilot projects, in coordination with Program staff.

Program staff and member agency representatives also participated in the Bay Area Stormwater Management Agencies Association's (BASMAA) process to select a consultant to help with regional management of data and reporting on green streets projects that meet the Provision C.3.b.iii requirements for green street pilot projects. The selected consultant, Geosyntec, has begun working with BASMAA to develop green streets data collection procedures, consistent with the green street reporting requirements in Provision C.3.b.v(2).

Provision C.3.c Low Impact Development (LID)

LID Feasibility Criteria

Program staff and Subcommittee members participated in BASMAA's process to select and work with a consultant to prepare criteria and procedures for determining the feasibility and infeasibility of rainwater harvesting and use, evapotranspiration, and infiltration in new and redevelopment projects, per Provision C.3.c.iii(1). The LID feasibility criteria and procedures were submitted to the Water Board on April 29, 2011. (The transmittal letter is included in Appendix B). As allowed by the MRP, the member agencies have begun using these criteria and procedures for proposed development projects that will receive final discretionary approval on or after December 1, 2011. Program staff and Subcommittee members are also participating in ongoing discussions with BASMAA and Water Board staff regarding Water Board staff's feedback on the LID feasibility and procedures.

Soil Specifications

Program staff and Subcommittee members participated in BASMAA's development of proposed soil specifications for biotreatment systems, and guidance for permittees to apply the specifications, per Provision C.3.c.iii(3). This report, which was prepared by BASMAA's consultant WRA, was submitted to the Water Board on December 1, 2010. (The transmittal letter is included in Appendix B). Member agencies have begun to use the soil specifications in development projects in their jurisdictions, although this is not required until December 1, 2011.

Green Roof Specifications

Program staff and Subcommittee members participated in BASMAA's development of minimum specifications for identifying green roofs that may be considered biotreatment systems, per Provision C.3.c.iii(4). These specifications were submitted to the Water Board on April 29, 2011. (The transmittal letter is included in Appendix B).

Provision C.3.e Alternative or In-Lieu Compliance with Provision C.3.c

Special Projects Criteria

Program staff and Subcommittee members participated in BASMAA's preparation of criteria and procedures for identifying smart growth, high density and transit oriented development projects that may receive reductions in LID requirements, per Provision C.3.e.ii. The special projects proposal was submitted to the Water Board on December 1, 2010. (The transmittal letter is included in Appendix B). As a result of Water Board staff comments on the proposal, BASMAA and Water Board staff collaborated to identify revised proposed special projects criteria and procedures that Water Board staff used as a basis to draft a Tentative Order for an amendment to the MRP. When adopted, the amendment will include approved special projects criteria and procedures. Program staff and Subcommittee members were active participants in this collaborative process.

Provision C.3.g Hydromodification Management

Bay Area Hydrology Model Support

The Program continued to maintain the website for the Bay Area Hydrology Model (BAHM) software and guidance, and to give responses or referrals to users' questions. During this fiscal year, Clear Creek Solutions, the firm that developed the BAHM, offered training sessions on the BAHM on April 27 and 28, 2011. A basic session was offered on both mornings, and an advanced session was offered in the afternoons. The training was not sponsored by the Program, although the Program publicized it to the member agencies. Agency staff members who attended the program offered feedback that it would be helpful to have a separate training session specifically for agency staff, to focus on how to review BAHM outputs submitted by project applicants during the development review process. This is discussed further in the Future Actions section below.

Provision C.3.h Operation and Maintenance of Stormwater Treatment Systems

New requirements in Provision C.3.h went into effect on December 1, 2010. The Program conducted the following activities to help the member agencies incorporate the new requirements into their existing operation and maintenance (O&M) verification inspection programs.

Operation and Maintenance Verification Inspection Form

The New Development Subcommittee and the Industrial and Illicit Discharge Subcommittee collaborated to update the Program's O&M Verification Inspection Form (see Appendix B) to help local inspectors capture data on new inspection requirements in Provision C.3.h of the MRP, such as the requirement to inspect newly-installed treatment systems and HM controls within 45 days of installation.

Model Maintenance Agreement

The New Development Subcommittee updated the Program's Model Maintenance Agreement (see Appendix B) for consistency with new requirements of the Provision C.3.h of the MRP, such as the requirement to require maintenance assurance (such as a maintenance agreement) not only for stormwater treatment measures but also for hydromodification management controls.

Accomplishments Related to Multiple MRP Provisions

C.3 Technical Guidance Update

The Program updated its C.3 Technical Guidance (see Appendix B for excerpts) for consistency with new requirements of the MRP and to help the agencies prepare for the December 1, 2011, implementation of the new requirements in Provisions C.3.b (Regulated Projects) and C.3.c (Low Impact Development – LID). The update included modifying the technical guidance for bioretention areas and flow-through planters to maximize infiltration in locations where the underlying soils have a low rate of infiltration. The new technical guidance raises the underdrain higher in the rock layer beneath the bioretention soil, which allows the detention and gradual infiltration of stormwater into the native soil.

New Development Workshop

The Program held a workshop on September 29, 2011, to inform agency staff of Provision C.3 requirements, including new C.3.b (Regulated Projects) and C.3.c (LID) requirements that go into effect December 1, 2011, and the corresponding updates to the C.3 Technical Guidance. A number of private consultants also attended the workshop. Training topics included: BASMAA's draft regional biotreatment soil specifications, preliminary water quality monitoring results for a bioretention area in San

Mateo County, and overcoming obstacles to green roofs. This training workshop helped member agencies meet the C.3.a.(4) requirement to provide training to agency staff adequate to implement Provision C.3. A total of 95 people attended the workshop, excluding Program staff and speakers. The workshop flyer, agenda, and sign-in sheet are included in Appendix B.

Field Trip to View Rainwater Harvesting Systems and Green Roof

On February 8, 2011, the New Development Subcommittee toured two recently constructed green buildings on the Mills College campus in Oakland. The tour focused on the rainwater harvesting system installed at the Moore Natural Sciences Building and the rainwater harvesting system and green roof installed at the Lokey Graduate School of Business. This helped Subcommittee members prepare to implement C.3.c LID requirements, and to meet C.3.a.(4) training requirements.

Future Actions

The following C.3 implementation actions are anticipated in FY 2010/11.

1. Provision C.3.c: C.3 Technical Guidance Update

   The Program plans to update the C.3 Technical Guidance to add tools to assist applicants and agency staff with implementing the new LID requirements that go into effect December 1, 2011. This will include a user-friendly LID feasibility checklist, based on the LID Feasibility criteria and procedures submitted to the Water Board, as well as technical guidance for bioinfiltration systems, which may be used in projects in which it is feasible to infiltrate the C.3.d amount of stormwater runoff.

2. Provision C.3.g: Bay Area Hydrology Model (BAHM) Training for Agency Staff

   The Program is coordinating with the Santa Clara Valley Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program to plan a BAHM training session specifically for agency staff. The session will train staff on how to review BAHM outputs submitted by project applicants during the development review process.

3. Multiple Sections of Provision C.3: New Development Workshop

   The Program has scheduled a New Development Workshop for Tuesday, October 11, 2011. The workshop will focus on preparing municipal staff to implement the new Provision C.3 requirements that go into effect on December 1, 2011.

4. Multiple Sections of Provision C.3: Regional Projects

   Program staff will continue to participate in and to inform the member agencies, through the New Development Subcommittee, of opportunities to participate in the following regional projects:

   - C.3.b: Green Street Data Collection and Reporting. BASMAA will continue working on the green street activities described in the Provision C.3.b section, above.
   - C.3.c: LID Feasibility/Infeasibility Criteria. BASMAA will continue to coordinate with Water Board staff regarding the LID feasibility criteria and procedures, as described in the Provision C.3.c section, above.
   - C.3.i: Standard Specifications for Stormwater Controls for Small Projects. During the coming fiscal year, BASMAA plans to begin work on standard specifications for stormwater controls required by Provision C.3.i. The standard specifications will be used to meet the C.3.i requirements to implement at least one of several specified site design measures in development projects that create and/or replace at least 2,500 square feet but less than 10,000 square feet of impervious surface, and individual detached single family homes that create and/or replace 2,500 square feet or more of impervious surface. Provision C.3.i goes into effect on December 1, 2012.

4: Provision C.4 Industrial & Commercial Site Controls

Introduction

This section of the report describes the Clean Water Program's activities conducted to implement the MRP's Provision C.4 Industrial and Commercial Site Controls. Activities summarized in this section were implemented jointly for the benefit of the Clean Water Program's member agencies. The Clean Water Program's role is to help municipal staff to receive training and to develop and use various tools, templates, reporting forms, and other MRP compliance support materials and participate in countywide inspector training workshops.

Information about each agency's business inspection and educational outreach efforts is contained in the agencies' reports.

During this reporting period the following activities were completed with input and assistance from the Industrial & Illicit Discharge Control (I&IDC) Subcommittee.

- Identified priorities for updating educational outreach materials as part of the process of branding materials with the new Clean Water Program name, logo and tagline.
- Initiated work with the Public Information and Participation Subcommittee to update the Vehicle Facilities BMPs booklet and to create a new restaurant BMPs booklet.
- Conducted a training workshop that focused on improving inspection skills and understanding about how to handle priority pollutants of concern.

Implementation

The Clean Water Program's primary Provision C.4-related accomplishments during the past fiscal year include the following:

Facilitated Industrial & Illicit Discharge Control Subcommittee Meetings

The I&IDC Subcommittee assists municipalities to implement the MRP's Provision C.4 Industrial and Commercial Site Controls requirements. Peter Schultze-Allen, City of Emeryville, chaired the I&IDC Subcommittee through January 2011 and Scott Seery, Alameda County Department of Environmental Health, took over as chair starting in March 2011.

Table 1-3 summarizes agencies' participation last fiscal year in the I&IDC Subcommittee. Most agencies regularly attended I&IDC Subcommittee meetings. Representatives from the following twelve agencies attended the majority of the FY 2010/11 subcommittee meetings: Alameda, Berkeley, Dublin, Emeryville, EBMUD, Fremont, Hayward, Livermore, Oakland, San Leandro, Alameda County unincorporated (Alameda County Environmental Health) and Alameda County Flood Control and Water Conservation District (Appendix C).

Most of the I&IDC Subcommittee's work is accomplished through three work groups. In FY 2010/11 the Workshop Planning Work Group assisted in planning and holding the training workshop. This work group consisted of James Barse, City of Alameda; Scott Seery, Alameda County; Martha Aja, City of Dublin; Peter Schultz-Allen, City of Emeryville; Joseph Mendoza, Union Sanitary District (on behalf of the City of Fremont); and Jim Scanlin, Program Manager.

The Educational Outreach Materials Work Group provided direction that was essential for identifying how to proceed with updating various materials. Members of this work group included the following: Martha Aja, City of Dublin; Molly Ong and Marie Kulka, EBMUD; Lynna Allen, City of Livermore; and Jim Scanlin, Program Manager.

Lastly, the Database Work Group provided advice about how to proceed with the MRP's new business inspection documentation and reporting requirements. The entire I&IDC Subcommittee comprises this work group.

Educational Outreach Priorities for Updates

<u>Compilation of Educational Materials Downloaded from Website</u>

The Clean Water Program compiled information about the number of I&IDC related educational outreach materials downloaded from the Clean Water Program's website. This information is useful in identifying priorities for updating materials and incorporating the Clean Water Program's new logo and tagline.

While 20 different business-related educational outreach materials had been downloaded from the Clean Water Program's website, the three most popular business-related educational outreach materials accounted for about one-half (17,503 downloads) of all of the downloads (36,034) (Appendix C). One of the common characteristics of these three popular outreach items is that they are all available in English, Spanish, Chinese, and Vietnamese. Another three educational outreach materials are available in Spanish and English, and the remaining 14 outreach materials are only available for download in English.

The most popular I&IDC related educational item downloaded from the Clean Water Program's website was the Vehicle Service Facilities Best Management Practices booklet. The Spanish language version of this booklet was downloaded more that twice as often as the English version. The Chinese and Vietnamese versions each accounted for about 9 percent of the versions downloaded.

The second most popularly downloaded I&IDC related educational item was the Tips for a Cleaner Bay How Your Business Can Prevent Stormwater Pollution booklet. This booklet provides all businesses information about commonly used stormwater BMPs. The Spanish language version of this booklet was downloaded more often than the English language version. In addition, the Chinese translation of this booklet was downloaded nearly as often as the English version, and the Vietnamese version accounted for about 18 percent of the versions downloaded. Since this booklet is the newest educational outreach item on the Clean Water Program's website, it has the highest rate of downloads based on the number downloaded per year (2,756).

The third most popularly downloaded I&IDC educational outreach item was a series of restaurant BMP cards.

Survey to Determine Priorities for Updating Educational Outreach Materials

The Countywide Program surveyed each of its member agencies to determine their priorities for updating various I&IDC related educational outreach materials. Only ten items were identified as needing updating (Appendix C), and these items fall into high, medium and low groups for updating. The two high priority items identified for updating are the restaurant BMP guide cards and the Vehicle Service Facilities BMPs. The medium priority for updating includes the following three items: Urban Runoff is Everybody's Business; Mobile Cleaners; and Reducing Mercury Pollution.

Work to Update High Priority Educational Outreach Materials

The Public Information and Participation Subcommittee has created a work group with members from the I&IDC Subcommittee to update the Vehicle Service Facilities BMPs booklet and to create a new restaurant BMP booklet. These outreach materials will have a new look based on the marketing ideas of Gigantic Ideas Studio. It is anticipated that the updated Vehicle Service Facilities BMPs booklet and the new restaurant BMP booklet will be completed before the end of 2011.

Provision C.4.d Staff Training

In order to meet the MRP's requirements for annual training of municipal stormwater inspection staff, the I&IDC Subcommittee held an inspector training workshop on June 9, 2011 titled Stormwater Business Inspectors Workshop: Pollutants of Concern and Inspection Skills. The trainers included knowledgeable local agency, consultant, U.S. EPA, Regional Water Board, and State Water Resources Control Board staff (Appendix C).

The pollutants of concern portion of the training focused on informing inspectors about what to do if they identify leaking PCBs containing equipment and about the priority efforts being implemented by the State Water Resources Control Board and the Water Board staff on regulating the release of pre-production plastic into the environment. Cooperative efforts between Water Board and local agency staff resulted in the recent issuance of a four Cleanup and Abatement Orders for cleaning up pre-production plastic releases at east bay businesses.

The training was attended by 70 staff (Appendix C) and participants' evaluations showed that it was a very useful workshop. About one half of the participants, especially the inspectors, found the table top exercises were the most beneficial part of the training and the other approximate half of the participants found the pollutants of concern information to be particularly helpful (Appendix C).

Future Actions

The Clean Water Program's activities scheduled for FY 2011/12 include the following:

1. Continue to update the Vehicle Service Facilities BMPs booklet and create a new food facilities booklet in collaboration with the PIP Subcommittee.
2. Facilitate the availability of training needed to comply with the MRP's requirements.
3. Participate through BASMAA's Municipal Operations Committee in collaborative activities.
4. Continue to work with the Database Work Group to decide what, if any, changes to the database and its utilities would be useful to make in order to assist with the business inspection data tracking and reporting required by the MRP.

5: Provision C.5 Illicit Discharge Detection & Elimination

Introduction

This section of the report describes the countywide activities conducted to help the Clean Water Program's member agencies to implement the MRP's Provision C.5 Illicit Discharge Detection and Elimination. The Clean Water Program's role is to help municipal staff to develop and use MRP compliance support materials. This includes acting as a liaison with BASMAA on its continued development of a mobile business educational outreach program and enforcement strategy.

Information about each agency's illicit discharge detection and elimination activities is contained in the agencies' reports.

During this reporting period the following activities were completed with input and assistance from the I&IDC Subcommittee.

- Continued to track the progress of BASMAA's Maintenance Operations Committee's expansion of BASMAA's surface cleaner training and recognition program to include fleet washers and carpet cleaners.
- Shared information at I&IDC Subcommittee meetings about illicit discharge incidents that provide useful case study type of information.

Implementation

The primary Provision C.5-related accomplishments of the Clean Water Program during the past fiscal year include the following:

Provision C.5.d Control of Mobile Sources

During FY 2010/11 the Clean Water Program continued to participate in BASMAA's Municipal Operations Committee and its work to expand the surface cleaner recognition program to include fleet washers and carpet cleaners. As part of BASMAA's development and implementation of an enforcement strategy for mobile businesses, this project will add web-based information sharing capability to BASMAA's website so that inspectors will be able to find information about whether mobile businesses they encounter have previously caused illicit discharges or used poor BMPs (Appendix D).

This project has taken longer than BASMAA's Executive Director originally anticipated because of the additional time needed to resolve Orange County's possible involvement in the project. Even so, the Executive Director anticipates that the bulk of the work will be completed before the end of 2011. A project update is provided in the *BASMAA Training and Outreach for FY10-11 Regional Supplement* (Appendix F).

Once this phase of the surface cleaner recognition program's expansion has been completed, the I&IDC Subcommittee is interested in having BASMAA address illicit discharges that may result from mobile businesses that clean restaurant hoods and filters and mobile businesses that wash pets.

Provision C.5.f Tracking and Case Follow-up

The I&IDC Subcommittee has tracked information about illicit discharges as useful cases that have broad applicability. One example of information presented and discussed at an I&IDC Subcommittee meeting was an administrative civil liability issued by the Water Board staff to a large water utility. This case involved both planned and unplanned potable water discharges. The planned discharge resulted in killing trout in a local east bay creek. The unplanned discharge resulted from a water main break, and the Water Board staff determined that the water utility used inadequate BMPs to control erosion and sedimentation. Issues that the I&IDC Subcommittee identified included the following:

- Lack of available chlorine residual field test kits that measure down to the concentrations needed to protect creeks.
- The decline in the effectiveness of dechlorination by sodium sulfite tablets as the tablets dissolve.
- Poor judgment to rely on treating superchlorinated water with dechlorination tablets and a diffuser prior to disposal to a creek rather than to dispose the water to a readily available sanitary sewer.

Future Actions

The Countywide Program's activities scheduled for FY 2011/12 include the following:

1. Continue to work with BASMAA's Municipal Operations Committee on its mobile cleaners program. This will include providing input on the BMP outreach and other materials developed as part of the current phase of expansion of BASMAA's surface cleaner training and recognition program.
2. Facilitate the availability of illicit discharge detection and elimination training needed to comply with the MRP's requirements.

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6: Provision C.6 Construction Site Controls

Introduction

During the past fiscal year, the New Development Subcommittee continued to support the member agencies in meeting the requirements of Provision C.6, Construction Site Controls. This Subcommittee also assists with implementing Provision C.3, New Development and Redevelopment. More information about the Subcommittee is provided in Chapter 3. The following sections describe the FY 2010/11 actions to assist the member agencies with Provision C.6 compliance, and plans for future actions.

Implementation

The primary accomplishments of the Program in implementing Provision C.6 during the fiscal year are described in the following sections, according to the applicable MRP provisions. In addition to the specific accomplishments listed below, Subcommittee meetings more generally provide a valuable forum for agency representatives from throughout the county to bring issues related to construction site compliance for information sharing, discussion, brainstorming and problem solving.

Provision C.6.c Best Management Practice Categories

Adapted Alameda County BMP Plan Sheet for Countywide Use

Alameda County Flood Control District shared with the New Development Subcommittee its revision of a regional BASMAA educational outreach piece regarding construction best management practices (BMPs). The outreach piece is a plan-sheet-size poster listing a wide range of construction BMPs. The Program made minor updates to the County's plan sheet to help member agencies throughout the county implement Provision C.6.c requirements for Best Management Practice Categories (Appendix E).

Provision C.6.e Inspections

Site Inspection Form

The Subcommittee made minor changes to the Program's existing construction site inspection checklist to help agencies meet the C.6.e requirements for inspections, clarifying the role of local agencies in verifying that projects disturbing one acre or more of land have obtained coverage under the statewide Construction General Permit (Appendix E).

Wet Season Notification

A model letter was provided to the member agencies in July 2010 to assist them in meeting the Provision C.6.e.ii.(1) requirement to remind, by September 1st of each year, all site developers and/or owners disturbing one acre or more of soil to prepare for the upcoming wet season (Appendix E).

Provision C.6.f Staff Training

Training Workshop

The Program offered two sessions of a training workshop on construction site inspections. The sessions were held on May 25th in Dublin and on May 26th in Oakland, to facilitate attendance by construction site inspection staff throughout the county. Topics included overviews of Provision C.6 requirements and statewide Construction General Permit requirements, recognizing BMPs, tools to plan and conduct inspections, and a presentation by Water Board staff on tracking and reporting the results of construction site inspections. Attendees were given a test at the beginning and end of the workshop, to evaluate their knowledge of construction site control requirements and BMP implementation. The results showed that test scores generally improved as a result of attending the workshop. The workshop helped member agencies meet the Provision C.6.f requirement to provide training or access to training for staff conducting construction stormwater inspections at least every other year. The workshop flyer, agenda, sign-in sheets, evaluation, and test results are included in Appendix E.

Future Actions

New Development Subcommittee meetings will continue to serve as a countywide forum for information sharing and problem solving regarding Provision C.6 implementation. This will include the scheduled discussion of the C.3.e tracking spreadsheet, described below.

1. C.3.e: Tracking Spreadsheet
   At an upcoming meeting of the New Development Subcommittee, the Subcommittee will review and discuss the results of the Water Board staff's review of the construction site inspection tracking spreadsheets of 18 randomly selected MRP copermittees, to help the member agencies review their own tracking systems and confirm that construction site inspection data are being properly tracked.

2. C.6.f: Future Training

   The results of the test given at the end of the May 25th and 26th training workshop suggest that, while test scores were generally high, it would be beneficial to offer additional training on some of the topics. The New Development Subcommittee will identify an appropriate schedule for the next training session.

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7: Provision C.7 Public Information & Outreach

Introduction

Stormwater pollution results from the collective and incremental activities of each person within Alameda County. Thousands of routine, seemingly inconsequential decisions result in the unintended and unanticipated generation of stormwater pollutants. Public Information and Participation (PIP) is essential to minimizing stormwater pollution. The Program assists the members in complying with Provision C.7 through the PIP Subcommittee, which continues to be chaired by Kristin Hathaway from the City of Oakland. The PIP Subcommittee met five times in FY 2010/11 (see Table 1-3 for attendance).

The Chair is responsible for running the Subcommittee's meetings and working with the PIP Coordinator to implement the Subcommittee's decisions. Additionally, work groups, consisting of Subcommittee members, help to implement tasks for this provision.

To assist with the implementation of this provision's tasks, PIP Subcommittee members participated in the following work groups during FY 2010/11:

- Educational/Promotional Materials
- Community Stewardship Grants
- Website Redesign

Table 7-1 at the end of this section provides a brief description of work group tasks and lists participating members.

This chapter describes Provision C.7 implementation actions during FY 2010/11, as well as planned future actions.

Implementation

Provision C.7.b Advertising Campaign

<u>BASMAA Regional Advertising Campaign</u>

The Program is participating in the BASMAA Regional Advertising Campaign on litter. In FY 10-11, the BASMAA PIP Committee selected Stephen Groner and Associates (SGA) to develop regional outreach strategies for litter and pesticides. SGA completed literature reviews on both topics and used them as a basis for developing the strategies. The Pesticide Strategy recommended ideas for further promoting the Our Water Our World (OWOW) Program (an attachment to the *BASMAA Training and Outreach for FY10-11 Regional Supplement* in Appendix F). The Litter Strategy (an attachment to the *BASMAA Training and Outreach for FY10-11 Regional Supplement* in Appendix F) recommended targeting youth using peer-to-peer outreach strategies such as social media (e.g., Facebook, twitter, blogs). Following approval of the Litter Strategy, the BASMAA Board directed SGA to develop the Implementation Plan for the Litter Strategy. The Implementation Plan for Litter Outreach was approved by the BASMAA Board of Directors in June 2011 and implementation of outreach is expected to begin soon (Appendix F).

<u>Our Water Our World Newspaper Insert</u>

The Program developed an insert titled "Summer Reeds" for the Bay Area Newspaper Group papers to highlight the OWOW Program, available less-toxic pest control methods, and general stormwater pollution prevention messages. The insert was included in Bay Area Newspaper Group papers on Sunday, June 19, 2011, and sent out to 137,000 households.

A copy of the insert is included in Appendix F.

Fig. 7.1. Cover of "Summer Reeds" insert sent out in the Bay Area Newspaper Group papers.

Provision C.7.c Media Relations

The BASMAA Regional Media Relations project made six pitches on the following topics:

- Rainy Season/Car Maintenance PSAs
- Don't Burn Holiday Gift Wrap
- Reusable Lunch Boxes/Water Bottles
- Hiring an IPM Certified PCO
- Ant Control PSAs
- Summertime Reusables/Anti-Litter Tips

In all, the six pitches resulted in thirty-five media placements: 23 on the radio; and 12 online. Details are provided in the *BASMAA Media Relations and Regional Advertisement Campaign Annual Report* (an attachment to the *BASMAA Training and Outreach for FY10-11 Regional Supplement* in Appendix F).

<u>Rainy Season/Car Maintenance PSAs</u>

These PSAs focused on the importance of basic car maintenance, particularly fixing leaks, in the rainy season. The PSAs were aired on eleven radio stations, posted on ten station websites and also resulted in interviews on two radio stations for a total of twenty-three placements.

<u>Don't Burn Holiday Gift Wrap</u>

This press release focusing on the pollution caused when holiday gift wrap is burned or used as a fire starter. This pitch resulted in five placements: four radio stories and coverage on KQED's blog.

<u>Reusable Lunch Boxes/Water Bottles</u>

This pitch was designed to call attention to litter via choices a consumer can make in daily behaviors. Two press releases were developed: one dealt with eating on the go and how reusable items can fit into that (reusable coffee cups, water bottles, etc). The other release, sent to parenting publications, focused solely on building a greener lunch box for children. This pitch resulted in one interview placement on the family-friendly station, KMKY (Radio Disney).

<u>Hiring an IPM Certified PCO</u>

This pitch focused on the wide availability of pest control operators certified in integrated pest management (IPM) techniques. The BayWise.org website was updated to include a "box" on the homepage advising users to "click here to find a pest control professional." Also included were links to listings of Bay Area contractors certified by three different programs. This pitch resulted in three placements: one on claycord.com and two radio interviews. The claycord story drove eighty-six visitors to BayWise.org the day it was posted. Since the pitch began, the pest control page has received over 150 visitors.

Ant Control PSAs

These PSAs dealt with effective ways to control ants and also promoted BayWise.org as a resource for pest control information. The PSAs aired on three stations: KLIV, KDIA and KCBS.

Summertime Reusables/Anti-Litter Tips

This pitch began at the end of the fiscal year. Although some media outlets expressed interest in running the tips and/or using them in conjunction with other summertime/destination stories, no placements have been confirmed as of this writing.

Provision C.7.d Stormwater Point of Contact

This provision requires Permittees to individually or collectively create and maintain a point of contact, e.g., phone number or website, to provide the public with information on watershed characteristics and stormwater pollution prevention alternatives.

In 2010, through the BASMAA PI/P Committee, Permittees decided BASMAA could assist with this provision by enhancing the regional website, BayWise.org, to list or link to member programs' lists of points of contact and contact information for the stormwater agencies in the Bay Area. Permittees were polled for stormwater contact information, and the information was posted on BayWise.org. BASMAA is continuing to post this information on BayWise.org.

Program Website

The Program's website, www.cleanwaterprogram.org, was updated in FY 2010/11. The updated website has an improved look and enhanced navigation features. It also features the new Program name and logo. The Program's website was published in the Our Water Our World newspaper insert that went out to 137,000 homes in Alameda County.

Provision C.7.e Public Outreach Efforts

Outreach Materials

The Program ordered the following outreach and promotional items for distribution at public outreach events in fiscal year 2010/11:

- 5,000 seed packets
- 21,000 stickers for kids

- 5,000 labels featuring "less-toxic" pest control recipes for spray bottles
- 20 banners for outreach events
- 19,000 Less-Toxic Pest Management Fact Sheets

Fig. 7.2. Customized ChicoBag™ with New Program Logo and Name.

In addition, the Program ordered 5,000 customized ChicoBags™ for distribution to volunteers at the September 17, 2011 Coastal Cleanup Day. The ChicoBags feature the new Program logo and name and have the message "one less plastic bag" printed on them.

Earth Day 2011 Bee-Themed Outreach Materials

The Program worked with Gigantic Ideas Studios to develop materials for Earth Day Booths being hosted by local agencies. The booth theme was reducing pesticide use and protecting bees. Each agency received banners with magnetic "graffiti" so that the tag line "Protecting Alameda County Creeks, Wetlands and the Bay" read "Protecting Alameda County Creeks, Wetlands and the Bee." Booth activities, such as the Spelling Bee, the quiz Bee-lieve it or NOT, and Bee-Dazzled Flower Pots were also developed. Along with the banners, spray bottle labels featuring non-toxic pest control recipes, Coreopsis seeds for the flower pot activity, and stickers for decorating flower pots were provided to local agencies. Agency staff reported that event attendees participated in and enjoyed the activities.

Alameda County Fair

Fig. 7-3 The Clean Water Program's booth at the 2011 Alameda County Fair.

The Program hosted a booth at the Alameda County Fair held from June 22, 2011 to July 10, 2011 in Pleasanton. Approximately 452,746 fairgoers attended the fair this year setting a new attendance record. This number represents an approximate 8% increase over 2010, and, is the largest recorded attendance in the last 20 years. Cynthia Butler from Alameda County was instrumental in making sure the booth was well maintained and well stocked with promotional and educational items.

The Program worked with Gigantic Ideas Studios to create a new display. The concept this year was to show booth visitors how their pest control choices impact wildlife and water quality.

Several city representatives staffed the booth on Fridays and weekends and disseminated the stormwater pollution prevention message by interacting with booth visitors and distributing promotional items and educational materials such as IPM fact sheets, and other stormwater related educational materials.

The County Fair, with its large and diverse audience, continues to be an effective way for the Program to get its message across to a wide variety of people and not just those who are already savvy to environmental issues.

Our Water Our World Store Partnership Program

The Program is an active participant in the Regional Our Water Our World (OWOW) Store Partnership Program. Thirty one nurseries and retail stores in Alameda County participate in the OWOW Program. The Program provides less-toxic pest management fact sheets to these stores for distributing to customers. In addition, store shelves are tagged with shelf tags that identity less-toxic pest control products.

In FY 10-11, the Program continued to contract with Ms. Annie Joseph (IPM Consultant) to provide training to store employees on integrated pest management techniques and available less-toxic pest control products. Ms. Joseph conducted 15 trainings and trained 113 employees representing 13 stores. More information on these trainings is included in Section 9 of the FY 10-11 Annual Report.

Provision C.7.f Watershed Stewardship Collaborative Efforts

Event Partnership Program

The Clean Water Program promoted Watershed Stewardship Collaborative Efforts by awarding funds for FY 10/11 through its Event Partnership program. The Clean Water Program awarded grants in the amount of $5,000 to the following events:

- Bringing Back the Natives Garden Tours held on May 1, 2011. The tours showcase pesticide-free, water-conserving gardens that reduce solid waste, provide habitat for wildlife and contain 50% or more native plants.
- StopWaste.org for Bay-Friendly Gardening Tours private residential gardens that demonstrate gardening techniques appropriate for local conditions. The tour was held on May 15, 2011.

Table 7-4 at the end of this section provides a summary including event descriptions and number of participants reached. Copies of the final reports for the above listed programs are included in Appendix F.

The Bay-Friendly Gardening Tours attracted approximately 2,000 people. It featured sixty-eight host gardens through the length of the Bay Area, from San Jose to Napa, with 31 in Alameda County. Thirty four percent of registrants were self-identified as “beginning gardeners,” the Tours’ target demographic. A post Bay-Friendly Gardening Tour e-news and participant survey was sent to 832 residents that provided their email addresses. The survey response rate was over 20%, with 182 completed surveys. Overall, results indicate a high level of satisfaction with the tour:

- 79% were “more interested in adopting Bay-Friendly practices at home” after the tour.
- 98% would “recommend the tour to a friend, neighbor or fellow gardener.”

The Bringing Back the Natives Gardening Tours final report contains an extensive effectiveness evaluation component. Some highlights are provided below:

- Estimated overall attendance at the event was 7,041 registrants.
- 2,958 registrants were from cities located in Alameda County.
- 19,741 garden visits were made to the gardens located in Alameda County.
- Of first time registrants, 46% planned to incorporate native plants into their gardens; 29% planned to reduce the size of their lawns; 14% planned to reduce or eliminate pesticide use; and 11%% planned to reduce the amount of hardscape in their gardens. Of repeat registrants, 74% said they had changed their gardening practices because of their participation in the Tour.

Provision C.7.g Citizen Involvement Events

Community Stewardship Grant (CSG) Program

The 2010-2011 Community Stewardship Grant Program chose five projects for funding in October 2010 for a total of $18,000 in small grants. These projects are:

- Park Day School for the Water Lifecycle, Conservation, and Protection Project
- San Francisco Estuary Project/Codornices Creek for the Codornices Forge Rain Gardens Project
- The Watershed Project for The Watershed Project's Riparian Lab
- Friends of Peralta Creek for the Peralta Creek Restoration Project
- Longfellow Community Association for the Longfellow Neighborhood Street Tree Project

The Clean Water Program has incorporated an evaluation component into all its funded programs. To be eligible for funding through the Community Stewardship Grant program, applicants have to demonstrate how they plan to evaluate the effectiveness of their project. Table 7-4 includes a summary of the projects funded in FY 10-11. The final FY 10-11 Community Stewardship Grant Program reports will be available in November 2011.

Provision C.7.h School-Age Children Outreach

Educational Services Program

One of the Clean Water Program's major accomplishments is the education of students and teachers about their local creeks, storm drain systems, and watersheds, as well as the encouragement of stormwater pollution prevention and watershed stewardship. In FY 2009-10, the Program issued a RFP and selected the following five organizations for conducting school outreach programs from 2010-11 through 2013-14:

- Kids for the Bay - "Storm Drain Rangers"
- Caterpillar Puppets - "Watershed Babies Go the Water School"
- Zun Zun - "The Musical Watershed"
- Livermore Area Recreation and Park District - "Watershed Education"
- Golden Gate Audubon Society - "Eco-Oakland"

Table 7-3 at the end of this section provides a concise summary including brief program descriptions, targeted audience, and number students/teachers reached. Additionally, copies of the final reports from for the school outreach programs are included in Appendix F.

Highlights of the effectiveness evaluation conducted by these organizations are provided below.

- The "Storm Drain Rangers" conducted programs at 15 schools this year. Over 45 students proudly graduated as "Storm Drain Rangers," and have the knowledge and inspiration to educate their family members about urban run-off pollution. In addition, five teachers trained during the FY 2009-2010 school year taught the SDR Program to their students through the SDR Follow-Up Program in FY 2010-11.
- Joe and Ronna Leon of Caterpillar Puppets offered the following quotes from teachers:
    - "Excellent program. The kids love it and learn SOOOO much from you." - Oxford School.
    - "Very cool, my kids really enjoyed it. They really liked the coloring page." - Hillside School.
- Zun Zun offered the following quotes from teachers about the "The Musical Watershed" assembly:

- “It was OUTSTANDING!! This was the best watershed assembly I've seen. The music, the energy, and the content were all great. Thank you for such a quality and important assembly! - 3rd Grade Teacher, Lorenzo Manor Elementary.
- “The two presenters were fabulous and engaging. My students enjoyed the assembly very much. Thank you.” - Kindergarten Teacher, F.A.M.E. Public Charter.

- The Golden Gate Audubon Society reported that approximately 80% of the students surveyed after attending the “Eco-Oakland” Program correctly identified storm drains as the main pathway for marine debris entering the San Francisco Bay. They also provided the following quote from a teacher: “This is my second year in the Eco-Oakland Program and I feel compelled to share how much value this experience has given my students. The class visits, the field trips and the shared experience with their families has not only enriched their lives but has also allowed them to become effective stewards of their local environment. I look forward to the years ahead.”

Future Actions

The following actions are anticipated in FY 2011/12:

1. Continue to hold PIP Subcommittee meetings;
2. Continue the Educational Services Grant Program;
3. Continue the Event Partnership Program;
4. Continue the Community Stewardship Grant Program;
5. Continue to update and create new outreach and educational materials; and
6. Develop materials to educate the public about car washing issues.

TABLE 7-1. PIP WORK GROUP PARTICIPATION IN FY 2010/11

Type of Work Group	Work Group Accomplishments	PIP Representatives	Agencies
Educational /Promotional Materials	Determined types and quantities of educational materials to order and distribute during the year. Assisted with the design and content of promotional and educational materials.	Kristin Hathaway	Oakland
		Jordan Figueiredo	Dublin
		Patrizia Guccione	Alameda
		Barbara Silva	Fremont
		Barb Kusha	Zone 7 Water
Website Redesign	Worked with consultant to redesign the Clean Water Program's website	Kristin Hathaway	Oakland
		Lynna Allen	Livermore
		Martha Aja	Dublin
Community Stewardship Grants	Selected five community projects for funding in FY 10-11.	Kristin Hathaway	Oakland
		Patrizia Guccione	Alameda
		Barbara Silva	Fremont
		Martha Aja	Dublin
		Lynna Allen	Livermore

TABLE 7-2. EVENT PARTNERSHIP PROGRAM FY 2010/11

Name of Project Group	Name of Event	Brief Event Description	Participants
Kathy Kramer Consulting	Bringing Back the Natives Garden Tours	Showcase pesticide-free, water-conserving gardens that reduce solid waste, provide habitat for wildlife and contain 50% or more native plants. The tours showcased 49 gardens in 17 cities.	7,041 people
StopWaste	Bay-Friendly Gardening Tours	Self-guided tour of private residential gardens that demonstrate gardening techniques appropriate for local conditions. Includes stops for buying locally grown plants, neighborhood garden clusters, and noontime talks.	2,000 people

TABLE 7-3. EDUCATIONAL SERVICES PROGRAMS FY 2010/11

Name of Program (*Name of Organization*)	Type of Program	Brief Program Description	Target Audience	Approximate Number of Students/Teachers[1]
Eco-Oakland *(Golden Gate Audubon Society)*	In-Class Presentations and Field Trip	Eco-Oakland is an education program consisting of the following components: 1) Introduction to Watershed/Stormwater Pollution (in-class); 2) Schoolyard Ecology (in-class); 3) California Native (in-class); 4) Local Creek Field Trip; and 5) Arrowhead Marsh Field Trip.	Educators Grades 3-5	655 students and their teachers
Storm Drain Rangers *(Kids for the Bay)*	In-Class Presentations	To educate Alameda County students about watersheds, stormwater pollution, and stormwater pollution prevention, the Storm Drain Rangers program consists of the following three lessons: 1) Our Watershed; 2) Taking Action for a Healthy Watershed; and 3) Becoming a Storm Drain Ranger.	Educators Grades 3-5	15 educators and 450 students
The Musical Watershed (*ZunZun*)	Assembly	Musical assembly that educates students and their teachers on watersheds and urban runoff pollution through audience participation. All assemblies are performed in English and Spanish, with a greater emphasis on Spanish whenever needed.	Grades K-5	9,325 students
Watershed Education (*Livermore Area Recreation and Park District*)	In-Class Presentations	A series consisting of the following three watershed education programs for 4th and 5th grade students in Livermore, Pleasanton, and Dublin: 1) Water Flows: A look at Watersheds - Students learn about watersheds; 2) Stream Life I - A program to prepare students for a field trip to a local creek; and 3) Stream Life II - Students explore a local stream and get a hands-on experience assessing stream health by testing the water and catching and recording numbers of aquatic animals.	Grades 4-5	2,748 students
Watershed Workout , Froggy to the Rescue *(Caterpillar Puppets)*	Assembly	Engaging puppet shows that introduce students to watersheds and stormwater pollution and ways they can help to prevent it.	Grades 1-3	5,925 students

[1] Numbers of students/teachers reached were taken from the final report provided by each individual educational program.

TABLE 7-4. COMMUNITY STEWARDSHIP GRANTS FY 2010/11

Project Group/School	Project Title	Brief Project Description
Park Day School	Water Lifecycle, Conservation, and Protection Project	The "Water Lifecycle, Conservation and Protection Project" is a rainwater harvesting, rain garden and environmental education program that will address two main issues: 1) stormwater runoff: this project will protect water quality by ensuring onsite reuse and treatment of roughly 33,000 gallons of stormwater from the roof of the main campus building; and 2) public awareness and stewardship: the public is generally unaware of the interconnectedness of human actions, our water systems, and water security. This project will increase public understanding and behavior related to protecting the Bay's water quality, using demonstration, promotion and education.
San Francisco Estuary Project/Codornices Creek	Codornices Forge Rain Gardens	The Codornices Forge Rain Gardens project features impervious surface removal and construction of two rain gardens in Berkeley near Codornices Creek. Two rain gardens will capture and infiltrate runoff from approximately 7,000 square feet of impervious surface that would otherwise drain directly into Codornices Creek. The project will remove approximately 350 square feet of asphalt and will treat runoff from adjacent buildings and parking areas that currently drain to the storm drain, Codornices Creek, and San Francisco Bay.
The Watershed Project	The Watershed Project's Riparian Lab	The Riparian Lab is a free 8-week after-school environmental education program at Lincoln Elementary School in Oakland's Chinatown that provides children who have few opportunities (and whose schools are faced with budget cuts) to experience nature and learn the joy of being proud environmental stewards of their watershed. It will be run with the Oakland Asian Student Education Services LEAP program at Lincoln Elementary, and will be part of a science-based enrichment class during their after-school program. The program will involve field trips to creeks and other watershed resources, hands-on activities, games and projects.
Friends of Peralta Creek	Peralta Creek Restoration Project	Habitat restoration along Peralta Creek at Peralta Hacienda Historical Park and Peralta Creek Park will achieve the following: 1) restore highly degraded areas of Peralta Creek with native vegetation; 2) provide habitat for native insects and wildlife; 3) create opportunities (volunteer restoration days which have an environmental education component) for increasing community awareness of watershed issues focusing on pollution prevention; 4) decrease litter and overall neglect of these parks through active recruitment of community volunteers and youth participation; 5) help decrease non-point source pollution along this waterway through creation of native vegetation buffer zones to help filter storm run-off. Peralta Creek Restoration Project is working with the City of Oakland to develop a planting and maintenance plan.

Project Group/School	Project Title	Brief Project Description
Longfellow Community Association	Longfellow Neighborhood Street Tree Project	The Longfellow Neighborhood Street Tree Project will address four important issues: 1) urban stormwater management; 2) habitat restoration; 3) urban heat-island reduction; and 4) neighborhood beautification and revitalization. By partnering with Urban ReLeaf, the project will plant trees in sidewalks as well as medians and parks throughout the Longfellow neighborhood. By removing concrete and adding areas of exposed earth in the sidewalks there will be increased natural filtration in the water table, and decreased runoff from driveways and sidewalks (and the pollutants this carries) into the storm drains, and ultimately the bay. By reducing the amount of pavement surface in the urban watershed this project will contribute to growing the neighborhood's urban forest and reducing stormwater runoff. The trees will be donated by the City of Oakland.

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8: Provision C.8
Water Quality Monitoring

Introduction

Provision C.8 of the MRP requires Permittees to conduct water quality monitoring and associated projects during the permit term. All water quality monitoring activities required by Provision C.8 are coordinated regionally through the Regional Monitoring Coalition (RMC), a collaborative effort of MRP Permittees under the auspices of the Bay Area Stormwater Management Agencies Association (BASMAA). Many of the tasks for compliance with provisions in C.8 are conducted as BASMAA Regional Tasks, with scopes and budgets approved by the BASMAA Board of Directors (BOD) and implemented through the BASMAA Monitoring and Pollutants of Concern Committee (MPC).

Implementation

Provision C.8.a Compliance Options

Provision C.8.a of the MRP allows Permittees to address monitoring requirements through a "regional collaborative effort". In a November 2, 2010 letter to Permittees, the Water Board's Assistant Executive Officer (Thomas Mumley) acknowledged that all MRP Permittees have opted to conduct monitoring required by the MRP through the RMC. The letter noted that monitoring coordinated through the RMC must begin by October 2011. The letter also asked that Permittees submit to Water Board staff:

- Status reports on RMC projects and activities by March 15th and September 15th of 2011 and 2012; and,
- A status report and proposed schedule for completing an alternative sampling design(s) and associated multi-year monitoring plan(s) to address Pollutants of Concern and Long-Term Trends Monitoring requirements included in Provision C.8.e, no later than March 15, 2011.

BASMAA's second Monitoring Status Report for January-June 2011 (Monitoring Status Report) has been prepared on behalf of all MRP Permittees by representatives of Clean Water Program and other programs working through the MPC (see Appendix I). It describes the RMC Work Plan and BASMAA's FY 2010/11 regional activities for its implementation.

Provision C.8.b San Francisco Estuary Receiving Water Monitoring

The Program fulfilled this provision by continuing its fair-share annual contributions to the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) in 2010 and 2011, as shown in Table B.1 of the Monitoring Status Report. The Program participated in stakeholder oversight of the RMP through BASMAA representation on the Steering and Technical Review Committees. Program staff actively participated as a BASMAA representative to the following RMP work groups:

- Sources, Pathways and Loadings Workgroup;
- Contaminant Fate Workgroup and related modeling subgroup;
- Exposure and Effects Workgroup; and
- Nutrients Strategy science session.

Provision C.8.c Creek Status Monitoring

The Monitoring Status Report describes the RMC planning activities for Creek Status Monitoring including development of a regional creek status monitoring design that Clean Water Program and other member RMC participating programs will use to guide their site selection for monitoring the parameters required by the MRP Table 8.1. Clean Water Program's active participation in RMC activities included:

- Program staff participated in monthly meetings of the RMC Work Group, and commented on draft products.
- Program staff and consultants prepared portions of the draft Quality Assurance Project Plan and Standard Operating Procedures to be used by all RMC participants.
- The Program co-sponsored the tenth annual Bay Area Macroinvertebrate Bioassessment Information (BAMBI) networking meeting on January 31, 2011 (see Appendix G), a forum for information-sharing and updates about the development of a Bay Area Index of Biological Integrity that will be an important tool for interpretation of Creek Status Monitoring data.

Provision C.8.e Pollutants of Concern Monitoring

In a regional collaboration with the RMP, the Program and other Permittees are pursuing an alternative approach to answering the information needs identified in MRP Provision C.8.e, as described in the Monitoring Status Report and its appendices. In FY10/11 the Program actively participated in this collaborative process in the following ways:

- Program staff served as one of two BASMAA representatives on the Small Tributaries Loading Strategy (STLS) Team, in which BASMAA, Water Board staff and scientists from San Francisco Estuary Institute (SFEI) designed an alternative monitoring approach to the locations and methods for Pollutants of Concern Loads Monitoring in Provision C.8.e.

- Program staff coordinated development of the STLS Multi-Year Plan, which describes the planned monitoring approach as well as other elements in the overall STLS approach to load estimation, evaluation of trends and data analysis. The STLS elements will also form the core of the Permittees' study designs to comply with characterization and load estimation requirements in MRP Provisions C.8.e.vi (sediment) and C.14 (PBDEs, legacy pesticides and selenium). The STLS Multi-Year Plan is a working document with ongoing updates that will be included as an appendix to BASMAA Monitoring Status Reports.
- Program staff and consultants developed cost estimates for the baseline monitoring effort specified in the MRP, to inform STLS discussions of overall effort and the choice of specific methods for sampling and laboratory analysis.

Future Actions

The Program will continue participation in the RMP and the RMC development process, and conduct Creek Status Monitoring in accordance with the RMC Quality Assurance Project Plan, Standard Operating Procedures and Information Management System.

The Program also will continue participating in the STLS Team and provide in-kind services as needed to assist setup and operation of the STLS station at San Leandro Creek, as part of the alternative approach for monitoring to comply with C.8.e. The Clean Water Program will also participate in regional planning and selection of additional STLS monitoring stations to be monitored in the future, and development of a Field Manual and Standard Operating Procedures for monitoring, a Quality Assurance Project Plan, and contracting for laboratory analyses and data management.

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9: Provision C.9 Pesticides Toxicity Control

Introduction

This section summarizes the Program's efforts to comply with Provision C.9, Pesticides Toxicity Control, to prevent the impairment of urban streams by pesticide-related toxicity. Provisions in C.9 reflect the implementation actions incorporated in the Basin Plan through the Total Maximum Daily Load and Water Quality Attainment Strategy for diazinon and pesticide–related toxicity in urban creeks throughout the Bay Area. Agency-led tasks, such as adoption and implementation of an IPM policy or ordinance (Provisions C.9.a and b respectively), can be found in each agency's annual reporting forms, as can information on compliance with Provision C.9.d. Require Contractors to Implement IPM.

Implementation

Provision C.9.c Train Municipal Employees

The Program hosted a workshop on Integrated Pest Management for municipal employees on June 2, 2011. The workshop was very successful and well attended. The workshop flyer, agenda, and sign-in sheet are included in Appendix A.

Provision C.9.e Track and Participate in Relevant Regulatory Processes

Provision C.9.e is being implemented as a BASMAA Regional Project. A report on the implementation of this provision is included in the *BASMAA Regional Pollutants of Concern Report for FY2010-2011 and Monitoring Status Report* in Appendix I.

Program staff participated directly in the following activities related to C.9.e:

- Participated in two meetings with Chuck Andrews of the California Department of Pesticide Regulation (DPR) to discuss DPR's proposed regulation to significantly restrict the use of pesticides impacting water quality including pyrethroids and bifenthrin.
- Participated in meetings and conference calls of CASQA's Pesticide Subcommittee.

Provision C.9.f Interface with County Agricultural Commissioner

Program staff has communicated with the County Agricultural Department's Integrated Pest Management Coordinator. The IPM Coordinator includes information on integrated pest management in their presentations to pest control applicators.

Provision C.9.g Evaluate Source Control Actions

This Provision will be reported on in a BASMAA report in 2013.

Provision C.9.h.i and ii Point-of-Purchase Outreach

In FY 2009/10, the Clean Water Program's targeted outreach focused on promoting Integrated Pest Management (IPM) methods at the point-of-purchase and generating media coverage to encourage individuals to adopt environmentally beneficial behaviors.

<u>Our Water Our World (OWOW) Integrated Pest Management (IPM) Store Partnership Program</u>

As part of the Clean Water Program's targeted outreach, the Clean Water Program's contractor, Anne Joseph Consulting, implemented the region-wide *Our Water, Our World* (OWOW) *Integrated Pest Management (IPM) Store Partnership Program* in Alameda County. Ms. Joseph visited participating stores throughout the year to update store displays, restock fact sheets, and place shelf talkers to highlight recommended, less-toxic products.

Fig. 9-1. Store manager with less toxic products and shelf talkers at Orchard Supply Hardware in Dublin.

Currently, six Orchard Supply Hardware (OSH) stores, four Ace Hardware stores, three Home Depot stores and 20 independent stores in Alameda County participate in the partnership.

To train store employees on IPM methods and promote the *OWOW IPM Store Partnership Program*, Annie Joseph conducted the following training and outreach events:

- Fifteen IPM training workshops for employees of participating stores. A total of 113 staff were trained.
- Two weekend customer tabling events.

The IPM store trainings have been successful in convincing store employees and management to recommend and stock less-toxic products. Annie Joseph collected 92 evaluations from the 15 store trainings that were conducted (see Appendix H for the final report detailing all store activities and training events). The evaluations showed that 79% of respondents agreed or strongly agreed with the statement "the information changed my mind about pesticides"; 96% agreed that "the information will help me recommend and sell less toxic products" ; and 87% agreed that they would like to learn more about IPM and IPM certification.

Fig. 9.2 Annie Joseph training staff at Alden Lane Nursery in Livermore.

Annie also reports that participating stores are cutting back on their stocks of highly toxic pesticides. Westbrae Nursery continues to reduce their toxic pesticide offerings. Grand Lake Ace Oakland stands out as a store that actively engages customers when they are purchasing products and lets them know about less toxic alternatives to a toxic pesticide they may be selecting.

BASMAA Our Water Our World (OWOW) Integrated Pest Management (IPM) Program

A report of BASMAA's activities and accomplishments of the regional *Our Water, Our World* program for FY 10-11 is included in the *BASMAA Training and Outreach for FY10-11 Regional Supplement* (Appendix F).

C.9.h.iii and iv Pest Control Contracting Outreach

The Program developed a newspaper insert that was included in a Sunday edition of the Oakland Tribune, Hayward Review, Fremont Argus and the Valley Times (137,000 homes within Alameda county). The insert included information on less toxic pest control methods, IPM, Our Water Our World, and Ecowise and Green Pro IPM Certification Programs. A copy of the insert is included in Appendix F.

C.9.h.v and vi Outreach to Pest Control Operators

The Program is a member of CASQA. Through CASQA, the Program has assisted in the development of the EcoWise Certified IPM program and the industry's new GreenPro Certified IPM program. As a result, a number of California (including 12 Bay Area) companies are now able to provide certified IPM services. Program staff has participated in the CASQA Pesticide Committee which has fostered outreach to the PCO community. The County Agricultural Department's IPM Coordinator promotes integrated pest management in their day-to-day interactions with PCOs and in trainings.

Future Actions

The Program will continue its communications with the County Agricultural Commission and its support of BASMAA and CASQA efforts to participate in regulatory processes, and will continue to contract with Annie Joseph for implementation of Point of Purchase IPM outreach**.**

10: Provision C.10 Trash Load Reduction

Introduction

In FY 2010/11 Program staff participated in the BASMAA Trash Committee. Through the Committee, the Program participated in the development of the Baseline Trash Load Assessment and Trash Load Reduction Tracking Method. This chapter describes the Provision C.10 implementation actions during FY 2010/11, as well as planned future actions.

Implementation

Provision C.10.a.i Short-Term Trash Loading Reduction Plan

Through participation in the BASMAA Trash Committee, the Program is assisting in the development of a Model Short-Term Trash Loading Reduction Plan that will be distributed to the Permittees for their use in developing Permittee specific plans.

Provision C.10.a.ii Baseline Trash Load and Trash Load Reduction Tracking Method

Through participation in the BASMAA Trash Committee and contributing to the funding of these regional projects, the Program is assisting in the development of a Baseline Trash Load Estimate and a Trash Load Reduction Tracking Method. The Program also funded the installation and maintenance of 20 full trash capture inlet filters that will be included in the development of the baseline trash loading estimate. The cities of Berkeley, Dublin, Fremont, Livermore, Oakland, Pleasanton, and San Leandro assisted in the installation of these filters within their jurisdictions. See the *BASMAA Regional Pollutants of Concern Report for FY2010-2011 and Monitoring Status Report* in Appendix I for a detailed status report and schedule.

Provision C.10.a.iii Minimum Full Trash Capture

Program staff worked with San Francisco Estuary Partnership (SFEP) staff to facilitate the implementation of SFEP's $5 million grant to fund Permittee purchase and installation of full trash capture devices.

Provision C.10.b Trash Hot Spot Cleanup and Assessment

Actions required under this provision were implemented by individual Permittees.

Provision C.10.d Trash Load Reduction Reporting

The Trash Load Reduction Tracking Method is still in development. See the *BASMAA Regional Pollutants of Concern Report for FY2010-2011 and Monitoring Status Report* in Appendix I for a detailed status report and schedule.

Future Actions

Program staff will continue to work with the BASMAA Trash Committee and Program member agencies to develop the Trash Baseline Load Estimate, the Load Reduction Tracking Method, and the Short-Term Trash Load Reduction Plans.

11: Provision C.11 Mercury Controls

Introduction

Provisions in C.11 reflect the implementation plan incorporated in the Basin Plan through the Total Maximum Daily Load for mercury in San Francisco Bay. For mercury, polychlorinated biphenyls (PCBs) and other sediment-bound pollutants, the Water Board has proposed to implement control measures primarily as pilot projects that are intended to reduce uncertainties about the sources, occurrence or effectiveness of control measures for these POCs.

Implementation

The following provisions are being implemented as BASMAA Regional Projects, and regional activities for these are reported in the BASMAA Regional Pollutants of Concern Report (see Appendix I):

- C.11.b, Monitor Methylmercury;
- C.11.c, C.11.d, C.11.e, C.11.i (addressed as a group by BASMAA's Clean Watersheds for Clean Bay project);
- C.11.f, Diversion of Dry Weather and First Flush Flows to POTWs;
- C.11.g, Monitor Stormwater Pollutant Loads and Loads Reduced;
- C.11.h, Fate and Transport Study of Mercury in Urban Runoff; and
- C.11.j, Develop Allocation Sharing Scheme with Caltrans.

MRP Provisions C.11.c through Provision C.11.i for mercury are essentially identical to C.12.c through Provision C.12.i for PCBs. In addition to participation in Regional Projects via BASMAA, the Program's direct activities included:

- Program staff participated in Project Team meetings for the Clean Watersheds for Clean Bay and C.11/12.f Pump Station updates to the Feasibility Evaluation Report (FER) and technical memo discussing regional candidate pilot projects.
- Program Staff worked with Permittees to identify candidate locations for stormwater treatment retrofits pilot projects (C11/12.d).

- Program Staff developed a conceptual plan for the pilot project at the Ettie Street Pump Station for Diversion of Dry Weather and First Flush Flows to POTWs (C11/12.f).
- Program staff represented BASMAA at meetings of RMP workgroups conducting and planning studies of PCBs fate and transport addressing the requirements of Provision C.12.h.
- Through the four household hazardous waste facilities within the County, 101,268 lbs. of mercury containing fluorescent lamps and compact fluorescent bulbs were recycled.
- The Program conducted a training workshop that focused on improving inspection skills and understanding how to handle pollutants of concern regarding including mercury.

Future Actions

The Program will continue its active participation and support for regional activities as described in BASMAA workplans and Regional Project Profiles, and will initiate the diversion pilot project at the Ettie Street Pump Station in fall 2011.

12: Provision C.12 Polychlorinated Biphenyls (PCBs) Controls

Introduction

Provisions in C.12 reflect the implementation plan incorporated in the Basin Plan through the Total Maximum Daily Load for PCBs in San Francisco Bay, and their requirements and implementation approach are mostly identical with provisions in C.11 as described above.

Implementation

The following provisions are being implemented as BASMAA Regional Projects, and regional activities for these are reported in the BASMAA Regional Pollutants of Concern Report (see Appendix I):

- C.12.b, Conduct Pilot Projects to Evaluate Managing PCB-Containing Materials and Wastes during Building Demolition and Renovation (e.g., Window Replacement) Activities;
- C.12.c, C.12.d, C.12.e, C.12.i (addressed as a group by BASMAA's Clean Watersheds for Clean Bay project);
- C.12.f, Diversion of Dry Weather and First Flush Flows to POTWs,
- C.12.g, Monitor Stormwater Pollutant Loads and Loads Reduced, and
- C.12.h, Fate and Transport Study of PCBs in Urban Runoff.

In addition to participation in Regional Projects via BASMAA, the Program's direct activities included:

- Program staff participated in Project Team meetings and conference calls for the PCBs in Caulk project of the San Francisco Estuary Partnership, and in the review of the project's draft BMP guidance and Model Implementation Process for managing PCB-containing demolition waste.

- Program staff participated in Project Team meetings for the Clean Watersheds for a Clean Bay (CW4CB) and C.11/12 f updates to the Feasibility Evaluation Report and technical memo discussing regional candidate pilot projects for diversion.
- As part of the Program's in-kind matching support for the CW4CB grant project, Program consultants prepared a draft Quality Assurance Project Plan and Progress Reports for review by USEPA, and also facilitated the selection and documentation of proposed retrofit treatment pilot projects.
- Program Staff developed a conceptual plan for the pilot project at the Ettie Street Pump Station for Diversion of Dry Weather and First Flush Flows to POTWs (C11/12.f).
- Program staff represented BASMAA at meetings of RMP workgroups conducting and planning studies of PCB fate and transport addressing the requirements of Provision C.12.h.
- The Program conducted a training workshop that focused on improving inspection skills and understanding how to handle pollutants of concern regarding including PCBs.

Future Actions

The Program will continue its active participation and support for regional activities as described in BASMAA work plans and Regional Project Profiles, and will initiate the diversion pilot project at the Ettie Street Pump Station in fall 2011.

13: Provision C.13 Copper Controls

Introduction

The requirements of Provision C.13 reflect the copper management strategy incorporated in the Basin Plan amendment for Site Specific Objectives for copper in San Francisco Bay.

Implementation

The following requirements are being implemented as BASMAA Regional Projects, and regional activities for these are reported in the BASMAA Regional Pollutants of Concern Report (see Appendix I):

- C.13.c, Vehicle Brake Pads; and
- C.13.e, Studies to Reduce Copper Pollutant Impact Uncertainties.

In addition to participation in Regional Projects via BASMAA, the Clean Water Program's direct activities included:

- Program staff participated in conference calls of the CASQA team to develop and support legislation to phase out copper in brake pads sold in California, culminating in successful passage and signature of SB 346 in September 2010.
- The Program conducted a training workshop that focused on improving inspection skills and understanding how to handle pollutants of concern regarding including copper.

Future Actions

The Program will continue its active participation and support for regional activities as described in BASMAA workplans and Regional Project Profiles.

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14: Provision C.14 Polybrominated Diphenyl Ethers (PBDEs), Legacy Pesticides & Selenium

Introduction

This provision requires the Permittees to work with the other municipal stormwater management agencies in the Bay Region to identify, assess, and manage controllable sources of polybrominated diphenyl ethers (PBDEs), legacy pesticides, and selenium found in urban runoff. Initial reporting focuses on characterization.

Implementation

The following provisions are being implemented as BASMAA Regional Projects, and regional activities for these are reported in the BASMAA Regional Pollutants of Concern Report (see Appendix I):

- C.14.a, Control Program for PBDEs, Legacy Pesticides, and Selenium.

Program staff actively participated in development of the Small Tributaries Loading Strategy Multi -Year Plan, included as Appendix B2 of the BASMAA Monitoring Status Report as described above under C.8. The coordinated RMP and BASMAA monitoring implemented through this plan will be the primary approach to addressing the information needs identified in this MRP provision.

Future Actions

The Program will continue its active participation and support for regional activities as described in BASMAA workplans and Regional Project Profiles.

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15: Provision C.15 Exempted & Conditionally Exempted Discharges

Introduction

This section of the report describes the countywide activities conducted to help the Clean Water Program's member agencies to implement the requirements of the MRP's Provision C.15 Exempted and Conditionally Exempted Discharges. The Clean Water Program's role is to help municipal staff to understand the MRP's requirements and to make available for their use various MRP compliance support materials.

The MRP describes a variety of different types of non-stormwater discharges that may be conditionally exempted. The most extensive tracking, monitoring, and reporting requirements are for planned and unplanned potable water discharges by water purveyors. The only Clean Water Program's member agencies that are water purveyors are the cities of Hayward, Livermore, and Pleasanton and the Zone 7 Water Agency. Because there are so few water purveyors covered by the MRP, this MRP provision has had a low priority for countywide implementation.

Information about each agency's activities to comply with this MRP provision is contained in the agencies' reports.

During this reporting period the following activities were undertaken with input and assistance from the I&IDC Subcommittee.

- Discussed as a case study an administrative civil liability (ACL) issued to EBMUD for a planned and unplanned potable water discharge.

Implementation

The Clean Water Program's primary Provision C.15-related accomplishments of the General Program during the past fiscal year include the following:

Potable Water Discharge Plan and Reporting Forms

One of the I&IDC Subcommittee meetings included a discussion of EBMUD's planned potable water discharge that resulted in killing trout in a local creek and an unplanned potable water discharge that resulted from a water main break. According to information provided with the ACL, the Water Board staff believes that the amount of sediment in runoff from the water main breakage was excessive and could have been handled by using better BMPs. Issues that the I&IDC Subcommittee identified included the following:

- There is a lack of available chlorine residual field test kits that measure down to the concentrations needed to protect creeks.
- The dechlorination effectiveness of sodium sulfite tablets declines as the tablets dissolve.
- It would be safer to discharge superchlorinated water from a planned discharge to the sanitary sewer rather than a storm drain inlet near a creek.

Future Actions

The Clean Water Program will work with BASMAA's Municipal Operations Committee to identify any conditionally exempted discharge requirements that may be implemented more efficiently on a regional basis.

APPENDIX A
Provision C.2
Municipal Operations

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clean water PROGRAM

Attention!

- **Park and Facility Maintenance staff and supervisors**

Don't miss this Event!

Integrated Pest Management
in
Public Buildings and Landscapes

Thursday June 2nd
7:30 a.m. to 12:30 p.m.
Hayward City Hall, Council Chambers
777 B Street, Hayward
1 Block from Downtown Hayward BART!

7:30 to 8:00	Registration and Refreshments
8:00 to 10:00	Public Agency Parks, Urban Turf, and Landscapes - *From Conventional to Project Based*
10:00 to 10:30	Break and Refreshments
10:30 to 12:30	Public Facilities: Structural Pest Management – *A Model Approach*

There is no fee for the workshop

Name/Title:____

Agency/Company:____

Address: ____

Phone:________________ **Fax:** ______________**Email:** ________________

Please complete and email to Mashon (***mashonj@lwa.com***) or fax to 510/625-1588 – **No later than May 26th.**
Questions? Call or email Mashon (510-625-1580 x10)

Note: The Clean Water Program has applied for CEUs from both the CA Dept. of Pesticide Registration and the Structural Pest Control Board. Attendees will be notified of approved CEU hours prior to the workshop.

Integrated Pest Management in Public Buildings and Landscapes

June 2, 2011 7:30-12:30
Hayward City Hall, Council Chambers
777 B. Street, Hayward, CA

Workshop Agenda

Check-in and Refreshments		7:30-8:00
Welcome and Survey	Jim Scanlin *Clean Water Program*	8:00-8:15
Public Agency Parks, Urban Turf, and Landscapes	Naresh Duggal *Santa Clara County*	8:15-10:00
Break		10:00-10:20
Public Facilities: Structural Pest Management – a Model Approach	Naresh Duggal *Santa Clara County*	10:20-12:15
Question and Answers, Survey and Wrap Up		12:15-12:30

cleanwater PROGRAM

Integrated Pest Management
in Public Buildings and Landscapes
June 2, 2011
Sign-In Sheet

Last Name	First Name	Agency	Phone Number	Email	Signature
Angel	John	City of San Leandro – Traffic Division			
Amador	Ed	City of San Leandro – Parks Dept			
Arbios	Max	City of Alameda Public Works Dept	510.787.7900	marbios@ci.alameda.ca.us	
Baker	Ron	County of Alameda			
~~Barajas~~ Grajeda	~~Raplh~~ Patrick	City of San Leandro – Traffic Division			
Barse	Jim	City of Alameda Public Works Dept	510.747.7950	jbarse@ci.alameda.ca.us	
Bench	Jeff	City of Dublin – MCE Corporation			
Browning	Thomas	City of San Leandro – Traffic Division			
Cabral	Segi	New Image Landscape Company	510.226.9191	scabral@newimagelandscape.com	
Carvalho	Jorge	City of San Leandro – Parks Dept			
Schultze-Allen	Peter	City of Emeryville	510-596-3728	pschultze-allen @emeryville.org	
Koo	Michelle	City of Hayward	510-583-4732	Michelle.Koo@ hayward-CA.gov	

clean water PROGRAM

Integrated Pest Management in Public Buildings and Landscapes
June 2, 2011
Sign-In Sheet

Last Name	First Name	Agency	Phone Number	Email	Signature
Casassa	Larry	City of Fremont			
Conner	Tony	City of Fremont			
Cryer	Doug	County of Alameda			
DeLand	Kimberly	City of Hayward Streets Division	510.881.7745	kimberly.deland@hayward-ca.gov	
Doughty	Tim	City of Hayward	510.583.8909		
Fanara	Frank	City of Hayward	510.583.8906	frank.fanara@hayward-ca.gov	
Finlinson	Wade	Alameda County GSA	510.815.4227	wade.finlinson@acgov.org	
Flores	Geronimo	City of Dublin – MCE Corporation			
Flores	Martin	City of Dublin – MCE Corporation			
Flores	Sam	City of San Leandro – Parks Dept	(510) 909.5867		
Frankel	Dave	City of Piedmont	510.420.3050	dfrankel@ci.piedmont.ca.us	
Galena	Bobby	City of Alameda Public Works Dept	510.747.7900		

cleanwater PROGRAM

Integrated Pest Management in Public Buildings and Landscapes
June 2, 2011
Sign-In Sheet

Last Name	First Name	Agency	Phone Number	Email	Signature
Garcia	George	City of San Leandro – Traffic Division			[illegible]
Gonzales	David	City of San Leandro – Parks Dept DMG			[illegible]
Grajeda	Patrick	City of San Leandro – Traffic Division			
Guccione	Patrizia	City of Alameda Public Works Dept	510.747.7951	pguccion@ci.alameda.ca.us	Patrizia Guccia
Hartwick	Rita	City of Fremont			
Honore	Athena	San Francisco Estuary Partnership	510.622.2325	ahonore@waterboards.ca.gov	[illegible]
Hylton	Scott	County of Alameda			[illegible]
Jackson	David	City of Hayward	510.750.0165	david.jackson@hayward-ca.gov	[illegible]
Jones	Stephen	Alameda County Public Works Agency	510.670.5534	stevej@acpwa.org	[illegible]
Kennedy	Robert	City of Dublin – MCE Corporation			
Kirk	Nelson	City of Union City	510.760.3394	nelsonk@unioncity.org	[illegible]
Kunisawa	Debra	City of Hayward	510.881.7960	debra.kunisawa@hayward-ca.gov	[illegible]

clean water PROGRAM

Integrated Pest Management in Public Buildings and Landscapes
June 2, 2011
Sign-In Sheet

Last Name	First Name	Agency	Phone Number	Email	Signature
Lambert	Ron	City of San Leandro – Parks Dept			
Langlois	Dave	City of Dublin – MCE Corporation			
Lee	Gary	City of Fremont			
Leyva	Robert	City of San Leandro – Traffic Division			
Logan	Floyd	City of Piedmont	420 3050		
Madrigal	Jesus	City of Fremont			
Mataresse	Martin	City of Oakland	510.482.7857	mmatarrese@oaklandnet.com	
Matherly	Mark	City of Albany	510.455.1877	mmatherly@albanyca.org	
Mercer	Gary	City of Albany	510.524.9541		
Mckee	Winston	City of San Leandro – Parks Dept			
Milosovich	Nick	City of Piedmont	510 710 8791		
Montoya	Tom	Alameda Municipal Power	510.748.3955	montoya@alamedamp.com	
Silva	Barbara	City of Fremont	510 494 4575	~~bsi~~ bsilva@fremont	Barbara Silva

clean water PROGRAM

Integrated Pest Management in Public Buildings and Landscapes
June 2, 2011
Sign-In Sheet

Last Name	First Name	Agency	Phone Number	Email	Signature
Nava	Frank	City of Fremont	510.979.5782	fnava@ci.fremont.ca.us	
Nava	Frank	City of Fremont			
O'Donnell	David	City of San Leandro – Parks Dept			
Pal	Dharam	City of San Leandro – Parks Dept			Dharam Pal
Perry	David	City of San Leandro – Traffic Division			
Postestio	Doug	City of San Leandro – Parks Dept			
Quintero	Alex	City of Union City	510.760.3547	alexq@unioncity.org	
Reta	Gloria	City of Fremont			Gloria Reta
Romero	Alfredo	New Image Landscape Company	707.974.0023	aromero@newimagelandscape.com	Alfredo Romero
Rossi	Tom	City of Hayward Landscape Division	510.583.8907	thomas.rossi@hayward-ca.gov	
Rossiter	Zack	City of San Leandro – Traffic Division			
Rude	Jeff	Alameda Municipal Power	510.748.3980	rude@alamedamp.com	
Rullman	Todd	City of Hayward Streets Division	510.881.7746	todd.rullman@hayward-ca.gov	

clean water PROGRAM

Integrated Pest Management in Public Buildings and Landscapes
June 2, 2011
Sign-In Sheet

Last Name	First Name	Agency	Phone Number	Email	Signature
~~Scotts~~ STOTTS	Michael	City of Hayward	510.583.8906		
Shaffer	Bill	City of Fremont			
Shonk	Kathleen	City of Fremont	510 979 5715	kshonk @fremont.gov	
Singh	~~George~~ Cobra	City of San Leandro – Parks Dept			
Smith	Darin	City of Fremont			
Soto	Larry	City of Fremont	510.979.5783	lsoto@ci.fremont.ca.us	
Suarez	Ignacio	City of San Leandro – Traffic Division			
Tamayo	Jose	City of Dublin – MCE Corporation			
Taylor	Justin	City of San Leandro – Parks Dept			
Van Vliet	Bob	City of Dublin – MCE Corporation			
Vigil	Thomas	City of Dublin – MCE Corporation			
Wilfong	Elisa	Contra Costa Clean Water Program	925.313.2164	ewilf@pw.cccounty.us	
Wolcott	Tony	City of Albany	510.559.4275	twolcott@albanyca.org	

Last Name	First Name	Agency	Phone #	Email	Signature
~~Banton~~ Banton	John	City of Livermore			John Banton
Chavez,	Juan	City of Livermore	(925) 525-3445	jmchavez@ci.livermore.ca.us	

Last Name	First	Phone #	Agency	Signature
Chavez	JUAN	(925) 525-3445	City of Livermore	[signature]
Soriano	Mixel		"	[signature]
MOSER	MARK		COUNTY ALAMEDA	[signature]
ORR	TIM		City of San Leandro	[signature]
SOUZA	STEVEN		CITY OF SAN LEANDRO	[signature]

APPENDIX B
Provision C.3
New Development and Redevelopment

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Alameda Countywide
Clean Water Program
A Consortium of Local Agencies

MODEL LIST OF SOURCE CONTROL MEASURES

With notations in tracked changes to indicate revisions needed for consistency with the specific source control requirements identified in Provisions C.3.a.i(7), C.3.c.i(1), and C.15.b.v of the Municipal Regional Stormwater Permit (MRP).

The following list contains measures to control sources of stormwater pollutants associated with the post-construction phase of new development and redevelopment projects. Each identified source of pollutants may have one or more appropriate control measures. The model list is intended to be a menu from which agencies may select appropriate measures to apply to specific projects. Agency discretion is reserved to consider constraints such as municipal sewer system capacity and allocation restrictions and storm drain system infrastructure and design features/limitations. Phrases in brackets represent alternative or optional wording. An asterisk is used to indicate which source control measures on the Model List are also included in, or similar to conditions included in, the New Development Subcommittee's COAs, dated April 1999.

I. STRUCTURAL CONTROL MEASURES

I.A. Illegal Dumping to Storm Drain Inlets and Waterways

* On-site storm drain inlets shall be clearly marked with the words "No Dumping! Flows to Bay," or equivalent, using methods approved by the [Agency].

I.B. Interior Floor Drains

Interior floor drains shall be plumbed to the sanitary sewer system and shall not be connected to storm drains [or interior floor drains are prohibited]. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements. [In the event that the sanitary district does not approve the connection, the applicant may propose an alternative method of plumbing interior floor drains, subject to approval by RWQCB staff.]

I.C. Parking Garages

Interior level parking garage floor drains [receiving non-stormwater discharges] shall be connected to [a water treatment device approved by the

(Agency) prior to discharging to] the sanitary sewer system. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements. [Or – If a municipality determines that connecting to a sanitary sewer system is not practicable, the applicant may propose an alternative method of plumbing interior parking garage floor drains or addressing runoff subject to approval by RWQCB staff].

I.D. Pesticide/Fertilizer Application and Irrigation

1) * Landscaping shall be designed to minimize irrigation and runoff, promote surface infiltration where ~~appropriate~~ possible, ~~and~~ minimize the use of fertilizers and pesticides that can contribute to stormwater pollution, and incorporate appropriate Bay-Friendly Landscaping principles.

2) Structures shall be designed to discourage the occurrence and entry of pests into buildings, thus minimizing the need for pesticides. For example, dumpster areas should be located away from occupied buildings, and building foundation vents shall be covered with screens.

3) If a landscaping plan is required as part of a development project application, the plan shall meet the following conditions related to reduction of pesticide use on the project site:

   a. * Where feasible, landscaping shall be designed and operated to treat stormwater runoff by incorporating elements that collect, detain, and infiltrate runoff. In areas that provide detention of water, plants that are tolerant of saturated soil conditions and prolonged exposure to water shall be specified.

   b. Plant materials selected shall be appropriate to site specific characteristics such as soil type, topography, climate, amount and timing of sunlight, prevailing winds, rainfall, air movement, patterns of land use, ecological consistency and plant interactions to ensure successful establishment.

   c. Existing native trees, shrubs, and ground cover shall be retained and incorporated into the landscape plan to the maximum extent practicable.

   d. Proper maintenance of landscaping, with minimal pesticide use, shall be the responsibility of the property owner.

   e. Integrated pest management (IPM) principles and techniques shall be encouraged as part of the landscaping design. Examples of IPM principles and techniques include:

      1. Select plants that are well adapted to soil conditions at the site.
      2. Select plants that are well adapted to sun and shade conditions at the site. Consider future conditions when plants reach maturity. Consider seasonal changes and time of day.

3. Provide irrigation appropriate to the water requirements of the selected plants.
4. Select pest- and disease-resistant plants.
5. Plant a diversity of species to prevent a potential pest infestation from affecting the entire landscaping plan.
6. Use "insectary" plants in the landscaping to attract and keep beneficial insects.

4) * Landscaping shall also comply with [Agency's] "water efficient landscape ordinance" or equivalent.

5) An efficient irrigation system shall be installed in areas requiring irrigation. An example of an efficient irrigation system is one that includes a weather-based (automatic, self-adjusting) irrigation controller with a moisture and/or rain sensor shutoff, and in which sprinkler and spray heads are not permitted in areas less than 8 feet wide.

I.E. Pool, Spa, and Fountain Discharges

1) ~~Pool (including swimming pools, hot tubs, spas and fountains) discharge drains shall not be connected directly to the storm drain or sanitary sewer system, unless the connection is specifically approved by the local permitting authority [and/or sanitary district with jurisdiction, as applicable]. [Exception: Public pool discharge drains may be connected to the sanitary sewer system, in accordance with applicable local requirements.]~~

   New or rebuilt swimming pools, hot tubs, spas and fountains must have a connection to the sanitary sewer to facilitate draining. This connection could be a drain in the pool to the sanitary sewer or a cleanout located close enough to the pool so that a hose can readily direct the pool discharge into the sanitary sewer cleanout. [Agency with permitting authority shall coordinate with local sanitary sewer agencies to determine the standards and requirements necessary for the installation of a sanitary sewer discharge location to allow draining with the proper permits from the local sanitary sewer agency.]

2) Subject to local requirements, when draining is necessary, a hose or other temporary system shall be directed into a sanitary sewer clean out~~. The clean out shall be installed in a readily accessible area [example: within 10 feet of the pool]. T~~, or vegetated areas that are large enough to accommodate the volume without allowing the discharged water to flow to the storm drain system or receiving water body. For discharges to the sanitary sewer, the applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific ~~connection and~~ discharge requirements.

3) [If there are no other feasible disposal alternatives (e.g. disposal to sanitary sewer or landscaped areas)~~Subject to local requirements~~, swimming pool, spa and fountain water may be allowed to discharge to the storm drains if the water has been properly dechlorinated to non-detectable levels of chlorine consistent with water quality standards, the water is within ambient temperature, and no copper-based algae control projects have been added to the water.]

~~4)If commercial and public swimming pool discharges are discharged to land where the water would not flow to a storm drain or to a surface water, the discharge may be subject to the requirements of the State Water Resources Control Board's (SWRCB) Statewide General Waste Discharge Requirements (WDRs) for Discharges to Land with a Low Threat to Water Quality.~~

I.F. Food Service Equipment Cleaning

* Food service facilities (including restaurants and grocery stores) shall have a sink or other ~~floor mat, container, and equipment cleaning area~~ container or area for cleaning floor mats, equipment, and hood filters, which is connected to ~~[~~a grease interceptor prior to discharging to~~]~~ the sanitary sewer system. The cleaning area shall be large enough to clean the largest mat or piece of equipment to be cleaned. The cleaning area shall be indoors or in a roofed area outdoors; both areas must be plumbed to the sanitary sewer. Outdoor cleaning areas shall be designed to prevent stormwater run-on from entering the sanitary sewer and to prevent stormwater run-off from carrying pollutants to the storm drain. Signs shall be posted indicating that all food service equipment washing activities shall be conducted in this area. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements. [In the event that the sanitary district does not approve the connection, the applicant may propose an alternative method of plumbing interior or roofed floor drains, subject to approval by RWQCB staff.]

I.G. Refuse Areas

1) * New or redevelopment projects [such as food service facilities, recycling facilities and/or multi-family residential complexes or subdivisions or similar facilities] [or - such as food service facilities, recycling facilities or similar facilities] shall provide a roofed and enclosed area ~~[or enclosed area]~~ for dumpsters, ~~and~~ recycling containers, compactors, and food waste containers. The area shall be designed to prevent water run-on to the area and runoff from the area and to contain litter and trash, so that it is not dispersed by the wind or runoff during waste removal. Dumpster drips from covered trash and food compactor enclosures shall drain to the sanitary sewer, subject to the local sanitary sewer agency's authority and standards.

2) * Runoff from food service areas, trash enclosures, recycling areas, and/or food compactor enclosures or similar facilities shall not discharge to the storm drain system. Trash enclosure areas shall be designed to avoid run-on to the trash enclosure area. Any drains installed in or beneath dumpsters,

compactors, and tallow bin areas serving food service facilities shall be connected [to a grease removal device and/or treatment devices prior to discharging] to the sanitary sewer. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements. [In the event that the sanitary district does not approve the connection, the applicant may propose an alternative method of providing for drainage from the trash enclosure area, subject to approval by RWQCB staff.]

I.H. Outdoor Process Activities/Equipment[1]

1) Process activities shall be performed either indoors or in roofed outdoor areas. If performed outdoors, the area shall be designed to prevent run-on to and runoff from the area with process activities.

2) * Process equipment areas shall drain to the sanitary sewer system. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements. [In the event that the sanitary district does not approve the connection, the applicant may propose an alternative method of providing for drainage of process equipment areas, subject to approval by RWQCB staff.]

I.I. Outdoor Equipment/Materials Storage

1) * All outdoor equipment and materials storage areas shall be covered [and bermed], or shall be designed with BMPs to limit the potential for runoff to contact pollutants

2) Storage areas containing non-hazardous liquids shall be covered by a roof and drain to the sanitary sewer system, and be contained by berms, dikes, liners, vaults or similar spill containment devices. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements. [Or – Storage areas containing non-hazardous liquids shall be covered by a roof and contained by berms, dikes, liners, vaults or similar spill containment devices.]

3) All on-site hazardous materials and wastes, as defined and/or regulated by the California Public Health Code and the local Certified Unified Program Agency (CUPA) [, i.e., Alameda County Environmental Health Department], must be used and managed in compliance with the applicable CUPA program regulations and the facility hazardous materials management plan approved by the CUPA authority.

I.J. Vehicle/Equipment and Commercial/Industrial Cleaning

1) Wastewater from vehicle and equipment washing operations shall not be discharged to the storm drain system. [However, for car dealerships, if water only (without soap or other cleaning agent) is used for a minimal amount of

[1] Examples of businesses that may have outdoor process activities and equipment include machine shops and auto repair shops, and industries that have pretreatment facilities.

rinsing of vehicle exterior surfaces for appearances purposes, the runoff may be discharged to the storm drain system.]

2) * Commercial/industrial facilities having vehicle/equipment cleaning needs [and new residential complexes of 25 units or greater] shall either provide a roofed, bermed area for washing activities or discourage vehicle/equipment washing by removing hose bibs (faucets) and installing signs prohibiting such uses. Vehicle/equipment washing areas shall be paved, designed to prevent run-on to or runoff from the area, and plumbed to drain to the sanitary sewer. A sign shall be posted indicating the location and allowed uses in the designated wash area. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements. [In the event that the sanitary district does not approve the connection, the applicant may propose an alternative method of providing for drainage of the vehicle/equipment washing area, subject to approval by RWQCB staff.]

3) * Commercial car wash facilities shall be designed and operated such that no runoff from the facility is discharged to the storm drain system. Wastewater from the facility shall discharge to the sanitary sewer [or a wastewater reclamation system shall be installed and the wastewater reused with no discharges to the storm drain]. The applicant shall contact the local permitting authority [or sanitary district with jurisdiction] for specific connection and discharge requirements.

I.K. Vehicle/Equipment Repair and Maintenance

1) Vehicle/equipment repair and maintenance shall be performed in a designated area indoors, or if such services must be performed outdoors, in an area designed to prevent the run-on and runoff of stormwater.

2) Secondary containment shall be provided for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid, acid-containing batteries or other hazardous materials or hazardous wastes are used or stored. Drains shall not be installed within the secondary containment areas.

3) Vehicle service facilities shall not contain floor drains [unless the floor drains are connected to wastewater pretreatment systems prior to discharge to the sanitary sewer, for which an industrial waste discharge permit has been obtained. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements.]

4) Tanks, containers or sinks used for parts cleaning or rinsing shall not be connected to the storm drain system. Tanks, containers or sinks used for such purposes may only be connected to the sanitary sewer system if allowed by an industrial waste discharge permit. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements. [In the event that the sanitary district does not approve the connection, the applicant may propose

an alternative method of providing for drainage of tanks, containers or sinks used for parts cleaning or rinsing, subject to approval by RWQCB staff.]

I.L. Fuel Dispensing Areas

1) * Fueling areas[2] shall have impermeable surfaces (i.e., portland cement concrete or equivalent smooth impervious surface) that are: a) graded at the minimum slope necessary to prevent ponding; and b) separated from the rest of the site by a grade break that prevents run-on of stormwater to the maximum extent practicable.

2) * Fueling areas shall be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be roofed and the roof's minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area, as defined below.[4]] The canopy [or roof] shall not drain onto the fueling area.

I.M. Loading Docks

1) * Loading docks shall be graded to minimize run-on to and runoff from the loading area [and/or be covered]. Roof downspouts shall be positioned to direct stormwater away from the loading area. Stormwater runoff from loading dock areas shall be drained to the sanitary sewer, or diverted and collected for ultimate discharge to the sanitary sewer. [Or – Stormwater runoff from loading dock areas shall be connected to a post-construction stormwater treatment measure(s) prior to discharge to the storm drain system]. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements.

2) Door skirts between the trailers and the building shall be installed to prevent exposure of loading activities to rain, unless one of the following conditions apply:: the loading dock is covered, or the applicant demonstrates that rainfall will not result in an untreated discharge to the storm drain system.

I.N. Fire Sprinkler Test Water

~~Fire sprinkler test water shall be drained to the sanitary sewer system (with approval from the local permitting authority [and/or sanitary district with jurisdiction]) or drain to landscaped areas where feasible. [In the event that the sanitary district does not approve the connection and drainage to landscaped areas is infeasible, the applicant may propose an alternative method of providing for drainage of fire sprinkler test water, such as by filtering and dechlorinating the water prior to discharge to a storm drain, subject to approval by RWQCB staff.]~~ Provisions shall be made in the project design and construction to allow for the discharge of fire sprinkler test water to an onsite vegetated area. If this is not

[2] The fueling area shall be defined as the area extending a minimum of 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus a minimum of one foot, whichever is greater.

feasible, provide for discharge to the sanitary sewer subject to approval from the local permitting authority and/or sanitary district with jurisdiction.

I.O. Miscellaneous Drain or Wash Water

1) Boiler drain lines shall be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain system. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements. [In the event that the sanitary district does not approve the connection, the applicant may propose an alternative method of providing for boiler drain lines, subject to approval by RWQCB staff.]

2) For small air conditioning units, air conditioning condensate should be directed to landscaped areas as a minimum BMP. For large air conditioning units, in new developments or significant redevelopments, the preferred alternatives are for condensate lines to be directed to landscaped areas, or alternatively connected to the sanitary sewer system after obtaining permission from the sanitary sewer's owner. As with smaller units, any anti-algal or descaling agents must be properly disposed of. Any air conditioning condensate that discharges to land without flowing to a storm drain may be subject to the requirements of the State Water Resources Control Board's (SWRCB) Statewide General Waste Discharge Requirements (WDRs) for Discharges to Land with a Low Threat to Water Quality. [Or – Air conditioning condensate lines may discharge to the storm drain system provided they are not a source of pollutants].

3) Roof drains shall discharge and drain away from the building foundation to an unpaved area wherever practicable.

4) Roof top equipment [other than that producing air conditioning condensate] [or including that producing air conditioning condensate] shall drain to the sanitary sewer [or be covered and have no discharge to the storm drain]. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements.

5) * Most washing and/or steam cleaning must be done at an appropriately equipped facility that drains to the sanitary sewer. Any outdoor washing or pressure washing must be managed in such a way that there is no discharge of soaps or other pollutants to the storm drain. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements. [These conditions shall be required for automotive related businesses]. [In the event that the sanitary district does not approve the connection, the applicant may propose an alternative method of providing for drainage of the washing or steam cleaning facility, subject to approval by RWQCB staff.]

II. OPERATIONAL BMPS

This section describes Operational best management practices (BMPs) that rely on private property owners to implement following construction of projects.

Responsibility for implementation of these BMPs clearly rests with the property owners. Because some of these Operational BMPs may be difficult to implement, the municipalities may consider some of these Operational BMPs as reasonable goals to achieve. The municipalities have certain limited responsibilities for verification of property owner implementation. [The municipality will check on a property owner/operator's implementation of required Operational BMPs only during industrial and commercial business inspections, if any, and/or any inspections to verify the operation and maintenance of stormwater treatment measures, and/or may require the property owners to submit technical reports to verify the effective implementation of the Operational BMPs.]

II.A. Paved Sidewalks and Parking Lots

* Sidewalks and parking lots shall be swept regularly to minimize the accumulation of litter and debris. Debris resulting from pressure washing shall be trapped and collected to prevent entry into the storm drain system. Washwater containing any soap, cleaning agent or degreaser shall not be discharged to the storm drain [and shall be collected and discharged to the sanitary sewer] [or collected and treated prior to being lawfully disposed]. The applicant shall contact the local permitting authority [and/or sanitary district with jurisdiction] for specific connection and discharge requirements.

II.B. Private Streets, Utilities and Common Areas

1) The owner of private streets and storm drains shall prepare and implement a plan for street sweeping of paved private roads and cleaning of all storm drain inlets.

2) * For residential developments, where other maintenance mechanisms are not applicable or otherwise in place a property owners association, architectural committee, or similar organization [or a maintenance assessment district, special assessment district, or similar arrangement] shall be created and shall be responsible for maintaining all private streets and private utilities and other privately owned common areas and facilities on the site including landscaping. These maintenance responsibilities shall include implementing and maintaining stormwater BMPs associated with improvements and landscaping [and will include the maintenance responsibilities described in the maintenance plan, which is included as an attachment to the stormwater treatment measure O&M agreement for the subject property]. [CC&R's creating the association shall be reviewed and approved by the City or County Attorney prior to the recordation of the Final Map and recorded prior to the sale of the first residential unit.] The CC&R's [or special assessment district] shall describe how the stormwater BMPs associated with privately owned improvements and landscaping shall be maintained by the association [or the special assessment district].

II.C. Vehicle/Equipment Repair and Maintenance

1) No person shall dispose of, nor permit the disposal, directly or indirectly, of vehicle fluids, hazardous materials, or rinsewater from parts cleaning operations into storm drains.

2) No vehicle fluid removal shall be performed outside a building, nor on asphalt or ground surfaces, whether inside or outside a building, except in such a manner as to ensure that any spilled fluid will be in an area of secondary containment. Leaking vehicle fluids shall be contained or drained from the vehicle immediately.

3) No person shall leave unattended drip parts or other open containers containing vehicle fluid, unless such containers are in use or in an area that cannot discharge to the storm drain, such as an area with secondary containment.

II.D. Fueling Areas

The property owner shall dry sweep the fueling area and spot clean leaks and drips routinely. Fueling areas shall not be washed down with water unless the wash water is collected and disposed of properly (i.e., not in the storm drain).

II.E. Loading Docks

* The property owner shall ensure that BMPs are implemented to prevent potential stormwater pollution. These BMPs shall include, but are not limited to, a regular program of sweeping, litter control and spill clean-up.

II.F. On-site Storm Drains

* All on-site storm drains must be cleaned [or inspected and, if necessary, cleaned] at least once a year immediately prior to the rainy season. Additional cleaning may be required by the [Agency].

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San Mateo Countywide Water Pollution Prevention Program

Santa Clara Valley Urban Runoff Pollution Prevention Program

Sonoma County Water Agency

Vallejo Sanitation and Flood Control District

BASMAA

April 29, 2011

Bruce Wolfe, Executive Officer
California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

Subject: Feasibility/Infeasibility Criteria Report - MRP Provisions C.3.c.i.(2)(b)(iv) and C.3.c.iii.(1)

Dear Mr. Wolfe:

This letter and attachment are submitted on behalf of all 76 municipalities subject to the requirements of the Municipal Regional Stormwater NPDES Permit (MRP).

MRP Provision C.3.c.i.(2)(b) requires Regulated Projects to treat 100% of the amount of runoff identified in Provision C.3.d. for the Regulated Project's drainage area with LID treatment measures onsite or at a joint stormwater treatment facility. LID treatment measures are harvesting and re-use, infiltration, evapotranspiration, or biotreatment. A properly engineered and maintained biotreatment system may be considered only if it is infeasible to implement harvesting and re-use, infiltration, or evapotranspiration at the project site.

MRP Provision C.3.c.i.(2)(b)(iv) requires the Permittees to submit a report on the criteria and procedures that will be used to determine when harvesting and re-use, infiltration, or evapotranspiration is feasible and infeasible at a Regulated Project site. MRP Provision C.3.c.iii.(1) states that the report shall contain the following information:

- Literature review and discussion of documented cases/sites, particularly in the Bay Area and California, where infiltration, harvesting and re-use, or evapotranspiration have been demonstrated to be feasible and/or infeasible; and
- Discussion of proposed feasibility and infeasibility criteria and procedures the Permittees shall employ to make a determination of when biotreatment will be allowed at a Regulated Project site.

Through the Bay Area Stormwater Management Agencies Association (BASMAA), the Permittees have worked together to prepare the attached "Harvest and Use, Infiltration, and Evapotranspiration Feasibility/Infeasibility Criteria Report" (Report). This Report fulfills the MRP requirements to develop criteria and procedures for Permittees to follow to determine whether harvesting and use, infiltration, or evapotranspiration are feasible or infeasible at a Regulated Project site and when biotreatment may be used. The Report also provides a literature

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review (Appendix B) and a description of documented cases/sites in the Bay Area and California where harvesting and use, infiltration, and evapotranspiration have been demonstrated to be feasible or infeasible (Appendix C).

The criteria and procedures recommended in this Report will be incorporated into the Permittees' local and/or countywide guidance documents for compliance with Provision C.3. requirements for new development and redevelopment projects. When the LID site design, source control and treatment requirements in Provision C.3.c take effect, and throughout the remaining term of the MRP, Permittees will require applicants to apply the feasibility/infeasibility criteria and procedures to Regulated Projects as part of the development of stormwater quality control plans for those projects.

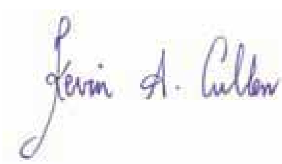
The Permittees intend to develop a status report on their experience implementing the feasibility/infeasibility criteria and procedures and submit it to the Regional Water Quality Control Board by December 1, 2013, as required by MRP Provisions C.3.c.i.(2)(b)(v) and C.3.c.iii.(2). The status report will include discussion of: 1) the most common criteria employed, with site specific examples; 2) barriers, including institutional and technical site specific constraints, to implementation of harvesting and use, infiltration and evapotranspiration, and proposed strategies for removing the barriers; 3) any proposed changes to the feasibility/infeasibility criteria and procedures and rationale for those changes; and 4) guidance to Permittees for future implementation efforts.

Please contact Jill Bicknell, BASMAA Development Committee Chair, at 408-720-8811 if you have any questions about the Report or need additional information.

We certify under penalty of law that this document was prepared under our direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on our inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of our knowledge and belief, true, accurate, and complete. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

James Scanlin, Alameda Countywide Clean Water Program

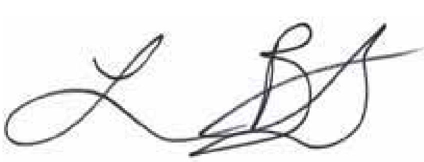
Tom Dalziel, Contra Costa Clean Water Program



Kevin Cullen, Fairfield-Suisun Urban Runoff Management Program

Matt Fabry, San Mateo Countywide Water Pollution Prevention Program

Adam Olivieri, Santa Clara Valley Urban Runoff Pollution Prevention Program



Lance Barnett, Vallejo Sanitation and Flood Control District

Attachment: Harvest and Use, Infiltration, and Evapotranspiration Feasibility/Infeasibility Criteria Report and Appendices

cc: Tom Mumley, Regional Water Board
Shin-Roei Lee, Regional Water Board
Dale Bowyer, Regional Water Board
Sue Ma, Regional Water Board
BASMAA Board of Directors

Prepared for

Bay Area Stormwater Management Agencies Association (BASMAA)
P.O. Box 2385
Menlo Park, CA 94026

Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report

Municipal Regional Permit Provisions C.3.c.i (2) and C.3.c.iii(1)

Prepared by

Geosyntec consultants

engineers | scientists | innovators

1111 Broadway, 6th Floor
Oakland, California 94607

WW1419

1 May 2011

Final Report

Alameda Countywide Clean Water Program

Contra Costa Clean Water Program

Fairfield-Suisun Urban Runoff Management Program

Marin County Stormwater Pollution Prevention Program

Napa County Stormwater Pollution Prevention Program

San Mateo Countywide Water Pollution Prevention Program

Santa Clara Valley Urban Runoff Pollution Prevention Program

Sonoma County Water Agency

Vallejo Sanitation and Flood Control District

B A S M A A

December 1, 2010

Bruce Wolfe, Executive Officer
California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

Subject: Model Bioretention Soil Media Specifications–MRP Provision C.3.c.iii.(3)

Dear Mr. Wolfe:

This letter and attachments are submitted on behalf of all 76 permittees subject to the requirements of the Municipal Regional Stormwater NPDES Permit (MRP).

Provision C.3.c.iii.(3) requires the permittees, collaboratively or individually, to submit a report containing the following information:

- Proposed soil media specifications for biotreatment systems;
- Proposed soil testing methods to verify a long-term infiltration rate of 5-10 inches/hour;
- Relevant literature and field data showing the feasibility of the minimum design specifications;
- Relevant literature, field, and analytical data showing adequate pollutant removal and compliance with the Provision C.3.d hydraulic sizing criteria; and
- Guidance for the permittees to apply the minimum specifications in a consistent and appropriate manner.

The permittees have worked diligently since the MRP was adopted in October 2009 to develop this information. The work has been carried out collaboratively among the permittees and in cooperation with your staff.

In April 2010 the permittees sponsored a roundtable discussion of bioretention soils. The roundtable included members of your staff, consultants, permittee staff, and representatives of the building industry. This diverse group included soil scientists and soils engineers with expertise in soil testing and construction of bioretention facilities. The meeting was facilitated by Sandi Potter of your staff.

Based on that discussion, BASMAA retained WRA, Inc., to develop regional guidance for bioretention soil. WRA was directed to use as a starting point guidance they had previously developed for the Contra Costa Clean Water Program (CCCWP). The CCCWP published its guidance in February 2009 as Appendix B to their *Stormwater C.3 Guidebook*. Contra Costa permittees have overseen construction of many bioretention facilities using this guidance and have had the opportunity to see the facilities perform through at least one full rainy season. The "soil" is a mix of 60-70% sand meeting a size gradation consistent with ASTM C33 for fine aggregate and

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30-40% compost meeting the standards developed by the US Composting Council. The sand and compost are readily available from Bay Area suppliers, and at least two companies currently provide and advertise their own versions of the bioretention "soil" mix. For the regional guidance, WRA has recommended some minor improvements and clarifications to the Contra Costa guidance.

The permittees are pleased to make this guidance available to permittee staff and the land development community. However, we believe the MRP should continue to allow, as it does now, room for experimentation and innovation with bioretention soils, as long as that experimentation and innovation is within the bounds of the minimum requirements needed to achieve effective stormwater treatment.

MRP Provision C.3.c.i.(2)(b)(vi) currently provides that: "Bioretention systems shall be designed to have a surface area no smaller than what is required to accommodate a 5-inch-per-hour stormwater runoff surface loading rate." This existing permit requirement sets the minimum square footage of the bioretention facility. For a facility this size to successfully treat the design runoff flow, the soil media must infiltrate runoff at a rate of at least 5 inches per hour. Thus, the essential characteristic of the bioretention soil is already established within the permit.

Accordingly, we recommend that the Regional Water Board take no action with regard to bioretention soil specifications, as the current MRP language is already adequate to the purpose. However, if the permit is to be amended to explicitly incorporate a bioretention soil objective, we recommend the following:

> "Soils for bioretention facilities must be sufficiently permeable to infiltrate runoff at a minimum rate of 5 inches per hour during the life of the facility, and must provide sufficient retention of moisture and nutrients to support healthy vegetation."

The guidance developed by WRA on behalf of the permittees meets this objective, and the guidance is clearly feasible to implement, but it would be incorrect (and counterproductive) to suggest this guidance is the only means and method by which the objective can be achieved.

Similarly, WRA's report includes proposed testing methods for verification of alternative bioretention soil mixes. Although this information will be useful to permittee staff, some permittees have already indicated a preference for fewer or different tests to estimate the long-term infiltration rate.

WRA's report also includes guidance on soil installation, the use of mulch, water conservation, and other topics of interest to designers and operators of bioretention facilities. This information is outside the scope of permit requirements, but will be useful to permittee staff and land development professionals.

We thank your staff for their helpful and attentive participation in the April roundtable and other discussions leading to this submittal.

We certify under penalty of law that this document was prepared under our direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on our inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of our knowledge and belief, true, accurate, and complete. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

James Scanlin

James Scanlin, Alameda Countywide Clean Water Program

Tom Dalziel, Contra Costa Clean Water Program

Kevin A. Cullen

Kevin Cullen, Fairfield-Suisun Urban Runoff Management Program

Matthew Fabry

Matt Fabry, San Mateo Countywide Water Pollution Prevention Program

Adam Olivieri, Santa Clara Valley Urban Runoff Pollution Prevention Program

Lance Barnett, Vallejo Sanitation and Flood Control District

Attachments:
Technical Memorandum, "Regional Bioretention Soil Guidance and Model Specification," by WRA, Inc.
Technical Memorandum, "Regional Bioretention Installation Guidance," by WRA, Inc.
Annotated Bibliography, "Regional Biotreatment Soil Guidance," by WRA, Inc.

cc: Tom Mumley, Regional Water Board
Shin-Roei Lee, Regional Water Board
Dale Bowyer, Regional Water Board
Sue Ma, Regional Water Board
BASMAA Board of Directors

TECHNICAL MEMORANDUM

Regional Bioretention Soil Guidance & Model Specification
Bay Area Stormwater Management Agencies Association

Prepared For:

Bay Area Stormwater Management Agencies
Association (BASMAA)

Contact:

Megan Stromberg
stromberg@wra-ca.com

Date:

November 12, 2010

ENVIRONMENTAL CONSULTANTS

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Clean Water Program

Contra Costa
Clean Water Program

Fairfield-Suisun
Urban Runoff
Management Program

Marin County
Stormwater Pollution
Prevention Program

Napa County
Stormwater Pollution
Prevention Program

San Mateo Countywide
Water Pollution
Prevention Program

Santa Clara Valley
Urban Runoff Pollution
Prevention Program

Sonoma County
Water Agency

Vallejo Sanitation
and Flood
Control District

B A S M A A

April 29, 2011

Bruce Wolfe, Executive Officer
California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

Subject: Green Roof Minimum Specifications - MRP Provision C.3.c.iii.(4)

Dear Mr. Wolfe:

This letter and attachment are submitted on behalf of all 76 permittees subject to the requirements of the Municipal Regional Stormwater NPDES Permit (MRP).

MRP Provision C.3.c.i.(2)(vii.) states:

> Green roofs may be considered biotreatment systems that treat roof runoff only if they meet certain minimum specifications. By May 1, 2011, the Permittees shall submit for Water Board approval proposed minimum specifications for green roofs. This submittal to the Water Board shall, at a minimum, contain the information required in Provision C.3.c.iii.(4). Once the Water Board approves green roof minimum specifications, the Permittees shall ensure that green roofs installed to meet the requirements of Provision C.3.c. and C.3.d. comply with the Water Board-approved minimum specifications.

MRP Provision C.3.c.iii.(4) requires the Permittees, collaboratively or individually, to submit a report to the Water Board containing the following information:

- Proposed minimum design specifications for green roofs;
- Relevant literature and field data showing the feasibility of the minimum design specifications;
- Relevant literature, field, and analytical data showing adequate pollutant removal and compliance with the Provision C.3.d. hydraulic sizing criteria;
- Discussion of data and lessons learned from already installed green roofs;
- Discussion of barriers, including institutional and technical site specific constraints, to installation of green roofs and proposed strategies for removing these identified barriers; and
- Guidance for the Permittees to apply the minimum specifications in a consistent and appropriate manner.

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Through the Bay Area Stormwater Management Agencies Association (BASMAA), the Permittees have worked together to develop the attached report, which addresses each of these requirements. The Permittees reviewed available literature, including USEPA's 2009 report, "Green Roofs for Stormwater Runoff Control," considered their experience with green roof projects in their jurisdictions, and queried some Bay Area developers who have experience with green roof projects or have evaluated using green roofs in their projects.

Our report concludes that typical green roof designs meet the C.3.d. hydraulic sizing criteria for treatment systems.

A recent media release by Green Roofs for Healthy Cities states the green roof industry grew by more than 16% in 2009. This acceleration in green roof installations appears to be separate from the influence of standards, requirements, or other regulatory drivers related to stormwater pollution prevention. The primary drivers include energy efficiency, reduction of greenhouse gases, credits toward LEED certification, and environmental cachet. Barriers to green roof construction appear to be cost and the regional development community's lack of familiarity with green roof construction; these barriers are already being overcome through the active promotion of green roof technology by groups such as Green Roofs for Healthy Cities.

As required, our report proposes strategies for furthering green roofs and overcoming barriers to green roofs and includes language the Permittees intend to incorporate in their C.3 compliance guidance for applicants for development approvals.

Please contact Jill Bicknell, BASMAA Development Committee Chair, at 408-720-8811 if you have any questions about the submittal or need additional information.

We certify under penalty of law that this document was prepared under our direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on our inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of our knowledge and belief, true, accurate, and complete. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

James Scanlin, Alameda Countywide Clean Water Program

Tom Dalziel, Contra Costa Clean Water Program

Kevin Cullen, Fairfield-Suisun Urban Runoff Management Program

Matt Fabry, San Mateo Countywide Water Pollution Prevention Program

Adam Olivieri, Santa Clara Valley Urban Runoff Pollution Prevention Program

Lance Barnett, Vallejo Sanitation and Flood Control District

Attachment: Green Roof Minimum Specifications

cc: Tom Mumley, Regional Water Board
Shin-Roei Lee, Regional Water Board
Dale Bowyer, Regional Water Board
Sue Ma, Regional Water Board
BASMAA Board of Directors

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Green Roof Minimum Specifications

Provision C.3.c.iii.(4)

Submitted to the

California Regional Water Quality Control Board

San Francisco Bay Region

29 April 2011

Alameda Countywide Clean Water Program

Contra Costa Clean Water Program

Fairfield-Suisun Urban Runoff Management Program

Marin County Stormwater Pollution Prevention Program

Napa County Stormwater Pollution Prevention Program

San Mateo Countywide Water Pollution Prevention Program

Santa Clara Valley Urban Runoff Pollution Prevention Program

Sonoma County Water Agency

Vallejo Sanitation and Flood Control District

B A S M A A

December 1, 2010

Bruce Wolfe, Executive Officer
California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

Subject: Special Projects Proposal / LID Treatment Reduction Credits MRP Provision C.3.e.ii.(2)

Dear Mr. Wolfe:

This letter and attachment are submitted on behalf of all 76 permittees subject to the requirements of the Municipal Regional Stormwater NPDES Permit (MRP).

MRP Provision C.3.e.ii.(2) states:

When considered at a watershed scale, certain types of smart-growth, high-density and transit-oriented development can either reduce existing impervious surfaces or create less "accessory" impervious areas and automobile-related pollutant impacts. Incentive LID [Low Impact Development] treatment reduction credits approved by the Regional Water Board may be applied to these types of Special Projects.

Regarding these Special Projects, Provision C.3.e.ii.(2) requires the permittees to submit a report containing the following information:

- Identification of the types of projects proposed for consideration of LID treatment reduction credits and an estimate of the number and cumulative area of potential projects during the remaining term of this Permit for each type of project;
- Identification of institutional barriers and/or technical site-specific constraints to providing 100% LID treatment onsite that justify the allowance for non-LID treatment measures onsite;
- Specific criteria for each type of Special Project proposed, including size, location, minimum densities, minimum floor area ratios, or other appropriate limitations;
- Identification of specific water quality and environmental benefits provided by these types of projects that justify the allowance for non-LID treatment measures onsite;
- Proposed LID treatment reduction credit for each type of Special Project and justification for the proposed credits. The justification shall include identification and an estimate of the specific water quality benefit provided by each type of Special Project proposed for LID treatment reduction credit; and

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- Proposed total treatment reduction credit for Special Projects that may be characterized by more than one category and justification for the proposed total credit.

Through the Bay Area Stormwater Management Agencies Association (BASMAA), the permittees have worked with each other, with your staff, and with staff of the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC) as this proposal was developed.

The permittees developed an informational slide show and presented it to members of your staff on April 1, 2010. This initial discussion was followed up by informal discussions throughout the ensuing months. Regional Water Board staff also attended an October 27, 2010 meeting with BASMAA, ABAG, and MTC. At this meeting, participants discussed the types of projects proposed for consideration of LID treatment reduction credits, institutional barriers and technical site-specific constraints to providing 100% LID treatment onsite, and the water quality and environmental benefits provided by these types of projects. In particular, Regional Water Board staff discussed with the permittees and with MTC and ABAG staff how the types of "smart growth" projects that are proposed as "special projects" contribute to regional efforts to promote more sustainable urban growth patterns within the San Francisco Bay Area.

The 76 municipal permittees vary considerably with regard to current and future development patterns, and also vary with regard to experience implementing LID. BASMAA has found it challenging to define proposed "special projects" categories that will apply regionally and where institutional barriers and site-specific constraints may require the use of alternatives to the LID treatment measures allowed by MRP Provision C.3.c.

In the attached proposal, BASMAA has defined four categories of projects (designated Categories A, B, D, and E) that we estimate would, all together, create approximately 33 acres of impervious area, or 1% of the total impervious area projected to be created or replaced by Regulated Projects under Provision C.3 during the remaining permit term. BASMAA has also defined a fifth category of projects (designated Category C), which aims to facilitate transit-oriented development (TOD) projects as described in the permit. BASMAA has found it difficult to reach consensus on a proposed category delineation that incorporates TOD projects that merit additional options for treatment and that also limits the size and extent of projects that would fall within the proposed category. Category C in the attached proposal places various restrictions on the geographic location and project characteristics, including a requirement that surface parking constitute no more than 10% of the post-project impervious area. We estimate projects in this category would comprise between 5% and 15% of the total impervious area projected to be created or replaced by Regulated Projects under Provision C.3, creating between 168 and 503 acres of impervious area during the remaining MRP term.

Working through BASMAA, the permittees have developed a proposal that addresses the permit provision and the need to support sustainable growth strategies across the region. The applicability of the proposal has been substantially restricted to ensure that it is implemented as the exception rather than the rule. Under our proposal, these projects would be strongly encouraged to use the Provision C.3.c. LID measures and would also be allowed the option of installing tree-box-type high-rate biofilters or below-ground vault-based high-rate media filters to treat runoff.

We look forward to working with your staff to further our mutual understanding of this proposal and its consequences, to possibly refine one or more project categories, and to articulate the appropriate Special Projects categories in a draft permit amendment for consideration by your Board.

We certify under penalty of law that this document was prepared under our direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on our inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of our knowledge and belief, true, accurate, and complete. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

James Scanlin, Alameda Countywide Clean Water Program

Tom Dalziel, Contra Costa Clean Water Program

Kevin Cullen, Fairfield-Suisun Urban Runoff Management Program

Matt Fabry, San Mateo Countywide Water Pollution Prevention Program

Adam Olivieri, Santa Clara Valley Urban Runoff Pollution Prevention Program

Lance Barnett, Vallejo Sanitation and Flood Control District

Attachment: Special Projects Proposal

cc: Tom Mumley, Regional Water Board
Shin-Roei Lee, Regional Water Board
Dale Bowyer, Regional Water Board
Sue Ma, Regional Water Board
BASMAA Board of Directors

Bay Area
Stormwater Management
Agencies Association

Special Projects Proposal

Provision C.3.e.ii.

Submitted to the

California Regional Water Quality Control Board

San Francisco Bay Region

1 December 2010

Alameda Countywide

Clean Water Program

Standard Stormwater Treatment BMP Inspection Report Form

Municipality:________________

Date:_____________

Facility has closed or Facility Information has changed: ☐ yes ☐ no

Reason for Inspection: ☐ First Inspection ☐ Routine Inspection ☐ Response to Complaint ☐ Follow-up		Follow-up Inspection Due:	
NAME OF FACILITY	SITE ADDRESS		ID #
CONTACT NAME	PHONE	BUSINESS TYPE/ACTIVITY	SIC	Map Code:
Is the property owner different than the facility owner? ☐ yes ☐ no	If yes, complete the following:		Location::
NAME MAILING ADDRESS	CONTACT: TITLE:	PHONE	
Is the BMP Operator different than the facility owner? ☐ yes ☐ no	If yes, complete the following:		
NAME MAILING ADDRESS	CONTACT: TITLE:	PHONE	

Needed maintenance noted for the Treatment BMPs below shall be completed within 30 days and notification of correction faxed, emailed or mailed to the over sight agency.

Treatment BMP Type (Numbers in parentheses correspond to fact sheets in CASQA's New Development Handbook)	No visible problems	Trash or Debris	Pollutants	Rodent Holes	Hazardous Trees/Brush	Erosion or Scouring	Excessive Sediment	Liner Condi-tion (if visible)	Spillway/Berm Damaged, Settled	Damaged Trash Rack or	Inlet/Outlet Condition	Security (fence, gates,	Coating/Paint	Standing Water	Mosquitoes/ Other Insects	Flow Spreader/ Equalizer	Invasive Weeds or Vegetation	Poor Vegetation Cover < 90%	Pedestrian Path Devegetation/ Compaction	Vegetation Too Tall	Odors		
Vegetated Swale (TC-30)																							
Extended Detention Basin (TC-22)																							
Bioretention Facility (TC-32)/ Flow-Through Planter																							
Vortex Separator (MP-51)																							
Infiltration Basin (TC-11)																							
Water Quality Inlets –Oil/ grit/water Separator (TC-50)																							
Media Filters - Sand Filters (TC-40)																							
Drain Inserts (MP-52)																							

COMMENTS/REMARKS/REQUIREMENTS Stormwater treatment BMP destroyed or eliminated ☐ yes ☐ no Maintenance required in storm drain system ☐ yes ☐ no

Number of BMP brochures distributed? ☐ Describe: ☐ See attached for more comments.

PRIORITY FOR RE-INSPECTION: ☐ 1. First ☐ 2. Second ☐ 3. Third

ENFORCEMENT: ☐ None ☐ Verbal Notice ☐ Warning Notice ☐ Administrative Action ☐ Administrative Action w/ Penalty &/or Cost Recovery ☐ Legal Action

O&M Representative:______________________________ Inspector: ______________________________

Needed Maintenance	Conditions When Maintenance Is Needed
Trash or Debris	Treatment BMP: Trash, debris, or litter dumped or accumulated in BMP. Vortex separator floatables should be removed according to maintenance plan. Check for mulch washout.
Pollutants	Treatment BMP: Any evidence of oil, gasoline, improper pesticide or fertilizer use, or other visible pollutants.
Rodent Holes	Extended Detention Basin: If facility acts as dam/berm, any evidence of rodent holes or water piping through dam/berm via rodent holes.
Hazardous Trees/ Brush	Extended Detention Basin: Growth does not allow access or interferes with maintenance; dead, diseased or dying trees. Growth >4 ft. high on berms/emergency spillway or covering >10% of spillway.
Erosion or Scouring	Treatment BMP: Eroded or scoured bottom due to flow channelization or higher flows. Extended Detention Basin: Side slopes eroded >2 inches deep where cause of damage is present or there is potential for continued erosion; Erosion on compacted berm embankment.
Excessive Sediment	Vegetated Swale/Bioretention: Sediment accumulated >2 inches deep on vegetation. Extended Detention Basin: Accumulated sediment >10% of designated basin depth or affects inletting/outletting condition of facility.
Liner Condition (if visible)	Extended Detention Basin: Liner is visible and has more than 3, ¼-inch holes in it.
Spillway/Berm Damaged, Settled	Extended Detention Basin: Spillway and/or berm settlement is 4 inches lower than design elevation. Rock missing & soil exposed at top of spillway or outside slope.
Damaged Trash Rack or Screen	Treatment BMPs: Trash/debris plugging openings in barrier. Vortex Separator: Screen damaged. Extended Detention Basin: Bars missing, loose, bent out of shape or deteriorating due to excessive corrosion.
Inlet/Outlet Condition	Treatment BMPs: Inlet/outlet areas clogged with sediment, vegetation and/or debris. Check any high-flow bypass for clogging. Extended Detention Basin: Debris barrier missing or not attached to pipe.
Security (fence, gates, and/or covers)	Treatment BMPs: Any defect or damage to fence/gate that prevents easy entry to the BMP and/or cover for below surface BMPs.
Coating/Paint	Treatment BMPs: Parts that are corroding or have scaling paint.
Standing Water	Treatment BMPs: When water stands in BMP for longer than 72 hours between storms and does not drain freely, unless this is part of the BMPs' design. Check for irrigation problems.
Mosquitoes/Other Insects	Treatment BMPs: If mosquito larvae are present in a BMP, contact the Alameda County Mosquito Abatement District at (510) 783-7744 or http://www.mosquitoes.org/water_inspect.htm (in the city of Albany contact the Alameda County Vector Control Services District). Insects such as wasps and hornets interfere with maintenance activities.
Flow Spreader	Vegetated Swale/Bioretention: Spreader uneven/clogged (flow not uniformly distributed over entire swale width).
Invasive Weeds or Vegetation	Extended Detention Basin/Infiltration Basin: Examples - Arundo, Castor Bean, Cattails, Pampas Grass, Tamarisk, Willows, Morning Glory, English Ivy, Blackberry, Scotch Broom, or Poison Oak. Vegetated Swale/Bioretention: Planted vegetation becomes excessively tall; nuisance vegetation/weeds start to take over.
Poor Vegetation Coverage < 90%	Treatment BMPs: Check for mulch failure. Vegetated Swale: When planted vegetation is sparse, bare or eroded patches occur in >10% of swale bottom. Bioretention: Ten percent of plants have died and not been replaced.
Pedestrian Path Devegetation/Compaction	Vegetated Swale/Bioretention: Pedestrian trails are forming or been established that are devegetating portion of BMP and compacting soil.
Odor	Treatment BMPs: Any odor associated with the accumulation and decomposition of pollutants or other material in the BMP that is causing a nuisance.

STORMWATER TREATMENT MEASURES AND HYDROMODIFICATION MANAGEMENT CONTROLS MAINTENANCE AGREEMENT

RECITALS

This Stormwater Treatment Measures and Hydromodification Management (HM) Controls Maintenance Agreement ("Agreement") is entered into this [insert date] by and between the City of [insert name of City] ("City") and [insert name of property owner] , a property owner of real property described in this Agreement.

WHEREAS, On October 14, 2009, the Regional Water Quality Control Board, San Francisco Bay Region, adopted Order R2-2009-0074, the Municipal Regional Stormwater Permit (MRP) (CAS612008); and

WHEREAS, Provision C.3.h of this MRP, and as it may be amended or reissued, requires the permittee public agencies to provide minimum verification and access assurances that all treatment measures and HM controls (if any) shall be adequately operated and maintained by entities responsible for the stormwater treatment measures and HM controls; and

WHEREAS, the Property Owner, [insert name], is the owner of real property commonly known as [insert address]_____(the "Property"), and more particularly described in the attached legible reduced-scale copy of the Site Plan or comparable document (Exhibit XX) upon which stormwater treatment measures and HM controls (if any) are located or to be constructed; and

WHEREAS, the City is the permittee public agency with jurisdiction over the Property.

WHEREAS, the Property Owner, its administrators, co-owners, executors, successors, heirs, assigns or any other persons, including any homeowners association (hereinafter referred to as "Property Owner") recognizes that the stormwater treatment measure(s) and HM controls (if any) more particularly described and shown on Exhibit XX, of which full-scale plans and any amendments thereto are on file with the [Planning] Department of the City of XXX must be installed and maintained as indicated in this Agreement and as required by the NPDES permit.

WHEREAS, the City and the Property Owner agree that the health, safety and welfare of the citizens of the City require that the stormwater treatment measure(s) and HM controls (if any) detailed in the Site Plan or comparable document be constructed and maintained on the Property; and

WHEREAS, the City's Stormwater Management Ordinance, guidelines, criteria and other written directions require that the stormwater treatment measure(s) and HM controls (if any), as shown on the approved Site Plan or comparable document, be constructed and maintained by the Property Owner

THEREFORE, in consideration of the benefit received by the Property Owner as a result of the City's approval of the Site Plan, the Property Owner hereby covenants and agrees with the City as follows:

SECTION 1: CONSTRUCTION OF TREATMENT MEASURES AND HM CONTROLS

The on-site stormwater treatment measure(s) and HM controls (if any) shown on the Site Plan or comparable document shall be constructed by the Property Owner in strict accordance with the approved plans and specifications identified for the development and any other requirements thereto which have been approved by the City in conformance with appropriate City ordinances, guidelines, criteria and other written direction.

SECTION 2: OPERATION & MAINTENANCE RESPONSIBILITY

This agreement shall serve as the signed statement by the Property Owner accepting responsibility for operation and maintenance of stormwater treatment measures and HM controls (if any) as set forth in this Agreement until the responsibility is legally transferred to another entity. Before the Property is legally transferred to another entity, the Property Owner shall provide to the City at least one of the following:

1) A signed statement from the public entity assuming post-construction responsibility for treatment measure and HM controls maintenance and that the treatment measures and HM controls (if any) meet all local agency design standards; or

2) Written conditions in the sales or lease agreement requiring the buyer or lessee to assume responsibility for operation and maintenance (O&M) consistent with this provision, which conditions, in the case of purchase and sale agreements, shall be written to survive beyond the close of escrow; or

3) Written text in project conditions, covenants and restrictions (CCRs) for residential properties assigning O&M responsibilities to the home owners association for O&M of the treatment measures and HM controls (if any); or

4) Any other legally enforceable agreement or mechanism that assigns responsibility for the maintenance of treatment measures and HM controls (if any).

SECTION 3: MAINTENANCE OF TREATMENT MEASURES AND HM CONTROLS

The Property Owner shall not destroy or remove the stormwater treatment measures and HM controls (if any) from the Property nor modify the stormwater treatment system and HM controls (if any) in a manner that lessens their effectiveness, and shall, at its sole expense, adequately maintain the stormwater treatment measure(s) and HM controls (if any) in good working order acceptable to the City and in accordance with the maintenance plan agreed hereto and attached as Exhibit XX. This includes all pipes, channels or other conveyances built to convey stormwater to the treatment measure(s) and HM controls (if any), as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater. Adequate maintenance is herein defined as maintaining the described facilities in good working condition so that these facilities continue to operate as originally designed and approved. The maintenance plan shall include a detailed description of and schedule for long-term maintenance activities.

SECTION 4: SEDIMENT MANAGEMENT

Sediment accumulation resulting from the normal operation of the stormwater treatment measure(s) and HM controls (if any) will be managed appropriately by the Property Owner. The Property Owner will provide for the removal and disposal of accumulated sediments. Disposal of accumulated sediments shall not occur on the Property, unless provided for in the maintenance plan. Any disposal or removal of accumulated sediments or debris shall be in compliance with all federal, state and local law and regulations.

SECTION 5: ANNUAL INSPECTION AND REPORT

The Property Owner shall, on an annual basis, complete the Treatment Measure and HM Control Operation and Maintenance Inspection Report (annual report), attached to this agreement as Exhibit XX . The annual report shall include all completed Inspection and Maintenance Checklists for the reporting period and shall be submitted to the City in order to verify that inspection and maintenance of the applicable stormwater treatment measure(s) and HM controls (if any) have been conducted pursuant to this agreement. The annual report shall be submitted no later than December 31 of each year, under penalty of perjury, to [insert name or title of City staff member, department and address] or another member of the City staff as directed by the City. The Property Owner shall provide a record of the volume of all accumulated sediment removed from the treatment measure(s) and HM controls (if any) in the annual report. The Property Owner shall conduct a minimum of one annual inspection of the stormwater treatment measure(s) and HM controls (if any) before the wet season. This inspection shall occur between August 1st and October 1st each year. More frequent inspections may be required by the maintenance plan (Exhibit XX). The results of inspections shall be recorded on the Inspection and Maintenance Checklist(s) attached as Exhibit XX.

SECTION 6: NECESSARY CHANGES AND MODIFICATIONS

At its sole expense, the Property Owner shall make changes or modifications to the stormwater treatment measure(s) and HM controls (if any) and/or the long-term maintenance plan (Exhibit XX) as may be determined as reasonably necessary by the City to ensure that treatment measures and HM controls (if any) are properly maintained and continue to operate as originally designed and approved.

SECTION 7: ACCESS TO THE PROPERTY

The Property Owner hereby grants permission to the City; the San Francisco Bay Regional Water Quality Control Board (Regional Water Board); the Alameda County Mosquito Abatement District (Mosquito Abatement District); and their authorized agents and employees to enter upon the Property at reasonable times and in a reasonable manner to inspect, assess or observe the stormwater treatment measure(s) and HM controls (if any) in order to ensure that treatment measures and HM controls (if any) are being properly maintained and are continuing to perform in an adequate manner to protect water quality and the public health and safety. This includes the right to enter upon the Property when it has a reasonable basis to believe that a violation of this Agreement, the City's stormwater management ordinance, guidelines, criteria, other written direction, or the MRP (Regional Board Order R2-2009-0074, and any amendments or reissuances of this permit) is occurring, has occurred or threatens to occur. The above listed agencies also have a right to enter the Property when necessary for abatement of a public nuisance or correction of a violation of the ordinance guideline, criteria or other written direction. Whenever possible, the City, Regional Water Board, or the Mosquito Abatement District shall provide reasonable notice to the Property Owner before entering the property.

SECTION 8: FAILURE TO MAINTAIN TREATMENT MEASURES AND HM CONTROLS

In the event the Property Owner fails to maintain the stormwater treatment measure(s) and/or HM controls as shown on the approved Site Plan or comparable document in good working order acceptable to the City and in accordance with the maintenance plan incorporated in the Agreement, the City, and its authorized agents and employees with reasonable notice, may enter the Property and take whatever steps it deems necessary and appropriate to return the treatment measure(s) and/or HM control(s) to good working order. Such notice will not be necessary if emergency conditions require immediate remedial action. This provision shall not be construed to allow the City to erect any structure of a permanent nature on the Property. It is expressly understood and agreed that the City is under no obligation to maintain or repair the treatment measure(s) and/or HM control(s) and in no event shall this Agreement be construed to impose any such obligation on the City.

SECTION 9: REIMBURSEMENT OF CITY EXPENDITURES

In the event the City, pursuant to the Agreement, performs work of any nature (direct or indirect), including any reinspections or any actions it deems necessary or appropriate to return the treatment measure(s) and/or HM control(s) in good working order as indicated in Section 8, or expends any funds in the performance of said work for labor, use of equipment, supplies, materials, and the like, the Property Owner shall reimburse the City, or shall forfeit any required bond upon demand within thirty (30) days of receipt thereof for the costs incurred by the City hereunder. If these costs are not paid within the prescribed time period, the City may assess the Property Owner the cost of the work, both direct and indirect, and applicable penalties. Said assessment shall be a lien against the Property, or prorated against the beneficial users of the Property or may be placed on the property tax bill and collected as ordinary taxes by the City. The actions described in this section are in addition to and not in lieu of any and all legal remedies as provided by law, available to the City as a result of the Property Owner's failure to maintain the treatment measure(s) and/or HM control(s).

SECTION 10: INDEMNIFICATION

The Property Owner shall indemnify, hold harmless and defend the City and its authorized agents, officers, officials and employees from and against any and all claims, demands, suits, damages, liabilities, losses, accidents, casualties, occurrences, claims and payments, including attorney fees claimed or which might arise or be asserted against the City that are alleged or proven to result or arise from the construction, presence, existence or maintenance of the treatment measure(s) and/or HM control(s) by the Property Owner or the City. In the event a claim is asserted against the City, its authorized agents, officers, officials or employees, the City shall promptly notify the Property Owner and the Property Owner shall defend at its own expense any suit based on such claim. If any judgment or claims against the City, its authorized agents, officers, officials or employees shall be allowed, the Property Owner shall pay for all costs and expenses in connection herewith. This section shall not apply to any claims, demands, suits, damages, liabilities, losses, accidents, casualties, occurrences, claims and payments, including attorney fees claimed which arise due solely to the negligence or willful misconduct of the City.

SECTION 11: NO ADDITIONAL LIABILITY

It is the intent of this agreement to insure the proper maintenance of the treatment measure(s) and HM controls (if any) by the Property Owner; provided, however, that this Agreement shall not be deemed to create or effect any additional liability not otherwise provided by law of any party for damage alleged to result from or caused by storm water runoff.

SECTION 12: PERFORMANCE FINANCIAL ASSURANCE

The City may request the Property Owner to provide a performance bond, security or other appropriate financial assurance providing for the maintenance of the stormwater treatment measure(s) and HM controls (if any) pursuant to the City's ordinances, guidelines, criteria or written direction..

SECTION 13: TRANSFER OF PROPERTY

This Agreement shall run with the title to the land. The Property Owner further agrees whenever the Property is held, sold, conveyed or otherwise transferred, it shall be subject to this Agreement which shall apply to, bind and be obligatory to all present and subsequent owners of the Property.

SECTION 14: SEVERABILITY

The provisions of this Agreement shall be severable and if any phrase, clause, section, subsection, paragraph, subdivision, sentence or provision is adjudged invalid or unconstitutional by a court of competent jurisdiction, or the applicability to any Property Owner is held invalid, this shall not affect or invalidate the remainder of any phrase, clause, section, subsection, paragraph, subdivision, sentence or provision of this Agreement.

SECTION 15: RECORDATION

This Agreement shall be recorded by the Property Owner, or by the City by mutual agreement, within [insert number of days]____ days after the execution date of this Agreement as stated above among the deed records of the County Recorder's Office of the County of Alameda, California at the Property Owner's expense.

SECTION 16: RELEASE OF AGREEMENT

In the event that the City determines that the stormwater treatment measures and/or HM controls (if any) located on the Property are no longer required, then the City, at the request of the Property Owner shall execute a release of this Inspection and Maintenance Agreement, which the Property Owner, or the City by mutual agreement, shall record in the County Recorder's Office at the Property Owner's expense. The stormwater treatment measure(s) and/or HM controls (if any) shall not be removed from the Property unless such a release is so executed and recorded.

SECTION 17: EFFECTIVE DATE AND MODIFICATION

This Agreement is effective upon the date of execution as stated at the beginning of this Agreement. This Agreement shall not be modified except by written instrument executed by the City and the Property -Owner at the time of modification. Such modifications shall be effective upon the date of execution and shall be recorded.

____________________________________ ____________________
Signature for the City Date

____
Type or print name and title

____________________________________ ____________________
Property Owner Signature Date

____
Type or print Property Owner name and address

Member Agencies:

Alameda

Albany

Berkeley

Dublin

Emeryville

Fremont

Hayward

Livermore

Newark

Oakland

Piedmont

Pleasanton

San Leandro

Union City

Unincorporated
Alameda County

Alameda County
Flood Control and
Water Conservation
District

Zone 7 of the
Alameda County Flood
Control and
Water Conservation
District

Alameda Countywide
Clean Water Program
A Consortium of Local Agencies

October 19, 2010

C.3 Stormwater Technical Guidance

A handbook for developers, builders and project applicants

Version 2.1

Updates and Errata

On October 19, 2010, the following changes were made to the C.3 Stormwater Technical Guidance, Version 2.0, dated September 27, 2010. In this updated version (Version 2.1, dated October 19, 2010) these changes have been made to the applicable sections.

#1 – Deleted October 2010

Local Contacts:
Pleasanton Utility Engineer phone number deleted, replaced with City Engineering 925.931.5650

#2 – Deleted October 2010

Chapter 6, Section 6.1 Bioretention Area/Rain Garden, page 69.

- Surface ponding depths should vary, with a maximum 18-inch depth. If ponding depths exceed 6 inches, landscape architect shall approve planting palette for desired depth.

Replaced with

- Surface ponding depths should vary, with a maximum 12-inch depth. If ponding depths exceed 6 inches, landscape architect shall approve planting palette for desired depth.

#3 – Deleted October 2010

Chapter 6, Section 6.2 Flow-Through Planter, page 74.

INLETS TO TREATMENT MEASURE
Flow may enter the treatment measure (see example drawings in Section 5.10):

- Through a curb opening (minimum 12 inches)

Replaced with

INLETS TO TREATMENT MEASURE
Flow may enter the treatment measure (see example drawings in Section 5.10):

- Through a curb opening (minimum 18 inches)

#4 –Deleted October 2010

Chapter 6, Section 6.3 Tree Well Filter, page 79.

INLETS TO TREATMENT MEASURE
Flow may enter the treatment measure (see example drawings in Section 5.10):
- Through a curb opening (minimum 12 inches)

Replaced with

INLETS TO TREATMENT MEASURE
Flow may enter the treatment measure (see example drawings in Section 5.10):
- Through a curb opening (minimum 18 inches)

#4 – Deleted October 2010

Chapter 6, Section 6.4 Vegetated Buffer Strip, page 83.

INLETS
Flow may enter the treatment measure (see example drawings in Section 5.10):
- Through a curb opening (minimum 12 inches)

Replaced with

INLETS
Flow may enter the treatment measure (see example drawings in Section 5.10):
- Through a curb opening (minimum 18 inches)

#5 – Deleted October 2010

Appendix B, Plant List and Planting Guidance, page B-5

- Table B-1: Plant List for Stormwater Measures

Replaced with

- Revised Table B-1: Plant List for Stormwater Measures

#6 – Deleted October 2010

Appendix B, Plant List and Planting Guidance, pages B-9 (Bioretention), B-11 (Flow-through planter), B-13 (Tree well filter), B-14 (Vegetated buffer strip), B-18 (Infiltration trench), B-19 (Extended detention basin), B-23 (Turf block pavers), Page B-23 (Green roof)

- Reiteration of plants listed in Table B-1, for each specific type of stormwater measure.

Replaced with

- Paragraphs regarding each specific type of stormwater measure were revised to refer to Table B-1, instead of reiterating plants listed in the table.

Local Contacts

Contact information for each of ACCWP's member agencies is given below. Please contact the local agency with any questions regarding requirements specific to the local jurisdiction.

Alameda: Public Works Department, 510.749.5840

Albany: Community Development and Environmental Resources Department 1000 San Pablo Avenue, Albany, CA 94706. 510.528.5760

Berkeley: 510.981.7451

Dublin: 925.833.6650

Emeryville: Civic Center, 1333 Park Ave, Emeryville, CA 94608
510.596.3728, www.ci.emeryville.ca.us/planning/stormwater.html

Fremont: Environmental Services Division, 39550 Liberty Street, Fremont CA 94538, 510.494.4570, www.fremont.gov/stormwaterdevelopment

Hayward: Engineering and Transportation Division, 510.583.4785

Livermore: 925.960.8100 (Inspection/reporting), 925.960-4500 (C.3 Technical Info)
Permit Center, 1052 South Livermore, Ave. Livermore, CA 94550

Newark: Michael Carmen or Soren Fajeau, City Hall – Public Works, 37101 Newark Boulevard, 1st Floor, Newark CA 94560, 510.578.4320

Oakland: Permit Center, 250 Frank H. Ogawa Plaza, 2nd Floor, Oakland, CA 94612
510.238.3911, www.oaklandnet.com

Piedmont: Public Works Counter, City Hall, 120 Vista Avenue, Piedmont, CA 94611; 510.420.3050; www.ci.piedmont.ca.us

Pleasanton: City Engineering, 925.931.5650

San Leandro: Engineering and Transportation Department, Civic Center- 835 East 14th Street, San Leandro, CA 94577
Nick Thom, 510.577.3431, nthom@ci.san-leandro.ca.us OR
Keith Cooke, 510.577.3439, kcooke@ci.san-leandro.ca.us

Union City: 34009 Alvarado-Niles Blvd., Union City, CA 94587, 510.675.5362

Unincorporated Alameda County: 510.670.5543
339 Elmhurst Street, 1st Floor, Permit Center, Hayward, CA 94544

Alameda County Flood Control and Water Conservation District: 510.670.5543
339 Elmhurst Street, 1st Floor, Permit Center, Hayward, CA 94544

Zone 7 Water Agency: 925.454.5036

Table of Contents

[1] Vegetated swale technical guidance is available at www.cleanwaterprogram.org (click on "for businesses," then "New Development") until the phase-in of LID requirements (12/1/11) that exclude this swale design.

List of Tables

Page

List of Figures

Alameda Countywide
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- FREE -
Register now!

New Development Workshop:

New C.3 Requirements for Development Projects in the Municipal Regional Stormwater Permit

Attention!

- **Planners**
- **Engineers**
- **Landscape Architects**

Don't miss this event!

Wednesday, September 29, 2010

8:00 am to 12:00 noon
Shannon Community Center, Ambrose Room
11600 Shannon Avenue
Dublin

The Municipal Regional Stormwater Permit (MRP) was adopted in Fall 2009, with new low impact development (LID) requirements that go into effect December 1, 2011. Projects will need to evaluate the feasibility of meeting stormwater treatment requirements by harvesting and using rainwater, infiltrating it into the ground, or allowing it to evapotranspire. Where these approaches are infeasible, landscape-based biotreatment will be allowed – with new soil requirements. Regional criteria are also being developed for high density, transit-oriented "special projects," where some vault-based treatment may be allowed. The workshop will cover:

- ✓ New ***MRP requirements*** for development projects
- ✓ New update of the countywide ***C.3 Technical Guidance***
- ✓ Overcoming obstacles to building ***green roofs***
- ✓ Upcoming regional biotreatment ***soil specifications***
- ✓ Preliminary results of water quality monitoring at a ***bioretention*** area: how well is it working?

Green roof in Emeryville

There is no fee for the workshop
Please pass this flyer to appropriate staff in your organization.

NOTE: Municipal staff will receive first priority for registration. If space is available, developers, builders and consultants may also attend.

Name/Title:______________________________

Agency/Company:______________________________

Address:______________________________

Phone:____________ **Fax:**____________ **Email:**____________

Please complete and email to Christina (*Chovland@eoainc.com*) or fax to 510/832-2856 – **No later than September 22.** Questions? Call or email Christina (510/832-2852 x 126)

Alameda Countywide
Clean Water Program
A Consortium of Local Agencies

2010 New Development Workshop

New C.3 Requirements for Development Projects in the Municipal Regional Stormwater Permit

Wednesday, September 29, 2010

Shannon Community Center, Ambrose Room
11600 Shannon Avenue, Dublin

AGENDA

Registration and Refreshments	8:30 – 8:45
Welcoming Remarks Mark Lander, *City of Dublin,* *ACCWP New Development Subcommittee Chair*	8:45 – 8:50
New MRP Provision C.3 Requirements for Development Projects and Corresponding Update of the C.3 Technical Guidance Laura Prickett, *EOA, Inc.* Ed Boscacci, *BKF Engineers*	8:50 – 9:35
Preparation of Regional Biotreatment Soil Specifications Megan Stromberg, *WRA*	9:35 – 10:05
BREAK	10:05 – 10:15
Design of Bioretention Areas at Serramonte Library, Daly City Jonathan Buck, *ENGEO*	10:15 – 10:35
Preliminary Findings of Water Quality Monitoring at Serramonte Library: How Well Are Bioretention Areas Working? Nicole David, *San Francisco Estuary Institute*	10:35 – 11:00
Overcoming Obstacles to Green Roofs Sarah Sutton, *Design, Community and Environment* Peter Schultze-Allen, *City of Emeryville*	11:00 – 11:55
Closing Remarks Mark Lander	11:55 – 12:00

Alameda Countywide Cleanwater Program 2010 New Development Workshop

On-Site Registration

Present	Last Name	First Name	Agency	Phone	AICP	Email Address
X	Scanlin	Jim	ACCWP			jims@acpwa.org
X	Barse	James	City of Alameda	510.749.5857		jbarse@ci.alameda.ca.us
X	Guccione	Patrizia	City of Alameda	510.749.5857		pguccion@ci.alameda.ca.us
	Sankoh	Ajati	Alameda County Environmental Health	510.567.6820		ajati.sankoh@acgov.org
X	Lee	Howard	Alameda County Planning	510.670.6521		howard.lee@acgov.org
X	Chu	James	Alameda County Public Works	510.670.5566		james@acpwa.org
X	DeLeon	Rosemarie	Alameda County Public Works	510.670.6601		roseld@acpwa.org
X	Gonzales	Fernando	Alameda County Public Works	510.670.6601		fernando@acpwa.org
X	Laurence	Justin	Alameda County Public Works	510.670.5435		justinl@acpwa.org
X	Lee	Ken	Alameda County Public Works	510.670.5711		kenl@acpwa.org
X	Lewis	David	Alameda County Public Works	510.670.6601		davidl@acpwa.org
X	Modrell	Paul	Alameda County Public Works	510.670.5248		paulm@acpwa.org
X	Ng	Bond	Alameda County Public Works	510.670.5785		bond@acpwa.org
X	Valderrama	Arthur	Alameda County Public Works	510.670.6601		arthur@acpwa.org
X	Yin	Kyin	Alameda County Public Works	510.670.6601		kyin@acpwa.org
X	Bernardes	Anna	City of Albany			abernardes@albanyca.org
	Bond	Jeff	City of Albany	510.528-5769		jbond@albanyca.org
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Alameda Countywide Cleanwater Program 2010 New Development Workshop

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Alameda Countywide
Clean Water Program
A Consortium of Local Agencies

Evaluation Summary

2010 New Development Workshop

New C.3 Requirements for Development Projects in the Municipal Regional Stormwater Permit

September 29, 2010

Shannon Community Center, Dublin

52 evaluations (96 attendees, not including workshop staff)

What Did You Think of the Following Presentations?

1. **New MRP Provision C.3 Requirements for Development Projects and Corresponding Update of the C.3 Technical Guidance**
   – Laura Prickett and Ed Boscacci

6 too detailed **10** not enough detail **33** just right **3** no answer

Comments:
Went through too fast / hard to comprehend / too rushed (12)
Difficult to hear / need to speak up (2)
Good examples and understandable.
Good example and walk-through of calculation/sizing.
More of this to be given to developers.
EB was talking to engineers only. Huh?
Ed's presentation was too technical for non-engineers.
Need to speak slower (Laura)
Handout too small to read, put in handout calculations for future reading/studying.
First part of presentation too detailed for speed of presentation, 2nd part OK.
Need more emphasis on background and regulations.

2. **Preparation of Regional Biotreatment Soil Specifications** *– Megan Stromberg*

1 too detailed **4** not enough detail **46** just right **1** no answer

Comments:
Would have been nice to touch on Alameda's specifications, either the overview or a brief description of the differences.
Consider elaborating the topic rather than reading those slides to audience.
Hard to pinpoint exact soil/mix requirement as part of the new C.3 rule.
I really liked her presentation. Would have liked her to go into depth on certain areas. Too fast.
List approved suppliers.
Good information.
Good examples and understandable

3. **Design of Bioretention Areas at Serramonte Library, Daly City** *– Jonathan Buck*

0 too detailed **2** not enough detail **49** just right **1** no answer

Comments:
Very good (2)
Lessons learned remarks are helpful.
Hard to see the stages.
Case studies good approach. This was a good case study to share.
Great project, great example, testing provided essential info.

4. **Preliminary Findings of Water Quality Monitoring at Serramonte Library –** *Nicole David*

4 too detailed **0** not enough detail **44** just right **2** did not attend **2** no answer

Comments:
Jonathan and Nicole gave a good presentation. Very interesting. Great data showing reduction in pollutants. Good example to provide engineers with the "purpose" behind these requirements.
It was detailed BUT understandable.
Lessons learned remarks are helpful.
Good information. Good to hear. (2)
Excellent information, simple and informative. Essential information. Thanks for presenting preliminary data.
Seemed too technical. Might work better with general summary of why contaminants are bad and what benefits are.
Well presented!
Would like to see more subsequent monitoring 3-5 years from installation.
Discussion ran too long.

5. **Overcoming Obstacles to Green Roofs –** *Sarah Sutton and Peter Schultze-Allen*

3 too detailed **0** not enough detail **44** just right **4** no answer **1** did not attend

Comments:
Too specialized for local government entity to learn and implement as part of the C.3 requirements.
Need this info to be available to all developers.
Sarah – useful for designers, Peter – useful for agency staff.
Peter's presentation is very good – just right!
A little too long.
Excellent. Really good "need to know" info about designing / building green roofs. Perfect level of detail for this audience.
Excellent information – great Emeryville examples also – most valuable information.
Didn't address obstacles.

Did this workshop meet your expectations?

1 Exceeded **38** Yes **1** Somewhat **2** No **10** No answer

Which topics were most beneficial?

Update on C.3 requirements (14)
Testing of pilot project (7)
Soil mix (5)
All (4)
Green roof info and examples (3)
Design guidelines (2)
Discussion of applicable treatments
Good mix between theoretical and example projects.
Details of construction
Lessons learned

Which topics were least beneficial?

Green roofs (9)
None (2)
Serramonte Library (2)

Permit overview because I already had this info.
Soil
Calculations and tables
Handouts are too small to read and need more time for Ed to explain calculations

Suggestions for future workshop topics?

More biological testing/treatment research data and technical guidance for treatment measures and green roofs
Continue C.3 implementation case studies, lessons learned, monitoring results.
Soil science: soil fertility in long term when initial compost gradually biodegrades, plant health and long-term success of bioretention.
Possible hands-on work topic – do some sample calculations.
Discuss life cycle of projects and cost analysis.
Hold them at Shannon Center.
Provide or be ready to provide more info on questions that are still unanswered such as concentrating pollutants into bioswale areas. What happens to groundwater? Etc.
Results of hazardous material test in bioretention planter/swales and costs to replace and how soon.
More detail/guidelines regarding regulation thresholds and more examples.
Spend a little more time at beginning reviewing the advent of C.3
Continued review of permit requirements as they relate to public works issues i.e. road widenings and rehabilitation.
Show specific projects and what has worked and not along with <u>details</u>.
Discuss more research on stormwater facilities.
Bay friendly landscaping
Adequate coverage and emphasis on background of new requirements.
Examples of LID Tier 1 design and implementation
More lessons learned.
Solar /photovoltaic – examples
Specific for existing roadway – not new developments. How do you implement C.3 in existing 50' roadway while maintaining parking and 2 lanes?
Real design solution for a roadway repaving project where MRP implemented.

Suggestions for future audiences to reach out to?
Contractors, builders, owners – demonstrate that these projects aren't scary and how to integrate into traditional designs.
Builders, developers, engineering firms, landscape architects and maintenance workers / companies.
Landscape architects, engineers, site maintenance professionals and developers
Contractors. Find out their point of view in terms of implementing the C.3 requirements.
Landscape architects, engineering firms and city capital project departments.

What interest do you represent?

12 Municipal Agency (Engineering / Transportation)

10 Municipal Agency (Unspecified)

6 Municipal Agency (Development Services)

5 Municipal Agency (Public Works)

2 Municipal Agency (Parks)

1 Municipal Agency (Building)

1 Developer/Builder

_5_ Consultant (Engineering)

_2_ Other

General Comments:

Thank you! (2)

How do we answer questions about balancing requirements – water conservation /irrigation/accessibility

Great location and facility to hold meeting. I appreciated the coffee and refreshments as well as natural lighting. This made the reception of information better.

Overall, it is very educational and informative for the updated C.3 requirements

Very well-organized event. Beautiful conference roof and facility. Enjoyed all the refreshments. Would have maybe enjoyed a little more on new C.3 regs that everybody needs to meet and less on green roofs that not many will implement. Thanks for hosting this event.

Include slide in C.3 requirements presentation specifics about requirements especially the non-special land use categories (even though same as old, should be reiterated).

It was a good overview for myself.

I was hoping the presentation was going to cover the guidelines in much more detail.

Great workshop! Good job, Mark and Laura.

Much better than I feared when my supervisor told me to attend.

APPENDIX C
Provision C.4
Industrial and Commercial Site Controls

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ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

Industrial & Illicit Discharge Control Subcommittee - FY 20010/11

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List of IIDC Related Educational Outreach Materials Downloaded from ACCWP's Website

Rank Order	Name of Outreach Piece	Audience	Language	Number of Pages	Year Produced	Number Downloaded	Total
1	Vehicle Service Facilities Best Management Practices	owners, managers and workers at vehicle service facilities	Spanish	8	2007	4610	7895
			English			1857	
			Vietnamese			727	
			Chinese			701	
2	Tips for a Cleaner Bay How Your Business Can Prevent Stormwater Pollution	owners, managers and workers of any business	English	8	2009	1939	5512
			Spanish			1374	
			Chinese			1218	
			Vietnamese			981	
3	Restaurant BMP Guide	owners, managers, and workers at food service facilities	Spanish	4	2003	1451	4096
			English			1314	
			Chinese			629	
			Vietnamese			610	
			unknown			92	
4	Urban Runoff Pollution is Everybody's Business	owners, managers and workers of any business	English	2	1999	2951	2951
5	Tips for a Cleaner Bay How Your School Can Prevent Stormwater Pollution	school maintenance managers and maintenance staff	English	8	2009	1145	2074
			Spanish			929	
6	Fund Raising Carwash	organizations holding carwashes	English	2	1999	1728	1728
7	Clean It Right!	owners, managers, and workers at food service facilities	Spanish	1 - poster	2006	742	1457
			English			715	
8	School Facilities BMPs to Protect Local Water Quality	school administrators and staff responsible for maintenance	English	35	2002 & revised 2009	1131	1131

List of IIDC Related Educational Outreach Materials Downloaded from ACCWP's Website

Rank Order	Name of Outreach Piece	Audience	Language	Number of Pages	Year Produced	Number Downloaded	Total
9	Don't Set a Table for Pests	owners, managers, and workers at food service facilities	English	1	old	592	1120
			Spanish			528	
10	Your Shop Can Make a Difference!	owners, managers, and workers at vehicle service facilities	English	7	old	993	993
11	Reducing Mercury Pollution	small business owners and managers who dispose fluorescent lamps	English	2	2004 & revised 2006	992	992
12	Washing Cars and Other Vehicles	owners, managers, and workers at vehicle service facilities	English	2	old	733	733
13	Mobile Pet Care Proper Disposal Tips	owners, managers, and workers of businesses that provide mobile pet care	English	2	2004	733	733
14	Proper Disposal Tips for Carpet Cleaners	owners, managers, and workers of mobile carpet cleaners	English	2	2004	714	714
15	Mobile Cleaners	owners, managers, and workers who conduct transportation related cleaning, surface cleaning, food related cleaning, etc.	English	4	2004	708	708
16	Engine & Parts Cleaning & Radiator Flushing	owners, managers, and workers at vehicle service facilities	English	2	old	702	702

List of IIDC Related Educational Outreach Materials Downloaded from ACCWP's Website

Rank Order	Name of Outreach Piece	Audience	Language	Number of Pages	Year Produced	Number Downloaded	Total
17	Tips for Managers of Vehicle Service Facilities	managers of vehicle service facilities	English	2	old	676	676
18	Changing Oil and Other Fluids	owners, managers, and workers at vehicle service facilities	English	2	old	640	640
19	Keeping a Clean Shop	owners, managers, and workers at vehicle service facilities	English	2	old	639	639
20	Body Work	owners, managers, and workers at vehicle service facilities	English	2	old	540	540
						Total	36034

Survey to Determine I&IDC Subcommittee's Priorities for Revising Educational Outreach Materials That ACCWP Produced

Name of Outreach Piece	Number of Pages	Year Pro-duced	Relative Popularity Based on Website Downloading	Alameda, City	Berkeley	Dublin	Fremont	Hayward	Livermore	Newark	Oakland	Pleasanton	San Leandro	Union City	Alameda County	Score/voter	Priority Rank
Restaurant BMP Guide	4	2003	3	1	5	1	3	2	3	1	6	OK	5	2	OK	2.9	**1**
Vehicle Service Facilities BMPs	8	2007	1	OK	OK	2	OK	1	1	2	8	2	6	3	OK	3.13	**2**
Urban Runoff is Everybody's Business	2	1999	4	6	4	4	8	3	2	4	7	7	8	1	1	4.58	**3**
Mobile Cleaners	4	2004	12	4	1	6	1	4	9	9	1	4	1	11	OK	4.64	**4**
Reducing Mercury Pollution	2	2006	9	5	6	8	6	5	6	8	2	1	2	7		5.09	**5**
Fund Raising Carwash	2	1999	6	10	7	12	2	6	5	10	5	OK	7	4	2	6.36	**6**
Clean It Right! (poster)	1	2006	7	9	OK	5	OK	8	4	5	OK	OK	5	9	OK	6.43	**7**
Proper Disposal Tips for Carpet Cleaners	2	2004	11	7	3	7	5	9	8	11	3	5	3	12		6.64	**8**
Mobile Pet Care Proper Disposal Tips	2	2004	10	8	8	9	7	10	7	12	4	6	4	10		7.73	**9**
School Facilities BMPs to Protect Local Water Quality	35	2009	8	OK	OK	10	4	12	OK	7	OK	9	OK	8		8.33	**10**
Tips for a Cleaner Bay - Businesses	8	2009	2	OK	OK	3	OK	7	OK	3	OK	3	OK	5		**OK**	**OK**
Tips for a Cleaner Bay - Schools	8	2009	5	OK	OK	11	OK	11	OK	6	OK	8	OK	6		**OK**	**OK**
Other - Good Housekeeping				2													
Other - Building Maintenance & Remodeling				3													
Dry Materials and Liquid Materials					2												

Industrial and Illicit Discharge Subcommittee Annual Training

Stormwater Business Inspectors Workshop: Pollutants of Concern and Inspection Skills

Thursday, June 9, 2011
8:30 a.m. to 3:00 p.m.

Shannon Community Center
Ambrose Room
11600 Shannon Avenue
Dublin, CA

This workshop is designed for municipal staff that conducts or oversees storm water inspections at commercial and industrial businesses. The workshop will provide an opportunity for inspectors and their supervisors to improve their inspection skills through presentations on issues relevant to inspectors, and a facilitated table-top exercise of inspection challenges.
Morning refreshments and lunch will be provided.

- ✓ Hear the latest on plastic debris and PCB management from the regulators
- ✓ Case study on effective use of administrative proceedings
- ✓ How would you deal with…inspection challenges

Annual C-12 Training PCB-Containing Equipment Identification

There is no fee for the workshop
Please pass this flyer to appropriate staff in your organization.

NOTE: Municipal staff will receive first priority for registration.
If space is available, business representatives and consultants may also attend.
Registering multiple people from the same organization? Attach a sheet of paper with the registration information.

Name/Title:______________________________

Agency/Company:______________________________

Address:______________________________

Phone:______________ **Email:** ______________

Please complete and email to Mashon (***mashonj@LWA.com***) or fax to 510/625-1588 – **No later than May 26th.** Questions? Call or email Mashon (510-625-1580 x10)

Tentative IIDC Training Workshop Agenda

June 9, 2011 8:30 a.m. - 2:45 p.m.
Shannon Center, Dublin CA

Check-in and Refreshments		8:30-9:00
Welcome	Scott Seery, Sub Committee Chair *Alameda County Public Works*	9:00-9:15
BASMAA Regional Training on PCB, Cu, and Hg	Sandy Mathews *LWA*	9:15-10:00
What happens with reported discoveries of PCBs	Mark Johnson *SFBRWQCB* Amy Miller *USEPA Region 9*	10:00-10:45
Break		10:45-11:00
Pre-production Plastic Pellets	Dylan Seidner *State Water Board*	11:00-11:30
Addressing Trash during Business Inspections	Val Blakely *City of Fremont*	11:30-12:00
Lunch		12:00-1:00
Table Top Exercise – Inspection Challenges		1:00-2:00
Case Study: Effective Use of Administrative Proceedings	Barney Chan *Alameda County Public Works*	2:00-2:30
Question and Answers and Wrap Up		2:30-2:45

Summary of Stormwater Business Inspection Workshop Evaluation Form - June 2011

	The presentations/ exercises were clear and easy to follow	Overall, this was a very useful workshop	Materials/hand outs were useful and informative	I will use the skills learned in the workshop today	The presenter(s) were knowledgeable in the subject.	The presenter(s) encouraged questions	Total number of surveys
Inspectors	**3.6**	**3.6**	**3.4**	**3.7**	**4.0**	**3.7**	**27**
Supervise Inspectors	**2.8**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**4**
Program Manager	**3.4**	**3.6**	**3.9**	**3.5**	**3.9**	**3.4**	**9**
Other	**3.3**	**3.5**	**3.3**	**3.0**	**3.8**	**3.5**	**6**
Overall	**3.3**	**3.4**	**3.4**	**3.3**	**3.7**	**3.4**	**46**

Inspector Evaluation Forms

Organization	Q2:	Q3	Q4	Q5	Q6	Q7	What was most valuable about today's training?	What was least valuable about today's training?	Do you have any suggestions for improvement?	What subjects would you like to see future workshops?
City of Alameda	4	4	4	4	4	4	The workshop table top exercise			
Al Co Env. Health	4	4	4	4	4	4	Table top - such a broad range of subjects interp. of what each plate represents			quarries, hourse boarding facilities, shooting ranges
City of Alameda	4	4	4	4	4	4	PCB perspective from EPA and RWQCB staff; exchange of perspectives during table top			Add in table top inspection exercise
Oakland Fire Dept.	3	3	3	3	4	4	Plastic MFG/recycling impacts on SW protection			
City of Berkeley	3	2	3	3	3	3	Identifying and Process for reporting PCB's	Adressing Trash	Closer to BART	Return to compliance for NSW Cases; Examples of Best Available Technologies for various scenarios
USD	4	4	4	4	4	4	Interaction with other professionals; PCB and plastics training; references			
Union Sanitary Disctrict	4	4	4	4	4	4	Table Top exercises		More case studies; open discussion on enforcement proceedings/stances from one agency to another; Learning about differen t agencies enforcement postures for unformity in stormwater regulation	enforcement case studies
DSRSD	4	4	4	4	4	4	Exercise quiz; teamwork			to cover pharmaceuticals; Hg and other metals from metal furnishings or electric plateing shops
Alameda County DEH	4	4	4	4	4	4	Paint can contain PCB	Nothing	Great training	
Alameda County Env. Health	4	4	3	4	4	4	Ground exercise		List of attendees	
City of Newark	3.5	3.5	3.5	4	3.5	2.5	Everything	Too much PCBs	Maybe a field visit, if possible; pictures are tough and simulations are subjectiveq	Some cities go over actual case studies and go through all the steps take plus outcomes; similar to barney's but right after lunch

EBMUD	4	3	3	3	4	4	Hg/Cu/PCB info; pre-production plastics	Administrative Procedures	Alameda Stormwater workshops are always informatitive and well done	Using the Alameda report form; violation follow inpsections
Oakland Fire Dept.	4	4	4	4	4	4	I learned a lot and was able to use some of what I learned in current ongoing operation			
Berkeley Toxics	4	4	4	4	4	4				
City of Fremont	3	3	3	2	4	4				
City of Livermore	4	4	4	3	4	3	Pollutants of concern info		If group activities must be done, please provide more handouts and make smaller groups	
Union Sanitary Dsctrict	4	3	3	3	3	3				
USD/City of Freemont	3	4	2	4	4	3	Plastic Pellets; There was enough info for me to determine which business to inspect and brought examples; Trash talk	Admin Proceedures (but got better by the end with example photos)	Table tob needed at least one more packet of pictures; started asa 'shotgun'; groups start on different areas	MRP requirements; how each agency is handling
USD	4	3	3	4	4	4				
Blank	3	3	3	4	4	3	Instructors Knowldege			Cleanup info for needles
Blank	3	3	3	4	4	3	Workgroups			
USD	4	4	3	4	4	3	Different Perspectives		more time	
City of Berkeley	3	3	3	4	4	4	PCB Training was new and good			
Blank	4	3	3	4	4	4	Discussion/networking			
EBMUD	4	7	4	4	6	4	Very geared towards actual inspectors and their activities; Applicable knowldege from table top		Gaining some consistency between inspectors findings is immportant	PCB's trash (plastics); mor on how to get more consistency with inspectors findings
EBMUD	3	3	3	3	4	4	Clearer on enforcement options	Dark black and white slides	less slides/better pictures	more industrial slides
Pleasanton	3	4	4	3	4	4	Enforcement		Sound was hard to hear, screan was hard to see	keep a micorphone from scott

Supervise Inspectors Evaluation Forms

Organization	Q2:	Q3	Q4	Q5	Q6	Q7	What was most valuable about today's training?	What was least valuable about today's training?	Do you have any suggestions for improvement?	What subjects would you like to see future workshops?
Fremont	1	1	1	1	1	1				
Blank	3	4	4	4	4	4	Situational table top exercise; interaction with other inspectors			
City of Livermore	3	3	3	3	3	3	PCB presentations			
EBMUD	4	4	4	4	4	4	PCB sources		Put materials/slideshow on web	

Program Manager Evaluation Forms

Organization	Q2:	Q3	Q4	Q5	Q6	Q7	What was most valuable about today's training?	What was least valuable about today's training?	Do you have any suggestions for improvement?	What subjects would you like to see future workshops?
City of Newark	3.5	3.5	3.5	4	3.5	2.5	Everything	Too much PCBs	Maybe a field visit, if possible; pictures are tough and simulations are subjectiveq	Some cities go over actual case studies and go through all the steps take plus outcomes; similar to barney's but right after lunch

Pleasanton	3	4	4	3	4	4	Enforcement		Sound was hard to hear, screan was hard to see	keep a micorphone from scott
CWP	4	4	4	4	4	3	EPA and state perspectives		fewer table top examples	
UC Berkeley	3	3	4	3	4	4	Understanding how local agencies review sites and environmental controls	Some presenters are just better than others		more focus on industiral construction
City of Livermore	4	4	3	3	4	4				
City of Emeryville	3	3	3	3	4	4	PCB		Waterboard staff fill out worksheet on inspections to see if they agree with our determinations	
Blank	4	3	4	2	4	3	Really good case studies; Exercises were good effort and length		Presenters should be provided some basic guidance on giving/developing PP presentations (eg. Slides should not have too many words and small type; presenter should talk to audience not the screen); Barney's PP was not very helpful, too small	
City of Hayward	3	3	3	4	4	4	identification of POC's in the field		Allow additional time for table top exercises; more converstaion regarding inspection photos only	Another presentation on stormwater treatment measure BMP device inspection issues; examples of problems and adequate maintenance
Supervise EBMUD	4	4	4	4	4	4	new' pollutants of concern (Hg, Cu, PCBs); will use on the job		Hard compy samples of valuable guidelines/implementation documents onsite to review that we can use back at the office and where we can get them	

Other' Evaluation Forms

Organization	Q2:	Q3	Q4	Q5	Q6	Q7	What was most valuable about today's training?	What was least valuable about today's training?	Do you have any suggestions for improvement?	What subjects would you like to see future workshops?
Alameda Co Env. Health	3	3	2	2	3	2	PCBs		Improve visual system and lighting	field exercises if possible
Blank	3	3	3	3	4	4	Table top			
Blank	4	4	4	4	4	4	Learning where PCB's are found and how to deal with them; pre-production plastics	use of administrative proceedings	allow more time for group tabletop exerciese and/or form smaller groups	focus on recommendations for ineffective BMP implementation; more case studies
Alameda Co Env. Health	3	4	4	3	4	4				
USD	4	3	3	3	4	4	PCBs and plastics pellet presentations	Administration fo enforcement		
City of Pleasanton	4	3	3	4	4	3	Plastics and PCBs	Admin Proceedings		Outreach to public

Clean Water Program

Stormwater Business Inspectors Workshop:
Pollutants of Concern and Inspection Skills

June 9, 2011

Last Name	First Name	Agency/Company	Exercise Group #	Please Sign-in and Note your Exercise Group Number	
Aguiar	Steve	City of Livermore Water Resources	2		
Aja	Martha	City of Dublin	5		
Allen	Lynna	City of Livermore Water Resources	3	Lynna Allen	lgaller@ci.livermore.ca.us
SPENCER ~~Archacki~~	Chris ~~Stan~~	EBMUD Christopher Spencer 1@hotmail.com		Christopher Spencer	*Christopher Spencer 1@hotmail.com
Auer	Mike	Union Sanitary District	~~2~~		
Barse	Jim	City of Alameda Public Works Dept	4		
Berger	Tim	City of Fremont	4		
Biber	Karen	EBMUD	3		
Blakely	Val	City of Fremont	7	Val Blakely	
Boschen	Christine	SFBRWQCB			*
Bradley	Roger	City of Dublin	5		
Busche	Karl	City of San Leandro	5		
Camp	John	City of San Leandro	4		
Carmen	Michael	City of Newark Public Works	6		
Chan	Barney	Alameda County	6	Barney Chan	

Clean Water Program

Stormwater Business Inspectors Workshop:
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June 9, 2011

Last Name	First Name	Agency/Company	Exercise Group #	Please Sign-in and Note your Exercise Group Number
Denis	Dave	City of San Leandro	3	[illegible]
Dib	Gabriel	EBMUD	2	[illegible]
Dunning	Michael	Union Sanitary District	1	
Estadt	Carrie	City of Berkeley	1	Carrie Estadt
Fiedler	Geoff	City of Berkeley	2	GEOFF FIEDLER
Flores	Geronimo	City of Dublin	6	Geronimo Flores
Freeman	William	City of Hayward	5	[illegible]
Frisbee	John	City of Dublin	7	[illegible]
Garcia-La Grille	Roseanna	Alameda County DEH	3	Roseanna Garcia-La Grille
Gosselin	Sharon	County of Alameda	7	Sharon [illegible]
Griffin	Leroy	City of Oakland Fire Dept	5	[illegible]
Guccione	Patrizia	City of Alameda Public Works Dept	6	Patrizia Guccione
Henrie	Vaughn	Union Sanitary District	7	
Huynh	My Le	Alameda County Environmental Health	4	[illegible]

Clean Water Program

Stormwater Business Inspectors Workshop:
Pollutants of Concern and Inspection Skills

June 9, 2011

Last Name	First Name	Agency/Company	Exercise Group #	Please Sign-in and Note your Exercise Group Number
Jarvis	Fred	EOA, Inc.	4	Fred Jarvis
Johannesson	Chandra	EBMUD	1	[illegible]
Johnson	Mark	SFBRWQCB		[illegible]
Kanagasundaram	Ananthan	City of Dublin	1	[illegible]
Kennedy	Robert	City of Dublin	2	[illegible]
Khatri	Paresh	Alameda County Environmental Health	5	[illegible]
Khaw	Florence	Dublin San Ramon Services District	5	[illegible]
Klumpp	Nick	EBMUD	7	[illegible]
Kulka	Marie	EBMUD	6	[illegible]
Kunisawa	Debra	City of Hayward	6	Debra Kunisawa
Lear	Merideth	City of Berkeley- Toxics	4	M Lear
Lee	Philip	City of Alameda Public Works Dept	7	[illegible]
Lorimer	Brian	City of Pleasanton	7	[illegible]

Clean Water Program

Stormwater Business Inspectors Workshop:
Pollutants of Concern and Inspection Skills

June 9, 2011

Last Name	First Name	Agency/Company	Exercise Group #	Please Sign-in and Note your Exercise Group Number
Maffei	Lisa	City of San Leandro	2	Lisa Maffei
Marasigan	Edda	Union Sanitary District	6	[illegible]
Martinez	Phil	City of Livermore Water Resources	4	[illegible]
Mathews	Sandra	LWA		[illegible]
Matthews	Keith	City of Oakland Fire Dept	4	Keith Matthews
Mendoza	Joe	Union Sanitary District	3	[illegible]
Miller	Amy	USEPA		[illegible]
Mohan	Kapil	Dublin San Ramon Services District	6	[illegible]
Ogden	Jay	City of Berkeley	3	Jay Ogden
Parades	Alex	Union Sanitary District	5	[illegible]
Perez	Alejandro	Union Sanitary District	4	[illegible]
Pon	Craig	City of Oakland Public Works Agency	2	[illegible]
Ravalin	Ryan	City of Pleasanton	6	[illegible]
Roberts	John	City of Livermore Water Resources	5	[illegible]
Robles	Aaron	Union Sanitary District	3	[illegible]
Rosenberg	Jaime	City of Hayward	7	[illegible]
Ryuto	Randy	Union Sanitary District	2	[illegible]

Clean Water Program

Stormwater Business Inspectors Workshop:
Pollutants of Concern and Inspection Skills

June 9, 2011

Last Name	First Name	Agency/Company	Exercise Group #	Please Sign-in and Note your Exercise Group Number
Sarwary	Bashir	City of Hayward	1	
Schultze-Allen	Peter	City of Emeryville Public Works Dept	2	
Scrimger	David	UC Berkeley Environ, Health & Safety	3	DAVID SCRIMGER
Seery	Scott	Alameda County	1	
Seidner	Dylan	SWRCB		
Skillern	Sheryl	City of Oakland Fire Dept	3	Sheryl Skillern
Soto	Jose	Union Sanitary District	1	
Strawder	Angelee	EBMUD	5	Angelee Strawder * astrawde@ ebmud.u
Tamayo	Jose	City of Dublin	3	Jose Tamayo
Tougeron	Chris	Alameda County	2	
Trammell	Rob	City of Livermore Water Resources	6	RG TRAMMELL
Treece	Tiffany	City of San Leandro	1	Tiffany Treece
Tuden	Rebecca	City of Oakland Public Works Agency	1	
Wells	Mike	City of Livermore Water Resources	7	
Weston	Robert	Alameda Co. Environmental Health	1	

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APPENDIX D
Provision C.5
Illicit Discharge Detection and Elimination

BASMAA Regional Project Profile

Project Name: Enhancement of BASMAA Surface Cleaner Training and Recognition Program

Description: *(with background as necessary)* MRP provision C.5.d, Control of Mobile Sources requires development and implementation of a program to reduce the discharge of pollutants from mobile businesses, including (emphasis added):

- (1)(a) Development and implementation of minimum standards and BMPs to be required for each of the various types of mobile businesses such as automobile washing, power washing, steam cleaning, and carpet cleaning. This guidance can be developed via county-wide or regional collaboration.
- (1)(b) Development and implementation of an enforcement strategy, which specifically addresses the unique characteristics of mobile businesses.
- (1)(c) Outreach to mobile businesses operating within the Permittee's jurisdiction with minimum standards and BMP requirements and local ordinances through an outreach and education strategy.
- (1)(d) Inspection of mobile businesses as needed.
- Permittees should cooperate regionally in developing and implementing their programs for mobile businesses, including sharing of mobile business inventories, BMP requirements, enforcement action information, and education.

Background: Starting in 1995, BASMAA conducted a series of projects and produced products that make up the current Surface Cleaner Training and Recognition Program. The currently used products are: an automated web-based training course, including video and self-test application (in English and Spanish), web-based database of trained and recognized cleaners, and program materials – both training materials and marketing materials for trained and recognized cleaners (only the primary BMP guidance – *Pollution from Surface Cleaning* – is in Spanish). In addition to the permit driver, BASMAA has considered the surface cleaning focus of the current program to be 'phase 1" because there is another major mobile cleaning activity – vehicle-related cleaning, which BASMAA had planned to add to the existing program at the appropriate time.

Proposed approach: To address the new requirements in C.5.d.(1)(a) through (c) [(1)(d) is a permittee by permittee responsibility] and the long time need to address other major mobile cleaning activities, BASMAA will: 1) add to the current program, training and recognition for two new professional mobile cleaning operations – automotive washing and carpet cleaning, 2) work from existing materials from BASMAA agencies as well as others, 3) develop training videos and self-test applications, and training materials and marketing materials, 4) create Spanish tracks of information for each new business type to the extent needed, and 5) create a web-based application to share information about mobile businesses.

FY: 10-11
MRP reference: C.5.d Control of Mobile Sources
Committee task ID: Not applicable
Overseer 1: Municipal Ops Committee
Overseer 2: Not applicable
Budget: $55,000

One-time___X___ multi-FY_______
Compliance date: Not applicable
Profile last updated on: November 19, 2010
Project Officer: Geoff Brosseau

Status: BOD approved–September 23, 2010
BOD approved fund source-October 28, 2010

Funding source(s): BASMAA Restricted / Regional funds; Orange County (?)
Contracting Agency(s): BASMAA
Contractor(s): See table

BASMAA Regional Project Profile

Deliverables and Activities

MRP Provision	MRP Deliverable	Proposed BASMAA Activity	MRP Reporting Date
C.5.d(1)(a)	BMPs for fleet cleaning and carpet cleaning	Literature review; Meetings with MS4 and industry reps.; BMPs confirmation / development	9/15/2011
C.5.d(1)(b)	Enforcement strategy	Web-based application to share information about mobile businesses	9/15/2011
C.5.d(1)(c)	Outreach and education strategy	Automated web-based training course, including video and self-test application (in English and Spanish) Web-based database of trained and recognized cleaners Program materials – both training materials and marketing materials for trained and recognized cleaners	9/15/2011 9/15/2012 9/15/2013 9/15/2014 (ARs)

Roles, Schedules, and Budgets

BASMAA Deliverable	Potential Contractors	Target date	FY10-11 funding
BMPs – fleet cleaning	LWA	2/11	$7,000
BMPs – carpet cleaning	LWA	2/11	$3,000
Web-based application – information sharing	Adammer	03/11	$4,000
Training video – fleet cleaning (English / Spanish)	Video production co.	04/11	$20,000
Automated web-based training application and database (English / Spanish)	Adammer; Spanish – International Contact	05/11	$8,000
BMP education piece(s), including IC/ID card – fleet cleaning (English / Spanish)	English – LWA / Spanish – International Contact; Beverly Catli Design	03/11	$6,000
BMP education piece(s), including IC/ID card – carpet cleaning (English / Spanish)	English – LWA / Spanish – International Contact; Beverly Catli Design	03/11	$5,000
Self-tests – fleet and carpet cleaning (English / Spanish)	English – LWA / Spanish – International Contact	03/11	$1,000
Marketing materials – Customer card; customer flyer; Voucher (English)	Beverly Catli Design	05/11	$1,000
		Estimated budget*:	$55,000

* Orange County has offered to share in costs.

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APPENDIX E
Provision C.6
Construction Site Control

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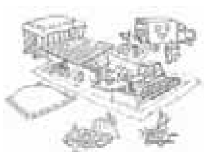
Pollution Prevention - It's Part of the Plan



Make sure your crews and subs do the job right!

Runoff from streets and other paved areas is a major source of pollution and damage to creeks and the San Francisco Bay. Construction activities can directly affect the health of creeks and the Bay unless contractors and crews plan ahead to keep dirt, debris, and other construction waste away from storm drains and local creeks. Following these guidelines and the project specifications will ensure your compliance with County of Alameda requirements.

Materials storage & spill cleanup

Non-hazardous materials management

- Sand, dirt, and similar materials must be stored at least 10 feet (3 meters) from catch basins. All construction material must be covered with a tarp and contained with a perimeter control during wet weather or when rain is forecasted or when not actively being used within 14 days.
- Use (but don't overuse) reclaimed water for dust control as needed.
- Sweep or vacuum streets and other paved areas daily. Do not wash down streets or work areas with water!
- Recycle all asphalt, concrete, and aggregate base material from demolition activities. Comply with Alameda County Ordinances for recycling construction materials, wood, gyp board, pipe, etc.
- Check dumpsters regularly for leaks and to make sure they are not overfilled. Repair or replace leaking dumpsters promptly.
- Cover all dumpsters with a tarp at the end of every work day or during wet weather.

Hazardous materials management

- Label all hazardous materials and hazardous wastes (such as pesticides, paints, thinners, solvents, fuel, oil, and antifreeze) in accordance with city, county, state, and federal regulations.
- Store hazardous materials and wastes in water tight containers, store in appropriate secondary containment, and cover them at the end of every work day or during wet weather or when rain is forecasted.
- Follow manufacturer's application instructions for hazardous materials and be careful not to use more than necessary. Do not apply chemicals outdoors when rain is forecasted within 24 hours.
- Be sure to arrange for appropriate disposal of all hazardous wastes.

Spill prevention and control

- Keep a stockpile of spill cleanup materials (rags, absorbents, etc.) available at the construction site at all times.
- When spills or leaks occur, contain them immediately and be particularly careful to prevent leaks and spills from reaching the gutter, street, or storm drain. Never wash spilled material into a gutter, street, storm drain, or creek!
- Dispose of all containment and cleanup materials properly.
- Report any hazardous materials spills immediately! Dial 911 or Alameda

[[== Insert Agency Name and phone number ==]]

Construction Entrances and Perimeter

- Establish and maintain effective perimeter controls and stabilize all construction entrances and exits to sufficiently control erosion and sediment discharges from site and tracking off site.
- Sweep or vacuum any street tracking immediately and secure sediment source to prevent further tracking.

Vehicle and equipment maintenance & cleaning

- Inspect vehicles and equipment for leaks frequently. Use drip pans to catch leaks until repairs are made; repair leaks promptly.
- Fuel and maintain vehicles on site only in a bermed area or over a drip pan that is big enough to prevent runoff.
- If you must clean vehicles or equipment on site, clean with water only in a bermed area that will not allow rinse water to run into gutters, streets, storm drains, or creeks.
- Do not clean vehicles or equipment on-site using soaps, solvents, degreasers, steam cleaning equipment, etc.

Earthwork & contaminated soils

- Keep excavated soil on the site where it will not collect in the street.
- Transfer to dump trucks should take place on the site, not in the street.
- Use fiber rolls, silt fences, or other control measures to minimize the flow of silt off the site.

- Earth moving activities are only allowed during dry weather by permit and as approved by the County Inspector in the Field.
- Mature vegetation is the best form of erosion control. Minimize disturbance to existing vegetation whenever possible.
- If you disturb a slope during construction, prevent erosion by securing the soil with erosion control fabric, or seed with fast-growing grasses as soon as possible. Place fiber rolls down-slope until soil is secure.
- If you suspect contamination (from site history, discoloration, odor, texture, abandoned underground tanks or pipes, or buried debris), call the Engineer for help in determining what should be done, and manage disposal of cntaminated soil according to their instructions.

Dewatering operations

- Effectively manage all run-on, all runoff within the site, and all runoff that discharges from the site. Run-on from off site shall be directed away from all disturbed areas or shall collectively be in compliance.
- Reuse water for dust control, irrigation, or another on-site purpose to the greatest extent possible.

- Be sure to notify and obtain approval from the Engineer before discharging water to a street, gutter, or storm drain. Filtration or diversion through a basin, tank, or sediment trap may be required.
- In areas of known contamination, testing is required prior to reuse or discharge of groundwater. Consult with the Engineer to determine what testing is required and how to interpret results. Contaminated groundwater must be treated or hauled off-site for proper disposal.

Saw cutting

- Always completely cover or barricade storm drain inlets when saw cutting. Use filter fabric, catch basin inlet filters, or sand/gravel bags to keep slurry out of the storm drain system.
- Shovel, absorb, or vacuum saw-cut slurry and pick up all waste as soon as you are finished in one location or at the end of each work day (whichever is sooner!).
- If saw cut slurry enters a catch basin, clean it up immediately.

Paving/asphalt work

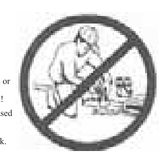
- Always cover storm drain inlets and manholes when paving or applying seal coat, tack coat, slurry seal, or fog seal.
- Protect gutters, ditches, and drainage courses with sand/gravel bags, or earthen berms.
- Do not sweep or wash down excess sand from sand sealing into gutters, storm drains, or creeks. Collect sand and return it to the stockpile, or dispose of it as trash.
- Do not use water to wash down fresh asphalt concrete pavement.

Concrete, grout, and mortar storage & waste disposal

- Store concrete, grout, and mortar under cover, on pallets, and away from drainage areas. These materials must never reach a storm drain.
- Wash out concrete equipment/trucks off-site or into contained washout areas that will not allow discharge of wash water onto the underlying soil or onto the surrounding areas.

- Collect the wash water from washing exposed aggregate concrete and remove it for appropriate disposal off site.

Painting



- Never rinse paint brushes or materials in a gutter or street!
- Paint out excess water-based paint before rinsing brushes, rollers, or containers in a sink.
- Paint out excess oil-based paint before cleaning brushes in thinner.
- Filter paint thinners and solvents for reuse whenever possible. Dispose of oil-based paint sludge and unusable thinner as hazardous waste.

Landscape Materials

- Contain, cover, and store on pallets all stockpiled landscape materials (mulch, compost, fertilizers, etc.) during wet weather or when rain is forecasted or when not actively being used within 14 days.
- Discontinue the application of any erodible landscape material within 2 days of forecasted rain and during wet weather.

Storm drain polluters may be liable for fines of $10,000 or more per day!

For references and more detailed information:
www.cleanwaterprogram.org
www.cabmphandbooks.com

REVISIONS

NO.	DESCRIPTION	BY	DATE	APPV'D

APPROVED

REGISTERED PROFESSIONAL ENGINEER
HENRY E. ACKERMAN
No. 037823
Exp. 3/31/2011
CIVIL
STATE OF CALIFORNIA

DATE
ADV DATE

COUNTY OF ALAMEDA ☆ PUBLIC WORKS AGENCY

ZONE X, LINE X
PROJECT DESCRIPTION
POLLUTION PREVENTION

WORK ORDER NO. FXXCXX
SPECIFICATION NO. FC XX–XXX
SHEET NO. 2 OF #
FILE NO. **CB-XXX**

Alameda Countywide
Clean Water Program
A Consortium of Local Agencies

INSPECTION CHECKLIST FOR CONSTRUCTION STORMWATER CONTROLS

1. Inspection Date: ____________________________ Inspector: ____

2. Inspection Type: ❑ Routine ❑ Pre-Wet Season ❑ Pre-Storm ❑ During Storm ❑ After Storm
❑ Complaint ❑ Agency Referral ❑ Follow-up ❑ Other: ____________________

3. Current Weather Conditions: ____________________ 3a. Rainfall with runoff since last inspection? ❑ Yes ❑ No

4. Site Name: ______________________________________ 4a. Project No./Permit No.: ____________________

Location: ____

5. Site Contact: ______________________________________ 5a. Site Phone No.: ____________________

6. Mailing Address: ____

7. Developer: ______________________________________ 7a. Developer Phone No.: ____________________

8. Developer Mailing Address: ____

9. Permit Type: ❑ Building Permit ❑ Grading Permit ❑ Site Development ❑ Capital Improvement

10. Project Type: ❑ Commercial/Industrial ❑ Residential ❑ Landscaping ❑ Public Improvement
❑ Utility (water/sewer/PG&E) ❑ Grading ❑ Demolition ❑ Other: ____________

11. Verification of Coverage under the Statewide Construction Activity NPDES Permit

Does the project disturb 1 acre of land, or more? ❑ Yes ❑ No NOI filed? ❑ Yes ❑ No

SWPPP dated: ____/____/____. SWPPP on site? ❑ Yes ❑ No Comments/Follow up to Regional Water Board:

____

12. High Priority Site? ❑ Yes ❑ No (Sites with significant threat to water quality.) NOTE: Sites disturbing 1 acre or more and high priority sites require monthly inspections during wet season (Oct. 1 thru April 30).

13. Erosion Control Measures:	**Adequate**	**Non-Compliant**	**Comments/Date for Correction**
❑ Jute Netting / Fiber Blankets	❑	❑	❑ ____________________
❑ Mulch	❑	❑	❑ ____________________
❑ Hydroseed / Soil Binders / Compost Blankets	❑	❑	❑ ____________________
❑ Mark Areas of Vegetation to be Preserved	❑	❑	❑ ____________________
❑ Tree Protection Fencing	❑	❑	❑ ____________________
❑ Riparian Area Barrier	❑	❑	❑ ____________________
❑ Other: ____________________	❑	❑	❑ ____________________

14. Sediment Control Meaures:	**Adequate**	**Non-Compliant**	**Comments/Date for Correction**
❑ Fiber Rolls / Wattles / Compost Socks	❑	❑	❑ ____________________
❑ Silt Fences / Compost Berms	❑	❑	❑ ____________________
❑ Check Dams	❑	❑	❑ ____________________
❑ Stabilized construction entrance	❑	❑	❑ ____________________
❑ Dust Control	❑	❑	❑ ____________________
❑ Street Sweeping	❑	❑	❑ ____________________
❑ Sedimentation Basin	❑	❑	❑ ____________________
❑ Inlet filters (Bags, sand, gravel)	❑	❑	❑ ____________________
❑ Other: ____________________	❑	❑	❑ ____________________

15. Run-on and Run-off Control:	Adequate	Non-Compliant	Comments/Date for Correction
❑ Earth Dikes / Drainage Swales	❑	❑	❑ ______
❑ Sampling is conducted, if required	❑	❑	❑ ______
❑ Other:______	❑	❑	❑ ______

16. Active Treatment Systems (if any):	Adequate	Non-Compliant	Comments/Date for Correction
❑ Daily log shows treatment objectives met	❑	❑	❑ ______
❑ Other:______	❑	❑	❑ ______

17. Good Site Management:	Adequate	Non-Compliant	Comments/Date for Correction
❑ Material Storage (wood, cement, etc)	❑	❑	❑ ______
❑ Petroleum Product Storage (oil, fuel)	❑	❑	❑ ______
❑ Hazardous Material Storage (paint,solvents)	❑	❑	❑ ______
❑ Waste Systems Management	❑	❑	❑ ______
❑ Soil Stockpiles	❑	❑	❑ ______
❑ Vehicle Servicing	❑	❑	❑ ______
❑ Other:______	❑	❑	❑ ______

18. Non-Stormwater Management:	Adequate	Non-Compliant	Comments/Date for Correction
❑ Concrete washout area	❑	❑	❑ ______
❑ Vehicle and equipment cleaning	❑	❑	❑ ______
❑ Dewatering operations	❑	❑	❑ ______
❑ Other:______	❑	❑	❑ ______

19. Are the discharge points free of any evidence of illicit discharge? ❑ Yes ❑ No Comments: ______

______

20. Describe sediment discharge from site:______

______

21. Enforcement /Follow-Up Date problem first identified: ___/___/___. Next follow-up inspection date: ___/___/___.

Corrective action(s) to be taken to remedy problems and date for completion: ______

______

Comments:______

______

Enforcement Actions: ❑ None/In compliance ❑ Verbal Warning ❑ Written Warning/ Notice of Violation ❑ Notice to Comply/ Stop work order

❑ Notice to Comply with Monetary Penalty ❑ Legal action Enforcement Action No.:______

❑ Referred to (check one): ❑ Regional Water Board ❑ Other:______

Resolution: ❑ Problem fixed ❑ Need more time (include rationale in comments) ❑ Escalate enforcement Date resolved:___/___/___

Was there rain with runoff after problem identified and before resolution? ❑ Yes ❑ No

22. Inspector's Signature:______ Date:______

23. Name of Site Superintendent (Print):______

24. Signature of Site Superintendent:______ Date:______

[[== Date ==]]

[[== Name of Project Developer or Owner ==]]
[[== Mailing Address ==]]

Reference: [[== Insert project name and address, and/or project number ==]]

Dear [[== Insert Name of Developer or Owner ==]]

This letter is an official notice regarding the above-referenced project, which has received a development permit from [[== Name of Jurisdiction ==]]. Please be advised that the project is subject to the [[== Name of Jurisdiction ==]]'s stormwater control requirements, as well as applicable State requirements.

Appropriate stormwater best management practices are required throughout the year, but are of particular concern during the wet season, which begins on October 1, and continues through April 30. The purpose of this letter is to remind you to prepare the above-referenced construction site for the coming wet season.

Failure to implement effective best management practices that prevent construction site discharges of pollutants, and impacts on beneficial uses of receiving waters, is a violation of the [[== Name of Jurisdiction ==]]'s stormwater ordinance and subject to enforcement action. Violations may also result in enforcement action by the Regional Water Quality Control Board.

For more information regarding this correspondence, please contact [[== Insert name and contact information for local contact ==]].

Sincerely,

[[== Name and Title ==]]

Attention!

- **Inspectors**
- **Engineers**

Don't miss this Event!

Construction Inspection Workshop - Understanding the Requirements and Enhancing Inspection Skills

Workshop agenda attached!

Wednesday, May 25th
8:30 a.m. to noon
Shannon Community Center, Ambrose Room
11600 Shannon Avenue, Dublin

Or

Thursday May 26th
8:30 a.m. to noon
Elihu Harris Building, Room 2
1515 Clay Street, Oakland

This workshop designed for municipal inspectors and their supervisors will highlight the Best Management Practices (BMPs) required by the Municipal Regional Permit (MRP) and review the requirements of the Statewide Construction General Permit. A combination of presentations and interactive exercises will cover the basics for new inspectors and enhance inspections skills of experienced inspectors. Regional Board staff will highlight how the inspection reports roll into the programs' annual reports.

- ✓ C.6 Requirements
- ✓ CGP Requirements
- ✓ Recognizing BMPs
- ✓ Tools to Plan and Conduct Inspections
- ✓ Regional Board Inspection Highlights

There is no fee for the workshop
Please pass this flyer to appropriate staff in your organization.

NOTE: Municipal staff will receive first priority for registration.
If space is available, developers, builders and consultants may also attend.

DATE: (Select One) ______May 25 in Dublin ______May 26 in Oakland

Name/Title:______________________________

Agency/Company:______________________________

Address: ______________________________

Phone:____________ **Fax:** ____________**Email:**____________

Please complete and email to Mashon ***(mashonj@lwa.com)*** or fax to 510/625-1588 – **No later than May 11th.**
Questions? Call or email Mashon (510-625-1580 x10)

Construction Inspection Workshop
Understanding the Requirements and Enhancing Inspection Skills

May 25, 2011 8:30-Noon
Shannon Center, Dublin CA

May 26, 2011 8:30-Noon
Elihu Harris Building Oakland CA

Workshop Agenda

Check-in and Refreshments		8:30-9:00
Welcome	Jim Scanlin *Clean Water Program*	9:00-9:10
Overview of C.6 Requirements and CGP Awareness	Mark Lander *City of Dublin*	9:10-9:35
Recognizing BMPs	Sandy Mathews *LWA*	9:35-10:05
Break		10:05-10:25
Table Top Exercise – Using the C.6 BMP Toolbox for Typical Construction Sites		10:25-10:50
Planning and Conducting Inspections	Tim Berger *City of Fremont*	10:50-11:25
Regional Board Inspection Insights	Selina Louie *SFBRWQCB*	11:25-11:45
Question and Answers and Wrap Up		11:45-noon

Clean Water Program
Construction Inspection Workshop
May 25, 2011
Sign-In Sheet

Acamo	Dale	Alameda County	Dale Acamo
Aguiar	Steven	City of Livermore ~~Alameda County Bldg Inspection Dept~~	
Aikenhead	Diana	City of Berkeley ~~Alameda County GSA-TSD~~	
Aja	Martha	~~Alameda County GSA-TSD~~ City of Dublin	
Armbruster	Tim	Alameda County Public Works Agency	
Atienza	Vennie	Alameda County Public Works Agency	
Azim	Farooq	City of Union City ~~Alameda County Public Works Agency~~	
Barreras	Roehl	City of Dublin ~~Alameda County Public Works Agency~~	
Batin	Rahman	Alameda County Public Works Agency	Rahman Batin
Bolton, III	George	Alameda County Public Works Agency	
Boyd	Terrence	Alameda County Public Works Agency	
Breining	Paul	Alameda County Bldg. Inspection Dept. ~~Public Works Agency~~	
Bucknam	Jeff	City of Dublin ~~Alameda County Public Works Agency~~	
Bussell	John	Alameda County GSA	John Bussell

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Clean Water Program
Construction Inspection Workshop
May 25, 2011
Sign-In Sheet

Campos	Miguel	Alameda County Public Works Agency	Miguel B. Campos
Cardwell	John	~~Alameda County Public Works Agency~~ City of Livermore	John W. Cardwell
Carmen	Michael	~~Alameda County Public Works Agency~~ City of Newark	M Carmen
Cashen	George	Alameda County Public Works Agency	
Cho	Andy	Alameda County Public Works Agency	[illegible]
Del Rio	Arturo	Alameda County Public Works Agency	
Delacruz	Nolascoe	Alameda County Public Works Agency	[illegible]
Dizon	Cheryl	~~Alameda County PW-M&O Flood Control~~ Zone 7 Water Agency	[illegible]
Drewes	Blaine	City of ~~Berkeley~~ Livermore	Blaine Drewes
Ellis	Steven	~~City of Dublin~~ Zone 7 Water Agency	
Fitch	Ray	City of ~~Dublin~~ Union City	
Flood	John	City of ~~Dublin~~ Union City	[illegible]
Fong	Jack	Zone 7 Water Agency	
Fockler	Henry	Alameda County P.W.	Henry Fockler
Mills	Ken	City of Dublin	Kenneth Mills

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Clean Water Program
Construction Inspection Workshop
May 25, 2011
Sign-In Sheet

Gee	Arnold	~~City of Dublin~~ Alameda Co PWA	
Geigle	Robert	City of ~~Dublin~~ Pleasanton Bldg & Safety	
Ghumnam	Jarnail	City of Fremont	
Gutierrez	Jose	City of ~~Fremont~~ San Leandro	Jose Gutierrez
Guzman	Danny	~~City of Fremont~~ Alameda Co PWA	
Harris	Alfred	~~City of Hayward~~ Alameda Co PWA	Alfred Harris
Hilst	Greg	County of Alameda ~~City of Hayward~~	Greg Hilst
Inthavong	Hamm	City of Hayward	[illegible]
Jones	Jeff	~~City of Hayward~~ Zone 7 Water Agency	
Kanagasundaram	Anathan	City of ~~Hayward~~ Dublin	[illegible]

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Clean Water Program
Construction Inspection Workshop
May 25, 2011
Sign-In Sheet

Lander	Mark	City of ~~Livermore~~ Dublin	
Laurence	Justin	City of Livermore	
Lear	James	City of ~~Livermore~~ Hayward	
Lopez	Omar	~~City of Livermore~~ Alameda Co	
Lung	Pamela	City of Livermore	Pamela Lung
Martin	Doug	City of Livermore	
Matlock	Daniel	City of Livermore	Daniel Matlock
Mattison	Patricia	City of Livermore	Patricia Mattison
Maxwell	Ken	City of Livermore	
Messa	Mark	City of Livermore	
Navarro	Frank	City of ~~Livermore~~ Dublin	
Nelkie	Adam	City of Pleasant Hill	
Santhosh	Jayasree	City of Pleasanton	Jayasree
Louie,	Selina	SFBRWQCB	Selina

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Clean Water Program
Construction Inspection Workshop
May 25, 2011
Sign-In Sheet

Olmsted	Mona	~~City of Pleasanton~~ Zone 7 Water Agency	
Pato	Mike	City of ~~Pleasanton~~ Livermore	
Pulu	Paulo	City of Pleasanton	
Purcell	Lorraine	City of Pleasanton	
Raven	Jon	City of Pleasanton	
Renk	Michael	City of Pleasanton Building & Safety	
Romero	Robert	City of Pleasanton Building & Safety	
Ross	Ken	City of Pleasanton Building & Safety	
Russell	Gary	City of San Leandro	Gary Russell

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Clean Water Program
Construction Inspection Workshop
May 25, 2011
Sign-In Sheet

Sarwary	Bashir	City of Union City	
Schaffer	Mike	City of Union City	
Skoczen	Jeff	City of Union City	
Soto	Jose	~~City of Union City~~ Union Sanitary District	
Taha	Mustafa	City of Union City	
Tingley	Robert	~~Union Sanitary District~~ City of Livermore	
Travis	Lyle	Zone 7 Water Agency	
Vasquez	Alfredo	Zone 7 Water Agency	
Vinson	Shawn	Zone 7 Water Agency	
Tanios	JOSEPH	City OF OAKLAND	

clean water PROGRAM

Clean Water Program
Construction Inspection Workshop
May 25, 2011
Sign-In Sheet

Watson	Athena	Zone 7 Water Agency	Athena Watson
Whipple	Jason	Zone 7 Water Agency	[illegible signature]
Wiehe	Bill	Zone 7 Water Agency	
Wilcox	Alan	~~Alameda County GSA~~ City of Livermore	[illegible signature]
Williams	Bob	City of Newark	
Wui	Roderick	City of Pleasant Hill	

Summary of Construction Inspection Workshop Evaluation Form - May 25th and 26th, 2011 (1=Strongly Disagree, 4 = Strongly Agree).

	The presentations/ exercises were clear and easy to follow.	Overall, this was a very useful workshop.	Materials/handouts were useful and informative	I will use the skills learned in the workshop today	The presenter(s) were knowledgeable in the subject.	The presenter(s) encouraged questions	The presenter(s) addressed current issues and concern	Total number of surveys
May 25th Evaluations	3.41	3.38	3.36	3.42	3.71	3.61	3.52	35
May 26th Evaluations	3.48	3.49	3.41	3.44	3.67	3.59	3.54	62

May 25th Evaluation Forms

What was most valuable about today's training?	What was least valuable about today's training?	Do you have any suggestions for improvement?	What subjects would you like to see future workshops?
General info and requirements			Smaller maintenance project requirements
Table Top exercise; discussion of BMP's and Photos			
Exercises; Review of sites		More good/bad examples	
BMP review	Table top exercise		More photos of sites; more technical info on measurements
Tool box exercise			New regulation updates; pending updates
hands on exercise		Difficult to see presenters faces with light behind them and room darkened; how to obtain electronic copy of inspection form; very nice facility; convienent location	More MRP vs Construction GP
qualifing rain event			
Spending time with staff of same agency to discuss and get on the same page	A lot of details were redundant but necessary - lost attention	Take questions; written ahead of meeting to identify and answer questions prior to presentations	Identify agencies and indivisuals who have done a great job meeting/exceedubg requirements; do a permit udate; field training class
Refresh memory and the Q&A brought up some good information	the late start time (9:10)	hot Brunch?	Keepign streets free of dried mud once original mud has been cleand up

May 26th Evaluation Forms

What was most valuable about today's training?	What was least valuable about today's training?	Do you have any suggestions for improvement?	What subjects would you like to see future workshops?
Slides, photos w/discussions were helpful		Review all abreviations; need explinations	mre examples with lessons learned
recognizing BMP's and table top discussion		More application type exercises;	more specifics on BMP's and when to use them
Selina Lovie's presentation	Table top exercise; a list of most acceptatble answers should be given		
General Information about SWPPP and BMP			
Difference between MRP, ERP and CGP		number of slides	
refreshment	no Beds	Tacos	
Understanding the requirements	BMPs	Presented well	how to regulate for each project, and how often we should inspect projects
		On hand sample	Presenter should mention what was missing ; pictures showing how the corrections were done before and after

Most valuable	Least valuable	Suggestions	Future topics
learning how to impememtn BMP's and Erosion controls			
Clean water program in terms of construction inspection			
MRP			
Learng the purpose of stormwater control			
Practical application of BMP's; reporting requirements			
erosion control and reporting		display different types of erosion materials (s/d ect.)	Construction driveways with wash stations
Method and clairification on reporting to RWB			
		Start at 8 or 7:30	appropriate uses for BMPs
Differntiation between CGP and MRP; resources			
M. Lander overview; photos discussions;			interest in knowing when the 'what is violation' issue is settled
Knowledgeable presenters			
2nd presentation	Table top exercise;		
		The presenters information overlapped too much	General BMP for smaller construction sites
		more hands on applications	
			Address the proper products or kinds of sediment control examples
The need to enforce clean wateer	enforcement costs to implement programs		application steps and requirements for regional boards to local cities
			Specifiy that this si QSP/Clean water inspection
			Penalties
	tiny forms on powerpoint (not able to be viewed)		
the urgency of issues			
how to protect soil and prevent soil particles from becoming detachted by water or wind			
the scheduled interviews were timely met and presenters heard well and were enthusiastic			
Available BMP's as the pertain to various projects		Stop using abbreviations; provide BMP reference manual or website	
	the permit requirements between CGP and MRp was not clear		
up to date info			
		pick a specific example of violations	
		Provide information of the difference between MRP and CGP	
Clear overview of BMP and strategies		Present exercie layout plan on screen ; an overall chart or table to show how MRP's differ from CGP's	
	Gender neutral language		

Most valuable	Least valuable	Suggestions	Future topics
Specific Pictures and examples of what to look for	paper exam wastes paper!; do on screen	Explain regulatory framework; who does enfocement of each (MRP, CGP and city progrmas	cost and efficancy of different BMPs
			QSD review class
review of construction site photos and identifying issues		more information on state permit; general neutral language- many inspectors are women!	

	Exam Summary CWP Construction Inspection Workshop - May 25 and 26, 2011	Correct Answer	Answer description	Pre-workshop % Correct	Post-workshop % Correct	Difference
Q2	Erosion control plans are reviewed and approved by the local	B	False, the plan is	93%	98%	5%
Q3	High Priority sites with active permits are inspected by the	C	Monthly, during	40%	88%	48%
Q4	The purpose of erosion control BMPs are to?	A	Protect the soil	50%	76%	26%
Q5	When violations are documented at a site, a re-inspection	C	Within 10 days	52%	93%	40%
Q6	Projects regulated by the MRP are never subject to the State	B	False	95%	98%	2%
Q7	Which should an inspector use to determine appropriate	C	The local	62%	69%	7%
Q8	When noticing a violation during an inspection the local	B	Inform the site	90%	95%	5%
	Totals					
	Respondent Percentage Correct			69%	88%	19%
	Number of 50% or above			88%	93%	
	Number of 49% or below			12%	7%	

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APPENDIX F
Provision C.7
Public Information and Outreach

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Bay Area Stormwater Management Agencies Association

Implementation Plan for Youth Litter Outreach

Submitted: August 3, 2011

Prepared by S. Groner Associates, Inc. (SGA)
ehooper@sga-inc.net
www.sga-inc.net
(P) 562-597-0205
(F) 562-597-0231

Table of Contents

BASMAA Implementation Plan 7.27.11

Tasks	Timing	Budget	Permittee Actions*	Measuring Success	MRP
Phase A – Laying the Groundwork and Starting up the Youth Panel					Municipal Regional Permit Sections C.7.b, C.7.b.1, C. 7.b.ii
Build database of high school and college environmental clubs, civic organizations, and other stakeholders populated by 16-24 year olds in the BASMAA region.	Sept-Nov	$12,245.00	Provide any info for any relevant orgs they are working with --- Optional: Help consultant establish contact at organization via introductory email	Check tags & categories are still meeting the needs of the campaign (every 6 months). The tags & the categories in the database will help us ensure that we are reaching our primary audience (i.e. youth in the bay area).	
Research what would be appropriate platforms for the database to fit BASMAA needs (e.g. ongoing tracking, email addresses, tags, categories & search fields)		$895.00	N/A		
Create the appropriate categories and set up the database tracking with a customer relationship management (CRM) format in order to be able to track increased commitments and participation through the life of the campaign.		$2,750.00	N/A		
Research and create a list of youth related (and eco related) organizations in the region and add it to the database.		$3,000.00	Provide info (name and general contact information) on known interested organizations they are working with -------------------------------------- Optional: 1) Provide a contact name at a known interested organization 2) Write an an introductory email to your contact introducing the the consultant and the outreach campaign.	Compile 50 organizations.	
Research and create a list of eco clubs and service clubs at High Schools, Colleges & Universities and add them to the database.		$5,400.00	Provide info (name and general contact information) on known interested school they are working with -------------------------------------- Optional: 1)Provide a contact name at a known interested school 2) Write an an introductory email to your contact at interested school introducing the consultant and the outreach campaign	Compile 100 organizations.	
Expenses: Cost of the database program (there may be a monthly subscription fee).		$200.00	N/A		
Set up integrated email list serve/ e-Newsletter program	Aug-Sept	$10,000.00	Review/approval		
Create an email marketing account with a service like Constant Contact or Mail Chimp		$1,500.00	N/A		
Create an email newsletter template to send out general announcements.		$5,500.00	Review emails/newsletters	Send out 4 emails to our email list and achieve at least a 23% open rate (industry standard)	
Send enrolling email newsletter each quarter with links to forward to friends	Aug-ongoing through year 3	$3,000.00	Optional: Forward newsletters/emails to local contacts	Collect 800 email addresses	

Conduct a pre-evaluation survey assessment	Aug-Oct	$21,905			
Note: Dr. Nicole Sintov has now officially joined the SGA ranks. She has her Phd in Psychology with an emphasis in behavior change from USC. She has published studies in half a dozen journals including titles such as "Effectiveness of a Web-based Intervention in Promoting Energy Conservation in a University Residential Setting." I had Nicole take a look at the outreach approach and make recommendations regarding what she thinks would be our best evaluation options. Her thoughts were very closely aligned with the school site model we had discussed at the last meeting. Please visit this link (http://bit.ly/qxFcGT) to see					
Engage Residential Youth Participation Through Events	Sept-Oct	$15,750			Municipal Regional Permit Section C.7.b.ii.1 (litter only)
Build strategic partnerships with local community event organizers. If amenable, event representative receives the materials from the program (i.e. consultant) and the event organizer would set up and break down the booth display.		$3,750.00	Send over a list of event organizers that would be valuable to reach out to -- Optional: Reach out to contacts that you have relationships with and ask if they are interested in hosting a booth in a box	Develop partnerships with 20 organizations.	
Create booth materials, raffle prize, and sign up sheets available for cities and counties that will be hosting a booth at an event.		$6,000.00	Review materials		
Design a rotating display that can be easily used and transported at events. The display will focus on getting passerby to join the program in some way (e.g. email sign-up, take a picture, enter a raffle, etc).		$5,000.00	Review display		
Produce and print 5 displays to rotate throughout the various cities.		$2,500.00	N/A		
Coordinate with permitees to collect data from the raffle, sign ups, newsletter and continue adding to CRM database. Data includes age and city.		$6,000.00	Request and host materials at community events they are already slated to attend	Host materials at a minimum of 12 events	
Before the event, coordinate with individual permitees to receive and set up the display for their event.		$3,000.00	Coordinate with consultant to set-up displays		
After the event, coordinate with individual permitees to collect the event sign-ups and enter the sign-ups in the database to add them tot he campaign.		$3,000.00	Provide information to consultant -------------------------------------- Optional: Enter sign-ups received from their events directly into the database		
Create and Partner with Youth Panel	Oct-	$19,750	Approval and (if desired) review of potential panel members	Create a panel with at least 15 youth participants	Municipal Regional Permit Section C.7.b.ii.2
Develop criteria for eligible youth to serve on an advisory Youth Panel (16-24 year olds currently living in the BASMAA region)		$2,400	Review criteria		
Create Youth Panel of 15 eligible, demonstrably committed participants		$7,750	----------------------------------- Optional: participate in selection of youth panel members	Success if quick turnaround time on branding questions, long-term commitments	
Work within school networks to recruit panel members from existing clubs, leaders, active youth		$3,600	----------------------------------- Optional: Reach out to already established contacts or teachers to recruit youth panelists	Recruit at least 15 youth participants	
If necessary, initiate participation incentive program (e.g. school credit, monetary compensation) in underrepresented market segments to ensure broad geographic diversity		$2,750	N/A		
Create a sign-up form, review and accept applicants.		$1,400	N/A		
Create user-friendly private forum to host online discussions (e.g. private invite-only Facebook page)		$2,600	N/A	Spontaneous idea suggestions & volunteer posts from Youth Panel	

Ongoing contact with the panel to keep them informed and involved with the campaign		$7,000	N/A	Reach out to panel, at least, every other month	
Phase B – Designing Tactical Elements & Launching the Video Contest					Municipal Regional Permit Section C.7.b.ii.2
Develop concepts for partnership engagement with corporations; enlist them on sponsorships, cleanups and other promotional opportunities	Dec-Feb	$6,500	Review/approval	Sponsorship quality and prizes equivalent of a $500 monetary value equivalent	
Develop corporation list of historically interested, related industries and also those with charitable giving arms for additional sponsorship possibilties. Create contact list and add to tracking database		$1,200	---------------------------- Optional: Provide contact information for relevant organizations.	Develop a contact list with 15 organizations	
Coordinate with Youth Panel to gauge their feedback on the attractiveness of potential prizes		$1,500	N/A		
Outreach to potential sponsors and secure partnership(s) and contest prizes for the campaign		$3,800	N/A		
Design look/brand of campaign	Dec-Jan	$9,800	Review/approval	Ongoing feedback, synergy with Youth Panel	
Develop the creative brief to kick start the design process		$1,400	Review and approve creative brief		
Create 2-3 initial design mock-ups of a video contest flyer for the group to choose from		$5,400	Review and provide comments		
Write the text for the flyer		$1,800	Review and provide comments		
Design various iterations of the flyer in order to set the tone for the "look" of the campaign		$3,600	Review and provide comments		
After two rounds of edits, finalize the video contest flyer as well as the campaign aesthetic		$3,000	Final Review	Establish the colors, font and style of the campaign's design	
Develop the PSA Advertising Contest opportunity to engage high school organizations, local colleges and universities and other stakeholders	Nov-Mar	$37,000	Review/approval	Assess initial popularity with key interested parties and make modifications as needed	
Reach out to some key interested parties (e.g. high school principals, college film professors, youth film networks, etc) to gauge interest/thoughts about the contest and modify the approach accordingly.		$1,800	--- Optional: If you have any contacts in this category, provide their contact information to consultant	Get feedback from half a dozen people	
Define the specifications of the contest (e.g. what type of subject matter) and get feedback from the Youth Panel		$840	Review contest specifications		
Line out all of the campaign logistics including rules, deadlines, eligibility requirements, etc.		$3,000	Review		
Design the needed campaign materials. May include: poster, email blast, bookmark, etc.		$5,160	Revew	Design 1 and print needed campaign materials to publicize the contest	
Present options and decide which additional material would be best to create (receive feedback from committee and youth panel)		$960	Provide feedback		
Design 1 additional handout such as a poster (includes two rounds of revisions)		$4,200	Revew		
Work closely with early adopters to submit a video and seed interest.		$7,800	N/A		
Reach out directly to teachers, film related orgs and youth panel to scout potential early adopters for the contest.		$1,800	N/A		
Identify 3-5 early adopters and provide any support they may need to ensure they submit videos and help seed interest in the contest.		$6,000	N/A		

Promote the contest		$14,400	------------------------------ Optional: Distribute materials locally to promote contest	Distribute the materials directly to 60 teachers throughout the County	
Work through early adopters and the previously developed list of teachers, film organizations, college resident advisors, etc to promote the contest by mailing handouts for distribution to their members/students		$14,400	------------------------------ Optional: Actually post flyers/posters on high school and college campuses		
Expenses: Printing expenses		$4,000			
Design Website/Blog that is run by a Content Management System (CMS)	Jan-	$18,600	Review/approval	Create a website with up to 8 pages	
Example: SGA created the LA Team Effort website that was originally used to launch LA Stormwater's "team effort" advertising campaign. Website has since evolved to be available indefinitely as a portal for people who want to help protect water quality.					
Write and develop all of the content for the site		$3,840	Review content		
Map the website navigation bar structure		$1,200	N/A		
Create homepage and internal page wireframes (e.g. skeletal layouts of what the pages will look like)		$1,800	N/A		
Design the website "look"		$3,000	Review		
Program the website pages, include capacity for people to upload videos for the contest		$7,800	N/A		
Configure content to make it Search Engine Optimization (SEO) friendly		$960	N/A	200+ visitors per month as per Google Analytics calculations	
Media Engagement/Press Releases for video contest	Mar-Apr	$24,840	Review/approval		
Coordinate with BASMAA's already existing media relations effort to ensure that the contest is tied into media pitches		$2,400	Help coordinate into BASMAA's media relations effort		
Outreach to online portals such as bloggers, podcast series, online news sites, etc to promote the contest		$14,040	N/A	Placement in at least 15 online blogs	
Create a list of potential locations to reach out to		$3,000	Optional Activities -Recommend online portals		
Develop a general pitch for reaching out to the bloggers or editors		$840	Review		
Customize the pitch accordingly and reach out directly to bloggers and editors. Field questions as needed and follow up with contacts to get coverage of the contest.		$7,800	Review		
Track placements of the contest online		$2,400	N/A		
Work with local jurisdictions to send out email announcements to their already established email lists as well as promote the contest through newsletters and City publications		$8,400	Distribute info locally through city/county email lists & government publications and websites	Placement in at least 15 online, print city publications or email list send outs	
Prepare files (i.e. text only and with images) that the individual cities can use to send out and announce the contest		$2,400			
Coordinate with BASMAA reps to provide the needed info along with the email template		$3,600			
Follow up with BASMAA reps to track send outs in their individual jurisdictions		$2,400			
Launch & maintain the Facebook page	Mar-	$35,000	Provide event photos and local City related updates for posting on the page.	100 fans 60 user interactions from our fans (posts, comments, 'likes', links, photos)	

BASMAA Implementation Plan 7.27.11

Example: SGA created and maintains the LA Stormwater program's FB page: facebook.com/lastormwaterprogram. You can see our latest promotion, the Pet N Water photo contest, on the wall.					
Assumptions: The budget/time allocation for this task has been done using a blended rate of $120; however, during the implementation SGA's actual rates will be used (i.e. higher than this for a Project Manager and lower than this for a Project Coordinator). This task also assumes coordination and input from the committee. The budget assumes that the committee will want to give approval on each of the consultant's wall posts. If this is not the case and a general approval is given when the page is first launched then the price will adjust down accordingly. I feel more comfortable leaving as is until we start implementing the task and are					
Coordinate with Youth Panel to get feedback about topics and areas of interest for the Facebook page. Use this information to create the Facebook strategy.		$950.00	N/A		
Create the Facebook page and recruit an initial base of fans		$8,550	-------------------------- ------------ Optional: If your agency has a Facebook page, follow or like the BASMAA Litter page		
Research and compile a list of related Facebook pages. Reach out to the Facebook pages with a "nice to meet you" and a wall post.		$2,400.00	-------------------------- ------------ Optional:Provide information on related Facebook pages		
Create and place Facebook ads.		$4,400.00	Review ads -------------------------- Optional: If budget available, use the ad in local promotions.		
Create a Facebook invite and send it out to people in our email list.		$1,750.00	Forward the invite to local contacts		
Maintain the Facebook page with posts at least 3 x's a month and run mini promotions to engage fans. This also includes checking and responding to comments on a daily basis as well as posting "trust agent" (trustagent.com/) comments on partner Facebook pages in order to create meaningful online partnerships.		$25,500.00	Review promotions and wall posts If your agency has a FB page, "like" or "share" the BASMAA posts	Secure partnerships (e.g. posting on our wall or "liking" our page) with 10 other Facebook pages. These will be "non-stormwater program" pages, i. e., pages from organizations that are not Permittees or their partner agencies.	
Research and keep a pipeline of updates to post on the page a minimum of 3xs per month.		$4,800.00	Review ads -------------------------------------- OPTIONAL: If budget available, use the ad in local promotions.		
Respond to fan comments and likes (frequency depends on amount of interaction received from fans).		$3,600.00	N/A		
Visit other Facebook pages approx once a week and post comments and likes on their posts as part of our trust agent comments.		$3,600.00	N/A		
Run mini Facebook promotions approx every 6 weeks. Promotions are characterized by encouraging fans to interact with the page and receiving a t-shirt or kudos in return (e.g. tell 1 friend about our page and both you and your friend will receive one of our nifty t-shirts)		$12,000.00	Review promotions -------------------------------------- OPTIONAL: Promote promotions on local FB pages.		
Expenses: advertisements, giveaways for promotions (in some cases).		$1,500.00			
Campaign CRM Management / Engagement Tracking/ Evaluation	Feb	$4,200	Individual municipalities to send over contacts as appropriate		
Maintain and update database as needed			N/A		

Create distribution plan for PSA winner(s) (online and offline)	Feb-Apr	$4,250	Review/approval		
Create advertising plan detailing points of distribution for winning contest entry			Review advertising plan		
Research a list of potential outlets, taking into account demographics, geographic reach and relevance to issue, to distribute the video					
Get pricing options for the select outlets					
Explore opportunities for un-paid exposure of the ads (e.g. film festivals, school announcements, etc)					
Create a plan detailing which locations will feature the PSA					
Engage our audience and our audience's social networks to review and vote on the best PSAs	May	$19,200			
Review contest entries to ensure they are complying with the rules (e.g. no foul language) and are relevant.		$3,600.00	Optional: Review contest enteries		
Post the appropriate entries to make them available for voting/viewing.		$3,600.00	N/A		
Create a YouTube channel to feature the contest entries		$3,600.00	N/A		
Seed engagement and encourage voting through online social networks. If necessary, reach out to the schools of the contest participants to find ways of promoting the contest to the student body.		$8,400.00	-- Optional: Conduct local outreach (online or at events) to promote the contest	Have at least 5 viable videos for voting	
Phase C – Distributing the Winning Video					Fulfills Municipal Regional Permit Section C.7.b.ii.2
Advertising - PSA Online and Offline Releases	Jun-Jul	$53,160	Review/approval	Winning entry celebrated in 15 or more outlets (e.g. local city channels, film festivals, movie theaters, art museum exhibit)	
Regular Check-in meetings with Youth Panel to survey effectiveness, awareness, knowledge, trends		$1,320	N/A		Municipal Regional Permit Section C.7.b.ii.2
Format video into different file extensions to allow it to be posted on different mediums (e.g. online, t.v., etc)		$3,600			
Actively distribute the winning contest entry to the outlets noted in the ad buy plan. Purchase limited ad buy space, if needed.		$6,000	-- Optional: If budget available, place BASMAA ads locally		

Coordinate with the added value opportunities to promote the winning entry (e.g. film festivals, eco festivals, etc).		$8,400	N/A		
Coordinate with individual cities and counties to have the PSA run on local access channels and via an embedded video on government websites and Facebook pages		$3,840	Post the PSA on local city television channels and website	Placement in at least 7 city stations.	
Expenses: Advertising space, contractor for the video conversion		$30,000			
Develop and distribute campaign branded promotional item like a t-shirt, hat, tote bag, etc. (Distribute based on participants taking some type of action to further engage them in pollution prevention/litter reduction)	May-Jul	$16,880	Review/approval		
Research potential giveaways and consult Youth Panel on appropriate items		$1,800	Review/approval		
Create initial design concepts and receive input (includes up to two rounds of edits)		$3,600	Review/approval		
Finalize the design concept		$1,800	Review/approval		
Price and place order		$2,880	-- Optional: purchase giveaways for local outreach	200-300 prize giveaways depending on pricing	
Outline criteria for who is to receive a giveaway item. Distribute items 9e.g. shipping or distributing to BASMAA members) to be distributed to target audience.		$4,800	N/A		
Expenses: Printing of items and shipping costs for distributing the		$2,000			
	Year 1 Total	$309,080			
YEAR 2					
Tasks	**Timing**	**Budget**	**Permittee Actions***	**Measuring Success**	**MRP**
Phase A – Maintain Buzz and Continue to Grow Presence					
Program Check-In	Ongoing	$3,000.00			
Conduct assessment of what worked and what didn't work from Year 1. Modify Year 2 implementation plan accordingly		$3,000.00			
Facebook page	Ongoing	$25,500.00	Provide event photos and local City related updates for posting on the page.	350 fans and 200 user interactions from our fans (posts, comments, 'likes', links, photos)	

Maintain the Facebook page with posts at least 3 x's a month and run mini promotions to engage fans. This also includes checking and responding to comments on a daily basis as well as posting "trust agent" (trustagent.com/) comments on partner Facebook pages in order to create meaningful online partnerships.		$25,500.00	Review promotions and wall posts ----------------------------------- Optional: If your agency has a FB page, "like" or "share" the BASMAA posts	Secure partnerships (e.g. posting on our wall or "liking" our page) with 10 other Facebook pages	
Research and keep a pipeline of updates to post on the page a minimum of 3xs per month.		$4,800.00	N/A		
Respond to fan comments and likes (frequency depends on amount of interaction received from fans).		$3,600.00	N/A		
Visit other Facebook pages approx once a week and post comments and likes on their posts as part of our trust agent comments.		$3,600.00	N/A		
Run mini Facebook promotions approx every quarter. Promotions are characterized by encouraging fans to interact with the page and receiving a t-shirt or kudos in return (e.g. tell 1 friend about our page and both you and your friend will receive one of our nifty t-shirts)		$12,000.00	Review promotions ------------------------------------- Optional:Promote promotions on local FB pages.		
Expenses: advertisements, giveaways for promotions (in some cases).		$1,500.00	Review giveaway ides.		
Website	Ongoing	$23,440	Review website and provide input as needed		
Keep the website maintained		$16,440.00			
Review website content after the end of the video contest. Modify content and layout as needed to keep the website updated and current.		$3,000.00			
Monthly website checks to ensure all links and pages are functioning correctly		$4,800.00			
Post new content on the website monthly either through articles, links, images or videos to ensure the website is being updated frequently.		$8,640.00		New monthly website content	
Search Engine Ranking Credibilty		$7,000.00		600+ visitors per month as per Google Analytics calculations	
Do Search Engine Optimization (SEO) to increase the website's ranking on search engines		$4,000.00			
Secure inbound links to the website from external websites		$3,000.00		Secure 10 in bound links	
Email Marketing	Ongoing	$23,040			
Coordinate with fan base regarding some key areas of interest. Send out at least 4 emails.		$17,040.00	Review email content	List of 1,000 email subscribers with an open rate of 23% or more (industry standard)	
Develop topic ideas for the year's emails		$3,480.00			
Write the content for the emails (4)		$4,800.00			
Design the emails (4)		$6,600.00			
Send out the emails and track the statistics to inform future correspondences (i.e. what worked and what didn't)		$2,160.00			
Manage the list (e.g. clean out bounces, add new names, generate reports, etc)		$6,000.00			
YouTube channel	Ongoing	$15,640		2,500 views and 25 channel subscribers	
Maintain the channel by responding to comments and posting videos that are relevant and were created by cities that are part of BASMAA or other partner organizations		$8,640.00	Provide video content as it becomes available		

Create 1 new video to post on the channel		$7,000.00	Review/approval		
Database Maintenance & Youth Panel Updates	Ongoing	$11,000		Receive 60 interactions/comments from our youth panel	
Clean out and update the database to prepare for the "action" the campaign will ask participants to do this upcoming year		$5,000.00	N/A		
Continue to engage Youth Panel Facebook group for input on an as needed basis		$6,000.00	N/A	Check in with the youth, at minimum, once a	
Phase B – Increase the Level of Commitment (get new people to join the campaign but also get Year 1 people to step it up)				Recruit 200 new newsletter subscribers and 250 new Facebook fans. Ideally, 40% of the contest entries would be from already existing program fans to show an increased level of commitment.	
Take Action-- Volunteer!	Oct-Jul 13	$36,600	Review/Approval		
Host a "Give a Day" volunteer and win online contest to encourage people to volunteer for a water related event (e.g. clean-up, tree planting, etc)		$36,600.00	Review contest/event idea. -- Optional: conduct local outreach to promote contest/event		
Set up the infrastructure (i.e. new custom programmed tab on the Facebook page) to allow people to upload a photo volunteering in order to be entered for a chance to win a cool prize		$6,000.00	N/A		
Coordinate with last year's sponsors to secure a prize		$1,500.00	N/A		
Create contest rules, requirements, etc		$2,700.00	Review/Approve		
Design the Facebook landing pages and a flyer to promote the giveaway		$7,000.00	Review/Approve		
Promote the contest with local organizations that are hosting volunteers as well as through existing City/County networks with tactics such as, but not limited to: sending out emails to existing listservs, placing announcements in local newsletters, mailing flyers for distribution, posting the promo on external websites		$14,000.00	Reach out to existing networks of other organizations and non-profits	Partner with, at least, 10 organizations and/or schools	
Track entries and award the prize		$5,400.00	N/A	Receive 120 entries	
	Year 2 Total	$138,220			
YEAR 3					
Tasks	**Timing**	**Budget**	**Permittee Actions***	**Measuring Success**	**MRP**
Phase A – Maintain systems, strategies that worked during Year 2					
Program Check-In	Ongoing	$3,000.00			
Conduct assessment of what worked and what didn't work from Year 2. Modify Year 3 implementation plan accordingly		$3,000.00			
Facebook page	Ongoing	$25,500.00		700 fans and 300 user interactions (posts, comments, 'likes', links, photos)	

BASMAA Implementation Plan 7.27.11

Maintain the Facebook page with posts at least 3 x's a month and run mini promotions to engage fans. This also includes checking and responding to comments on a daily basis as well as posting "trust agent" (trustagent.com/) comments on partner Facebook pages in order to create meaningful online partnerships.		$25,500.00	Review promotions and wall posts ----------------------------------- Optional: If your agency has a FB page, "like" or "share" the BASMAA posts	Secure partnerships (e.g. posting on our wall or "liking" our page) with 10 other Facebook pages	
Research and keep a pipeline of updates to post on the page a minimum of 3xs per month.		$4,800.00	N/A		
Respond to fan comments and likes (frequency depends on amount of interaction received from fans).		$3,600.00	N/A		
Visit other Facebook pages approx once a week and post comments and likes on their posts as part of our trust agent comments.		$3,600.00	N/A		
Run mini Facebook promotions approx every quarter. Promotions are characterized by encouraging fans to interact with the page and receiving a t-shirt or kudos in return (e.g. tell 1 friend about our page and both you and your friend will receive one of our nifty t-shirts)		$12,000.00	Review promotions ------------------------------------- Optional:Promote promotions on local FB pages.		
Expenses: advertisements, giveaways for promotions (in some cases).		$1,500.00	Review giveaway ides.		
Website	Ongoing	$16,440		1,000+ visitors per month as per Google Analytics calculations	
Keep the website maintained		$16,440.00			
Modify content and layout as needed to keep the website updated and current.		$3,000.00			
Monthly website checks to ensure all links and pages are functioning correctly		$4,800.00			
Post new content on the website monthly either through articles, links, images or videos to ensure the website is being updated frequently.		$8,640.00		New monthly website content	
Email Marketing	Ongoing	$23,040		List of 1,000 email subscribers with an open rate of 23% or more (industry standard)	
Coordinate with fan base regarding some key areas of interest. Send out at least 4 emails.		$17,040.00	Review email content		
Develop topic ideas for the year's emails		$3,480.00			
Write the content for the emails (4)		$4,800.00			
Design the emails (4)		$6,600.00			
Send out the emails and track the statistics to inform future correspondences (i.e. what worked and what didn't)		$2,160.00			
Manage the list (e.g. clean out bounces, add new names, generate reports, etc)		$6,000.00			
YouTube channel	Ongoing	$16,140		2,500 views and 35 channel subscribers	
Maintain the YouTube channel by recruiting subscribers		$8,640.00			
Post updated video content on the channel (new or repurposed) in order to keep it fresh		$7,500.00	Review videos ---------------------------------- Provide videos that have been developed locally for posting on the channel	Posting 2 additional videos on the channel	
Database Maintenance & Youth Panel Updates	Ongoing	$10,000			
Clean out and update the database to prepare for the "action" the campaign will ask participants to do this upcoming year		$6,000.00			
Continue to engage Youth Panel Facebook group for input on an as needed basis		$4,000.00			

Phase B – Engage New People in the Campaign and Involve Another Group (e. g. the art community)					Municipal Regional Permit Section C.7.b
Increased Commitment for the Year-- Get crafty!	Oct-May 14	$44,580			
Set up the details for an art related/water quality contest (e.g. painted rain barrels, painted storm drains, found litter art, etc). Secure sponsors for the prizes/giveaways.		$5,400.00	Review/approve ideas		
Coordinate with interested parties (e.g. art museums, high school and college art teachers) to pique interest and gauge their interest in the promotion		$3,000.00		Reach out to at least 15 organizations	
Promote the contest		$17,400.00			
Design the materials to promote the contest and encourage entries/involvement		$3,000.00	Review/approve	Flyer & email blast announcing the promotion	
Reach out to teachers and school clubs to spread the word		$5,400.00			
Send out messages to our existing online networks		$2,760.00			
Reach out to online bloggers & other Facebook pages to spread the word about the promo		$6,240.00			
Track, review and, if appropriate, judge entries		$5,640.00			
Tie in with BASMAA's already existing media relations efforts to promote the entries. In addition, possibly host a media event to showcase the art installations that will be featured throughout the counties		$9,000.00			
Promote the contest entries on the social media channels and with our network		$2,640.00		Receive 120 entries	
Expenses: printing of flyers, other misc		$1,500.00			
Conduct a post- evaluation survey assessment	Feb-Apr 14	$20,000			
Note: Dr. Nicole Sintov has now officially joined the SGA ranks. She has her Phd in Psychology with an emphasis in behavior change from USC. She has published studies in half a dozen journals including titles such as "Effectiveness of a Web-based Intervention in Promoting Energy Conservation in a University Residential Setting." I had Nicole take a look at the outreach approach and make recommendations regarding what she thinks would be our best evaluation options. Her thoughts were very closely aligned with the school site model we had discussed at the last meeting. Please visit this link (http://bit.ly/qxFcGT) to see					
Put together the final report	May 14.	$9,000			
	Year 3 Total	$167,700			
	GRAND TOTAL	$615,000			
* This indicates the minimum level of effort the consultant would be asking for of the permittees. If permittees are interested in getting more involved then wonderful! I didn't include this here because I thought it would be best to plan budget around the assumption that we would not be getting additional involvement. If permittees provide more assistance than originally anticipated then we can put the budget savings in other places.					

BASMAA Evaluation Approach

The two objectives of the BASMAA "advertising" campaign are to decrease litter and to increase engagement. The following write-up provides our approach to how to evaluate these two goals.

DECREASE LITTER

Evaluation approach

- Two-pronged approach to evaluating success of program to include self-reported surveys and observational data collection

Survey component

- Select 4 schools (high schools or universities or community colleges) throughout the entire geographic area.
- Engage the school network at all 4 schools
    - e.g., teachers, administration, student groups, athletic teams – to promote survey taking and involvement in outreach programs.
    - A few preliminary ideas include:
        - Teachers providing an extra credit opportunity for survey participation
        - Offering raffle prizes as incentives for survey taking
        - Provide a survey item where students write in names of friends who referred them to survey. Give student referrers incentives/FB recognition
            - Similar ideas for teachers who get their students to participate
- Administer baseline survey prior to program implementation
    - Surveys administered online
        - To address online survey validity issues, we'll include a simple random/careless responding check to enable identification of bogus responses
    - Suggested sample size = 300 students total at baseline
    - As part of surveys, gather contact information from student participants – this is a highly mobile population with frequent changes in contact information.
        - Obtain cell phone, home phone, email address.
- Throughout program
    - Reach out to students on FB, through e-newsletters, and through other avenues to keep them in touch with program throughout years 2 & 3
- Post-outreach (end of year 3)
    - Follow-up with same students who participated in initial survey

Observational component

The observational component will supplement the self reported surveys above. Since the ultimate goal is to reduce litter, this will help to bolster the validity of the findings.

- At same 4 schools above
    - Conduct a pre-outreach trash assessment after school lunch one day where amount/type of litter is assessed.
    - Conduct similar trash assessment after outreach complete.

Why did we go with this approach?

- Focusing on existing cohesive communities has the following benefits:
    - Increases likelihood of program success because:
        - Increases likelihood that program will be noticed by target audience members
        - Offers better opportunity to leverage social norms
    - Likely to result in greater sample size for surveys
    - Makes observational data collection a reasonable supplement versus obtaining observational measures in the community at large where outreach effects will be extremely dilute and probably not detectable
- Provides for direct evaluation of outreach success
- Multi-method approach (self-report surveys plus observational data) is stronger relative to one that uses a single measure of program success
- Enhanced efforts to keep in touch with participants likely to result in higher follow-up rate

What are the drawbacks to this approach?

- In general, the broad nature of the program we are implementing doesn't lend itself well to contained evaluation (as opposed to a program that was designed to specifically take place within the schools).
- May be difficult to work with constraints of schools
- School subsample may not be entirely representativeness of entire target audience
    - To address this: Youth who access outreach elements and surveys from sources outside of the 4 schools would also be able to participate, so we will be able to:
        - Assess level of involvement in outreach as well as recruitment source in baseline and follow-up surveys and adjust statistically for these effects

INCREASE ENGAGEMENT YEAR ONE

Build database of high school and college environmental clubs, civic organizations, and other stakeholders populated by 16-24 year olds in the BASMAA region.

- Research and create a list of 50 youth related (and eco related) organizations in the region and add it to the database.
- Research and create a list of 100 eco clubs and service clubs at High Schools, Colleges & Universities and add them to the database.

Set up integrated email list serve/ e-Newsletter program

- Send out 4 emails to our email list and achieve at least a 23% open rate (industry standard)
- Collect 800 email addresses

Engage Residential Youth Participation through Events

- Develop partnerships with 20 event organizers.
- Host materials at least 12 events

Create and Partner with Youth Panel

- Create a panel with at least 15 youth participants
- Reach out to panel, at least, every other month

Develop concepts for partnership engagement with corporations; enlist them on sponsorships, cleanups and other promotional opportunities

- Sponsorship quality and prizes equivalent of a $500 monetary value equivalent
- Develop a contact list with 15 corporations

Develop the PSA Advertising Contest opportunity to engage high school organizations, local colleges and universities and other stakeholders

- Get feedback from half a dozen people from the Youth Panel
- Design 1 and print needed campaign materials to publicize the contest
- Distribute the materials directly to 60 teachers throughout the Bay Area

Design Website/Blog that is run by a Content Management System (CMS)

- Create a website with up to 8 pages
- 200+ visitors per month as per Google Analytics calculations

Media Engagement/Press Releases for video contest

- Placement in at least 15 online blogs
- Placement in at least 15 online, print city publications or email list send outs

Launch & maintain the Facebook page

- 100 fans 60 user interactions from our fans (posts, comments, 'likes', links, photos)
- Secure partnerships (e.g. posting on our wall or "liking" our page) with 10 other Facebook pages. These will be "non-stormwater program" pages, i.e., pages from organizations that are not Permittees or their partner agencies.

Engage our audience and our audience's social networks to review and vote on the best PSAs

- Have at least 5 viable videos for voting

Advertising - PSA Online and Offline Releases

- Winning entry celebrated in 15 or more outlets (e.g. local city channels, film festivals, movie theaters, art museum exhibit)
- Placement in at least 7 city stations.

Develop and distribute campaign branded promotional item like a t-shirt, hat, tote bag, etc. (Distribute based on participants taking some type of action to further engage them in pollution prevention/litter reduction)

- 200-300 prize giveaways depending on pricing

YEAR TWO

Facebook page

- 350 fans and 200 user interactions from our fans (posts, comments, 'likes', links, photos)

- Secure partnerships (e.g. posting on our wall or "liking" our page) with 10 other Facebook pages

Website
- 600+ visitors per month as per Google Analytics calculations
- Secure 10 in bound links

Email Marketing
- List of 1,000 email subscribers with an open rate of 23% or more (industry standard)

YouTube channel
- 2,500 views and 25 channel subscribers

Database Maintenance & Youth Panel Updates
- Receive 60 interactions/comments from our youth panel
- Check in with the youth, at minimum, once a month

Increase the Level of Commitment (get new people to join the campaign but also get Year 1 people to step it up)
- Recruit 200 new newsletter subscribers and 250 new Facebook fans. Ideally, 40% of the contest entries would be from already existing program fans to show an increased level of commitment.

Take Action-- Volunteer!
- Partner with, at least, 10 organizations and/or schools
- Receive 120 entries

YEAR THREE

Facebook page
- 700 fans and 300 user interactions (posts, comments, 'likes', links, photos)
- Secure partnerships (e.g. posting on our wall or "liking" our page) with 10 other Facebook pages

Website
- 1,000+ visitors per month as per Google Analytics calculations

Email Marketing
- List of 1,000 email subscribers with an open rate of 23% or more (industry standard)

YouTube channel
- 2,500 views and 35 channel subscribers

Increased Commitment for the Year-- Get crafty!
- Reach out to at least 15 organizations
- Receive 120 entries

ALAMEDA COUNTY

Summer Reeds

2011 ISSUE

You can be a Lazy Gardener too! Page 6

7 Community Grants Available

3

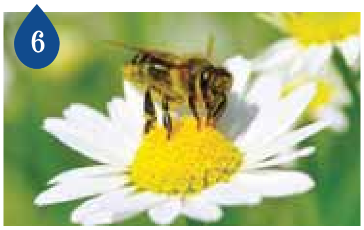
Protecting Kids & Pets in the Home and Garden

2

The Best Ways to Control Ants

4

Everyday Actions Affect Creeks, Wetlands & the Bay



6

The Bee-All and End-All about Bees

Ask the Gardening Queen

Dear G.Q.,

People (including one of my family members who shall remain nameless) seem to flip out when they see ants. Do ants really deserve such a strong reaction?

Unruffled in Union City

Dear Unruffled,

What a diplomat you are! To answer your question: No, ants don't warrant the kind of panic they often trigger. The most common ant invading our homes is the Argentine ant. It is small, dark brown, 1/8" long with queens that are slightly larger. When some people see them, their first reaction is to spray, but that will only take care of about 10% of the population. If you follow these simple steps instead, you'll have more success preventing and managing a future infestation. Here they are:

1. Find out why the ants are coming in. If the reason is food, remove it and store it in an airtight container.
2. Seal the ants out with caulking.
3. Keep your home clean and dry. (Ants need food and water.)
4. Put pet food dishes in a moat of soapy water.
5. Use bait stations so the ants take the bait back to the nest and stop the source. (Note: It's important to use bait stations rather than loose bait, which can attract non-target animals and is more difficult to dispose of properly.)
6. Don't spray around bait stations as this repels ants and prevents them from taking the bait.

Spraying ants is actually not the best way to control them, and it's not the healthiest way either.

7. Argentine ants change their food preferences frequently, so keep several different baits on hand and alternate as needed.

Sincerely,
The Gardening Queen

For more information, go to www.ourwaterourworld.org/FactSheets and click on Ants.

Gardening Queen **Annie Joseph** has been a California Certified Nursery Professional for over 30 years. For over a decade she has consulted to the Our Water Our World Program, working collaboratively with water pollution prevention agencies and industry professionals to reduce pesticide and nutrient runoff into our waterways.

BEE-LIEVE IT OR NOT?

ALMOST A THIRD OF OUR DAILY DIET COMES FROM CROPS POLLINATED BY BEES.

ANSWER: BEE-LIEVE IT! Without bees there would be very few fruits, vegetables or seeds.

HIRE PROFESSIONALS WITH THE RIGHT KNOW-HOW

How to Find a Green Pest Management Operator

Are you looking to hire a professional pest control service? Choosing an Integrated Pest Management (IPM)-certified provider ensures that the contractor emphasizes pest prevention and uses the least toxic methods available. To find an IPM operator near you, search the following web listings:

ecowise CERTIFIED — **www.ecowisecertified.org**

GREEN PRO CERTIFIED — **www.certifiedgreenpro.org**

our water our world

For more information, visit www.ourwaterourworld.org and click on "Pest Control Operators and Landscapers." Here you can also download a fact sheet with questions to ask pest management services before you choose one.

Protecting the Ones You Love

Are you doing everything you can?

by Sharon Gosselin

If you're a parent or a pet owner—or both—you already go to great lengths to keep your kids and pets safe. Your dog wears a reflective collar, and your daughter doesn't get on her bike without her helmet. So why not take the next step?

Children and pets are safer when household and garden chemicals are kept to a minimum.

More and more parents and pet owners realize that keeping their loved ones safe means protecting them from harmful chemicals as well as more obvious hazards. Of course, first and foremost you need to prevent access to harmful products, like bug sprays, radiator coolant and so on. But you can avoid many common hazards by using safer alternatives to some of these products.

You can find non-toxic "recipes" for many common household chores and gardening needs at www.cleanwaterprogram.org. You can also find information on non-chemical solutions such as traps, weed fabric and tree wraps at www.ourwaterourworld.org.

Sharon Gosselin is a Stormwater Program Manager for the County of Alameda and the Alameda County Flood Control and Water Conservation District.

Top 5 Low-Toxic Gardening Tips

1. Healthy plants are less susceptible to pests. Work nutrient-rich compost into your soil-ideally from your own compost bin!
2. Hummingbirds and beneficial insects such as ladybugs and lacewings feast on pests. Attract this natural pest patrol with plants whose nectar and pollen provide food. (To learn more, visit www.ourwaterourworld.org/QuickLinks/BeneficialInsects.aspx)
3. Choose native plants. They need less maintenance and are better adapted to resist pests. (To learn more, visit www.cnps.org)
4. Fight ants by spraying them with a mixture of water and liquid soap. Find non-toxic recipes to control other pests at www.cleanwaterprogram.com.
5. Avoid overhead sprinkling, especially with roses. Wet foliage is more susceptible to diseases.

BEE-LIEVE IT OR NOT?

ALL BEES LIVE IN LARGE COLONIES IN HIVES.

ANSWER: NOT!

Only the social honeybee builds and lives in hives, along with the rest of the colony. Most other bee species are solitary and burrow in soil to build their nests.

The Clean Water Program: *Teaming up to protect local creeks and the Bay*

by Stefanie Pruegel

Living in an urban environment, it's easy to forget how closely connected we are to our local creeks, lakes and the Bay. That is, until large amounts of litter end up on our shorelines after a storm. Surprisingly, most of this debris originates inland.

The Clean Water Program sponsors the Storm Drain Rangers program for third–fifth graders in Alameda County elementary schools. Students learn how water pollution happens through hands-on investigations that reveal how rain and storm drains connect their neighborhood to local creeks and the Bay. Here, instructor Jonah Yamagata leads the lesson at Hesperian Elementary School in San Lorenzo.

"The rain water washes plastic bags and cups, cigarette butts and other trash off the streets and into storm drains. From there the litter is carried directly into our creeks and the Bay, without any treatment," explains Jim Scanlin, Manager of the Clean Water Program.

Comprised of local government agencies, the Clean Water Program works to prevent pollution to waterways throughout Alameda County. "Our member agencies all deal with very similar issues, so pooling our resources to take action on a countywide level makes a lot of sense," reasons Scanlin. Since its inception in 1991, the Clean Water Program has been monitoring the health and water quality of the county's creeks, and has worked with the community to keep the water entering the storm drains as clean as possible.

Patrizia Guccione, a Clean Water Program Specialist for the City of Alameda, runs through some of the Program's many outreach activities: "We sponsor environmental education programs for schools, talk to residents at public events and help businesses prevent harmful discharges to the storm drain system." During her routine visits to Alameda businesses, Guccione takes time to explain the impact even one spill can have on local waterways. "I am known as the storm drain lady," she laughs.

Invisible Pollution

While the Clean Water Program is working hard to keep trash out of the county's waterways, less visible pollutants present an even bigger threat to our creeks' health. "Cars leaking fluids on the road, soapy water dumped into the gutter, rain washing garden chemicals off the lawn and into storm drains … all these incidents add up to a significant toxic injection into our local creeks," illustrates Scanlin. Pesticides used by home gardeners are of particular concern because they can harm fish and other sensitive aquatic organisms. On land, pesticides have unwelcome side effects, too, posing a risk to kids and pets, and killing beneficial insects like bees and ladybugs, along with the pests.

To bring awareness to this issue, and to help home gardeners find alternative pest control methods, the Clean Water Program has launched a countywide outreach campaign highlighting the vulnerability of bees and other beneficial insects in order to raise awareness about the many harmful effects of water pollution. Barb Kusha, who represents the Zone 7 Water Agency at the Clean Water Program, helped develop the materials, which included a spray bottle label with non-toxic pesticide recipes. "These formulas use ingredients you can find in most kitchens—like cooking oil and dish soap," she explains.

"They're not only safer for people and the environment, but also cheaper than commercial pesticides."

Continued on page 5

Storm Drains: Your Connection to the Bay

When it rains, pesticides, motor oil and other residues are washed off surfaces around your home and into storm drains. Storm drains flow directly into creeks, wetlands and the Bay—they do not flow to a water treatment plant, as many people believe. Everyday actions, such as gardening, cleaning and auto care can directly impact water, even when that water is miles away from home.

Clean Water Program

from page 4

Partnering with Retailers

Beyond this summer's "bee campaign," the Clean Water Program is working year-round with local nurseries and hardware stores to help them assist customers in choosing safe and least toxic gardening products. The efforts are coordinated through a regional partnership called Our Water Our World, at no cost to the stores. Since 1997, the program has trained hundreds of employees at participating stores in pest control methods that protect people, pets and the environment. Partner stores also receive over 20 fact sheets on different pests and plant diseases to hand out to customers, as well as colorful shelf tags that help identify low-risk products.

"To date we have over 200 partner stores—31 of them in Alameda County," marvels Annie Joseph, a less-toxic pest management expert who conducts the staff trainings and keeps partner stores abreast of the latest developments in least toxic pest control. "Plant diseases and pests—as well as products and methods to keep them in check—change constantly," Joseph explains. "We make sure that our partner stores are in the know, so they can pass this information on to their customers," she adds.

With an increasing number of home gardeners looking for green products, partner stores appreciate the guidance Our Water Our World provides. "Most people want to do the right thing and protect their local environment," asserts Scanlin. "The Clean Water Program is here to offer support wherever we can."

Stefanie Pruegel has written articles on environmental topics for over 15 years. She currently works at Gigantic Idea Studio in Oakland.

Visit the Clean Water Program at the Alameda County Fair!

June 22-July 10

Look for their distinctive booth in the Ag Building.

Featured Partner: Orchard Supply Hardware in Dublin

No matter if you're looking to prevent ants from coming into your house or trying to keep snails off your plants, Orchard Supply Hardware in Dublin has you covered. Since the store joined Our Water Our World as a partner in 1999, staff and patrons alike have become fans of the free pest-specific fact sheets and shelf tags that quickly identify less toxic pesticide alternatives.

"Our customers are very interested in products that are safe for people, kids and the environment," observes store manager Judy Macaluso. "With the tools I get from Our Water Our World, I can be sure to give sound advice and make helpful recommendations."

List of Our Water Our World Partner Stores

Alameda
Encinal Nursery
2057 Encinal Ave.

Encinal Hardware
2801 Encinal Ave.

Thomsen's Garden Center
1113 Lincoln Ave.

Berkeley
Berkeley Ace Hardware
2145 University Ave.

Berkeley Horticultural
1310 McGee Ave.

Dwight Way Nursery
1001 Dwight Way

Orchard Supply Hardware
1025 Ashby Ave.

East Bay Nursery
2332 San Pablo Ave.

Westbrae Nursery Garden Supply
1272 Gilman Ave.

Castro Valley
Pete's Ace Hardware
2569 Castro Valley Blvd.

Dublin
Armstrong Garden Center
7360 San Ramon Rd.

Orchard Supply Hardware
7884 Dublin Blvd.

Emeryville
Home Depot Emeryville
3838 Hollis St.

Fremont
Orchard Supply Hardware
5130 Mowry Ave.

Regan's Nursery
4268 Decoto Rd.

Home Depot Fremont
43900 Ice House Rd.

Dale Hardware
37100 Post

Hayward
A& Foothill Hardware
22500 Foothill Blvd.

Livermore
Orchard Supply Hardware
1450 First St.

Alden Lane Nursery
981 Alden Ln.

Oakland
Grand Lake Ace Garden Center
4001 Grand Ave.

Broadway Terrace Nursery
4340 Clarewood Dr.

CVS (Old Long's)
5100 Broadway

Thornhill Nursery
6250 Thornhill Dr.

Montclair Village Hardware
5048 Woodminister Ln.

Pleasanton
Western Garden Nursery
2756 Vineyard Ave.

Home Depot
6000 Johnson Dr.

San Leandro
Evergreen Nursery and Garden Supply
350 San Leandro Blvd.

Tom's Ace Hardware
14315 East 14th St.

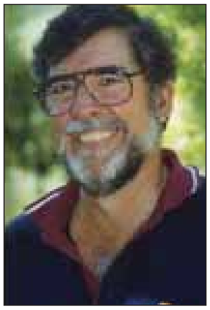
Orchard Supply Hardware
300 Floresta Blvd.

San Lorenzo
Orchard Supply Hardware
1777 Lewelling Blvd.

Local Expert Dispels Myths

Dr. Frankie and colleagues prove they're the bee-all and end-all in insect advice

Gardening expert Annie Joseph's mind was buzzing with questions about bees. Her hankering for the truth got the better of her recently, and she just couldn't mind her own beeswax any longer. Joseph decided to interview local expert Dr. Gordon Frankie, who helped clear up a lot of issues that were bugging her bee-fore.


Dr. Gordon Frankie of UC Berkeley

AJ: How important are native bees to our gardens?

GF: Native bees are a part of the natural heritage of California. They pollinate fruit trees and flowers and are an important educational tool.

AJ: I understand you're writing a book about native bees.

GF: Yes, we have nearly completed a book that has been twelve years in the making called *Bees of North America: Bees and their Flowers in Urban California Gardens*. The 300-page book is the first of its kind in the world. It lists all of the main plants that bees like.

AJ: What kinds of things can we do to encourage native bees in our gardens?

GF: Plant a diverse garden, including plants that bloom throughout the season. Use organic products as much as possible. If you want to encourage bees, don't use pesticides. Since 70% of native bees are ground nesters, leave 50% of the area around your plants bare soil. Females dig their nests or may use existing holes from last year. Bumble bees use cavities of old rodent burrows and even use old bird houses.

AJ: Some people are concerned about being stung by bees. Is this a legitimate worry?

GF: Bees are vegetarian. They're more interested in pollen, nectar, and sex so there's no reason for them to bother you.

For more information go to http://nature.berkeley.edu/urbanbeegardens/.

Gordon Frankie is a professor and research entomologist in the Division of Insect Biology, College of Natural Resources, University of California, Berkeley.

Annie Joseph has been a California Certified Nursery Professional for over 30 years. For over a decade she has consulted to the Our Water Our World Program.

BEE-LIEVE IT OR NOT?

ALL BEES HAVE BLACK AND YELLOW STRIPES.

ANSWER: NOT! Bees actually come in a wide range of colors. Some are metallic green!

Less Work, More Fun: Tips from a Lazy Gardener

Tired of endless weeding, feeding, watering and mowing? Try some lazy gardening techniques such as replacing your lawn with native and other drought-resistant plants. Albany resident Leslie Zander did just that and hasn't looked back since. "I used to spend all weekend mowing and edging the lawn, and many summer evenings watering it by hand," she

recalls with a sigh. "Then the pests! I was always combating rust and other diseases, and spending a lot of time and money on that." Today a wide array of California native plants flourish where the lawn once was, providing greenery and color throughout the year. "My garden has become a lot more interesting," notes Leslie. "And now that there's less maintenance work, I actually have time to enjoy it!"

Leslie's garden was featured on this year's Bringing Back the Natives Garden Tour. For pictures and more information on gardening with native plants, visit www. bringingbackthenatives.net, or the Bay Friendly Gardening section on www.StopWaste.Org.

Grant Program Makes Great Things Possible

What do you want to do in your community?

by Kristin Hathaway

Have a project you've been burning to do? Want to make a difference in your community but don't have the funds? The Clean Water Program's Community Stewardship Grant Program may be just the ticket!

Volunteers remove invasive plants from the Sausal Creek watershed. Replacing these plants with native plants helps create a healthier ecosystem for the creek and ultimately, for the Bay.

Grants of up to $5,000 (and no less than $1,000) are available to schools, non-profit groups, and community organizations. The types of projects that are eligible range from creek clean-ups to art projects—as long as they take place in Alameda County and help promote protection of our creeks or the Bay. Imagination, innovation and collaboration between groups are all strongly encouraged!

EarthTeam of Berkeley applied for a Community Stewardship Grant in 2009. The funding helped to support their partnership with the Friends of Sausal Creek (FOSC), allowing Dr. Katie Noonan's Oakland High School students to help with restoration work at FOSC's Monterey Blvd. redwood restoration site. Noonan is co-founder of Oakland High School's Environmental Science Academy. Their field trips allowed her sophomore biology students to learn lots of great science while having a positive impact on their community.

"I'm so proud of what we've accomplished at Sausal Creek," Noonan declares. "By removing invasive species and planting natives, the students have had a real impact on the local ecology, and ultimately, on the Bay. They learned so much and they developed a connection to a natural place that they wouldn't have otherwise."

The next grant cycle closes on July 15. Grant manager Betsy Diaz encourages anyone with an idea for protecting Alameda County's waterways to apply. "We've received applications for so many fantastic projects in the past. It's really exciting to see the passion and creativity people have!"

For more detailed information and to download an application, go to www.cleanwaterprogram.org. For other questions, please contact Betsy Diaz at betsydiaz@earthlink.net.

Kristin Hathaway, CSM, is a Watershed Program Specialist with the City of Oakland Public Works Agency's Watershed and Stormwater Management Program, and Chair of the Clean Water Program's Public Information and Participation Subcommittee.

PIONEERING WORDS

"…nonselective chemicals…have the power to kill every insect, the 'good' and the 'bad,' to still the song of birds and the leaping of fish in the streams, to coat the leaves with a deadly film, and to linger on in soil—all this though the intended target may be only a few weeds or insects."

— Rachel Carson, author of Silent Spring, 1962

BEE-LIEVE IT OR NOT?

TO PRODUCE ONE TEASPOON OF HONEY, 12 WORKER BEES HAVE TO WORK ALL THEIR LIVES.

ANSWER: BEE-LIEVE IT! The average worker bee produces only about 1/12th teaspoon of honey in her lifetime (about 6 weeks).

"Ask Our Expert" Answers Your Questions

From Ants to Yellowjackets

bv Annie Joseph

Is a pest question bugging you? Not to worry. Try the "Ask Our Expert" function on the Our Water Our World website. Your answer will be just an email away, courtesy of the Bio-Integral Resource Center in Berkeley or BIRC.

Since 1979 BIRC has worked with experts in the field and researchers at universities throughout the U.S. to study pests and ways to keep them in check without resorting to toxic pesticides. "We have gathered a wealth of knowledge on safe, prevention-based pest control," explains BIRC's director Bill Quarles. "It is our mission to make those resources available to anybody dealing with urban or agricultural pest problems, and answering questions is one way."

Most "Ask Our Expert" inquiries come from Bay Area residents. The calls peak during the summer months when pests are on the rise. "Many people ask us about ants and termites, and how to get rid of them using the least toxic methods," observes Quarles, who responds to most of the questions himself. Another popular topic: mystery insect bites that appear overnight with no apparent cause. "Sometimes these are rat mites, sometimes bed bugs, and sometimes it takes a lot of detective work to figure it out," Quarles confesses.

Besides giving hands-on tips to regular folks, BIRC trains pest management professionals in practices that emphasize prevention and non-chemical treatment methods. Qualifying firms can obtain EcoWise certification, which BIRC helped develop. "Many people would like to hire professionals who minimize or eliminate the use of pesticides. The EcoWise Certified Program is designed to help locate those contractors," explains Quarles.

To submit your pest question to BIRC, visit www.ourwaterourworld.org and click on the Ask Our Expert tab.

Bay-Friendly Garden Tour 2011
Executive Summary

June 2011

For the past seven years StopWaste.Org has been featuring Alameda County home gardens on the annual Bay-Friendly Tour. This year the Bay-Friendly Coalition organized the first regional tour in Alameda, Napa, and Santa Clara Counties. Offering the tour through the Coalition provided an exciting opportunity to expand the geographic and demographic scope of the program. Tours were held on May 1, 2011 in Napa County, and May 15, 2011 in Alameda and Santa Clara Counties.

The tour offers an introduction to the Bay-Friendly gardening principles of reducing waste, conserving water and energy, creating wildlife habitat, building healthy soil, promoting healthy communities, and protecting our local watersheds and the bay. The tour continues to inspire residents with real-life examples of Bay-Friendly gardens demonstrating these principles, and provides the opportunity for the general public to learn more about Bay-Friendly resources and programs. The tour also supports Bay-Friendly Qualified Landscape Professionals by featuring their personal or client's gardens and serves to build a base of Bay-Friendly supporters. (Bay-Friendly Qualified Landscape Professionals have completed 21 hours of training in Bay-Friendly principles and practices and passed a final exam).

2011 Tour Numbers at a Glance

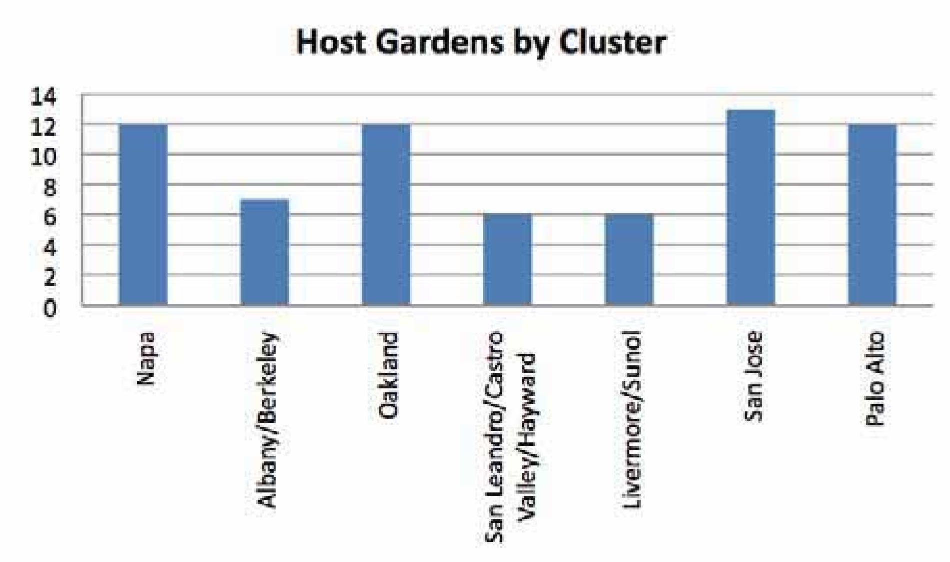
- 2000 tour participants
- 1000 email contacts
- 120 volunteers
- 74 new members
- 68 host gardeners
- 10 sponsors

Host Gardens

Sixty-eight host gardens were featured and ran the length of the Bay Area, from San Jose to Napa, with 31 in Alameda County. They represented the many different styles of Bay-Friendly, showcasing urban homesteads with goats, chickens and vegetables, hillside collector's gardens, and large lots with acres of growing space. The hosts themselves were a diverse group that included permaculturists, native plant enthusiasts, do-it-yourselfers and professional landscapers. **Eight Bay-Friendly Qualified Landscape Professionals** participated regionally.

In addition to picking gardens that demonstrated Bay-Friendly practices, gardens were selected with geography in mind. Garden clusters were created to help reduce driving time and maximize visits. Where possible, bikeable clusters were developed and identified within the guidebook.

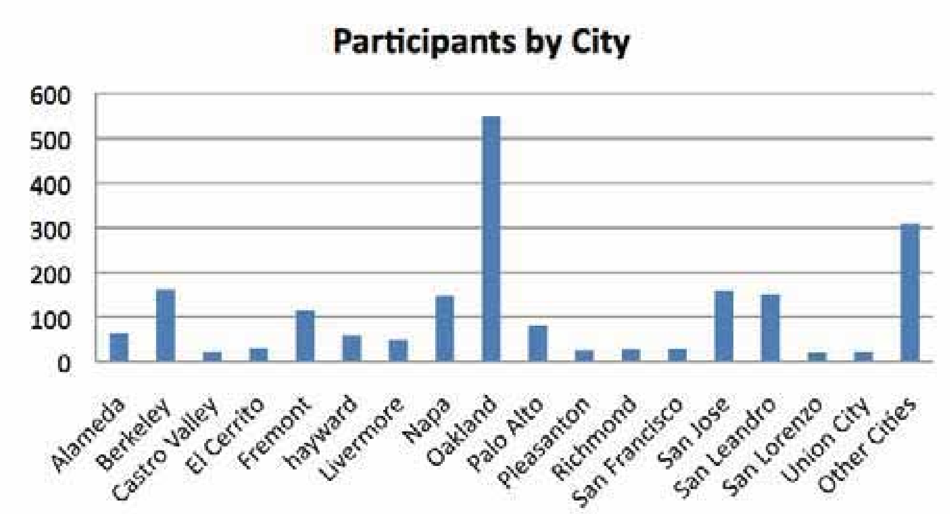
The following table demonstrates the breakdown by city cluster.



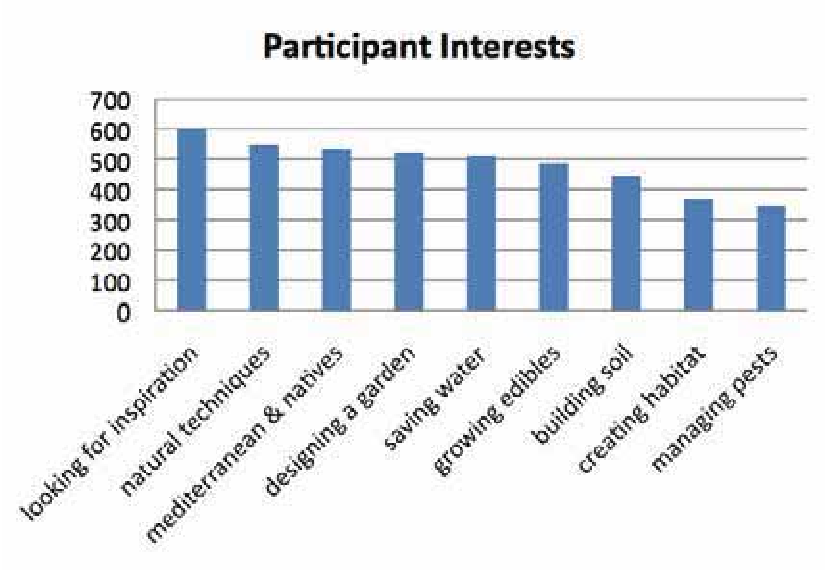
Tour Registration

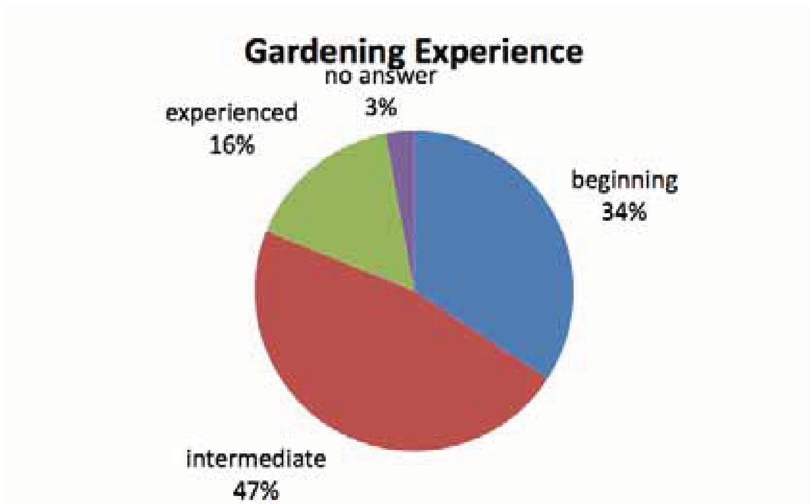
On-line registrants are asked how many people will be using the guidebook they are purchasing (guidebooks can be shared so long as each guest turns in a ticket at each garden visited—18 tickets are included). Over 800 individuals purchased a guidebook and more than **2000 were planning to participate**.

The chart below demonstrates the number of participants based on mail city. Cities with fewer than 20 participants were grouped together under "Other Cities".



Aside from contact information, participants who registered on-line were asked what they "are more interested in learning about" as well as their level of gardening experience. Following are highlights from **835 participants** who pre-registered.

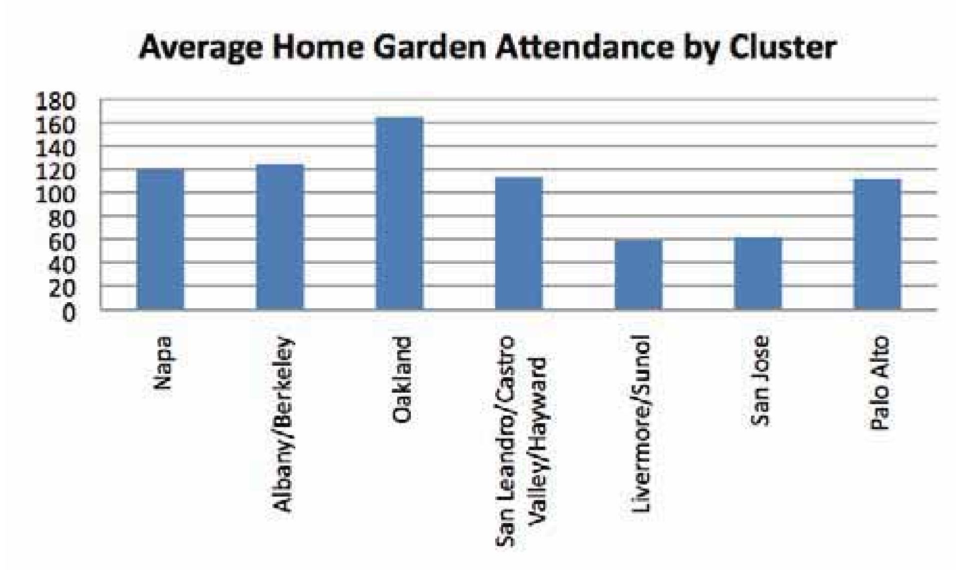




Tour Day

Ticket Counts

Eighteen tickets are included in each guidebook. Each guest must present a ticket at each garden visited. Volunteers are asked to count tickets at the end of their shift. Counts may not be perfect but do provide a sense of how many visitors are passing through the gardens. The following chart demonstrates the average number of visitors per home garden.



Participant Evaluations
A post tour e-news and survey was sent to 832 participants whose email addresses were collected. The survey response rate was over 20%, with **182 completed surveys**. Overall, results indicate a high level of satisfaction with the tour:

- 98% would "recommend the tour to a friend, neighbor or fellow gardener".
- 94% rated the quality of the gardens as "excellent" or "good".
- 79% were "more interested in adopting Bay-Friendly practices at home" after the tour, with a number of participants reporting that they aren't more interested because they already employ such practices.

After the tour some host gardeners and participants took it upon themselves to post on-line about their experience. Following is a list of some of these blog posts.

- DryStoneGarden
- FLORADORA
- Havenscourt Homestead
- Calnativescapes
- Simply living
- Pluck & Feather

Bringing Back the Natives Garden Tour
1718 Hillcrest Road
San Pablo CA 94806
(510) 236-9558
Kathy@KathyKramerConsulting.net
www.BringingBackTheNatives.net

Final Report

Why a Native Plant Garden Tour?

The spring 2011 Bringing Back the Natives Garden Tour was held in order to showcase pesticide-free, water-conserving gardens that reduce solid waste, provide habitat for wildlife, and contain 50% or more native plants.

The tour enlists local residents to demonstrate by example that seasoned and novice gardeners can garden with good results without the use of synthetic chemicals, and with minimal supplemental water, while providing food, shelter, and nesting areas for wildlife. Garden hosts show that it is possible to implement sustainable garden practices and still have beautiful places for people to relax in and enjoy. The goals of the Bringing Back the Natives Garden Tour are to motivate attendees to eliminate pesticide use, reduce water use, generate less solid waste, and provide habitat for wildlife in their own gardens.

Local California native plants survive naturally with only fall-to-spring rainfall. Once established in the garden setting, these plants need little or no summer water. In addition, California natives are hardy; they do not require the use of pesticides and fertilizers, as many non-natives do. Native plants also need less pruning than many non-natives, such as lawn, ivy, or cotoneaster, thus generating less green waste. Natives also provide the best habitat for birds, butterflies, beneficial insects and other forms of wildlife.

A four year study of water use, green waste generation, maintenance hours, and maintenance labor costs between a traditional garden and a California native plant garden was conducted by the City of Santa Monica. (See http://www.smgov.net/Departments/OSE/Categories/Landscape/Garden-Garden.aspx). The results of this study showed that the native garden used one tenth of the water that the traditional garden did; generated less than half of the green waste; took a quarter of the time to maintain; and cost 75% less to maintain than the traditional garden.

Tour gardens contain minimal or no lawn. This is of particular value since the majority of the chemicals purchased by homeowners support lawn care, and the majority of water used in home gardens is applied to lawns. According to the 2000 U.S. Fish and Wildlife Service's Division of Environmental Contaminants publication, "Homeowner's Guide to Protecting Frogs—Lawn and Garden Care," homeowners use up to 10 times more chemical pesticides per acre on their lawns than farmers use on crops. In addition, half of the water used by the average household is applied to the landscape—with most of that water being applied to keep turf green. Eighty four percent of the gardens included on the tour had no lawn, and the rest had lawns that were reduced in size to 10% to 40% of the gardened area.

2011 Bringing Back the Natives Garden

The Seventh Annual Bringing Back the Natives Garden Tour, which took place on Sunday, May 1, 2011, showcased forty nine gardens located in seventeen cities and unincorporated areas in Alameda and Contra Costa counties (Alamo, Albany, Berkeley, Clayton, El Cerrito, Fremont, Hayward, Kensington, Lafayette, Livermore, Martinez, Moraga, Oakland, Orinda, Pittsburg, Pleasanton, Richmond, San Ramon, and Walnut Creek).

A variety of gardens were featured on the tour. The gardens ranged from Jenny and Scott Fleming's 50 year old collector's garden to a number of gardens that had been recently installed, and from large lots to small front gardens in the flats. Tour gardens contained everything from local native plants to the horticulturally available suite of natives from throughout California. Fourteen of the gardens were designed and installed by owners, and thirty five of the gardens were designed and installed by professionals. Ninety six percent of the gardens were landscaped with between 70% to 100% native plants. Nearly 20% of the gardens on this year's tour were offered by former registrants who had attended a previous Bringing Back the Natives Garden Tour and become inspired to transform their own garden.

This year four walkable garden clusters were on the tour; walkable clusters were located in Berkeley, Livermore, Pleasanton, and Richmond.

Native Plant Sale Extravaganza
In additional to the May 1 tour day, on which forty nine gardens were open for viewing, the Native Plant Sale Extravaganza took place throughout the week-end of April 30 and May 1.

During the Native Plant Sale Extravaganza a number of native plant nurseries—some not normally open to the public, and others open only for limited hours—were open from 10:00–5:00 both Saturday and Sunday. Bringing Back the Natives Garden Tour registrants took advantage of this opportunity to shop for unique or hard-to-find native plants that are not normally available in most nurseries. This year eight nurseries took part in the Extravaganza, and nearly $11,000 worth of natives were sold over the course of the week-end.

Number of registrants, volunteers, and garden visits
The tour received overwhelming interest from the public; this year there were 7,041 registrants, making this the most well-attended tour yet. This was a 9% increase in registrants over the 2010 Tour. The bulk of the registrants (6,728) registered for the tour in advance, and on-line. On the day of the tour an additional 303 people visited the same day walk-in registration sites, which were set up in Alameda, Berkeley, Castro Valley, Concord, El Cerrito, Livermore, Martinez, Moraga, Oakland, and Richmond, and Walnut Creek.

This year 19,741 garden visits were made on the day of the tour. The number of visits to each garden varied from a low of 91 visitors in Pittsburg to a high of 929 visitors at the cluster of three gardens in Berkeley. (See the end of this report for a list of the number of visitors counted at each garden.)

Nearly 200 volunteers either worked at gardens for a half-day shift on the day of the tour, or helped with tour preparation and clean-up, contributing more than 800 hours of time to the tour. The 49 hosts put in countless hours preparing for the tour, and 400 hours on the day of the event.

Garden Talks

More than 60 garden talks and demonstrations were given throughout the day on a plethora of subjects. Talk topics included how to: remove a lawn; select, plant, and care for natives in general, and select natives for specific areas; design a simple, low-maintenance native plant garden; how to attract bees; improve soil so as to have a healthier garden; choose appropriate natives; design and install a native plant garden; create a low-maintenance native plant garden; control weeds without using herbicides; water efficiently; maintain a native plant garden; design a native hillside garden; design and install a native garden yourself; garden for wildlife in general, and native bees and butterflies in particular; and how to control erosion, among other topics.

The website

The website, http://www.BringingBackTheNatives.net, was extremely popular, receiving more than 400,000 page requests over the course of the year.

The website contains numerous photographs of all of the gardens that have ever been on the tour (information on prior tours remains accessible on the website for reference), extensive garden descriptions, plant lists for each garden, and some garden-specific bird, butterfly, mammal, reptile, and amphibian lists, as well as resource information on how to garden with California natives. The resource information includes contact information for landscaper designers with gardens on the tour, a list of Easy-to-Grow East Bay Natives, lists of nurseries that carry native plants, lists of reference books, “How I got started gardening with native plants” essays by several of the host gardeners, and more.

In order to attract hosts and volunteers, and to thank them for their time, four Garden Soirees—free, private tours of native plant gardens—were held in 2011. Garden Soirees offer host gardeners and volunteers the opportunity to see tour gardens that they would otherwise miss. They also create a feeling of camaraderie between hosts and volunteers, and provide a venue for people who are both knowledgeable and passionate about gardening with natives to meet and exchange information.

Misc. details

Thirty three of the gardens were at least partially wheelchair accessible. Fifteen of the gardens were certified by the National

Wildlife Federation as Backyard Wildlife Habitat Gardens. The California Native Plant Society set up and staffed tables at five gardens, and the Society's Native Here Nursery participated in the Native Plant Sale Extravaganza.

Tour Partnerships

The Bringing Back the Natives Garden Tour created partnerships with a variety of organizations that share common values—that chemical-free and water conserving gardening preserves water quality and quantity, and creates wildlife habitat. The list of major sponsors and supporters of this year's tour includes a flood control district, two county stormwater programs, two water districts, six cities and an unincorporated area, and a private foundation. The list of tour sponsors, who were credited on the website, and in the printed garden guide, is provided below.

Sponsors of the 2011 tour

$15,000

Alameda County Flood Control and Water Conservation District

$10,000

Contra Costa Clean Water Program

$5,000

JiJi Foundation

$4,000

Contra Costa Water District

$3,000

Contra Costa Watershed Program

$2,500

County Clean Water Program (Alameda)

$2,000

Bay Area Water Supply and Conservation Agency
California Native Plant Society (East Bay Chapter)
City of Richmond

$1,500

City of El Cerrito

$1,000
City of Antioch
City of Orinda
City of Pittsburg
Zone 7 Water District

$500
City of Martinez

Host Gardeners
The gardens selected to take part in the tour are excellent examples of chemical-free and water-conserving gardens that provide habitat for wildlife. Hosts were chosen because of their willingness to be on site on the day of the tour to explain first-hand the techniques they use in their gardens, and their enthusiasm for and commitment to educating others about how to garden in environmentally sensitive ways.

Host gardener recruitment began in the spring of 2010 for the 2011 tour. Potential candidates completed an application, and applicants who met the criteria received a site visit. Host criteria were as follows:

- Gardener must reside in Alameda or Contra Costa County.
- Gardener must use organic and/or natural techniques for pest control rather than synthetic pesticides.
- Garden must demonstrate water conservation techniques. Examples include mulches, groundcover plants, drip or soaker hose irrigation, and the use of plants that do not require excessive watering during the dry part of the growing season.
- Gardener must be a good ambassador for chemical-free, water-conserving gardening: enjoy educating the public; and have the knowledge base to employ natural gardening techniques and share this information with the public.
- Garden must provide food, shelter and nesting areas for wildlife.
- Garden must contain 50% or more California native plants.
- No invasive plants are found in the garden.

Host's gardening experience ranged from native plant novices to professional landscape designers. All of the host gardeners were good ambassadors for natural gardening techniques.

Host Comments from the 2011 evaluations:

- I had no idea that so many people would show up; it was exhilarating! Over 400 people walk through our garden. They seemed very happy with their experience and impressed with the guidebook. My husband was impressed with the variety of people who came—amateur photographers, hobby gardeners, landscape architects, and most common, those trying to find a replacement landscaping for their lawn.
- Some who came stayed for several hours and a few returned later in the day. In general, people seemed very enthusiastic and spoke of gaining inspiration from the experience. I believe most people went away with a great appreciation for gardening with California natives.
- I was impressed to have visitors from the Regional Water Quality Control Board and EBMUD who were interested in the native gardens and water use. The EBMUD representative was getting ideas for a new program that is just starting that will provide incentives for removing the lawn. This suggests to me that the tour is gaining stature in the regulatory community.
- The tour has really helped and continues to help spread the news about gardening with natives locally.
- The tour was very well organized! There were 504 people at my garden; a steady stream from 10- 5.
- We enjoyed having a chance to share our garden with people interested in natives. Everybody was very complimentary and appreciative, which made the effort of preparing for the tour worthwhile.
- My husband and I and my volunteers had a great time! This is a unique opportunity to do outreach on water conservation, stormwater runoff, habitat preservation, and so on. 7000 registrants is impressive and I'm pleased that so many people are coming to understand the benefits of going native.

These comments were taken from 2011 Volunteer evaluations:

- I enjoyed being able to talk to people and inform them of great places to get information on pest management practices that minimize the use of chemicals.

- Visitors at the garden I worked at loved the tour and thought it was a fantastic event not only to see the beauty of native plant gardens, but as learning experience.

- A lot of people took the free literature that was provided.

Tour Survey and Evaluation
Two surveys were offered to the tour's 6,728 pre-registered participants. The first was available as part of the registration process. Below are some statistics taken from this survey.

The 2011 tour attendees were highly motivated to learn new gardening techniques. When asked what they would like to learn from the tour the majority of respondents (75%) wanted to learn how to select native plants; 55% wanted to learn how to conserve water; 52% wanted to learn how to garden for wildlife; 34% percent wanted to learn how to reduce pesticide use; 33% wanted to learn how to remove their lawns; and 23% wished to learn about composting.

What do you want to learn from the tour?	2011 Responses
How to select native plants	75%
How to reduce water use	55%
How to garden for wildlife	52%
How to reduce or eliminate pesticide use	34%

How to replace a lawn with a garden	**33%**
How to compost	**23%**

Evaluations
There was a return of 599 participant evaluations.

98% of those filling out the evaluations rated the tour "Excellent" or "Very Good."

This year 58% of the registrants were repeat visitors, and 42% were attending the tour for the first time.

Motivation and Behavior Change
The registrant evaluations were split up into two groups—those who had attended the tour before, and those who had not. The data for Repeat Registrants and First-Time Registrants was tabulated separately. Both of these categories are discussed below.

Repeat Registrants
74% of registrants who had attended a previous Bringing Back the Natives Garden Tour, and who filled out the evaluation form, said they had changed their gardening practices because of their participation in the Bringing Back the Natives Garden Tour.

The first column below shows the percentages of the repeat registrants who changed their gardening behaviors after attending the Bringing Back the Natives Garden Tour. The second column shows the percentage of repeat registrants who plan to change their gardening behaviors.

Evaluations of repeat registrants from the 2011 tour showed that after attending a prior Bringing Back the Natives Garden Tour: 18% of respondents had incorporated natives into their gardens (thereby reducing herbicide use and conserving water); 13% were encouraging wildlife with plant choices; 12% had grouped plants by water needs and incorporated drought-resistant plants into their gardens; 12% had increased the density of plantings to out-compete weeds (reducing herbicide use and conserving water); 11% were tolerating some insect damage; 10% had begun mulching; 8% had amended their soil; 6% had reduced the size of their lawn; 5% had reduced or eliminated pesticide use; 5% had installed efficient irrigation; 5% were grasscycling; 4% were composting; and 4% had reduced the amount of hardscape in their gardens.

Repeat visitors were highly motivated to make changes in their gardens. When asked what they planned to do: 34% planned to increase the density of plantings to out-compete weeds; 26% to group plants of similar water needs; 24% to install efficient irrigation; 19% to encourage wildlife; 18% to reduce the size of their lawn; 16% to incorporate native plants into their gardens; 15% to mulch; 15% to minimize hardscapes; 13% to compost; 12% to amend their soil with compost; 8% to tolerate some insect damage to plants; 5% to grasscycle; and 5% to reduce or eliminate pesticide use.

How do you manage your garden? (This information was taken from evaluations filled out by repeat registrants.)

ITEM	Began after participation in a previous BBTN Tour	Plan to do this
1. Reduce/eliminate insecticide/ herbicide use.	5%	5%
2. Increase the density of plantings to out-compete weeds.	12%	34%
3. Encourage birds, butterflies, etc. with plant choices, food, shelter, and water.	13%	19%
4. Tolerate some insect damage to plants.	11%	8%
5. Incorporate native plants into our garden.	18%	16%
6. Group plants of similar water needs.	12%	26%
7. Incorporate drought-resistant plants into our garden.	11%	16%
8. Install efficient irrigation (such		

as drip, timers, soaker hoses).	5%	24%
9. Grasscycle (leave grass clippings on the lawn).	5%	6%
10. Reduce the size of our lawn.	6%	18%
11. Mulch with leaves, grass, wood chips, etc.	10%	15%
12. Amend soil with compost.	8%	12%
13. Minimize hardscapes (patios, decks).	4%	15%
14. Compost yard waste and kitchen scraps at home.	4%	13%

First-time registrants
The tour was highly motivating to the first time registrants who completed the evaluation. 46% planned to incorporate native plants into their gardens; 40% of first-time registrants responded that they planned to increase the density of plants, thus helping to out-compete weeds and reduce water use; 40% of first time registrants planned to group plants by water needs; 36%planned to encourage wildlife; 33% planned to incorporate drought-resistant plants into their gardens; 29% planned to reduce the size of their lawns; 29% to install efficient irrigation; 23% planned to mulch; and 31% to amend their soils; 19% to compost kitchen scraps and yard waste; 22% planned to tolerate some insect damage; 14% planned to reduce or eliminate pesticide use; and 11% planned to reduce the amount of hardscape in their gardens.

How do you manage your garden? (These are responses from first-time registrants.)

ITEM	Plan to
1. Reduce/eliminate insecticide/herbicide use.	14
2. Increase the density of plantings to	40

out-compete weeds.	
3. Encourage birds, butterflies, etc. with plant choices, food, shelter, and water.	36
4. Tolerate some insect damage to plants.	22
5. Incorporate native plants into our garden.	46
6. Group plants of similar water needs.	40
7. Incorporate drought-resistant plants into our garden.	33
8. Install efficient irrigation (such as drip, timers, soaker hoses).	29
9. Grasscycle (leave grass clippings on the lawn).	6
10. Reduce the size of our lawn.	29
11. Mulch with leaves, grass, wood chips, etc.	23
12. Amend soil with compost.	31
13. Minimize hardscapes (patios, decks).	11
14. Compost yard waste and kitchen scraps at home.	19

Number of visitors at each garden, and total number of garden visits made

This year the number of garden visits increased by 8%, from 15,594 on the 2010 Tour to 19,741 in 2011.

BAYSIDE CITIES	Number of garden visits made on May 1
Albany	
Leslie Zander	308
Berkeley	
Brenda Buxton	929
California Native Bee	467

Garden	
Timothea and William Campbell	696
Scott and Jenny Fleming	833
Jason Koenig and Rachel Roisman	390
Christopher Kroll	929
Margaret Norman	765
Glen Schneider	730
Schoolhouse Creek Common	920
El Cerrito	
Donna Bodine	297
Nalani and Anna Heath-Delaney	423
Lyn Talkovsky	171
Fremont	
Angie and David Hexum-Pope	118
Kathleen McCabe-Martin	160
Hayward	
Brenda Senturia and Gary Cooper	179
Natalie Forrest and Douglas Sprague	177
Kensington	
David Matthews	236
Oakland	
Stephen Asztalos	340
Diane Fagan	427
Wen Hui Shen	732
Richmond/Point Richmond	

Rick and Monica Alatorre	344
Sharon and Dan May	250
Debbie Rheuark	196
Jocelyn and Peter Rohan	250
Kate Sibley	237
INLAND CITIES	
Alamo	
Ted and Barbara Shapas	383
Clayton	
Kelly Marshall and Mike Weidner	184
Lafayette	
Mary Jennings and Michael Jennings	525
Betty Nelson	504
Livermore	
John and Drew Andersen	349
Cindy and David Angers	302
Lisa and Andy Paterson	343
Bryan and Donna Weber	238
Martinez	
Chris and Marianne Dundon	231
Troy McGregor	243
Moraga	
Al Kyte	359
Orinda	

Barbara Leitner	384
Alma Raymond	342
Pittsburg	
Frances Dahlquist	91
Luis-Felipe and Gracie Torres	112
Pleasanton	
Melinda and Steve Ballard	470
Ward and Pat Belding	419
Colleen Clark	419
San Ramon	
Don and Kathy Brancheau	225
Walnut Creek	
Mary Andre and Dennis Hoagland	507
BJ and Larry Ledgerwood	711
Rich McDrew	413
Meg McShannic and David Wallace	483
TOTAL	19,741

When planning for a year, plant corn. When planning for a decade, plant trees.

When planning for life, train and educate people.
(Chinese proverb)

Below are comments from garden tour attendees, either taken from registrant evaluation forms, or received via e-mail.

- Great job by everyone. As we drove home from this wonderful tour, we saw our next door neighbor spraying ROUND UP! Egads!

- It's great! My whole family loves to go look at the gardens and we are getting tons of inspiration for ways to add native plants to our gardens. Thank you so much!

- Thank you for putting the tour together so we can all enjoy the beauty and learn more about having a native garden (especially ones that attract bees, birds and butterflies). It is always a delight. Hats off to all the volunteers. They are all terrific!

- Thank you to the organizers of the tour and the homeowners who hosted and opened their gardens to us.

- Thank you!!!!

- Congratulations. Through this tour, I am sure you have increased knowledge about and use of native plants significantly in the tour area and among participants/attendees.

- I am impressed with the scope of this tour, and the overall production. I will definitely recommend it, and return, next year.

- I love the garden tour. We got into natives soon after acquiring a garden (not soon enough) and seeing other people's gardens gives us a chance to see what grows well locally, in different micro-environments, and to get advice from fellow gardeners.

- I brought along a friend new to the tour and she LOVED it. Great job!

- Love this tour. It's always inspiring!

- The brochure was awesome!

- Wonderful variety of gardens. The volunteers were all helpful and friendly. It was a pleasure, and a gorgeous day too!

- It’s always wonderful! I especially like being able to see the plants and ask questions about how much water they are getting, how much sun/shade for a particular plant, whether a particular plant still needs some water or none, etc.

- Well done. We really enjoyed it. We hope to buy a house soon and we will use what we learned.

- Thank you so much for all your work. I went on the tour in '09, started our plan to switch to natives in Nov. of '09 and completed 80% of the project in Nov. of '10. Thanks for all the encouragement to go native.

- Best in the Bay. Wonderful range of gardens, educational emphasis, terrific examples of native plantings. Fabulous organization and geographic focus;

best of tech/printed material - both at this point very useful and worth saving and sharing. The book is worth holding on to, showing current practices at their best. I keep my copies in the "guestroom." There were knowledgeable people on site, and this is a perfect time of the year to see natives in the Bay Area. Excellent plant labeling. Congratulations!

- Love the garden talks, the opportunity to see repeat gardens as they grow and mature, and the opportunity to buy plants.

- Thank you so much for organizing this tour. I now have a better understanding of what a native garden is. You have given me inspiration and confidence that I can do without my lawn.

- This was our first tour. We had a great time visiting four gardens and came away with lots of ideas for improving our garden. We bought some plants from Garden Natives Nursery in Martinez, and have ordered seeds for some other natives online. Thanks for inspiring us!

- This was an inspiring tour! I look forward to creating a front yard full of California natives when I re-landscape this spring.

- Very well organized! The information is ample and the printed self-guided tour guide is super!

- Fabulous. Thank you for this great tour.

- I was impressed with the helpfulness and enthusiasm of the people at each house.

- The tour was great. We got many ideas for California Natives that we want to plant. Thanks!

- I'm very impressed with the high degree of detailed information assembled and managed in this project, not only in coordinating among garden presenters, but also in producing the website and printed guide. The website provided wonderful previews to the tour gardens, and is a rich collection of native gardening information resources. The printed booklet was indispensable for planning a visiting schedule and effectively navigating to the garden locations, and is a "keeper" informational resource in its own right.

- The booklet that was mailed was very complete and well done. Lot's of great references in the booklet and passed out on tour. A totally lovely day, very helpful and pleasant people. I really liked the talks I attended - Michael Thilgen, choosing natives for water conservation; I learned a lot. Chris Dundon on removing your lawn with low cost, etc. was very helpful and informative. We rehab houses to sell and we are very interested in doing no lawn - dryscapes with drip irrigation. We will definitely incorporate the things we learned into our business. I brought my husband along and he also had a great time!

- I finally installed our butterfly garden back yard this winter, thanks in large part to encouragement from tour participants and attendees - lots of really great people!

- Living in the Oakland Hills, we are sold on native gardening. We liked the variety of gardens and locations and found several that appealed to us. The website content (esp. preview/plant lists), emails, tour, publications are well designed, helpful, and executed. We found this information to be extremely helpful to get started with our remaking garden. We look forward to sharing this information with neighbors and friends.

- We got some great ideas for native plants for our hillside, which has been a challenge to plant. I am feeling encouraged and confident about reducing our lawn size now.

- My wife and I loved the tour. We are overwhelmed by our large dirt lot. We learned a lot from all of the gardeners, and were very inspired by what we saw.

- The tour is excellent the way it is. I love that it is low-key, low-pressure. I love that the homeowners are so nice and willing to chat. I love that it doesn't cost a fortune. I love that everyone labels their plants. I love the excellent booklet and excellent descriptions. Thank you!

EDUCATIONAL SERVICES ANNUAL REPORT FORM Fiscal Year 2010/2011

A) PROJECT INFORMATION

Organization Name: Joe Leon, Caterpillar Puppets **Mailing Address:** 2060 Casa Grande Benicia CA 94510

Street
City State

Fax Number: (925) 543-3042 **Project Director:** Joe Leon **Phone:** 707 746-5597 cell 707 334-1380 **E-mail:** caterpillarpuppets@mac.com

Name of Person Completing the Report: Ronna Leon **Phone:** 707 746-5597

E-mail:CATERPILLARPUPPETS@MAC.COM **Date of Report 6/22/11**
Reporting Period: From 7//2010 **to** 6/30/2011
Project Scope:
Educational outreach puppet show assembly for grades 1-3. 100 Students per assembly program. Teaches what is a watershed, what is a storm drain. How we can keep our watershed clean. What causes watershed pollution and how to prevent watershed pollution!!

B) PROJECT UPDATE

1. Sorted by City, list the school programs* completed during this reporting period into table provided below:

EMERYVILLE

February 17 Anna Yates School 2x 9:00 and 10:00 210 Students
1070 41st. Emeryville, Contact: Mary McGruder

BERKELEY

Jan. 11 Rosa Parks, Elementary2x 1:15 and 2:10 160 students
920 Allston, Berkeley Contact: Paco Furlan
March 10 Oxford School 2x 11:00, 1:00 150 students
1130 Oxford St, Berkeley Contact: Luticia
Dec 13 Walden School 1x 1:15 60 students
2446 McKinley Ave Berkeley, Contact: Carolyn
March 22 Berkeley School 1x 60 students
1310 University, Berkeley, Contact: Clair Patterson
May 20 Le Conte School 2x 8:30 & 10:00
2241 Russell St, Berkeley, Contact: Cheryl Wilson

CASTRO VALLEY, SAN LORENZO, SUNOL

Oct 21 Palomeres School 1x 11:00 90 students
6395 Palo Verde Rd, Castro Valley Contact: Stephany, Secretary
Oct. 25 Jensen Ranch Elementary 3x 9:00, 1:30 and 2:00 afternoon 300 students
20001 Carson Ln, Cstro Valley Contact: Pam
Jan 12 Hacienda School 1x 50 students
3800 Stoneridge Dr Contact: Megan Madden
Dec 16 Del Rey Elem. 3x 8:50 , 9:30, 10:10 340 students
1510 Via Sonya, San Lorenzo Contact: Principal
May 27 Redwood Christian School 2x 1:45 and 2:30 140 students
19300 Redwood Rd, Castro Valley Contact: Patricia Boyd

HAYWARD

October 20 Treeview School 2x 9:00 and 10:40 150 students
30565 Treeview St. Hayward Contact: Sue
Oct 19 Bidwell School 2x 9:00 and 9:45 150 students
175 Fairway St Hayward contact: Sue

HAYWARD CONT.

Nov 2 East Ave School 3x 9:00, 9:45 & 10:30 300 students
2021 Highland Blvd. Hayward Contact: Betty Lu
March 31 Lea's Christian School 1x 2:40 70 students
26236 Adrian Ave Hayward Contact: Terry Jaykle
Feb 10 Eden Garden School 3x 9:00, 9:40, 10:15 360 students
2184 Thayer Ave Hayward Contact: Elizabeth Jessie
February 23 Lorenzo Manor 3x 8:30, 9:10, 10:00 230 students
18250 Bengal Ave, Hayward Contact: Eleen, Principal

OAKLAND
Oct 8 Park Day School 2x 12:45 and 1:25 160 students
360 42nd St, Oakland Contact: Karen Colaric
Jan 28 Archway School 1x 10:30 45 students
250 41st St., Oakland Contact: Kim
Feb 22 Beacon School 1x 1:05 90 Students
2101 Livingston St. Oakland, Contact: Ann Myers
March 24 CoVA School 4x 8:30, 9:00, 9:45 and 10:30
Contact: Valerie Abad

SAN LEANDRO
March 23 James Madison School 2x 250 Students
14751 Juniper St. San Leandro Contact: Carol
March 11 St Leander School 1x 1:30 75 students
451 Davis, San Leandro Contact: Amy Cross
March 30 Hillside Elementary 4x 8:15, 8:50, 9:20 and 10:00
15980 Marcella St, San Leandro Contact: Pam Vandekamp
May 23 Roosevelt School 3x 8:30, 9:30 and 10:30 320 students
951 Dowling San Leandro Contact: Tricia Reichert

FREMONT
Nov. 19 Warwick Elementary 2x 9:00 and 9:30 125 students
3375 Warwick, Fremont Contact: April Bishop
May 16 James Leitch Elementary 6x 8:45, 9;30, 1:45 each day 670 students
May 18 47100 Fernald St, Fremont Contact: Kiki Heller

Feb 25 Stratford School 3x 9:00. 10:00, 11:00 250 students
5301 Curtis St, Fremont Contact: Kim Cullen
Feb. 24 Harvey Greene 3x 9:45, 10:45 and 11:45 260 students
42875 Gatewood, Fremont Contact: Janette
March 8 Mission Valley 2x 9:15 and 10:35 160 students
41700 Denise St Fremont, Contact: Virgina August
Jan. 24 Peace Terrace Academy 1x 10:00 45 students
33330 Peace Terrace, Fremont Contact: Anita

UNION CITY
Nov. 4 Our Lady of the Rosary 1x 10:30 60 students
678 B Street, Union City Contact: Chris McKeon

UNION CITY Cont.

EDUCATIONAL SERVICES ANNUAL REPORT FORM Fiscal Year 2010/2011

Jan 20 Kitayama Elementary School 4x 8:10, 9:00 and 9:45 12:30 380 students
1959 Sunsprite Dr. Union City, 94587

NEWARK
March 1 Milani Elementary 2x 9:15 and 10:30 140 students

Total 75 as of June 15, 2010 total possible for year 75

*If your program consists of multiple class visits, please list the name of the lesson(s) and/or activity(ies) implemented
during the reporting period for **each class**. **2. Estimate percent of programs completed:100%**

3. How did activities implemented during this reporting period enhance students' understanding about stormwater pollution prevention and watershed awareness:

The assembly teaches WHAT IS A WATERSHED, WHAT CAUSES STORMWATER POLLUTION. It involves students in thinking about and problem solving watershed issues. It involves them emotionally with characters associated with the creek, bay and ocean systems: frogs, ducks, racoons, seals, fish and the effect that watershed pollution has on them and their habitats.

4. Were all the workshops implemented by the end of the 2010/11 school year? If not, please explain: Yes. As in other years of this program some areas and districts were more receptive to having outside programs then others. We believe this does not reflect on the quality of the program as much as on the culture of a particular school district. **C) PROGRAM EVALUATION**

Attached to mailed copy in full Sample: "Excellent Program. The kids love it and learn SOOOO much from you." Oxford School , "Very Cool, my kids really enjoyed it. They really liked the coloring page." Hillside School " The puppet show was wonderful. It not only engaged the kids but the teachers as well. The information delivered went perfectly with what the students were learning about. We can't wait to have Joe Leon back next year."

D) BUDGET UPDATE

1. Funds awarded (as per agreement): $22,500
2. Costs invoiced during this reporting period: $22,500 **3. Costs invoiced to date:** $22,500(Final Invoice payment not received yet for $3,600 as of June 22) **4. Funds remaining:** none **E) PUBLICATIONS 1. Attach copies of any press releases, newsletter articles, or other publicity materials regarding the program produced during last quarter.** Materials, brochure, evaluation form, pre-class activity sheet, follow-up coloring page are the same as submitted in report 1. Nothing new added.

All reports submitted to the Alameda Countywide Clean Water Program must contain the following certification
statement, and be signed and dated by the Project Director. "I hereby certify that the above and attached statements are true and accurate."

____________________________ ____________________ Signature of Project Director
Date

NOTE: An **electronic copy** (unsigned) of this final report must be emailed to jims@acpwa.org, **AND** as per agreement, a **signed hard copy** of this electronic report including a summary of evaluations, and copies of the receipts (indirect costs) must be submitted to the following address: Jim Scanlin Alameda Countywide Clean Water Program 951 Turner Court, Room 300 Hayward, CA 94545 **EDUCATIONAL SERVICES FINAL REPORT FORM Fiscal Year 2010/2011**

EDUCATIONAL SERVICES END-OF-YEAR PROGRESS REPORT

A) PROGRAM INFORMATION

Organization Name: KIDS for the BAY

Mailing Address: 1771 Alcatraz Avenue (Street) Berkeley (City) CA (State) 94703 (Zip Code)

Program Director: Mandi Billinge

Phone: 510-985-1602 **E-mail:** mandi@kidsforthebay.org

Name of Person Completing the Report: Bhavana Mody

Phone: 510-985-1602 **E-mail:** bhavana@kidsforthebay.org

Date of Report: July 1, 2011 **Reporting Period:** **From** Feb.1, 2011 **to** June 15, 2011

Program Scope:

The Storm Drain Rangers (SDR) Program is designed to educate third-fifth grade students in Alameda County about storm water pollution reduction. Students learn about watersheds, storm water pollution and pollution prevention strategies in a program that consists of three classroom lessons:

1. Our Watersheds
2. Taking Action for a Healthy Watershed
3. Becoming a Storm Drain Ranger

The 2010-2011 school year was a great success for the SDR Program in Alameda County public schools. Fifteen SDR Programs were provided at six different schools in Alameda, Alameda County Unincorporated Areas, Fremont, Hayward, and Oakland. Over 450 students proudly graduated as "Storm Drain Rangers," and have the knowledge and inspiration to educate their family members about urban run-off pollution. One fourth grade student, Yvette, at Acorn Woodland Elementary School in Oakland was so moved to educate others in her community that she decided to organize her own neighborhood clean-up on Memorial Day. The event consisted of several families picking up garbage in their East Oakland community and learning about storm drains; according to Yvette's mother, "The event was a hit in our neighborhood and I am so impressed that my daughter was inspired to organize something like this!"

Additionally, fifteen teachers learned the SDR Program alongside their students. After being trained on how to implement the SDR Program, they will continue to educate future classes of students through the SDR Follow-Up Program. In fact, this year, five teachers trained during the 2009-2010 school year taught the SDR Program to their students through the SDR Follow-Up Program.

The following are more highlights from the SDR Program classroom lessons completed during this reporting period:

Henry Haight Elementary School, Alameda

Ms. Joanne Lee and Ms. Joyce Craig's fourth grade classes received the SDR Program taught by KIDS for the BAY (KftB) Instructor Bhavana Mody. Students in both classes were very excited to learn how to use a satellite map to identify cities, bridges and bodies of water. Students made numerous connections throughout the activity, especially to the main theme of the lesson: *In a watershed, everything is connected.* Ms. Mody asked students what body of water the city of Alameda and the city of Fremont have in common. In unison, all the students shouted, "The San Francisco Bay!" Both Ms. Lee and Ms. Craig were very impressed by how much students learned during the satellite map investigation. Ms. Lee shared, "The students got a lot out of participating in the hands-on map study and learning about the entire area that surrounds them. This is an excellent way to connect them more to the larger community and environment – it really opened their eyes."

Hesparian Elementary School, San Lorenzo

At Hesparian Elementary, fifth grade students in Ms. Elaine Weissman, Ms. Denise Fitzgerald, and Ms. Mary Burke's classes, were taught the SDR Program. During the first lesson, KftB Instructor Jonah Landor-Yamagata explained the concept of an estuary, and then students used their new geographical knowledge to construct a three-dimensional model of the San Francisco Bay using clay. Students excitedly worked in teams to roll clay, build estuaries, and pour water into their models. One fifth grade student, Stephanie, commented, "I never knew where San Lorenzo was before. Now I do!" The three fifth grade teachers were thrilled to see how much new knowledge their students received after the first lesson. Ms. Weissman remarked: "We used our hands and we used our heads, and students gained so much information about the San Francisco Bay!"

During Lesson Two, Mr. Landor-Yamagata described the differences between a storm drain system and sewer system. Students were very interested in the comparison and could accurately describe differences between the two. On his take-home assignment one student, Noel, wrote, "The storm drain is for run-off on the road and doesn't get cleaned before it goes to the bay." The Hesparian Elementary fifth graders then learned about some of the harmful effects of run-off pollution. One fifth grade student, Juan, shared, "I learned that there is a lot of garbage going to the closest creek or canal, to the bay, and to the ocean. We should keep our storm drains clean."

Acorn Woodland Elementary School, Oakland

At Acorn Woodland Elementary, KftB Instructor Evan Wong taught the SDR Program to fourth graders in Ms. Renee Manrique and Mr. David Norris's classes. During Lesson One, Ms. Wong shared with students the amount of fresh water we have on our planet. The fourth graders were awestruck to learn how little fresh water on our planet is available to use. They brainstormed a long list of possibilities to reduce water usage in their homes. One fourth grade student, Daniella, shared, "I'm going to go home today and ask my mom how many loads of laundry we do each week, and see if we can not do so many."

Brookfield Elementary School, Oakland

Three classes of fourth grade students at Brookfield Elementary completed their Storm Drain Rangers experience. KftB Instructor Bhavana Mody taught the program to students in Ms. Yitera Martin's and Ms. Diana Luu's classes. KftB Instructor Jose Luis Martinez taught the program in Mr. Corrin Haskell's class. In all three classes, students responded with enthusiasm and with a strong desire to take action within their urban community.

Brookfield Elementary students were strongly impacted by studying photographs of animals harmed by marine debris, and quickly made the connection to urban run-off pollution. One student in Ms. Luu's class, Cedrick, shared, "Pollution, soda rings and cigarettes can all harm animals in the ocean." During the Neighborhood Clean-up and Survey activity, students in all three classes had the opportunity to walk around their neighborhoods in search of storm drains, garbage and evidence of other forms of pollution, such as oil leaking from a car. The students were inspired to thoroughly remove the garbage from the streets near their school neighborhood. They were careful to pick up tiny pieces of plastic and paper and whenever they approached a storm drain, they were especially meticulous about removing garbage. At the end of the lesson, one student in Mr. Haskell's class, Karen, shared proudly, "My favorite activity was the clean-up, especially after picking up that piece of plastic string right before it went down the storm drain!"

According to all three teachers at Brookfield Elementary, students took their Storm Drain Ranger jobs very seriously. "My students feel good to teach something new to family members, especially if its making a positive impact," remarked Mr. Haskell. One student in Mr. Haskell's class was especially eager to take action to reduce storm drain pollution – he used leftover bricks to build a wall near the storm drain near his house to catch debris!

Brier Elementary School, Fremont

Three classes of fourth graders at Brier Elementary participated in the SDR Program. Jonah Landor-Yamagata taught the program in Mr. Gerald Sidney's class and Bhavana Mody taught the program in Ms. Tammy Pachote and Ms. Deanna Stemm's classes.

The fourth graders were able to share what they learned during the program by completing informational posters to educate the Brier Elementary community about concepts learned during the program. The students completed creative eye-catching posters with images of litter going down storm drains and into the water. The posters featured persuasive slogans such as, "Stop polluting our streets – it goes to the bay!" During the program, Mr. Landor-Yamagata and Ms. Mody taught the students about pesticides entering the watershed. This concept clearly made an impression on the students. One fourth grade student in Mr. Sidney's class, Kevin, explained his poster to the class: "I made my poster about pesticides. If pesticides get into the water when it rains, then the fish in the water could get hurt. I drew a boy putting pesticides on his garden and his dad fishing in the bay." Kevin went on to explain how people eating fish could get sick from pesticides.

Students in all three classes were very moved by the program and felt inspired to take action as Storm Drain Rangers. One concerned student in Ms. Stemm's class shared, "I feel shame knowing that we cause so many animals to suffer." Another student, Nancy replied to his comment with, "We cause the litter, and we cause the problems, but we can give back, too. We can pick up trash and make the world better."

Follow-Up SDR Programs

Third grade students at Niles Elementary School were taught the SDR Program by their teachers, Ms. Lisa Gilbert and Ms. Codel Frydahl. These teachers were trained to teach the program during the 2009-10 school year, and then implemented the program themselves with support from KftB. KftB Instructor Jose Luis Martinez delivered equipment to the teachers and assisted during the first lesson. The students in both classes were very excited to learn about estuaries because the class had visited Stiver's Lagoon, an esturary near Fremont, on a field trip. During the bay model activity, Ms. Gilbert encouraged her students to observe closely how the fresh and salt water becomes connected. One student, Meghan, remarked, "Look how the ocean water comes and mixes in the bay!"

Both teachers at Niles Elementary enjoyed teaching the SDR Program to their students and are looking forward to teaching it year after year. Ms. Frydendahl shared with Mr. Martinez that her students talked about the program throughout the school year. "They often shared stories about what they had seen happen around storm drains in their neighborhoods," she said.

Fourth grade students at Palomares Elementary in Castro Valley were taught the SDR Program by their teacher, Noelle Rapozo, with the support of KftB Instructor Jonah Landor-Yamagata. The campus survey and clean-up activity was a highlight of the program for students at Palomares Elementary. During the activity students located storm drains that led directly to San Leandro Creek, which they could see as they completed the activity and collected trash on their school campus. "They found a lot of trash around the creek, especially because it was towards the end of the school year," noted Ms. Rapozo. This activity and the other components of the SDR Program provided students with tools to positively impact the health of their environment. Ms. Rapozo noted, "They are stewards of the Earth and want to help make it a better place for animals and people."

B) PROGRAM UPDATE

1. List the school programs completed during this reporting period into table provided below (sorted by city):

City	School/Teacher	Lessons/Activities	Date	# of Students reached
Alameda	Henry Haight Elementary School/ Joanne Lee	**Lesson 1** Our Watershed **Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	Feb. 25 March 4 March 11	32 students
Alameda	Henry Haight Elementary School/ Joyce Craig	**Lesson 1** Our Watershed **Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	Feb. 25 March 4 March 11	29 students
San Lorenzo (Unincorporated)	Hesparian Elementary School/ Elaine Weissman	**Lesson 1** Our Watershed **Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	Feb. 18 Feb. 25 March 4	31 students
San Lorenzo	Hesparian Elementary School/ Denise Fitzgerald	**Lesson 1** Our Watershed **Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	Feb. 18 Feb. 25 March 4	30 students
San Lorenzo	Hesparian Elementary School/ Mary Burke	**Lesson 1** Our Watershed **Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	Feb. 17 Feb. 24 March 4	31 students
Fremont	Brier Elementary School/ Deanna Stemm	**Lesson 1** Our Watershed **Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	May 26 May 31 June 3	30 students
Fremont	Brier Elementary School/ Gerald Sidney	**Lesson 1** Our Watershed **Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	May 26 May 31 June 3	29 students
Fremont	Brier Elementary School/ Tammy Pachote	**Lesson 1** Our Watershed **Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	May 26 May 31 June 3	30 students

Oakland	Acorn Woodland Elementary School/ Renee Manrique	**Lesson 1** Our Watershed **Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	March 16 March 28 April 8	18 students
Oakland	Acorn Woodland Elementary School/ David Norris	**Lesson 1** Our Watershed **Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	March 16 March 28 April 8	18 students
Oakland	Brookfield Elementary School/ Yitera Martin	**Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	Feb. 7 Feb. 14	25 students
Oakland	Brookfield Elementary School/ Corrin Haskell	**Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	Feb. 7 Feb. 14	25 students
Oakland	Brookfield Elementary School/ Diana Luu	**Lesson 2** Taking Action for a Healthy Watershed **Lesson 3** Becoming a Storm Drain Ranger	Feb. 7 Feb. 14	25 students

*If your program consists of multiple class lessons/activities, please list the name of the lesson(s) and/or activity(ies) implemented for **each class** during the reporting period.

2. Estimated percent of program completed:

100% of SDR program completed

3. Will all the planned lessons/activities be implemented by the end of the 2010-11? school year? Yes

If no, please explain:

4. Attach an activity schedule planned for the next quarter (sorted by city). Schedules need to include city, school, name of teacher, date, and time of scheduled programs. If your program consists of multiple class lessons/activities, list lesson(s) and activity(ies) for each class.

C) PROGRAM EVALUATION

5. Evaluation data for SDR Programs in the 2010-11 school year was collected through meetings with and written evaluation forms from teachers, samples of student work, and through observations and written reports from KftB Instructors. This anecdotal information was incorporated into our reports to the ACCWP. Please see the enclosed sample teacher evaluation form and samples of student work.

EDUCATIONAL SERVICES End-of-Year REPORT FORM Fiscal Year 2010/11

D) BUDGET UPDATE

1. **Funds awarded (as per agreement):** $29,970.00   ($666.00 x 45 lessons)
2. **Costs invoiced during this reporting period:** $23,976.00
3. **Costs invoiced to date:** $5,994.00
4. **Funds remaining:** $0.00

E) PUBLICATIONS

1. **Attach copies of any press releases, newsletters, articles, and/or other program marketing materials produced during this reporting period.**

Please email an **electronic copy** of this report to Jim Scanlin (jims@acpwa.org) and Christina Hovland (chovland@eoainc.com).

_______________________________ _____________________

Signature of Associate Director Date
Sheela Shankar

(in absence of Mandi Billinge,
Program Director and KftB Executive Director/Founder)

EDUCATIONAL SERVICES MID-YEAR PROGRESS REPORT

A) PROGRAM INFORMATION

Organization Name: ZunZun

Mailing Address: PO Box 2951 (Street) Santa Cruz (City) CA (State) 95063 (Zip Code)

Program Director: Gwynne Cropsey

Phone: 831-426-0684 **E-mail:** zunzun@zunzuntunes.com

Name of Person Completing the Report: Meadow Gibbons

Phone: 831-426-0684 **E-mail:** zunzun@zunzuntunes.com

Date of Report: 3/1/11 **Reporting Period:** **From** 3/2/11 **to** 6/30/11

Program Scope:

B) PROGRAM UPDATE

1. List the school programs* completed during this reporting period into table provided below (sorted by city):

City	School/Teacher		Lessons/Activities	Lesson/Activity Date	# of Students reached
Albany	Ocean View	Terry Georgeson	"The Musical Watershed"	3/2	560
Berkeley	Berkeley Bay Festival	Patty Donald	Assembly Program	4/16	200
Castro Vly.	Castro Valley Elem	Denise Hohn		3/22	440
Dublin	Fallon	Kara Holthe		3/29	300
Dublin	Green Elementary	Keith Nomura		5/10	771
Emeryville	Anna Yates	Mary McGruder		5/11	410
Fremont	Durham	Patty Sandoval		3/31	380
Fremont	F.A.M.E. -KEARNEY	Karim Serageldin		6/13	220
Fremont	F.A.M.E. -LESLIE	Krista Kastriotis		6/8	220
Hayward	Lorenzo Manor	Greg Sahakian		5/25	650
Hayward	Treeview	Mary Ann Huebel		5/26	325
Hayward	Bidwell	Mary Ann Huebel		5/26	250
Hayward	Colonial Acres	Linda Santillan		6/9	620
Livermore	Altamont Creek	Michelle Jesse		5/12	650
Newark	St. Edwards	Brenda Banchieri		4/12	260

EDUCATIONAL SERVICES QUARTERLY REPORT FORM Fiscal Year 2010/2011

Oakland	Brookfield	Arcelia Gonzalez		3/10	400
Oakland	Community United	Carole Taylor		3/17	360
Oakland	Redwood Hgts	Julie Pence		5/31	350
Pleasanton	Donlon	Ruth Highstreet		6/6	719
San Leandro	Dayton	Neal Bloch		5/24	490
San Leandro	F.A.M.E.	Asha M.		6/3	150
San Lorenzo	Roosevelt	Julie Pence		6/3	600

*If your program consists of multiple class lessons/activities, please list the name of the lesson(s) and/or activity(ies) implemented for **each class** during the reporting period.

2. **Estimated percent of program completed:** 100%

3. **Will all the planned lessons/activities be implemented by the end of the 2010-11? school year?** ☒ **Yes** ☐ **No** **If no, please explain:**

4. **Attach an activity schedule planned for the next quarter (sorted by city). Schedules need to include city, school, name of teacher, date, and time of scheduled programs. If your program consists of multiple class lessons/activities, list lesson(s) and activity(ies) for each class.**

C) PROGRAM EVALUATION

1. **Attach a summary of evaluations received.**

D) BUDGET UPDATE

1. **Funds awarded (as per agreement):** $ 22,000
2. **Costs invoiced during this reporting period:** $ 22,000
3. **Costs invoiced to date:** $ 22000
4. **Funds remaining:** $ 16,000

   To date, we have only received payment for one invoice in the amount of $6,000.
   Billed, but not yet received are as follows: 4/18/11: $2,000
   6/2/11: $9,000
   6/17/11: $5,000

E) PUBLICATIONS

1. **Attach copies of any press releases, newsletters, articles, and/or other program marketing materials produced during this reporting period.**

Please email an **electronic copy** of this quarterly report to Jim Scanlin (jims@acpwa.org).

Signature of Program Director

Date

ZunZun Assembly Programs for
Clean Water Program
FINAL REPORT 2010-2011 School Year
July 5, 2011

ZunZun performed "The Musical Watershed" in Clean Water Program's (CWP) service area in the 2010-2011 school year. ZunZun performed 35 assemblies at 22 schools for 9,125 students and for around 200 people at the Berkeley Bay Festival. In all, we saw approximately 9,325 young people this year to share information about the Alameda County watershed—what it is, where students are in their watershed, how to keep it clean, and how to protect the watershed.

Included in this final report are the following:

- Outreach
- Supplemental Materials
- State Standards
- Performances
- Evaluations
- Possibilities for Next Year
- Program Evaluation Summary
- Final Performance Schedule

Enclosed with this report, please find:

- Educational Services Progress Report
- Sample Newsletter Article
- Pre and Post Assembly Activities
- Paper Evaluations

OUTREACH

Creating a list of target schools within the parameters provided by CWP, ZunZun advertised this year's program to the principals and assembly coordinators at eligible elementary schools. ZunZun faxed or emailed a flyer to the school contact person and then followed up to answer questions and book assemblies. Schools booked directly

with ZunZun and performance updates were sent to Jim Scanlin and Christina Hovland on a regular basis.
One month before each school's scheduled assembly, we emailed a confirmation letter and sent the vocabulary lists and a newsletter article to the school contact person. One week before the scheduled performance, we called the school to confirm show times.

SUPPLEMENTAL MATERIALS

Supplemental materials to aid in retention of the assembly information were sent to each school one month prior to the assembly. Post assembly activities were distributed to teachers at the assembly for use after the performances. A newsletter article about the performance was also emailed to help inform students' families of the presentation and to encourage parents to ask questions about what the students learned about watershed pollution prevention. The activities and newsletter facilitate discussions at home about CWP's message and the ZunZun show.

STATE STANDARDS

In addition to being extremely fun, ZunZun assemblies cover a large number of California State Content Standards for grades K-6. Because we use music and musical instruments, they meet many **Visual and Performing Arts Standards.** As the assemblies are about water issues, they cover **Science Content Standards.** Students are learning new vocabulary and words, so they are meeting many **Language Arts and English Language Development Standards.** We introduce instruments from around the world, which meets many standards in **History- Social Science Standards.** Finally, we use both Spanish and English which meets **English Language Development Standards** and **World Language Content Standards.**

A few specific examples of State Content Standards in **Science, Language Arts, and Visual and Performing Arts** met in our shows are as follows:

Science: Water education for all grade levels is included in every assembly. (ie: Grade 3 physical science 1.e, 1.f.; Grade 5, earth sciences 3a, 3b, 3c) Education standards regarding water on earth, evaporation, water present in the form of salt water, etc.

Language Arts: Use of rhythm and rhyme to remember a concept. Learning new words such as "runoff" and seeing/ hearing a description while repeating a rhyme that reiterates the definition. (See CA Content Standards, Reading Standards- Craft and Structure, Key Ideas and Details Integration and Knowledge of Ideas. Also Speaking and Listening Standards for grades K-6).

Visual and Performing Arts: As students sing and perform with us in the assembly, they are not only hearing music (All grades, Music Standards 1.1-1.5), but performing it (Grade 2, Music Standards, 2.1, 2.2 for example).

Because all students learn differently, ZunZun strives to use as many different types of learning tools as possible in our assemblies, so they are learning *visually, musically, physically, scientifically, mathematically, verbally.* Students are thinking things through, moving and singing throughout. In summary, so many standards are contained in the assemblies, it would be a very long list to include them all here.

PERFORMANCES

We design our assembly segments to be interactive and to appeal to the many learning styles of the students. Always included are the following elements: visuals, call and response, movement, comedy, and lots of fun informative facts. Some schools included their 6-8th graders, for whom we change the content to be more age-appropriate. All assemblies are performed in English and Spanish, with a greater emphasis on Spanish whenever needed. Each assembly is 45 minutes in length and introduces students to the topic of watershed and watershed pollution prevention. Performance segments included in this year's program are as follows:

Chuchumbé: As we play a song from México, we invite students to do a dance representing parts of the watershed: creeks, rivers, lakes and reservoirs, water seeping into an aquifer, waterfalls, waves on the beach and evaporation as part of the water cycle. Then students invent their own dance to represent that they are about 72 % water. This is a water fact/watershed science segment that emphasizes our dependence on water (we are made of mostly water) and a great introduction that gets students thinking about watershed. The piece is performed in Spanish and English and is a great way for English Language Learners to hear watershed terms in both languages. Using this segment to start the show enables us to later describe the land around us as watershed. We then explain that all the land around us – school, playground, streets and even parking lots - are all part of the watershed.

Watershed Instruments from Around the World

The segment begins by introducing water instruments from around the world that represent watershed sounds, while we explain how important and precious clean, safe water is all over the world. We show instruments from North and South America, Africa, and Asia that represent the sounds of rain, storms, water in rivers and streams, and finally the ocean. This "water music" segment serves as a great jumping off point to explain the importance of the watershed and to show how cultures worldwide depend on their watersheds.

Run Off

In this segment, we use various string instruments from South America to sing about street runoff. Students learn about what happens when materials such as paint, soap, oil, and garbage go down a storm drain and into the local watershed leading to the sea. Two students carry these materials to a storm drain we have created in the assembly hall. We emphasize the issue of keeping the watershed clean not just for ourselves, but also for the entire ecosystem. This segment is an opportunity to share information on how to not pollute the watershed while doing common household duties such as rinsing paintbrushes, washing a vehicle, or dealing with a vehicle oil leak.

Fish Flies to Audience

After explaining how pollutants go into storm drains and go through our watershed, we reinforce the lesson with our flying fish activity. We pretend to dump oil down the storm drain on the backdrop and then ask audience members to remind themselves of the path that oil would take (from the storm drain to a creek, then a river, then the bay, and then the ocean). We specify the particular path based on the local geography. A black blob of oil enters into the ocean section of the backdrop and (from backstage) fish begin flying out of the water, unhappy to be in the oil. We repeat the same steps with paint and garbage, see the paint and garbage travel to the ocean, and this time the fish not only flies up into the air, but out into the audience. This segment is perhaps the most memorable part of our assembly! Kids love it! We refer to this activity in our parent newsletter to help students with recall and to give parents a chance to hear about assembly content.

Dirty Water

This is a call and response song during which we invite students to come up front while the audience sings the call and response. The whole audience sings
"Dirty water, down the storm drain, goes to a creek which reaches the sea where the fish are swimming. They start to feel sick, the poor, poor fish, it makes you think."
The song is repeated three times as the students dance faster and faster.

"Hour After Hour", 2,500,000 Bottles

The next activity is the "so many bottles thrown away" segment. We show how many plastic water bottles are thrown away every hour in the U.S. using a place value activity. Initially, three students join us in performance area and hold the numbers 2, 5 and 0 (two hundred and fifty). We say, "Is that it? No, there is more! We need another volunteer!" By adding a zero each time another child joins in, the number grows and grows until we reach 2,500,000. This is the number of bottles estimated to be thrown away, not recycled, every hour in the U.S. We use this segment to reiterate the importance of keeping the watershed clean (not throwing the bottles away, recycling them) and also to encourage families to use tap water. We explained how tap water is clean and safe to drink, and that it costs fractions of what people pay for bottled water. This activity is appropriate for older grades, 3rd and up, who have studied or are studying place value.

High Tide/ Low Tide Limbo

Using steelpan and marimbula, two instruments from the Caribbean made from recycled things, we celebrate our bay getting cleaner because of the actions of the audience. This segment allows us to define the San Francisco Bay as an estuary where fresh water drains from our towns and cities and mixes with salty water from the Pacific Ocean. We teach students that there are two high tides and two low tides per day. During low tide, mudflats, which are a rich habitat and space where egrets, herons, and other animals find food, are exposed. Students then come up front for the limbo and act as though they are fish under a high tide with lots of water and under a low tide. This piece is a celebration of student action because students and kids like them can help our watershed to become cleaner through their own efforts.

EVALUATIONS

For the first two schools we visited, we distributed paper evaluation forms to teachers, which were completed and returned to us directly. These are included with this packet. Subsequently, we implemented electronic evaluations as they complement our earth-friendly program. During the week of each assembly, the contact person at each school is emailed a description and link to an online survey. Survey

Onsite and online feedback was very positive this year. Schools are very appreciative of a free assembly program, especially one that incorporates music since Arts programs have been cut or reduced from so many school budgets.

The following is a taste of the feedback we received via electronic evaluations:

> "It was OUTSTANDING!! This was the best watershed assembly I've seen. The music, the energy, and the content were all great. Thank you for such a quality and important assembly! – 3rd Grade Teacher, Lorenzo Manor Elementary

"This was by far the most interactive and clear message that students got to interact in with many of the multiple intelligences including kinesthetic, musical, visual, and auditory. Great way to teach the vocabulary. Very inspiring! The students remembered the movements for all the different bodies of water and I saw kids on the playground making the movements."
-2nd Grade Teacher, Ana Yates Elementary

"Great fun and educational, at the same time. Amazing how well you kept the attention of such a large group of different ages."
– 4th Grade Teacher, Green Elementary

"The two presenters were fabulous and engaging. My students enjoyed the assembly very much. Thank you."
-Kindergarte Teacher, F.A.M.E. Public Charter

"This was the best assembly we have had! ZunZun really connects with the students in a personal way and made a long lasting impact!"
-2nd Grade Teacher, Roosevelt Elementary

This was our first year implementing electronic evaluations instead of paper forms. There are benefits to both modes. There has been a higher return rate for the paper forms than for the electronic evaluations. If CWP is looking for a larger number of total responses, we may want to revert to paper. Although electronic evaluations have a lower return rate, they still provide valuable information and a good understanding of the effectiveness of ZunZun assembly programs; they are easier to distribute to schools, faster for teachers to complete and they also meld with our environmental message. If CWP wants to continue with the online format, we would be happy to make efforts to increase response rates. If you would like to revert to paper forms, we can absolutely do that. We look forward to a meeting to decide what will work best for next year's program.

POSSIBILITIES FOR NEXT YEAR

We look forward to working with Clean Water Program again in the 2011-2012 school year! Thank you for your continued support of our assembly programs.

After assemblies, teachers and students are always very excited about watershed protection and watershed pollution prevention. We would love to encourage more action at the classroom level with a change to the very popular follow-up activity sheet that we distribute to schools. In addition to the activities, a list of resources and contact information by city may prove to be very helpful for teachers to learn about additional educational opportunities for their classes.

PROGRAM EVALUATION SUMMARY

Survey respondents were given the following instructions: Rate the following by circling the most appropriate score, with 7 being the highest or best rating and 1 being the lowest rating.

1. Rate the educational value of this program.

   55% awarded the highest value, with a total of 98% awarding 5 or higher.

2. Rate the program's ability to stimulate student discussion.

   49% awarded the highest value, with a total of 96% awarding 5 or higher.

3. Rate the likelihood that students will retain the material covered.

   34% awarded the highest value, with a total of 93% awarding 5 or higher.

4. Rate how well the program promoted storm water pollution prevention and watershed awareness.

   62% awarded the highest value, with a total of 98% awarding 5 or higher.

5. Rate the effectiveness of the musical elements of the program in communicating the educational message.

   74% awarded the highest value, with a total of 100% awarding 5 or higher.

6. Rate the effectiveness of the audience participation activities in keeping the students' attention and reinforcing the educational message.

   81% awarded the highest value, with a total of 100% awarding 5 or higher.

7. Rate the ability of live presentations such as this one to increase the students' capacity for retaining the educational message.

   75% awarded the highest value, with a total of 100% awarding 5 or higher.

8. Rate the actors' professional and courteous manner.

   91% awarded the highest value, with a total of 100% awarding 5 or higher.

9. Would you like to see Clean Water Program continue with this or a similar program in the future? Yes or No

   98% answered "Yes" to this question. (Only 1 respondent replied "No").

FINAL PERFORMANCE SCHEDULE

Date	School	Contact	# of Shows	Times	# of Students	City
3/2	Ocean View	Terry Georgeson	2	9:00 & 10:00	560	Albany
3/10	Brookfield	Arcelia Gonzalez	1	9:30	400	Oakland
3/17	Community United	Carole Taylor	2	9:00 & 10:00	360	Oakland
3/22	Castro Valley	Denise Hohn	2	9:00 & 10:00	440	Castro Vly.
3/29	Fallon	Kara Holthe	1	9:45	300	Dublin
3/31	Durham	Patty Sandoval	2	9:00 & 10:15	380	Fremont
4/12	St. Edwards	Brenda Banchieri	1	8:30	260	Newark
4/16	Berkeley Bay Festival	Patty Donald	1	3:45	200	Berkeley
5/10	Green	Keith Nomura	2	9:00 & 10:15	771	Dublin
5/11	Anna Yates	Mary McGruder	2	9:30 & 10:10	410	Emeryville
5/12	Altamont Creek	Michelle Jesse	2	11:00 & 1:30	650	Livermore
5/24	Dayton	Neal Bloch	2	9:00 & 10:00	490	San Leandro
6/3	F.A.M.E.	Asha M.	1	11:45	150	San Leandro
5/25	Lorenzo Manor	Greg Sahakian	2	9:00 & 10:00	650	Hayward
5/26	Treeview	Mary Ann Huebel	1	9:15	325	Hayward
5/26	Bidwell	Mary Ann Huebel	1	10:40	250	Hayward
5/31	Redwood Hgts	Julie Pence	1	1:30	350	Oakland
6/3	Roosevelt	Julie Pence	2	8:45 & 9:45	600	San Lorenzo
6/6	Donlon	Ruth Highstreet	2	9:00 & 10:00	719	Pleasanton
6/8	F.A.M.E. - LESLIE	Krista Kastriotis	1	2:00	220	Fremont
6/9	Colonial Acres	Linda Santillan	2	9:00 & 9:55	620	Hayward
6/13	F.A.M.E. - KEARNEY	Karim Serageldin	2	1:00 & 2:00	220	Fremont
	TOTAL SCHOOLS	**22**		**TOTAL STUDENTS**	**9325**	

The Musical Watershed

The musical duo, ZunZun, came to your school [insert date], and presented a musical assembly about watersheds. Did you know that no matter where you live, you are in a watershed? It’s true! Our foothills, homes, yards, driveways, streets and storm drains are all part of a watershed. All rain and yard water drains directly into local creeks and the San Francisco Bay. This means that keeping pollutants and yard waste out of the storm drain helps keep our creeks, Bay and ocean clean. Ask your kids what they learned at this assembly. They might remember “a fish flying” or “people playing garbage instruments” or “someone catching a plastic bag while fishing in a creek.” Ask them why those things happened in the show!

"The Musical Watershed" is sponsored by the Clean Water Program (www.cleanwaterprogram.org), a public outreach and education campaign encouraging protection of Alameda County's creeks, wetlands, and the Bay, and performed by ZunZun (www.zunzuntunes.com).

There are many ways to continue exploring watershed issues with your kids. Do a storm drain walk in your neighborhood and try to guess which creeks and rivers your storm drains run to. You can also visit one of the beautiful bayside parks where you can see wetlands, birds, and all kinds of wildlife who depend on a clean watershed. East Bay parks include: Tilden, Oyster Bay, Don Castro, Temescal, Pioneer, and Monument Peak.

PO Box 2951, Santa Cruz, CA 95063
Tel: 831-426-0684
Email: zunzun@zunzuntunes.com
Website: www.zunzuntunes.com

Here are some fun ways to stop watershed pollution right at school with no special materials- just time and fun!

Field Trip at School

On--site "field trip" at school! Have the students in your class walk together to find all (or most) of the storm drains on the school campus. They return to class and draw maps with the storm drains (CA State Standard re: map creation and use).

Storm Drain Monitoring

Then dedicated classes can even monitor the storm drains throughout the school year to see what goes down the storm drain at their school and then decide how to prevent the pollution. At the beginning of every month, a storm drain check can be part of your calendar, or "storm drain monitor" can become one of the classroom jobs that rotate every month.

The Big Picture Map

For this activity you will need an area map of your school and it's surroundings. First, have students find the school on the map. Next, decide which creek or river (or even bay/ocean) the school storm drain would probably lead to (the closest one especially that is down from the school). Follow the school's waterway to the sea (storm drain, to creek to river, to bay, to ocean). Next, have each student take a turn finding their own house and mapping their watershed and seeing where they live in the watershed. Have them learn the names of the creeks and rivers near them. Visit http://museumca.org/creeks/crkmap.html for help with local watershed maps.

Basura Batucada Band

Your class can create a band from recycled things! Visit zunzuntunes.com and click on the "kid zone" to see the names of instruments and what recycled items to use to make them.

Visit Your Local Wildlands- See the Watershed

Visiting some of the wildlands near our homes and the watershed in our area can be amazing. We can see animals that depend on a clean watershed and get a chance to slow down. Need help finding a good place to visit? We would be happy to help. E-mail us at zunzun@zunzuntunes.com and we'll look at a map with you to help make it happen!

EDUCATIONAL SERVICES FINAL REPORT

A) PROGRAM INFORMATION

Organization Name: Golden Gate Audubon Society

Mailing Address: 2530 San Pablo Avenue, Ste. G (Street) Berkeley (City) CA (State) 94702 (Zip Code)

Program Director: Anthony DeCicco

Phone: 510-843-2222 **E-mail:** adecicco@goldengateaudubon.org

Name of Person Completing the Report: Rosi Bustamante

Phone: 415-425-1728 **E-mail:** rosi@robuco.com

Date of Report: July 21, 2011 **Reporting Period:** **From** March 2, 2011 **to** July 15, 2011

Program Scope:

1. Provide elementary classroom sessions in at least 5 separate public elementary schools with an environmental education program.
   * Lesson 1 Schoolyard Ecology
   * Lesson 2 Effects of Pollution and Habitat Loss on Bay Food Chain
   * Lesson 3 California Native Education
   * Lesson 4 We All Live in a Shared Watershed

2. Involve these same classrooms in a field trip that engages students in hands-on discovery, restoration and stormwater pollution prevention activities at local water resource sites: Arrowhead Marsh at Martin Luther King Jr. Regional Park, Lion Creek, Arroyo Viejo Creek or Sausal Creek.

3. Conduct pre- and post- program evaluations assessing students' knowledge and retention of key watershed and stormwater pollution prevention concepts.

4. Prepare and submit a mid-year progress report and an Annual Report to the DISTRICT.
The Annual Report will provide at a minimum an activity summary, the total number of lessons delivered, the total number of students involved, an overall evaluation of the learning of the educational messages, and any recommendations for improving the program in subsequent years. The Annual Report will be submitted by July 15th of each year of the contract.

EDUCATIONAL SERVICES QUARTERLY REPORT FORM Fiscal Year 2010 – 2011

B) PROGRAM UPDATE

1. List the school programs* completed during this reporting period into table provided below (sorted by city):

City	School/Teacher	Lessons/Activities	Lesson/Activity Date	# of Students reached
Ex: Fremont	*Warwick/S. Peters*	*Fieldtrip to Arrowhead Marsh*	*10/24/06*	*35 Students*
Oakland	Melrose/Jung. J	Lesson 4	3/8/11	20
Oakland	Melrose/R. Kurshan-Emmer	Lesson 4	3/8/11	20
Oakland	Lighthouse Charter/ Thiercof, D.	Field trip to Arrowhead Marsh	3/10/11	30
Oakland	Melrose/J. Jung	Creek field trip	3/29/11	20
Oakland	ICS/I. Wheeler	Lesson 4	3/31/11	20
Oakland	ICS/P. Long	Lesson 4	3/31/11	20
Oakland	Melrose,/ R. Kurshan-Emmer	Creek field trip	4/5/11	20
Oakland	ICS/ I. Wheeler	Creek field trip	4/12/11	20
Oakland	ICS/ P. Long	Creek field trip	4/14/11	20
Oakland	Lighthouse Charter/ D. Thiercof	Lesson 4	5/5/11	30
Oakland	Lighthouse Charter/ D. Thiercof	Lesson 4	5/5/11	30
Oakland	Sobrante Park/L. Becerra	Lesson 4	5/9/11	30
Oakland	Markham/ R. Martinez	Lesson 4	5/10/11	25
Oakland	Markham/E. Feuille	Lesson 4	5/10/11	20
Oakland	Markham/ R. Martinez	Creek field trip	5/17/11	20
Oakland	Korematsu/N. Pal	Lesson 4	5/23/11	20
Oakland	Korematsu/A. Keen	Lesson 4	5/23/11	20
Oakland	Sobrante Park/ L. Becerra	Creek Field trip	5/25/11	20
Oakland	Markham/ E. Feuille	Creek Field trip	5/31/11	30
Oakland	Melrose/R. Kurshan-Emmer	Lesson 3, California Native Education Program	6/2/11	20
Oakland	Korematsu/N. Pal	Creek Field trip	6/2/11	20
Oakland	Korematsu/A. Keen	Creek Field trip	6/3/11	20
Oakland	Esperanza/C. Segura	Lesson 4	6/6/11	20
Oakland	Esperanza/K. Nibblett	Lesson 4	6/6/11	20
Oakland	Esperanza/M. Lara	Lesson 4	6/6/11	20
Oakland	Esperanza/C. Segura	Creek field trip	6/7/11	20
Oakland	Esperanza/ K. Nibblett	Creek field trip	6/8/11	20
Oakland	Esperanza/M. Lara	Creek Field trip	6/9/11	20
Oakland	Markham/N. Gibbs	Lesson 4	6/14/11	20
Oakland	Markham, C. Wong	Lesson 4	6/16/11	20
TOTAL	**Schools: 7**	**Lessons: 14; Field Trips: 11**		**Students: 655**

*If your program consists of multiple class lessons/activities, please list the name of the lesson(s) and/or activity(ies) implemented for **each class** during the reporting period.

2. Estimated percent of program completed: 100 %

3. Will all the planned lessons/activities be implemented by the end of the 2010-11? school year? Yes **x** No

If no, please explain:

We were unable to provide presentations of Lesson 3, "California Native Education Program (CNEP)" to four out of the 5 schools, due to health and scheduling challenges on the part of the presenters.

Since the grant agreement describes providing lessons and field trips to 5 schools within the Eco-Oakland Program, we compensated the lack of Lesson 3 by increasing the number of Lesson 4 presentations and their corresponding field trips to 7 schools.

4. Attach an activity schedule planned for the next quarter (sorted by city). Schedules need to include city, school, name of teacher, date, and time of scheduled programs. If your program consists of multiple class lessons/activities, list lesson(s) and activity(ies) for each class. Programming is complete for the academic year. Dates for upcoming activities during the 2011-2012 academic year will be available in the fall.

C) PROGRAM EVALUATION

1. Attach a summary of evaluations received.

EDUCATIONAL SERVICES QUARTERLY REPORT FORM Fiscal Year 2010 – 2011

Attached is a summary of an initial assessment from our 2010-2011evaluation process. Each fall our consulting team, Mountain Light Consulting, prepares an in-depth report which will be available during the next reporting period.

D) BUDGET UPDATE

1. **Funds awarded (as per agreement):** $ 10,000
2. **Costs invoiced during this reporting period:** $ 0
3. **Costs invoiced to date:** $ 10,000
4. **Funds remaining:** $ 0

E) PUBLICATIONS

1. **Attach copies of any press releases, newsletters, articles, and/or other program marketing materials produced during this reporting period.**

We have completed our professionally-created promotional video which features students and families from the Eco-Oakland Program. In the list of credits, we have given special thanks to the Alameda County Clean Water Program for their continued support of our outreach. The video can be found on our website, at the following link (you must scroll down to the embedded video '*To Learn more About our Eco-Education Program, Watch Our New Video!'):*

http://www.goldengateaudubon.org/education/eco-education-programs/

Also attached is a recent copy of our newsletter that features two of our Eco-Oakland Program interns, Chan Saelee and Steven Saefong, from Oakland High School's Environmental Science Academy.

Please email an **electronic copy** of this quarterly report to Jim Scanlin (jims@acpwa.org) and Christina Hovland (chovland@eoainc.com).

______________________________ Signature of Program Director

_____7/22/11_______ Date

Golden Gate Audubon
Eco-Oakland Program
Final Evaluation Summary

With input from teachers, volunteers, students and community members, the Eco-Oakland Program staff continuously adapt the program to meet the needs of its participants and to ensure its cultural relevancy.

An initial assessment of our formal evaluation process reveals that:

- roughly 80% of the students surveyed correctly identified storm drains as the main pathway for marine debris entering the San Francisco Bay.

- roughly 85% of the students reported that they "never do this", when asked about their behavior in regards to littering.

- a significant number of students were able to name a local creek and correctly state the creek flowed out to the bay and/or ocean.

- a significant number of students marked "don't throw garbage in the street" and "keep chemicals out of the storm drain" as ways to help protect wildlife.

- A significant number of students correctly answered that their community is part of a watershed.

Data from our weekend family trips to Muir Beach and Alcatraz Island reveal the following: over 90% claimed that the trips increased their appreciation for the ocean and were able to provide at least one method of preserving watershed health. About 40% reporting the beach trip was their first ever to the Pacific Ocean.

A parent in the program, Manuel Pelayoz, shared his thoughts after a family trip: "The most valuable part of the day was when my family learned ways to maintain the health of the bay. I would like to see a day organized at the school where we clean up the schoolyard and surrounding streets."

Second-year Eco-Oakland Program teacher, Nandini Pal, said, "This is my second year in the Eco-Oakland Program and I feel compelled to share how much value this experience has given my students. The class visits, the field trips and the shared experience with their families has not only enriched their lives but has also allowed them to become effective stewards of their local environment. I look forward to the years ahead."

Lesson learned:

1) Altering the sequence of year's activities to allow for more consistent interaction with students. We shifted the second lesson *The Effects of Pollution and Habitat Loss on Bay Food Webs* to serve as a follow up to their trip to Arrowhead Marsh and Point Pinole.

2) Shifting the emphasis of our curricula to a six-step, inquiry-based approach that uncovers the ultimate impacts of trash within the community and addresses the mounting issue of marine debris in the Pacific (we plan to incorporate lessons from NOAA's Turning the Tide on Trash and will create new lesson plans in summer of 2011);

3) Strengthening the 'reflection phase' of our program to include student-led after-school community assemblies at each participating school. Schoolmates and community members will be invited to celebrate the achievements of participating students and their family members in their efforts to reduce urban run-off pollution and promote watershed health;

4) Broadening our volunteer base in each community by collecting and recording contact information for those participants who have expressed interest in assisting with restoration events at Arrowhead Marsh. We plan to create and distribute informational flyers that highlight monthly restoration events.

5) Adopting a community-based social marketing approach (McKenzie-Mohr, 1999) to identify the barriers and benefits of reducing urban run-off pollution within the target community. We will utilize existing our best practices and test new 'tools' of pro-environmental behavior change.

Best practices Through meaningful, culturally relevant experiences, participants will have an easier time acquiring skills to build environmental stewardship. They will more effectively realize that they are part of the solution and that their actions have an aggregated impact, either positive or negative, on any adjacent natural systems. They must be empowered to believe that their actions can truly make a difference.

In defining "culturally relevant" outreach, we have determined a few crucial strategies for providing effective outreach to our target community:

1) provide as many materials as possible in the languages represented in the community (Spanish was the dominant language in our project) and provide translation for all instruction and information sharing

2) all educational materials should be engaging with either photographs or illustrations that correspond to each topic

3) whenever possible, provide role models from the community as staff members, volunteers, interns or parent liaisons

4) attempt to include modern indigenous perspectives of conservation within the proposed curriculum; in doing so, programs participants are better able to understand how habitats (and watersheds!) have been altered over time

5) conservation outreach events should be viewed as social events and therefore should include food, drinks and fun activities (such as bird watching, games, puzzles, plankton study, crabbing, art) that celebrate the wildlife that the group is working collaboratively to conserve. When wildlife is the theme, people understand more about the importance of why they are there (usually on a weekend) instead of where they think they should be!

EDUCATIONAL SERVICES MID-YEAR PROGRESS REPORT

A) PROGRAM INFORMATION

Organization Name: Livermore Area Recreation and Park District

Mailing Address: 4444 East Avenue (Street) Livermore (City) CA (State) 94550 (Zip Code)

Program Director: Mike Nicholson

Phone: (925) 960-2400 **E-mail:** mnicholson@larpd.dst.ca.us

Name of Person Completing the Report: Peggy Simi

Phone: (925) 960-2400 **E-mail:** psimi@larpd.dst.ca.us

Date of Report: 5/15/2011 **Reporting Period:** **From: 9/10 to:4/11**

Program Scope: To implement a watershed education program for up to 43 – 4th and 5th grade classes in Livermore, Pleasanton, and Dublin.

B) PROGRAM UPDATE

1. List the school programs* completed during this reporting period into table provided below (sorted by city):

City	School/Teacher	Lessons/Activities	Lesson/Activity Date	# of Students reached
Dublin	Frederiksen /Lum	Water Flows – In class	*02/01/11*	30
Dublin	Frederiksen/Lum	Stream Life I – In class	*03/15/11*	30
Dublin	Frederiksen/Vergara	Water Flows – In class	*02/01/11*	30
Dublin	Frederiksen/Vergara	Stream Life I – In class	*03/15/11*	30
Dublin	Frederiksen/Suminski	Water Flows – In class	*02/01/11*	30
Dublin	Frederiksen/Suminski	Stream Life I – In class	*03/15/11*	30
Livermore	St. Michaels/Pittl	Water Flows – In class	*09/14/10*	29
Livermore	St. Michaels/Pittl	Stream Life I – In class	*9/28/10*	29
Livermore	St. Michaels/Pittle	Stream Life II- Field	*10/07/10*	29
Livermore	Altamont Creek/Becker	Water Flows – In class	*12/10/10*	37
Livermore	Altamont Creek/Becker	Stream Life I – In class	*02/25/11*	37
Livermore	Altamont Creek/Dugger/Eddy	Water Flows – In class	*12/10/10*	32
Livermore	Altamont Creek/Dugger/Eddy	Stream Life I – In class	*02/25/11*	32
Livermore	Altamont Creek/Loftus	Water Flows – In class	*12/10/10*	32
Livermore	Altamont Creek/Loftus	Stream Life I – In class	*02/25/11*	32
Livermore	Rancho/Littlefield	Water Flows – In class	*01/04/11*	30
Livermore	Rancho/Littlefield	Stream Life II – Field	*03/01/11*	30
Livermore	Rancho/Swanson	Water Flows – In class	*01/07/11*	30
Livermore	Rancho/Swanson	Stream Life I – In class	*03/11/11*	30
Livermore	Rancho/Swanson	Stream Life II - Field	*05/13/11*	25
Livermore	Rancho/Swenson	Water Flows – In class	*01/07/11*	25
Livermore	Rancho/Swenson	Stream Life I – In class	*03/04/11*	25
Livermore	Rancho/Swenson	Stream Life II - Field	*05/13/11*	30
Livermore	Rancho/Cannon	Water Flows – In class	*01/14/11*	30
Livermore	Rancho/Cannon	Stream Life I – In class	*03/11/11*	30

Livermore	Our Saviors/Greenhagen	Water Flows – In class	01/19/11	30
Livermore	Our Saviors/Greenhagen	Stream Life I – In class	01/20/11	30
Livermore	Our Saviors/Greenhagen	Stream Life II – Field	03/09/11	33
Pleasanton	Donlan/Mahoney	Water Flows – In class	9/22/10	33
Pleasanton	Donlan/Mahoney	Stream Life I – In class	09/23/10	33
Pleasanton	Donlan/Mahoney	Stream Life II - Field	10/15/10	33
Pleasanton	Donlan/Rice	Water Flows – In class	09/22/10	33
Pleasanton	Donlan/Rice	Stream Life I – In class	09/23/10	33
Pleasanton	Donlan/Rice	Stream Life II – In class	10/06/10	33
Pleasanton	Donlan/Robinson	Water Flows – In class	09/24/10	33
Pleasanton	Donlan/Robinson	Stream Life I – In class	09/30/10	33
Pleasanton	Donlan/Robinson	Stream Life II - Field	11/14/10	33
Pleasanton	Donlan/Finney	Water Flows – In class	09/24/10	33
Pleasanton	Donlan/Finney	Stream Life I – In class	09/30/10	33
Pleasanton	Donlan/Finney	Stream Life II – Field	10/20/10	33
Pleasanton	Valley View/Leyva	Water Flows – In class	10/08/10	33
Pleasanton	Valley View/Leyva	Stream Life I – In class	10/13/10	33
Pleasanton	Valley View/Leyva	Stream Life II – Field	10/28/10	33
Pleasanton	Valley View/Carpenter	Water Flows – In class	10/11/10	33
Pleasanton	Valley View/Carpenter	Stream Life I – In class	10/18/10	33
Pleasanton	Valley View/Carpenter	Stream Life II – Field	11/02/10	33
Pleasanton	Valley View/Palassou	Water Flows – In class	10/11/10	33
Pleasanton	Valley View/Palassou	Stream Life I – In class	10/18/10	33
Pleasanton	Valley View/Palassou	Stream Life II – Field	11/05/10	33
Pleasanton	Hearst/Aparicio	Water Flows – In class	11/02/10	33
Pleasanton	Hearst/Aparicio	Stream Life I – In class	11/09/10	33
Pleasanton	Hearst/Aparicio	Stream Life II – Field	11/17/10	33
Pleasanton	Hearst/Mitchell/Palmer	Water Flows – In class	11/02/10	33
Pleasanton	Hearst/Mitchell/Palmer	Stream Life I – In class	11/10/10	33
Pleasanton	Hearst/Mitchell/Palmer	Stream Life II – Field	11/16/10	33
Pleasanton	Hearst/Evans	Water Flows – In class	11/04/10	33
Pleasanton	Hearst/Evans	Stream Life I – In class	11/10/10	33
Pleasanton	Hearst/Evans	Stream Life II – Field	11/17/10	33
Pleasanton	Hearst/O'Brien	Water Flows – In class	11/04/10	33
Pleasanton	Hearst/O'Brien	Stream Life I – In class	11/09/10	33
Pleasanton	Hearst/O'Brien	Stream Life II - Field	11/16/10	33
Pleasanton	Mohr/Britto	Water Flows – In class	02/18/11	33
Pleasanton	Mohr/Britto	Stream Life I – In class	03/03/11	33
Pleasanton	Mohr/Britto	Stream Life II – Field	04/28/11	33
Pleasanton	Mohr/Harrsma	Water Flows – In class	02/18/11	33
Pleasanton	Mohr/Harrsma	Stream Life I – In class	03/03/11	33
Pleasanton	Mohr/Harrsma	Stream Life II – Field	04/28/11	33
Pleasanton	Mohr/Carrolan	Water Flows – In class	02/18/11	33
Pleasanton	Mohr/Carrolan	Stream Life I – In class	03/03/11	33
Pleasanton	Mohr/Carrolan	Stream Life II – Field	04/28/11	33
Pleasanton	Vintage Hills/Kidd	Water Flows – In class	02/22/11	33
Pleasanton	Vintage Hills/Kidd	Stream Life I – In class	04/14/11	33
Pleasanton	Vintage Hills/Jara/Creighton	Water Flows – In class	02/22/11	33
Pleasanton	Vintage Hills/Jara/Creighton	Stream Life I – In class	04/14/11	33
Pleasanton	Vintage Hills/Cease	Water Flows – In class	02/22/11	33
Pleasanton	Vintage Hills/Cease	Stream Life I – In class	04/14/11	

*If your program consists of multiple class lessons/activities, please list the name of the lesson(s) and/or activity(ies) implemented for **each class** during the reporting period.

2. Estimated percent of program completed: 87%

3. Will all the planned lessons/activities be implemented by the end of the 2010-11? school year? X Yes ☐ No

If no, please explain:

4. Attach an activity schedule planned for the next quarter (sorted by city). Schedules need to include city, school, name of teacher, date, and time of scheduled programs. If your program consists of multiple class lessons/activities, list lesson(s) and activity(ies) for each class.

C) PROGRAM EVALUATION

EDUCATIONAL SERVICES QUARTERLY REPORT FORM Fiscal Year 2010/11

1. **Attach a summary of evaluations received.**

D) BUDGET UPDATE

1. **Funds awarded (as per agreement):** $7097.93
2. **Costs invoiced during this reporting period:** $10,139.58
3. **Costs invoiced to date:** $10,139.58
4. **Funds remaining:** $-3041.65

E) PUBLICATIONS

1. **Attach copies of any press releases, newsletters, articles, and/or other program marketing materials produced during this reporting period.**

Please email an **electronic copy** of this quarterly report to Jim Scanlin (jims@acpwa.org) and Christina Hovland (chovland@eoainc.com).

______________________________ ____________________

Signature of Program Director Date

EDUCATIONAL SERVICES MID-YEAR PROGRESS REPORT

A) PROGRAM INFORMATION

Organization Name: Livermore Area Recreation and Park District

Mailing Address: 4444 East Avenue (Street) Livermore (City) CA (State) 94550 (Zip Code)

Program Director: Mike Nicholson

Phone: (925) 960-2400 **E-mail:** mnicholson@larpd.dst.ca.us

Name of Person Completing the Report: Peggy Simi

Phone: (925) 960-2400 **E-mail:** psimi@larpd.dst.ca.us

Date of Report: 6/1//2011 **Reporting Period:** **From: 9/10 to:5/30/2011**

Program Scope: To implement a watershed education program for up to 43 – 4th and 5th grade classes in Livermore, Pleasanton, and Dublin.

B) PROGRAM UPDATE

1. **List the school programs* completed during this reporting period into table provided below (sorted by city):**

City	School/Teacher	Lessons/Activities	Lesson/Activity Date	# of Students reached
Dublin	Frederiksen/Lum	Stream Life II – Field	*05/20/11*	30
Dublin	Frederiksen/Vergara	Stream Life II - Field	*05/20/11*	30
Dublin	Frederiksen/Suminski	Stream Life II - Field	*05/20/11*	30
Livermore	Altamont Creek/Becker	Stream Life II – Field	*05/19/11*	37
Livermore	Altamont Creek/Dugger/Eddy	Stream Life II -Field	*05/19/11*	32
Livermore	Altamont Creek/Loftus	Stream Life II - Field	*05/19/11*	32
Livermore	Rancho/Littlefield	Stream Life II – Field	*05/16/11*	30
Livermore	Rancho/Cannon	Stream Life II - Field	*05/17/11*	30
Pleasanton	Vintage Hills/Kidd	Stream Life II - Field	*05/24/11*	33
Pleasanton	Vintage Hills/Jara/Creighton	Stream Life II – Field	*05/25/11*	33
Pleasanton	Vintage Hills/Cease	Stream Life II – Field	*05/26/11*	33

*If your program consists of multiple class lessons/activities, please list the name of the lesson(s) and/or activity(ies) implemented for **each class** during the reporting period.

2. **Estimated percent of program completed: 100%**

3. **Will all the planned lessons/activities be implemented by the end of the 2010-11? school year?** X Yes ☐ No **If no, please explain:**

4. **Attach an activity schedule planned for the next quarter (sorted by city). Schedules need to include city, school, name of teacher, date, and time of scheduled programs. If your program consists of multiple class lessons/activities, list lesson(s) and activity(ies) for each class.**

C) PROGRAM EVALUATION

1. **Attach a summary of evaluations received.**

D) BUDGET UPDATE

1. **Funds awarded (as per agreement):** $7097.93
2. **Costs invoiced during this reporting period:** $13,109.58
3. **Costs invoiced to date:** $13,109.58
4. **Funds remaining:** -$6011.65

E) PUBLICATIONS

1. **Attach copies of any press releases, newsletters, articles, and/or other program marketing materials produced during this reporting period.**

Please email an **electronic copy** of this quarterly report to Jim Scanlin (jims@acpwa.org) and Christina Hovland (chovland@eoainc.com).

Signature of Program Director

Date

Annual Reporting for FY 2010-2011

Regional Supplement for Training and Outreach

San Francisco Bay Area Municipal Regional Stormwater Permit

B A S M A A
Bay Area Stormwater Management Agencies Association

September 2011

MRP Regional Supplement for Training and Outreach
Annual Reporting for FY 2010-2011

Table of Contents

LIST OF ATTACHMENTS:

C.7.b. Advertising Campaign

Five-Year Regional Strategic Outreach Plan: Litter
Five-Year Strategic Advertising Plan: *Our Water, Our World* Pesticides Program

C.7.c. Media Relations – Use of Free Media

BASMAA Media Relations Campaign Final Report

C.9.h.i. Point of Purchase Outreach

Photo of *Our Water, Our World* booth at Bay Friendly Landscaping Conference
Photo of *Our Water, Our World* booth at NorCal Trade Show
Photo of on-call assistance being provided to Walgreens store

INTRODUCTION

This Regional Supplement has been prepared to report on regionally implemented activities complying with portions of the Municipal Regional Stormwater Permit (MRP), issued to 76 municipalities and special districts (Permittees) by the San Francisco Bay Regional Water Quality Control Board (Water Board). The Regional Supplement covers training and outreach activities related to the following MRP provisions:

- Provision C.5.d., Control of Mobile Sources,
- Provision C.7.b., Advertising Campaign,
- Provision C.7.c., Media Relations – Use of Free Media,
- Provision C.7.d., Stormwater Point of Contact, and
- Provision C.9.h.i., Point of Purchase Outreach.

These regionally implemented activities are conducted under the auspices of the Bay Area Stormwater Management Agencies Association (BASMAA), a 501(c)(3) non-profit organization comprised of the municipal stormwater programs in the San Francisco Bay Area. Most of the 2011 annual reporting requirements of the specific MRP Provisions covered in this Supplement are completely met by BASMAA Regional Project activities, except where otherwise noted. Scopes, budgets and contracting or in-kind project implementation mechanisms for BASMAA Regional Projects follow BASMAA's Operational Policies and Procedures as approved by the BASMAA Board of Directors. MRP Permittees, through their program representatives on the Board of Directors and its subcommittees, collaboratively authorize and participate in BASMAA Regional Projects or Regional Tasks. Regional Project costs are shared by either all BASMAA members or among those Phase I programs that are subject to the MRP.

Training

C.5.d. Control of Mobile Sources

This provision requires Permittees to develop and implement a program to reduce the discharge of pollutants from mobile businesses, including development and implementation of minimum standards and BMPs, and outreach to mobile businesses. BASMAA's long-standing Surface Cleaner Training and Recognition program addresses these aspects of the provision by focusing on the most common type of outdoor cleaning – cleaning of flat surfaces like sidewalks, plazas, parking areas, and buildings. Individual Permittees address the inspection and enforcement aspects of the provision.

Previously, BASMAA, the Regional Water Board, and mobile businesses jointly developed best management practices. The BMPs were packaged and delivered in training materials (e.g., *Pollution from Surface Cleaning* folder), and via workshops and training videos. The folder and the training video have since been translated into Spanish. Cleaners that take the training and a self-quiz are designated by BASMAA as Recognized Surface Cleaners. BASMAA also created and provides marketing materials for use by Recognized Surface Cleaners. Previously, BASMAA converted the delivery mechanism to being online so that mobile businesses would have on-demand access to the materials and the training. BASMAA continues to maintain the Surface Cleaner

Training and Recognition program. Cleaners can use the website to get trained and recognized for the first time or renew their training and recognition, as required annually. Recognized cleaners can also download marketing materials from the website. Potential customers, including Permittees can use the site to verify the recognition status of any cleaner, as can municipal inspectors. In FY 10-11, BASMAA and the Permittees scoped and budgeted for a new project to enhance the existing Surface Cleaner Training and Recognition program in the following ways.

1. Expand the existing Surface Cleaner Training and Recognition Program to include two new mobile business categories - automotive washing and carpet cleaning;
2. Utilize existing resources that are available to complete the necessary tasks;
3. Develop marketing materials, training videos and self-test applications for the new categories;
4. Create Spanish tracks of information for each new business type; and
5. Create a web-based application to share information about mobile businesses.

A consultant team with expertise in best management practices and commercial training programs, videography, graphic design, web design, and translation was assembled and the project will be conducted in FY 11-12.

Public Information and Outreach

C.7.b. Advertising Campaign

This provision requires Permittees to participate in or contribute to advertising campaigns on trash/litter in waterways and pesticides with the goal of significantly increasing overall awareness of stormwater runoff pollution prevention messages and behavior changes in target audience. Through the BASMAA Public Information / Participation (PI/P) Committee, Permittees previously decided to take a broader view of some of its regional tasks (e.g., Regional Advertising Campaign, Regional Media Relations, *Our Water, Our World* program) to ensure that work on individual MRP provisions was coordinated and part of an overall strategy.

In FY 10-11, working with SGA, Inc., BASMAA developed broader Regional Strategic Outreach Plans – one for litter and one for pesticides – that include audiences related to the MRP provisions and ways of reaching them regarding trash/litter and pesticides (e.g., advertising, media relations, schools outreach, events) (see attached Regional Strategic Outreach Plans for details). Although the scopes of the strategies are broad, the level of stormwater agency (regional, areawide program, city) implementing each part will vary (i.e., each part will not be implemented via BASMAA). The strategies are multi-year and also include recommendations for creative, media placement, media relations, partnerships, and evaluation. Also starting in FY 10-11, BASMAA, again working with SGA, Inc., began developing an Implementation Plan for the litter strategic plan, which will provide more detailed tasks and budgets for the multi-year project. Implementation will begin in FY 11-12.

C.7.c. Media Relations – Use of Free Media

This provision requires Permittees to participate in or contribute to a media relations campaign, maximize use of free media/media coverage with the objective of significantly increasing the overall awareness of stormwater pollution prevention messages and associated behavior change in target audiences, and to achieve public goals. The Annual Reporting requirement includes providing the details of each media pitch, such as the medium, date, and content of the pitch. BASMAA has conducted a Regional Media Relations project since FY 96-97 that assists Permittees in complying with this type of provision. The FY 10-11 BASMAA Regional Media Relations project made six pitches – rainy season, wrapping paper, reusables, IPM – pest control operators, ants, and litter (see attached Media Relations Program report for details).

C.7.d. Stormwater Point of Contact

This provision requires Permittees to individually or collectively create and maintain a point of contact, e.g., phone number or website, to provide the public with information on watershed characteristics and stormwater pollution prevention alternatives. The Annual Reporting requirement states that any change in the contact be reported in annual reports subsequent to FY 09-10 annual report. There was no change in FY 10-11 to the point of contact provided by BASMAA. BASMAA assists with this provision by using the regional website: BayWise.org to list or link to member programs' lists of points of contact and contact information for the stormwater agencies in the Bay Area.

Pesticides Toxicity Control

C.9.h.i. Point of Purchase Outreach

This provision requires Permittees to:

- Conduct outreach to consumers at the point of purchase;
- Provide targeted information on proper pesticide use and disposal, potential adverse impacts on water quality, and less toxic methods of pest prevention and control; and
- Participate in and provide resources for the "Our Water, Our World" program or a functionally equivalent pesticide use reduction outreach program.

The Annual Reporting requirement allows Permittees who participate in a regional effort to comply with C.9.h.i. to reference a report that summarizes these actions. Below is a report of activities and accomplishments of the *Our Water, Our World* program for FY 10-11.

- Coordinated program implementation with major chains Home Depot, Orchard Supply Hardware, and Ace Hardware National. OSH reported "natural insecticides" sales down 13.7% compared to the previous year, but sales of all pesticides was also down compared to the previous year.

- Coordinated master print run of the following: fact sheets, shelf talkers, literature rack signage, beneficial bug brochure, magnet, Pest or Pal activity guide for kids, pocket guide, and Pests Bugging You? booklet.

- Updated less-toxic Product Lists: Master – by brand name version; by pest version, and OSH and Home Depot-specific lists/labels.

- Maintained *Our Water, Our World* website.

- Provided Ask-the-Expert service.

- Provided and staffed exhibitor booths.
  - Excel Gardens Dealer Show, Las Vegas (August 2010)
  - Bay Friendly Landscaping Conference (September 2010) (see photo attached)
  - L&L Dealer Show, Reno (October 2010)
  - NorCal trade show (February 2011) (see photo attached)

- Provided on-call assistance (e.g., display set-up, training, IPM materials review) to specific stores (e.g., OSH, Walgreens) (see photo attached).

- Provided print advertising and articles – Green Zebra guide and Chinook Book.

- Provided print advertising – Bay Nature magazine; Bringing Back the Natives Garden Tour's garden guide.

- Mentioned in articles by others: San Jose Mercury News (March 6, 2011).

Additionally, BASMAA, in partnership with the UC IPM Program, competed for and won award of a Pest Management Alliance grant from the Department of Pesticide Regulation for the *IPM Advocates for Retail Stores* project. The project's purpose is to develop and implement a program that will recruit, train, and mentor individuals to help retail stores implement the *Our Water, Our World* program. The project kicked off in December 2010. The project team developed an IPM Advocate profile, recruited for and selected 10 IPM Advocate candidates who started their classroom training in early June 2011 learning from a curriculum developed by the project team.

Bay Area Stormwater Management Agencies Association

Five-Year Regional Strategic Outreach Plan: Litter

Plan Submitted: March 9, 2011

S.GRONER ASSOCIATES, INC.

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CREATIVE MESSAGING • BEHAVIOR CHANGE • STRATEGIC PLANNING
REGIONAL EFFORT • WATER QUALITY • BEHAVIOR CHANGE
BEHAVIOR CHANGE • STRATEGIC PLANNING • REGIONAL EFFORT • CREATIVE MESSAGING
QUALITY • CREATIVE MESSAGING • STRATEGIC PLANNING
REGIONAL EFFORT • BEHAVIOR CHANGE • WATER QUALITY • CREATIVE MESSAGING
STRATEGIC PLANNING • REGIONAL EFFORT

Dear BASMAA Committee & City Reps,

The following document is SGA's proposal for how to approach litter outreach and education in the Bay Area. While I would love for you to read the entire thing cover to cover, I understand that time constraints may leave you skimming some sections. With that in mind, I wanted to give you a short cheat sheet of what the following forty pages are really all about.

The Background.

As part of BASMAA's duty to comply with the Municipal Regional Stormwater Permit, they are required to conduct an advertising campaign specifically focused on one of the Bay Area's most troublesome pollutants – litter. The strategy in this plan is rooted in Community-Based Social Marketing (CBSM), and the tactics woven throughout use principles in social psychology that have been tested and proven to be effective in changing behavior. Most facets of this plan, from having the audience take a specific action, to commitments, to peer-to-peer messaging, to step-by-step changes, are taken from principles of persuasion and have been tailored by SGA specifically for litter and a youth audience.

The Issue.

Research has shown that litter is not a black and white issue. It is rare to find people who litter all the time or, conversely, those who never throw anything on the ground. So much of a person's propensity to litter is based on a mix of internal factors (e.g. age, concern for the environment, smoker vs. non-smoker) and external factors (e.g. if peers litter, the cleanliness of an area, proximity of the closest trash can). Because litter is such a multi-faceted issue, the plan does not assume that a traditional knowledge-based approach (i.e. "Littering is bad for the Bay") is going to do the trick with this audience. Most everyone knows that littering is bad, yet so many people are still doing it. The key to reaching the audience is going to be using an approach and message that resonates with them.

The Audience.

Because youth have displayed higher rates of littering behaviors, they have been singled out as the primary audience for this strategic plan. The key to reaching this audience is to leverage the power of social norms (i.e. "I want to do what my friends are doing"). The goal is to influence members of the youth audience to influence their peers so that messages are traveling top down (from BASMAA to the youth) as well as laterally (from the youth to their peers). In order to ensure that the outreach remains fresh and relevant, SGA recommends involving the youth themselves, as much as possible, in giving input about messaging and proposed outreach tactics so that the program is received as talking "with them," not "at them." Although this plan was written with youth in mind, the strategy is such that people of any age are welcome, and will likely be interested, in also joining the effort.

The Approach.

One of the central tenets of this plan is the importance of having the audience take an action. Action and involvement are the keys to changing behavior. Every facet of the plan, from the advertisements, to the Facebook page, to the viral sharing, is included with the goal of inciting action among the target population. Essentially, how can we make every opportunity a chance for the youth to get involved and invested in the program?

The goal is to have involvement build over time into more difficult and invested actions (i.e. from the relatively easy act of signing up for the program's Facebook page to the much more involved act of actually taking part in a clean-up). The strategic plan therefore does not assume that a person is simply going to see an ad and, just like that, stop littering forever! Studies have proven that people are more likely to take small steps at a time, rather than one big leap (wikipedia "foot-in-the-door technique" for some neat references), so BASMAA's goal should be to encourage the youth to start walking down a road toward ending their littering behaviors (*see Page 28)*. This incremental approach will lead to long-lasting behavior change.

The Long, Long Term Vision.

How can we transform what started as an advertising campaign into a movement? Sure, we want youth to stop littering, but ultimately what we want is to keep stormwater clean in order to protect bay area waterways. That's what this plan does – it thinks of the pollutant at hand, litter, but doesn't lose sight of the larger goal. One of the suggestions in the plan is to create a database of the youth who get involved in the program (*see Page 27)*. The purpose of the database is to build on their commitments, but also to provide a value-added opportunity to BASMAA. Let's say Susie Teenager gets involved in the program and she has since joined the Facebook page, participated in a local clean-up, recruited friends and is now looking to go and speak to elementary school kids about the importance of protecting waterways. Perhaps Susie Teenager will then grow up into Susie Home Owner, who thinks that installing rain barrels and permeable pavement is the way to go. Susie Teenager is now not just someone who abated her littering, but she also has added value to the overall BASMAA program by encouraging others to do the same and by protecting water quality in a more holistic sense. In the words of the great Confucius, "A journey of a thousand miles begins with a single step."

Thank you so much for the opportunity to work on this plan – we had a blast!

Sincerely,

Erica Hooper

Table of Contents

I. Literature Review

1. Introduction

This literature review is meant to inform the development of BASMAA's five-year strategic marketing campaign, addressing the littering behaviors of Bay Area youths aged 16-24. The following review will outline the barriers and motivators acting on the littering behavior of the target population through an examination of pertinent case studies. By uncovering these barriers and motivators, targeted outreach tactics and key messages can be developed, which overcome the barriers and elevate the motivators associated with appropriate waste-disposal behaviors in youths. The program will also gain valuable insight into the preferred methods of communication of litter-prevention message dissemination to this notoriously inaccessible population.

The importance of identifying an audience's barriers and motivators in encouraging certain types of behaviors is a central tenet of Community-Based Social Marketing (CBSM). This approach focuses on analyzing the perceived barriers and benefits associated with the target behavior that the assessor aims to promote. By developing a complete understanding of what would limit the target population in engaging in the desired behavior, the assessor can create mechanisms in the intervention that overcome or remove these perceived barriers (Alcalay and Bell 2001; Neiger, Thackery, Merril, Miner, Larsen and Chalkey 2001; Walsh, Rudd, Moeykens and Moloney 1993).

The following literature review will discuss an array of barriers and motivators that have been identified in previous studies. Many of the studies cited in this review analyzed littering prevention practices, tools and awareness programs. Others examined youth-marketing best practices, innovations and case studies. The results of these similar programs will provide an actionable context in developing a targeted, long-term marketing strategy across BASMAA's eight counties.

Part 1: Littering Across All Populations | Barriers & Motivators

Activating Social Norms: The Masses Make Messes Messier

Across all age groups, the most powerful factor influencing littering behaviors is the influence of perceived social norms—what is perceived as the "right" thing to do, or conversely at times, "what everyone else is doing."

The Writing on the Walls: The Effects of Context on Behavior

Social norms may be identified by the individual through a variety of perceptive and cognitive mechanisms. One such mechanism is the perception of a social norm through the impact of human behavior on the environment in which individuals find themselves. To this end, Dutch researcher Kees Keizer and his team concluded that the very presence of disorderly environmental items, whether or not they are examples of outright littering, implies that others are engaging in disorderly behavior, thus augmenting the likelihood of others littering (Keizer 2008).

The Dutch research team conducted a series of experiments on which their hypothesis was tested: first, flyers were attached to bike handlebars in an alley with bike parking and a prominent "No Littering" sign. Thirty-three percent of bikers littered the alley with the flyers under these control conditions. However, when the alley was defaced with graffiti, 69% of bikers littered. In a similar experiment, flyers were placed under windshield wipers of cars in a parking lot. Thirty percent of owners proceeded to remove the flyers from their windshields and discard them on the ground, thereby littering. As in the case of the defaced alley, a full 58% of car owners littered the lot with flyers once a few disorderly carts were noticeably present in the lot. This work exemplifies the inter-connectivity between seemingly disparate behaviors, in this case, littering in the presence of graffiti or rogue carts. It seems that whether or not people see outright littering, if they perceive themselves to be in a place where disorderly environmental behavior is the norm, they are more likely to participate in this now normative littering behavior.

Mirroring the same underlying principles_as the Keizer study, which found that people are more likely to litter in areas that are perceived to be in a more disorderly state, Beck's 2007 Keep America Beautiful Study found that in communities where recycling was readily available and integrated into the community as a whole, littering was decreased. From these findings, a potential causal synopsis of littering emerges: that littering is not an isolated activity; rather it is the by-product of individuals' perceptions of the general orderliness of their environment and social community. Thus, when an individual perceives their environment to be orderly, regularly participating in recycling, devoid of graffiti and other similar defacements, they are unlikely to litter. Alternatively, when an individual perceives their community to be disorderly, dirty and chaotic, they are much more likely to litter.

These findings suggest that anti-littering messaging should therefore feed into the perception of an orderly social norm. Depictions of disorderly norms, as true to reality as they may seem, could serve to be counter-productive because they reinforce a negative social norm. In other words, *telling people that they should not litter because littering is so rampant could actually encourage littering behaviors since it is being depicted as the norm*. Instead, messages should reinforce positive norms, by expressing that "*everyone else is keeping the community clean, and so should you*", whether or not that is truly the case.

The concept of aligning social norms with the desired behavior has been aggressively pursued through multiple youth-centered marketing campaigns in the recent past. Nowhere is this more apparent than in the popular energy drink Redbull's campaigns (Turner, 2008). Redbull identified its target audience as young adults seeking to gain an extra energy boost, presumably for late-night activities or any activity that required strenuous physical exertion: you're young, you've got something you have to do; you drink a Redbull. To accomplish this, Redbull set out first to find the communities that were already participating in this social norm. These areas were college campuses, bars, night clubs and spring-break locations. Strategically targeting these areas, Redbull sent out crews of 18-30-year-old spokespeople, who provided youths with complimentary Redbulls. By connecting their product through no cost with people already engaged in the appropriate social norm, Redbull effectively included the consumption of their energy drinks into the culture.

Redbull was able to continue the momentum created by these efforts through online outlets, where Redbull consumers were encouraged to "tell their stories." As a whole, this strategy of both reaching their target audience through face-to-face outreach and maintaining the momentum created through online user participation proved to be an impactful means of aligning behavior with a social norm.

The Smoking Gun: Self-Reported Effects of Social Norms

The 2009 Keep Los Angeles Beautiful (KLAB) study by S. Groner Associates featured a survey of approximately 700 Los Angeles-area youth (16-24 years old) and aimed to identify the waste-disposal behaviors of this target population. Overall, the item that was found to be most likely to be littered was a cigarette butt. Upon further investigation into the issue of cigarette-butt litter, Lelde McCoy's "Case in Point" (2008) reviewed the demographics and greater analytics surrounding an Australian effort, entitled *No Butts About It*.

No Butts About It was jointly staged by several associations and municipalities, including the City of Melbourne, the Australian Hotels Association and the Department of Human Services to curb youth littering of cigarette butts specifically. Two major barriers to the appropriate disposal of cigarette butts were identified: (1) Smokers were already sensitive to being vilified, potentially because of an existing perceived social marginalization of smokers; thus any messaging which involved an active or passive negative connotation of smokers became counter-productive; and (2) Night clubs, bars, coffee clubs and their immediate surroundings did not provide adequate ashtrays for smokers.

As a potentially complicating qualifier to the former assertion that smokers are particularly sensitive to vilification, Renee J. Bator (2007) found that social disapproval is a strong motivator of individuals' decisions not to litter, particularly so when a visual cue in the environment is repeated in a public messaging campaign.

Bator's findings are echoed in the 2007 BASMAA Public Opinion Survey, where 92% of those surveyed who do not litter cite the belief that littering is morally and socially wrong as their primary reason not to litter (BASMAA 2007). Once again these findings are echoed in SGA's KLAB study which found that an individual's propensity to feel guilty about littering was the single most impactful variable working against littering. Between these studies, a picture emerges of a delicate audience, one which is at once sensitive to vilification and yet responsive to social disapproval and guilt.

It will be important for any program seeking to affect this group to be balanced in its interest to bring light to the social disapproval surrounding littering and yet refrain from outright blaming and vilification.

BEYOND SOCIAL NORMS: STRUCTURAL FACTORS AFFECTING LITTERING BEHAVIORS

The Problem of Forgetting: Passive v. Active Litter

Beyond social norms, there are a myriad of other factors affecting littering behaviors overall, and youth littering behaviors specifically. Even the most well-intentioned, environmentally conscious, negative norm-immune individual is victim to the occasional slipup. Oftentimes, these slipups can be characterized as "passive" littering, which is distinct from the "active" variety. Understanding this particular behavior is important in developing a communications campaign as the mechanisms to target each behavior are fundamentally different.

First, active littering is defined as the willful dispersal of waste into non-trash repositories; active littering tends to comprise what is thought of as “littering.” Conversely, passive littering is characterized as unintended littering, resulting principally from situations where someone sets an item down nearby and simply forgets to dispose of it. In the study, *Differentiating Active and Passive Litter*, the authors found that passive littering was more difficult to curtail than active littering (Sibley & Liu 2003). Their subsequent explanations for this observation were three-pronged:

1. Passive littering may be less overt than active littering and thus less likely to entail negative social consequences;
2. Passive littering is a strategic form of covert littering that occurs through the omission of behavior; and
3. People are more likely to genuinely forget their litter at longer time delays.

So, although the individual may have internalized the anti-littering norm, he or she may simply forget to follow that behavior in the absence of a cue or a prompt to serve as a reminder. As a result, in addressing the problem of passive littering, a communications campaign would be best served by utilizing visual cues or prompts to help people remember to dispose of their trash. For example, utilizing a multi-sensory approach by adding signs or alarms near trash cans could provide the cues needed to involve passive litterers into more socially beneficial waste-disposal behaviors (Kort, McCalley & Midden 2008.)

Kort found that trashcans that included a verbal or sound cue to passers-by were 50% more effective in reducing littering than non-sounding trash cans. Through the multi-sensory outreach provided by a physical repository that sounds off towards passers-bys, littering is greatly reduced. Kort concludes that individuals who may have internalized an antilittering norm previously are welcomed into participation of the norm through this multi-sensory, attention-grabbing design.

Prevalence of Proper Repositories

Across a number of studies, an insufficient quantity of waste receptacles has been cited as a prominent barrier to antilittering behaviors. For instance, 65% of respondents in BASMAA’s 2007 survey reported that the existence of additional trash cans or proper waste repositories would prevent littering. This finding is supported by a similar result in the 2008 Contra Costa Public Opinion Poll, which found that for a number of populations, including teens, an increased number of trash cans would result in littering reductions. SGA’s Keep Los Angeles Beautiful study (2009) reached similar results, finding that the single highest situational barrier to proper waste disposal was the unavailability of waste receptacles.

The previously mentioned *No Butts About It* campaign, implemented in the city of Melbourne, actively incorporated the introduction of additional repositories near the target audience into their program. Central to the program was the use of so-called “Butt Champs” or young adults dressed in casual clothes, equipped with public transportation vouchers and ashtrays. Butt Champs would travel to locations where large groups of smokers in the under-30 age demographic were gathered, such as bars, night clubs and cafes. Once at the location, Butt Champs would offer smokers complimentary ashtrays and proceed to incentivize the use of said ashtrays through a further gift of public transportation vouchers.

Part II: Reaching the Youth | Barriers, Motivators & Marketing Tactics

Target Generation Profile

Meet Generation Y

Ask many people to describe a teenager and they will speak of short-sighted, rebellious, disengaged and altogether self-destructive adrenaline junkies. Nothing could be further from the truth when it comes to today's teenagers and young adults: Generation Y.

Goals Are Good: Comprising nearly 80 million people, Generation Y is second in gross size only to the Baby Boomers. As there are no precise dates for when the Millennial generation starts and ends, commentators have used birth dates ranging between 1977 and 1996. Also called the Millennial Generation, this group is the most educated generation in the history of the United States with more than 60% having attended at least some college (Papp 2007). This educational pedigree underlies a more pervasive factor in this generation: worldly ambition.

Unlike many past generations that sought to reject the material and cultural status quo, Generation Y generally grew up with respect for their parents, their parents' culture and the working world. They tended to have multiple childhood activities cultivated through organizations such as sports, arts, specialized academic interests and a slew of other activities, ranging from space camp to youth leader groups. This focus on teams and collaborative activities in childhood have produced teens who are collaborative team players, who think in groups and are optimistic about their place in the world (Frank N. Magid Associates 2009). As a whole, this busy childhood has created busy young adults—a group more eager to participate in much of the status quo than destroy it (Papp 2007).

No Alone Time: Generation Y is the first generation to grow up in a world of hyper-communication. Cell phones, Facebook, email…this is a generation that has never seen life without instantaneous communication available in multiple platforms. These factors have produced several traits in Gen Y: first and foremost, social communities have become larger, more inclusive and more impactful on their individual decisions (McCrindle 2003). While the Builder generation relied on authority and Baby Boomers on facts, Gen Y is most driven by the experience of their peers in making decisions. In some respects, this can be viewed as a defense mechanism against the glut of information facing this generation. In fact, by the age of 18, the average young person has viewed more than 500,000 ads; it follows then that they may not trust anything they see because they have already seen too much of it.

Understandably, Gen Y is uniquely focused on improving the social good. Oftentimes, they have already been active volunteers and are generally concerned with the scope of consequences to their actions as they relate to global phenomenon (Papp 2007). As a whole, this is a group characterized by activity, social consciousness, education, material comfort and constant communication.

This Is Your Brain. This Is Your Brain on Teenage Hormones

As savvy and sophisticated as the youth of the Y Generation tend to be, they are still teenagers, subject to the same hormonal highs and lows of the stereotypical teenage brain across the decades. It turns out that two of these classically "teenage" characteristics—fearlessness and naïve idealism—are largely tied to the "under construction" status of the teenage brain.

Scientists have identified a specific region of the brain called the amygdala, which is responsible for instinctual, animal-like reactions including fear and aggressive behavior. This region develops early in life, while the area that controls reasoning and logic for our actions develops over time. The more "reasonable" part of the brain, the frontal cortex, is still changing and maturing as we enter full adulthood.

In fact, according to studies, the adolescent brain goes through a biological remodeling as critical to human development as that which takes place during the first two years of life (National Institute of Mental Health 2005). Because of this, teens have difficulty controlling their impulses, lack foresight and judgment, and are especially vulnerable to peer pressure. This helps to explain the extreme highs and lows of teenage behavior: idealistic and enthusiastic at one moment, cynical and aggressive the next.

It has also been shown that serotonin levels, which are low in teens, and fear are directly correlated (Psychiatric News 2002). As the parent of any teenager can tell you, scare tactics and "doom and gloom" appeals tend to be as effective with teens as sugar-coated brussel sprouts are in luring them into eating their vegetables. This may also explain why teens are more prone than adults to engage in risk-taking behaviors—with little fear of consequence.

Of course, these brain differences don't mean that young people can't make good decisions or tell the difference between right and wrong! It also doesn't mean that they shouldn't be held responsible for their actions. Yet an awareness of these differences can help to inform the development of campaign messages targeting a youth audience.

A teen's "nothing bad will ever happen to me" attitude can definitely be considered reckless, but it also speaks to a sort of optimism that adults—who have become more jaded by years of life—may not necessarily possess. Furthermore, if leveraged properly, this biological teen characteristic can be a powerful tool in activating widespread social change from an idealistic audience.

MECHANISMS, MEDIUMS & TACTICS FOR MESSAGE DISSEMINATION

Reaching Gen Y in the Age of "Instant"

Every generation has its own unique channels of communication. Likewise, Generation Y migrates towards certain communication mechanisms that are particularly prevalent within this subgroup. The common thread linking this group together is the elevated proclivity to engage in "instant," ultra-convenient, efficient forms of communication. This is a generation that grew up online, with a cell phone in hand. Traditional marketing techniques like television and newspapers are not going to resonate as strongly with this audience. With services like TiVo, internet video and file sharing, being constrained to watch a program at a scheduled time does not make sense to them (MobiADNews 2009).

These principles have become the covenant of modern youth marketing, instructing practitioners where their target audience is located and how to get there, as outlined below:

- *Get Digital:* A longitudinal study conducted by Edison Research compared the media platform behavior of youths aged 12-24 in the year 2000 with youths aged 12-24 in the year 2010 (Edison Research 2010). Across the board, the study found that internet use has nearly tripled within this population over the 10-year period, with the average youth spending approximately three hours online every day.

- *Social Networking:* The social community is firmly at the center of the teen internet experience (MobiADNews 2009). Nearly 75% of 12-24-year-olds actively use Facebook: 55% of 12-24 year olds have a Facebook account, which they log into on a daily basis, with an additional 19% reporting to have a Facebook account, which they log into on a frequent, but non-daily, basis. When it comes to receiving information, teens are more likely to trust the credibility of that message when it comes from their peers—even unknown peers—more than an expert (MobiADNews 2009).

- *Text Messaging:* According to a Harris Interactive study, second to clothing, teens say a mobile phone tells the most about a person's social status or popularity, outranking jewelry, watches and shoes. The study also found that mobile phones are fast becoming a social necessity among teens. In fact, 57% view their cell phones as the key to their social life (Tsirulnik 2009). From texting to talking and logging on to social networking sites, teens carry cell phones to have access to friends, family and current events. Even with these figures in mind, some may still find it surprising to learn that 81% of youths aged 12-24 own their own cell phone (Lenhart, Ling, Campbell, Purcell, 2010.) Of those teen cell phone users, 88% report text-messaging on a daily basis, with more than half of that percentage sending in excess of 50 text messages per day. Additionally, over 69% report texting an average of 55 minutes a day (Frank N. Magid Associates 2009).

- *Cell Phone Advertising:* With the astonishing number of youths who both own and actively use their own cell phones, many practitioners are turning to mobile marketing as their new campaign power house. This movement towards mobile marketing is further supported by the fact that 80% of teens have reported spending at least one hour each day surfing the Net via mobile devices (Knight 2008). Perhaps the primary factor contributing to mobile advertising's greater effectiveness when compared to online advertising comes down to the engagement people have with the device and the environment the ads are being served in. Additionally, the recent explosion in technical capabilities, low levels of clutter and the novelty of mobile advertising will likely contribute to increased message impact (Butcher 2010)

The common thread tying all of these mediums together is also the most fundamental trait of Generation Y: the importance of interaction. Today's teens are highly connected to their social networks, seek engagement, and actively build and contribute to their growing on- and off-line communities. This connection to and valuation of social networks can be leveraged into effective "viral vehicles" of communication through peer-to-peer messaging across a variety of the platforms described above. Not only are youths more likely to respond positively to outreach provided by other youths than to that which is provided by other parties, but the capacity for a "viral" campaign exists within a program which actively seeks out peer-to-peer tactics. Any viral campaign, or campaign which works primarily through internet and word-of-mouth distribution, is to be considered especially desirable as it represents a tremendous return on investment regarding the scope of its reach (MobiADNews 2009).

The Paradox of Cool

Miles Davis, skateboarding, iPhones: these are the sorts of people, products and activities that conjure up the illusive concept of “cool.” While it is a word whose meaning can be difficult to pin down, one thing is certain: cool is always changing. A major push in contemporary Generation Y marketing has been to abandon the notion of conventional “cool” product branding and move towards self-replicating, viral, “brand-hijacked” campaigns (Wipperfurth 2005).

Well-Laid Roots Yield Well-Grown Fruits: The concept of brand-hijacking presents the model for a long-term marketing campaign that is both cost-effective and self-perpetuating. Alex Wipperfurth broadly describes the hijacked brand in Brand Hijack: Marketing Without Marketing as a brand which has embraced the true nature of the consumer-provider relationship; namely, the hijacked brand is the one that recognizes that any brand truly belongs to its consumers (2005). After all, it is the consumers who ultimately find use and pump revenue into the products which the brand represents.

Brand-hijacking takes more time to get going than conventional brand marketing, which seeks to inundate a market with a brand image and concept (Wipperfurth 2005). Brand-hijacking seeks to provide various outlets directly to consumers to provide them with the forum to become the major messaging vehicles. In many cases, these outlets are online in the form of social media outlets, websites, user forums and cell phone applications. Inversely to conventional brand marketing, which seeks to develop an initial spike in consumer interest, brand-hijacking seeks to steadily develop communities of passionate supporters who will ultimately drive the brand forward.

Leading sports apparel producer, Nike has successfully transitioned from a conventional brand to a hijacked brand over the past decade (Pankraz 2009). The crux of this transition has been in shifting the focus of the campaigns from awareness-raising tactics, such as television commercials, to internet and grassroots micro-campaigns aimed at engaging consumers. Nike provides online outlets for consumers to “tell their stories”, and in the case of the “Why do you play” campaign, a user-generated effort combining sports with activism and incentivized through small cash prizes (Dilworth 2009).

The “Why do you play” campaign is part of Nike's push to build an online community in the youth demographic, in which youths can share their personal stories about how they have used sports to create some sort of social good. The campaign encourages these youths to be creative about telling their stories visually, by submitting videos or photos. For example, one user submitted a photo from a soccer clinic that she helped organized for impoverished, inner-city kids. Other users then view and rate the submission, increasing the viral, community-based framework of this engagement campaign (Dilworth 2009).

These shared stories have become the lifeblood of the hijacked Nike brand—a brand that is cultivated from the consumer rather than something meaningless that is thrust upon them. The Nike campaign effectively demonstrates the new face of Generation Y hijacked marketing, the new, ever-changing face of “cool”. For this generation, cool marketing is derived organically from the consumer, resonates with them in a meaningful way, and is constantly in flux. While it is slower moving in its infancy, once fully developed, a hijacked-brand is fueled by cost-effective online outlets such as social media and websites rather than more traditional, costly outlets like television ads.

The Fun Factor

Something that is fun to do immediately answers a profound question: the question of "why did you do it?"

"Because it was fun."

In many capacities, an activity which is considered to be fun becomes intrinsically valuable. As in the discussion of "cool," the definition of what exactly constitutes "fun" amounts to a moving target—what is fun to one person can be an exercise in the most excruciating pain to the next. However, one aspect of fun seems to be in play no matter what the subject seems to enjoy doing: interaction.

Whistle While You Work: Since 2009, the Volkswagen-funded "Fun Theory" campaign has been working under the following premise: "We believe that the easiest way to change people's behavior for the better is by making it fun to do" (The Fun Theory 2009). The Fun Theory has produced several case-studies, including the "World's Deepest Trash Bin." This case study involved equipping a trash can in a metropolitan park area with a motion-activated sensor which when activated, created a sound mimicking an item falling down a cavernous hole. Unwitting passers-by who proceeded to throw away their garbage as they would in any other trash can were of course surprised, and in many cases, delighted by this "World's Deepest Trash Bin." Not only were they delighted to have stumbled across this playful public repository, they were activated by it. Over the course of one day of use, the "World's Deepest Trash Bin" collected 72 kilograms of trash, compared with 31 kilograms of trash collected by an identical nearby bin that was not equipped with the motion sensors.

Comparatively, the public sector has been relatively slow to utilize the powerful, cost-efficient possibilities afforded by "fun" interactive campaigns. However a number of these groups have recently harnessed the power of fun to develop several highly successful, peer-to-peer marketing campaigns. For example, All Terrain. Net launched the user-generated "Dude we can fix it" campaign, supporting Al Gore's "We can solve it" climate organization, whose goal is to have America's electricity generated from non-fossil fuel sources within 10 years. The campaign runs on a series of sketch-comedy video spoofs of people trying to be green, but whose tactics are far from effective.

As observed by the "Fun Theory" and "Dude we can fix it" campaigns, re-framing a conventionally un-fun activity or idea in a fun way can produce measurable alterations in human behavior. By adding an element of play, lightness and interaction, a boring task can become something enjoyable, activating the adoption of the desired behavior within the target audience.

This fundamental element of interaction appeals to nearly every generation, but is perhaps most applicable to Generation Y. As mentioned earlier, Generation Y is comprised of a cadre of youths defined by their valuation of social connectivity and interaction. From participating in team sports, to engaging with their friends online—instantly and in real time—this generation has brought new meaning to the word “interaction.” With this observation in mind, it is no wonder why hijacked campaigns like Nike’s “Why do you play” are so popular among youth: not only is it cool, but it’s fun too.

Power to the People
It has been argued that behavior-change communication strategies that focus on "target" audiences and externally determined behavioral outcomes can violate the very principles that underlie work in the community: dignity, participation and choice. Rather, campaigns should seek to directly involve the target community in both the design and implementation of a program to not only increase their ownership over the campaign’s outcome, but their commitment to the cause.

Given the focus that today’s youth place on their involvement in brand development in addition to their interest in social causes, it would make sense to utilize these complementary characteristics in the design and implementation of campaigns promoting the public good. Numerous public-sector departments and organizations have utilized youth activism in rolling out youth-focused campaigns. For example, the County Health Department in Pinellas County, Florida, worked directly with youths in designing and rolling out a youth violence prevention program in Pinellas County. The high school-aged youth group was trained in basic social-marketing principles and worked with a subcontracted advertising agency and a university researcher to create and test the campaign slogan, logo and tagline. The youth group also developed a six-session curriculum for three middle schools, designed for a team of youth group leaders to instruct in each middle school. As a result of this youth group partnership, middle school students throughout the county now recognize the slogan, and most middle schools have at least one campaign poster (Loomas 2004).

PART III: YOUTH LITTERING | BARRIERS, MOTIVATORS & MARKETING TACTICS

As outlined in Part I, context, or one’s physical environment, plays a significant role in both driving and curtailing littering behaviors. Statistical analyses have shown that among youths, 22% of a person’s willingness to litter is a result of physical context, while the remaining 78% results from individual preferences (SGA 2009). While context is still a strong factor, more nuanced, less visible factors such as individual preferences play a much larger role in youth littering behaviors. The following section will outline some of the more prominent barriers and motivators associated with individual preferences as they relate to youth littering.

Friend of a Friend: When the Social Norm Is Set by a Peer
Precedents set by a friend or known peer’s behavior may be indicative of an especially salient social norm (SGA 2009). In SGA’s youth littering study for Keep Los Angeles Beautiful (KLAB), survey results discovered that the most impactful, non-situational factor in determining an individual’s likelihood of littering was the littering habits of their friends. Moreover, friends’ behaviors with regard to littering were found to be twice as impactful as the littering habits of their parents.

In considering this point, it should also be noted that a social norm is not the same thing as “peer pressure.” In the 2007 BASMAA Public Opinion Survey, the least cited cause for appropriate trash disposal behavior was “peer pressure” at 26% of respondents who reported appropriate trash disposal habits (i.e., not littering). The principal difference between peer pressure and perceived social norms is the concerted participation of separate parties in the attempt to influence certain behaviors—that is, an individual or group of individuals that is actively trying to influence their peer's behavior defines peer pressure. As opposed to a social norm's effects, which are defined as those effects stemming from the perceived behavior of others by the individual. It is important to make this distinction when identifying the social norms acting on the target population, and how to utilize those norms to activate the desired behavior change.

Meaning Well and Doing Bad: The Knowledge-Gap Barrier

Although knowledge does not directly relate to behavior change, a lack of knowledge can certainly be a barrier to adopting the desired behavior. Studies have found that a lack of knowledge or understanding as to how litter is defined acts as a significant barrier to sustainable behavior.

For instance, unsurprisingly, the KLAB study found that the individuals reporting the highest levels of concern for the environment were amongst those found to be least likely to litter (SGA 2009.) As a whole, this group was characterized as essentially being "good kids": less likely to smoke cigarettes, watch less TV and spend more time volunteering. However one area of overlap that these so-called "Green Crusaders" shared with the other litter bug groups was the elevated potential to improperly dispose of bio-degradable items. A potential explanation for this phenomenon is a misunderstanding as to what litter is, and what happens to that particular item once it is improperly disposed of. Plainly, people think that throwing away an apple core into a bush is different than throwing a Styrofoam cup into the bush because an apple will more quickly be broken down and integrated into the natural environment.

Upon further investigation, in fact, less than half of the "Green Crusaders" and less than 40% of other groups could correctly identify what actually happens to litter. Thus, an area of strategic redress in any litter prevention program focusing on youths should educate the target audience on the true fate and environmental impact of litter, especially those "Green Crusaders" who have already exhibited a willingness to curtail the brunt of their littering ways (McKenzie-Mohr 1999).

I've Got Bigger Problems: Mood, Class, Personality, Life, You Name It…

With 97% of respondents reporting that littering was a problem in the BASMAA study, one must conclude that littering is already perceived to be a problem by the vast majority of the general public. This information provides a slight but meaningful course to potential messaging. The goal then should not be to convince the target audience that littering is a problem; rather, that it is a *more important and soluble* problem than they currently perceive.

In establishing a framework that positions sustainable behaviors as "easy" and "convenient", compared to the other responsibilities and woes in their life, it is important to first understand what those factors are for the target population. Thus, the emotional and socio-economic barriers to litter-prevention among teens include:

- *Mood:* Teens who are in a bad mood exhibit an elevated propensity to litter.
- *Employment:* Youths with jobs are less likely to litter than the unemployed.
- *Hurried*: Those in a hurry have an elevated propensity to litter.

- *Video Games:* Teens who regularly use video games exhibit an elevated propensity to litter.
- *Laziness:* Youths who are "feeling lazy" are more likely to litter (SGA 2009).

Obviously, the practical answer to the questions raised by these findings is not: "Get teens jobs, make them happy, energetic, healthfully busy and off of video games to stop littering." Nor is the answer to resign to a set of data that is to be considered too pervasive, too endemic and altogether true, but useless, information (Heath and Heath, 2010.)

But the answer could be to utilize messaging and outreach to elevate the importance and perceived ease of proper waste-disposal behavior amongst the target audience into a position where it can effectively compete with these barriers.

In the case of video games, precedent has been set by the Dublin City Council 'Anti-Litter' campaign to shift the programmatic perception of video-game play as a barrier to a channel of communication. When viewed as a channel of communication, the Dublin Campaign created a simple video game that was disseminated to its target audience (Brosseau). This tactic underscores a greater strategy: the barriers cited by the target audience can be used to inform messaging and more directly reach that very same audience.

Age Is Just a Number…Or Is It?

In addition to social norms, knowledge, mood and interests, KLAB also found that demographic variables such as age were highly influential in determining youth littering behaviors. Statistical analysis found that those most likely to litter were between 16 and 17 years old. Results also found that littering progressively decreased as age increased, with young adults between the ages of 21 and 24 being the least likely to litter (SGA 2009). Therefore, certain behaviors and attitudes seem to cluster around very specific points along the age continuum. These behaviors then change, quickly and simultaneously, once the teen reaches young adulthood. Framing messages that speak to this pattern (i.e., that littering is "not cool" because it's something that "kids" do) could positively impact littering behaviors.

The only exception to this pattern was that the "Green Crusaders" group was found to be evenly distributed across all age groups. Potentially then, environmental activism should be viewed as unrelated to age.

Keep It Culturally Relevant

Research on consumer behavior has revealed that an individual's personal values, which are defined by their culture, underlie their buying motives. As a result, identifying consumers' personal values contributes to explaining and understanding consumer preferences. Personal values are part of a culture and differ depending on one's cultural background. Therefore, culture-specific values result in specific consumer behavior. It would then follow that if there are differences between the personal values of consumers who are from different cultural backgrounds, this has to be taken into account by differentiating the strategic direction of marketing strategies, which should incorporate culture-specific messaging (Rewerts & Hanf 2006).

These compelling results from the world of consumer marketing can be directly applied to the world of public interest marketing. Thus, if personal values underlie buying behaviors, then they probably motivate other behaviors as well. The importance of aligning the target audience's cultural preferences to the direction of strategic marketing strategies is not a foreign concept to most communications practitioners. Although not a new idea, it is certainly not an easy undertaking.

Perhaps one of the most successful culturally focused marketing campaigns, especially in the field of litter prevention, is the famous "Don't Mess with Texas" campaign. Originally an effort focused on litter prevention, "Don't Mess with Texas" has evolved into a cultural icon, encapsulating the essence of "what it means to be a Texan" (Don't Mess with Texas 2010).

The campaign was first developed in 1985 by the Texas Highway Commission. From the program's survey research, the Commission identified the state's worst offenders and how best to reach them. Unlike other litter-prevention programs, this campaign opted to focus on the audience as opposed to the pollutant. In doing so, messages were crafted so that they spoke to the unique underlying values of Texan society, parceling out exactly what it meant to be a Texan and then touting those qualities through the legendary slogan.

The slogan was paired with iconic Texas celebrities to help spread the message, like Willie Nelson, Lee Ann Womack, Stevie Ray Vaughan, Matthew McConaughey and even Chuck Norris. As a result, the campaign has become more than a public program, and the slogan has become more than a tag line. "Don't Mess With Texas" expresses a way of life. It incites action by activating cultural values; in this case, state pride. As the Texas campaign demonstrates, behavior change is more likely to occur when culture-specific messaging has been incorporated in the strategic direction of a campaign.

Part IV: Barriers, Motivators & Marketing Tactics: Review

Identifying & Overcoming Barriers	
Barrier	**How to Overcome**
Social norms that encourage littering such as: *Context:* A littered/disorderly environment prompts others to litter *Peers:* Littering friends increase likelihood of littering	**Reframe the norm** so that it is more aligned with the desired behavior Utilize the norm of **social disapproval,** but **do not vilify** the offenders
Forgetfulness: Individuals may engage in passive littering as opposed to active littering; i.e., littering is not the intention; rather the individual forgets to dispose of an item	**Prompts:** Utilize visual cues near the trash receptacle to encourage individuals to remember to dispose of waste
Lack of proper **repositories**	Place **additional** repositories **or** utilize **signs** to clearly indicate repository locations
Lack of **knowledge** about litter: *Definition* (i.e.,plastics are perceived as litter, but organics may not be) *Fate* (environmental/social consequences)	Identify the most prevalent misconceptions with regard to litter's definition or fate and **target messages** to address these specific information gaps

EMOTIONAL STATES: Bad mood Laziness Hurried These emotional states can make people more **PRONE** to littering	**ELEVATE MOTIVATORS** to demonstrate that litter prevention is more important than fleeting emotional states
The TEENAGE BRAIN is still UNDER CONSTRUCTION	**CAPITALIZE ON THE EXTREMES** OF TEENAGE BEHAVIOR (I.E., IDEALISM) TO CREATE SOCIAL CHANGE
AGE greatly influences littering behaviors, even within the small bracket of the target age group	MAKE LITTERING UNAPPEALING BY DEMONSTRATING THAT LITTERING IS SOMETHING THAT **"KIDS"** DO
IDENTIFYING & UTILIZING MOTIVATORS	
Motivator	**How to Utilize**
SOCIAL NORMS that encourage litter prevention	**ALIGN SOCIAL NORMS** with litter prevention behaviors (i.e., show responsible behavior as the norm and encourage others to follow suit)
Concern for the **ENVIRONMENT** among certain groups within the target audience	Demonstrate through messaging that litter prevention **PROTECTS** environmental integrity
OWNERSHIP: desire to be *involved & engaged* among certain groups	**INVOLVE TARGET AUDIENCE** into program design and/or implementation
The desired behavior resonates with the underlying CULTURAL VALUES of the audience	**Incorporate CULTURE-SPECIFIC MESSAGING in the strategic direction of the campaign**
The desired behavior is perceived as being "COOL"	ALLOW THE CAMPAIGN TO BE **"OWNED"** BY THE TARGET AUDIENCE AND ENCOURAGE THE CONSTANT **CHANGE** & **EVOLUTION** OF THE MESSAGE AND/OR BRAND
The desired behavior is perceived as being "FUN"	INCLUDE **PLAYFUL, INTERACTIVE** ELEMENTS
HOW TO GET MESSAGES ACROSS	
Use **ONLINE PLATFORMS** as a central mechanism to message distribution	
SOCIAL NETWORKING, ON- AND OFF-LINE: Empower the audience to become a vehicle of communication through peer-to-peer messaging via social networking sites & word of mouth	
GET MOVING, GO MOBILE: Utilize text messaging & mobile advertising to reach the target audience	

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II. Litter: Anatomy of a Message

The Source---*Who is the Message From?*

The source of the campaign should have a nonprofit, as opposed to a government-based, look, tone and overall feel. BASMAA should just be seen as the funding arm of the overall campaign, with the actual source being a fast-moving, young and hip nonprofit. That said, even the source itself will essentially "take a back seat" to the brand—where the campaign is the element that is front and center.

The Issue---*What is the Issue We are Promoting?*

For the program, litter[1] is the issue. But for the youth, the environment—and more specifically, marine water quality—is the issue. This audience is not necessarily moved by the thought of litter. However, oceans and the Bay are tangible, and evoke an emotion, which makes this group more apt to care about this issue over abandoned water bottles littering their streets.

The Action---*What is it we are asking them to do?*

The entire "feel" of the campaign should be action-oriented. For this reason, the message needs to be able to just transcend a littered paper cup. Initially, the campaign will ask the target audience to simply not litter. However, this initial commitment will evolve into several other commitments and actions as the campaign progresses. With each singular, targeted action the participant undertakes, the campaign will ask them to take on one more singular targeted action—and then again and again. This singular step-wise approach is so important because, as the literature review demonstrated, people are more apt to adopt one behavior at a time, as opposed to undergoing an entire lifestyle change. For example, the primary action would be "don't litter." Once they are involved, we would follow up with the participant via email/social media, asking them to attend a clean-up event, then to "tell a friend", etc.

The Brand---*What is the Overall, Overarching Identity of the Campaign?*

The brand should appeal to the target audience: it should be cool, fun and kitschy in name, program language/materials, design and aesthetic. The brand slogan should encompass an idea beyond litter, norms and the environment to include the cultural identity of the Bay Area, such as "Keep the Bay Golden", for example. These elements will create a link between the campaign's identity and how it relates to the target audience.

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[1] It is important to note that certain key terms in addition to overall campaign language should be field-tested during the message development phase (while creative designs are being assessmbled for the advertisements). For example, "litter" vs. "trash" as well as "bay" vs. "ocean" should be field-tested to ascertain the target population's understanding of these terms, in addition to identifying the most easily and commonly comprehensible terminology to express these ideas.

The brand should ultimately convey a call to action and appeal to the youth's concern with fitting in and being part of a norm, while also playing off of their drive to feel empowered—as though their actions are making a real impact on the world around them.

THE FACE---*WHO/WHAT WILL BE THE "FACE" OR THE AMBASSADOR OF THE CAMPAIGN?*

The outward faces of the campaign, or the message ambassador, are the youths themselves. The face should show the public that this campaign is created for youth, by youth.

The "face" is distinguished from the "brand" such that the face comprises only one facet of the larger campaign identity.

THE ANGLE---*HOW WILL THE CAMPAIGN BE PRESENTED?*

The angle, or how the campaign is presented to the target audience, will be differentiated by each sub-group of the larger target population. This campaign is comprised of two basic audiences: the Green Crusaders, and then everyone else between the ages of 16 and 24. For the Green Crusaders, the angle will center on ocean water quality. However, ocean water quality is a monumental topic, so focusing on a specific aspect of water quality would probably be more effective. To that end, when targeting Green Crusaders, the campaign could focus on the health of a singular, iconic Bay Area marine animal, such as the sea lion. By focusing on the sea lion, the issue now has a face—it is a living, breathing thing as opposed to an ugly intangible, such as discarded trash.

For everyone else in this age group (including the general advertising campaign), they are more likely to respond to social norms as opposed to environmental concerns, as demonstrated in the literature review. So for this target audience, the angle will be focused around two norms: (1) that littering is "something that kids do", and (2) that everyone else is picking up after themselves. As demonstrated by the literature review, this group above all others is most persuaded by the actions and social norms set by their peers. Moreover, as young adults, this group is also eager to rid themselves of stereotypes and behaviors that are seen as "childish".

KEEPING IT RELEVANT---*HOW WILL THE CAMPAIGN MAINTAIN A CONNECTION WITH THE TARGET AUDIENCE?*

To maintain a connection with the target audience, the campaign should develop a "youth panel" that provides feedback on the campaigns, while also taking ownership over its direction. Relevance could also be maintained by partnering with highly youth-trafficked and credible establishments, such as local boutiques and nonprofits.

III. FIVE-YEAR LITTER MARKETING STRATEGY

1. COMMUNICATIONS STRATEGY GOALS & OBJECTIVES: AN AERIAL VIEW

The overarching goal of the following advertising campaign strategy is to encourage the target population to curb and eventually eliminate their littering behaviors. In promoting this behavior change, the campaign will apply a series of strategies to encourage the viral spread of anti-littering messages through peer-to-peer networks of communication. This grassroots approach will seek to incite action among the target youth audience, allowing for engagement and empowerment in the peer-to-peer distribution of campaign messages. By promoting these specific, action-oriented messages, the campaign will be better equipped to successfully mold the behaviors of the target population by attempting to influence the social norm.

2. Hi, My Name Is…Identifying & Tracking Your Audience

Targeting messages to specific audience groups helps conserve finite program resources by focusing efforts on those groups who engage in the target behavior most frequently (i.e., youth littering behaviors). By refining marketing efforts and messages to a well-defined subset of the larger population, the program will be able to target resources more efficiently, while also strengthening the impact of the message through this tailored approach.

The target audience for this campaign is comprised of youths aged 16-24, residing in the eight Bay Area Counties participating in BASMAA. Utilizing SGA's 2009 Keep Los Angeles Beautiful Youth Litter Study, we have further refined this general audience into five unique sub-populations, each distinct in their respective attitudes, beliefs, general characteristics and propensity to littering. These sub-groups comprising the larger youth population include: Apathetics, Digitally Disengaged, Acceptance Seekers New Adults and Green Crusaders.

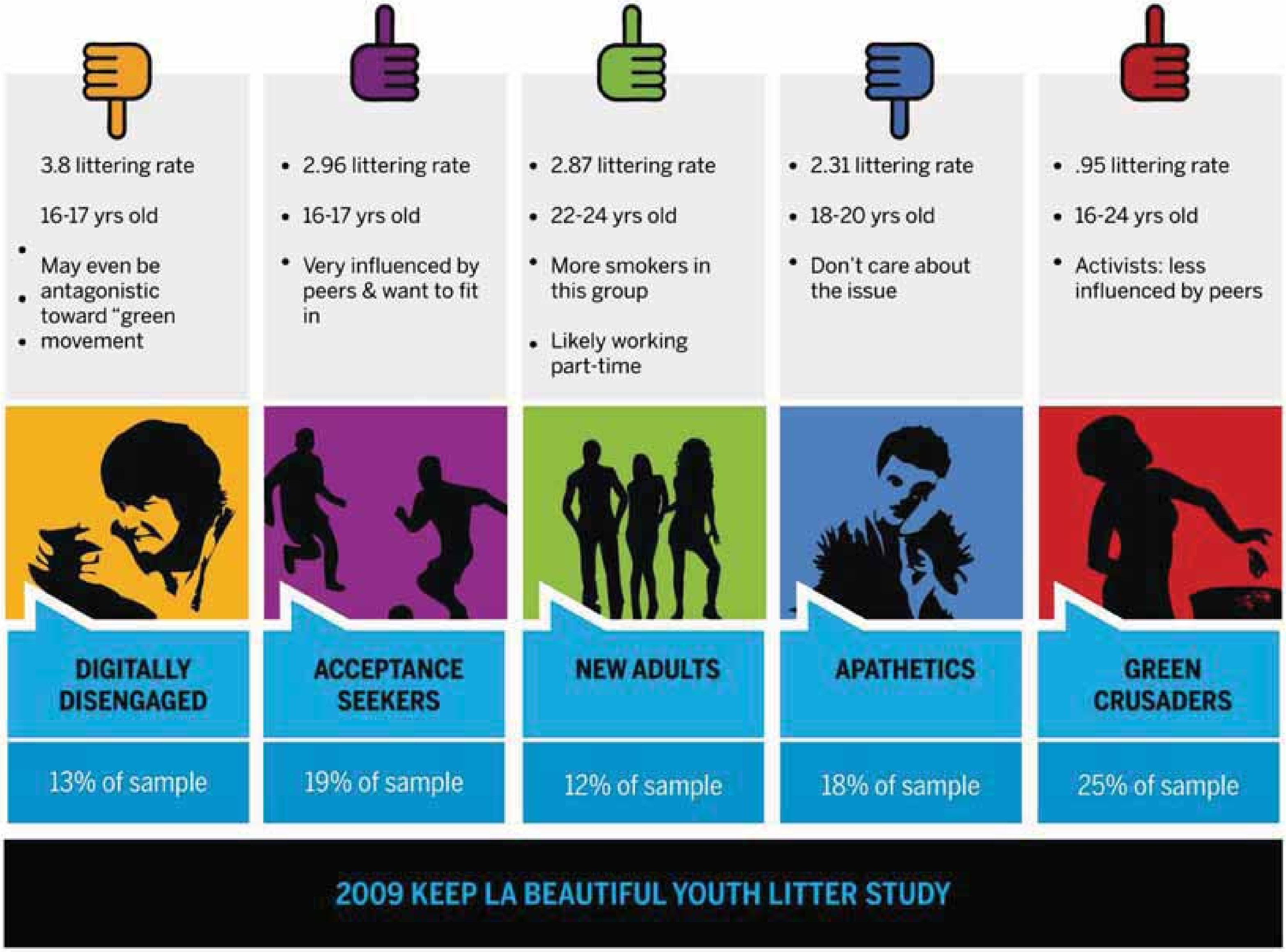


Figure 1:
Note that the "thumbs up" symbol represents audience sub-groups that the campaign will focus on reaching directly, while the "thumbs down" symbol represents audience groups that the program will not specifically reach out to, but will be affected through indirect interactions with the target audience groups.

As illustrated by the image above, each group differs in terms of their propensity to litter, as well as their propensity to adopt more sustainable behaviors. For example, the Digitally Disengaged and Apathetics are not only most likely to litter, but they are also least likely to care about the negative effects associated with littering and to engage in positive changes. As a result of this finding, this campaign will not seek to engage these extremely hard-to-reach groups directly, and will instead focus energies on the other three subpopulations most likely to change and also use them as a catalyst for reaching the other two. Therefore, the target populations for this campaign include the Green Crusaders, New Adults and Acceptance Seekers. Collectively, these three groups account for 56% of the youth population. As defined by the 2009 Youth Litter Study, these audience groups are defined according to the following characteristics.

Target Sub-Population 1

<u>**Green Crusaders:**</u> These youths, which are found across all age groups between the ages of 16 and 24, are the least likely to litter. They are high in environmental concern, they are likely to feel guilty for littering, and they report that their friends do not litter. They are less likely to smoke cigarettes, watch less TV, spend more time volunteering, less time in organized sports, less time playing video games, and are less likely to attend church. They are also generally knowledgeable about what happens to litter on the ground. *Green Crusaders* widely perceive fewer reasons for not properly disposing, and they are willing to overcome greater barriers to avoid littering. In general, they are less influenced by perceptions of peers and more motivated to act on their personal convictions. They are already invested in the environmental issue and are likely to be invested in other types of activities as shown by their propensity for volunteering. It is important to note that this group is not completely void of any littering behavior; however their propensity to litter is far less than that of other groups.

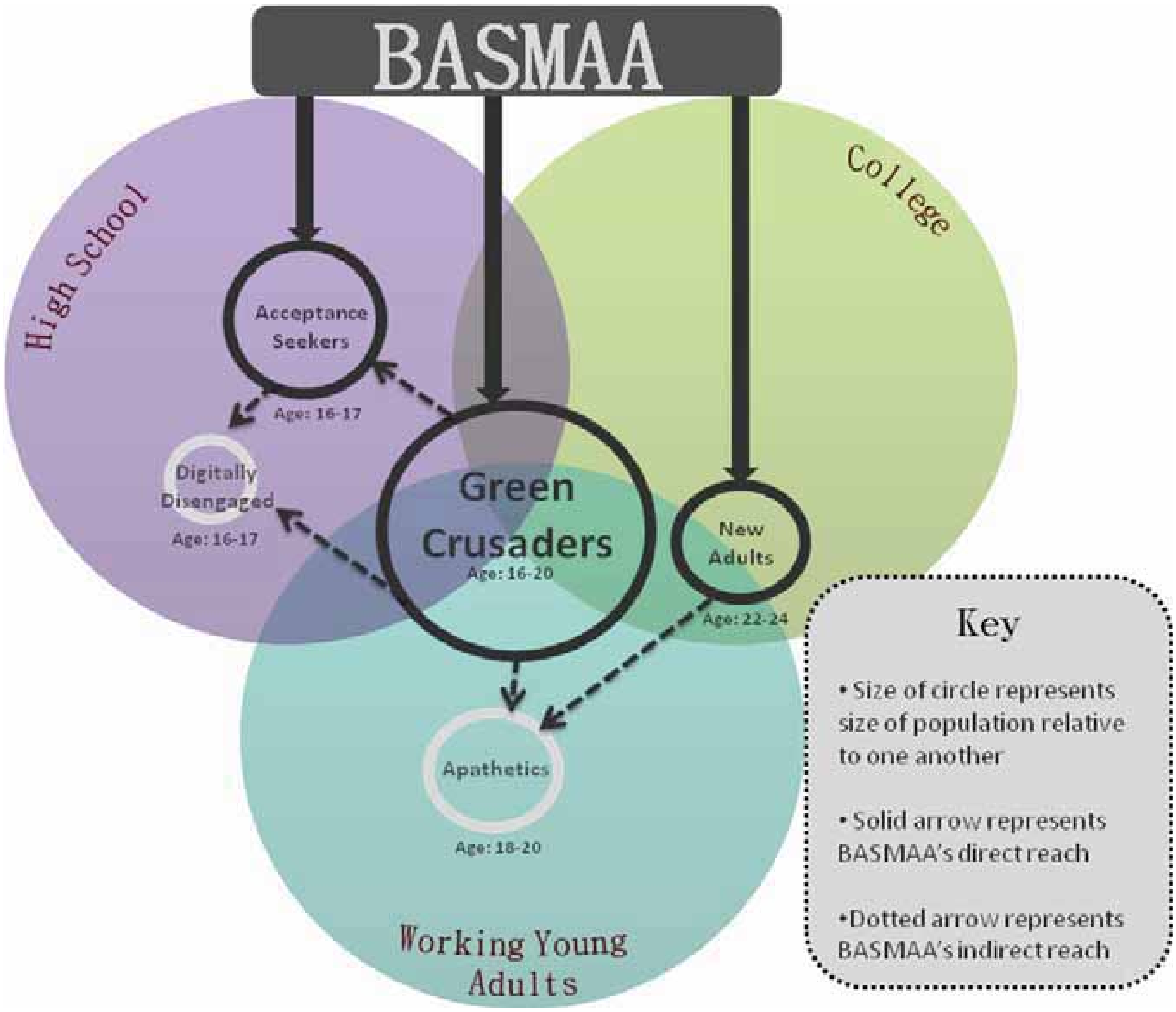
Target Sub-Population 2

<u>**New Adults:**</u> These young adults are working and not currently attending school. They are typically over 18, have a higher probability of smoking (55%), spend fewer hours in sports, fewer hours watching TV, fewer hours playing video games, and are less likely to attend church. They are less knowledgeable about what happens to litter on the ground. Since this group is older than the average college age and more likely to work, it is assumed that they are becoming part of the adult workforce, having a different role in society than they did when younger. Because of their working status, they may perceive themselves as increasingly more a part of this society that the *Digitally Disengaged* find themselves rebelling against.

Target Sub-Population 3

<u>**Acceptance Seekers:**</u> These youth are still typically in high school and may be termed the 'over-achievers' who care about their academic performance, and are involved in sports and other organized activities. They are less likely to smoke, more likely to volunteer, less likely to work, and more likely to attend church. They are less knowledgeable about what happens to litter on the ground. They are strongly influenced by their parents and their peers, and are likely to be swayed by their actions. Since they are highly influenced by their social networks, we can assume that they want to fit in, and they seek acceptance among these groups. Environmental concern is not high on their scale of things that they care about.

__Figure 2__
The strategies described above and below will not only directly reach the three target populations, but messages will also affect the harder- to- reach groups through cross-pollination and viral-sharing between groups.



As the plan below will describe, the campaign will demand a tremendous amount of interaction between the program and these three youth populations. Offering this opportunity for engagement provides a cost-effective means for increased participation on the part of the audience members, in addition to an increased opportunity for directly tracking campaign progress on the part of the program.

To track this participation and maintain engagement, the program is advised to build a database that would include the participant's name, mailing address, email address and the way the participant first came into contact with the program (e.g., an outreach event, program website, through a friend, etc.). In addition to general contact information, each database should also describe to what extent each participant has been involved in the project (e.g., signed up for Facebook page, entered viral video contest, etc.). The database should then record a follow-up action that should be taken for each participant (e.g., send email invitation to participate in a clean-up, respond to a Facebook wall post, etc.) to automate and streamline interactions and as a way of asking for an increased number of commitments.

Leveraging Existing Resources

Start the database by collecting emails and names from all of the contacts that have been made through the existing County efforts such as the annual Coastal Clean Up events that the Counties host.

3. To the Point: Key Campaign Messages

3.1 Overall Messaging Strategy

As mentioned earlier, the overall goal is to deliver a set of targeted messages that not only increase the audience's awareness of the issue, but that actively reduce their littering frequency. This approach is characterized by Community-Based Social Marketing's (CBSM) stepwise process for behavior change, as described in the literature review:

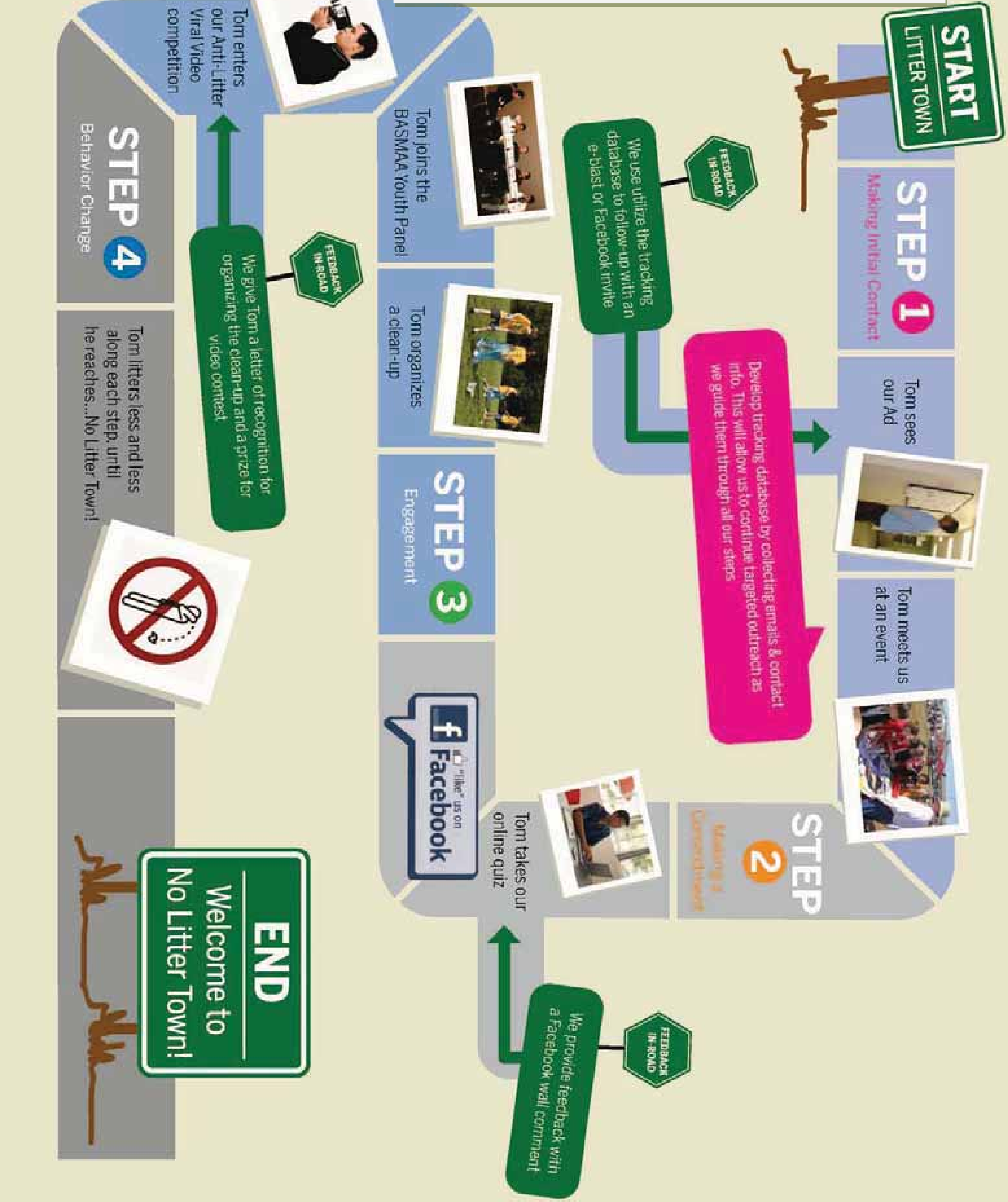
Phase 1. Raising Awareness (*General Advertising Campaign*): The campaign will begin with raising awareness of the newly launched youth-focused campaign. Targeted advertising will encourage viewers to visit a website or enter a contest.

Phase 2. Produce Engagement: The ultimate goal of the advertising campaign will be to involve the youth into the program, either by joining a Facebook page, entering our contest, playing our quiz, etc. This is where the program will have the opportunity to get the youth involved in the program (e.g., by obtaining their email address, Facebook sign-up, etc) in order to continue sending the participant information throughout the life of the campaign.

Phase 3. Change Behaviors: To move the audience along the behavior change continuum, the campaign will develop a feedback mechanism facilitated by electronic platforms such as email marketing and social networking sites to continue to encourage participants to engage in increasingly more difficult behavior changes.

Phase 4. Maintain Engagement: To maintain the engagement and behavior change that has been achieved, the campaign will continue to utilize the feedback and engagement tracking mechanisms to automate interactions with the target audience.

Figure 3:
A visual representation of the "road to behavior change," demonstrating how the various program activities will move participants to increased awareness, engagement, and eventually, behavior change.



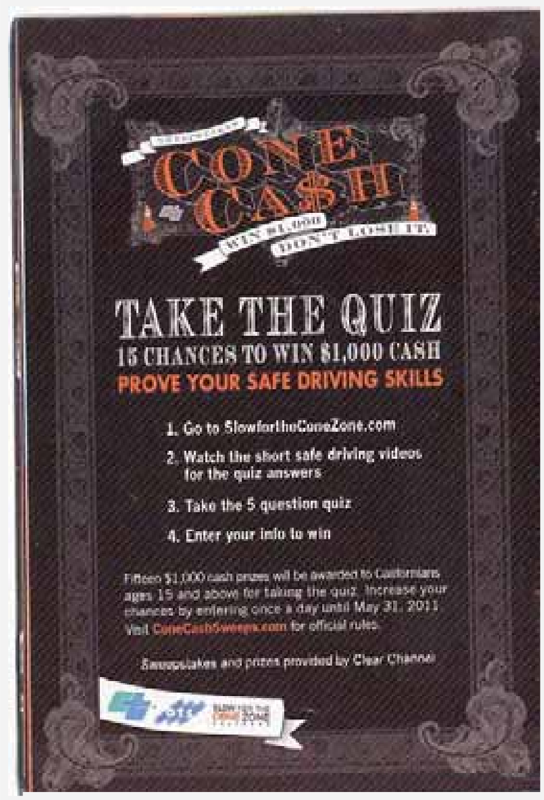
3.2 Specific Messaging Strategy

Throughout each phase of the campaign, messages will be action-oriented and will mirror the behavior-change continuum of awareness to engagement to behavior change. As mentioned above, the general advertising campaign messages will only focus on the first two steps of the continuum—raising awareness and producing engagement. For example, to increase awareness, the campaign would convey that negatively impacting the Bay by littering is frowned upon by your peers (i.e., not the norm). The second engagement phase of the campaign would then ask teens to join the movement. In moving along this behavior-change continuum, the campaign's messages and specific steps may include those described below.

Phase 1. <u>Getting Their Attention:</u> As mentioned above, the campaign will begin with raising awareness regarding how to get involved in the campaign.

- For the general advertisements, we suggest using social norms as the primary motivator in encouraging behavior change. For these groups, the angle will be focused around two norms: (1) that littering is "something that kids do", and (2) that everyone else is picking up after themselves.
- For the more targeted one-on-one outreach (e.g., BASMAA youth panel), the angle will center on a specific aspect of water quality, given the size and scope of water quality in general. To that end, campaign messages will focus on the health of a singular, iconic Bay Area marine animal, such as the sea lion. By focusing on the sea lion, the issue now has a face—it is a living, breathing thing, as opposed to an ugly intangible, such as discarded trash.

Phase 2. <u>A Call to Action Is Issued:</u> In addition to the overarching campaign message, a call to action would also be issued to encourage teens to "join the movement" by, for example: signing up for the program's Facebook page, email list, text-messaging campaign, enter a raffle, play an online game, etc. In order to generate the most interest, this initial call to action should ideally be associated with a "cool" prize or giveaway. It would be in BASMAA's best interest to secure a private partner (see 4.3.4) in order to allow for a prize that would be of interest to the youth. See Figure 4 and 5 as an example of campaigns that either secured or are led by the private sector, Clear Channel and Mc Donald's, respectively. For BASMAA, promotions could resemble a year's worth of tickets to the Giants' games.



<u>Figure 4</u>
This Caltrans advertisement issues their call to action by encouraging youth to take a quiz for a chance to win a prize, while raising awareness about safe driving in the process. Strategically placed in a concert booklet with an edgy design, this call to action piques the interest of their target audience.

Phase 3. **Recipients Respond to the Call:** Viewers of the campaign would then respond to the call to action by taking a pledge to reduce their littering behaviors (for example, "I take the pledge against littering" or "I take the pledge to pick up one piece of litter a day"). In taking the pledge, participants would be required to submit a form that includes their basic contact information (e.g., email address). The program would then use this information to increase, maintain and track their engagement throughout the life of the campaign.

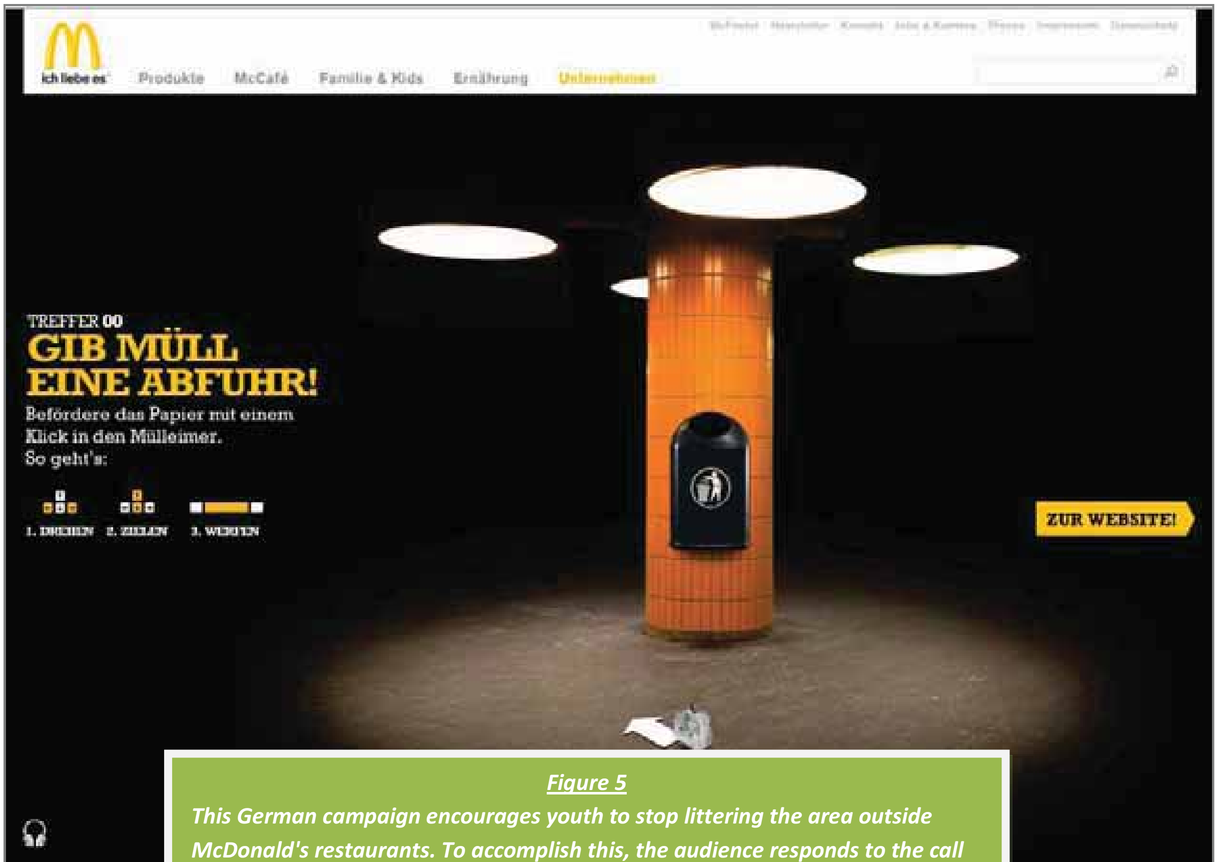


Figure 5

This German campaign encourages youth to stop littering the area outside McDonald's restaurants. To accomplish this, the audience responds to the call by slipping into the role of tricky street kickers. They could map their own face into the video and kick the trash in the bin to win tickets for the Fifa World Cup

Phase 4. **Feedback Is Provided:** After taking the pledge, the program would follow up with the participant with the information collected in Phase 3 to reinforce their positive behavior. For example, the program could send an electronic "I Took the Pledge" certificate that participants could plug in to their Facebook pages by copying and pasting a strip of HTML code onto their walls.

Phase 5. **Recipients Are Asked to Do More:** At this phase, the program would gradually expand the participant's level of commitment by continually requesting that they take on increasingly more involved litter reduction habits. In increasing order of commitment, these requests could include:

- Pick up one piece of litter a day
- Participate in contests (e.g., found art contest)

- Participate in a clean-up or organize your own clean-up
- Participate in the BASMAA youth advisory board
- Participate in the program's Speaker's Bureau

4. Building a Movement from the Grassroots: Distribution Mechanisms

4.1 The 800-Pound Guerilla: Harnessing the Power of Guerilla Marketing

The centerpiece of BASMAA's youth anti-littering campaign will be the application of a number of nontraditional word-of-mouth guerilla marketing techniques. As a result of the approach's viral, word-of-mouth promotional basis and creative as opposed to expensive advertising strategies, guerilla marketing is an extremely cost-effective mechanism to reach specific target audiences. Depending on project budget, the campaign could develop and engage in a number of guerilla marketing strategies, such as:

1. <u>**Branded Promotional Products:**</u> To act as an incentive to engagement as well as an effective marketing mechanism, the program could develop branded promotional products by simply repurposing paid advertisement messaging and graphics. For example, the program could develop posters for college dorm rooms, tote bags for schoolbooks or beach bags.

<u>Figure 6</u>

<u>Panadol</u> wants to be your druge of choice when you have a headache, so they developed a series of excruciating ad bags to bring that fact to your attention. The full effect is realized when you either grab the bag by the grips or swing it by its strings. These kinds of branded promotional items get the message across, while increasing interest in what's being promoted.

2. **<u>'Fun Factor' Public Happenings</u>:** The program could also garner attention and disseminate campaign messages through the development and staging of fun and creative installations or happenings in unexpected public locations. For example, an "endless" trash bin could be installed in high-traffic youth zones such as malls, movie theaters and college campuses (see page 12 of Literature Review for further description of the "endless" bin). Likewise, the program could also develop unusual installations to bring increased awareness to the issue. For example, the campaign could work with local artists to create a "trash sculpture", representing the number of tons of trash released into the bay every week, month or year. These "happenings" also offer interesting material to shoot and edit into videos for the program's "viral video" efforts.
3. **<u>Interactive Online Platforms:</u>** To produce direct engagement with the target audience, the program could utilize interactive online social-marketing platforms that allow teens to not only be the content consumers, but the content producers. This type of content-producing engagement could be facilitated by a series of contests targeting youths. For example, the program could create a "clean street contest" where the community would be tasked to take a picture of a clean street and submit it electronically. Then on a regular basis, every week or every month, the best photo would be selected and featured on the website homepage and Facebook page. In addition to this public recognition, each winner would also receive one of the program's promotional products. As a result of this type of contest, not only are youths engaging in the program, but they are also producing content to feed online platforms.

4.2 The Social Network: Staying Connected with Electronic Media

Today's teens are highly connected to their social networks, seek engagement and actively build and contribute to their growing on- and off-line communities. The campaign will therefore seek to leverage this connection to and valuation of social networks to create "viral vehicles" of communication through peer-to-peer messaging across a variety of the platforms. Not only are youths more likely to respond positively to outreach provided by other youths (than to that which is provided by other parties), but the capacity for a "viral" campaign exists within a program that actively seeks out peer-to-peer tactics. Additionally, this type of viral online campaign will also produce a tremendous return on investment regarding the scope of its reach.

The use of electronic communication and social media will also allow the program to regularly spread program messages on a continuous basis. Frequent message saturation and easy online access to participants will allow the program to ask for increasingly more involved levels of commitment and engagement. As a result of the interactive nature of online outreach, all other program components (paid advertising, in-person outreach, guerilla marketing, etc.) will be coupled with an opportunity for the audience member, if they are interested, to become further involved with the program online. In developing this e-engagement program, SGA recommends taking the following step-wise approach. The goal of the strategy described below is to first build off simple actions to grow into more complex efforts as the online movement gains momentum.

1. **<u>Building a Program Hub (Website):</u>** A campaign website should be developed to act as the "program hub", housing all relevant information, messages and ways to get further involved in the program. The site should remain consistent with the messages and branding of all advertisements and

Leveraging Existing Resources

By linking up with the Facebook pages of Contra Costa Clean Water Program, Sonoma County Water Agency and Santa Clara's Watershed Watch, the program could instantly leverage over 600 fans!

collateral material produced. As the program hub, it should connect users to other online campaign components such as the Facebook page, YouTube Channel and blog. To increase exposure, the page should also cross-link with relevant organizations to attract additional user traffic.

2. <u>**All a Buzz with New Media (Social Networking):**</u> While developing a website presence, the program should also start a Twitter and/or Facebook page to allow for a more continuous dispersal of program information and increased opportunity for audience engagement.
3. <u>**Virtual Soap Box (Blog):**</u> After developing the website and social networking tools, the program should start a blog where messages can be coupled with more extensive write-ups and user-generated content. Blogs also allow for the opportunity to reach out to audience members beyond those currently connected with the program, as their infrastructure includes the built-in capacity to push forward campaign messages through their viral network of readers and content-producers.
4. <u>**In the Loop (e-Newsletters):**</u> To quickly and efficiently foster youth involvement, BASMAA should develop an e-Newsletter that would be sent to individuals who provided their email address at community events or signed up for the Facebook page, for example. Email tends to be a less-popular medium among youth, compared to social networks like Facebook or Twitter. For that reason, we recommend using the email list as the secondary mode of communication with this audience for information that is most conducive to this medium (e.g., clean-up tool kit, BASMAA youth panel application form).

<u>Figure 7</u>

The Extraordinaries are a San Francisco-based group whose mission is to get people to volunteer whenever it's convenient. Mixing social media technology with cell phone accessibility, All the volunteer needs is The Extraordinaries' free iPhone app to get involved.

5. <u>**Not Your Average Text (Text Messaging)**</u>**:** Given the amazing prevalence of cell phone usage among teens, text messaging has become a vital vehicle of communication. The program should capitalize on this opportunity by creating a simple SMS text-message campaign, where participants on the distribution list would receive periodic texts notifying them of important program happenings

Figure 8

Transport for London's "Awareness Test" viral video strikingly demonstrates how easy it is to overlook huge details – like the moonwalking bear that glides across the background, somehow below the radar of the average video before the pause and replay. This government- funded public awareness video has garnered an astounding 12 million + views. Check it out: http://bit.ly/cvKlQk

and time-sensitive events, or we recommend that the program plug into or create systems that allow youth to easily volunteer in their community.

6. **The Inner Spielberg in All of Us (YouTube/Viral Videos):** After building out a basic social networking framework, the program should then move to the development of a program YouTube Channel. BASMAA will need to create an online video strategy that positions its YouTube channel as its primary vehicle for video advertisements, thereby replacing costly television ads. The "YouTube ads" will be made up of videos that are edgy and engaging in the hopes of making them go viral, thereby activating the peer-to-peer information sharing and giving the program added credibility. The YouTube channel will also allow the program to quickly and easily post videos captured at outreach events and beach clean-ups.

7. **You've Gotta Give a Little, to Get a Little (Strategic Online Partnerships):** In building the campaign's credibility among the youth audience and growing its e-community to disseminate messages, the program should seek to develop a broad coalition of online support. To accomplish this, the program should identify related blogs, Facebook and Twitter pages, websites and YouTube channels, and regularly provide comments, respond to posts, provide expertise and/or share relevant articles. Collectively, these efforts will feed the larger effort by providing a mechanism for program messages to reach the wider audience and grow credibility through this cost-efficient "word of mouth" capacity.

4.3 Strategic Partnerships

Developing strong relationships with local community groups, businesses and organizations will be important in the successful execution of the campaign. To effectively reach and influence youth populations, the program should seek stakeholder input and assistance across a number of key objectives, including: (1) refining program messages, (2) identifying message distribution channels, and (3) leveraging their own networks to distribute messages. In addition to providing insights, partnering with trusted local organizations and businesses also offers a number of built-in channels to engage the target audience, build off partner networks and develop trust and legitimacy in the youth community. In seeking out potential partners, the program should develop a central list identifying these key organizations, which would be added to the aforementioned contact database of program participants. Potential partners that will likely appeal to the relevant interests of the youth audience include:

1. **Established Youth Groups:** Reaching out to existing, well-established groups, comprised of and targeted to youth populations, would be the first set of organizations that the program should reach out to. As the low-hanging fruit, these groups would offer unparalleled exposure to the target audience, providing comprehensive networks through which messages could be distributed. In addition to being youth-centric to provide access to younger populations, each organization should also focus on interests relevant to the campaign, occupying the spaces where Acceptance Seekers, Young Adults and Green Crusaders may inhabit. These spaces might be organizations with a community or service focus, environmental groups and youth empowerment centers. More specifically:
   - High-school community service clubs
   - Local surfing teams
   - Youth-oriented outdoor adventure clubs
   - Youth empowerment centers and organizations, such as:
     - Oakland Youth Empowerment Center (http://www.youthec.org)
     - Santa Clara Valley Water District Youth Commission (www.valleywater.org/Newsletter/October2010/YouthProgram.aspx)
     - Alameda County & Berkeley's Mobilize project (www.mobilize.org)
     - Santa Clara County and Mountain View's Global Youth Connect (www.globalyouthconnect.org)
     - Bay Area's Alliance for Climate Education (www.acespace.org)
2. **BASMAA "Youth Panel":** The program is also advised to develop a Youth Advisory Panel to engage the target audience, build off panel member networks, foster trust and legitimacy in the youth community, and provide insight on BASMAA with regard to program messaging and distribution tactics. Participation in the panel would be positioned as a volunteer opportunity when presenting the idea to youths and school districts. To get the panel off the ground, the program may need to conduct several school presentations to recruit candidates, accompanied by an application. Ultimately, the panel would consist of a diverse group of representatives from high schools across the various Counties. Long-term plans for the panel includes projects that are initiated by BASMAA and then disseminated through the various areas by panel members (e.g., start a conservation group at your school, adopt a sea lion program, install a rain garden on your campus, etc).
3. **Schools, Universities and Educators:** Figurative "youth beehives," places of education are natural partners for the program to engage in reaching the target population. Reaching out to area high schools will be a necessary step in recruiting potential "Youth Panel" members, in addition to reaching established college and high school clubs and organizations. Beyond reaching individual students or key organizations, local high schools and universities should be viewed as strategic partners in spreading BASMAA's anti-litter message. In developing these strategic partnerships, the program should establish relationships with educators at high schools and institutions of higher learning. Through these partnerships, teachers and professors would act as conduits in reaching the target youth population.

LEVERAGING EXISTING RESOURCES

Working off Santa Clara's Zero Litter Initiative could be a great way for the program to build exposure, while also factoring into wider policy issues.

4. **Conservation Groups:** In seeking out partnerships with environmental organizations, it is also important to ensure that these groups are involved or are at least seen as credible within the target youth audience. A sample list of potential organizations include:
   - Sierra Club
   - Save the Bay
   - Surfrider Foundation
   - San Francisco Estuary Partnership (www.sfestuary.org)
   - North Bay Watershed Association (www.nbwatershed.org)
5. **Commercial Business Partners:** Partnering with highly youth-trafficked local businesses would build exposure, credibility and leveraged resources. For example, developing partnerships with businesses may allow the program to request donations from them to be used as incentive prizes during contests. Some of the businesses (e.g., small music venues, coffee shops) may also post program posters and materials where their patrons could see them. Potential business types include:
   - Independently owned clothing boutiques and vintage stores located in areas with a high volume of foot traffic within the 16-24 age bracket
   - Fast-casual restaurants and juice bars, particularly eco-conscious institutions
   - Coffee shops and tea houses
   - Small music venues
   - Professional sports teams

LEVERAGING EXISTING RESOURCES

The program could leverage existing strategic partnerships with businesses already participating in the Watershed Watch Discount Card.

4.4 Community Events

Community events offer a unique opportunity for the program to directly engage with the target audience and qualitatively assess how campaign messages are being received. Community events also offer a significant opportunity to collect critical contact information to feed the larger social-media effort. Mirroring the strategy used to identify potential partners when selecting community events, the program should target those catering to the interests of the target population, which include:

1. **Conservation, Water Quality and Environmental Events:** Potential events might include the Berkeley Earth Day Celebration, which has been widely popular for over 40 years (www.bayareaearthday.org/berkeleyearthday/index.html) or the Bay Area Environmental Education Resource Fair (www.baeerfair.org/).
2. **Youth-Focused Events:** Like environmental fairs, there are a number of youth-focused events to choose from in the Bay Area. A few examples include the iconic, 100-year running Bay to Breakers (http://baytobreakers.com/), as well as San Francisco's famous Lovefest Parade (www.sflovevolution.org/home.php).

LEVERAGING EXISTING RESOURCES

Litter campaign messages and materials could also find their way into environmental events and fairs that various counties are already staffing as per the NPDES permit.

4.5 Paid Advertising

The use of traditional paid advertising should be limited to highly targeted outlets that ensure the eyes and ears of our target population. These venues include:

Figure 9

This bus shelter ad from United Way speaks to youth to really get the point across: "This doesn't really stink but the consequences of teen pregnancy do. And this is just part of the ugly mess you'd be getting yourself into. Get the facts at babycanwait.org"

1. **Niche Outlets:** Print advertisements should be limited to targeted, niche publications that boast high rates in youth readership and inexpensive ad placements, such as San Francisco Weekly and high school and college newspapers, yearbooks, concert programs/booklets.
2. **Online Ads:** Since the majority of teens consume the majority of their information online, a large percentage of ads should be placed in highly youth-trafficked sites such as Facebook and sparknotes.com. Online advertisements should also be placed in spaces that are near in both location and frame of mind to the desired behavior. For example, the program could create online placements that appear during Google searches, using specific search terms like: "beach clean-ups" and "Bay Area".
3. **Outdoor Ads:** Ads could also be placed in targeted youth-populated outdoor locations, such as pro-bono bus shelters placements, beach and city trash bins, and park benches. Outdoor ads should be used sparingly to supplement the rest of the advertising campaign. Layouts should be direct and edgy in order to capture the audience's attention.
4. **Guerilla Ads:** To increase program exposure and engagement, the campaign could develop a series of innovative ads placed in unexpected locations. For example, the program could place advertisements in bathroom stalls at relevant locations such as music venues, coffee shops, parks and bars. To make the connection between littering and its effect on marine water quality, the program could commission a local artist to create a series of water stencils with appropriate messaging around storm drains throughout the region.

Figure 10:

Water stencils don't only provide free ad space in high-traffic areas, but they offer a powerful mechanism to tie the message directly to the location of the target behavior. Producing images related to the effects of littering at the exact locations where littering occurs, such as by storm drains or on the street, acts as a prompt for the individual to think twice before discarding their trash.

4.6 Earned Media

Earned, unpaid media offers a number of opportunities to supplement the larger campaign, and in the case of the electronic media, to drive engagement. Reaching out to targeted media outlets also allows for increased program exposure at little cost. In building the media outreach campaign, the program should engage in the following three-pronged approach:

1. **Reach Out to Youth Journalists:** Ideally, the campaign should reach a point where the majority of messaging is coming from the youth themselves. Staying aligned with this principle, the program should seek out youth correspondents from major newspapers as well as student journalists in high schools and colleges so that campaign coverage is driven by the audience's peers.
2. **Connect with Online Bloggers:** Numerous online bloggers have developed enormous credibility and popularity—and occasionally cult status—within their respective communities. To generate program buzz and build legitimacy, the program should connect with prominent bloggers active within the Bay Area youth generation and environmental blogospheres.
3. **Organize Press Conferences:** To promote areas of note, such as youths creating artistic stenciling of catch basins or significant achievements such as awards, the program should organize press conferences to attain broader media coverage and attention.

LEVERAGING EXISTING RESOURCES

Media outreach should be in sync with BASMAA's already- existing media relations push.

5. MAKING THE GRADE: EVALUATION APPROACHES

A Note About Our Approach

At SGA, we've come to rely on the term Outreach:ology to convey the unique way we approach public education. Outreach:ology (i.e., the science behind behavior change) uses a blend of Community-Based Social Marketing (CBSM) and proven tactics from social psychology and persuasion in order to influence the behavior of the target audience. CBSM focuses first on identifying the barriers and motivators of the target audience (see Literature Review, page 4), and then on finding ways to lower the barriers and increase the motivators. Social psychology allows us to use research from prominent leaders in the academic field who have tested and found tactics that work in influencing a person's behavior. By using both social psychology and CBSM as the backbone of the approach, SGA has proposed strategies throughout the plan (e.g., power of commitments, peer-to-peer communication, action-oriented messages, etc) that are all included as a result of their proven success in persuading people to change their behavior. Because these types of strategies have proven success, SGA recommends monitoring the audience's participation (instead of their awareness) as one of the campaign's primary metrics for success. For example, getting a youth to take an online pledge would be more valuable than finding out that said youth is aware of the difference between storm drains and sewers.

What Numbers Should Be Tracked for Success: Recommended Measures

In order to reflect the strategies proposed in the plan, the table below reflects which outreach tactics should be measured quantitatively. Specifics regarding what goals should be reached (e.g., 50 Facebook followers) will be more clearly articulated in the implementation plan.

Campaign Component	Evaluation Metric
Paid Advertisements	• *Number of impressions per advertisement*
	• *Number of interactions as a result of advertisement (e.g., if the ad encouraged the viewer to play a game, take a quiz, etc)*
NonTraditional Word-of-Mouth Marketing	Branded Promotional Products
	▪ *Number distributed* ▪ *Number requested*
	"Fun-Factor" Public Happenings
	▪ *Number of impressions (media coverage, tweets, etc)*
Electronic Media	Social Networking (Facebook and/or Twitter)
	▪ *Number of "friends" or "fans"* ▪ *Number of interactions (e.g., posts/comments) from target audience*
	Website
	▪ *Number of unique visitors* ▪ *Number of page views*
	Blogs
	▪ *Number of posts by program on external blog sites* ▪ *Number of comments to posts by program on external blog sites*
	e-Newsletter
	▪ *Distribution number* ▪ *Open rate* ▪ *Number of article click-throughs* Viral Videos ▪ *Number of video submissions* ▪ *Number of total views across all videos posted* ▪ *Number of channel subscribers & comments* Texting Campaign ▪ *Distribution list*
Earned Media	• *Online news placements* • *Print news placements*
Strategic Partnerships	BASMAA Youth Panel ▪ *Number of members* ▪ *Number of interactions (meetings, events attended, etc)* • *Number of partnerships with related organizations/schools/businesses, etc* • *Dollar amount of total annual donations from local business partners*
Community Event	• *Number of eNewsletter sign-ups received at events*

Learning from Mishaps and Successes: Monitoring and Adjusting

The most effective outreach plans are those that are able to be malleable and adjust tactics as needed. In terms of the overall strategy, periodic evaluations should be done at least once a year to allow the program to take a step back and assess what's working (and do more of that) and what's not working (and figure out how it can be improved). On a more tactical level, adjustments should be occurring on an ongoing basis. Because a good chunk of the plan focuses on online outreach, this comes with the added benefit of an ongoing evaluation component. Programs like Facebook, eNewsletters, etc., all produce statistics to see which posts are popular and which emails people are opening and not opening. This encourages a continuous stream of automated monitoring that would allow the program to optimize it's rates of online engagement and success by simply giving their users more of what they want.

Pilot testing programs are also a means of assessing effectiveness before they are implemented on a large scale. Pilot testing is best used when conducting "on the ground" outreach programs. That is, programs that involve face-to-face contact like the store outreach being done for the Our Water, Our World program. Because of the geographic area of BASMAA, face-to-face outreach was not included as an integral part of this plan due in part to the budget and the fact that the strategic plan was written to comply with the MRP's advertising requirement. However, for some components of the plan (e.g., Youth Panel), pilot testing is feasible and recommended as a way of seeing what works and what doesn't—before rolling it out on a larger scale.

To Ask or Not to Ask: Self-Reported Surveys

SGA is aware that one of the MRP's requirements is to do a pre- and post- campaign survey before and after the advertising buy. Because we are recommending that BASMAA veer away from traditional paid advertising buys, we are also recommending that this evaluation approach be adjusted accordingly. SGA's concern with self-reported surveys are as follows: (1) They tend to place an emphasis on knowledge and awareness. As we know from CBSM, the idea that knowledge equals behavior change is an erroneous one. Case in point: every smoker knows that smoking cigarettes is bad for their health, but does this stop them from smoking? For this reason, it is amiss to assume that simply because a teen knows that storm water is untreated, that they are going to stop littering; (2) They are self-reported and therefore are limiting in their ability to get candid answers from the participants; and (3) They can be quite expensive for little return. Administering these types of surveys is often costly, and the data that is received is not always actionable or of value to the program.

SGA instead recommends taking the following approach to self-reported surveys: (1) Stay away from focusing on questions related to awareness; (2) Rely primarily on the people collected in the program's outreach database (see page 27) as the means for getting survey data. The people who become part of the program can therefore be tracked and their progress monitored in terms of how successfully they are moving along the road to behavior change. This also minimizes program costs if the surveys are sent out and collected online; and (3) Only collect face-to-face surveys in conjunction with other programs and outreach initiatives the individual cities/counties are already doing as part of MRP compliance. For example, taking surveys to a community event and doing them there. In this way, no added budget is spent in trying to collect survey data.

6. Down to Brass Tacks: Projected Budget

The next step with this strategic plan would be to make it come to life—implementation! Ideally, the implementation phase would include critical decisions such as which specific tactics and level of effort should be expended in the first year, second year, etc. The focus of the first year would be to collect as many program supporters as possible (i.e., Step 1 and Step 2 from *Figure 3*) with the goal of continuing to engage them in subsequent years of the program. For this reason, Year 1 of the campaign would operate more like a traditional advertising campaign in that there will be a good amount of paid ads. As the campaign progresses and goes viral (i.e., peers sharing with peers),paid advertising will cease to be the focal point of the campaign, and the monies being dedicated to it below will instead be used for other tactics highlighted in the plan (e.g., fun factor happenings, viral videos, social media, etc). Specific about the program budget will be outlined in the implementation plan.

Bay Area Stormwater Management Agencies Association

Five-Year Strategic Advertising Plan
"Our Water, Our World" Pesticides Program

Plan Submitted: March 28, 2011

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CREATIVE MESSAGING • BEHAVIOR CHANGE • STRATEGIC PLANNING • REGIONAL EFFORT • WATER QUALITY

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To BASMAA Committee & City Folks,

BASMAA has a long history of successfully administering the Our Water, Our World program. The campaign is primarily focused on building relationships with home improvement stores and garden centers in order to arm consumers with information about how to choose less toxic pest alternatives.

This strategic plan is therefore intended to supplement much of the on-the-ground outreach that is already taking place with the Our Water, Our World program and introduce a strategy that covers both a sustained way of engaging and tracking the target audience as well as a proposed approach for implementing an advertising & online outreach campaign.

Because of the somewhat complex nature of Integrated Pest Management (IPM), change is not going to happen overnight. A person is likely not going to go from buying a can of Raid to embracing the four-step IPM continuum in a snap. Because of this, SGA recommends taking the foot-in-the-door approach. Study after study has proven that people are more likely to embrace a desired behavior if you ask them to do a little at a time ("Foot in the Door Technique", Wikipedia: http://en.wikipedia.org/wiki/Foot-in-the-door_technique). Susie Gardener may start with buying a less toxic product and then she might learn how to identify harmful and beneficial pests and then maybe start integrating plants that attract more beneficial bugs, etc, etc. Each person's journey may look different, but the end goal is the same – get people on the road to IPM by starting with small requests and slowly making them bigger.

Meeting, Knowing and Listening to the Audience

In order to get people on the road to IPM, BASMAA needs to start tracking the program audience. This would allow BASMAA to do some gentle prodding by encouraging people down the road, but it would also provide the program with the invaluable opportunity to collect stories. The stories of the audience themselves should be the face of the campaign in anything from advertisements, to media pitches, to program handouts. The art of storytelling adds credibility to any message and allows the audience to hear tips from people they identify with - their peers and neighbors.

A Tale of Two Audiences

The Our Water, Our World program has traditionally focused on do-it-yourselfers (DIYers) who are dealing with pesticide issues on their own. The strategic plan includes the DIYer audience, but it also suggests that BASMAA consider the domestic outsourcers (DO) group.

Domestic outsources are the folks who have a pest issue but would rather just pay someone else to take care of it by either asking their landscaper to do it or by hiring a pest control company. SGA recommends that BASMAA target this audience by providing more visibility, to them as the consumer, about landscapers and pest control operators that have received eco certifications (e.g. Bay Friendly

Landscaping and Eco Wise Certified). There are a number of organizations in the Bay Area that provide certification to both landscapers and pest controllers in less toxic pest management strategies and BASMAA would nicely be able to supplement these efforts with some positive exposure for the certified businesses.

<u>Getting the Audience to Take an Action</u>

All facets of the Our Water, Our World program should be working in tandem to get the audience on the road towards IPM. Less toxic products and very specific pest control solutions (e.g. baits for ants) are easiest and should therefore be considered the low hanging fruit. These are the types of foot-in-the-door allures that BASMAA would use with the audience to initially get them involved in the program.

Because the purpose should be to get people involved in the program, in a long lasting way, the advertising campaign should be no exception. The ads should be driven by real stories and they should pointedly ask the audience to take some type of action (e.g. try our coupon, enter our contest, sign up for our newsletter, etc). In all cases, the strategic plan recommends placing ads in locations and outlets that are specifically targeted to the audience so that dollars are not wasted reaching audiences who are not affected by the message.

While the ads may help get the program exposure, it is the online media that will really keep the fire going. Online media helps to keep the audience involved, invested and doing something. The online space also allows for peer-to-peer sharing, message distribution and a geographic reach wide enough to cover all of the counties involved in BASMAA simultaneously.

In short, the following strategic plan embraces some key principles. Engagement and commitment are the keys to changing behavior. Stories are the program's most powerful tool. Integrated Pest Management is a journey – start simply and build to there.

Thanks for the opportunity to work on this. Happy reading!

Sincerely,

Erica Hooper

Table of Contents

I. Literature Review

1. Introduction

This literature review is meant to inform the development of BASMAA's five-year strategic marketing campaign, key messages and distribution channels. This study aims to reveal the motivators and barriers related to homeowner and renter pesticide use and misuse throughout BASMAA's eight counties including: Alameda, Contra Costa, Fairfield-Suisun, Marin, San Mateo, Santa Clara, Sonoma & Vallejo. Additionally, the review examines communication tactics focused primarily on traditional advertising approaches used to target adult homeowners about their pesticide use. By uncovering the barriers and motivators associated with the proper application of pesticides, BASMAA's current pesticide program — "Our Water, Our World" — can be better refined and expanded by developing outreach tactics that speak to these specific barriers and motivators. The program will also gain valuable insight about preferred methods of communication when disseminating pest control and integrated pest management messages.

The importance of identifying an audience's barriers and motivators in encouraging certain types of behaviors is a central tenet of Community-Based Social Marketing (CBSM). This approach focuses on analyzing the perceived barriers and benefits associated with the target behavior that the assessor aims to promote. By developing a complete understanding of what would limit the target population in engaging in the desired behavior, the assessor can create mechanisms in the intervention that overcome or remove these perceived barriers (Alcalay and Bell 2001; Neiger, Thackery, Merril, Miner, Larsen and Chalkey 2001; Walsh, Rudd, Moeykens and Moloney 1993).

The following literature review will discuss an array of barriers and motivators that have been identified in previous studies. All of the studies cited in this review analyzed public participation practices and tools with respect to surveys of residential pesticide use behaviors in Northern California as well as California Integrated Pest Management (IMP) and awareness programs. The results of these similar programs will provide an actionable context in developing a strategic advertising campaign to complement the current "Our Water, Our World" campaign.

2. Barriers & Motivators Associated with Pesticide Use

In developing this literature review, several barriers were identified with regard to adult homeowner pesticide use in Northern California. One of the most prominent barriers to the proper application or reduction of pesticide use was an overall lack of knowledge regarding (1) responsible pesticide usage, (2) non-toxic alternatives, and (3) the detrimental effects that these chemicals have on environmental and human health (Flint 2003; Matheny 2009; Brosseau 1999). For example, a 2005 awareness and effectiveness study of the "Our Water, Our World" campaign indicated that 45% of the people were unaware that there were less-toxic, safer pest control products available in the marketplace. Additionally, in a 2003 evaluation of the "Watershed Watch" campaign, a series of focus groups revealed that most participants were not aware that pesticide use, especially within the home, adversely affects water quality (Evans/McDonough Company, Inc. 2003).

However, lack of knowledge is only one of the many barriers that may deter homeowners from engaging in a sustainable behavior. While attitudes and knowledge have been demonstrated to relate to behavior, frequently this relationship is extremely weak compared to the plethora of social, economic and cultural factors that are at play when individuals make environmental decisions (McKenzie-Mohr 1999). This correlation between knowledge and behavior change has been demonstrated across several studies, including an evaluation of the San Francisco Public Utilities Commission's "Grow It! And Control It!" program (Godbe Research Gain Insight 2005). The evaluation showed that even when homeowners had recently been exposed to information about the relationship between pesticides and water quality, approximately 75% of those same homeowners did not adopt more responsible pesticide use behaviors (Flint 2003).

This pattern of behavior reveals that while lack of knowledge is a barrier to thoughtful pesticide use, knowledge alone does not necessarily predicate the desired actions. To raise awareness in such a way that the individual's increased knowledge base translates into behavior change; more focus should be made on the specific actions that can be taken to achieve the desired results (Flint 2003).

2.1 Stick to Clear & Simple Messaging

A fundamental step in crossing the divide between awareness and behavior change is utilizing targeted and effective messaging. The markers of effective communication are numerous; however, two of the most important characteristics are clarity and simplicity. To achieve behavior change, the desired actions associated with the plan must be effectively and explicitly communicated to the target audience. This necessity for clear, simple and actionable message points regarding the proper use of pesticides is evident in a 2003 survey of over 3,200 Northern California residents. One of the questions in the survey asked "Do you follow (pesticide) label directions?" — To which 33% responded "No" (Flint 2003). This result was echoed in a related study examining the differences between residential and commercial pesticide use. Survey findings highlighted that households are generally less likely than farmers to use pesticides, read labels and take precautions (Templeton 1998).

Programs across the country have also identified this challenge and have developed several recommendations in crafting clear and simple message points to encourage responsible pesticide use. For example, a study evaluating the Watershed Watch Campaign prepared for the Santa Clara Valley Urban Runoff Pollution Prevention Program revealed that gardeners were receptive to reducing pesticide use under the condition that specific and actionable recommendations are provided (Evans/McDonough Company, Inc. 2003).

This finding demonstrates that messages should clearly answer the basic question: What is the desired action? Additional academic research supports this claim, finding that messages that are clearly articulated are more likely to be comprehended and abided by than those that are more complex (Brunetti Tomasik and Taraba 2000; Regger, Wootan, Booth-Butterfeild and Smith 1998). Incorporating these recommendations in the current work, the campaign may consider determining and prioritizing the top three pesticide best practices that would have the largest pollution prevention impact and focus advertising messaging and outreach exclusively on those key steps.

2.2 Demonstrate Convenience & Direct Benefits

People are most willing to undertake relatively “cheap” activities, in the sense that they require few major behavioral changes or relatively small investments of time or money. As a result, the advertising campaign should demonstrate to consumers that proper pesticide or integrated pest management (IPM) use is not only “quick and easy,” but directly benefits them in some way. For example, a Santa Clara Valley Urban Runoff Pollution Prevention Program affirmed that communications promoting a specific behavior change should emphasize minimal effort required and personal benefits accruing from the action (Fairbank, Maslin, Maulin & Associates, 1999). Similarly, a study evaluating home gardener preferences and behaviors associated with pest management strategies found that homeowners and gardeners indicated a strong desire to use a pest control method that was easy to use, but when factors such as harm to humans or the environment were incorporated into the scenario, the broad majority also desired to use the method that would impose the least amount of harm (Matheny 2009).

Oftentimes, convenience is simply a matter of perception, as opposed to a reflection of reality. As a result, the convenience barrier can be successfully overcome through targeted messages. For instance, homeowners considering a transition from the use of conventional pest control products to integrated pest management methods (IPM) have anecdotally suggested that they will often choose to utilize a “simple” pesticide solution rather than IPM approaches. This demonstrates a preconceived notion that IPM strategies may appear inconvenient, costly and difficult to adopt (Matheny 2009). Similarly, McKenzie-Mohr points out those external barriers such as the “inconvenience” of adopting IPM strategies “are to some extent a matter of perception” because “after people have experience with an activity, they often come to see that activity as being more convenient than when they first began.”

2.3 Combine Motivating Messages with Visual Images

Communications campaigns have demonstrated that utilizing tangible visual images can be extremely influential in not only creating awareness, but changing behavior (Horn 1999; Roam 2008). The text-heavy nature of many public engagement and/or environmental campaigns often results in a “shut-down effect,” where community members are simply overwhelmed by the number of messages to which they are exposed (American Dietetic Association 1995). To this effect, a picture is really worth a thousand words, particularly in the information age, where individuals are constantly bombarded with complex information. Utilizing effective visual images can therefore be very successful in communicating program messages.

Through examining the “Our Water, Our World Promotional Awareness and Effectiveness Study” conducted for BASMAA in 2005, the top motivators to buy a less-toxic product for people who were planning to do so on the day they were interviewed were: “Health and Human Safety” (51%), “Environmental Concern” (46%) and “Pet Safety” (44%). Of the participants who were *not* planning on buying a less-toxic product, “safer product method” was still the top motivating factor (45%). The program’s key messages would benefit from emphasizing these behavioral drivers: human, pet, and environmental health and safety, preferably through visual, non-text-heavy formats. The Watershed

Watch Campaign survey prepared for Santa Clara Valley noted that focus group participants did not respond well to stormwater materials that were too text-heavy and did not clearly state the issue (Evans/McDonough Company 2003). Thus, program messages and advertisements should focus on the aforementioned behavioral motivators through a visual format.

2.4 Keep It Personal: Tailoring Materials to Your Target Audience

After developing a strong understanding of the target audience, advertising messages and materials should speak to the specific attitudes and beliefs of the target population to increase participation. Adding a "personal touch" to the outreach materials by tailoring them to the target audience — in this case, homeowners and gardeners — and relating the information to what the audience already knows could encourage participation by increasing the impact of the message (Schultz and Tabanico 2008).

2.5 Utilize Prompts

Prompts, or images or phrases that serve as an aid to remind people to perform an activity, can be powerful behavior-change tools. A trait almost every person possesses is forgetfulness, which is why prompts are so useful. People oftentimes overlook sustainable behaviors, not for lack of motivation, but simply for forgetting. With the help of prompts people are more likely to engage in a particular behavior, as they are provided with a reminder to do so. For a prompt to reach its pinnacle of effectiveness, it should be delivered as close in space and time as possible to the target behavior. Prompts are also typically most effective when they are used to reinforce overall campaign efforts and messages, as opposed to acting as a stand-alone piece.

2.6 Utilize Person-to-Person Contact to Distribute Materials

Numerous studies have demonstrated that personal contact is the most powerful outreach mechanism in influencing individual attitudes and behaviors (McKenzie-Mohr and Smith 1999; Neiger *et al*. 2001; Schultz 2002; Schultz and Tabanico 2008). The absence of meaningful person-to-person education can act as a substantial barrier to behavior change. In motivating employees to adopt sustainable waste reduction practices, the Waste Board (2004) suggests utilizing personal channels to change behavior through the use of such resources as employees or trained volunteers. For the current program, garden supply and home improvement store employees could be utilized as message conduits as they are regularly on the communication front lines by engaging with homeowners on a daily basis. As such, it is imperative to educate employees on the proper use of pesticides and non-chemical alternatives as they relate to stormwater pollution prevention (Flint 2003).

A 2003 survey on residential pesticide use in Northern California showed that retail staff is a vital information source, and that better education initiatives among this group could greatly extend program messages (Flint 2003). A number of Southern California stormwater programs with a focus on smart pesticide use integrate one-on-one trainings with garden supply and home improvement store employees. Staying true to these values of person-to-person outreach, BASMAA's current "Our Water, Our World" campaign's direct outreach efforts fulfill the need of this critical behavior-change tactic.

2.7 Involve Employees & Forge Commitment

When building buy-in, it is important to forge collaboration and consensus. This principle applies to nearly any public participation program, as noted by the University of British Columbia's (UBC) research on developing sustainability strategies within organizations (2006). Forging ownership and commitment is one basic criterion in encouraging participation. However, one's level of commitment to the program is of course secondary to the elemental prerequisite to "getting people 'on board' with change" (McKenzie-Mohr 1999). To this effect, studies have shown that the simple act of asking for someone's commitment actually encourages that person to participate in the voluntary program or behavior. For example, "individuals who were asked to wear a pin publicizing the Canadian Cancer Society were nearly twice as likely to subsequently donate than were those who were not asked to wear the pin" (UBC 2006).

There is a multitude of ways to ask for this commitment: through verbal or written pledges, or by requesting public commitments by publishing the participant's name in a newsletter or annual report (McKenzie-Mohr 1999; UBC 2006). With this in mind, it would be valuable for "Our Water, Our World" to consider the use of public pledges to encourage responsible pesticide use.

3. Barriers & Motivators: Review

Identifying & Overcoming Barriers	
Barrier	**How to Overcome**
• ***Lack of knowledge*** regarding: (1) responsible pesticide usage, (2) non-toxic alternatives, (3) the detrimental effects that these chemicals have on environmental and human health	• ***Increase knowledge*** of pesticide usage best practices, non-toxic alternatives, and negative effects of pesticides to environmental and human health
• Pesticide use/application messages/directions are ***complex*** and ***confusing*** (i.e. spray-can labels)	• Keep messages ***clear*** and ***simple***. Messages should be ***direct*** and ***focused*** on answering the following questions: *What is the desired action, and why is it important?* • Use ***visual images*** to convey messages, as opposed to complicated text-heavy formats that may otherwise result in a "shut-down effect"
• Proper pesticide use/IPM is ***difficult to implement***, ***time-consuming*** and ***inconvenient***	• Demonstrate to consumers that proper pesticide use is not only "***quick and easy***," but ***directly benefits*** them in some way (through financial savings, etc.)
Identifying & Utilizing Motivators	
Motivator	**How to Utilize**
• ***Ownership*** of a cause and ***commitment*** to furthering the goals of a cause (in this case, responsible pesticide use)	• Ask store employees to sign ***commitment letters*** to remind customers of responsible pesticide use • Integrate a ***pledge*** or ***honor badge*** into the promotional effort to showcase a consumer's thoughtful dedication to gardening smart
• Concern for ***human health*** and ***safety***	• Demonstrate through messaging that proper pesticide use ***protects*** human health, pet safety and environmental integrity
• Concern for ***pet health*** and ***safety***	
• Concern for the ***environment***	

How to Get Messages Across
• Tailor materials to target audience: A***dd a personal touch***
• Utilize ***prompts*** to remind people to practice responsible pesticide use
• ***Television*** advertisements are an effective means to reach the target Northern California pesticide-using population
• Train garden supply and home improvement ***store employees*** to deliver program messages

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II. Pesticides: Anatomy of a Message

1. The Source---*Who is the Message From?*

The “Our Water, Our World” brand.

2. The Issue---*What is the Issue We are Promoting?*

From the eyes of the program, the issue that we are promoting is the need to reduce or eliminate the use of toxic pesticides in or around the home — but to the consumer, the issue is the need to protect human and pet health against toxic pesticide use.

3. The Action---*What is it we are asking them to do?*

Since there are two audiences in this campaign, it would follow that there would be two specified actions. The two audience groups are: (1) Do-It-Yourselfers (DIYers) who control pests in and around their homes themselves; and (2) domestic outsourcers who hire sustainable landscaping companies or pest control operators to accomplish this task for them. For the DIY group, the desired action is to encourage their purchase and use of less-toxic alternatives to regular pesticides. For the domestic outsourcing group, the desired action is to hire sustainable agricultural pest controllers or sustainable landscapers, hereafter referred to as “contractors,” and/or ask their current contractors for sustainable services (i.e. the use of IPM and/or less-toxic pesticide alternatives).[1]

For both groups, the focus during the initial phase of the program would be first on the action of purchasing/using less-toxic products and/or services. After obtaining this initial commitment, the second phase would be to focus on introducing the adoption of Integrated Pest Management (IPM) strategies including non-toxic pest control options. This second phase, and all consequent ones, could be accomplished by delivering targeted messages to consumers who already purchased less-toxic products or interacted with the “Our Water, Our World” program. These consumers could be tracked, for example, via a coupon redemption program for less-toxic products where the consumer is required to include an email or mailing address. These consumers could then be reached for phase two either electronically or through direct mail.

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[1] Certain key terms should be field testing during the message development phase of the campaign. For example, the terms “less-toxic pesticide alternatives” and “sustainable landscaping services” should be tested to ascertain the audience’s understanding of these phrases, in addition to identifying the most easily and commonly comprehensible terminology to express these ideas.

A quick note about the action: Research has shown that asking people to first take a simple action and then incrementally building commitment is the most effective way of achieving behavior change.[2] This approach especially rings true of practices such as IPM, which can be somewhat abstract and more complicated than just spraying a can of bug killer. IPM should be seen as the end of a journey vs. the "hook" that will get the majority of the audience interested in the campaign.

4. THE BRAND---*WHAT IS THE OVERALL, OVERARCHING IDENTITY OF THE CAMPAIGN?*

The identity of the campaign, like the source, will be the Our Water, Our World brand.

As a brand, "Our Water, Our World" will identify the campaign via name, logo, design and aesthetic, and will create a link between the campaign's identity and how it relates to the target audience. The brand is what creates the campaign's image, or the symbolic construct created within the minds of the target audience, consisting of the sum total of information and expectations associated with the campaign.

5. THE FACE---*WHO/WHAT WILL BE THE "FACE" OR THE AMBASSADOR OF THE CAMPAIGN?*

The outward face of the campaign, or the message ambassador, is the target audience themselves: everyday homeowners, trusted neighbors and fellow household gardeners. When it comes to household products and domestic fixes, people trust referrals from people like themselves.

The "face" is distinguished from the "brand" such that the face comprises only one facet of the larger campaign identity.

6. THE ANGLE---*HOW WILL THE CAMPAIGN BE PRESENTED?*

The angle, or how the campaign is presented to the target audience, will focus on two themes: health and a singular action. The primary angle will be slanted towards the protection of human and pet health. Based on the literature review, concern for one's family's health and one's pet's health were the primary motivators for reducing the use of toxic pesticides. As a result, the overarching angle will be slanted toward this emotional appeal.

The secondary angle will focus on promoting a singular action: using less-toxic pesticide alternatives and hiring sustainable contractors. The campaign may also want to consider the use of a "gateway pest," something that is common such as ants, in order to get people initially interested and involved in the program. In the initial stages, especially for the advertisements themselves, simple is always better! As the campaign progresses and evolves, additional singular actions will be promoted through direct marketing (e.g. email, story bank, etc.) to guide the audience along the path of a more holistic IPM strategy.

7. KEEPING IT RELEVANT---*HOW WILL THE CAMPAIGN MAINTAIN A CONNECTION WITH THE TARGET AUDIENCE?*

[2] "Foot-in-the-Door Technique" *Wikipedia: The Free Encyclopedia*. Wikimedia Foundation, Inc. Web. 23 Feb. 2011. http://en.wikipedia.org/wiki/Foot-in-the-door_technique (see the scientific studies cited in the article's footnotes).

To maintain a connection with the target audience, the campaign will partner with Home Owners Associations (HOAs), garden supply stores, home improvement stores and the like to both inform the development of the campaign and deliver its messages. The campaign's story bank (see Page 15*)* will also provide an opportunity to stay connected with the actual target audience, both the good and the bad.

III. Five-Year Pesticides Marketing Strategy

1. The Big Picture: Communications Strategy Goals & Objectives

The overarching goal of the following advertising campaign strategy is to encourage the target population to use less-toxic pesticide alternatives in and around their homes, complementing the current "Our Water, Our World" (OWOW) campaign. These less-toxic alternatives include the use of less-toxic products, the practice of Integrated Pest Management (IPM) as well as the utilization of sustainable agricultural pest controllers, hereafter referred to as sustainable contractors. By promoting specific action-oriented messages, the campaign will be better equipped to successfully mold the behaviors of the target population, as opposed to simply raising awareness about the use of less-toxic pesticide alternatives.

2. Nice to Meet You: Identifying & Tracking Your Audience

Targeting messages to specific audience groups helps conserve finite program resources by focusing efforts on those groups who engage in the target behavior most frequently (i.e. using toxic pesticides). By refining marketing efforts and messages to a well-defined subset of the larger population, the program will be able to target resources more efficiently while also strengthening the impact of the message through this tailored approach.

Leveraging Existing Resources

Start the database by collecting emails and names from all of the contacts that have been made through the existing garden programs in the various cities.

The target audience for this campaign is composed of adult homeowners residing in the eight Bay Area counties participating in BASMAA. This general audience has been further refined into two subgroups: (1) Do-It-Yourselfers (DIYers), who control pests in and around their homes themselves; and (2) Domestic Outsourcers (DO), who hire pest controllers or landscaping companies to accomplish this task for them (hereafter referred to as "contractors"). In marketing to these two subgroups, the program will roll out two interconnected yet distinct outreach campaigns to increase the impact of the message.

As the plan below will describe, the campaign will allow for a significant degree of interaction between the program and the populace. Offering this opportunity for engagement provides a simple and cost-effective means for increased participation on the part of the audience member in addition to an increased opportunity for directly tracking campaign progress on the part of the program.

To track this participation and maintain engagement, the program is advised to build out a database for each target subgroup. The database should include the participant's name, mailing address, email address and the way the participant first came into contact with the program (e.g. an outreach event, coupon redemption program, etc.). In addition to general contact information, the database should also describe to what extent each participant has been involved in the project (e.g. participated in the coupon redemption program, provided a testimonial, etc.). The database should then record a follow-up action that should be taken for each participant (e.g. send email solicitation for testimonial, send coupon via mail, etc.) to automate and streamline interactions. Therefore, the purposes of this database are to:

1. **Target the Audience:** The database will allow BASMAA to reach the audience in the most targeted way possible by providing them with incentives and information that is specific to them. The more targeted we can make the correspondence (e.g. "Hey, Jill! We know that you've already tried a less-toxic pesticide product and we wanted to see if you had considered telling one of your fellow gardeners about our program."), the more effective the program is going to be (e.g. Jill passes on the message to her friend). Obama's online campaign did a great job of using this targeted marketing (see this article for more info: salon.com/news/feature/2008/07/16/obama_data).

2. **Build on Commitments:** By tracking participants' involvement in the program, BASMAA can continue to engage the participant by gradually asking for increasingly more complex commitments. If you introduce one commitment at a time, the request is seen as less onerous than if all of the changes were requested at once. Additionally, people typically change their perception of what a small commitment is compared to a large one depending on their point of reference. For example, if BASMAA were to ask participants to utilize an IPM strategy at the immediate onset of the program, participants might see it as too large of a commitment relative to their past efforts (presumably, nothing). However, if first asked to purchase less-toxic products, and then asked to engage in IPM, the latter commitment is viewed as less intensive given that we've changed the participants' point of reference by asking for a smaller commitment first.

3. **Allow for Strategic Outreach:** The database also provides the opportunity to easily grow and expand outreach efforts to include more personal, one-on-one interactions. For example, if the program wanted to grow the campaign to include "less-toxic pesticide parties" (like Tupperware parties, but for recommended products and IPM strategies) at residents' homes, BASMAA could easily organize this by utilizing the database to identify likely participants and hosts (e.g. by using the filter functions to search by zip code, engagement level, etc.).

4. **Track Engagement & Behavior Change:** By keeping track of the audience in a systematic way, BASMAA would have a way to truly track changes in behavior over a sustained period of time. Surveys and other evaluations would also be more cost-effective with a list of already established program participants.

3. In a Nutshell: Key Campaign Messages

3.1 Overall Messaging Strategy

As described above, specific messages and distribution modes will be differentiated across the two target populations; however, each strategy will share the same fundamental approach. This approach is characterized by Community-Based Social Marketing's (CBSM) stepwise process for behavior change as described in the literature review:

Phase 1. <u>Raising Awareness:</u> The campaign will begin with raising awareness regarding the adverse health effects for family members and pets associated with exposure to toxic pesticides through targeted advertisements and outreach.

Phase 2. <u>Changing Behaviors:</u> In addition to raising awareness about the issue, the program will also deliver a series of targeted, action-oriented messages to drive the adoption of desired behaviors.

Phase 3. <u>Produce Engagement:</u> To produce and continually engage both audience groups, the campaign will develop a feedback mechanism facilitated by electronic platforms such as email marketing and social networking sites.

Phase 4. <u>Maintain Engagement:</u> The aforementioned feedback mechanism will then be utilized to produce a "story bank" of testimonials, where real people share their experiences in their adoption of the desired behavior. Positive testimonials will then feed back into the messaging campaign to encourage others to engage in the promoted behavior change (i.e. using less-toxic alternatives or hiring sustainable landscaping companies).

> <u>Leveraging Existing Resources</u>
>
> **Many cities already have people who would be great program messengers. These people could initially be the "face" of the ad campaigns and then new people would fill the bank more organically as the program progressed.**

3.2 Specific Messaging Strategy for the Do-It-Yourself (DIY) Population

For both audiences, campaign strategy will follow the same basic stepwise approach as described above. However, each campaign will contain its own unique elements to ensure a tailored and impactful message. For the DIY population, the communications strategy will follow the process described below:

Phase 1. <u>A Call to Action Is Issued:</u> The advertisement's overarching message would encourage the purchase and use of less-toxic pesticide alternatives to protect the health of the audience member's family and pets; however, the call to action would include the promotion of a specific behavior that allows BASMAA to collect the participant's contact information. For example, the program could partner with a company like TerraCycle to provide a rebate or a coupon for a less-toxic pesticide within the ad.

Phase 2. <u>**Recipients Respond to the Call:**</u> Viewers of the coupon or promotion would then respond to the call to action by sending in their contact information (e.g. email address) to maintain and track their engagement in the program. For example, the participant would redeem their TerraCycle coupon by contacting the program, at which point they would provide their contact information to receive the discounted product. This incentive piece thereby serves the dual purpose of encouraging the adoption of the desired behavior (purchasing less-toxic products) while also providing a way for the program to collect contact information.

Phase 3. <u>**Feedback Is Provided:**</u> After redeeming the coupon, BASMAA would follow up with the recipient to reinforce their positive behavior and to ask about their experience using the eco-friendly alternative. For example, BASMAA could send an email recognizing the participant for their positive behavior (e.g. "Good job for buying green!") and request that they share their story.

Phase 4. <u>**Sharing Is Encouraged:**</u> Recipients would be provided with the opportunity to share their story so that BASMAA can use the testimonials in future iterations of the campaign (e.g. in advertisements, on the website or as a quote for a media relations pitch). For example, the program could add a tab on the existing OWOW website to allow people to submit their stories and experiences in using less-toxic products. The tab could be entitled "Share Your Story," for example, and comments and stories would be sent directly to the story bank. The story bank would then be privately managed by the program. Testimonials would be filtered and only those suitable for media pitching or future advertisements would remain in the bank.

> <u>Leveraging Existing Resources</u>
>
> **Stories can also be used as an anecdotal evaluation tool. The program has the opportunity to take "negative" stories and see how they can be used as a learning experience to improve the program.**

Phase 5. <u>**Recipients Are Asked To Do More:**</u> Finally, BASMAA could gradually expand the participant's level of commitment by continually requesting that they take on increasingly more involved water-friendly pest management strategies. For example, after a participant shares their experience with the program, BASMAA could again provide positive reinforcement while making an additional request, such as introducing the adoption of Integrated Pest Management (IPM) strategies.

Simply providing the *opportunity* for engagement is the highlight of the program, distinguishing BASMAA's advertising campaign from more traditional approaches.

Allowing for engagement will come at a minimal marginal cost for the program as a large portion of the interaction workload can be automated thanks to a number of online networking and email marketing sites. The benefits of providing this opportunity for engagement greatly outweigh the nominal administration costs given that it produces a continuous outreach flow. Perhaps most importantly, the engagement process also allows the program to track outreach achievements such as the number of individuals reached and the rates of behavior change.


PESTICIDES:
Do It Yourself
Ad Campaign
John sees our ad
John participates
in the ad promotion
(e.g. emailing for a coupon
for a green product)
John purchases the
less toxic products
with the coupon
our water
our world
The program gets in touch with John to ask him
about his experience and provide him with feedback
John writes a testimonial
about his good experience
We add John's testimonial
to our story bank to feed the ad
campaign and other marketing
efforts. At this stage, we could
also ask for increased commitments
(e.g. asking John to try IPM)
YOUR
2¢

3.3 Specific Messaging Strategy for Domestic Outsourcers (DO) Population

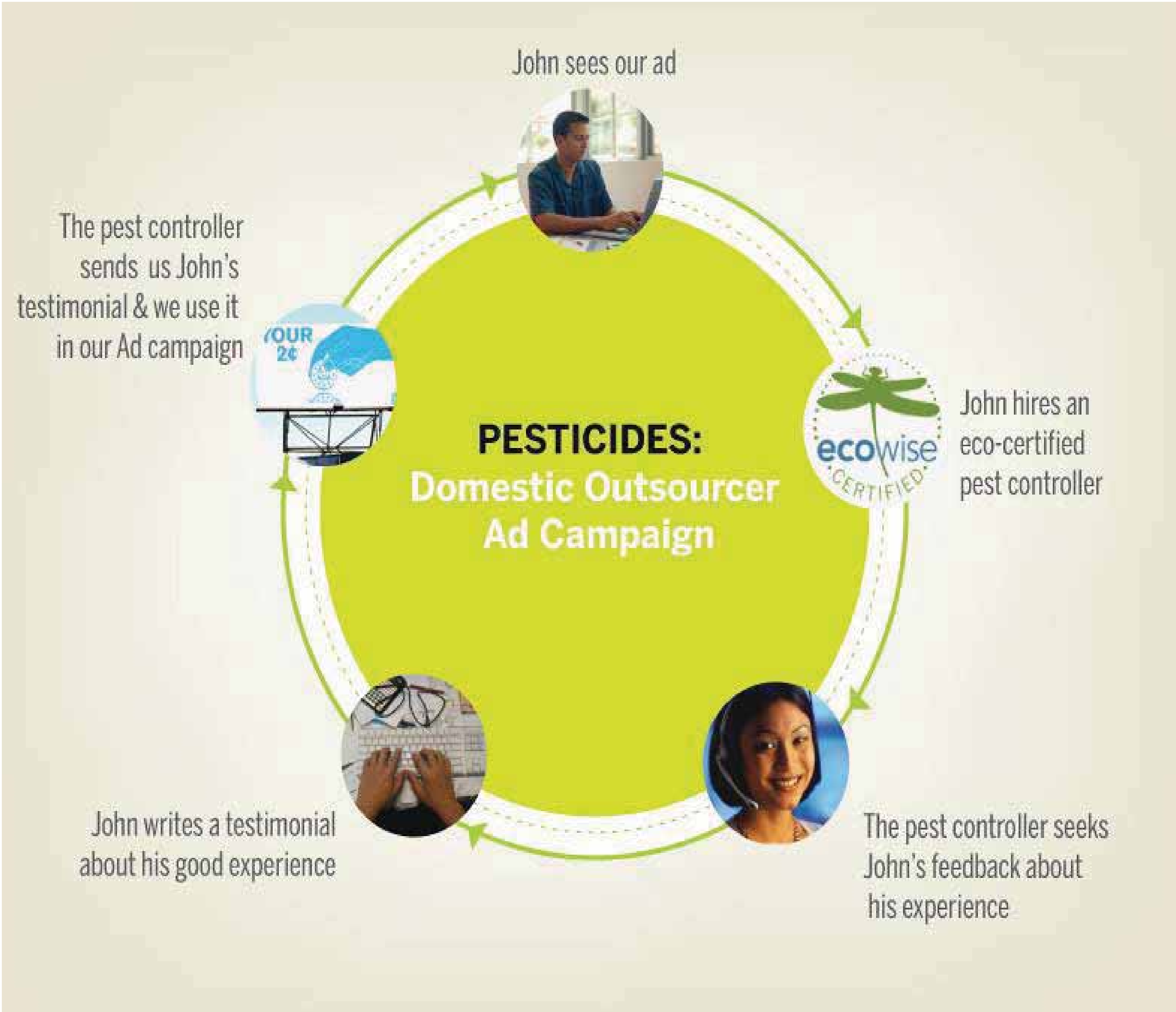
For the DO population, campaign strategy resembles the DIY approach, with several key differences in terms of both messaging and structure, as noted below:

Phase 1. **Deliver Targeted Messages:** The advertisement's overarching message would encourage homeowners to hire sustainable agricultural pest controllers or sustainable landscapers, hereafter referred to as "contractors," and/or ask their current contractors for sustainable services (i.e. the use of IPM and/or less-toxic pesticide alternatives) to protect the health of their family and pets against noxious pesticides.

Phase 2. **Recipients Respond to Program Messages:** Viewers of the advertisement would then contact and hire sustainable contractors.

Phase 3. **Feedback is Provided:** After completion of service, the sustainable contractors would follow up with the recipient to reinforce their positive behavior and to ask about their experience using their less-toxic services. For example, BASMAA could provide a designed email template for participating contractors that would contain recognition of the customer's positive behavior (e.g. "Thanks for going green!") and request that they share their story about their experience using the sustainable service.

Phase 4. **Sharing is Encouraged:** Customers would then be provided with the opportunity to share their stories for BASMAA to use as testimonials in future campaign efforts (e.g. in advertisements or as a quote for a media relations pitch). For example, customers could simply submit their stories via email, which would then be forwarded from the sustainable landscaping companies to BASMAA.


PESTICIDES:
Domestic Outsourcer Ad Campaign
John sees our ad
John hires an eco-certified pest controller
ecowise CERTIFIED
The pest controller seeks John's feedback about his experience
John writes a testimonial about his good experience
The pest controller sends us John's testimonial & we use it in our Ad campaign
YOUR 2¢

4. Getting the Word Out: Distribution Mechanisms

4.1 Paid Advertising

4.1.1 Paid Advertising Approach for Both Target Audiences

Utilizing paid advertising will serve as the primary mechanism for initially raising the awareness of both target audiences about the behaviors being promoted. In addition to acting as the campaign "starting point," paid advertising efforts will also seek to continually engage both audience groups by offering actual testimonials from program participants as the campaign grows and matures.

4.1.2 DIY Population-Specific Paid Advertising Approach

For the DIY populations, paid advertising should be placed in targeted locations that are near in both location and frame of mind to the desired behavior (purchasing less-toxic products). Paid advertisements should span a variety of mediums, ranging from social networking sites to websites to print advertising. Despite this broad array of outlets, each medium should remain focused on issues relevant to purchasing less-toxic products, particularly DIY and sustainable gardening. For example, the program could place inserts and advertisements in gardening magazines, Home & Garden sections of newspapers, DIY and gardener blogs and websites, Facebook ads and niche "eco" media like *Greenopia*.

When reaching out to this population, it will also be important to further refine advertising approaches to the primary subgroups within the larger DIY subset. These primary subgroups include non-gardeners, or residents using pesticides to eliminate outdoor pest problems affecting their health and/or lifestyle; and gardeners, or residents using pesticides to address pest problems affecting their flower and/or produce gardens. In reaching these two groups, potential distribution mechanisms might include:

Non-Gardener DIY Population:

- Home & Garden show booklets/programs (e.g. Alameda County Home & Garden show)
- Home & Garden sections of the newspaper (e.g. Mercury News Home & Garden)
- Home improvement store inserts and leaflets
- General print newspapers

Leveraging Existing Resources

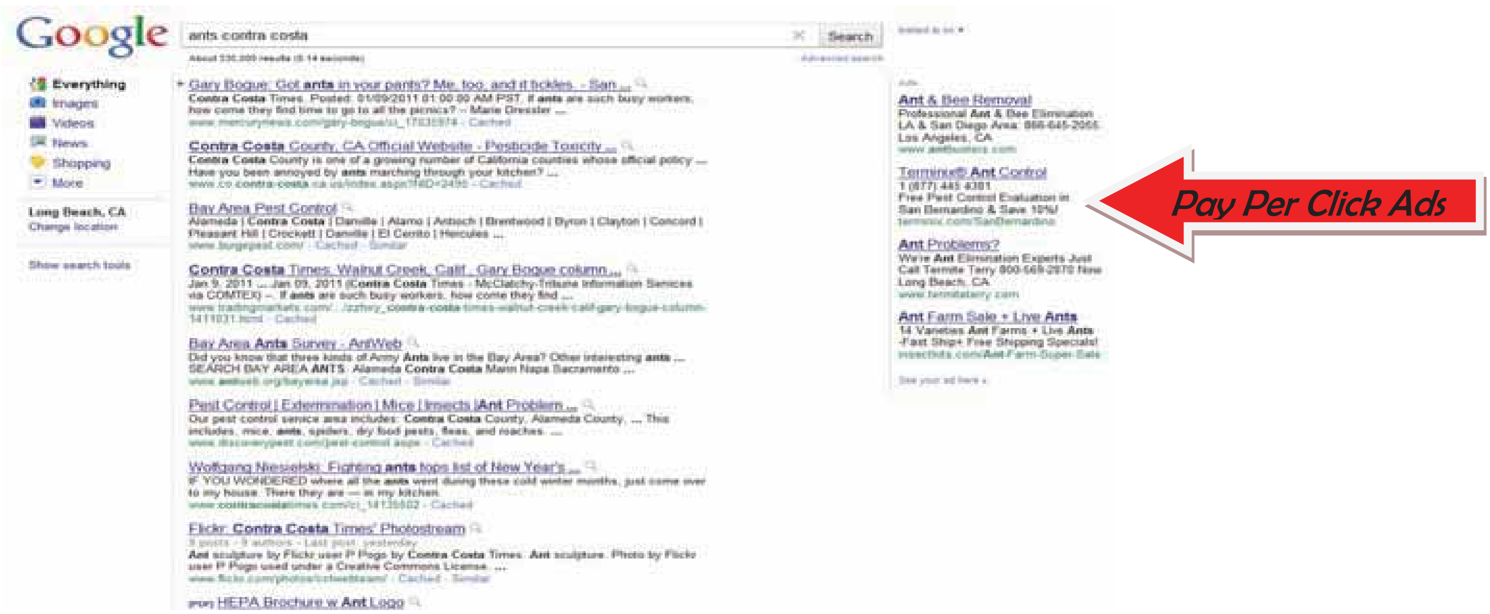
If a program like Alameda County is already attending events such as the Alameda County Home and Garden Show, this would be a great event to distribute key program messages and place ads.

Gardener DIY Population:

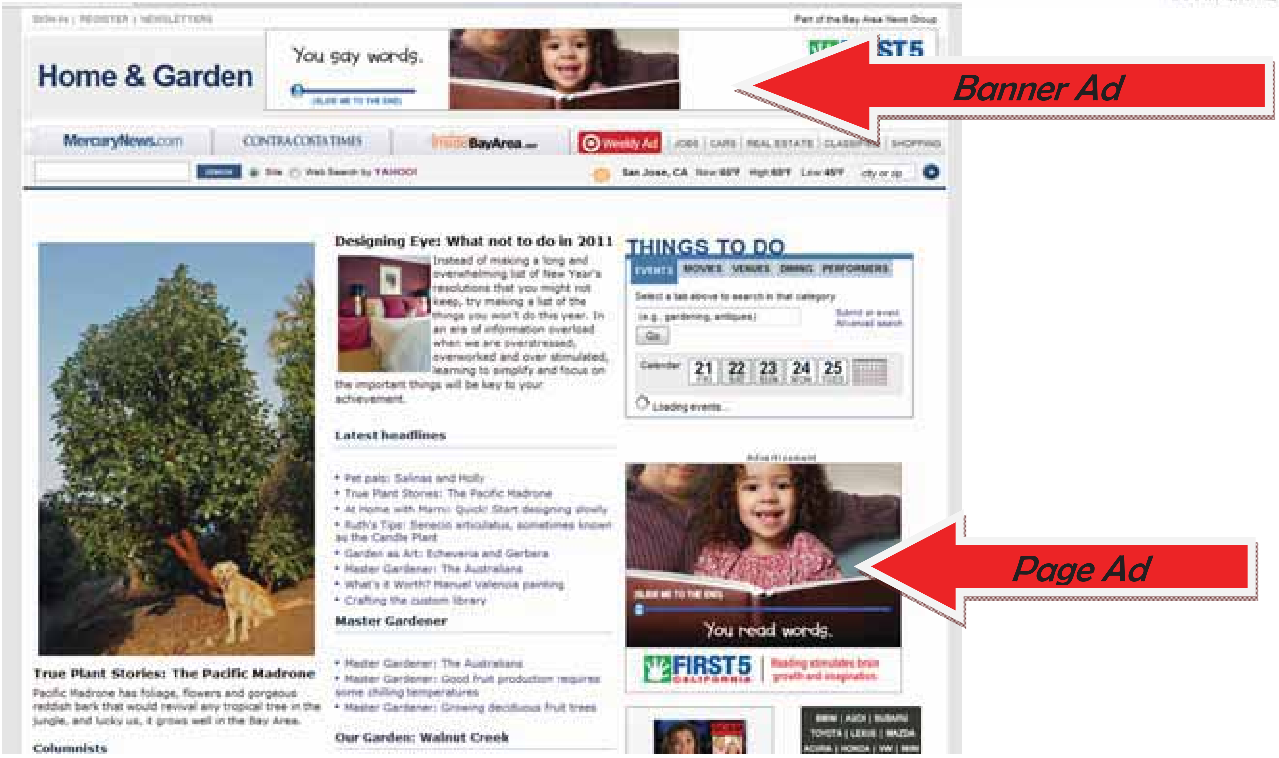
- Home & Garden show booklets/programs (e.g. Alameda County Home & Garden show)
- Home & Garden sections of the newspaper (e.g. Mercury News Home & Garden)
- Home improvement store inserts and leaflets
- Garden-specific targeted Facebook ads
- Gardening-targeted and keyword-specific online search term ads
- Garden-specific website banner ads

4.1.3 DO Population-Specific Paid Advertising Approach

Similarly, the paid advertising strategy for marketing to the DO population should follow the same comprehensive approach in terms of advertising modes, yet targeted in terms of the niche focus of those vehicles. Like the DIY strategy, the DO advertisements should also be placed in targeted locations that are near in both location and frame of mind to the desired behavior (hiring sustainable landscaping companies or finding an exterminator to deal with a pest problem). For example, the program could create online placements that appear during Google searches using specific search terms like "ants" + "Marin County." It would also be advantageous to post advertisements in established databases and review sites that are commonly referenced to locate landscaping services and pest control companies such as the Yellow Pages, angieslist.com, yelp.com and Pennysaver.



Shows a sample of where a keyword specific, geo-targeted ad would appear. For example, if someone only typed in the word "ants," Google's geo-targeting can make it so that only people in a certain geographic region would see the ad.



Sample of a banner ad and a page ad in the San Jose Mercury News' Home & Garden page.

4.2 Earned Media Approach for Both Target Audiences

Earned, unpaid media offers a number of ripe opportunities to supplement the larger campaign and in the case of the electronic media, to drive engagement. For both target populations, earned media, such as user-generated content about the program posted on social networking sites, blogs or reported in news media, should convey the same messages as those communicated in the paid advertising campaign.

Promoting program messages across earned news media sources can be accomplished through BASMAA's existing media relations push. In driving this effort forward, the program should position "Our Water, Our World" as a go-to expert in local water quality issues so that BASMAA is the primary contact reporters seek when writing pieces related to this issue.

<u>Leveraging Existing Resources</u>

This should be in sync with BASMAA's already existing media relations push.

To further bolster BASMAA's reputation as an expert on water quality issues, the program should systematically seek out opportunities to comment on and contribute to related articles published online. By offering BASMAA's expertise, the program will be able to publicly build and assert its credibility, while simultaneously building a network of supporters. The program should therefore consistently monitor media to track articles and reporters writing about related subject matter.

4.3 Building Engagement through Electronic Media

For the DIY population in particular, the use of unpaid electronic media will be a central mechanism in the consistent dissemination of program messages. Thanks to free electronic platforms, and user-generated social networking sites, the program will be able to regularly spread program messages on a continuous basis. Frequent message saturation and easy online access to participants will also allow the program to ask for increasingly more involved levels of commitment, culminating in the submittal of testimonials with regard to their adoption of sustainable pest management practices and products. In short, the paid advertising campaign — and any other interaction that the OWOW program has with a resident (e.g. events, trainings, etc.) — is ideally coupled with an opportunity for the recipients, if they are interested, to become further involved with the program online. In developing this e-engagement program, SGA recommends taking the following step-wise approach. The goal of the strategy below is to first build off simple actions to grow into more complex efforts as the online movement gains momentum. BASMAA should also leverage already existing resources by making every point of contact with a resident (e.g. how-to workshop, event, etc.) an opportunity to make them part of the online media program.

Step 1 **Reaching Out with e-Newsletters:**
To quickly and efficiently foster audience involvement, BASMAA should develop an e-Newsletter specifically targeting the DIY population to increase their access to program messages. The newsletter could be sent out to individuals who provided their email address at community events or through coupon redemptions from the purchase of less-toxic products, for example. The newsletter should be sent out once a month, featuring short, easy "to do" tips. For example, the newsletter could feature one tip a month about the latest less-toxic products, related product discounts or useful IPM strategies. The newsletter should also promote website perusal by linking articles to an e-Newsletter section of the website where the program could store archived editions.

Example of an electronic newsletter that SGA created for the County of San Bernardino Stormwater Program. The medium allows for articles as well as user commenting and questions.

Step 2 **Navigating the Eco-Blogosphere:**
After developing the program e-Newsletter, BASMAA should start a blog where tips can be coupled with more extensive write-ups. Linking the tips sent out in the e-Newsletter with the blog also allows readers to comment, thereby increasing interactivity and engagement. Blogs also allow for the opportunity to reach out to audience members beyond those currently connected with the program, as their infrastructure includes the built-in capacity to push forward campaign messages through their viral network of readers and content-producers.

Step 3 **Fostering Trust and Buzz Through Social Networking:**
While developing a blog presence, the program should also start a Twitter and/or Facebook page to allow for a more continuous dispersal of program information and increased opportunity for audience engagement. This type of platform also provides endless opportunities for peer-to-peer information sharing. DIYers should be encouraged to share their non-toxic solutions for dealing with pests and their peers would therefore be able to get advice from their online neighbors and, as a result, the messages would carry added credibility.

Leveraging Existing Resources

By linking up with the Facebook pages of Contra Costa Clean Water Program, Sonoma County Water Agency and Santa Clara's Watershed Watch, the program could instantly leverage over 600 fans!

Step 4 **Creating a Movement with Moving Pictures:** After building out a basic social networking framework, the program should then move to the development of an OWOW YouTube Channel. The YouTube channel will allow the program to quickly and easily post videos captured at outreach events and gardening workshops, or informational videos (e.g. how to spot an aphid).

Step 5 **Growing Relationships to Build Credibility:** In building the program's credibility among the target DIY audience and growing its e-community to disseminate messages, BASMAA should seek to develop a broad coalition of online support. To accomplish this, BASMAA should identify related blogs, Facebook and Twitter pages, websites and YouTube channels and regularly provide comments, respond to posts, provide expertise, and/or share relevant articles. Collectively, these efforts will feed the larger effort by providing a mechanism for program messages to reach the wider audience and grow credibility through this cost-efficient "word of mouth" capacity.

Step 6 **Evolving from Website to Program Hub:** Ultimately, social networking and blogging efforts will aim to drive users back to the OWOW website, which will unify the numerous electronic outreach activities described above. As the information hub of the program, it's important to grow and streamline the current website to increase its efficiency and usability. To do this, SGA suggests designing and executing a web optimization strategy based on the follow principles:

1. **Increase Site Usability and Accessibility:** Website navigability is one of the most important features of any effective information hub because if people can't use the site, they won't stay. With this in mind, the program should develop a strategy to increase the usability of the site by assessing current website information flow, layout and organization to determine retooling and reformatting needs.
2. **Develop a Robust Search Engine Optimization (SEO) Plan:** Developing an effective SEO strategy is critical, because if people can't find you, then they won't be able to use your resources. In developing OWOW's SEO strategy, the program should examine the following features:
    - **Titles:** Reassess consistency and clarity of each title on every website page to ensure that each title accurately describes the content of the page.
    - **Link around:** Increase the use of internal links within web pages to easily direct external and internal users to information.
    - **Strengthen keywords:** Highlight critical keywords and phrases and add a *strong* tag around them to increase search results.
3. **Put Your Best Face Forward:** The design and branding of the site acts as the face of the program, and should thereby engage and draw the audience in. In light of the updated Five-Year Strategic Plan, BASMAA should revisit the current website design to fully optimize the use of engaging website images, web layout and design consistency throughout the site.

4. **Clarify, Grow and Tailor Content:** The information that the site is providing is the central reason why the audience is visiting. To keep the target audience coming back for more, it is important that the program develop a plan to consistently and systematically refine and update website content.

4.2.3 DO Population-Specific Earned Media Approach

For the DO population, the use of unpaid electronic media should be utilized as a mechanism where individuals could simply and easily submit testimonials describing their positive experiences using a sustainable contractor. Electronic media would also be implemented in conjunction with the sustainable contractors to leverage outside resources.

To easily automate this feedback loop, the program could develop a designed email template requesting testimonials from former sustainable contractor clients. This e-blast template could then be provided to partnering sustainable contractors to send directly to their customers. The e-blast would include several easy ways for customers to submit their testimonials, such as simply replying to the email (which would then be forwarded by the contractors to BASMAA) or by posting their testimonial to OWOW's future Facebook page.

4.3 Strategic Partnerships

For the DO population in particular, developing strong relationships with sustainable landscaping companies will be critical in the successful execution of the campaign. However, the need for fruitful partnerships does not end there. To effectively reach and influence both target audiences, the program should develop, build on and utilize strategic partnerships with a number of relevant groups and existing stakeholders. While building these partnerships, the program should seek stakeholder input and assistance across a number of key objectives, including: (1) refining program messages, (2) identifying message distribution channels and (3) leveraging their own networks to distribute messages.

In seeking out potential partners, the program should reach out to organizations that appeal to the relevant interests of both populations, which include:

- **Environmental Issues:** The program could appeal to the target audience's desire to be environmentally friendly in using less-toxic pesticides by developing strategic partnerships with relevant environmental organizations (e.g. The Urban Pesticide Pollution Prevention Project, http://www.up3project.org).

Leveraging Existing Resources

The program could easily draw on participants currently involved with Santa Clara Valley's Green Gardner Program or the Bay Friendly Landscaping Program.

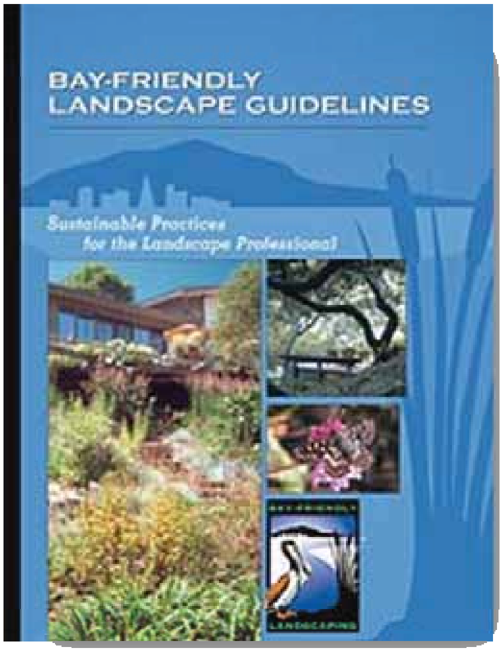
- **Health Concerns:** Like their concern for the environment, protecting the health of their families and pets is a major driver for many residents' use of less-toxic pesticides. Noting this interest, the program should seek out partnerships with related health organizations, particularly those that focus on the family and the home (e.g. Healthy Child, Healthy World, http://healthychild.org/).

Leveraging Existing Resources

Santa Clara's Master Gardeners program is another great opportunity to leverage program resources and current participants (www.mastergardeners.org/scc.html). For example, BASMAA could build off the Master Gardeners program's La Mesa Verde, a newly established community project dedicated to building organic vegetable gardens at the homes of low-income families in Santa Clara County (pictured right).

- **Green Gardeners:** For the DIY sect, reaching out to sustainable gardening groups would allow the program to pick the low-hanging fruit of individuals who already have a developed interest in the message.

Plug-in Opportunity: Alameda's guideline book for the County's Bay-Friendly Gardening program.



Plug-in Opportunity: Santa Clara's La Mesa Verde Project for the Master Gardeners program.

- **Master Gardeners:** The program could also find a broad group of willing participants and effective channels of communication to leverage by partnering with master gardener

- **Sustainable Landscaping Companies:** Finally, partnering with sustainable landscaping companies will not only help move the program forward; it will be a necessary action in developing the DO campaign (e.g. The Bay-Friendly Gardening Program, http://www.stopwaste.org/home/index.asp?page=8).

Leveraging Existing Resources

Alameda County's Bay-Friendly Gardening program offers landscape professionals a number of tools and resources to help them stay competitive in the marketplace, such as workshops, qualifications, tours and guidelines (pictured right) (www.stopwaste.org). The program could utilize existing contacts from this program to build out strategic partnerships with sustainable landscapers.

5. Making the Grade: Evaluation Approaches

A Note about Our Approach

At SGA, we've come to rely on the term Outreach:ology to convey the unique way we approach public education. Outreach:ology (i.e., the science behind behavior change) uses a blend of Community-Based Social Marketing (CBSM) and proven tactics from social psychology and persuasion in order to influence the behavior of the target audience. CBSM focuses first on identifying the barriers and motivators of the target audience (See Literature Review, page 4), and then on finding ways to lower the barriers and increase the motivators. Social psychology allows us to use research from prominent leaders in the academic field who have tested and found tactics that work in influencing a person's behavior. By using both social psychology and CBSM as the backbone of the approach, SGA has proposed strategies throughout the plan (e.g., power of stories, peer-to-peer communication, action-oriented messages, etc) that are all included as a result of their proven success in persuading people to change their behavior. Because these types of strategies have proven success, SGA recommends monitoring the audience's participation (instead of their awareness) as one of the campaign's primary metrics for success. For example, getting a home owner to sign up for the program's eNewsletters would be more valuable than finding out that said homeowner is aware of the toxicity of pesticides.

What Numbers Should Be Tracked for Success: Recommended Measures

In order to reflect the strategies proposed in the plan, the table below reflects which outreach tactics should be measured quantitatively.

Campaign Component	Evaluation Metric
Paid Advertisements	• *Number of impressions per advertisement* • *Number of interactions as a result of advertisement*
Testimonials	• *Number of testimonials received*
Electronic Media	Social Networking (Facebook and/or Twitter) ▪ *Number of "friends" or "fans"* ▪ *Number of interactions (e.g. posts/comments) from target audience* ▪ *Number of interactions from OWOW* Website ▪ *Number of unique visitors* ▪ *Number of page views* Blogs • *Number of posts by program on external blog sites* • *Number of comments to posts by program on external blog sites* • e-Newsletter • *Distribution number* • *Open rate* • *Number of article click-throughs*
Earned Media	• *Online news placements* • *Print news placements*
Strategic Partnerships	• *Number of partnerships with related organizations/non-profits/associations* • *Number of partnerships with sustainable landscaping companies & pest control operators* • *Number of strategic partnership events/workshops* • *Number of people who attended all strategic partnership events/workshops*

Learning from Mishaps and Successes: Monitoring and Adjusting

The most effective outreach plans are those that are able to be malleable and adjust tactics as needed. In terms of the overall strategy, periodic evaluations should be done at least once a year to allow the program to take a step back and assess what's working (and do more of that) and what's not working (and figure out how it can be improved). On a more tactical level, adjustments should be occurring on an ongoing basis. Because a good chunk of the plan focuses on online outreach, this comes with the added benefit of an ongoing evaluation component. Programs like Facebook, eNewsletters, etc., all produce statistics to see which posts are popular and which emails people are opening and not opening. This encourages a continuous stream of automated monitoring that would allow the program to optimize its rates of online engagement and success by simply giving their users more of what they want.

Pilot testing programs are also a means of assessing effectiveness before they are implemented on a large scale. Pilot testing is best used when conducting "on the ground" outreach programs. That is, programs that involves face-to-face contact like the store outreach being done for the Our Water, Our World program. Because of the geographic area of BASMAA, face-to-face outreach was not included as an integral part of this plan due in part to the budget and the fact that the strategic plan was written to comply with the MRP's advertising requirement. However, for some components of the plan (e.g., Youth Panel), pilot testing is feasible and recommended as a way of seeing what works and what doesn't—before rolling it out on a larger scale.

To Ask or Not to Ask: Self-Reported Surveys

SGA is aware that one of the MRP's requirements is to do a pre- and post- campaign survey before and after the advertising buy. Because we are recommending that BASMAA veer away from traditional paid advertising buys, we are also recommending that this evaluation approach be adjusted accordingly. SGA's concern with self-reported surveys are as follows: (1) They tend to place an emphasis on knowledge and awareness. As we know from CBSM, the idea that knowledge equals behavior change is an erroneous one. Case in point: every smoker knows that smoking cigarettes is bad for their health, but does this stop them from smoking? For this reason, it is amiss to assume that simply because a homeowner knows that IPM is the most eco friendly pest control alternative, that they are going to stop using pesticides altogether; (2) They are self-reported and therefore are limiting in their ability to get candid answers from the participants; and (3) They can be quite expensive for little return. Administering these types of surveys is often costly, and the data that is received is not always actionable or of value to the program.

SGA instead recommends taking the following approach to self-reported surveys: (1) Stay away from focusing on questions related to awareness; (2) Rely primarily on the people who are part of the program's outreach database (see page 13) as the means for getting survey data. The people who become part of the program can therefore be tracked and their progress monitored in terms of how successfully they are moving along the road to behavior change. This also minimizes program costs if the surveys are sent out and collected online; and (3) Only collect face-to-face surveys in conjunction with other programs and outreach initiatives the individual cities/counties are already doing as part of MRP compliance. For example, taking surveys to a community event and doing them there. In this way, no added budget is spent in trying to collect survey data.

BASMAA
Media Relations Campaign
Final Report FY 2010-2011

Submitted by O'Rorke Inc
June 30, 2011

During the fiscal year 2010-2011, O'Rorke Inc. continued to serve as BASMAA's media relations contractor.

Early in the year O'Rorke worked directly with project manager Sharon Gosselin and the PIP committee to brainstorm pitch topics. The result was several planned pitches and distributing radio/online public services announcements on key stormwater issues as well as monitoring of breaking news opportunities. Additionally, O'Rorke provided localized templates of each release developed for use by local agencies to pitch community-specific media.

The pitches resulted in thirty-five total media placements. The report that follows gives a synopsis of each pitch and the number and type of placements each garnered. Details coverage reports for each pitch are attached.

Rainy Season/Car Maintenance PSAs
O'Rorke drafted a series of public service announcements (PSAs) for use on radio. The copy focused on the importance of basic car maintenance, particularly fixing leaks, in the rainy season.

The PSAs were aired on eleven radio stations, posted on ten station websites and also resulted in interviews on two radio stations for a total of twenty-three placements.

Don't Burn Holiday Gift Wrap
O'Rorke drafted a press release focusing on the pollution caused when holiday gift wrap is burned or used as a fire starter.

This pitch resulted in five placements: four radio stories and coverage on KQED's blog.

Reusable Lunch Boxes/Water Bottles
To call attention to one of the major pollutants BASMAA is dealing with, O'Rorke conceived of a pitch designed to call attention to litter via choices a consumer can

make in daily behaviors. Two press releases were drafted: one dealt with eating on the go and how reusable items can fit into that (reusable coffee cups, water bottles, etc). The other release, sent to parenting publications, focused solely on building a greener lunch box for children.

This pitch resulted in one interview placement on the family-friendly station, KMKY (Radio Disney).

Hiring an IPM Certified PCO
This pitch focused on the wide availability of pest control operators certified in integrated pest management (IPM) techniques. O'Rorke worked to have BayWise.org updated to include a "box" on the homepage advising users to "click here to find a pest control professional." Also included were links to listings of Bay Area contractors certified by three different programs.

This pitch resulted in three placements: one on claycord.com and two radio interviews. The claycord story drove eighty-six visitors to BayWise.org the day it was posted. Since the pitch began, the pest control page has received over 150 visitors.

Ant Control PSAs
These PSAs dealt with effective ways to control ants and also promoted BayWise.org as a resource for pest control information.

The PSAs aired on three stations: KLIV, KDIA and KCBS.

Summertime Reusables/Anti-Litter Tips
This pitch began at the end of the FY and, although some media outlets expressed interest in running the tips and/or using them in conjunction with other summertime/destination stories, no placements have been confirmed as of this writing.

Recommendations for FY 2011-12

- Work to find new ways to present the litter story and messages to the media. O'Rorke found this topic to be a "tough sell." It may be, in part, because downsizing at news organizations has made lighter, lifestyle-oriented pieces more difficult to get covered. But there also did seem to be a real lack of interest in this topic from the media.

- Look to new local/regional studies as a jumping off point for pitching. Timeliness and a sense of having real news to share would help get BASMAA more coverage.

- Continue to pitch FM radio stations and seek out public affairs coverage via PSAs or direct pitches. Public affairs directors have been receptive to BASMAA messages.

- Update BayWise.org to include more stormwater related information.

- Continue to pitch/seek out online coverage as much as possible. One story on claycord.com drove over eighty visitors to BayWise.org. Online stories and placements can lead to the public directly getting even more information about water pollution prevention activities at home.

- Brainstorm things on the horizon in the next six months that could prove to be strong media opportunities for BASMAA. This could range from new regulations to surveys and studies.

Rainy Season/Car Maintenance PSA Coverage Report

Online

- KISS-FM (98.1)
- KMEL-FM (106.1)
- WILD 94.9
- KKSF-FM (103.7)
- STAR 101.3
- GREEN 960
- 910 KNEW
- KKIQ-FM (101.7)
- KKDV-FM (92.1)
- 107.7 THE BONE

Radio

- KISS-FM (98.1)
- KMEL-FM (106.1)
- WILD 94.9
- KKSF-FM (103.7)
- STAR 101.3
- GREEN 960
- 910 KNEW
- KIQI-AM (1010) (Spanish)
- KKIQ-FM (101.7)
- KKDV-FM (92.1)
- KUFX-FM (98.5) (KFOX) – Will begin airing week of 12/27

Radio (Interview)

- **KEAR-AM (610)**. Sharon Gosselin w/ Jonathan Rickert on Tuesday 12/14. Two 5-minute segments aired Wednesday 12/15/10 and Thursday 12/16 at both 11:04 a.m. and 4:04 p.m.
- **Radio Disney KMKY-AM (1310)**. Sharon Gosselin w/ Shalon Rogers on Monday 11/20 at 11 a.m.

Don’t Burn Gift Wrap Coverage Report

Radio

- **GREEN 960**. Sharon Gosselin w/ Sebastian Kunz on Friday 12/10/10.
- **KEAR-AM (610)**. Sharon Gosselin w/ Jonathan Rickert on Tuesday 12/14/10. Two 5-minute segments aired Wednesday 12/15/10 and Thursday 12/16/10 at both 11:04 a.m. and 4:04 p.m.
- **KGO-AM (810)**. Sharon Gosselin w/ Ravi Peruman on Monday 12/20/10.
- **KCBS-AM (740)**. Lisa Fasano (Air District) on Friday 12/24/10. Two segments.

Online

- **KQED News Fix Blog.** What Not to Burn This Holiday Season. Dan Brekke. 12/24/10.

Reusable Lunch Box/Water Cups Media Coverage Report

Radio

- KMKY – Geoff Brosseau interviewed by Shalon Rogers on March 30th.

Hiring an IPM Certified PCO Coverage Report

Online

- Claycord.com

Radio

- KEAR – Interview with Jim Scanlin; aired in two parts on two consecutive days.
- KIQI – Interview with Ricardo Barajas

Ant Control PSA Coverage Report

Radio

- KCBS
- KDIA
- KLIV


Got Bugs? Get Answers!
Choose less toxic products for a healthy home and garden
visit www.ourwaterourworld.org
Look for this symbol before you buy
APHIDS
ANTS
BEAUTIFUL
HOW TO CONTROL
WEEDS


Got Bugs? Get Answers!
Choose less toxic products for a healthy home and garden
visit www.ourwaterourworld.org
TRAPPING
SKUNKS
RACCOONS
POSSUMS
FERAL CATS
WILD PIGS
SNAKES


Got Bugs? Get A
Choose less toxic produ
healthy home and ga
visit www.ourwaterourw

APPENDIX G
Provision C.8
Water Quality Monitoring

10th Annual

Bay Area Macroinvertebrate Bioassessment Information (BAMBI) Network Meeting

Monday, January 31, 2011
10:00 AM to 3:00 PM
Room 11, 2nd Floor, Elihu Harris State Office Building
1515 Clay St., Oakland, CA, 94612

MEETING AGENDA

9:45 **Registration and Coffee/Tea**

10:00 **Welcome and Agenda Review -** *Arleen Feng (Clean Water Program of Alameda County)*

10:10 **Bay Area Bioassessment Activities - Introductions and Summaries from Bay Area Agencies and Organizations -** *Meeting Attendees (up to 5 minutes per attendee)*

10:40 **Update on San Francisco Bay Area Benthic IBI Development -** *Chris Sommers (EOA, Inc.)*

11:00 **Development of Biological Objectives for California Wadable Streams -** *Peter Ode (California Department of Fish and Game)*

11:30 **Preliminary Results of Reference Site Sampling in the Bay Area** – *Karen Taberski (SF Bay Regional Water Quality Control Board)*

12:00 ***Lunch (Provided)***

12:40 **Progress on Steam Algae Assessment Tool Development in Southern California -** *Betty Fetcher (Southern California Coastal Water Research Program)*

1:10 **Reference Conditions in Bay Area Streams: Site Selection Criteria and Variability over Space and Time** - *Kevin Lunde (UC Berkeley PhD Candidate)*

1:40 **Do Benthic Macroinvertebrates Respond to Sediment? –** *Matthew Cover (Cal State University Stanislaus)*

2:10 **Development of a Probabilistic Monitoring Design for Bioassessment in San Francisco Bay Area Creeks** – *Chris Sommers*

2:40 **Wrap-up, Questions and Suggestions for Next Year's Meeting**

3:00 **Adjourn**

Driving Directions to Bambi Meeting

From San Francisco:
Distance: 8.8 miles Approximate Travel Time: 30 minutes

Go East on US 101 to I-80
Go Northeast on I-80 (Portions toll)
Take the I-80 EAST ramp.
Take the I-580 EAST exit towards HAYWARD/STOCKTON/DOWNTOWN OAKLAND/CA-24/ALAMEDA.
Merge onto I-580 E.
Take the I-980 WEST exit towards DOWNTOWN OAKLAND/(I-880 S).
Take the I-980 WEST exit on LEFT.
Take the 18TH STREET exit towards 14TH STREET.
Turn SLIGHT LEFT onto BRUSH ST.
Turn LEFT onto 17TH ST.
Turn RIGHT onto CLAY ST.

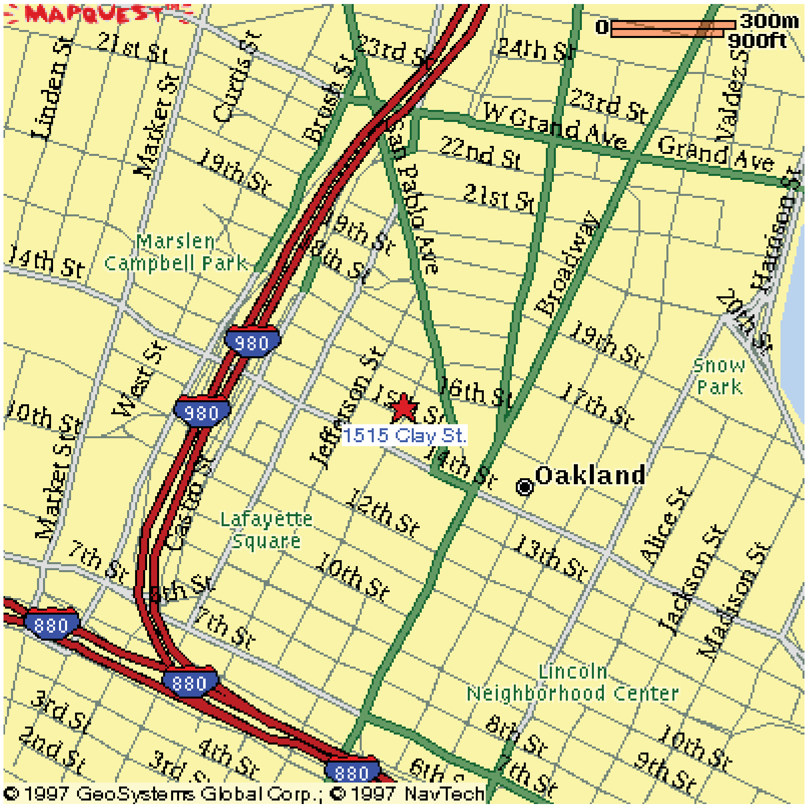
From Sacramento:
Distance: 80.6 miles Approximate Travel Time: 1 hour, 49 minutes

Go South on I-5 to I-80
Go Southwest on I-80 (Portions toll)
Merge onto I-580 E/I-80 W.
Merge onto I-580 E.
Take the I-580 EAST exit towards DOWNTOWN OAKLAND/HAYWARD
Keep LEFT at the fork in the ramp.
Merge onto I-580 E.
Take the I-980 WEST exit towards DOWNTOWN OAKLAND/(I-880 S).
Take the I-980 WEST exit on LEFT.
Merge onto I-980 W.
Take the 18TH STREET exit towards 14TH STREET.
Turn SLIGHT LEFT onto BRUSH ST.
Turn LEFT onto 17TH ST.
Turn RIGHT onto CLAY ST.

From San Jose:
Distance: 49 miles Approximate Travel Time: 1 hour, 9 minutes

Take the I-880 NORTH ramp.
Merge onto I-880 N.
Follow the signs to get onto I-980 E.
Take the 11TH ST exit towards 14th St.
Turn SLIGHT LEFT onto CASTRO St.
Turn RIGHT onto 14th St.

Turn LEFT onto CLAY St.



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APPENDIX H
Provision C.9
Pesticides Toxicity Control

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Alameda County OWOW Stores Final Report July 2011
Annie Joseph 7/19/2011

Again the most successful piece of the program continues to be the training. It gave me a chance to focus on the stores' individual concerns with current pests and to discuss additional issues about the most popular pesticides promoted by the pesticide companies in 2011. I had my work cut out for me this season and because of the declining economy the pesticide companies were vying for market share and were making additional offers to pay for advertising, sales, and shelf space. They even were offering to buy back pesticides from other companies at the smaller stores which was really a surprise to me. Again I encountered resistance from the pesticide industry out in the field. I also added in food, lunch or breakfast rolls, to the trainings to encourage folks to attend.

My trainings focused on beneficial insects, what flowers will attract them, and how to set up an eco system in their yard without the use of toxic pesticides. The goal was educate the stores on insect identification through the use of the power point presentations, 10 Most Wanted Bug Guides, Mac Field Guides for the Good Bugs and Bad Bugs of California. Included in the trainings sheets that I made were Whitefly control, Citrus Leaf Miner, Spider Mites, Spotted Winged Fruit Fly. The Spotted Winged Fruit Fly is a new invasive pest that I focused on this year because the controls need to be done before the fruit is ripe. I handed out a bulletin from UCIPM that showed colored photos of the pest and the damage. My power point presentation also touched on this pest so they all had a visual. The WhiteFly and Spider Mite populations are increased by the use of several commonly recommended pesticides. I used these as examples so when they see a pattern of increased whitefly and spider mites they would be able to ask customers if they were using other pesticides that could be knocking out the predator insects. I stressed troubleshooting pest problems not just handing the customer a spray. I also highly encouraged, as I did last year, that trainees take the two free online training modules from UCIPM. Beyond Pesticides which is on IPM, and How to Read a Pesticide Label.

113 employees trained in 2010/2011 FY compared to 111 in 2009/2010 FY

15 trainings at 13 stores

Pete's Hardware 2 staff 2/24/11
Osh Berkeley 9 staff 1/19/11
Osh Dublin 8 staff 3/23/11
Grand Lake Ace 6 staff 1/26/11
Home Depot Fremont 20 staff two trainings 1/10/11, 4/14/11
Home Depot Pleasanton 7 staff two trainings 8/6/10, 10/14/10
Westbrae Nursery 4 staff 1/21/11
East Bay Nursery 10 staff 6/15/11
Alden Lane Nursery 16 staff 2/14/11
Armstrong Nursery 6 staff 10/9/10
Osh San Leandro 5 staff 3/2/11
Regan Nursery 14 staff 3/1/11
Western Gardens Nursery 5 staff 3/25/11

Trainings

Home Depot Pleasanton 2 trainings: 8/6/2010 and 10/14/2010
I trained 7 staff in the two trainings. They were very interested to learn what additional products they might be getting in 2011 that are less toxic. They said their customers are very interested to use more less toxic products. They have several very knowledgeable nursery staff that help guide customers towards those options.

Armstrong Nursery Dublin 10/09/10
6 staff trained. This nursery has a lot of potential and has several very knowledgeable nursery staff who are keenly interested in IPM. They are interested to have additional training when they hire new employees in the spring. They really liked the information on the spotted winged fruit fly and also were interested to know more about the timing of applications of less toxic pesticides so they can be more effective.

Home Depot Fremont 1/10/11
14 staff trained
I had to do two 1 hour sessions power point so they could have the staff cover the floor while I trained half of the group. This is a good store we have an advocate Gus who works in the nursery and helps to get the store manager to set the dates and stick by them. The staff was very supportive and we focused on their new products that were coming this year from Ortho under the Ortho Elementals label. I also focused on Sluggo, which was new for them to carry this year.

OSH Berkeley 1/19/11
9 staff trained
May, the assistant store manager, made sure that we got off the floor time in the training room. I did a power point presentation and they all really liked it. I had two 45 minute sessions so we could cover most of the staff. I focused on citrus leaf miner and the spotted winged drosophila which are going to continue to be difficult pests in our area.
They are going to need a new literature rack as this one is falling apart. I also gave them their product list by pest so they can see what products they carry and how they work.

Westbrae Nursery 1/21/11
5 staff trained
This nursery continues to shine and is reducing the bulk of their more toxic pesticides. The staff really enjoyed the training and I focused on beneficial insects and what pesticides would give the customer relief yet not leave a toxic residue. This store is one that I want to have in the IPM Advocates program because they have been so committed to OWOW.

Grand Lake Ace 1/26/11
6 staff trained
Tom Nelson the manager focuses on the least toxic methods and makes sure that the staff follows suit. They have a cashier who actually asks people if they have pets and if they do she asks them to put the metahdehyde bait back and buy Sluggo. Most of the customers do as she suggests those that don't she asks if they want a bag for their poison.

Alden Lane Nursery February 14, 2011
16 staff trained
Great turnout this year considering they had to downsize staff.
I spent quite a bit of time customizing their training around the benefits of using native plants and Mediterranean plants in the landscape and how that reduces the need for pesticides and water.
They are trying to promote more plants in that group. We also refreshed about the spotted winged drosophila and we discussed the new fruits that are probably going to be a target: blueberries and raspberries. I scheduled a presentation in March but had to cancel last minute due to illness. Photos taken and sent to Jim Scanlin

Pete's Hardware Castro Valley February 24, 2011
2 staff trained
New garden manager because the former one has injured his leg and is semiretired. This makes it challenging because he was extremely knowledgeable and ran the nursery section. Of the two I trained Josh had a training last year so at least they have one person who knows the section. The other is not knowledgeable and will need more guidance.

Regan Nursery March 1, 2011
14 staff trained
This was great because I had not done a power point presentation here and they loved it. They particularly liked learning about identifying beneficial insects. I had not had a chance to train them last year so they were really receptive and interactive. They have been taking our literature out to events like the Earth Day event at Washington Hospital and the Pollinator Festival. Also when the manager speaks at garden clubs he takes our fact sheets to hand out. When they had their annual rose show by the Bay Area Rose Society at the nursery I made sure they had 200 of the rose fact sheets to give to attendees.

OSH San Leandro March 2, 2011
5 staff trained
Zack the store manager is relatively new and he really appreciated the training. Osh has strict rules about not training during certain times but he let me do an in the aisle training that was very fun and he joined in. This was good to get some excitement going here as this store has kind been limping along since they lost Diane a manager who really was supportive of OWOW. Zack seems like he is going to be very supportive too.

OSH Dublin March 23, 2011
8 staff trained
Judy Macaluso the store manager is a gem. She arranged for everyone to be available and have time to go through the training. We did it in their seasonal section where the patio furniture is and then we walked over to the aisle so we could talk about all of the products. Everyone had good questions about their new less toxic products. Photos taken and sent to Jim Scanlin

Home Depot Fremont April 14, 2011
6 staff trained
Gus requested another training for the folks that missed the last one. I had two people come in on their days off for the training. Depot paid for them to attend. We had a lot of time in fact the two nursery folks who came in for the training stayed two hours. Photos taken and sent to Jim Scanlin

Western Garden Nursery Training March 25/ 2011
This was a great group to work with. They have a good customer following in the Pleasanton area. They all had a lot of good questions and really appreciated the added information to help them sell the less toxic products. The owner Aires is not as on board as his employees are but he does see the benefit of offering the less toxic options to their customers. This store has a lot of potential and will take some additional attention to bring along. Photos taken and sent to Jim Scanlin

East Bay Nursery Training June 15
A terrific group to get with each year as they have a lot of good questions about less toxic products and how they work. They also are very interested in how products even the less toxic can effect beneficial insects. They want more in depth information on what immature beneficial insects look like.Photos taken and sent to Jim Scanlin

Compilation of Training Feedback 2010/2011

The **trainings** were more challenging to arrange than last year because the stores did not want to pay overtime for trainings which put a crimp in the before or after hours trainings. It also made some of them schedule late in the season because they hired help later than in previous years. I conducted 15 trainings in 13 stores, 113 individuals were trained and 92 evaluations collected.

Questions asked:
1. The training workshop was well organized and interesting 77% strongly agreed, 20% agreed, 2% neutral.

2. The information changed my mind about pesticides 54% strongly agreed, 25% agreed, 21% were neutral.

3. My training manual will be a useful resource in the future 79% agreed strongly, 16% agreed, 5% neutral

4. The information will help me recommend and sell less toxic products. 77% Agreed strongly, 19% Agreed, 3% neutral

5. The instructor was responsive to questions 94% agreed strongly, 6% neutral.

6. The level of detail was appropriate 81% agreed strongly, 17% agreed, 2% neutral.

7. Visual Aides were effective 84% strongly agreed, 16% agreed.

8. Written materials were effective. 80% strongly agreed, 18% agreed, 2 % neutral: For **the independent nurseries I tailored each of the trainings to the questions the stores wanted answered and to the products they carry. I made extra efforts this year to discuss pesticides of concern the pyrethroids for their dangers to water quality and systemic pesticides that have negative effects on pollinators and beneficial insects. I also discussed concerns with nutrient runoff when using synthetic fertilizers.**

9. I would recommend this training to coworkers. 86% Strongly agreed, 9% agreed, 2% neutral, 4% strongly disagree

10. I would like to learn more about IPM and IPM certification. 64% strongly agreed, 23% agreed, 12% neutral.

Having served on the advisory committee for the UCIPM online training for retail employees 2years ago, I highly recommended the UCIPM online training for retail employees modules on How to Read a Pesticide Label and Beyond Pesticides. I also heavily promoted the Ask the Expert Feature on the OWOW website.

The differences from last year were questions:

#1. The training workshop was interesting and well organized.
77% strongly agreed compared to 71% last year increase over 2010
20% agreed compared to 21% last year
2% neutral compared to 5% last year

#2 The information changed my mind about pesticides
This year 54% strongly agreed compared to 61% last year decrease from 2010
This year 25% agreed compared to 32% agreed last year
This year 21% were neutral compared to 12% last year

#3My training manual will be a useful resource in the future
This year 79% strongly agreed compared to 76% last year increased over 2010
This year 16% agreed compared to 21% last year
This year 5 % were neutral compared to 4 % last year

#4 the information will help me recommend and sell less toxic pesticides
This year 77% strongly agreed compared to 84% last year decreased from 2010
This year 19% agreed compared to 15% last year

#5 The instructor was responsive to questions
94% Strongly agreed compared to 85% last year increase over 2010
6% were neutral compared to 3% last year

#6 the level of detail was appropriate
81% strongly agreed compared to 78% last year increase over 2010
17% agreed compared to 19% last year

#7 Visual aides were effective
84% strongly agreed compared to 75% last year increase over 2010
16% agreed compared to 23% last year

#8 Written materials were effective
80% strongly agreed compared to 94% last year decrease from 2010
18 % agreed compared to 5% last year

#9. I would recommend this training to coworkers
86% strongly agreed compared to 77% last year increased over 2010
9% agreed compared to 23% last year

#10. I would like to learn more about IPM and IPM certification
64% strongly agreed compared to 67% last year almost the same
23% agreed both years
12% neutral compared to 3% last year

Conclusions on trainings

With the economy many seasoned employees were let go or hours cut back so there were many new faces and many part time employees filling those positions. This made the trainings more challenging not only to schedule but adding the wet weather changed many of the previously set dates. The staff continue to value our trainings and 96% strongly agree and agree that it helps them to sell less toxic pesticides. It seems we had more staff who are interested in less toxic pesticides and not as many who needed to have their eyes opened about the toxicity of pesticides as in years past.

Most of the training the employees received is still from the pesticide companies so all the more reason to have a neutral party giving them information There is a lot of misinformation being given by pesticide companies regarding the safety of certain pesticides for use on food crops. The rational is that these products have been used for over 20 years in commercial fields.

Some of the pesticide companies have their employees working in the stores helping customers on the weekends. This again was much more common than in the past and is very disconcerting. This is happening in Depot and some OSH stores on weekends in the spring.

I was able to meet several pesticide representatives and have had the rep for Ortho Scott's products in Emeryville Home Depot actually help get better visibility for products by making a display with half of the display being their eco-friendly products. Photos sent to Jim Scanlin.

Most of the % increase or decrease were slight variations between strongly agree or agree so we continue to receive positive feedback on our trainings.

IPM Outreach Events

Special event Home Depot Emeryville 4/21/11
4 to 7pm

The new nursery indoor department head Charlene asked me to come and do a tabling for Earth Day week. I set up in the pesticide section and was fortunate to meet with one of the pesticide distributor reps who cares for their store. I told him about OWOW and how we are supporting his products. He was excited and happy to learn more about the products he carries that are eco friendly. I am trying to schedule a training here for June. I contacted about 48 customers and handed out Sluggo samples, 10 most wanted bug guides, pest bugging you wallet guides, in addition to fact sheets. Photos sent to Jim Scanlin

Evergreen Nursery June 26th tabling event. Good customer turn out and opportunity to support the staff with their efforts for the OWOW program. I met with about 56 customers and they were very busy considering it being a Sunday. There were also some new employees that I was able to meet with and tell about our program between the customers I was helping with pest questions. In addition to fact sheets I handed out pests bugging you wallet guides and 10 Most Wanted Bug Brochures. Photos sent to Jim Scanlin

Pesticide Reduction and increase in sales and shelfspace of less toxic products:

Broadway Terrace Nursery has discontinued selling systemic pesticides and are open to telling their customers that they not only pollute but they are not that effective for the plant.

Westbrae Nursery continues to reduce their toxic pesticide offerings. By the end of this year Jeff the owner plans to phase out the systemic rose care. He is always open to new effective less toxic products.

Grand Lake Ace Oakland stands out as a store that actively engages customers when they are purchasing products and lets them know about less toxic alternatives to a toxic pesticide they may be selecting. I have interviewed them on tape and they are very active in guiding customers to better solutions.

Regan Nursery has been a star in the Fremont area and actively engages their customers in conversations about less toxic options. They also have taken the OWOW materials off the nursery property and out at events in the community at the Earth Day event at Washington Hospital contacting over 200 participants, the regional parks event in Fremont dedicated to Butterflies and Pollinating plants. They hand out hundreds of the fact sheets on Healthy Gardening, Aphids, Roses and more. They actively promote the OWOW message. They also frequently promote the Ask the Expert Feature on the OWOW website.
They most often encourage customers to choose a more responsible and effective solution when they pick up a less eco friendly product.

Challenges:

The challenges were dealing with making appointments to set up the Home Depots and to schedule trainings. They had hours cut this spring and many of the garden staff work different days. I was able to schedule meetings with staff who supervise departments and who may work in garden also. Staff turnover high here too. The fact sheets and shelf talkers remain up but need maintaining when prices get changed so more frequent visits especially in Spring to keep materials looking fresh. The Home Depots are five times the maintenance of an independent nursery or an OSH.

Recommendations for 2010/2011
The 10 most wanted brochures continue to be a hit as do the bug charts. These familiarize staff with common beneficial insects and help them not to recommend sprays for them. If we could do an ad campaign like we did a year ago it would help unite the group with a theme for the season. The Home Depots need to be seen about every 4-6 weeks to keep materials and shelf talkers tidy.

The stores have received a lot of pressure and incentives to bring in more toxic products than in years past. The economy has made a very competitive marketplace for shelf space for anything so our presence is even more important. I would like to have a campaign that would include billing inserts mentioning partner stores, recycling guides mentioning partner stores, calendars listing partner stores. Raising the visibility of participating in the program so consumers are seeing the stores in multiple publications throughout the year would be very helpful.

Thank you for this tremendous opportunity to work with the stores I really appreciate it.

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APPENDIX I
BASMAA POC/Monitoring Regional Supplemental Report

Alameda Countywide
Clean Water Program

Contra Costa
Clean Water Program

Fairfield-Suisun
Urban Runoff
Management Program

Marin County
Stormwater Pollution
Prevention Program

Napa County
Stormwater Pollution
Prevention Program

San Mateo Countywide
Water Pollution
Prevention Program

Santa Clara Valley
Urban Runoff Pollution
Prevention Program

Sonoma County
Water Agency

Vallejo Sanitation
and Flood
Control District

B A S M A A

Regional Pollutants of Concern Report for FY2010-2011

and

Monitoring Status Report for January-June 2011

FINAL

September 12, 2011

Bay Area

Stormwater Management

Agencies Association

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Table of Contents

Page

List of Figures

List of Tables

List of Appendices: Regional Pollutants of Concern Report

List of Appendices: Monitoring Status Report

INTRODUCTION

This document is divided into two main parts, each serving a different purpose. Part A, the **Regional Pollutants of Concern Report** for FY 2010-2011 (Regional POC Report), summarizes the status of regionally-implemented activities that were conducted on behalf of all 76 municipalities and special districts (Permittees) subject to the Municipal Regional Stormwater NPDES Permit (MRP, Order R2009-0074) issued to by the San Francisco Regional Water Quality Control Board (Water Board). The Regional POC Report covers annual reporting requirements for portions of MRP Provisions C.9, C.11, C.12, C.13 and C.14, and also reports on the status of regionally-implemented activities implemented in compliance with Provision C.10.a. The Regional POC Report complements separately submitted Annual Reports prepared by Permittees individually or by their respective countywide stormwater programs.

Part B of this document is a **Monitoring Status Report** that provides an update on activities related to MRP Provision C.8 (Water Quality Monitoring). As described in the introduction to the Status Report, the MRP does not require reporting for C.8 provisions until 2013, but Permittees have agreed to provide the Water Board with brief Monitoring Status Reports in March and September of 2011 and 2012 to demonstrate progress in water quality monitoring planning activities. This Monitoring Status Report covers activities roughly from the time period January through June 2011.

Regionally-implemented activities for Pollutants of Concern (POCs) and water quality monitoring are conducted under the auspices of the Bay Area Stormwater Management Agencies Association (BASMAA), a 501(c)(3) non-profit organization comprised of the municipal stormwater programs in the San Francisco Bay Area. Most of the MRP requirements pertinent to activities discussed in the Regional POC Report and Monitoring Status Report are met entirely by BASMAA regional projects, except where otherwise noted. Scopes, budgets, and contracting or in-kind project implementation mechanisms for BASMAA regional projects follow BASMAA's *Operational Policies and Procedures,* approved by the BASMAA Board of Directors (BOD). MRP Permittees, through their stormwater program representatives on the BOD and its subcommittees, collaboratively authorize and participate in BASMAA regional projects or tasks. Regional project costs are shared by either all BASMAA members or among those Phase I municipal stormwater programs that are subject to the MRP[1].

[1] The BASMAA programs supporting MRP Regional Projects include all MRP Permittees as well as the cities of Antioch, Brentwood, and Oakley which are not named as Permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities.

PART A

REGIONAL POLLUTANTS OF CONCERN REPORT

POLLUTANTS OF CONCERN

Provisions C.9 through C.14 of the MRP address pollutants that are identified as being of regulatory concern for the San Francisco Bay or other local water bodies. For some, regulatory water quality attainment strategies, such as Total Maximum Daily Loads (TMDLs), have been adopted or are currently under development.

For mercury, PCBs and other sediment-bound pollutants, the Water Board has proposed to implement stormwater-related control measures in the following modes:

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

Many regional tasks reported in this section focus on MRP provisions relating to modes 3 and 4, which require studies or pilot projects intended to reduce uncertainties about the sources, occurrence or effectiveness of control measures for POCs. Other tasks will be implemented through participation in regional or state-wide collaboratives, such as

- The Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP), described in more detail in the Monitoring Status Report below; and
- initiatives to control sources of specific pollutants.

PESTICIDES TOXICITY CONTROL (C.9)

C.9.e. Track and Participate in Relevant Regulatory Processes

The essential requirements of this provision are to track USEPA and DPR actions related to urban-uses of pesticides and actively participate in the shaping of regulatory efforts currently underway. This provision allows for cooperation among Permittees through the California Stormwater Quality Association (CASQA), BASMAA and/or the Urban Pesticide Pollution Prevention Project (UP3 Project). Recognizing that this approach is the most likely to result in meaningful changes in the regulatory environment, Permittees elected to continue on this course in FY 2010-11 to achieve compliance with this provision. One change in FY 2010-11 is that the oversight of this provision was removed from the purview of the BASMAA Monitoring and POCs Committee and instead oversight was provided directly by the BASMAA BOD. Two project profiles were developed and approved by the BASMAA BOD, one to fund the reporting element of this task and one to fund the actual work of tracking pesticide -related regulatory actions. These profiles were approved by the BOD on June 23, 2011 and Oct. 29, 2010, respectively.

The actual work of tracking and participating in the ongoing regulatory efforts related to pesticides was accomplished through BASMAA member participation in the UP3, and chairing of the CASQA Pesticides Subcommittee. FY 2010-11 was very productive; details of the specific achievements in FY 10-11 can be found in the Appendix A1 —Pesticide Regulation for Water Quality Protection, Annual BASMAA Participation Summary and Outcomes Assessment, 2011 (TDC Environmental 2011).

C.9.g. Evaluate Implementation of Source Control Actions Relating to Pesticides

There are no Annual Reporting requirements for Provision C.9.g in 2011. In future years, additional information will be provided on the status of implementation activities designed to comply with this provision.

TRASH LOAD REDUCTION (C.10)

The goal of MRP Provision C.10 (Trash Load Reduction) is to implement control measures and other actions to significantly reduce trash loads to local urban creeks by the end of the term of the MRP (i.e., 40% by 2014), which will set the course for additional load reductions in future years. To achieve this goal, Co-permittees are required to develop and implement a Short-Term Trash Load Reduction Plan, which includes the installation and maintenance of trash full-capture devices, designed to treat a mandatory minimum level of land area, and implementation of other control measures and best management practices (i.e., trash reduction ordinances) to prevent or remove trash loads. To address longer-term goals of trash reduction, Co-permitees are also required to develop a Long-Term Trash Load Reduction Plan near the end of the MRP term in preparation for the next permit.

Activities associated with Provision C.10 requirements were conducted at the Permittee, stormwater program and regional levels in FY 2010-11 on behalf of Permittees. Actions conducted by Permittees are documented in section C.10 of each Permittee's annual report. Regional projects are coordinated through the BASMAA Trash Committee, which includes participation by Bay Area stormwater program and Permittee staff, Water Board staff and other stakeholders (e.g., Save the Bay, Clean Water Action and USEPA Region 9), and approved by the BASMAA Board of Directors (BOD).

In FY 2010-11, the BASMAA Trash Committee began implementing the following three regional projects on behalf of all MRP Permittees in compliance with MRP C.10 provisions:

- Baseline Trash Load Project;
- Trash Load Reduction Tracking Method; and,
- Model Short-Term Trash Reduction Plan.

Summaries on the status of each BASMAA regional project are included in this section. Summaries are organized by MRP provision or by major heading (both marked in bold).

C.10.a.i Model Short-Term Trash Loading Reduction Plan

Provision C.10.a.i of the Municipal Regional Permit (MRP) requires each Co-permittee to submit a Short-Term Trash Load Reduction Plan to the Water Board by February 1, 2012. The plan must describe control measures and best management practices that are currently being implemented and the current level of implementation, and the planned new or enhanced control measures and best management practices that will be implemented to attain a 40% trash load reduction by July 1, 2014.

Near the end of FY 2010-11, BASMAA began to develop a *Draft Model Short-Term Trash Reduction Plan* (Model Plan) to assist Permittees in complying with this requirement (C.10.a.i) and reduce resources needed by each Permitee to develop a plan. The Model Plan provides a template for Permittees to use when developing their own plans and creates MRP-wide consistency in format. The Draft Model Plan is currently under review by Permittees and includes model text descriptions for the following information:

- Trash baseline load for the Permittee;
- Baseline trash control measure implemented prior to the effective date of the MRP (12/1/09);
- Enhanced levels of trash control measure implementation expected to address the 40% trash load reduction goal; and,
- Schedule for implementation of enhanced control measures.

The Model Plan is expected to be finalized by the BASMAA Trash Committee in the fall of 2011.

C.10.a.ii Baseline Trash Loading Rates

MRP Provision C.10.a.ii requires Permittees to develop and report on baseline trash loads from their MS4s by February 1, 2012. On February 1, 2011, BASMAA submitted a progress report to the Water Board on behalf of all towns, cities, and counties (i.e., Permittees) subject to this provision of the MRP. Through the submittal of this progress report, all MRP Permittees agreed to use methods developed collaboratively through BASMAA to develop their baseline trash load. These methods are fully described in the *Baseline Trash Loading Rates Literature Review and Methodology – Technical Memorandum* (BASMAA 2010a) and the *Baseline Trash Loading Rates Sampling and Analysis Plan* (BASMAA 2010b).

Baseline trash loading estimates are currently under development via the BASMAA *Baseline Trash Loading Rates Project*, which was approved by the BOD in December 2010. Roughly 160 storm drain inlets equipped with full capture devices that are dispersed throughout the Bay Area serve as the monitoring sites that will assist Permittees in establishing baseline loading rates. Monitoring sites were selected to test the effect that land use and other factors (e.g., economic profile and population density) may have on trash loading rates.

It is anticipated that trash and other debris will be removed and characterized an average of three times from each device. The first cleanout and characterization event occurred in May 2011 and is depictive of the 2010/11 wet weather season. The dry weather season cleanout and characterization event is scheduled for September 2011. Additional wet weather cleanout/characterization events are planned for late fall and winter 2011.

As an outcome of the Trash Baseline Loading Rates Project, dry and wet weather trash generation rates will be calculated for each monitoring site. These generation rates can then be used by Permittees to develop trash baseline loading rates and trash loads specific to their jurisdictional areas and incorporate the effectiveness of current (baseline) street sweeping and stormwater conveyance system maintenance programs. Trash baseline loading rates will be reported by each Permittee in their *Short-Term Trash Load Reduction Plans* by February 1, 2012.

C.10.a.ii Trash Load Reduction Tracking Method

Provision C.10.a(ii) requires Permittees to develop a method by which they will demonstrate progress towards the MRP trash load reduction goal (i.e., 40% by 2014). On February 1, 2011, BASMAA submitted a progress report to the Water Board on behalf of all towns, cities, and counties (i.e., Permittees) subject to this provision of the MRP. Through the submittal of this progress report, all MRP Permittees agreed to use the load reduction tracking methods that will be developed collaboratively by BASMAA.

In FY 2010-11, the BASMAA BOD approved a regional project to develop load reduction tracking methods. As a first step, a list of trash control measures that may be considered for implementation by Permittees was developed. These control measures formed the scope of a literature review that was conducted by BASMAA to document methods that were successfully used to assess effectiveness. The findings of the literature review were documented in BASMAA (2011c) and discussed among participants on a control measure by control measure basis at monthly BASMAA Trash Committee meetings during FY 2010-11. Based on these discussions, trash control measures were tentatively separated into two general types: 1) quantification formulas and, 2) credits (Table A.1).

A preliminary Draft Trash Load Reduction Tracking Method Technical Report is currently under development by BASMAA. It is anticipated that the technical report will fully describe the load reduction tracking method selected for each control measure, and the process by which load reduction tracking will take place. On behalf of all Permittees, the Final Trash Load Reduction Tracking Method Technical Report will be submitted to the Water Board by BASMAA by February 1, 2012.

Table A.1. Initial trash control measures selected by BASMAA for trash load reduction tracking method development.

Load Reduction Quantification Formulas
Single-use Carryout Plastic Bag Ordinance
On-land Litter Pickup/Removal (Volunteer and/or Municipal)
Enhanced Street Sweeping
Partial-Capture Treatment Devices
Enhanced Stormwater Conveyance System Maintenance
Full-Capture Treatment Devices
Creek/Channel/Shoreline Cleanups (Volunteer and/or Municipal)
Load Reduction Credits
Polystyrene Foam Food Service Ware Ban
Public Education and Outreach Programs
Trash Reduction from Vehicles with Unsecured Loads
Anti-Littering and Illegal Dumping Enforcement Activities
Improved Trash Bin/Container Management (Municipally or Privately-Controlled)

JOINT MERCURY AND POLYCHLORINATED BIPHENYLS (PCBS) CONTROLS

Provisions C.11.c through C.11.j for mercury are written almost identically to C.12.c through Provision C.12.g for PCBs. This reflects similarities between the respective TMDLs for these pollutants, based on the legacy and sediment-associated nature of their occurrence. For Provisions C.11/12.c through C.11/12.f, MRP requirements focus on pilot studies (sites for these pilots will primarily be chosen on the basis of the potential for reducing PCB loads, but consideration will be given to mercury removal in the final design and implementation of the studies). Provisions C.11.i and C.12.i are written identically, since the primary San Francisco Bay beneficial use impairment for both mercury and PCBs is associated with consumption of fish containing these pollutants.

Overview of Mercury and PCB Pilot Projects

Provisions C.11/12.c through Provision C.11/12.f require pilot studies to test methods to reduce urban runoff loadings of PCBs and mercury to San Francisco Bay. These provisions require that Permittees pilot-test a variety of potential control methods, including site remediation, enhanced sediment management during municipal operation and maintenance activities, stormwater treatment retrofitting, and diversion of stormwater to existing Publicly-Owned Treatment Works (POTWs). Table A.2 summarizes the wide range of pilot projects proposed by BASMAA agencies to pilot-test various control methods. Most projects are located in the older industrial regions in the Bay Area where past studies have found elevated PCB and mercury concentrations in sediments collected from street and storm drain infrastructure. Thus the pilot projects,

Table A.2. Bay Area PCB/Mercury Pilot Projects

Project Watershed Location	City/County	C.11/12.c – Pilot Property ID & Referral	C.11/12.d –Pilot Sediment Manage-ment	C.11/12.e – Pilot Stormwater Treatment Retrofit	C.11/12.f -Pilot Stormwater Diversion to POTW	Green Street	Source(s) of Funding
Ettie St. Pump Station watershed	Oakland, Alameda	Yes	Pipe flushing to POTW	1. Amended sand filter 2. Tree well(s)?	1. Hard-piped pump station to POTW 2. Pipe flushing to POTW	No	CW4CB, ACCWP, Oakland
Lauritzen Channel watershed	Richmond, Contra Costa	Yes	2nd St. and Cutting Blvd. storm drain inlet cleanout	1st and Cutting PG&E substation flow-through biotreatment	No	No	CW4CB, CCCWP, Richmond
Parr Channel watershed	Richmond, Contra Costa	Yes	Possible frequency of storm drain inlet cleaning study	Nevin Ave. green street improvements - bioretention, flow-through biotreatment, tree well(s).[2]	No	Yes	CW4CB, CCCWP, Richmond
Pulgas Creek Pump Station watershed	San Carlos, San Mateo	Yes	Street flushing to POTW	Bransten Rd. bioretention curb extensions	Street flushing to POTW	Yes	CW4CB, SMCo VLF, SMCWPPP, San Carlos
Leo Ave. watershed	San Jose, Santa Clara	Yes	Street sweeping study	Water quality-enhanced Hydrodynamic Separator	No	No	CW4CB, ARRA, SCVURPPP, San Jose

2The Nevin Ave. green street improvements are located partly within the Parr Channel watershed and partly within an adjacent watershed in Richmond.

Table A.2. Bay Area PCB/Mercury Pilot Projects - continued

North Richmond Pump Station watershed	Richmond, Contra Costa	No	No	No	Hard-piped pump station to POTW	No	SFBWQIF, CCCWP, CCC-FCWCD
Drainage bounded by Hamilton Ave., Bryant St., Channing Ave., and Alma St.	Palo Alto, Santa Clara	No	No	No	Hard-piped diversion structure to POTW	No	SCVURPPP, Palo Alto
State St. Pump Station watershed	Fairfield, Solano	No	Strategic cleanout of pump station to POTW	No	Strategic cleanout of pump station to POTW	No	FSURMP
El Cerrito Green Street	El Cerrito, Contra Costa	No	No	Flow-through biotreatment	No	Yes	CW4CB, CCCWP, El Cerrito
Alameda and High St. - local unnamed sewershed that drains into the canal between Oakland and Alameda	Oakland, Alameda	No	No	CDS unit for trash and sediment capture	No	No	ARRA, ACCWP? Oakland
International and 73rd drainage area	Oakland, Alameda	No	No	CDS unit for trash and sediment capture	No	No	ARRA, CCCWP? Richmond
31st and Market drainage area - pending property owner identification and agreement to participate	Richmond, Contra Costa	No	No	Tree well(s)	No	No	CW4CB, CCCWP, Richmond

Table A.2. Bay Area PCB/Mercury Pilot Projects - continued

Osgood Rd. - one-block drainage – may exclude because low PCBs and Hg?	Fremont, Alameda	No	No	Tree well(s)	No	No	CW4CB, ACCWP, Fremont
Under discussion	Vallejo, Solano	No	No	Swale or catch basin filter-type application by PG&E substation?	No	No	CW4CB, FSURMP, Vallejo
Under discussion	? Santa Clara	No	No	?	No	?	CW4CB, SCVURPPP, ?
Trash capture devices in numerous Bay Area drainages	Various	No	No	Trash capture devices that also capture sediments	No	No	ARRA, BASMAA agencies
Low dissolved oxygen cleanouts in various pump station drainages –Under discussion	Various	No	?	No	?	No	BASMAA agencies

which are described in more detail later in this section, appear representative of the known types of potentially effective control measures and the geographic area of potential wider implementation in the future.

To evaluate effectiveness of the pilot studies, field monitoring will be conducted to inform a quantitative estimation of the degree to which each type of stormwater control measure reduces PCBs and other pollutants to the Bay. Monitoring results and conclusions will be presented in the Integrated Monitoring Report due March 2014 to the Water Board. Pilot study results presented in the Integrated Report, at a minimum, will be evaluated based on the following general criteria:

1. **Feasibility** – is a control measure technically and economically feasible?
2. **Cost Efficiency** – what is the cost-effectiveness of the control measure (e.g., $/kg pollutant load removed or avoided).
3. **Opportunity** – what mass of the pollutant can reasonably be avoided over a given time period via the control measure? For example, enhanced inlet cleaning is potentially feasible and cost-effective but it is possible that only a relatively limited mass of sediment and associated pollutants could be captured each year using this method due to the small amount of sediment usually found in Bay Area inlets.

The successful pilot program outcome will contribute to developing a comprehensive regional strategy for reducing PCB and mercury loads in urban runoff, based on the relative effectiveness of a range of potential pollutant control methods. Recommendations to implement the most feasible and cost-effective control methods that significantly reduce pollutant loads to the Bay on a more widespread scale may be included in the regional strategy.

Overview of Clean Watersheds for a Clean Bay

Clean Watersheds for a Clean Bay (CW4CB) is a grant-funded project that is anticipated to result in Permittee compliance with the following MRP Provisions that jointly address PCBs and mercury (each of these provisions is described further in subsequent sections):

- C.11/12.c (CW4CB Tasks 2 and 3) - Pilot Projects to Investigate and Abate Mercury/PCB Sources;
- C.11/12.d (CW4CB Task 4) - Pilot Projects to Evaluate and Enhance Municipal Sediment Removal and Management Practices;
- C.11/12.e. (CW4CB Task 5) - Pilot Projects to Evaluate On-Site Stormwater Treatment via Retrofit; and,
- C.11/12.i (CW4CB Task 6) - Development of a Risk Reduction Program Implemented throughout the Region.

These provisions implement priority urban runoff-related actions called for by the San Francisco Bay PCBs and mercury Total Maximum Daily Load (TMDL) water quality restoration programs. CW4CB will help implement these TMDLs by developing and pilot-testing a variety of potential methods to reduce urban runoff loading of PCBs and mercury to the Bay. The project began July 1, 2010 and is scheduled for implementation over four years.[3] CW4CB is facilitated through a partnership among Bay Area municipalities and countywide municipal stormwater management programs and is funded by a grant to BASMAA from the United States Environmental Protection Agency (EPA).[4] A work plan was submitted to EPA on September 23, 2009 (a final revised version is dated April 19, 2010).[5] The total project cost is $7.04 million - $5M from EPA and $2.04M matching funds from Bay Area municipal stormwater agencies, municipal wastewater treatment agencies, and industrial dischargers. The project's efforts are also leveraged by in-kind assistance from participating municipalities. The knowledge and experience gained and the lessons learned during CW4CB will be promoted and made readily available to inform future similar efforts by others in the Bay Area and elsewhere in California and the United States.

Oversight and Coordination

A Project Management Team (PMT) consisting of BASMAA's executive director and representatives from several BASMAA member agencies (i.e., Bay Area stormwater programs)[6] was formed at the outset of the project. Several Bay Area cities are also participating in CW4CB and send representatives to the PMT.[7] The PMT provides project oversight and facilitates coordination among the participating stormwater programs and cities. The PMT meets periodically, usually on the second Wednesday of the month, and met eight times during FY 2010/11: (July 14, August 11, October 13, November 10, and December 8, 2010, and February 9, April 13, and June 8, 2011). Each meeting's highlights and action items are memorialized in subsequent meeting agenda packages that are available upon request. The PMT also formed two workgroups during FY 2010/11. One workgroup focuses on CW4CB Task 4 (sediment management) and met once during FY 2010/11 on May 23, 2011. A large number of municipal public works operation and maintenance staff attended this meeting. The other new workgroup focuses on CW4CB Task 5 (urban runoff treatment retrofitting) and met three times during FY 2010/11: April 11, April 26, and June 22, 2011.

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[3]It should be noted that CW4CB started later than originally anticipated. EPA's original Request for Proposal included an anticipated award date of February 2010. However, despite EPA's and BASMAA's best efforts to expedite the process, EPA was not able to provide BASMAA with an assistance agreement until June 2010 which resulted in a project start date of July 1, 2010.

[4]Funding is through EPA's San Francisco Bay Water Quality Improvement Fund.

[5]Clean Watersheds for a Clean Bay. Proposal/Workplan prepared by BASMAA for EPA for funding via San Francisco Bay Water Quality Improvement Fund. Submitted September 23, 2009. Revised April 19, 2010 (included with FY2009-10 Annual Reporting BASMAA Regional Supplement for POCs and Monitoring as itsAppendix A2).

[6]The following BASMAA agencies are represented on the PMT: San Mateo Countywide Water Pollution Prevention Program, Santa Clara Valley Urban Runoff Pollution Prevention Program, Alameda Countywide Clean Water Program, Contra Costa Clean Water Program, and Fairfield-Suisun Urban Runoff Management Program.

[7]The following cities are participating in CW4CB: City of Oakland, City of San Carlos, City of Richmond, and the City of San Jose.

Technical Advisory Committee

A Technical Advisory Committee (TAC) comprised of local and national experts will help optimize the scientific and technical soundness, integrity, and objectivity of CW4CB. The areas of expertise for the TAC members include:

1. Designing and implementing stormwater pollutant controls targeting particle-bound pollutants such as PCBs and mercury.
2. Addressing pollutants via enhancement of municipal operation and maintenance activities that remove sediment from streets and storm drain system infrastructure (i.e., sediment management).
3. Designing and implementing urban runoff treatment retrofits, especially in highly urbanized built-out industrial areas where available land space is often sparse.
4. Evaluating the effectiveness of stormwater pollutant controls through field monitoring, including estimating load reductions.

During FY 2010/11, the PMT developed a document that compiles information needed to facilitate convening the TAC(BASMAA 2011a).[8] The document included an introduction to CW4CB, project background, a description of the purpose of the TAC, scope of work, a list of additional candidate members, and a list of questions to ask when interviewing additional candidates. The PMT then formed a TAC comprised of four to five individuals:

1. Dr. Tom Mumley (Assistant Executive Officer, Regional Water Board).
2. Dr. Lester McKee (Director of the Watershed Program, San Francisco Estuary Institute).
3. Scott Taylor (Senior Vice President, RBF Consulting) - pending confirmation
4. Roger Bannerman (Environmental Scientist, Wisconsin Department of Natural Resources) - pending confirmation

An initial meeting of the TAC is tentatively scheduled for October 2011.

Sampling and Analysis and Quality Assurance Plans

On March 7, 2011 CW4CB's Principal Investigator and Project Manager met with the EPA Project Manager and Quality Assurance Officer assigned to CW4CB to discuss scoping the CW4CB Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP). Initial draft versions of the SAP(BASMAA 2011b)[9] and QAPP(BASMAA 2011c)[10] were subsequently submitted to EPA on July 29, 2011. These documents cover field sampling related activities associated with CW4CB Task 3. Tasks 4 and 5 will be

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[8] BASMAA 2011a. Clean Watersheds for a Clean Bay. Technical Advisory Committee. Draft May 9, 2011.

[9] BASMAA 2011b. Sampling and Analysis 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 No. CFDA 66.202. Prepared by Applied Marine Sciences, Inc. DRAFT July 29, 2011.

[10] BASMAA 2011c. 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 No. CFDA 66.202. Prepared by Applied Marine Sciences, Inc. DRAFT July 29, 2011.

conducted chronologically later than Task 3 and future revisions of the SAP and QAPP will provide further details about the Task 4 and 5 monitoring fieldwork.

C.11/12.c - Pilot Projects To Investigate and Abate Mercury/PCB Sources

CW4CB Tasks 2 and 3 are anticipated to result in Permittee compliance with MRP Provisions C.11/12.c. Task 2 of CW4CB was completed during FY 2010/11 and entailed selecting five Bay Area region watersheds for pilot source property identification and referral investigations. Each watershed was selected due to the relatively high levels of PCBs[11] observed in sediments from roadway and stormwater drainage infrastructure and other attributes that previous studies[12] indicated would make these watersheds high priority for investigation. Task 3 of CW4CB entails conducting the investigations. Further details regarding the selection methodology and maps of the watersheds are provided in a progress report that was submitted to EPA in April 2011.[13] The following five project watersheds were selected:

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

As Task 3 of CW4CB, during FY 2010/11 Permittees began implementing 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. The process consists of the following five steps:

1. <u>Records review</u>. Review general information sources (e.g., spill site databases) and records on specific properties/businesses to begin identifying potential source properties within the pilot watersheds.
2. <u>Driving/walking survey</u>. 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. <u>Facility inspections</u>. Perform inspections of selected facilities within each pilot watershed.
4. <u>Surface soil/sediment testing</u>. 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. <u>Property referrals</u>. Where laboratory data confirm elevated pollutant concentrations, refer properties to regulatory agencies for cleanup and abatement.

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[11] Reducing loads of PCBs is the primary selection factor whereas reducing loads of mercury and other sediment-bound pollutants is a secondary consideration.

[12] Discussed in Appendix A3 of the FY2009-10 Annual Reporting Regional Supplement for POCs and Monitoring

[13] Clean Watersheds For a Clean Bay (CW4CB) Semi-Annual Progress Report Number 2. April 29, 2011.

During FY 2010/11 the PMT prepared a general work plan and guidance (BASMAA 2011e)[14] for the Steps 1 - 3 above and investigations were initiated in each watershed. The results from Steps 1 - 3 will characterize each inspected property in the project watersheds as having higher, medium or lower potential to release PCBs/mercury to streets and stormwater conveyances. It should be noted that in some watersheds some of these types of activities have previously been conducted and thus the extent of additional effort needed is under evaluation. Table A.3 presents typical attributes of sites with higher, medium or lower potential for PCB/mercury release. A map of each watershed showing the locations of sites with higher potential for PCB/mercury release will be created using GIS software. This information will be used to inform the development of a soil/sediment sampling and chemical analysis monitoring program designed to identify potential source properties (above Step 4).

The surface soil/sediment sampling is anticipated to be conducted on both the public right-of-way and private properties within the project watersheds. Soil/sediment samples will be analyzed for PCBs, mercury, total organic carbon (TOC), and grain size. Approximately 10 percent of these samples (selected randomly) will also be analyzed for dioxins, PBDEs, organochlorine pesticides, and PAHs. In general, the first phase of Task 3 (records review, field surveys, and facility inspections) in the watersheds is scheduled for completion by September 2011 and soil/sediment sampling is scheduled for September through December 2011, except for two of the watersheds, Parr and Lauritzen, where the site investigations were completed in June 2011. Further details are provided in the project SAP. In addition, further details regarding investigations in individual watersheds are provided in the following sections.

Ettie Street Pump Station Watershed

In 2000 and 2001 investigations by the Alameda Countywide Clean Water Program suggested that there are multiple sites in the Ettie Street Pump Station watershed that continue 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 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. 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).

Table A.3. Typical attributes of sites with higher, medium and lower potential for

[14]BASMAA 2011e. General Work Plan and Guidance for CW4CB Task 3 Records Review, Driving/Walking Survey and Facility Inspections. August 2011.

PCB/mercury release to streets and stormwater conveyances.

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., PCB transformers). • Outdoor hazardous material/waste storage areas (e.g., tanks, drums) with 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.

A case study and final report that details the methods and results for the PCB Abatement Grant Project was completed (Kleinfelder 2006).[15] For CW4CB Task 3 the City of Oakland is currently reviewing the inspection and sampling data in detail to determine if any additional sampling is needed in the watershed. In particular, the City will conduct sampling on industrial properties that were considered "high priority" sites but lack sufficient sampling data to determine if the property is a potential source. A review of existing data and additional sampling results will be used to provide referrals to the appropriate agencies. These referral identifications will be performed after coordination with the referral agencies and are anticipated for fall/winter 2011.

Parr Channel and Lauritzen Channel Watershed

In FY2010-2011, CCCWP conducted investigations of properties in catchments draining into the Lauritzen Channel and the Parr Channel watersheds. Of 166 parcels identified in those watersheds, 62 parcels were inspected from outside the property line, and 13

[15] Kleinfelder 2006. Final Project Report, Ettie Street Pump Station Watershed, Oakland, California. Prepared for City of Oakland PWA - ESD by Kleinfelder, Inc. September 29, 2006.

were inspected onsite. Inspection procedures built upon lessons learned from similar investigations that have been conducted in the past in the Ettie Street catchment in Alameda County. 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. The CCCWP will coordinate with other programs and the CW4CB project management team in early 2011-2012 to share lessons learned from the site inspections and propose priorities for monitoring under CW4CB tasks.

Pulgas Creek Pump Station Watershed

In 2000 and 2001, BASMAA member agencies collaborated to measure concentrations of PCBs, mercury and other pollutants in embedded sediments within stormwater conveyance systems throughout the Bay Area. The primary goal of this project, referred to as the Joint Stormwater Agency Project (JSAP), was to characterize the distribution of pollutants among land uses in watersheds draining to San Francisco Bay. The JSAP identified elevated PCB concentrations in the Pulgas Creek Pump Station watershed, an area with current and historic industrial land uses in the City of San Carlos, and other urban areas around the Bay Area (KLI and EOA 2002).[16] In 2002 and 2003, the San Mateo Countywide Stormwater Pollution Prevention Program (SMCWPPP) performed a PCB source identification case study(EOA 2003)[17] in the Pulgas Creek Pump Station watershed. The study identified some potential source properties in the watershed; however, based on the spatial distribution of PCBs in storm drain sediments other sources remained unidentified.

For CW4CB Task 3, the records review process for this watershed began in November 2010. Address and parcel information on the 480 properties located within the watershed was obtained from the San Mateo County assessor website.[18] The addresses and parcel numbers of these properties were then used to perform an online search of a number of databases that contain information regarding pollutant use and/or release sites (see BASMAA 2011e[19]). During December 2010 and February 2011, all available hazardous materials records for properties in the watershed were reviewed at the San Mateo County Department of Environmental Health (SMCDEH).[20] In July 2011, additional records regarding stormwater inspections were obtained from the City and

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[16]KLI and EOA 2002. Final Report, Joint Stormwater Agency Project to Study Urban Sources of Mercury, PCBs, and Organochlorine Pesticides. Prepared by Kinnetic Laboratories, Inc. and EOA, Inc. April 2002.

[17]EOA, Inc. 2003. Case Study Investigating Elevated Levels of PCBs in Storm Drain Sediments in the Pulgas Creek Pump Station Drainage, San Carlos, CA. Prepared for the San Mateo Countywide Stormwater Pollution Prevention Program by EOA, Inc. June 2003.

[18]http://www.smcare.org/apps/ParcelMaps/default.aspx

[19] See footnote 14 above for BASMAA 2011e reference

[20]San Mateo County Department of Environmental Health regulates hazardous materials use and hazardous waste generation by businesses in the county. Properties not regulated report that hazardous wastes are not generated and hazardous materials are stored only in small quantities (less than 55 gallons liquid, 500 pounds solid or 200 cubic feet gas).

reviewed. All pertinent information related to the records review was entered into a data management spreadsheet developed for this watershed.

The next steps in the records review for this watershed are scheduled to commence in September 2011. SMCWPPP will review City business permits for information regarding types of current and historic activities at properties within the watershed. In addition, satellite and aerial imagery software (Google Earth™) will be used to preliminarily identify the current land use of properties located within the watershed, including screening out low priority properties such as residential units and commercial buildings. Google Earth™ will also be 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.

Based on the information collected in the previous steps, SMCWPPP may also review other data sources described in the Task 3 general work plan and guidance (BASMAA 2011e).

In September 2011, SMCWPPP and the City plan to carry out a driving and walking reconnaissance survey of the watershed's public right-of-way areas to collect additional information about the properties and verify information collected during the records review. A survey field form created as part of the Task 3 general work plan and guidance (BASMAA 2011e) will be used to record information during the survey. In addition, a global positioning system camera will be used to capture locations and photographs of suspect properties that may be PCB or mercury sources, including those that have the potential for sediment mobilization to the public right-of-way. The records review spreadsheet will then be updated and corrected as needed based upon information obtained during the survey. This information will then be used to build upon the records review data and assist SMCWPPP and the City select and prioritize sites for facility inspections.

Facility inspections are scheduled for October and November 2011 and will be coordinated with the City and SMCDEH, the agency that routinely conducts stormwater inspections in the city. The results of the records review, field survey, and facility inspections will be used to characterize each inspected property in the project watersheds as having higher, medium or lower potential to release PCBs/mercury to streets and stormwater conveyances. This information will then be used to inform the development of a soil/sediment sampling and chemical analysis monitoring program designed to identify potential source properties in the watershed.

Leo Avenue Watershed

One of the locations with elevated PCB concentrations identified by the JSAP (KLI and EOA 2002 - see previous section) was the Leo Avenue area in San Jose. In response, the City of San Jose, in collaboration with Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), conducted a source identification study at the Leo Avenue area in 2002/2003 that included a review of the enforcement history for stormwater-related violations in the area directly draining to the stormwater conveyance on Leo Avenue and additional sediment sampling (City of San Jose and EOA 2003).[21] Through this effort some private properties on Leo Avenue were identified as possibly contributing PCBs to the stormwater conveyance system. Additionally, large volumes of sediment containing PCBs were removed from the stormwater conveyance system via line flushing and proper disposal.

For CW4CB Task 3, a study area referred to as the Leo Avenue watershed was delineated for further investigation. This larger geographical area (540 acres) includes the area where the original studies and actions described above took place. In February 2011, the SCVURPPP and the City began developing a work plan to outline the steps that will be taken during Task 3 (SCVURPPP 2011)[22] and the work commenced in June 2011 following completion of the work plan.

As a first step, the Santa Clara County (County) assessor website was accessed to obtain addresses and parcel information for the 234 properties located within the watershed. The addresses and parcel numbers of these properties were then used to perform an online search of a number of databases that contain information regarding pollutant use and/or release sites (see BASMAA 2011e).

The next step was to review the City Hall Records Imaging System (CHRIS) database. CHRIS is a comprehensive City database containing information about hazardous waste generators, hazardous materials business plans and types of historic businesses. These records were reviewed for any indication of potential PCB sources in the watershed. Other City and County databases were considered for further records review research; however, CHRIS contained the necessary information for this step and further database searches were determined to be unnecessary.

Finally, satellite and aerial imagery software (Google Earth™) was used to gain a better understanding of the type of properties currently located within the watershed. Using Google Earth™, the list of 234 relevant properties was reduced to 139 by removing land uses such as residential units and commercial buildings that are low priority for this project. Google Earth™ was also used to collect preliminary information about apparent housekeeping and the current condition of properties, including the existence of unpaved areas and the condition of paved areas such as parking lots and driveways.

Following the completion of the records review, SCVURPPP and the City carried out a driving and walking reconnaissance survey around the Leo Avenue watershed to collect additional information about subject properties and verify information collected during the records review. A survey form created as part of the Task 3 general work plan and guidance (BASMAA 2011e) was used to collect information during the survey. Additionally, a global positioning system camera was used to capture locations and

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[21] City of San Jose and EOA 2003. Year Two Case Study Investigating Elevated Levels of PCBs in Storm Drain Sediments in San Jose, California. July 2003.

[22] SCVURPPP 2011. Work Plan – PCBs Source Identification Pilot Project Leo Avenue Watershed, San Jose, California. June 2011.

photographs of suspect properties that may be PCB or mercury sources, including those that have the potential for sediment mobilization to the public right-of-way. Information was recorded that was later used to correct the records review spreadsheet and fill in missing information. After the survey, the spreadsheet was also refined to remove properties that have closed, relocated, or were paved or remediated.

Google Earth™ was then revisited to determine whether certain businesses should remain on the list as potential inspection sites. The results of the reconnaissance survey led to reducing the list of 139 properties to approximately 40 that are being considered for inspection. SCVURPPP and the City are in the process of assigning an inspection priority to each of the 40 properties, and final decisions will be made in September as to which will be inspected by the City and SCVURPPP. Staff from the San Jose Fire Department will be involved in the inspections if properties are hazardous waste generators. In addition, although not on the property inspection list, abandoned and vacant properties and historic railroad right-of-ways were identified for right-of-way sampling.

In October, the City and SCVURPPP will conduct facility inspections at the facilities on the final list of sites. Based on the results of the records review, walking/driving surveys, and property inspections, high priority locations for public right-of-way and/or private property sampling will be identified. This information will then be used to inform the development of a soil/sediment sampling and chemical analysis monitoring program designed to identify potential source properties in the watershed.

C.11/12.d - Pilot Projects to Evaluate and Enhance Municipal Sediment Removal and Management Practices

CW4CB Task 4 is anticipated to result in Permittee compliance with 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 described in the previous section.

Literature Review

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 ((BASMAA 2011f , Appendix A2)[23]. The literature review identified the following key data gaps with respect to evaluating the effectiveness of municipal sediment management practices in reducing PCB and mercury loads to San Francisco Bay:

- <u>Existing studies do not address PCBs and mercury</u> - although there have been a few Bay Area studies that characterized PCBs and mercury concentrations in

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[23](BASMAA 2011f. Sediment Management Practices, Clean Watersheds for a Clean Bay Task 4 Literature Review. Prepared for BASMAA by EOA, Inc. and Geosyntec Consultants. June 7, 2011.

materials collected from streets, stormwater conveyance systems and in street sweeper hoppers, there is a lack of information addressing the effectiveness of sediment management practices to reduce loads of PCBs and mercury. One particular concern is the lack of information on the buildup of PCBs and mercury on street surfaces, which can affect the frequency at which sweeping would be most effective. Thus, it is necessary to infer the effectiveness of street sweeper studies based on the effectiveness of sweepers to remove dust and dirt (<2 mm) and in particular the finer fractions of dust and dirt (less than 63 µm). In addition, information is lacking in regards to the amount of sediment that accumulates in inlets, particularly in industrial areas with elevated pollutant concentrations, and the concentrations of PCBs and mercury in that sediment. In addition, very limited information is available on how PCB and mercury mass is distributed among various particle sizes.

- <u>Few studies have been conducted in semi-arid climates</u> - most reviewed street sweeper effectiveness studies that evaluate advanced sweeper types designed to improve water quality benefits were not carried out in semi-arid climates like the Bay Area. Moreover, a number of studies were conducted where road abrasives are applied during the winter, and this can cause results to be even less representative. There are even fewer studies for inlet cleaning, and only one local study was found that evaluated the effect of cleaning frequencies on the effectiveness of sediment removal.
- <u>Few studies have documented water quality improvements</u> - a number of studies have attempted to measure the potential improvement in water quality associated with street sweeping; however, very few studies indicated a statistically reliable improvement in water quality. A recent paper (Kang et. al 2009) indicates that most street sweeping study designs do not have sufficient statistical power to measure a change given the variability in runoff water quality. One inlet cleaning study attempted to measure water quality improvements based on a semi-annual cleaning frequency; however, it was determined that the number of samples collected was insufficient to characterize the improvements.
- <u>Lack of local studies that evaluate recent improvements in street sweeper technology</u> - no recent studies were found conducted in Bay Area that evaluate the effectiveness of equipment that reflects improvements in street sweeper technology in approximately the last decade.
- <u>Confounding factors make it difficult to compare results across studies</u> - most street sweeper effectiveness studies are affected by confounding factors that affect effectiveness, including climate, particle loadings, street texture, moisture, parking car conditions, equipment operating conditions, and frequency of cleaning and also differ in terms of study design such that it is difficult to compare results amongst different studies. Thus, the best comparison amongst sweeper types is limited to the same study and study conditions. There are also factors that confound comparisons among the results of inlet cleaning effectiveness studies, including variations in rainfall patterns, particle size distributions of local sediments collected, configurations of inlet structure, and cleanout frequency.

- Most studies address effectiveness of catch basins rather than drop inlets – the majority of studies found during this literature review addressed catch basins (with sumps) rather than drop inlets (without sumps). Drop inlets are believed to be the predominant type of inlet in the Bay Area. Since catch basins tend to accumulate more sediment than drop inlets, these studies have limited applicability to the effectiveness of inlet cleaning in the Bay Area.
- Limited information was found on the effectiveness of stormwater conveyance system cleaning enhancements - only limited information was found on the effectiveness of storm drain inlet cleaning (and especially how effectiveness varies with frequency of cleanout) and storm drain line and street flushing.
- Cost-benefit information is not adequately addressed - there was a general lack of cost-benefit analysis found for the major municipal maintenance practices included in this literature review (street sweeping, storm drain inlet cleaning, storm drain line flushing, and street flushing).

Regarding the design of future studies that evaluate the effectiveness of municipal sediment management practices in relation to reducing PCB and mercury loads to San Francisco Bay, the literature review recommended that such studies should:

- Be conducted in Bay Area industrial areas known to have elevated concentrations of PCBs in street and storm drain system sediments.
- Measure concentrations of PCBs and mercury and particle size distributions in sediments. Evaluating effectiveness via water quality monitoring is likely to be challenging. For example, Kang et al. (2009) examined why most studies could not document an effect of street sweeping on water quality and concluded that most monitoring studies do not have sufficient statistical power to distinguish the effect of sweeping given the variability in runoff water quality.
- Be conducted at appropriate spatial and temporal scales to optimize what can be learned within resource constraints. This may require implementation at relatively small scales.
- Document rainfall totals and intensities in the study area over the course of the study.
- Gather the appropriate data and conduct cost-benefit analyses.
- Incorporate working with municipal maintenance staff to document practical lessons learned (e.g., successes, failures, challenges) and thereby facilitate future training of maintenance staff if enhanced practices are implemented on a more widespread basis.

The literature review also noted that as new information is generated by future Bay Area studies on municipal sediment management practices, the spreadsheet models developed during SFEI's Proposition 13-funded study on urban stormwater BMPs should be adapted and refined to incorporate available data on costs and benefits, including estimated load reduction projections based on regional implementation scenarios and associated cost-benefit analyses.

The literature review also recommended consideration of conducting street sweeper effectiveness studies on road segments containing elevated levels of PCBs and mercury that focus on one or more of the following:

- Establishing a baseline for sweeper effectiveness and costs for removing sediment (fine and coarse) and associated PCBs and mercury;
- Evaluating the effect of increasing frequency on sweeper effectiveness and costs;
- Evaluating the effects of utilizing advanced street sweeper equipment on sweeper effectiveness and costs;
- Documenting the effects of site-specific confounding factors that affect sweeper effectiveness and costs; and
- Conducting marginal cost benefit analysis for modifying sweeper programs.

The literature review noted that particular care should be taken to control for confounding factors. Experience has shown that studies that consider controls, differences in surface loadings on different streets, statistical study design (a sampling plan that is sufficient to distinguish the changes anticipated), and quality assurance and control are likely to be more successful. In evaluating sweeper types, it is critical that the testing ensure that the sweepers alternatively operate on the same roadway segments so that the surface loading on the streets is the same for each type of equipment. General guidance on conducting street sweeping programs can be found in the literature.

The literature review also recommended consideration of conducting three general types of stormwater conveyance system cleaning studies:

1. Evaluating the effect of increasing storm drain inlet cleanout frequency on PCB/mercury load reduction benefits and costs.
2. Evaluating costs and PCB/mercury load reduction benefits of street sediment removal including flushing and capture of wash water.
3. Evaluating costs and PCB/mercury load reduction benefits of storm drain line flushing with capture of wash water.

The literature review noted that these studies should include working with municipal staff to develop inventories and maps within the study area of storm drain facilities and other pertinent drainage characteristics, including:

- Types and locations of inlet structures (e.g., drop inlet vs. catch basin) and condition.
- Types and locations of piping and condition.
- Sources of sediment to the storm drain system.
- Specific points within the storm drain system where sediment accumulates (e.g., certain inlets and any "sag" points in piping).

Sediment Management Pilot Studies

Based on the results of the literature review and discussions with municipal staff, the CW4CB Task 4 sediment management workgroup has developed a conceptual regional plan for sediment management studies (Table A.4). Individual work plans are currently under development that detail planned field activities for each pilot sediment management study and include tasks, schedules and budgets.

Table A.4. Pilot Sediment Management Studies

Project Watershed Location	City/County	Type of Study
Ettie St. Pump Station watershed	Oakland, Alameda	Pipe flushing to POTW
Lauritzen Channel watershed	Richmond, Contra Costa	2nd St. and Cutting Blvd. storm drain inlet cleanout
Parr Channel watershed	Richmond, Contra Costa	Frequency of storm drain inlet cleaning study
Pulgas Creek Pump Station watershed	San Carlos, San Mateo	Street flushing to POTW
Leo Ave. watershed	San Jose, Santa Clara	Street sweeping study
State St. Pump Station watershed	Fairfield, Solano	Strategic cleanout of pump station to POTW

To evaluate effectiveness of the pilot studies, a field monitoring plan will be developed in FY 2011-12 that includes collecting and analyze sediment samples to inform a quantitative estimation of the degree to which enhanced sediment management activities reduce loads of PCBs (and other pollutants as appropriate) to the Bay. The desired outcome is to evaluate the cost-effectiveness of various sediment management methods and provide recommendations regarding the implementation of cost-effective methods on a larger scale.

C.11/12.e. - Conduct Pilot Projects to Evaluate On-Site Stormwater Treatment via Retrofit

CW4CB Task 5 is anticipated to result in Permittee compliance with MRP Provisions C.11/12.e. Through the implementation of this task, existing infrastructure will be retrofitted with stormwater treatment measures at 8 to 10 sites in the Bay Area region, and the effectiveness of each measure to remove PCBs and other pollutants will be evaluated. Areas in the Bay Area urban landscape with elevated PCBs are the primary targets for retrofits, with mercury and other pollutants being a secondary consideration. At least one retrofit will likely be installed in each of five major Bay Area counties (Santa Clara, San Mateo, Alameda, Contra Costa, and Solano).[24] The retrofits will use proven

[24] It is anticipated that some but not all of the retrofits will be sited within the five watersheds selected for source property identification and referral described previously.

existing technologies (e.g., filtration devices such as sand filters and green street bioretention facilities) that have been shown to be effective at removing pollutants when properly designed, installed, operated and maintained. These technologies rely on one or more of a variety of processes to remove pollutants, including sedimentation, filtration, adsorption, and decomposition. Devices that can be characterized as meeting "Low Impact Development" principles are being emphasized to the extent their use is consistent with the overall project objectives. Per MRP requirements, the retrofit types will span treatment types and to some extent Bay Area urban watersheds' characteristics.

During FY 2010-11, a preliminary conceptual planning document (BASMAA 2011g)[25] was prepared that serves as a roadmap for all aspects of the stormwater treatment retrofitting program including planning, design, engineering, permitting and construction of the retrofits and associated schedules and budgets. The strategy for selecting retrofit types and locations included issuing a call for existing/planned Capital Improvement Projects (CIPs) that include or could be modified to include stormwater treatment retrofits. This strategy was chosen based upon the retrofit workgroup's assessment that this may produce the best results given existing budget and schedule constraints. After completion of the call for projects the work group evaluated the results and prepared a document presenting candidate locations and types of urban runoff treatment retrofits (BASMAA 2011h, Appendix A3).[26]

The current schedule calls for the construction of the retrofits to be completed by October 2012. A field monitoring plan will be developed to evaluate pilot retrofit effectiveness by collecting and analyzing water samples during the 2012/13 rainy season. The results of the monitoring will inform a quantitative estimation of the degree to which the retrofits reduce loads of PCBs (and other pollutants as appropriate) to the Bay. The desired outcome is to evaluate the cost-effectiveness of various stormwater treatment retrofits and provide recommendations regarding potentially implementing the more cost-effective types on a larger scale.

C.11/12.i - Development of a Risk Reduction Program Implemented throughout the Region

Provisions C.11/12.i require that Permittees implement a regional program of risk communication activities to raise public awareness of fish contamination issues in San Francisco Bay and to encourage fish-consuming populations to reduce their exposure to pollutants in contaminated fish. These provisions require that Permittees report in this 2011 Annual Report the status of the risk reduction efforts. Task 6 of the CW4CB project work plan (submitted with the FYr 2009-10 Annual Reporting Regional Supplement for POCs and Monitoring) includes a description of the tasks being conducted via the

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[25] BASMAA 2011g. Conceptual Planning Roadmap for Implementing Urban Runoff Treatment Retrofits, Clean Watersheds for a Clean Bay Task 5. Prepared for BASMAA by Geosyntec Consultants. August 2011.

[26] BASMAA 2011h. Candidate Locations and Types of Urban Runoff Treatment Retrofits, Clean Watersheds for a Clean Bay Task 5. Prepared for BASMAA by Geosyntec Consultants. August 2011.

project to raise public awareness and encourage reduction of exposure. The effort includes four general subtasks:

- Sub-task 1. Convene a risk reduction stakeholder advisory group.
- Sub-task 2. Develop a broad risk communication strategy.
- Sub-task 3. Award and oversee implementation of mini-grants.
- Sub-task 4. Conduct evaluation activities.

This section reports on progress during FY 2010-11 for all of the above sub-tasks. BASMAA further developed task workplans and an associated schedule in coordination with a Bay Area risk communication and exposure reduction work group that included representatives from BASMAA, the California Department of Public Health (CDPH), Bay Area Clean Water Agencies (BACWA), and Water Board and EPA staff. CDPH is now under contract through the Aquatic Science Center (ASC) to BASMAA to conduct the above sub-tasks as part of what is now called the San Francisco Bay Fish Project" (SFBFP).

Through the CW4CB project in FY 10-11, the Permittees initiated and made significant progress on sub-tasks 1-4 as described below.

Sub-task 1. Convene a risk reduction stakeholder advisory group – BASMAA worked with the Bay Area risk communication and exposure reduction work group and also ASC to plan the details of how this task will be managed and implemented, including the role of the Aquatic Science Center and plans for convening the Stakeholder Advisory Group (SAG). The SAG's primary function is to review and guide the risk communication and exposure reduction activities implemented under the SFBFP. The SAG also provides a forum for SAG members to learn about fish contamination and related topics, and promote collaboration and new activities. The SAG met in December 2010 and in February 2011 to develop a request for proposals (RFP) and a process for awarding a request for proposals (RFP) and a process for selecting proposers to receive mini-grants (i.e., sub-awards) as part of sub-task 3 (see below). The SAG also met in May 2011 to be introduced to the funded groups and their projects and for all to receive and discuss a presentation about the new advisory for San Francisco Bay, including key advisory messages and effective delivery methods.

Sub-task 2. Develop a broad risk communication strategy – The Bay Area risk communication and exposure reduction work group has agreed that this sub-task will focus on developing a broad risk communication framework that will serve as the basis for planning future outreach, education, and risk reduction activities. The framework will address how to communicate information about fish contamination issues, including the current advisory, to fish consuming populations, with an emphasis on those populations at greatest risk. One important component of the framework is the mini-grant program (sub-task 3). During FY 10-11, CDPH developed a draft framework for review and comment by the SAG, including a project goal and five objectives; and after review and comment, the framework was finalized.

Sub-task 3. Award and oversee implementation of mini-grants – As reported under sub-task 1, working through the SAG, CDPH developed an RFP and proposal selection process for awarding mini-grants (i.e., sub-awards). CDPH received significant and valuable input from the SAG to guide the general goals of the mini-grant program and several SAG members, including a BASMAA / Permittee representative, were selected to be on the proposal selection panel. The RFP was released in mid-February 2011 with nine proposals received in April. The selection panel selected four projects from the following organizations for funding:

- California Indian Environmental Alliance
- APA Family Support Services
- Greenaction for Health and Environmental Justice
- Kids for the Bay

CDPH assessed the training needs of the four groups, developed the training, and conducted the training for nine staff from the four grantee groups in June. The first half of the training focused on fish contamination issues including the sources of PCBs and mercury in San Francisco Bay, health risk and benefits of fish, and the San Francisco Bay advisory (see sub-task 4 for information on the second half training). Also, by June 30, Memoranda of Agreements regarding the mini-grants for two of the four groups had been signed.

Sub-task 4. Conduct evaluation activities – Evaluation is a critical sub-task. Evaluation activities include: evaluation of the SAG, mini-grant evaluation activities by the funded groups, and evaluation of the mini-grants task overall. During FY 10-11, CDPH facilitated real-time, self-evaluations by the SAG of their meetings. Additionally, the RFP required that project evaluation be a key component of any mini-grant proposal and subsequent project, including assigning a significant of amount of the proposal scoring (20%) to that aspect of the proposals.

The second half of the training CDPH conducted in June (see sub-task 3) focused on evaluation and included an overview of evaluation methods and tools, and a review of project evaluation reporting requirements. Also, the funded groups filled out an "Evaluation Workbook" that will serve as their project's evaluation plan.

C.11/12.f Diversion of Dry Weather and First Flush Flows to POTWs

Provisions C.11.f and C.12.f are nearly identical provisions for control of mercury and PCBs requiring pilot studies that evaluate diversion of dry weather urban runoff and first flush events into publicly owned treatment works (POTWs). The first deliverable was met through submittal of a Feasibility Evaluation Report (FER) that was included in the 2010

Annual Report. The MRP requires annual updates of the status of pilot studies in each subsequent Annual Report.

The FER was revised in December 2010 in response to Water Board staff comments. Preliminary descriptions of candidate diversion projects were then summarized by BASMAA on behalf of member programs in a brief preliminary memorandum to the Water Board in February 2011. During the remainder of FY 2010-11, programs developed more detailed definitions of six pilot diversion projects, as described in Appendix A4 (BASMAA 2011i).[27] Three of the six diversion projects involve hard-piped diversions of dry and/or wet weather flows to a POTW, two of which entail diversion of discharges from stormwater pump stations. The other three projects are operational diversions that entail street flushing, stormwater conveyance piping flushing, and a periodic strategic cleanout of a pump station sump. These operational diversions correspond to the following general scenarios for removing sediments containing PCBs and other pollutants from urban stormwater conveyance infrastructure and treating at a POTW:

1. Flushing out to POTW sediment with PCBs/Hg that collected in streets in urban areas with elevated levels of PCBs.
2. Flushing out to POTW sediment with PCBs/Hg that collected in storm drain piping in urban areas with elevated levels of PCBs.
3. Removing sediment with PCBs/Hg that collected in pump station sumps in urban areas.

The three above possibilities represent the general range of scenarios that could potentially be scaled-up for wider implementation in the future. The first two scenarios essentially entail creating an artificial "first flush," capturing the flows and diverting to a POTW. Such projects avoid the relatively high costs of diversion structure capital improvements and therefore may be more practical for wider implementation in the future, especially in the short-term.

Baseline monitoring has commenced at the North Richmond Pump Station pilot diversion project, which is further along compared to other projects due to a recent grant award that was funded in 2010. In addition, monitoring work plan development has commenced in support of the Ettie Street Pump Station diversion pilot project (see Appendix A4).

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[27]BASMAA 2011i. Technical Memorandum: Status Report on Candidate Pilot Diversion Projects. Prepared for BASMAA by Brown and Caldwell. August 2011.

C.11/12.g Monitor Stormwater Pollutant Loads and Loads Reduced

Provisions C.11.g and C.12.g require Permittees to develop and implement a monitoring program to quantify mercury and PCB loads and loads reduced through source control, treatment and other management measures implemented by Permittees. Average annual region-wide mercury (160 kg/yr) and PCB (20 kg/yr) loads to the San Francisco Bay from urban (and non-urban) runoff discharges have been calculated by the Water Board through the development of Total Maximum Daily Loads (TMDLs) for these pollutants. Over the next five years, refinement of PCB and mercury loading estimates will occur through the implementation of Pollutants of Concern Monitoring required by Provision C.8.e, and associated technical studies coordinated through the BASMAA Regional Monitoring Coalition (see Water Quality Monitoring Section) and the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP). These loading estimates provide a baseline to which compliance with TMDL Waste Load Allocations (WLAs) issued to Bay Area stormwater agencies can be determined.

A BASMAA regional project was initiated in FY 09-10 o develop methods to assess Permittee progress towards TMDL milestones and attainment of WLAs. The project entailed the review of existing information on loads reduced methodologies developed through other recent efforts (e.g., SFEI Proposition 13 Urban Runoff BMP Project) and development of draft loads reduced formulas for specific stormwater management measures. These methods are intended to assist Permittees in calculating PCB and mercury loads reduced through stormwater management measures.

A draft technical memorandum describing initial load reduction quantification methods was submitted to the Water Board in the BASMAA FY 2009-10 Regional POCs and Monitoring Supplement. Written comments were received by Water Board staff and are currently being addressed (see Appendix A5). In FY 11-12, a revised technical memorandum will be developed that incorporates Water Board staff comments and aligns load reduction quantification methods for PCBs and mercury with those currently under development for trash (see Trash Section). Additionally, as information on the effectiveness of management measures becomes available via the Clean Watersheds for Clean Bay (CW4CB) project or other MRP-required pilot studies, the methods presented in the revised technical memorandum may be updated.

In compliance with the MRP, loads reduced reporting for PCBs and mercury will begin with the Integrated Monitoring Report due on March 15, 2014.

MERCURY CONTROLS

This section includes summaries of regional projects/tasks conducted in compliance with provision C.11 that are not connected to parallel PCB (C.12) provisions.

C.11.b. Monitor Methylmercury

MRP Provision C.11.b duplicates the requirement in C.8.g to report results of methylmercury monitoring required in Provision C.8.e. Per the schedule for commencement of POC monitoring described in the Monitoring Status Report, methylmercury monitoring was not required in FY 2010-11.

C.11.h Fate and Transport Study of Mercury in Urban Runoff

This MRP provision requires Permittees to conduct or cause to be conducted studies aimed at better understanding the fate, transport, and biological uptake of mercury discharged in urban runoff to San Francisco Bay and tidal areas. The 2009-10 annual report described the specific manner in which Permittees will meet these information needs through the RMP. The RMP Master Plan (see Appendix A6) describes several strategies to address pollutant-specific information needs and support management decisions through investigation of prioritized Management Questions. During FY 2010-11, the RMP's Mercury Strategy activities included:

- Continuing work on the synthesis of results from recently completed studies on food web mercury uptake and methods to identify high leverage pathways that introduce mercury to Bay food webs. Recommendations for further studies are anticipated in a draft report later in 2011, and may include the development of a methylmercury fate model, more work on mercury isotopes, and more small fish studies.
- A draft report outlining a conceptual model of transport and food web uptake for mercury and PCBs in Bay Margin areas.
- Ongoing Status and Trends monitoring of mercury, PCBs and other pollutants in water, sediment and biota.

BASMAA representatives will continue participation in RMP Work Groups and Committees to ensure future implementation of studies that meet the MRP's stated information needs, which include understanding the in-Bay transport of mercury discharged in urban runoff, the influence of urban runoff on the patterns of food web mercury accumulation, and the identification of drainages where urban runoff mercury is particularly important in food web accumulation.

C.11.j Develop Allocation Sharing Scheme with Caltrans

The San Francisco Bay Mercury TMDL wasteload allocations for urban stormwater implicitly include California Department of Transportation (Caltrans) facilities located within the geographic boundaries of Bay Area urban runoff management agencies. Caltrans manages roadways and other transportation facilities within the urban areas that are covered under both the MRP and the TMDL. Consistent with the TMDL, MRP Provision C.11.j requires the Permittees to develop an equitable mercury allocation-sharing scheme, in consultation with Caltrans, to address runoff from the Caltrans facilities in the program area.

Caltrans may elect to pursue its own program of mercury load reduction, in lieu of sharing the allocation with the urban runoff management agencies, in which case the Water Board may designate a separate mercury wasteload allocation for Caltrans.

The Permittees are required to report on the status of the efforts to develop the allocation-sharing scheme in the 2010, 2011, and 2012 Annual Reports, and to submit in the 2014 Integrated Monitoring Report the details regarding the manner in which the urban runoff mercury TMDL allocation will be shared between the Permittees and Caltrans.

To comply with this provision, the Permittees are conducting a study with the following objectives:

- Estimate the relative contributions of runoff from Caltrans facilities to urban runoff mercury loadings on an average annual basis within the MRP regulated area,
- Identify any significant temporal or geographical factors that may influence relative proportions of Caltrans vs. MS4 loadings,
- Identify the appropriate share of the TMDL's urban runoff wasteload allocation that is attributable to Caltrans, and
- Engage in a facilitated discussion with Caltrans to identify an equitable allocation-sharing scheme.

As initial steps in this process, BASMAA representatives met with representatives of Caltrans District 4 and Caltrans Headquarters on June 23, 2011, and subsequently exchanged documents relating to pertinent BASMAA and Caltrans activities. Initial discussions have focused on mercury data needs, the potential for collaboration between BASMAA and Caltrans in future mercury monitoring projects, and preliminary work performed to date regarding the estimated proportion of Caltrans contributions to mercury runoff loadings in the SF Bay Area.

Stormwater runoff from Caltrans facilities is regulated under a separate, statewide stormwater NPDES permit, and Caltrans has an active stormwater management program (SWMP). An important aspect of the ongoing discussions involves reconciliation by Caltrans of mercury monitoring requirements within the TMDL, the MRP, and the statewide Caltrans NPDES permit.

Based on monitoring data collected over a number of years, Caltrans has developed a mathematical characterization of stormwater discharge quality from highways and other types of facilities under its jurisdiction, through the Caltrans Discharge Characterization Study. Using data from this study, which includes total mercury, Caltrans has prepared preliminary estimates of the relative contributions of runoff from Caltrans facilities to the overall urban runoff mercury loadings in the SF Bay Area.

Additional document exchange with Caltrans is planned in FY 2011-12, along with follow-up meetings involving BASMAA and Caltrans representatives. Meanwhile the Permittees also will be proceeding with the study as described above.

PCB CONTROLS

This section includes summaries of regional projects/tasks conducted in compliance with provision C.12 that are not connected to parallel Mercury (C.11) provisions.

C.12.b Conduct Pilot Projects to Evaluate Managing PCB-Containing Materials and Wastes during Building Demolition and Renovation (e.g., Window Replacement) Activities

To fulfill MRP requirements in Provision C.12.b, BASMAA has been working with the regional PCBs in Caulk Project (Project) managed by the San Francisco Estuary Partnership (SFEP) and funded by federal stimulus funds (ARRA). The objective is to evaluate the effectiveness of management practices that address legacy caulks containing PCBs as measures to reduce PCB loadings to the Bay. All of the Project deliverables described below are anticipated to be finalized by the Project end date of January 2012. The Project is:

- Evaluating PCB levels in caulk sampled from at least 10 Bay Area sites to better understand which types/ages of buildings are most likely to have caulks with PCBs, so that management actions can be targeted effectively. Surveys previously conducted in Europe and other parts of North America have found caulks/sealants containing PCBs, sometimes in very high concentrations, in a large proportion of older buildings, particularly those built or renovated in the 1950s, 1960s and 1970s. SFEI has conducted the sampling and submitted samples to the laboratory. SFEI anticipates releasing a draft report with the results in October 2011.
- Developing Best Management Practices (BMPs), a Model Implementation Process (MIP), and associated model policies or ordinances to reduce or prevent the release of PCB-laden caulks to the environment during renovation, maintenance and demolition of Bay Area buildings and the subsequent conveyance of the PCB-laden caulks by urban stormwater runoff to San Francisco Bay.

Related products currently available on the SFEP web site include:[28]

- Best Management Practices (2nd draft)
- Model Implementation Process (2nd draft)
- Training Program Outline (2nd draft)

[28]http://www.sfestuary.org/projects/detail.php?projectID=29

- Technical memorandum on existing regulatory controls and policies related to managing wastes and hazardous materials during building demolition and/or remodeling programs.
- Requests for Participation in Sampling and Implementation Trial Elements of the Project
- Request for Participation - Sampling Element
- Request for Participation - Implementation Trials Element (for municipalities)
- Request for Participation - Implementation Trials Element (for non-municipal agencies and organizations)

During FY 2010-11, BASMAA approved continuation of a Regional Project that allows staff from member stormwater programs to dedicate time on behalf of all Permittees to working with the Project team on implementing the project. The stormwater program staff reports to and receives feedback and guidance from the BASMAA Monitoring and POCs Committee. The staff has fully participated in all facets of the project, including frequent project teleconferences, development of project work plans, review and commenting on all project deliverables, a stakeholder meeting held on October 26, 2010, and a workshop held on July 26, 2011 to perform implementation trials of the recently developed regulatory process to add PCB controls to demolition/renovation permitting. The workshop targeted municipal staff with responsibility for this type of permitting.

It should be noted that the following important direction was provided to Permittees during a discussion with Water Board staff at the BASMAA Board of Directors meeting on June 23, 2011.

- When the MRP was developed it may have been envisioned that PCB BMPs would be applied during demolition/renovation. It now seems more plausible that a process involving hazardous material inspection, sampling, lab testing, preparing an abatement plan, and abatement, would all happen before demolition/renovation, similar to current procedures for asbestos and lead.
- The construction and demolition industry is becoming aware of the problem with PCBs but the focus is on human exposure at the site rather than water quality concerns.
- 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 should continue to participate in the stakeholder process as EPA develops related regulations.
- The Project should continue as planned. At this time the highest priority is to use the results from the recent local sampling to estimate how large this source is relative to other PCB sources to the Bay. SFEI is currently addressing this issue via implementing a scope of work that focuses on the following four management questions:
  1. What is the PCB mass associated with sealants in currently standing, commercial and industrial buildings constructed between 1950 and 1980 in the Bay Area?

2. What is the PCB mass released to stormwater during the renovation and demolition of these buildings using current practices (i.e. prior to any PCB in caulk BMP implementation)?
3. How does mass released to stormwater from building renovation and demolition sources compare to other PCB sources in the Bay Area?
4. What information is available, if any, regarding the removal efficiency of BMPs for demolition and renovation of PCB-containing caulk and sealants?

C.12.h Fate and Transport Study of PCBs in Urban Runoff

This MRP provision requires Permittees to conduct or cause to be conducted studies aimed at better understanding the fate, transport, and biological uptake of PCBs discharged in urban runoff. The 2009-10 annual report described the specific manner in which Permittees will meet these information needs through the RMP. The RMP Master Plan (see Appendix A6) describes several Strategies to address pollutant-specific information needs and support management decisions through investigation of prioritized Management Questions. During FY2010-11 the RMP's PCB strategy activities included:

- Recommendations for further studies are anticipated in a draft report later in 2011, and may include more small fish work and ongoing modeling work in an effort to identify high leverage pathways.
- A draft report outlining a conceptual model of transport and food web uptake for mercury and PCBs in Bay Margin areas.
- Monitoring of mercury, PCBs and other pollutants in biota, both ongoing (Status & Trends) and in a special 3-year study of Small Fish living along the Bay margins that are an important link in the Bay food web (funded 2008-2010).
- Development of conceptual models of transport and food web uptake for mercury and PCBs, and Bay Margin areas that will be incorporated with a planned water-sediment-contaminant model linking small tributary inputs to Bay processes.

BASMAA representatives will continue participation in RMP Work Groups and Committees to ensure future implementation of studies that meet the MRP's stated information needs, which include understanding the in-Bay transport of PCBs discharged in urban runoff, the influence of urban runoff on the patterns of food web PCBs accumulation, and the identification of drainages where urban runoff PCBs are particularly important in food web accumulation.

COPPER CONTROLS

C.13.c Vehicle Brake Pads

This MRP provision requires Permittees to engage in efforts to reduce the copper discharged from automobile brake pads to surface waters via urban runoff. Provision

C.13.c.iii requires that the Permittees report on legislation development and implementation status in Annual Reports during the permit term.

Compliance is being achieved through continued participation in a process initiated by the Brake Pad Partnership (BPP) to develop California legislation phasing out copper from certain automobile brake pads sold in California. In FY2010-11 the BPP achieved passage of Senate Bill 346 (Chapter 307, Statutes of 2010). Appendix A7 provides a summary of the bill's provisions and key Permittee activities during FY 10-11, which included:

1. Participating in revisions to bill language and strategy discussions with bill sponsors during negotiations with industry representatives from the auto and brake pad manufacturers, brake pad wholesalers and retailers, and car dealers;
2. advocating for passage of the bill in the Senate and for signature into lawby Governor Schwarzenegger; and
3. tracking and supporting initial implementation steps for the new law.

The above activities were coordinated through the California Stormwater Quality Association (CASQA) BPP Team, a group of stormwater quality agencies affected by copper or metals listings, TMDLs, or permit requirements; as well as through BASMAA.

Appendix A7 also describes progress towards implementation of SB 346. Additional documentation in the form of final SB346 language, a fact sheet from CASQA, two BASMAA support letters, and legislative analysis of the Senate version of the bill are provided in Appendices A8, A9, A10, A11, and A12, respectively.

C.13.e Studies to Reduce Copper Pollutant Impact Uncertainties

This MRP provision requires Permittees to conduct or cause to be conducted technical studies to investigate possible copper sediment toxicity and technical studies to investigate sub-lethal effects on salmonids. These uncertainties regarding copper effects in the Bay are described in the amended Basin Plan's implementation program for copper site-specific objectives. Provision C.13.e.ii does not require reporting on this provision in 2011. Compliance will be achieved through continued participation in the RMP, which is preparing a report on Causes of Toxicity and initiating a study of salmonid olfactory effects that will be completed in FY 2011-12.

PBDES, LEGACY PESTICIDES, AND SELENIUM

C.14.a Control Program for PBDEs, Legacy Pesticides, and Selenium.

This provision requires the Permittees to work with the other municipal stormwater management agencies in the Bay Region to identify, assess, and manage controllable sources of poly-brominated diphenyl ethers (PBDEs), legacy pesticides, and selenium found in urban runoff. The reporting requirement for 2011 is to describe progress towards the following MRP implementation objectives:

Characterize the representative distribution of PBDEs, legacy pesticides, and selenium in the urban areas of the Bay Region covered by this permit to determine:

(1) If PBDEs, legacy pesticides, and selenium are present in urban runoff;
(2) If PBDEs, legacy pesticides, or selenium are distributed relatively uniformly in urban areas; and
(3) Whether storm drains or other surface drainage pathways are sources of PBDEs, legacy pesticides, or selenium in themselves, or whether there are specific locations within urban watersheds where prior or current uses result in land sources contributing to discharges of PBDEs, legacy pesticides, or selenium to San Francisco Bay via urban runoff conveyance systems

The specific approach to filling these information needs is described in the POC Loads Monitoring section of the Monitoring Status Report (Part Two of this Document). The Small Tributaries Loading Strategy Multi-Year Plan (Appendix B2) serves as a framework for monitoring of representative Bay Area watersheds and estimation of regional pollutant loads. These activities will be coordinated among both MRP Permittees and the RMP. Monitoring data collected through the STLS will be supplemented by recent stormwater and sediment monitoring to characterize the distribution and potential source areas of legacy pesticides.

PART B

MONITORING STATUS REPORT

WATER QUALITY MONITORING

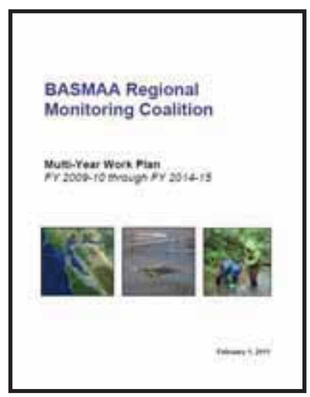
This monitoring status report was developed on behalf of all Permittees subject to the Municipal Regional Stormwater NPDES Permit (MRP, Order R2009-0074) issued by the San Francisco Regional Water Quality Control Board (Water Board) on October 14, 2009. Provision C.8 of the MRP requires Permittees to conduct water quality monitoring and associated projects during the term of the MRP.

All water quality monitoring activities required by Provision C.8 are coordinated regionally through the BASMAA Regional Monitoring Coalition (RMC). In a November 2, 2010 letter to Permittees, the Water Board's Assistant Executive Officer (Thomas Mumley) acknowledged that all Permittees have opted to conduct monitoring required by the MRP through the RMC. The letter noted that monitoring coordinated through the RMC must begin by October 2011. The letter also asked that Permittees submit to Water Board staff:

- Status reports on RMC projects and activities by March 15 and September 15 of 2011 and 2012; and,
- A status report and proposed schedule for completing an alternative sampling design(s) and associated multi-year monitoring plan(s) to address Pollutants of Concern and Long-Term Trends Monitoring requirements included in Provision C.8.e, no later than March 15, 2011.

A monitoring progress report was submitted to the Water Board on March 15, 2011. This progress report[29] provides updates on RMC activities conducted between January and mid-July 2011.

RMC MULTI-YEAR WORK PLAN



In February 2011, the RMC developed a Multi-Year Work Plan (RMC Work Plan) to provide a framework for implementing regional monitoring and assessment activities required under MRP provision C.8. The RMC Work Plan summarizes RMC projects planned for implementation between Fiscal Years 2009-10 and 2014-15. Projects were collectively developed by RMC representatives to the BASMAA Monitoring and Pollutants of Concern Committee (MPC), and were conceptually agreed to by the BASMAA Board of Directors (BOD). The BOD serves as the overall oversight committee to the RMC, and the MPC has the responsibility of directly managing and implementing projects summarized in The RMC Work Plan.
A total of 27 regional projects are identified in the RMC Work Plan, based on the requirements described in provision C.8 of the MRP. Many regional projects were approved as Regional Projects by the BOD during FY 2009-10 and 2010-11, and are

[29] This status report is not required by the MRP and is provided as a courtesy to Water Board staff in response to the November 2, 2010 letter. It addresses the above request for information to be provided by September 15, 2011.

currently underway. Others are planned to begin in FY 2011-12 or subsequent fiscal years based on schedules outlined in the MRP. The following sections provide brief summaries on progress made by the RMC on approved regional projects that are currently underway or in the planning process. Summaries provided are grouped by sub-provision of MRP provision C.8, which include:

- Compliance Options (C.8.a)
- San Francisco Estuary Receiving Water Monitoring (C.8.b)
- Creek Status Monitoring (C.8.c)
- Monitoring Projects (C.8.d)
- Pollutants of Concern and Long-Term Trends Monitoring (C.8.e)
- Citizen Monitoring and Participation (C.8.f)
- Reporting (C.8.g)
- Monitoring Protocols and Data Quality (C.8.h)

C.8.A COMPLIANCE OPTIONS

Provision C.8.a (Compliance Options) of the MRP allows Permittees to address monitoring requirements through a "regional collaborative effort" (e.g., RMC), their Stormwater Program, and/or individually. In June 2010, Permittees notified the Water Board in writing of their agreement to participate in a regional monitoring collaborative to address requirements in Provision C.8[30]. The regional monitoring collaborative is referred to as the BASMAA Regional Monitoring Coalition (RMC). With notification of participation in the RMC, participating Permittees are required to commence water quality data collection by October 2011. Therefore, with the exception of monitoring described in this section under provision C.8.b (SF Bay Receiving Waters), Permittee efforts in FY 2010-11 described in this section were generally focused on the development and early implementation of the RMC- associated near-term projects.

C.8.B SAN FRANCISCO ESTUARY RECEIVING WATER MONITORING

As described in Provision C.8.b, Permittees are required to contribute their fair-share financially on an annual basis towards implementing an Estuary receiving water monitoring program that at a minimum is equivalent to the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP). During FY 2010-11, Permittees complied with this provision by making financial contributions to the RMP directly or through stormwater programs (Table B.1). Additionally, Permittees actively participated in RMP committees and work groups through Permittee and/or stormwater program staff as described in the following sections, which also provide a brief description of the RMP and associated monitoring activities conducted in FY 2010-11.

Regional Monitoring Program (RMP)

The RMP is a long-term monitoring program that shares financial support, direction, and participation by regulatory agencies and the regulated community with the goal of

[30] The Cities of Antioch, Brentwood and Oakley, and portions of Contra Costa County are not subject to the MRP, but have similar requirements and are therefore are participating in the RMC.

assessing water quality in the San Francisco Bay. The regulated community includes Permittees, publicly owned treatment works (POTWs), dredgers and industrial dischargers. The RMP is intended to answer the following core management questions:

1. Are chemical concentrations in the Estuary potentially at levels of concern and are associated impacts likely?
2. What are the concentrations and masses of contaminants in the Estuary and its segments?
3. What are the sources, pathways, loadings, and processes leading to contaminant related impacts in the Estuary?
4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?
5. What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?

Table B.1. Stormwater Program annual contributions to the Regional Monitoring Program for Water Quality in the San Francisco Bay Estuary in 2010 and 2011.

Stormwater Program/Agency	2010	2011
Santa Clara Valley Urban Runoff Pollution Prevention Program	$173,820	$173,934
Alameda Countywide Clean Water Program	$168,561	$168,592
Contra Costa Clean Water Program	$136,589	$136,623
San Mateo Countywide Water Pollution Prevention Program	$83,603	$83,602
Marin Countywide Stormwater Pollution Prevention Program	$55,557	$55,507
Vallejo Sanitation and Flood Control District	$12,864	$12,809
Fairfield-Suisun Urban Runoff Management Program	$14,803	$14,697
City and County of San Francisco[a]	$38,773	$38,805
California Department of Transportation (CalTrans)[a]	$76,063	$76,063

[a]Although contributors to the RMP under the umbrella of "stormwater", during FY 2010/11 these entities were not members of BASMAA.

The RMP budget is generally broken into two major program elements: Status and Trends, and Pilot/Special Studies. The following paragraphs provide a brief overview of these programs.

RMP Status and Trends Monitoring Program

The Status and Trends Monitoring Program (S&T Program) is the long-term contaminant-monitoring component of the RMP. The S&T Program was initiated as a pilot study in 1989 and redesigned in 2007 based on a more rigorous statistical design that enables the detection of trends. In FY 2010-11, the S&T Program was comprised of the following program elements that collect data to address RMP management questions described above:

- Water/Sediment/Biota Chemistry and Toxicity Monitoring
- Sediment Benthos Monitoring
- Small and Large Tributary Loading Studies
- Small Fish and Sport Fish Contamination Studies
- Studies to Determine the Causes of Sediment Toxicity
- Suspended Sediment, Hydrography and Phytoplankton Monitoring
- Bird Egg Monitoring

Additional information on the S&T Program and associated monitoring data are available for downloading via the RMP website using the Status and Trends Monitoring Data Access Tool at www.sfei.org/rmp/data.htm.

RMP Pilot and Special Studies
The RMP also conducts Pilot and Special Studies (P/S Studies) on an annual basis. Studies usually are designed to investigate and develop new monitoring measures related to anthropogenic contamination or contaminant effects on biota in the Estuary. Special Studies address specific scientific issues that RMP committees and standing workgroups identify as priority for further study. These studies are developed through an open selection process at the workgroup level and selected for funding through RMP committees. Results and summaries of the most pertinent P/S Studies can be found on the RMP website (www.sfei.org/rmp/).

In FY 2010-11, a considerable amount of RMP and Stormwater Program staff time was spent in defining and implementing special studies associated with the RMP's Small Tributary Loading Strategy (STLS) and the development of the STLS Multi-Year Monitoring Plan (MYP). Pilot and special studies associated with the STLS are intended to fill data gaps associated with loadings of Pollutants of Concern (POC) from relatively small tributaries to the San Francisco Bay. Additional information is provided on STLS-related studies under section C.8.e (POC and Long-Term Trends Monitoring) of this monitoring status report.

Participation in Committees, Workgroups and Strategy Teams
In FY 2010-11, Permittees actively participated in the following RMP Committees and work groups:

- Steering Committee (SC)
- Technical Review Committee (TRC)
- Sources, Pathways and Loadings Workgroup (SPLWG)
- Contaminant Fate Workgroup (CFWG)
- Exposure and Effects Workgroup (EEWG)
- Emerging Contaminant Workgroup (ECWG)
- Sport Fish Monitoring Workgroup
- Toxicity Workgroup
- Strategy Teams (e.g., PCBs, Mercury, Dioxins, Small Tributaries)

Committee and workgroup representation was provided by Permittee, stormwater program staff and/or individuals designated by RMC participants and the BASMAA Board of Directors (BOD). Representation included participating in meetings, reviewing technical reports and work products, co-authoring articles included in the RMP's *Pulse of the Estuary*, and providing general program direction to RMP staff. Representatives of the RMC also provided timely summaries and updates to, and received input from stormwater program representatives (on behalf of Permittees) during MPC and/or BOD meetings to ensure Permittees' interests were adequately represented.

C.8.C CREEK STATUS MONITORING

Provision C.8.c requires Permittees to conduct creek status monitoring that is intended to answer the following management questions:

1. Are water quality objectives, both numeric and narrative, being met in local receiving waters, including creeks, river and tributaries?
2. Are conditions in local receiving waters supportive of or likely supportive of beneficial uses?

Creek status monitoring parameters, methods, occurrences, durations and minimum number of sampling sites for each stormwater program are described in Table 8.1 of the MRP. Based on the implementation schedule described in MRP Provision C.8.a.(ii), creek status monitoring coordinated through the RMC is not scheduled to begin until October 2011 (FY 2011-12). Therefore, the status of field work required by Table 8.1 is not included in this progress report. That said, Permittee and stormwater program staff (on behalf of Permittees) spent considerable time conducting RMC creek status monitoring related planning projects included in the RMC Work Plan. Planning projects conducted in FY 2010-11 were intended to assist Permittees in designing and implementing a regional creek status monitoring program that will allow each stormwater program to assess the status of local water bodies, while contributing data to answering regional questions about the condition of aquatic life beneficial uses in all Bay Area creeks.

The following sections provide brief summaries of each RMC creek status monitoring project that was conducted in FY 2010-11. A draft implementation schedule for RMC creek status monitoring is included as Appendix B1.

Creek Status Monitoring Design

Significant progress was made in FY 2010-11 on designing a regional monitoring strategy for complying with MRP provision C.8.c - creek status monitoring. First, the RMC agreed to collectively design a regional creek status monitoring program that includes both ambient/probabilistic and targeted components. These monitoring designs allow each individual RMC participating program to assess the status of beneficial uses in local creeks within its Program (jurisdictional)area while contributing data to answer management questions at the regional scale (e.g., differences between aquatic life condition in urban and non-urban creeks). The creek status monitoring designs are primarily intended to answer the following core management questions:

- What is the condition of aquatic life San Francisco Bay Area creeks?
- What are the major stressors to aquatic life?

Table B.2 lists each chemical, biological and physical response and stressor indicators that will be monitored by RMC participants, and the associated monitoring designs and reporting formats. Additional information is provided below about the design by which each of these questions will be answered, and can also be found in *Draft RMC Creek Status and Trends Monitoring Plan* that is currently under review by RMC participants and SWAMP.

Table B.2. Summary of RMC creek status indicators, associated monitoring designs and scales of reporting.

Biological Response and Stressor Indicators	Monitoring Design		Reporting	
	Regional Ambient/Probabilistic	Locally Targeted	Regional	Local
Bioassessment & Physical Habitat Assessment	X		X	
Chlorine	X		X	
Nutrients	X		X	
Water Toxicity	X		X	
Sediment Toxicity	X		X	
Sediment Chemistry	X		X	
General Water Quality (Continuous)		X		X
Temperature (Continuous)		X		X
Bacteria		X		X
Stream Survey		X		X

Regional Probabilistic Design

RMC participants will conduct a condition assessment to address the first core monitoring question, by sampling two biological response indicators: benthic macroinvertebrates and algae. This question will be addressed using an ambient (probabilistic) monitoring design in order to establish a statistically representative understanding of the relative condition of aquatic life in wadable creeks in the RMC area (Figure B.1). The number of monitoring sites sampled annually by RMC participants is consistent with Table 8.1 of the MRP. With agreement from Water Board staff, RMC participant sites are distributed among creek reaches with urban (80%) and nonurban (20%) land uses. Additionally, Region 2 SWAMP is also participating in the regional condition assessment by sampling 10 nonurban sites annually.

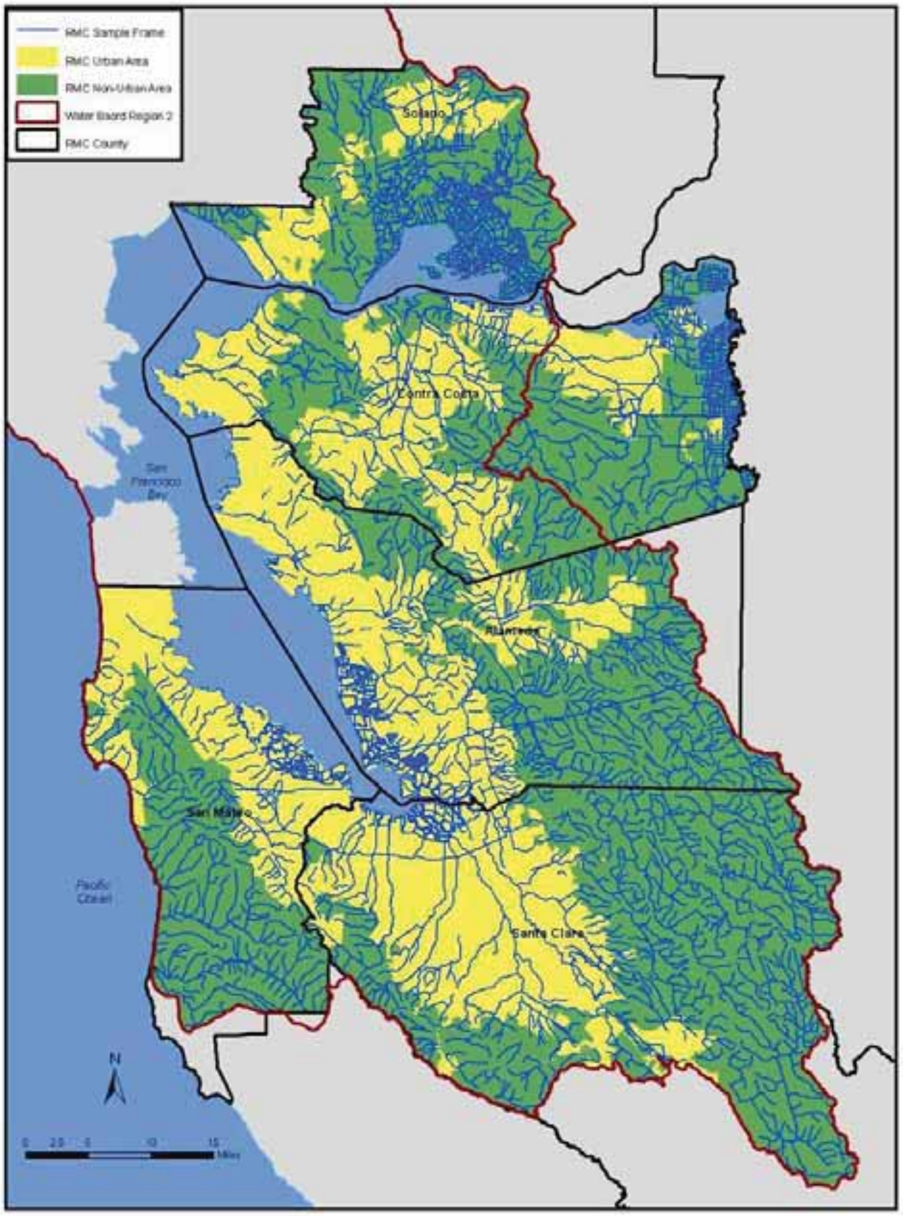


Figure B.1. BASMAA Regional Monitoring Coalition (RMC) applicable urban and non-urban areas and associated creeks.

Stressor Assessment

Stressor assessments will also be conducted by RMC participants in compliance with provision C.8.c. Stressor assessments are intended to address the second core RMC management question, and depending on the indicator, will either be monitored at bioassessment sites selected via the ambient (probabilistic) monitoring design or at targeted sites selected by RMC participating programs (see Table B.2).

Standard Operating and Data Quality Assurance Procedures

In parallel with the RMC creek status monitoring plan development, the RMC is also developing RMC-specific Standard Operating Procedures (SOPs) and a Quality Assurance Project Plan (QAPP) through a regional project. These documents are consistent with the existing SWAMP QAPP and build upon SWAMP SOPs. These documents are currently in draft form and under review by RMC participants and SWAMP staff. Finalization is expected in the fall of 2011.

Creek Status and Trends Information Management System Development

RMC participants are currently scoping the development of a regional RMC creek status and trends information management system (i.e., database) through a regional project. A draft Information Management System Work Plan has been created and is currently being reviewed by RMC participants. It is anticipated that database development will begin in the fall 2011 and be completed by spring 2012.

C.8.D MONITORING PROJECTS

Three types of monitoring projects are required by provision C.8.d of the MRP: 1) Stressor/Source Identification (C.8.d.i); 2) BMP Effectiveness Investigation (C.8.d.ii); and, 3) Geomorphic Project (C.8.d.iii). These projects are generally described in the RMC Work Plan. Based on the compliance schedules described in the MRP for these Provisions, in FY 2010-11 Permittees focused mostly on scoping future collaborative RMC projects, except that the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) completed field work for a stressor/source identification study in FY 2010-11 (Coyote Creek) and began planning for an additional FY 2011-12 study (Guadalupe River & Alviso Slough). Additional information on these studies can be found in the monitoring section of the SCVURPPP FY 2010-11 Annual Report.

C.8.E POLLUTANTS OF CONCERN AND LONG-TERM TRENDS MONITORING

POC Loads Monitoring

Pollutants of Concern (POC) loads monitoring is required by provision C.8.e(i) of the MRP. Loads monitoring is intended to assess inputs of POCs to the Bay from local tributaries and urban runoff, assess progress toward achieving wasteload allocations (WLAs) for TMDLs, and help resolve uncertainties associated with loading estimates for these pollutants. In particular, there are four priority management questions that need to be addressed though POC loads monitoring:

1. Which Bay tributaries (including stormwater conveyances) contribute most to Bay impairment from POCs;
2. What are the annual loads or concentrations of POCs from tributaries to the Bay;
3. What are the decadal-scale loading or concentration trends of POCs from small tributaries to the Bay; and,

4. What are the projected impacts of management actions (including control measures) on tributaries and where should these management actions be implemented to have the greatest beneficial impact.

Based upon compliance schedules described in MRP Provision C.8.a(ii), participants of the RMC are required to begin POC loads monitoring in October 2011. Therefore, RMC participant activities associated with POC loads monitoring during FY 2010-11 were generally spent preparing for monitoring by this date. To assist participants in effectively and efficiently conducting POC loads monitoring required by the MRP and answer POC loads management questions listed above, an RMP Small Tributaries Loading Strategy (STLS) was developed in 2009 by the STLS Team, which included representatives from BASMAA, Water Board, RMP/SFEI and technical advisors. The objective of the STLS is to develop a comprehensive planning framework to coordinate POC loads monitoring/modeling between the RMP and RMC participants.

FY 2010-11 STLS Projects

On behalf of RMC participants and the RMP, the STLS Team completed a number of POC loads monitoring projects in 2010-11. The main goal of the projects was to inform the development of an alternative approach to POC loads monitoring requirements described in MRP Provision C.8.e.i. The alternative approach is briefly described in the next section and fully described in the Small Tributaries Loading Strategy (STLS) Multi-Year Plan (Appendix B2). Summaries for STLS projects completed in FY 2010-11 are provided below. Full descriptions of these studies are included in the STLS MYP and associated appendices.

- Sampling Methods Optimization – The STLS Team completed a study in FY 2010-11 that evaluated a variety of POC loads sampling methods, including those currently employed by the RMP (e.g., turbidity surrogate) and the MRP default sampling method (i.e., flow-weighted composite). The methods optimization study was intended to provide recommendations on the most cost effective methods that could be employed by RMC participants and the RMP, while still adequately addressing POC loads management questions with needed accuracy and precision. The results of the study are presented in Appendix B2c.

- Watershed Categorization - The STLS Team completed a desktop study in FY 2010-11 that categorized watersheds into different "types" based on a variety of watershed characteristics (e.g., land use, imperviousness, area, sediment loading, and contaminant history). The goal of the study was to answer two key questions for the design of the STLS Multi-Year Plan (MYP) watershed monitoring:

    1. How many types of watersheds occur in the region and,
    2. How many watersheds should be studied to answer key management questions, and how should they be distributed among the identified types?

    To answer these questions, SFEI conducted a preliminary characterization study using ordination and cluster analysis; exploratory statistical techniques designed to visualize patterns on complex multivariate data sets. The study aimed for an initial classification of Bay Area small tributary watersheds into a small number (<10) of classes, relevant for POC loads monitoring and assessments of Bay margin impacts. A total of eight classes of watersheds were developed and appear to be meaningful for the STLS purposes. Additional information regarding this study is included in Appendix B2c.

- POC Characterization Monitoring (16 Watersheds) - As an alternative to continuing long-term POC loads monitoring at bottom of watershed locations (e.g., Guadalupe River or Zone 4 – Line A) in FY 2010-11, the STLS Team agreed that the RMP should conduct a geographically broader study in FY 2010-11 to characterize POC concentrations in a number of small tributaries in the Bay Area. A total of 16 tributaries were sampled during one or two storms that occurred in FY 2010-11 and water samples were analyzed for a number of POCs, including PCBs, total mercury, PBDEs, polycyclic aromatic hydrocarbons (PAHs) and selenium. Preliminary results were presented to the STLS Team and the Sources, Pathways and Loadings Workgroup (SPLWG) in spring 2011. Appendix B2e provides a summary of the methods and results.

- Regional Watershed Spreadsheet Model – In FY 2010-11, the STLS Team began development of a Regional Watershed Spreadsheet Model (RWSM), which will be the primary tool for estimation of overall POC loads to the Bay. Given the large number of small tributaries, initial STLS Team discussions indicated this is more suitable as a framework for regional load estimation than simulation models (e.g., HSPF and SWMM) that require large and detailed calibration datasets. The RWSM is structured similarly to Ha and Stenstrom (2008), using GIS-derived data for land use, imperviousness, average soil type/slope and annual precipitation. It also uses recent local data on land use based POC concentrations collected in the Bay area and augmented using recent stormwater literature on Event Mean Concentrations (EMCs). FY 2010-11 outcomes included the development of two parallel hydrological models, one using land use based runoff coefficients and the other using imperviousness based runoff coefficients. The model outcomes were compared to empirical observations in 18 calibration watersheds.

STLS Multi-Year Plan (version 2011)

Based on the consensus of the STLS Team, RMC representatives in coordination with SFEI staff created a STLS Multi-Year Plan (MYP) that is intended to assist Permittees in complying with provision C.8.e (POC Monitoring) through an alternative POC monitoring program than the one described in the MRP. The MYP is designed to address the four core POC monitoring management questions, while integrating activities funded by BASMAA via the RMC and the RMP. The MYP provides a more comprehensive description of the suite of activities to be included in the STLS over the next 5 to10 years, including a detailed rationale for the methods and locations of proposed activities (e.g., POC loads monitoring in small tributaries).

The following four major POC monitoring components are included in the MYP (version 2011):

- Watershed modeling (RWSM);
- Bay Margins Modeling;
- Source Area Runoff Monitoring; and,
- Small Tributaries Monitoring

A full description activities planned in FY 11-12 for each of these components is included in the MYP (Appendix B2). The following paragraphs provide brief summaries of each.

- Watershed Modeling - Updates to the RWSM currently underway focus on developing load estimates for sediment, mercury and PCBs. Additional information on the status and future plans for the RWSM will be included i with the next version of the MYP. To be provided by March 2012.

- Bay Margins Modeling – The RMP is also in the process of developing a Bay Margins Conceptual Model as part of a separate Bay Modeling Strategy overseen by the RMP's Contaminant Fate Work Group. The initial draft strategy (Jones et al., 2011) recommends development of a full-Bay 3-D model that could identify high-leverage watersheds whose POC loadings contribute disproportionately to Bay impacts. Further development of the Bay Modeling Strategy is planned to occur in FY 2011-12.

- Source Area Runoff Monitoring – This is a placeholder in the STLS for studies to develop Event Mean Concentrations of POCs to parameterize the RWSM.

- Small Tributaries Watershed Monitoring - Four stations were selected for small tributary loads monitoring beginning in October 2011. These stations include; 1) Lower Marsh Creek(Contra Costa County); 2) Guadalupe River (Santa Clara County); 3) Lower San Leandro Creek (Alameda County); and, 4) Sunnyvale East Channel (Santa Clara County). The Lower Marsh Creek and Guadalupe River stations will be operated by the Contra Costa Clean Water Program and the Santa Clara Valley Urban Runoff Pollution Prevention Program, respectively, on behalf of RMC participants. The Lower San Leandro Creek and Sunnyvale East Channel stations will be operated by SFEI on behalf of the RMP. Monitoring methods and analytes are described in the MYP (Appendix B2).

Long-Term Trends Monitoring

In addition to POC loads monitoring, Provision C.8.e requires Permittees to conduct long-term trends monitoring to evaluate if stormwater discharges are causing or contributing to toxic impacts on aquatic life. Required long-term monitoring parameters, methods, intervals and occurrences are included in Table 8.4 of the MRP and prescribed long-term monitoring locations are included in Table 8.3. Similar to creek status and POC loads monitoring, long-term trends monitoring is scheduled to begin October 2011 for RMC participants.

As described in the *Draft RMC Creek Status and Trends Monitoring Plan*, the State of California's Surface Water Ambient Monitoring Program (SWAMP) through its Statewide Stream Pollutant Trend Monitoring Program (SPoT) currently monitors the seven long-term monitoring sites required by Provision C.8.e.ii. Sampling via the SPoT program is currently conducted atthe sampling interval described in Provision C.8.e.iii in the MRP. The SPoT program is generally conducted to answer the management question:

- What are the long-term trends in water quality in creeks?

Based on discussions with Region 2 SWAMP staff, RMC participants intend to comply with MRP provision C.8.e that are associated with long-term trends via monitoring conducted by the SPoT program. This manner of compliance is consistent with the MRP language in provision C.8.e.ii. In FY 2011-12, RMC representatives will continue to coordinate with the SPoT program on long-term monitoring to ensure MRP monitoring requirements are addressed.

Sediment Delivery Estimate/Budget

Provision C.8.e.(vi) of the MRP requires Permittees to develop a design for a robust sediment delivery estimate/sediment budget in local tributaries and urban drainages, and implement the study by July 1, 2012. The purpose of the sediment delivery estimate is to improve the Permittees' ability to estimate urban runoff contributions to loads of POCs, which are generally closely associated with sediment. To determine a strategy for a robust sediment estimate/budget, the BASMAA Board of Directors (BOD) approved a Regional Project in FY 2009-10 to begin reviewing current sediment delivery estimates, better define the objectives for improvement and determine what additional work is needed in FY 2010-11 and beyond. Based on the work conducted by the STLS Team in FY 2010-11, it is highly likely that RMC participants will reply on information collected via the STLS MYP and previous sediment delivery estimates developed by the RMP to comply with this MRP requirement. Therefore, the implementation of the sediment delivery/budget study will occur in parallel to the MYP. Additional information the scope of the study and pertinent details will be included in future Monitoring Status Reports (March and September 2012).

Emerging Pollutants Work Plan

In compliance with Provision C.8.e.v, Permittees are required by March 2014 to develop a work plan and schedule for initial loading estimates and source analyses for the following emerging pollutants: 1) endocrine-disrupting compounds; 2) PFOS/PFAS (Perfluorooctane Sulfonates (PFOS); 3) Perfluoroalkyl Sulfonates (PFAS); and, 4) and NP/NPEs (nonylphenols/nonylphenol esters —estrogenlike compounds). The intent of the work plan is to begin planning for implementation during the next permit term (i.e., post December 2014). Because the compliance date for completion of this work plan is over four years into the future, only initial discussions of the scope of this project were discussed in FY 2010-11 by the RMC participants. BASMAA representatives to the STLS Team will coordinate efforts with the Emerging Contaminants Strategy being developed by the RMP through the Master Planning process. Additional information on the status of this project will be provided in subsequent Monitoring Status Reports.

C.8.F CITIZEN MONITORING AND PARTICIPATION

Participants of the RMC, to varying degrees, currently coordinate with or support citizen monitors within their geographical areas. As a result, relationships have been developed between RMC participants and citizen monitors. In FY 2010-11, Permittees began to plan for future coordination with citizen monitors in their respective geographical areas. Information sharing among RMC participants about activities designed to encourage citizen monitoring is planned to occur in FY 2011-12 and future years at MPC meetings.

C.8.G REPORTING

Provision C.8.g requires Permittees to report annually on water quality data collected in compliance with the MRP. Annual reporting requirements include: 1) water quality standard exceedances; 2) creek status monitoring electronic reporting; and, 3) urban creeks monitoring reporting. For RMC participants, annual reporting requirements begin following monitoring which is scheduled to commence in October 2011. Therefore, reporting of water quality monitoring data collected in compliance with the Provision C.8 of the MRP is not required in FY 2010-11.

In preparation for the development of future monitoring reports, and less frequent reporting requirements included in Provisions C.8.g.iv (Monitoring Project Reports) and C.8.g.v (Integrated Monitoring Report), the RMC Work Plan, Draft Creek Status and Trends Monitoring Plan, and STLS MYP describe reporting planned by RMC participants in future fiscal years.

C.8.H MONITORING PROTOCOLS, DATA QUALITY AND DATA MANAGEMENT

Provision C.8.h requires that water quality data collected by Permittees in compliance with the MRP should be of a quality that is consistent with the State of California's Surface Water Ambient Monitoring Program (SWAMP) standards, set forth in the SWAMP Quality Assurance Project Plan (QAPP). To assist Permittees in meeting SWAMP data quality standards and developing data management systems that allow for easy access of water quality monitoring data by Permittees, the RMC began implementing a number of regional projects in FY 2010-11. These projects include:

- <u>Standard Operating and Data Quality Assurance Procedures</u> – Two projects designed to address monitoring protocols and data quality requirements described in Provision C.8.h were approved by the BOD in FY 2009-10. The first entails the development of a new field manual and quality assurance project plan (QAPP) for POC loads monitoring coordinated through the STLS Team and described in the MYP (Appendix B2). The Field Manual and QAPP will be completed in FY 2011-12. The second project entails the adaptation of existing creek status monitoring SOPs and QAPP developed by SWAMP to document the field procedures necessary to maintain comparable and high quality data among RMC participants. This project is also scheduled for completion in FY 2011-12.

- Information Management System Development/Adaptation – As described in the RMC Work Plan, RMC participants would like to store and manage water quality data collected in compliance with Provision C.8 in a cost effective manner that allows data users to easily access and query data and information. Therefore, in FY 2010-11 the RMC began two regional projects designed to develop POC Monitoring and Creek Status and Trends Information Management Systems (IMSs) for use by the RMC. The goal of these projects is to provide standardized data storage formats, thus providing a mechanism for sharing data among RMC participants. Each project is planned for completion in FY 2011-12.

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Pesticide Regulation for Water Quality Protection

Annual BASMAA Participation Summary and Outcomes Assessment 2011

Documentation of action taken to comply with San Francisco Bay Area Municipal Regional Stormwater NPDES Permit, Order R2-2009-0074, Section C.9.e.i.(1), (2), and (4)

Prepared for the Bay Area Stormwater Management Agencies Association

September 2011

PREFACE

This is a report of research performed by TDC Environmental, LLC for the Bay Area Stormwater Management Agencies Association (BASMAA). This report was prepared to assist San Francisco Bay Area municipalities with documenting compliance with Municipal Regional Stormwater Permit Provision C.9.e.i.(1), (2), and (4). Preparation of this report was funded by BASMAA.

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Pesticide Regulation for Water Quality Protection Annual BASMAA Participation Summary and Outcomes Assessment 2011

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Sections C.9.e.i.(1), (2), and (4) of the San Francisco Bay Area Municipal Regional Stormwater NPDES Permit (MRP) requires tracking and participating in pesticide-related California and Federal regulatory processes and reporting on these activities. This regional report is intended to document actions taken to comply with Sections C.9.e.i.(1), (2), and(4) to fulfill the reporting requirement for these sections in Section C.9.e.ii. The time period covered by this report is July 1, 2010 through June 30, 2011 (fiscal year [FY] 2011).

During this time period, Bay Area Stormwater Management Agencies Association (BASMAA) members participated in pesticide regulatory activities through the California Stormwater Quality Association (CASQA). CASQA has a Pesticides Subcommittee that manages its day-to-day involvement in pesticide regulatory activities. The Subcommittee is supported by CASQA's statewide membership—including BASMAA agencies—in managing, staff and funding consultant support for pesticide regulatory engagement. Until January 2011, CASQA relied on the Urban Pesticide Pollution Prevention Project (UP3 Project) for tracking California and Federal pesticide regulatory activities, identifying priorities for municipality engagement, and coordinating CASQA's regulatory engagement with the pesticide regulatory activities of California municipal wastewater treatment plants and the State Water Resources Control Board and Regional Water Quality Control Boards. Until January 2011, all of these agencies relied on the UP3 Project to provide scientific information, regulatory analysis, and assistance in communicating with pesticide regulators. Starting in February 2011 when UP3 Project grant funding was exhausted, CASQA took on most of these functions.

The ultimate goals of CASQA's and BASMAA's pesticide regulatory engagement are to prevent surface water impairment and to prevent violations of stormwater NPDES permits (see Section 4.1). Major FY 2011 objectives were to end pyrethroid-related toxicity in California urban watersheds without transitioning to other harmful products and to encourage changes in California and Federal pesticide regulatory processes such that these processes effectively prevent future water quality and compliance problems.

CASQA's pesticide regulatory engagement prioritized the pesticides of concern listed in the MRP (see Section 3.2). Pyrethroid insecticides, which have been linked to widespread toxicity in creek waters and sediments, were the highest priority for pesticide regulatory involvement. CASQA wrote 10 letters and participated in seven regulatory process meetings to provide information and recommendations to pesticides regulators (see Section 3.3 and Table 2). CASQA also shared information with regulators and other stakeholders at three Urban Pesticides Committee meetings and through CASQA's and the UP3 Project's informal contacts with regulators (Table 2).

Although regulatory processes can take many years to reach outcomes, the results of pesticide regulatory engagement are starting to be evident, and show substantial progress toward the BASMAA, CASQA, and Water Board goals of preventing surface water impairment from pesticides, implementing the Diazinon and Pesticide-Related Toxicity in Bay Area Urban Creeks Water Quality Attainment Strategy and Total Maximum Daily Load, and preventing pesticide-related violations of stormwater NPDES permits (see Section 4 and Table 3). Nevertheless, additional work will be needed to end pyrethroid-related toxicity in urban watersheds, to prevent a transition to other harmful products, and to achieve the ultimate goal of ensuring that pesticides do not interfere with Clean Water Act compliance.

1.0 INTRODUCTION

1.1 Scope of This Report

The San Francisco Bay Area Municipal Regional Stormwater NPDES Permit includes the following provision for tracking and participating in pesticide-related regulatory processes and for reporting on these activities:

> ***C. 9. e. Track and Participate in Relevant Regulatory Processes*** *(may be done jointly with other Permittees, such as through CASQA or BASMAA and/or the Urban Pesticide Pollution Prevention Project)*
>
> ***i. Task Description***
>
> *(1) The Permittees shall track USEPA pesticide evaluation and registration activities as they relate to surface water quality, and when necessary, encourage USEPA to coordinate implementation of the Federal Insecticide, Fungicide, and Rodenticide Act and the CWA and to accommodate water quality concerns within its pesticide registration process;*
>
> *(2) The Permittees shall track California Department of Pesticide Regulation (DPR) pesticide evaluation activities as they relate to surface water quality, and when necessary, encourage DPR to coordinate implementation of the California Food and Agriculture Code with the California Water Code and to accommodate water quality concerns within its pesticide evaluation process;*
>
> *(3) The Permittees shall assemble and submit information (such as monitoring data) as needed to assist DPR and County Agricultural Commissioners in ensuring that pesticide applications comply with water quality standards; and*
>
> *(4) As appropriate, the Permittees shall submit comment letters on USEPA and DPR re-registration, re-evaluation, and other actions relating to pesticides of concern for water quality.*
>
> ***ii. Reporting*** *– In their Annual Reports, the Permittees who participate in a regional effort to comply with C.9.e. may reference a regional report that summarizes regional participation efforts, information submitted, and how regulatory actions were affected. All other Permittees shall list their specific participation efforts, information submitted, and how regulatory actions were affected.*

This regional report is intended to document actions taken to comply with Section C.9.e.i.(1), (2), and (4) to fulfill the reporting requirements for these sections in Section C.9.e.ii. The time period covered by this report is July 1, 2010 through June 30, 2011 (fiscal year [FY] 2011).

1.2 Report Organization

This report is organized as follows:

- <u>*Section 1*</u> (this section) provides the scope and organization of the report.

- *Section 2* explains why BASMAA members have joined municipalities across California in participating in pesticide regulatory activities and summarizes the major California and Federal pesticide review processes.
- *Section 3* summarizes FY 2011 pesticide regulatory engagement.
- *Section 4* evaluates the outcomes of pesticide regulatory engagement to the extent that outcomes were known as of July 2011 (some pesticide regulatory processes of interest in FY 2011 are still underway).

2.0 BACKGROUND

2.1 Pesticides and Water Quality—A Regulatory Gap

Numerous scientific studies have demonstrated that use of some pesticides registered in accordance with Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requirements can adversely affect aquatic species. Those impacts can, in turn, cause violations of water quality standards. As a result of discharges containing pesticides registered for use by the U.S. Environmental Protection Agency (U.S. EPA), many surface waters in California have been designated as "impaired" in accordance with Federal Clean Water Act §303(d). This finding means that the surface waters do not meet water quality standards. These listings demonstrate that current U.S. EPA and California Environmental Protection Agency (Cal-EPA) procedures for regulating pesticides are insufficient to ensure that pesticide use does not cause violations of the Federal Clean Water Act and California Porter-Cologne Water Quality Control Act.

Federal law provides U.S. EPA with the ability to protect surface water from pesticides. California law technically provides two parts of the California Environmental Protection Agency (Cal-EPA), the California Department of Pesticide Regulation (DPR) and California state water quality regulators, with the ability to protect surface water from pesticides. Except in extraordinary circumstances, California Water Boards defer pesticides regulation to DPR.

While the mandates of these pesticide and water quality laws differ slightly, the approaches to implementing these two groups of laws are very different and have important ramifications for pesticides and water quality. In general, pesticide regulatory programs are structured to respond slowly when water quality problems occur—and without financial penalties to pesticide manufacturers or users. In contrast, water quality programs are generally structured to react quickly when water quality problems occur—with immediate financial consequences, particularly for municipalities. Pesticide regulators and water quality regulators employ very different procedures to manage pesticides. While these differences sometimes seem arcane, they create regulatory gaps that leave states and municipalities responsible for solving water quality problems that could have been prevented at the time a pesticide was registered or re-registered.

Three groups of agencies that manage California's water quality are working with pesticide regulators to address this regulatory gap: the State Water Resources Control Board and Regional Water Quality Control Boards ("Water Boards"), municipal wastewater treatment plants (also known as sewage treatment plants or publicly-owned treatment works [POTWs]), and urban runoff management agencies (including BASMAA members). This report refers to these three groups of agencies collectively as "California water quality agencies."

Urban runoff management agencies—including BASMAA's members—have conducted their portion of this effort through their statewide organization, the California Stormwater Quality Association (CASQA).

Why California Municipalities Are Working with Pesticide Regulators

California municipalities began regular engagement in pesticide regulatory processes because they had concluded that the most cost-effective approach to protecting surface water from pesticide-related toxicity is to <u>prevent</u> pesticide uses that have significant potential to cause water quality impairment or that cause violations of NPDES permits.

Preventing water quality problems at the source is well known to be more effective—and far less costly—than alternatives.

In the mid-2000s, the scientific finding that pyrethroid insecticides are linked to widespread toxicity to sediment-dwelling organisms in California urban creeks[1] increased the importance of active California municipality participation in California and Federal pesticide regulatory processes. Since California law precludes local regulation of pesticides, municipal urban runoff programs must rely on pesticide regulators to solve this problem.

Role of the Urban Pesticide Pollution Prevention Project (UP3 Project)

Because understanding and participating in regulatory activities is complex and time-intensive, CASQA, the Water Boards, and POTWs found that they needed scientific and regulatory support to participate in pesticide regulatory processes. The Urban Pesticide Pollution Prevention (UP3) Project was established in mid-2004 specifically to provide this much-needed support. From its inception through January 2011, a State Water Resources Control Board grant administered by the San Francisco Estuary Partnership (SFEP) funded the UP3 Project. TDC Environmental provided technical support for the project.

To maximize the effectiveness of their pesticide regulatory involvement and minimize cost, CASQA, the Water Boards, and POTWs have organized their pesticide regulatory involvement efforts jointly. Between mid-2004 and January 2011, the UP3 Project took on the role of coordinating the joint cooperative regulatory involvement effort. Starting in February 2011 when UP3 Project grant funding was exhausted, CASQA took on most these functions. Starting July 1, 2011, this role is being transitioned to a jointly funded partnership between CASQA and California POTWs.

The UP3 Project supported California water quality agency participation in pesticide regulatory actions by identifying and tracking pesticide regulatory processes of significant interest for water quality, analyzing pesticide regulatory documents to identify water quality protection gaps, and reviewing scientific studies to assemble the information needed to fill the identified gaps. The UP3 Project assists water quality agencies with communicating this information directly to regulators at U.S. EPA and the California Department of Pesticide Regulation (DPR) through letters, meetings, informal communications, and presentations. The CASQA-POTW partnership intends to continue to provide these services.

To coordinate agency activities and facilitate dialog, the UP3 Project also:

- Managed the Urban Pesticides Committee (UPC), which served as a center for information exchange, coordination, and collaboration among local, regional, and state agencies and other stakeholders seeking to end pesticide-related surface water toxicity problems;
- Operated an announcement-only e-mail list for UPC members to keep them up to date on regulatory, scientific, and educational program developments; and
- Maintained a web site (www.up3project.org) that provided documents and other resources to assist agencies with implementing programs to prevent pesticide-related water quality problems.

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[1] The many scientific studies documenting this toxicity are summarized in TDC Environmental (2008). *Pesticides in Urban Surface Water: Annual Review of New Scientific Findings 2008*, prepared for the UP3 Project. April.

Although its State Water Board grant funding will soon be exhausted, SFEP hopes to be able to continue managing UPC meetings, the email list, and the website.

2.2 U.S. EPA and DPR Pesticide Review Processes

California water quality agencies primarily engage with pesticide regulators within the existing regulatory processes established by U.S. EPA and DPR. Both U.S. EPA and DPR have processes to review pesticides prior to their first use and processes to respond to human health and environmental problems that occur after a pesticide is approved for use. Both agencies also have the responsibility to review all pesticides periodically. Table 1 (on the next two pages) provides a brief description of the various pesticide review processes conducted by U.S. EPA and DPR and identifies the public input opportunities associated with each process.

If a pesticide-related water quality problem (like the problems with diazinon, chlorpyrifos, and the pyrethroids) is documented in the environment, the DPR regulatory process offers the most immediate response mechanisms. DPR's pesticide "reevaluation" process is structured to respond to environmental problems more rapidly than the "special review" process at U.S. EPA. If water quality problems are associated with professional pesticide applications, DPR also has the authority to adopt regulations requiring that professional pesticide applicators implement water quality protection measures.

On the basis of the structure of the public involvement processes and the nature of pesticide regulatory agency authorities, two pesticide regulatory processes have been the focus of regulatory engagement: U.S. EPA Pesticide Registration Review and California DPR pesticide reevaluation. While the focus is on engagement in formal regulatory processes, the participation has extended to less formal situations, to facilitate a sharing of scientific information and to increase mutual understanding of the regulatory context provided by California and Federal pesticide and water quality legal frameworks.

Table 1: Summary of U.S. EPA and DPR Pesticide Review Processes

Agency	Process	Description	Overview of Public Input Opportunities
U.S. EPA	Registration	New pesticides must be registered or exempted by U.S. EPA before they may be sold. New uses of existing pesticides must also be registered. During registration, U.S. EPA evaluates effects on humans and the environment (including surface water).	U.S. EPA has limited public involvement processes for pesticide registration. It makes a registration workplan available (but does not keep it up to date),[2] provides brief announcements of registration applications (these lack sufficient detail to determine water quality implications), and occasionally provides very brief public comment opportunities on registration decisions.
	Registration review	All currently registered pesticides are planned for review on a 15-year cycle.[3] Each pesticide's review process starts with a "docket opening," which is an opportunity to submit scientific information and to comment on the registration review workplan. Subsequent steps are established by the workplan.	Public involvement opportunities after the docket opening depend on the workplan; these may include opportunities to review U.S. EPA-prepared risk assessments, to provide recommendations for risk reduction options, and to comment on U.S. EPA's proposed registration review decision.
	Special review	U.S. EPA has the power to initiate special review when it discovers that the use of a registered pesticide may result in unreasonable adverse effects on humans or the environment; however, it very rarely uses this authority, preferring to address problems through other means such as Registration Review or voluntary agreements. The special review process usually involves intensive review of a specific problem. During special review, U.S. EPA may review scientific information, re-evaluate the identified risk, and select risk reduction measures.	Processes vary. At a minimum, the public is offered the opportunity to comment on the decision proposed by U.S. EPA on the basis of its special review.

[2] Conventional pesticides – new pesticides http://www.epa.gov/opprd001/workplan/newchem.html new uses - http://www.epa.gov/opprd001/workplan/newuse.htm ; Biopesticides - http://www.epa.gov/pesticides/biopesticides/regtools/biopesticides_2011_workplan.html ; Antimicrobial pesticides - http://www.epa.gov/oppad001/

[3] Schedules are available on the Internet: http://www.epa.gov/oppsrrd1/registration_review/schedule.htm

Table 1: Summary of U.S. EPA and DPR Pesticide Review Processes (Continued)

Agency	Process	Description	Overview of Public Input Opportunities
DPR	Registration	California has a state requirement for pesticide registration. Like U.S. EPA, it evaluates effects on humans and the environment. Unlike U.S. EPA (which reviews products containing the same active ingredient as group) DPR registers each pesticide product individually. DPR determines whether to evaluate a pesticide product's potential to cause surface water quality or wastewater discharge impacts on a case-by-case basis.	Other than making lists of products entering review available, DPR has no public involvement process for pesticide registration. By providing these lists to its interagency advisory committee (the Pesticide Registration and Evaluation Committee), DPR provides an opportunity for interagency consultation.
	Annual Registration Renewal	California law requires annual renewal of all pesticide registrations. This review is very brief; ordinarily, registrations are renewed if fees are paid and if registrants certify compliance with the requirement to disclose factual or scientific evidence of any adverse effect or risk of the pesticide to human health or the environment.	DPR issues a formal notice of the proposed annual renewal for all pesticides and provides a comment period. Because the notice does not include pesticide-specific information, the process serves as an annual opportunity for the public to provide DPR with information about adverse effects of pesticides.
	Reevaluation	If DPR finds that a significant adverse impact has occurred or is likely to occur from the use of a pesticide, it initiates a reevaluation. During reevaluation, DPR reviews existing data and may require development of additional data related to the impacts of the pesticide. DPR's goal is to identify ways to reduce or eliminate confirmed problems.	DPR has no formal public involvement process for reevaluation; however, it has offered selected stakeholders opportunities to meet with DPR and to review various documents associated with the reevaluation of pyrethroid insecticides. DPR usually consults with its interagency advisory committee (the Pesticide Registration and Evaluation Committee) when approaching major reevaluation decisions.

3.0 PESTICIDE REGULATORY ENGAGEMENT SUMMARY

3.1 BASMAA Participated through CASQA and UP3 Project

Since 2005, urban runoff management agencies—including BASMAA's members—have conducted their engagement in pesticide regulatory activities through their statewide organization, the California Stormwater Quality Association (CASQA). In keeping with this strategy, the BASMAA Board of Directors established that BASMAA's FY 2011 pesticide regulatory involvement would be conducted via CASQA. In FY 2011, MRP Permittees participated in pesticide regulatory processes through CASQA.

CASQA has a Pesticides Subcommittee that manages its day-to-day involvement in pesticide regulatory activities. In fiscal year 2011, the subcommittee had two co-chairs: Jamison Crosby of the Contra Costa Clean Water Program (CCCWP) and Dave Tamayo of the Sacramento County Stormwater Quality Program. Six teleconference meetings were held in FY 2011. Staff of agencies in the Alameda Countywide Clean Water Program (ACCWP) and the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) are also on the subcommittee roster. Both CCCWP and ACCWP participated in subcommittee meetings in FY 2011.

The CASQA Pesticides Subcommittee coordinates stormwater agency participation in pesticide regulatory activities. The subcommittee determines the actions to be taken by CASQA, provides direction to its representatives for participation in agency meetings, peer reviews draft correspondence, and shares information among members. As co-chair, Ms. Crosby has assumed a role in identifying financial resources necessary to support CASQA's activities (which are obtained not only from CASQA but also through contributions from member agencies) and in managing committee-related contracts.

Ms. Crosby provides the linkage between CASQA and the BASMAA Board of Directors.

3.2 Engagement Prioritized Pesticides of Concern in the MRP

U.S. EPA and DPR regulatory processes involve thousands of pesticides each year. Only a small fraction of these pesticides pose significant threats to the quality of urban runoff. CASQA has focused its participation in pesticide regulatory processes on pesticides identified by the UP3 Project as most likely to threaten urban surface water quality through urban runoff.[4] Of these pesticides, the highest priorities are the same current-use pesticides listed as pesticides of concern in the MRP (pyrethroids, fipronil, carbamates, and organophosphorous pesticides).

On the basis of urban watershed monitoring data from across California and urban pesticide use estimates assembled by the UP3 Project, when further prioritization is necessary, CASQA has followed the UP3 Project recommendation to prioritize fipronil and the following pyrethroids: bifenthrin, cyfluthrin, beta-cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, permethrin, and tralomethrin.[5] Among the pyrethroids, those most commonly linked to aquatic toxicity (bifenthrin, cyfluthrin [including beta-cyfluthrin], and cypermethrin) are the top priorities.

According to UP3 Project analysis, organophosphates (chlorpyrifos, diazinon, and malathion) and carbamates (carbaryl) are lower priorities than the pyrethroids and

[4] For the most recent list see TDC Environmental (2010). *Pesticides in Urban Runoff, Wastewater, and Surface Water. Annual Review of new Scientific Findings 2010*. Prepared for the UP3 Project. March.
[5] TDC Environmental (2008). *Pesticides of Interest for Urban Surface Water Quality. Urban Pesticides Use Trends Annual Report 2008*. Prepared for the UP3 Project. July 30; Moran, K. D. (2007). "Urban Use of the Insecticide Fipronil—Water Quality Implications." Memorandum prepared for the UP3 Project. June 18.

fipronil. Neither diazinon nor chlorpyrifos pose a continuing threat to urban watersheds now that U.S. EPA has prohibited almost all urban use.[6] Similarly, urban watersheds are benefitting from significant reductions in use of both carbaryl and malathion, likely the consequence of U.S. EPA regulatory requirements.[7]

3.3 Engagement Summary for Fiscal Year 2011

CASQA and UP3 Project Conducted All Tasks Listed in MRP Section C.9.e.i. (1), (2), and (4)

CASQA encouraged U.S. EPA and DPR to coordinate implementation of pesticide and water laws to accommodate water quality concerns as required under MRP sections C.9.e.i.(1) and (2) and submitted comment letters as required under C.9.e.i.(4). Table 2 (on the following pages) lists specific CASQA and BASMAA member actions, including meetings and correspondence.

Until January 2011, CASQA relied on the UP3 Project to complete the pesticide evaluation and registration activities tracking required under C.9.e.i.(1) and (2). Starting in February 2011, CASQA took on these functions. UP3 Project regulatory tracking tables for fall 2010 are available on the UP3 Project website together with other Urban Pesticides Committee (UPC) meeting materials.

California Pyrethroid Reevaluation / DPR Surface Water Regulations and U.S. EPA Bifenthrin Registration Review Were 2011 Priorities

Responding to widespread toxicity in California surface waters linked to pyrethroid insecticides, in August 2006 DPR initiated regulatory action ("reevaluation") to identify mitigation measures to address the toxicity. DPR has offered California water quality agencies—including CASQA—opportunities to provide information at various junctures in the pyrethroid reevaluation. Participating in DPR's pyrethroid reevaluation was the top pesticide priority for CASQA at the start of FY 2011. In fall 2010, after conducting a series of stakeholder meetings to explore the pyrethroid problem, it sources and potential solutions, DPR decided to prepare regulations to control the major source of pyrethroids in urban runoff—professional structural pest control applications. Working with DPR on these regulations became CASQA's highest pesticide priority for the remainder of FY 2011.

In FY 2011, U.S. EPA moved rapidly forward with its Registration Review process for all of the priority pyrethroids, including bifenthrin, the major cause of pyrethroid-related toxicity in California urban waterways. Educating U.S. EPA about urban runoff and providing input into the design of U.S. EPA's pyrethroids registration review was CASQA's second priority for FY 2011.

[6] For this reason they were dropped from the UP3 List of pesticides of concern in urban runoff (see TDC Environmental (2010). *Pesticides in Urban Runoff, Wastewater, and Surface Water. Annual Review of new Scientific Findings 2010*. Prepared for the UP3 Project. March.)
[7] TDC Environmental (2010). *Pesticides in Urban Runoff, Wastewater, and Surface Water. Annual Urban Pesticide Use Data Report 2010*. Prepared for the UP3 Project. June 28.

Table 2: Pesticide Regulatory Process Participation in FY 2011

Organization	Process	Action	Desired Outcome from Process
U.S. EPA	Bifenthrin Registration Review	CASQA letter – August 23, 2010 Explained urgent need for U.S. EPA action to end pyrethroid-related toxicity and costs associated with current toxicity problem. Requested specific changes to the environmental risk assessment workplan, including an exposure assessment for urban uses that addresses intentional applications on impervious surfaces, both water column and sediments, both acute and chronic toxicity, and cumulative risks with other pyrethroids in urban watersheds. Supported U.S. EPA's proposed environmental risk assessment data request list. Recommended utilization of existing information from the scientific literature, from surface water monitoring programs, and from the DPR pyrethroid reevaluation.	End to pyrethroid-related toxicity in California urban watersheds. Changes to the registration review process to better identify and mitigate urban water quality impacts and adoption of these changes as part of U.S. EPA's overall approach to the registration review process for all pesticides with urban use patterns.
	Carbaryl Registration Review	CASQA letter – November 22, 2010 Requested specific changes to the environmental risk assessment workplan, including an exposure assessment for urban uses of carbaryl that is based on modeling appropriate for urban watersheds. Recommended utilization of existing information from surface water monitoring programs. Requested use restrictions to prevent water quality impacts.	Prevent carbaryl problems in urban watersheds. Changes to the registration review process to better identify and mitigate urban water quality impacts and adoption of these changes as part of U.S. EPA's overall approach to the registration review process for all pesticides with urban use patterns.
	Copper Compounds Registration Review	CASQA letter – November 22, 2010 Requested specific changes to the environmental risk assessment workplan, including an exposure assessment for all urban uses of copper that is based on modeling appropriate for urban watersheds and includes all urban copper pesticide uses. Recommended utilization of water quality criteria in the effects assessment. Requested that U.S. EPA obtain existing information from surface water monitoring programs. Requested use restrictions to prevent water quality impacts.	Reduction of copper levels in urban watersheds. Changes to the registration review process to better identify and mitigate urban water quality impacts and adoption of these changes as part of U.S. EPA's overall approach to the registration review process for all pesticides with urban use patterns.

Table 2: Pesticide Regulatory Process Participation in FY 2011 (Continued)

Organization	Process	Action	Desired Outcome from Process
U.S. EPA	Cyfluthrin Registration Review	CASQA letter - November 22, 2010 Explained the urgent need for U.S. EPA action to end pyrethroid-related toxicity. Requested specific changes to the environmental risk assessment workplan, including an exposure assessment for urban uses that addresses intentional applications on impervious surfaces and that is based on modeling appropriate for urban watersheds, both water column and sediments, both acute and chronic toxicity, and cumulative risks with other pyrethroids in urban watersheds. Recommended utilization of existing information from the scientific literature, from surface water monitoring programs, and from the DPR pyrethroid reevaluation.	End pyrethroid-related toxicity in California urban watersheds. Changes to the registration review process to better identify and mitigate urban water quality impacts and adoption of these changes as part of U.S. EPA's overall approach to the registration review process for all pesticides with urban use patterns.
	Gamma and Lambda-Cyhalothrin Registration Review	CASQA letter – February 22, 2011 Provided support for the environmental risk assessment work plan and thanked U.S. EPA for substantial improvements in work plan design. Requested that the OPP/OW Common Effects Assessment Methodology be used and that modeled exposure time periods be consistent with OW standards. Requested urban runoff modeling improvements and offered specific suggestions for how these might be achieved.	End pyrethroid-related toxicity in California urban watersheds. Improvements in the registration review process to better identify and mitigate urban water quality impacts and adoption of these changes as part of U.S. EPA's overall approach to the registration review process for all pesticides with urban use patterns.
	Piperonyl Butoxide Registration Review	CASQA letter – February 22, 2011 Provided support for the environmental risk assessment work plan, particularly for the plan to assess the cumulative impacts of piperonyl butoxide with other pesticides in the aquatic environment.	Support elements of the proposed the registration review work plan that better identify and mitigate urban water quality impacts and encourage adoption of these changes as part of U.S. EPA's overall approach to the registration review process for all pesticides with urban use patterns.

Table 2: Pesticide Regulatory Process Participation in FY 2011 (Continued)

Organization	Process	Action	Desired Outcome from Process
U.S. EPA	Office of Pesticide Programs (OPP) and Office of Water (OW) Effects Assessment Methodology Reconciliation Project	CASQA letter – January 14, 2011 Thanked U.S. EPA for conducting the project, supported the expedited schedule, requested project methodologies be checked to ensure that the methodologies develop values that are below concentrations toxic to standard aquatic toxicity testing species, and asked that the U.S. EPA project team do its work in the context that U.S. EPA pesticide regulations—rather than Clean Water Act mechanisms—are the appropriate mechanisms to address water pollution from pesticides.	Ensure project outcome fully coordinates OPP's effects assessments with the OW-approved toxicity testing procedures. Revise U.S. EPA regulatory processes so that they trigger actions to prevent pesticide-related toxicity before water pollution occurs.
	Advanced Notice of Proposed Rulemaking – Delta Aquatic Resource Protection	CASQA letter – April 25, 2011 Described municipality roles in controlling pesticides in urban runoff and explained how legal frameworks and treatment infeasibility preclude local control of pesticides discharges. Recommended improvements in pesticide regulatory programs to better protect the Delta, including specific improvements needed in urban runoff modeling for pesticides. CASQA, Water Boards, and DPR Meeting with U.S. EPA – April 5, 2011 Shared information about California water quality agency teamwork to work with pesticide regulators to address pesticide-related water pollution and (in collaboration with DPR) described anticipated benefits of DPR plans for surface water protection regulations to reduce pyrethroids in urban runoff.	U.S. EPA Region 9 assistance with efforts to address current pesticide-related water pollution problems and prevent new ones. Educate Region 9 as to why working with pesticide regulators to address the FIFRA/Clean Water At regulatory gap is more likely to increase Delta protection than expanding Clean Water Act permitting.

Table 2: Pesticide Regulatory Process Participation in FY 2011 (Continued)

Organization	Process	Action	Desired Outcome from Process
U.S. EPA	None	The UP3 Project provided the following information to U.S. EPA: • Paper on pesticide (nanosilver) washing out of building paint into urban runoff – August 2010 • Presentation on urban pesticide use and water pollution at U.S. EPA training for pesticides regulators, explaining conceptual models, urban pesticide use patterns, recent water pollution problems, and regulatory gaps – September 2010 • Met with U.S. EPA OPP modeler to discuss scientific challenges with U.S. EPA's urban runoff modeling capabilities – September 2010 • Conference presentation to audience with many U.S. EPA employees and met with U.S. EPA staff to provide further information on pyrethroid urban use and urban watershed aquatic toxicity problems, including details on bifenthrin use – November 2010 • Paper on pyrethroid washoff from impervious surfaces - December 2010	Improve U.S. EPA's scientific understanding of pesticides in urban runoff such that U.S. EPA has sufficient scientific information to structure regulatory processes to ensure that pesticide applications comply with water quality standards.

Table 2: Pesticide Regulatory Process Participation in FY 2011 (Continued)

Organization	Process	Action	Desired Outcome from Process
DPR	Pyrethroid Reevaluation	DPR Pyrethroid Reevaluation Stakeholder Meetings (PRSM meetings) – July, August, and October 2010 Participated in a series of meetings among DPR, CASQA, the Water Boards, POTWs, pyrethroid pesticide manufacturers, and professional pest control applicators to improve communications, to conduct joint fact finding, to identify priority data gaps requiring additional information to be generated, and to identify mitigation strategies to end pyrethroid-related toxicity in urban watersheds. In FY 2011, the stakeholder group concluded its meetings after educating DPR and each other about pyrethroids in urban runoff and municipal wastewater treatment plants, pyrethroid urban use patterns, pyrethroid-related toxicity in water and sediment, and the regulatory and environmental consequences thereof. DPR announced its intent to pursue regulations to reduce pyrethroids in urban runoff. CASQA and the UP3 Project provided the following information to DPR at FY 2011 meetings: • Evaluation of the feasibility of various mitigation options. • Scientific rationale for taking action to reduce pyrethroids in urban runoff without conducting additional scientific studies. • Estimates of pyrethroid use in California urban areas, identification of major and minor users and use patterns for each pyrethroid, and identification of pyrethroids commonly used outdoors and those commonly used indoors.	End pyrethroid-related toxicity in California urban watersheds without transitioning to other harmful products. Educate DPR about pesticide-related toxicity in urban watersheds. Ask DPR to change its regulatory processes so that it identifies and prevents such toxicity.
		CASQA meeting with DPR – October 20, 2010 DPR shared its strategy for responding to pyrethroid-related toxicity in urban watersheds (adopting regulations to reduce pyrethroid use on outdoor impervious surfaces). CASQA briefed DPR on the reasons that action is urgent (compliance, cost, legal liability, and environmental stewardship responsibilities of municipalities) and the anticipated time frames for higher levels of regulatory consequences for municipalities.	

Table 2: Pesticide Regulatory Process Participation in FY 2011 (Continued)

Organization	Process	Action	Desired Outcome from Process
DPR	Pyrethroid Reevaluation	PWG Pathways Study Proposal – Letter to DPR, December 13, 2010 Recommended that DPR prioritize completion of the surface water protection regulations and other mitigation actions instead of this study proposal, recommended abandoning this study proposal in favor of a more targeted research approach informed by a panel of independent technical advisors, and provided a detailed scientific critique of the project proposal.	See above
	Surface Water Protection Regulations	Letter to DPR – August 11, 2010 Thanked DPR and supported adoption of surface water protection regulations. Requested that regulations cover all pesticides with the potential to cause or contribute to surface water toxicity and recommended specific changes to clarify exemptions and to improve controls for pre-construction termiticide applications. Meeting with DPR – February 11, 2011 Thanked DPR for prioritizing urban runoff regulations and supported the general regulatory approach. Requested clarification of pin-stream application exemption, consideration of further limitations for impervious surface applications and all bifenthrin applications, addition of additional pesticides, and minor wording changes. Email to DPR – February 12, 2011 Provided list of pesticide priorities in urban runoff and detailed rationale for CASQA request that several pyrethroids be added to regulations. Email to DPR – March 24, 2011 Provided suggested language for clarification of the aquatic pesticide application exemption. Meeting with DPR – May 23, 2011 Thanked DPR for its proposal and its thorough consideration of CASQA comments. Clarified schedule, technical issues, and bifenthrin mitigation plan. Email to DPR – May 24, 2011 To support requested minor modification of regulatory language for creek buffer zones, provided examples of how water quality agencies and municipalities regulate activities based on distances from urban creeks.	Implement effective measures to prevent water pollution associated with professional urban pesticide use. Include in regulatory structure the ability to control pesticides most likely to threaten urban surface water quality through urban runoff, including pesticides that might be registered in the future.

Table 2: Pesticide Regulatory Process Participation in FY 2011 (Continued)

Organization	Process	Action	Desired Outcome from Process
DPR	Pest Management Advisory Committee (PMAC)	DPR PMAC meetings - Quarterly DPR has one general external stakeholder advisory group, called the Pest Management Advisory Committee. A CASQA representative (Dave Tamayo of the Sacramento County Stormwater Quality Program) participates in most meetings and is formally an alternate member of the committee (the lead member in the seat is a POTW representative).	Educate DPR and other urban pest management stakeholders.
	None	The UP3 Project provided the following information to DPR: • Paper on pesticide (nanosilver) washing out of building paint into urban runoff – August 2010 • Briefing on urban pyrethroid use and copy of UP3 Project Urban Pesticide Use Data Report – August 2010	Improve DPR's scientific understanding of pesticides in urban runoff such that DPR has sufficient scientific information to structure regulatory processes to ensure that pesticide applications comply with water quality standards.
UP3 Project	Urban Pesticides Committee (UPC) Meetings	UPC meetings - Three meetings in FY 2011 The UPC serves as a center for information exchange, coordination, and collaboration among local, regional, and state agencies and other stakeholders seeking to end pesticide-related surface water toxicity problems. Examples of information and insights shared by CASQA in 2011 include: • Concerns with ongoing pyrethroid-related toxicity, including the high costs for municipalities and the ongoing threat of third-party lawsuits. • Pyrethroids and toxicity monitoring data from the San Diego area. • Updates on participation in California and Federal pesticide regulatory activities.	Educating other stakeholders through informal interactions. Become informed about issues relevant to the development of regulatory and non-regulatory measures to prevent pesticide-related water pollution.

4.0 EVALUATION OF 2011 OUTCOMES

4.1 Goals and Objectives for Pesticide Regulatory Engagement

The goals of CASQA's and BASMAA's engagement in pesticide regulatory processes are:

1. To prevent surface water impairment.
2. To prevent violations of stormwater NPDES permits.

To achieve these goals, CASQA has three long-term objectives for its participation in pesticide regulatory processes:

A. Improve design of pesticide water quality impact evaluations. Pesticide water quality impact evaluations conducted by U.S. EPA and DPR should be based on all available scientific information, assess the impacts of pesticides transported to surface water via all pathways (including urban runoff), fully address all urban use patterns, and incorporate evaluation endpoints consistent with Clean Water Act regulatory endpoints.

B. Encourage pesticide regulators to address urban surface water quality in pesticide risk management decisions and to do so in a timely manner. Pesticide risk management decisions should address all significant surface water quality risks including those posed by urban pesticide use patterns, consider costs to water quality agencies, be implemented quickly when water quality problems occur, and prevent new environmental or health impacts from future pesticide market shifts.

C. Seek meaningful public participation opportunities for water quality agencies. To achieve the above objectives, pesticide regulatory decisions relevant to water quality need to include public participation processes that make all relevant information available for water quality agency review and provide opportunity for water quality agencies to share information to ensure that decisions are based on accurate scientific and management information and include practical and effective risk management strategies.

Major FY 2011 objectives were:

- To end pyrethroid-related toxicity in California urban watersheds without transitioning to other harmful products.
- To encourage changes in pesticide regulatory processes such that these processes effectively prevent future water quality and compliance problems.

4.2 Overview of Past Outcomes

Regular interagency dialogue about pesticide-related water quality problems started with the formation of the Urban Pesticides Committee (UPC) in the mid-1990s. By the late 1990s, California water quality agencies recognized that while the information-exchange forum provided by the UPC is valuable, informal dialogue with pesticide manufacturers and pesticide regulators was not a sufficient means to achieve the changes needed to ensure long-term water quality protections from the impacts of urban pesticide use.

In 1999, California water quality agencies started to engage in pesticide regulatory processes on an ongoing basis. In 2003, the scope of the effort was increased in recognition of the water quality threat posed by the market shift to pyrethroid insecticides that occurred as a consequence of the phase out of most urban uses of diazinon and chlorpyrifos. Beginning in mid-2004, the effort was further strengthened due to State Water Board grant funding to the UP3 Project, which provided California water quality agencies with an ongoing base of scientific and regulatory support for their individual engagement with pesticide regulators.

Although the process was slow at first, by 2005 staff from both pesticide and water quality regulatory agencies had recognized the importance of pesticide-related water quality issues. By 2007, pesticide regulators had recognized and acknowledged that gaps in their regulatory processes—particularly gaps related to urban pesticide use—were connected to urban water quality problems from pesticides.

In 2006, pesticide regulatory agencies began to take specific steps to address pesticide-related urban surface water quality problems. At the Federal level, U.S. EPA changed allowable uses for several pesticides due to water quality problems. California DPR initiated the pyrethroid reevaluation in response to water quality problems and created an Urban Pest Management Workgroup to give it advice on development of management strategies specific to pesticide use in urban areas.

In 2007-2010, further changes continued. Federal regulators required a few initial measures to prevent washoff of pyrethroids into urban runoff. The first federal pyrethroid Registration Review workplans acknowledged the need to address urban runoff. Federal regulators also initiated the Office of Pesticide Programs (OPP) and Office of Water (OW) Effects Assessment Methodology Reconciliation Project to address a regulatory gap highlighted in California water quality agency comments. California regulators started work on surface water protection regulations, including measures to protect urban runoff. In 2010, DPR accelerated the pace of the pyrethroid reevaluation and expanded communications with water quality stakeholders, including CASQA.

4.3 FY 2011 Outcomes

Table 3 (on pages 21-26) summarizes the outcomes of CASQA's recent pesticide regulatory engagement, which was conducted in collaboration with other California water quality agencies. These outcomes reflect the teamwork of all of the partners. Outcomes since the last BASMAA pesticide regulatory outcomes evaluation in August 2010[8] are included in the table.

In FY 2011 the persistence of CASQA and its partners began to pay off:

- DPR began laying the groundwork for regulatory solutions to the pyrethroid toxicity problem. DPR drafted regulations that would substantially reduce levels of pyrethroids in urban runoff. DPR also announced plans to work with bifenthrin manufacturers to add additional restrictions to bifenthrin product labels. The regulations and label changes may be finalized before the end of FY 2012.
- U.S. EPA modified its Registration Review workplans to improve its evaluation of the water quality impacts of urban pyrethroid use:
    - All urban pyrethroids uses—most importantly outdoor impervious surface applications—will be addressed in environmental risk assessments.
    - Both water column and sediment toxicity will be endpoints in environmental risk assessments.

[8] TDC Environmental (2010). Pesticide Regulation for Water Quality Protection. Annual BASMAA Participation Summary and Outcomes Assessment 2011. Prepared for BASMAA. August 30.

 - Both acute and chronic toxicity data will be required to be generated by pyrethroid manufacturers and will be used by U.S. EPA in its risk assessments.
 - Risks to both salt water and fresh water organisms will be assessed.

 The modified work plans will allow U.S. EPA to create the scientific basis for implementation of measures that may be needed to solve the pyrethroid toxicity problem (e.g., restrictions on use of non-professional products).

- Pesticides regulators at both U.S. EPA and DPR continued slow progress toward implementing operational changes that better integrate water quality protection into pesticide regulatory processes.
- U.S. EPA pesticides regulators have begun consulting their Office of Water colleagues with regard to water quality modeling, effects assessment, aquatic toxicity data, and urban water pollutant transport pathways.

U.S. EPA's responses to CASQA and California Water Board comments on bifenthrin (see Table 4 on pages 27-28) illustrate the changes that regulatory engagement has achieved. The table lists specific changes in U.S. EPA's Bifenthrin Registration Review workplan; these changes have been reflected in all subsequent pyrethroid workplans. The responses also reflect a more positive U.S. EPA approach toward the responsibility to manage pesticide-related water pollution in urban areas. Although these changes have not been reflected in most non-pyrethroid U.S. EPA registration review work plans to date, CASQA's and its partners' input prompted similar revision of the carbaryl and copper registration review work plans.

In evaluating regulatory outcomes, it is important to recognize that water quality is but one of many economic, social, and environmental factors that U.S. EPA and DPR consider when making regulatory decisions.

Improved communications with pesticide regulators helped CASQA focus its engagement more productively. CASQA and its partners developed a better understanding of California and Federal pesticide regulatory processes, obtained a greater appreciation for the constraints faced by pesticide regulators, and learned more about the specific types of information that pesticide regulators need to improve their ability to use their existing regulatory authorities to protect water quality.

While the specific outcomes listed above reflect meaningful progress toward achieving the goals of California water quality agency engagement in pesticide regulatory processes, these goals have not yet been fully achieved. The record shows that the engagement of California water quality agencies has significantly improved water quality protection since their initial engagement in the 1990s.

This evaluation is necessarily an interim evaluation. The types of processes that CASQA and other California water quality agencies have engaged in take years to complete—and the systemic changes desired will probably take many years to implement fully. Due to the complexity of pesticide regulatory processes, responses to comments may not be issued for more than one year after comments are submitted and outcomes often occur years after comments are made.

Table 3. FY 2011 Pesticide Regulatory Engagement Outcomes

Regulatory Process	**Desired Outcome from FY 2010 & 2011 Engagement**	**Actual Outcome**	**Assessment of Relationship of Water Quality Agency Involvement to Outcome**
U.S. EPA Deltamethrin Registration Review	Specific changes to the Registration Review workplan, including an exposure assessment for urban uses of deltamethrin that addresses both water column and sediments as well as cumulative risks with other pyrethroids in urban watersheds. Utilization of existing information from surface water monitoring programs and from the DPR pyrethroid reevaluation.	Applications onto impervious surfaces will be included in the environmental risk assessment. Both water column and sediments will be addressed. U.S. EPA added requirements for manufacturers to conduct *Hyalella azteca* water column toxicity testing. U.S. EPA will examine ways to address cumulative pyrethroid risks qualitatively; no method exists for a quantitative assessment. U.S. EPA will use information from "pertinent" monitoring sources and from the DPR pyrethroid reevaluation.	High. Without active involvement by CASQA and other California water quality agencies, U.S. EPA would not have made these revisions to its workplans. No other commenters addressed these topics.
U.S. EPA Esfenvalerate Registration Review	Specific changes to the Registration Review workplan, including an exposure assessment for urban uses of esfenvalerate that addresses both water column and sediments as well as cumulative risks with other pyrethroids in urban watersheds. Utilization of existing information from the scientific literature, from surface water monitoring programs, and from the DPR pyrethroid reevaluation.	Due to problems with the U.S. EPA docket, CASQA's letter was not addressed in the final Registration Review workplan; however, letters from other California water quality agencies containing similar comments were received and triggered significant workplan revisions to better address urban runoff and receiving water quality.	High. Without active involvement by California water quality agencies, U.S. EPA would not have made these revisions to its workplans. The glitch with the CASQA letter submittal emphasizes the importance of teamwork with other agencies.

Table 3. FY 2011 Pesticide Regulatory Engagement Outcomes (Continued)

Regulatory Process	Desired Outcome from FY 2010 & 2011 Engagement	Actual Outcome	Assessment of Relationship of Water Quality Agency Involvement to Outcome
U.S. EPA Bifenthrin Registration Review	Specific changes to the environmental risk assessment workplan, including an exposure assessment for urban uses that addresses intentional applications on impervious surfaces, both water column and sediments, both acute and chronic toxicity, and cumulative risks with other pyrethroids in urban watersheds. Utilization of existing information from the scientific literature, from surface water monitoring programs, and from the DPR pyrethroid reevaluation.	Major revisions to the environmental risk assessment workplan addressing all comments (though not always exactly as requested). See details in Table 4.	High. Without active involvement by CASQA and other California water quality agencies, U.S. EPA would not have made these revisions to its workplans. No other commenters addressed these topics.
U.S. EPA Carbaryl Registration Review	Specific changes to the environmental risk assessment workplan, including an exposure assessment for urban uses of carbaryl that is based on modeling appropriate for urban watersheds. Utilization of existing information from surface water monitoring programs. Use restrictions to prevent water quality impacts.	The environmental risk assessment workplan will be modified to include outdoor carbaryl urban use (including applications onto impervious surfaces and slug-snail applications) and urban runoff transport pathways. U.S. EPA did not agree to take a more active role in obtaining monitoring data from states and municipalities. At the appropriate time in the Registration Review process, U.S. EPA will attempt to model risk mitigation measures that are needed for aquatic life protection.	High. Without active involvement by CASQA and other California water quality agencies, U.S. EPA would not have made these revisions to its workplans. No other commenters addressed these topics.

Table 3. FY 2011 Pesticide Regulatory Engagement Outcomes (Continued)

Regulatory Process	Desired Outcome from FY 2010 & 2011 Engagement	Actual Outcome	Assessment of Relationship of Water Quality Agency Involvement to Outcome
U.S. EPA Cyfluthrin Registration Review	Specific changes to the environmental risk assessment workplan, including an exposure assessment for urban uses that addresses intentional applications on impervious surfaces and that is based on modeling appropriate for urban watersheds, both water column and sediments, both acute and chronic toxicity, and cumulative risks with other pyrethroids in urban watersheds. Utilization of existing information from the scientific literature, from surface water monitoring programs, and from the DPR pyrethroid reevaluation.	Major revisions to the environmental risk assessment workplan addressing all comments in the same manner as the bifenthrin comments were addressed (see Table 4). U.S. EPA is continuing to explore how cumulative environmental risks from pyrethroids can be addressed.	High. Without active involvement by CASQA and other California water quality agencies, U.S. EPA would not have made these revisions to its workplans. No other commenters addressed these topics.
U.S. EPA Gamma and Lambda Cyhalothrin Registration Reviews	Urban runoff modeling improvements. Commitment to use the OPP/OW Common Effects Assessment Methodology. Ensure modeled exposure time periods are consistent with OW standards.	Minor improvements to the workplan, which was relatively well designed. U.S. EPA is working on how it will address urban runoff, but has not acknowledged the shortcomings of its current urban modeling scenario. OPP has not yet committed to using the outcome of the OPP/OW Common Effects Assessment Methodology project in its pesticide risk assessments.	High. Without active involvement by CASQA and other California water quality agencies, U.S. EPA would not have made these revisions to its workplans. No other commenters addressed these topics.

Table 3. FY 2011 Pesticide Regulatory Engagement Outcomes (Continued)

Regulatory Process	Desired Outcome from FY 2010 & 2011 Engagement	Actual Outcome	Assessment of Relationship of Water Quality Agency Involvement to Outcome
U.S. EPA Copper Registration Review	Specific changes to the environmental risk assessment workplan, including an exposure assessment for all urban uses of copper that is based on modeling appropriate for urban watersheds and includes all urban copper pesticide uses. Utilization of water quality criteria in the effects assessment. Obtain existing information from surface water monitoring programs. Use restrictions to prevent water quality impacts.	The environmental risk assessment workplan will be revised to include all registered uses of copper as a pesticide. U.S. EPA is struggling with how to conduct watershed modeling on a national scale; it may not be able to address problems that only occur in a few watersheds. U.S. EPA will enter into a dialog with stakeholders to determine if a swimming pool discharge assessment is needed. U.S. EPA intends to evaluate impacts on the basis of values generated by the Biotic Ligand Model (BLM) for fresh water rather than the water quality criteria adopted by U.S. EPA for California. (OPP does not understand that California did not select its non-BLM water quality criteria). U.S. EPA will not go to state resources to obtain monitoring data. U.S. EPA would welcome the opportunity to engage in a dialog with stakeholders to discuss issues related to copper assessment during Registration Review.	High. Without active involvement by CASQA and other California water quality agencies, U.S. EPA would not have most of these revisions to its workplans. Except for DPR, no other commenters addressed most of these topics.
U.S. EPA Piperonyl Butoxide Registration Review	Support elements of the proposed the registration review workplan that better identify and mitigate urban water quality impacts and encourage adoption of these changes as part of U.S. EPA's overall approach to the registration review process for all pesticides with urban use patterns.	CASQA and Water Board comments in support of cumulative environmental risk assessments of this synergist were used by U.S. EPA to respond to other comments questioning U.S. EPA's election to conduct a precedent-setting cumulative environmental risk assessment.	Moderate. Without active involvement by CASQA and other California water quality agencies, U.S. EPA would have had greater difficulty defending its cumulative risk assessment workplan.

Table 3. FY 2011 Pesticide Regulatory Engagement Outcomes (Continued)

Regulatory Process	Desired Outcome from FY 2010 & 2011 Engagement	Actual Outcome	Assessment of Relationship of Water Quality Agency Involvement to Outcome
U.S. EPA Office of Pesticide Programs (OPP) and Office of Water (OW) Effects Assessment Methodology Reconciliation Project	Ensure project outcome fully coordinates OPP's effects assessments with the OW-approved toxicity testing procedures. Revise U.S. EPA regulatory processes so that they trigger actions to prevent pesticide-related toxicity before water pollution occurs.	Project-specific outcome unknown. Waiting for U.S. EPA to take next step in project. Initial educational goals achieved in FY 2010.	Project-specific relationship cannot yet be determined High for education goals.
Delta ANPR	U.S. EPA Region 9 assistance with efforts to address current pesticide-related water pollution problems and prevent new ones. Educate Region 9 as to why working with pesticide regulators to address the FIFRA/Clean Water At regulatory gap is more likely to increase Delta protection than expanding Clean Water Act permitting.	Unknown. Waiting for U.S. EPA to issue the draft regulation.	To be determined
U.S. EPA Antimicrobials Data Rule	Require manufacturers to provide all data necessary for a complete evaluation of urban runoff impacts when a pesticide is registered or is subject to registration review.	Unknown. Waiting for U.S. EPA to finalize the regulation.	To be determined
U.S. EPA Advanced Notice of Proposed Rulemaking – Pesticide Inert Ingredients Disclosure	Disclosure of pesticide inert ingredient identities to assist with efforts to prevent water pollution.	Unknown. Waiting for U.S. EPA to issue the draft regulation.	To be determined

Table 3. FY 2011 Pesticide Regulatory Engagement Outcomes (Continued)

Regulatory Process	Desired Outcome from FY 2010 & 2011 Engagement	Actual Outcome	Assessment of Relationship of Water Quality Agency Involvement to Outcome
DPR Pyrethroid Reevaluation	End pyrethroid-related toxicity in California urban watersheds without transitioning to other harmful products. Educate DPR about pesticide-related toxicity in urban watersheds. Ask DPR to change its regulatory processes so that it identifies and prevents such toxicity.	As of August 2011, DPR was about to propose regulations designed to reduce the amount of pyrethroids in urban runoff. In parallel, DPR is seeking special restrictions on bifenthrin use that would be implemented through product label changes. DPR senior management has developed an understanding of the causes and consequences of pyrethroid-related toxicity in urban watersheds. DPR regulatory processes sometimes have identified and prevented such toxicity and sometimes have failed to do so.	High. Without active involvement by CASQA and other California water quality agencies, regulations would not have been identified as the best strategy to use to reduce pyrethroids in urban runoff.
DPR Surface Water Protection Regulations	Implement effective measures to prevent water pollution associated with professional urban pesticide use. Include in regulatory structure the ability to control pesticides most likely to threaten urban surface water quality through urban runoff, including pesticides that might be registered in the future.	For pyrethroids, goal may soon be achieved (see above). Additional work will be necessary to control other currently registered pesticides. Other mechanisms (i.e., not registering highly toxic pesticides in California for applications linked to urban runoff pollution) might better address future pesticides.	High. DPR's decision to make regulations addressing pyrethroids in urban runoff its highest priority was a direct result of CASQA/Water Board engagement and UP3 Project scientific information linking professional pesticide applications to water pollution.

Source: TDC Environmental evaluation of U.S. EPA and DPR regulatory documents and meetings.

Table 4. Bifenthrin Registration Review Comment and Response Summary

General Comment	U.S. EPA Response
Pyrethroids are causing costly non-compliance with the Clean Water Act.	OPP acknowledges the costs of non-compliance with the Clean Water Act and is making every effort to ensure that it adequately identifies and mitigates ecological risks from use of bifenthrin and other pyrethroids during registration review.
Urban Runoff Comments	**U.S. EPA Response**
Recognize intentional applications to impervious surfaces.	Will do.
Modify outdoor runoff conceptual model to include impervious surfaces & flow through pipes.	Will do.
Do real urban runoff modeling. Modeling does not account for impervious surface.	Our existing models will be set up to address impervious surfaces. Will use the impervious scenario we developed.
Pyrethroid transport is not only via particles, could also be washed in water; modeling needs to account for both possibilities.	Exposure modeling will reflect the potential for both water and sediment transport.
Need formulation-specific washoff data for urban runoff modeling.	Product-specific washoff data will not be required, but we will use the recent published studies on washoff, studies required in the DPR pyrethroid reevaluation, plus any other relevant open literature.
Pyrethroid Use Data Comments	**U.S. EPA Response**
Examine both professional and non-professional urban use.	Will do.
Urban use can be estimated from available data.	DPR pesticide use report data, the professional structural applicator survey, and other available data will be used. We will consider the UP3 Project report estimating urban pyrethroid use.
Cumulative Risk Comments	**U.S. EPA Response**
Assess cumulative risks with other pyrethroids.	We don't have a modeling approach we can use, but we will consider open literature, modeling and other lines of evidence (including monitoring data) as available to address the potential for cumulative effects in the risk description portion of the forthcoming risk assessment.
Please assess cumulative risks with synergists.	U.S. EPA intends to assess cumulative risks with piperonyl butoxide (PBO), which is the only synergist in multiple pyrethroid products. We have included this in the PBO Registration Review workplan and have proposed data requirements to support this analysis.
Aquatic Toxicity Comments	**U.S. EPA Response**
Use open literature for the aquatic portion of the risk assessment.	U.S. EPA did a partial literature search; will do an updated literature search in the future.
Assess both water column and sediment exposures.	This has always been our intent. We have clarified this in the workplan.

Table 4. Bifenthrin Registration Review Comment and Response Summary (Continued)

Aquatic Toxicity Comments	U.S. EPA Response
Please used agency-wide ECOTOX database, not just the OPP version.	Will do.
Add immobilization as a sublethal endpoint, could have population implications.	Already included. We consider immobilization equivalent to mortality.
Need to assess affects at colder temperatures. This will entail requiring toxicity data at 13-15 °C.	Will not require testing, but will consider available and submitted literature on the temperature effects on pyrethroid toxicity as part of the risk assessment. We will take into account this factor in its characterization of risk (e.g., potentially as part of a sensitivity analysis).
Water column *H. azteca* toxicity data are available for some pyrethroids.	Registrants are free to request use of the open literature data instead of doing new tests. We will review the open literature.
Please use open available data on toxicity to *Eohaustorius estuarius*.	*L. plumulosus* (an east coast species), which is the only species for which we have an approved chronic toxicity methodology, has similar sensitivity to *Eohaustorius*. We will also use data for other species from the open literature.
Need chronic water column toxicity data.	These data are required for both *H. azteca* (fresh water) and *A. bahia* (salt water).
Salt-water acute and chronic water column toxicity data are needed.	These data are required.
Use outcome of OPP/OW Common effects assessment methodology.	OPP intends to work with OW.
Other Comments	**U.S. EPA Response**
Please coordinate with California DPR pyrethroid reevaluation and get all relevant information from them.	Will do. Coordination has already started.
Monitoring data submitted; more exists.	Will use monitoring data that was submitted and we will do an open literature search. U.S. EPA is also requiring manufacturers to submit any existing monitoring data known to them.
Information on pyrethroid 303(d) listings is not up to date.	New 303(d) listings are not included because U.S. EPA hasn't finalized its approval of the most recent California list. We will update this information in the risk assessment.
No U.S. EPA-approved chemical analysis methods exist for pyrethroids. Chemical analytical methods should have d.l. <0.1 ng/L. Should include wastewater influent, effluent, and biosolids.	We have required some methods and expect that requested methods be developed to fulfill our data requirements.[9]
U.S. EPA issues too many data waivers for aquatic toxicity data.	No waivers have been issued for bifenthrin.

Source: TDC Environmental paraphrasing of CASQA, Water Board and U.S. EPA documents.

[9] OPP is unaware that U.S. EPA-approved chemical analysis methods are not the same as methods that OPP asks pesticide manufacturers to develop.

Acronyms

ACCWP – Alameda Countywide Clean Water Program

BASMAA – Bay Area Stormwater Management Agencies Association

Cal-EPA – California Environmental Protection Agency

CASQA – California Stormwater Quality Association

CCCWP – Contra Costa Clean Water Program

DPR – California Department of Pesticide Regulation

FIFRA – Federal Insecticide, Fungicide, and Rodenticide Act

FY – Fiscal Year (July 1 through June 30)

MRP – Municipal Regional Permit (NPDES permit for urban runoff from Bay Area municipalities)

NPDES permit – National Pollutant Discharge Elimination System permit (permit for discharge of wastewater or urban runoff to surface waters)

OPP – U.S. EPA Office of Pesticide Programs

OW – U.S. EPA Office of Water

PBO – Piperonyl Butoxide

PMAC – DPR Pest Management Advisory Committee

POTW – Publicly-Owned Treatment Works (municipal wastewater treatment plant)

PRSM – Pyrethroid Reevaluation Stakeholder Meetings hosted by DPR

PWG – Pyrethroid Working Group (organization of pyrethroid insecticide manufacturers)

SCVURPPP – Santa Clara Valley Urban Runoff Pollution Prevention Program

SFEP – San Francisco Estuary Partnership

TMDL – Total Maximum Daily Load (regulatory plan for solving a water pollution problem)

UP3 Project – Urban Pesticides Pollution Prevention Project

UPC – Urban Pesticides Committee

U.S. EPA – United States Environmental Protection Agency

Sediment Management Practices

Clean Watersheds for a Clean Bay Task 4 Literature Review

Prepared for:

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TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

List of Abbreviations and Acronyms

ac	Acre
BASMAA	Bay Area Stormwater Management Agencies Association
BMP	Best Management Practice
ft^3	Cubic feet
m^3	Cubic meter
ft	Feet
hr	Hour
in	Inch
kg	Kilogram
km	Kilometer
L	Liter
MDL	Method detection limit
m	Meter
mg	Milligram
µm	Micrometer (micron)
MRP	Municipal Regional Stormwater NPDES Permit
MS4s	Municipal Separate Storm Sewer Systems
NPDES	National Pollutant Discharge Elimination System
PCBs	Polychlorinated Biphenyls
Lbs	Pounds
Bay Area	San Francisco Bay Area
SFRWQCB	San Francisco Regional Water Quality Control Board
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
yr	Year

1. INTRODUCTION

Due to elevated levels of polychlorinated biphenyls (PCBs), mercury and other pollutants of concern in sport fish in San Francisco Bay (Bay), the California Office of Environmental Health Hazard Assessment issued an interim advisory on the consumption of some fish caught from the Bay. The advisory led to the San Francisco Regional Water Quality Control Board (SFRWQB) designating the Bay as an impaired water body on the Clean Water Act Section 303(d) list and the subsequent development of Total Maximum Daily Load (TMDL) water quality restoration programs targeting PCBs and mercury. The general goals of the TMDLs are to identify sources of PCBs and mercury to the Bay and implement actions to control these sources and protect beneficial uses of the Bay. One pathway for conveyance of PCBs and mercury identified in the TMDLs is urban stormwater. Priority actions related to urban runoff are addressed through the Municipal Regional Permit (MRP) for stormwater discharges in the Bay Area issued to 76 municipalities and agencies, collectively known as Permittees. Provisions C.11 and C.12 of the MRP address mercury and PCBs, respectively.

Clean Watersheds for a Clean Bay (CW4CB) is a grant-funded project designed to assist Permittees in implementing priority actions called for in the mercury and PCB TMDLs and corresponding requirements in MRP Provisions C.11 and C.12. The Bay Area Stormwater Management Agencies Association (BASMAA), in collaboration with BASMAA member agencies and participating Bay Area cities, manages the CW4CB project. The CW4CB project includes the following seven major tasks, which are intended to comply with MRP provisions associated with PCBs and mercury (in parentheses):

1. Project management, oversight and reporting;
2. Pilot watershed selection;
3. Property identification and referral (C.11/12.c);
4. Municipal sediment removal and management practices (C.11/12.d);
5. Stormwater treatment retrofits (C.11/12.e);
6. Risk communication (C.11/12.f); and,
7. Outreach and technology transfer.

This literature review is an initial step in implementing Task 4, municipal sediment management. Task 4 is evaluating on a pilot-scale methods to enhance the pollutant load reduction benefits of municipal operation and maintenance activities that remove sediment from streets and storm drain system infrastructure. Older industrial areas in the Bay Area urban landscape with elevated PCBs will be targeted, with mercury and other pollutants being a secondary consideration. The project will work with municipal staff to test enhancing removal of sediments and associated particle-bound pollutants during routine activities such as street sweeping, storm drain inlet cleaning, storm drain system piping maintenance, and pump station maintenance. The evaluation will also include consideration of street and piping flushing (potentially with recycled water) and capture, collection, and/or routing to the sanitary sewer.

1.1. PURPOSE AND SCOPE OF LITERATURE REVIEW

This literature review summarizes past relevant Bay Area studies and peer-reviewed studies carried out in other states or countries on particular municipal sediment management practices. The sediment management topics on which the literature review is based are outlined in MRP Provisions C.11.d and C.12.d and include:

- Street sweeping,
- Stormwater conveyance system cleaning, and
- Street flushing and capture.

The purpose of this review is to present available information from studies that evaluated the effectiveness of the management practices listed above to remove sediment and associated pollutants (especially PCBs and mercury) from streets and other paved surfaces and stormwater conveyance systems before entering receiving waters. Because studies that quantify effectiveness are limited, summaries of relevant studies[1] are presented to provide adequate background in order to identify affordable and practical ways to enhance sediment management practices in high priority areas and to identify management priorities. This literature review also summarizes major findings and makes recommendations to improve our collective understanding of how to improve the effectiveness of sediment management practices to reduce PCB and mercury loadings to the Bay. Finally, a cost-benefit analysis is presented to assist Bay Area municipalities in designing and implementing specific sediment management strategies.

1.2. USE OF THE DOCUMENT

This literature review was developed under the oversight of the CW4CB Project Management Team (PMT), which is made up of the BASMAA Executive Director and representatives from several BASMAA agencies (i.e., Bay Area stormwater management programs). The literature review is intended to be used by the PMT and CW4CB's municipal partners to inform the development of the aforementioned municipal sediment management pilot-scale evaluations.

1.3. DOCUMENT ORGANIZATION

The literature review is organized in the following sections:

Section 1. Introduction, Purpose and Scope
Section 2. Background and Methods
Section 3. Street Sweeping Studies
Section 4. Stormwater Conveyance System Cleaning Studies
Section 5. Street and Storm Drain Line Flushing Studies
Section 6. Summary of Findings
Section 7. Costs of Sediment Management Practices
Section 8. Cost/Benefit Analysis of the Evaluated Sediment Management Practices
Section 9. Data Gaps
Section 10. Recommendations
Section 11. References

[1] Lists of attributes to select the most relevant studies to summarize were created and described in the methodology section (3.0).

2. BACKGROUND AND METHODS

The San Francisco Estuary Institute (SFEI) recently completed a California Proposition 13-funded project entitled "Regional Stormwater Monitoring and Urban BMP Evaluation" that focused on characterizing PCBs and mercury in urban runoff in the Bay Area and potential control measures for these pollutants (e.g., McKee et al. 2006 and Yee and McKee 2010). The project provides valuable background on PCBs and mercury, including current knowledge of these pollutants, their sources, distribution in the environment and Bay Area, and sediment transport processes. This section describes pertinent general information related to PCBs and mercury and the factors that may affect the effectiveness of sediment management measures to remove or control associated pollutant loads. In addition, because PCBs and mercury tend to be bound to particulates, sediment transport processes are primary pathways through the stormwater conveyance system, and consequently are briefly described below. Note that this literature review does not describe PCB and mercury sources; rather it focuses on potential methods to manage these pollutants in the street and storm drain pathways in order to reduce loads to the Bay. Because this section serves simply as basic background for the literature review, the reader is referred to the studies conducted through the Proposition 13 project (http://www.sfei.org/urbanstormwaterBMPS), and especially McKee et al. (2006), for additional details on PCB and mercury sources, sediment transport, and other related topics.

2.1. GENERAL INFORMATION REGARDING PCBS AND MERCURY

PCBs are considered a legacy pollutant, meaning that peak production and release to the environment occurred years ago; however, the impact to receiving waters, in particular the Bay Area, continues to be significant because PCBs degrade slowly in the environment. 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). The total U.S. production of PCBs has been estimated to be approximately 640,000 tons (Breivik et al. 2002).

According to Erickson (1992), PCB 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. Although the production of PCBs was banned in the U.S. in 1979, closed systems such as capacitors and transformers continue to be in use in the U.S.

Mercury is both a legacy pollutant and a contemporary pollutant. Unlike PCBs, which are synthetic, mercury can be extracted in the raw form by mining. Peak production and use of mercury occurred twice in U.S. history. First, it was mined extensively during the Gold Rush in California[2] and a second time after World War II. 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). However, it is still obtained as a by-product in other mining activities and in natural gas extraction (USGS 2011). Another source of mercury in the U.S. is the chlor-alkali process[3], though McKee et al. (2006) noted that no chlor-alkali plants have been identified in the Bay Area. Current uses of mercury , including dental services, lighting, and switches, medical and other types of instruments, as well as the use and improper disposal of old equipment, still contribute mercury to the environment (McKee at al. 2006).

Sources of PCBs and mercury to Bay Area stormwater conveyance systems include sediment erosion from current and former industrial areas where PCBs and mercury were used. The largest use of PCBs was electrical equipment such as transformers and capacitors. Another source of PCBs is demolition and remodeling of buildings that were built when PCBs were used in building products such as caulk.

For both PCBs and mercury, studies have shown that the highest median concentrations are found in industrial areas. The spatial distribution of PCBs tends to be more "spotty," and therefore, more variable than mercury. PCB concentrations in bulk sediment and near surface soils range across eight orders of magnitude whereas mercury concentrations range across three orders of magnitude (Yee and McKee 2010). McKee et al. (2006) determined that the significant differences between PCBs and mercury concentrations were likely due to a combination of source characteristics and the dispersion of mercury by means of long-range atmospheric transport. Knowledge of PCB and mercury sources and of the factors that may affect their concentrations is important in estimating potential pollutant loads and the effectiveness of sediment management practices.

The next section on sediment transport briefly summarizes the processes that mobilize sediment-bound pollutants (e.g., PCBs and mercury) from source areas into stormwater conveyance systems.

2.2. Sediment Transport Processes

Runoff from increased imperviousness and other factors related to urbanization mobilizes particulate material that accumulates on streets and other paved surfaces and in stormwater conveyance systems. Large storms may also erode pervious surfaces and streams, further increasing the sediment supply to inlets and the stormwater conveyance system. In addition to the contribution of PCB and mercury from transported sediment, tires from heavy vehicles that transport materials from industrial areas transfer sediment, sometimes containing PCBs and/or mercury, from private properties to adjacent streets and gutters[4]. Consequently, the stormwater conveyance system can provide a main pathway from urban PCB and mercury source areas to the Bay. Although less polluted sediment contributed from the

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[2] The Guadalupe River watershed in south SF Bay has been shown to have highly elevated mercury concentrations as a result of the upstream New Almaden mercury mine. Once the largest producer of mercury in the U.S., this mine produced an estimated 38,000,000 kg of mercury from the time it was claimed in 1845 until its closure in 1975, yielding a gross revenue in excess of $60,000,000 (SFBRWQCB 2000).

[3] This term refers to two chemicals, chlorine and an alkali (sodium hydroxide or potassium hydroxide), which are simultaneously produced as a result of the electrolysis of saltwater.

[4] The City of Oakland carried out a PCB source identification and abatement study (Kleinfelder 2006) in the Ettie Street Pump Station watershed and found that elevated PCB concentrations in street right-of-ways were related to contaminated sediment that originated from nearby properties.

upstream watersheds may dilute stormwater runoff pollutant concentrations, the impact from elevated PCB and mercury concentrations is still significant (McKee et al. 2006). The evaluation of sediment management practices in this literature review focuses on the potential to reduce or control PCB and mercury loads to Bay.

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). 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. Yee and McKee (2010) noted that the high spatial heterogeneity of pollutant concentrations in over 600 sediment samples from the Bay Area reflected the intermittent nature of many pollutant release events (e.g. accidental spills) and sediment transport processes. Consequently, the relative mass, or size, of the particles being transported is an important factor along with the relative concentration of the pollutants within various particle size ranges (McKee et al. 2006).

2.3. PARTICLE SIZE DISTRIBUTIONS

To evaluate the effectiveness of sediment management measures to control PCB and mercury concentrations associated with various particle sizes, it is important to understand the relationship between particle sizes and pollutant concentrations and mass. Generally, high concentrations of particle-bound pollutants (e.g., PCBs and mercury) are assumed to be associated with smaller particles (Xanthopoulos and Hahn 1990) due to a larger surface-to-volume relationship and the efficient adsorption properties of fine particles such as clay minerals (Krumgalz et al. 1992). A settling experiment conducted by Yee and McKee (2010) provides some insight into the relationship of PCBs and mercury to particle size. The study analyzed a limited number of stormwater runoff samples[5] for PCB and mercury concentrations in three separate size fractions:

1) Material that settled out in less than 2 minutes (approximately >75 µm);
2) Material that settled in 2-20 minutes (approximately 75-25 µm); and
3) Material that had not settled within a 20-minute period (approximately <25µm).

For five out of six stormwater samples about 50-70% of the total PCBs settled within 20 minutes (fractions > 25 µm) (Figure 1). Conversely, for all six samples only about 10-30% of the mercury settled out within 20 minutes (Figure 2). Thus mercury was more difficult to settle and therefore associated with finer particles to a greater extent than PCBs.

Analysis of sediments from the Guadalupe River in San Jose, CA, and its tributaries (McKee et al. 2005 and Austin 2006) found a similar relationship between particle size and mercury concentration. Results indicated that greater concentrations of mercury were found on finer size particles; however, there were not enough data to determine a clear relationship between mercury and grain size fractions (McKee et al. 2006).

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[5] Samples were collected during three separate rain events from a storm drain line near the Bay margin in Hayward, CA in February 2007 and Richmond, CA site in January 2008.

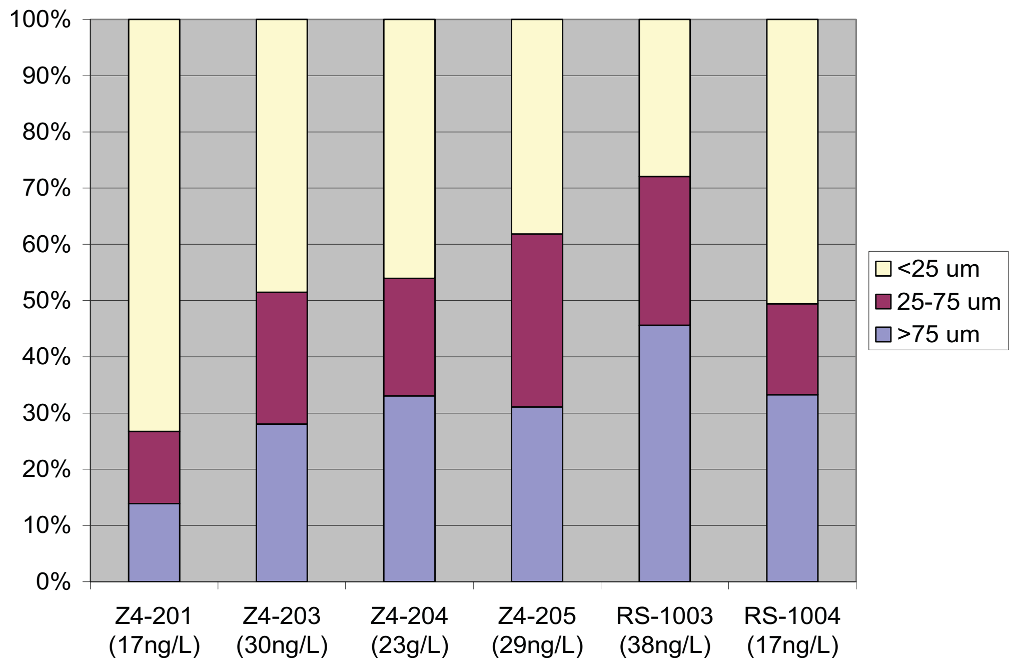

Figure 1. PCBs in settled fractions from stormwater runoff samples at Hayward (Z4) and Richmond (RS) storm drains (as presented in Yee and McKee 2010). Samples (with corresponding PCB concentrations) are shown on the x-axis, with percentages of particle fractions on the y-axis.

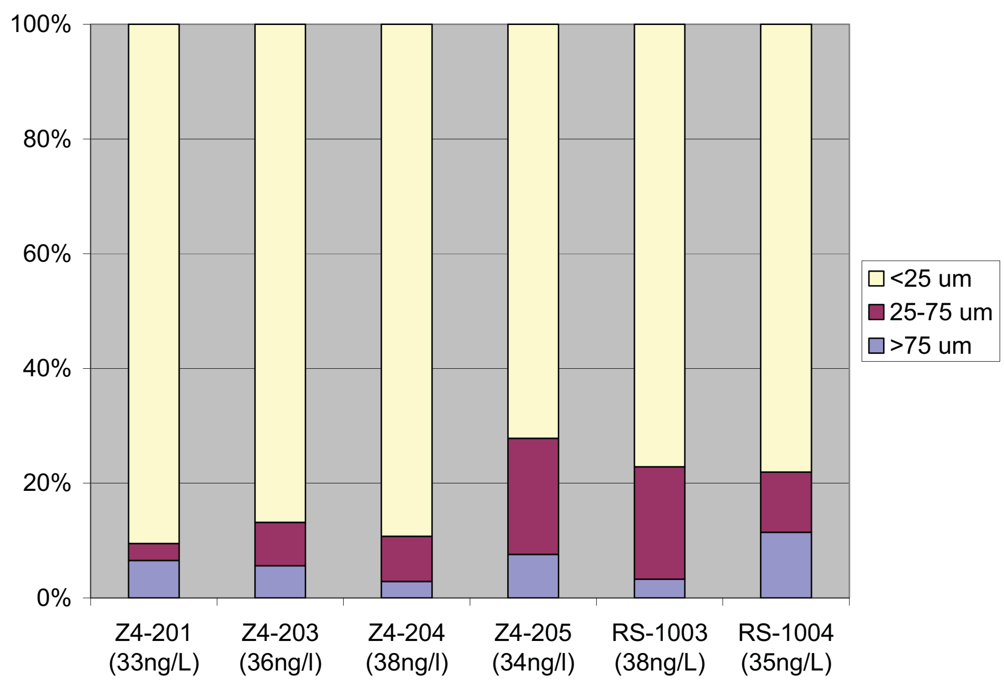

Figure 2. Mercury in settled fractions from stormwater runoff samples at Hayward (Z4) and Richmond (RS) storm drains (as presented in Yee and McKee 2010). Samples (with corresponding mercury concentrations) are shown on the x-axis, with percentages of particle fractions on the y-axis.

2.4. STREET SURFACE SEDIMENT/DIRT

The concentrations of mercury and PCBs on Bay Area sediment/dirt collected from street surfaces have been characterized by a number of studies. McKee et al. (2006) summarize PCB data collected in the Ettie Street catchment in Oakland, California, an area where elevated PCB concentrations have been found in sediments. Concentrations ranged from 0.28-7.35 mg/kg with a mean of 1.1 mg/kg and a coefficient of variation of 1.7, suggesting that variability in these data is relatively high.

EOA (2007b) conducted sampling of sediments in catch basins and gutters for PCB analysis in industrial locations in Richmond, California that have exhibited elevated PCB concentrations. Results from the 18 gutter samples indicated a PCB range of about 0.07-2.80 mg/kg with a mean concentration of 0.86 mg/kg and a coefficient of variation of 0.95. These two data sets are fairly similar in range and average concentration.

Yee and McKee (2010) conducted a more comprehensive sampling program focused primarily in industrial areas in a total of 20 areas distributed around the Bay Area.[6] Phase I conducted from June through September 2007 collected a total of 267 sediment and soil samples, which were collected from street surfaces near the gutter (n=137), inside drop inlets (n=112), near the lip of drop inlets (n=9), and roadside soils (n=5). Phase II was conducted in September 2008 when a total of 94 more locations were sampled, including drop inlets (n=53), sediment around inlet grates (n=31), street surface dirt (n=6), and driveways (n=3). The study characterized 153 data points as street surface sediment and the 90th percentile concentrations were 0.28 mg/kg PCBs and 0.51 mg/kg mercury. The sites that had PCBs concentrations above the 90th percentile were located in Richmond, Oakland, Port of Oakland, San Francisco, South San Francisco, San Carlos, Sunnyvale, and San Jose, all of which are densely populated urban areas with industrial land uses.

These data indicate that there is a large variation in PCB and mercury concentrations within industrial land uses. Yee and McKee (2010) also point out that the mercury and PCB site data do not necessarily correlate, i.e., the PCB hot spots are not necessarily the same as the mercury hot spots though there is some overlap.

2.5. STREET SWEEPER DATA

Table 1 and Table 2 summarize PCB and mercury data, respectively, from samples of sediments collected by street sweepers in Alameda County (Salop 2006) and Contra Costa County (EOA 2007a, EOA 2007b). The tables show the municipalities in which the samples were obtained, the predominant land use associated with the sampling site, the number of samples analyzed and the concentration measured or the range of concentrations[7].

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[6] Areas included Albany, Benicia, Berkeley, Concord, El Cerrito, Emeryville, Hayward, Oakland, Pittsburg, Port of Oakland, Richmond, San Bruno, San Carlos, San Francisco, San Jose, San Leandro, South San Francisco, Sunnyvale, unincorporated Contra Costa County, and Vallejo.

[7] There are a total of 209 individual chlorinated biphenyls, 17 of which were analyzed using Method 8082. Thus, the total concentration equals the sum of the concentrations of the individual congeners. Where the analysis for an individual congener is below the method detection limit (MDL), it is necessary to assume a value. In these studies, the range in PCB concentrations reflects the difference between assuming a non-detect equals zero or a non-detect equals the MDL/2.

As illustrated in Table 1, observed PCB concentrations tend to fall into three tiers: 1) those with relatively higher concentrations (> 0.10 mg/kg), including those sampled from Richmond, Martinez, and Berkeley; 2) relatively moderate concentrations (0.050-0.100 mg/kg) in Walnut Creek, Pinole, Orinda, and Brentwood; 3) and relatively low concentrations (<0.050 mg/kg) in Newark, Pleasanton, Concord, and Livermore. Salop (2006) suggested that the trends in Alameda County could be explained by the age of development, where older cities like Berkeley tended to have higher PCB concentrations. Based on these data, age of development rather than land use is the more important factor affecting PCB concentrations.

Table 2 shows the observed mercury concentrations in street sweeper materials. The locations with higher concentrations (> 0.2 mg/kg) were Berkeley, Richmond, Martinez and Pinole. Locations having concentrations in the moderate range (0.1-0.2 mg/kg) include Orinda, Walnut Creek, and Concord. Locations with the lowest observed concentrations (< 0.1 mg/kg) include Hayward, Newark, Pleasanton, Fairfield-Suisun, and Livermore. In general, cities with elevated concentrations of PCBs also had elevated mercury concentrations, but it was not always the case.

Salop also reported the percent fines (<63μm) of the collected material less than 2mm. The percent fines ranged from 3-18% with the highest PCB and mercury concentrations found in those samples where the percent fines ranged from 11-14%. Salop also recorded the sweeper type, and it is interesting to note that the range of percent fines collected by the regenerative air sweeper (8-18%) was higher that the range collected by the mechanical broom (8-11%) and wet vacuum sweepers (4-7%).

2.6. Comparison of Street Sweeper and Street Surface Data

A comparison was made of PCB concentrations in sweeper and street surface samples from the City of Richmond, where both types of data were collected, albeit at different times. The PCB concentrations in the two samples of street sweeping material from Richmond ranged between about 0.2-0.9 mg/kg, whereas the street surface concentrations based on the 18 gutter samples in Richmond ranged from 0.07-2.8 mg/kg. Thus the street sweeper data, although quite limited in terms of sample size, were less variable than the gutter sample data.

A similar trend appears to be valid for mercury. For example, the range of street dirt data reported by Yee and McKee (2010) was 0.08 to 1.11 mg/kg for Berkeley and the data reported by Salop (2006) for concentrations in sweeper material indicates a range of 0.17 to 0.27 mg/kg. The Salop (2006) dataset was limited to three data points. Concord presents a somewhat different pattern in that the range of sweeper data (0.07-0.18 mg/kg) is generally lower than the range of street surface data (0.17-0.24 mg/kg).

In summary, these street sweeper data, which reflect a composite of sediment collected along a road segment, tend to be less variable than discrete data from samples collected at specific locations along the road segment, and consequently are not as skewed (a few very high concentrations among many lower values) as the street surface data.

Table 1. PCB concentrations (mg/kg)[1] in sweeper samples.

Source	Location	Predominant Land Use					
		Residential		Mixed Commercial/Residential		Industrial	
		#	(mg/kg)	#	(mg/kg)	#	(mg/kg)
Salop 2006	Berkeley	1	0.07	1	0.14	1	0.12
	Hayward	1	0.01	1	0.05	1	0.03
	Newark	1	0.02	1	ND	1	0.003
	Pleasanton	1	0.01	1	0.01		
	Livermore	1	0.01	1	ND		
EOA 2007b	Brentwood	1	0.001-.02[3]	1	0.05-0.08[3]		
	Concord	1	0.01-0.03[3]	1	0.04-0.06[3]	1	0.01-0.02[3]
	Martinez	1	0.10-0.11[3]	1	0.15-0.18[3]	1	0.10-0.12[3]
	Orinda	1	0.02-0.05[3]	1	0.05-0.07[3]		
	Pinole	1	0.07-0.09[3]	1	0.02-0.04[3]		
	Richmond			1	0.22-0.22[3]	1	0.37-0.40[3]
	Richmond			1	0.90-0.93[3]		
	Walnut Cr.	1	0.02-0.06[3]	1	0.05-0.07[3]		

1. Dry weight
2. PCB concentrations equals sum of individual congeners. Lower end of range assumes ND=0; upper end assumes ND=MDL/2.

Table 2. Mercury concentrations (mg/kg)[1] in sweeper samples.

Source	Location	Land Use					
		Residential		Mixed Commercial/Residential		Industrial	
		#	(mg/kg)	#	(mg/kg)	#	(mg/kg)
Salop 2006	Berkeley	1	0.22	1	0.17	1	0.27
	Hayward	1	0.05	1	0.12	1	0.08
	Newark	1	0.05	1	0.04	1	0.04
	Pleasanton	1	0.07	1	0.05		
	Livermore	1	0.03	1	0.03		
EOA 2007b	Brentwood	1	0.05	1	0.08		
	Concord	1	0.07	1	0.09	1	0.19
	Martinez	1	0.14	1	0.34	1	0.17
	Orinda	1	0.05	1	0.15		
	Pinole	1	0.29	1	0.25		
	Richmond			2	0.20-0.39	1	0.41
	Walnut Cr.	1	0.12	1	0.13		

1. Dry weight

2.7.

LITERATURE REVIEW METHODOLOGY

The methodology used for the literature review was to focus on two types of studies: 1) representative studies that were conducted in the Bay Area or other semi-arid areas and 2) studies (preferably peer-reviewed) conducted outside of the Bay Area that may be applicable to the Bay Area. The street sweeping studies tended to fall into three categories:

1. Monitoring studies of street sweeper effectiveness and characterization of pollutants on roadways;
2. Modeling tests to predict potential street sweeping effectiveness under a range of conditions; and
3. Review articles that tended to integrate the literature and discuss the current understanding of street sweeping practices.

Bay Area studies were identified by obtaining referrals from PMT members and reviewing the SFEI Proposition 13 study products and referred studies, including referring to the bibliographies of these studies for additional information. In addition, some leading academic researchers[8] in the field were contacted to request references to the most useful studies and information that they could share based on their specific experiences in sediment management. All studies that were exclusively conducted in the Bay Area or were broader studies that included one or more sites in the Bay Area were included in the review.

To find studies outside of the Bay Area, a search was conducted for peer-reviewed publications using journal article databases and indexes, including Environmental Sciences and Pollution Management, Web of Science, Compendex and CE Database. In addition, the Google search engine was used to search for both peer-reviewed and non-peer reviewed publications and white papers. Several key word strings were used for all database, index and online searches and are listed below.

- Catch basin/storm drain inlet/ gully pot[9] cleaning with or without the term effectiveness
- Catch basin/storm drain inlet/gully pot maintenance with or without the term effectiveness
- Street cleaning/sweeping with or without the term effectiveness
- Street flushing/washing with or without the term effectiveness
- Sediment management/municipal sediment management with or without the term effectiveness
- Combination of PCBs and the following terms: abatement, street cleaning, storm drains, catch basins/inlets/gully pots, sediment management, industrial land use, and effectiveness
- Combination of mercury and the following terms: abatement, street cleaning, storm drains, catch basins/inlets/gully pots, sediment management, industrial land use, and effectiveness
- Fine sediment or total suspended solids and street cleaning/sweeping/washing and inlet/catch basin/gully pot cleaning with or without the term effectiveness

[8] Robert Pitt, University of Alabama; Roger Bannerman, Wisconsin Department of Environmental Resources; Mike Stenstrom, University of California-Los Angeles; and Mike Barrett, University of Texas-Austin.
[9] The term gully pot is used in Europe, Australia and New Zealand to refer to a stormwater inlet or catch basin.

- Particle size distribution and the following terms: street sweeping/washing/cleaning, inlet/catch basin/gully pot cleaning and sediment management with or without the term effectiveness

- Sediment management in industrial areas with or without the term effectiveness

Furthermore, bibliographies from relevant studies and literature reviews on urban wet-weather flow from the Water Environment Research Federation journal were reviewed for additional references.

The International BMP Database (http://www.bmpdatabase.org/), which stores detailed information about structural and non-structural BMP projects, was also searched for relevant studies.

A large number of studies conducted outside the Bay Area were identified and prioritized based on the following desirable attributes:

- Representative of Bay Area or semi-arid climate
- Peer-reviewed literature
- Relatively recent publications (generally since 2000)
- Study conducted in industrial area or hot spot area
- Addressed representative land use type (industrial or mixed industrial)
- More emphasis on monitoring rather than modeling
- Addressed particle size distributions
- Addressed effectiveness
- Addressed costs

For street sweeping, the following attributes were also considered:

- Addressed a variety of sweeper types including advanced street sweepers
- Robust study design in terms of adequate controls, sampling, etc.
- Addressed runoff water quality

Additional attributes for stormwater conveyance system cleaning and street flushing and capture were:

- Addressed sediment (rather than stormwater) monitoring[10]
- Measured sediment quality

Studies that were not considered for this literature review included the following:

- Tests conducted in a laboratory under strictly controlled conditions
- Modeling studies
- Tests conducted on freeways
- Studies evaluating the combined effectiveness of stormwater conveyance system cleaning and a structural BMP
- Tests conducted under ideal conditions (e.g., inside buildings on smooth surfaces)
- Model projections of street sweeper performance
- Tests conducted on freeways
- Tests conducted on specific facilities (e.g., ports)
- Test results reported in vendor associated publications.

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[10] Although stormwater runoff quality was considered important, it was considered more relevant to summarize studies with sediment quantity and quality data as CW4CB monitoring will focus on sediment loadings.

Tables 3 and 4 list the studies on street sweeping, stormwater conveyance system and street flushing that were conducted outside of the Bay Area and focused on during this literature review and identifies the corresponding attributes among those listed above. Appendices A - C summarize the studies that are summarized in Sections 3-5.

Table 3. Studies conducted outside of the Bay Area regarding street sweeping.

Reference	Applicable to Semi-Arid Climate	Peer-Reviewed[11]	Addresses Variety of Sweeper Types	Statistical Study Design and Analysis	Street Loading Reduction Monitoring	Runoff Water Quality Monitoring	Costs	Comments
Pitt 1985		X	X	X	X	X	X	Sweeper effectiveness study conducted in Bellevue, Washington which has different climate regime than Bay Area. Focus was on effectiveness of sweeper types on street load reduction and water quality.
Blosser 2000			X				X	Sweeper evaluation analysis authored by public works employee with City of Olympia, Washington. Major focus on costs and practical implementation issues associated with different sweeper types.
Pitt et al. 2004a			X		X	X		Review article with focus on buildup-washoff and effects of street sweeping on dust and dirt loadings, and ability of sweepers to remove fine particulates.
Pitt et al. 2004b		X	X		X			Review article with focus on buildup-washoff of street dust and dirt and effects of street sweeping on street dust and dirt load, and implications for modeling.
Breault et al. 2005		X	X	X	X	X	X	USGS street sweeper effectiveness study conducted in New Bedford, Massachusetts. Focus on effectiveness of sweepers to remove dust and dirt from roadways.
Shilling 2005			X				X	Review article. Literature review conducted for Ramsey-Washington Metro Watershed District, North St. Paul, Minnesota.
Selbig & Bannerman 2007		X	X	X	X	X		USGS street sweeper effectiveness study conducted in Madison, Wisconsin. Comprehensive multi-year study design with paired catchments and controls.

[11] Assumed to be either peer reviewed journal article, federally sponsored document (e.g., USEPA, USGS), or report peer reviewed by independent panel of experts.

Reference	Applicable to Semi-Arid Climate	Peer-Reviewed[11]	Addresses Variety of Sweeper Types	Statistical Study Design and Analysis	Street Loading Reduction Monitoring	Runoff Water Quality Monitoring	Costs	Comments
Rochfort et al. 2007			X	X	X	X	X	Street sweeper effectiveness study conducted in Burlington, Ontario. Multi-year study design that included washoff studies.
Law et al. 2008		X	X	X	X	X	X	Street sweeper effectiveness study conducted in Baltimore, Maryland by Center for Watershed Protection. Includes review of literature and effectiveness estimates by sweeper type and frequency.
Herrera 2009		X	X	X	X		X	Street sweeper effectiveness study in Seattle, Washington. Included evaluating effects of sweeping on need to and frequency of catch basin cleaning.
Weston 2010	X	X	X	X	X	X		Street sweeper effectiveness study in San Diego, CA. Evaluating effects of advanced sweepers.

Table 4. Studies conducted outside of the Bay Area regarding stormwater conveyance cleaning and street flushing.

Reference	Rep. of Semi-Arid Climate	Peer-Reviewed[12]	Sediment Monitoring (Quantity and/or Quality)	Particle Size Distributions	Pollutant Load Reductions[13]	Effective-ness	Costs	Comments
Amato et al. 2010		X	X	X	X	X		Review of available scientific and municipal studies and expert consultations to summarize past research on the effects of street cleaning and washing in the abatement of PM[14] emissions.
Gromaire et al. 2000		X			X	X		Evaluation of municipal street washing procedures on three different streets in a central Paris district with a combined sewer system. The pollutant load associated with street washing was compared to both the surface runoff load and the catchment's dry weather pollutant load. The maximum street surface pollutant load was compared to the load removed using regular street washing procedures.
Grottker 1990		X			X	X		Grottker studied approximately 200 gully pots in different catchments located in Germany and analyzed their capacity to remove pollutants, subsequently using the results to build a simulation model.
Herrera 2009			X	X		X	X	Conducted in Seattle, WA, the study applied a mass balance approach to determine the amount of materials and associated pollutants on streets and in catch basins (with a sump), and how street and catch basin cleaning might affect that balance.

[12] Assumed to be either peer reviewed journal article, federally sponsored document (e.g., USEPA, USGS), or report peer reviewed by independent panel of experts.
[13] Studies that evaluated pollutant load reductions due to change in application of sediment management practice.
[14] Atmospheric particulate matter (PM) is a complex mixture of components arising from a number of emission sources (anthropogenic and natural) and atmospheric processes (secondary PM). Two common categorizations of PM are PM_{10} (particles with mean aerodynamic diameter <10 µm) and $PM_{2.5}$ (particles with mean aerodynamic diameter <2.5 µm), which is considered the fine fraction (Amato 2010).

Reference	Rep. of Semi-Arid Climate	Peer-Reviewed[15]	Sediment Monitoring (Quantity and/or Quality)	Particle Size Distributions	Pollutant Load Reductions[16]	Effective-ness	Costs	Comments
Jartun et al. 2008		X		X				Jartun et al. evaluated sediment in 68 stormwater traps around a harbor area in the urban city Bergen, Norway to identify sources of pollutants and their pathways via the stormwater conveyance system to the surrounding water body.
Law et al. 2008			X	X	X			Law et. al. (2008) conducted an effectiveness study in Baltimore, Maryland that addressed pollutant removal rates for street sweeping and storm drain cleanout programs in the Chesapeake Bay Basin.
Pitt and Field 2004		X	X		X	X		Pitt and Field (2004) reviewed and summarize past studies of catch basin inlet devices, including two extensive EPA-funded case studies conducted in Bellevue, WA and Stafford Township, NJ.

[15] Assumed to be either peer reviewed journal article, federally sponsored document (e.g., USEPA, USGS), or report peer reviewed by independent panel of experts.
[16] Studies that evaluated pollutant load reductions due to change in application of sediment management practice.

2.8. TERMINOLOGY

There is no generally accepted terminology to describe how well a stormwater pollutant control measure works, thus the terminology used in the literature varies widely. Various terms used in the literature include performance, efficiency and effectiveness. This literature review primarily uses the term effectiveness to describe the overall reduction in mass of sediment or mass of PCBs or mercury due to a sediment management measure. The term cost-benefit (rather than cost-effectiveness) is also used as a measure of the cost of collecting a given mass of sediment or mass of pollutant. The one use of the term efficiency is in the context of street sweeping, where it is common practice to use the term "pickup efficiency" as the percent reduction in street sediments achieved by a sweeper.

The units for expressing effectiveness can be as an absolute reduction in mass or as a percent of the mass available. Absolute reduction has the advantage of being more directly comparable to TMDL load reduction targets.

3. STREET SWEEPING

Some of the original research conducted in the early 1980s including the Nationwide Urban Runoff Program (USEPA 1983) indicated that street sweeping was not an effective measure for water quality treatment, but these studies were for the most part conducted using mechanical broom sweepers. In the last decade or so, there has been technological changes in street sweepers including the introduction of advanced street sweeping equipment that include regenerative air sweepers and vacuum assisted sweepers.

Regenerative air sweepers use air in a closed loop system that blasts air under pressure in the form of jets to dislodge dust and dirt, and applies vacuum suction to lift the dust and dirt into a collection hopper. Air containing the fine road dust is cleaned (or regenerated) by filtering and is then directed under pressure to the road surface. Gutter brushes are used that extend out to the side of the sweeper to direct material in the gutter into the vacuum area.

Vacuum assisted sweepers utilize a combination of mechanical brooms and brushes to dislodge the material and vacuum that material up and into the hopper. A filter is also used to prevent dust and dirt from leaving the hopper.

Much of the focus of these technologies has the goal of removing finer particulates which can contain a disproportionate amount of those pollutants that tend to associate with particulates, including for example, metals and certain pesticides. For this reason, the literature review methodology focused on the more recent publications, while still examining all the work conducted in the Bay Area irrespective of when it was conducted.

The focus of the review was on street sweeper effectiveness, and it is useful to explain the definitions of effectiveness and efficiency that are used particularly in this review. In this report, two measures of effectiveness are used: (1) reduction of dust/dirt load (lbs/curb mile or kg/km), and (2) runoff water quality improvement or reduction in pollutant loads in runoff.

Dust and dirt load refers to the mass of material exclusive of trash and vegetative debris per curb length (e.g., lbs/curb mile).The reduction in dust/dirt load can be reported in two ways. The first way is the reduction measured by comparing the load of dust/dirt on the roadway prior to the passage of the sweeper to that following the passage of the sweeper. This is sometime referred to as pick-up efficiency. The second way is the cumulative reduction in the dust and dirt load that takes into account the frequency of sweeping, and is estimated by comparing a swept test road segment with an unswept control road segment. The control could be a separate segment monitored at the same time as the test segment (this has the advantage that the control and test segments experience the same rainfall patterns) or could be the same segment with monitoring conducted during a period of non-sweeping.

Although many sources addressed the effectiveness of street sweeping to reduce dust and dirt loads, the reduction of the loads of finer particles is very critical for at least two reasons. One, a number of studies have shown that certain pollutants (e.g., mercury) have higher concentrations in the finer fraction, so where there is a substantial amount of finer material in the dust and dirt loading, removal of the finer fraction can increase water quality benefits for these types of pollutants. Secondly, research conducted on washoff indicates that the finer fractions are the most likely to be mobilized during typically sized storms (Pitt et al. 2004a). Consequently, where provided, effectiveness estimates are also summarized for effectiveness to remove the finer fractions of dust/dirt.

The most important measure of effectiveness is the improvement of runoff water quality and loads to receiving waters. This is measured by monitoring the runoff at some location downstream of the road segment during swept and unswept periods. Although less studies of sweeper performance include runoff measurements, this was one of criteria used in selecting literature sources to review.

In much of the literature effectiveness measurements are expressed as a % reduction, and are therefore used herein. But the reader should be aware that the use of % reduction can be misleading because of a bias towards higher % reduction on dirtier roads, independent of the type of sweeper. For this reason, overall street surface load reduction effectiveness is also presented in the form of lbs/curb mile or kg/km removed.

Lastly, please note that the terminology used for the amount of material on a road surface is referred to with different terminology in various sources. Many of the original references use the term "dust and dirt load", and should not be confused with the pollutant load associated with a runoff event. A recent publication by Selbig and Bannerman (2007) use the term "street dirt yield." Dust and dirt also can be defined differently depending on the source, but herein it refers to material that generally passes through a 2000 µm (2 mm) sieve.

Appendix A includes key attributes and findings of each summarized study for the reader to easily compare and contrast findings[17].

3.1. Bay Area Studies

Studies summarized below are organized chronologically, from oldest to most recent, to represent the development of work in street sweeping throughout the Bay Area.

Water Pollution Aspects of Street Surface Pollutants (Sartor and Boyd 1972)

Sartor and Boyd (1972) conducted one of the first comprehensive studies to characterize pollutants on street surfaces and to evaluate the effectiveness of street sweepers. Sampling was conducted in various cities throughout the United States, including San Jose, Phoenix, Milwaukee, Baltimore, Seattle, and Atlanta. Sartor and Boyd found that a disproportionate amount of some pollutants were associated with the solids finer than 248 microns (µm). For example fine particles less than 246 µm constituted about 37% of the mass of solids on the street surface, but accounted for about 73 percent of the pesticides, and about 51% of the metals. Data on nutrients and PCBs did not show this propensity to attach to finer particles.

In-situ street sweeper tests were limited to mechanical broom sweepers and were conducted in Milwaukee, Baltimore, Scottsdale, Phoenix, Atlanta, and Tulsa. Effectiveness was determined by measuring the accumulated dust and dirt (using hand sweeping and flushing with water) before and following the passage of the sweeper. The test results indicated that broom sweepers removed on average approximately 50% of the dust and dirt per pass of sweeper, but 70% of the material removed was particle sizes greater than 246 µm.

[17] Note that only main points of the summaries are included in the table, and it is recommended to read the entire summaries for complete information.

A set of controlled street sweeper tests were conducted in San Jose where a prescribed amount of a synthetic material (with representative size distribution) was spread evenly over a previously clean road segment. Six tests were conducted and the removal effectiveness per single pass of sweeper ranged from 26 to 77% depending on the sweeper type and sweeper speed (higher effectiveness for slower speeds).

PCBs were also measured on street surfaces in San Jose[18], and data indicated that the PCB loading in lbs/curb mile for PCBs in the test samples was about 1.2E-3 lbs/curb mile.

The study also provides an excellent discussion of the factors that affect street sweeper efficiency including loading factors (mass level, particle size, and uniformity), road surface condition (type and condition), sweeper type, and sweeper operation (speed, frequency of sweeping, and availability of gutter broom), and operator skill. Climatic conditions, including rainfall amounts, intensity and pattern also are important.

Demonstration of Nonpoint Abatement through Improved Street Cleaning Practices (Pitt 1979)

Pitt (1979) conducted a study of the effectiveness of street sweeping at 5 locations at 3 sites (Downtown, Keyes, and Tropicana) in San Jose, California. All sites were classified as having good asphalt road surfaces except for one oil/screens site not discussed here. Sweeping was generally conducted daily or weekly and was sustained for about 4 to 6 weeks. Equipment consisted of three varieties of mechanical street sweepers: 4-wheel mechanical street cleaner, state-of-the-art 4-wheel mechanical street cleaner, and 4-wheel vacuum-assisted mechanical street cleaner. Median particle size before sweeping ranged from 150-330 µm, but the median size decreased with street sweeping which was more effective at removing larger particles. Pitt points out that street conditions (especially dust/dirt loading) were more important in terms of determining effectiveness than the type of equipment which included broom and vacuum type sweepers. In other words, the most effective equipment was that which was cleaning the dirtier streets, and which was cleaning most frequently.

Pitt found that road condition played an important role in effectiveness. Percent reductions in overall dust/dirt loading for sites with good asphalt varied on average from 33-43% with removals ranging from 83-130 lbs/curb mile. However for site classified as poor asphalt, the removals was 40%, not much different from the other sites, however the load reduction was 540 lbs/curb mile. The reason for this large difference is that the loading on the poor condition asphalt was 1400 lbs/curb mile, compared to 200-400 lbs/curb mile on the good asphalt roads. In other words, the dust and dirt on a poor asphalt road may be 3 to 7 times more than that on a good asphalt road.

Pitt also examined how effectiveness varied with particle size. For example, the downtown site with good asphalt had dust/dirt load reductions which ranged from about 20% for fine particles (<45 µm) to about 40% for coarser fractions (850-2000 µm). He also determined that, on good asphalt road, over 80% of the dust and dirt was within 5 feet of the curb and therefore parking restrictions were important for effective street sweeping.

On the basis of limited monitoring of runoff quality (three storms), Pitt concluded that water quality improvements in runoff of about 50% reduction in solids and metals could only be achieved with very

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[18] This study measured PCBs by analyzing individual Aroclors which was a trade name used by Monsanto Company and represent a mixture of of individual PCB congeners. Method detection limits tend to be higher when analyzing Aroclors than when analyzing individual PCB congeners.

frequent (e.g. daily or twice daily) sweeping. Pitt also indicated that street sweeping was not generally effective for nutrients whose sources he attributed to runoff from areas surrounding roads (e.g., parkways between streets and sidewalks) and not the roads themselves.

San Francisco Bay Area Nationwide Urban Runoff Program, A Demonstration of Non-Point Source Pollution Management on Castro Valley Creek (Pitt and Shawley 1981)

Pitt and Shawley (1981) conducted a two year study of the effectiveness of street sweeping at sites located within the Castro Valley Creek watershed. Most of the street cleaning tests used modern, mechanical, four-wheel brush-type cleaner. Cleaning frequency varied during the first year, and then in the second year the frequency was 5 times/week for one month, followed by two months of no sweeping. After about two or three passes a week, there is little improvement in street surface loadings. Sweeping could not reduce the surface loadings to below 200 lbs/curb mile irrespective of sweeping frequency. Sweeping intensely prior to winter storms was recommended.

A survey of street cleaning practices in Alameda County indicated that commercial areas received the most frequent cleaning (estimated on average as every other day) with industrial areas being cleaned on average once per week. The study recommended that more frequent cleaning of industrial areas with less frequent cleaning of commercial areas could result in water quality benefits.

A test was conducted using mechanical and regenerative air sweepers working either side of a road segment and alternating sides to ensure comparable initial (pre sweeping) loadings. The sweepers were operated about every 3 or 4 days for the first part of December 1979 for a total of 24 test runs for each sweeper type. The regenerative air sweeper was found to be slightly more effective than the broom sweepers but the effect was dependent on the initial loadings. For fairly clean streets where the initial loadings was about 400 lbs/curb mile, the effectiveness of RA sweeper was about 61% compared to broom sweeper effectiveness of 53%. If initial loading was 850 lbs/curb mile, the RA sweeper effectiveness was estimated at 69% compared to 64% for the mechanical broom.

By comparing the watershed loads during runoff events with the initial surface road loadings in the watershed, the authors indicate that a maximum of 20% of the total solids could have been removed from the runoff if twice weekly sweeping were conducted.

San Jose Street Sweeping Equipment Evaluation Report (WCC 1994)

Woodward Clyde Consultants tested 5 sweepers on 20 test routes in San Jose, California. The sweepers included a new and old Mobil broom, Elgin broom, Tymco regenerative air, and Elgin regenerative air. The goal of the study was to evaluate the relative effectiveness of the sweepers to remove copper, lead, and zinc on roadways. The sampling included hand vacuuming the test routes prior to sweeping so that the effectiveness analysis could take into account the difference in surface loading (lbs/curb mile) amongst the test routes. Dust and dirt collected in the hoppers of the sweepers were screened using a 1 cm square mesh and separated into five size fractions between 75 and 1000 µm and analyzed to estimate the mass of copper, lead and zinc collected per curb mile swept, and the effectiveness of each sweeper in removing smaller particles.

A frequency analysis of baseline copper concentrations showed elevated concentrations of copper (> 200 mg/kg) on routes that had average daily traffic (ADT) values that were as high as 32,000 to 52,000 vehicles/day compared to a an average for all routes of about 21,000/day.

A statistical analysis of sweeper performance indicated that the new Mobil broom and regenerative air sweepers removed significantly more dust and dirt from the roads than the Elgin broom and old Mobil broom. The regenerative air sweepers removed the highest amount of copper per mile or about 0.017 to 0.026 lbs/curb mile. The new Mobil broom sweeper collected a modest of copper in the range of 0.01 to 0.016 lbs/ curb mile. The Elgin broom and older Mobil broom sweepers picked up the least amount of copper in the range of 0.005 to 0.01 lbs/curb mile.

An analysis of copper concentrations and mass indicated that copper concentrations increased as particle size decreased such that the concentration of copper was as high as 0.15 mg/kg in the particle size range <75 µm compared to about 0.05 mg/kg for particles > 700 µm. However, the largest percentage of copper by mass was in the 170-425 µm size fraction. The Elgin regenerative air was the best sweeper at picking up particles in this size range and almost 60% of the copper collected by the Elgin sweeper was in this size range. The Elgin broom was the least capable of picking up the smaller particles and most of the copper collected by the Elgin broom sweeper was in the > 700 µm size range.

Analysis of Street Sweeping Data for Alameda Countywide Clean Water Program (EOA 1999)

EOA evaluated trends in the annual volume of sweeper materials collected by various agencies in Alameda County from 1991 through 1997, with special emphasis on data from FY 92/93, 93/94, 94/95, and 96/97. Agencies included Alameda, Alameda County, Berkeley, Hayward, Livermore, Newark, Oakland, San Leandro, and Union City. The data for all the agencies were combined except for Oakland, which was analyzed separately as it represents approximately 50% of the mile swept in the county. The analysis also distinguished the dry and wet season volume collected.

For the agencies other than Oakland, the total annual removal rates varied from about 0.28 to 0.36 cubic yards per curb mile (yd^3/curb mile). Estimates for the dry season only ranged from 0.25 to 0.30 yd^3/curb mile. Removals in commercial areas (0.26-0.30 yd^3/curb mile) were comparable to removals in industrial areas (0.24-0.35 yd^3/curb mile). The data reported were highly variable and statistical analysis of the annual data before and after changes in street sweeping frequency and other factors such as the issuance of parking citations indicated only limited differences.

For the city of Oakland, the total annual removal rates ranged from 0.33 to 0.42 yd^3/curb mile depending on the year, with the lowest removal rates in commercial areas (0.21 to 0.29 yd^3/curb mile), and highest removal rates in industrial areas (0.36 to 0.77 yd^3/curb mile). Dry season data indicated high removal rates in industrial areas during FY 92/93 (2.3 yd^3/curb mile) and FY 93/94 (1.08 yd^3/curb mile).

The data were converted to lbs/curb mile by multiplying by 6.43 lbs/gallon which was an average density measured in the City of San Mateo. Using this conversion factor, the overall removal rate for the county ranged from about 260 to 520 lbs/curb mile. The data reported included trash and vegetative debris, so the estimate of mass removed could be biased high.

A Review of Source Control Options for Selected Particulate-Associated TMDL Pollutants (Salop 2004)

Salop (2004) conducted a desktop analysis based on existing information to estimate the range of removals of PCBs and mercury achieved by Alameda County MS4s as part of their sediment management programs, which included street sweeping, storm drain facilities cleaning and channel de-silting. For each effectiveness evaluation summarized below, the estimates presented are provided a range and a 'best' estimate of the mass of PCBs and mercury removed, where the best estimate corresponded to the median and the range corresponded to the 25th to 75th percentile estimate.

Salop identified four factors that could affect efficiency: type of sweeper, operation and maintenance practices, commitment of local agencies to adapt street sweeper programs to address water quality concerns, and physical geography. Efficiency factors were based on sweeper types and assigned 50% for high-efficiency sweepers (dry vacuum sweepers), 30% for medium efficiency sweepers (wet vacuum and regenerative air), and 10% for low efficiency sweepers (mechanical broom). These efficiencies were based on street sweeper modeling study projections. Efficiency factors were then assigned to each MS4 in Alameda County based on the mix of sweeper types contained in their sweeper fleets. The mix for a number of agencies included regenerative air sweepers and one agency (ACPWA) reported using a wet vacuum sweeper. Efficiency factors ranged from 10-30% depending on the MS4.

Salop then estimated the amount of PCBs and mercury removed from street sweeper programs based on PCBs and mercury data collected in storm drain inlets, catch basins, and pump stations as there were no data on PCB and mercury concentrations in street dust and dirt. For Alameda County as a whole, the best estimate for PCBs was 0.6 kg, with a range of 0.3-2.0 kg. The best estimate for mercury was 1.2 kg with a range of 0.6-1.9 kg.

Salop estimated benefits associated with conversion of sweeper types to more efficient sweepers and benefits associated with increasing sweeper frequency from monthly to weekly. Conversion to high-efficiency sweepers was estimated to increase the mass of PCBs removed from 0.6 kg to 1.7 kg (best estimate) and mass of mercury from 1.2 kg to 3.4 kg (again best estimate). Benefits for increased frequency of sweeping using current mix of sweepers indicated an increase in PCBs of 0.2 kg (best estimate) and in mercury of 0.3 kg.

Municipal Maintenance and Sediment Management: Evaluation of Source Control Options for TMDL Implementation (Salop 2006)

Salop conducted targeted studies to confirm previous estimates of pollutants removed by street sweeping, inlet cleaning and pump stations. Salop collected and analyzed thirteen samples taken from the hoppers of various types of street sweepers in 5 municipalities in the County of Alameda. The study design called for sampling in two municipalities located in either the northern, southern or eastern portions of the county. In Berkeley three samples were collected with regenerative air sweepers operating in industrial, residential and mixed (commercial residential) areas. In Hayward three samples were collected with mechanical broom sweepers in the three types of land uses. In Newark, three samples were obtained with wet vacuum sweepers in residential and mixed use areas, and mechanical broom in industrial areas. In Pleasanton, two samples were obtained with regenerative air sweepers operating in residential and mixed land use areas. In Livermore, two samples were taken with wet vacuum sweepers in mixed and residential areas. Samples taken in Piedmont consisted primarily of vegetative matter and were not analyzed.

Samples were also analyzed for particle sizes in three fractions: <63 µm, 63-2000 µm, and >2000 µm. The percent by mass of fines in the first two fractions varied from 3-18%. The five samples collected with regenerative air sweepers contained the highest percentage of fines ranging from 8-18% with a mean of 11%. By contrast the percent of fines collected in the hoppers of the four mechanical broom sweepers ranged from 3 -11% with a mean of about 6.5%. The three wet vacuum samples ranged between 4-7% with a mean of 5 %. Although obviously a small sample taken from diverse locations, the data does suggest that the regenerative air sweepers are more efficient in picking up smaller particles than the other two types of sweepers.

PCB concentrations ranged from non-detect (2 samples) to 0.136 mg/kg (dry). The samples obtained in Berkeley were the highest measured corresponding to 0.107 mg/kg for the industrial site, 0.136 mg/kg for the mixed use site, and 0.067 mg/kg for the residential site. The percent fines collected in the mixed use site was 11% and in the industrial site 14%. (Percent fines for the residential site not reported because of lack of sufficient sample). PCB concentrations in samples from other municipalities ranged from 0.012-0.047 mg/kg (Hayward), ND-0.018 mg/kg (Newark), 0.008-0.018 mg/kg (Pleasanton), and 0.004-0.006 mg/kg (Livermore). Salop concluded from these data that the higher concentrations in Berkeley could be attributed to the older age of development in this municipality, and that industrial land uses did not necessarily result in the highest concentrations of PCBs.

Mercury concentrations ranged from 0.03 mg/kg (dry) generally in the municipalities in the eastern portion of the county, to 0.27 mg/kg at the Berkeley industrial site. The range of mercury concentrations in the various municipalities was: 0.17-0.22 mg/kg (Berkeley), 0.05-0.12 mg/kg (Hayward), 0.04-0.05 mg/kg (Newark), 0.05-0.07 (Pleasanton), and 0.03 (Livermore).

Salop then obtained estimates of the volume material collected by the sweeper programs in the municipalities as contained in Annual Reports ending in FY 2002/2003 and estimated the reduction in loads of mercury and PCBs by converting these estimates to mass and applying the measured concentration data by region. The estimates indicated that 2-8 kg of PCBs were removed annually during the period analyzed with 90% of the removal associated with those municipalities located in the northern portion of the county (which includes Oakland which is responsible for about 50% of the material collected). The estimated range of mercury was 5-8 kg/year, and again 90% of the reduction was estimated to occur in the northern portion of the county.

Fairfield-Suisun Urban Runoff Management Program (EOA 2006)

EOA conducted a study in the cities of Fairfield and Suisun City to characterize street sweeping constituents and effectiveness of street sweeping as water quality measure. Materials collected by sweepers at one commercial site and one residential site in each city were sampled and analyzed for selected metals, petroleum products, chlorinated and organophosphate pesticides, and PCBs. Chromium, copper, lead, nickel and zinc were detected in all samples with concentration ranges as follows: copper (18-26 mg/kg), lead (5-45 mg/kg), nickel (9-22 mg/kg), and zinc (62-91 mg/kg). Mercury was detected in 3 of the 4 samples with concentrations ranging from 0.03 to 1.2 mg/kg. PCBs were all below the detection limit of 0.2 mg/kg[19].

EOA estimated the annual mass of constituents removed from street sweeping based on these data and information on the total volume and mass of material collected and reported by the two cities. The estimates were made using statistical representations for selected inputs in a Monte-Carlo framework. The distribution of annual load reductions from sweeping was then provided including the mean, median, and 10th and 90th %ile values. For both cities, the projected load reduction for mercury in both cities was 2.2 lbs (mean) with a 10th %ile load reduction of 0.016 lbs and a 90th %ile load reduction of 3.3 lbs.

Development of Typical Concentration Values for Pollutants of Concern in Contra Costa County, CA (EOA 2007a)

EOA collected and analyzed street sweeping materials from 17 routes in seven cities in Contra Costa County consisting of Brentwood, Concord, Martinez, Orinda, Pinole, Richmond, and Walnut Creek. The routes were located in residential, mixed and industrial areas. The routes were swept with different types of sweepers including regenerative air (12 routes) and mechanical broom (5 routes).

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[19] These samples were analyzed as Aroclors, which are a mixture of individual PCBs, and results in higher detection limits than the analysis for individual congeners.

Street sweepers samples were analyzed for metals, hydrocarbons, pesticides and PCBs. Results indicated that PCBs, total mercury, copper, nickel, and PBDEs were consistently detected in street sweeping material. The PCB concentrations ranged from 0.015-0.932 mg/kg (assuming non-detects equal to half the method detection limit). The highest concentrations were found in the mixed and industrial land use routes in Richmond where the range of PCBs was 0.244-0.932 mg/kg. The second highest set of samples was in Martinez where the PCB concentration ranged from 0.114-0.174 mg/kg with the highest concentration at the mixed land use. Mercury concentrations ranged between 0.05-0.41 mg/kg with highest concentrations found in Richmond (0.20-0.41 mg/kg), Pinole (0.22-0.29 mg/kg), and Martinez (0.08-0.34 mg/kg).

The study also analyzed some samples for concentrations in the bulk sediment (<2000 μm) and in the fine sediments (<63μm). The analysis was conducted for samples collected in Brentwood, Richmond and Martinez. The PCB concentrations for the Richmond site were 0.369 mg/kg in the bulk sediment, and 0.530 mg/kg in the fine fraction. In the Martinez sample, the bulk concentration was measured at 0.151 mg/kg, compared to 0.071 mg/kg in the fine fraction. The mercury concentration in the Richmond sample was 0.40 mg/kg in the bulk sediment compared to 0.90 in the fine fraction. The mercury concentration in the Martinez sample was 0.34 mg/kg in the bulk sediment compared to 0.60 mg/kg in the fine fraction. So, except for the PCB concentrations in Martinez, the remaining three samples indicate enrichment in the finer fraction.

A statistical analysis indicated that industrial mercury concentrations were significantly higher than residential data, and that mercury and PCB data were significantly elevated in older developments (early 1900s) compared to data from more recently developed areas. This latter finding was incorporated into an analysis of loads from the various municipalities in Contra Costa County. The estimated load reduction in the County credited to street sweeping was 1 0.kg of PCBs and 1.85 kg of mercury.

Summary of Polychlorinated Biphenyls (PCBs) Data in Sediment Collected from Richmond, California Streets and Storm Drains (EOA 2007b)

EOA collected and analyzed 47 sediment and water samples from streets, storm drains, and private properties in primarily southwestern portion of the City of Richmond, and analyzed the samples for PCBs. Nineteen of the samples were obtained from material collected by street sweepers in 2006 and 2007. The mean of the 13 samples above detection was 0.262 mg/kg. The highest concentrations sampled were from industrial areas with a maximum concentration of about 2.8 mg/kg. In general street sweeping material contained lower concentrations of PCBs than sediment collected from street gutters or storm drains.

3.2. Studies Conducted Beyond the Bay Area

Studies summarized below are organized alphabetically by author.

City of Olympia Public Works Department Issue Report (Blosser 2000)

Blosser prepared a short report discussing whether the City of Olympia, Washington should utilize an advanced street cleaner in lieu of requiring on-site stormwater treatment for the proposed Capital Mall expansion. This source provides a discussion of the practical considerations that public agencies must deal with in evaluating alternative control strategies that include street cleaning. The street sweeper that was selected for evaluation was the Schwarze EV-1 high efficiency vacuum sweeper, whose capital costs ($290,000) and annual O&M costs ($50,000) would be borne by the applicant.

City staff raised a number of issues regarding the EV-1 including maneuverability, difficult to maintain due to hydrostatic drive, inability to work during wet weather, slow speed (4 mi/hr), new and unproven technology, and sweepings would be dirtier and more difficult to dispose. Discussions with other agencies that had purchased the EV-1 indicated that those municipalities that had avoided problems were those that conducted extensive training and had access to technical support. Also having access to a local dealer who could provide training and technical support was key. It was also noted that the EV-1 drives differently than other sweepers, and has a wide-swinging rear end that can be troublesome if the driver is not used to it. The author concludes that the risk of failure for this approach would not be greater than the risk with a structural treatment measure, where it is more difficult to judge adequate performance.

Residential Street-Dirt Accumulation Rates and Chemical Composition, and Removal Efficiencies by Mechanical-, and Vacuum-Type Sweepers (Breault et al. 2005)

The authors report on a street sweeper study conducted on two streets in New Bedford, Massachusetts in 2003 and 2004. Street dirt collected by the city using hand held vacuums, and street dirt hopper samples were analyzed for particle size distribution, elements, and organic compounds. Trace metal and PAH concentrations were generally greatest on fine grained particles (<63 µm), although copper concentration was highest in the gravel fraction (>2mm).

The study evaluated the effectiveness of two types of sweepers, mechanical and vacuum assisted by applying a known mass of dirt to a street and measuring the mass of dirt picked up by each sweeper type. The know mass of dirt consisted of gravel (22%), coarse sand (44%), fine sand (22%), very fine sand (9%), and silt and clay (about 6 %). Overall, street sweeper efficiencies ranged from about 21-31% for the mechanical sweeper and 60-92% for vacuum sweeper. The vacuum sweeper efficiency was higher for all particle size classes from gravel to silt/clay.

The Role of Street Cleaning in Stormwater Management (Pitt 2004a)

The authors present a review article that summarizes research conducted by them and others, including data on street sweeping effectiveness in several locations including Castro Valley, California, Bellevue Washington, and Milwaukee Wisconsin. Early street sweeping tests using mechanical sweepers indicated that removal was higher for the coarser fraction and for dirtier streets. If the loadings of the 500-1000 µm fraction were less than 75 kg/curb-km (about 100 lbs/curb mile) conventional sweeping is not effective. For higher loading, the removal performance could be in range of 25-50%.

New technology sweepers such as regenerative air sweepers showed improved performance for removing finer particles, especially in areas with intermediate street loadings. (The hypothesis is that the higher loadings of large particles may armor or cover the smaller particles, making them more difficult to remove).

Test results using advanced street sweeping technology (Schwarze Industries Enviro Whirl I) for a freeway segment in Milwaukee, Wisconsin indicated a 25 % reduction in street dirt while the dust and dirt load at the upswept control site increased 160 %. Data indicates that the Enviro Whirl I removed about 50% of the street dirt when the loading was about 500 lbs/curb mile. Removal was zero when the street loading was about 100 lb/curb/mile. This performance is similar to the regenerative air sweeping results achieved in Bellevue, Washington, and is much better than mechanical street cleaning performance tested in some of the earlier programs.

The effects of sweeping on outfall quality will be limited given that roads are only one of several sources of pollutants in urban areas. Analysis of data collected in Bellevue, Washington indicated that streets contribute less than 10% of the total solids, but much larger amounts of metals and organics in the form of chemical oxygen demand (COD). Moreover, rainfall tends to remove the smaller particles, whereas conventional street sweeping is effective in removing the large particles.

Nonetheless, the Milwaukee data indicated a 40% reduction in solids concentrations at the outfall at the 80% confidence level, one of the first statistically reliable documentation of stormwater quality being improved due to street sweeping.

Review of Historical Dust and Dirt Accumulation and Washoff Data (Pitt et al. 2004b)

The authors review and discuss the empirical data available to properly characterize the dust and dirt buildup washoff routines in mathematical models and provide a summary of studies conducted as of the publication date (Pitt et al. 2004b).

The paper summarizes much of the data on initial and ultimate street dirt loading and deposition rates collected by the authors and others, including data from San Jose and Castro Valley, California. Initial (or residual) loadings following intensive street cleaning ranged from 35-85 gm/curb-meter (140-340 lbs/curb mile) for smooth and intermediate textured streets, and from 220 to 510 gm/curb-m (880 – 2000 lbs/curb mile) for rough textured streets (the upper end of the range corresponds to what is referred to as an “oil on screens” overlay applied to asphalt roadways in need of repair. The residual load is the load that remains on the roadway even after intensive sweeping and typical rain events.

The ultimate load on the road is the maximum that would be obtained during dry conditions and no sweeping. The maximum observed loading in grams per curb meter (g/curb-m) varied from 140 – 230 g/curb-m (560 – 920 lbs/curb mile) for smooth and intermediate textured conditions, to 430 -710 g/curb-m (1720 - 2840 lbs/curb mile) for rough textured streets with again the high end of the range corresponding to “oil and screens”. The time required to reach these levels was inversely related to road condition and varied from 30 days for very poor conditions to 50-70 days for fair or good conditions. Accumulation of dust and dirt on roadways is not a linear process and much of the ultimate load is achieved within 1-3 weeks following the initial loading state.

Of particular interest is the discussion of washoff data that is generally less available in the literature, and refers to tests using simulated rainfall to examine the characteristics of the particles mobilized in the tests. A key finding is that typical rain events ranging from 10-30 mm (approximately 0.5-1 inch) tend to mobilize primarily the finer fraction (<63µm) of dust and dirt, and the organic coarse material that is lighter in density. The median particle size of dust and dirt in the washoff tests ranged between15-50 µm. This fine fraction may only account for 10-20% of the dust and dirt mass on the roadway, and typical storms may remove about 50% of the total fine fraction, or 5-10% of the total loading. These estimates are for typical rains on smooth roads. For low intensity rains on poor condition streets the amount removed is less.

The majority of the coarse fraction of dust and dirt remains on the roadway following typical rainfall events. This fraction is then preferentially removed by mechanical and other types of street cleaning equipment, or very intense rainfall events. Data indicates that washoff loads tend to increase only when rainfall intensities reach about 15 mm/hr (approximately 0.6 in/hr).

Characterizing and Controlling Urban Runoff through Street and Sewerage Cleaning (Pitt 1985)

The author reports on a comprehensive study of street sweeper effectiveness conducted at two 100 acre residential sites in Bellevue, Washington from 1980-1983. The study involved an extensive runoff water quality monitoring program involving over 400 storm events. The Bellevue area has a distinctive rainfall pattern typically involving many small rainfall events that generate relatively low runoff (25-35% of rainfall). A source area evaluation indicated that streets were the major source of lead (60%) and zinc (44%) and COD (45%), but only accounted for about 9% of the solids load.

About 600 samples of street dirt accumulations were collected from the two test areas during the 2-year project. Most of the particles in the street dirt samples were in the 125 µm to 1000 µm range. An analysis of the particle distribution in the runoff showed that smaller particles are mobilized more easily than larger particles. For example, approximately 50% of the particles less than 63 µm in size are mobilized by rainfall events, compared to about 10% in the 500-1000 µm range.

Street dirt loadings were reduced to about 50-100 grams/curb meter (approximately 200-400 lbs/curb mile) following rain events of 6mm (2.5 inches) or greater. Approximately 8.5 to 19 g/curb-meter (34-76 lbs/curb mile) were removed during a typical rain event. Of this, approximately 4-6 g/curb meter (16-36 lbs/curb mile) were particles less than 125 µm, accounting for 33-50% of the solids in the runoff.

Street cleaning tests using mechanical sweepers were conducted using an intensive 3 day per week frequency and no sweeping (control) with the sweeping/no sweeping alternated between the two sites. During the street sweeping tests, street loadings ranged from about 40-300 g/curb-meter (160-1200 lbs/curb mile) with an average of about 115 g/curb meter (460 lbs/curb mile). The loadings were reduced to about 20-200 g/curb meter (80-800 lbs/curb mile) with an average of about 60 g/curb meter (240 lbs/curb mile) after cleaning. Particle size smaller than about 350 µm were not substantially affected by street cleaning, however very substantial removals were observed in the large particles.

A series of special tests were conducted in September and October of 1982 to compare the effectiveness of a standard and modified regenerative air sweepers with the mechanical sweepers. Both the modified and standard regenerative air sweepers showed substantially better performance than the regular mechanical sweeper, especially for the finer particle sizes.

Bellevue street cleaning O&M costs were about $13/curb kilometer ($21/curb mile).

A Summary of the 2004, 2005 & 2006 Field Seasons (Rochert et al. 2007)

Rochert et al. conducted fifteen sweeping effectiveness tests over a three period (2004 -2006) on a road segment in Markham Road, Toronto, Canada. The tests were conducted in June through November of each year. Each test included collection and analysis of dry material removed by hand sweeping a 4 m wide by 20 m long stretch of curb lane, and collection and analysis of wet sample obtained by washing with tap water a similar length of lane. Sediment was divided into three fractions (<64 µm, 64-2000 µm, and >2000 µm) for analysis for total metals, nutrients, PAHs, and TOC. The wet samples were analyzed for similar constituents including dissolved metals, total suspended solids (TSS), and volatile suspended solids (VSS).

Two types of sweepers were tested: a conventional mechanical sweeper, an old regenerative air sweeper, and a new regenerative air sweeper. The new technology regenerative air sweeper was the only sweeper effective in removing a statistically significant mass of solids from the road surface, but only from the southbound lanes where the unswept dust and dirt loading was about 150 kg/curb km (605 lbs/curb mile) in 2005 and 225 kg/curb km (907 lbs/curb mile) in 2006. The corresponding removal effectiveness was about 70%. In the northbound lanes, there was no significant change in surface loadings with the newer regenerative air sweeper because the unswept dust and dirt loading were quite low ranging from about 25-50 kg/curb km (100 – 200 lbs/curb mile). These loadings are considered a residual level, beyond which further removal was unlikely, independent of the sweeper type.

The newer regenerative air sweeper significantly removed the silt and clay fraction (< 63 um) in the southbound lane. The pre swept mass of silt of clay was about 10 kg/curb km (40 lbs/curb mile) and post swept silt and clay loading was about 2.5 kg/curb km (10 lbs/curb mile) resulting in an effectiveness of 75%.

Simulated runoff was generated by spraying potable water on the swept and unswept road segments and collecting and analyzing samples in the runoff for various constituents, including solids (TSS), selected metals, and selected hydrocarbons. The dissolved copper data did not show any significant changes due to street sweeping. Dissolved zinc was reduced in one case only, with the new regenerative air sweeper in the dirtier northbound lane. There were no significant changes in the concentrations of selected PAHs including Pyrene, Phenanthrene, and Fluoranthrene.

Runoff toxicity testing was also conducted using microtox and 96 hour rainbow trout LC50 test. The rainbow trout toxicity tests indicated that the toxicity of the runoff both before and after sweeping was minimal (the lowest % survival was approximately 70%) and there was no difference in toxicity in the runoff from the swept and unswept road segments.

Street Sweeping – Report No. 1 State of the Practice (Shilling 2005)

Shilling prepared a series of reports as part of a Street Sweeping Project for the Ramsey Washington-Metro Watershed District, Minnesota. Report 1 addressed the existing state of practice. The report also included information on street sweeper costs. The report cites several sources that indicated that the initial capital cost of sweeper could range from $100,000 for a mechanical broom sweeper that had a life of 5 years, to $200,000+ for a vacuum assisted sweeper that had a life of 8 years. Operation and Maintenance (O&M) costs for the mechanical sweeper were given as $40 per curb mile (for one pass of sweeper) versus $20 per curb mile for the vacuum sweeper (costs are in 2005 dollars).

Shilling also did an analysis of annual O&M cost for different sweeper types and frequency of sweeping. The annual O&M cost for mechanical sweeping varied from $2,235 per curb mile for weekly sweeping to $520 per curb mile for monthly sweeping. The comparable annual O&M cost for vacuum sweeping was given as $1,260 for weekly sweeping and $290 for monthly sweeping. Shilling did not indicate why the O&M costs were higher for mechanical sweepers, but mechanical sweepers have more moving parts subject to wear.

Shilling cites the Chesapeake Bay 2000 Agreement that concludes “regardless of absolute cost-effectiveness, street sweeping is one of the few easily implemented practices for use in highly developed urban areas that will clearly reduce sediment, and any associated pollutants, and provide for improved water quality to often severely degrades streams.”

Evaluation of Street Sweeping as a Stormwater-Quality-Management Tool in Three Residential Basins in Madison, Wisconsin (Selbig and Bannerman 2007)

Selbig and Bannerman (2007) conducted an extensive street sweeping study in Madison Wisconsin which involved a multi-year (2001-2006) multi-catchment monitoring that evaluated the effectiveness of weekly sweeping with mechanical, vacuum assisted, and regenerative air sweepers. The catchments, all residential varying from 50-90 acres in area, included a control catchment (no sweeping) and two test catchments where sweeping was alternated in subsequent years. Data were collected on street dirt yield (lbs/curb mile) using vacuum sweepers, and runoff quantity and quality monitoring using flow based automatic samplers. Measurements of street dirt yield before and after sweeping were used to estimate pickup efficiency expressed as a % of the yield prior to sweeping. Water quality parameters included particulate and dissolved solids, metals and nutrients. Particle size analysis was conducted on street dirt samples and runoff samples.

The effectiveness of street sweeping can be expressed in terms of pickup efficiency, reduction in overall street dirt yield (accumulation), or water quality improvements. Pick up efficiency is the % of material removed per sweeping, whereas the reduction in overall dust and dirt accumulation (expressed as lbs/curb mile) is a measure of the cumulative effect of sweeping at, in this case, the weekly frequency. Selbig and Bannerman analyzed pickup efficiency as a function of particle size and found that mechanical broom pickup efficiency ranged from a high of approximately 20% for large (>2000μm) to negative values for small (<63 μm) particles, which indicated to the authors that the mechanical broom sweepers could potentially be grinding up larger particles and thereby increasing the mass of finer particles. The pickup efficiency for regenerative air sweepers varied from about 30% for larger particles to negative values for smaller particles. Vacuum assisted sweepers showed positive efficiencies over the range of particle sizes from about 10% for smaller particles to about 50% for larger particles. The average pickup efficiencies for each sweeper were 5% for mechanical broom, 25% for regenerative air, and 30% for vacuum assisted.

The study indicated that all sweepers reduced the accumulation of dust and dirt (street dirt yield) on the swept streets when compared to the unswept control. The reductions were on average 20 % for the mechanical broom, 76% for the regenerative air, and 63 % for the vacuum assisted. (The 20% effectiveness for the broom sweeper was primarily associated with removing larger particles associated with winter application of friction materials and might not apply to Bay Area conditions.) Statistical analysis indicated that these reductions were statistically significant at the 5% significance level. Statistical analysis of event mean concentrations and loads of pollutants in the runoff failed to show a difference, which the authors attributed to the variability in the runoff data, and the inadequate number of samples in the data set.

City of San Diego Street Sweeping Pilot Study (Weston 2010)

The City of San Diego is conducting pilot tests to evaluate the effects of sweeping frequency on reducing pollution, specifically debris and trace metals associated with fine sediment, and if newly acquired vacuum-assisted sweepers are more efficient or cost effective than conventional sweepers. The sweepers selected for the study were the Schwartz A7000 regenerative air sweeper and an Elgin Whirlwind vacuum sweeper along with the City's currently owned Johnson 4000 mechanical sweeper. Three pilot areas are being tested in Mid-City, Clairmont, and La Jolla Shores and include residential and commercial land uses.

The two-year study began in April 2007 and is near completion. Testing has been conducted under two wet seasons and two dry seasons. The first phase focused on street sweeper effectiveness and frequency, and the second phase addressed monitoring runoff to evaluate benefits to water quality.

The results of the sweeper frequency assessment indicate that the amount of material collected by the vacuum sweepers per pass (approximately 80 lbs/curb mile) does not go down if the sweeper frequency is increased from once to twice per week. Thus the amount of material collected is doubled if the frequency is doubled. By contrast, the amount of material collected using the mechanical sweeper once per week was only about 50 lbs/curb mile and this reduced to about 30 lbs/curb mile if twice-weekly sweeping was conducted. However, there were no discernable differences in the effectiveness (grams of metal removed per curb mile) based on sweeping frequency.

Preliminary results indicate that street sweeping has a positive impact on water quality. Comparisons indicate that the vacuum sweeper is more effective in reducing pollution than the mechanical sweeper on flat, even street surfaces, while the mechanical sweeper works equally well on uneven, hilly streets.

Based on these findings, the City plans to utilize the vacuum sweepers on the flat routes with good road surface conditions and well-defined curb and gutter. This sweeping modification will allow the City to benefit from improved water quality without affecting existing budgets and resources.

Potential long-term modifications to the City's street sweeping program include the following:

- Transition the City's fleet of sweepers to more equitable mix of vacuum and mechanical sweepers (50% vacuum, 50% mechanical);
- Identify residential areas interested or requesting enhanced (e.g., once per week) sweeping;
- Identifying commercial and industrial routes for aggressive (e.g., twice per week) sweeping; and
- Sweeping center medians along high traffic roadways.

Seattle Street Sweeping Pilot Study (Herrera 2009)

This study applied a mass balance approach to determine the amount of materials and associated pollutants on streets and in catch basins (with a sump), and how that balance might be affected by street and catch basin cleaning. It is one of the few studies reviewed that attempts to evaluate a relationship of street sweeping with catch basin cleaning. The mass balance approach was selected after it was concluded from a power analysis that a runoff monitoring study sufficiently robust to evaluate the benefits of sweeping on water quality was too expensive. The studies were conducted at three sites representing residential and industrial land uses that had an area consisting of 4-15 blocks. At each site, a portion of site was unswept to provide a control, and a portion of swept. The test sweeping involved sweeping either side of the street weekly, so the frequency of sweeping each side of the street was once every two weeks. The sweeper used was a Schwarze Industries Model A8000 regenerative air sweeper. The mass of street dirt, sweeper waste, and catch basin sediment was measured approximately every four weeks. Street dirt samples were obtained using a hand-held industrial vacuum on swept and unswept road segments prior to sweeping.

Study results indicated that sweeping at the biweekly frequency with this type of sweeper reduced the amount street dirt on the road (referred to as street dirt yield) in all three sites by 48, 74, and 90 percent compared to the controls. The lowest effectiveness was associated with the industrial site. Sweeping also reduced the mass of pollutants on the swept segments compared to the unswept controls by as much as 78 percent (PAHs), various phthalates (29-65%), and zinc (18%). Test results indicated that street sweeping removed at least 80 percent more material than catch basin cleaning, but the results did not indicate that sweeping affected the amount or rate of sediment accumulation in the test area catch basins.

The study concluded that street sweeping, with an estimated life cycle cost for removal is approximately $5 per kilogram dry TSS is cost effective compared to regional-scale treatment where the cost is estimated at $10 - $30/kg.

Herrera also evaluated the effects of street sweeping once every two weeks on accumulation of materials in catch basins with the intent of determining if street sweeping might affect the need for or frequency of catch basin cleaning. The evaluation was based on monitoring the accumulation of sediments in 12 catch basins located in each of the three test areas that were subject to a period of sweeping and a period of non-sweeping. The duration of the study was one year for two of the test sites, and eight months for the third test area.

Test results did not show that street sweeping every other week affected the rate of sediment accumulation in the test area catch basins, which indicates that sweeping may not reduce the frequency that catch basins would need to be cleaned. The tests indicated that during the testing periods, the actual accumulations in the catch basin during the swept periods either remained the same or actually increased somewhat, although not statistically. The authors point out that the accumulation rates in the catch basin were such that the catch basins were less that 10 percent full, and the short study period as well as monitoring by measuring down to the surface of the sediment was subject to some uncertainty.

The particle size distribution of the street dirt and catch basin samples was fairly similar between the swept and unswept test sites. While there were some differences for specific sites, there was no consistent pattern observed across all sites. The industrial area generally exhibited somewhat higher percentages of fine-grained particles (fine sand plus silt/clay) for catch basin sediment (24 to 51 percent) than in the two residential basins (10 to 51 percent in catch basin sediment). Truck traffic in the industrial area may have contributed to the larger amount of fine-grained material present on the streets.

Concentrations of pollutants (i.e., metals and PCBs) were higher in the samples collected from the industrial site compared to the two residential sites. Cadmium, lead, and zinc concentrations were generally higher in the industrial catch basins compared to the two residential study areas. Furthermore, in most cases, concentrations of cadmium, copper, lead, and zinc were higher in the catch basin samples than street dirt and street sweeping material. This was likely due to the greater proportion of fine-grained material found in the catch basin sediment since finer material. Overall, PCB concentrations collected from the industrial study area (34 to 910 µg/kg dry weight) were typically higher than the concentrations measured in the two residential study areas (<19 to 73 µg/kg dry weight). The variability in PAH concentrations observed at each test site made it difficult to distinguish trends between the different media or study areas.

One interesting result is that the amount of sediment removed from street sweeping was higher by as much as a factor of five to the amount of sediment accumulated in catch basins. For both sites (total of 12.7 ac) on an annualized basis, sweeping is estimated to have removed approximately 33,800 pounds (15,400 kg) of dry sediment, while annual cleaning of catch basins in the area is estimated to have removed about 6,200 pounds (2,800 kg) dry sediment.

Thus, street sweeping carried out on a bi-weekly schedule at these test sites is much more effective in terms of sediment removed than annual catch basin cleaning.

Estimated life cycle costs for a full-scale street sweeping program ($0.34 per wet kilogram of material removed and $0.62 per dry kilogram of material removed) are generally lower than the costs for the SPU city-wide catch basin cleaning program ($0.42 per wet kilogram and $0.74 per dry kilogram). Inspection, cleaning, material handling, and disposal costs were included in the estimate. Catch basin cleaning costs vary widely on a dry weight basis ($0.47 - $1.36 per dry kilogram of material) depending on the estimated moisture content.

Baltimore Street Sweeping Study (Law et al. 2008)

Law et al. (2008) conducted an effectiveness study in Baltimore, Maryland that addressed pollutant removal rates for street sweeping and storm drain cleanout programs in the Chesapeake Bay Basin. Two sampling sites, Catchment F (Lanvale Street) and Catchment O (Baltimore Street), were monitored for water quality runoff. Both catchments were approximately 30 ac in size and were about 70% impervious. Land use was primarily high density residential in the form of row houses. The study included water quality monitoring during a 15-month baseline period (Sept. 2004-Dec. 2005) during which existing street sweeping frequency (1 or 2 times per week) was followed. During the treatment period (Jan. 2006 – July 2007), sweeping was increased to twice a week on all streets in Catchment O and reduced to once per week on all streets in Catchment F. This change in frequency corresponded to an increase in curb miles swept per week of about 150% in Catchment O and a decrease in curb miles swept of about 45% in Catchment F. Sweeping was conducted using an Elgin Whirlwind© MV 4 Wheel Vacuum Air Sweeper.

Flow composite samples were obtained from 17 events during the baseline period and 11 events during the test period at Catchment O and 15 events during baseline and 7 events during test period at Catchment F. In addition to water quality samples, 41 first flush grab samples were obtained at Catchment O. Bedload samples were also obtained: 8 samples at Catchment O and 2 samples at Catchment F. Streets were also hand swept in Catchment O yielding a total of 10 samples of street particulate matter (SPaM) before sweeping and 10 samples following sweeping.

The water quality data did not show any statistically significant differences in runoff concentrations between the baseline and test periods. Factors cited for this finding include the relatively small number of samples, the difficulty of isolating street runoff from other sources, and the concern that automatic water samplers may not obtain representative samples especially with respect to the larger and denser particles.

Average SPaM loadings was about 645 lbs/curb mile prior to sweeping, and 553 lbs/curb mile following sweeping, corresponding to an approximately 14% reduction in loading. Forty percent of the mass of the SPaM was in the 250-1000 um size range, compared to only about 4% for the SpaM less than 63 um. A similar distribution was found for metals and nutrients with the exception of copper where approximately 18% of the copper was found the fraction less than 63 um.

A conceptual model was developed by the authors that took into account various factors that affect sweeping performance and inlet sediment retention. Based on the conceptual model and best professional judgment regarding the effects of these factors, the authors recommended that sweeper pickup efficiency for weekly sweeping would vary from about 25% for mechanical broom to 60% for regenerative air or vacuum assisted sweepers. For monthly sweeping, the estimated efficiencies decreased to 18% for mechanical broom and 42% for regenerative air/vacuum assisted sweepers.

The monitoring study characterized the material removed from storm drain inlets[20] in both residential and commercial/industrial land uses in two different physiographic regions. Four inlets in each of the four groups[21] were sampled to determine the rate of accumulation of material in the time period

[20] The storm drain inlets were designed without a sump and are considered a flow-through or 'self-cleaning' component of the stormwater conveyance system.

[21] Sixteen storm drain inlets were grouped into four categories that represented the various combinations of land use types and physiographic regions in the study.

between a spring and fall (2006) cleanout. Inlet samples were analyzed for particle size distribution, total solids, nutrients and metals. Although samples were analyzed for metals, it was noted that an insufficient number of samples were collected to sufficiently characterize the patterns in water quality pre- and post-treatment.

Different land uses resulted in significantly different monthly accumulation rates, with inlets in commercial/industrial land uses having higher accumulation rates of material. Daily accumulation rates were found to be statistically significant for both land use types, with residential land use ranging from 0.001 to 0.005 ft^3/day and commercial/industrial land use from 0.011 to 0.013 ft^3/day. Material removed from the inlets consisted of, on average, 52% leaves and other organic matter, 39% sediment and 9% trash.

The particle size distribution for the inlet material, especially the coarser fractions, was found to be similar to the distribution for the SPaM, which was likely due to the 'self-cleaning' inlets. For all inlets, an average of 86% of total sediment was between 0.25 mm and 4.0 mm. About 60% of commercial/industrial inlet samples were found to be between the 0.25-2.0 mm fractions.

A total of eight bedload samples were collected. The average mass of bedload collected was 225g (standard deviation of 114g) per sample, which typically represented material accumulated over a 1-2 week period. The monitoring set-up did not function as expected, and consequently, the amount of bedload material collected was considered an underestimation.

Information generated from the project's literature review, municipal practices survey, and monitoring data, though limited, was used to estimate pollutant removal efficiencies for inlet cleaning using the conceptual model created for this study. The estimated range in pollutant removal efficiencies for total solids was 18% and 35% for annually and semi-annually, respectively.

4. STORMWATER CONVEYANCE SYSTEM CLEANING

For the purposes of this literature review, the term "stormwater conveyance system" refers to the constructed conveyance system designed to transport water to receiving waters during runoff events. The conveyance system includes storm drain inlets, underground pipes, and pump stations. Different terms have been used in literature in reference to storm drain inlets, which serve as the entry point to the underground storm drain pipe system and are generally designed to reduce flood risks and convey flow to the underground pipe system. Types of storm drain inlets include:

- Drop Inlet - inlet structure where the outlet pipe is at approximately the same height as the structure's base. [22] Drop inlets are also referred to as simple inlets in the United States (U.S.). Drop inlets are intended to be "self cleaning" and effectively pass water and sediment directly into the outlet pipe. Drop inlets are not designed to provide substantial storage capacity for sediment or other material.

- Catch Basin - inlet structure built with the outlet pipe at some height above the base of the structure in order to provide a sump for storage of sediment and other materials. The base of the sump is typically 0.5 to 1.0m below the bottom of the outlet (Pitt and Field 2004) and collects particulates and non-floatable litter that have passed through the inlet grate and settled out during smaller storms. The sump is meant to provide a layer of water over the accumulated material to minimize resuspension of the solids via scouring by the inflow. Catch basins work most effectively when the accumulated material is removed before the storage capacity is lost. Terms used for catch basins in other countries include gully pot (e.g., United Kingdom and Germany), catchpit (e.g. New Zealand), and stormwater trap (e.g., Australia and Norway).

Because a stormwater conveyance system includes various components (e.g., inlets, drain lines and pump stations) that accumulate sediment at different points in time and based on various factors, available studies evaluating these individual components were collected and are summarized below.

Appendix B includes key attributes and findings of each summarized study to facilitate comparing and contrasting findings.

4.1. BAY AREA STUDIES

Studies summarized below are organized chronologically, from oldest to most recent, to represent the development of work in stormwater conveyance system cleaning throughout the Bay Area.

Water Pollution Aspects of Street Surface Pollutants (Sartor and Boyd 1972)

In addition to the street sweeper tests described above, Sartor and Boyd conducted a limited study involving two controlled tests to determine the effectiveness of catch basins to retain sediment in a residential area of San Francisco. The catch basins were standard, made of concrete with curb inlets and cast iron gratings. The first test evaluated the effectiveness of an empty catch basin to remove solids from injected fire hydrant water mixed with previously collected street sediment. Results indicated that, for a simulated heavy rainfall intensity (1/2 in/hr), the catch basin was reasonably effective in removing coarse solids, i.e., solids with a diameter larger than 246 µm, but ineffective at removing fine solids. The retention time was less than a minute for low flows, which is consistent with the catch basin being effective in removing only coarse material. The study found that removal efficiencies also

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[22] Most storm drain inlets in the Bay Area are believed to be drop inlets (Sommers 2011, personal communication).

decreased with respect to time. The authors speculated that this was due to unstable conditions of hydraulic turbulence and resuspension, but noted that this conclusion was based on limited data.

The second test investigated the hydraulic flushing effect of inlet water on preexisting catch basin contents. ‘Clean’ water was added at several predetermined flow rates to three catch basins that had not been cleaned for several months. The catch basins were described as containing several thousand pounds of solids, with a layer of water and floating debris up to the outlet level. The initial discharged water was supernatant water, with some floating debris and particulate matter suspended by the turbulent flow. After one hour, approximately one percent of the initial solids in the catch basin were removed. The results indicated that most of the material originally contained in the catch basin appeared to remain, regardless of the runoff volume.

Demonstration of Nonpoint Abatement through Improved Street Cleaning Practices (Pitt 1979)

As part of this study, Pitt (1979) constructed a catch basin (with a sump), according to recommendations by Lager and Smith (1976), and partially filled it with sediment and fluorescent particle tracer material to monitor the routing of particulates in a stormwater drainage system. The catch basin was installed in a street corner of the study area, with eight manholes between its installation and an outfall on Coyote Creek. Five-hundred lbs of sediment material, made up of a similar particle distribution as the street surface dirt measured in the study area, was added to the constructed catch basin. Furthermore, 2.5 lbs of yellow fluorescent particles were mixed with the bottom half of the sediment material in the catch basin, and 2.5 lbs of green fluorescent particles were mixed with the top half.

Samples were collected five times from the catch basin, the eight downstream manhole locations, and the creek outfall between September 1977 and January 1978. During that time, there were more than 10 days of rain, including four significant storms. Storm drain inspections were also routinely conducted during this time period to document the depth of sediment in the main storm drain and in the adjacent laterals, which were all flushed out at the beginning of the study.

Results indicated that some of the sediment and tracer material was removed from the catch basin during dry weather flows. A general decrease in relative concentrations between the catch basin and outlet was noted; however, there were large variations in the data results. The concentrations of fluorescent particles in the catch basin did not significantly change with time. Yellow particles were not found at most of the manhole sampling locations during some of the sampling periods. This was expected because the yellow material located at the bottom of the catch basin would only be discharged into the stormwater conveyance system during larger storms. The authors found that the overall depth of material in the catch basin decreased approximately 20%.

A Demonstration of Non-Point Source Pollution Management on Castro Valley Creek (Pitt and Shawley 1981)

In addition to conducting a two-year study of the effectiveness of street sweeping at sites located within the Castro Valley Creek watershed, Pitt and Shawley (1981) presented data from an Oakland study conducted in September 1979 (Shawley 1980) to make observations about inlet particulates in the Castro Valley area. For the Oakland study, the Alameda County Flood Control District examined 20 residential storm drain inlets that were cleaned every year or every two years and measured an average of 60 lbs. of dry particulates in each inlet. Based on these results, the authors estimated that about 12,000 pounds (2% of the total annual runoff yield) of dry particulates were present in a total of approximately 200 inlets in the Castro Valley area. The sediment accumulation or washout rates were unknown.

Results from analysis of the sediment in the 20 inlets indicated that the median total solids particle size was approximately 2,300 µm, which was substantially greater than that of the street dirt measured in the authors' study (500 µm). However, results from a one-time cleanout were compared to a two-year street sweeping study, which explain the large difference in particle sizes.

Storm Inlet Pilot Study (Mineart and Singh 1994)

Mineart and Singh (1995) carried out an extensive study in Alameda County to determine the optimal frequency of storm inlet cleaning that achieved the maximum pollutant removal. Sixty storm drain inlets[23] were selected for the 11-month study (December 1992 to October 1993) in residential, commercial and industrial land use areas. Within each of the three land uses, 20 inlets were studied, of which five were cleaned monthly, five semi-annually, five quarterly, and five annually.[24] Qualitative observations showed that trash and leaves were the most common materials found in inlets in the three land uses. Other material found in all three land uses included soil and decomposing organic material. Sediment volume and mass were recorded for each inlet cleaning, and materials from a subset of the inlets were analyzed for pollutants. A grain size analysis indicated that over 80% of all inlet sediments were sand (within the range of 62-2,000 µm). The inlet sediments contained a variety of pollutants typically found in urban stormwater runoff, including metals (lead, zinc and copper), petroleum hydrocarbons, and polynuclear aromatic hydrocarbons (PAHs).

The greatest average removed mass per cleanout was achieved through semi-annual cleanouts. In general, total annual sediment volumes removed increased with increased cleaning frequency in all land uses. However, in terms of total sediment mass removed, that trend was most evident in industrial land use. The study showed that for all land uses monthly inlet cleaning removed the most sediment on an annual basis (3-5 cubic feet), and therefore the greatest mass of pollutant. Quarterly, semi-annual and annual cleanings removed 1.5 to 2.5 cubic feet annually, except for industrial inlets, where debris accumulation was not observed when cleaned annually.

For residential land use, monthly cleaning removed approximately 70% more mass than that removed by quarterly or semi-annual cleanings. However, annual cleaning removed approximately 50% more than quarterly and semi-annual cleaning. Annual cleaning also removed more sediment volume than quarterly and semi-annual cleaning in residential land use. The authors did not give a reason for these unexpected results. For commercial land use, monthly cleaning removed approximately 70% more mass than that removed by quarterly cleaning, approximately 30% more than semi-annual cleaning, and 40% more than annual cleaning. For industrial land use, there was a clear decrease in sediment volume and mass removed with decreased frequency. Monthly cleanings removed about 30% more mass than quarterly cleanings, 50% more mass than semi-annual cleanings, and 80% more than annual cleaning.

The study also evaluated seasonal differences in sediment volumes and mass removed for the four cleaning frequencies. Differences in sediment removed were evaluated for the wet season (October to April) and dry season (May to September). Monthly cleaning was carried out during both the wet and dry seasons, quarterly cleaning twice during each season, semi-annual cleaning once during the wet season and once near the end of the dry season, and annual cleaning near the end of the dry season. Data from the four cleaning frequencies were combined together for each land use. Median values showed that slightly more volume accumulated during dry weather in residential land use, but slightly

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[23] All inlets selected for the study were drop inlets, as opposed to catch basins (with sumps), and were 41 in long by 25 in wide, with depths ranging from 16 to 54 in.
[24] Results were extrapolated to calculate annual values, since data were collected for 11 months.

more accumulated in commercial and industrial land use during the wet season. However, because of the large variability in data, especially in the commercial and industrial land uses, the authors noted that this difference was not significant.

Samples from inlets cleaned semi-annually had the lowest metal (lead, zinc and copper) concentrations, though the reason for this was not clear. Concentrations of lead and zinc appeared to increase over time. Overall, sediment samples collected from inlets cleaned annually had higher average metal concentrations than sediments from inlets cleaned monthly. Seasonal differences did not affect metal concentrations.

Increasing the cleaning frequency to monthly appeared to significantly increase the removal of copper. However, this was based on sediment samples from inlets in two illegal dumping areas, where concentrations of 1,140 mg/kg (commercial) and 1,500 mg/kg (industrial) were detected. Assuming similar 'hot spot' areas were found during regular monthly cleanings, the copper load would be reduced by 11-12 %. If these two high concentration areas were not included in the estimate, there would only be a one percent decrease in the annual copper load to the Bay.

Because cost-benefit was not evaluated, the authors recommended that annual cleaning be continued until more information about staffing and resource needs associated with increased frequency was obtained. The authors also recommended that municipalities consider other alternatives to increased inlet cleaning, such as improving inlet design, using more effective equipment to clean inlets, eliminating pollutants at the source (e.g., illicit discharge control programs and public education), and placing more emphasis on other maintenance activities (e.g., street sweeping). In addition, the authors recommended monthly inlet inspections during the wet season in potential illegal dumping areas. The study results suggested increasing cleaning frequency in identified hot spots or inlets that consistently accumulate sediment should be effective, especially if data are collected when inlets are cleaned to target and optimize the cleaning program.

A Review of Source Control Options for Selected Particulate-Associated TMDL Pollutants (Salop 2004)

Salop (2004) conducted a desktop analysis based on existing information to estimate the range of removals of PCBs and mercury achieved by Alameda County MS4s as part of their sediment management programs, which included street sweeping, storm drain facilities cleaning and channel de-silting. For each effectiveness evaluation summarized below, the estimates presented are provided a range and a 'best' estimate of the mass of PCBs and mercury removed, where the best estimate corresponded to the median and the range corresponded to the 25th to 75th percentile estimate.

Data submitted by the MS4s to various Alameda County Annual Reports (FY 1997-98 through FY 2000-01) was used to calculate a total annual average volume of waste material collected from stormwater conveyance system[25]. Based on communications with ACCPW staff, it was estimated that approximately 25% of the volume of the total collected material from the storm drain facilities was

[25] Data is submitted by each municipality as a total value for volume of material collected from a stormwater conveyance system, which includes inlets, catch basins, culverts, V-ditches, pump stations, open channels and watercourses. Consequently, volume calculations for each facility type cannot be estimated. Additional limitations include 1) differences in types and volumes of material removed from different facility types; 2) varying proportion of facility types among agencies and unincorporated areas; and 3) lack of known method to convert volumes of material collected for disposal into an associated sediment volume or mass (Salop et al. 2004).

sediment. In addition, the study used data from past local studies[26] to develop estimates of mass of PCBs and mercury (and their concentrations) removed in collected material, which Salop noted added additional uncertainties to the data results.

Pollutant concentrations and Alameda County municipalities were grouped into urban (pre-1950s development), mixed urban and recent urban land use categories. Salop et al. (2004) roughly estimated the percentage of volume removed from each land use type as 30% from pre-1950s urban, 20% from mixed urban and 50% from the recent urban. Based on samples collected in inlets, catch basins and pump stations and the study's 'best' estimates, the pre-1950s urban land use type had both the highest total PCB and mercury sediment concentrations of 0.138 mg/kg and 0.3 mg/kg, respectively. The mixed and recent urban land use types had the same estimated total sediment concentrations for PCBs and mercury of 0.113 mg/kg and 0.3 mg/kg, respectively.

The estimated concentrations calculated from past studies were used to estimate the PCB and mercury mass removed from storm drain inlets, catch basins, and pump stations in the study year (2004). The study estimated that ACCWP municipalities and unincorporated areas removed a total PCB mass of 2.6 kg and 1.0 kg of total mercury mass.

Based on Mineart and Singh (1994) study, Salop et al. (2004) projected a 30% increase of additional collected material if cleanout frequency was increased from annual to semi-annual[27]. It was estimated that the additional mass of pollutants removed from semi-annual cleanouts would result in an additional decrease of 0.0007 mg/Kg of total PCBs, or a 0.2% decrease from the annual total PCB concentration. In addition, the additional removed mercury mass would results in an additional decreased of 0.3 mg/kg of total mercury, or a 43% decrease from the annual total mercury concentration. It would roughly cost Alameda County MS4s an additional $300,000 due to increased disposal costs.

Using past data from Alameda County and BASMAA Joint Stormwater Programs' 2000-2001 investigations, Salop et al. (2004) also estimated PCB and mercury concentrations in sediment removed by channel de-silting carried out by the Alameda County Flood Control and Water Conservation District (District). District data on volumes of dredged material from 1990-2002 was used to calculate an average annual sediment amount. Total PCB and mercury concentrations for dredged sediment were estimated for each of the land use types described earlier. The pre-1950s urban land use type had the highest estimated total PCB concentration of 0.049 mg/kg, while the mixed urban and recent urban land use types had estimated total PCB concentrations of 0.032 mg/kg and 0.0023 mg/kg, respectively. The highest estimated total mercury concentration was 0.3 mg/kg for the mixed urban land use type. The other two estimated total mercury concentrations were 0.2 mg/kg and 0.1 mg/kg for the pre-1950s urban and recent urban land use types, respectively. It was estimated that the District removed 2.3 kg of total PCB mass and 20.5 kg of total mercury mass.

In order to estimate the additional pollutant mass that could be removed with increased channel de-silting, Salop et al. (2004) compared de-silting practices between the periods 1990-2004 and 1979-89. Based on higher de-silting rates in the earlier time period, it was estimated that a range of 1.5-13.8 kg additional total PCBs would be removed, with a best estimate of 5.1 kg of total PCBs, and a range of

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[26] Data sources included the Program (Salop et al. 2002a, Salop et al. 2002b, and BASMAA[26] Joint Agencies (KLI and EOA 2002), and a mercury sampling investigation conducted by Contra Costa County in 2000 (Contra Costa County Public Works Department, unpublished data).

[27] Mineart and Singh (1994) found that semi-annual cleanouts increased the volume of removed material, especially in industrial areas.

18.4-77.5 kg of total mercury removed, with a best estimate of 38.8 kg of total mercury, or 48% more than that later time period, would be removed. Based on median costs from channel-desilting projects carried out between 1998 and 2002, increasing de-silting rates was estimated to cost between $1 and $9 million annually.

Municipal Maintenance and Sediment Management: Evaluation of Source Control Options for TMDL Implementation (Salop, 2006)

In 2005 Salop conducted targeted studies to confirm previous estimates of pollutants removed by street sweeping, inlet cleaning and pump stations. For the inlet cleaning study, fourteen samples were collected from the same targeted regions and land uses that were described in the street sweeping study. Out of the 14 samples, six were taken from residential land use, five from mixed (commercial and light industry) land use, and three from industrial land use.

Samples were also analyzed for particle sizes in three fractions: <63 µm, 63-2000 µm, and >2000 µm. The average particle size distribution showed that 5% of the total dry mass was in the <63 µm particle size fraction, 63% in the 63-2000 µm fraction and 32% in the >2000µm. Several samples from individual land uses were not analyzed. Overall, the mixed land use category had the highest percentage of fines in the first two fractions, ranging from 5-33% with a mean of 17%. The next highest was in residential, ranging from 3-19% with a mean of 12%. The industrial land use areas had the lowest percentage of fines with a range of 3-20% and a mean of 9%.

As with the street sweeping waste, PCB concentrations were significantly higher in Berkeley, regardless of land use. The highest (0.590 mg/kg) was found in the mixed land use, with 0.182 mg/kg found in the industrial land use, and 0.166 mg/kg in the residential. The percent fines in each of these samples were, respectively, 22%, 20% and 19%. However, the highest percentage of fines in the first two fractions (33%) was in a mixed land use area in Livermore, where a much lower PCB concentration was observed (0.064 mg/kg). The following ranges of PCB concentrations were found in the remaining municipalities: 0.009-0.066 mg/kg in Hayward, 0.013-0.095 mg/kg in Newark, 0.003-0.014 mg/kg in Pleasanton, and 0.007-0.064 mg/kg in Livermore. A single sample in Piedmont resulted in a PCB concentration of 0.065 mg/kg.

Mercury concentrations ranged from 0.04 mg/kg to 0.38 mg/kg. Again, the highest concentrations were in the City of Berkeley, with 0.38 mg/kg in the industrial area, 0.27 mg/kg in the mixed area, and 0.24 in the residential area. One other high concentration value of 0.24 mg/kg was found in a Piedmont sample. The remaining concentrations were as follows: 0.04-0.18 mg/kg in Hayward, 0.05-0.08 mg/kg in Newark, 0.05-0.06 mg/kg in Pleasanton, and .06-.11 mg/kg in Livermore.

To estimate the volume of material collected from storm drain inlets, Salop used data for the years 2000-01 and 2004-05 reported by all municipalities of the material collected from storm drain facilities[28] on a monthly basis. Salop assumed that 75% of the average collected from these years would account for the 'best[29]' estimate of material collected from storm drain inlets and that the wasted collected from the urbanized land uses (residential, mixed and industrial) was proportional to the areas covered by

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[28] When reporting amounts of waste collected on a monthly basis, municipalities did not distinguish what type of storm drain facility was cleaned or from what type of land use. Therefore, it was necessary to estimate the amount collected from an individual facility.

[29] Salop et al. (2006) developed 'low', 'best' and 'high' estimates, which corresponded with 25th, 50th and 75th percentile calculations. For the purpose of this summary, the 'best' estimates will be reported.

each. He then calculated the mass of PCBs and mercury contained within the material collected using the average concentrations measured for each land use type and region[30]. Results indicated that inlet cleaning removed between 0.5 and 1.6 kg of mass of PCBs, with a best estimate of 1.1 kg, and a range of 0.8 and 2.3 kg of mercury mass, with a best estimate of 1.5 kg.

Salop carried out a study to determine if increasing the inlet cleaning frequency would increase the amount of material collected, and thus, the mass of PCBs and mercury. In industrial areas of the three study regions, a total of 11 test sites were cleaned and sampled during a dry period midway during the rainy season, while fourteen control sites were only visually inspected. Test and control sites were again inspected the following year before the beginning of the rainy season. Sediment volumes did not change in the control sites over the time period. Salop concluded that either no additional material entered the inlets or the inlets had reached a steady state where inputs to the inlet were equal to the outputs. The test sites accumulated 30-40% of the volume that was removed at the beginning of the study period.

Results from this study and earlier estimations (described above) were used to estimate the increased amount of PCBs and mercury mass that would be collected with one additional wet season inlet cleanout. For both PCBs and mercury, less than 0.1 kg mass of each would be collected, a slight gain from one yearly cleanout. Salop did note that the amount that accumulated in each inlet appeared to be related to its type of construction. The older type of inlet, found in the Berkeley industrial area, was built as a catch basin with a sump and had greater storage capacity as compared to newer inlets designed to flush out during storms.

Salop also analyzed material collected from two pump stations, one associated with a railroad overpass in Pleasanton and the other from the Ettie Street pump station in Oakland[31]. PCB concentrations were highest at the Ettie Site (0.028 mg/kg), with 0.005 mg/kg measured at the Pleasanton pump station. Mercury concentrations were 0.32 mg/kg at the Pleasanton station, while a 0.27 mg/kg concentration was measured at Ettie. Percent fines in the first two fractions were relatively the same at both pump stations, with 2% at Ettie and 5% at Pleasanton. An estimated solids volume of 2.4 cy was removed from the Pleasanton station, though the volume of suspended material contained in the liquid fraction that drained during the dewatering process was not included. The estimated amount of solids accumulated in four sumps within the Ettie station was 33 cy. Salop estimated that <0.01 kg of both PCBs and mercury was collected in the Pleasanton pump station. The Ettie station material had <0.01 kg of PCBs and <0.03 kg of mercury. Using the highest PCB concentration measured during the period 2000-2006 (3,263 µm), Salop estimated that the 33 cy of volume of material collected from the Ettie Street pump station could have as much as 0.3 kg of PCB mass.

Desktop Evaluation of Controls for Polychlorinated Biphenyls and Mercury Load Reduction (Mangarella et al. 2010)

Mangarella et al. (2010) carried out a desktop evaluation to to assess the efficacy of source and treatment controls to prevent or remove PCBs and mercury from entering the stormwater conveyance system. Information from McKee et al. (2006) was used to characterize sources by land use, which were then used to calculate estimates of the annual loads of mercury and PCBs to the Bay from various land

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[30] Municipalities were grouped into regions as follows: the Northern region included the cities of Berkeley and Piedmont, the Southern region included the Cities of Newark and Hayward, and the Eastern region included Livermore and Pleasanton.
[31] This effort was coordinated through a Proposition 13-funded project conducted by the City of Oakland.

use categories. The ‘unit loading[32]’ for both mercury and PCBs were found to be highest for industrial and commerical areas. Using the results from the source and land use characterization analysis, the report evaluated various Better Management Practice (BMP) scenarios and evaluated their effectiveness in terms of reducing loads to the Bay. Scenario results showed that the most effective BMPs were those that addressed source control, rather than treatment, such as drop inlet cleaning and street sweeping. Application of these two source controls in elevated industrial areas were thought to result in relatively higher PCB load reductions. Street washing was found to result in low load reductions. The report recommends that future local studies take into account land use type and condition, which are considered important in characterizing loads and prioritizing controls, and that local agencies consider updating the workbooks as part of the planned studies.

To assess the effectiveness of each BMP, existing data were used to estimate baseline load reductions and reductions associated with BMP implementation. Regional projections were then estimated based on area, land use or population. Much variability in the local and regional data existed, because most of the data was obtained from municipal agencies as part of their annual stormwater permit reporting requirement in a particular county. Agencies reported the volume of material collected from the maintenance of their entire storm drain facilities. Specifics, such as distinguishing between components of a stormwater conveyance system (e.g., inlet versus storm drain pipe) and characterizing volumes of material removed by types of land use or neighborhoods, were not reported. Thus, for each BMP scenario, the authors identified various assumptions and reasons for uncertainties in the results.

The major sources of uncertainty comprised of: 1) load reductions projected over 20 years were based only on current data; 2) data from local studies was used in combination with regional study results to project Bay area-wide load reductions; 3) information was inadequate to take into account land use in every scenario, a factor shown to greatly influence pollutant loads; 4) most data did not address PCBs and mercury specifically, so the effectiveness results were presented as general estimates based on the authors’ understading of existing literature; and 5) load reductions were calculated for individual scenarios, and benefits from the application of a combination of BMPs was not taken into account. The authors presented this report as a ‘work in progress’ and designed the workbooks to be manipulated and refined by the user once more data was available from subsequent studies implemented in the Bay Area.

PCB Source and Abatement Study (Dunlavey 2011, Personal Communication)

In 2000, the Bay Area Stormwater Management Agencies Association (BASMAA) member agencies collaborated to measure concentrations of PCBs, mercury and other POCs in embedded sediments within stormwater conveyance systems. The primary goal of the Joint Stormwater Agency Project (JSAP) was to characterize the distribution of pollutants among land uses in watersheds draining to the San Francisco Bay (Bay). The JSAP report (KLI and EOA 2002) documented 83 sites in the Bay area with PCB contamination, two of which were located in the City of San Jose (San Jose). The two sediment samples had PCB concentrations of 26.75 mg/kg and .65 mg/kg.

Sediment samples from four locations[33] in San Jose were composited into the two JSAP samples. As a result, it was not possible to determine the source of the elevated PCB concentrations, so three of the

[32] Unit loading was calculated by dividing the annual loads from each land use by the area of that land use.
[33] Four sediment samples were combined into two composite samples that were then analyzed for PCBs: the Leo Ave. and Burke Street samples were combined into the first sample, and the West Home St. and Auzerais/Sunol samples were combined into the other.

four sites were resampled in 2001. The follow-up testing confirmed the Leo Avenue area as having elevated concentrations of PCBs, while no PCBs were detected at the other locations. The sampling and analysis of PCBs congener distribution pointed to either properties adjacent to Leo Avenue or the vicinity of the Southern Pacific railroad tracks at the end of Leo Avenue as the source of PCB contamination.

The follow-up Leo Avenue sample resulted in a much lower concentration of 1.18 mg/kg, as compared to the initial high PCB concentration of 26.75 mg/kg. The reason for the large discrepancy between samples that were taken four months apart was not clear. However, one factor that was considered was a storm drain cleanout event carried out on behalf of Premier Recycling that had occurred one month before the initial sampling that detected the highly elevated PCB concentrations. The cleanout occurred as a result of a San Jose issued Notice of Violation and subsequent Administrative Citation due to Premier's workers washing dirt from the property's paved areas directly into the storm drain. The Violation and Citation were unrelated to PCBs at Leo Ave since it had not yet been identified as an area with elevated PCBs concentrations. In response to the Citation, Premier Recycling had a contract service perform a flushing of the storm drain laterals on their property and a portion of the main line stormwater conveyance system under Leo Avenue from just upstream of where their lateral connects and downstream to the main line on S. 7th Street. Shortly after Premier Recycling had performed its line flushing, the San Jose Department of Transportation (DOT) flushed the main storm sewer line on Leo Ave. It was not known to what extent the line flushing may have removed sediments that had been trapped for a long period of time.

In 2004, San Jose staff once again sampled various inlets and manholes in the vicinity of Leo Avenue. This sampling effort showed significantly lower PCB levels (1-5 mg/kg) than had been found in the prior years. In the following year (2005), San Jose hired Clean Harbors, an environmental services company, to clean out the Leo Avenue storm drain inlets, publicly owned laterals, and the Leo Ave main line from the western cul-de-sac to S. 7th Street. Prior to the line cleaning by Clean Harbors, San Jose Department of Transportation (DOT) took video of the Leo Ave main line and discovered that a section of the western end of the line was substantially blocked with accumulated sediment. During their line cleaning, Clean Harbors removed a large amount of gravel and silt from the blocked section of the main line. Clean Harbors suspected that there may be a break in the Leo Ave main storm sewer line because of the high gravel content and larger grain size characteristics of the 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. The water and sediment that was removed from the line was collected into a single 5000 gallon tanker and disposed of at a hazardous waste facility. The collected material was estimated to be made up of 20% solids and 80% water (a relatively high percentage of solids according to Clean Harbors). The 2005 storm drain line cleanout removed 3,500 kg of solids and approximately 0.004 - 0.07 kg of PCBs based on the range of PCB concentrations previously measured in Leo Ave storm drain line sediments.

The cost for Clean Harbors to perform the one-day cleanout and dispose of the collected material at the hazardous waste facility was approximately $25,000. Although this amount includes Clean Harbors' field crew and transport and disposal of the material, it does not include San Jose staff time, analytical testing costs, and cost to video the storm drain line before and after the line cleaning. San Jose estimated that the amount could increase to $50,000 if these latter costs are considered. As of March 2011, the sediment in the stormwater conveyance system had not been reanalyzed to determine the effectiveness of the storm drain cleanout.

4.2. STUDIES CONDUCTED OUTSIDE THE BAY AREA

Stormwater conveyance system pollutant removal studies from outside the Bay Area are summarized below and organized alphabetically by author.

Pollutant Removal by Gully Pots in Different Catchment Areas (Grottker 1990)

Grottker (1900) studied approximately 200 gully pots in different catchments in Hannover, West Germany and analyzed their capacity to remove pollutants, subsequently using the results to build a simulation model[34]. The author examined two basic types of gully pots – dry and wet. The dry type had a slotted bucket and drained after each storm; however, its contents remained wet for a time, because the ventilation and temperature within the pot were low. The wet type was similar to what is also known as a catch basin, with a small settling pit where sediments could accumulate.

The following characteristics of each catchment draining to each gully pot were examined in the study: percent imperviousness, road surface type, gutter size, and the slope of the road surface. In addition, sediment dry weight, particle size distribution, organic matter content and ion exchange capacity were analyzed at the time the annual pollutant removal of each gully pot was determined. Correlation analysis found that there was not a significant relationship between any of the parameters analyzed and catchment characteristics. Furthermore, there were no significant correlations found between the parameters, with the exception of small particle sizes and the ion exchange capacity. The author noted that the correlation analysis results confirmed that the pollutant removal effectiveness of a gully pot was mainly dependent on the flow rate. In addition, the author found that the average annual dry weight of the collected material was about the same as that of a pollutant load of a single storm. Thus, the sediment removal effectiveness of the gully pots appeared to be minimal.

Seattle Street Sweeping Pilot Study (Herrera 2009)

This study applied a mass balance approach to determine the amount of materials and associated pollutants on streets and in catch basins (with a sump), and how that balance might be affected by street and catch basin cleaning. It is one of the few studies reviewed that attempts to evaluate a relationship of street sweeping with catch basin cleaning.

Herrera also evaluated the effects of street sweeping once every two weeks on accumulation of materials in catch basins with the intent of determining if street sweeping might affect the need for or frequency of catch basin cleaning. The evaluation was based on monitoring the accumulation of sediments in 12 catch basins located in each of the three test areas that were subject to a period of sweeping and a period of non-sweeping. The duration of the study was one year for two of the test sites, and eight months for the third test area.

Test results did not show that street sweeping every other week affected the rate of sediment accumulation in the test area catch basins, which indicates that sweeping may not reduce the frequency that catch basins would need to be cleaned. The tests indicated that during the testing periods, the actual accumulations in the catch basin during the swept periods either remained the same or actually increased somewhat, although not statistically. The authors point out that the accumulation rates in the catch basin were such that the catch basins were less that 10 percent full, and the short study period as

[34] This portion of the study is not considered relevant to this literature review and is therefore not presented in this summary.

well as monitoring by measuring down to the surface of the sediment was subject to some uncertainty.

The particle size distribution of the street dirt and catch basin samples was fairly similar between the swept and unswept test sites. While there were some differences for specific sites, there was no consistent pattern observed across all sites. The industrial area generally exhibited somewhat higher percentages of fine-grained particles (fine sand plus silt/clay) for catch basin sediment (24 to 51 percent) than in the two residential basins (10 to 51 percent in catch basin sediment). Truck traffic in the industrial area may have contributed to the larger amount of fine-grained material present on the streets.

Concentrations of pollutants (i.e., metals and PCBs) were higher in the samples collected from the industrial site compared to the two residential sites. Cadmium, lead, and zinc concentrations were generally higher in the industrial catch basins compared to the two residential study areas. Furthermore, in most cases, concentrations of cadmium, copper, lead, and zinc were higher in the catch basin samples than street dirt and street sweeping material. This was likely due to the greater proportion of fine-grained material found in the catch basin sediment since finer material. Overall, PCB concentrations collected from the industrial study area (0.034 to 0.91 mg/kg dry weight) were typically higher than the concentrations measured in the two residential study areas (<0.02 to 0.07 mg/kg dry weight). The variability in PAH concentrations observed at each test site made it difficult to distinguish trends between the different media or study areas.

One interesting result is that the amount of sediment removed from street sweeping was higher by as much as a factor of five to the amount of sediment accumulated in catch basins. For both sites (total of 12.7 ac) on an annualized basis, sweeping is estimated to have removed approximately 33,800 pounds (15,400 kg) of dry sediment, while annual cleaning of catch basins in the area is estimated to have removed about 6,200 pounds (2,800 kg) dry sediment.

Thus, street sweeping carried out on a bi-weekly schedule at these test sites is much more effective in terms of sediment removed than annual catch basin cleaning.

Estimated life cycle costs for a full-scale street sweeping program ($0.34 per wet kilogram of material removed and $0.62 per dry kilogram of material removed) are generally lower than the costs for the SPU city-wide catch basin cleaning program ($0.42 per wet kilogram and $0.74 per dry kilogram). Inspection, cleaning, material handling, and disposal costs were included in the estimate. Catch basin cleaning costs vary widely on a dry weight basis ($0.47 - $1.36 per dry kilogram of material) depending on the estimated moisture content.

Runoff of particle bound pollutants from urban impervious surfaces studied by analysis of sediments from stormwater traps (Jartun et al. 2008)

Thirty-one harbors and fjords in Norway have high concentrations of polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and heavy metals, leading to dietary consumption advisories of certain fish and crustaceans. Jartun et al. evaluated sediment in 68 stormwater traps[35] around a harbor area in the urban city Bergen, Norway to identify sources of pollutants and their pathways via the stormwater conveyance system to the surrounding water body. The study was carried out in October

[35] Structure is similar to a gully pot or catch basin with a sump. Each stormwater trap had a diameter of 1 m and a depth of about 3 m with an effective sediment trap of >60 cm located at the bottom of each stormwater sediment trap, giving each unit a capacity to capture 450–500 L of sediment.

and November 2004, two of the rainiest months of the year. Sediment samples were analyzed for PCBs, PAHs, total organic carbon (TOC), heavy metals, and grain size.

The study detected PCBs in 63 out of 68 samples with a detection limit of 0.0004 mg/kg (based on seven congeners). The median PCBs concentration was 0.080 mg/kg, with a range of <0.0004 - 0.704 mg/kg. Concentrations of PAHs had a median of 3.4 mg/kg, with a range of <0.2 - 80 mg/kg. The detection limit was 0.2 mg/kg. Concentrations of mercury were relatively low, with a median of 0.06 mg/kg and a range of <0.01 - 2.81 mg/kg (detection limit 0.01 mg/kg). The authors explained that the maximum mercury concentration was due to an excavation site located close to the stormwater trap where the sample was collected.

The sediments collected from the stormwater traps were mostly inorganic, with a median TOC content of 4.3%, ranging from 0.4–39%. Authors found that the high content of 39% TOC was due to runoff from a waste pile at a renovated building. A Principal Component Analysis of the investigated components indicated a correlation between TOC, PCBs, PAHs and mercury. The authors explained the correlation by a strong sorption between PCBs and PAHs to soil organic matter (Krauss et al. 2000) and the relationship between organic matter and mercury as described by Sanei and Goodarzi (2006).

The grain size distributions of 21 sediment samples ranged from mostly clay and silt to mostly coarse sand. The median grain size ranged from 23–646 µm, with diameters 250–300 µm being the most frequent. However, several samples had very fine-grained particles even up to the 90 percentile of the samples, making them available for stormwater dispersion in suspended form.

Baltimore Street Sweeping Study (Law et al. 2008)

Law et. al. (2008) conducted an effectiveness study in Baltimore, Maryland that addressed pollutant removal rates for street sweeping and storm drain cleanout programs in the Chesapeake Bay Basin. Two sampling sites, Catchment F (Lanvale Street) and Catchment O (Baltimore Street), were monitored for water quality runoff. Both catchments were approximately 30 ac in size and were about 70% impervious. Land use was primarily high density residential in the form of row houses. During the treatment period (Jan. 2006 – July 2007), sweeping was increased to twice a week on all streets in Catchment O and reduced to once per week on all streets in Catchment F.

The monitoring study characterized the material removed from storm drain inlets[36] in both residential and commercial/industrial land uses in two different physiographic regions. Four inlets in each of the four groups[37] were sampled to determine the rate of accumulation of material in the time period between a spring and fall (2006) cleanout. Inlet samples were analyzed for particle size distribution, total solids, nutrients and metals. Although samples were analyzed for metals, it was noted that an insufficient number of samples were collected to sufficiently characterize the patterns in water quality pre- and post-treatment.

Different land uses resulted in significantly different monthly accumulation rates, with inlets in commercial/industrial land uses having higher accumulation rates of material. Daily accumulation rates were found to be statistically significant for both land use types, with residential land use ranging from

[36] The storm drain inlets were designed without a sump and are considered a flow-through or 'self-cleaning' component of the stormwater conveyance system.
[37] Sixteen storm drain inlets were grouped into four categories that represented the various combinations of land use types and physiographic regions in the study.

0.001 to 0.005 ft^3/day and commercial/industrial land use from 0.011 to 0.013 ft^3/day. Material removed from the inlets consisted of, on average, 52% leaves and other organic matter, 39% sediment and 9% trash.

The particle size distribution for the inlet material, especially the coarser fractions, was found to be similar to the distribution for the street particulate matter (SPaM), which was likely due to the 'self-cleaning' inlets. For all inlets, an average of 86% of total sediment was between 0.25 mm and 4.0 mm. About 60% of commercial/industrial inlet samples were found to be between the 0.25-2.0 mm fractions.

A total of eight bedload samples were collected. The average mass of bedload collected was 225g (standard deviation of 114g) per sample, which typically represented material accumulated over a 1-2 week period. The monitoring set-up did not function as expected, and consequently, the amount of bedload material collected was considered an underestimation.

Information generated from the project's literature review, municipal practices survey, and monitoring data, though limited, was used to estimate pollutant removal efficiencies for inlet cleaning using the conceptual model created for this study. The estimated range in pollutant removal efficiencies for total solids was 18% and 35% for annually and semi-annually, respectively.

Catch basins and Inserts for the Control of Gross Solids and Conventional Stormwater Pollutants (Pitt and Field 2004)

Pitt and Field (2004) review and summarize past studies of catch basin inlet devices, including two specific EPA-funded case studies. Although three types of stormwater conveyance system inlet structures are described, the authors focus on a type of inlet structure with a sump that typically extends 0.5 to 1.0m below the bottom of the outlet. The authors conclude that catch basins (with sumps) remove up to 30% of the suspended solids load that enters the structure. However, much of this material is relatively coarse (larger particle sizes) and therefore may lack mobility and have relatively low pollutant concentrations. The authors also recommend features to optimize catch basin performance and identify an ideal catch basin design, with a large enough sump to trap a significant amount of material and a hooded outlet to withstand higher flows with little scouring.

The first EPA-funded case study was conducted in Bellevue, WA as part of the Nationwide Urban Runoff Program (Pitt 1985). The purpose of this study was to characterize Pacific Northwest stormwater quality and to evaluate the effectiveness of street and catch basin cleaning. The Bellevue area has a distinctive rainfall pattern typically involving many small rainfall events that generate relatively low runoff (25-35% of rainfall). For a period of three years (1980-1983), the study monitored sediment accumulations at more than 200 locations in the stormwater conveyance system including catch basins, simple inlets[38] and manholes in two mixed, medium density residential and commercial areas in Bellevue. Four separate types of conditions were examined in each of the two study areas: no controls, street cleaning alone, catch basin cleaning alone, and both street and catch basin cleaning together. The runoff stormwater quality of both areas was measured, and comparisons were made between the two areas while evaluating the effectiveness of the sediment management practices. Catch basin and other storm

[38] Pitt and Field (2004) describe a simple inlet as having a grating at the curb and a box, with the discharge outlet located at the bottom of the box, which connects directly to the main stormwater conveyance system or combined sewer system.

drain sediments had a much smaller median particle size than street sediments, suggesting that storm drain sediments potentially have higher pollutant concentrations than sediments captured by street sweepers.

When comparing the two areas under the four types of “treatment” conditions, Pitt expected to find the same results (i.e., reduction of outfall total solids concentrations) between the two areas. While most comparisons were consistent with that assumption, such as when comparing the effects of both street and catch basin cleaning in both areas, Pitt found some comparisons yielded different results than expected. For example, in one study area, when effects of both street and catch basin cleaning were compared to a control site, the outfall total solids concentrations were significantly higher than when no cleaning was conducted. Several explanations have been proposed since the study was conducted. One potential explanation given is that older street equipment was not as efficient as newer equipment in removing the particles that are washed off and potentially remove the larger particles that armour the finer particles, potentially increasing the solids discharges.

Sediment accumulation in the inlet structures was measured during this study using two approaches. For one approach, the structures were cleaned in the beginning of the project and subsequently surveyed nine times over two years (1979-1981) to determine the depth of accumulating material. Sediment loading was found to be constant over the first two years. During the second year the stormwater conveyance system contained about twice as much contaminated sediment at any one time as there was on the street. The stormwater system did not appear to flush out a large amount of sediment during the two years, likely due to the mild rainfall. The study found that, in inlet structures, depth below the outlet appeared to be the most significant factor affecting the maximum sump volume available. Catch basins accumulated sediments until reaching approximately 60% of the total sump capacity, when the sediment reached equilibrium (i.e., scour balancing new deposition). In one study area, nine of the most sediment-filled catch basins were located near streets that did not have curbs and had extensive nearby sediment sources (hillsides).

Storm drain pipes were also studied for sediment accumulation. It was assumed that the critical slope for sediment accumulation was less than one percent. A one-time survey found that pipes that had significant amounts of sediment were either sloped less than 1.5% or located close to a source of sediment. In one study area, most of the sediment found was in pipes that were located in an area that was not swept and was close to major sediment sources. Sediment from inlet structures and street dirt were tested and found to have similar pollutant concentrations.

The second EPA-funded case study (Pitt et al. 1994 and 1999) was more recent and carried out in a residential area of Stafford Township, NJ to evaluate the stormwater pollutant removal effectiveness of a catch basin (with a sump) and two proprietary filtering devices that were retrofitted into storm drain inlets. Paired samples that represented composite inflow and outflow stormwater were collected at each of the three devices and chemically analyzed. The catch basin was the only device that showed statistically significant reductions of several important pollutants including total solids (median removal rate of about 20%) and suspended solids (median removal rate of about 30%). The study also found that the filter devices increased suspended and volatile solids, likely due to the washing through of decomposing organic material trapped by the filter screens.

5. STREET AND STORM DRAIN LINE FLUSHING

The following section summarizes studies that addressed the effectiveness of street flushing or street washing to remove sediment and other solids from street surfaces and prevent them from entering the stormwater conveyance system. Street flushing is also used in some cities, such as Paris (Gromaire et al. 2000) to keep sidewalks and streets clean in densely populated areas and improve air quality by reducing the amount of particulates resuspended into the air from street surfaces (Amato et al. 2010).

The summaries below illustrate what is currently known about the effectiveness of this sediment management practice. Results are summarized in the following text and grouped into Bay Area studies or studies conducted outside of the Bay Area. Appendix C includes key attributes and findings of each summarized study for the reader to easily compare and contrast findings[39].

5.1. BAY AREA STUDIES

Ettie Street Pump Station Watershed Studies (Kleinfelder 2006, Kleinfelder 2007, and Salop 2007)

Kleinfelder (2006) summarized a project carried out between June 2004 and June 2006 in the Ettie Street Pump Station watershed in Oakland, California to further investigate, identify, and abate sources of PCB-containing sediment in the watershed. The identification of PCB sources included the following steps:

1. Reviewing environmental records and inspection of suspect properties that were potential PCB sources;
2. Collection and analysis of sediment samples from the public right-of-way (ROW) locations in front of or nearby suspect properties; and,
3. Collection and analysis of sediment samples from private properties identified as potential sources of PCBs during the public ROW sampling.

Several data sources, including online databases and city files, were used to identify businesses and properties that were potentially contributing PCB-containing sediment to the stormwater conveyance system. Based on these results, the City of Oakland inspected 121 sites and facilities and subsequently prioritized them according to their potential to contribute PCB-containing sediments to the watershed.

Based on the results of this process, 37 high priority sites and 16 medium/low priority sites were chosen for sampling in public ROWs in front or nearby the selected sites. PCB concentrations in the 37 high priority sites ranged from 0.023 to 31 mg/kg. Twenty-two of the 37 sites had PCB concentrations exceeding a residential soil environmental screening level (ESL) for PCBs of 0.22 mg/kg. PCB concentrations at the 16 lower priority sites ranged from 0.0093 to 0.99 mg/kg. Nine samples exceeded the ESL.

To further identify the potential PCB sources, 23 locations at 19 private properties were chosen for composite sediment sampling based on the public ROW analysis and site visits. PCB concentrations from private property samples ranged from 0.04 to 93 mg/kg. Private properties with PCB concentrations exceeding 1 mg/kg were reported to the California Department of Toxic Substances Control for potential abatement actions. The SFRWQCB and other local agencies took responsibility for

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[39] Note that only main points of the summaries are included in the table, and it is recommended to read entire summaries for complete information.

providing oversight to properties with PCB concentrations less than 1 mg/kg but above the residential soil ESL of 0.22 mg/kg.

Results from analysis of the ROW areas were used to identify 11 high priority areas for potential abatement. These areas were prioritized based on PCB concentration, feasibility of the selected abatement methodologies, proximity to the Ettie Street Pump Station and distance to residences. The two highest priority areas (Area 1 and 2), both identified as illegal dumping sites, were chosen for abatement. Before abatement began, City of Oakland staff removed all dumped debris from both locations.

During the abatement (May 15 - 24, 2006) excess dry sediment was removed from both locations using either a Bobcat excavator or a brush and shovel. Paved surfaces at both sites considered to be in good condition were then cleaned with a high-pressure washer. Sediment and wash water were collected and vacuumed into a self-contained vacuum truck. Sediment and wash water were analyzed for disposal purposes. Lead concentrations were considered hazardous according to CA regulations, and the sediment was disposed of at a hazardous waste landfill.

The abatement removed approximately 1.1 cubic yards (cy) of material, including 0.6 cy of dry sediment and 0.5 cy of wet sediment from Area 1. For Area 2, about 16.6 cy was removed, consisting of 16 cy of dry sediment and 0.6 cy of wet sediment. This equated to approximately 1.2 tons[40] of sediment removed from Area 1 and 18.7 tons of sediment removed from Area 2.

The total PCB concentrations in the dry sediment collected from Areas 1 and 2 were 2.7 mg/Kg and 0.3 mg/Kg, respectively. The total mass of PCBs removed from both areas was estimated at 0.0085 kg, with 0.0028 kg removed from Area 1 and 0.0057 kg removed from Area 2.

The cost of abating and disposing of approximately 20 tons of sediment containing about 0.0085 kg of PCBs from 921 linear feet of street (Areas 1 and 2) was approximately $100,000, or 0.9 grams per $10,000. This amount included disposal of the sediment at a Class I Hazardous Waste landfill as a result of elevated concentrations of lead. Based on this figure, the cost estimated to abate the remaining nine identified ROW areas, an additional 7,990 linear feet, with an estimated amount of 0.047 kg of PCBs was $839,000.

Kleinfelder (2006) also reported on the amount of sediment removed by the Alameda County Public Works Agency at the pump station between 2001 and 2006, during which a total of 104 cy was collected. The agency estimated a cost of $27,500 to remove 61 cy (or 70 tons) of sediment. However, this cost only included labor, as the County disposed of the sediment at its own facility. Sampling of the pump station sediment in 2006 showed a PCB concentration of 0.32 mg/kg. The estimated mass of PCBs removed in 2006 was 0.019 kg.

Based on the study results and a qualitative effectiveness analysis, Kleinfelder recommended the following management measures in order of importance: 1) source control, 2) ROW cleaning and sediment management, and 3) storm drain cleanout. Also, the study recommended follow-up sampling of sediments in the abated ROW areas.

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[40] The amount in tons was calculated using a value of 2250 lbs/cy for density of dry sediment based on the CA Integrated Waste Management Board value for dry density.

Kleinfelder (2007) collected five composite samples from the ROWs of Areas 1 and 2 to evaluate abatement effectiveness a year later (May 22-23, 2007). In both areas, samples were collected at the same locations where samples had been collected pre-abatement. In Area 1, PCBs concentrations dropped 42% in front of a private facility (AMG) from a pre-abatement concentration of 7.3 to 4.3 mg/kg and 75% at a storm drain located on a street corner from a pre-abatement concentration of 31 to 7.7 mg/kg. In Area 2, PCB concentrations decreased from pre- to post-abatement levels at the three sample locations by the following percentages: 1) 94% at a vacant lot, from 11 to 0.65 mg/kg; 2) 83% at a private facility (Giampolini), from 2.4 to 0.39 mg/kg; and 3) 27% at another private facility (Precision Casting), from 0.45 to 0.33 mg/kg. The results suggested that PCBs were abated more effectively in areas where PCBs concentrations were initially higher. In one case abatement of PCBs at an adjacent private property (Giampolini) may have contributed to the reduction in levels of PCBs found post-abatement.

Salop (2007) carried out follow-up sampling of non-abated areas in the watershed on May 24, 2007 to supplement Kleinfelder's abatement area sampling. Sampling sites were generally chosen from the list of 11 high priority sites identified in the Ettie Street project by Kleinfelder (2006). Sampling and analytical methods followed those used in the first phase of the project (Kleinfelder 2006). In contrast to the lowered PCB concentrations found in the abated areas, the concentrations in samples collected from the non-abated areas were generally similar to previous results at each sampling site, though Salop noted some uncertainty due to the heterogeneous sample material and inherent laboratory variability observed in prior investigations.

5.2. STUDIES CONDUCTED OUTSIDE THE BAY AREA

A Review on the Effectiveness of Street Sweeping, Washing and Dust Suppressants as Urban PM Control Methods (Amato et al. 2010)

Amato et al. (2010) reviewed available scientific and municipal studies and consulted experts to summarize past research on the effects of street cleaning and washing in the abatement of PM[41] emissions. Mineral dust (atmospheric aerosols originated from the suspension of minerals constituting the soil) has been shown to be a main component of PM_{10} and $PM_{2.5}$ and has shown a clear origin from road dust resuspension, especially in highly urban areas (Keuken et al. 2010 and Putaud et al. 2004). Lenschow et al. (2001) estimated that up to a 15% reduction in road dust emissions from paved roads could be achieved with effective control measures such as street sweeping and washing at urban background[42] locations and at the street level.

The sediment removal efficiency of water flushing using high-pressure jet equipment (without sweeping) was highly variable (20-65%), and the authors found limited benefit from street cleaning when measuring street cleaning waters (Bris et al., 1999; Gromaire et al., 2000). Small (6%) to no reductions in PM_{10} levels have been found with water flushing, with or without street sweeping (Düring et al., 2005/2007, John et al. 2006 and Norman and Johansson 2006). However, PM_{10} reductions in

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[41] Atmospheric particulate matter (PM) is a complex mixture of components arising from a number of emission sources (anthropogenic and natural) and atmospheric processes (secondary PM). Two common categorizations of PM are PM_{10} (particles with mean aerodynamic diameter <10 µm) and $PM_{2.5}$ (particles with mean aerodynamic diameter <2.5 µm), which is considered the fine fraction (Amato 2010).

[42] Urban locations distanced from sources and broadly representative of city-wide background concentrations, e.g., elevated locations, parks and urban residential areas (UK Department for Environment, Food and Rural Affairs website 2011).

morning hours suggested that they could have been due to the wetting of the road surface just hours before, which reduced dust re-suspension, rather than actually removing PM_{10} particles.

In a few studies, the combined use of street sweepers and washing reduced road dust and ambient PM emissions (Chang et al., 2005; Chou et al., 2007). Street sweepers, followed by washing with a pressurized jet, decreased the PM daily mean concentrations by 7-10% (Amato 2009) and total suspended particles[43] concentrations up to 30% (Chang 2005). Reductions in PM_{10} concentrations have been significant in the immediate vicinity of a road (Dobroff 1999) though not in wide areas (ARPA 2003). Keuken et al. (2010) confirmed that local rainfall patterns affect the re-suspension of street dust rather than runoff removing the particles from the street surface. PMx levels decreased with rainfall intensities larger than 2mm/h, which may have resulted in longer periods of a wet road surface.

The results of the summarized studies indicate that, in general, a combination of street sweeping and subsequent washing is a reliable control measure to mitigate PM emission from road dust re-suspension. Langston et al. (2008) showed that short-term effects confound the ability to generalize on emissions reductions over urban areas where the number of streets treated may be low. Amato et al. (2010) noted the need to carry out street cleaning investigations in wider areas (order of magnitude in km^2) in order to increase the absolute emission benefit.

The Quality of Street Cleaning Waters: Comparison with Dry and Wet Weather Flows in a Parisian Combined Sewer System (Gromaire et al. 2000)

Gromaire et al. (2000) evaluated two municipal street washing procedures on three different streets in the Le Marais catchment area of central Paris, which is an old, densely-populated residential and commercial district served by a combined sewer system. The pollutant load to the combined system from street washing procedures was compared to both the surface runoff load and the catchment's dry weather pollutant load. Streets were also washed under a controlled setting to determine the maximum street surface pollutant load, and the results were compared to the load removed using regular street washing procedures.

At the time of the study, municipal street washing procedures were being carried out daily, either manually or using high-pressure water jet equipment. During the early morning hours, valves were opened along the street in order to wash the gutter, while workers manually swept litter into the sewers. Sidewalks and gutters were also washed two to five times a week with pressurized water jet equipment. In addition, for most streets, the gutter and a 1 m-wide strip of pavement next to the gutter were vacuumed five days a week using a small sidewalk sweeper. The vacuuming procedure was not evaluated in this study.

The study sampled street washing water on six different days during dry weather periods. Dry weather flows were monitored at the outlet of the catchment area for two sampling periods of 5 to 7 days each. For wet weather runoff, about 20 rainfall events were studied at each sampling site. Samples were analyzed for suspended solids, organic matter and metals.

To assess the maximum street surface pollutant load that could be made available to runoff, samples were taken from three streets that were cleaned using both a brush and pressurized water jet equipment after a 4 to 5 day dry weather period. The equipment used for this test was the same

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[43] Particles ranging in size from 0.1 µm to about 30 µm in diameter (U.S. Environmental Protection Agency website 2011).

(including the same jet pressure and flow rate) used by the municipality in its typical maintenance practices. However, the streets were cleaned for an average of four minutes for one meter of street whereas regular municipal cleaning took approximately two seconds for the same length of street. Even using this prolonged street washing procedure, the authors found that a small percentage of pollutants still remained.

Gromaire et al. compared the estimated pollutant load from regular street washing of the entire catchment to the total dry weather pollutant load measured at the catchment outlet. Street washing water represented less than 15% of the total dry weather load, although it appeared to be a major source of lead. When comparing dry weather flows at the outlet in a period with street washing to one with no street washing, the study found an estimated decrease of 15% in suspended solids, organic matter and copper when street washing was not conducted. The results were attributed to the street surface loads and potential erosion within the sewer system.

In addition, the daily pollutant load removed from street surfaces by regular street washing was compared to the pollutant load removed during a rainfall event and to the maximum load that can be removed from the street surface by a very intensive cleaning with the pressurized water jet equipment. The amount of suspended solids (g/m^2 of street surface) removed daily by street washing was in the same range as the amount of suspended load eroded during a rainfall event. The comparison with the total load that can be removed by intensive washing with a pressurized jet indicated that regular street washing only removed a very small part of the existing street pollutant load.

Finally, the characteristics of particles found in street cleaning waters were compared to the characteristics of particles in runoff. Street washing appeared to remove large biodegradable solids that were not easily removed by rainfall events. In general, heavy metal concentrations in runoff were similar to that of overall available street deposits, but were significantly higher than that of particles removed by street washing. These results indicated that regular street washing procedures did not remove as much of the fine particles associated with heavy metals as that removed by rainfall events.

6. SUMMARY OF FINDINGS

6.1. STREET SWEEPER EFFECTIVENESS

The effectiveness of street sweepers can be measured in a number of ways including: 1) the extent to which street cleaning removes solids and associated pollutants on the roadway, and 2) the extent to which runoff quality is improved. The following sections summarize the findings of the literature review with regard to the effectiveness of street sweeping. The sections are organized by effectiveness assessment method.

Street surface sediment[44] removal was defined herein as the reduction in the amount of sediment on a street removed by a street sweeper. In some literature this was evaluated based on each pass of the sweeper (i.e., street sediment prior to and following passage of the sweeper) and in some sources it was evaluated on a cumulative basis by comparing the dust and dirt on a test road segment versus a controlled (unswept) segment. The latter method has the advantage of incorporating the frequency of sweeping. The key findings are provided below in bulleted format with the supporting documentation following the finding.

- **Street Sweeper Effectiveness Depends on Street Surface Sediment Loading** - Figure 3 compares pre- and post-sweeping solids data (in the form of lbs of solids per curb mile) from the various literature sources reviewed. The data are organized by sweeper type and literature source. The solid line is the no removal line and points below the line indicate removal equal to the difference between the no removal line and the data point. The following findings are illustrated in Figure 3. All sweeper types are effective in removing street sediments, and the effectiveness tends to increase with loading. Moreover, even under the best of circumstances a residual loading of about 100-200 lbs/curb mile remains on the street, so no sweeper can remove all the sediments from a street.

  For relatively clean streets (e.g., <200 lbs/curb mile), all sweeper types are relatively ineffective. For intermediate (most common) street loadings (approximately 200-1000 lbs/curb mile), the most effective sweepers can reduce the loadings to between 100-200 lbs/curb mile. For very dirty streets (that are often dirty because of poor condition), the removals are highest but the residuals are also the highest.

  The scatter in the data shown in Figure 3 reflects the influence of a variety of factors that can affect street sweeper performance in any given test. Such factors include climate, road condition, sweeper frequency, sweeper condition and operation. Poor road conditions have been shown by some sources to be dirtier and more difficult to clean because of texture, cracks and non-smooth conditions. In the City of San Diego (Weston 2010), it was determined that vacuum sweepers should be preferentially deployed where roads were in a good condition to take full advantage of the vacuum sweeper performance (Weston 2010). In the hillier areas, the city determined that mechanical broom sweepers were adequate. Also, some references indicated that mechanical broom sweepers were better able to

[44] There are various terms used in the literature for the material on streets that passes through a standard mesh commonly 2mm in size. Terms such as dust and dirt, street sediment, and street loading are some examples of the terms used to characterize the solid particles on street surfaces. In this report these various terms are used interchangeably.

remove large, heavier objects (e.g., cans) whereas the vacuum sweeper and regenerative air sweepers were not as effective in removing such materials (Blosser 2000).

- **Sweeping Effectiveness Can Increase with Frequency, But There is Point of Diminishing Returns** - The frequency of sweeping is discussed extensively in the literature, although there does not appear to be agreement on the issue. Most sources conducted sweeping tests with a bi-weekly or a weekly schedule, although one study examined a frequency of three times per week (Pitt 1985) and for another, a frequency of five times per week (Pitt and Shawley 1981). The ideal goal is to sweep prior to a forecasted storm as closely as possible, but this is difficult given logistical and resource constraints. Some references suggest that the frequency be set so as to conduct, on average, one or two sweepings between storms. In semi-arid climates such as the Bay Area, some references recommended more intensive sweeping prior to the onset of the wet season.

- **Sweeper Type Comparisons are Best Conducted within a Given Test Where the Researchers Ensured that Conditions for Each Sweeper Were Similar** - Given the variability in the data, it is difficult to see a clear trend showing the relative performance of sweeper types. The best comparisons are those sources where multiple types of sweepers were tested under reasonably identical conditions. For example, the testing conducted by a number of researchers did indicate improved performance with the vacuum assisted and regenerative air sweepers compared to mechanical sweepers (Selbig and Bannerman 2007; Rochert et al. 2007).

- **Advanced Street Sweepers Can Be More Effectiveness in Removing Fine Particulates** - Many of the literature sources examined the effectiveness of street sweeping in removing the finer fraction of solids consisting of silts and clay and finer organic debris (typically less than 63 um). The reasons for this are twofold. One, studies of particles washed off of street during typical storm events (e.g., 0.5-1.0 inches) indicates that most particles are in the finer fraction (Pitt et al. 2004b). Secondly, some constituents such as trace metals tend to be higher in concentration in the finer particles, so the mass of such constituents may be disproportionately higher in the finer fraction.[45] The regenerative air and vacuum sweepers were designed specifically to better address the fine fraction of dust and dirt, and a number of the literature sources supported this finding (Selbig and Bannerman 2007; Rochert et al. 2007). In a local study conducted at various sites in Alameda County (Salop 2006, 2007), data also indicated that regenerative air sweepers tended to collect about 11% of the fines compared to about 6.5% for mechanical sweepers, however these data are from different locations. In order to accomplish this higher efficiency, one source indicated that the speed of the sweeper had to be maintained at about 4 miles per hour (Blosser 2000). Table 5 summarizes information on particle size effectiveness for the three major categories of sweepers. Because of the effects of confounding factors that can affect each study differently and also differences in study design and testing, the effectiveness estimates vary from source to source. With respect to the overall effectiveness of collecting sediment, the table indicates a general trend for somewhat improved effectiveness with the more advanced sweeper types, and within any given study, effectiveness is consistently higher with the more advanced equipment. A number of sources indicated however, that overall

[45] The mass of the fraction of solids <63 µm generally makes up less than 20% of the mass of solids <2mm, so the mass of constituent associated with the finer fraction is often less than 50% of the total. Thus, although the concentration of certain constituents may increase in the fine fraction, the mass of the constituent is associated with both the fine and coarse fraction.

effectiveness is strongly influenced by how dirty the street is, and this factor may be more important than sweeper type for very dirty streets. Similarly effectiveness as a percent is limited when sweeping cleaner streets, independent of sweeper type. There is much less effectiveness information specific to fine particles in the literature, but in general there is some indication that mechanical brooms are less effective than the more advanced sweepers. An interesting case that illustrates the difficulty of reaching broad consensus is the study of Selbig and Bannerman (2007) that indicated an actual increase in fine particles for mechanical broom and regenerative air sweepers, and the authors thought that perhaps the gutter brooms in these sweepers could actually be grinding up larger particles into smaller ones. This study was conducted in Wisconsin and the effects of winter application of abrasives may also have played a part in this finding.

Figure 3. Comparison of pre- and post-sweeping solids data (in the form of lbs of solids per curb mile) from the various street sweeping studies reviewed.

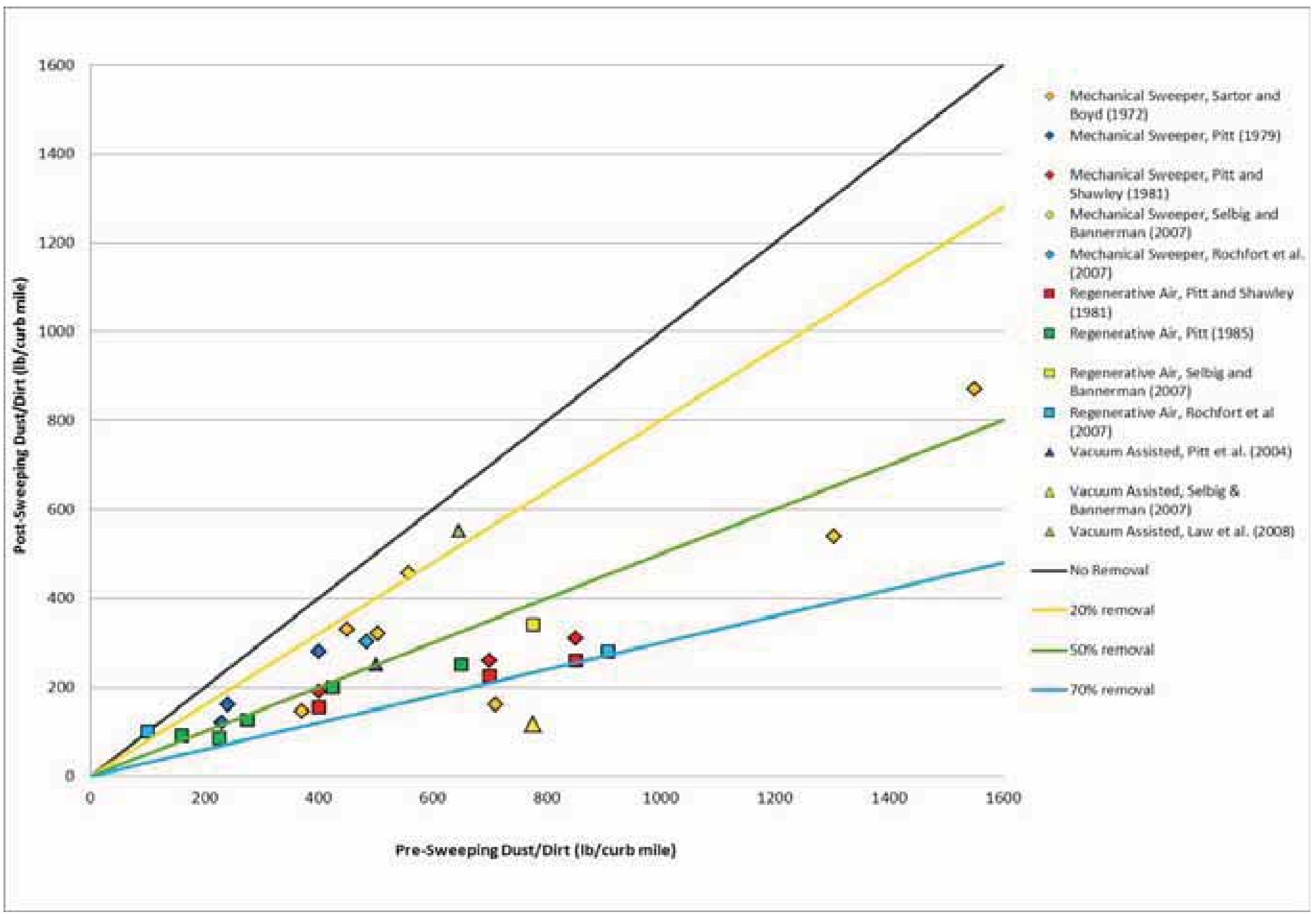

Table 5. Effectiveness of different types of street sweeping equipment to collect coarse and fine particles.

Literature Source	Effectiveness In Removing Fine And Coarse Particles (<2000 µm)			Effectiveness In Removing Fine Particulates (<63 µm)			Comments
	Mechanical Broom	**Regenerative Air**	**Vacuum Assisted**	**Mechanical**	**Regenerative Air**	**Vacuum Assisted**	
Sartor and Boyd 1972	36-78%						
Pitt 1979	34-43%			15-30%			Broom sweepers are only about 20% effective at removing smaller particles (<45 um).
Pitt and Shawley 1981	53-64%	61-69%		36-61%	55-74%		Regenerative air slightly (5-10%) more efficient than broom sweeping especially if streets are initially cleaner.
Pitt 1985		53-62%					Regenerative air sweepers were more effective at removing fine particulates than mechanical sweepers
Pitt 2004a			50%				Vacuum assisted sweeper effective in removing fine particles when streets are dirty (~500lbs/curb mile) but not when streets are clean (~100 lbs/curb mile)
Breault et al. 2005	20-31%		60-92%	13%		39-81%	Controlled sweeper effectiveness tests, which included seeding streets with prescribed amount of graded dirt, indicated vacuum sweeper efficiencies consistently greater (by 1.6 -10 times) than mechanical sweeper for all particle size ranges.
Bannerman 2007		76%	63%	-30%	-50%	10%	Street sweepers significantly reduced the dust and dirt loading on streets, with larger reductions achieved with vacuum assisted or regenerative air sweepers. Mechanical broom sweepers more effective when street dirt yield approaches 1000 lbs/curb mile.

Literature Source	Effectiveness In Removing Fine And Coarse Particles (<2000µm)			Effectiveness In Removing Fine Particulates (<63 µm)			Comments
	Mechanical Broom	Regenerative Air	Vacuum Assisted	Mechanical	Regenerative Air	Vacuum Assisted	
Rochfort et al. 2007	37%		70%		75%		New regenerative air sweeper tested on both north and southbound lanes was effective in reducing dust and dirt loading only in southbound lane because of higher surface loading. Regenerative air sweeper also able to reduce loadings of fines from 40 lbs/curb mile to 10 lbs/curb mile or 75%.
Law et al. 2008			14%				Vacuum sweeper tested on 2 sites in Baltimore, Maryland.
Herrera 2009		48-90%					Study investigated effectiveness of street sweeping in Seattle, WA.

6.2. EFFECTIVENESS OF STREET SWEEPING IN IMPROVING RUNOFF WATER QUALITY

A number of sources attempted to measure the effectiveness of street sweeping in terms of improving the quality in the runoff water. Most of these efforts were unable to measure a statistically reliable improvement. One study that indicated a statistically valid improvement in water quality was conducted in Milwaukee using a Schwarze Industries Enviro Whirl I (Pitt et al. 2004a). The study documented a 40% reduction (at 80% confidence) in TSS concentrations measured at an outfall that drained the test catchment.

Kang et al. (2009) recently published a paper examining why most studies could not document an effect of street sweeping on water quality and concluded that most monitoring studies do not have sufficient statistical power to distinguish the effect of sweeping given the variability in runoff water quality. Conducting a statistical analysis of 15 data sets they found that only four of the studies had sufficient statistical power to determine an effect, and of the four, only a study conducted in Austin, Texas was able to show a statistically reliable difference (at the 95% confidence level) between the solids in runoff from a swept and unswept catchment. The study (Irish et al. 1998) found a reduction in runoff TSS loading based on 402 grab samples collected from 23 natural storm events and 35 rainfall simulation events conducted on a freeway segment in Austin, Texas.

6.3. EFFECTIVENESS OF STORMWATER CONVEYANCE SYSTEM CLEANING

This section identifies major findings based on the studies summarized in Section 4 - Stormwater Conveyance System Cleaning. Nearly all studies reviewed are focused on the removal of sediment and associated pollutants via inlet or catch basin cleaning. The majority of those focus on the effectiveness of catch basins (with sumps) versus drop inlets (without sumps). Although limited, major findings of studies about storm drain line and pump station cleaning are also presented.

6.3.1. Inlet/Catch Basin Cleaning

Most of the studies reviewed address inlet and catch basin cleanouts, sediment characterization, and/or monitoring of sediment accumulation. Of those, most do not define effectiveness or carry out comprehensive effectiveness evaluations. Furthermore, most studies measure inlet sediment and analyze the removed sediment for various pollutants, with a few also measuring particle sizes.

Several factors affect the pollutant removal effectiveness of an inlet or catch basin, including configuration/design, particle size distribution, maintenance and cleanout frequency, rainfall patterns, and inflow velocity. The following sections describe information identified through the literature review regarding these factors.

Configuration

Different configurations and designs of inlet structures affect the amount of material retained within the structure during runoff events. Factors that increase the volume of a catch basin's sump (e.g., greater distance from the outlet pipe to the base of the sump and greater area of the base of the sump) increase solids retention (Memon and Butler 2000). Salop (2006) noted that the amount of materials that accumulated in an inlet appeared to be related to its type of construction, and an older type of inlet found in a Bay Area industrial area in Berkeley with a sump had greater storage capacity than newer inlets designed to flush out during storms.

Particle Size

Coarse material tends to settle more rapidly relative to finer particulates (< 63 µm), while finer material tends to settle in lower velocities due to the longer settling time (Yee and McKee 2010). Thus, coarse material is more likely to be found in inlets during cleanouts, especially in areas with less intensive storms. Studies have confirmed this particle size behavior. Butler et al. (2003) conducted laboratory studies using an experimental catch basin and found that 80-90% of sediment accumulation in the catch basin consisted of particles with sizes ranging from 300-600 µm. Neely et al. (2008) found that sediment samples from inlets had between 22 and 41% materials within the 250-2,000 µm range. The coarser particles may be due to the 'flow-through' design of the inlets evaluated in this study that provide only a short settling time for particles as compared to the experimental catch basin with a sump that Butler et al. (2003) constructed. Although the particle size distribution found in accumulated sediment varies partly due to the type of sediment supply in a watershed and geographic region, rainfall patterns and street dust particle distributions, limited data show that in general, coarse particles tend to dominate the particle size distributions of sediments that accumulate in storm drain inlets, especially in regions such as the Bay Area, where few catch basins with sumps are currently believed to exist.

Maintenance and Cleanout Frequency

The amount of sediment in a catch basin's sump limits the amount of sediment retained during subsequent storms. A catch basin that is not adequately maintained will not function properly and may increase the sediment load to a stormwater conveyance system and consequently to receiving waters. Catch basins have been shown to retain sediment until 60% of the total sump capacity is reached, at which point Pitt and Field (2004) determined that the sediment within the sump had reached equilibrium (i.e., scour balancing new deposition). Pitt (1985) tested inlet capacities by adding sediment to inlets thought to be at equilibrium, and, as expected, the added sediment was not retained but instead washed out by storm flows. Furthermore, in the Castro Valley in the Bay Area, Pitt and Shawley (1981) determined that large storms that occur approximately once a year completely scour out the inlets and stormwater conveyance system. Thus, cleanout frequency is a key factor in sediment retention and the effectiveness of inlets to reduce pollutant loads.

As the frequency of inlet and catch basin cleanouts increases, the cumulative volume and mass of sediment removed also increases. Mineart and Singh (1994) found that, for industrial land use in particular, there was a clear decrease in the annual sediment volume and pollutant mass removed (i.e., total per year) from inlets with decreased cleanout frequency. Semi-annual cleanouts removed the greatest average mass per cleanout, suggesting that this frequency may be relatively cost-beneficial. For residential, commercial and industrial land uses, monthly inlet frequency removed the most sediment volume (3-5 ft^3), when totaled over a period of a year as compared to annual, semi-annual and quarterly cleanout frequencies. A higher frequency of clean out apparently removed accumulated sediment and other materials that otherwise would have been scoured out by stormwater runoff. In general, Mineart and Singh (1994) appeared to be the best source of data found regarding the effectiveness of different cleanout frequencies in the Bay Area. This study evaluated inlets (as opposed to catch basins) and serves as a good starting point in beginning to assess the general effectiveness of inlet cleaning to reduce pollutant loads.

Rainfall Patterns and Inflow Velocity

Generally, stormwater conveyance systems tend to accumulate more sediment in regions with little rain or during periods of low-intensity storms. At lower flow velocities, materials conveyed into an inlet structure by stormwater runoff are more likely to settle out. Sartor and Boyd (1972) found that the retention time in a constructed catch basin was less than a minute during low flows, indicating that the catch basin was effective in removing only coarse material. Turbulence caused by higher flow velocities can cause materials (both coarse and fine) to migrate out of the inlet into the storm drain pipes. Thus, rainfall patterns affect the amount, as well as the particle size distribution, of accumulated sediment in an inlet.

Significant storms tend to be a major factor in sediment retention and the transport effectiveness of a stormwater conveyance system. Pitt and Shawley (1981) found that a Castro Valley, CA rain storm of about 1.5 in total was capable of transporting much of the material through the stormwater conveyance system. Furthermore, Sartor and Boyd (1972) found that for a simulated heavy rainfall intensity (1/2 in/hr), a constructed catch basin was reasonably effective in removing coarse solids, i.e., solids with a diameter larger than 246 µm, and ineffective at removing fine solids. Herrera (2009) noted that, on average, catch basins only accumulated sediment at 10% of their capacity at the end of the study period, due likely to a relative lack of mobilization of sediments by the mild rainfall of the Puget Sound Region (Seattle, WA). In general, understanding the local rainfall regime is helpful in selecting cleanout frequencies and understanding the expected particle size distribution of accumulated sediment.

Relationship of Inlet Cleaning to Street Sweeping

Inlet cleanout removal rates are not independent of street sweeping removal rates. Many of the factors of the Law et al. (2008) conceptual model affecting street sweeping effectiveness also impacted inlet cleanout effectiveness. For example, the total street dirt load and the amount of dirt removed by street sweeping both influence the quantity and particle sizes of sediment that can be trapped within storm drains, inlets or catch basins.

Herrera (2009) found that the amount of sediment removed from street sweeping was higher by as much as a factor of five than the amount of sediment accumulated in catch basins at test sites. Thus street sweeping carried out on a bi-weekly schedule at the test sites was much more effective in terms of sediment removed than annual catch basin cleaning. However, this result was likely climate-specific in that the light intensity rainfall in the region (Seattle, WA) has relatively limited ability to convey street dirt/dust loads to the catch basins.

Pitt and Field (2004) found that sediments collected from inlets and other storm drain sediments (catch basins and manholes) had a smaller median particle size than street sediments. Herrera (2009) measured higher concentrations of cadmium, copper, lead, and zinc in catch basin samples than in street dirt and street sweeping material and noted that this was likely due to the greater proportion of fine-grained material found in the catch basin sediment.

6.3.2. Storm Drain Line Cleaning/Flushing

Only limited information was found on storm drain line cleaning and flushing during this literature review. Storm drain cleanout effectiveness is impacted by the frequency of and method of cleanout (CWP 2006) and the design of the stormwater 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). An effort by the City of San Jose, CA removed sediments in an industrial area with elevated PCB concentrations. The City hired a private contractor to clean out drain inlets, publicly owned laterals, and the main storm drain line below a short cul de sac street in San Jose (Leo Avenue). The contractor removed a significant amount of sediment (3,500 kg of solids) and approximately 0.004-0.07 kg of PCBs based on the approximate range of PCB concentrations previously measured in the street's storm drain line sediments (1 - 20 mg/kg). Most of the accumulated sediment was found in a 'dip' of the storm drain line (Dunlavey 2011, personal communication).

6.3.3. Pump Station Cleaning

As with storm drain line cleaning/flushing, only limited information was found on pump station cleaning during this literature review. Salop (2006) analyzed PCB and mercury concentrations in material collected from two pump stations, one associated with a railroad overpass in a suburban city (Pleasanton, CA) and the other from an industrial area (Ettie Street pump station in Oakland, CA). The estimated solids removed during a cleanout of the Pleasanton pump station sump was 2.4 cy (2,455 kg). The Ettie Street pump station was not cleaned out during the study but the estimated amount of solids accumulated in its four sumps was 33 cy (33,740 kg). Based on these amounts of solids and the corresponding pollutant concentrations measured, the study estimated that a relatively small mass of PCB and mercury are removed during cleanouts of the 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 Ettie St. pump station based on the highest PCB concentration measured in the sumps since 2000 to be 0.3 kg.

6.4. Effectiveness of Street Flushing

Two areas in the Ettie Street pump station watershed were abated via dry sediment removal and power washing of streets. PCB concentrations measured in sediments collected from these sites were 27 to 94% lower post-abatement compared to pre-abatement (Kleinfelder 2007). The results suggested that PCBs were abated more effectively in areas with higher PCBs concentrations. In one case abatement of PCBs at an adjacent private property may have contributed to the reduction in levels of PCBs.

In addition, Gromaire et al. (2000) found that daily street flushing in a densely populated residential/commercial area of Paris contributed an estimated 15% in loads of suspended solids, organic matter and copper to the outlet flow of a catchment that discharges to a combined sewer system. This demonstrates the ability of street flushing to mobilize additional pollutant loads.

A few studies have evaluated the combined use of street sweeping and street washing/flushing to reduce ambient particulate matter (PM) emissions. In general, based on the monitoring of airborne particulates, a combination of street sweeping and subsequent washing is a reliable control measure to mitigate PM emission from road dust re-suspension. Chang (2005) found that street sweepers, followed by washing with a pressurized jet, decreased airborne total suspended particle[46] concentrations up to 30%.

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[46] Particles ranging in size from 0.1 µm to about 30 µm in diameter (U.S. Environmental Protection Agency website 2011).

7. COSTS OF SEDIMENT MANAGEMENT PRACTICES

Information obtained in the literature review regarding costs of sediment management practices was limited, especially regarding stormwater conveyance system cleaning and street flushing. Based on available information, the following costs are adjusted to 2011 dollars using an online inflation calculator accessed at http://www.usinflationcalculator.com.

7.1. STREET SWEEPING COSTS

Literature sources that addressed costs often addressed life cycle costs on a dollar per curb mile swept basis. Shilling (2005) indicated that life cycle costs for mechanical sweepers was approximately $40 (2005 dollars) per curb mile swept and about $20 for a vacuum sweeper (Shilling 1950). Although this author did not address the reason for the difference, another report indicated that vacuum sweepers have many less wearing parts than mechanical broom sweepers. Shilling quoted a capital cost of approximately $100,000 for a mechanical sweeper compared to a vacuum sweeper of over $200,000. The life of the mechanical sweeper was given as 5 years compared to 8 years for the vacuum sweeper.

In an evaluation of street sweepers, Blosser (2000) for the City of Olympia Washington estimated the cost of a Schwarze EV-1 vacuum sweeper at $300,000, annual operation and maintenance costs at $50,000, and annual capital replacement costs at $30,000 (although he stated that latter figure was conservative). If we assume the equipment is operated 40 hours/week at 4 mph, the total distance travelled per year would be about 8300 miles. Assuming 80% of those miles are associated with cleaning would yield about 6500 curb miles swept per year. If as indicated by Blosser, the O&M costs are about $80,000 per year, the O&M costs on a per curb mile swept would be about $12.

Phone calls were made to three major sweeper manufacturers requesting current cost information for their products. One manufacturer responded that the purchase price for regenerative air sweepers currently range from $170,000-$200,000 depending on options. Dustless regenerative air sweepers that comply with stringent air quality requirements promulgated by the South Coast Air Quality Management District range in price from $250,000 to $280,000.

Discussions with local agencies (City of San Jose and City of Oakland) also provided some insight into two Bay Area street sweeping programs. The City of Oakland relies primarily on mechanical broom sweepers whereas the City of San Jose is moving more towards regenerative air sweepers. According to the contact at the City of San Jose a typical sweeper might sweep about 28 curb miles per day, 5 days a week, and 50 weeks a year for a total of approximately 7000 curb mile swept per year. Using an estimated life cycle cost of $40/curb mile based on several references results in a life cycle cost of about $280,000 per year. Sweeper life depends on numerous factors but a rough rule might be about 10 years during which time a sweeper would have swept about 70,000 curb miles. If the capital cost of a sweeper is $300,000 the capital cost per curb mile is about $4, or about 10% of the overall life cycle cost of operating a sweeper.

7.2. STORMWATER CONVEYANCE SYSTEM CLEANING COSTS

Herrera (2009) conducted a comprehensive street cleaning and inlet cleanout study that determined approximate life cycle costs for the Seattle Public Utilities city-wide catch basin cleaning program at $0.44 per wet kg and $0.78 per dry kg of sediment removed. Inspection, cleaning, material handling, and disposal costs were included in the estimate. In a desktop evaluation, Salop et al. (2004) projected that it would roughly cost Alameda County (Bay Area) MS4s an additional $300,000 to perform semi-annual cleanouts of inlets (as opposed to annual) due to increased disposal costs. In addition, Kleinfelder (2006) reported that the Alameda County Public Works Agency estimated a cost of $30,480 to remove 61 cy (or 70 tons) of sediment from the Ettie Street pump station. However, this cost did not include disposal, as the County disposed of the sediment at its own facility.

7.3. STREET AND STORM DRAIN LINE FLUSHING COSTS

The only study found that included costs for street flushing was the Ettie Street Pump Station project conducted in the Bay Area. Kleinfelder (2006) calculated that the cost of abating and disposing of approximately 20 tons of sediment containing about 9 g of PCBs from 921 linear feet of street (high priority Areas 1 and 2) was approximately $100,000. This amount included disposal of the sediment at a Class I Hazardous Waste landfill due to elevated concentrations of lead. Based on this figure, the cost estimated to abate the remaining nine high priority areas, an additional 7,990 linear feet of street with an estimated additional 47 g of PCBs, was $839,000.

The only information found on costs for storm drain line flushing was provided by the City of San Jose (Dunlavey 2011, personal communication). The cost for the city to contract with a private company to perform the one-day cleanout and dispose of the collected material at a hazardous waste facility[47] was approximately $25,000. Although this amount includes the company's field crew and transport and disposal of the material, it does not include San Jose staff time, analytical testing costs, and cost to video the storm drain line before and after the line cleaning. San Jose estimated that the amount could increase to $50,000 if these latter costs were considered.

Table 6 summarizes limited information found during the literature review on unit costs for municipal operation and maintenance practices.

Table 6. Unit costs of municipal operation and maintenance practices.

Practice	Approximate Unit Cost	Reference
Street sweeping	$20 - $40 per curb mile.	Pitt 1979, Pitt 1985, Shilling 2005, and Herrera 2009
Storm drain inlet cleaning	$0.44 per kilogram wet sediment removed.	Herrera 2009
Street flushing	$100 per linear foot of street.[1,2]	Kleinfelder 2006
Storm drain line cleanout	$40 to $80 per linear foot of pipe.[1]	Dunlavey 2011, personal communication

[1]Based on very limited data (one site).
[2]Cost includes disposal of sediment as hazardous waste due to elevated lead concentrations.

[47] The City of San Jose tested the collected material for lead, and because of elevated concentrations, chose to dispose of the material at a hazardous waste facility.

8. COST/BENEFIT ANALYSIS OF THE EVALUATED SEDIMENT MANAGEMENT PRACTICES

8.1. BENEFITS

8.1.1. Street Sweeping

The implication for street sweeping for the control of mercury and PCBs discharges to the San Francisco Bay can be addressed through a cost-benefit analysis. Benefits can be assumed to equal the mass of PCBs and mercury collected by street sweeping and can be estimated by combining the information from the literature review on street sweeper effectiveness with concentrations of PCBs and mercury measured on street surfaces in the Bay Area assembled contained in a regional database (SFEI 2010).

The analysis focused on 153 samples taken from street and parking lot surfaces in industrial areas throughout the Bay Area. The SFEI analysis of the PCB data indicated that approximately 100 samples were below the detection limit (0.073 mg/kg). Analysis of the data also showed that most of the mass of PCBs that could potentially be collected by street sweeping would be collected at those sites where concentrations were in the upper 10^{th} percentile (90^{th} percentile and above). Based on this analysis, it was decided that the cost benefit analysis should focus on those approximately 15 sites where samples were in the 90^{th} percentile (0.27 mg/kg PCBs or 0.47 mg/kg mercury) and above.

The cost benefit analysis was conducted where the benefit was assumed to be the mass of PCBs and mercury collected by street sweeping. Estimates of mass collected are given Table 7 for PCBs and mercury where the mass collected is for the areas where sample concentrations were in the upper 10^{th} percentile of the street surface data contained in the SFEI database. Two rows of estimates are provided for each constituent: the upper row corresponds to assumptions chosen to provide a "lower bound" on the mass collected, and the lower row corresponds to assumptions chosen to provide an "upper bound" on the mass collected. For each scenario, the mass collected is estimated for three concentrations: the low concentration (corresponding to the 90^{th} percentile concentration), the best estimate (corresponding to the median) and the highest (corresponding to the mean). Specific assumptions for the columns in Table 6 are provided in the footnotes below the table.

The table indicates that the range of mass of PCBs collected would be 0.04-1.31 kg, with a best estimate in the range of 0.06-0.75 kg. The corresponding mass for mercury would be 0.03-1.45 kg, and the range for the best estimate would be 0.05-0.54 kg. This would indicate that the relative benefits of sweeping would be comparable for mercury and PCBs, although the absolute mass collected, even under the upper bound scenario is low relative to the TMDL targets.

Table 7. Estimated annual mass (kg) and annual cost of collecting PCBs and mercury by sweeping areas in the upper 10th percentile of street surface data contained in the SFEI Proposition 13 project database (SFEI 2010).

		Constituent Concentration (mg/kg)							Mass Collected (kg)		
Constituent	Scenario (Bound)	Low[1]	Best[2]	High[3]	Dust/Dirt Collected[4] (kg/km)	Road Length Swept[5] (km)	Number of Sweepings per Year[6]	Number of Areas Swept[7]	Low[8]	Best[8]	High[8]
PCBs	Lower	0.66	1.09	1.9	28	10	12	17	0.04	0.06	0.11
	Upper	0.66	1.09	1.9	85	20	24	17	0.46	0.75	1.31
Mercury	Lower	0.48	0.78	2.1	28	10	12	17	0.03	0.05	0.12
	Upper	0.48	0.78	2.1	85	20	24	17	0.33	0.54	1.45

1. 90th percentile concentration of data taken on street surfaces (SFEI 2010).
2. Median concentration of data taken on street surfaces (SFEI 2010).
3. Mean concentration of data taken on street surfaces (SFEI 2010).
4. Assumed range in amount of dust and dirt collected by sweepers per km (equivalent to range of 100-300 lbs/curb mile from literature review).
5. Assumed range in length of roads in each hot spot area, intended to bracket road length that could be swept and which would have corresponding elevated concentrations. Range is designed to bracket expected value that is based on 3 km "halo" (Yee and McKee 2010) or area of 7.1 km^2 around each elevated sample and road density of 2.5 km/km^2 (based on arterial road density of 4 miles/square mile for San Francisco: http://www.newgeography.com/content/001316-road-network-density-major-metropolitan-areas).
6. Assumed range in sweeping frequency is monthly to twice per month; therefore, 12 versus 24 sweepings.
7. Number of sites in upper 10th percentile is 17.
8. Mass collected estimated by multiplying concentration times dust and dirt collected, road length swept, frequency, and # of sites.

8.2. INLET CLEANING

As with street sweeping, implications for the control of PCBs and mercury by inlet cleaning are presented as both benefits and costs. The benefit, or effectiveness, of inlet cleaning is presented as the PCB or mercury mass removed per cleanout of an inlet located in an area with elevated pollutant concentrations. This pollutant mass was calculated by multiplying the estimated amount of sediment removed per inlet cleanout by an estimated pollutant concentration in the sediment (Table 8). Data on average sediment removed per inlet cleanout in industrial areas, which are assumed to have relatively high concentrations of PCBs and mercury, were obtained from Mineart and Singh (1994). This study was conducted somewhat recently (in last 16 years) and locally (Alameda County in the Bay Area), addressed industrial land use (among others), had a relatively large sample size (60 total inlets, including 20 inlets in industrial land use), and evaluated several cleaning frequencies. Concentrations of PCBs and mercury in sediment were estimated using the chemistry data from the 236 Bay Area storm drain inlet sediment samples compiled by the Proposition 13 study (SFEI 2010). Assuming cleanout of inlets in areas with elevated pollutant concentrations, the median of the upper 10^{th} percentile was used as a 'best' estimate, the 'low' estimate was based on 90^{th} percentile concentration, and the 'high' estimate was based on the mean of the upper 10^{th} percentile (Table 8). The calculated removed mass was subsequently used to estimate a cost/benefit ratio for inlet cleanouts (Section 8.3). Table 8 shows that the mass of PCBs and mercury collected per cleanout decreases as concentrations decrease. Thus, the most PCB and mercury mass would be removed in areas with elevated concentrations, as expected.

Table 8. Estimated annual mass (kg) and annual cost of collecting PCBs and mercury by inlet cleaning in the upper 10th percentile of inlet/catch basin data contained in the SFEI Proposition 13 project database (SFEI 2010).

	Constituent Concentration (mg/kg)			Sediment	Constituent Mass Collected per Cleanout[5] (mg)					Unit Cost for Removal of Constituent[8] ($/mg)		
	High[1]	Best[2]	Low[3]	Average Mass Collected per Cleanout[4] (kg)	High	Best	Low	Unit Cost/ Wet kg. Sed.[6] ($/kg)	Cost for Removal of Avg. Sed. Mass[7] ($)	High	Best	Low
PCBs	1.5	1.3	0.71	14	20	18	9.8	$0.44	$6.1	$0.30	$0.33	$0.62
Mercury	1.2	1.0	0.65	14	17	14	9.0	$0.44	$6.1	$0.35	$0.43	$0.68

1. Based on mean concentration of the top 10th percentile of the inlet/catch basin data of the Proposition 13 study database (SFEI 2010).
2. Based on the median of the top 10th percentile of the inlet/catch basin data of the Proposition 13 study database (SFEI 2010).
3. Based on the 90th percentile of the inlet/catch basin data of the Proposition 13 study database (SFEI 2010).
4. Average sediment mass removed per cleanout based on an annual cleaning frequency (Mineart and Singh 1994).
5. Constituent mass = sediment mass collected per cleanout multiplied by corresponding concentration.
6. Unit cost for one kilogram of wet sediment collected from an inlet based on estimates from City of Seattle study (Herrerra 2009) and estimated in 2011 dollars. Inspection, cleaning, material handling, and disposal costs were included in the estimate. Costs refer to disposal of material at a local disposal facility without being dewatered.
7. Cost = unit cost multiplied by average mass per cleanout.
8. Unit cost = cost for removal of average sediment mass divided by constituent concentration. Low cost estimate based on high concentration, moderate estimate based on moderate concentration, and high estimate based on low concentration.

8.3. COSTS

8.3.1. Street Sweeping

The second part of the cost benefit analysis is to estimate the annual cost to sweep an area that represents a "hot spot" defined here as having a sample in the upper 10th percentile. The estimated cost to collect PCBs and mercury are provided in Table 9 where the cost of sweeping is estimated at $24 per curb kilometer ($40 per curb mile) swept based on information gathered in the literature review (Pitt 1979, Pitt 1985, Shilling 2005, and Herrera 2009). Assumptions were then needed to estimate the number of curb kilometers contained in an area and the number of times per year the roads would be swept. For the "low bound scenario" it is assumed that the area would have arterial streets ranging from 10-20 km in length and that these streets would be swept either monthly or twice per month. The total annual cost is then the product of the cost/km times the km swept times the frequency times the number of sites (17). This total cost is then divided by the estimated mass of material collected to get a cost benefit expressed as dollars per mg of constituent.

The results of the cost calculations indicate that there is an inverse relationship between the cost to remove the constituent and its concentration. In other words, (based on a constant removed sediment mass), the higher the PCB or mercury concentration, the less expensive it is to remove it. Thus, the 'dirtier,' or more polluted the sediment removed is, the more cost-efficient it would be for a municipality or responsible agency.

8.3.2. Inlet Cleaning, Street Flushing and Storm Drain Line Flushing

To determine the cost corresponding to the benefits of inlet cleaning described above, the unit cost to remove one kilogram of wet sediment[48] ($0.44/kg) via inlet cleaning estimated by a recent study conducted in Seattle, WA (Herrera 2009) was used. This was the only information related to the cost of inlet cleaning found during the literature review; a unit cost per inlet cleanout was not found. Thus, the cost benefit calculations in Table 8 represent a rough estimate for the Bay Area using very limited information. The unit cost ($0.44/kg) was multiplied by the mean sediment removed per cleanout to give a rough estimate of cost per inlet cleanout. This cost was divided by the previously calculated estimated pollutant mass removed per cleanout, to give rough cost-benefit figures in terms of $/mg pollutant removed (Table 8).

Similar to street sweeping, the results of the cost calculations indicate that there is an inverse relationship between the cost to remove the constituent and its concentration. Thus, the more polluted the sediment removed from an inlet is, the more cost-efficient the cleanout is in terms of pollutant removal.

In addition, the Ettie Street study results (Kleinfelder 2006) were used to calculate a rough estimate of $/mg PCBs removed for street flushing and capture and information provided by the City of San Jose (Dunlavey 2011, personal communication) was used similarly for storm drain flushing. Mercury concentrations were not measured during the Ettie Street and San Jose projects. The calculated cost for street flushing and capture was higher than the other sediment management practices at about $11/mg

[48] Cost adjusted to 2011 dollars (www.usinflationcalculator.com). Unit cost includes labor, handling and disposal costs.

PCBs removed, but included disposing of sediment as hazardous waste due to elevated lead concentrations. It is unknown whether concentrations of lead would be similarly elevated in other Bay Area locations.

Table 10 compares cost-benefit calculations for inlet cleanout, street flushing and capture, storm drain flushing and street sweeping (based on sweeping 12 times per year). It should be noted that these calculations are based on limited data and there are many uncertainties in the results, but they can serve as a starting point for the comparison of the cost-benefit of municipal operations and maintenance activities until more information becomes available.

Table 9. Street sweeping - estimated range in costs to collect PCBs and mercury ($/mg) for areas having concentrations in the 10th percentile of concentrations as provided in the SFEI Proposition 13 project database (SFEI 2010).

	Constituent Mass Collected[1] (kg)							Cost/Mass ($/mg)		
Constituent	**Low**	**Best**	**High**	**Road Length Swept (km)**	**Number of Sweepings Per Year**	**Cost per Km[2] ($/km)**	**Total Cost[3] ($)**	**High[4]**	**Best[4]**	**Low[4]**
PCBs	0.04	0.06	0.11	10	12	$24	$43,200	1.29	0.78	0.45
	0.46	0.75	1.31	20	24	$24	$172,800	0.43	0.26	0.15
Mercury	0.03	0.05	0.12	10	12	$24	$43,200	1.77	1.09	0.40
	0.33	0.54	1.45	20	24	$24	$172,800	0.59	0.36	0.13

1. See Table 7 for details on mass calculations.
2. Corresponds to approximately $40 per curb mile based on information from literature review
3. Equals cost per km times the total number of kilometers swept in one year (road length swept times frequency) times number of sites
4. High cost estimate corresponds to low mass collected, low cost estimate corresponds to high mass collected, and best cost estimate corresponds to best mass collected.

Table 10. Comparison of estimated costs to remove PCBs and mercury ($/mg) by sediment management practices.

	Inlet Cleanouts at Areas with Elevated Concentrations[1] ($/mg)			Street Flushing and Capture at Areas with Elevated Concentrations[2] ($/mg)	Storm Drain Flushing at Areas with Elevated Concentrations[3] ($/mg)		Monthly Street Cleaning at Areas with Elevated Concentrations[4] ($/mg)		
	High	**Best**	**Low**		**High**	**Low**	**High**	**Best**	**Low**
PCBs	$0.62	$0.33	$0.30	$11	$6.2	$0.36	$1.3	$0.78	$0.45
Mercury	$0.68	$0.43	$0.35	N/A	N/A	N/A	$1.8	$1.1	$0.40

1. See Table 8 for details on cost calculations.

2. Cost data from Kleinfelder (2006) used to calculate unit cost. Study results showed it cost $100,000 to and dispose of approximately 20 tons of sediment containing 0.009 kg of PCBs from 921 linear feet.

3. Cost data from City of Jose (Dunlavey 2011, personal communication) was used to calculate unit cost. Study results showed that it cost $25,000 to remove 3,500 kg of solids with approximately 0.004 kg (min.) - 0.07 kg (max.) of PCBs based on the range of PCB concentrations previously measured in Leo Ave storm drain line sediments.

4. See Table 9 for details on cost calculations.

9. DATA GAPS

Based on the results of the literature review, the following key data gaps were identified with respect to evaluating the effectiveness of sediment management practices in reducing PCB and mercury loads to San Francisco Bay.

Effectiveness Studies Do Not Address PCBs and Mercury - Although there have been a few Bay Area studies that characterized PCBs and mercury concentrations in materials collected from streets, stormwater conveyance systems and in street sweeper hoppers, there is a lack of information addressing the effectiveness of sediment management practices to reduce loads of PCBs and mercury. One particular concern is the lack of information on the buildup of PCBs and mercury on street surfaces, which can affect the frequency at which sweeping would be most effective. Thus, it is necessary to infer the effectiveness of street sweeper studies based on the effectiveness of sweepers to remove dust and dirt (<2 mm) and in particular the finer fractions of dust and dirt (less than 63 µm). In addition, information is lacking in regards to the amount of sediment that accumulates in inlets, particularly in industrial areas with elevated pollutant concentrations, and the concentrations of PCBs and mercury in that sediment. In addition, very limited information is available on how PCB and mercury mass is distributed among various particle sizes.

Few Effectiveness Studies are Conducted in Semi-Arid Climates - Most reviewed street sweeper effectiveness studies that evaluate advanced sweeper types designed to improve water quality benefits were not carried out in semi-arid climates like the Bay Area. Moreover, a number of studies were conducted where road abrasives are applied during the winter, and this can cause results to be even less representative. There are even fewer studies for inlet cleaning, and only one local study was found that evaluated the effect of cleaning frequencies on the effectiveness of sediment removal.

Few Effectiveness Studies Document Water Quality Improvements - A number of studies have attempted to measure the potential improvement in water quality associated with street sweeping; however, very few studies indicated a statistically reliable improvement in water quality. A recent paper (Kang et. al 2009) indicates that most street sweeping study designs do not have sufficient statistical power to measure a change given the variability in runoff water quality. One inlet cleaning study attempted to measure water quality improvements based on a semi-annual cleaning frequency; however, it was determined that the number of samples collected was insufficient to characterize the improvements (Neely et al. 2008).

No Local Street Sweeping Studies that Evaluate Recent Improvements in Technology - No recent studies were found conducted in Bay Area that evaluate the effectiveness of equipment that reflects improvements in street sweeper technology in approximately the last decade.

Confounding Factors Make it Difficult to Compare Effectiveness Results Across Studies - Most street sweeper effectiveness studies are affected by confounding factors that affect effectiveness, including climate, particle loadings, street texture, moisture, parking car conditions, equipment operating conditions, and frequency of cleaning and also differ in terms of study design such that it is difficult to compare results amongst different studies. Thus, the best comparison amongst sweeper types is limited to the same study and study conditions. There are also factors that confound comparisons among the results of inlet cleaning effectiveness studies, including variations in rainfall patterns, particle size distributions of local sediments collected, configurations of inlet structure, and cleanout frequency.

Most Studies Address Effectiveness of Catch Basins Rather than Drop Inlets – The majority of studies found during this literature review addressed catch basins (with sumps) rather than drop inlets (without sumps). Drop inlets are believed to be the predominant type of inlet in the Bay Area. Since catch basins tend to accumulate more sediment than drop inlets, these studies have limited applicability to the effectiveness of inlet cleaning in the Bay Area.

Limited Information was Found on the Effectiveness of Stormwater Conveyance System Cleaning Enhancements - Only limited information was found on the effectiveness of storm drain inlet cleaning (and especially how effectiveness varies with frequency of cleanout) and storm drain line and street flushing.

Cost-Benefit Information is Not Adequately Addressed - There was a general lack of cost-benefit analysis found for the major municipal maintenance practices included in this literature review (street sweeping, storm drain inlet cleaning, storm drain line flushing, and street flushing).

10. RECOMMENDATIONS

Based on the results of the literature review, this section presents general recommendations regarding the design of future studies that evaluate the effectiveness of municipal sediment management practices in relation to reducing PCB and mercury loads to San Francisco Bay. In general, these studies should:

- Be conducted in Bay Area industrial areas known to have elevated concentrations of PCBs in street and storm drain system sediments.
- Measure concentrations of PCBs and mercury and particle size distributions in sediments. Evaluating effectiveness via water quality monitoring is likely to be challenging. For example, Kang et al. (2009) examined why most studies could not document an effect of street sweeping on water quality and concluded that most monitoring studies do not have sufficient statistical power to distinguish the effect of sweeping given the variability in runoff water quality.
- Be conducted at appropriate spatial and temporal scales to optimize what can be learned within resource constraints. This may require implementation at relatively small scales.
- Document rainfall totals and intensities in the study area over the course of the study.
- Gather the appropriate data and conduct cost-benefit analyses.
- Incorporate working with municipal maintenance staff to document practical lessons learned (e.g., successes, failures, challenges) and thereby facilitate future training of maintenance staff if enhanced practices are implemented on a more widespread basis.

As new information is generated by future Bay Area studies on municipal sediment management practices, the spreadsheet models developed during the SFEI Proposition 13 study (Mangarella et al. 2010) should be adapted and refined to incoroporate available data on costs and benefits, including estimated load reduction projections based on regional implementation scenarios and associated cost-benefit analyses.

Recommendations specific to street sweeping and stormwater conveyance system cleaning are provided below.

10.1. STREET SWEEPING

Based on the results of the literature review, consider conducting street sweeper effectiveness studies on road segments containing elevated levels of PCBs and mercury that focus on one or more of the following:

- Establishing a baseline for sweeper effectiveness and costs for removing sediment (fine and coarse) and associated PCBs and mercury;
- Evaluating the effect of increasing frequency on sweeper effectiveness and costs;
- Evaluating the effects of utilizing advanced street sweeper equipment on sweeper effectiveness and costs;
- Documenting the effects of site-specific confounding factors that affect sweeper effectiveness and costs; and
- Conducting marginal cost benefit analysis for modifying sweeper programs.

Particular care should be taken to take into account confounding factors. Experience has shown that studies that consider controls, differences in surface loadings on different streets, statistical study design (a sampling plan that is sufficient to distinguish the changes anticipated), and quality assurance and control are likely to be more successful. In evaluating sweeper types, it is critical that the testing ensure that the sweepers alternatively operate on the same roadway segments so that the surface loading on the streets is the same for each type of equipment. General guidance on conducting street sweeping programs can be found in the literature (e.g., Selbig and Bannerman 2007).

10.2. STORMWATER CONVEYANCE SYSTEM CLEANING

Based on the results of the literature review, consider conducting three general types of stormwater conveyance system cleaning studies:

1. Evaluating the effect of increasing storm drain inlet cleanout frequency on PCB/mercury load reduction benefits and costs.
2. Evaluating costs and PCB/mercury load reduction benefits of street sediment removal including flushing and capture of wash water.
3. Evaluating costs and PCB/mercury load reduction benefits of storm drain line flushing with capture of wash water.

These studies should include working with municipal staff to develop inventories and maps within the study area of storm drain facilities and other pertinent drainage characteristics, including:

- Types and locations of inlet structures (e.g., drop inlet vs. catch basin) and condition.
- Types and locations of piping and condition.
- Sources of sediment to the storm drain system.
- Specific points within the storm drain system where sediment accumulates (e.g., certain inlets and any "sag" points in piping).

CCTV inspection is one potential tool to assist with developing the inventory and maps.

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Appendix A. Summary of Reviewed Street Sweeper Characterization and Effectiveness Monitoring Studies

Reference	Sweeper Type[1]	Sweeper Frequency	Location	Period	Land Use And Site Information	Pollutants	Study Design[2]	Effectiveness					Costs (2011)[3]	Summary/Benefits
								Pre Sweeping Dust/Dirt Street Load (lbs/curb mile)	Post Sweep Street Load (lbs/curb mile)	Pre-Post Street Load (lbs/curb mile)	Percent Reduction Street Load (%)	Percent Reduction Fines (<63µm)		
Bay Area Studies														
Sartor & Boyd 1979	M		San Jose, Phoenix, Baltimore, Milwaukee, Atlanta, Seattle, Tulsa	1970-1971	Residential, commercial, industrial	Solids, BOD/COD nutrients, pesticides, metals, PCBs, Mercury	1	370 (M)[6] 710 (M) 1303 (M) 450 (M) 1550 (M) 504 (M)	146 (M)[6] 160 (M) 540 (M) 330 (M) 870 (M) 320 (M)		60% (M)[7] 78% (M) 58% (M) 36% (M) 44% (M) 36% (M)			Current street sweeping practices are essentially for aesthetic purposes, and even under well-operated and highly efficient street sweeping programs, their efficiency in the removal of the dust and dirt fraction of street surface contaminants is low.
Pitt 1979	M	Generally daily or weekly for period of 4-6 weeks	San Jose, CA	1976-1977	3 sites (Downtown, Keyes St., Tropicana)	Solids, BOD/COD nutrients, pesticides, metals, FIB, PCBs	2	240 (M)[3] 400 (M) 230 (M)	160 (M) 280 (M) 120 (M)	120 (M) 120 (M) 110 (M)	34% 33% 43%	15-30% (M)	$41 per curb mile swept[12]	Road conditions are more important than the type of broom sweeper in determining effectiveness. Broom sweepers are only about 20% effective at removing smaller particles (<45 um).Water quality benefits from sweeping with broom sweepers require daily frequency.
Pitt and Shawley 1981	M,R	5 times per week for 1 month	Castro Valley, CA	1978-1980	3 study areas (lower, middle, upper)	Solids, BOD/COD nutrients, pesticides, metals, hydrocarbons	2	850 (M) 700 (M) 400 (M) 850 (R) 700 (R) 400 (R)	310 (M) 260 (M) 190 (M) 260 (R) 225 (R) 155 (R)		64% (M) 62% (M 53% (M) 69% (R) 68% (R) 61% (R)	36-61% (M) 55-74% (R)	$24 per curb mile swept[12]	Recommend period of more frequent street sweeping prior to wet season. Street sweeping cannot reduce street surface loadings below 200 lbs/curb mile. Three passes/week is point of diminishing returns. Regenerative air slightly (5-10%) more efficient than broom sweeping especially if streets are initially cleaner.
Woodward Clyde 1994	M,R	Once every 2 weeks	San Jose	1994	Commercial, industrial,	Metals, TOC, O&G, TPH, PAHs, pesticides, PCBs	1			180 (M)[5] 200 (M) 290 (M) 300 (R) 230 (R)				Copper concentrations on streets and in hoppers were about 150 µg/kg in particle range <75um, compared to abut 50 µg/kg for particles > 700 um. The majority of the mass collected by the sweepers were >170um.
EOA 1990	M	Varied generally from weekly to monthly depending on agency and land use	Alameda, Alameda County, Berkeley, Hayward, Livermore, Newark, San Leandro, Union City	1991-1997	Residential, commercial, and industrial	Solids				260-540[8]				EOA compared reported street sweeper collection data in cy and miles swept in commercial, industrial and residential areas from 9 participating agencies in Alameda County. Statistical analysis was unable to show any significant trends although removal rates tended to be lower in commercial areas compared to industrial. This could reflect the tendency to sweep streets more often in commercial areas.

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								Pre Sweeping Dust/Dirt Street Load (lbs/curb mile)	Post Sweep Street Load (lbs/curb mile)	Pre-Post Street Load (lbs/curb mile)	Percent Reduction Street Load (%)	Percent Reduction Fines (<63µm)		
Salop 2004	M,R,V					PCBs, mercury								Desktop analysis of available information. Assigned efficiency factors for different types of sweepers based on modeling studies conducted by Sutherland, and then applied these to MS4s in Alameda County based on mix of sweepers used in their sweeper fleet.
EOA 2006			Fairfield, Suisun City	2005	Residential (2 sites) Commercial (2 sites)	Metals, hydrocarbons pesticides, PCBs								Primarily a street sweeping characterization study based on 4 samples of street sweeping materials collected in 2 sites in each city. PCBs were below detection (<0.2 mg/kg). Three of four mercury samples were above detection (<0.02 mg/kg) and ranged from 0.03 to 0.05 mg/kg.
Salop 2006	M,R,V	One pass only	Berkeley, Hayward, Newark, Pleasanton, Livermore	2005	Residential, Mixed, industrial	PCBs, mercury, TOC, PSD								Street sweeping characterization and load reduction study based on analysis of 13 samples taken from hoppers of various types of sweepers in 5 municipalities in Alameda County. Found that highest concentrations and load reduction occurred in northern portion of county which has older developments.
EOA 2007a			Contra Costa County	2006	Residential, Mixed, industrial	Metals, hydrocarbons pesticides, PCBs								EOA collected and analyzed street sweeping materials from 17 routes in seven cities in Contra Costa County. Results indicated that PCBs, total recoverable mercury, copper, nickel, and PBDEs were consistently detected in street sweeping material.
EOA 2007b			Richmond, CA	2001-2007	Industrial Residential (47 sites)	PCBs								EOA collected and analyzed 18 sediment samples from streets in primarily southwestern portion of the City of Richmond. Concentrations of PCBs in street sweeping samples varied from below detection (5 samples) to 900 µg/kg. The mean of the 13 samples above detection was 262 µg/kg.
Studies Outside the Bay Area														
Pitt 1985	M,R	3 times/ week	Bellevue, Washington	1980-1983	Residential sites (2)	Solids, metals, nutrients, PSD	2,3	650 (R) 425 (R) 275 (R) 225 (R) 160 (R)	250 (R) 200 (R) 125 (R) 85 (R) 90 (R)	400 (R) 225 (R) 150 (R) 140 (R) 70 (R)	60% 53% 54% 62% 44%		$42 per curb mile swept[12]	Study involved extensive monitoring (400 storm events) to evaluate water quality benefits of street sweeping. Intensive 3 times/week sweeping did not show statistical change in water quality. Standard and regenerative air sweepers were more effective at removing fine particulates than mechanical sweepers.
Blosser 2000														Report for the City of Olympia, Washington discussing pros and cons of utilizing advanced sweeper in lieu of structural treatment, and need for operator training and vendor support to facilitate transition from mechanical to advanced sweeping technology.

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Reference	Sweeper Type[1]	Sweeper Frequency	Location	Period	Land Use And Site Information	Pollutants	Study Design[2]	Effectiveness					Costs (2011)	Summary/Benefits
								Pre Sweeping Dust/Dirt Street Load (lbs/curb mile)	Post Sweep Street Load (lbs/curb mile)	Pre-Post Street Load (lbs/curb mile)	Percent Reduction Street Load (%)	Percent Reduction Fines (<63µm)		
Pitt, Williamson, Voorhees, Clark 2004														Review article adressing buildup-washoff data that indicated that median particle size in runoff from typical storms tends to be in 15-50 um range. This fine fraction may only account for 10-20% of the dust and dirt mass on a roadway. Typical storms may remove up to about 50% of this fraction during a storm event.
Pitt, Bannerman and Sutherland 2004	V		Milwaukee Wisconsin		freeway		2	500 (V) 100 (V)	250 (V) 0	250 (V) 0	50% 0%			Review article that includes discussion of results from tests conducted using Sshwarze Industries Enviro Whirl I vacuum type sweeper.
Breault et al. 2005.	M,V		New Bedford, Mass.	2003-2004	Residential	Trace metals, PAHs	1				20-31% (M) 60-92% (V)	13% (M) 39-81% (V)		Controlled sweeper effectiveness tests, which included seeding streets with prescribed amount of graded dirt, indicated vacuum sweeper efficiencies consistently greater (by 1.6 -10 times) than mechanical sweeper for all particle sized ranges.
Shilling 2005													$40 per curb mile (M) $20 per curb mile (V)	A review report that included more extensive analysis of costs, including capital cost estimates of $100,000 for mechanical broom sweepers and $200,000+ for vacuum assisted. Expected life of each was 5 years for mechanical and 8 years for vacuum.
Selbig and Bannerman 2007	M,R,V	Weekly for at least a year	Madison, Wisconsin	2001-2006	Residential (3 sites)	Solids, PSD, metals, nutrients	2,3	558 (M) 776 (R) 776 (V)	456 (M) 340 (R) 116 (V)	102 (M) 436(R) 660(V)	20% (M)* 76% (R)* 63% (V)*	-25% (M)[4] -50% (R)[4] 10% (V)		Street sweepers significantly reduced the dust and dirt loading on streets, with larger reductions achieved with vacuum assisted or regenerative air sweepers. Mechanical broom sweepers more effective when street dirt yield approaches 1000 lbs/curb mile. Statistical comparisons of Event Mean Concentrations (EMCs) and loads between test catchment and control catchment indicated no statistical difference regardless of street-sweeper type.
Rochfort et al. 2007	M,R		Toronto, Canada	2004-2006	1 site	Solids, metals, nutrients, hydrocarbons TOC	1	484 (M) 100 (R)[9] 907 (R)[10]	302 (M) 100 (R) 280 (R)	182 (M) 0 (R) 627 (R)	37% (M) 0% (R) 70% (R)*	75% (R)*		New regenerative air sweeper tested on both north and southbound lanes was effective in reducing dust and dirt loading only in southbound lane because of higher surface loading. Regenerative air sweeper also able to reduce loadings of fines from 40 lbs/curb mile to 10 lbs/curb mile or 75%.

Appendix A. Summary of Reviewed Street Sweeper Characterization and Effectiveness Monitoring Studies

Reference	Sweeper Type[1]	Sweeper Frequency	Location	Period	Land Use And Site Information	Pollutants	Study Design[2]	Effectiveness	Costs (2011)	Summary/ Benefits	Reference	Sweeper Type[1]	Sweeper Frequency	Location
								Pre Sweeping Dust/Dirt Street Load (Lbs/Curb Mile)	Post Sweep Street Load (Lbs/Curb Mile)	Pre-Post Street Load (Lbs/Curb Mile)				
Law et al. 2008	M,R,V	Weekly, monthly	Baltimore, Maryland	2006-2008	Residential (2 sites)	Solids, nutrients	1	645(V)	553(V)	92(V)	14%(V)			Vacuum sweeper tested on 2 sites in Baltimore, Maryland. Street Particulate Matter (SPaM) shown is for Catchment O where frequency of sweeping increased to twice/week on all streets from baseline of once or twice per week.
Herrera 2009	R	biweekly	Seattle, Washington	2006-2007	Residential sites (2) Industrial (1)	Solids, metals, PAHs	3	1110 (R)[13] 1010 (R) 790 (R)	240 (R) 150 (R) 350 (R)		74% 90% 48%		$43 ($44) per curb mile swept[11]	Study investigated effectiveness of street sweeping and also relationship between street sweeping and catch basin cleaning frequency. Tests did not indicate a statistically significant change in the accumulation of sediments in catch basins between the test road segments and the control road segments.
Weston 2010	M,R,V	Weekly, bi-weekly	San Diego	2007-2009	Residential, commercial (3 sites total)	Solids, metals,	1			Route 3J 37(M) 54(R) 82(V) Route 103 133(M) 135(R) 157(V) Route 617 96(M) 110(R)				Debris removal rates (lbs/curb mile) varied between routes and temporally within each route, but generally were higher with vacuum assisted sweepers. Vacuum assisted and regenerative air sweepers removed finer material than mechanical sweepers on flatter route (Route 3J) whereas less difference in steeper routes (Routes 1C, 103). Chemistry results for most pollutants indicated that increasing frequency of sweeping from once to twice per week indicated no discernable difference in the effectiveness of constituent removal. (In other words, the pollutant removal did not decrease with increased frequency.)

[*] Statistically Significant
Note: no entry indicates report did not address

1. M = mechanical sweeper, R = regenerative air, V = vacuum assisted.
2. Study designs: (1) single road segment(s) subjected to before and after sweeping, (2) single road segment(s) with period of no sweeping followed by period of sweeping, (3) paired testing involving control (unswept) and test (swept) road segments.
3. Costs are adjusted for 2011 dollars (http://www.usinflationcalculator.com/).
4. Data illustrated in order by Downtown, Keyes, and Tropicana sites, all good condition asphalt.
5. Authors suggest that increase in fines may be related to abrasive action of wire bristles attached to gutter brooms for mechanical sweepers, also state that mechanical brooms and regenerative air sweepers were unable to pick up particles less than 250 um and 125 um, respectively.
6. All estimates of pre vs post dust/dirt load for this study based on material collected in sweeper hopper.
7. San Jose controlled tests using synthetic street surface contaminant, reported units are in grams over test area that averaged 50 feet long and 8 feet wide.
8. Data are organized by sweeper type, with first four entries Mobil-TE-3 broom sweeper, and last 2 entries are Tymco-300 broom sweeper.
9. Based on hopper volume data compiled and reported by the cooperating agencies; includes trash and vegetative debris, and density of 6.43 lbs/gallon.
10. Northbound side of test road segment.
11. Southbound side of test road segment.
12. Actual sweeping costs, does not include solids handling (estimated at $34/wet ton) and disposal ($43/wet ton).
13. Does not include capital costs, but includes O&M, supplies, equipment depreciation, and disposal.
14. Median effectiveness estimates ordered by site: West Seattle (residential), Southeast Seattle (residential), and Duwamish (industrial).

Appendix B. Summary of Reviewed Stormwater Conveyance System Characterization and Effectiveness Monitoring Studies

Reference	Location	Period	Land Use and Site Information	Pollutants	Study Design	Cleaning Frequency	Effectiveness			Particle Size Distribution	Costs (2011)[1]	Summary/Benefits
							Sediment Load Removed (lbs)	% Reduction in Pollutant Concentrations	Pollutant Load Removed (lbs)			
Bay Area Studies												
Sartor and Boyd 1972	San Francisco, CA	1972	Residential		Controlled tests to evaluate effectiveness of empty catch basins and partially-filled catch basins							For a simulated heavy rainfall intensity (1/2 in/hr.), the empty catch basin was reasonably effective in removing solids with a diameter larger than 246 µm, and ineffective at removing fine solids. For a partially-filled catch basin, the results indicated that most of the material originally contained in the catch basin appeared to remain, regardless of the runoff volume.
Pitt 1979	San Jose, CA	1979			Fluorescent tracer experiment to determine movement of sediment from a constructed catch basin and through the storm drain pipes to creek outfall.							The particles located at the bottom of the catch basin were discharged into the stormwater conveyance system during larger storms. Overall depth of material in the catch basin decreased approximately 20%.
Pitt and Shawley 1981	Alameda County, CA	Sept. 1979	Residential		Accumulation measured in 20 inlets after being cleaned every 1 or 2 years		60 lbss of dry particulates /inlet			Median inlet particle size - 2300 µm; median street particle size - 500µm	$0.31 - total solids[2]	Based on these sediment in 20 inlets, authors estimated that about 12,000 pounds of dry particulates were present in a total of approximately 200 inlets in the Castro Valley area.
Mineart and Singh 1994	Alameda County, CA	Dec. 1992-Oct. 1993	20 inlets each in residential, commercial and industrial areas	Metals (lead, zinc and copper), petroleum hydrocarbons, and polynuclear aromatic hydrocarbons (PAHs)	Sediment accumulation in inlets based on cleaning frequencies	1. Monthly 2. Quarterly 3. Semi-annually 4. Annually	1. 9 2. 18 3. 30 4. 24[3]		1. 270 2. 38 3. 19[4]	A grain size analysis indicated that over 80% of all inlet sediments were sand (within the range of 62-2,000 microns)		Study showed that for all land uses monthly inlet cleaning removed the most sediment on an annual basis (3-5 cubic feet) and greatest mass of pollutant. For industrial land use, there was a clear decrease in sediment volume and mass removed with decreased frequency. Increasing the cleaning frequency to monthly appeared to significantly increase the removal of copper.
Salop 2004	Alameda County, CA	2004	Various (pre-1950s urban, mixed urban, and recent urban)	PCBs and mercury	Desktop evaluation of inlet cleaning	Annual and semi-annual		Potential decrease of 0.2% PCBs and 43% mercury if inlet cleaning increased from annual to semi-annual			$355,000 (disposal costs)	Desktop analysis using available MS4 information. Estimated mass of PCBs and mercury removed by annual inlet cleaning and increased cost of increasing frequency to semi-annual cleaning.

Appendix B. Summary of Reviewed Stormwater Conveyance System Characterization and Effectiveness Monitoring Studies

Reference	Location	Period	Land Use and Site Information	Pollutants	Study Design	Cleaning Frequency	Effectiveness			Particle Size Distribution	Costs (2011)[1]	Summary/Benefits
							Sediment Load Removed (tons)	% Reduction in Pollutant Concentrations	PCB Load Removed (g)			
Salop 2004	Alameda County, CA	2004	Mixed (various MS4s)	PCBs and mercury	Desktop evaluation of channel de-silting				10.2 of PCBs and 77.6 of mercury[5]		$1.2-22.5 million	Desktop analysis using available MS4 information. Estimated mass of PCBs and mercury removed by increasing channel de-silting rates from the period 1990-2004 to those of the period 1979-89.
Salop 2006	Alameda County, CA	2006	Various (pre-1950s urban, mixed urban, and recent urban)	PCBs and mercury	Assessed additional removed sediment among a combination of inlets and catch basins across different land use types with an additional wet season cleanout	Two wet season cleanouts			0.2 of PCBs and 0.2 of mercury with an additional wet season cleanout	5% of the total dry mass was in the <63 µm particle size fraction, 63% in the 63-2000 µm fraction and 32% in the >2000µm[6]		Conducted targeted studies to confirm previous 2004 estimates. Less than an estimated 0.1 kg mass each of PCBs and mercury would be collected with an additional wet season cleanout. Salop noted that a catch basin with a sump had greater storage capacity.
Salop 2006	Alameda County, CA	2006	Industrial/ commercial	PCBs and mercury	Collected samples from two pump stations for characterization					% fines in the < 2mm fraction were 2% at Ettie Pump Station and 5% at Pleasanton pump station		Collected samples from two pump stations to determine volume of material and pollutant mass removed. Salop noted that estimates of pollutant mass contained within a pump station can vary greatly based upon pollutant concentrations measured at any one point in time.
Mangarella et al. 2010	Bay Area	2010		PCBs and mercury	Desktop evaluation of inlet cleaning	Quarterly			0.9 lbs/yr PCBs 10.2 lbs/yr mercury[7]			Desktop Evaluationto found the 'unit loading[8]' for both mercury and PCBs were found to be highest for industrial and commerical areas. Application of these street sweeping and inlet cleaning in elevated industrial areas were thought to result in relatively higher PCB load reductions. Street washing was found to result in low load reductions.
Studies Outside Bay Area												
Grottker 1990		1990	Unknown		Simulation model based on data collected from 200 gully pots							Correlation analysis results confirmed that the pollutant removal effectiveness of a gully pot was mainly dependent on the flow rate. Average annual dry weight of the collected material was about the same as that of a pollutant load of a single storm. Thus, the removal efficiency of the gully pots appeared to be minimal.

Appendix B. Summary of Reviewed Stormwater Conveyance System Characterization and Effectiveness Monitoring Studies

Reference	Location	Period	Land Use and Site Information	Pollutants	Study Design	Cleaning Frequency	Effectiveness			Particle Size Distribution	Costs (2011)[1]	Summary/Benefits
							Sediment Load Removed (tons)	% Reduction in Pollutant Concentrations	PCB Load Removed (g)			
Herrera 2009	Seattle, WA	1. Two sites, June 2006-June 2007 (1 yr.); 2. One site, Nov. 2006-June 2007 (8 mths.)	1.Two residential sites 2. One industrial site	Solids	Monitored sediment accumulation in 12 catch basins located in the three sites to assess effect of periods of sweeping and no sweeping.	Sediment accumulation monthly from swept (once every two weeks) and non-swept sites	Swept sites: 1. 1,160 and 1,260 2. 400 Unswept sites: 1. 1,120 2. 520 3. 280[9]			Swept sites: 1. 14-48% 2. 24-44% Unswept sites: 1. 17-29% 2. 26-51%[10]	$0.44/ wet kg sediment and $0.78/ dry kg sediment[11]	Tests did not indicate a statistically significant change in the accumulation of sediments in catch basins between the swept and non-swept sites. Most of the catch basins monitored were less than 10% full at the end of the study period in both swept and non-swept areas.
Jartun et al. 2008	Bergen, Norway	Oct.-Nov. 2004	Urban harbor area	PCBs, PAHs, total organic carbon, and heavy metals	Source and pathway identification of sediment pollution in 68 stormwater traps					21 sediment samples ranged from mostly clay and silt to a main fraction of coarse sand. The median grain size ranged from 23–646 μm, with diameters 250–300 μm being the most frequent.		A Principal Component Analysis of the investigated components indicated a correlation between TOC, PCBs, PAHs and mercury. The authors explained the correlation by a strong sorption between PCBs and PAHs to soil organic matter (Krauss et al. 2000) and the relationship between organic matter and mercury as described by Sanei and Goodarzi (2006).
Law et al. 2008	Baltimore, MD	Jan. 2006 – July 2007	1. High density residential 2.Industrial/ commercial	Total solids, nutrients and metals	Monitored sediment accumulation in an area with biweekly street sweeping	Sediment accumulation measured monthly between a spring and fall cleanout	1. 13.4 lbs/yr 2. 2. 53.7 lbs/yr[12]	Total solids: 18%, annual cleanouts 35%, semi-annual cleanouts		1. 22-41% 2. 33-39%[13]		Daily accumulation rates were found to be statistically significant for both land use types, with residential land use, 0.001-0.005 ft^3/day, and commercial/industrial land use, 0.011-0.013 ft^3/day. The particle size distribution for the inlet material was similar to that of the street dirt.

Appendix B. Summary of Reviewed Stormwater Conveyance System Characterization and Effectiveness Monitoring Studies

Reference	Location	Period	Land Use and Site Information	Pollutants	Study Design	Cleaning Frequency	Effectiveness			Particle Size Distribution	Costs (2011)[1]	Summary/Benefits
							Sediment Load Removed (tons)	% Reduction in Pollutant Concentrations	PCB Load Removed (g)			
Pitt and Field 2004[14]	1.Bellevue, WA 2. Stafford Township, NJ	1. 1980-83 2. 1994	1. Two mixed, medium density residential and commercial areas 2. Residential area	1. Solids, chemical oxygen demand, nutrients (nitrogen and phosphorus), and metals (lead and zinc) 2. Solids	1a. 4 conditions examined in two study areas: no controls, street cleaning alone, catch basin cleaning alone and both street and catch basin cleaning together; 1b. Sediment accumulation in more than 200 inlets after a single cleaning over two-year period. 2. Paired samples of inflow and outflow of inlet devices analyzed.			1. 10-25% in lead and solids and 5-10% in zinc 2. 20% of total solids and 30% of suspended solids				Two studies were reviewed regarding sediment accumulation in catch basins with sumps and storm drain pipes. Catch basins removed up to 30% of the suspended solids load that entered the structures. Much of this material was relatively coarse and may lack mobility and have relatively low pollutant concentrations. Catch basins accumulated sediments until reaching approximately 60% of the total sump capacity, when the sediment reached equilibrium (i.e., scour balancing new deposition). A one-time survey found that pipes that had significant amounts of sediment were either sloped less than 1.5% or located close to a source of sediment.

Note: no entry indicates report did not address

1. Costs are adjusted for 2011 dollars (http://www.usinflationcalculator.com/).
2. Unit costs to remove a pound of constituent, based on one inlet cleaning. This figure is based on limited data, and it is not known what is included in this cost.
3. Median mass collected per inlet by frequency (values listed according to order of frequency in respective column).
4. Annual copper loads reduced based by frequency (values listed according to order of frequency in respective column).
5. Increased removed mass of PCBs if channel de-silting was increased to rates from the period 1990-2004 to that of 1979-89.
6. Based on particle size distribution of annual sediment samples
7. Projected load rates are presented as Individual mass values were not given. Results given are for industrial land use; commercial area did not show an estimated change, and residential areas showed a decrease in loads.
8. Unit loading was calculated by dividing the annual loads from each land use by the area of that land use.
9. Sediment mass removed from inlets at swept and unswept sites. Values presented respective to land use types.
10. Percentage of fines represent particle sizes < 250µm (fine sand and silt/clay)
11. Inspection, cleaning, material handling, and disposal costs were included in the estimate. Cleaning estimates increased with decreased moisture content.
12. Rates are presented as individual mass values were not given.
13. Percentage of fines represent particle sizes < 250µm (fine sand and silt/clay). Values presented respective to land use types. Range in percent fines for residential land uses likely due to different physiographic
14. Pitt and Field (2004) review two past studies regarding 1) sediment accumulation and pollutant concentrations in catch basins with sumps and storm drain pipes and 2) compared effectiveness of catch basin to others with filters. Entries in the table correspond to both studies.

Appendix C. Summary of Reviewed Street and Storm Drain Flushing Characterization and Effectiveness Monitoring Studies

Reference	Location	Period	Land Use and Site Information	Pollutants	Study Design	Effectiveness			Particle Size Distribution	Costs (2011)[1]	Summary/Benefits
						Sediment Load Removed (lbs)	% Reduction in Pollutant Concentrations	PCB Load Removed (lbs)			
Bay Area Studies											
Dunlavey 2011, Personal Communica-tion	San Jose	2000-2006	Single street in Industrial/ Commercial	PCBs	Source identification and abatement on single street		7,000		0.0008-0.14 of PCBs		$27,700[2]
Kleinfelder 2006	Oakland, CA	June 2004-June 2006	Industrial /Commercial (Ettie St. Pump Station Watershed)	PCBs and mercury	Source identification and abatement of two priority areas, each a block long	Area 1 – 2,177 Area 2 – 33,929		Area 1 – 0.0056 Area 2 – 0.0114		$111,000 to remove 20 tons of sediment containing 9g of PCBs from 921 ft ($5,500 to remove 0.4g PCBs/ton sediment)[3]. Est. cost to abate remaining 9 identified priority areas - $930,000 for 7,990 ft with an est. amount of 47 g of PCBs.	Report summarized a project to further investigate, identify, and abate sources of PCB-containing sediment in the watershed. Two of 11 priority areas were high-pressure washed after excess dry sediment was removed using a Bobcat excavator or a brush and shovel. Sediment and wash water were vacuumed into a self-contained vacuum truck with a capacity of 3,000 gallons.
Kleinfelder 2007	Oakland, CA	May 2007	Industrial /Commercial (watershed focus)	PCBs and mercury	Effectiveness evaluation of abated areas		Area 1 @ 2 sites – 42%, 75% and Area 2 @ 3 sites – 94%, 83% and 27%				The two areas abated in Kleinfelder (2006) were resampled to determine effectiveness. Findings found significant reduction in PCB concentrations.
Salop 2007	Oakland, CA	May 2007	Industrial /Commercial (watershed focus	PCBs and mercury	Evaluation of non-treated areas (controls)		Little to no change				Sampling sites (to supplement Kleinfelder 2007) were chosen from the list of high priority sites in Kleinfelder's 2006 report. The concentrations from pre- and post-abatement periods were relatively similar at each sampling site.
Studies Conducted Outside of the Bay Area											
Amato et al. 2010											Review of research on the effects of street cleaning and washing in the abatement of PM[4] emissions. Results indicated that, in general, a combination of street sweeping and subsequent washing was a reliable control measure to mitigate PM emissions from road dust re-suspension.

Appendix C. Summary of Reviewed Street and Storm Drain Flushing Characterization and Effectiveness Monitoring Studies

Reference	Location	Period	Land Use and Site Information	Pollutants	Study Design	Effectiveness			Particle Size Distribution	Costs (2011)[1]	Summary/Benefits
						Sediment Load Removed (lbs)	% Reduction in Pollutant Concentrations	PCB Load Removed (lbs)			
Gromaire et al. 2000	Paris, France	2000	Three single streets in a densely-populated residential and commercial district with a combined sewer system	Solids and metals	Before and after street washing						

Note: no entry indicates report did not address

1. Costs are adjusted for 2011 dollars (http://www.usinflationcalculator.com/).
2. The cost for Clean Harbors to perform the one-day cleanout and dispose of the collected material at the hazardous waste facility. Although this amount includes Clean Harbors' field crew and transport and disposal of the material, it does not include San Jose staff time, analytical testing costs, and cost to video the storm drain line before and after the line cleaning. San Jose estimated that the amount could increase to $50,000 if these latter costs are considered.
3. This amount included disposal of the sediment at a Class I Hazardous Waste landfill as a result of elevated concentrations of lead. Kleinfelder (2006) also reported on the amount of sediment removed by the Alameda County Public Works Agency (ACPWA) at the Ettie Street Pump Station between 2001 and 2006. ACPWA estimated it cost $27,500 to remove 70 tons of sediment with 19.1 g of PCBs in 2006. This cost only included labor, as the County disposed of the sediment at its own facility.
4. Atmospheric particulate matter (PM) is a complex mixture of components arising from a number of emission sources (anthropogenic and natural) and atmospheric processes (secondary PM). Two common categorizations of PM are PM10 (particles with mean aerodynamic diameter <10 µm) and PM2.5 (particles with mean aerodynamic diameter <2.5 µm), which is considered the fine fraction (Amato 2010).

Prepared for

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Clean Watershed for a Clean Bay

Task 5 Implementation Plan Report

Municipal Regional Permit
Provisions C.3.c.i (2) and C.3.c.iii(1)

Prepared by

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16 August 2011

Draft Report - For Discussion Only

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

1. INTRODUCTION

1.1 CW4CB Project Background

The Bay Area Stormwater Management Agencies Association (BASMAA) is implementing a project to improve water quality in San Francisco Bay called Clean Watersheds for a Clean Bay (CW4CB). CW4CB is evaluating a variety of potential control options to reduce mass loadings of polychlorinated biphenyls (PCBs) as well as mercury and other pollutants in urban stormwater runoff to the Bay. The project will lay the groundwork for meeting Total Maximum Daily Load (TMDL) waste load allocations and restoring water quality in the future.

The project work plan consists of seven tasks. In Task 2 and Task 3, CW4CB has selected five high priority subwatersheds that discharge urban runoff with PCBs and other pollutants to the Bay, will identify PCB and mercury source areas within the project subwatersheds, and will refer these sites to regulatory agencies for cleanup and abatement. In Task 4, CW4CB is developing methods to enhance removal of sediment with PCBs and other pollutants during municipal sediment management activities. The objective of Task 5, the focus of this report, is to retrofit eight to ten urban runoff treatment facilities into existing infrastructure throughout the Bay Area and to evaluate their effectiveness at removing PCBs and other pollutants of concern. Task 6 will facilitate development and implementation of a regional risk reduction program that focuses on educating the public about the health risks of consuming certain species of Bay fish that contain high levels of PCBs and mercury. The knowledge and experience gained and the lessons learned during CW4CB will be promoted and made readily available to inform future similar efforts by others in the Bay Area and elsewhere in California and the United States as part of Task 7.

CW4CB is facilitated through a partnership among Bay Area municipalities and countywide municipal stormwater management programs and is funded by a grant to BASMAA from the United States Environmental Protection Agency (EPA). The total project cost is $7.04 million - $5M from USEPA and $2.04M matching funds from Bay Area municipal stormwater agencies, municipal wastewater treatment agencies, and industrial dischargers. The planned project period is four years (July 2010 – June 2014).

1.2 CW4CB Task 5

The objective of CW4CB Task 5 is to select and implement representative urban stormwater treatment retrofit projects that can be used to evaluate potential PCB load reductions at the larger Bay Area scale. This objective coincides with Municipal Regional Stormwater NPDES Permit (MRP, Order R2-2009-0074) provision C.12.e, which requires the permittees to identify and conduct on-site pilot treatment projects in ten locations during the MRP permit term and to document the knowledge and experience gained to provide a basis for determining the scope of implementation of on-site treatment retrofits in subsequent permit terms.

A CW4CB Task 5 Workgroup (Workgroup) was formed to facilitate the selection and implementation of the ten pilot projects. The Workgroup includes representatives from the EPA, the San Francisco Bay Regional Water Quality Control Board (SFRWQCB), BASMAA, BASMAA member agencies, and their consultants. Table 1 lists the Workgroup members (in alphabetical order).

Table 1: CW4CB Task 5 Workgroup

Name	Organizational Affiliation	Title
Khalil Abusaba	Brown & Caldwell	CCCWP Support
Lisa Austin	Geosyntec Consultants	Task Manager and Alameda CWP Support
Geoff Brosseau	BASMAA	Principal Investigator
Jamison Crosby	CCCWP	PMT representative
Kevin Cullen	FSURMP	PMT representative
Eric Dunlavey	City of San Jose	PMT representative
Arleen Feng	Alameda CWP	PMT representative
Jon Konnan	SMCWPPP	Project Manager and PMT representative
Richard Looker	SFRWQCB	SFRWQCB PCB TMDL Lead
Lynne Scarpa	City of Richmond	PMT representative
Chris Sommers	SCVURPPP	PMT representative
Rebecca Tuden	City of Oakland	PMT representative
Erica Yelensky	EPA	EPA Project Officer

PMT – Project Management Team

CW4CB Task 5 can be considered in the five phases described below:

Phase 1 Select Retrofit Pilot Projects (May through October 2011): Develop and implement a strategy for selecting appropriate locations for ten pilot retrofit projects. Prepare conceptual designs for the specific treatment facility best suited for each location. Provide planning level cost estimates for construction and O&M. The final product of Phase I is an Implementation Plan Report that describes each of the selected sites; each site's tributary catchment, land uses and expected pollutant concentrations; the selected treatment facilities; and planning level cost estimates.

Phase 2 Construction Planning and Permitting (May 2011 through April 2012): Conduct the necessary planning for constructing and monitoring of the ten pilot projects. By the end of Phase 2, a complete construction package including necessary design plans and specifications should be completed for each site that will be constructed. Evaluate the need for, and, if necessary, complete CEQA documentation and obtain necessary permits. Prepare a Sampling and Analysis Plan that is integrated with a Regional Study Design for each pilot project. Contract with the Cities for distribution of construction funds.

Phase 3 Construction Activities (May 2012 through October 2012): Install BMPs at the selected locations. Phase 3 work will be carried out by the municipality in whose jurisdiction the project is located.

Phase 4 Monitoring (2012/2013 wet season): Monitor each of the ten retrofit projects.

Phase 5 Reporting (Draft to Workgroup by January 15, 2014; Submit to Water Board by March 15, 2014): Monitoring contractor prepares section on field and lab work including QC review.

1.3 Report Organization

Section 2 of this report discusses the selection criteria and process used by the Workgroup to identify potential retrofit locations and to select ten projects for implementation. Project concepts for seven of the top ten potential projects are provided in Section 3. Section 4 discusses the next steps for implementation and the CW4CB Task 5 project schedule.

2. SITE SELECTION

2.1 Selection Criteria

Retrofit project site selection criteria included a variety of factors. Per MRP Provision C.12.e, the pilot study locations should be selected primarily on the basis of elevated PCBs concentrations with additional consideration to mercury concentrations, and the proposed retrofit projects should span treatment types and drainage characteristics.

The criteria used to select potential retrofit sites are listed below:

- **Pollutant loading:** Selected projects should have drainage catchments in the vicinity of medium to high detections of PCBs in past monitoring studies and/or should have current or historical land uses in the drainage catchment associated with medium to high PCB loadings. Potential mercury loadings were also assessed and considered.

- **Representativeness as a demonstration project:** The selected locations and drainage catchments should be representative, as a group, of the range of implementation feasibility characteristics within the MRP area.

- **Stormwater treatment measures**: Selected projects should include a range of stormwater treatment measures, including low impact development (LID measures) and conventional treatment measures. Hydrodynamic separators should be included as they are being installed across the Bay Area under a separate MRP provision related to trash reduction.

- **Ease of implementation:** Selected projects must be able to move forward with design, construction, permitting, and monitoring with reasonable design, permitting, and construction efforts within the grant and MRP deadlines (i.e., monitoring results should be included in the MRP's March 15, 2014 Integrated Monitoring Report).

- **Parcel ownership:** Selected projects may include publicly-owned parcels, privately-owned parcels, new and redevelopment parcels, or public/private partnerships, provided that the owner allows adequate access to the site for monitoring.

- **Feasibility considerations:** Feasibility of design and construction of treatment measures was considered for project selection. These considerations include the presence of adequate space for treatment, accessibility for construction and operation and maintenance, lack of engineering barriers (e.g., existing utilities, site hydraulics, tidal issues, or geotechnical concerns) and other political factors (e.g., public visibility, municipality concerns, or neighboring citizen concerns).

- **Project location:** Per MRP Provision C.12.e, every county (San Mateo, Contra Costa, Alameda, Santa Clara, and Solano) should have at least one location.

2.2 Project Selection Process

The project selection process began with a Call for Projects to the BASMAA member agencies and independent evaluation of additional sites. The response to the Call for Projects was screened through correspondence with proposed project representatives and using available PCB data to identify those sites that warranted further consideration. Site visits were then conducted to identify those sites that best met the selection criteria listed above. Final selection was based on discussion and recommendations by the Workgroup. Table 2 outlines the steps taken to select the retrofit projects. Each step is further described below.

Table 2: Retrofit Pilot Projects Selection Process

Selection Process Steps	Date Complete
Call for Projects Sent Out	May 1, 2011
Submittal of Proposed Projects	May 31, 2011
Preliminary Screening of 27 Proposed Projects	June 21, 2011
Workgroup Meeting; Selection of 14 Potential Projects	June 22, 2011
Site Visits of Potential Projects	July 26, 2011
Workgroup Meeting to Discuss Site Visits; Selection of Top 6 Projects	July 27, 2011
Further Evaluation of 4 More Projects	August 12, 2011

2.2.1 Call for Projects

On May 1, 2011, a Call for Projects was sent out to Program representatives to assist in identifying potential retrofit projects. The stated purpose of the Call for Projects was to "seek participation from municipal permittees in assembling a list of municipal Capital Improvement Plan (CIP) candidate projects that include or could be modified to include stormwater treatment retrofits."

The Call for Projects summarized the preferred outcomes of the site selection process:

- Identify at least ten locations that present opportunities to install and evaluate treatment systems (e.g., detention basins, bioretention units, sand filters, infiltration basins, treatment wetlands).
- Assess the best treatment options for those locations.
- Select sites to perform pilot studies, with a minimum of one in each MRP county (San Mateo, Contra Costa, Alameda, Santa Clara, and Solano).
- Conduct pilot studies in 10 selected locations, which should span treatment types and drainage characteristics.

The Call for Projects also included a list of considerations for eligible projects. Important considerations listed in the Call for Projects were:

- The project may be already constructed, under construction, or sufficiently advanced in design and planning to allow construction by October 2012.
- The project already incorporates treatment device(s) or presents a fairly easy opportunity for adding one or more treatment devices through which stormwater runoff can be diverted.
- Proposed retrofit would treat runoff from an urban area where PCBs/mercury may be present.
- Proposed retrofit would require minimal or no CEQA permitting.
- Proposed retrofit would be safely accessible for monitoring by CW4CB contractor.
- Municipal commitment to ongoing maintenance of proposed retrofit.

Twenty-four responses to the Call for Projects were received on May 31, 2011. These projects, along with other projects independently examined as part of the selection process, are listed in Appendix A, Table A-1.

2.2.2 Preliminary Screening

A preliminary screening of the projects submitted in response to the Call for Projects was conducted to establish the desired range of land use and implementation feasibility characteristics. To do this, project attributes, including program, city, proposed treatment measures, adjacent land uses, construction/design phase, proximity to detected PCB concentrations, and other distinguishing factors were summarized. This allowed inspection of different groupings of projects and provided a means for comparing projects. Based on the project information that was supplied, a preliminary desktop evaluation was conducted to determine potential site constraints using GIS datasets and aerial imagery. Following desktop evaluation, the preliminary selected sites were determined by the Workgroup to meet the criteria included in section 2.1 above.

To the extent feasible, the project site locations and drainage catchments were selected to be representative, as a group, of medium to high PCB loading and the range of implementation feasibility characteristics within the MRP region. These projects were researched further via site visits, discussions with project representatives, and a comprehensive analysis of available GIS datasets and aerial imagery.

Pollutant Loading

PCB Loading

The potential for medium to high PCB loads in stormwater runoff from each project site's drainage catchment was determined by analyzing available sediment data in a comprehensive database provided by the San Francisco Estuary Institute (SFEI), in addition to inspection of adjacent current land uses and historical industrial land uses. The database obtained from SFEI summarized results from the studies shown in Table 3. All of the studies listed in Table 3 (exclusive of the SFEI 2010 data) in the SFEI database did not indicate what data (if any) were less than the minimum detection limit (MDL); but rather included numerical estimates for all data records. The SFEI 2010 data did indicate non-detected data using the identifier "<MDL", and these data represent a little over a quarter of the total data set (194 of 724 data points). For the purpose of assigning concentrations to represent "High", "Medium" and "Low" PCB presence, these "<MDL" values were set equivalent to zero. The PCB results were ranked as shown in Table 4 below, which also includes the cumulative percentile corresponding to each concentration range.

Table 3: Studies included in SFEI Database

Author, Year	Title of Study
City of San Jose and EOA, Inc. 2003	Year Two Case Study Investigating Elevated Levels of PCBs in Storm Drain Sediments in San Jose, California
EOA, 2007	Summary of Polychlorinated Biphenyls (PCBs) Data in Sediment Collected from Richmond, California Streets and Storm Drains
EOA, Inc. 2002	Case Study Investigating Elevated Levels of PCBs in Storm Drain Sediments in San Mateo County
EOA, Inc. 2004	Case Study Investigating PCBs in Storm Drain Sediments from Colma Creek, Colma, California
Gunther et al, 2001.	Initial Characterization of PCB, Mercury, and PAH Contamination in the Drainages of Western, Alameda County, CA

Kleinfelder Inc., 2005	Sediment Sampling Report: Ettie Street Pump Station Watershed, Oakland, California.
Kleinfelder Inc., 2006	Private Property Sediment Sampling Report: Ettie Street Watershed, Oakland, California.
KLI and EOA, 2002	Joint Stormwater Agency Project to Study Urban Sources of Mercury, PCBs and Organochlorine Pesticides
Salop et al., 2002a	Analysis of 2000-01 Source Investigations in Ettie Street Pump Station and Glen Echo Creek Watersheds, Oakland, California
Salop et al., 2002b	2000-01 Alameda County Watershed Sediment Sampling Program: Two-Year Summary and Analysis
SFEI, 2010.	Regional Stormwater Monitoring and Urban BMP Evaluation
STOPPP, 2003.	Case Study Investigating Elevated Levels of PCBs in Storm Drain Sediments in the Pulgas Creek Pump Station Drainage, San Carlos, California

Table 4: PCB Categories, Corresponding Concentration and Percentile

Category	Concentration (mg PCBs/ kg sediment)	Percentile
Very High	10.0 +	98% - 100%
High	1.0 – 10	90% - 98%
Medium	0.1 – 1.0	61% - 90%
Low	0.01 – 0.1	37%[1] – 61%
Very Low	Less than 0.01[1]	Less than 37%[1]

[1] The “Very Low” category also includes not-detected values, which were set to zero. These values could actually be equivalent to up to 0.073 mg/kg sediment (the maximum concentration of the MDL). Depending on the actual values of the not detected samples and their distribution, the percentile value separating the “Low” and “Very Low” categories could be lower than 37%. Other defining percentile values would not be affected.

For a distribution of the detected data, see Appendix B, Figure B-1 (note logarithmic axis). The percentiles listed on the figure represent the percentiles calculated including the non-detected data as zero values. The non-detected values are thus included in the “Very Low” category. However, the values of the “<MDL” noted samples listed in the SFEI data could be equivalent to up to 0.073 mg/kg based on the list of congeners used for the SFEI study (Yee and McKee, 2010). Thus, some “<MDL” data points could possibly fall in the “Low” category. While a more robust estimation of the distribution of the “<MDL” samples could be obtained from statistical analyses, it is not needed for the sake of ranking the selected sites because all the sites were selected based on proximity to a “Medium”, “High” or “Very high” PCB concentration. The percentile values above 0.1 mg/kg (61% and higher) would not change regardless of the estimated or actual values of the non-detected samples and their statistical distribution.

The distance selected to represent “proximity” to a medium or high PCB value was 2.5 kilometers, which is the distance estimated to be the maximum at which there is correlation of concentrations between proximate sites, per calculations by Yee and McKee (Yee and McKee, 2010). The 2.5-kilometer radius “halos” are shown and colorcoded based on concentration in Appendix B, Figure B-2. The locations of the screened retrofit projects are also shown on this figure.

In addition to the proximity to a "Medium", "High" or "Very high" PCB concentration, adjacent land uses and locations of historical industrial land uses were also considered when determining the PCB ranking of a site. The PCB rankings for all sites that were screened and those selected are listed in Appendix A, Table A-1 and Table A-2, respectively, and are illustrated in Appendix B, Figure B-2 and Figure B-3, respectively.

Mercury Loading

Mercury loadings in the vicinity of project sites were also determined using the SFEI database. All of the studies in the SFEI database did not indicate what data (if any) were less than the MDL; but rather included numerical estimates for all data records. Thus, the statistical issue presented in the PCB Loading discussion above did not carry over to the mercury distribution analysis.

The mercury results were ranked as shown in Table 5 below, which also includes the cumulative percentile corresponding to each range. Appendix B, Figure B-4 shows the proximity of projects to 2.5-kilometer radius mercury "halos".

Table 5: Mercury (Hg) Categories, Corresponding Concentration and Percentile

Category	Concentration (mg Hg/ kg sediment)	Percentile
Very High	2.0 +	98% - 100%
High	0.75 – 2.0	90% - 98%
Medium	0.25 – 0.75	63% - 90%
Low	0.01 – 0.25	20% – 61%
Very Low	Less than 0.01[1]	Less than 20%

2.2.3 Preliminary List of Retrofit Projects and Site Visits

On June 22, 2011, the Workgroup met to deliberate on a preliminary list of 14 projects that were screened from the initial list of 24 submitted and independently-identified projects. The preliminary projects that were selected for further consideration are listed in Table 6 below.

Table 6: Projects Selected for Site Visits based on Preliminary Screening

Program	Preliminary Projects
Alameda Clean Water Program (ACWP)	Ettie Street Pump Station Retrofit
	Fremont Tree Wells
	Oakland HDS Units (includes Alameda and High Streets HDS Unit and International and 73rd Streets HDS Unit)
Contra Costa Clean Water Program (CCCWP)	El Cerrito Green Streets
	Nevin Avenue Improvement
	PG&E Substation Retrofit
Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)	Leo Avenue HDS Unit
	Leo Avenue Sand Filter
	Mathilda Avenue Overpass
	River Oaks Pump Station
	Stanford Permeable Pavement
San Mateo Countywide Water Pollution Prevention Program (SMCWPPP)	Daly City Library
	Bransten Road Green Streets
Fairfield-Suisun Urban Runoff Management Program (FSURMP) and Vallejo	Solano County Project

Site visits were conducted to determine the feasibility of implementing the selected retrofit projects. Information collected during site visits included an inspection of the drainage area, information about the parcel(s), proposed treatment measure concept, design/construction phase, and inspection of proposed installation location. Additionally, project representatives were asked for more information as it was available, including design drawings, feasibility constraints, and cost and funding information. Additional information gathered in site visits is included in Appendix A, Table A-2.

2.2.4 Second Screening

Using information gathered from the site visits, as well as information gathered from project representatives and analysis of available GIS data and aerial images, ten sites were selected for further consideration. From this list of ten, the Workgroup selected six retrofit projects for implementation (Table 7). Project concepts for these six projects are provided in the Section 3 below.

Table 7: Projects Selected for Pilot Study by Workgroup

Program	Top Projects Selected
ACWP	Ettie Street Pump Station Retrofit
	Alameda and High Streets HDS Units
CCCWP	Nevin Avenue Improvement
	PG&E Substation Retrofit
SCVURPPP	Leo Avenue HDS Unit

Program	Top Projects Selected
SMCWPPP	Bransten Road Green Streets

In addition to the six projects listed in Table 7, the Workgroup agreed to further evaluate the projects listed in Table 8 below to achieve the target of 10 retrofit projects.

Table 8: Projects Selected for Further Evaluation

Program	Project Further Evaluated for Recommendation
ACWP	West Oakland Industrial Area Retrofit
CCCWP	El Cerrito Green Streets
SCVURPPP	TBD
Vallejo	Broadway and Redwood Streets Retrofit

Project concepts for the West Oakland Industrial Area Retrofit project and the Broadway and Redwood Streets Retrofit project are included in Section 3 below. A brief discussion of the El Cerrito Green Streets project is also provided. A second Santa Clara County project (in addition to the Leo Avenue HDS System project) has not yet been selected. Figures illustrating each project concept are provided in Appendix B.

3. PROJECT CONCEPTS

Project concepts are presented in this section for the selected projects. The project concepts include a discussion of the project background, the proposed treatment measure, catchment information, project design/ construction phase, and planning level cost estimates. The selected projects are in varying stages of design. For those projects with complete designs (i.e., the Nevin Avenue Improvement project and Alameda and High Streets HDS Unit), project design drawings or example specifications are referenced. For projects which in the conceptual planning stage (i.e., the Ettie Street Pump Station project, the PGE Substation project, the Bransten Road Green Street project, and the West Oakland Industrial Area project), treatment measure concepts are provided.

3.1 Ettie Street Pump Station Project

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 (Appendix B, Figure B-5). 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 1,200 acres in West Oakland and includes residential, commercial, and industrial areas. The proposed stormwater treatment measure for the project is a media filter system with two separate filter beds containing different media. The stormwater program and Alameda County representative for the project is Arleen Feng.

Treatment Measure Concept

The Ettie Street Pump Station project will install two parallel media filter beds to treat PCBs and mercury (Hg) that enter the Ettie Street Pump Station from the drainage catchment. The media filter would be located at grade outside the pump station building and would include a pump and pretreatment storage tank. The pump (nominally 1-2 gpm) would draw water up from one of the two wet wells into the pretreatment storage tank, designed to settle out the fine and coarse sand sizes (>63 µm).

Water from the pretreatment storage tank would then be split and conveyed to each tank containing the filter media. Water would be directed over a weir onto the surface of the media filter bed where it would infiltrate through the 2-foot-thick filter media to a 4 inch gravel drainage layer. One filter bed would contain sand and the second bed would contain a mix of media types, including sand, zeolite and granulated active carbon (GAC). The residence time in the pretreatment settling tank would be approximately 1.5 hours and the residence time in the sand filter bed would be approximately 12 hours.

To separate the filter media from the drainage layer, a geotextile filter fabric (or alternatively a choking stone layer) would be placed between the media and the drainage layer. Perforated PVC pipes (2 in diameter) would be located in the drainage layer to carry the water to a line to be discharged into the other wet well. The bottom of the filter bed would be sloped for drainage. The total depth of the media filter would be approximately 2 feet with an additional 6 inches for the underdrain layer.

The area of the pretreatment tank would be approximately 10 square feet and the total area of each filter bed would be approximately 50 square feet. These dimensions are well within the available project area identified as 14 feet by 14 feet and would allow space for access and testing (specific clearances to existing fence and structures will be provided at the start of the design phase).

Figure 1 below summarizes the proposed retrofit project configuration with respect to the primary components and monitoring locations. As shown in the figure, flows will be pumped from the Ettie Street Pump Station wet well through the settling tank, and then will be evenly split to each media bed using flow control valves. Discharge from the media beds will be combined prior to returning to the storm drain system. Flows will be continuously monitored and water quality grab samples will be collected at influent and effluent locations. Additional solids monitoring locations could be added at the inflow from the wet well.

The primary components for the retrofit project include the inlet works, media beds, underdrains, outlet works, tanks, flow control valves, in-line strainer, PVC piping and connections, sampling ports, flow meter, filtration media, geotextile, and the slotted underdrain.

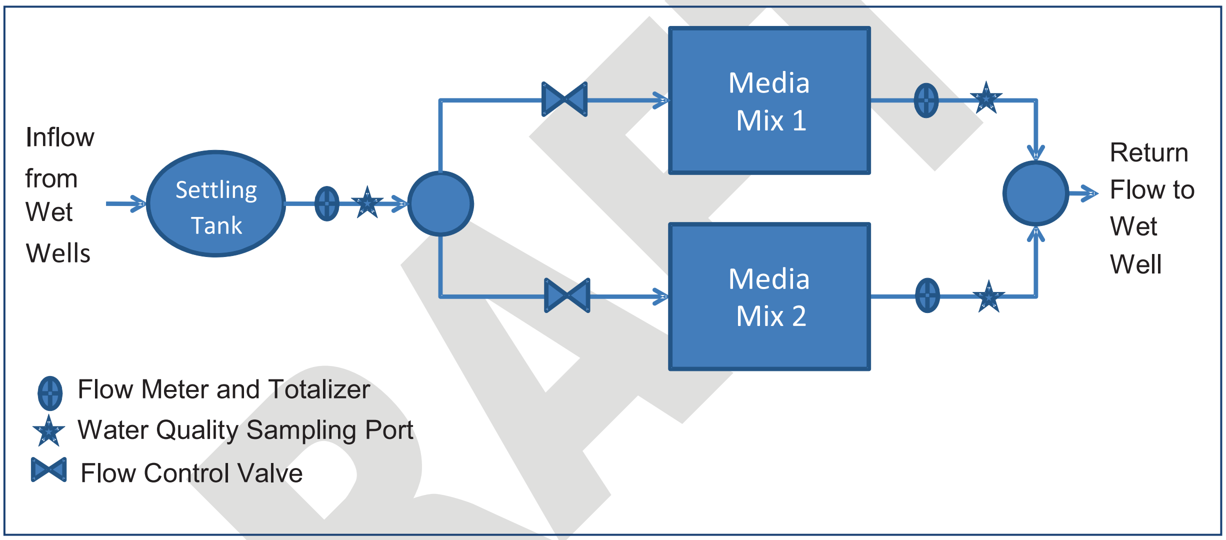


Figure 1. Overall Eddie Street Pump Station Pilot Project Components and Monitoring Locations

Project Design and Construction Schedule

The Ettie Street Pump Station Retrofit project is currently in the conceptual design phase. Design of the project would begin in November 2011 and construction would occur in 2012.

Project Catchment

The site is located in a highly industrial area, located adjacent to MacArthur Freeway to the north, Nimitz Freeway to the west, and industrial and residential areas to the south and east. The Ettie Street Pump Station receives rainfall and other flows from an approximately 1,200 acre watershed. The watershed contains mixed land uses currently comprised of approximately 42% residential, 38% industrial, and 20% commercial land uses.

PCBs have been previously found in sediments collecting at both the Ettie Street Pump Station and in the surrounding catchment. A 2010 report by East Bay Municipal Utility District (EBMUD) presents data from water samples collected between April 2008 and February 2010, during dry weather, first flush, and wet weather events at the Ettie Street Pump Station wet well inlet and diversion outlet. The EBMUD report states that average concentrations for PCB congeners for the pump station effluent were 2,930 pg/L, 19,900 pg/L, and 34,500 pg/L, for dry weather, first flush and wet weather flows respectively. Additionally from 2004 to 2006, the City of Oakland performed an evaluation of potential source properties and collection of sediment samples from right-of-way areas and private properties, which found elevated PCB concentrations (http://www2.oaklandnet.com/Government/o/PWA/o/FE/s/ID/OAK024739).

Project Costs

The estimated planning level costs for the Ettie Street Pump Station Retrofit project are provided in Table 9; cost references and details are provided in Appendix D.

Table 9: Ettie Street Pump Station Retrofit Project Cost Estimate Summary

Project Phase	Cost
Construction	$32,600
Design	$13,000
Maintenance	$3,000/year

3.2 Alameda and High Street HDS Unit

The City of Oakland Alameda and High Street Hydrodynamic Separator (HDS) Unit project is located at the intersection of Alameda Avenue and High Street in Oakland (see Appendix B, Figure B-6). Figure B-6 also shows the location of another planned HDS project, at International boulevard and 73rd Street, which serves as an alternate site for this project. These HDS units are planned for installation as part of Oakland's Trash Load Reduction Plan. The stormwater program representative for the project is Arleen Feng of the Clean Water Program and the City of Oakland representative is Rebecca Tuden.

Project Concept

The HDS unit proposed for project is the Contech CDS unit. The unit combines hydrodynamic forces and treatment screens to remove solids from stormwater. Specifications for the Contech CDS Model used for a City of Oakland HDS Project in 2010 (located near Lake Merritt) are provided in Appendix C.

Project Design and Construction Schedule

The project is in the design phase and is expected to go out to bid by September, 2011. Construction would take place in 2012.

Project Catchment

The Alameda and High Street CDS unit is located in a watershed with a high concentration of old industrial land uses, including historic rail lines. The current watershed is a mix of industrial and commercial land uses.

Both HDS unit locations are located within 3 kilometers of medium (0.1 – 1.0 mg PCBs/ kg sediment) PCB concentrations.

Project Costs

The project design, installation, and maintenance costs will be paid by the City of Oakland.

3.3 Nevin Avenue Improvement Project

The Nevin Avenue Improvement project is a planned streetscape project along Nevin Avenue between 19th Street and 27th Street in the City of Richmond. This project includes stormwater treatment measures integrated into the streetscape. Planned streetscape features include standard street trees and curb extensions to make the street more bicyclist and pedestrian friendly. The city's base contract for the project includes rain garden curb extensions as the primary stormwater treatment measure. Additional treatment measures would be added by the CW4CB project, including permeable pavers with subterranean drainage, porous asphalt concrete pavement, and tree well filters. The stormwater program representative for the project is Jamison Crosby, with the Contra Costa Clean Water Program, and the municipal representative is Lynne Scarpa, Environmental Manager for the City of Richmond Stormwater Program.

Project Concept

The Nevin Avenue Improvement project is a streetscape project along eight blocks of Nevin Avenue, from the Richmond BART station to Richmond City Hall (See Appendix B, Figure B-7). The primary stormwater treatment measure proposed along Nevin is rain garden (bioretention) curb extensions. A total of 4,200 square feet of the bioretention curb extensions are proposed for as part of the improvements.

Additional stormwater treatment features proposed for the project include a pilot treatment train. The treatment train would include permeable pavers with subterranean drainage, porous asphalt concrete pavement, and tree well filters, along with the bioretention curb extensions, and would be installed on two blocks of the project (from 24th to Civic Center along Nevin Avenue). The treatment train concept would allow for added treatment benefit in this space-constrained location.

Project Design and Construction Schedule

The Nevin Avenue Improvement project is currently in the final design phase. Design of this project is scheduled to be completed in February, 2012. The project construction will be posted for bidders in April, 2012, and construction is proposed to begin in June, 2012. Schedule may change pending authorization from grant funding organizations.

Project Catchment

The site is located in a mixed civic, residential, and commercial area. Light industrial and historical industrial land uses are within close proximity to the Nevin Avenue Improvement project location. See Figure B-7 for the project extent and surrounding parcels. The project catchment contains mixed land uses. The area is largely residential in the lower blocks (19th through 23rd Streets), and is adjacent to the Richmond BART station. From 23rd to 25th Streets, the land use is largely commercial, and from 25th to 27th Streets, the City Hall buildings are the dominant land use (civic), with some commercial buildings interspersed.

The drainage to the treatment measures will be largely street drainage with possible drainage from adjacent parcels. Existing storm drains, partial culverts, and inlets can be seen in Figure B-7. Flow direction varies along the extent of the project. According to a survey obtained from City of Richmond, flow direction is to the west for the blocks between 19th Street and 23rd Street, and again for the blocks between 24th Street and 27th Street. Flow is to the east for the block between 23rd Street and 24th Street.

The site is adjacent to old industrial land uses and is within a 3 kilometer halo of high PCB concentrations.

Project Costs

A summary of the total cost of the stormwater treatment measures is included in the Table 10; cost references and details are provided in Appendix D (from BKF, e-mail correspondence August 2011).

Table 10: Nevin Avenue Improvement Project Cost Estimate Summary

Stormwater Treatment Measure	Unit	Cost per Unit	Total Proposed	Total Cost
Rain Garden Curb Extensions	sq-ft	$100	4,200 sq-ft	$420,000
Permeable Pavers with Subterranean Drainage	sq-ft	$80	1190 sq-ft	$95,000
Pervious Pavement	sq-ft	$10	3,200 sq-ft	$32,000
Tree Wells	•	-	-	$25,000
Total				**$572,000**

3.4 PG&E Substation Project

The PG&E Substation project is located at South 1st Street and Cutting Boulevard in the City of Richmond (See Appendix B, Figure B-8). PCBs have been detected in storm drains directly adjacent to the site as well as in the greater site vicinity. Bioretention facilities are the proposed stormwater treatment measure for the project. The stormwater program representative for the project is Jamison Crosby, with the Contra Costa Clean Water Program, and the municipal representative is Lynne Scarpa, Environmental Manager for the City of Richmond Stormwater Program.

Treatment Measure Design Concept

The proposed treatment measures for the project include bioretention facilities installed in the parkway adjacent to the PGE substation along Cutting Boulevard and South 1st Street (See Figure B-8). Bioretention Facility #1 would collect approximately 0.6 acres along Cutting Boulevard drainage and a small portion of the PGE substation entrance driveway. Bioretention Facility #2 would collect drainage from approximately two acres of South 1st Street and the substation. Figure B-9 illustrates similar bioretention treatment measures installed along roadways to those proposed for this project.

Project Design and Construction Schedule

The City of Richmond PG&E Substation project is currently in the conceptual planning phase. Design of this project would begin in November 2011. Construction of the project would occur in 2012.

Project Catchment

The PGE 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 which retains most stormwater runoff on the site. Ground cover is largely gravel, along with a parking lot which consists partially of concrete. There is no landscaping on site. There is landscaping (trees and mulch) and sidewalk to the south of the substation parcel, which runs along the public right-of-way of Cutting Blvd. There are also utilities (power line pole and a utility box) located along the landscaped strip. Along the eastern site boundary, there is bare compacted dirt and no sidewalk between the substation parcel boundary and South 1st Street.

There are two catch basins that the proposed project would connect to. The first catch basin (adjacent to Bioretention Facility #1 on Figure B-8) is located to the south of the substation directly adjacent to the driveway. This catch basin has an inlet depth of 3 to 4 feet based on visual inspection. The second (adjacent to Bioretention Facility #2 on Figure B-8) is located at the southeast corner of the site and has a drop inlet depth below storm grate of about one foot based on visual observation.

Sediment samples taken at the catch basins proposed for retrofit yielded high PCB concentrations.

Project Costs

The estimated planning level costs for the PG&E Substation project concept described above are provided in Table 11; cost references and details are provided in Appendix D.

Table 11: PG&E Substation Retrofit Project Cost Estimate Summary

Project Phase	Cost
Construction	$535,000
Design	$107,000
Maintenance	$2,500/year

3.5 Leo Avenue HDS Unit Project

The Leo Avenue Hydrodynamic Separator (HDS) Unit project is located on 7th Avenue just southeast of Phelan Avenue in southeast San Jose (see Appendix B, Figure B-10). This HDS unit is planned for installation as part of San Jose's Trash Load Reduction Plan, but a modified unit has been selected for enhanced sediment removal. The stormwater program representative for the project is Chris Sommers of the Santa Clara Valley Urban Runoff Pollution Prevention Program and the City of San Jose representative is Eric Dunlavey with the City of San Jose's Environmental Service Department.

Project Concept

The City of San Jose proposes to implement a modified prefabricated HDS unit which incorporates a larger sump for enhanced sediment collection.

Project Design and Construction Schedule

The project is in the design phase and is expected to go out to bid by February 2012. Construction would take place in 2012.

Project Catchment

The Leo Avenue HDS unit is expected to receive runoff from approximately 214 acres of commercial and industrial land uses. See Figure B-10 for the approximate catchment delineation.

Sediment samples taken on Leo Avenue, which is located within the project's drainage catchment have detected high levels of PCBs (SFEI database, 2010).

Project Costs

Cost estimates for the Leo Avenue HDS unit are currently under development, but are estimated to be approximately between $500,000 and $700,000.

3.6 Bransten Road Green Streets Project

The Bransten Road Green Streets project is located along Bransten Road, between Old County Road to the southwest and Industrial Road to the northeast, in the City of San Carlos. Curb extension bioretention facilities are the proposed stormwater treatment measure for the project. The countywide stormwater program representative for the project is Jon Konnan, with the San Mateo Countywide Water Pollution Prevention Program. The City of San Carlos representative for the project is Ray Chan, Acting City Engineer.

Project Concept

The concept plan is a green street retrofit along Bransten Road (see Figure B-11). Curb extension bioretention facilities are proposed along Bransten Road between Old County Road and Industrial Road. The curb extension bioretention facilities are proposed to be similar to the stormwater curb extension illustrated in the Countywide Program's Sustainable Green Streets and Parking Lots Design Guidebook and the City of Portland design schematic (see Appendix C). The curb extension bioretention facilities would include an underdrain where the storm drain is present and would not include an underdrain, if allowable, upgradient of the existing storm drain (on Figure B-11, the start of storm drain is indicated with a 'star' symbol).

Stormwater would flow into the facilities through a curb cut located at the upstream end of the curb extension. The outlet from the facilities would be an elevated curb cut at the downstream end, which would act like an overflow weir designed to provide for 12 inches of ponding depth across the facility. The facility cross-section would include 1.5 feet of bioretention media underlain by gravel to provide storage and potential infiltration below these facilities, provided it is allowable. Approximately 770 linear feet of curb extension bioretention facility without an underdrain are proposed upstream of the storm drain. Approximately 500 linear feet of curb extension bioretention with an underdrain are proposed. The curb extensions are proposed to be approximately 6.0 feet wide, yielding a proposed total area of curb extension bioretention without an underdrain of 4,620 square feet, and a proposed total area of curb extension bioretention with an underdrain of 3,000 square feet.

Project Design and Construction Schedule

The Bransten Road Green Streets project is currently in the conceptual planning phase. Design of this project would begin in November 2011. Project construction would occur in 2012.

Project Catchment

The site is located in a highly industrial area, located adjacent to Caltrain tracks and El Camino Real to the southwest, and the 101 freeway to the northwest. The combined acreage of the estimated catchment, which consists of Bransten Road and adjacent commercial and light industrial land uses, is approximately 25 acres. See Figure B-11 for estimated catchment delineation and an aerial view of surrounding parcels. The approximate area of the roadway right-of-way (sidewalks, parkways, and street width) is two acres. It is unknown if the drainage from the adjacent parcels flows into the street; it is assumed for this concept that parcel drainage would not be treated in the curb extension bioretention facilities.

Industrial land uses within the estimated tributary area include a concrete batch processing plant, a top soil facility, a transfer station and fire station, and other light industrial and commercial land uses, including a school bus yard.

Flow direction on the street is known to be towards the northeast. There are no storm drains along the upstream portion of Bransten Road. Beginning at 977 Bransten Road, there is a storm drain (unknown diameter) which runs along the center of the road towards Industrial Road. Soils underlying the site have low infiltration rates.

Sediment samples taken on Bransten Road have detected high levels of PCBs (SFEI database, 2010).

Project Costs

The estimated planning level costs for the Bransten Road Green Street project concept described above are provided in Table 12; cost references and details are provided in Appendix D.

Table 12: Bransten Road Green Streets Project Cost Estimate Summary

Project Phase	Cost
Construction	$600,000
Design	$120,000
Maintenance	$5,000/ year

3.7 West Oakland Industrial Area Project

The West Oakland Industrial Area Project is located in the vicinity of Peralta Street between 28th and 30th streets in the City of Oakland (See Appendix B, Figure B-12). PCBs have been detected in sediment at the site as well as in the greater site vicinity. Biofilter treatment measures (such as tree well filters) are proposed in up to three possible locations in the area. The stormwater program representative for the project is Arleen Feng with the Clean Water Program and the municipal representative is Rebecca Tuden with the City of Oakland.

Project Concept

The treatment measures would be designed to filter runoff from streets and an industrial site prior to discharging into adjacent catch basins. This project could be conducted cooperatively with Urban Releaf, an urban forestry/environmental non-profit 501(c)3 organization that was established in 1999 in the City of Oakland to address the needs of communities that have little greenery. Urban Releaf works with At Risk Youth organizations to promote and sustain community beautification projects, exposing youth to the various fields of arboriculture, biology, and advanced plant sciences. The At Risk Youth programs could be used to provide long term maintenance for the project.

Treatment measure option 1, which is proposed for Peralta between 26th street and 28th Street, is proposed to consist of three to four treatment measure facilities. The southern-most facility would involve retrofit of the existing catch basin on the corner of Peralta and 26th Streets to provide filtration or biofiltration of runoff prior to discharge to the storm drain. Additionally, a bioretention or biofilter facility is proposed for an existing sidewalk cut-out located one-third of the way between 26th and 28th. Finally, treatment measure option 1 would include retrofit of the catch basin located at Peralta and 28th streets to provide treatment of road runoff and runoff from the facility driveway located on 28th.

Treatment measure option 2 is proposed on Hannah street between 32nd and Peralta Streets. This facility would be designed as a biofilter or bioretention facility and would treat runoff along the street and possibly from the adjacent property, where an urban farm is proposed.

Treatment measure option 3 includes two facilities on Poplar Street, each adjacent to catch basins located on either side of 26th street. These facilities would be filtration or biofiltration catch basin retrofits, or possibly bioretention facilities.

Project Design and Construction Schedule

The West Oakland Industrial Area Project is currently in the conceptual planning phase. Design of this project would begin in November 2011. Construction of the project would occur in 2012.

Project Catchment

The project is located in the Ettie Street Pump Station watershed. The blocks adjacent to the three proposed treatment facility options 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. Treatment measure option 1 is adjacent to the seven acre Custom Alloys Scrap Sales Inc. (CASS) property. CASS recycles metals and produces aluminum alloys; this site generates much truck traffic. Treatment measure option 2 is located adjacent to an open lot which is currently overgrown with vegetation. An urban farm is proposed for that location.

The drainage areas for the proposed facilities range from approximately 0.5 acres and 2 acres, and largely consist of road land uses.

Sediment samples taken at the catch basins adjacent to the proposed facilities yielded medium to very high PCB concentrations.

Project Costs

The estimated planning level costs for the West Oakland Industrial Area project concept described above are provided in Table 13; cost references and details are provided in Appendix D.

Table 13: West Oakland Industrial Area Project Cost Estimate Summary

Project Phase	Option 1	Option 2	Option 3
Construction	$237,000	$314,000	$205,000
Design	$47,000	$63,000	$41,000
Maintenance	Maintenance performed by Urban Releaf		

3.8 El Cerrito Green Streets Project

The El Cerrito Green Streets Project includes two constructed flow-through biotreatment facilities. One is located at San Pablo and Madison Avenues and the second is located at San Pablo and Eureka Avenues, both in the City of El Cerrito (see Appendix B, Figure B-13). Details about this project can be found on the City's website (http://www.el-cerrito.org/esd/landscapeandwater.html) and at the San Francisco Estuary Partnership website (http:// http://www.sfestuary.org/projects/detail.php?projectID=41).

This project is planned for monitoring by the SFEI in the 2012/ 2013 wet season. The project is being evaluated to determine if additional benefit would be gained by including additional monitoring parameters for the purposes of the CW4CB project.

3.9 Santa Clara County Project

A second Santa Clara County Project is to be recommended for the selected pilot projects.

3.10 Broadway and Redwood Project

The Broadway and Redwood project is located east of Broadway between Redwood and Valle Vista in downtown Vallejo (See Appendix B, Figure B-14). The project would retrofit a vegetated swale in the area between Broadway and the Southern Pacific Railroad tracks. The land is owned by Southern Pacific but the Vallejo Sanitation and Flood Control District has an easement on the property that would permit construction of a treatment measure within the easement. Kevin Cullen, with the Fairfield-Suisun Sewer District, Lance Barnett, with Vallejo Sanitation & Flood Control District, and Sam Kumar with the City of Vallejo are the municipal leads for the project.

Project Concept

The treatment measure concept is to install a vegetated swale between the railroad tracks and Broadway. The width of the swale will be designed within the VSFCD easement. The length of the swale will ideally extend along the entire block of Broadway between Redwood and Valle Vista, but may be shorter depending on the final design. Curb cuts would be made through the existing curb along Broadway to divert roadway runoff into the swale.

Project Design and Construction Schedule

The Broadway and Redwood Project is currently in the conceptual design phase. Design of the project would begin in November 2011 and construction would occur in 2012.

Project Catchment

The catchment would include (1) that portion of Broadway (between Redwood and Valle Vista) that drains to the east (from the crown in the road) and (2) the area between the railroad tracks and Broadway (See Figure B-14). The portion draining from Broadway is completely impervious, whereas the area draining between the tracks and Broadway is mostly pervious. The land use can be characterized as transportation.

The site is within a 3 kilometer halo of high PCB concentration.

Project Costs

The estimated planning level costs for the Broadway and Redwood project concept described above are provided in Table 14; cost references and details are provided in Appendix D.

Table 14: Broadway and Redwood Project Cost Estimate Summary

Project Phase	Cost
Construction	$56,000
Design	$22,000
Maintenance	$5,000/year

4. IMPLEMENTATION OF RETROFIT PROJECTS

4.1 Construction Activities

To implement the retrofit projects, construction plans and specifications will be prepared and permits will be obtained (including environmental review as needed) for each of the retrofit pilot projects that will be constructed (Table 15).

A Request for Qualifications (RFQ) was released on July 29, 2011, for the selection of a design firm(s) who will conduct this work. The RFQ described the purpose of CW4CB Task 5 and requested Statement of Qualifications (SOQs) for the selection of qualified on-call engineering firms to provide engineering design services in support of CW4CB Task 5 objectives. Up to 3 design firms will be selected and work orders will be issued for specific facility design needs. The requested SOQs were due by August 26, 2011.

Table 15: Retrofit Pilot Projects Implementation Process

Implementation Process Steps	Schedule
Design Contract RFQ Released	July 29, 2011
Design Contract SOQs Submitted	August 26, 2011
Negotiate Contracts with Selected Design Firm(s)	September 2011
Workgroup Meeting to Discuss Phase 2 Implementation	September 21, 2011
Issue Notice to Proceed /Task Orders to Selected Design Firm(s)	October 2011
BASMAA Contracts with Selected Cities for Construction Funding	October 2011
Workgroup/PMT Selects and BASMAA Contracts of 3rd Party Design and Construction Oversight Contractor	October 2011
Design Firm(s) Prepare Construction Packages of Necessary Design Plans and Specifications	November 2011 through March 2012
3rd Party Design and Construction Oversight Contractor and Cities work with Design Firm(s); 3rd Party Design and Construction Oversight Contractor	November 2011 through March 2012
Complete CEQA Documentation and Obtain Necessary Permits	November 2011 through April 2012
Select Sampling & Analysis Plan Contractor	March 2012
Prepare Sampling & Analysis Plans for Pilot Project	April 2012
Construction Activities	**May through October 2012 (Dry Season)**

In October 2011, a notice to proceed and task orders will be issued to the selected design firm(s) and BASMAA will contract with the Cities in which the pilot projects are located for distributing the grant's construction funding and staff funding assistance. The Workgroup will select, either through a competitive Request for Proposal process or sole source, a 3rd Party Design and Construction Oversight Contractor whose scope of work will be to review and coordinate the work conducted by the Design Contractors for the Workgroup.

Over the course of November 2011 to March 2012, the Design Contractor(s) will complete the construction drawing and specification bid packages, in close cooperation with the municipality, for each site that will be constructed. The municipality will obtain the necessary permits and approvals for project construction, including any associated environmental review for compliance with CEQA. During this same period, the 3rd Party Design and Construction Oversight Contractor and municipal staff will review drafts (e.g., 30%, 60%, and 90% design drawings) produced by the Design Firm(s), who will revise the designs accordingly. The 3rd Party Design and Construction Oversight Contractor will report back to the Workgroup and will set up Workgroup meetings if necessary to discuss project design issues as they arise.

Construction activities will be conducted during the 2012 dry season (approximately between May through October). Construction activities will include the installation of the treatment facilities at the selected retrofit locations, installation of monitoring equipment, and quality assurance/quality control of all constructed facilities. Construction contracting and oversight will be provided by the municipality in whose jurisdiction the project is located. BASMAA will assist with construction oversight of the treatment facility via the 3rd Party Design and Construction Oversight Contractor.

4.2 Monitoring Activities

Monitoring of all ten retrofit projects will be conducted during the 2012-2013 wet season. A Sampling and Analysis Plan will be prepared, which will be integrated with the overall CW4CB Regional Study Design, for each pilot project. The Sampling and Analysis Plan will be prepared by a monitoring contractor, selected by a RFQ that will be sent out in early 2012. A Workgroup/TAC meeting will be held in April 2012 to discuss the Sampling and Analysis Plan.

Monitoring will follow the protocol established in the Sampling and Analysis Plan approved by the Workgroup and TAC. Laboratory results and data summaries will be provided by the monitoring contractor.

5. REFERENCES

Yee and McKee, 2010. "Concentrations of PCBs and Hg in soils, sediment and water in the urbanized Bay Area: Implications for best management." San Francisco Estuary Institute, March 31, 2010.

APPENDIX A

Project Tables

Table A-1 Screened Retrofit Projects

Program	Project Name	Owner/ Municipality	Treatment Measure	Final Selection	Expected PCB Concentration[1]	Selection Notes
ACWP	Alameda and High St HDS Units	Oakland	Hydrodynamic Separator Unit	Recommended	Medium	• High PCBs • Regular trash CDS unit design
ACWP	Davis Street	ACFCWCD / San Leandro	Stormdrain High Flow Bypass Treatment	Not Selected	High	• Not designed to treat water quality flows
ACWP	Ettie St. Pump Station Retrofit	ACFCWCD	Sand filter	Recommended	Very High	• Industrial and residential • High PCBs • Pump station • Amended sand filter BMP
ACWP	Grant Avenue	San Lorenzo	Biotreatment/ Tree Well	Not Selected	Low	• Low PCB Area • Other more representative green streets projects selected
ACWP	International Blvd and 73rd HDS Unit	Oakland	Hydrodynamic Separator Unit	Preliminary Selection	Medium	• Other HDS Units selected in higher PCB areas
ACWP	Meek land Ave	San Lorenzo	Tree Wells	Not Selected	Low	• Low PCB Area • Other more representative green streets projects selected
ACWP	Osgood Rd	Fremont	Tree Wells	Preliminary Selection	Low	• Low PCB Area • Other more representative green streets projects selected
ACWP	West Oakland Industrial Area	Oakland	Bioretention/ Biofilters	Further Evaluation	Very High	• Industrial and residential • High PCBs • Within Ettie St. Pump Station watershed • Amended tree well BMP
CCCWP	El Cerrito Green Streets	El Cerrito	Flow-Through Biofilters/ Green Streets	Further Evaluation	Medium	• Mixed Land Uses/High traffic arterial • Monitoring by SFEI in 2011-2012 wet season
CCCWP	Hartz Avenue Beautification	Danville	Bioretention	Not Selected	Low	• Low PCB Area

Program	Project Name	Owner/ Municipality	Treatment Measure	Final Selection	Expected PCB Concentration[1]	Selection Notes
CCCWP	Moraga Commons Parking Lot	Moraga	Bioretention, Detention Basin	Not Selected	Low	• Low PCB Area
CCCWP	N. San Carlos Drive Improvements	Walnut Creek	Bioretention, Flow-through Biotreatment	Not Selected	Low	• Low PCB Area
CCCWP	Nevin Avenue Improvement	Richmond	Tree Wells, Bioretention Curb Extensions, Permeable Pavement with Underground Storage	Recommended	High	• Mixed land uses • 60% design stage • Variety of different BMPs proposed • High PCB Area
CCCWP	PG&E Substation	Richmond	Bioretention	Recommended	High	• PG&E substation - High PCBs • In public right-of-way
CCCWP	San Pablo Avenue Greenspine	San Pablo Greenspine	Various	Not Selected	Low to High	• Specific projects not identified
Vallejo	Oakwood Avenue Channel	Vallejo	Flow-through Wetlands	Preliminary Selection	Low	• In channel wetlands too complicated to monitor
Vallejo	Broadway and Redwood	Vallejo	Bioretention/ Biotreatment	Further Evaluation	High	• Mixed land uses • Next to Railroad tracks • Flood Control easement
SCVURPPP	Hacienda Avenue	Campbell	Bioretention, Permeable Pavement	Not Selected	Medium	• Not in area indicative of High PCBs
SCVURPPP	Leo Avenue HDS unit	San Jose	Hydrodynamic Separator Unit	Recommended	Very High	• Highly industrial • High PCBs • WQ-enhanced HDS design
SCVURPPP	Leo Avenue Sand Filter	San Jose	Sand Filter	Preliminary Selection	High	• HDS unit preferred.

Program	Project Name	Owner/ Municipality	Treatment Measure	Final Selection	Expected PCB Concentration[1]	Selection Notes
SCVURPPP	Mathilda Avenue Caltrain Overpass	Sunnyvale/ Caltrans	Bioretention, Hydrodynamic Separators	Preliminary Selection	High	• High PCB land uses not treated by treatment measure
SCVURPPP	Packard Foundation Headquarters	Los Altos	Permeable Pavement, Tree Well	Not Selected	No Data; Anticipated Low	• Not in area indicative of High PCBs
SCVURPPP	River Oaks Pump Station	San Jose	Swale	Preliminary Selection	Low	• Not in area indicative of High PCBs
SCVURPPP	San Fernando Street Improvement	San Jose	Flow-through Biotreatment	Not Selected	Medium	• Other Green Street projects were selected
SCVURPPP	Santa Clara Street Bus Rapid Transit	San Jose	TBD	Not Selected	Medium	• Would not be constructed by 2012
SCVURPPP	Stanford Pervious Paving Demo. Project	Stanford	Permeable Pavement	Preliminary Selection	Low	• Low PCBs
SCVURPPP	Stevens Creek Corridor Park	Cupertino	Flow-through Biotreatment	Not Selected	No Data; Anticipated Very Low	• Low PCBs
SCVURPPP	The Alamea Street Improvement	San Jose	Biorention and Tree Wells	Not Selected	Low	• Low PCBs • Would not be constructed by 2012
SCVURPPP	TBD	TBD	TBD	Further Evaluation	TBD	
SMCWPPP	Bransten Road Green Streets	San Carlos	Bioretention Curb Extensions	Recommended	Very High	• High PCBs • Developed/ mixed industrial • Not a busy street
SMCWPPP	Daly City Public Library	SFEI/ Daly City	Bioretention	Preliminary Selection	Medium/ Low	• Site land use not indicative of High PCBs

Table A-2 Selected Retrofit Projects

	Program	No	Project Name	Owner/ Municipality	Range of Treatment Types: LID: Bioretention	LID: Permeable Pavement	LID: Flow-through Biotreatment (Planter or Swale)	LID: Tree Well	Other: Detention Basin/Wet Pond	Other: Sand Filter	Other: Hydrodynamic Separators	Land Use: Industrial	Land Use: Commercial/ Mixed Use	Land Use: Roads/ Rail	Land Use: Institutional	Land Use: Residential	Land Use: Recreational	Design/ Construction Status: Conceptual	Design/ Construction Status: Design	Design/ Construction Status: Constructed post-MRP Adoption	Design/ Construction Status: Constructed pre-MRP Adoption	Expected PCB Concen-tration[1]	Expected Mercury Concen-tration[2]	Reasons for Selection
Selected Top 6 Projects	ACWP	1	Ettie St. Pump Station Retrofit	ACFCWCD						X		X	X			X		X				Very High	High	• Industrial and residential • High PCBs • Pump station • Amended sand filter BMP
	ACWP	2	Alameda and High St HDS Units	Oakland							X	X	X	X		X			X			Medium	High	• High PCBs • Regular trash CDS unit design
	CCCWP	3	Nevin Avenue Improvement	Richmond	X	X	X	X					X		X	X			X			High	High	• Mixed land uses • 60% design stage • Different BMPs possible including pervious pavement • In PCB halo source area
	CCCWP	4	PG&E Substation Retrofit	Richmond	X		X					X		X				X				High	High	• PG&E substation - High PCBs • In public right-of-way
	SCVURPPP	5	Leo Avenue HDS Unit	San Jose							X	X						X				Very High	Very High	• Highly industrial • High PCBs • WQ-enhanced HDS design
	SMCWPPP	6	Bransten Road Green Streets	San Carlos	X		X					X	X	X				X				Very High	High	• High PCBs • Developed/mixed industrial • Not a busy street
Projects Requiring Further Evaluation	ACWP	7	West Oakland Industrial Area	Oakland				X				X	X	X				X				Very High	High	• Industrial and residential • High PCBs • Within Ettie St. Pump Station watershed • Amended tree well BMP
	CCCWP	8	El Cerrito Green Streets	El Cerrito			X						X	X						X		Medium	High	• Mixed Land Uses/High traffic arterial • Monitoring by SFEI in 2011-2012 wet season
	SCVURRP	9	TBD	TBD																				•
	SC	10	Broadway and Redwood	Vallejo	X		X					X	X	X		X		X				High	High	• Mixed land uses • Next to Railroad tracks • Flood Control easement

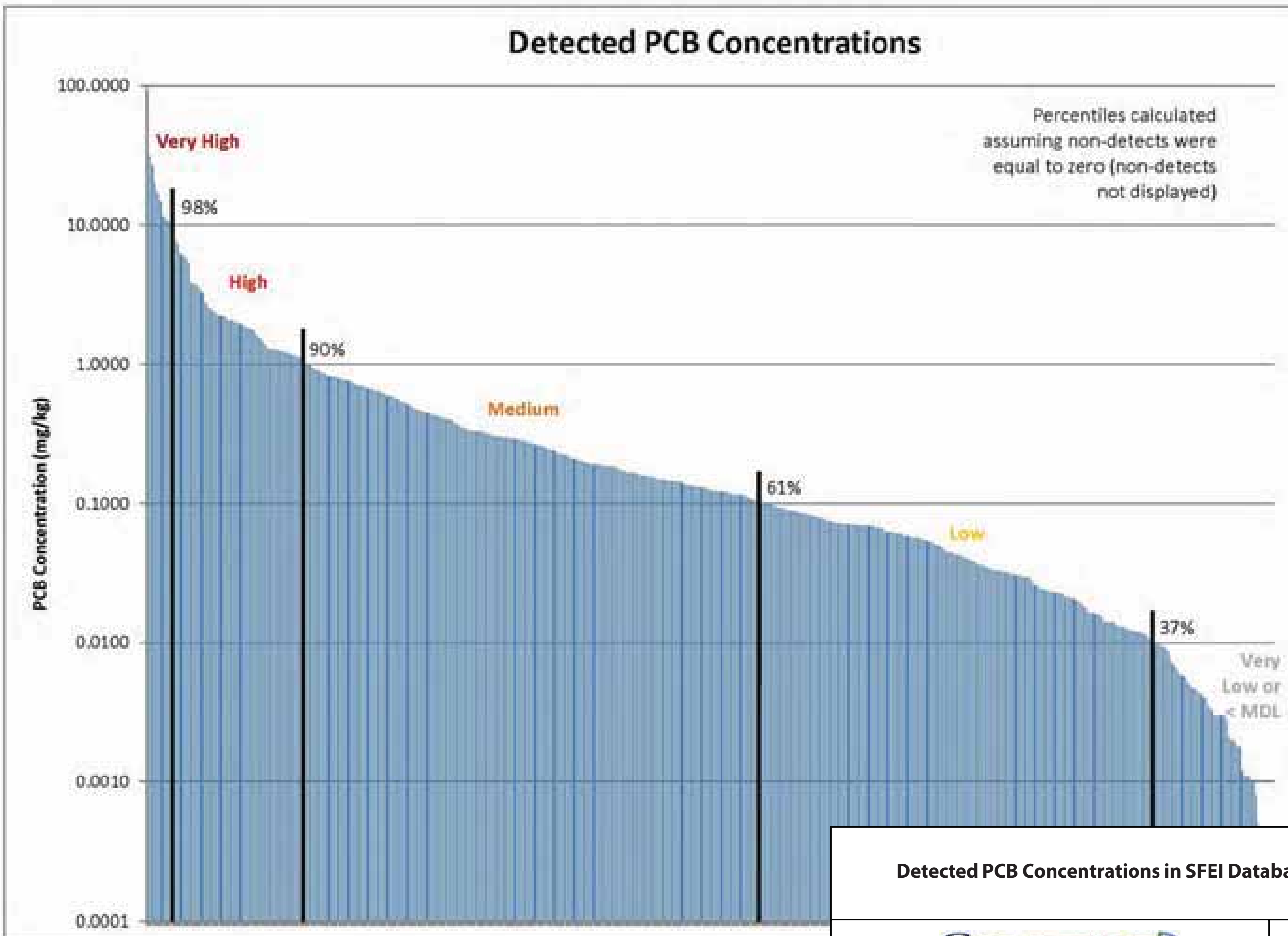
Footnotes:

1 PCB data from the San Francisco Estuary Institute database. PCB ranking (mg/kg sediment): Very Low (<0.01), Low (0.01-0.1); Medium (0.1-1.0); High (1.0-10); and Very high (>10)

2 Mercury data from the San Francisco Estuary Institute database. Mercury ranking (mg/kg sediment): Very Low (<0.1), Low (0.1-0.25); Medium (0.25-0.75); High (0.75-2.0); and Very high (>2.0)

APPENDIX B

Project Figures



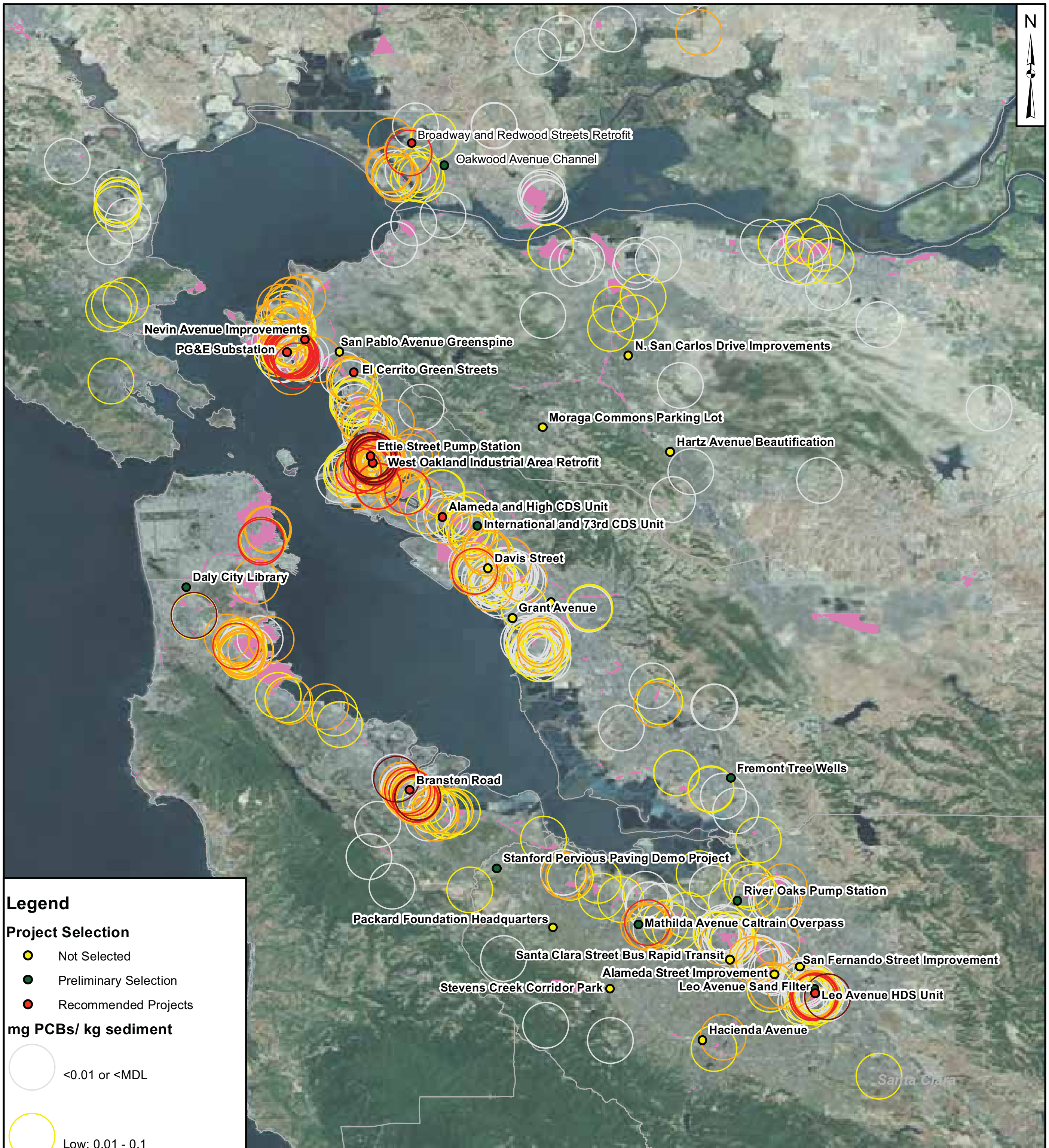
Detected PCB Concentrations in SFEI Database

Geosyntec consultants

Figure **B-1**

Oakland, CA | August 2011

PCB_Rank_081511.ppt



Legend

Project Selection

- Not Selected
- Preliminary Selection
- Recommended Projects

mg PCBs/ kg sediment

- <0.01 or <MDL
- Low: 0.01 - 0.1
- Med: 0.1 - 1.0
- High: 1.0 - 10
- Very High: >10
- Old Industrial Land Uses
- County Boundary

mg PCBs/ kg Sediment	Percentile
0.01	37%
0.1	61%
1	90%
10	98%

10 5 0 10 Miles

Concentration of PCBs in Sediment (mg/kg) and 2.5 Kilometer Halo with all Projects

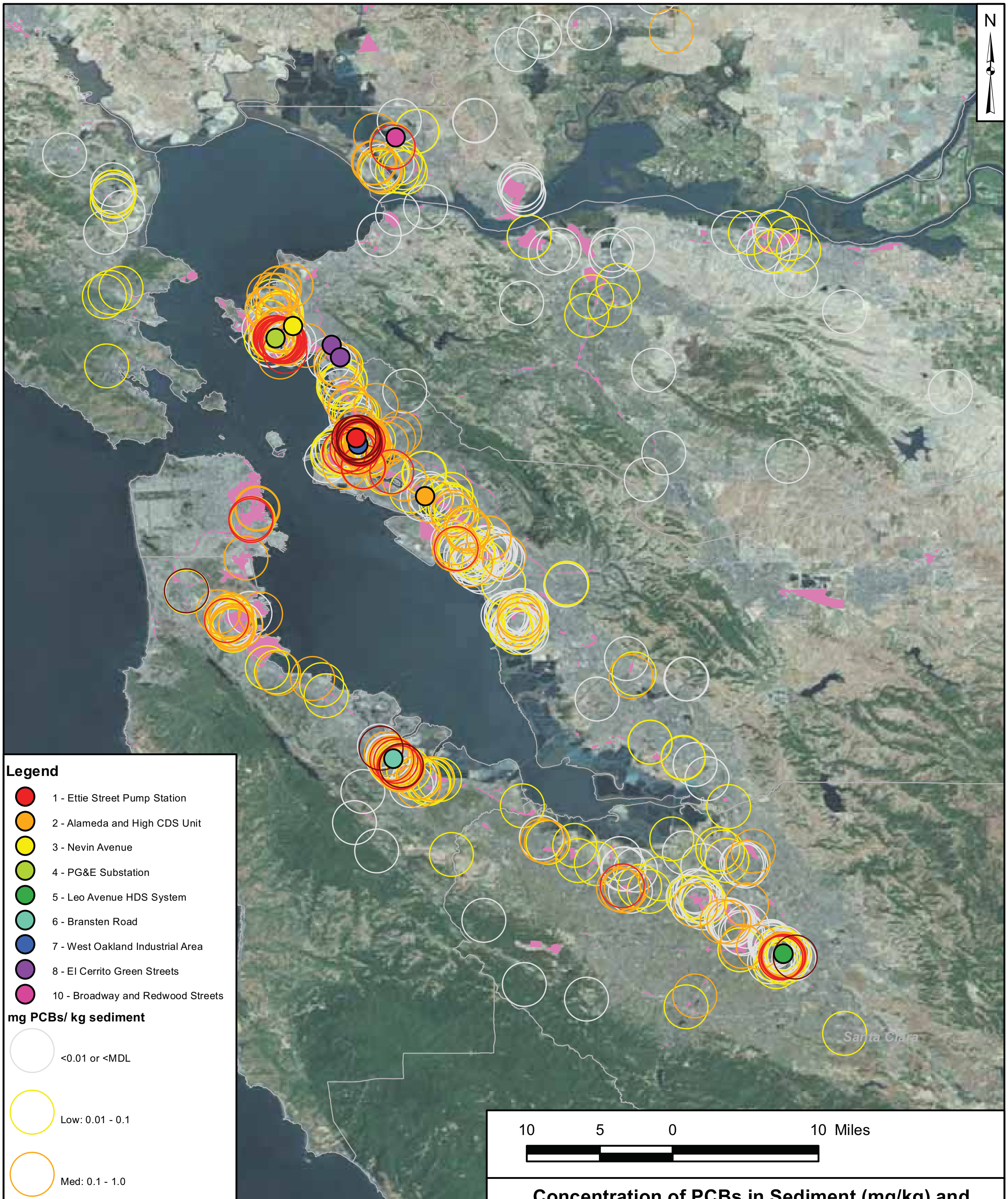
San Francisco Bay Area, CA

Geosyntec consultants

Oakland Office | August 2011

Figure **B-2**

P:\GIS\BASMAA_CW4CB\Projects\Yee_McKee_PCB_Conc_081511.mxd, KLH, Aug 15, 2011



mg PCBs/ kg Sediment	Percentile
0.01	37%
0.1	61%
1	90%
10	98%

Concentration of PCBs in Sediment (mg/kg) and 2.5 Kilometer Halo with Top Ten Projects

San Francisco Bay Area, CA

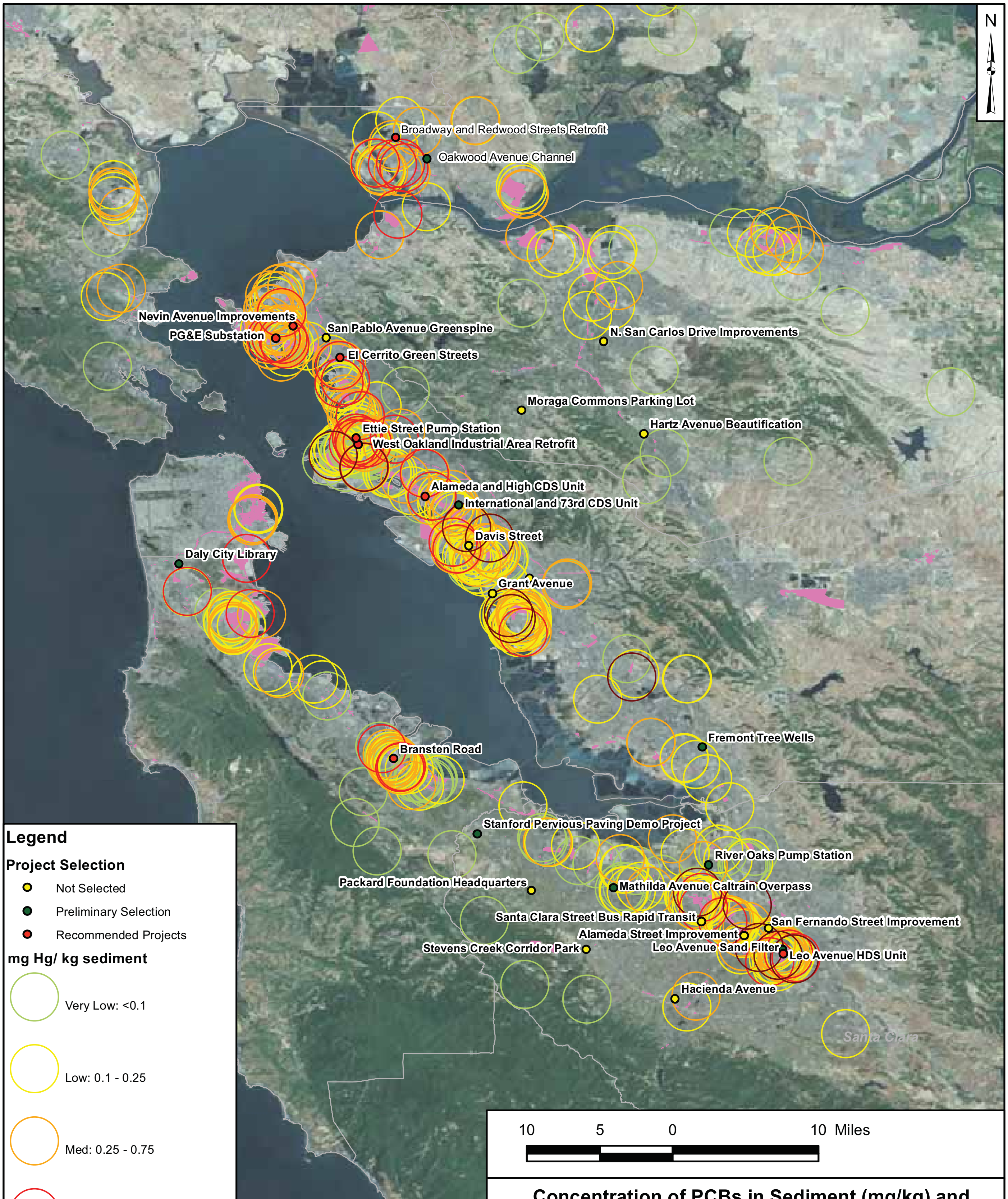
Geosyntec consultants

Oakland Office | August 2011

Figure

B-3

P:\GIS\BASMAA_CW4CB\Projects\Yee_McKee_Top10_PCB_Conc_081511.mxd, KLH, Aug 15, 2011



Legend

Project Selection

- Not Selected
- Preliminary Selection
- Recommended Projects

mg Hg/ kg sediment

- Very Low: <0.1
- Low: 0.1 - 0.25
- Med: 0.25 - 0.75
- High: 0.75 - 2.0
- Very High: >2.0
- Old Industrial Land Uses
- County Boundary

mg PCBs/ kg Sediment	Percentile
0.01	37%
0.1	61%
1	90%
10	98%

Concentration of PCBs in Sediment (mg/kg) and 2.5 Kilometer Halo with all Projects

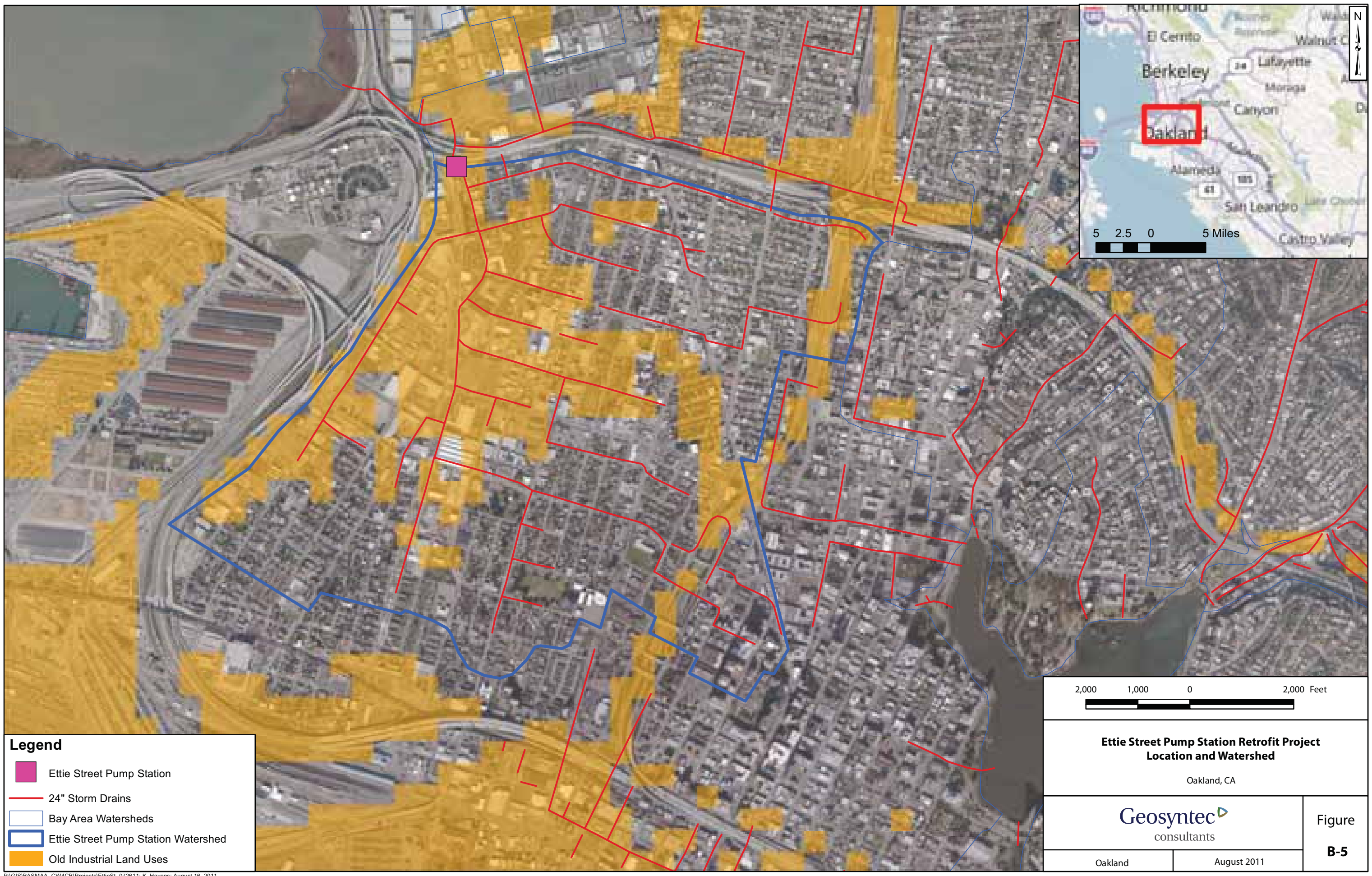
San Francisco Bay Area, CA

Geosyntec consultants

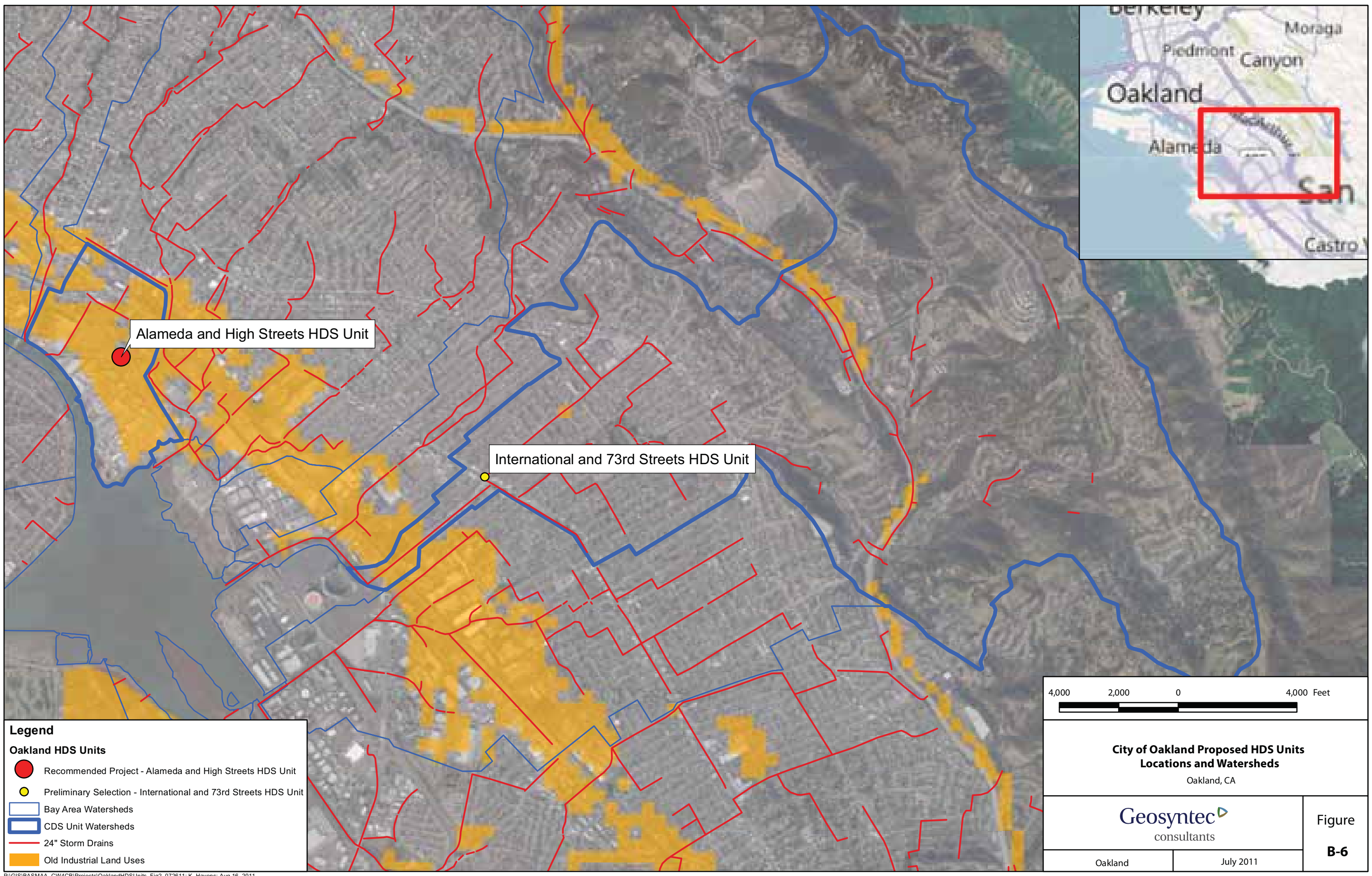
Figure **B-4**

Oakland Office | August 2011

P:\GIS\BASMAA_CW4CB\Projects\Yee_McKee_Hg_Conc_081511.mxd, KLH, Aug 15, 2011



P:\GIS\BASMAA_CW4CB\Projects\EttieSt_072611; K. Havens; August 16, 2011



City of Oakland Proposed HDS Units Locations and Watersheds

Oakland, CA

Oakland	July 2011	Figure B-6

P:\GIS\BASMAA_CW4CB\Projects\OaklandHDSUnits_Fig2_072611; K. Havens; Aug 16, 2011


North Richmond
San Pablo
East Richmond
Richmond
El Cerrito
1 0.5 0 1 Miles
N
Legend
Estimated Nevin Avenue Improvement Project Watershed
Storm Drain Pipe
CollectionDevice
Catch Basin
Curb Inlet
Partial Pipe Culvert
Flow lines from City of Richmond Survey, 1976
300 150 0 300 Feet
Nevin Avenue
Drainage Area and Proposed Treatment Measures
Richmond, CA
Geosyntec
consultants
Figure
B-7
Oakland
August 2011

PG&E Substation
Drainage Area and Proposed Treatment Measures
Richmond, CA

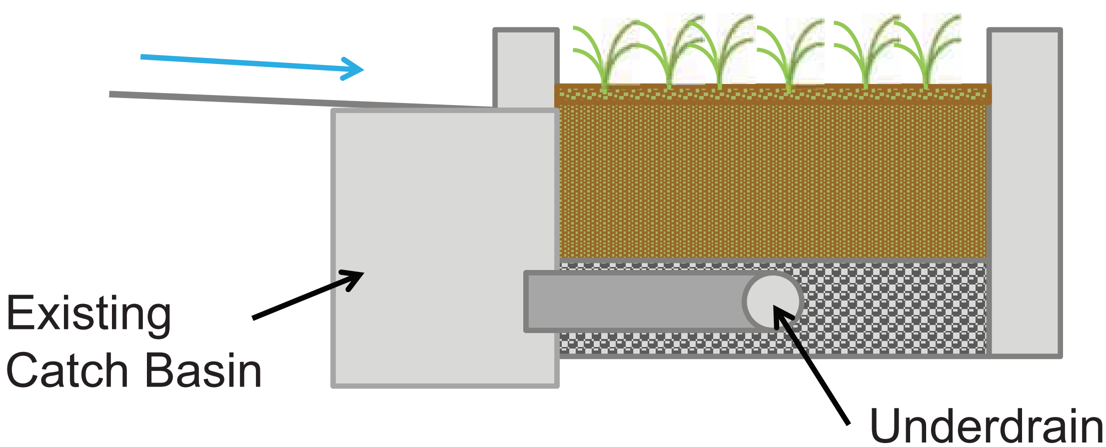
Geosyntec consultants

Oakland | August 2011

Figure **B-8**

Example Bioretention Facility with Curb Cuts from San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook, Photo Credit Nevue Ngan Associates

Possible BMP Cross-Section



Not to Scale

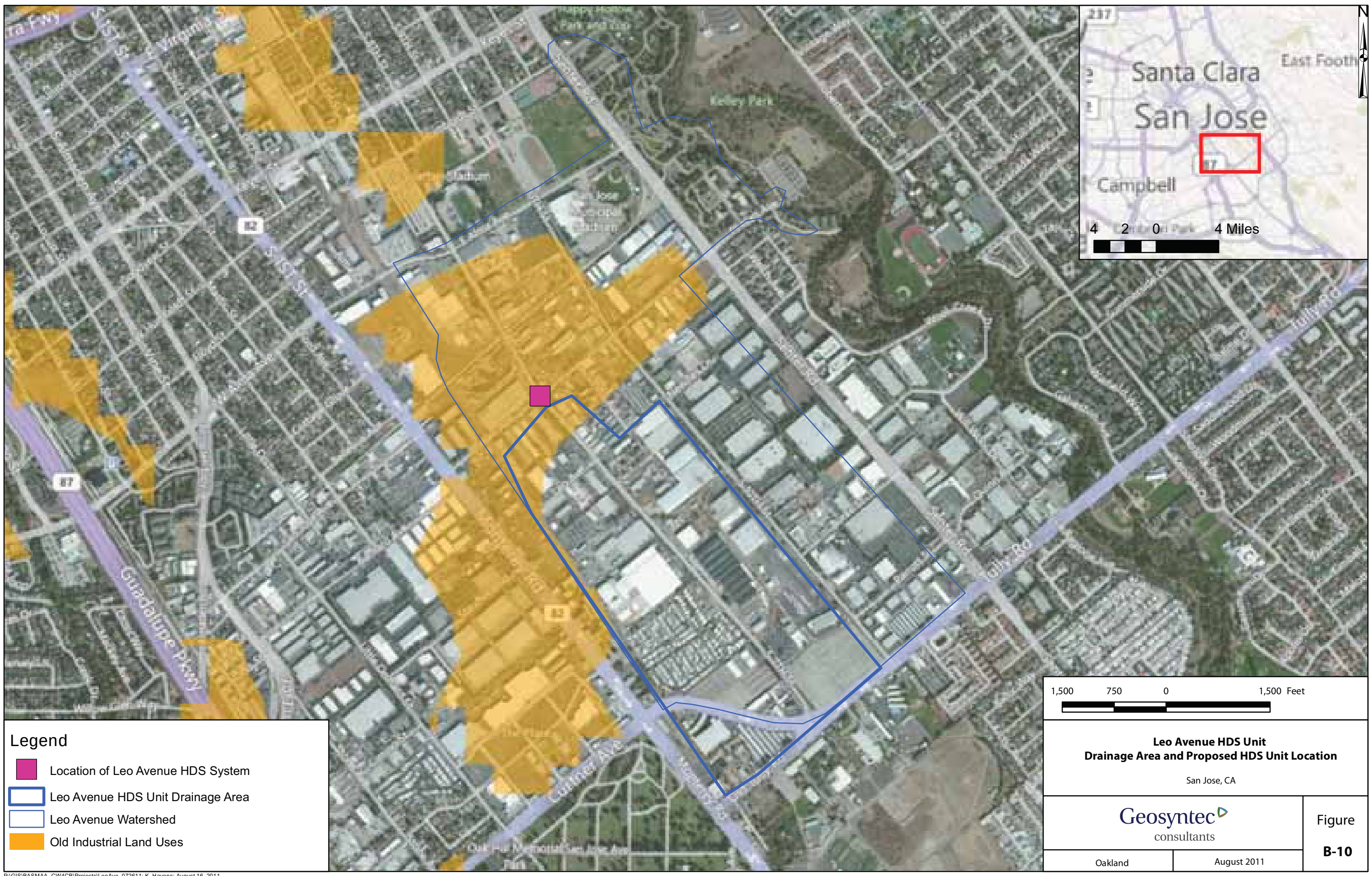
PG&E Substation
Example Bioretention Facility and Cross-Section
Richmond, CA

Geosyntec consultants

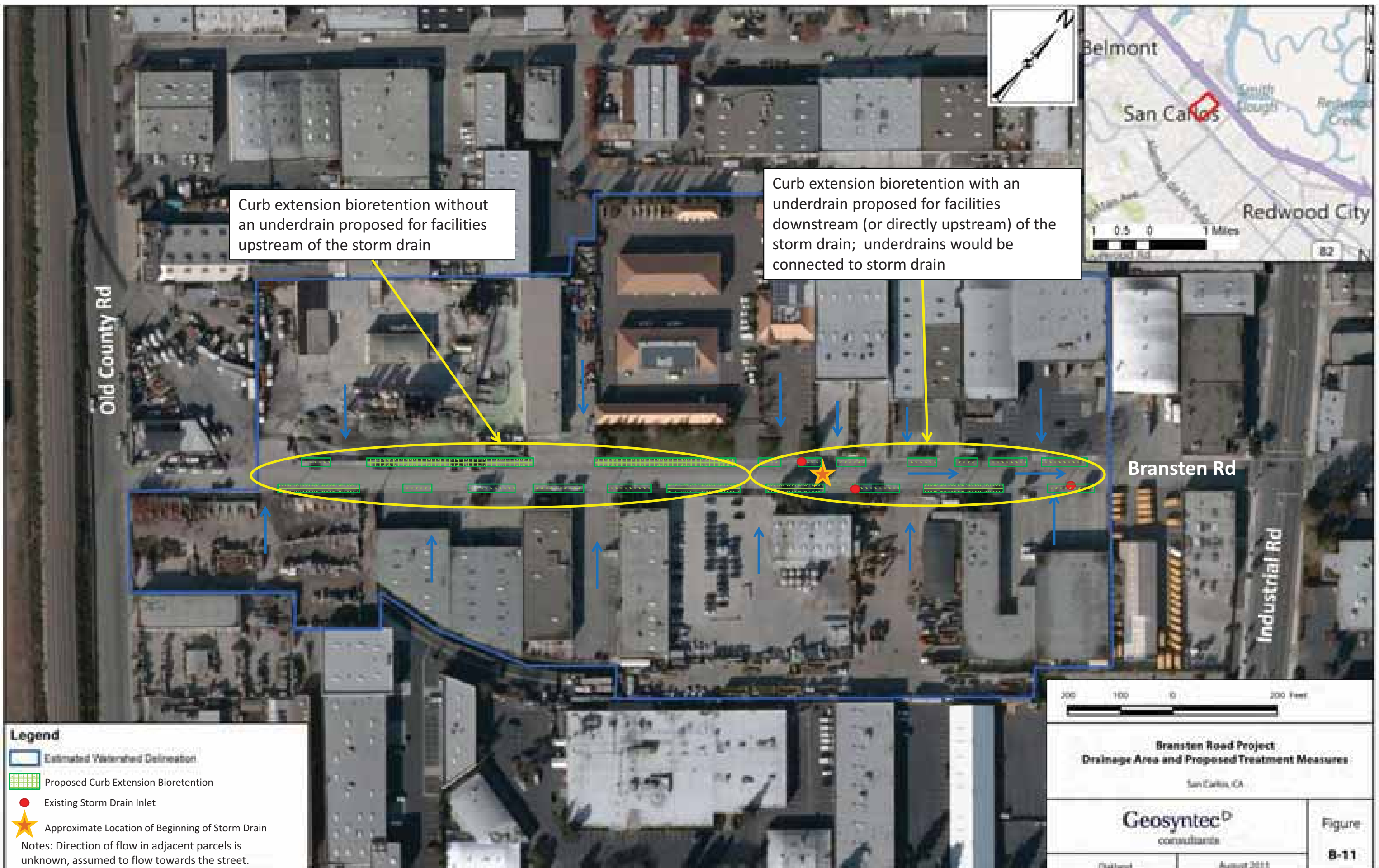
Figure **B-9**

Oakland | August 2011

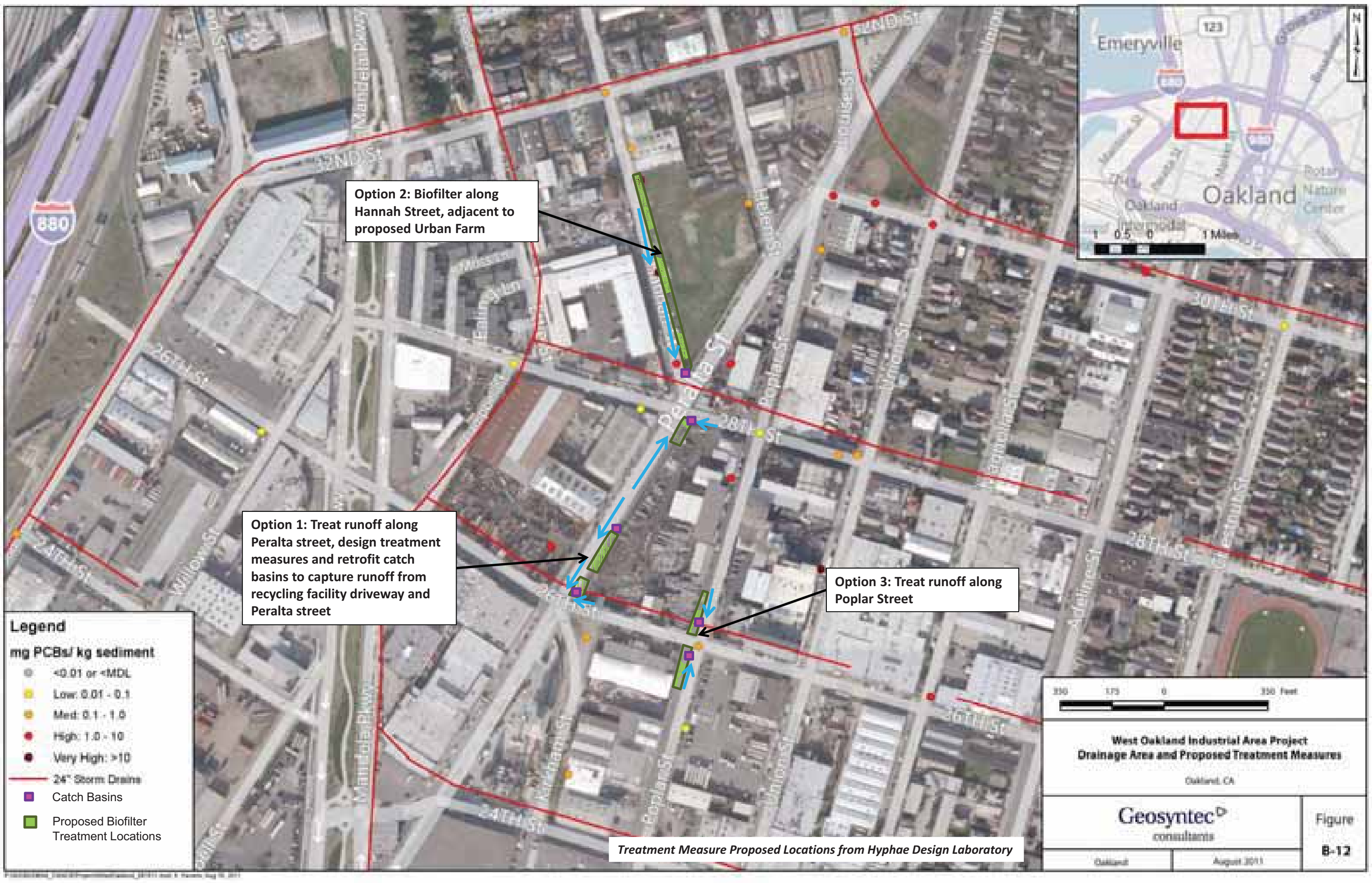
PGE_Fig2_080141 1; K.Havens; Aug 16, 2011



P:\GIS\BASMAA_CW4CB\Projects\LeoAve_072611; K. Havens; August 16, 2011



Curb extension bioretention without an underdrain proposed for facilities upstream of the storm drain
Curb extension bioretention with an underdrain proposed for facilities downstream (or directly upstream) of the storm drain; underdrains would be connected to storm drain
Old County Rd
Bransten Rd
Industrial Rd
N
Belmont
San Carlos
Redwood City
1 0.5 0 1 Miles
82
Legend
Estimated Watershed Delineation
Proposed Curb Extension Bioretention
Existing Storm Drain Inlet
Approximate Location of Beginning of Storm Drain
Notes: Direction of flow in adjacent parcels is unknown, assumed to flow towards the street.
200 100 0 200 Feet
Bransten Road Project
Drainage Area and Proposed Treatment Measures
San Carlos, CA
Geosyntec
consultants
Oakland
August 2011
Figure
B-11


Option 2: Biofilter along Hannah Street, adjacent to proposed Urban Farm
Option 1: Treat runoff along Peralta street, design treatment measures and retrofit catch basins to capture runoff from recycling facility driveway and Peralta street
Option 3: Treat runoff along Poplar Street
Legend
mg PCBs/ kg sediment
<0.01 or <MDL
Low: 0.01 - 0.1
Med: 0.1 - 1.0
High: 1.0 - 10
Very High: >10
24" Storm Drains
Catch Basins
Proposed Biofilter Treatment Locations
Peralta St
Poplar St
28TH St
26TH St
24TH St
32ND St
30TH St
36TH St
Mandela Pkwy
Willow St
880
Emeryville
Oakland
123
West Oakland Industrial Area Project
Drainage Area and Proposed Treatment Measures
Oakland, CA
Geosyntec consultants
Figure
B-12
Oakland
August 2011
Treatment Measure Proposed Locations from Hyphae Design Laboratory

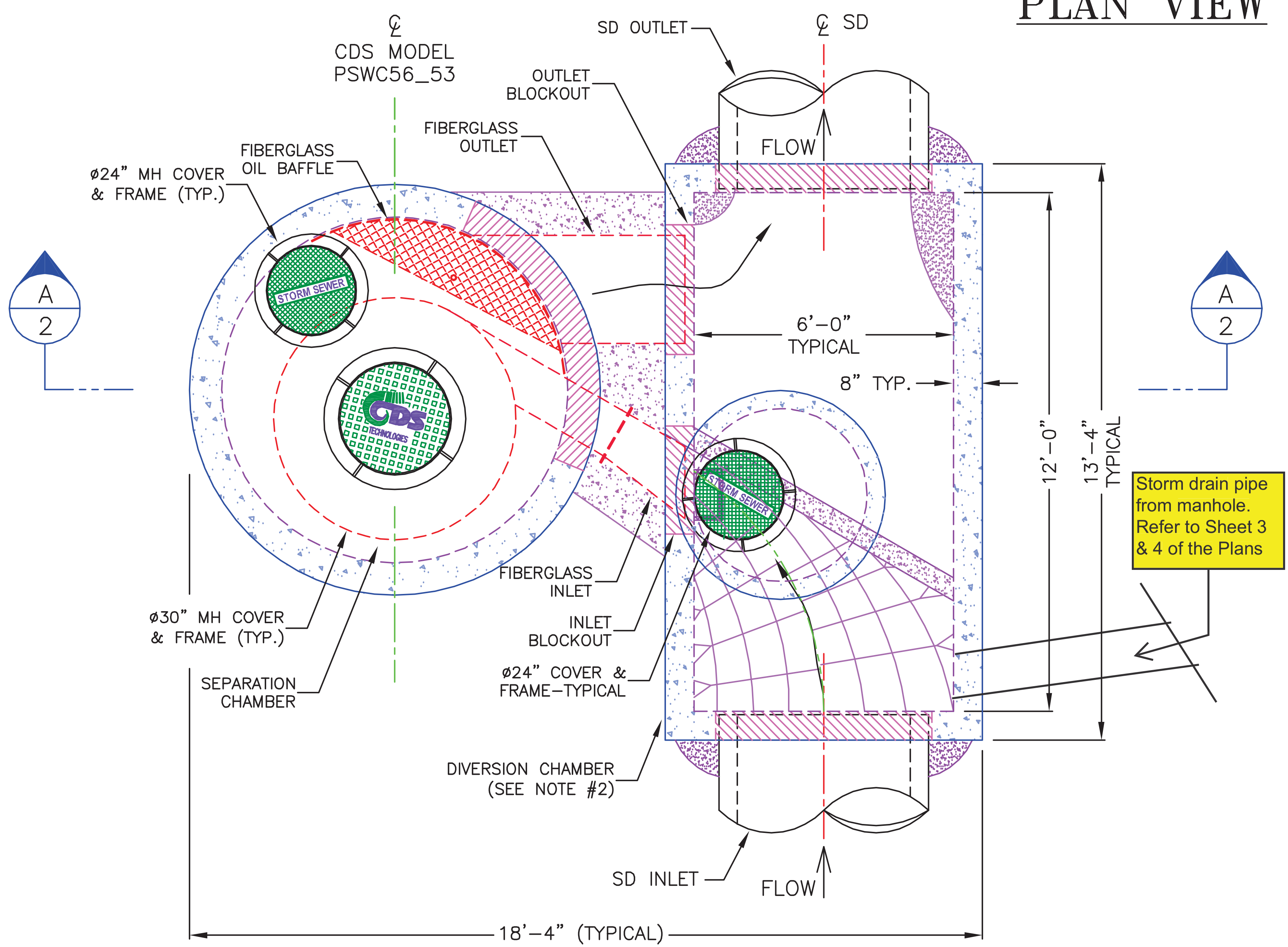
P:\GIS\BASMAA_CW4CB\Projects\ElCerrito_072611.mxd; K. Havens; August 16, 2011

P:\GIS\BASMAA_CW4CB\Projects\Vallejo_081211; W. Lewis rev K. Havens; August 16, 2011

APPENDIX C

Proposed Treatment Measure Specifications

PLAN VIEW



NOTES:
1. CDS UNIT SHOWN IN LEFT–HAND CONFIGURATION.
2. DIVERSION CHAMBER MAY BE PRECAST OR CAST IN FIELD BY CONTRACTOR.

CDS MODEL PSWC56_53
STORMWATER TREATMENT UNIT
(LEFT HANDED UNIT SHOWN)

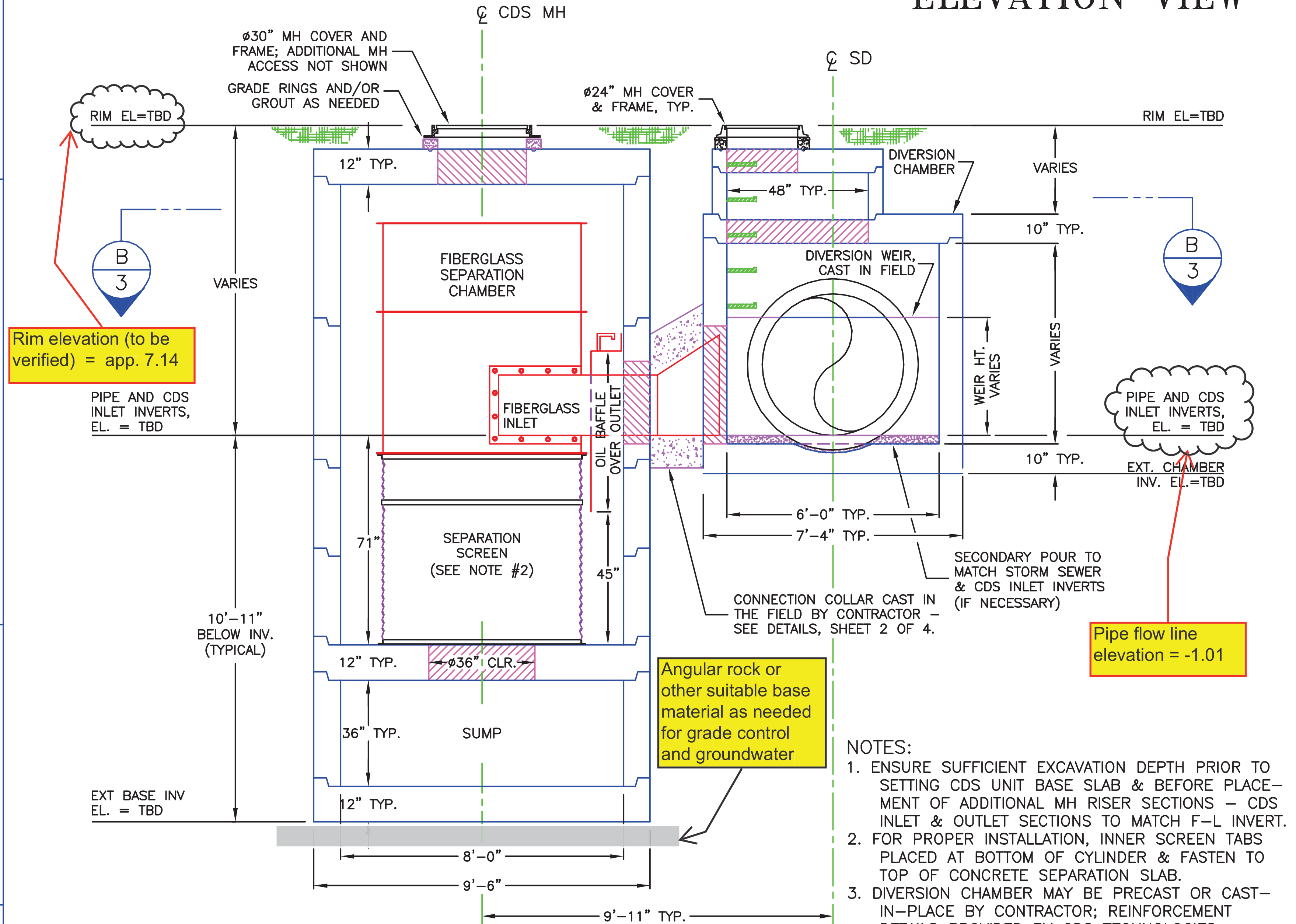
CDS TECHNOLOGIES™

PROJECT NAME
PROJECT LOCATION

JOB#	SCALE 1"=40"
DATE:	SHEET
DRAWN:	1
APPROV.	

16360 S. MONTEREY RD. SUITE 250 MORGAN HILL, CA. 95037 TEL: (888) 535–7559

SECTION A–A
ELEVATION VIEW



NOTES:

1. ENSURE SUFFICIENT EXCAVATION DEPTH PRIOR TO SETTING CDS UNIT BASE SLAB & BEFORE PLACEMENT OF ADDITIONAL MH RISER SECTIONS – CDS INLET & OUTLET SECTIONS TO MATCH F–L INVERT.
2. FOR PROPER INSTALLATION, INNER SCREEN TABS PLACED AT BOTTOM OF CYLINDER & FASTEN TO TOP OF CONCRETE SEPARATION SLAB.
3. DIVERSION CHAMBER MAY BE PRECAST OR CAST–IN–PLACE BY CONTRACTOR; REINFORCEMENT DETAILS PROVIDED BY CDS TECHNOLOGIES.

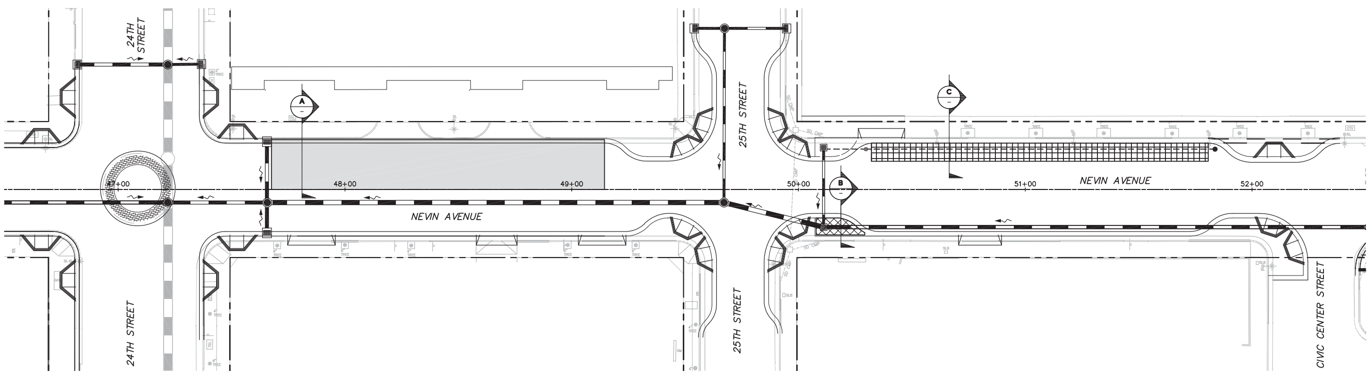
CDS MODEL PSWC56_53
STORMWATER TREATMENT UNIT
(LEFT HANDED UNIT SHOWN)

CDS TECHNOLOGIES™

PROJECT NAME
PROJECT LOCATION

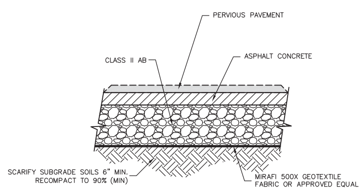
JOB#	SCALE 1"=48"
DATE:	SHEET
DRAWN:	2
APPROV.	

16360 S. MONTEREY RD. SUITE 250 MORGAN HILL, CA. 95037 TEL: (888) 535–7559



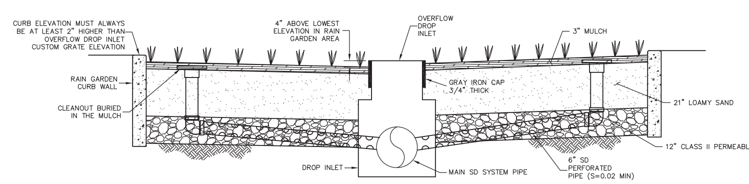
NEVIN AVENUE (STA 46+50 TO 52+50)

SCALE: 1" = 20'



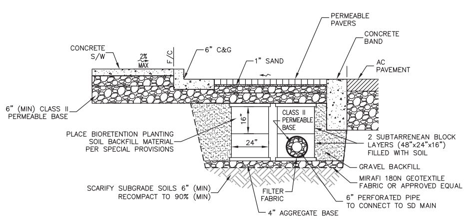
A PERVIOUS PAVEMENT

NTS



B RAIN GARDEN PROFILE

NTS



C SUBTERRANEAN SYSTEM

NTS

N

C.3 FEATURES

- RAIN GARDEN AREA
- SUBTERRANEAN SYSTEM (PERMEABLE PAVER)
- PERVIOUS PAVEMENT

VALLIER DESIGN ASSOCIATES, INC.

BKF

ENGINEERS / SURVEYORS / PLANNERS

322 HARBOUR WAY, STE 23
RICHMOND, CA 94801
PH: (510) 529-0336

NO.	DATE	REVISION

SHEET TITLE:

STORM WATER MANAGEMENT OPTIONS (BETWEEN 24TH ST. AND CIVIC CENTER DRIVE)

PROJECT:

RICHMOND TRANSIT VILLAGE
NEVIN AVENUE PEDESTRIAN IMPROVEMENTS

SCALE: 1" = 20'-0"

0 10 20 40

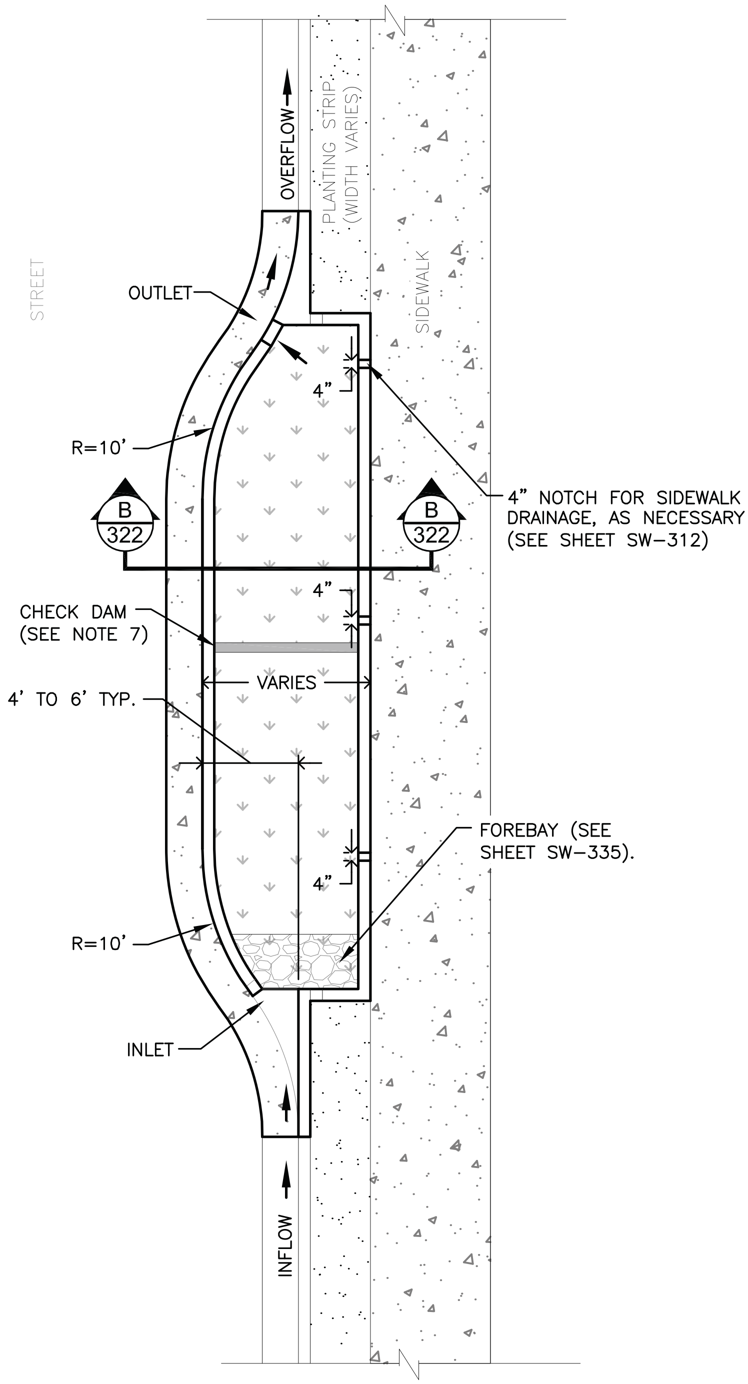
DATE: 08-09-2010

SHEET

FIG - 1

XX OF XX

60% CONSTRUCTION DOCUMENT SUBMITTAL



PLAN VIEW

NOTES:

1. See City of Portland Standard Construction Specifications Section 00415 - Vegetated Stormwater Facilities.
2. Area and depth of facility are based upon engineering calculations and right-of-way constraints. See Chapter 2 of the City of Portland Stormwater Management Manual (SWMM).
3. Longitudinal slope of planter matches road.
4. Include beginning and ending stations for each facility. Provide stations and elevations at every check dam, outlet, and planter wall corner.
5. Sidewalk elevation must be set above inlet and outlet elevations to allow overflow to drain to street before sidewalk.
6. See sheet SW-335 for inlet and outlet details.
7. Check dams may be required: See sheets SW-341 and SW-342 for details.
8. See Appendix F.3 in the SWMM for stormwater facility topsoil requirements.
9. Special requirements for water lines, meters, and fire hydrants: See sheet SW-324 for details.
10. Utility lines may need to be sleeved or relocated.
11. Curb and Gutter: Standard Drawing P-540. Use 1'-6" wide gutter.
12. See Landscape Planting Templates on SW-323.

IMPORTANT: Utility conflicts and existing conditions can create major design variables. Locate utilities and survey existing conditions prior to beginning design work.

The Portland Bureau of Transportation (PBOT), Portland Water Bureau (PWB), and Bureau of Environmental Services (BES) are responsible for the review and approval of Stormwater Swales in the public right of way. Stormwater facilities in *Well Field Protection Areas* may require special containment measures.

For more information contact:

PBOT (503) 823-7884 BES (503) 823-7761
PWB (503) 823-7368 Urban Forestry (503) 823-4489

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- 2010 Green Streets -

In-Planting Strip Plan View

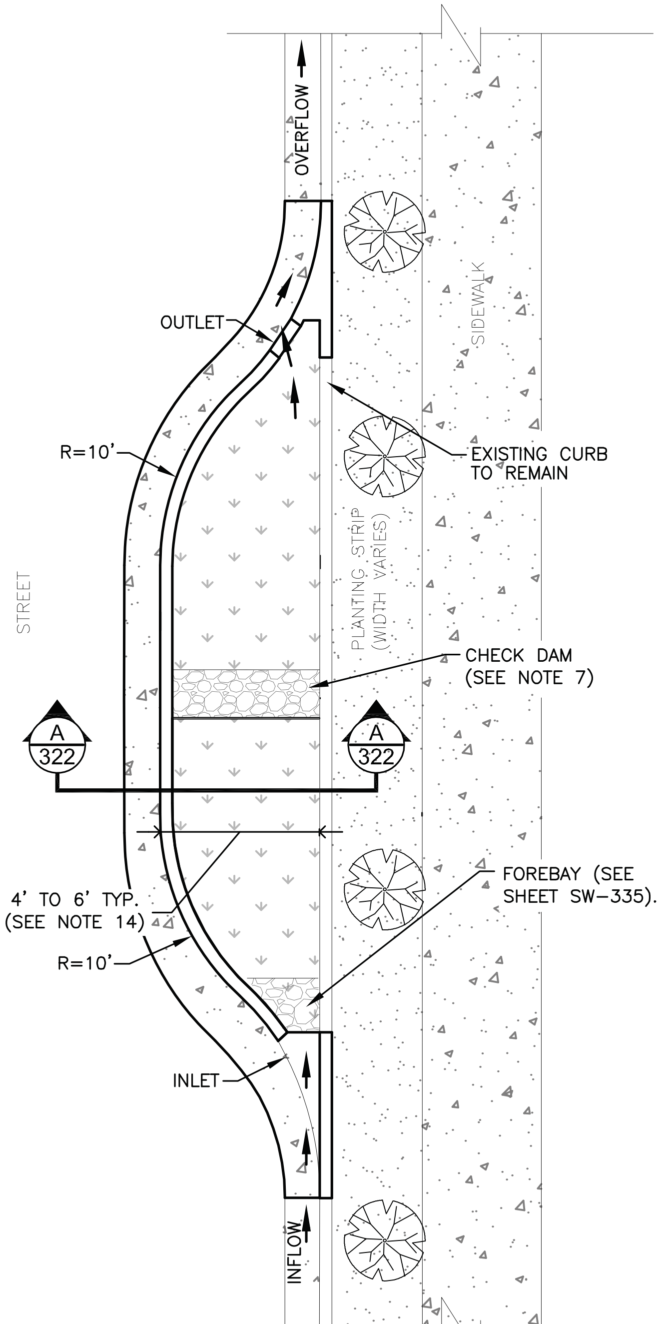
Curb Extensions

NUMBER

SW-320

Bureau of Environmental Services

REVISED: 03/05/10 11:18



PLAN VIEW

NOTES:

1. See City of Portland Standard Construction Specifications Section 00415 - Vegetated Stormwater Facilities.
2. Area and depth of facility are based upon engineering calculations and right-of-way constraints. See Chapter 2 of the City of Portland Stormwater Management Manual (SWMM).
3. Longitudinal slope of planter matches road.
4. Include beginning and ending stations for each facility. Provide stations and elevations at every inlet, outlet, and check dam.
5. Sidewalk elevation must be set above inlet and outlet elevations to allow overflow to drain to street before sidewalk.
6. Inlets and outlets required: See sheet SW-335 for inlet and outlet details.
7. Check dams may be required: See sheets SW-340, SW-341, and SW-342 for details.
8. See Appendix F.3 of the SWMM for stormwater facility topsoil requirements.
9. Special requirements for water lines, meters, and fire hydrants: See sheet SW-324 for details.
10. Utility lines may need to be sleeved or relocated.
11. Curb and Gutter: Standard Drawing P-540. Use 1'-6" wide gutter.
12. Where feasible, width of stormwater facility should extend into existing planting strip (See sheet SW-320).
13. See Landscape Planting Templates on SW-323.

IMPORTANT: Utility conflicts and existing conditions can create major design variables. Locate utilities and survey existing conditions prior to beginning design work.

The Portland Bureau of Transportation (PBOT), Portland Water Bureau (PWB), and Bureau of Environmental Services (BES) are responsible for the review and approval of Stormwater Swales in the public right of way. Stormwater facilities in *Well Field Protection Areas* may require special containment measures.

For more information contact:

PBOT (503) 823-7884 BES (503) 823-7761
PWB (503) 823-7368 Urban Forestry (503) 823-4489

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- 2010 Green Streets -

In-Street Plan View

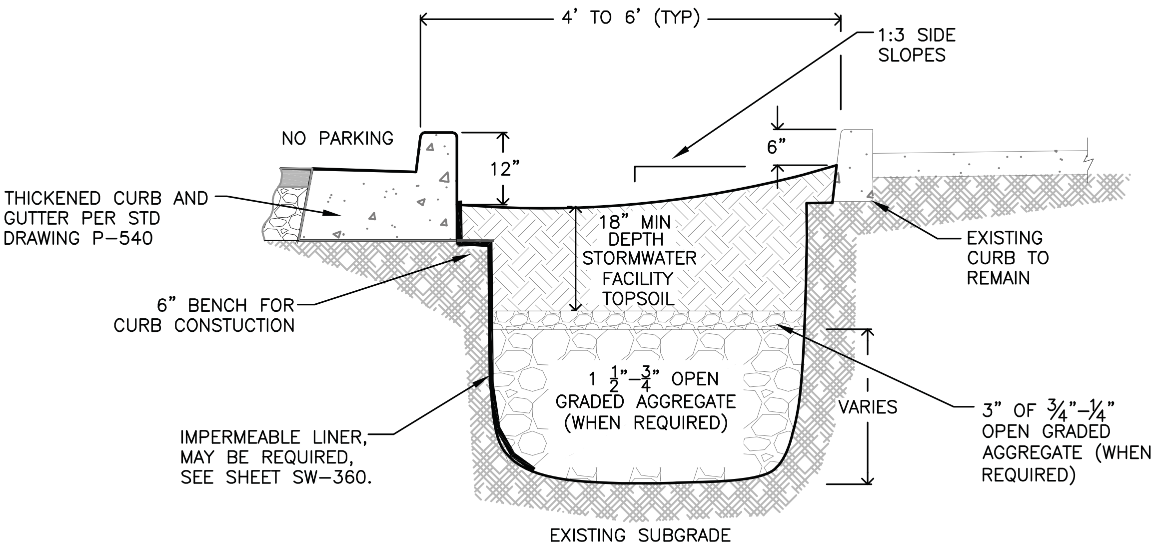
Curb Extensions

Bureau of Environmental Services

NUMBER

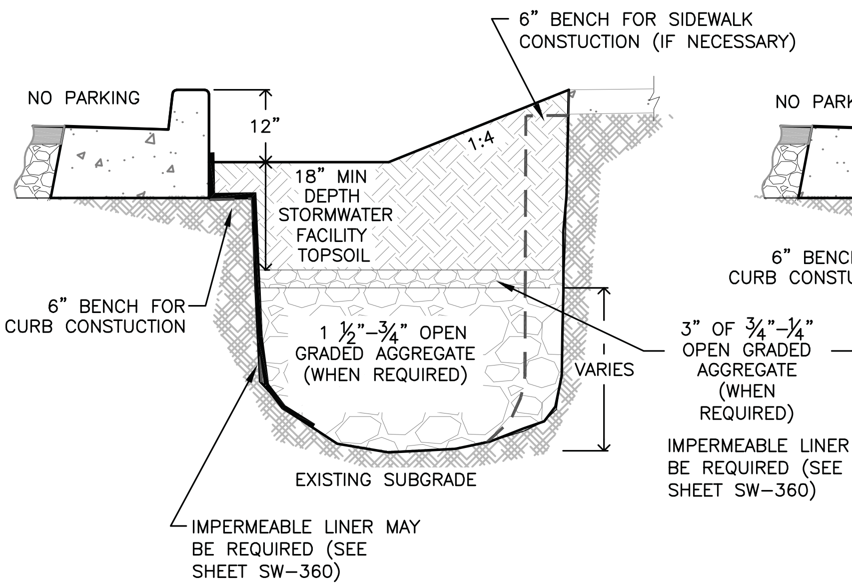
SW-321

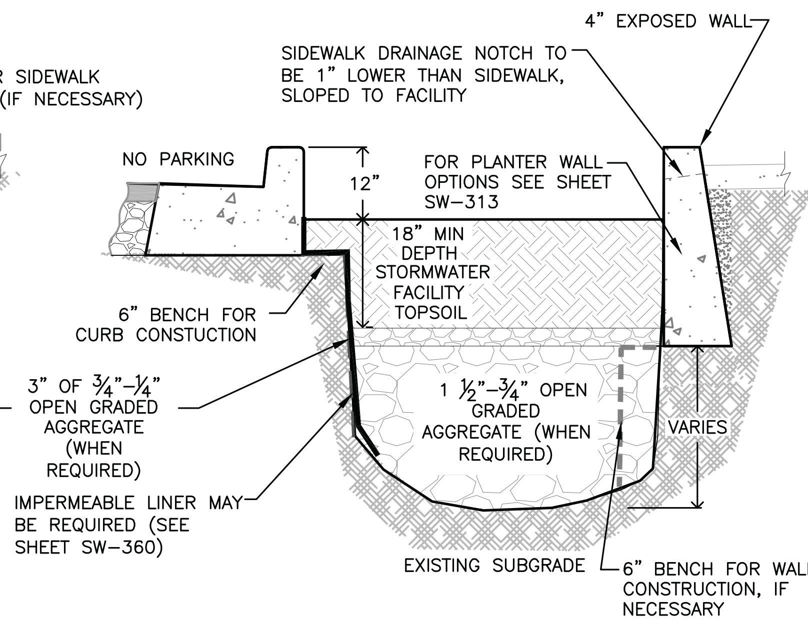
REVISED: 03/05/10 11:18



SECTION A-A
CURB EXTENSION SECTION

FOR PLAN VIEW REFER TO SW-321





SECTION B-B
CURB EXTENSION SWALE

SECTION B-B
CURB EXTENSION PLANTER

FOR PLAN VIEW REFER TO SW-320

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- 2010 Green Streets -

Section Views

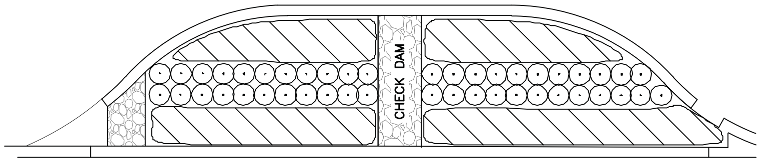
Curb Extensions

NUMBER

SW-322

Bureau of Environmental Services

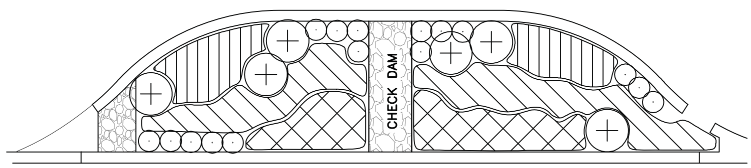
REVISED: 03/05/10 11:18



TEMPLATE 1

PLANT LEGEND 1

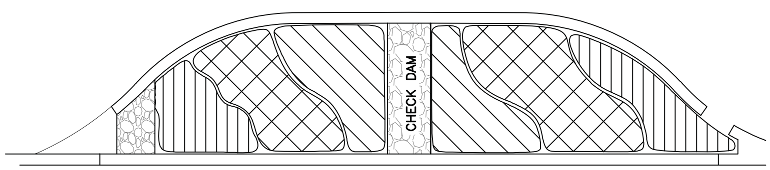
Symbol	Botanical Name / Common Name
	Carex testacea / Orange sedge — w/ OPTIONAL CAMAS BULBS
	Deschampsia cespitosa / Tufted hair grass



TEMPLATE 2

PLANT LEGEND 2

Symbol	Botanical Name / Common Name
	Camassia quamash / Common camas
	Carex densa / Dense sedge
	Cornus sericea 'kelseyii' / Kelsey dogwood
	Deschampsia cespitosa / Tufted hair grass
	Juncus patens / Spreading rush



TEMPLATE 3

PLANT LEGEND 3

Symbol	Botanical Name / Common Name
	Carex obnupta / Slough sedge
	Carex testacea / Orange sedge
	Juncus patens / Spreading rush

NOTES:

1. These are examples of approved planting templates. Other planting plans may be approved.
2. See Section 2.3.3 and Appendix F.4 of the SWMM for planting requirements.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- 2010 Green Streets -

Landscape Planting Templates

Curb Extensions

NUMBER

SW-323

Bureau of Environmental Services

REVISED: 03/05/10 11:18

APPENDIX D

Project Cost Estimates

Table D-1: Ettie Street Pump Station Retrofit Project Cost Estimate

Project Phase	Item	Unit	Unit Price	Quantity	Amount	Source
Con-struction	Fiberglass tanks	cu-ft	$5,000	2	$10,000	Tank dimensions: (13ft x 4 ft x 5 ft); Vendor: http://dtfiberglass.com/
	Pump	each	$2,000	1	$2,000	Assumes 1 gpm pump (0.5 Hp); http://www.mcmaster.com
	Flow control valves	each	$300	4	$1,200	http://www.mcmaster.com
	Flow meter	each	$1,000	1	$1,000	http://www.mcmaster.com
	Weir	each	$500	2	$1,000	Assumes local fabrication at metal workshop of 2 weirs
	Media	cu-yd	$250	1000	$1,000	Assumes media blended and placed; Vendor: http://www.stcloudmining.com/
	Filter fabric	sq-yd	$2.31	8	$18	RS Means category 33 46 26 ($2.31/SY)
	Waterproofing membrane	sq-yd	$1.32	8	$11	R.S. Means category 33 47 13 ($1.32/SF); 60 mil
	Pea gravel	cu-yd	$35	2	$70	R.S. Means category 31 23 23.17 ($35/CY); assuming by hand installation
	Underdrain	feet	$1.42	20	$28	Assumes 2 inch Schedule 40 perforated PVC pipe R.S. Means category 33 11 13.25 ($1.42/LF)
	Piping for inlet/outlet	feet	$4.5	40	$180	Assumes 40 ft of 3 inch Schedule 40 PVC pipe R.S. Means category 33 11 13.25 ($$4.50/LF)
	Total Cost – Materials				*$16,500*	
	Staff Rate (with overhead)	$/ man-hr		77		Light Equipment Operator RS Means Heavy Construction Cost Data 2011 (with 20% increase for Bay Area)
	Labor for Fabrication	hour		80	$6,200	Assume 80 hours for fabrication,
	Labor for Installation	hour		120	$9,200	Assume 120 hours for installation.
	Total Cost – Labor				*$15,400*	
Total Construction Cost		$			$32,000	Includes construction and labor for fabrication and installation of filter system.
Design	Assume 40% of Construction				$13,000	
Main-tenance	Staff Rate (with overhead)	$/ man-hr		77		Light Equipment Operator RS Means Heavy Construction Cost Data 2011 (with 20% increase for Bay Area)
	Sediment removal and equipment maintenance	man-hrs/yr		36	$2,400	Assume one person working quarterly, total of 36 hrs annually
	Replacing spent media	cu-yd		250	$250	Assumes annual replacement of 250 cu-yds of media
	Total Maintenance Labor	$/yr			$3,000	

Table D-2: Nevin Avenue Improvement Project Cost Estimate

Attach Nevin detailed cost estimate from BKF here.

Table D-3: PG&E Substation Retrofit Project Cost Estimate

Project Phase	Item	Unit	Amount	Source
Construction	Total Length of Bioretention Facilities	feet	810	PG&E Concept Plan, 25 July 2011 (Geosyntec)
	Average Width	feet	9	PG&E Concept Plan, 25 July 2011 (Geosyntec)
	Total Landscaped Area	sq-ft	7,300	Includes 2 bioretention facilities
	Cost/Area (Portland)	$/sq-ft	60	T. Kurtz (Portland, Oregon Bureau of Environmental Services) based on 2010 bids for 67 facilities most of which were curb extensions
	Cost/Area (San Francisco Bay Area)	$/sq-ft	72	RS Means Location Factors for installation (Bay Area has installation factor 20% higher than Portland)
	Total Cost – Curb Extensions, no Underdrain		*$526,000*	
	Underdrains	feet	810	Assumes one underdrain pipe in each bioretention facility
	Cost of underdrain	$/feet	20	Estimation based on preliminary analysis using BMP and LID Whole Life Cost Models (WERF, 2009) and RSMeans CostWorks, 2011
	Total Cost – Underdrains		*$16,000*	
	Linear feet of connection to storm drain	feet	60	Assumes connections for 2 bioretention facilities, approximately 30 feet per connection.
	Cost of connection to storm drain	$/ feet	130	Includes estimates for demolition, excavation/trenching, installation, connection pipe to storm drain; Estimation based on preliminary analysis using BMP and LID Whole Life Cost Models (WERF, 2009) and RSMeans CostWorks, 2011
	Total Cost – Connections to Storm Drain		*$7,800*	
	Total Construction Cost	$	$535,000	Includes construction, plant installation and 2 years of plant establishment
Design	Assume 20% of Construction		$107,000	
Maintenance	Weeding, Leaf and Sediment Removal	hrs/yr	32	Activity and frequency from 2008 Stormwater Management Facility Monitoring Report for NE Siskiyou Green Street (Portland Environmental Services Dept.) Geosyntec assumes a crew of 2 working one full day, 2xs per year - once during the fall/winter and once during the spring/summer.
	Staff Rate (with overhead)	$/hr	77	Light Equipment Operator RS Means Heavy Construction Cost Data 2011 (with 20% increase for Bay Area)
	Total Maintenance Cost	$/yr	2,500	

Table D-4: Branston Road Green Streets Project Cost Estimate

Project Phase	Item	Unit	Amount	Source
Construction	Total Length of Curb Extensions	feet	1,270	Branston Road Rough Concept Plan 18 Jan. 2011 (K.R. Perry, Portland Oregon)
	Average Width	feet	6	Concept Plan (K.R. Perry)
	Total Landscaped Area	sq-ft	7,600	Includes flow-through and filtration curb extensions
	Cost/Area (Portland)	$/sq-ft	60	T. Kurtz (Portland, Oregon Bureau of Environmental Services) based on 2010 bids for 67 facilities most of which were curb extensions
	Cost/Area (San Francisco Bay Area)	$/sq-ft	72	RS Means Location Factors for installation (Bay Area has installation factor 20% higher than Portland)
	Total Cost – Curb Extensions, no Underdrain		*$547,000*	
	Underdrains	feet	500	Assumes one underdrain pipe in each filtration curb extension
	Cost of underdrain	$/feet	20	Estimation based on preliminary analysis using BMP and LID Whole Life Cost Models (WERF, 2009) and RSMeans CostWorks, 2011
	Total Cost – Underdrains		*$10,000*	
	Linear feet of connection to storm drain	feet	330	Assumes connections for all filtration facilities, approximately 30 feet per connection.
	Cost of connection to storm drain	$/ feet	130	Includes estimates for demolition, excavation/trenching, installation, connection pipe to storm drain; Estimation based on preliminary analysis using BMP and LID Whole Life Cost Models (WERF, 2009) and RSMeans CostWorks, 2011
	Total Cost – Connections to Storm Drain		*$43,000*	
Total Construction Cost		$	$600,000	Includes construction, plant installation and 2 years of plant establishment
Design	Assume 20% of Construction		$120,000	
Maintenance	Vegetation Management, Trash and Sediment Removal	man-hrs/yr	64	Activity and frequency from 2008 Stormwater Management Facility Monitoring Report for NE Siskiyou Green Street (Portland Environmental Services Dept.) Assumes a crew of 4 working one full day, twice per year - once during the fall/winter and once during the spring/summer.
	Staff Rate (with overhead)	$ / man-hr	77	Light Equipment Operator RS Means Heavy Construction Cost Data 2011 (with 20% increase for Bay Area)
	Total Maintenance Labor	$/yr	$5,000	

Table D-5: Broadway and Redwood Project

Project Phase	Item	Unit	Unit Price	Quantity	Amount	Notes
Con-struction	Removal of asphalt pathway	SY	$8.60	400	$3,440	RS Means Category 02 41 13.17
	Swale	Acres (drainage area)	$15,000	3	$45,000	WERF Life Cycle Cost Template “very high estimate” (includes grading, soil improvements, and landscaping)
	Irrigation system	SF	$1.25	6000	$7,500	RS Means Category 32 84 23
Total Construction Cost					***$55,940***	Includes construction and labor for fabrication and installation of filter system.
Design	Assume 40% of Construction				**$22,000**	
Main-tenance	Staff Rate (with overhead)	$/ man-hr		77		Light Equipment Operator RS Means Heavy Construction Cost Data 2011 (with 20% increase for Bay Area)
	Sediment removal and Vegetation Management	man-hrs/yr		64	$5,000	Assume two staff quarterly for 8 hours
	Total Maintenance Labor	**$/yr**			**$5,000**	

Table D-6: West Oakland Industrial Area Project Cost Estimate

Project Phase	Item	Unit	Option 1	Option 2	Option 3	Source
Construction	Total Length of Bioretention Facilities	feet	350	700	250	West Oakland Concept Plan,11 August 2011 (Geosyntec)
	Average Width	feet	6-15	6	6-15	West Oakland Concept Plan,11 August 2011 (Geosyntec)
	Total Landscaped Area	sq-ft	3,200	4,200	2,800	Includes facilities proposed for each option
	Cost/Area (San Francisco Bay Area)	$/sq-ft	72	72	72	RS Means Location Factors for installation (Bay Area costing)
	Total Cost – Bioretention, no Underdrain		*$230,000*	*$300,000*	*$200,000*	Includes construction, plant installation and 2 years of plant establishment
	Underdrains	feet	350	700	250	Assumes one underdrain pipe in each bioretention facility
	Cost of underdrain	$/feet	20	20	20	Estimation based on preliminary analysis using BMP and LID Whole Life Cost Models (WERF, 2009) and RSMeans CostWorks, 2011
	Total Cost – Underdrains		*$7,000*	*$14,000*	*$5,000*	
	Total Cost of Construction	$	$237,000	$314,000	$205,000	
Design	Assume 20% of Construction	$	$47,000	$63,000	$41,000	

Maintenance would be conducted by the Urban Releaf project. Costs would be estimated with the organization.

Technical Memorandum

201 North Civic Drive
Walnut Creek, CA 94596
Tel: 925-937-9010
Fax: 925-937-9026

Prepared for: Bay Area Stormwater Management Agencies Association (BASMAA)

Project Title: Stormwater Diversion Pilot Projects (C.11.f / C.12.f)

Project No: 140589

Technical Memorandum

Subject: Status Report on Candidate Pilot Diversion Projects

Date: August 12, 2011

To: Geoff Brosseau, Executive Director, BASMAA

From: Khalil Abusaba, Supervising Scientist

Copy to: Stormwater Diversion Pilot Projects Oversight Committee

Prepared by: Khalil Abusaba, Ph.D.

1. Executive Summary

This Status Report summarizes activities by Permittees to implement actions required under provisions C.11.f and C.12.f of the Municipal Regional Stormwater National Pollutant Discharge Elimination System (NPDES) Permit (Order No R2-2009-0074), more commonly referred to as the Municipal Regional Permit (MRP). Provisions C.11.f and C.12.f of the MRP are nearly identical provisions for control of mercury (C.11) and polychlorinated biphenyls (PCBs) (C.12) that require the evaluation of pilot diversions to publicly owned treatment works (POTWs) of dry weather urban runoff and/or first flush events from stormwater pump stations. The pilot projects are being evaluated in parallel with other BMP pilot implementation projects, including stormwater treatment retrofits, sediment management pilot projects, and source investigations to identify contaminated sites.

The MRP establishes the following reporting requirements for Permittees:

- **Summarize the results of a feasibility evaluation in the 2010 Annual Report.** On behalf of all MRP Permittees and as part of their 2010 Annual Reports, a Feasibility Evaluation Report was submitted to the San Francisco Bay Regional Water Quality Control Board (Water Board) via the BASMAA Regional Pollutants of Concern and Monitoring Supplement that included selection criteria for candidate diversion projects and a time schedule for pilot projects implementation (Table 1). Delete Table 1? Probably not helpful to have a generic table at this point.
- **Report the status of pilot studies in each subsequent Annual Report** - This Status Report serves in compliance with this MRP requirement.
- Integrated Report Summary – The MRP also requires Permittees to include in the March 15, 2014 Integrated Report information on pilot program effectiveness, mercury loads reduced, and updated feasibility evaluation procedures to guide future diversion project selection.

During 2010 – 2011, stormwater program representatives (on behalf of Permittees) implemented the screening process proposed in the 2010 Feasibility Evaluation Report 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 Feasibility Evaluation Report. Staff of the 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 Water Board staff concurred that there was likely overlap between evaluations of the proposed diversion pilots and sediment management activities and they could to some extent collectively be carried out in fulfillment of Provisions C.11.d and C.12.d of the MRP.

A refined list of six pilot diversion projects, including at least one for each County regulated by the MRP, is shown in Table 1. The corresponding project areas are indicated in Figure 1.

This status report presents an assessment framework that describes flow and constituent monitoring needed to assess loads reduced and avoided, as well as concepts for infrastructure assessments needed to characterize feasibility, potential impacts, and lessons learned from these planned or potential future pilot diversion projects. Next steps planned for 2011 – 2012 include advancing plans, agreements and designs needed for pilot diversion projects and initiating baseline monitoring. Specific details on the status of each pilot diversion project and next steps are summarized by County in Section 3.0.

Table 1. Proposed Pilot Diversion Projects	
County	**Proposed pilot project**
Contra Costa	Dry weather hard-piped diversion from North Richmond pump station into West County Sanitation District POTW
Alameda	1. Dry and wet weather hard-piped diversion from Ettie Street pump station into East Bay Municipal Utility District POTW 2. Dry weather pipe flushing in Ettie Street pump station watershed into East Bay Municipal Utility District POTW
Santa Clara	Dry and wet weather hard-piped diversion from existing structure in Palo Alto to Palo Alto Regional Water Quality Control Plant
Solano	Dry season and first flush vactor truck cleanout of State St. pump station and discharge into Fairfield-Suisun Sewer District POTW
San Mateo	Dry weather street flushing in the Pulgas Creek pump station watershed into South Bayside System Authority POTW.

Figure 1. Locations of Planned Pilot Diversion Projects

2. Background

This Technical Memorandum describes the six stormwater diversion pilot projects that are being planned by Bay Area stormwater programs (on behalf of Permittees) in compliance with provisions C.11.f and C.12.f of the MRP. The MRP requires Permittees to implement control measures on a pilot scale to determine their effectiveness and technical feasibility for reducing discharge of PCBs and mercury to urban runoff. Provisions C.11.f and C.12.f of the MRP are nearly identical provisions for control of mercury (C.11) and polychlorinated biphenyls (PCBs) (C.12) that require the evaluation of pilot diversions of dry weather urban runoff and/or first flush events to publicly owned treatment works (POTWs). The pilot projects are being evaluated in parallel with other BMP pilot implementation projects, including stormwater treatment retrofits, sediment management pilot projects, and source investigations to identify contaminated sites. The MRP requires a minimum of one such pilot diversion project in each county covered by the MRP (Contra Costa, Solano, Alameda, Santa Clara, and San Mateo).

Pilot projects will be led by stormwater management programs and/or their affected Permittees, with coordination and facilitation provided through the Bay Area Stormwater Management Agencies Association (BASMAA). The first deliverable required by provisions C.11.f and C.12.f was a Feasibility Evaluation Report (FER). Representatives of stormwater programs met on a monthly basis from June 2010 through December 2010 to provide oversight and direction on completion of the FER. That deliverable was submitted to the Water Board by BASMAA on behalf of all member agencies and their respective Permittees by September 15, 2010, for incorporation by reference in Permittee/Program Annual Reports. The FER was later revised based on input from the Water Board (the revised version is dated December 1, 2010).

The proposed selection criteria presented in Table 2 below were included in the FER and were designed to assist in the identification of five primary candidates and five alternate candidates for diversion pilot projects. The selection criteria are based on needs, costs, and acceptability of candidate pilot projects.

Table 2. Selection Criteria and Information Needed		
Criteria		Information Needed
Needs	Will the pilot 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 pilot project provide unique or new information?	Peer review 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?	Peer review 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 of FER)

3. Proposed Pilot Projects

This section describes the pilot diversion projects being developed in each MRP county. Details are provided on the locations, approach, expected learning benefits, and current status of each project.

3.1 Contra Costa County

3.1.1 Pilot Project Overview

The Contra Costa County Flood Control and Water Conservation District (CCC-FCWCD) , a copermittee of the Contra Costa County Clean Water Program (CCCWP), is planning a dry weather diversion from the North Richmond Pump station into the West County Sanitation District (WCSD). The pilot project is an opportunity area because it involves a pump station favorably located with respect to the collection system infrastructure. CCC-FCWCD sought and obtained grant funding administered by the San Francisco Estuary Project through U.S. EPA's 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 EPA funds, matched by $165,550 from CCC-FCWCD to plan, design, construct, and monitor an engineered diversion into WCSD.

The project is located in a 339 acre watershed comprised mainly of industrial and residential land uses (Figure 2, Figure 3). Because of the watersheds' proximity to older industrial areas known to have elevated PCB concentrations in sediments, and the potential for vehicle tracking and other processes to mobilize PCBs into a "halo" area around sources, this watershed is a useful location to study removal of PCBs.

The plan will proceed in two phases: monitoring and feasibility evaluation (Phase 1), followed (if determined to be feasible) by construction, diversion, and assessment (Phase 2). During the initial monitoring phase, both dry season events and wet season events are planned. One of the wet season monitoring events would provide evenly spaced grab samples across the hydrograph to characterize pollutant distributions over time; other wet season events and all dry season events would characterize pollutants in composite samples. Therefore, although the diversion itself is limited to dry weather because of wet weather capacity constraints, monitoring will provide learning benefits about the potential for pollutant load reductions in wet weather and dry weather.

The expected learning benefits from this pilot diversion project include:

- What is the feasibility and cost of designing and constructing a pump station diversion?
- What are the loads of PCBs and mercury reduced by dry weather diversions?
- What are the permitting procedures in a situation where the pump station owner has no formal connection or relationship to the treatment plant service provider?
- What ancillary water quality benefits are obtained, in addition to PCBs and mercury?
- How can controls be implemented to differentiate wet weather vs. dry weather discharges?
- Does the diversion impact collection system capacity and / or treatment plant operations?

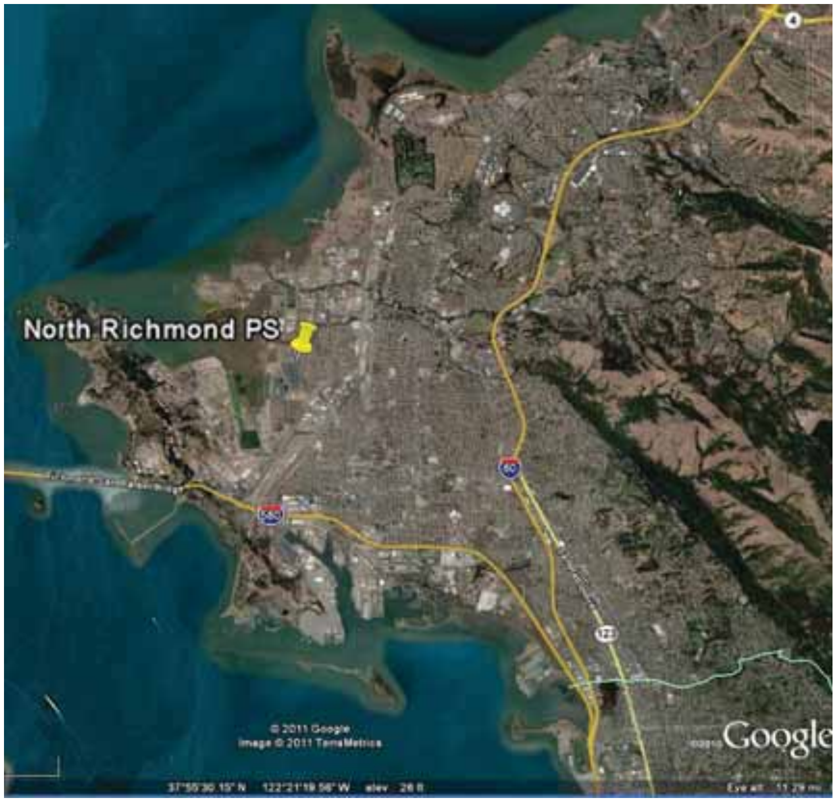


Figure 2. Regional Setting of North Richmond Pump Station Diversion

Figure 3. Delineation of Watershed Served by North Richmond Pump Station

Figure from Draft Quality Assurance Project Plan Developed by SFEI

3.1.2 Current Status

A project work plan has been completed, and the San Francisco Estuary Institute (SFEI) has been contracted by the CCC-FCD to provide monitoring services. The watershed has been delineated. A Sampling and Analysis Plan has been completed and dry season baseline monitoring has commenced. Monitoring results are being evaluated by the WCSD to determine whether they meet local limits.

3.1.3 Additional Sediment Management Pilot Project Opportunities

During the conduct of site investigations to implement Provisions C.11.d (enhanced sediment management practices), a storm drain inlet was identified that may be a useful location to evaluate the load reduction benefits of inlet cleaning. A storm drain located at Second Street and Cutting Blvd, in Richmond was inspected after late spring rain storms in May and June of 2011 and found to be clogged. The inlet has been found to have sediments with elevated PCBs in the past.

In preparation for the 2011 - 2012 storm season, The City of Richmond and the CCCWP plan to coordinate with the Veolia Water (The City of Richmond's contractor for operating the wastewater and stormwater infrastructure) to collect and analyze PCBs in sediment samples in conjunction with inlet maintenance. Opportunities will be sought to leverage CCCWP resources to derive MRP-related learning benefits pursuant to provisions C.11.d, C.11.f, C.12.fd, and C.12.f while performing this maintenance activity. The CCCWP will discuss with the City of Richmond and Veolia Water options for disposal of the wash water from the cleanout, including the potentially diverting wash water into the sanitary sewer system.

3.2 Alameda County

As shown previously (Table 2), two pilot projects are proposed in Alameda County:

- Pilot Project No. 1 - Dry and wet weather hard-piped diversion from Ettie Street pump station into East Bay Municipal Utility District POTW
- Pilot Project No. 2 - Dry weather storm drain piping flushing in Ettie Street pump station watershed into East Bay Municipal Utility District POTW

3.2.1 Pilot Project No. 1 Overview

Alameda Countywide Clean Water Program (ACCWP) is planning a pilot diversion project from the Ettie Street Pump Station into the East Bay Municipal Utility District (EBMUD). The Ettie Street Pump Station watershed has been previously identified as impacted by PCB-contaminated sediments as a result of historic land uses[1]. The pump station serves an approximately 1000 acre watershed in an industrialized watershed where some redevelopment has occurred (Figure 4, Figure 5). Some property-specific cleanups have occurred in the watershed as a result of municipal inspections and outreach to property owners. In addition, a pilot project was conducted by EBMUD at that location that involved dry weather diversion and characterization of forebay water during both wet and dry weather[2].

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[1] See references in Yee, D. and L.J. McKee, *Concentrations of PCBs and Hg in soils, sediments and water in the urbanized Bay Area: Implications for best management*. SFEI Contribution 608 March 2010.

[2] East Bay Municipal Utilities District. *Environmental Enhancement Project and Supplemental Environmental Project. Characterization of Stormwater Flows, Diversion of Dry Weather and First Flush Flows to a Publicly-Owned Treatment Works. Final Report.* July 2010.

ACCWP's Ettie Street pump station diversion pilot project is intended to address the following technical and management questions:

- Technical:
  - What is the average and range of variability for PCB and mercury concentrations in stormwater passing through the Ettie St. Pump Station, and how does that compare with previously reported results from EBMUD and the RMP?
  - What is the particle size distribution of suspended sediments in runoff entering the Ettie St. Pump Station, and how do concentrations and mass of PCBs and mercury partition among the size fractions?
- Implementation
  - What are the permitting procedures in a situation where the pump station owner (Alameda County Flood Control and Water Conservation District) has no formal connection or relationship to the treatment plant service provider?
  - What additional considerations apply when the diversion is implemented through a conveyance owned and operated by another jurisdiction (City of Oakland)?
  - What would be the technical and cost considerations for ongoing operation of the pilot diversion?
  - What would be the technical and cost considerations for the stormwater managers if scaling up to a larger diversion?
  - What would be technical, regulatory and cost considerations for EBMUD to accept ongoing or scaled-up pilot diversions? Information needs cited in EBMUD's report include storm-to-storm variability and evaluation of hydraulic capacity.
- Water Quality Benefits
  - What would be the net reductions in PCBs and mercury to the Bay from ongoing or scaled-up diversion from the Ettie Street Pump Station?
  - How would these reductions compare with those resultingfrom alternative reduction strategies based on treatment retrofit a the pump station and/or enhanced sediment management upstream of the pump station?

Planned diversions would consist of two types: after initial pretreatment settling in a storage tank, a complete diversion will discharge the diverted water to the EBMUD plant via the existing City of Oakland sanitary sewer connection at the pump station. In a more limited "study diversion", water from the storage tank will be sampled and released back into the pump station forebay. ACCWP plans to conduct two to four complete diversions, for which it will obtain permission and permits as needed from the city and EBMUD.

For each diversion, a fixed volume of urban runoff entering the Ettie St. Pump Station will be diverted to an above ground storage tank installed adjacent to the Pump Station forebay. Due to limitations on available space and safe bearing loads that can be applied to the soil adjacent to the forebay, the tank volume is expected to be no more than 500 gallons. Figure 6 is an aerial image and schematic of the proposed diversion tank and pump station features.

To optimize capture of PCBs in the diverted volume, diversion from the forebay to storage tank will be triggered by turbidity levels from a sensor installed in the forebay. The turbidity threshold value will be based on a review of recent stormwater data from the pump station and other Bay Area urban stormwater monitoring locations. Once the predetermined turbidity threshold is exceeded, a submersible pump will begin filling the storage tank. Automated samplers will be programmed to characterize forebay concentrations of PCBs, mercury and suspended sediment throughout the sampled event and also at the times of diversion.

At least three wet weather events and one dry weather event will be diverted and sampled. Complete diversions will be implemented for at least two events.

Figure 4. Regional Setting of the Ettie Street Pump Station Diversion

Figure 5. Close-up of area served by Ettie Street Pump Station.

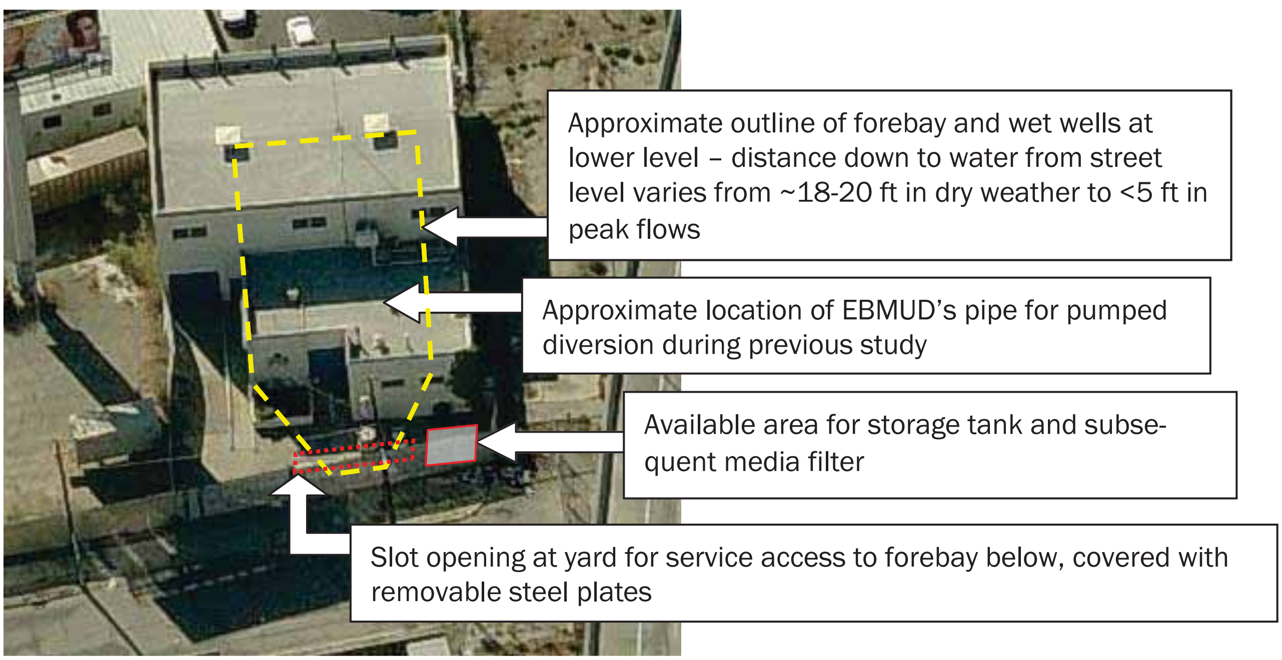


Figure 6. View of Ettie Street Pump Station from the east, with schematic outline of forebay below and approximate diversion tank location in northeast corner of yard

3.2.2 Current Status of Pilot Project No. 1

Larry Walker Associates has prepared a draft memo describing the study design and workplan for the pilot project, based on previous discussion with EBMUD staff. Proposed target milestones for implementation include:

- July-August 2011 obtain concurrence from ACFCWCD, EBMUD and ACCWP on workplan details
- September 2011 Prepare Sampling and Analysis Plan, install diversion tank and samplers
- Winter 2011-12 Conduct pilot diversions and associated monitoring
- July 2012 Report on characterization of diversions
- July 2013 Final project report

3.2.3 Pilot Project No. 2 Overview

The second pilot project being developed in the Ettie Street Pump Station drainage is storm drain piping flushing into the local sanitary sewer collection system served by EBMUD's regional wastewater treatment plant.

The management questions this pilot project would address include:

- Technical challenges:
  - What are the operational challenges and constraints to performing piping flushing and routing the wash water to a POTW?
  - What are the operational challenges and constraints to the POTW receiving this diversion?
- Water quality benefits:
  - What are the PCB and Hg load reduction benefits derived from piping flushing in an old industrial area with elevated PCBs?
  - Are there specific flushing methods and approaches that are more or less effective for removing sediments that contain PCBs and other pollutants?
  - Can piping flushing and follow-up monitoring help identify ongoing sources of PCBs into the stormwater conveyance system?

This type of project essentially entails creating an artificial "first flush," capturing the flows, and diverting to a POTW. This approach avoids the relatively high costs of diversion structure capital improvements and therefore may be more practical for wider implementation in the future, especially in the short-term.

3.2.4 Current Status of Pilot Project No. 2

The proposed target milestones for implementation of this project include:

- September 2011 - March 2012: ACCWP staff to work with staff from the City of Oakland, ACFCWCD, and EBMUD and the CW4CB Sediment Management Workgroup to prepare a detailed project work plan, including a Sampling and Analysis Plan.

- April - June 2012: ACCWP staff to work with staff from the City of Oakland, ACFCWCD, and EBMUD and the CW4CB Sediment Management Workgroup to plan mobilization of field crews and flushing/monitoring equipment.
- Summer 2012: Conduct piping flushing fieldwork and associated monitoring.
- January 2013: Prepare draft report that documents field methods and evaluates results.
- July 2013: Finalize project report.

3.3 Santa Clara County

3.3.1 Pilot Project Overview

The pilot diversion project that will be implemented and evaluated by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), in cooperation with the City of Palo Alto is 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 (Figure 7). The diversion structure's drainage area is comprised of commercial, light industrial, multi-family residential and other land uses. The site was originally selected by the City of Palo Alto because of the land use in the drainage area, the proximity of the sewer trunk line to the storm drain line, and because the sewer trunk line (27" Channing Avenue sewer trunk line) was determined to have excess capacity.

The City of Palo Alto diversion project will address the following management and technical questions:

- Project implementation
  - Construction:
    - What were the challenges and constraints to constructing this diversion?
    - What are the operational challenges and constraints to operating and maintaining this diversion?
  - Operation:
    - What are the operational challenges and constraints to the POTW receiving this diversion?
  - Costs:
    - What were the capital costs of constructing this diversion structure?
    - What are the costs associated with operation and maintenance(O&M) of the diversion structure?
    - What are the additional O&M costs to the POTW receiving the diversion?
    - How do the construction and O&M costs and constraints compare to those of the other pilot strategies outlined in MRP provisions C.11 and C.12?
- Technical & Water Quality
    - What percentage of dry and wet weather flows are diverted under current operation?
    - What are the suspended sediment particle size distributions in wet weather runoff from the drainage area, and how do they change under different flow conditions?
    - What are the water quality benefits and operational challenges of the diversion structure under different flow conditions?

- What are the projected benefits and challenges of operating a similar diversion structure in a larger drainage area and/or an area known to have elevated concentrations of PCBs or mercury?
  - How do these load reductions compare to other pilot strategies outlined in MRP provisions C.11 and C.12 to manage PCB and mercury loads?
  - What are the other benefits to receiving water quality?

Figure 6. Regional Setting of City of Palo Alto Pilot Diversion Project

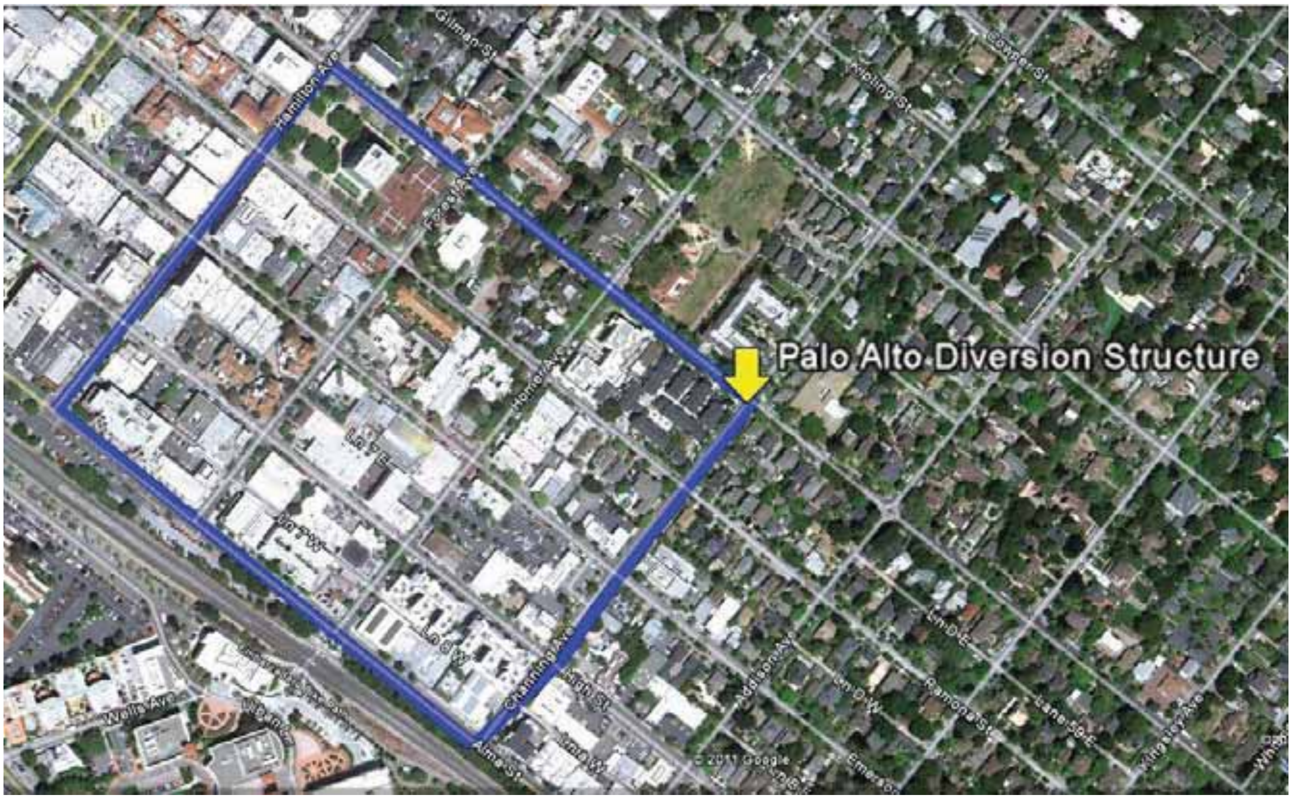


Figure 7. Drainage Area Served by the Palo Alto Diversion Structure

The City of Palo Alto diversion structure includes two valves: a vortex valve and plug valve. The vortex valve is designed to continually regulate flows to the sewer line to reduce erosive velocities. The plug valve diverts flows from the stormwater conveyance system until a designed capacity of 350 gpm (0.78 cfs) is reached. It is estimated that wet weather diversions to the sanitary sewer occur up to a rainfall intensity of 0.33 inches per hour. In addition, the structure was designed with a bar screen to collect large debris and allow solids to settle to the bottom of the vault. The City's maintenance crew regularly cleans out the accumulated debris with a vactor truck.

This pilot diversion project provides a contrast to the other projects described in this status report due to the fact that it requires no pumping (passive) and it has been in place for a number of years, which will provide Permittees with a better understanding of the long-term costs and challenges and assist in addressing the various management and technical questions listed above.

3.3.2 Current Status

SCVURPPP is currently developing a work plan for the Palo Alto Pilot Diversion Project that will guide data and information collection activities over FYs 2011-12 and 2012-13. The work plan will consist of background information, a summary monitoring and cost data collected to-date, and a monitoring/modeling plan. The work plan is expected to be completed in fall 2011. Monitoring will likely initiate during the winter 2011-12 (Water Year 2012) and continue through the winter of 2012-13. Once complete, the monitoring plan will be shared with the BASMAA Pilot Diversion Projects Oversight Committee and the Water Board via the SCVURPPP website.

3.3.3 Additional Sediment Management Pilot Project Opportunities

In addition to the Palo Alto Pilot Diversion Project, SCVURPPP Permittees are also planning two additional projects in the in the Leo Avenue watershed (City of San Jose) that are assessing the ability to remove sediment-bound PCBs and mercury via enhanced street sweeping and stormwater treatment. This location was previously identified in a case study follow-up to the 2001 Joint Stormwater Agencies Project investigation of PCBs in bedded storm drain sediments[3]. This location was evaluated a potential diversion site, but was not located near the necessary size of sanitary sewer system infrastructure for an effective diversion. These projects will complement the Palo Alto Pilot Diversion Project and through planned stormwater monitoring located upstream of the Leo Avenue stormwater treatment devices (i.e., hydrodynamic separator) and simple spreadsheet modeling, they may collectively provide the opportunity to predict the benefits of constructing a structure similar to the Palo Alto diversion structure in a larger drainage area with elevated PCB or mercury concentrations. Additionally, SCVURPPP will continue to collaborate with other stormwater programs carrying out diversion projects to evaluate the effectiveness, such as cost per pound of pollutant, of this management approach to reduce PCB and mercury loads to the Bay.

[3] City of San Jose and EOA. 2003. Year Two Case Study Investigating Elevated Levels of PCBs in Storm Drain Sediments in San Jose, California.

3.4 Solano County

3.4.1 Pilot Project Overview

The Fairfield-Suisun Urban Runoff Management Program (FSURMP) is implementing operational changes at the State Street pump station in the City of Fairfield. Operational changes to be evaluated include: shutting off the stormwater pump station during dry weather; removing standing water in the pump station wet well by vactor truck throughout the dry season and before first flush. Water removed is discharged into the Fairfield Suisun Sewer District collection and treatment system. This pilot project is being implemented to address low dissolved oxygen levels that have been found during dry weather conditions, in compliance with Provision C.2.d of the MRP. Additional monitoring for mercury and PCBs will be implemented to fulfill the requirements of provisions C.11.f and C.12.f.

The pumping station is serves a watershed area of approximately 6 acres (Figure 8, Figure 9). The contributing area is commercial land use (a significant percentage of which is automotive repair).

The expected learning benefits include:

- What are the PCB and mercury loads that are removed during dry weather diversion? (the pump station does not have historic data on mercury or PCBs in sediments)
- Does the reduction in loadings of COD/BOD measurably avoid low dissolved oxygen in receiving waters?
- Does avoiding low dissolved oxygen in receiving waters provide a benefit by reducing methylmercury production?
- Are there any discernible environmental benefits from the enhanced operational procedures of the stormwater pump station?
- Can additional controls at stormwater pump station(s) inlet(s) have a positive impact on water quality being discharged?
- Is there significant water quality stratification in pump station wet wells?

3.4.2 Current Status

Dry weather vactoring and D.O. monitoring has commenced.

3.4.3 Additional Sediment Management Pilot Project Opportunities

Unlike Contra Costa, Alameda, Santa Clara, and San Mateo County, there is not as much information available on existing locations of contaminated sediments. A stormwater treatment retro-fit is planned to be implemented in Solano County. Evaluation of enhanced sediment management practices are also planned. Sediment assessments conducted prior to those activities are expected to identify opportunity areas for street flushing or drainage inlet cleaning evaluations. To the extent that those evaluations can be coordinated with discharge of flushed water to sanitary sewers, additional learning benefits may be derived.

Figure 8. Regional Setting of the State Street Pump Station

Figure 9. Close View of State Street Pumping Station.

3.5 San Mateo County

3.5.1 Project Overview

The pilot project being developed by the San Mateo County Countywide Water Pollution Prevention Program (SMCWPPP) is street flushing in the Pulgas Creek Pump Station drainage into the local sanitary sewer collection system served by the South Bayside System Authority (SBSA) regional wastewater treatment plant. The approximately 330 acre Pulgas Creek pump station drainage (Figure 10, Figure 11) is located within an old industrial area and has been previously identified as having elevated concentrations of PCBs in storm drain sediments based on a regional dataset compiled by the San Francisco Estuary Institute.

Previous surveys of PCBs in urban runoff sediments revealed relatively high concentrations in samples from the wet well of the Pulgas Creek pump station, which is at the bottom of the watershed. Follow-up investigations confirmed the presence of PCBs and suggested multiple sources within the pump station's watershed. Two possible sources have been identified, a DTSC cleanup site and a PG&E substation, but these sources have not been confirmed and other sources remain unidentified.

The management questions this pilot project would address include:

- Technical challenges:
  - What are the operational challenges and constraints to performing street flushing and routing the wash water to a POTW?
  - What are the operational challenges and constraints to the POTW receiving this diversion?
- Water quality benefits:
  - What are the PCB and Hg load reduction benefits derived from street flushing in an old industrial area with elevated PCBs?
  - Are there specific flushing methods and approaches that are more or less effective for removing sediments that contain PCBs and other pollutants?
  - Can street flushing and follow-up monitoring help identify ongoing sources of PCBs into the stormwater conveyance system?

This type of project essentially entails creating an artificial “first flush,” capturing the flows, and diverting to a POTW. This approach avoids the relatively high costs of diversion structure capital improvements and therefore may be more practical for wider implementation in the future, especially in the short-term.

3.5.2 Current Status

Proposed target milestones for implementation of this project include:

- September 2011 - March 2012: SMCWPPP staff to work with staff from the City of San Carlos and SBSA and the CW4CB Sediment Management Workgroup to prepare a detailed project work plan, including a Sampling and Analysis Plan.
- April - June 2012: SMCWPPP staff to work with staff from the City of San Carlos and SBSA and the CW4CB Sediment Management Workgroup to plan mobilization of field crews and flushing/monitoring equipment.
- Summer 2012: Conduct street flushing fieldwork and associated monitoring.
- January 2013: Prepare draft report that documents field methods and evaluates results.
- July 2013: Finalize project report.

Figure 10. Regional Setting of Pulgas Creek Pump Station.

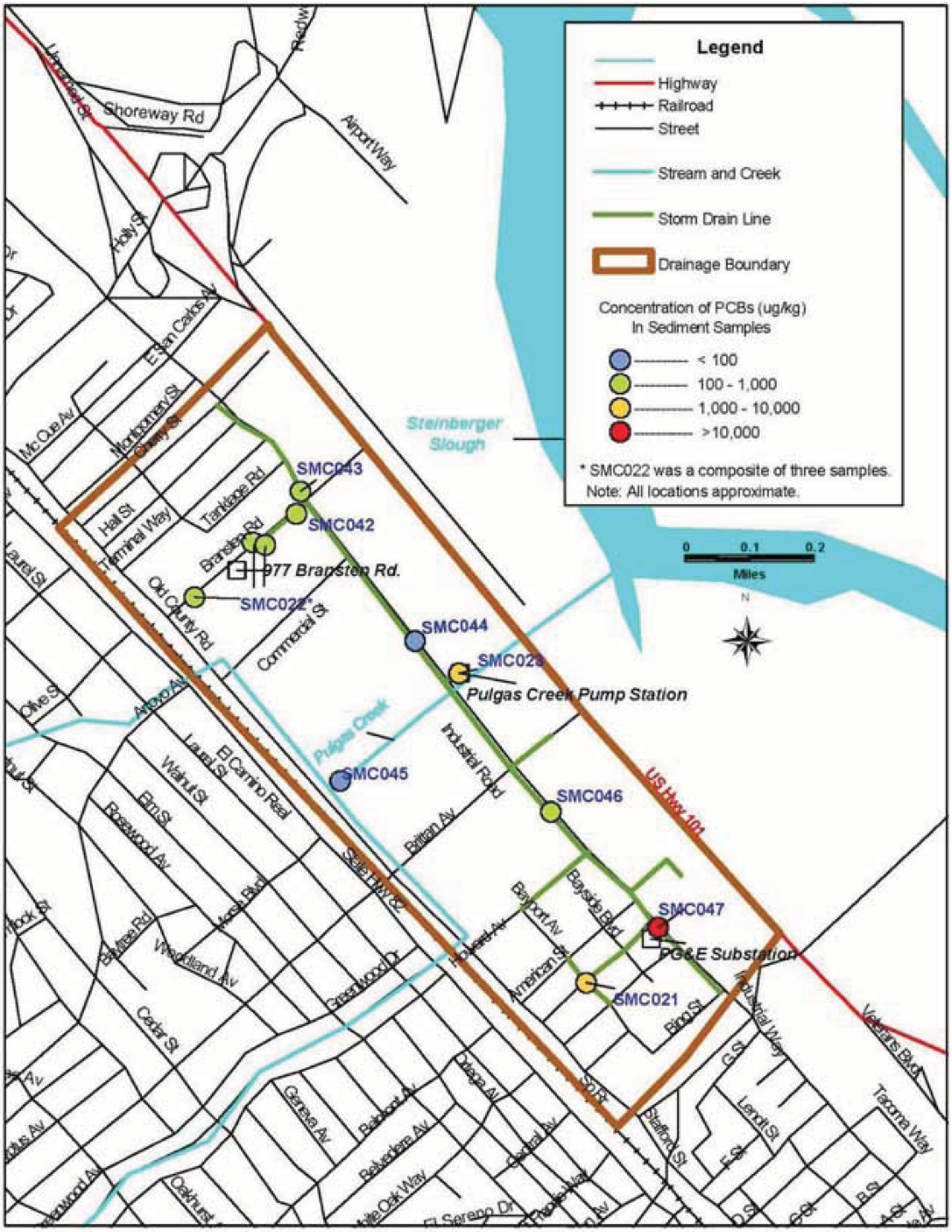


Figure 11. Watershed Delineation of Pulgas Creek Pump Station.

4. Assessment Framework

The monitoring plans for each pilot diversion project will be unique to the project setting and expected learning benefits. This section outlines a framework for assessment that addresses some of the monitoring and assessment issues that are expected to be common among all pilot projects. Assessment tools can be divided into two general questions that any pilot diversion project would need to address:

- What water quality benefits were derived from the pilot diversion?
- What potential future constructability challenges or negative impacts to the receiving POTW could be anticipated as a result of lessons learned from the pilot diversion?

4.1.1 Water Quality Benefits

The Alameda Countywide Clean Water Program has developed a draft monitoring alternatives evaluation for the Ettie Street Pump Station that guides this portion of the assessment framework (Table 3). Monitoring Options are divided into Tier 1 – those considered essential to fulfillment of MRP requirements, and Tier 2, those which provide added value information but are not necessarily required to fulfill MRP requirements. The decision to add Tier 2 options would involve balancing the cost of those added parameters with the value of information gained. For an equivalent cost, limiting the project to Tier 1 Monitoring Options could enable a greater range of spatial and / or temporal coverage.

Table 3. Monitoring Options

	Tier 1	Tier 2
Diversion of dry weather urban runoff and stormwater	Storm event data – rainfall intensity and duration, catchment area, estimated runoff volume Flow data – flow meters, telemetry, pump run times, or number of baker tanks filled Target constituents– mercury, methylmercury, and PCBs MRP Table 8.4 Category 1 Constituents	Suspended Sediment Particle Size* MRP Table 8.4 Category 2 Constituents
Conveyance system cleanouts / street flushing	Volume of water flushed Estimated mass of sediment captured - from disposal manifests, volume estimates of sediments in conveyance systems prior to removal, or TSS times volume of water discharge to POTW during cleanout PCB and mercury concentrations in sediments MRP Table 8.4 Category 1 constituents in sediments Sediment percent fines (<63 microns) Sediment Total organic carbon	MRP Table 8.4 Category 2 Constituents in Sediments Detailed grain size analysis of sediments

**The Alameda Countywide Clean Water Program considers particle size in suspended sediments a Tier 1 constituent for the intended learning benefits of their pilot study.*

4.1.2 Constructability and impacts

Pilot projects have been screened to provide constructible projects that minimize the risk of impacts to receiving POTWs. The 2014 Integrated Report submittal is to include revised selection criteria that would guide future diversion pilot projects. To guide future projects, the revised selection criteria should incorporate lessons learned about potential issues that could affect treatment plants or conveyance systems. Table 4 below summarizes some assessments that could address issues related to impacts on collection systems and POTWs.

Table 4.

Category	Issue	Solution	Action
Collection System	Stormwater diversion exceeds existing collection system hydraulic capacity	Perform capacity evaluation for facilities downstream of planned diversion connection to establish available capacity and maximum allowable stormwater diversion pumping rate.	Desktop or hydraulic model capacity evaluation. Limit stormwater flows to collection system based on evaluation.
	Collection system condition not adequate to handle increased flows.	Perform condition assessment for facilities downstream of planned diversion connection to identify structural or O&M deficiencies that could potentially cause an SSO (roots, grease, pipe collapse, etc.)	CCTV inspection of pipes. Repair or replacement of deficient pipes prior to diversion implementation.
	Hydraulic capacity monitoring after diversion implementation	Monitor flows during wet and dry weather diversions to prevent collection system SSO.	Flow monitoring, SmartCovers (ultrasonic depth measurement devices with warning system), visual wet weather checks at downstream facilities. If flows exceed collection system capacity, stormwater flows should be discharged elsewhere to prevent collection system SSO.
Collection System/WWTP	Trash/debris entering the collection system and/or WWTP could cause obstructions or disrupt processes.	Screen pump station influent to prevent trash from entering collection system/WWTP.	Monitor pump station effluent; clean pump station screening device. Periodic ongoing inspection to monitor increased grit load in the collection system.
WWTP	Stormwater diversion exceeds existing WWTP hydraulic capacity	Confirm that additional hydraulic loading will not exceed capacity of WWTP processes.	Desktop or hydraulic model capacity evaluation. Limit stormwater flows to WWTP based on evaluation.
	Stormwater constituents cause WWTP to exceed effluent discharge limits	Characterization of raw and effluent wastewater to determine WWTP removal rates of stormwater constituents and its impact on the WWTP.	Baseline and periodic sampling during and after discharge events to characterize waste stream (BOD, COD, TSS, ammonia, metals, mercury, PCB, oil and grease, debris).
	Stormwater constituents cause WWTP to exceed discharge limits in biosolids	Long-term characterization of biosolids at a frequent interval following stormwater discharge. Retention time is often 20-30 days following event.	Baseline and periodic sampling following discharge events to characterize biosolids.

APPENDIX A5

Monitor Stormwater Pollutant Loads and Loads Reduced (C.11/12.g)

Progress Report

Background

Provisions C.11.g and C.12.g require Permittees to develop and implement a monitoring program to quantify mercury and PCB loads and loads reduced through source control, treatment and other management measures implemented by Permittees. A draft technical memorandum describing initial load reduction quantification methods for PCBs and mercury was submitted to the Water Board in the BASMAA FY 2009-10 Regional POCs and Monitoring Supplement. Written comments from Water Board and Permittee staff were received on the technical memorandum following the submittal.

Summary of Comments Received

Comments received from Water Board Staff (Richard Looker and Tom Mumley) and Permittees were generally supportive of the methods included in the draft memorandum. Comments focused on including additional methods for all control measures pertinent to provisions C.11/12 of the MRP, including mercury-containing devices, PCB-containing demolition materials, and on-site abatements. Additionally, Water Board staff requested that a new section be included in the memorandum to explain how the methods for each control measures work together to quantify load reductions. Permittees also requested that methods for PCBs and mercury included in the memorandum be revised to align better with similar methods currently under development for trash.

Anticipated Next Steps

In FY 2011-12, BASMAA member agencies plan to revise methods presented in the draft memorandum to address Water Board and Permittee staff comments. Anticipated revisions include adding methods for quantifying loads from all C.11/12 associated control measures and providing consistency with trash load reduction tracking methods. Additionally, information will be added to the memorandum to better describe the process by which Permittees use these methods to quantify loads reduced.

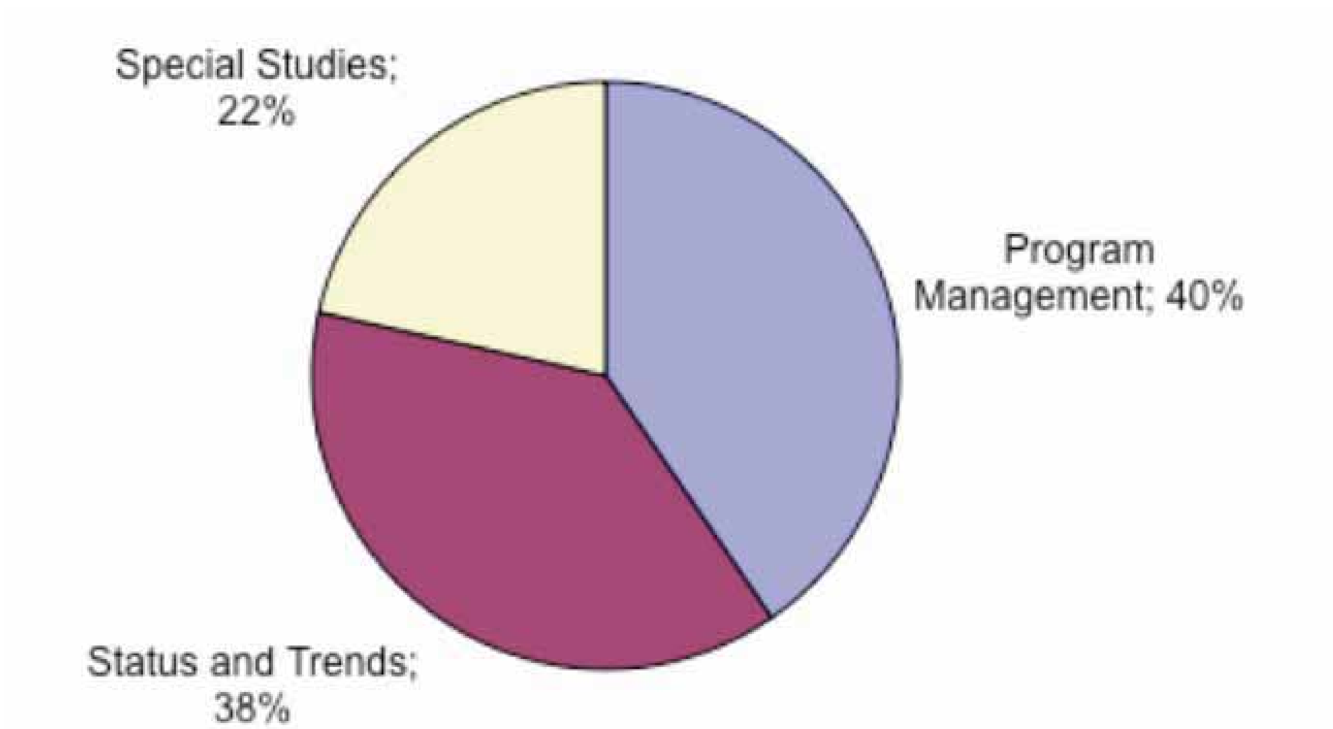
Discussions regarding revisions to these methods are planned in FY 2011-12 via the BASMAA Monitoring and Pollutant of Concern Committee (MPC). Revised methods are expected to be submitted with the FY 2011-12 Annual Report.

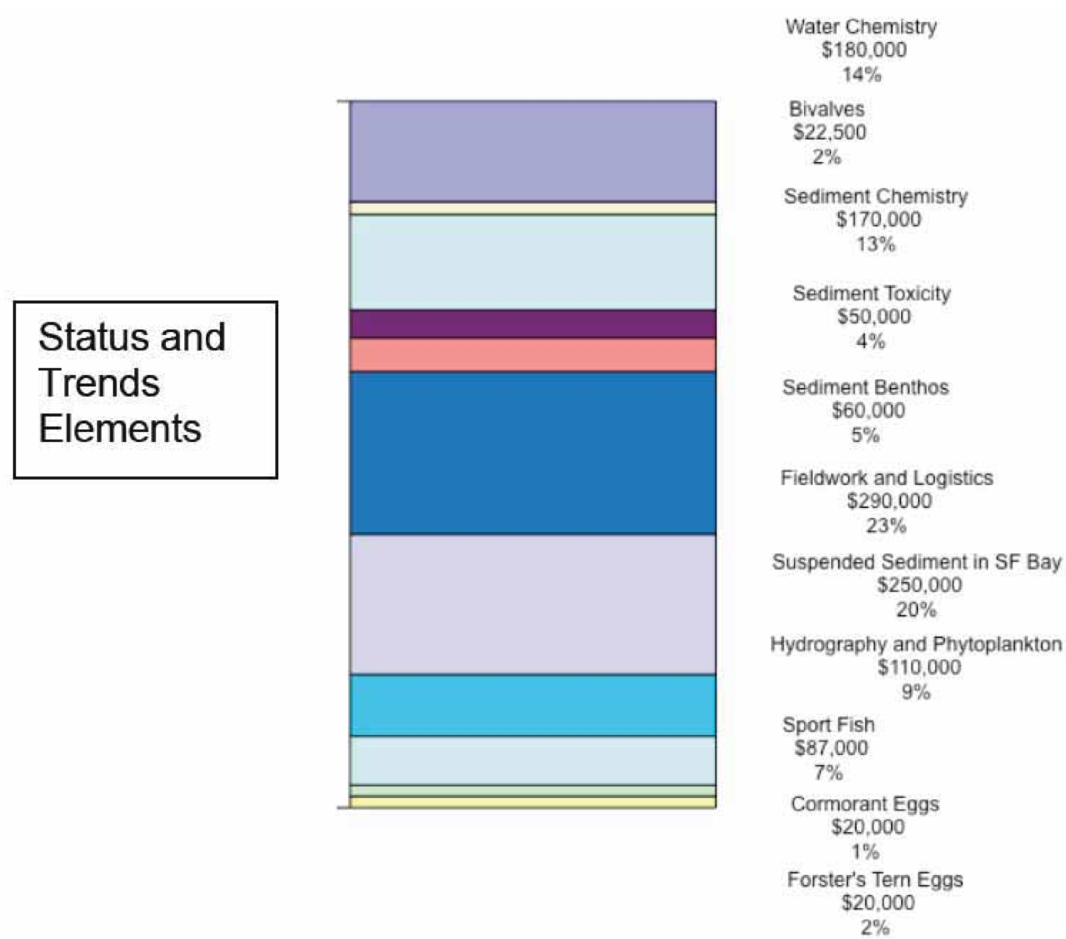
CURRENT AND ANTICIPATED WATER QUALITY MANAGEMENT DECISIONS, POLICIES, AND ACTIONS

Decisions, Policies, and Actions	Timing
Determination of Permit Limits	Ongoing
Biennial 303(d) List and 305(b) Report	2010-11 2012-13 2014-15
Mercury Review the existing TMDL and establish plan to revise it Revised mercury TMDL	 2011-13 2016-18
PCBs Review the existing TMDL and establish plan to revise it Revised PCBs TMDL	 2014-15 2019-20
Copper Compare levels to site specific objectives triggers Reevaluation of the site-specific objectives	 Annual Triennial (2012)
Cyanide Antidegradation policy Ambient levels below CTR threshold	Triennial (2012)
Selenium North Bay Selenium TMDL South Bay Selenium TMDL	 2012-14 > 2015
Legacy Pesticides (DDT, Dieldrin, Chlordane) Development of "Simple" TMDL	 2012-13
Dioxins Review/reissue permit requirements TMDL project plan TMDL	 2013-14 2017-19

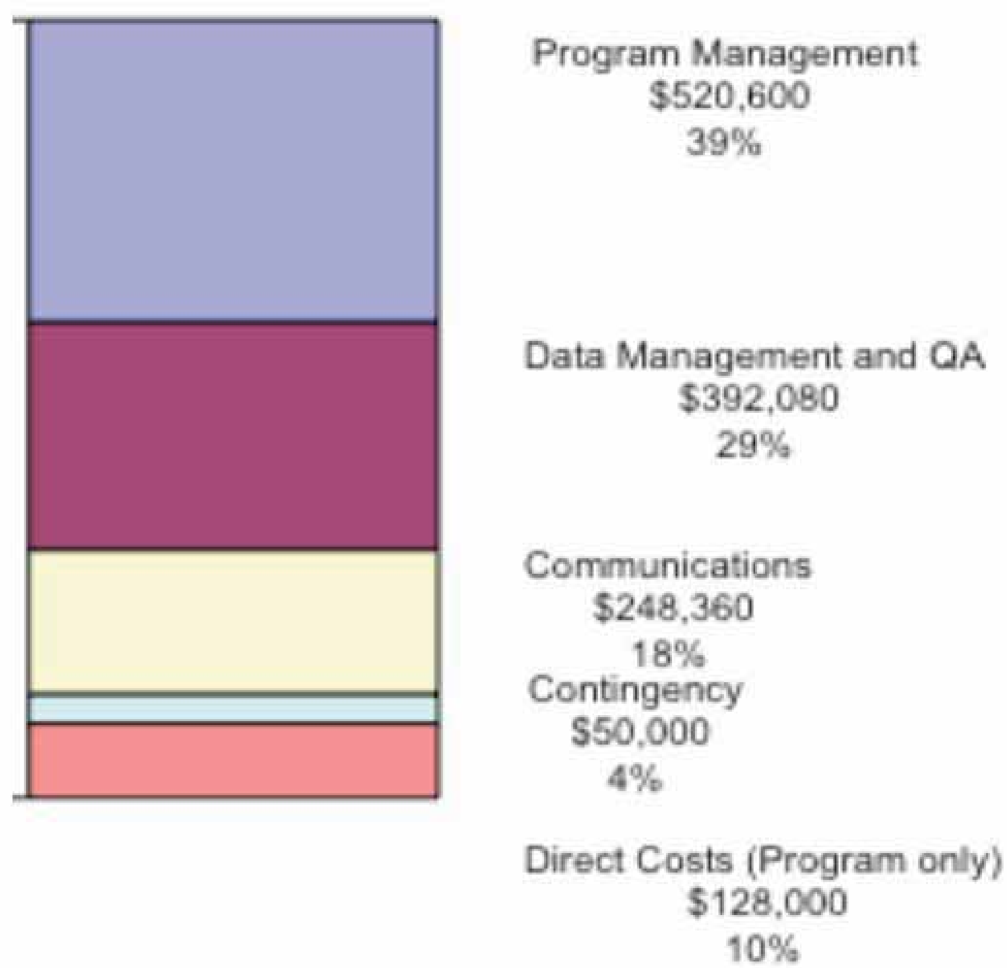
Decisions, Policies, and Actions	Timing
Sediment Quality Objectives 303(d) listings Determination of reasonable potential and permit requirements	 2010-11 2010-11
Nutrients New estuarine numerical endpoints Assessment of ammonia toxicity	2012-15
Municipal Regional Stormwater Permit (MRP)	2010 and beyond
Pathogens *XX*	 XX
Pyrethroids *XX*	 XX
PBDEs *XX*	 XX
LTMS-DMMP-Regional Sediment Management	2010 and beyond
Dredging Permits	2010 and beyond
Chemicals of Emerging Concern Regional Water Board considering a policy	 XX

The RMP contributes to effective management by providing scientific support for current policies and by anticipating and addressing information needs related to future policies and actions.


Special Studies; 22%
Program Management; 40%
Status and Trends; 38%


Status and Trends Elements
Water Chemistry
$180,000
14%
Bivalves
$22,500
2%
Sediment Chemistry
$170,000
13%
Sediment Toxicity
$50,000
4%
Sediment Benthos
$60,000
5%
Fieldwork and Logistics
$290,000
23%
Suspended Sediment in SF Bay
$250,000
20%
Hydrography and Phytoplankton
$110,000
9%
Sport Fish
$87,000
7%
Cormorant Eggs
$20,000
1%
Forster's Tern Eggs
$20,000
2%

Matrix	Analyte	Frequency
Sediment	Inorganics	Annual 47 sites (wet)/ 27 (dry)
	PCBs, PAHs, PBDEs, Pest, Pyrethroids	
	Grainsize, N, TOC	
Sediment toxicity		Annual 27
Sediment -benthos		Annual 27
Water	PBDEs, Inorganics, CN, ancilliary	Annual 22 sites
	PAHs, PCBs, pesticides	Biennial 22 sites
Bivalves	PCBs, PAHs, PBDEs, pesticides	Biennial
	Inorganics	Every five years
Sport Fish	Hg, Se, PBDEs, Pest, PFCs, Dioxin	Triennial
Cormorant eggs	PCBs, PBDEs, Pesticides, PFCs, Hg, Se	Triennial
Tern eggs	Hg, Se, PBDEs	Triennial


Program Management
$520,600
39%
Data Management and QA
$392,080
29%
Communications
$248,360
18%
Contingency
$50,000
4%
Direct Costs (Program only)
$128,000
10%

MERCURY

The Mercury Strategy began with a multi-year suite of studies in 2008. These studies are now being completed. A synthesis in 2011 will set the stage for a new multi-year plan for 2012 and beyond.

Mercury and methylmercury studies and monitoring in the RMP from 2008 to 2015. Numbers indicate budget allocations in $1000s.

General Area	Element	Mercury Questions Addressed	2008	2009	2010	2011	2012	2013	2014	2015
		Mercury-specific Studies								
Mercury Strategy	Methylmercury Synthesis	1,2,3,4,5				75	TBD	TBD	TBD	TBD
	Food Web Uptake (Small Fish) (Status and Trends)	1,4	150	150	150	20	TBD	TBD	TBD	TBD
	High Leverage Pathways (DGTs)	2	58	58			TBD	TBD	TBD	TBD
	High Leverage Pathways (Isotopes)	2,5	40	40			TBD	TBD	TBD	TBD
	Methylmercury Fate Model	3,4		25			TBD	TBD	TBD	TBD
Effects	Effects on Birds		70	54						

Possible next steps:

- methylmercury model
- more isotopes
- more small fish

PCBS

Studies under the PCB Strategy began in 2010. A synthesis in 2011 will set the stage for a multi-year study plan for 2012 and beyond.

PCB studies and monitoring in the RMP from 2010 to 2015. Numbers indicate budget allocations in $1000s.

General Area	Element	PCB Questions Addressed	2010	2011	2012	2013	2014	2015
		PCB-specific Studies						
PCB Strategy	Food Web Uptake (Small Fish)	1,7	50		TBD	TBD	TBD	TBD
	PCB Conceptual Model Update	1,2,3,4,5,6,7, 8,9		53	TBD	TBD	TBD	TBD

Possible next steps:

- more small fish
- margin studies to support modeling

DIOXINS

Dioxin studies and monitoring in the RMP from 2008 to 2015. Numbers indicate budget allocations in $1000s. Unlike the other contaminants, dioxin costs have generally been itemized explicitly as add-ons to RMP studies.

Dioxin Strategy studies began in 2008, with a multi-year plan extending through 2012. Synthesis activities are planned for 2013 and 2014 after the data from the earlier studies are available.

General Area	Element	Dioxin Questions Addressed	2008	2009	2010	2011	2012	2013	2014	2015
		Dioxin-Specific Elements								
Dioxin Strategy	QUALITY ASSURANCE	1,2,3,4,5,6		20						TBD
	Synthesis Report	1,2,3,4,5,6								TBD
Status and Trends	Sport Fish	1,2,4		22			22			TBD
	Avian Eggs	1,2,4					10			TBD
	Surface Sediments	2,3	57	57			57	TBD	TBD	TBD
	Water	2,3		20		28		TBD	TBD	TBD
Loads	Small Tributary Loading	4,5,6		34	34		68	TBD	TBD	TBD
	River Loading (THg)	4,5,6			34			TBD	TBD	TBD
Forecast	Sediment Cores	3,4,6			67			TBD	TBD	TBD
	Synthesis: One-Box Model	3,4,5,6						20	TBD	TBD
	Synthesis: Food Web Model	5,6							20	TBD

Possible next steps:

• synthesis

EMERGING CONTAMINANTS

Emerging contaminant studies in the RMP have been augmented substantially by pro bono work and matching funds. RMP expenditures on this topic from 2008 to 2011 add up to $380,000. Matching funds for this period were approximately $xx. A synthesis in 2011 and 2012 will set the stage for a multi-year plan for 2013 and beyond.

Emerging contaminant studies and monitoring in the RMP from 2008 to 2014. Numbers indicate budget allocations in $1000s. Matching funds indicated in parentheses.

Element	Emerging Contaminant Questions Addressed	2008	2009	2010	2011	2012	2013	2014	2015
PFCs in Biota	1	35				TBD	TBD	TBD	TBD
Alternative Flame Retardants (brominated, Dechlorane Plus, phosphate-based)	1	48				TBD	TBD	TBD	TBD
Chlorinated Paraffins in Biota	1	0 (xx)				TBD	TBD	TBD	TBD
Triclosan in Sediment	1	0 (xx)				TBD	TBD	TBD	TBD
White Paper on ECs in Wastewater	1		30			TBD	TBD	TBD	TBD
PFC Sources	1		52			TBD	TBD	TBD	TBD
Nonylphenol in Small Fish	1		0 (xx)			TBD	TBD	TBD	TBD
Broadscan Screening of Biota for EC	1			55 (xx)	70 (xx)	TBD	TBD	TBD	TBD
AXYS Mussel Study	1			27 (xx)		TBD	TBD	TBD	TBD
AXYS Brominated Dioxins in Sediments and Biota	1			0 (xx)		TBD	TBD	TBD	TBD
NOAA Mussel Pilot Study	1			33 (xx)		TBD	TBD	TBD	TBD
EC Synthesis Report	1				30	15	TBD	TBD	TBD
Nanoparticles	1			0 (xx)		TBD	TBD	TBD	TBD

SMALL TRIBUTARY LOADING STRATEGY

Small Tributary Loading Strategy studies began in 2008. Monitoring loads from representative watersheds will be the major emphasis for the next several years. Monitoring of representative source characterization sites in 2012 and beyond will provide data needed for model development in subsequent years. This work will be closely coordinated with and substantially augmented by MRP monitoring.

Small tributary loading studies in the RMP from 2008 to 2015.
Numbers indicate budget allocations in $1000s.

General Area	Element	STLS Questions Addressed	2008	2009	2010	2011	2012	2013	2014	2015
Synthesis	Develop Multi-year Watershed Loading Sampling Plan	1,2,3,4,5		80						
	Regional Loadings Estimates	1,2,3,4,5	40		35	20	20	20	20	TBD
Monitoring	Zone 4 Small Tributary Loading Study	1,2,3	100	100	151					
	POC Load Monitoring in Representative Watersheds	1,2,3			89	300	300	300	300	TBD
	Monitoring at Representative Source Characterization Sites	1,2,3,4,5				20	80	100	100	TBD
Modeling	Guadalupe River Model	4,5	75	75						
	Dynamic Modeling in a 2nd Selected Representative Watershed	4,5					150	TBD	TBD	TBD
	Additional Watershed Model	4,5						75	TBD	TBD
	Large Scale Watershed Model	4,5							TBD	TBD

EXPOSURE AND EFFECTS

Exposure and effects effort on Benthos and Fish in 2011 will focus on completion of studies from prior years and development of long-term plans for 2012 and beyond. For Birds, significant progress has been made in answering the priority questions, and further effects work is not needed at this time.

Exposure and effects studies and monitoring in the RMP from 2008 to 2014. Numbers indicate budget allocations in $1000s.

	Element	**Effects Questions Addressed**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Benthos	Spatial and Temporal Patterns of Benthic Impacts (Triad Monitoring)	1,2	275	275	231	280	263	271	279	287
	Understanding and Improving Benthic Assessment Tools	3	20	25	30					
	Causes of Sediment Toxicity: TIEs and LC50 Work	2	10	80						
	Causes of Sediment Toxicity: Molecular TIEs	2			60					
	USEPA Water Quality Synthesis	1,2,3				(50)				
	Hotspot Sediment Quality Followup Study	1,2				60	30			
	Synthesis on SQO Drivers	2					50			
Fish	Endocrine Disruption in San Francisco Bay Fish	4,6	35							
	Effects of PAHs on Flatfish	4,5,6	40	50						
	Effects of Copper on Salmon	4,5				37				
Birds	Mercury and Selenium Effects on Terns	1,2,3,4	74	54						
	PBDEs: Relative Sensitivity in Terns	1,3			48					

FORECASTING (MODELING)

The Forecasting Strategy outlines a long-term plan of studies with the ultimate goal of developing a three-dimensional model, beginning with the South Bay, to predict recovery of contaminated Bay regions and sites under different management scenarios.

Forecasting studies in the RMP from 2009 to 2016. Numbers indicate budget allocations in $1000s.

General Area	Element	Forecasting Questions Addressed	2009	2010	2011	2012	2013	2014	2015	2016
Bay and Margins Modeling	Margins Conceptual Model		40							
	South Bay Water and Sediment Model	1,2		100						
	Bioaccumulation Conceptual Model	1,2		40						
	Bay Modeling	1,2				TBD	TBD	TBD	TBD	TBD

Possible next steps:

- mechanistic model for Bay and margins - ~ $100K per year for three years

Nutrients

- Nutrient strategy to be developed this year
- USGS funding will disappear in four years
- Significant concerns
  - North Bay
  - South Bay
- Another draw on the special study pool

RMP SPECIAL STUDIES: 2011-2015

	2011	2012	2013	2014	2015	2016	2012-2015
TOPIC	**$713,000**	**$822,000**	**$510,000**	**$435,000**	**$5,000**	**$0**	
Mercury	$95,000	$0	$0	$0	$0	$0	**$95,000**
PCBs	$53,000	$0	$0	$0	$0	$0	**$53,000**
Dioxins	$28,000	$158,000	$20,000	$20,000	$0	$0	**$226,000**
Emerging Contaminants	$100,000	$15,000	$0	$0	$0	$0	**$115,000**
Small Tributaries	$340,000	$540,000	$485,000	$410,000	$0	$0	**$1,775,000**
Other SPL	$0	$0	$0	$0	$0	$0	**$0**
Exposure and Effects	$97,000	$80,000	$0	$0	$0	$0	**$177,000**
Forecasting	$0	$0	$0	$0	$0	$0	**$0**
Other	$0	$29,000	$5,000	$5,000	$5,000	$0	**$44,000**
TOTALS	**$713,000**	**$822,000**	**$510,000**	**$435,000**	**$5,000**	**$0**	
TOTAL AVAILABLE FOR SPECIAL STUDIES	$713,194	$678,688	$667,046	$648,103	$627,992	$606,667	
REMAINING FOR SPECIAL STUDIES	**$194**	**-$143,312**	**$157,046**	**$213,103**	**$622,992**	**$606,667**	

Questions for 2012

- How do we fit desired special studies within the existing budget?
- Do we want to use any funds from the reserve?
- What collaborations can we identify to help answer RMP management questions?

Questions for 2013 and Beyond

- Can we fit desired special studies within the existing budget?
- Should we plan fee increases?
- Can we reduce elements of Status and Trends or Program Management?
- How do we fit desired special studies within the planned budget?
- What collaborations can we identify to help answer RMP management questions?

tdc environmental

MEMO

TO:	Arleen Feng, ACCWP	**DATE:**	July 18, 2011
FROM:	Kelly Moran	**PROJECT:**	77
SUBJECT:	Brake Pad Copper Reduction – MRP Section C.13.c. Report 2011		

Section C.13.c. of the San Francisco Bay Area Municipal Regional Stormwater NPDES Permit (MRP) requires engaging in efforts to reduce the copper discharge from automobile brake pads to surface waters via urban runoff and reporting on these activities. This regional report is intended to document actions taken to comply with Section C.13.c. to fulfill the reporting requirement in Section C.13.c.iii. The time period covered by this report is July 1, 2010 through June 30, 2011 (fiscal year [FY] 2010-2011).

In FY 2010-2011, Bay Area Stormwater Management Agencies Association (BASMAA) members ("permittees") participated in the Brake Pad Partnership (BPP) process to develop California legislation phasing out copper from certain automobile brake pads sold in California through the California Stormwater Quality Association (CASQA). CASQA is supported by its statewide membership, including BASMAA agencies. CASQA organized its involvement in the BPP and brake pad legislation through the "CASQA BPP Team," a group of stormwater quality agencies affected by copper or metals 303(d) listings, TMDLs, or permit requirements.

Success – Brake Pad Copper Reduction Legislation Enacted into Law

On September 25, 2010, the goal of the Brake Pad Partnership was achieved when Governor Schwarzenegger signed California Senate Bill (SB) 346. A copy of the enacted version of SB 346 (Chapter 307, Statutes of 2010) is attached. The new law incorporates the BPP's copper source control program:

- SB 346 requires that brake pads sold in California contain no more than 5% copper by weight by 2021, and no more than 0.5% by 2025. (According to a representative industry analysis, as of 2006 brake pads contained an average of about 8% copper by weight.)
- Starting in 2014, a brake pad labeling system established by SB 346 will provide for ready identification of brake pads with the lowest copper content.
- The law also limits dangerous—but fortunately less common—brake pad pollutants, by prohibiting sale of brake pads containing more than trace amounts of lead, mercury, asbestos, cadmium, and hexavalent chromium in 2014.
- To avoid replacing one environmental problem with another, SB 346 requires manufacturers to examine new formulations carefully and to select alternatives that pose less potential hazard to public health and the environment.

- Consumer safety will be ensured through a limited deadline extension process for which manufacturers can apply starting in 2019 and by provisions allowing continued sales of replacement brake pads for older vehicles. Extension applications must demonstrate no alternative brake friction materials would be safe and available for the vehicles in question by 2025.
- California's Department of Toxic Substances Control (DTSC) will enforce SB 346.

On the basis of industry data about brake pad copper content, SB 346 should reduce annual statewide copper emissions by more than 1.2 million pounds per year and should reduce brake pad copper levels by about 95%.

The culmination of the Brake Pad Partnership through enactment of SB 346 received nationwide press coverage, including in the *San Francisco Chronicle* ("New State Law Reduces Copper in Brake Pads") and *Stormwater* magazine ("Governor Schwarzenegger Signs Law Protecting Waterways from Copper in Vehicle Brake Pads").

CASQA prepared a fact sheet (attached) that summarizes the problem posed by copper water pollution from brake pads, the elements of SB 346, and the implications of SB 346 for municipalities.

Permittee Efforts

Permittees participated in the BPP and brake pad copper legislation through BASMAA representation on the BPP team, funding contributions toward CASQA staff and consultant time to work on the legislation, and support for the legislation with letters and lobbying efforts. In FY 2010-2011, Permittees' efforts focused on:

1. Helping the bill's sponsors develop and revise the bill language to address concerns raised by automobile industry representatives,
2. Advocating for passage of the bill by the California Assembly Appropriations Committee, Assembly floor, and California State Senate floor.
3. Advocating for the Governor to sign the bill into law.
4. Supporting and monitoring initial implementation of the law through CASQA.

To document these activities, the following items are attached:

- BASMAA's letters of strong support for SB 346 to the Assembly Appropriations Committee and to Governor Schwarzenegger
- Senate floor analysis for SB 346, which lists most support letters (see pages 7-9), including at least a dozen letters generated through Permittees' efforts

Initial Implementation of SB 346 is Underway

CASQA is tracking the implementation of SB 346, maintaining contact with DTSC and brake industry representatives, and providing information as needed. In the nine months since SB 346 was enacted, industry organizations have moved quickly to implement the law:

- The Society of Automotive Engineers (SAE) established the Brake Materials Environmental Task Force to work with DTSC, laboratories, and potential certification organizations to set up the program to certify brake pad compliance with SB 346. A certification organization and certifying laboratories must be approved by DTSC in time for the certifications to be marked on all brake pads by SB 346's 2014 deadline.
- The likely certification organization, Automotive Manufacturers Equipment Compliance Agency (AMECA), set up its existing list of brake pads meeting safety certification requirements to indicate each pad's SB 346 compliance certifications.
- SAE formed the Brake Friction Materials Chemical Analysis Methodology Task Force to address brake-pad specific challenges in measuring pad metals and asbestos content. This Task Force is working with DTSC, Washington Department of Ecology, and Oregon Department of Environmental Quality to optimize chemical analysis methods for measuring copper and other metals in brake pads. Both screening methods (for process control) and laboratory chemical analysis methods are being optimized by both the state and private labs, using model brake pad materials provided by the industry. Measuring copper concentrations around the 5% level has proven more challenging than measuring concentrations around the 0.5% level. DTSC anticipates using the outcome of this joint effort as the basis for defining the specific measurement methods that must be used by laboratories certification testing laboratories.

DTSC has also moved quickly to establish the framework for SB 346 implementation. In addition to working with both of the above industry groups, DTSC has established an internal team for SB 346 implementation (including a State Water Board representative) and is completing detailed management planning for the long-term implementation of the law. Within the next two years, DTSC anticipates adopting regulations to specify the details of the certification system. DTSC likely will coordinate its regulations with those from Washington State, which has already initiated a similar regulatory process.

Encouraging Prospects for Reductions of Copper in Urban Runoff

To implement SB 346 mandates, brake pad copper reduction will need to be fully integrated into the new vehicle and vehicle parts supply chains. New brake pads will need to be created for all existing and future vehicles. Due to the importance of California's vehicle market and the interconnection of vehicle parts distribution systems throughout North America, brake pad manufacturers expect that it is unlikely that any manufacturer will produce California-specific products. Instead, copper reduction will be integrated throughout the entire North American brake pad market. This level of change will take many years to complete.

Once the brake pad compliance certification system is established, AMECA's web-based certification list will provide a simple means to track brake pad copper reduction progress. AMECA's list includes all brake pads meeting its safety certification standards, which most brake pads have. The growing fraction of pads with low copper and no-copper certifications should correlate with copper reductions.

Since the certification list is not yet in place and brake pad copper content is trade secret, no quantitative information is available to describe current trends in brake pad copper content. Anecdotal information was used to assess the general trend toward copper reductions in urban runoff.

- Contacts with brake industry representatives indicate that the industry has a strong focus on bringing new, compliant materials to the market quickly. Both vehicle manufacturers and brake pad manufacturers appear to be striving toward materials with less than 0.5% copper, rather than pausing at materials containing in the 5% copper range. A direct transition to preferred products would minimize industry transition costs, while providing copper reductions earlier than required by SB 346.
- Although much of the industry activity to remove copper form brake pads is company confidential trade secret, some companies are publicly touting their new low-copper and copper-free products. For example, Honeywell, FDP Brake, and Williams describe reformulated products and aggressive compliance schedules on their web sites. Companies with existing compliant products are promoting them in trade press (see Bendix and TRW Lucas promotions).
- The transition to low-copper and copper-free brake pad formulations has been a major topic at recent industry conferences (e.g., the fall 2010 SAE Brake Colloquium).

This information provides optimism that copper reductions will occur sooner than required by SB 346.

Attachments

1. SB 346, Chaptered version
2. CASQA fact sheet on SB 346 as enacted
3. BASMAA's letters to the Assembly Appropriations Committee and to Governor Schwarzenegger in support of SB 346
4. Senate floor analysis of SB 346, which lists letters of support (see pages 7-9)

Senate Bill No. 346

CHAPTER 307

An act to add Article 13.5 (commencing with Section 25250.50) to Chapter 6.5 of Division 20 of, and to repeal Section 25250.65 of, the Health and Safety Code, relating to hazardous materials.

[Approved by Governor September 25, 2010. Filed with Secretary of State September 27, 2010.]

LEGISLATIVE COUNSEL'S DIGEST

SB 346, Kehoe. Hazardous materials: motor vehicle brake friction materials.

(1) Existing law establishes the Department of Toxic Substances Control in the California Environmental Protection Agency, with powers and duties regarding the management of hazardous waste. Existing law, administered by the department, prohibits the management of hazardous waste except in accordance with the hazardous waste control laws, including laws governing the removal of any mercury-containing vehicle light switch from a vehicle, and the regulations adopted by the department. A violation of the hazardous waste control laws is a crime.

The bill, commencing on January 1, 2014, would prohibit the sale of any motor vehicle brake friction materials containing specified constituents in amounts that exceed certain concentrations. The bill would allow, until December 31, 2023, motor vehicle manufacturers and distributors, wholesalers, or retailers of replacement brake friction materials to deplete their inventory of noncompliant materials. The bill, commencing on January 1, 2021, would prohibit motor vehicle brake friction materials containing more than 5% copper by weight from being sold in the state, and, commencing on January 1, 2025, would prohibit motor vehicle brake friction materials exceeding 0.5% copper by weight from being sold in the state.

A violation of these provisions by certain manufacturers would be subject to a civil fine of up to $10,000 per violation. The bill would create the Brake Friction Materials Water Pollution Fund in the State Treasury, and would require those fines to be deposited in the fund. The moneys in the fund would be available, upon appropriation in the annual Budget Act, to implement the bill's requirements. Because a violation of these provisions also would be a crime pursuant to the hazardous waste control laws, the bill would impose a state-mandated local program.

The bill would establish a process by which a manufacturer may apply to the department for an extension of the prohibition against selling motor vehicle brake friction materials containing more than 0.5% copper by weight, including providing for the establishment of an advisory committee to be involved in that process. The bill would require the Secretary for

Environmental Protection to issue a decision regarding the extension. In making the determination whether to approve or disapprove the extension, the bill would require the secretary to rely upon certain recommendations made by the advisory committee. The bill would require the department to assess a fee for each extension application, and the department would be authorized to expend those fees, upon appropriation by the Legislature, for reimbursement for the costs incurred in implementing this process.

The bill would exempt brake friction materials used for certain motor vehicle classes from its requirements and would exempt from certain prohibitions the sale of vehicles or brake friction materials manufactured prior to certain dates.

The bill would require a vehicle brake friction material manufacturer to screen potential alternatives to copper using the existing Toxics Information Clearinghouse and to use an open source alternatives assessment or this screening analysis to select alternatives to copper that pose less potential hazard to public health and the environment. The vehicle brake friction material manufacturer or importer of record would be required to provide the department with a demonstration, upon request, of the manner in which the selection of alternatives is informed.

The bill would require all new motor vehicles offered for sale, on and after the specified compliance dates, to be equipped with brake friction materials meeting the requirements of this bill and would require all vehicle brake friction material manufacturers, on or after those compliance dates, to certify compliance with those requirements and mark proof of certification on all brake friction materials. The bill would require a vehicle brake friction materials manufacturer to file a copy of the certification with a testing certification agency.

The bill would require the department and the State Water Resources Control Board, by January 1, 2023, to submit a report to the Governor and the Legislature, on the implementation of the bill's requirements toward meeting the copper total maximum daily load (TMDL) allocations in the state. The bill would repeal this report requirement on January 1, 2027.

(2) The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement.

This bill would provide that no reimbursement is required by this act for a specified reason.

The people of the State of California do enact as follows:

SECTION 1. The Legislature finds and declares all of the following:

(a) Friction materials are an essential component of motor vehicle brake systems and of critical importance to transportation safety and the public safety in general.

(b) Debris from friction materials containing copper in all of its forms, including, but not limited to, elemental copper and all of its alloys and compounds, are generated and released to the surrounding environment in the course of normal brake system operation.

(c) Tens of thousands of pounds of copper and other substances released from brake friction materials enter California's streams, rivers, and marine environment every year.

(d) Copper is toxic to many aquatic organisms, including salmon.

(e) Limits on the copper content of brake friction materials are essential for California cities, counties, and industries to comply with federal Clean Water Act (33 U.S.C. Sec. 1251 et seq.) mandates, including copper water quality standards and copper total maximum daily loads in California's urban watersheds.

(f) Without limits on the copper content of brake friction materials, California taxpayers face billions of dollars in federal Clean Water Act compliance costs.

(g) Changes in the composition of brake friction materials made to comply with copper water quality standards and successfully implement copper total maximum daily loads in California's urban watersheds should meet all applicable safety standards.

SEC. 2. Article 13.5 (commencing with Section 25250.50) is added to Chapter 6.5 of Division 20 of the Health and Safety Code, to read:

Article 13.5. Motor Vehicle Brake Friction Materials

25250.50. For purposes of this article, the following definitions shall apply:

(a) (1) "Advisory committee" means a committee of nine members appointed by the secretary on or before January 1, 2019, to consider and recommend approval or denial of an application for an extension of the requirements imposed pursuant to Section 25250.53.

(2) A person considered for appointment to the advisory committee shall disclose any financial interests the person may have in any aspect of the vehicle or vehicle parts manufacturing industry prior to appointment by the secretary or, in the case of subparagraph (C) of paragraph (3), prior to nomination.

(3) The advisory committee shall be composed of the following members:

(A) (i) One-third of the members shall be representatives of the manufacturers of brake friction materials and motor vehicles, to be appointed by the secretary in consultation with the chair of the board and the director of the department.

(ii) If the application for an extension of the requirements imposed pursuant to Section 25250.53 pertains solely to brake friction materials to be used on heavy-duty motor vehicles, the members appointed pursuant to this subparagraph shall represent the manufacturers of heavy-duty brake friction materials and heavy-duty motor vehicles.

(B) One-third of the members shall be representatives of municipal storm water quality agencies and nongovernmental environmental organizations, to be appointed by the secretary in consultation with the chair of the board and the director of the department.

(C) One-third of the members shall be experts in vehicle and braking safety, economics, and other relevant technical areas, to be appointed by the secretary, upon nomination by a majority of the members specified in subparagraph (A) concurrently with a majority of the members specified in subparagraph (B).

(4) For purposes of this subdivision, a "financial interest" shall have the same meaning as a financial interest described in Section 87103 of the Government Code, except only with regard to business entities, real property, or sources of income that are related to the vehicle or vehicle parts manufacturing industry.

(b) "Board" means the State Water Resources Control Board.

(c) "Department" means the Department of Toxic Substances Control.

(d) "Heavy-duty motor vehicle" means a motor vehicle of over 26,000 pounds gross weight.

(e) (1) "Manufacturer," except where otherwise specified, means both of the following:

(A) A manufacturer or assembler of motor vehicles or motor vehicle equipment.

(B) An importer of motor vehicles or motor vehicle equipment for resale.

(2) A manufacturer includes a vehicle brake friction materials manufacturer.

(f) "Motor vehicle" and "vehicle" has the same meaning as the definition of "vehicle" in Section 670 of the Vehicle Code.

(g) "Testing certification agency" means a third-party testing certification agency that is utilized by a vehicle brake friction materials manufacturer and that has an accredited laboratory program that provides testing in accordance with the certification agency requirements that are approved by the department.

25250.51. (a) On and after January 1, 2014, any motor vehicle brake friction materials containing any of the following constituents in an amount that exceeds the following concentrations shall not be sold in this state:

(1) Cadmium and its compounds: 0.01 percent by weight.

(2) Chromium (VI)-salts: 0.1 percent by weight.

(3) Lead and its compounds: 0.1 percent by weight.

(4) Mercury and its compounds: 0.1 percent by weight.

(5) Asbestiform fibers: 0.1 percent by weight.

(b) Motor vehicle manufacturers and distributors, wholesalers, or retailers of replacement brake friction materials may continue to offer for sale brake friction materials not certified as compliant with subdivision (a) solely for the purpose of depletion of inventories until December 31, 2023.

25250.52. On and after January 1, 2021, any motor vehicle brake friction materials exceeding 5 percent copper by weight shall not be sold in this state, except as otherwise provided in this article.

25250.53. On and after January 1, 2025, any motor vehicle brake friction materials exceeding 0.5 percent copper by weight shall not be sold in this state, except as otherwise provided in this article.

25250.54. (a) (1) On and after January 1, 2019, a manufacturer may apply to the department for a one-year, two-year, or three-year extension of the January 1, 2025, deadline established in Section 25250.53, except as provided in subdivision (h).

(2) An extension application submitted pursuant to this section shall be submitted based on vehicle model, class, platform, or other vehicle-based category, and not on the basis of the brake friction material formulation.

(3) The application shall be accompanied by documentation that will allow the advisory committee to make a recommendation pursuant to subdivisions (e) and (f).

(4) The documentation shall include a scientifically sound quantitative estimate of the quantity of copper that would be emitted if the extension is granted, including a description of the assumptions used in arriving at that estimate.

(b) No more than 30 days after receipt of an application for an extension pursuant to subdivision (a), the department shall do all of the following:

(1) Post a notice of receipt on the department's Internet Web site that includes the vehicle model, class, platform, or other vehicle-based category, whether the brake friction material is intended for use in original equipment or replacement parts, and the quantity of copper that would be emitted if the extension is granted.

(2) Consult with the board and the State Air Resources Board.

(3) Solicit comment from the public and from scientific and vehicle engineering experts on the availability of generally affordable compliant brake friction materials, their safety and performance characteristics, and the feasibility of brake pad copper emissions reduction through means other than friction material reformulation.

(c) (1) In consultation with the board, the department shall determine if sufficient documentation has been presented upon which to base a decision. If the department determines that further documentation is needed, it shall deliver a detailed request for further documentation to the applicant.

(2) Not later than 30 days after receipt of the application for an extension pursuant to subdivision (a), the department shall forward the application to the advisory committee for the purpose of the advisory committee making a recommendation pursuant to subdivisions (e) and (f).

(d) (1) In considering any application for an extension, the advisory committee shall consider all of the documentation supplied by the applicant pursuant to subdivision (a).

(2) The advisory committee may request, no later than 75 days after receipt of the application from the department pursuant to subdivision (c), further documentation from the applicant.

(3) The advisory committee shall hold at least one public hearing at which it shall accept and consider comments from the public on each category of application. The advisory committee meetings shall be open to the public

and are subject to the Bagley-Keene Open Meeting Act (Article 9 (commencing with Section 11120) of Chapter 1 of Part 1 of Division 3 of Title 2 of the Government Code).

(e) (1) The advisory committee shall recommend to the secretary that the extension be approved if the advisory committee determines that there are no brake friction materials that are safe and available for individual or multiple vehicle models, classes, platforms, or other vehicle-based categories identified in the application.

(2) The advisory committee shall recommend to the secretary that the extension not be approved if the advisory committee determines that alternative brake friction materials are safe and available for individual or multiple vehicle models, classes, platforms, or other vehicle-based categories identified in the application.

(3) For purposes of this section, "safe and available" shall mean all of the following:

(A) The brake system for which the alternative brake friction material is manufactured meets applicable federal safety standards, or if no federal standard exists, a widely accepted safety standard.

(B) Acceptable alternative brake friction materials are commercially available for the individual or multiple vehicles, classes, platforms, or vehicle-based categories identified in the application.

(C) Adequate industry testing and production capacity exists to supply the alternative brake friction materials for use on the individual or multiple vehicles, classes, platforms, or vehicle-based categories identified in the application.

(D) The alternative brake friction material is technically feasible for use on the individual or multiple vehicles, classes, platforms, or vehicle-based categories identified in the application.

(E) The alternative brake friction materials meet customer performance expectations, including noise, wear, vibration, and durability for the individual or multiple vehicle classes, platforms, or vehicle-based categories identified in the application.

(F) The alternative acceptable brake friction material is economically feasible with respect to the industry and the cost to the consumer for the individual or multiple vehicles, classes, platforms, or vehicle-based categories identified in the application.

(4) The advisory committee shall provide relevant data to the department and the board concerning the potential impacts of the extension on California watersheds for purposes of the report required pursuant to Section 25250.65.

(f) (1) No sooner than 60 days and no later than 120 days after the department solicits comments pursuant to paragraph (3) of subdivision (b), the advisory committee shall make a recommendation to the secretary in accordance with subdivisions (d) and (e) as to whether the application for extension should be approved or not approved.

(2) The recommendation of the advisory committee that the secretary approve or not approve the application for extension shall be accompanied by documentation of the basis for the recommendation.

(g) (1) The secretary shall make available the recommendation of the advisory committee and the accompanying documentation for public review and comment for 60 days following receipt of the recommendation from the advisory committee.

(2) The secretary shall consider public comments on the advisory committee's recommendation and issue a final decision on the application for extension no later than 45 days after the conclusion of the 60-day comment period.

(3) In making the determination whether to approve or disapprove the extension, the secretary shall rely upon the recommendations made by the advisory committee pursuant to subdivision (f).

(4) If the secretary does not follow the recommendation of the advisory committee made pursuant to subdivision (f), he or she shall explain in writing the basis of his or her decision.

(h) (1) On or before December 31, 2029, a manufacturer with an approved extension of the January 1, 2025, deadline established in Section 25250.53, may reapply to the department for additional two-year extensions from the deadline in accordance with a schedule that may be established by the department.

(2) Except as provided in subdivision (i), a manufacturer may not apply on or after January 1, 2030, for an extension of the January 1, 2025, deadline established in Section 25250.53.

(3) The department shall comply with all of the requirements of this section when granting an additional extension of the January 1, 2025, deadline pursuant to this subdivision.

(i) (1) On and after January 1, 2030, a manufacturer of vehicle brake friction materials to be used on heavy-duty vehicles with an approved extension of the January 1, 2025, deadline established in Section 25250.53, may reapply to the department for additional two-year extensions from the deadline established in Section 25250.53, that results in an extension of that deadline to a date on and after January 1, 2032.

(2) The department shall comply with all of the requirements of this section when granting an additional extension of the January 1, 2025, deadline pursuant to this subdivision.

(j) The department shall assess a fee for each application for an extension sufficient to cover actual costs incurred in implementing this section. The department may expend the fees collected pursuant to this subdivision, upon appropriation by the Legislature, for reimbursement for the costs incurred in implementing this section.

(k) When granting an extension pursuant to this section, the department, board, advisory committee, and secretary shall comply with the requirements of Section 25358.2, to ensure the protection of trade secrets, as defined in Section 25358.2.

25250.55. Brake friction materials for the following motor vehicle classes are exempt from this article:

(a) Military tactical support vehicles.

(b) Vehicles employing internal closed oil immersed brakes, or a similar brake system that is fully contained and emits no copper, other debris, or fluids under normal operating conditions.

(c) Brakes designed for the primary purpose of holding the vehicle stationary and not designed to be used while the vehicle is in motion.

(d) Motorcycles.

(e) Motor vehicles subject to voluntary or mandatory recalls of brake friction materials or systems due to safety concerns. This exemption shall expire upon the lifting of the recall and provision of new brake friction materials that comply with this article.

(f) Motor vehicles manufactured by small volume manufacturers, as defined in Section 1900 of Title 13 of the California Code of Regulations.

(g) Vehicles manufactured prior to January 1, 2021, and brake friction materials for use on vehicles manufactured prior to January 1, 2021, from the requirements of Section 25250.52.

(h) Vehicles manufactured prior to January 1, 2025, and brake friction materials for use on vehicles manufactured prior to January 1, 2025, from the requirements of Section 25250.53.

(i) Vehicles for which an extension from the requirements of Section 25250.53 was approved pursuant to Section 25250.54.

25250.56. (a) In developing new formulations to comply with Sections 25250.52 and 25250.53, a manufacturer of vehicle brake friction materials shall screen potential alternatives to the use of copper by using the Toxic Information Clearinghouse developed by the department and the Office of Environmental Health Hazard Assessment pursuant to Section 25256, for the purpose of identifying potential impacts of these potential alternatives on public health and the environment.

(b) In conducting the screening analysis required by subdivision (a), a manufacturer of vehicle brake friction materials shall, using information available to the manufacturer at the time of the analysis, including information from the department and other sources, consider the environmental fate of brake friction materials and their emissions through all phases of the brake friction material life cycle.

(c) A manufacturer of vehicle brake friction materials shall use the screening analysis required by subdivision (a) or an open source alternatives assessment to select alternatives to copper that pose less potential hazard to public health and the environment.

(d) Upon request by the department, a manufacturer of vehicle brake friction materials or importer of record shall provide a summary demonstrating how the screening analysis conducted pursuant to this section or an open source alternatives assessment is used to inform the selection of alternatives to copper that pose less potential hazard to public health and the environment, as required by subdivision (c).

25250.60. (a) The department shall consult with the brake friction materials manufacturing industry in the development of all criteria for testing and marking brake friction materials and adopting certification procedures for brake friction materials, as required pursuant to this article. The mark of proof of certification on brake friction materials shall identify the brake friction material manufacturer, be easily applied, be easily legible, and not impose unreasonable additional costs on manufacturers due to the use of additional equipment or other factors.

(b) On and after January 1, 2014, any new motor vehicle offered for sale in the state shall be equipped with brake friction materials that comply with of Section 25250.51.

(c) (1) On and after January 1, 2014, a manufacturer of vehicle brake friction materials used in brakes on new motor vehicles or as replacement parts that are sold in the state shall certify compliance declaring that its formulation for brake friction materials complies with Section 25250.51.

(2) A vehicle brake friction material manufacturer shall mark proof of certification pursuant to this subdivision on all brake friction materials.

(d) On and after January 1, 2021, any new motor vehicle offered for sale in the state shall be equipped with brake friction materials that comply with Section 25250.52.

(e) (1) On and after January 1, 2021, a manufacturer of vehicle brake friction materials used in brakes on new motor vehicles or as replacement parts for those vehicles that are sold in the state shall certify compliance declaring that its formulation for brake friction materials complies with Section 25250.52.

(2) A vehicle brake friction material manufacturer shall mark proof of certification with this subdivision on all brake friction materials.

(f) On and after January 1, 2025, any new motor vehicle offered for sale in the state shall be equipped with brake friction materials that comply with Section 25250.53.

(g) (1) On and after January 1, 2025, a manufacturer of vehicle brake friction materials used in brakes on new motor vehicles or as replacement parts for those vehicles that are sold in the state shall certify compliance declaring that its formulation for brake friction materials complies with Section 25250.53.

(2) A vehicle brake friction material manufacturer shall mark proof of certification with this subdivision on all brake friction materials.

(h) Prior to offering brake friction materials for sale in this state, a manufacturer of vehicle brake friction materials shall file a copy of the certification for each of its brake friction materials formulations with a testing certification agency. Each certification shall be made available within a reasonable period of time on the testing certification agency's Internet Web site at no cost to the department and to the public, and shall serve as official registration of certification for compliance with this section.

(i) A manufacturer of vehicle brake friction materials may obtain from a testing certification agency a certification of compliance with the requirements of Section 25250.51, 25250.52, or 25250.53 at any time prior to the dates specified in those sections.

(j) The certification and mark of proof required pursuant to this section shall show a consistent date format, designation, and labeling to facilitate acceptance in all 50 states and United States territories for purposes of demonstrating compliance with all applicable requirements.

25250.62. (a) A violation of this article by a vehicle manufacturer, a vehicle brake friction materials manufacturer, a distributor, or a retailer, shall be subject to a civil fine of up to ten thousand dollars ($10,000) per violation.

(b) The department shall enforce this article. The department shall remove from sale in this state any replacement brake friction materials determined to be not in compliance with this article.

(c) If the department determines that a distributor, wholesaler, or retailer of replacement brake friction materials has been offering noncompliant brake friction materials for sale in the state, it shall allow the distributor, wholesaler, or retailer of replacement brake friction materials to establish that it obtained the noncompliant brake friction materials in good faith and after exercising due diligence in verifying that the material complied with this article prior to assessing fines and penalties pursuant to subdivision (a).

(d) In determining the amount of the civil fine to be assessed for a violation of this article, the department shall consider the particular circumstances of the violation, including, but not limited to, the amount of noncompliant brake friction material offered for sale in California and whether previous violations have occurred.

(e) The department may waive the imposition of a fine and issue a letter of warning if it determines, based on criteria, including, but not limited to, the amount of brake friction material offered for sale, the presence or absence of prior violations, and whether due diligence was exercised in determining that the brake friction materials offered for sale complied with this article, and that the violation of this article does not merit the imposition of a fine.

(f) A distributor, wholesaler, or retailer found by the department to have offered for sale noncompliant replacement brake materials shall cooperate with the department in the removal of the noncompliant brake friction materials from sale, inform the department of measures being implemented to avoid repeat violations, and provide the department with information that will assist in the identification and location of the source or sources of the noncompliant brake friction materials.

(g) In enforcing this article, the department shall not recall automobiles fitted with brake friction materials that do not comply with this article.

(h) A motor vehicle manufacturer that violates this article shall notify the registered owner of the vehicle within six months of knowledge of the violation and shall replace, at no cost to the owner, the noncompliant brake friction material with brake friction material that complies with this article. A motor vehicle manufacturer that fails to provide the required notification to registered owners of the affected vehicles within six months of knowledge of the violation is subject to fines and penalties authorized pursuant to subdivision (a).

25250.64. (a) The Brake Friction Materials Water Pollution Fund is hereby established in the State Treasury. Notwithstanding Section 25192, all fines and penalties collected by the department pursuant to this article shall be deposited in the fund.

(b) The moneys in the fund shall be expended, upon appropriation by the Legislature in the annual Budget Act, solely for the full implementation of this article by the department.

25250.65. (a) On or before January 1, 2023, the department and the board shall submit to the Governor and the Legislature, in compliance with Section 9795 of the Government Code, a report on the implementation of vehicle brake copper reduction efforts and the progress of this article toward meeting the copper total maximum daily load (TMDL) allocations in the state. The report shall make recommendations on actions necessary to address any deficiencies in meeting these copper TMDL allocations, including, but not limited to:

(1) Imposing additional restrictions on the extensions granted to manufacturers pursuant to Section 25250.54.

(2) Imposing additional restrictions on the exemptions from this article provided by Section 25250.55.

(3) Allowances for permitting a manufacturer to sell existing inventory, if the additional restrictions described in paragraphs (1) and (2) are implemented.

(b) Pursuant to Section 10231.5 of the Government Code, this section is repealed on January 1, 2027.

SEC. 3. No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because the only costs that may be incurred by a local agency or school district will be incurred because this act creates a new crime or infraction, eliminates a crime or infraction, or changes the penalty for a crime or infraction, within the meaning of Section 17556 of the Government Code, or changes the definition of a crime within the meaning of Section 6 of Article XIII B of the California Constitution.

O

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

Fact Sheet

SB 346 and Copper Compliance for Stormwater Permittees

A California law enacted in 2010, SB 346 (Kehoe) set in place a program that will nearly eliminate copper use in brake pads. This law grew out of a unique collaboration among brake pad manufacturers, government agencies, and environmental groups called the "Brake Pad Partnership," which was initiated by California municipalities and strongly supported by CASQA. Enacting SB 346 into law was truly a landmark event for California municipalities, which stand to save from $50 to $100 billion in copper-related Clean Water Act compliance costs over the next 30 to 40 years.

Importance of Brake Pad Copper Regulation

A simple action—vehicle drivers hitting the brakes—released about 1.3 million pounds of copper into California's environment in 2010. Each time vehicle brakes engage, a tiny amount of fine dust wears off of the vehicle's brake pads. When it rains, this dust washes into storm drains, which drain directly to creeks, rivers, and marine waters without any wastewater treatment. Scientific studies indicate that dust generated by vehicle brakes is by far the most significant source of copper in urban watersheds.

Copper is a major pollutant of concern for stormwater management agencies. Copper is one of the pollutants in stormwater that most often exceeds water quality standards at the point of discharge. Copper is also a common water pollution problem in California's waterways; in 2010, the State Water Board identified copper as causing impairment in 83 California waterways. California Water Boards have adopted 18 copper Total Maximum Daily Loads (TMDLs), primarily in Southern California.

Copper in Brake Pads

Copper is in most, but not all, brake pads. Although copper is not necessary for braking safety, it provides other desirable properties. For example, it helps brakes remain effective through extended braking events and can be used to prevent annoying squealing and shuddering.

Brake pads with low or no copper are sold today and safely stop cars. Due to the current lack of copper content labels, no one—not even experienced mechanics—can readily determine brake pad copper content. In general, "semi-metallic" brake pads have the least copper; "organic" brake pads have the most copper. Starting in 2014, a brake pad labeling system established by SB 346 will provide for ready identification of brake pads with the lowest copper content.

Provisions of SB 346

SB 346 requires that brake pads sold in California contain no more than 5% copper by weight by 2021, and no more than 0.5% by 2025. According to a representative industry analysis, as of 2006 brake pads contained an average of about 8% copper by weight. The law also limits dangerous—but fortunately less common—brake pad pollutants, by prohibiting sale of brake pads containing more than trace amounts of lead, mercury, asbestos, cadmium, and hexavalent chromium in 2014. To avoid replacing one environmental problem with another, SB 346 requires manufacturers to examine new formulations carefully and to select alternatives that pose less potential hazard to public health and the environment. Consumer safety will be ensured through a limited deadline extension process (available starting only when

Californians hit the brakes billions of times each year

Copper disrupts salmonids' sensory capabilities, making it difficult for them to avoid predators or find their way back to their spawning grounds

Which of these brake pads contain copper?

Photos by: TDC Environmental, LLC (top and bottom); NOAA (middle)

Fact Sheet

Water Quality Protection for all of North America

Due to the size of California's vehicle market, brake pad manufacturers expect that California's requirements will change the entire North American brake pad market. Nonetheless, other states are seeking to ensure their water quality will also be protected. The State of Washington enacted restrictions on brake pad copper content in 2010. Legislation is pending in several other states.

a manufacturer demonstrates that no alternative brake friction materials will be safe and available) and by provisions allowing continued sales of replacement brake pads for older vehicles.

California's Department of Toxic Substances Control (DTSC) will enforce SB 346. DTSC is working with manufacturers and other states to establish nationally accepted criteria for certifying that new brake pads comply with its requirements and to design the compliance markings that will be on every brake pad.

What SB 346 Means for Stormwater Copper Compliance

CASQA pressed for a "true source control" solution to the brake pad copper problem recognizing that attempting to treat runoff to remove brake pad copper would have been costly and unsuccessful. Treating stormwater runoff to remove copper is technically and financially challenging because expensive land-intensive infiltration-type treatment systems are the only measures capable of removing enough copper to meet water quality standards. Since brake pads appear in all developed areas, treatment of runoff from all land uses would have been required, entailing re-plumbing of entire storm drain systems and buying creek and ocean front land for treatment facilities, which would have disrupted established communities and ecosystems. The relatively small investment that CASQA and its members made in brake pad source control avoided billions of dollars in treatment cost. The Brake Pad Partnership's proactive problem-solving approach ensured that the solution was acceptable to the environmental community and state and Federal regulators.

A near phase-out of copper use in brake pads is essential for many California municipalities and private businesses to comply with NDPES permits, especially permits that implement copper Total Maximum Daily Loads. In highly urbanized watersheds, urban runoff copper levels will exceed required concentrations until most vehicles have installed brake pads containing less than 0.5% copper.

The copper reduction time frames in SB 346 are inconsistent with some adopted copper TMDLs. In addition to providing assistance to members that are working with regulators to address inconsistencies, CASQA plans to examine the potential for the vehicle industry to achieve brake pad copper reductions ahead of required timeframes. Once the low copper brake pad labeling system is in place, options include various voluntary programs, such as preferences for low-copper brake pads in purchasing specifications.

Most municipalities will need to control one or more other copper sources to ensure compliance. Copper sources that may need to be addressed through local actions and/or partnerships with other regulators include:

- Local copper emitting industries (e.g., boatyards, smelters)
- Architectural copper (controls like coatings or on-site treatment systems)
- Swimming pool, spa and fountain discharges (discharge management)

The enactment of SB 346 into law was the first major accomplishment of CASQA's Source Control Initiative. Like brake pad copper, many other pollutants are candidates for "true source control," which is an alternative, cost-saving compliance strategy.

CASQA's goal is for the market to shift quickly to brakes with <0.5% copper, the level essential for compliance.

Copper content markings should be similar to these current brake pad "edge codes"

Municipalities may need to require controls on copper roofs

www.casqa.org

Photos by: TDC Environmental, LLC

BASMAA

Alameda Countywide
Clean Water Program

Contra Costa
Clean Water Program

Fairfield-Suisun
Urban Runoff
Management Program

Marin County
Stormwater Pollution
Prevention Program

Napa County
Stormwater Pollution
Prevention Program

San Mateo Countywide
Water Pollution
Prevention Program

Santa Clara Valley
Urban Runoff Pollution
Prevention Program

Sonoma County
Water Agency

Vallejo Sanitation
and Flood
Control District

July 23, 2010

The Honorable Felipe Fuentes
Chair, Assembly Appropriations Committee
State Capitol, Room 2114
Sacramento, CA 95814

RE: SB 346 (Kehoe) – Source Control of Copper Water Pollution – Support As Amended August 2

Dear Assemblymember Fuentes:

The Bay Area Stormwater Management Agencies Association (BASMAA) strongly supports SB 346 (Kehoe), which will provide California's cities and counties with the tool they need to comply with stringent federal and state water quality mandates and avoid billions of dollars in costs and potential penalties. SB 346 requires that copper, a significant aquatic pollutant, be reduced to a *de minimis* 0.5% by weight in vehicle brake pads sold in California by 2025. Peer-reviewed scientific studies have established that by far the most significant source of copper in urban watersheds is the fine dust generated from the use of brake pads. This copper poses threats to aquatic life including migratory salmonid fish.

Pursuant to the requirements of the federal Clean Water Act, the San Francisco Bay Regional Water Quality Control Board mandates that Bay Area municipalities control copper discharges in urban runoff. Other Regional Water Quality Control Boards in Southern California have already imposed copper Total Maximum Daily Loads (TMDLs). The only technically and economically feasible way for municipalities to comply with these looming deadlines is to eliminate copper pollution at its primary source – vehicle brake pads – no later than 2025. Any attempt to try and remove copper in highly urbanized areas that is already dissolved in stormwater would most likely require large tracts of land and construction of new treatment infrastructure. The California Stormwater Quality Association estimates that this could easily cost already fiscally strapped local governments billions of dollars statewide with no guarantee that these methods would actually succeed.

It is our understanding that two days of constructive and productive meetings with industry, environmental, and local government representatives earlier this month resulted in amendments that accept nearly all of industry's requests in their entirety and are supported by environmental and local government representatives. SB 346 provides the auto industry with a generous timeline within which to develop and distribute safe and effective copper-free brake friction materials while also giving cities and counties the ability to demonstrate that they will meet their copper TMDLs in a timely manner. BASMAA is pleased to support SB 346.

Sincerely,

James Scanlin

James Scanlin
Chair, Bay Area Stormwater Management Agencies Association

cc: Senator Christine Kehoe
Assembly Appropriations Committee members

Bay Area
Stormwater Management
Agencies Association
P.O. Box 2385
Menlo Park, CA 94026
510.622.2326
info@basmaa.org

BASMAA

Alameda Countywide Clean Water Program

Contra Costa Clean Water Program

Fairfield-Suisun Urban Runoff Management Program

Marin County Stormwater Pollution Prevention Program

Napa County Stormwater Pollution Prevention Program

San Mateo Countywide Water Pollution Prevention Program

Santa Clara Valley Urban Runoff Pollution Prevention Program

Sonoma County Water Agency

Vallejo Sanitation and Flood Control District

September 14, 2010

Governor Arnold Schwarzenegger
State Capitol Building
Sacramento, CA 95814

RE: SB 346 (Kehoe) – SIGN

Dear Governor Schwarzenegger:

The Bay Area Stormwater Management Agencies Association (BASMAA[1]) strongly supports SB 346 (Kehoe), which will provide California's cities, counties, and the State (i.e., Caltrans) with the tool they need to comply with stringent federal and state water quality mandates and avoid billions of dollars in costs and potential penalties.

Pursuant to the requirements of the federal Clean Water Act, the Regional Water Quality Control Boards in Los Angeles and San Diego have already imposed deadlines and copper Total Maximum Daily Load (TMDL) limits on discharges of stormwater to California waters. Similar TMDLs are expected in other urban watersheds across the state in the near future. The only technically and economically feasible way for municipalities and the State to comply with these looming deadlines is to eliminate copper pollution at its primary source – vehicle brake pads. Any attempt to try and remove copper that is dissolved in stormwater in highly urbanized areas would most likely require large tracts of land and construction of new treatment infrastructure. Estimates are that this approach could easily cost fiscally strapped local governments, let alone the State of California, billions of dollars statewide with no guarantee that these methods would actually succeed.

The work to reduce copper in brake pads needs to start now. Local governments and the State need to demonstrate now to EPA, the Water Boards, and environmental stakeholders that they have solid TMDL compliance plans that can be achieved by the final compliance dates, and the auto industry needs to start now to complete the transition to new brake pad materials in time to help meet those deadlines. All parties need to be able bank now on copper in brake pads being eliminated as a pollution source to the State's waters and SB 346 becoming law is the best way to meet that objective.

BASMAA is proud to have supported the Brake Pad Partnership since its earliest days in the mid-90s – a private-public partnership that led to SB 346. SB 346 is based on 14 years of scientifically based, shared fact-finding and thoughtful discussion and negotiation. As a result, SB 346 provides the auto industry with a reasonable timeline within which to develop and distribute safe and effective copper-free brake friction materials while also giving cities and counties the ability to demonstrate that they will meet their copper TMDLs in a timely manner. SB 346 is the embodiment of good legislation and that was recognized when both the Senate and the Assembly, in overwhelming votes with significant bi-partisan support, approved it. All the major auto industries, environmental groups, and local governments support SB 346, and the bill has no recorded opposition.

BASMAA respectfully encourages your signature on this landmark legislation.

Sincerely,

James Scanlin

James Scanlin
Chair, Bay Area Stormwater Management Agencies Association

Bay Area Stormwater Management Agencies Association

P.O. Box 2385

Menlo Park, CA 94026

510.622.2326

info@basmaa.org

[1] BASMAA is a 501(c)(3) non-profit organization comprised of the municipal stormwater programs in the San Francisco Bay Area representing 96 agencies, including 84 cities and 7 counties. BASMAA is focused on regional challenges and opportunities to improving the quality of stormwater that flows to our local creeks, San Francisco Bay and Delta, and the Ocean.

BILL ANALYSIS

SENATE RULES COMMITTEE | SB 346
Office of Senate Floor Analyses
1020 N Street, Suite 524
(916) 651-1520 Fax: (916) 327-4478

UNFINISHED BUSINESS

Bill No: SB 346
Author: Kehoe (D), et al
Amended: 8/25/10
Vote: 21

SENATE ENV. QUALITY COMMITTEE : 5-2, 4/20/09
AYES: Simitian, Corbett, Hancock, Lowenthal, Pavley
NOES: Runner, Ashburn

SENATE APPROPRIATIONS COMMITTEE : 8-5, 5/26/09
AYES: Kehoe, Corbett, DeSaulnier, Hancock, Leno, Oropeza, Wolk, Yee
NOES: Cox, Denham, Runner, Walters, Wyland

SENATE FLOOR : 22-16, 6/3/09
AYES: Alquist, Calderon, Cedillo, Corbett, DeSaulnier, Ducheny, Florez, Hancock, Kehoe, Leno, Liu, Lowenthal, Negrete McLeod, Oropeza, Padilla, Pavley, Romero, Simitian, Steinberg, Wiggins, Wolk, Yee
NOES: Aanestad, Ashburn, Benoit, Cogdill, Correa, Cox, Denham, Dutton, Harman, Hollingsworth, Huff, Maldonado, Strickland, Walters, Wright, Wyland
NO VOTE RECORDED: Runner, Vacancy

ASSEMBLY FLOOR : 70-3, 8/30/10 - See last page for vote

SUBJECT : Hazardous materials: motor vehicle brake friction materials

SOURCE : City of San Diego

Sustainable Conservation on Behalf of the Brake
CONTINUED

Pad
Partnership

DIGEST : This bill restricts the use of copper and other toxic chemicals in automobile brake pads.

Assembly Amendments revise and recast various provisions of the bill while maintaining the intent of the bill.

ANALYSIS :

Existing law:

1. Requires the Department of Toxic Substances Control (DTSC), by January 1, 2011, to adopt regulations to establish a process to identify and prioritize chemicals or chemical ingredients in consumer products that may be considered a "chemical of concern," in accordance with a review process, as specified.

2. Requires DTSC, on or before January 1, 2011, to adopt regulations to establish a process to evaluate chemicals of concern, and their potential alternatives, in consumer products in order to determine how best to limit exposure or to reduce the level of hazard posed by a chemical of concern, as specified.

3. Prohibits the manufacture, processing, and distribution in products containing certain materials found to raise health risks, including lead, polybrominated diphenyl ethers, and phthalates.

4. Requires the State Water Resources Control Board (SWRCB) and the California regional water quality control boards to regulate the discharge of stormwater in accordance with the federal Clean Water Act and the Porter-Cologne Water Quality Control Act.

This bill:

1. Limits the use of copper in motor vehicle brake pads to

no more than five percent by weight on or after January 1, 2021, and no more than .5 percent by weight on or

CONTINUED

after January 2025.

2. Exempts specific vehicles from the copper limitation in brake pads including (a) military vehicles, (b) vehicles with internal closed oil immersed brakes that do not emit copper or other debris under normal operating conditions, (c) parking brakes, (d) vehicles manufactured by small volume manufactures, and (e) motorcycles.

3. Exempts from the five percent copper brake pad restrictions all vehicles, or brake pads manufactured for use on those vehicles, manufactured prior to January 1, 2021.

4. Exempts from the .5 percent copper brake pad restrictions all vehicles, or brake pads manufactured for use on those vehicles, manufactured prior to December 31, 2024.

5. Restricts the use of the following toxic materials in motor vehicle brake pads by January 1, 2014:

   Cadmium and its compounds: 0.01 percent by weight
   Chromium (VI)-salts: 0.1 percent by weight
   Lead and its compounds: 0.1 percent by weight
   Mercury and its compounds: 0.1 percent by weight

6. Requires manufacturers of brake pads to review safety data on alternatives to copper in brake pads. Allows manufactures to conduct an additional alternatives analysis based on an open source alternative analysis carried out by the brake pad manufacturer.

7. Requires brake pad manufacturers, beginning in 2014, to obtain certification to demonstrate compliance with the bill's limits and to include that certification of the content of the brake pads.

8. Requires vehicle manufacturers and retailers of brake pads to ensure that only compliant brake pads are sold in this state.

CONTINUED

9. Establishes a civil fine of up to $10,000 per violation of the brake pad limitations and certification requirements.

10. Allows a brake pad manufacturer, effective January 1, 2021, to apply to DTSC for a one, two or three-year extension of the 2025 ban and for additional two-year extensions until January 1, 2030. Heavy-duty brake pad manufacturers only will be able to apply for two-year extensions until January 1, 2032.

11. Requires an application for an exemption to be forwarded by DTSC to the Copper Brake Advisory Committee (CBAC), which will be a nine-member committee appointed by the Secretary of the California Environmental Protection Agency (Cal-EPA). The CBAC will be composed of:

    Three members representing the manufactures of brake friction materials and motor vehicles.

    Three members representing municipal storm water quality agencies and nongovernmental environmental organizations.

    Three members who are experts in vehicle and braking safety, economics and or relevant technical areas.

12. Provides that members of the CBAC shall disclose financial interest related to vehicle or vehicle parts prior to being appointed.

13. Allows the CBAC to request additional information from DTSC with 75 days of receipt of a request for an extension.

14. Provides that the Secretary of Cal-EPA shall rely on the recommendations of the CBAC when making a determination

on an extension request.

15. Establishes DTSC as the enforcing agency for the requirements of this bill and permits them to remove non-compliant brake pads from sale, but specifically does not authorize the recall of vehicles to remove the

CONTINUED

illegal brake pads.

16. Requires DTSC and SWRCB to submit a report to the Governor and Legislature not later than January 1, 2023, on recommended actions necessary to address any deficiencies in meeting the copper reduction targets established by this bill.

Comments

According to the author's office, elevated copper levels occur in urban watersheds across California. Dissolved copper is toxic to phytoplankton (the base of the aquatic food chain). It also impairs salmon's ability to avoid predators and deters them from returning to their home streams to spawn. Scientific studies have shown that a major source of copper in highly urbanized watersheds is material worn off vehicle brake pads. It is estimated that about one-half of the copper found in run-off is attributed to brake pads.

According to the United States EPA, elevated levels of copper are toxic to aquatic environments and may adversely affect fish, invertebrates, plants, and amphibians. Acute toxic effects may include mortality of organisms; chronic toxicity can result in reductions in survival, reproduction, and growth.

Motor vehicles are a major source of toxic contaminants such as copper, a metal that originates from brake pad wear. Copper and other pollutants are deposited on roads and other impervious surfaces and then transported to aquatic habitats via stormwater runoff.

Total Maximum Daily Loads . The SWRCB has established Total Maximum Daily Loads (TMDLs) as allowable pollution limits on copper and other pollutants in several Southern California urban watersheds. Failure to comply with these TMDLs will result in serious penalties to the responsible jurisdictions. SWRCB is working to establish these TMDLs for watersheds throughout California. The ubiquity of copper in the urban environment, and the technical difficulty and impracticality of treating stormwater to remove it, mean that compliance with copper TMDLs will not

CONTINUED

be feasible without source reduction of copper. Cost could go into the billions of dollars to remediate if source reduction measures are not taken.

This bill requires brake pad manufacturers to reduce the use of copper in brake pads sold in California to no more than five percent by 2021, and no more than 0.5 percent by 2025. This bill also (1) creates limits for other brake pad materials, (2) establishes a certification process for compliance, (3) establishes civil penalties for violations, (4) creates a Brake Friction Materials Water Pollution Fund into which any fines and penalties would be deposited, and (5) provides a mechanism that manufacturers can use to obtain extensions of the bill's deadlines if they cannot provide a safe and compliant product in time in order to make sure that Californians' safety is not compromised in any way. The goal is to improve California's water quality and allow stormwater agencies to meet their TMDLs, while also ensuring that brakes remain affordable and fully able to meet rigorous safety and performance standards.

FISCAL EFFECT : Appropriation: No Fiscal Com.: Yes Local: Yes

According to the Assembly Appropriations Committee, this bill will result in costs to DTSC and Cal-EPA including:

1. One-time costs to DTSC of approximately $200,000 during 2010-11 and 2011-12 for manufacturer outreach and education, including development of website materials. (Hazardous Waste Control Account (HWCA))

2. One-time costs to DTSC of approximately $200,000 during 2010-11 and 2011-12 to develop certification and marking

criteria. (HWCA)

3. One-time cost to DTSC of approximately $100,000 during 2011-12 to initially certify third-party certifiers of brake pads. (HWCA)

4. Minor annual costs to DTSC in the tens of thousands of dollars beginning in 2013-14 to accept filings by manufacturers of brake pad certification, covered fully by filing fee. (HWCA)

CONTINUED

5. Annual costs to DTSC of approximately $250,000 beginning in 2020-21 to accept and review requests for extension and exemption withdrawal, fully covered by request fees. (HWCA or Brake Friction Materials Water Pollution Fund (BFMWPF))

6. Annual costs to DTSC ranging from $250,000 to $500,000 beginning in 2013-14 to enforce bans, including inspections of brake manufacturers and third-party certifiers and laboratory analysis of brake pads. (HWCA or BFMWPF)

7. Minor annual costs to the Secretary for Cal-EPA in the tens of dollars beginning in 2020-21 to review extension and exemption requests. (General Fund)

8. Minor, absorbable annual costs to the Air Resources Board and DTSC, beginning in 2020-21, to consult with DTSC on extension and exemption requests.

SUPPORT : (Verified 8/27/10)

City of San Diego (co-source)
Sustainable Conservation on Behalf of the Brake Pad Partnership (co-source)
Alameda County Board of Supervisors
Alliance of Automobile Manufacturers
American Society of Civil Engineers
Association of International Automobile Manufacturers
Automotive Aftermarket Industry Association
Automotive Aftermarket Suppliers Association

Automotive Service Councils of California
Bay Area Stormwater Management Agencies Association
(representing 84 cities and seven counties)
Best Brakes
California Association of Environmental Health
Administrators
California Autobody Association
California Automotive Business Coalition
California Automotive Wholesalers' Association
California Coastkeeper Alliance
California Council for Environmental and Economic Balance
California League of Conservation Voters

CONTINUED

California Product Stewardship Council
California Retailers Association
California State Association of Counties
California Stormwater Quality Association
Calleguas Creek Watershed Steering Committee
Center for Environmental Health
Centric Parts
City and County of San Francisco
Cities of Arcadia, Artesia, Azusa, Bellflower, Beverly Hills, Camarillo, Carson, Cerritos, Commerce, Covina, Downey, Duarte, La Mirada, La Verne, Lakewood, Long Beach, Los Angeles, Lynwood, Monrovia, Monterey Park, Moorpark, Norwalk, Palo Alto, Paramount, Port Hueneme, Rolling Hills, San Gabriel, San Jose, San Pablo, Santa Marino, Santa Paula, Santa Fe Springs, Signal Hill, Sunnyvale, Thousand Oaks, Torrance, Ventura, Vernon, Vista, and Whittier
City/County Association of Governments of San Mateo County

Clean Water Action
Coalition for Auto Repair Equality
Coalition for Practical Regulation (representing 40 cities)
Coastal Environmental Rights Foundation
Defenders of Wildlife
East Bay Municipal Utility District
Environmental Entrepreneurs
Forests Forever
Gateway Authority (Los Angeles Gateway Region of Integrated Regional Water Management Joint Powers

Authority)
Heal the Bay
Industrial Environmental Association
Larry's Auto Works
League of California Cities
Los Angeles County Flood Control District
Los Angeles County Stormwater Quality Partnership
Motor and Equipment Manufacturers Association
Natural Resources Defense Council
Ocean Conservancy
Planning and Conservation League
Port of San Diego
Power Slot
San Diego Coastkeeper

CONTINUED

San Francisco Public Utilities Commission
Sanitation Districts of Los Angeles County
Santa Clara Valley Urban Runoff Pollution Prevention Program
Save the Bay
Sierra Club California
Stop Tech
StopWaste.Org
TDC Environmental
Truck Manufacturers Association
United States Navy
University of California, San Diego
Ventura County Board of Supervisors
Ventura Countywide Stormwater Quality Management Program
West Valley Clean Water Program

ASSEMBLY FLOOR :
AYES: Adams, Ammiano, Arambula, Bass, Beall, Tom Berryhill, Block, Blumenfield, Bradford, Brownley, Buchanan, Caballero, Charles Calderon, Carter, Chesbro, Cook, Coto, Davis, De La Torre, De Leon, Eng, Evans, Feuer, Fletcher, Fong, Fuentes, Fuller, Furutani, Galgiani, Gatto, Gilmore, Hagman, Hall, Harkey, Hayashi, Hernandez, Hill, Huber, Huffman, Jeffries, Jones, Lieu, Logue, Bonnie Lowenthal, Mendoza, Miller, Monning, Nava, Nestande, Niello, Nielsen, Norby, V. Manuel Perez, Portantino, Ruskin, Salas, Saldana, Silva, Skinner, Smyth, Solorio, Audra Strickland, Swanson, Torlakson, Torres, Torrico,

Tran, Villines, Yamada, John A. Perez
NOES: Anderson, Conway, Gaines
NO VOTE RECORDED: Bill Berryhill, DeVore, Garrick, Knight, Ma, Vacancy, Vacancy

TSM:mw 8/31/10 Senate Floor Analyses

SUPPORT/OPPOSITION: SEE ABOVE

**** END ****

CONTINUED

Appendix B1: DRAFT RMC Creek Status and Trends Monitoring Schedule (2011-2015)

Task	2011							2012											
	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Creek Status (Condition and Stressor Assessments)																			
Regional Ambient Creek Sample Draw	●	●																	
Ambient Creek Site Evaluation			●	●											●	●			
Storm Event Sampling					●	●	●	●	●	●	●						●	●	●
Dry Season Sampling												●	●	●	●	●			
Spring Season Sampling												●	●	●					
Long-Term Trends Monitoring																			
Dry Season Sampling												●	●	●					
Analysis and Information Management																			
Laboratory Analysis					●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Information Management					●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Data Analysis														●	●	●	●	●	●
Reporting																			
Electronic Data Submittal																			
Monitoring Progress Report				●						●						●			
Regional Urban Creeks Monitoring Report Submittal																			
Local Creeks Monitoring Report Submittal																			

Task	2013											2014												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Creek Status (Condition and Stressor Assessments)																								
Regional Ambient Creek Sample Draw																								
Ambient Creek Site Evaluation								●	●											●	●			
Storm Event Sampling	●	●	●	●						●	●	●	●	●	●	●						●	●	●
Dry Season Sampling					●	●	●	●	●								●	●	●	●	●			
Spring Season Sampling					●	●	●										●	●	●					
Long-Term Trends Monitoring																								
Dry Season Sampling					●	●	●										●	●	●					
Analysis and Information Management																								
Laboratory Analysis	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Information Management	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Data Analysis	●	●					●	●	●	●	●	●	●	●					●	●	●	●	●	●
Reporting																								
Electronic Data Submittal	●												●											
Monitoring Progress Report																								
Regional Urban Creeks Monitoring Report Submittal			●												●									
Local Creeks Monitoring Report Submittal			●												●									

Task	2015												2016											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Creek Status (Condition and Stressor Assessments)																								
Regional Ambient Creek Sample Draw						●	●											●	●					
Ambient Creek Site Evaluation								●	●											●	●			
Storm Event Sampling	●	●	●	●						●	●	●	●	●	●	●								
Dry Season Sampling					●	●	●	●	●								●	●	●	●	●			
Spring Season Sampling					●	●	●									●	●	●						
Long-Term Trends Monitoring																								
Dry Season Sampling					●	●	●										●	●	●					
Analysis and Information Management																								
Laboratory Analysis	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Information Management	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Data Analysis	●	●					●	●	●	●	●	●	●	●	●				●	●	●	●	●	●
Reporting																								
Electronic Data Submittal	●												●											
Monitoring Progress Report																								
Regional Urban Creeks Monitoring Report Submittal			●												●									
Local Creeks Monitoring Report Submittal			●												●									

Small Tributaries Loading Strategy Multi-Year Plan

Contents

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Introduction

The Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) was established to provide the scientific information needed to support water quality management. In the 21st century, the RMP's activities are shifting to provide more direct support for answering specific Management Questions through multi-year Strategies consisting of coordinated activities centered on particular pollutants or processes. The Small Tributaries Loading Strategy (STLS, SFEI 2009) presented an initial outline of potential activities to address four key Management Questions regarding local watershed contributions of Pollutants of Concern to San Francisco Bay. The objective of this Multi-Year Plan (MYP) is to provide a more comprehensive description of the suite of activities to be included in the STLS over the next 5-10 years. It provides a detailed rationale for the methods and locations of proposed activities, including watershed monitoring of local tributaries.

Some of these activities will be conducted by stormwater programs to fulfill the requirements of the Municipal Regional Stormwater Permit (MRP, SFRWQCB 2009) for Pollutants of Concern (POC) loads monitoring[1]; this MYP supports development of an improved alternative monitoring approach for addressing these MRP needs that will be integrated with the RMP-funded activities.

The MYP includes continuing development of the Regional Watershed Spreadsheet Model as a tool for estimating regional loads. It also clarifies the linkage between the STLS and the RMP's developing Modeling Strategy for pollutant fate and transport in the Bay as a whole and also in the Bay margins which are a vital link between the local watersheds and the Bay.

Background

Based on data collected by the RMP and others, the San Francisco Regional Water Quality Control Board (Water Board) has determined that San Francisco Bay is impaired or potentially impaired by a number of POCs. For some of these, the Water Board has adopted water quality attainment strategies including Total Maximum Daily Loads (TMDLs) for mercury and PCBs (SFRWRCB 2006, 2008) due to their persistence in the environment and accumulation in aquatic food webs that pose threats to wildlife and human consumers of fish from the Bay.

Each TMDL identifies sources and pathways contributing to the impairment or detrimental effects associated with the subject pollutant, as illustrated for PCBs (Figure 1). The sizes of the arrows on the figure illustrate, conceptually, the importance of each source, pathway or process. For PCBs, urban runoff, deposition of associated sediment, and transfer from sediment up through the food chain are the important pathways and processes. For each source, the TMDL estimates current annual loads and identifies reductions in those loads that would be required to eventually eliminate the

[1] Described in Provisions C.8.e and its sub-provisions i, iii, iv and v. Sub-provisions vi and vii are also related to the same objectives, see Appendix A.

impairment. Each TMDL is adopted along with an implementation plan consisting of management actions to be taken by various discharger groups in order to achieve these load reductions.

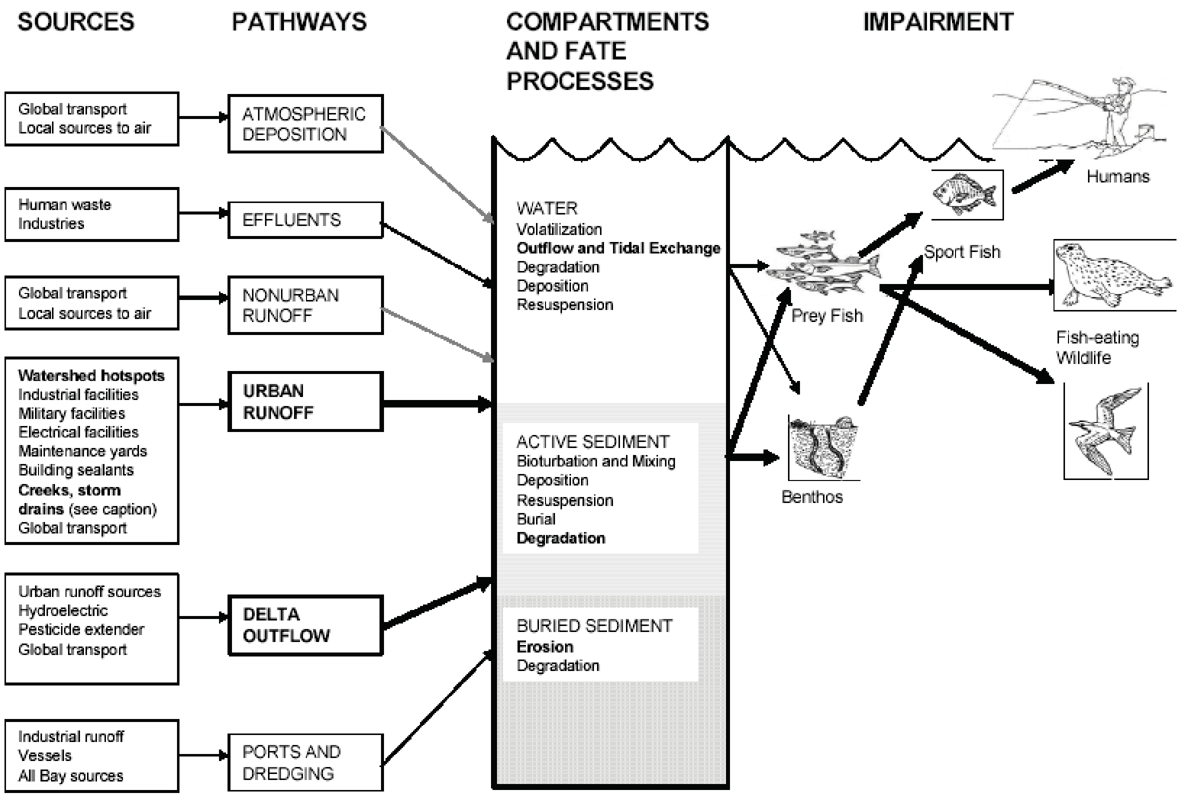

Figure 1. Conceptual Model of PCBs in San Francisco Bay (from Davis et. al 2006)

Urban runoff from local watersheds is a significant pathway for many pollutants of concern into the Bay, and the MRP contains several provisions requiring management actions and studies to address mercury and PCB its (see Appendix A for details). The MRP's monitoring provisions also include other pollutants for which storm water data are needed. The MRP also encourages coordination of storm water program activities with the RMP are other regional collaborative groups.

The STLS MYP is a major component of the RMP Master Plan, which integrates the efforts of many workgroups and strategy teams to develop five-year plans addressing the highest priority management information needs identified by the RMP stakeholders. The intent of the Master Plan is to anticipate regulatory or management decisions and policies that are on the horizon, so that the specific scientific knowledge needed to inform the decisions will be available at the required times.

The RMP's Master Planning Process, initiated in 2010[2], articulates several "strategies" which coordinate studies across the pre-existing process-oriented work groups (see Appendix A). The STLS is a major strategy with linkages to other strategies for mercury, PCBs and forecasting/ modeling. The Water Board has given a high priority to refining and tracking load estimates of PCBs and mercury to assess progress towards the reductions in the TMDLs. Initial estimates of stormwater contributions to annual loads of mercury and PCBs to the Bay were based on limited data and one of the RMP's goals has been to improve both data collection and the conceptual framework for developing load estimates. Understanding trends from individual watersheds will also be important, whether in response to general demographic and climatic changes or targeted management actions to reduce local discharges of PCBs and mercury.

Depending on the state of existing knowledge and potential impairment status, loading information needs may be a somewhat lower priority for other POCs such as copper (for which the highest priority information gaps are about effects and not loading) or legacy organochlorine pesticides (for which the monitoring objective may be tracking a long-term "recovery" curve of diminishing concentrations in the Bay). A third group of POCs are present in the Bay at concentrations that cause concern; since existing data are insufficient to assess the amount of contribution from stormwater conveyance, initial STLS work will contribute to a general characterization of spatial occurrence and ranges of concentrations. This differential prioritization is reflected in the MRP's partitioning of required stormwater monitoring parameters into two groups with different levels of minimum sampling frequency:

- Category 1 (minimum 4 events per year): Total and Dissolved Copper; Total Mercury; Methyl Mercury; Total PCBs; Suspended Sediments (SSC); Total Organic Carbon; Water Column Toxicity; Nitrate as N; Hardness.
- Category 2 (minimum 2 events in alternate years): Total and Dissolved Selenium; Total PBDEs (Polybrominated Diphenyl Ethers); Total PAHs (Poly-Aromatic Hydrocarbons); Chlordane; DDTs (Dichloro-Diphenyl-Trichloroethane); Dieldrin; (Nitrate as N –duplicate?); Pyrethroids - bifenthrin, cyfluthrin, beta-cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, permethrin, and tralomethrin; Carbaryl and fipronil; Total and Dissolved Phosphorus.

The RMP Sources Pathways and Loadings Work Group (SPLWG) was initiated in 1999 to address pollutant loading to the Bay. It has overseen monitoring studies of high-priority POCs in small tributaries at the Guadalupe River (McKee et al., 2004; 2005; 2006) and at Zone 4 Line A (a small flood control channel in Hayward) (McKee et al., 2009; Gilbreath et al., in review) as well as at Mallard Island (Leatherbarrow et al., 2005; McKee et al., 2006; David et al., 2009, David et al., in review) where the Sacramento River enters the region.

[2] RMP activities are planned on a calendar year basis, while BASMAA and most of its member agencies operate on a Fiscal Year that begins on July 1.

Development of the draft MRP led to an RMP initiative in 2007 to develop the STLS as a framework for coordinating stormwater requirements and RMP activities. In recognition of those discussions already initiated prior to its adoption, the MRP allows Permittees to pursue an alternative approach to answer the same information needs underlying the STLS. The STLS Team, a subgroup of SPLWG, includes representatives from BASMAA and Water Board staff to ensure close coordination, as well as SFEI staff and technical advisors recruited through the RMP. A series of meetings during 2008 and 2009 and associated meeting support materials led to the finalization of the draft Strategy (SFEI, 2009). In 2009 and 2010 SFEI provided further planning support through the completion of several data synthesis reports (Greenfield et al., 2010; Melwani et al., 2010). An initial draft MYP presented the STLS team's recommended approach for implementing the STLS, which was accepted by the SPLWG at its May 2011 meeting. This first working version gives the status in July 2011 of planning for coordinated watershed monitoring to begin October 1, 2011[3]. Further details and documentation of watershed monitoring and other work plan activities for later years will be added in future MYP versions in 2012 and 2013 (see Adaptive Updates below).

Management Questions and Strategy Elements

The stakeholder process established the following Management Questions for the STLS:

1. Which Bay tributaries (including stormwater conveyances) contribute most to Bay impairment from POCs;
2. What are the annual loads or concentrations of POCs from tributaries to the Bay;
3. What are the decadal-scale loading or concentration trends of POCs from small tributaries to the Bay; and,
4. What are the projected impacts of management actions (including control measures) on tributaries and where should these management actions be implemented to have the greatest beneficial impact.

STLS technical activities are grouped into three Elements, listed with their sub-elements in Table 1. Figure 2 shows the main linkages between Management Questions and individual Elements; some Elements also support each other, as suggested by the dotted lines and described in the following MYP sections. Other activities outside the scope of the STLS also have bearing on these Management Questions; see Appendix A for background and context of regional projects to evaluate the potential effectiveness of management actions to reduce PCB and mercury loads to the Bay.

[3] The Water Year designation used by USGS begins on October 1, which is the nominal start of the wet weather monitoring season. Stormwater monitoring beginning in October is customarily budgeted by the RMP with funds for the following calendar year and by BASMAA with funds for the FY beginning the previous July.

Table 1. Small Tributaries Loading Strategy Elements and projected implementation roles.

Element	RMP	Stormwater Programs
1. Watershed and associated Bay Modeling		
A. Regional Watershed Spreadsheet Model	X	
B. Coordination with Bay Margins Modeling	X	
C. HSPF dynamic modeling (potential)	(X)	
2. Source Area Runoff Monitoring	X	
3. Small Tributaries Monitoring		
A. Monitor Representative Small Tributaries	X	X
B. Monitor Downstream of Management Actions		X

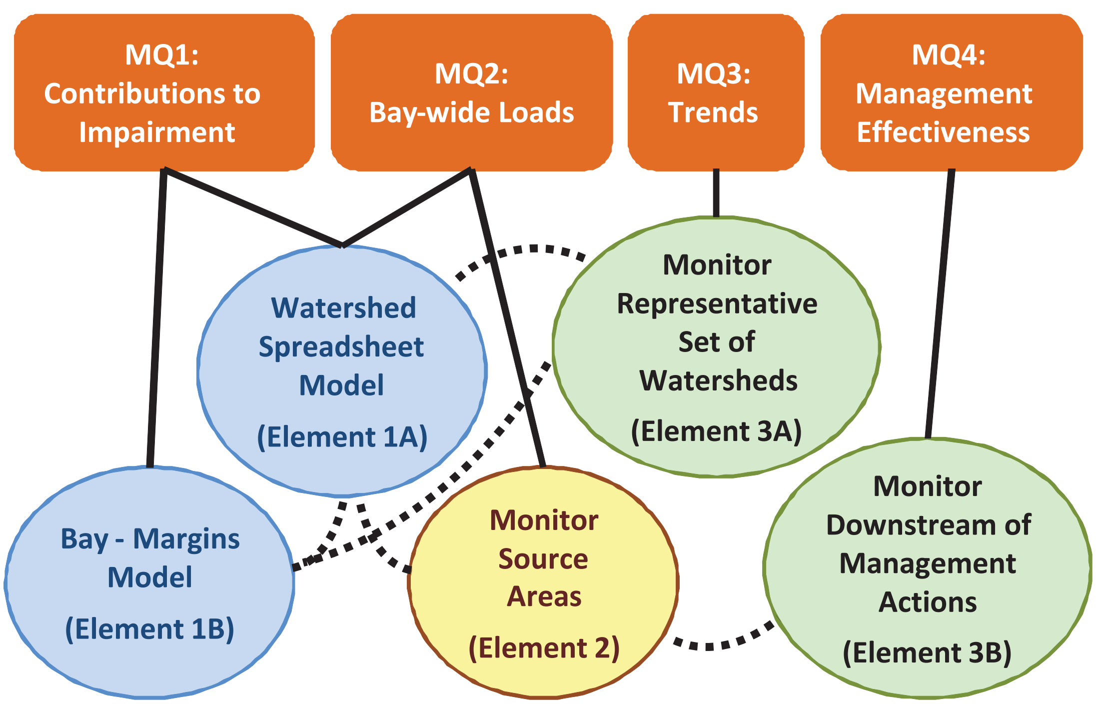

Figure 2: Primary relationships between Small Tributaries Loading Strategy management questions and Elements.

The first element, Modeling, includes a watershed spreadsheet model specifically designed to estimate Bay-wide loads of POCs (Management Question 2) which will also clarify the relative contribution of small tributary loads to the overall Bay impairment for each pollutant (Management Question 1). The spreadsheet model will provide estimates of relative load contributions from individual watersheds around the Bay and will help to identify high-leverage watersheds or more likely clusters of watersheds that may be having a greater local impact to sensitive reaches of the Bay margin[4]. However, the model is of limited use without comparable understanding of the spatial variation within the Bay and local contributions from non runoff sources; these will be provided through a Bay margins model being developed by the RMP as part of a separate Forecasting or Modeling Strategy. In the future, dynamic modeling of one or more individual watersheds may be useful to deepen the understanding of underlying mechanistic behavior not captured by the spreadsheet model. The finer temporal scale of dynamic models may also be helpful in linking the tributary loads to the time scales of biological processes represented in the Bay margins model.

The second element, Monitor Source Areas, will provide Event Mean Concentrations of targeted POCs to parameterize the watershed loadings spreadsheet model. This requires catchments that are relatively homogenous in terms of land use or other source area characteristics, which would differ from the watersheds selected for Element 3. However understanding that is gained about the range of EMCs and the factors that affect them can inform the approach to monitoring downstream of management actions. Element 3, Watershed Monitoring, has two sub elements to address Management Questions 3 and 4.

Strategy Elements

Load Estimation and Modeling

The Regional Watershed Spreadsheet Model (RWSM) will be the primary tool for estimation of overall loads to the Bay. Spreadsheet runoff models are based on the simplifying assumption that unit area runoff for each homogenous sub catchment can be represented by a constant concentration for each POC. Given the large number of small tributaries, initial STLS Team discussions indicated this is more suitable as a framework for regional load estimation than simulation models such as HSPF and SWMM that require large and detailed calibration datasets. The RWSM is structured similarly to Ha and Stenstrom (2008), using GIS-derived data for land use, imperviousness, average soil

[4] Another group of spreadsheet models is being used by the stormwater programs to address Management Question 4 by providing quantitative scenarios of PCB and mercury load reductions from implementation of source control measures in local watersheds. Monitoring data from pilot projects begun in 2010 to refine and test these “desktop evaluation” models is also likely to provide useful input for running scenarios on the RWSM. See Appendix A.

type/slope and annual precipitation. It uses recent local data on land use based concentrations collected in the Bay Area and augmented using data and information extracted from recent stormwater literature. These runoff concentration coefficients can be updated periodically as new data are collected through become available through the monitoring elements of the STLS or related compatible efforts.

RWSM Development

This section summarizes the details and development of the RWSM which will be described in a report to be provided as Appendix B in a 2012 version of the MYP. The model's spatial extent covers the entire region overseen by the Region 2 Water Board boundary (corresponding closely to the Calwater outline in Figure 3). Within this region, the spatial resolution of individual watershed areas is provided by several data sources:

- Watershed boundaries for Central and South Bay. The urban portions of this dataset are based on compilations by the Oakland Museum of California (OMC) Creek and Watershed Mapping Project (a long term collaboration between William Lettis and Associates, OMC, and SFEI funded by cities and counties (http://www.sfei.org/content/gis-data). Begun in 1993, and largely completed in 2008 through a state bond-funded Proposition 13 grant awarded to SFEI, this dataset incorporates further corrections by stormwater managers and is provides a fairly accurate depiction of urbanized catchments, although many of the smaller catchments have been arbitrarily aggregated and the dataset is not fully conformant to data standards of the National Hydrography Dataset.
- Contra Costa Flood Control District's watershed boundaries to fill in the eastern portion of Contra Costa County (Water Atlas cite)
- Provisionally, Calwater Hydrologic Areas are used to fill in remaining portions of the North Bay, Contra Costa, SF & coastal peninsula. Later versions of the RWSM could use increased spatial resolution provided by NHD or other sources if needed.

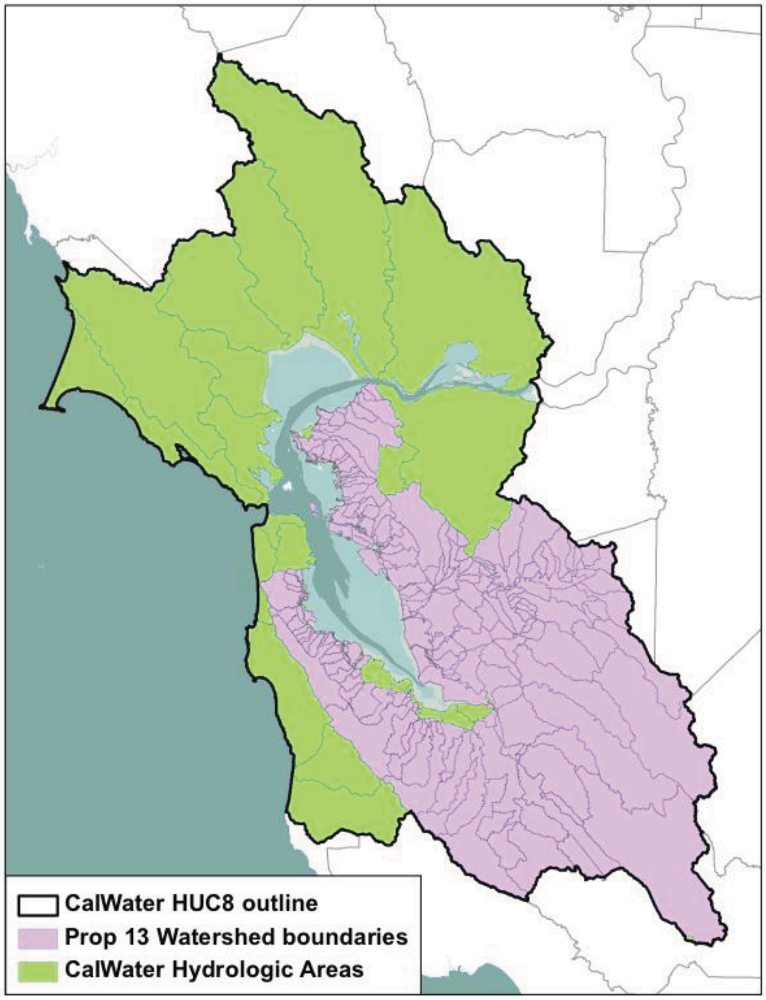

Figure 3: Spatial extent of RWSM and detailed watershed boundaries[5]

The outcomes of the first year included the development of two parallel hydrological models, one using land use based runoff coefficients and the other using imperviousness based runoff coefficients. The model outcomes were compared to empirical observations in 18 calibration watersheds. Preliminary loads of suspended sediment were also generated but the loads generated were quite different from the empirical observations (of which there are many).

An available land use dataset for the Bay Area (ABAG, 2005) is based on a combination of remote sensing and local assessor's parcel information. The first construction of the RWSM used the land use categories of Ha and Stenstrom (2008), with Event Mean

[5] Watershed boundaries based on the Oakland Musium of California Guide to San Francisco Bay Area Creeks (http://museumca.org/creeks/GIS/index.html) and compiled and improved through a Proposition 13 grant awarded to SFEI (http://www.sfei.org/content/gis-data).

Concentrations (EMCs) in initial runs taken from literature. Other categories could be substituted following further analyses from Element 2 studies to develop a framework for specific loads based on land use or other source area characteristics such as age or condition of development.

The initial version of the RWSM focuses on load estimates for sediment, mercury and PCBs. Following review of the first results by STLS Team and SPLWG, the next tier of POCs to be examined would include the rest of MRP Category 1 constituents. Work plan details will be updated as findings of further model testing and calibration are incorporated in future versions of Appendix A. These updates will also describe recommendations for further testing and verification, for example selection of monitoring locations that would be supportive for improving model weaknesses; EMC-related data needs and proposed future activities will be detailed in Appendix G for future versions of the MYP.

RWSM Uses

In 2011, the RWSM framework contributes to the watershed monitoring design. When coupled with monitoring data in the near future, it will provide improved estimates of current loading. Other near-term functions will be as a tool to help stormwater programs address two related MRP requirements:

- Provision C.8.e(vi) requires developing a design for a robust sediment delivery estimate/sediment budget in local tributaries and urban drainages. RWSM model coefficients will also be developed for sediment, to refine regional load estimates previously developed by Lewicki and McKee (2009).
- Provision C.14.a(v) requires developing information required to compute loads to San Francisco Bay of PBDEs, legacy pesticides, and selenium from urban runoff conveyance systems throughout the Bay. The RWSM will provide the framework for initial load characterization with available data from RMP and STLS monitoring, and to develop recommendations for additional studies as needed to improve these initial estimates.

A related model that was discussed in the STLS but is not part of the STLS workplan is a desktop model for evaluating the effectiveness of management options to reduce loads of POCs from local watersheds (see description of Proposition 13 products in Appendix A). As storm water programs collect monitoring data from sites of pilot management projects, these can be used in conjunction with existing EMC information to run scenarios for wider application of various management strategies and predict regional load reductions using the RWSM. Other medium and long term uses will be determined by the STLS Team, which will provide ongoing stakeholder discussion forums to update priorities as described in Adaptive Updates below.

Coordination with Bay Modeling and Other Modeling Efforts

The RMP is also developing a Bay Margins Conceptual Model as part of a separate Bay Modeling Strategy overseen by the Contaminant Fate Work Group (CFWG). The initial draft (Jones et al., 2011) recommends development of a full-Bay 3-D model that could identify high-leverage watersheds whose POC loadings contribute disproportionately to Bay impacts. Until the RMP Modeling Strategy is developed to a point that offers practical guidance on characterizing the relationship of specific tributaries or groups of tributary POC sources to contaminant fate in local portions of the Bay margin, working versions of the RWSM will not apply special weighting or other spatial considerations when estimating individual tributary inputs.

Dynamic Watershed Modeling (Potential)

The SPLWG supported development of a dynamic watershed model for the Guadalupe River Watershed as a pilot effort with funds from 2008 and 2009. This watershed is the subject of a separate TMDL for legacy mercury from the historic New Almaden ining district. An abundance of local water, sediment, and contaminant data made this watershed a logical place for an initial exercise in mechanistic modeling using Hydrologic Simulation Model-Fortran (HSPF). The basic proof-of-concept Guadalupe watershed model for hydrology was completed (Lent et al., 2009). The final report is presently being completed (Lent et al, in review)

Further dynamic modeling work for the Guadalupe River watershed, or initiation of modeling for other watersheds, may be recommended in the future depending on specific information needs of the STLS or Bay Modeling Strategy. STLS need for detailed watershed modeling would be identified through the Adaptive Update process.

Watershed Monitoring

This MYP element outlines a cost-effective and flexible approach to watershed monitoring that can be implemented in the context of both the RMP Master Plan and MRP permit requirements. As part of STLS development, the RMP conducted several related projects in 2010 through 2011 to evaluate potential design considerations:

- Desktop methods optimization study
- Preliminary watershed classification
- Watershed characterization sampling study

Results of these studies were evaluated along with several other considerations, including analytical sensitivity and cost, to develop several alternative scenarios for implementation of the MYP watershed monitoring element.

Monitoring Methods

A standard approach for stormwater monitoring is composite sampling in which multiple discrete samples from one storm event are combined into one sample for analysis. This concept is the basis for basic requirements in 40CFR121.21(7)(g)(ii), referenced in the MRP as the default procedure to be used. A common practice for collecting stormwater samples is to use automated samplers with onset of the storm event sampling triggered by increase in flow (as indicated by a change in stage height of the monitored channel or conveyance) with subsequent discrete aliquots sampled at pre-programmed intervals that may represent equal increments of elapsed time or of discharge volume.
The SPLWG oversaw RMP load studies on the Guadalupe River in water year (WY) 2003-06, 2010, and at Zone 4 Line A (Z4LA) in WY 2007-10, collecting multiple discrete depth integrated point samples (loosely referred to as grab samples for STLS purposes) during many storm and base flow events. These studies were based on the use of continuous turbidity monitoring as a more sensitive way to identify the onset of storm discharge, as well as for characterizing the within-storm variations in transport of sediments and POCs associated with fine sediments. The turbidity record was used as a surrogate for continuous estimation of finer fractions of SSC and the associated POCs to generate highly accurate and precise load estimates at 5-15 minute intervals which could then be summed to any other desired time interval (e.g. event, day, month or season).

Using the Guadalupe and Z4LA datasets, an optimization study was conducted to recommend sampling methods and style of sampling that would be useful for assessing loads and determining trends. Using methods similar to those outlined in Leecaster et al (2002) and Ackerman et al.(2011), a series of analyses were performed to assess the optimal number of samples and style of sampling for SSC, PCBs and mercury within storms as well as approaches for choosing which storm events to sample. Detailed methods and results are presented in Appendix C. Results differed somewhat for Guadalupe vs. Z4LA and for PCBs vs. mercury, but preliminary review of tested scenarios suggested the following:

- Turbidity triggering was slightly better than flow for defining the start of the storm, but no particular trigger strategy for within-storm sampling was identified that was consistently more accurate for characterizing the POC loads of a particular event.
- To use regression on the turbidity surrogate records for estimating annual loads, at least 10 but ideally 16 samples per year should be collected at each site; however focusing this number of samples on just a few randomly selected storms would likely cause spurious loads estimates of poor accuracy and precision.
- Strategies for selecting a more representative set of storms to sample (e.g. first flush + a larger storm + several random, first flush + several random, vs. all random) were evaluated. From the analysis it appears that scenarios that include first flush and one of the largest storms of the year provide more robust loads estimates than random sampling alone.
- Power for detecting trends appeared to be possible with just 10 samples collected per year, based on a preliminary scenario in which the samples were randomly selected and did not confirm to any of the tested sampling designs

While the optimization assessment focused on PCBs and mercury, its findings should be generally applicable to other sediment-associated pollutants and probably more than adequate for dissolved constituents since dissolved concentrations generally vary much less with flow. They may not be as relevant for methylmercury since the intent of the permit is to investigate a representative set of drainages and obtain seasonal information and to assess the magnitude and spatial/temporal patterns of methylmercury concentrations. It may also not be particularly good for water toxicity since toxicity response is a function of both concentration and cumulative duration of exposure; however, the decision was made to collect large composite samples over whole storm events – these can be done with many (e.g. 24) sips triggered by either changes in turbidity or stage.

Categories of watersheds

From its early days, the SPLWG has recommended stratifying the numerous watersheds of Bay Area small tributaries into general categories to provide a rationale for systematic sampling of a subset of watersheds in selected categories (Davis et al., 2000). These categories are needed to answer two key questions for the design of the STLS MYP watershed monitoring:

1. How many types of watersheds occur in the region and,
2. How many watersheds should be studied to answer key management questions, and how should they be distributed among the identified types?

To address the first question, SFEI conducted a preliminary characterization study using ordination and cluster analysis, exploratory statistical techniques designed to visualize patterns on complex multivariate data sets (see background in Appendix C preliminary discussion "Categorization of watersheds for potential stormwater monitoring in San Francisco Bay"). The study aimed for an initial classification of Bay Area small tributary watersheds into a small number (<10) of classes, relevant for loads monitoring and Bay margin impacts. Statistics were generated for 18 attributes on each of the watersheds to form the basis for analyses. Table 2 summarizes a scheme consisting of eight clusters or classes which appeared robust and meaningful for the STLS purposes.

The descriptions in Table 2 include those attributes that seemed most influential in discriminating among the clusters (all attributes were assigned equal weight in the analyses). Clusters 1, 2, and 3 are similar to each other in all having relatively high residential, commercial, and industrial land cover and consequently, high surface imperviousness. Combined, these clusters include 119 watersheds, and could therefore be described as typical watersheds for the study area. These clusters generally include densely populated, low-lying areas that drain into South Bay and Central Bay
In the remaining groupings, Cluster 6 watersheds are distinguished by their large size while the rest seem to fall into smaller, more specialized clusters.

Table 2. Description of eight preliminary watershed clusters generated using Bray-Curtis distance with Ward's linkage method.

Cluster No.	Number of watersheds	Description
1	41	High commercial and residential land cover and imperviousness. High historic industry and railroads. No PG&E facilities. Moderate area.
2	43	High commercial and residential land cover and imperviousness. High historic industry and railroads. One to four PG&E facilities. Large area.
3	35	High commercial and residential land cover and imperviousness. Low historic industry or railroads. Smaller area.
4	11	Small, sparsely populated, predominantly industrial, highest historic industrial and imperviousness. Located around San Francisco Airport and Brisbane.
5	11	Sparsely populated, low development, high open land cover, no railroads, "green space." Located adjacent to Bay or in undeveloped uplands.
6	22	Largest watersheds, with moderate population density, high open land cover, and low imperviousness.
7	17	High agricultural land cover, lower rainfall, draining to Carquinez Strait and Suisun Bay.
8	5	Small, sparsely populated, predominantly open, containing historic railroad, and draining to Carquinez Strait.

After reviewing the preliminary watershed classification the STLS agreed that further information was needed to select watersheds for future STLS monitoring. RMP resources for WY 2010-11 monitoring were redirected to a characterization study consisting of storm water grab samples from 16 of the candidate watersheds for which there were little or no existing PCB or mercury concentration data[6].

Table 3 shows the watersheds selected for the characterization study, along with a summary of some of their key attributes. Criteria for the composition of the sampling list included the following:

- Multiple representatives of the most common small to medium sized watershed classes 1-3, distributed throughout the four counties (Contra Costa, Alameda, Santa Clara, and San Mateo) where loads monitoring is required by the MRP.

[6] This redirection is allowed by MRP Provision C.8.a, which indicates that initiation of the required POC loads monitoring can be deferred to October 2011 if the stormwater Permittees are participating in a regional collaborative process to plan and conduct the monitoring.

- A few representatives of the medium to large watershed classes.
- Smaller catchments, generally heavily urban with industrial land uses, where stormwater programs are planning enhanced management actions to reduce PCB and mercury discharges.
- Other watersheds with distinctive histories of mercury or PCB occurrence, or related management concerns.

Figure 3 shows the general locations of the study watersheds and the drainage areas above the initially selected monitoring locations. Some of the monitoring station locations were adjusted after field reconnaissance. Table 4 lists watersheds considered but not selected for the study, and also watersheds excluded from the study because of the availability of significant amounts of previously collected PCB and mercury data. Appendix E provides details of the study design, methods and results.

In June 2011 the STLS Team reviewed the results of the WY2011-12 sampling. Analytes measured at each sampling site varied depending on budget and Water Board management questions (Table 5). Between 4-7 PCB, total mercury, SSC and organic carbon samples were collected at each site. PBDE and PAHs were collected at a subset of sites chosen based on logistics (essentially randomly from a water quality perspective). Selenium data were only measured at Contra Costa sampling locations.

Table 3. Watersheds sampled during reconnaissance characterization study of Water Year 2011.

Watershed/ station	Area (km^2)	Prelim, Cluster No.	Percent Impervious	Percent Old Industrial	Reconnaissance Feasibility/ Safety	PCB-Hg attributes
Ettie Street Pump Station	4.0	1*	73.4**	28.60**	Good/Good	PCB P13 Cluster, CW4CB pilot watershed
Pulgas Creek	7.1	2	28.2		Good/Good	CW4CB pilot watershed
Sunnyvale East Channel	18.0	2	59.7	3.47	Good/Good	PCB P13 Cluster
Santa Fe Channel	2.64	2	70.3	3.6	Poor-Medium/ Good	Confirm proposed station vs. locations of CW4CB pilot watersheds
Lower San Leandro Creek	8.9	2	37.5	2.96	Good/Good	PCB spill into creek in 1995
Stevens Creek	73.7	6	15.8	0.24	Good/Good	Within airshed of Lehigh-Hanson Cement Manufacturer
Zone 5 Line M	8.1	*	33.5	3.15	Good/Good	Hg P13 Cluster
Lower Marsh Creek	97.5	?	14.7		Good/Good	Drains historic Hg mine
San Lorenzo Creek	124.8	6	13.2	0.50	Medium/Good	
Walnut Creek	318.7	7	16.6	0.72	Good/Good	
Lower Penitencia Creek	12.0	*	67.1	7.14	Good/Good	
Belmont Creek	7.2	2	27.4	0.00	Medium/Good	
Borel Creek	3.2	2	31.4	1.57	Medium/Good	
Calabazas Creek	52.9	1	45.6	0.44	Good/Good	
Glen Echo Creek	5.4	3	39.3	0.80	Good/Good	Hg P13 Cluster
San Tomas Creek	114.1	1	34.4	0.35	Good/Good	

* Catchment does not correspond to a polygon used in cluster analyses
** Estimated for larger polygon used in cluster analyses

Figure 4. Watersheds sampled in Water Year 2010-11 reconnaissance characterization study.

Table 4. Potential candidate watersheds, not selected for reconnaissance characterization sampling during WY 2011.

County	Watershed	Area (km^2)	Prelim, Cluster No.	Percent Impervious	Percent Old Industrial	PCB-Hg attributes
San Mateo	Colma Creek	28.0	2	37.5	2.18	PCB P13 Cluster, CW4CB pilot watershed
Contra Costa	Alhambra Creek	41.0	6	6.0	0.01	
Alameda & Contra Costa	Cerrito Creek	1.9	2	35.8		
Contra Costa	East Antioch	14.4	7	41.4	1.31	
Contra Costa	Mt Diablo Creek	80.2	6	10.5		
Alameda	Oakland, East of Lake Merritt	2.1	2	67.3	6.18	PCB P13 Cluster
Alameda	Zone 4 Line A	8.78*	1	67.6	10.1	
Santa Clara	Lower Coyote Creek (below Anderson Dam)	318.6	6	21.1	0.38	PCB P13 Cluster
Santa Clara	Guadalupe River	226	6	32.5	2.7	Hg TMDL
San Mateo & Santa Clara	San Francisquito	111.8	6	7.3	0.27	

Table 5. Summary of analytes collected during the water year 2010-11 reconnaissance characterization study.

Analyte	MRP Category	Number of Samples
PCB	Category 1	91
Total Mercury	Category 1	91
SSC	Category 1	91
Total Organic Carbon	Category 1	91
PBDE	Category 2	22
PAH	Category 2	22
Total Selenium	Category 2	30
Dissolved Selenium	Category 2	30

Table 6 shows that while maximum concentrations of total mercury varied from 19-1740 ng/L (about 100x) between sites in relation to suspended sediment concentration and watershed characteristics, maximum PCB concentrations varied from 1,851 - 467,696 pg/L a variation of about 250x. . Methylmercury did not relate directly to maximum total mercury observed at each site. Normalizing mercury and PCB data to SSC and turbidity respectively (see Appendix E for discussion) resulted in a different pattern and rankings of the sampled watersheds, as shown in Table 7.

Table 6. Maximum concentrations of mercury and PCBs for the Water Year 2010-11 reconnaissance characterization study.

Watershed	Max HgT (ng/L)	Max. PCBs (pg/L)
Belmont Creek	59	4,909
Borel Creek	74	8,671
Calabazas Creek	89	24,765
Ettie Street Pump Station	73	68,996
Glen Echo Creek	179	85,815
Lower Marsh Creek	???	4,136
Lower Penetencia Creek	19	1,851
Pulgas Creek Pump Station - North	27	84,490
Pulgas Creek Pump Station - South	28	53,894
San Leandro Creek	477	31,336
San Lorenzo Creek	77	20,421
San Pedro Storm Drain	499	
San Tomas Creek	129	4,372
Santa Fe Channel	217	467,696
Stevens Creek	121	22,554
Sunnyvale East Channel	151	67,462
Walnut Creek	181	24,396
Zone 5 Line M	1740	25,091

Table 7. Summary of PCB and Hg results in relation to suspended sediment or turbidity and organized by PCB/turbidity ratio.

Site	PCB/Turb Avg Ratio (pg/NTU)	HgT/SSC Avg Ratio (ng/mg)	PCB Rank	Hg Rank	Rank Sum	Feasibility Constraint?
Santa Fe	2882	0.68	1	4	5	Tidal
Ettie St	1097	0.78	2	3	5	Access time restricted
Pulgas North	822	0.47	3	5	8	Extremely flashy
Pulgas South	639	0.83	4	1	5	Extremely flashy
Glen Echo	443	0.38	5	7	12	Underground downstream
Sunnyvale Channel	369	0.34	6	8	14	Bridge narrow
San Leandro	98	0.8	7	2	9	
Z5LM	84	0.41	8	6	14	SSC > 1800 mg/L
San Lorenzo	74	0.28	9	9	18	
Stevens	33	0.26	10	11	21	
Calabazas	29	0.16	11	16	27	
Walnut	21	0.1	12	17	29	SSC > 1800 mg/L, 12-24 hour hydrograph – sample preservation
San Tomas	21	0.27	13	10	23	
Lower Penetencia	20	0.16	14	15	29	
Borel	17	0.17	15	14	29	
Belmont	15	0.24	16	12	28	
Lower Marsh	4	0.2	17	13	30	SSC > 1800 mg/L, Remote, access by Hwy 4, sample preservation

For the most part, sampling logistics at these sites were taken into account as part of the decisions made prior to the reconnaissance study. However, there were some additional lessons learned during the reconnaissance study about feasibility and potential sampling constraints that are worth noting in Table 7. The tidal nature of the Santa Fe channel, although it was sampled during low tide, will challenge the measurement of discharge if loads at this site are desired in the future; acoustic Doppler technology at a greater cost would be needed. Three locations (Zone 5 Line M, Walnut and Lower Marsh) had observed turbidities that exceed the use of the DTS12 turbidity sensors employed previously at Guadalupe and Zone 4 Line A; sensor technology that ranges to 4000 NTU is available but with some loss of sensitivity at the lower end of the range (<50 NTU). The narrow sampling platform at Sunnyvale East Channel adds challenges for manual sampling equipment and safety due to lack of space. Sampling locations at the base of large watersheds such as Walnut Creek and Guadalupe River, with storm hydrographs that can span a day or more, may add sample preservation challenges if ice melts before samples can be retrieved following storm events. Lower Marsh Creek is a challenging location due to travel time to the site and the same kinds of preservation challenges.

Criteria for watershed selection

In June 2011 the STLS WG reviewed characteristics of the candidate watersheds that it considered as priorities for the watershed monitoring:

- **Representative** for purposes of long-term trends monitoring. Watersheds selected have a station near the bottom of the watershed, and include a range of sizes and land uses, ranging from already urban to those expected to undergo significant additional urbanization over the next 20 -30 years.
- Containing **Management** opportunities for TMDL load reductions, especially of PCBs and mercury, that are likely to be explored through pilot projects or other targeted stormwater program activities during the next 5-10 years (see Appendix A). Since the first round of pilot management activities will be limited to a few local catchments, the STLS team decided to focus the watershed selection for Phase 1 (WY2011-12) on representative sites and defer potential selection of these watersheds until later in 2011, to plan for Phase 2.
- Named as a monitoring location for specific NPDES **Permit** requirements affecting Bay Area stormwater programs. This includes Lower Marsh Creek which is named in a parallel C.8.e provision in the municipal stormwater permit for eastern Contra Costa County. The Guadalupe River site previously monitored by the RMP is one of the 8 stations identified as default locations for POC Loads Monitoring in the MRP, and continued monitoring at this site is also required by a permit supporting the implementation of the mercury TMDL for that watershed.[7]
- Feasibility of monitoring for the desired Management Question. For example, many catchments with planned or potential management activities are heavily culverted and located in low-lying Bayside areas, so that monitoring stations downstream of the management areas are often subject to tidal inflow or inaccessible due to private property boundaries.

The four stations selected for Phase 1 start-up were:

- Lower Marsh Creek (Contra Costa County) to be operated with funding from Contra Costa Clean Water Program on behalf of BASMAA.
- Lower San Leandro Creek (Alameda County) to be operated by SFEI for RMP
- Sunnyvale East Channel (Santa Clara County) to be operated by SFEI for RMP
- Guadalupe River (Santa Clara County) to be operated with funding from Santa Clara Valley Urban Runoff Pollution Prevention Program on behalf of BASMAA.

[7] Both of these permits specify additional monitoring requirements which are not included in the scope of this STLS MYP, i.e. additional parameters for Lower Marsh Creek and additional sites and periodic intensified monitoring in the Guadalupe River watershed.

Analytes and Data Quality Objectives

Where applicable, the MRP specifies that default standards for monitoring data quality be consistent with the latest version of the Quality Assurance Program Plan (QAPrP; SWAMP 2008) adopted by the Surface Water Ambient Monitoring Program (SWAMP). The QAPrP adopts a performance-based approach with target Reporting Limits (RL) for a large list of analytes in water and sediment.

The RMP has not specified target Reporting Limits for most analytes; for the SPLWG monitoring studies SFEI has utilized laboratory services that provide much lower method detection limits (MDL) for some analytes than those that would be associated with the SWAMP Target RLs.

Table 8 summarizes the results of a review of detection frequency at Zone 4 Line A, indicating that the RMP laboratories have obtained much higher frequencies of detection with much lower detection levels for the organic compounds (see Appendix F).

MDLs are variable depending on the concentrations of the target analyte and similar compounds as well as potential interference from other constituents in the sampling matrix. While quality assurance considerations should be used in interpreting data near the MDL, accurate quantitative results at low range are important for developing load estimates.

Table 8. Comparison of detection rates for selected analytes using SWAMP Reporting Limits vs. RMP-contracted lab results for storm water samples at Zone 4 Line A; see Appendix F for additional notes.

Analyte	SWAMP Target RL	Z4LA data, fraction > SWAMP RL	MDL range	Z4LA % detection	Sample Volume, Liters
Category 1					
Copper (Total)	0.01 µg/L	45/45		100%	0.12
Copper (Dissolved)	0.01 µg/L	11/11		100%	
Mercury (Total)	0.0002 µg/L	112/112		100%	0.25
Methylmercury	0.00005 µg/L	55/56		99%	0.25
PCB congeners	0.02 µg/L	20/77		(98%)	2.5
SSC	0.5 mg/L	392/392		99%	0.25
TOC	0.6 mg/L	40/40		100%	.25
Nitrate as N	0.01 mg/L	10/12		(NA)	(0.15)
Hardness (as CaCO3)	1 mg/L	NA		NA	NA
Category 2					
Selenium (Total) [e]	0.30 µg/L	15/30		36%	0.5
Selenium (Dissolved)	0.30 µg/L	0/5		66%	
PBDEs	NL - assume 0.02 µg/L	18/36		(75%)	2.5
PAHs [g]	10 µg/L	3/21		(99%)	2.5
DDTs	0.002 µg/L[h]	14/20		(100%)	
Chlordane[i]	0.002 µg/L	13/20		(100%)	
Dieldrin[i]	0.002 µg/L	3/20		(100%)	
Pyrethroids [j]	NL	NA		NA?	4
• Bifenthrin		--	NA		
• Delta/Trihalomethrin		--	NA		
• Permethrin, total		--	NA		
Carbaryl	NL	NA	NA	NA	NA
Fipronil	NL	NA	NA	NA	NA
Phosphorus (Total)	NL	NA	NA	NA	(with N)
Phosphorus (Diss.)	NL	NA	NA	NA	(0.17)

Watershed Monitoring Approach

The MRP requires POC loads monitoring effort that is equivalent to conventional flow weighted composite sampling at eight sites, with an annual average of four events sampled for Category 1 analytes and one event for Category 2. The MRP allows phased implementation: Phase 1 monitoring of at least four stations, or roughly half of the effort, must be initiated by October 2011 and Phase 2 monitoring of the remaining stations must start by October 2012.

After discussion of assumptions for the MRP default plan compared with alternative scenarios incorporating the recommendations for sampling frequency and laboratory data quality described above, the STLS work group agreed to pursue a watershed monitoring plan that would be roughly consistent with the MRP cost benchmark and include:

- A total of six watershed monitoring stations, with four to be deployed in Phase 1 (WY 2011) and an additional two stations in Phase 2 (WY 2012), subject to review after the first year to evaluate whether resources should be reallocated between watershed monitoring and EMC development elements.
- Continuous turbidity monitoring (not included in the MRP) at all stations to enable turbidity surrogate regression estimation of seasonal loads of particulate associated POCs and allow for the future inclusion of other analytes and the back calculation of loads using turbidity records.
- For best load estimation of mercury, PCBs and sediment at least 16 samples should be collected in a season; for planning purposes, this would be a minimum of 4 events with an average of 4 samples per event. Sampled events should target a first flush event and at least one of the larger storms of the year.
- Sample analyses for all stations would be performed by specific laboratories recommended on the basis of previous performance and reliability in achieving low MDLs for each parameter.

In March 2011 Water board staff indicated that this STLS program with annual cost similar to the MRP benchmark of \$800,000-\$1,000,000[8] would meet the MRP requirement for an alternative monitoring approach that addresses the priority Management Questions, with the assumption that at least 2/3 of this cost would be supported by the storm water programs (see work plan below).

In July 2011 the STLS WG determined that all monitoring stations should use the same sampling methods for each parameter, and began developing a plan using automated sampling equipment (Model 6712 full size by Teledyne ISCO, hereafter “ISCO”) for all parameters except methyl mercury. While evaluating available configurations of sample bottles to collect the water volumes recommended in Table [5], some modifications were made to the sampling plan to permit efficient use of four ISCOs. The STLS WG consensus plan for sampler configuration as of mid-July 2011 is shown in Table 9. Annual number of samples per site is equal to or greater than the average annual frequency specified in the MRP for all analytes except organochlorine pesticides, for which recent data have suggested a reduced regulatory priority.

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[8] Benchmark cost for default MRP monitoring (including ongoing project administration but excluding data management and reporting and contingency for false starts) was established as a range to express variation in labor costs among the participating agencies. Benchmark calculations distributed one-time start-up costs over 3 years of operation, although this assumption has limited value for actual project planning. No site-specific cost variations were assumed other than stage-discharge monitoring and calibration for sites not served by an existing USGS gauging station.

Table 9. Sample type and target frequency of STLS sampling by analyte.

MRP Category	Parameter	No. of Storms / year	No. of Samples/ storm	Frequency change from MRP	Sample Type	Recommended Lab
1	PCBs (40 congener)	4	4	400%	Discrete	AXYS
1	Total Mercury	4	4	400%	Discrete	MLML
1	Total methyl mercury	2[9]	4	400%	Grab	MLML
1	Dissolved Cu	4	1	0%	Composite	BRL
1	Total Cu	4	1	0%	Composite	BRL
1	Hardness	4	1	0%	Composite	BRL
1	SSC (GMA)	4	8	800%	Discrete	EBMUD
1	Nitrate as N and Total Phosphorous	4	4	400%	Discrete	EBMUD
2	Dissolved phosphorus	4	4	400%	Discrete	EBMUD
1	TOC	4	2.5	250%	Discrete	CAS?
1	Toxicity – water column	4	1	0%	Composite	TBD
2	Pyrethroids	4	4	1600%	Composite	AXYS?
2	Carbaryl	4	4	1600%	Composite	DFG – WPCL?
2	Fipronil	4	4	1600%	Discrete	DFG – WPCL?
2	Chlordane, DDTs, Dieldrin	0	0	-100%	N/A	N/A
2	Dissolved Se (collect with Dissolved Cu)	4	1	400%	Composite	BRL
2	Total Se (collect with Total Cu)	4	1	400%	Composite	BRL
2	PBDE	2	1	200%	Discrete	AXYS
2	PAH	2	1	200%	Discrete	AXYS

Watershed Monitoring Plan

This section contains recommendations in two categories. The <u>core plan</u> is the minimum recommendation to meet the requirements for an alternative equivalent approach to the POC Loads Monitoring in the MRP. Additional <u>plan options</u> may be considered subject to the availability of additional resources, either for the current participants or by leveraging resources of additional programs or partners in the future.

The core plan comprises 6 sites, using the sampler configuration plan in Table [6]:

- Representative long-term trends: four sites selected above for Phase 1
- Sites downstream of planned management actions: two sites to be selected in late 2011 for Phase 2. As suggested by the May SPLWG meeting, Phase 2 design

[9] Two additional dry weather methyl mercury grab sampling events, required by the MRP, will occur during station set-up in September and shutdown in April or May.

may involve reevaluating the relative allocation of effort for watershed monitoring and Source Area Monitoring.

The STLS is developing a Quality Assurance Project Plan and Field Manual with Standard Operation Procedures; these will document details of equipment and methods, to be summarized in a 2012 revision of Appendix F. The first year of monitoring in WY11-12 may use some special method variations or spreading of effort to field-test methods or resolve uncertainties in the long-term design approach.

Should additional resources become available, plan options could include:

- Accelerating Core Plan activities on an earlier schedule.
- Adding other analytes where compatible with the STLS sampler configuration shown in Table [6]. For example, a separate RMP Strategy for dioxins has developed a proposal for including dioxins analyses for some samples collected at STLS sites operated by the RMP.

The STLS team will not produce a detailed written interpretive report of WY11-12 results, but will provide a limited summary of the monitoring activities for purposes of the RMP and MRP. SFEI will present a preliminary review of the first year's data for discussion at STLS and SPLWG meetings likely schedules May, June, and July 2012. An integrative 2-year report will be prepared in late 2013, and will be incorporated in BASMAA's Integrated Monitoring Report for MRP reporting requirements.

Source Area Runoff Monitoring

The RWSM literature review identified several gaps in available information about EMCs. As an alternative to starting reconnaissance for source area monitoring sites, SFEI began exploratory work with an approach suggested at the May 2011SPLWG meeting that uses available data from sediment samples collected in storm drain conveyances. Results of this exploration and potential implications for source area runoff monitoring will be reviewed in a 2012 version of the MYP Appendix G.

Adaptive Updates

This MYP is a working document and will require revisions as new information and data are reviewed for POCs on the existing priority list, or new pollutants are identified as regional priorities. Updated working versions of the MYP will be incorporated in BASMAA Monitoring Status Reports or Urban Creeks Monitoring Reports related to MRP requirements. The next three revisions are shown below along with the timeframes in which the added or updated materials listed below each may be incorporated:

Version 2012 A (through December 2011):

- Update on preliminary EMC explorations and recommendations for EMC development studies
- Updated Appendix F with details of watershed monitoring sampling procedures, & QA, with reference to QAPP, field Manual, and field training materials; also documentation of procedures for coordinating management, QA/QC of watershed monitoring data
- Review priorities for watershed monitoring data vs. EMC studies, document potential scenarios for future allocations of STLS effort
- Selection and rationale for two additional candidate sites to begin watershed monitoring in WY 2013.
- Draft planning timeline for future data reviews (e.g. trends analyses, integration with spreadsheet modeling)

Version 2012 B (through June 2012):

- Review of first year data and experience, recommended changes to MYP watershed monitoring design, if applicable
- Coordination with RMP monitoring strategy, as applicable
- Update on Regional Watershed Spreadsheet Model development, study designs for preliminary test load estimates for selected POCs and sediment,
- Updates to work plan and descriptions of future planned studies

Version 2013 A (through December 2012):

- Approach for preparing integrated monitoring report (draft in September 2013)
- Coordination with RMP monitoring strategy, as applicable
- Updates to work plan and descriptions of future studies
- Timeframe for next MYP version(s) and adaptive updates

As the primary stakeholder forum, the STLS Team will track these various needs and set priorities for further MYP updates. The SPLWG will review these updates, at least annually but ideally several times per year, to track progress according to the RMP Master Plan, or at milestones such as the following:

- Trends power analysis, after accumulation of appropriate minimum number of samples. Revisions of the MYP in 2012 will develop a provisions timeframe for trends analyses over the next 3-5 years.
- Bay Modeling milestones as they become established through Modeling Strategy

Workplan and Detailed RMP Task Descriptions

This section outlines the 5-year STLS workplan for both the RMP and stormwater programs acting collaboratively through the Bay Area Stormwater Management Agencies Association (BASMAA) (see Table10), and presents capsule summaries of RMP workplan tasks for the same time period as guided by the RMP Master Plan. The budgets and scopes shown below are as of spring 2011 and do not reflect revisions that may be proposed later in 2011. Detailed task scopes for future years will be prepared as part of the annual planning process with STLS and SPLWG oversight.

1A) Regional Watershed Spreadsheet Model Development and Support.

Objective: Develop and use GIS-based spreadsheet model for regional load estimation.

Deliverables: Load estimates for priority pollutants of concern and sediment; see 2012 study proposal for more details on near-term activities.

Milestones and Linkages to other Projects: [to be included in future Appendix B]

Project Participants: RMP

Due Date: [to be included in future Appendix B]

RMP Contributions and Years: 2011 approved $20,000; 2012 proposed $20,000; 2013-2015 TBD.

Total Cost: TBD,

Table 10. Preliminary five-year STLS workplan. Numbers indicate budget allocations or planning projections in $1000s. Stormwater programs budgets interpolated from BASMAA Fiscal Year budgets (regional reporting budgets not shown). Budget numbers shown for years after 2012 are projected, subject to annual authorization processes of RMP and BASMAA.

Task ID	Funding Agency	Task Description	2011	2012	2013	2014	2015
1		**Watershed and Associated Bay Modeling**					
1A		Regional Watershed Spreadsheet Model					
1A.1	RMP	Phase I – Water, Sediment, PCBs and Mercury	20	20			
1A. 2	RMP	Phase II – Other Pollutants of Concern			20?		
1A.3	RMP	Phase III – Periodic Updates				TBD	TBD
1B	RMP	Coordination with Bay Margins Modeling			TBD	TBD	
1C	TBD	HSPF dynamic modeling					TBD
2	RMP	**Land Use/Source Area Specific EMC Development and Monitoring**	20	80	TBD	TBD	TBD
3		**Small Tributaries Monitoring**					
3.1	BASMAA	Multi-Year Plan Development	15				
3.2	BASMAA	Standard Operating and Quality Assurance Procedures	40				
3A	RMP	Monitor Two Representative Small Tributaries	300	328	300	300	300
3AB.1	BASMAA	Monitor Two to Four Representative Small Tributaries or Sites Downstream of Management Actions	380	850	700	700	700
3AB.2	BASMAA	Quality Assurance and Information Management	25	30	40	40	40
4	RMP	**Reporting, Stakeholder Administration and Adaptive Updates**			TBD	TBD	
RMP Total			340	428	TBD	TBD	TBD
BASMAA Total			460	880	TBD	TBD	TBD
Total			800	1,308	TBD	TBD	TBD

1B) Coordinate STLS with Bay Margins Modeling.

Objective: Identification of high-leverage watersheds contributing to POC impairment in S.F. Bay.

Deliverables: Timely coordination and exchange of information between STLS and Bay Margins modeling Work Groups.

Milestones and Linkages to other Projects: Depends on Modeling Strategy

Project Participants: RMP

Due Date: Depends on Modeling Strategy

RMP Contributions and Years: 2013-2015 TBD?

Total Cost: TBD

2) Land Use/Source Area Specific EMC Development and Monitoring.

Objective: Calibrate RWSM loading estimates to Bay Area specific conditions and POCs.

Deliverables: Refined EMCs or other modeling coefficients for RWSM; see 2012 study proposal for more details on near-term activities.

Milestones and Linkages to other Projects: Coordinate with 1A, RWSM Development.

Project Participants: RMP

Due Date: TBD

RMP Contributions and Years: 2011 approved $20,000; 2012 proposed $80,000; 2013-2015 TBD.

Total Cost: TBD

3.1) Development of STLS Multi-Year Plan

Objective: Develop alternative monitoring approach to POC Loads Monitoring that meets objectives of STLS and MRP; facilitate consistent implementation

Deliverables: Consensus STLS MYP document for timely implementation of required stormwater monitoring.

Milestones and Linkages to other Projects: To be coordinated with RMP 3A and MRP reporting requirements (initial Phase 1 results in late.2012)

Project Participants: BASMAA

Due Date: Selection of monitoring methods and Phase 1 sites by July 2011; sites for Phase 2 monitoring by January 2012

RMP Contributions and Years: (review using 2010 available funds); BASMAA funding 2011: $15,000

Total Cost: BASMAA $15,000 one-time

3.2) Stormwater Programs - Monitoring, Standard Operating and Quality Assurance Procedures.

Objectives: Ensure that alternative monitoring methods in STLS meet MRP requirements for SWAMP comparability and reporting formats; provide documentation and facilitate consistent implementation

Deliverables: Quality Assurance Project Plan, Standard Operating Procedures

Milestones and Linkages to other Projects: To be coordinated with RMP 3A and MRP reporting requirements (initial Phase 1 results in late.2012)

Project Participants: BASMAA

Due Date: August 2011

RMP Contributions and Years: RMP N/A; BASMAA funding 2011: $40,000

Total Cost: BASMAA $40,000 one-time
:

3A) Monitor Representative Small Tributaries.

Objective: Collect POC stormwater data to be used for tracking long-term trends in loading to S.F. Bay

Deliverables: small tributaries monitoring data

Milestones and Linkages to other Projects:

Project Participants: RMP, BASMAA

Due Date: Exploratory watershed characterization results by June 2011; Phase 1 monitoring begins October 2011; Phase 2 monitoring begins October 2012

RMP Contributions and Years: 2011 approved $300,000; 2012 proposed $328,000; 2013-2015 [$300,000/year projected]; BASMAA funding $380,000 2011, TBD 2013-2015 (see 3A/B.1 below)

Total Cost: RMP: [$300,000/year projected in RMP Master Plan?]

3A/B.1) Monitor Sites Downstream of Management Actions.

Objectives: Collect POC stormwater data to be used for tracking potential load reductions downstream of Management Actions.

Deliverables: Monitoring data.

Milestones and Linkages to other Projects:

Project Participants: BASMAA

Due Date: Phase 2 monitoring begins October 2012

RMP Contributions and Years: N/A. BASMAA funding up to $850,000 for all monitoring including 3A and setup in 2012, TBD 2013-2015

Total Cost: TBD.

3A/B.2) Stormwater Programs ongoing Quality Assurance and Data Management.

Objective: implement and document QA procedures and reporting for SWAMP comparability.

Deliverables: QA review and data management.

Milestones and Linkages to other Projects: To be coordinated with Task 3A/B.1 and MRP reporting requirements.

Project Participants: (BASMAA

Due Date: Ongoing Quality Assurance and Data Management; BASMAA funding

RMP Contributions and Years: N/A; BASMAA funding 2011: $25,000, 2012: 30,000, 2013-2015 TBD

Total Cost: TBD,

- Phase 1 setup, station operation and laboratory analyses: $
- Quality Assurance Project Plan, Standard Operating Procedures and Information Management:

4) Reporting, Stakeholder Administration and Adaptive Updates.

Objectives: Report results at agreed-upon intervals; support future STLS decision-making through facilitation of stakeholder processes and timely updates to STLS MYP.

Deliverables

Milestones and Linkages to other Projects

Project Participants: BASMAA (initial MYP draft); RMP (ongoing)

Due Date: WY 2012 Watershed Monitoring Plan complete by July 2011; other due dates TBD.

RMP Contributions and Years: $2012 proposed $0; 2013-2015 TBD.

Total Cost: TBD

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List of Appendices

Appendix A – References and Resources for PCBs and Mercury-related Activities by the Regional Monitoring Program and BASMAA.

Appendix B – Regional Watershed Spreadsheet Model Construction and Calibration (to be included in a 2012 version)

Appendix C - Optimizing Sampling Methods for Pollutant Loads and Trends in San Francisco Bay Urban Stormwater Monitoring.

Appendix D - Exploratory Categorization of Watersheds for Potential Stormwater Monitoring in San Francisco Bay.

Appendix E - Watershed Characterization Field Study

Appendix F – Sampling and Analysis: Quality Assurance

Appendix G – EMC Development and Source Area monitoring (to be included in a 2012 version)

References and Resources for PCBs and Mercury-related Activities by the Regional Monitoring Program and BASMAA[1]

Appendix A to Small Tributaries Loading Strategy Multi-Year Plan

Version 2011

RMP Master Planning

The RMP Master Planning process centers on guidance from the Steering Committee in the form of priority information needs and budget commitments. As part of the planning discussion among stakeholders comprising the Steering Committee, Regional Water Board staff listed priority information needs for existing and planned regulatory projects, shown in Table A-1.

Table A-1: Current and anticipated Water Board management decisions, policies and actions influencing priority information needs[2]

Decisions, Policies, and Actions	Timing
Determination of Permit Limits	Ongoing
Biennial 303(d) List and 305(b) Report	2010-11 2012-13 2014-15
Mercury Review the existing TMDL and establish plan to revise it Revised mercury TMDL	2011-13 2016-18
PCBs Review the existing TMDL and establish plan to revise it Revised PCBs TMDL	2014-15 2019-20
Copper Compare levels to site specific objectives triggers Reevaluation of the site-specific objectives	Annual Triennial (2012)
Cyanide Antidegradation policy Ambient levels below CTR threshold	Triennial (2012)
Selenium North Bay Selenium TMDL South Bay Selenium TMDL	2012-14 > 2015
Legacy Pesticides (DDT, Dieldrin, Chlordane) Development of "Simple" TMDL	2012-13
Dioxins Review/reissue permit requirements TMDL project plan TMDL	2013-14 2017-19

Decisions, Policies, and Actions	Timing
Sediment Quality Objectives 303(d) listings Determination of reasonable potential and permit requirements	2010-11 2010-11
Nutrients New estuarine numerical endpoints Assessment of ammonia toxicity	2012-15
Municipal Regional Stormwater Permit (MRP)	2010 and beyond
Pathogens *XX*	XX
Pyrethroids *XX*	XX
PBDEs *XX*	XX
LTMS-DMMP-Regional Sediment Management	2010 and beyond
Dredging Permits	2010 and beyond
Chemicals of Emerging Concern Regional Water Board considering a policy	XX

The RMP contributes to effective management by providing scientific support for current policies and by anticipating and addressing information needs related to future policies and actions.

[1] The Bay Area Stormwater Management Agencies Association is a 501(c)(3) non-profit organization representing 96 city, county and special district agencies comprising municipal stormwater programs in the San Francisco Bay Area.
[2] Presentation to the RMP Steering Committee Planning Workshop, February 7, 2011

Coordination of the Master Plan is achieved through the participation of stakeholders and scientists in four primary workgroups that report to the TRC and address the main technical subject areas covered by the RMP, and more recently through "strategy teams" in which stakeholders meet as needed to develop long-term RMP study plans addressing high priority topics. RMP strategy teams established by 2011 include mercury, PCBs, dioxins, small tributary loads, and forecasting/modeling.

Communication between the groups occurs via the participating stakeholder agencies, each of which has representatives on the TRC and the SC, as well as by RMP staff. While individual work groups such as SPLWG still have a role of identifying potential additional or alternative priorities, the new master planning process imposes a stronger "top down" framework for determining RMP funded activities.

Regional POC Conceptual Models and TMDLs

PCBs and mercury are the highest priority Pollutants of Concern (POCs), with TMDL and associated implementation plans already adopted and incorporated in the Basin Plan. Because the TMDLs were based on limited available data, several supporting documents were developed through the Clean Estuary Partnership, a regional stakeholder group. Conceptual model reports summarized and synthesized available knowledge for each POC on:

- sources, pathways, and loadings to the Bay
- the present rate of decline due to attenuation and removal
- fate processes and recovery forecasts.

Figure A 1 illustrates the main components of the conceptual model for PCBs. The conceptual model for mercury (Tetra Tech, 2006) is similar in its broad outlines, but contains additional components related to mercury speciation and transformation processes that facilitate production of methylmercury, the chemical form of mercury that accumulates in fish. These transformation processes in water, sediments, wetlands, and biota are complex and their interactions vary in the different Bay segments.

An important function of these conceptual model reports was to present this information in graphs, charts and other easily accessible formats along with assessment of uncertainties and data gaps that limit the ability to evaluate management alternatives and estimate recovery rates. The conceptual models provide a framework for evaluating potential management actions to reduce POC loadings and designing studies or projects that would best improve our understanding of the effectiveness and feasibility of those actions.

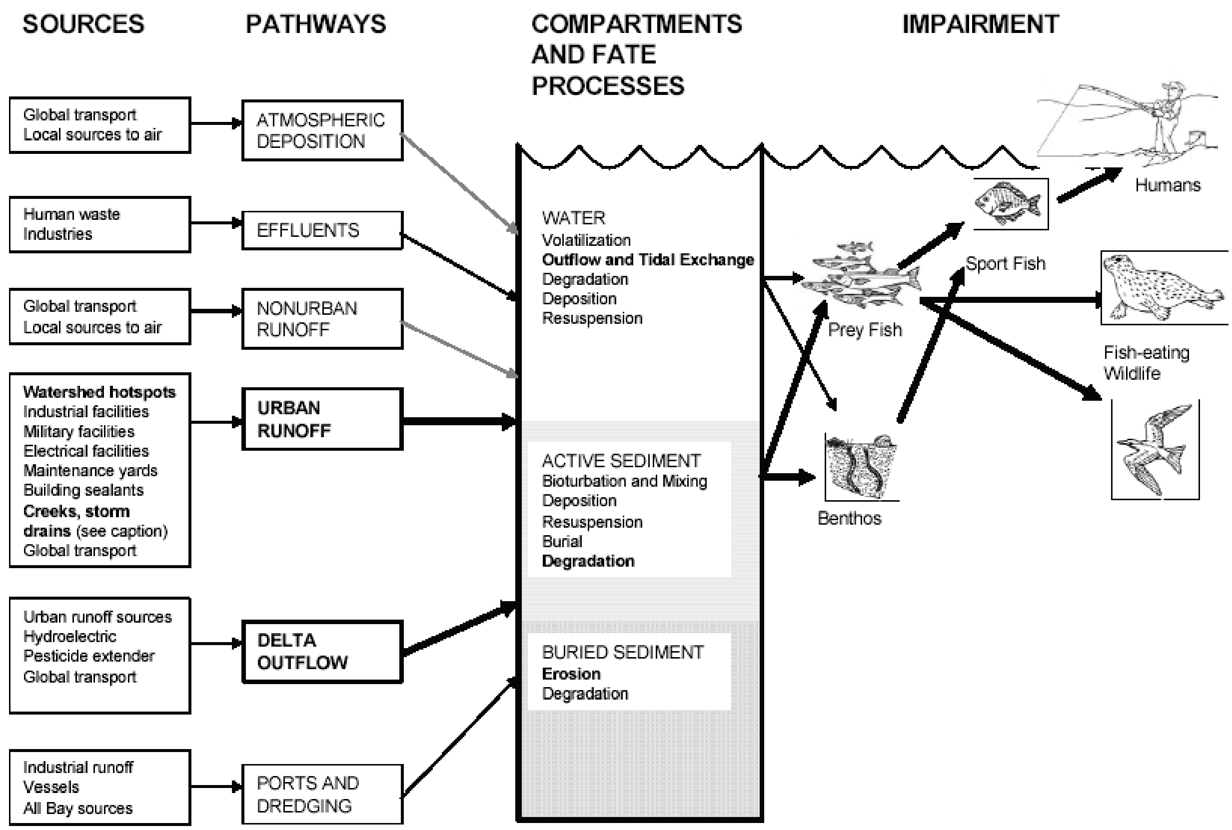

Figure A-1. Conceptual model of PCBs in San Francisco Bay (Davis et. al 2006).

The CEP also produced studies modeling Bioaccumulation in bay biota and evaluating options for discharger actions to achieve the load reductions set by the TMDLs. (Table A-2). Since stormwater runoff is the primary conveyance pathway involved in small tributary loading to the bay, another CEP study examined potential implementation options for municipalities to reduce PCB loads and recommended next steps for clarifying the effectiveness and feasibility of potential management actions, summarized in Table A-3. This report formed the framework for further investigations and later permit requirements in the Municipal Regional Stormwater Permit (MRP).

Table A-2. TMDL estimates of current loads and load reductions for urban runoff, (SFRWQCB 2006, 2008)

TMDL Loads or targets	Mercury	PCB
Total Annual Load (all sources), kg/year	1222	33
TMDL (all sources), kg/year	698	10
Urban runoff load, kg/year	160	20
Urban runoff TMDL Waste Load Allocation, kg/year	82	2
Final (20 year) Urban runoff reduction	49%	90%

Table A-3. PCB Implementation Options for Municipalities (adapted from Larry Walker Associates et. al, 2006)

Action	Tools / Sub-tasks	Suggested lead
Source Identification & prioritization		
Identify PCB contaminated sites in service area	Online databases, DTSC & Water Board records, site investigations	Individual municipalities
Research types and age of structures that would most likely contain PCB-containing materials	Define procedures to identify which structures are most likely to contain these materials.	One-time regional study
Identify unenclosed PCB sources in service area	Use procedures identified above to identify structures. Review building & planning department records, Sanborn maps, other local agency records, site investigations	Individual municipalities
Identify areas likely to have elevated levels of PCBs in sediments	Evaluate based on information obtained for contaminated sites and unenclosed sources	Individual municipalities
Evaluate accumulated sediments in conveyance systems	Conduct sediment monitoring, upstream investigations in identified areas	Individual municipalities
Prioritize identified sources for further action	Prioritization conducted periodically as information on sources is developed. Tools include: • Screening level load estimate • Concentration evaluation • Ease of implementation/ cost • Potential for runoff • Other factors	Individual municipalities
Remediation options/ control strategies		
Conduct demonstration project to address on-land sites	• Identify 6-10 sites split between redevelopment candidates and sites that are not targeted for redevelopment • Determine most effective approach for municipalities to mitigate runoff from on-land sites	Regional effort
Develop individual municipal plan for on-land sites	• Use approaches identified in demonstration projects to address candidates for redevelopment and sites not targeted for redevelopment	Individual municipalities
Unenclosed sources BMP development	• Develop BMPs for dealing with disposal during remodeling and demolition • Develop education materials and procedures	Regional effort
Unenclosed sources regulatory strategies	• Evaluate existing regulatory authorities and programs to determine approaches to enforcing requirements as necessary	Regional effort
Unenclosed sources	• Work with building departments to create	Individual municipalities

Action	Tools / Sub-tasks	Suggested lead
education and outreach program	protocols for identifying sources • Conducting outreach regarding BMPs	or regional effort as appropriate
Unenclosed sources regulatory approaches	• Implement programs to require measures to prevent runoff from unenclosed sources	Individual municipalities or regional effort as appropriate
Develop plan for addressing accumulated sediments in conveyance systems based on source evaluation	• Revise maintenance programs to increase sediment removal • Conduct upstream investigations to identify ultimate PCB sources to sediments.	Individual municipalities
Periodic review of effectiveness of implemented strategies to determine future directions	• Monitoring • BMP implementation review • Other effectiveness measures	Individual municipalities or regional effort as appropriate

The report noted that further analysis was needed of the feasibility of these implementation options, including quantitative evaluation of costs and benefits. It also noted the need to take into account other factors that could be important in assessing feasibility, including:

- The likelihood of identifying responsible parties or obtaining state or federal funding for identification and cleanup of on-land PCBs sites.
- The cumulative benefits of implementing strategies that address multiple sediment-bound pollutants.

Source Identification and Stormwater Load Reduction Measures

During preparation of the mercury and PCB TMDLs, BASMAA programs[3] conducted field surveys of bedded sediments in creeks and storm drain conveyances (e.g. Gunther et. al, 2001, KLI, 2001) which revealed some urban areas with relatively elevated levels of PCBs and mercury in storm drain sediments[4] In 2001 stormwater agencies began performing case studies in some of these areas, employing additional sampling, property database searches and site visits to attempt to identify PCB sources. Lessons and potential control strategies developed as a result of these case studies were summarized in a review by EOA (2004). Several programs also

[3] BASMAA members from four urbanized counties are organized into countywide programs (Alameda Countywide Clean Water Program, Contra Costa Clean Water Program, San Mateo Countywide Water Pollution Prevention Program and Santa Clara Valley Urban Runoff Pollution Prevention Program) which, along with Solano County member programs (City of Vallejo, Vallejo Sanitation and Flood Control District and Fairfield-Suisun Urban Runoff Management Program):comprise all Bay Area Phase 1 municipal stormwater permittees. (San Francisco operates a combined sewer system and is not subject to the MRP).
[4] relative to TMDL targets, though often below regulatory action levels for direct human exposure

conducted studies to assess the removal of PCBs and mercury by existing sediment management, e.g. street sweeping and cleanouts of storm drain inlets and other conveyances.

With advisers and partnership from the Water Board and BASMAA, SFEI obtained a grant in 2004 from the Proposition 13 Coastal Non-point Source Pollution Control Grant Program: (Proposition 13) for a Regional Stormwater Monitoring and Urban BMP Evaluation Project intended to build on the preceding studies to further assist stormwater programs in implementing the mercury and PCB TMDLs. The project's conceptual model for stormwater sources and potential reductions is shown in Figure A-2, and a list of its products with the main information needs that were addressed is shown in Table A-4. Additional project information and copies of reports are available at the project web page at http://www.sfei.org/urbanstormwaterbmps

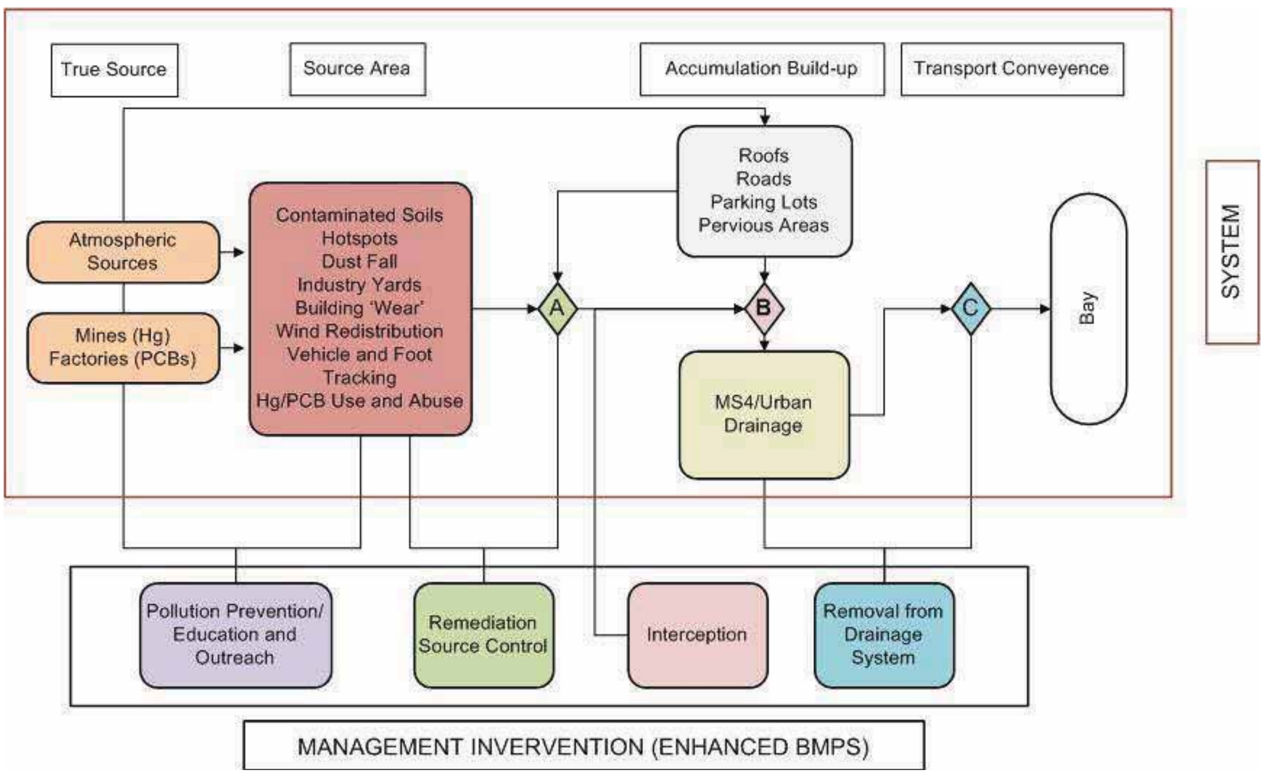

Figure A-2. Conceptual model of implementation points for reducing Hg and PCB loads to San Francisco Bay from local tributaries. (from SFEI 2010).

Table A-4. Main products of the Proposition 13 Urban BMP Evaluation Project

Deliverable	Key information provided
Storm drainage maps	Regional spatial dataset of urban storm drainage network and local watershed drainage areas
Report: (McKee et. al 2006) "White Paper" review of methods use to reduce urban stormwater loads	• Review of regulatory issues and history of use in relation to PCBs and mercury in the Bay Area • Preliminary mass balance analyses for Hg and PCBs in Bay Area local watersheds for the highest use (1950 -1990) and recent (1990 - 2005) periods. • Literature review of concentrations and particle characteristics of Hg and PCBs in soils, road surfaces, roof tops, catch basins, and storm drains, including previous BASMAA studies. • Initial hypotheses on effectiveness of BMPs particularly treatment control options.
Report: (SFEI 2010) BMP Toolbox for Reducing PCBs and Mercury	• Conceptual model of sources and pathways of PCBs and Hg in urban areas with best estimates of relative mass distribution in the Bay Area, • Review of different categories of institutional and treatment control BMPs for reducing PCB and Hg stormwater loads. • Discussion of BMP benefits for other pollutants and options for measuring programmatic effectiveness • Fact sheets and technical information for individual BMPs in relation to reducing loads of PCBs and Hg.
Report: (Mangarella et. al 2010) Desktop Evaluation of Controls for PCBs and Mercury Load Reduction Accompanied by spreadsheet templates for use in future updates	Evaluated different scenarios of implementing BMP types, • Institutional - Pollution Prevention: Fluorescent Bulb and Thermostat Recycling(Hg only); Building Demolition and Remodeling (PCB only); Atmospheric Deposition (Hg only) • Institutional – Operational: Street Sweeping; Street Washing; Drain Inlet Cleaning • Treatment and Site Stabilization: Redevelopment BMPs (retrofit of structural treatment); Cleanup/stabilization of "Elevated Industrial Areas"; Diversion (from pump stations to sanitary treatment)
Report: (Yee and McKee 2010) Concentrations of PCBs and Hg in soils, sediments and water	• Sediment samples were collected from street sides and storm water collection facilities at over 360 locations within the Bay Area, focusing on historically industrial areas more likely to contain elevated levels of PCBs. • Settling experiments were conducted with collected stormwater and sediment samples to examine pollutant portioning in various aqueous (suspended, dissolved) or solid (bed sediment) fractions.

Figures A-3 and A-4 from Yee and McKee (2010) summarize the spatial distribution and concentrations of total mercury and PCBs measured in samples collected during the Proposition 13 study, combined with results compiled from previous studies in the region (e.g. Gunther et. al, 2001, KLI 2001). On a regional scale, the general areas of highest concentrations are often clustered in different areas for mercury and PCBs. This lack of similarity in Hg and PCB distributions could also be demonstrated statistically.

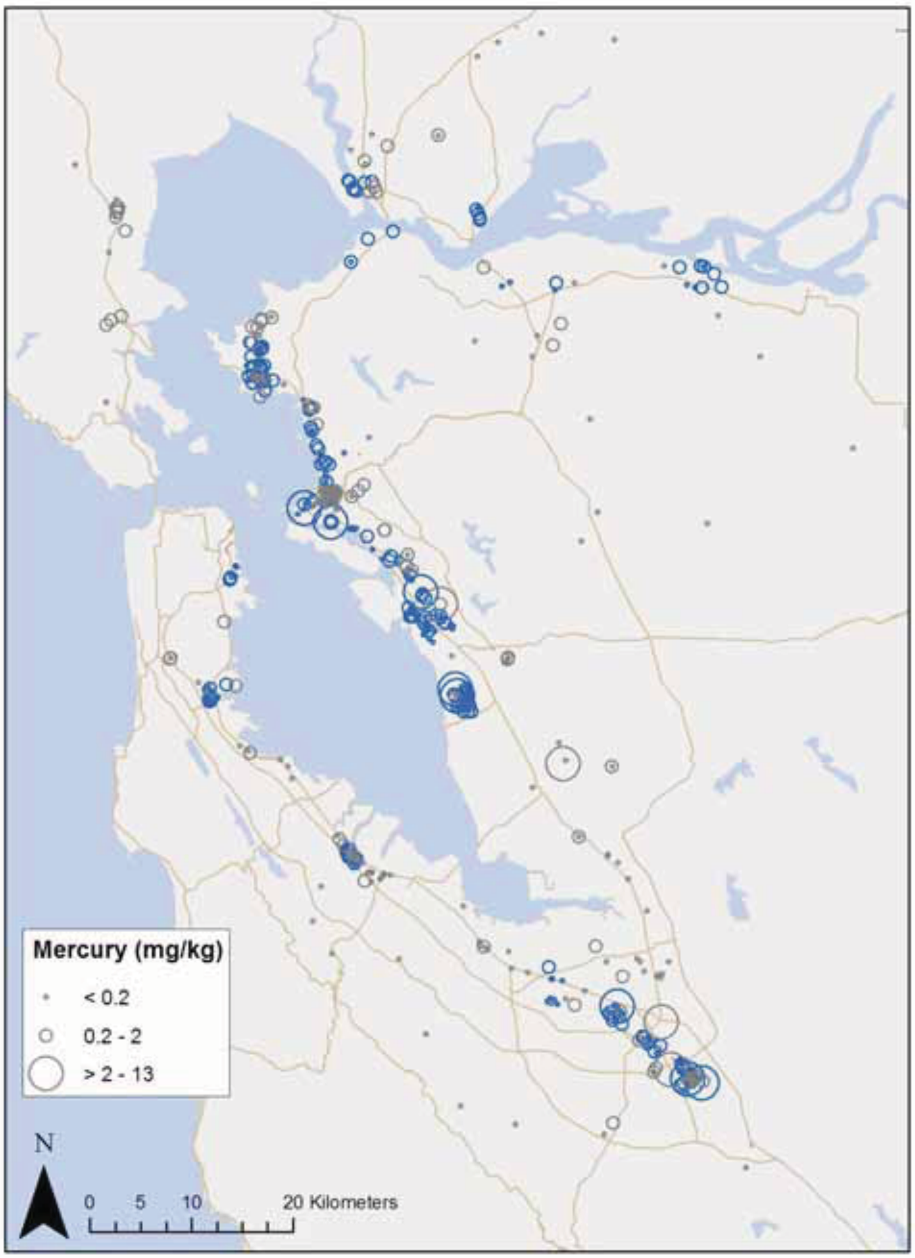

Figure A-3. Particulate Hg concentrations sampled in storm collection facilities and street side soils in the Bay Area in the Proposition 13 study (blue symbols) and others (grey).

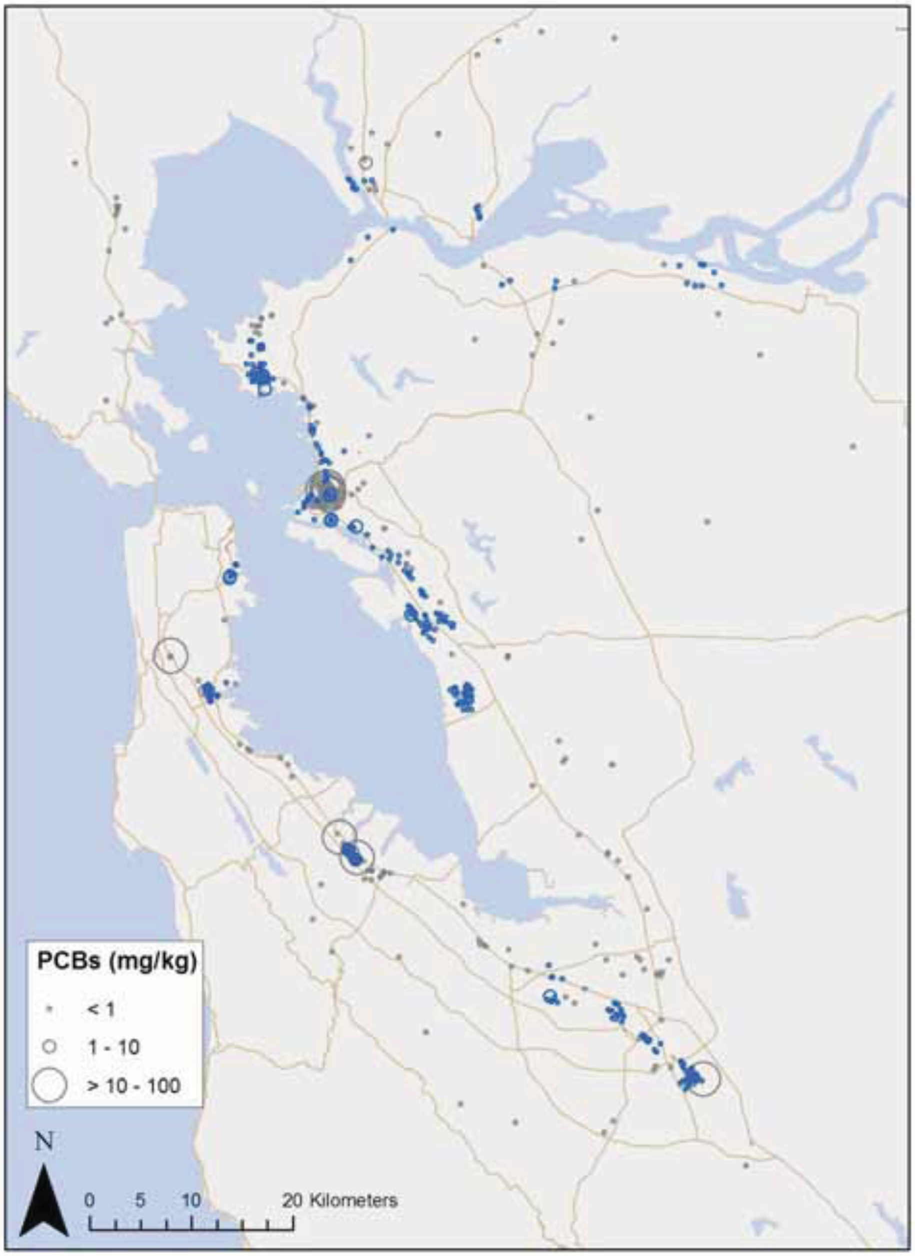

Figure A-4. Particulate PCB concentrations sampled in storm collection facilities and street side soils in the Bay Area in the Proposition 13 study (blue symbols) and others (grey).

Mangarella et al (2010) developed preliminary estimates of potential load reductions from various BMP implementation scenarios with somewhat differing results for mercury and PCBs. For each scenario they also identified the key assumptions and sources of uncertainty, and in many of the scenarios provided a range of projections based on different assumptions. The major sources of uncertainty consisted of:

- Projecting current regulatory or usage conditions into the future
- Projecting local study results developed by one or more municipal to other portions of the Bay Area or to the Bay Area as a whole.
- Inability to accurately incorporate land use in scenario development, for example where existing land use data did not capture characteristics thought to be related to PCB use.
- Potential for overlap amongst scenarios.

The report concluded that most effective scenarios are those that address source control and maintenance, namely air emissions, recycling, street sweeping, and drop inlet cleaning. The underlying message from the scenario analysis is that effectiveness improves as measures move up the continuum from San Francisco Bay to source. Controls like recycling that address the product at its point of usage are generally shown to be superior in effectiveness. Controls like sweeping or drop inlet cleaning, which address accumulation of pollutants in depositional sediments, can also be relatively effective if the depositional areas contain elevated concentrations of the constituent. Concentrations of suspended sediment and mercury associated with suspended sediment in urban runoff are sufficiently low to illustrate that treatment of urban runoff is projected to be less effective.

With understanding of the information gaps and uncertainties associated with the various management strategies, the Water Board developed MRP provisions C11 (mercury) and C12 (PCB) within a framework of four implementation modes, shown in Table A-5. Under the logic of this categorization, as actions are tested and confidence is gained regarding level of experience and confidence in a control measure's effectiveness, that control measure may be implemented with a greater scope in the next permit term.

Provisions C.11.c through Provision C.11.g for mercury are written identically to C.12.c through Provision C.12.g for PCBs, reflecting similarities between the respective TMDLs for these pollutants, based on the legacy and sediment-associated nature of their occurrence. For Provisions C.11/12.c through Provision C.11/12.f, the permit requirements focus on pilot studies; the MRP prioritizes selection of pilot sites primarily on the basis of the potential for reducing PCB loads, although consideration will be given to mercury removal in the final design and implementation of the studies. Provisions C.11.i and C.12.i are also written identically, since the primary San Francisco Bay beneficial use impairment for both mercury and PCBs is associated with consumption of fish containing these pollutants.

Table A-5. Modes of application for PCBs, mercury or other sediment-bound pollutants (from Fact Sheet portions of SFRWQCB 2009).

Mode of Implementation	MRP Provisions for mercury and PCBs
1. Full-scale implementation throughout the region.	C.11.a. Mercury Collection and Recycling: promote, facilitate, and/or participate in collection and recycling of mercury containing devices and equipment at the consumer level (e.g., thermometers, thermostats, switches, bulbs).
	C.12.a. Incorporate PCBs and PCB-Containing Equipment Identification into Existing Industrial Inspections
2. Focused implementation in areas where benefits are most likely to accrue.	C.11/12.i. Development of a Risk Reduction Program Implemented throughout the Region (addressing those people and communities most likely to be affected by mercury/PCBs in San Francisco Bay-caught fish)
3. Pilot-testing in a few specific locations.	C.12.b. Evaluate Managing PCB-Containing Materials and Wastes during Building Demolition and Renovation (e.g., Window Replacement) Activities C.11/12.c. Investigate and Abate On-land Locations with Elevated PCB Concentrations, Including Public Rights-of-way, and Stormwater Conveyances with Accumulated Sediments with Elevated PCBs Concentrations. C.11/12.d. Pilot Projects to Evaluate and Enhance Municipal Sediment Removal and Management Practices C.11/12.e. Evaluate On-Site Stormwater Treatment via Retrofit C.11/12.f. Diversion of Dry Weather and First Flush Flows to POTWs
4. Other: e.g. experimental control measures, Research and Development, desktop analysis, laboratory studies, and/or literature review.	C.11.j. Develop Allocation Sharing Scheme with Caltrans.
	C.11/12.g. Monitor Stormwater mercury/PCB Pollutant Loads and Loads Reduced
	Portions of C.12.b, C.11/12.c, C.11/12.d, C.11/12.e.
	C.11/12.h. Fate and Transport Study of mercury/PCBs in Urban Runoff

In 2010, BASMAA was awarded a $5 million grant from USEPA's San Francisco Bay Water Quality Improvement Fund for the Clean Watersheds For a Clean Bay (CW4CB) Project, which in anticipated to address most of the MRP pilot project requirements in C11 and C12 (table A-6). The total CW4CB project cost is $7.04 million including $2.04M matching funds from Bay Area municipal stormwater agencies, municipal wastewater treatment agencies and industrial dischargers. The planned project period is four years (July 2010 through June 2014) to synchronize with the implementation and reporting requirements of the MRP.

Table A-6. Summary of Key CW4CB Tasks and Associated Outputs and Outcomes.

TASK	MRP Provision	OUTPUTS/OUTCOMES
1. Management, oversight, and reporting.	N/A	▪ QAPP, quarterly progress reports, draft/final project report.
2. Select project watersheds.	C.11/12.c	▪ Five priority subwatersheds identified.
3. Identify locations with elevated PCBs/Hg, refer sites to regulatory agencies, and establish cleanup fund.	C.11/12.c	▪ Locations referred for cleanup. ▪ $100K fund to facilitate cleanups established. ▪ PCB and other pollutant loadings to the Bay reduced.
4. Enhance municipal sediment removal and management practices.	C.11/12.d	▪ Enhanced municipal removal and management of sediment with pollutants. ▪ PCB and other pollutant loadings to the Bay reduced.
5A. Urban runoff treatment retrofits - planning and design.	C.11/12.e	▪ Conceptual/engineering design, planning and permitting of eight to ten urban runoff treatment retrofits.
5B. Urban runoff treatment retrofits - construction, operation and monitoring.	C.11/12.e	▪ Eight to ten urban runoff treatment retrofits installed and evaluated. ▪ An estimated 2 to 12 square miles treated by retrofits to reduce potential hydrologic impacts on downstream receiving waters. ▪ PCB and other pollutant loadings to the Bay reduced.
6. Regional risk reduction program.	C.11/12.i	▪ Public education/outreach materials. ▪ Impacted populations will have a greater awareness and understanding of fish contamination issues and options for reducing exposures to pollutants in Bay fish.
7. Outreach and technology transfer.	N/A	▪ Project web portal. ▪ Guidance manual. ▪ Written outreach materials. ▪ Technical workshops.

To evaluate effectiveness of the pilot studies, field monitoring will be conducted to inform a quantitative estimation of the degree to which each type of control measure reduces loads of PCBs and other pollutants to the Bay. During preparation of the Integrated Monitoring Report due March 2014, the pilot study results will be evaluated based on the following general criteria:

1. **Feasibility** – is a control measure technically and economically feasible?
2. **Efficiency** – what is the cost-effectiveness of the control measure (e.g., $/kg pollutant load avoided).

3. **Opportunity** – what mass of pollutant can reasonably be avoided over a given time period via the control measure? For example, enhanced inlet cleaning is potentially feasible and cost-effective but it is possible that only a relatively limited mass of sediment and associated pollutants could be captured each year using this method due to the small amount of sediment usually found in Bay Area inlets.

BASMAA also is an active partner in the PCBs in Caulk Project managed by the San Francisco Estuary Partnership[5], which is intended to address the requirements in MRP provision C12 b. PCBs can be found in caulking and sealants installed in structures that were built or remodeled prior to 1980, especially during the 1950's through 1970's. The PCBs in Caulk Project is one portion of a larger SFEP program called Taking Action for Clean Water, originally funded through the State Water Resources Control Board Proposition 50 Coastal Nonpoint Source Pollution program and later with federal stimulus funds. The PCBs in Caulk Project will be completed in late 2011; more information and the following available draft products are posted on the SFEP website at http://www.sfestuary.org/projects/detail.php?projectID=29:

- **Best Management Practices** for managing contaminated caulk at a building site have already been developed for abatement of asbestos, which was often used in caulk during the same period as PCBs. Although methods and technology for testing for PCBs also are known, existing regulations do not require testing for PCBs
- **Model Implementation Process** is a proposed series of checklists and procedures that municipalities could use to educate proponents of renovation/demolition projects about the available BMPs, track progress and obtain certification that BMPs were correctly applied at a site.
- **Technical Memorandum** on existing regulatory controls and policies related to managing wastes and hazardous materials during building demolition and/or remodeling programs

Additional products of the PCBs in Caulk Project will include results of sampling from Bay Area structures and an outline for training inspectors. However review of existing regulations showed there are gaps in the regulatory structure concerning PCBs at the national and state level that would need to be addressed before municipalities could effectively implement procedures similar to the Model Implementation Process.

MRP Provisions C.11.g and C.12.g require stormwater programs to develop and implement a monitoring program to quantify mercury and PCB loads and loads reduced through source control, treatment and other management measures implemented by Permittees. Refinement of PCB and mercury loading estimates through the STLS will provide a baseline against which compliance with TMDL Waste Load Allocations (WLAs) issued to Bay Area stormwater agencies (see Table A-2 above) can be tracked.

BASMAA developed draft methods to assess Permittee progress towards TMDL milestones and attainment of WLAs through a regional project that reviewed the estimation methods developed through the Proposition 13 Project and drafted formulas for Permittee tracking of load reductions

[5] SFEP is a project of the Association of Bay Area Governments.

via specific stormwater management measures. The formulas included in BASMAA's final the technical memorandum (in prep) may be updated as additional information on the effectiveness of management measures becomes available via the CW4CB project or other MRP-required pilot studies.

Modeling and other information needs

MRP provisions C11.h. and C12.h. require stormwater programs to conduct or cause to be conducted studies aimed at better understanding the fate, transport, and biological uptake of mercury and PCBs discharged in urban runoff to San Francisco Bay and tidal areas. These requirements will be met through BASMAA participation in the RMP and in particular through support of the RMP's mercury and PCB strategies. In 2011 the RMP is developing synthesis documents for each of these POCs which will review the results of recent special studies and present recommendations for future studies that fit within the Master Planning framework. Some of these studies will also support the Forecasting or Modeling Strategy in which improved quantitative modeling of the Bay should address the following topic areas and Management Questions:

1. Bay Margins: What are the projected impacts of management actions on impairment at contaminated sites on the Bay margin?

2. Recovery of the Bay: What patterns of exposure are forecast for major segments of the Bay under various management scenarios?

3. Small Tributary Loads: What are the projected impacts of management actions on loads or concentrations of pollutants of concern from the high-leverage small tributaries? Where should management actions be implemented in the region to have the greatest impact?

Previous RMP Modeling work overseen by the Contaminant Fate Work Group included development of a "multi-box" mass budget model (Oram et al. 2008) that was more spatially explicit than the "one-box" model used to develop the mercury and PCB TMDLs. The multi-box model added contaminant modeling functions to an existing tidally averaged sediment transport model that represents the Bay's five main segments by 50 laterally-averaged segments, each divided into two layers (main channel and shallow-water) for a total of 100 boxes. Other improvements incorporated in the multi-box model include a more realistic treatment of mixing at the sediment-water interface, sediment erosion and deposition, and a quantification of the aggregate uncertainty of the model estimates. The initial version of the multi-box model was developed and calibrated for PCBs and was found to reasonably simulate observed patterns of PCB impairment. Forecast recovery scenarios using load reductions in the TMDL also were plausible, but were sensitive to uncertainties in assumptions about natural degradation and attenuation rates. A companion study sponsored by the CEP described PCB movement from water and sediment through the Bay food web (Gobas and Arnot 2005).

Another RMP-sponsored study developed an initial mass balance model of methylmercury in

San Francisco Bay (Yee et al. 2011). Other reports recently drafted for the CFWG present conceptual models for pollutant fate and transport in the marginal areas of the Bay (Jones et.al. in prep) and bioaccumulation in the food web (Melwani et al., in prep) that summarize available information about key biotic and abiotic processes that will need to be considered in future Bay modeling developments. These studies lay the groundwork for further development of a Modeling Strategy; future versions of this Appendix will provide updates on efforts to integrate the various recommendations and develop cost effective modeling tools operating at the appropriate temporal and spatial scales to support water quality management decisions.

Other pollutants or constituents

While initial Bay Modeling strategy development focuses on mercury and PCBs, the abiotic hydrodynamic and sediment transport components of future models can be parameterized for other POCs. The bioaccumulation conceptual model report also includes information on selenium, polybrominated diphenyl ethers (PBDEs), dioxins and organochlorine pesticides (DDTs, chlordane and dieldrin) for a variety of vertebrate and invertebrate target species. The Emerging Contaminants Work Group is evaluating other pollutants that may be given increasing priority in future RMP studies. These additional POCs or categories of pollutants overlap with MRP Provision C.8.e.vii which requires a work plan and schedule for future development of initial loading estimates and source analyses for:

- Endocrine disrupting compounds,
- Perfluorooctane Sulfonates (PFOS)/Perfluoroalkyl sulfonates (PFAS)
- Nonylphenols (NP) /nonylphenol esters (NPEs)

Nutrients have recently been identified as an area of concern in the Bay Delta system and the RMP is developing a Nutrient Strategy to coordinate RMP sponsored studies with the Numeric Nutrient Endpoints (NNE) regulatory development process for the San Francisco Estuary, sponsored by the State Water Resources Control Board. The RMP steering committee has projected increasing RMP funding for such studies in 2012 through 2014.

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DRAFT – FINAL

Optimizing sampling methods for pollutant loads and trends in San Francisco Bay urban stormwater monitoring

Technical Report

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July 2010.

REPORT SUMMARY

The purpose of this document is to summarize efforts to evaluate the optimization of sampling methods for pollutant loads and trend monitoring at Guadalupe River (GR) and Zone 4 Line A (Z4LA). This report presents a technical evaluation of sampling methods, load estimators, and strategies for storm selection. The sampling optimization focused on Hg, PCBs, and suspended sediments (SS) since these are the high management priorities in San Francisco Bay. The information summarized here will facilitate further discussion to develop appropriate study designs to address MRP questions and priorities at these and future sites. The focus of this study was to evaluate sampling designs for obtaining annual loads estimates. The study included two components:

- Comparison of the accuracy and precision of a variety of stormwater monitoring designs and mathematical equations (estimators) for determining annual pollutant loads; and
- Determining the power and sample size needed to detect declining trends in Hg and PCBs in the next 10 - 40 years.

The MRP default design is the automated sampling of four random storms using a composite sample method. The estimated range in bias (- 50 – 13%) and standard error (4.3 – 6.5%) for the default MRP method was among the highest of the designs evaluated. Alternatives were explored such as increasing the number of samples and storms to six or 10 storms using a composite sampling method. Although sampling of 10 storms would provide better precision than four or six storms, a design with 10 storms would likely exceed budgetary limits. A six storm sampling strategy was simulated to include the first flush and largest storm. This design produced a similar range in bias (-16 – 31%) and standard error (1.4 – 3.6%) to the sampling of four storms (-13 – 57% and 2.2 – 5.0%, respectively). It is likely that the small improvement in precision with six storms would not warrant the extra on-going cost for this design, but inclusion of first flush and largest storms may warrant consideration. Automated sampling of two, four, or six storms using a discrete sampling method was also explored. The total number of samples was assumed to remain the same in each scenario, thus the range in bias (-7 – 4%) and standard error (0.1 – 1.4%) of these designs did not change. The best configuration was four storms (3 samples per storm).

The addition of turbidity was also explored using the turbidity surrogate regression estimator for the loads calculation method. This method produced the highest accuracy and least bias of all the alternative designs. To use regression on the turbidity surrogate records for estimating annual loads, at least 10 but ideally 16 samples per year should be collected at each site. Given results from the discrete among-storm evaluations, it is likely that scenarios that include first flush and one of the largest storms of the year would provide more robust loads estimates than random sampling alone when applying the turbidity surrogate method.

Power for detecting trends appeared to be possible with just 10 samples collected per year, based on a preliminary scenario in which the samples were randomly selected and did not confirm to any of the tested sampling designs.

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TABLE OF CONTENTS

INTRODUCTION

Worldwide, coastal ecosystems adjacent to large urban, industrial and agricultural centers are subject to contamination, toxicity, and subsequent demise of wildlife and fisheries (Lauenstein and Daskalakis 1998, Linkov et al. 2002, Trimble 2003, Newton and Mudge 2005). In response, environmental laws in many countries are being developed and implemented to slowdown or reverse the process of contamination and even restore lost ecosystem attributes. In many cases, estimation of ecosystem-scale mass loads emanating from sources is one of the first data requirements needed to develop a plan of action (e.g., Godfrey et al. 1995, Schiff and Bay 2003, Balcom et al. 2004). San Francisco Bay is one such ecosystem that has been highly impacted by a history of urban, industrial, agriculture and mining land uses spanning about 150 years (Flegal et al. 2007). Approximately seven million people currently live in the nine counties bordering the Bay, and runoff and contaminants from mining legacies, urban areas, and agriculture drain to the Bay from about 37% of California (McKee et al. 2006a, David et al. 2009). Today, mercury (Hg) and polychlorinated biphenyls (PCBs) are considered the greatest threat to human and wildlife uses of the Bay (Conaway et al. 2007, Davis et al. 2007, Flegal et al. 2007, Yee et al. in review). However, there are also concerns about a number of emerging contaminants (Oros et al. 2003, Hoenicke et al. 2007, She et al. 2008).

In San Francisco Bay, urban runoff is considered one of the largest controllable sources of pollutant discharge. Total maximum daily loads (TMDL) reports written by the local Regional Water Quality Control Board (Water Board), summarize current estimates of loads from the main sources and pathways (urban and industrial wastewater, urban stormwater, Central Valley rivers, atmospheric deposition). The TMDL reports also argue for studies linking loads and toxic effects to beneficial uses, and provide loads allocations for each source and pathway (SFRWQCB 2006, 2008). The allocations are particularly stringent for urban stormwater and allow for 82 kg of Hg and 2 kg of PCBs with the objective of improving water quality in the Bay to desirable standards in 20 years (2028 for Hg and 2030 for PCBs). These represent estimated reductions of 50% and 90% over the present load estimates of 160 kg of Hg and 20 kg of PCBs, respectively. However, these load estimates remain uncertain, since measurements have only been made in a few of over two hundred tributaries (SFEI 2010).

The Regional Monitoring Program for Water Quality in San Francisco Bay (RMP), through its Sources, Pathways, and Loadings Workgroup (SPLWG), has been conducting tributary loading studies for nine years. The focus has been to provide information on sediment and pollutant transport processes in urban watersheds around the Bay (McKee et al. 2004, McKee et al. 2005, McKee et al. 2006b, Davis et al. 2007, Oram et al. 2008, David et al. 2009, McKee and Gilbreath 2009). The primary objective of these studies has been to achieve precise and unbiased estimates of loads of particle-associated pollutants-of-concern (particularly, Hg, PCBs, and suspended sediments). Most of the sampling effort has been focused on three locations: Mallard Island on the Sacramento River; Guadalupe River in San Jose; and the Zone 4 Line A flood control channel in Hayward. At all three study locations, a turbidity surrogate methodology has been employed, as it has been reported to be an appropriate and cost-effective method for accurate and unbiased particulate loads calculation (Grayson 1996, Wall et al. 2005). The tributary loading studies have provided valuable information for the development of the

San Francisco Bay and Guadalupe River Hg TMDLs (Austin 2006, SFRWQCB 2006), and the Municipal Regional Stormwater NPDES Permit (MRP) (SFRWQCB 2009).

The TMDLs and the MRP call for the Bay Area Stormwater Management Agencies Association (BASMAA) to improve loads information. In response, the RMP developed a small tributaries loading strategy (STLS) to guide the development of loads information over the next five years and to ensure coordination between the RMP and BASMAA. The STLS and Provision C.8.e. of the MRP aim to answer the following management questions:

1. Identify which Bay tributaries (including stormwater conveyances) contribute most to Bay impairment from pollutants of concern,
2. Quantify annual loads or concentrations of pollutants of concern from tributaries to the Bay,
3. Quantify the decadal-scale loading or concentration trends of pollutants of concern from small tributaries to the Bay, and
4. Quantify the projected impacts of management actions (including control measures) on tributaries and identify where these management actions should be implemented to have the greatest beneficial impact.

All of these questions require some level of information on the concentrations and mass loads in tributaries but the focus here is on optimization of study design for questions 2 and 3.

There are a number of sampling methods and corresponding mathematical calculation methods available for developing mass loading information. The optimal balance of sampling frequency within and among storm events is important to achieve precise, accurate, and cost effective loads measurements. Several methods, such as random and time-interval based sampling designs, have already been evaluated in other studies and essentially rejected as ineffective methods for evaluating tools towards our management questions (Walling 1985, 1988, Leecaster et al. 2002, Ma et al. 2009), and thus need not be evaluated further. Other calculation methods, including flow-weighted means, have been tested previously in southern California (Leecaster et al. 2002, Ma et al. 2009), and additional methods (turbidity surrogate, simple means, and linear interpolation) were examined in this study.

The focus of this study was to evaluate sampling designs for obtaining annual loads estimates. The study included two components:

1. Comparison of the accuracy, precision, and cost of a variety of stormwater monitoring designs and mathematical equations (estimators) for determining annual pollutant loads; and
2. Determining the power and sample size needed to detect declining trends in Hg and PCBs in the next 10 - 40 years.

High quality loading data from local watersheds collected by the SPLWG and RMP provided a resource to evaluate potential future monitoring approaches. A variety of sampling and mathematical loads calculation methods were simulated by statistically subsampling the existing high temporal resolution empirical data sets. Combining empirical data with simulation methods to test and optimize loading measurements has been carried out in numerous studies before (e.g., Walling 1985, Walling 1988, Leecaster et al. 2002, Ma et al. 2009). This study focused on sampling optimization for Hg, PCBs, and suspended sediments (SS) since these are the high management priorities in San

Francisco Bay, and suspended sediment concentration and load is an important vector for transport of sediment-associated pollutants. However, the findings are likely relevant for other particulate substances in similar sized watersheds.

METHODS

Three years of urban runoff data from the Guadalupe River (GR) and Zone 4 Line A (Z4LA) monitoring stations in San Francisco Bay, California were statistically analyzed in this study. GR is located near San Jose, the largest city in the San Francisco Bay Area. Its watershed is the fourth largest in the Bay Area (about 500 km^2) and is a network of mostly natural channels that have been modified by impoundments and flood control engineering. The monitoring station operated by the SPLWG developed through collaboration with the US Geological Survey (USGS) (station number 11169025) is upstream from tidal influence, but resides downstream from five main reservoirs, the City of San Jose, and the majority of flood control channels. The typical flood hydrograph produced by heavy rainfall passes through this watershed over a period of about 12-24 hours but larger and later season floods may last for several days. The free flowing area downstream from reservoirs is 236 km^2, of which approximately 80% is urbanized landscape. In addition, this area also drains the Quicksilver County Park, formerly the New Almaden Mining District, which, since 1849, has produced 6% of the total Hg worldwide (McKee, L., unpublished data) and is a known source of Hg to San Francisco Bay.

In contrast, the monitoring station in Z4LA, located in Hayward, drains a relatively small 4.47 km^2 watershed of completely urbanized landscape with over 38% industrial land use. Historically, there was no creek draining this area of the Bay margin. The flood channel of Zone 4 Line A is entirely engineered with approximately one-third open to the air and two-thirds underground culverts and storm drains. The monitoring station resides approximately 1.7 km from the Bay and upstream from tidal influence. There are no reservoirs in this watershed and rain passes largely unabated through the network of flood channels in minutes to hours.

Though an excellent data set is also available for the Mallard Island on the Sacramento River for a range of trace contaminants (David et al. 2009), these data were not included in the present study. There were two primary reasons for this: 1. the system is not representative of typical small tributaries to be monitored in the MRP, due to extreme size of the watershed (covering two-thirds of the land area of California); 2. time and resource limitations precluded the detailed examination necessary to evaluate optimal sampling design for this system. Since the system is much larger than GR, Z4LA, and others watersheds previously studied (e.g., Leecaster et al. 2002, May and Sivakumar 2009), and has considerably higher water volume and longer flood wave travel times, an optimal sampling strategy for this system is likely quite different. Performing a similar exercise for larger watersheds such as represented by our sampling station on the Sacramento River at Mallard Island remains a data gap in the published literature.

Three water years (WY) of data that spanned a range in climatic conditions (and thus a range in wet weather discharge and pollutant concentrations) were chosen for each watershed. A water year begins October 1st each year and ends September 30th and is designated by the end date. At GR, during WYs 2003 – 2005, the peak discharge was 172 m^3/s on December 16th, 2002 in WY 2003 (Table 1). In comparison, WYs 2004 and 2005 had relatively lower maximum discharge and pollutant concentrations. At Z4LA, three water years of data were also available, although not all years have complete records due to permitting issues and upstream construction. During WYs 2007 - 2009, Z4LA wet season discharge varied from 4.7 – 6.7 m^3/s. WY 2008 exhibited relatively higher peak wet season discharge than the other two years, but this was predominated by many small storms.

"Best Estimate" Loads Calculations

Statistical simulations of sampling designs were compared to existing "best estimates". The "best estimate" of annual loads (based on wet season data) was determined for each watershed based on the mathematical combination of estimated pollutant concentration and discharge volume. Hg, PCBs, and suspended sediment (SS) loads were examined. At both study locations, a turbidity surrogate regression (TSR) methodology has been used. Specifically, turbidity was monitored at short time intervals (15 minutes or less) and a statistical regression developed with a subset of water samples analyzed for suspended sediment concentration. This turbidity: SSC regression was combined with the continuous turbidity measurements to generate a time-continuous SSC record.

Additional depth integrated water samples (10-40 samples per year) were collected manually during high-flow events (storms), and analyzed for trace contaminants. Clean hands protocols were used. All analytical results were certified by the RMP data management and quality assurance plan (Lowe et al. 1999). Subsequently, during well sampled floods, linear interpolation was used to estimate concentrations between data points which were then combined with short interval flow measurements to determine loads. During storm periods when no sampling was conducted or during dry weather flows, regression relationships were determined between turbidity and each pollutant and used to calculate time-continuous estimates of contaminant concentration (turbidity surrogate regression or TSR). These estimates were then combined with discharge measurements to calculate loads. These combined methods were used to determine the "best estimate" of annual pollutant concentrations and loads to these watersheds over the years. It has been acknowledged in previous reporting (McKee et al. 2006b) that under complex conditions (e.g., Guadalupe River in 2005) professional judgment was used to guide these calculations. For example, Hg loads in GR were often stratified based on the predominant source of runoff indicated on hydrographs, resulting in separate regression relationships for urban vs. non-urban signals. These professional-judgment-based turbidity surrogate load estimates were used as the best available load estimates, against which all sampling design scenarios were compared.

Loads Analysis

Sampling programs for watershed loads estimates are designed with two attributes in mind; the number of samples taken within a storm and the number of storms sampled during a year or wet season (Leecaster et al. 2002). Our analysis of the optimal sampling method was performed in two steps. First, within-storm load estimates were compared among sampling designs and calculation methods. Secondly, using the results of the optimal within-storm sampling strategy, scenarios among storms were examined. A number of prospective designs were considered, including variations on sample collection and loads calculation within individual storms (i.e., within-storm designs), and sampling designs across the wet season (i.e., among-storm designs). All designs were evaluated by Monte Carlo simulation. Bias and precision were calculated to evaluate all design scenarios. Bias was calculated as the median percentage difference between the expected estimate and the actual results. Precision was calculated as the variability in bias, measured as the standard deviation. Results were calculated and compiled using the statistical software package R (v. 2.10.1).

The within-storm design analysis considered four aspects of sampling design: 1. storm sampling basis (i.e., flow based vs. turbidity based); 2. sampling emphasis; 3. sample size; and 4. loads estimation method (Table 2). To examine the first aspect of the analysis, each year of data for the two watersheds was analyzed for the presence of sampled storms using a) flow thresholds and b) turbidity thresholds (Table 3a and 3b). The use of a pre-set threshold simulates protocols for an automated sampler, which will collect water samples when preprogrammed thresholds are surpassed that characterize flow and concentration during each storm event hydrograph. Since both flow and turbidity increase during high-flow events, both were evaluated for use as primary drivers for sampling design. To define and select a storm, thresholds were statistically established for the start, peak, and end of each storm hydrograph. Storm selection criteria differed between the two watersheds. For GR, flow events greater than 200 cfs, with peak flow greater than 736 cfs, were flagged as storms (Table 3a). For Z4LA, flow events greater than 5 cfs, with peak flow greater than 26 cfs, were flagged as storms. The storm selection criteria were chosen to achieve thorough coverage of storm flow events, without including baseflow events. For the purposes of this analysis, flow that did not meet these criteria was deemed baseflow. In contrast to flow thresholds, turbidity-based storm selection thresholds were similar between GR and Z4LA (Table 3b). For GR, turbidity measurements greater than 30 NTU, during storms with peak turbidity greater than 84 NTU, were flagged as storms. For Z4LA, the thresholds were 30 NTU and 89 NTU, respectively.

The second aspect of the within-storm design was sampling emphasis, which refers to relative frequency of sample collection in the rising vs. falling stage. Two approaches were considered: a) equal spacing of the samples across the rising and falling stages (i.e., 1:1 sampling emphasis) or b) rising-stage emphasis, where twice as many samples were spaced on the rising stage of the hydrograph relative to the falling stage (i.e., 2:1 sampling emphasis). The rationale for considering a rising stage emphasis is that suspended sediment pollutant loads are typically greater and more variable during the rising stage (McKee et al. 2006b).

The third aspect of within-storm design evaluated was the number of water samples collected per storm (i.e., sample size). For Hg and SS, four sample sizes were considered: 6, 12, 18, and 24 collections per storm. For PCBs, 6 and 12 collections per storm were considered; larger numbers of collection would be unfeasible due to the large sample volumes required for PCB lab analysis. The actual number of samples that could be evaluated for each scenario varied based on the size of each storm sampled.

The final aspect of within-storm design was the loads calculation method (Table 4, Equations 1 - 3). Methods for loads calculation will depend on the method used to integrate individual water collection events (Leecaster et al. 2002). Specifically, auto samplers may obtain discrete or composite samples. Discrete samples are small samples (referred to as "sips") taken by the auto sampler throughout the storm. Composite samples are the combined collection of many discrete sips that are used to represent conditions over an entire storm. The data generated from composite samples collected in this manner are often referred to as event mean concentrations (USEPA 2002, Ma et al. 2009). For the discrete sampling method, two loads calculation methods were examined: 1) linear interpolation; and 2) flow weighted mean (Table 2). For the composite sampling, only a simple mean method was used to estimate loads because the other estimators require discrete data. These three loads calculation methods were tested for all combinations of sampling basis (flow or turbidity), number of samples collected per storm, and sampling stage emphasis (Table 2). The resulting within-storm load estimates were compared to the "best estimate" loads to assess performance of the sampling design and loads calculation methods.

The among-storm design evaluations focused on number and type of storms sampled. Using the results from the optimum within-storm design, three strategies for sampling among storms were considered for their ability to estimate annual loads (Table 5). The first among-storm design (Design A in Table 5) sampled the first flush (i.e., the first storm of a wet season) plus a variable number of random storms. The second among-storm design (Design B in Table 5) sampled the first flush plus one of the three largest storms of the wet season and a variable number of random storms (Note we chose one of the three largest because although it is easy to define and then respond to a weather forecast for a large storm, we may also miss a storm that ends up larger than the forecast predicted - we can never know until the end of the season if we sampled the largest storm of the season or one of the three largest). The third among-storm design (Design C in Table 5) is the design written in the MRP and was evaluated using either 2 or 4 random storms. Designs A and B were evaluated for 2, 4, 6, and 10 storms (actual number depends on available data). To correspond with the MRP requirements, Design C evaluated 2 and 4 storms only. All results were extrapolated to an estimated annual load by dividing by the ratio of sampled storm flow volume vs. total wet season flow volume (Table 4, Equation 4). Note that WY 2008 at Z4LA was deemed inappropriate for this analysis since the sampling began later in the season, and thus, an assessment of first flush and largest storms was not possible.

The accuracy and precision for annual loads calculation using each sampling strategy was compared. Monte Carlo simulations were employed to obtain random storm subsamples under each design method. Each design was run 50 times for each number of storms (to allow for random selection of storms), and an annual load was calculated for each run. The optimum strategy was identified as the design with the median closest to the annual best estimate of load, and the lowest variability in estimated annual loads. Each year of data was analyzed separately to demonstrate performance under a variety of climatic conditions.

A parallel analysis was performed to examine performance of the turbidity surrogate regression method for annual pollutant loads estimation. First, Monte Carlo simulation was employed to examine the sample size requirements for developing a relationship of turbidity to Hg, PCBs, and SS. This was performed for each design within each year of data. The optimal sample size was examined by varying the number of samples in the TSR from 4 – 40 using Monte Carlo simulation (1000 simulations per design/year combination). Again, the actual sample sizes that could be simulated varied based on the empirical data sets. Each regression generated from a sub-sampled data set was converted into a continuous estimated pollutant concentration record by applying the regression to the continuous turbidity record. The continuous pollutant concentrations were then extrapolated to loads using the same methods as for the mass emission estimator. These annual loads based on sub-sampled data were compared against loads calculated using each water years' complete grab sample data set to determine how many grab samples were necessary to obtain precise and unbiased load estimates. Once the optimum number of TSR samples was identified for each pollutant, the average regression slope and intercept (from the 1000 runs at the optimal sample number) were applied to the continuous flow and turbidity records to calculate per-storm loads. Finally, the TSR-based storm loads were extrapolated to annual loads using the same three among storms sampling strategies (Table 5), employing 50 runs per design. The performance of the TSR in the among-storm designs was compared to the TSR loads using all samples collected in a year, and the "best estimate" of annual loads.

Trend Analysis

Provision C.8.e. of the MRP calls for testing for trends towards compliance with loads allocations (SFRWQCB 2009). To support that provision, the objective of the trends analysis performed here was to determine the power to observe declining trends in the ratio of SSC to Hg concentration or SSC: PCB concentration given the current mean slope and variability. This is consistent with the presentation of TMDL targets on SSC normalized basis (SFRWQCB 2006, 2008). Trends were examined for reductions in the estimated particle concentration [mass/unit mass] from its current value to a value of 0.2 mg Hg / kg suspended sediment (i.e., the SSC: Hg target) and 0.002 mg PCB / kg suspended sediment. These targets assume that urban suspended sediment loads in the Bay Area average 400 million kg annually (following Lewicke and McKee 2009). Note that for the Z4LA Hg trend analysis, initial regression results demonstrated that the current SSC: Hg slope estimates were below the 0.2 target (Appendix A). Therefore, in this analysis, the trend was examined for a target value of 0.05 mg Hg / kg suspended sediment (75% below 0.2 mg/kg).

Power to observe trends were evaluated at time periods of 10, 20, 25, and 40 years. The analysis examined the power to detect a decline in SSC: Hg and SSC: PCBs (at alpha = 0.05) based on the coefficient of variation (CV = s.e. / mean). Sample sizes in future years were assumed to be the same as current (approximately 12 to 20 PCB samples per year and 15 – 50 Hg samples per year) or reduced to 7 or 10 samples per year. The CV was adjusted for the n = 7 and n = 10 scenarios. Although intuitively, one might expect CV to diminish over time, since a trait of cleaner systems is lower concentration variation (Appendix B), in the absence of information to quantitatively predict the shape of such a trend for Bay Area watersheds and pollutants of interest, power was evaluated assuming that the CV would show a linear decline over the time period evaluated.

RESULTS

Optimal Sampling Designs for Estimating Annual Loads

Guadalupe River

Within-storm sampling design scenarios for Hg, PCBs, and suspended sediment (SS) generally indicated linear interpolation to be the most accurate estimator of loads per storm (Table 6). Complete results are tabulated in Appendix C.1. For all three pollutants, using either the flow-based or turbidity-based storm sampling methods, the accuracy (median bias) and precision (variability of bias) was higher at n = 12 than at n = 6. However, accuracy and precision for Hg did not notably improve from n = 12 to n = 18 or n = 24. Variability of bias generally decreased with increasing sample size. No improvement in accuracy or precision was evident using a rising stage (2:1) emphasis compared to samples evenly spaced over a storm hydrograph (1:1). Based on these findings, linear interpolation was used to characterize annual loads in the among-storm scenarios. To obtain a cohesive analysis, a single storm sampling method and sample size was used for each pollutant and site combination (Table 7).

Evaluation of the three among-storm sampling designs at GR (Table 5) indicated that the number of sampled storms strongly affected accuracy of estimated pollutant loads (Hg results in Figure 1; PCBs and SS results in Appendix E). Scenario results were generally similar for Hg, PCBs and SS loads, and for flow based vs. turbidity based storm sampling. The Hg flow based selection results are described in further detail here (Figure 1), while PCB and SS results, as well as all turbidity-based selection results, may be found in Appendices D.1 and E. The highest sample size of storms evaluated generally resulted in the lowest variability and bias in loads estimates (Figure 1). In WY 2004 and 2005, Design A (including first flush) and Design B (including first flush plus largest storm) demonstrated pronounced increases in accuracy and precision with each increase in storm sampling frequency (Figure 1b, 1c). Depending on the available data for simulations, either 6 or 10 storms were optimal for reducing bias. Design C (random storms only) consistently exhibited the least precision of the three designs at GR. However, Design C also exhibited less bias for 2 and 4 storms than the other designs.

Zone 4 Line A

Consistent with GR results, linear interpolation was the most accurate estimator of Hg, PCBs, and suspended sediment (SS) loads within individual storms (Table 6; Appendix C.2). Flow weighted mean performed particularly poorly for Z4LA. This may suggest that flow and concentrations were not as closely related in the storms analyzed (strong hysteresis). Accuracy and standard deviation of Z4LA load estimates were improved at the higher sample sizes, using either the flow-based or turbidity-based storm selection methods. For Hg and SS, the bias and precision were similar at n = 18 and n =

24. For PCBs, the highest sample size (n = 12) was optimal. Larger sample sizes were not evaluated due to the limitations on PCB sample volume in auto-samplers. Both the magnitude of bias and variability in bias generally decreased with increasing sample size, particularly for linear interpolation. Similar to GR, no change in accuracy or precision was evident using a rising stage (2:1) emphasis versus evenly spaced (1:1) emphasis. Based on these findings for Z4LA, the flow-based design with 18 samples per storm for Hg and SS, 12 samples per storm for PCBs, and linear interpolation was used to characterize annual loads in the among-storm scenarios (Table 7).

Simulation of the three strategies for sampling among storms indicated that 10 storms (the highest sample size) generally resulted in the lowest variability and bias in loads estimates (Figures 2, 3, and 4). Turbidity-based results are summarized in Appendix D.2. Designs A and B generally had the lowest variability for both Hg and PCB loads (Figures 2 and 3). In WY 2009, there was little difference between Designs A and B. In contrast, simulation of WY 2007 indicated more variable results among designs. For Hg, PCBs, and SS (Figures 2, 3, and 4), Design C with 4 storms sampled approximated the best estimate load as well as the other designs (i.e., similar accuracy) but was associated with much higher variability (i.e., lower precision).

Optimal Turbidity Surrogate Regression Designs for Estimating Annual Loads

Guadalupe River

Similar loads estimates could be obtained by the turbidity surrogate regression (TSR) method with significantly fewer samples than the full available sample size. Generally, all simulations indicated median loads that were similar to the best estimate load, reflecting the close relationships of these pollutants to turbidity. Simulations of the TSR showed that variability in the load estimates was markedly reduced at sample sizes of 7 or more (Figures 5, 6, and 7). For example, the median Hg load in WY 2004 at n = 7 was 12.8 ± 2 kg, compared to the best estimate load of 13.0 kg. Monte Carlo simulations of the TSR also indicated that 7 samples were needed to accurately estimate for PCBs and SS loads. For example, median PCB load estimates in WY 2003 and 2004 were 1.7 ± 0.4 kg and 1.1 ± 0.4 kg, respectively, compared to loads determined using all samples of 0.9 kg and 0.5 kg, respectively. In WY 2005, a limited pool of samples (n = 12) was available for PCB simulation, and thus annual loads exhibited wider variability. However, SS loads were well sampled in all years and thus were generally consistent. Based on the finding that 7 samples provided an adequate basis for TSR in most GR scenarios, among-storm sampling strategies were examined using this sample size.

Simulation of three among-storm sampling (Table 5) designs for annual loads estimation using TSR indicated that sampling 10 storms per year was optimal to approximate the best estimate loads (Figures 8 – 10). The error bounds for annual loads generally narrowed as the sample size increased, but there was considerable variability among years and pollutants. Simulation of Designs A and B most consistently produced the least bias estimates, but not in all cases. For example, WY 2004 results indicated similar Hg load estimates using either Design A or B, and wider variability for Design C. In contrast, estimated loads with Design C were more consistent in WY 2005 than either of the other designs. PCB and SS loads were less variable than Hg loads, but still indicated that 10 storms were required for minimum bias in loads.

As a final comparison, the bias and precision in sampling 10 storms using either Design A or B (Table 5) were compared between linear interpolation and TSR. For all three pollutants, linear interpolation provided more accurate and precise estimation of the best estimate load in WY 2005 (Table 8). A sampling strategy employing first flush and 10 total storms (Design A) with linear interpolation suggested relatively high accuracy for Hg and PCB loads of approximately 10%. Using TSR, PCB loads had very low accuracy, suggesting variability on the order of 50%. For SS, linear interpolation with Design B suggested the best design, which was estimated to have accuracy of approximately 1% under the WY 2005 scenario.

Zone 4 Line A

Simulations of the TSR for Z4LA supported the GR results that similar estimates of loads could be obtained with significantly less samples than the full available sample size (Figures 11, 12, 13). Simulations for Hg and PCBs indicated that 7 samples per year were needed to accurately estimate loads each year. Although the median load estimate did not vary greatly with increasing sample size, variability was significantly reduced with 7 or more samples. Simulation of these datasets indicated that the TSR was robust at all sample sizes in WY 2007 and 2008. Due to lower sample size of PCBs in WY 2009, there was greater variability in the load estimates. The accuracy of SS loads was relatively high at all sample sized evaluated due to the larger number of available sample points for simulation. However, the variability in loads spanned more than two orders of magnitude at sample sizes less than 10 (particularly in 2007). In summary, storm sampling strategies based on TSR as described below, were examined using 7 samples for Hg and PCBs, and 10 samples for SS.

Simulation of three among-storm sampling (Table 5) designs for annual loads estimation using TSR indicated that sampling the maximum number of storms each year was optimal for minimum bias and precise load estimates. For Hg loads, sampling of 10 storms per year using Design A or B achieved the least amount of variability and most accurate loads in 2007 (Figure 14). Simulations using 2009 data, indicated 4 – 6 storms using Design A would be sufficient, as the median load and variability did not vary greatly at greater sampling intensity or when one of the largest storms was included. Design C under predicted the best estimate loads in WY 2007, but attained reasonably close estimation of the best estimate load in WY 2009. PCB and SS loads were similar to Hg and best approximated loads at Z4LA by sampling of 10 storms (Figures 15 and 16).

Finally, TSR was compared to linear interpolation to evaluate bias in loads using the first flush designs when sampling 10 storms in WY 2009 (Table 5). Using either TSR or linear interpolation, Design A indicated better accuracy and precision relative to Design B. PCB loads were the most variable of the three pollutants in both methods, with an estimated bias of around 30% relative to the best estimate. However, estimated loads were very accurate for Hg (~ 1%) using either method and represented similar levels of precision (5%). Interestingly, SS loads were generally more accurate using TSR, but exhibited less precision than linear interpolation.

Trend Analysis

Guadalupe River

Trend analysis indicated that the power to detect trends in SSC: Hg using the current sampling intensity (Table 9) was generally greater than 90%. In WY 2004 and 2005, future sample sizes could be reduced to 7 samples per year from current sample sizes of 37 and 52, respectively, without loss of power to detect trends in the next 10 – 40 years (Table 10). Due to the lower SSC: Hg slope estimate (1.14) and weak regression relationship in 2003 (CV = 2.35; R^2 = 0.30), there was very low power to detect trends in that year.

Estimates of power to detect trends in the SSC: PCB relationship were also generally high (> 90%). Based on WY 2003 and 2004 data, future sample sizes could be reduced to 10 samples per year from current sample sizes of 21 and 19, respectively (Table 10). However, trend analysis performed with the lower SSC: PCB slope estimate measured in WY 2005 (0.12) indicated that relatively high power would not be achieved for a 10 year trend. Overall, the power analysis suggested that fewer sample sizes at GR would not inhibit the ability to detect declines in Hg and PCB concentrations.

Zone 4 Line A

The trend analysis for Z4LA indicated the power to detect trends in SSC: Hg using the current sampling intensity (Table 11) was generally greater than 90%. Scenarios run with the SSC: Hg slope estimate from 2009, indicated that future sample sizes could be reduced to 10 samples per year from a current sample sizes of 30 without loss of power for trends in 20, 25, and 40 years (Table 12).

Estimates of power to detect trends in the SSC: PCB relationship were very high (> 95%). In WY 2007 and 2008, future sample sizes could be reduced to 7 samples per year from current sample sizes of 15 and 14, respectively, for all trend scenarios evaluated (Table 12). However, at a sample size of 7 per year, 95% power would only be achieved in WY 2007 for 25 and 40 year trends. Overall, the power analysis suggested that lower sizes would also not inhibit the ability to detect declines in Hg and PCB concentrations at Z4LA.

SUMMARY

- The optimal within-storm design in GR and Z4LA evaluations was an equal-spacing, flow or turbidity-based sampling method, with the linear interpolation estimator.

- The optimal among-storm design was highly dependant on sample size. When small numbers of storms were simulated per year, sampling strategies that included first flush or largest storms per year (i.e., Designs A and B) exhibited substantial upward bias in estimated annual load. The first flush and large storm events generally have greater suspended sediment and pollutant concentrations than other storms; as a result, overemphasizing these events would result in overestimates of annual loads. Not surprisingly, the best estimates of annual loads were achieved in the largest sample sizes examined (10 storms per year).

- Designs that randomly sample storms throughout the year (i.e., Design C) without emphasizing first flush or large events have better accuracy at small sample sizes. However, these designs exhibit poor precision, with highly variable estimated loads.

- Evaluation of the turbidity-surrogate regression methods suggested that sampling frequency could be significantly reduced. For example, 10 storms sampled per year with one or two samples per storm were indicated.

- Results of the trend analysis indicated that power to detect long term trends in SSC: Hg concentrations and SSC: PCB concentrations should be high using a variety of sampling designs.

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Table 1. Summary of Guadalupe River and Zone 4 Line A data examined in this study.

Location	Water Years Examined	Peak Discharge (m^3/s)	Suspended Sediment FWMC (mg/L)	THg FWMC (ng/L)	TPCBs FWMC (ng/L)
Guadalupe River (GR)	2003	172	204	2190	55
	2004	124	191	329	26
	2005	112	79	140	45
Zone 4 Line A (Z4LA)	2007	6.3	212	48	27
	2008*	6.7	350	60	25
	2009	4.7	109	23	11

* Data for partial year that included 2 dry season months.

Table 2. Design options examined for sampling within storms.

Design Criteria	Design Options for Sampling Within Storms
1. Storm Sampling Basis	Flow-based or turbidity-based thresholds
2. Emphasis	Rising stage (2:1) or evenly spaced (1:1)
3. Max Sample Size (n) per Storm (actual n depends on storm size)	24*, 18*, 12, 6
4. Load Calculation Methods**	
Discrete Designs	LI – linear interpolation; FWM – flow-weighted mean
Composite Designs	SM – simple mean **

* Evaluated for Hg and suspended sediments only due to limitation on volumes required for PCB lab analysis
** Loads calculation methods differed for discrete vs. composite designs.
*** The other methods require discrete measurements

Table 3a. Flow-Based storm selection criteria by watershed.

Dataset	Flow Thresholds for Storm Selection (cfs)	Minimum Peak Flow for Storm Selection (cfs)
Guadalupe River	200	736
Zone 4 Line A	5	26

Table 3b. Turbidity-Based storm selection criteria by watershed.

Dataset	Turbidity Thresholds for Storm Selection (NTU)	Minimum Turbidity Peak for Storm Selection (NTU)
Guadalupe River	30	84
Zone 4 Line A	30	89

Table 4. Equations used to evaluate pollutant loads within- and among-storms.

Within-storm Estimators	Among-storm Ratio Estimator[1]
Simple Mean Equation 1: $L_{S.M.} = \left(\sum_{j=1}^{N} [x_j]/N\right)\left(\sum_{i=1}^{n} Q_i * \Delta t\right)$	
Linear Interpolation Equation 2: $L_{L.I.} = \sum_{i=1}^{n} [x_{i,int}] * Q_i * \Delta t$	Equation 4: $WY\_L_{L.I.} = \sum_{k=1}^{M} V_k * \sum_{k=1}^{m} L_k \,/\, \sum_{k=1}^{m} V_k$
Flow-weighted Mean Equation 3: $L_{F.W.} = \left(\sum_{j=1}^{N} [x_j] * Q_j\right)\left(\sum_{i=1}^{n} Q_i * \Delta t\right) / \left(\sum_{j=1}^{N} Q_j\right)$	

1 = Ratio Estimator used to calculate annual loads using optimal within-storm estimation method (i.e. Equations 1,2 or 3).

Where, L = estimate of mass loading for a storm; WY_L = estimate of annual mass emissions; Δt = time interval between discharge measurements; N = number of samples taken during storm; n = number of time intervals in storm (based on frequency of discharge measurements); $[x_j]$ = concentration of sample *j*; $[x_{i,int}]$ = $[x_j]$ interpolated to all *n* time intervals in storm; Q_i = discharge at time step *i*; Q_j = discharge at sampling event *j* V_k = discharge volume for storm *k*; m = number of storms sampled; and M = number of storms.

Table 5. Design options examined for sampling among storms.

Design Criteria	Design Options for Sampling Among Storms		
	A	B	C**
Which storms	First flush, and random N	First flush, largest storm*, and random N	Random N
Total Number Storms (N)	10, 6, 4, 2	10, 6, 4, 2	4, 2

* To account for selection uncertainty, the largest storm was selected randomly from the three highest total volume discharges per water year
** MRP design and sample sizes

Table 6. Comparison of bias in within-storm loads estimates for sample designs at Guadalupe River and Zone 4 Line A (sample emphasis = 1:1, flow-based criteria).

	Guadalupe River		
	Median Bias +/- St. Deviation		
Pollutant*	Simple Mean	Linear Interpolation	Flow-weighted Mean
Hg (n = 12)	-0.21 ± 0.18	-0.05 ± 0.25	-0.02 ± 0.33
PCBs (n = 12)	-0.04 ± 0.30	0.02 ± 0.28	0.15 ± 0.35
SS (n = 12)	-0.20 ± 0.24	-0.01 ± 0.24	0.07 ± 0.42
	Zone 4 Line A		
	Median Bias +/- St. Deviation		
Pollutant*	Simple Mean	Linear Interpolation	Flow-weighted Mean
Hg (n = 18)	-0.14 ± 0.23	0.01 ± 0.23	0.17 ± 0.38
PCBs (n = 12)	-0.26 ± 0.26	-0.11 ± 0.30	-0.09 ± 0.45
SS (n = 18)	-0.17 ± 0.27	0.003 ± 0.26	0.15 ± 0.44

* Number in parentheses designates number of samples evaluated per storm

Table 7. Within-storm design strategies used for among-storm analyses.

Site	Pollutant	Loads Estimation Method	Sampling Emphasis	Sample Size per Storm
Guadalupe River	Hg	Linear Interpolation	Evenly Spaced (1:1)	12
	PCBs			12
	SSC			12
Zone 4 Line A	Hg			18
	PCBs			12
	SSC			18

Table 8. Comparison of bias in median annual loads (+/- st. dev) resulting from turbidity-surrogate and linear interpolation in WY 2005 at GR and WY 2009 at Z4LA using two among storm sampling strategies (Design A and B in Table 5; N = 10 storms).

			Turbidity-surrogate		Linear Interpolation	
Watershed	Pollutant	Water Year	Design A	Design B	Design A	Design B
Guadalupe River (GR)	Hg	2005	-0.20 ± 0.25	0.09 ± 0.22	0.08 ± 0.05	0.09 ± 0.06
Guadalupe River (GR)	PCBs		0.54 ± 0.22	0.57 ± 0.20	0.11 ± 0.06	0.13 ± 0.07
Guadalupe River (GR)	SS		0.09 ± 0.23	0.17 ± 0.22	-0.04 ± 0.05	-0.01 ± 0.05
Zone 4 Line A (Z4LA)	Hg	2009	-0.02 ± 0.05	-0.01 ± 0.04	-0.01 ± 0.08	0.04 ± 0.08
Zone 4 Line A (Z4LA)	PCBs		0.26 ± 0.09	0.33 ± 0.10	0.26 ± 0.15	0.30 ± 0.14
Zone 4 Line A (Z4LA)	SS		0.13 ± 0.08	0.19 ± 0.09	0.08 ± 0.17	0.17 ± 0.15

Table 9. Data used to examine power for trend analysis at Guadalupe River.

Pollutant	Year	Current Sample Size	Mean Slope	S.D. Slope	95% C.I. Slope (lower, upper)	R^2
Hg	2003	25	1.14	13.4	-4.42, 6.70	0.30
	2004	37	1.44	0.73	1.20, 1.69	0.94
	2005	52	2.23	1.34	1.86, 2.61	0.93
PCBs	2003	21	0.06	0.05	0.03, 0.08	0.87
	2004	19	0.11	0.11	0.06, 0.16	0.85
	2005	12	0.12	0.18	0.00, 0.23	0.75

Table 10. Estimates of power to detect trends in the slope of SSC: Hg and SSC: PCBs at Guadalupe River.

		Hg			PCBs		
Year	Number of Years to Reach Target	Power for Current Sample Size*	Power for n = 7	Power for n = 10	Power for Current Sample Size**	Power for n = 7	Power for n = 10
2003	10	12	10	11	100	83	93
	20	13	11	11	100	98	100
	25	14	11	12	100	99	100
	40	17	12	13	100	100	100
2004	10	100	100	100	99	77	88
	20	100	100	100	100	96	99
	25	100	100	100	100	98	100
	40	100	100	100	100	100	100
2005	10	100	98	100	63	45	56
	20	100	100	100	87	69	82
	25	100	100	100	93	77	88
	40	100	100	100	99	91	97

* For 2003, n = 25; For 2004, n = 37; For 2005, n = 52
** For 2003, n = 21; For 2004, n = 19; For 2005, n = 12

Table 11. Data used to examine power for trend analysis at Zone 4 Line A.

Pollutant	Year	Current Sample Size	Mean Slope	S.D. Slope	95% C.I. Slope (lower, upper)	R^2
Hg	2007	30	0.13	0.11	0.09, 0.17	0.60
	2008	15	0.38	0.61	0.04, 0.72	0.31
	2009	21	0.08	0.05	0.05, 0.10	0.71
PCBs	2007	18	0.06	0.07	0.03, 0.10	0.82
	2008	15	0.16	0.13	0.09, 0.23	0.90
	2009	14	0.08	0.02	0.07, 0.10	0.98

Table 12. Estimates of power to detect trends in the slope of SSC: Hg and SSC: PCBs at Zone 4 Line A. Note that the SSC: Hg are currently below the target of 0.2 mg/kg, therefore the trend was examined for a target of 0.05 mg/kg, which is 75% below the original target of 0.2 mg/kg for urban stormwater (see Methods).

		Hg			PCBs		
Year	Number of Years to Reach Target	Power for Current Sample Size*	Power for n = 7	Power for n = 10	Power for Current Sample Size**	Power for n = 7	Power for n = 10
2007	10	98	55	68	95	66	79
	20	100	81	91	100	90	97
	25	100	88	96	100	95	99
	40	100	97	100	100	99	100
2008	10	62	38	48	100	91	97
	20	87	60	73	100	100	100
	25	93	68	81	100	100	100
	40	99	85	94	100	100	100
2009	10	74	38	48	100	100	100
	20	94	59	72	100	100	100
	25	98	67	80	100	100	100
	40	100	84	93	100	100	100

* For 2007, n = 30; For 2008, n = 15; For 2009, n = 21
** For 2007, n = 18; For 2008, n = 15; For 2009, n =14

Figure Captions

Figure 1. Comparison of annual Hg loads at Guadalupe River in 2003-2005 based on three designs for sampling among storms (Table 5). Loads were calculated using linear interpolation with flow-based storm selection criteria. Design A simulated sampling of the first flush only and a variable number of random storms. Design B simulated the first flush plus one of the three largest storms and a variable number of random storms. Design C only tested the random storm component. --------- = best estimate Hg load for year (96 kg, 13 kg, and 7 kg, respectively).

Figure 2. Comparison of annual Hg loads at Zone 4 Line A in 2007 and 2009 based on three designs for sampling among storms (Table 5). See Figure 1 caption and text for further information. --------- = best estimate Hg load for year (17 g and 11 g, respectively).

Figure 3. Comparison of annual PCB loads at Zone 4 Line A in 2007 and 2009 based on three designs for sampling among storms (Table 5). See also Figure 1 caption and text. --------- = best estimate PCB load for year (8 g and 5 g, respectively).

Figure 4. Comparison of annual SS loads at Zone 4 Line A in 2007 and 2009 based on three designs for sampling among storms (Table 5). See also Figure 1 caption and text. --------- = best estimate SS load for year (0.10 10^6 kg and 0.05 10^6 kg, respectively).

Figure 5. Results of Monte Carlo simulations to determine the optimum number of samples required to estimate Hg loads at Guadalupe River using the turbidity surrogate regression method. --------- = load determined using all samples collected in each year.

Figure 6. Results of Monte Carlo simulations to determine the optimum number of samples required to estimate PCB loads at Guadalupe River using the turbidity surrogate regression method. --------- = load determined using all samples collected in each year.

Figure 7. Results of Monte Carlo simulations to determine the optimum number of samples required to estimate suspended sediment (SS) loads at Guadalupe River using the turbidity surrogate regression method. --------- = load determined using all samples collected in each year.

Figure 8. Comparison of annual Hg loads at Guadalupe River in 2003-2005 based on three designs for sampling among storms (Table 5) using turbidity surrogate regression. --------- = Hg load from all storms sampled each year.

Figure 9. Comparison of annual PCB loads at Guadalupe River in 2003-2005 based on three designs for sampling among storms (Table 5) using turbidity surrogate regression. --------- = PCB load from all storms sampled each year.

Figure 10. Comparison of annual SS loads at Guadalupe River in 2003-2005 for three designs for sampling among storms (Table 5). --------- = SS load from all storms sampled each year.

Figure 11. Results of Monte Carlo simulations to determine the optimum number of samples required to estimate Hg loads at Zone 4 Line A using the turbidity surrogate regression method. --------- = load determined using all samples collected in each year.

Figure 12. Results of Monte Carlo simulations to determine the optimum number of samples required to estimate PCB loads at Zone 4 Line A using the turbidity surrogate regression method. --------- = load determined using all samples collected in each year.

Figure 13. Results of Monte Carlo simulations to determine the optimum number of samples required to estimate suspended sediment (SS) loads at Zone 4 Line A using turbidity surrogate regression. --------- = load determined using all samples collected in each year.

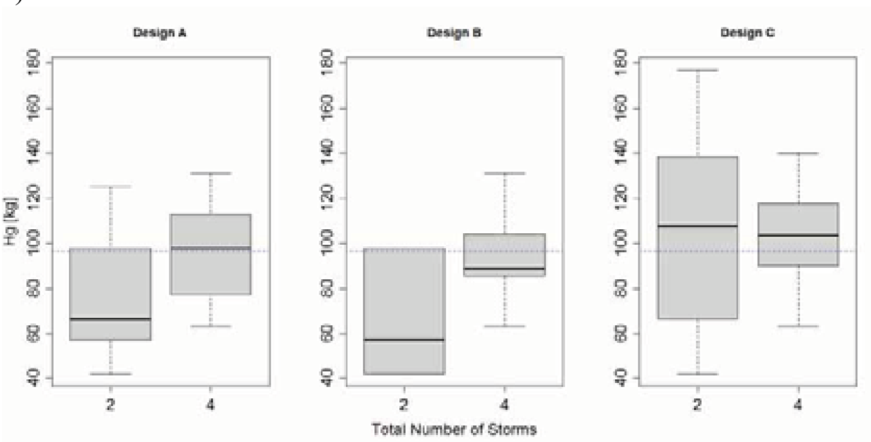
Figure 14. Comparison of annual Hg loads at Zone 4 Line A in 2007-2009 based on three designs for sampling among storms (Table 5) using turbidity surrogate regression. ---------- = Hg load from all storms sampled each year.

Figure 15. Comparison of annual PCB loads at Zone 4 Line A in 2007-2009 based on three designs for sampling among storms (Table 5) using turbidity surrogate regression. ---------- = PCB load from all storms sampled each year.

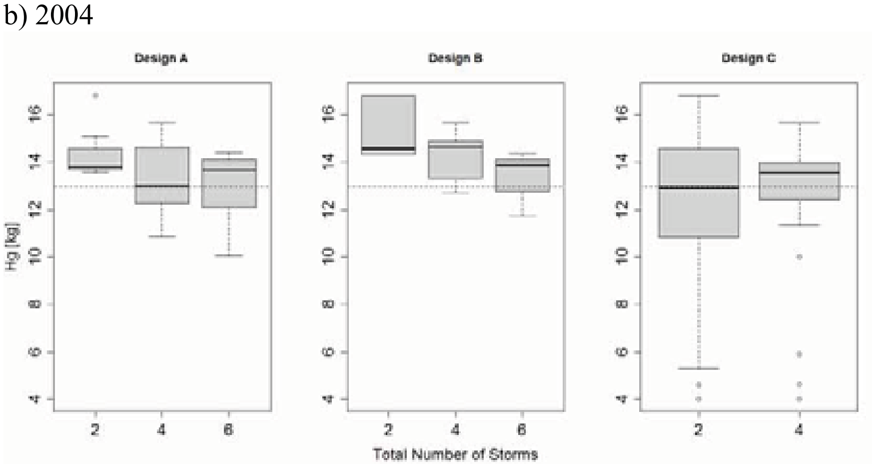
Figure 16. Comparison of annual SS loads at Zone 4 Line A in 2007-2009 based on three designs for sampling among storms (Table 5) using turbidity surrogate regression. ---------- = SS load from all storms sampled each year.

Figures

a) 2003



b) 2004



c) 2005

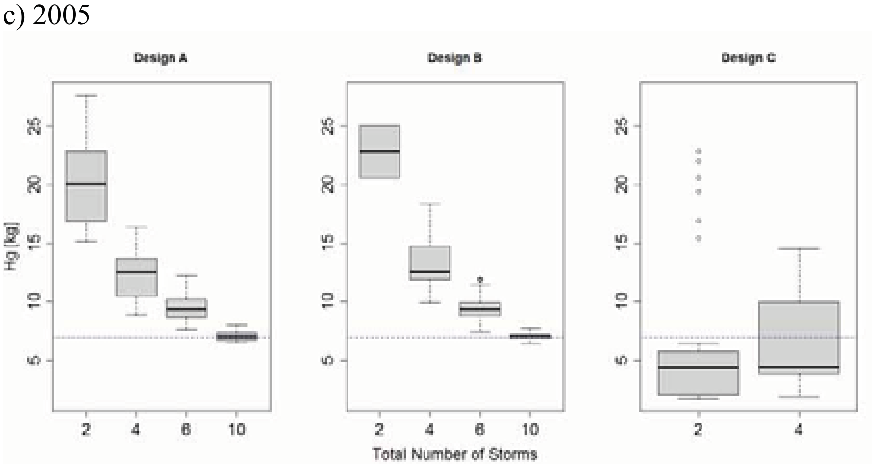
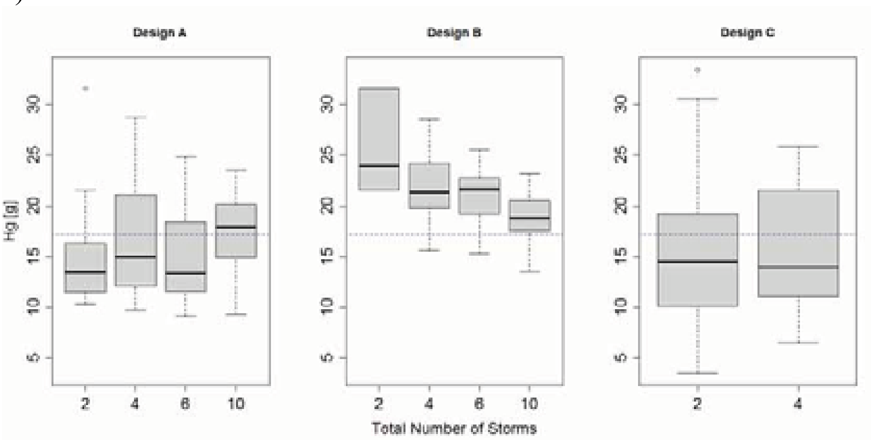


Figure 1a-c

a) 2007



b) 2009

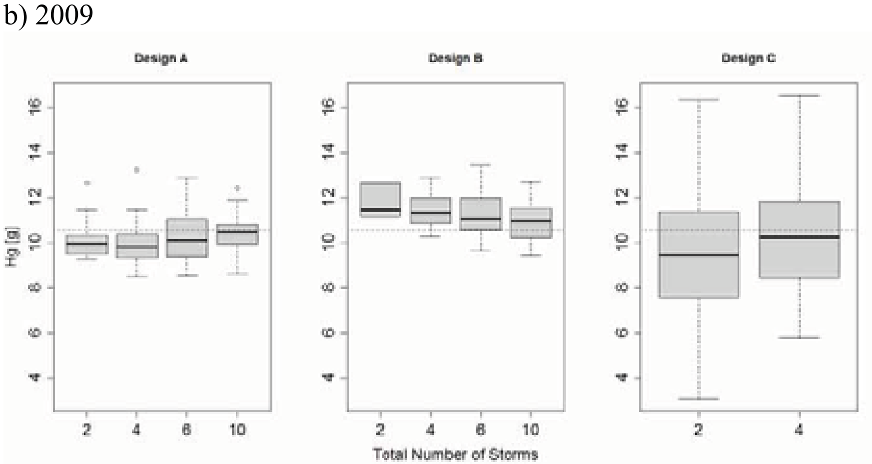
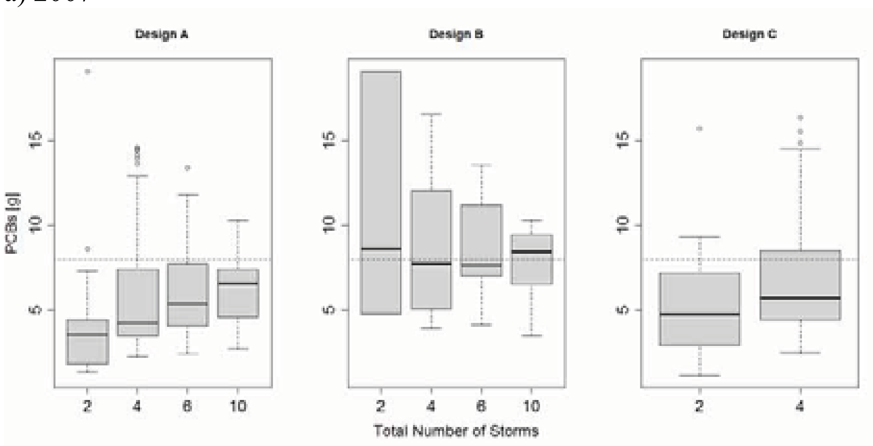


Figure 2a-b

a) 2007



b) 2009

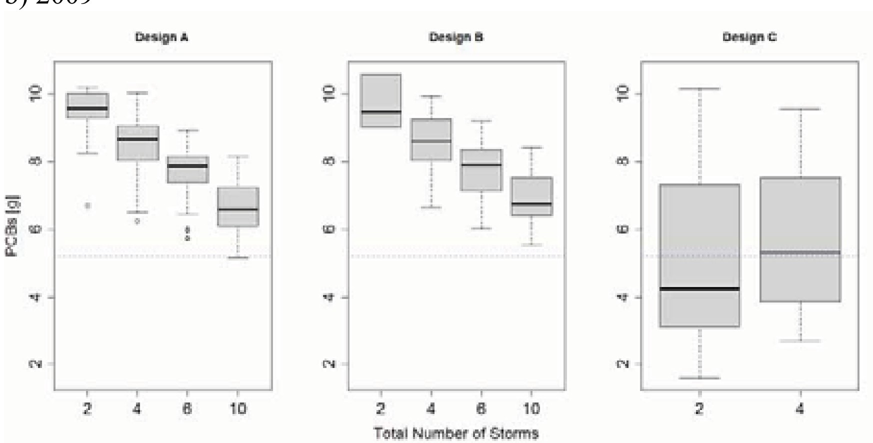
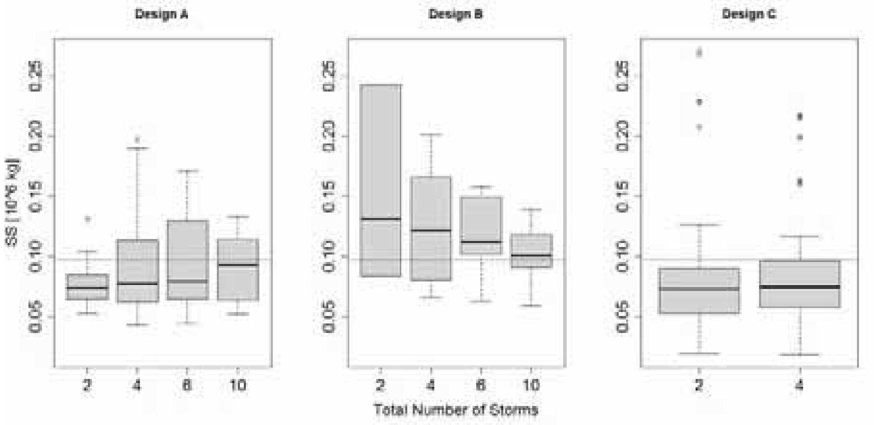


Figure 3a-b

a) 2007



b) 2009

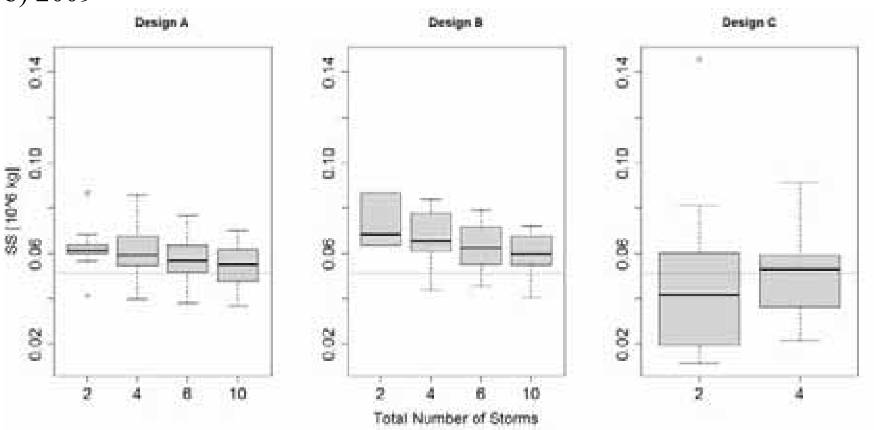
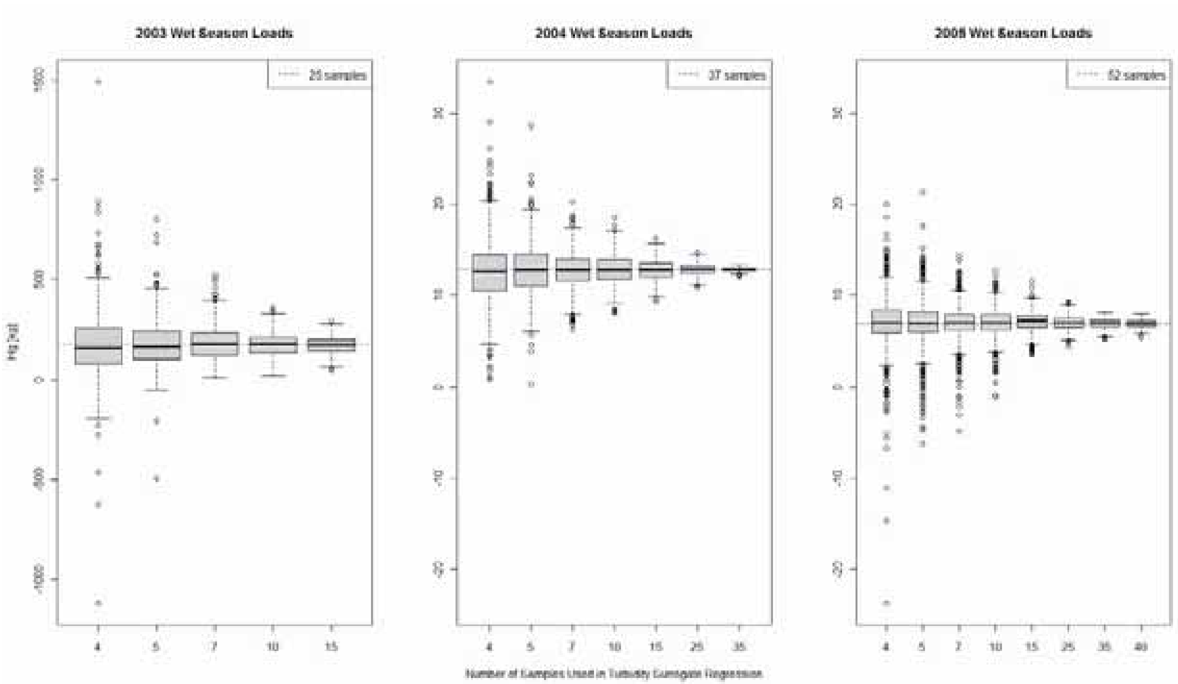


Figure 4a-b



2003 Wet Season Loads
2004 Wet Season Loads
2008 Wet Season Loads
25 samples
37 samples
52 samples
Hg (kg)
Number of Samples Used in Turbidity Surrogate Regression

Figure 5

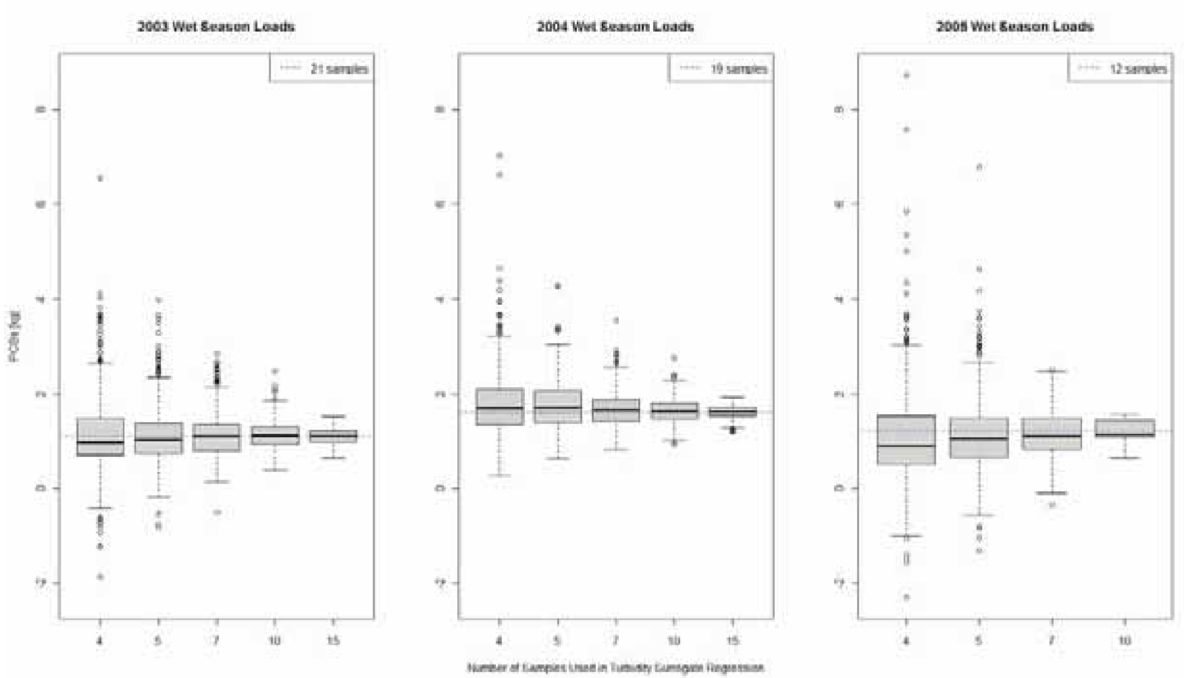

2003 Wet Season Loads
2004 Wet Season Loads
2005 Wet Season Loads
21 samples
19 samples
12 samples
Number of Samples Used in Turbidity Surrogate Regression

Figure 6

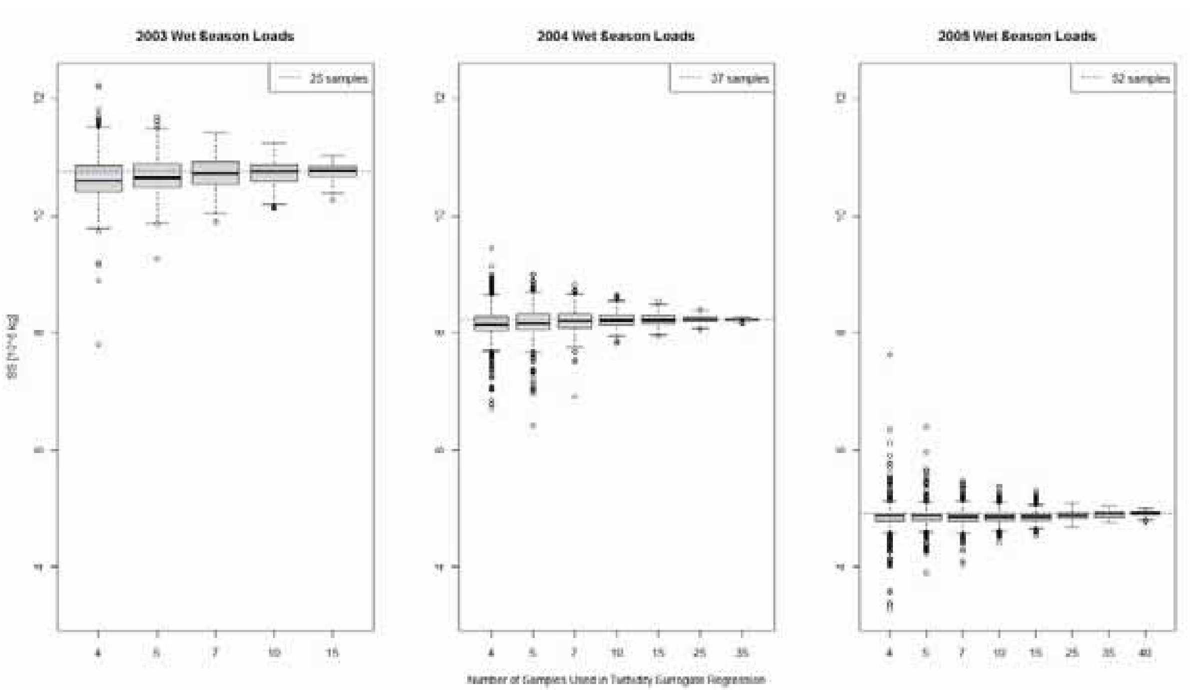
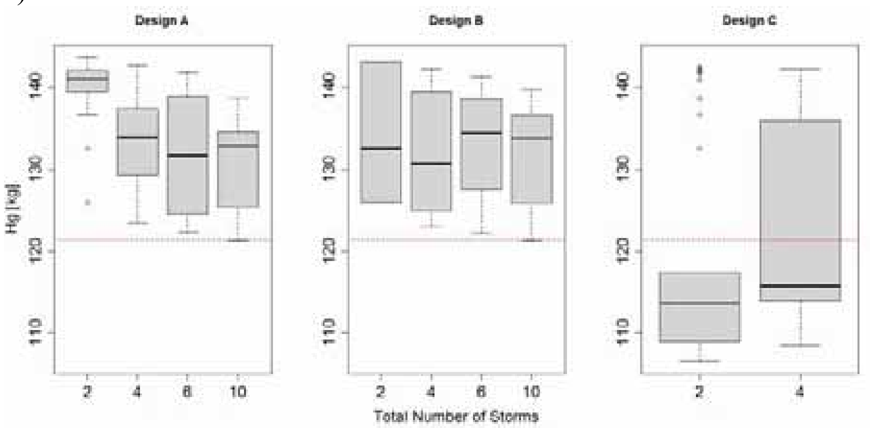
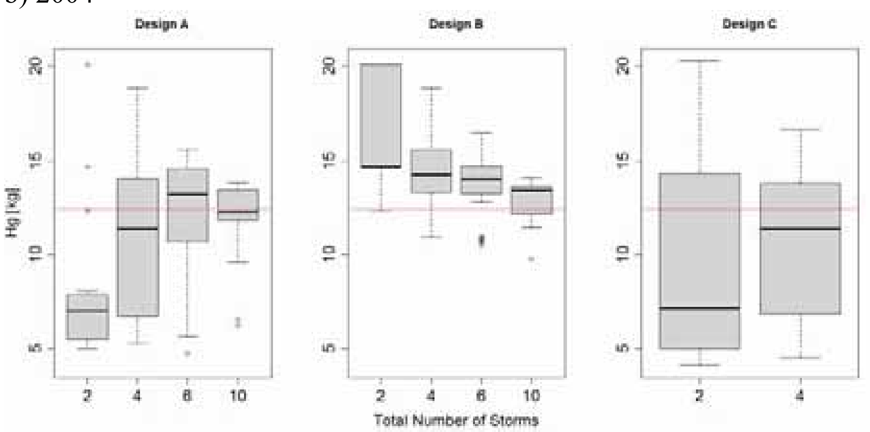

2003 Wet Season Loads
2004 Wet Season Loads
Number of Samples Used in Turbidity Surrogate Regression

Figure 7

a) 2003



b) 2004



c) 2005

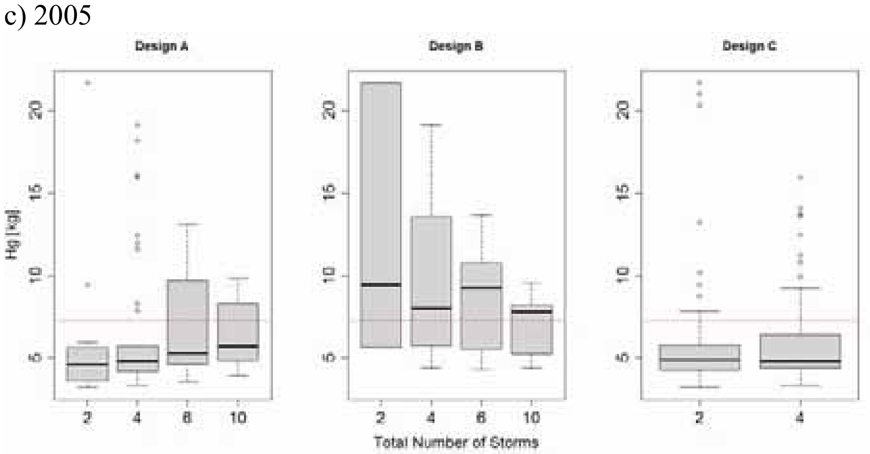
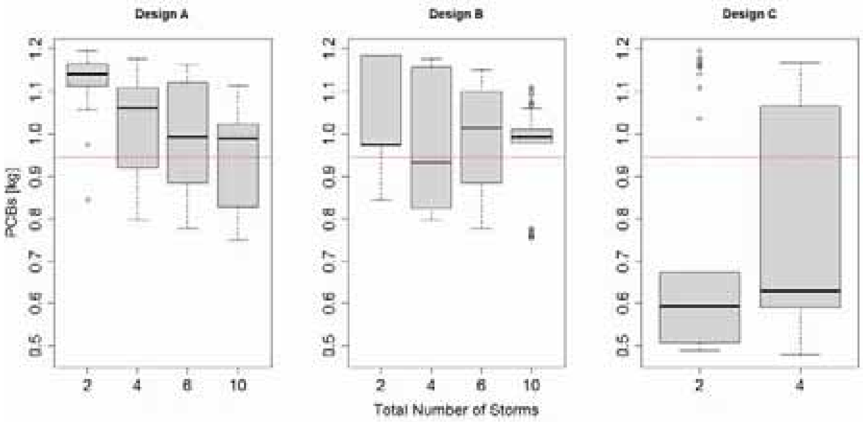
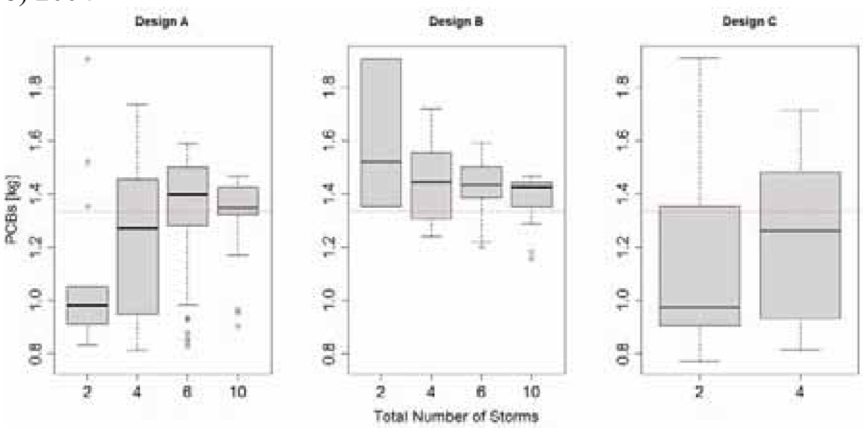


Figure 8a-c

a) 2003



b) 2004



c) 2005

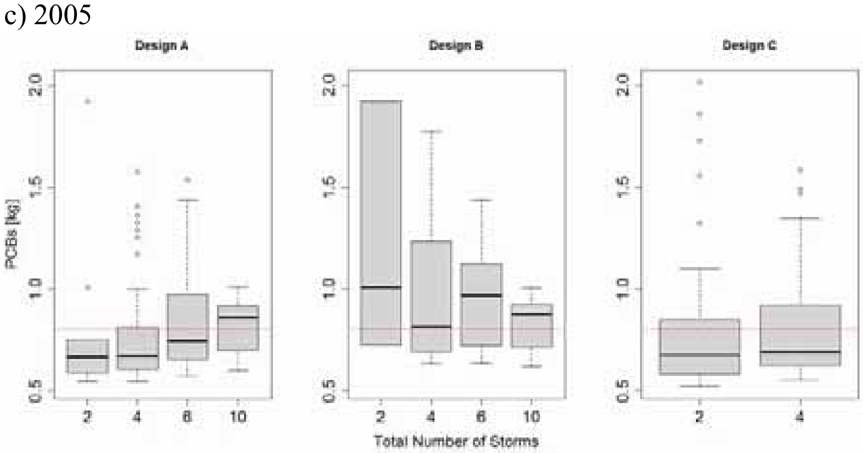
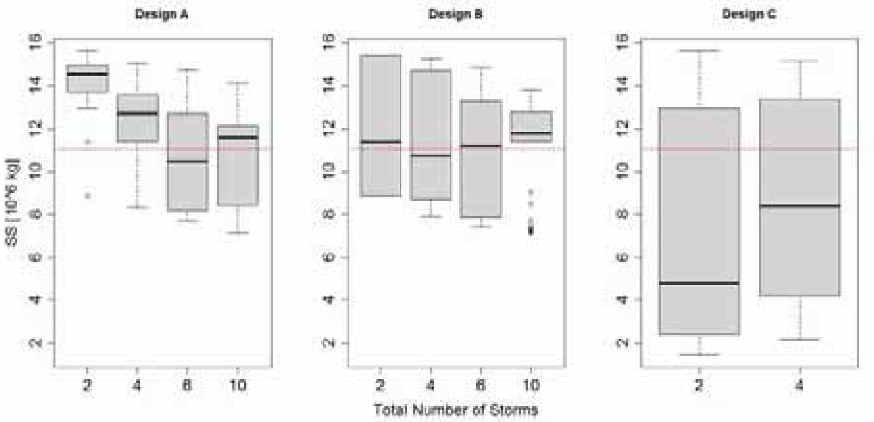
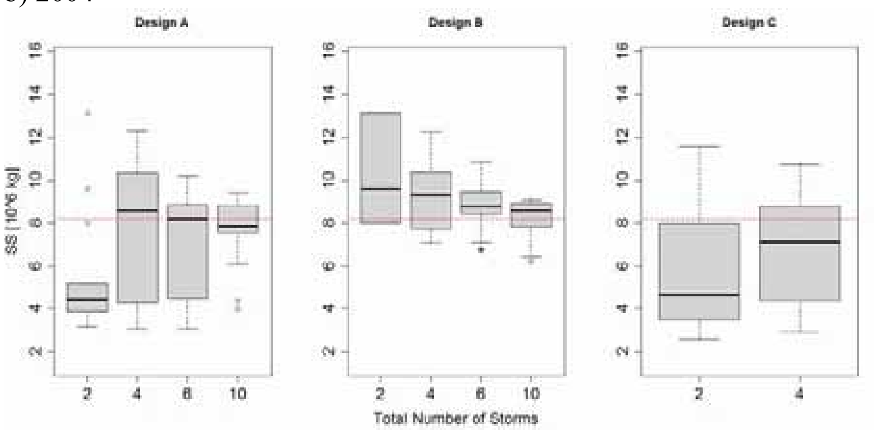


Figure 9a-c

a) 2003



b) 2004



c) 2005

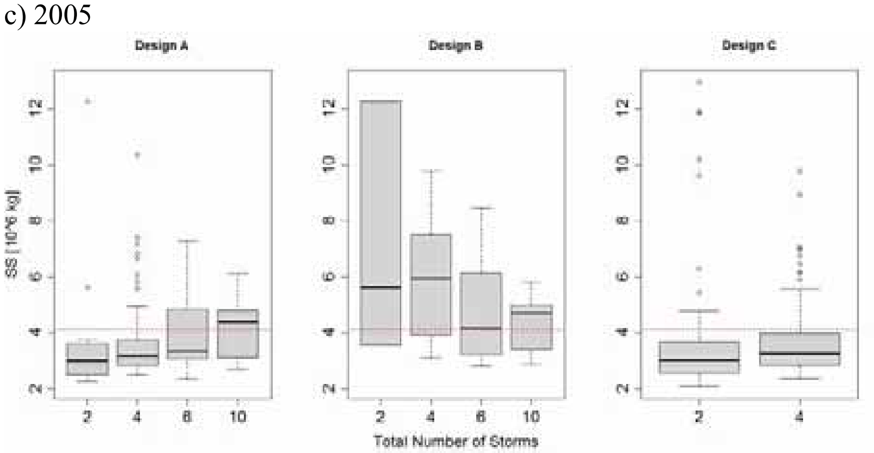


Figure 10a-c

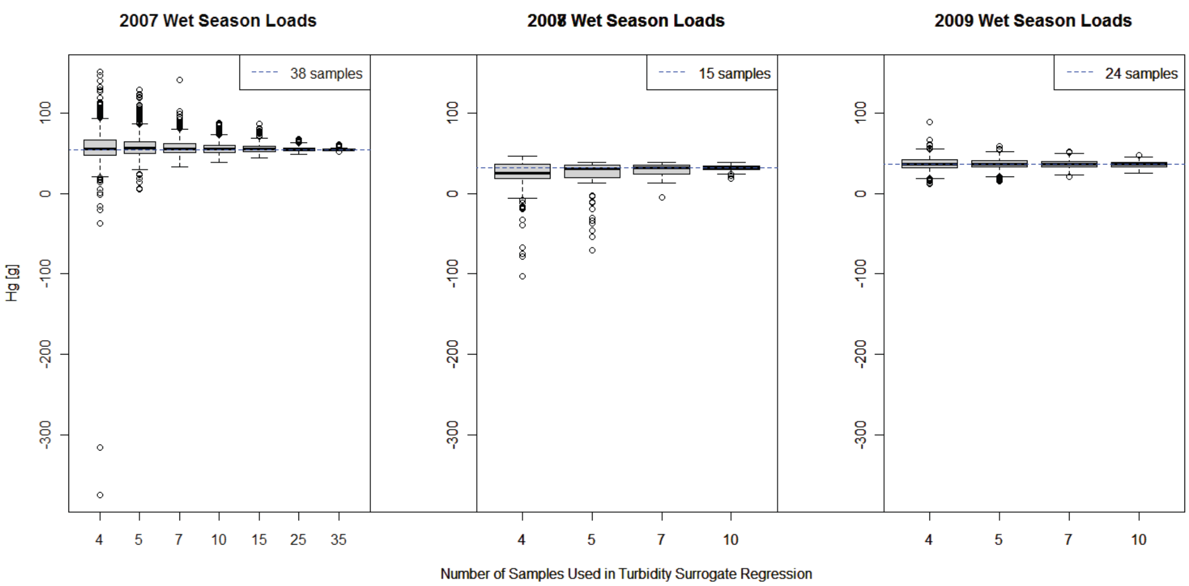

2007 Wet Season Loads
2008 Wet Season Loads
2009 Wet Season Loads
38 samples
15 samples
24 samples
Hg [g]
100
0
-100
-200
-300
4
5
7
10
15
25
35
Number of Samples Used in Turbidity Surrogate Regression

Figure 11

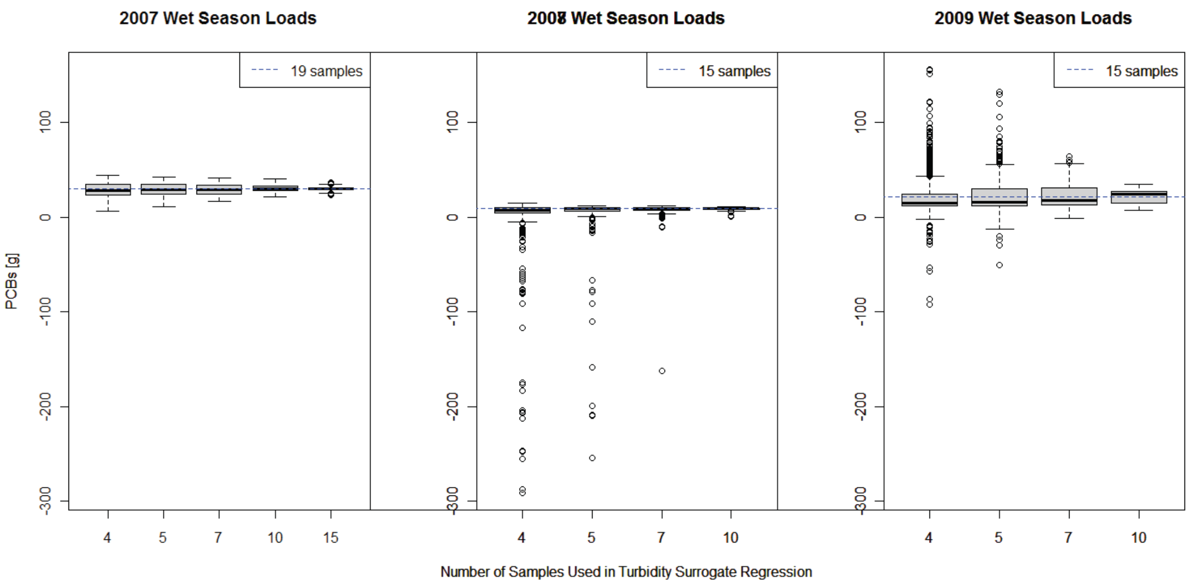

2007 Wet Season Loads
2008 Wet Season Loads
2009 Wet Season Loads
19 samples
15 samples
15 samples
PCBs [g]
100
0
-100
-200
-300
4
5
7
10
15
Number of Samples Used in Turbidity Surrogate Regression

Figure 12

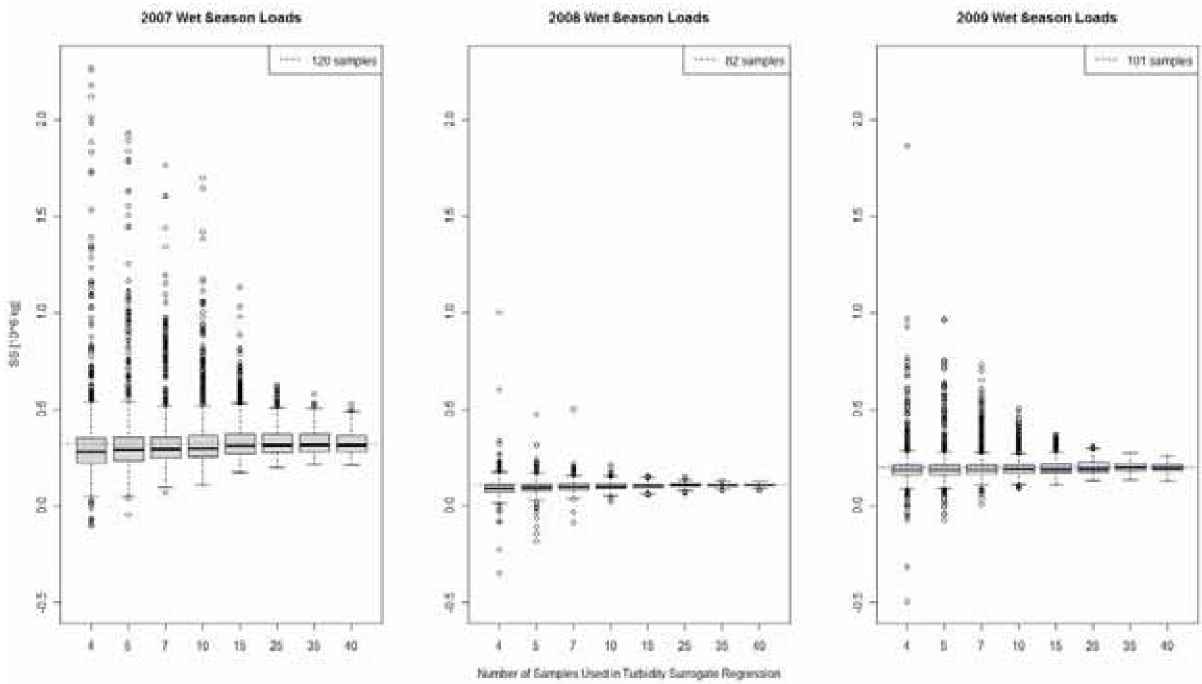
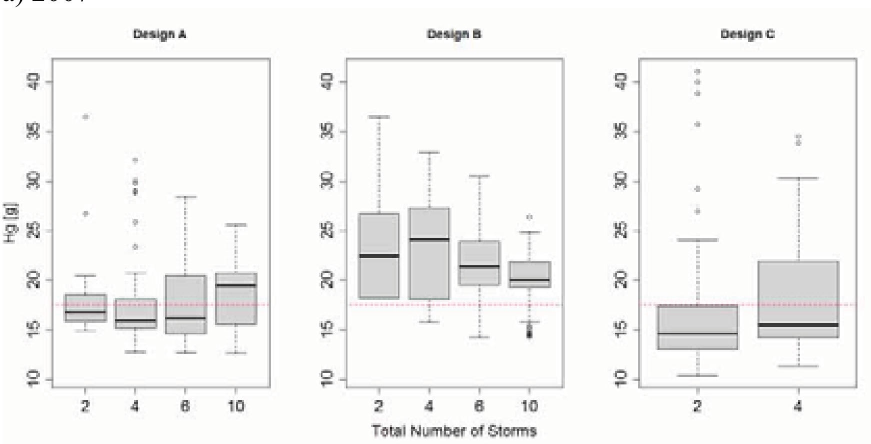

2007 Wet Season Loads
120 samples
2008 Wet Season Loads
82 samples
2009 Wet Season Loads
101 samples
2.0
1.5
1.0
0.5
0.0
-0.5
4
5
7
10
15
25
35
40
Number of Samples Used in Turbidity Surrogate Regression

Figure 13

a) 2007



b) 2009

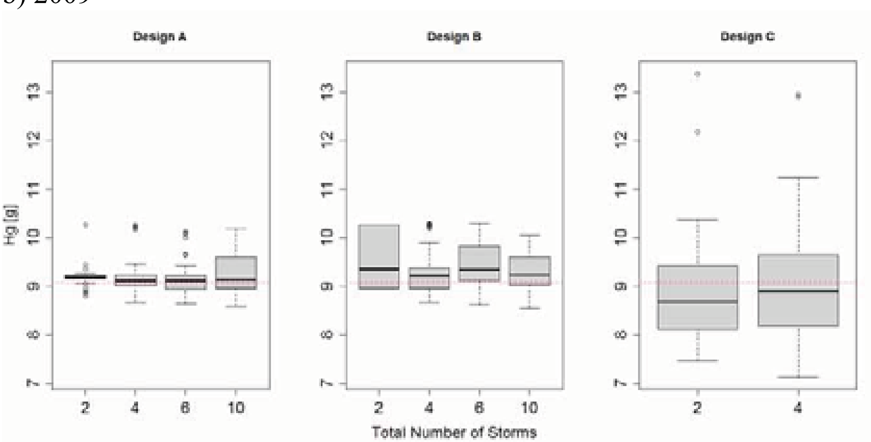
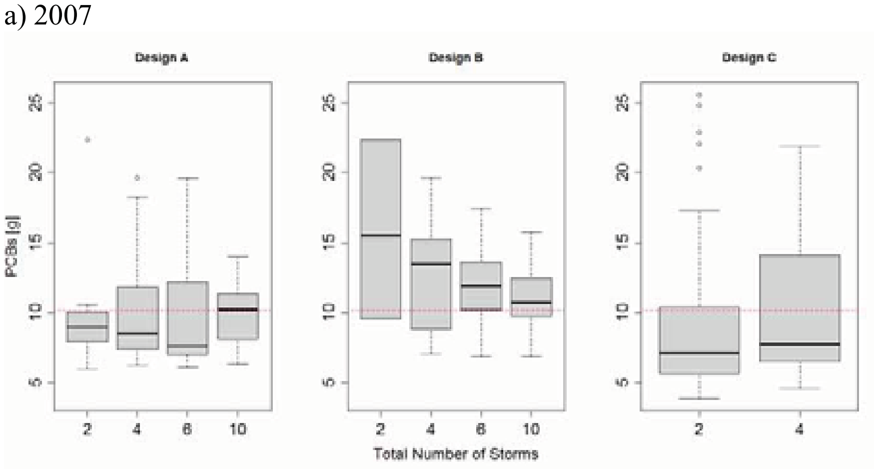


Figure 14a-b

a) 2007



b) 2009

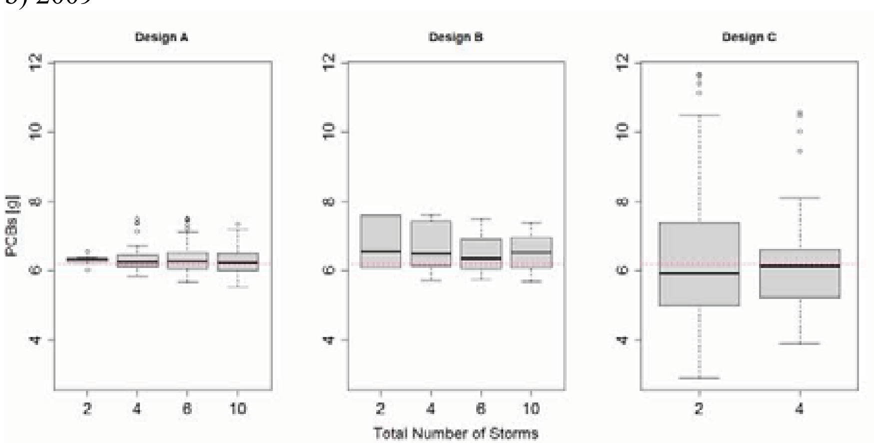
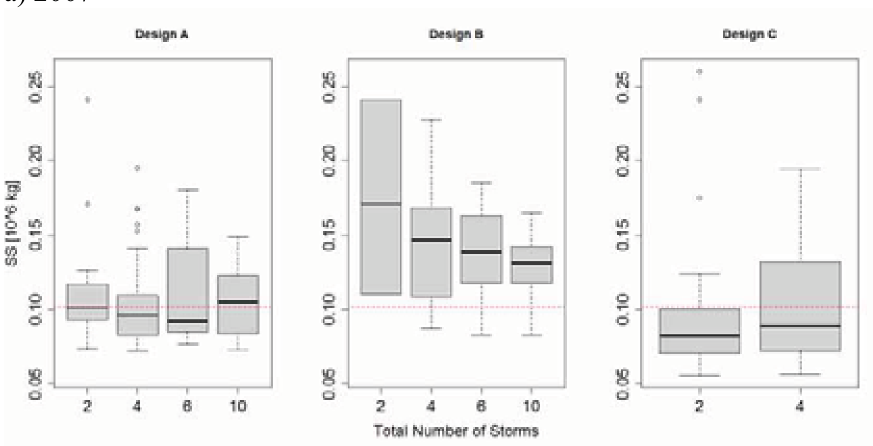


Figure 15a-b

a) 2007



b) 2009

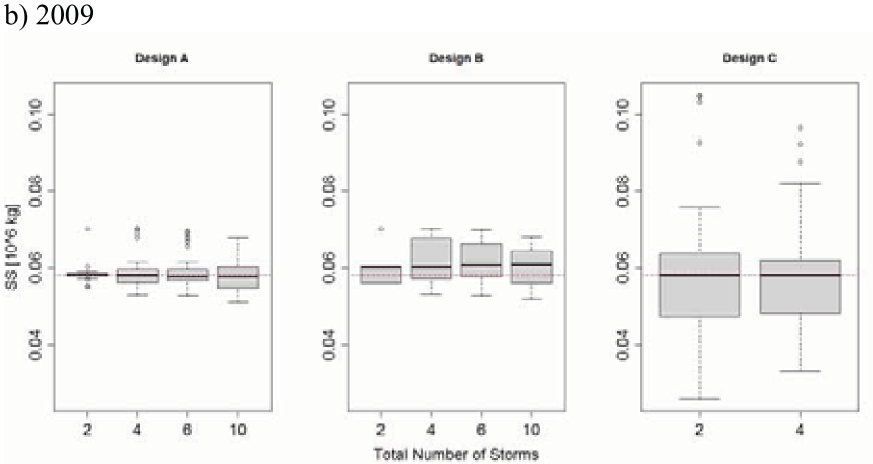


Figure 16a-b

Appendix A – SSC: Hg relationships at Zone 4 Line A

The mean slopes of SSC: Hg at Z4LA were below the target slopes for the trend analysis of 0.2 mg Hg / kg suspended sediment in two of the three years. Due to this situation, the Hg trend analysis examined power for trends assuming a target of 0.05 mg Hg / kg suspended sediment. The revised target was 75% below 0.2 mg/kg and was selected to ensure the trend could be examined for all years.

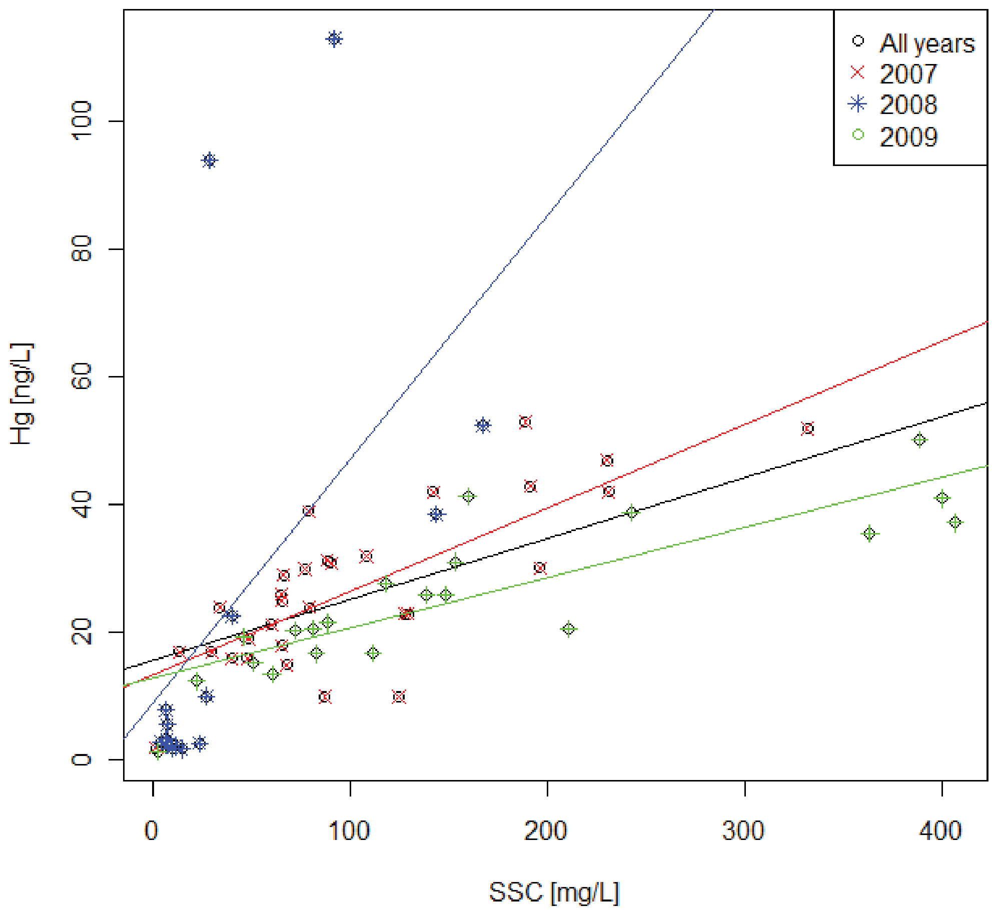
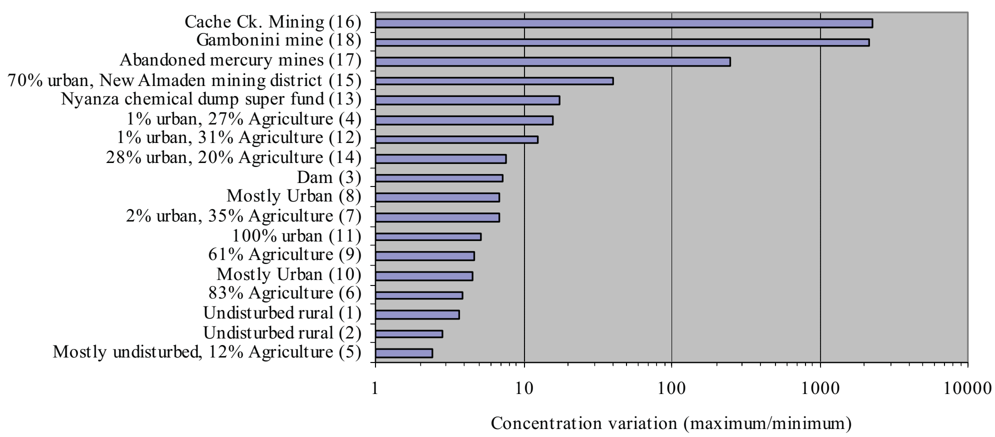


Figure A.1. SSC: Hg relationships at Zone 4 Line A. The mean slope estimate for 2007 – 2009 were 0.13, 0.38, and 0.08, respectively. The mean slope of all three years was 0.19.

Appendix B. Literature review of mercury variation by McKee et al. (2004)



	River (Source, see McKee et al. 2004)	Description	Min THg	Max THg	Max/min
5	Rappahannock R., Chesapeake (Lawson et al., 2001)	Mostly undisturbed, 12% Agriculture (5)	10.3	24.9	2.4
2	Site B1 Sudbury R., Massachusetts (Waldron et al., 2000)	Undisturbed rural (2)	1.9	5.4	2.8
1	Site B2 Sudbury R., Massachusetts (Waldron et al., 2000)	Undisturbed rural (1)	0.99	3.6	3.6
6	Choptank R., Chesapeake (Lawson et al., 2001)	83% Agriculture (6)	6.8	26.2	3.9
10	Anacostia R. NE. Branch (Mason and Sullivan, 1998)	Mostly Urban (10)	8.72	39.5	4.5
9	Susquehanna R., Chesapeake (Lawson et al., 2001)	61% Agriculture (9)	7	32.8	4.7
11	Herring Run R., Chesapeake (Lawson et al., 2001)	100% urban (11)	12.2	62.8	5.1
7	At Freeport, Sacramento Basin (Domagalski and Dileanis, 2000; Roth et al., 2001)	2% urban, 35% Agriculture (7)	4.2	29	6.9
8	Anacostia R. NW. Branch (Mason and Sullivan, 1998)	Mostly Urban (8)	4.45	30.8	6.9
3	Below Keswick Dam, Sacramento Basin (Domagalski and Dileanis, 2000; Roth et al., 2001)	Dam (3)	1.1	7.9	7.2
14	Potomac R., Chesapeake (Lawson et al., 2001)	28% urban, 20% Agriculture (14)	12.1	93.1	7.7
12	At Colusa, Sacramento Basin (Domagalski and Dileanis, 2000; Roth et al., 2001)	1% urban, 31% Agriculture (12)	6.5	81	12
4	Above Bend Bridge, Sacramento Basin (Domagalski and Dileanis, 2000; Roth et al., 2001)	1% urban, 27% Agriculture (4)	1.2	19	16
13	Site M1 Sudbury R., Massachusetts (Waldron et al., 2000)	Nyanza chemical dump super fund (13)	5.2	92	18
15	Guadalupe R., Bay Area (Leatherbarrow et al., 2002)	70% urban, New Almaden mining district (15)	18	730	41
16	Kuskakwim R. Basin, SW Alaska (Gray et al., 2000)	Abandoned mercury mines (17)	10	2500	250
17	Walker Ck. Marin County, California (Whyte and Kirchner, 2000)	Gambonini mine (18)	485	1040000	2144
15	Cache Ck., Sacramento Basin (Domagalski and Dileanis, 2000)	Cache Ck. Mining (16)	1	2250	2250

Appendix C –Within-storm Sampling Designs

Results are shown here for evaluation of within-storm sampling designs using flow and turbidity-based selection criteria. Bias here refers to the best estimate of loads per storm. Both flow and turbidity-based sampling criteria identified similar levels of accuracy (median load bias) and precision (standard error in load bias) in estimation of loads for the three pollutants (Hg, PCBs, suspended sediment).

C.1. Guadalupe River

Table C.1a. Summary of within-storm Hg loads (g) at Guadalupe River determined using three mass emission estimators. Flow-based storm selection criteria.

Emphasis	Sample Size	Median "Best Estimate" Load	Simple Mean Median Load	Simple Mean Median Bias	Simple Mean St. Error
Even	6	437	177	-50%	6%
Even	12		330	-21%	3%
Even	18		402	-14%	3%
Even	24		393	-10%	3%
Rising Stage	6		177	-50%	5%
Rising Stage	12		304	-25%	3%
Rising Stage	18		365	-15%	3%
Rising Stage	24		419	-10%	3%

Emphasis	Sample Size	Median "Best Estimate" Load	Linear Interpolation Median Load	Linear Interpolation Median Bias	Linear Interpolation St. Error
Even	6	437	205	-40%	7%
Even	12		411	-5%	5%
Even	18		510	0%	4%
Even	24		429	3%	3%
Rising Stage	6		205	-40%	7%
Rising Stage	12		454	-3%	6%
Rising Stage	18		460	3%	4%
Rising Stage	24		520	2%	4%

Emphasis	Sample Size	Median "Best Estimate" Load	Flow-weighted Mean Median Load	Flow-weighted Mean Median Bias	Flow-weighted Mean St. Error
Even	6	437	183	-47%	7%
Even	12		510	-2%	6%
Even	18		623	4%	5%
Even	24		533	10%	5%
Rising Stage	6		183	-45%	7%
Rising Stage	12		518	0%	7%
Rising Stage	18		479	9%	6%
Rising Stage	24		598	9%	6%

Table C.1b. Summary of within-storm Hg loads (g) at Guadalupe River determined using three mass emission estimators. Turbidity-based storm selection criteria.

			Simple Mean		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	285	149	-41%	4%
Even	12		241	-14%	3%
Even	18		251	-8%	-1%
Even	24		272	21%	3%
Rising Stage	6		149	-41%	4%
Rising Stage	12		237	-12%	4%
Rising Stage	18		277	-4%	4%
Rising Stage	24		289	0%	4%

			Linear Interpolation		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	285	175	-28%	4%
Even	12		257	-4%	3%
Even	18		284	0%	1%
Even	24		275	-1%	2%
Rising Stage	6		175	-30%	6%
Rising Stage	12		270	7%	4%
Rising Stage	18		274	4%	3%
Rising Stage	24		299	2%	2%

			Flow-weighted Mean		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	285	177	-30%	6%
Even	12		293	2%	4%
Even	18		321	12%	3%
Even	24		331	9%	3%
Rising Stage	6		178	-26%	7%
Rising Stage	12		307	13%	5%
Rising Stage	18		301	14%	5%
Rising Stage	24		324	17%	5%

Table C.1c. Summary of within-storm PCB loads (g) at Guadalupe River determined using three mass emission estimators. Flow-based storm selection criteria.

			Simple Mean		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	29	37	-18%	7%
Even	12		33	-4%	6%
Rising Stage	6		37	-15%	6%
Rising Stage	12		42	-1%	6%
			Linear Interpolation		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	29	40	-9%	8%
Even	12		34	2%	5%
Rising Stage	6		43	-1%	7%
Rising Stage	12		52	5%	6%
			Flow-weighted Mean		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	29	38	-13%	7%
Even	12		33	15%	7%
Rising Stage	6		39	1%	7%
Rising Stage	12		53	14%	7%

Table C.1d. Summary of within-storm PCB loads (g) at Guadalupe River determined using three mass emission estimators. Turbidity-based storm selection criteria.

			Simple Mean		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	10	9.1	-10%	4%
Even	12		11.3	-2%	4%
Rising Stage	6		9.1	-8%	5%
Rising Stage	12		11.5	3%	6%

			Linear Interpolation		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	10	9.3	-3%	4%
Even	12		11.3	-1%	4%
Rising Stage	6		9	-1%	7%
Rising Stage	12		13.5	12%	6%

			Flow-weighted Mean		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	10	9.1	-3%	5%
Even	12		13.4	10%	6%
Rising Stage	6		9.1	-1%	8%
Rising Stage	12		14.9	19%	8%

Table C.1e. Summary of within-storm suspended sediment loads (kg) at Guadalupe River determined using three mass emission estimators. Flow-based storm selection criteria.

			Simple Mean		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	224	111	-50%	4%
Even	12		199	-20%	5%
Even	18		197	-10%	4%
Even	24		219	-10%	4%
Rising Stage	6		111	-46%	4%
Rising Stage	12		182	-17%	4%
Rising Stage	18		218	-8%	4%
Rising Stage	24		219	-1%	4%

			Linear Interpolation		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	224	124	-40%	5%
Even	12		226	-1%	5%
Even	18		254	2%	4%
Even	24		245	2%	3%
Rising Stage	6		124	-34%	6%
Rising Stage	12		244	3%	6%
Rising Stage	18		258	6%	4%
Rising Stage	24		278	6%	4%

			Flow-weighted Mean		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	224	114	-47%	6%
Even	12		270	7%	8%
Even	18		286	16%	6%
Even	24		280	19%	5%
Rising Stage	6		114	-38%	8%
Rising Stage	12		282	17%	7%
Rising Stage	18		281	22%	6%
Rising Stage	24		316	20%	5%

Table C.1f. Summary of within-storm suspended sediment loads (kg) at Guadalupe River determined using three mass emission estimators. Turbidity-based storm selection criteria.

			Simple Mean		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	70	47	-37%	4%
Even	12		57	-19%	3%
Even	18		63	-2%	3%
Even	24		64	-3%	3%
Rising Stage	6		47	-37%	1%
Rising Stage	12		68	-4%	4%
Rising Stage	18		68	3%	4%
Rising Stage	24		72	4%	4%

			Linear Interpolation		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	70	50	-24%	5%
Even	12		68	-2%	3%
Even	18		72	2%	1%
Even	24		68	1%	2%
Rising Stage	6		50	-20%	6%
Rising Stage	12		78	18%	3%
Rising Stage	18		76	9%	3%
Rising Stage	24		77	5%	2%

			Flow-weighted Mean		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	70	48	-28%	6%
Even	12		74	13%	4%
Even	18		78	22%	3%
Even	24		80	19%	3%
Rising Stage	6		48	-19%	7%
Rising Stage	12		86	31%	4%
Rising Stage	18		86	30%	3%
Rising Stage	24		89	27%	3%

C.2. Zone 4 Line A

Table C.2a. Summary of within-storm Hg loads (mg) at Zone 4 Line A determined using three mass emission estimators. Flow-based storm selection criteria.

			Simple Mean		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	290	142	-46%	3%
Even	12		180	-26%	3%
Even	18		248	-14%	3%
Even	24		258	-8%	2%
Rising Stage	6		143	-41%	3%
Rising Stage	12		275	-15%	4%
Rising Stage	18		272	-5%	3%
Rising Stage	24		295	1%	3%

			Linear Interpolation		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	290	144	-44%	4%
Even	12		203	-11%	4%
Even	18		279	1%	3%
Even	24		278	3%	1%
Rising Stage	6		144	-38%	5%
Rising Stage	12		351	13%	4%
Rising Stage	18		311	9%	3%
Rising Stage	24		310	7%	2%

			Flow-weighted Mean		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	290	146	-44%	4%
Even	12		225	-9%	6%
Even	18		351	17%	5%
Even	24		358	17%	3%
Rising Stage	6		153	-38%	6%
Rising Stage	12		401	28%	7%
Rising Stage	18		395	28%	5%
Rising Stage	24		388	28%	4%

Table C.2b. Summary of within-storm Hg loads (mg) at Zone 4 Line A determined using three mass emission estimators. Turbidity-based storm selection criteria.

			Simple Mean		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	152	93	-41%	3%
Even	12		113	-12%	4%
Even	18		138	-5%	3%
Even	24		136	-1%	3%
Rising Stage	6		99	-34%	3%
Rising Stage	12		127	-1%	4%
Rising Stage	18		147	5%	4%
Rising Stage	24		152	8%	4%

			Linear Interpolation		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	152	108	-30%	4%
Even	12		143	3%	2%
Even	18		166	3%	1%
Even	24		158	3%	1%
Rising Stage	6		109	-22%	7%
Rising Stage	12		184	22%	4%
Rising Stage	18		177	12%	2%
Rising Stage	24		166	8%	2%

			Flow-weighted Mean		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	152	95	-29%	5%
Even	12		157	13%	4%
Even	18		192	17%	4%
Even	24		187	18%	4%
Rising Stage	6		109	-22%	7%
Rising Stage	12		202	34%	5%
Rising Stage	18		191	33%	5%
Rising Stage	24		196	31%	4%

Table C.2c. Summary of within-storm PCB loads (mg) at Zone 4 Line A determined using three mass emission estimators. Flow-based storm selection criteria.

			Simple Mean		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	131	59	-47%	3%
Even	12		89	-26%	3%
Rising Stage	6		61	-42%	3%
Rising Stage	12		119	-15%	4%

			Linear Interpolation		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	131	62	-44%	4%
Even	12		104	-11%	4%
Rising Stage	6		65	-40%	5%
Rising Stage	12		145	13%	4%

			Flow-weighted Mean		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	131	61	-44%	4%
Even	12		113	-9%	6%
Rising Stage	6		63	-38%	6%
Rising Stage	12		180	27%	7%

Table C.2d. Summary of within-storm PCB loads (mg) at Zone 4 Line A determined using three mass emission estimators. Turbidity-based storm selection criteria.

			Simple Mean		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	67	39	-45%	3%
Even	12		54	-14%	4%
Rising Stage	6		44	-40%	3%
Rising Stage	12		58	-5%	5%

			Linear Interpolation		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	67	44	-35%	4%
Even	12		63	3%	2%
Rising Stage	6		48	-22%	8%
Rising Stage	12		93	18%	4%

			Flow-weighted Mean		
Emphasis	**Sample Size**	**Median "Best Estimate" Load**	**Median Load**	**Median Bias**	**St. Error**
Even	6	67	47	-35%	5%
Even	12		68	14%	5%
Rising Stage	6		47	-22%	8%
Rising Stage	12		90	34%	6%

Table C.2e. Summary of within-storm suspended sediment loads (g) at Zone 4 Line A determined using three mass emission estimators. Flow-based storm selection criteria.

			Simple Mean		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	1244	536	-54%	4%
Even	12		705	-29%	4%
Even	18		1055	-17%	3%
Even	24		1171	-7%	2%
Rising Stage	6		536	-48%	4%
Rising Stage	12		1105	-15%	4%
Rising Stage	18		1163	-3%	3%
Rising Stage	24		1407	3%	3%

			Linear Interpolation		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	1244	549	-51%	5%
Even	12		947	-11%	4%
Even	18		1150	0%	3%
Even	24		1272	3%	1%
Rising Stage	6		585	-46%	6%
Rising Stage	12		1381	15%	5%
Rising Stage	18		1430	11%	3%
Rising Stage	24		1443	8%	3%

			Flow-weighted Mean		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	1244	551	-51%	6%
Even	12		1185	-10%	6%
Even	18		1337	15%	6%
Even	24		1592	18%	4%
Rising Stage	6		565	-43%	7%
Rising Stage	12		1739	33%	8%
Rising Stage	18		1594	35%	5%
Rising Stage	24		1836	32%	5%

Table C.2f. Summary of within-storm suspended sediment loads (g) at Zone 4 Line A determined using three mass emission estimators. Turbidity-based storm selection criteria.

			Simple Mean		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	653	328	-43%	4%
Even	12		590	-11%	6%
Even	18		643	-6%	5%
Even	24		662	2%	6%
Rising Stage	6		342	-38%	4%
Rising Stage	12		673	-1%	7%
Rising Stage	18		791	8%	7%
Rising Stage	24		741	10%	7%

			Linear Interpolation		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	653	351	-35%	4%
Even	12		682	4%	4%
Even	18		653	4%	3%
Even	24		640	4%	3%
Rising Stage	6		351	-29%	7%
Rising Stage	12		956	19%	5%
Rising Stage	18		745	15%	3%
Rising Stage	24		655	9%	3%

			Flow-weighted Mean		
Emphasis	Sample Size	Median "Best Estimate" Load	Median Load	Median Bias	St. Error
Even	6	653	353	-34%	6%
Even	12		709	13%	7%
Even	18		768	22%	5%
Even	24		820	21%	6%
Rising Stage	6		353	-27%	7%
Rising Stage	12		918	37%	7%
Rising Stage	18		890	36%	7%
Rising Stage	24		811	34%	7%

Appendix D. Among-storm sampling designs (turbidity-based sampling)

Results are presented here for among-storm sampling designs with turbidity-based storm sampling. These results were generally more variable than the flow-based results presented in the main text of the report.

Figure Captions

Figure D.1a-c. Comparison of annual Hg loads at Guadalupe River in 2003-2005 based on three designs for sampling among storms (Table 5). Loads were calculated using linear interpolation with turbidity-based storm selection criteria. Design A simulated sampling of the first flush only and a variable number of random storms. Design B simulated the first flush plus one of the three largest storms and a variable number of random storms. Design C only tested the random storm component. --------- = best estimate Hg load for year

Figure D.2a-c. Comparison of annual PCB loads at Guadalupe River in 2003-2005 based on three designs for sampling among storms (Table 5). See Figure D.1 caption and text for further information. --------- = best estimate PCB load for year.

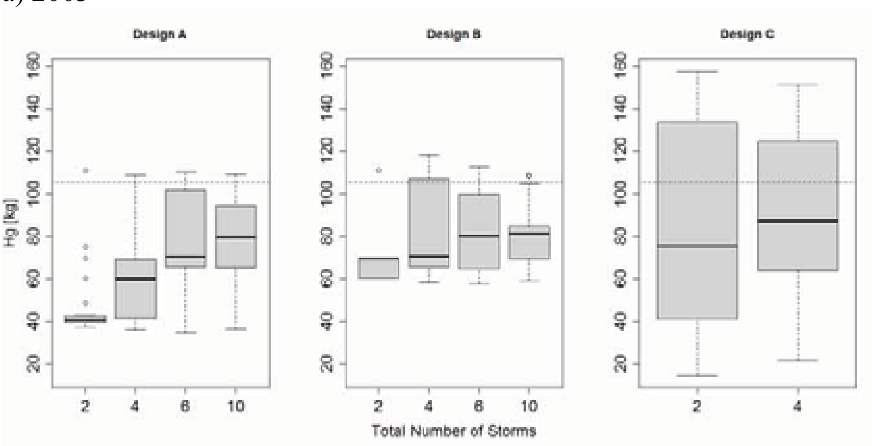
Figure D.3a-c. Comparison of annual SS loads at Guadalupe River in 2003-2005 based on three designs for sampling among storms (Table 5). See Figure D.1 caption and text for further information. --------- = best estimate SS load for year.

Figure D.4a-c. Comparison of annual Hg loads at Zone 4 Line A in 2007 and 2009 based on three designs for sampling among storms (Table 5). See Figure D.1 caption and text for further information. --------- = best estimate Hg load for year.

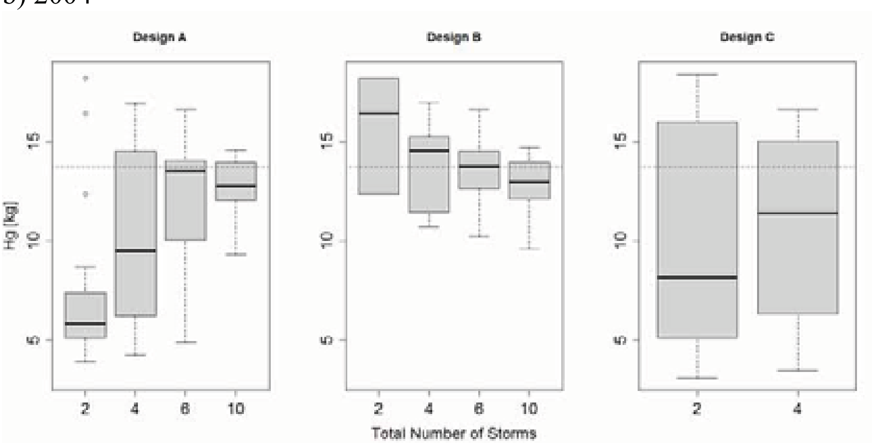
Figure D.5a-c. Comparison of annual PCB loads at Zone 4 Line A in 2007 and 2009 based on three designs for sampling among storms (Table 5). See Figure D.1 caption and text for further information. --------- = best estimate PCB load for year.

Figure D.6a-c. Comparison of annual SS loads at Zone 4 Line A in 2007 and 2009 based on three designs for sampling among storms (Table 5). See Figure D.1 caption and text for further information. --------- = best estimate SS load for year.

a) 2003



b) 2004



c) 2005

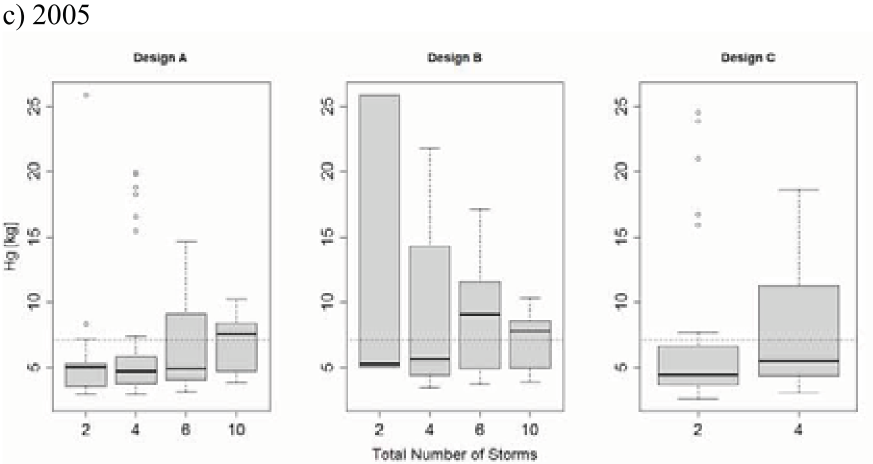
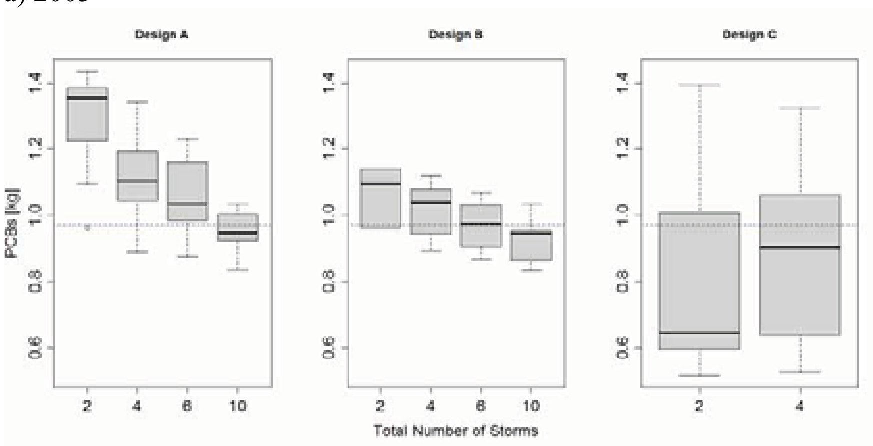
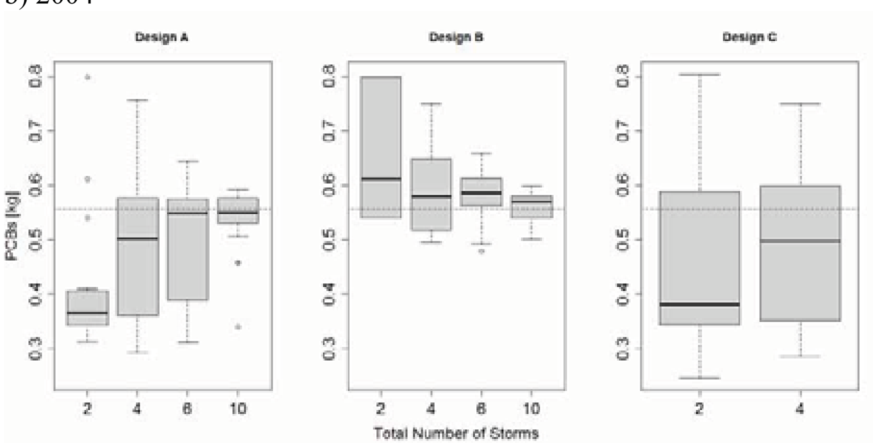


Figure D.1a-c

a) 2003



b) 2004



c) 2005

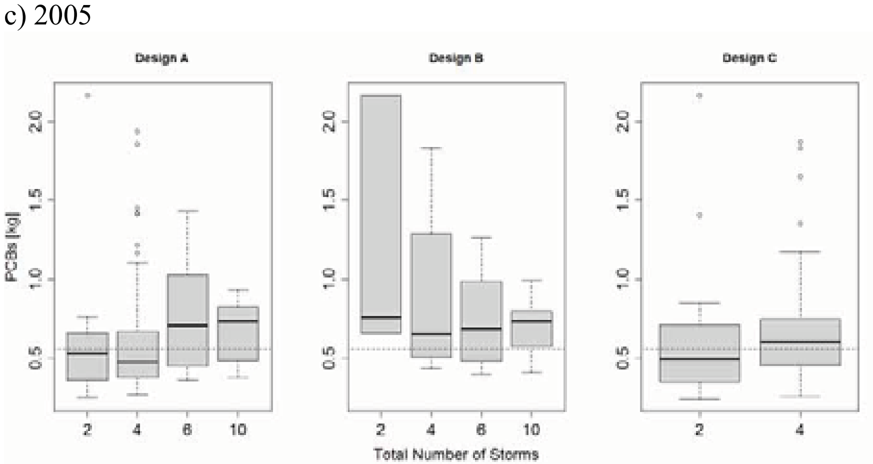
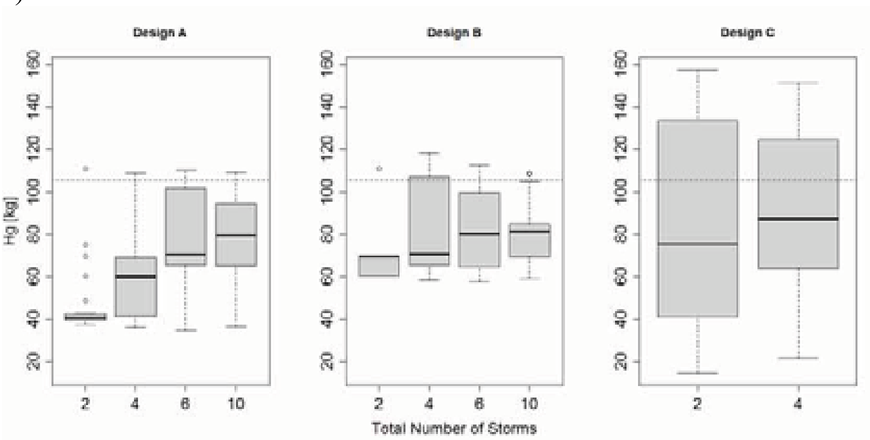
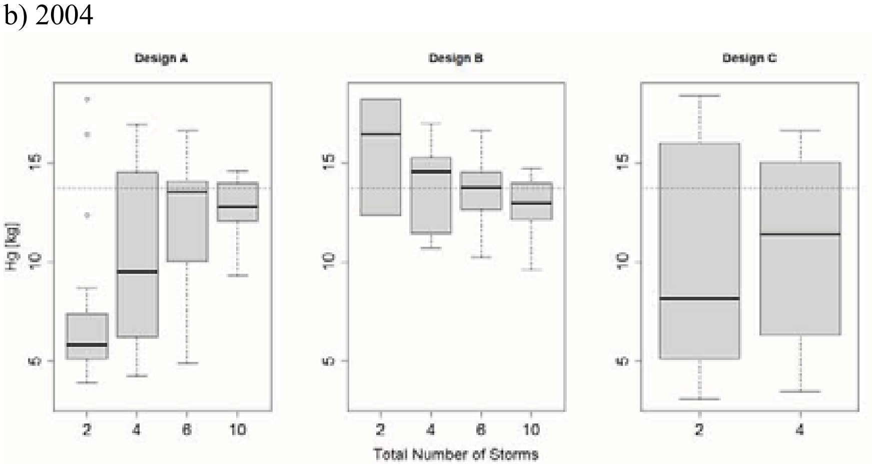


Figure D.2a-c

a) 2003



b) 2004



c) 2005

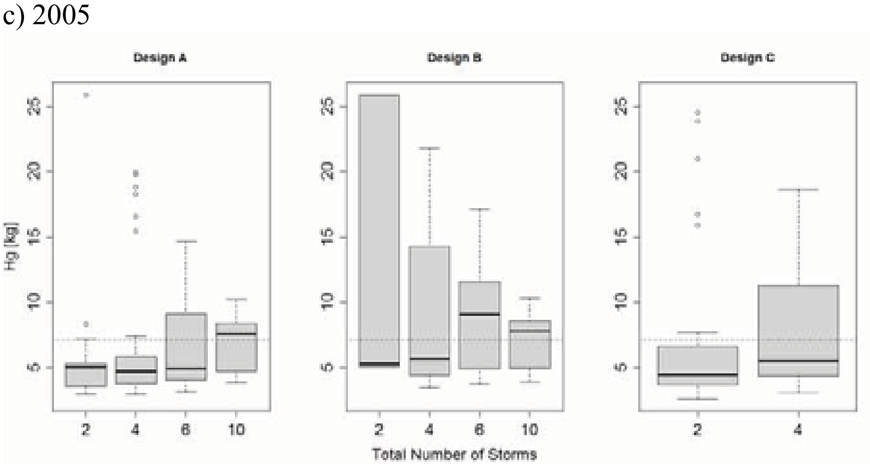
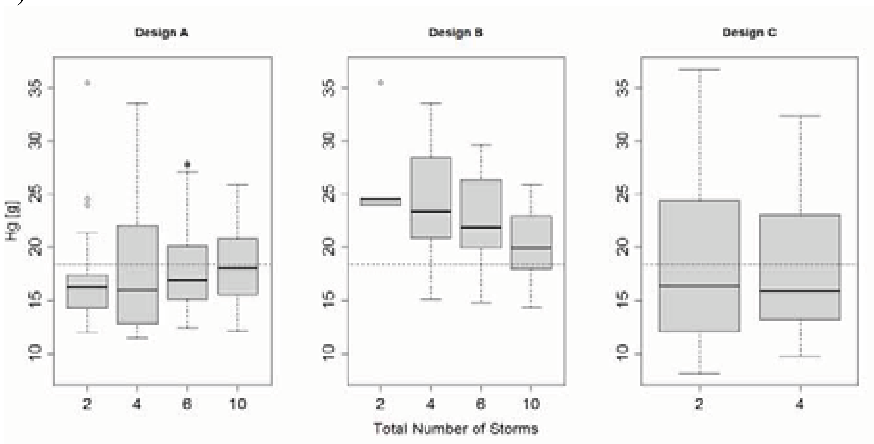


Figure D.3a-c

a) 2007



b) 2009

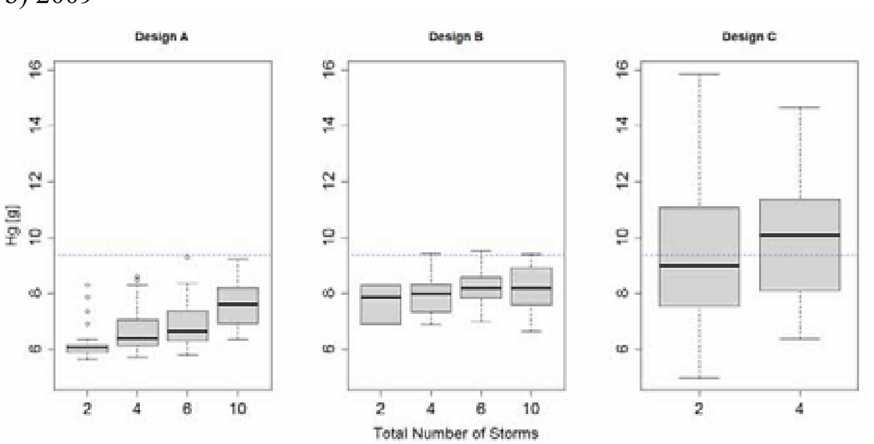
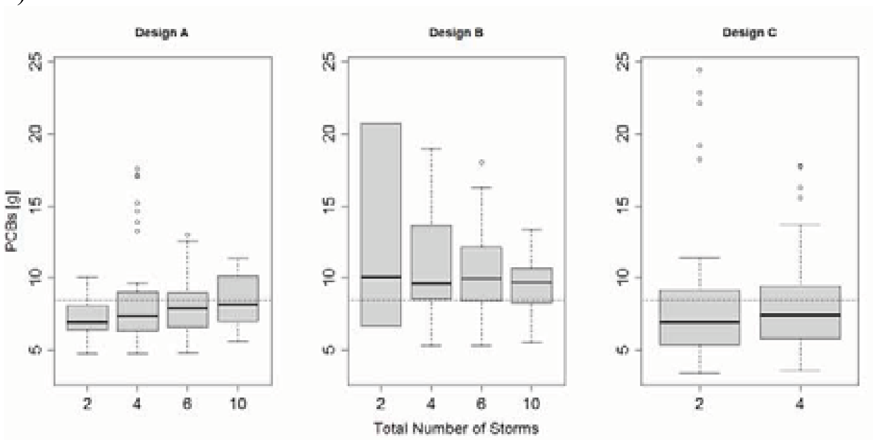


Figure D.4a-b

a) 2007



b) 2009

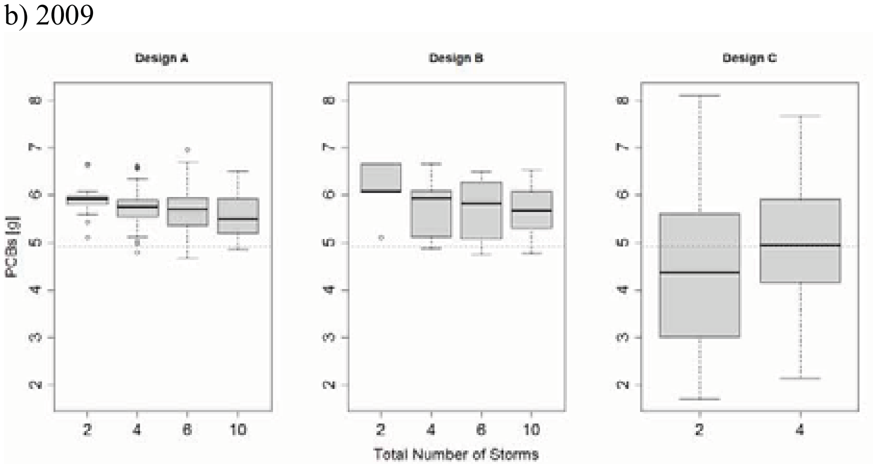
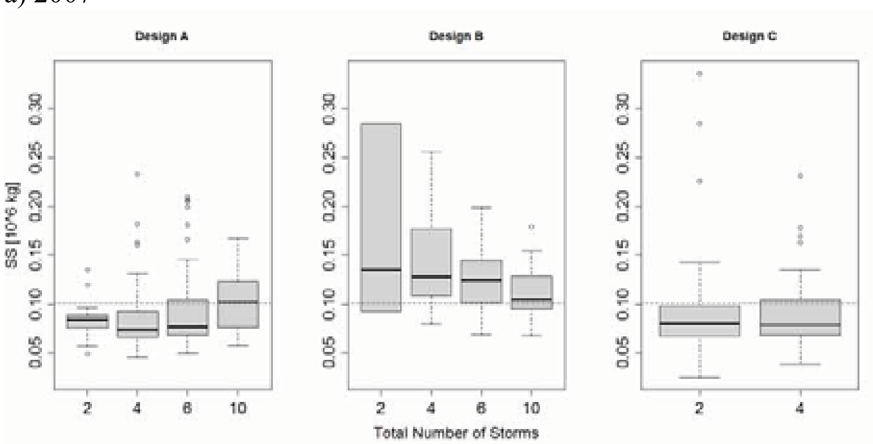


Figure D.5a-b

a) 2007



b) 2009

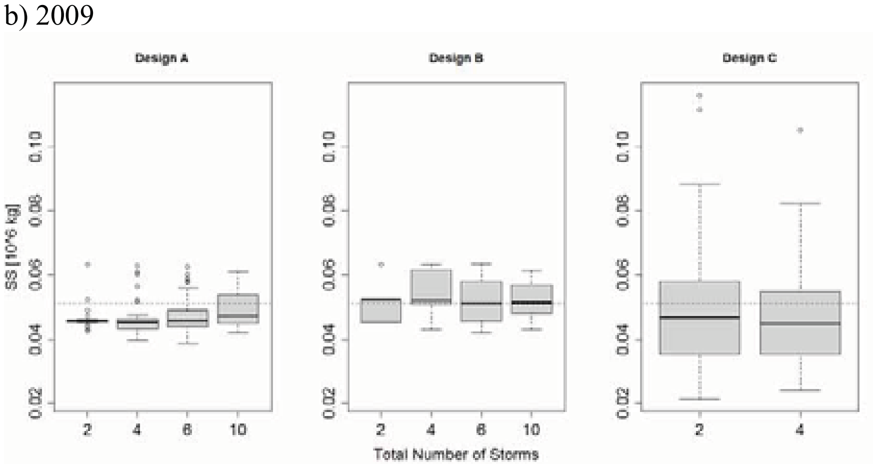


Figure D.6a-b

Appendix E. Comparison of annual PCB and SS loads at Guadalupe River in 2003 – 2005 based on three designs for sampling among storms.

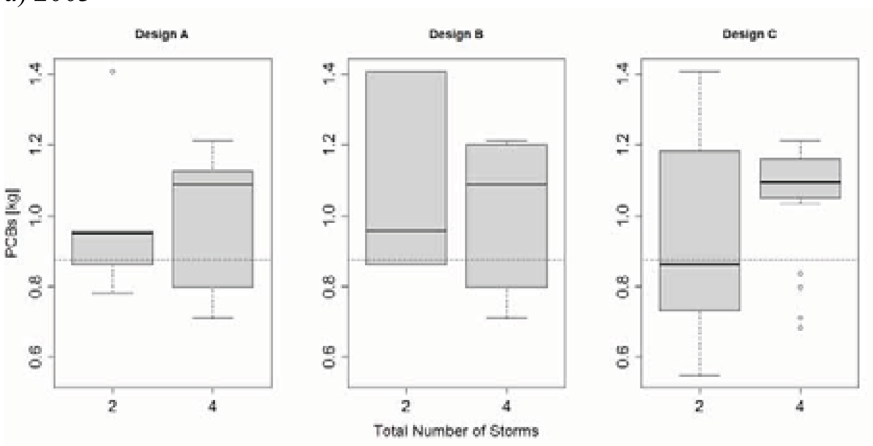
Results for estimation of annual PCB and SS loads at Guadalupe River mirrored that of Hg loads. Accuracy and precision were optimal at 6 or 10 storms samples per water year. Designs A and B performed the best and similarly well, with Design C exhibiting good accuracy, but poor precision.

Figure Captions

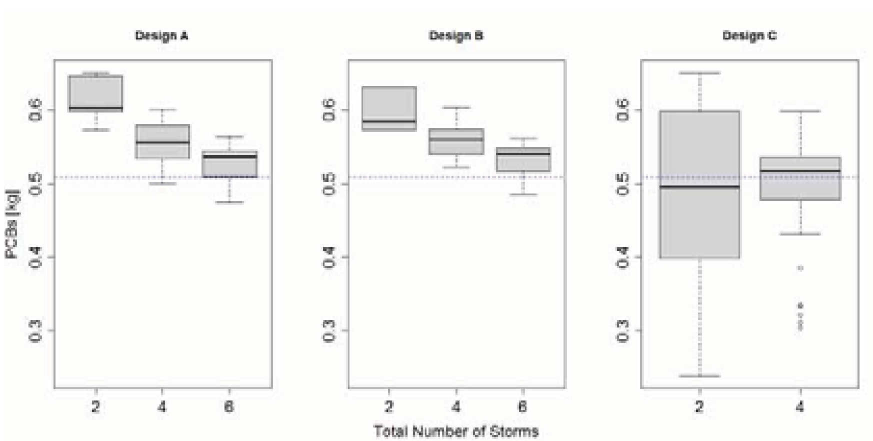
Figure E.1a-c. Comparison of annual PCB loads at Guadalupe River in 2003-2005 based on three designs for sampling among storms (Table 5). Loads were calculated using linear interpolation with flow-based storm selection criteria. In addition to the random component, Designs A and B simulated sampling of the first flush (A) and first flush plus one of the three largest storms (B). Design C only tested the random storm component. --------- = best estimate PCB load for year (0.9 kg, 0.5 kg, and 0.5 kg, respectively).

Figure E.2a-c. Comparison of annual SS loads at Guadalupe River in 2003-2005 based on three designs for sampling among storms (Table 5). Loads were calculated using linear interpolation with flow-based storm selection criteria. In addition to the random component, Designs A and B simulated sampling of the first flush (A) and first flush plus one of the three largest storms (B). Design C only tested the random storm component. --------- = best estimate SS load for year (10 x 10^6 kg, 8 x 10^6 kg, and 4 x 10^6 kg, respectively)

a) 2003



b) 2004



c) 2005

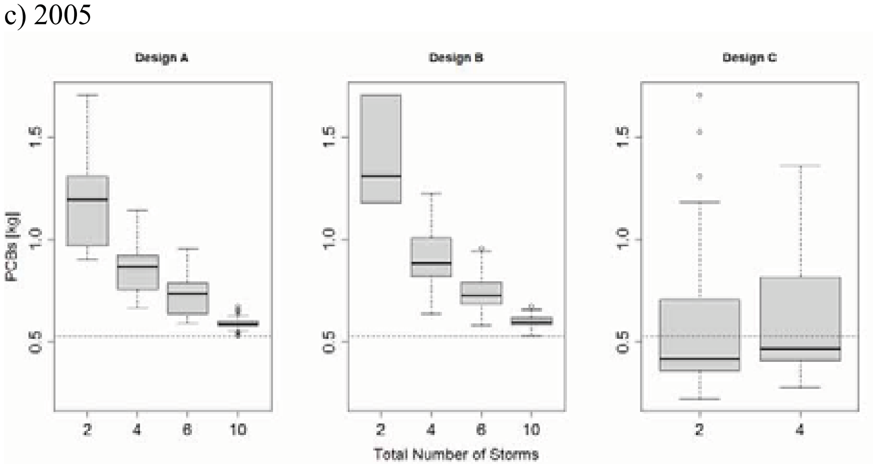
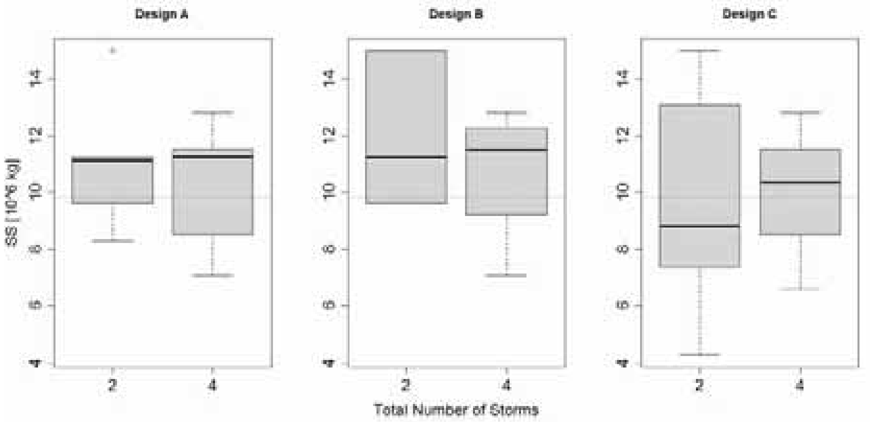
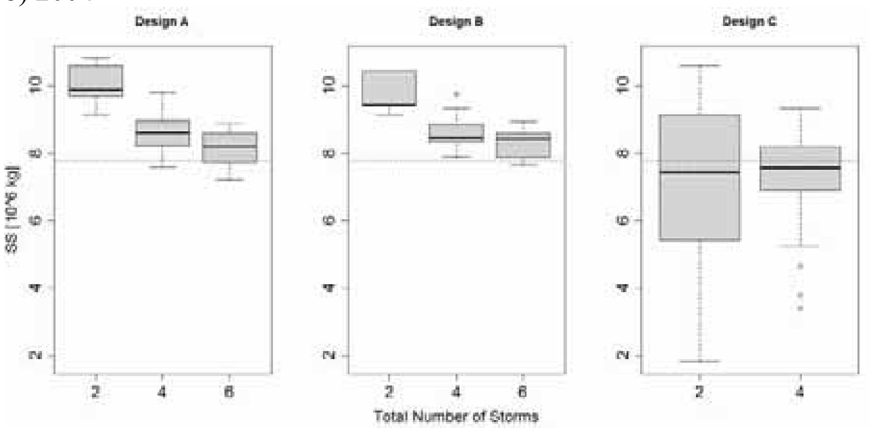


Figure 1a-c.

a) 2003



b) 2004



c) 2005

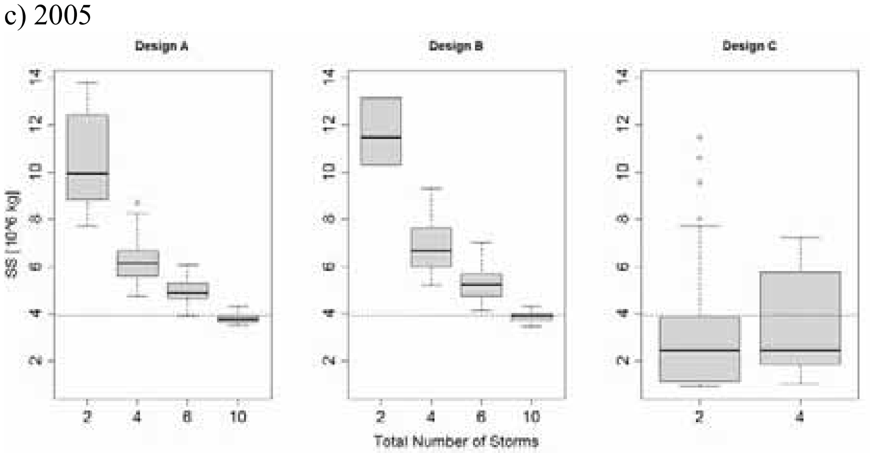


Figure 2a-c.

Exploratory categorization of watersheds for potential stormwater monitoring in San Francisco Bay.

Technical Memorandum

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[1] Deceased

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TABLE OF CONTENTS

Summary

This document presents technical information regarding watershed classification schemes and potential sampling priorities for contaminant monitoring in small tributaries draining to San Francisco Bay. This study provides information to be used in conjunction with other technical information, monitoring and management considerations, and stakeholder priorities to develop and design monitoring studies conducted to address management needs and questions of the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) and the Municipal Regional Stormwater Permit (MRP).

Cluster analysis using Bray-Curtis dissimilarity was used to classify 185 Bay Area watersheds into eight categories based on existing information and data pertaining to several watershed characteristics and attributes: population; historic and current land use, cover (i.e., imperviousness), and activities (e.g., auto dismantling, railroads); and contaminant data describing PCB and Hg distribution in watershed soils and sediment. The majority of watersheds (n = 119) were categorized into three main clusters [Cluster 1 (n = 41), Cluster 2 (n = 43) and Cluster 3 (n = 35)] that are typical of urban watersheds in the Bay Area, characterized by densely populated low lying areas with high proportions of residential, commercial, and industrial land use that drain into South and Central Bays. These watersheds differ primarily in the existence of PG&E substations (only for Cluster 2) and historic land use for railroads and pumping stations (general absence in Cluster 3).

The remaining watersheds (n = 76) fall into the five other clusters that have relatively distinct watershed attributes, primarily based on imperviousness and land use. These clusters span the range of impervious cover found in the Bay Area: small, densely industrial (68% current and 73% historic) watersheds in the vicinity of San Francisco International Airport in Cluster 4 (n = 11); larger watersheds with high proportions of land uses devoted to open space in Clusters 5 (n = 11, 61%,) and 6 (n = 22, 63%) and agriculture in Cluster 7 (n = 17, 43%); and small, nearly total open land use (97%) watersheds draining to Carquinez Strait in Cluster 8 (n = 5). Some Cluster 6 watersheds occurred in low-lying areas adjacent to the Bay and had relatively high density of PG&E substations, both of which could contribute to higher pollutant loads, compared to Cluster 5.

Ordination results indicated two watershed attributes influencing variation in watershed clusters. The first influence on clustering was gradients in impervious cover. This was exemplified by the gradient in industrial land cover with high imperviousness observed in Cluster 4 to open land cover in Cluster 8. The second influence on clustering was specific industrial development within the watershed. This was illustrated by differences between Cluster 3 and Clusters 1 and 2. Though all three of these clusters contain moderate to high industrial land cover, watersheds in Cluster 3 do not contain railroads or PG&E facilities. The ordination results suggest that the small urbanized watersheds (Bray-Curtis Cluster 3), agricultural watersheds (Bray-Curtis Cluster 7), and the industrial watersheds near SF Airport (Bray-Curtis Cluster 4) are clearly distinct from the other watersheds in the study area.

Further analyses were conducted to explore the use of the clustering approach based on only two important variables: impervious cover plus either historic railroads or PG&E substations. Although a loss of detail occurs when only using two variables to cluster watersheds, the results generally agree with the cluster results using the full set of variables.

This watershed classification provides information for efforts aimed at selecting watersheds for subsequent contaminant concentration and loads monitoring with the goal of targeting specific land attributes and thus, potential historic and current sources. In the case of targeting historic pollutants with industrial sources (e.g., PCBs), candidate watersheds would contain areas of historic industrial land use and activities, such as those found in Clusters 1, 2, 4, and 6. Additional considerations for selecting watersheds may include: collection of monitoring data on contaminant concentrations and loads; including a range of watershed sizes; and including a range of impervious cover. Characterization of the full range of watershed sizes and impervious cover, particularly for small, open-space watersheds, where contamination is dominated by atmospheric deposition and natural attenuation, should aid in evaluating the relative severity of contamination and loading from high-leverage tributaries. Monitoring for watersheds spanning a wide range of attributes should assist in calibration of concurrent land-use based loading models efforts for the Bay.

Introduction

The San Francisco Bay Regional Water Quality Control Board (Water Board) has developed Total Maximum Daily Load reports (TMDLs) for mercury (Hg) and polychlorinated biphenyls (PCBs) (SFBRWQCB 2006, 2008). These TMDLs summarize available knowledge, provide linkages between wasteloads and beneficial uses, and prescribe mass load reductions aimed at bringing San Francisco Bay into compliance with water quality objectives or other applicable standards (SFBRWQCB 2006, 2008). Both TMDLs call for increased effort by stormwater agencies to manage and reduce loads over a 20 year period (2028 for Hg and 2030 for PCBs). The TMDLs allow for wasteload allocations (WLAs) of 82 kg of Hg and 2 kg of PCBs in urban stormwater. These represent estimated reductions of 50% and 90% over the present load estimates of 160 kg of Hg and 20 kg of PCBs. However, the current loads estimates are highly uncertain. In addition, since one method of demonstrating compliance is to determine trends in loads (either mass or particle concentrations), there is a need for increased effort to measure loads.

This need is reflected in the recently adopted Municipal Regional Stormwater Permit (MRP) (SFBRWQCB 2009) that covers the co-permittees of the cities of Vallejo, Fairfield, and Suisun, and the counties of Contra Costa, Alameda, Santa Clara, and San Mateo. Provision C.8.e of the MRP calls for pollutants of concern (POCs) monitoring that is intended to assess inputs of POCs to the Bay from local tributaries and urban runoff. This monitoring should provide a basis to assess progress toward achieving WLAs for TMDLs. It is also intended to help resolve uncertainties associated with loading estimates for these pollutants.

Consistent with this permit requirement, the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) has developed a Small Tributaries Loadings Strategy (STLS). The STLS is intended to help RMP and Bay Area Stormwater Management Agencies Association (BASMAA) efforts achieve common objectives laid out by the permit. The STLS and the permit provision C.8.e. were developed in parallel and contain the same basic management needs:

1) Identify which Bay tributaries (including stormwater conveyances) contribute most to Bay impairment from pollutants of concern;
2) Quantify annual loads or concentrations of pollutants of concern from tributaries to the Bay;
3) Quantify the decadal-scale loading or concentration trends of pollutants of concern from small tributaries to the Bay; and
4) Quantify the projected impacts of management actions (including control measures) on tributaries and identifying where these management actions should be implemented to have the greatest beneficial impact.

A long-standing recommendation of the Sources Pathways and Loadings Workgroup (SPLWG), a technical workgroup of the RMP, is to stratify watersheds into general categories and then to sample a subset of watersheds in selected categories. Two key questions in relation to the STLS and the MRP are as follows: (1) how many types of watersheds occur in the permitted region; and (2) how many watersheds should be studied to answer key management questions? In response to needs of the MRP as well as the RMP (described below), this study has two main objectives:

1) To develop and document a rationale for initially classifying Bay Area small tributary watersheds into a small number (<10) of classes, relevant for loads monitoring and Bay margin impacts;
2) To provide STLS stakeholders with a tool to help develop a list of representative watersheds in each class, and rank them for focused follow-up evaluation.

Categorizing watersheds and determining which watersheds to study will provide a basis for improving the cost effectiveness of developing loads information. It will also provide support for other strategies and initiatives. For example, the RMP *Modeling Strategy* is developing a Bay margins conceptual model that will benefit from establishing priority watersheds, and from compiling watershed contaminant and process data. In addition, the RMP Small Fish Study (Greenfield and Jahn 2010), originally conceived in the *Mercury Strategy,* is proposed to be expanded to include PCBs in 2010. Information developed for classifying watersheds could help to identify candidate sites for small fish sampling. As the RMP continues to support process studies for contaminant uptake into the food web, this watershed classification study will help identify high leverage areas on the Bay margin likely to have relatively large food web impacts.

Cluster analysis is one approach used in previous studies to categorize and characterize water bodies and watersheds, based on general land cover attributes available through GIS (Eilers et al. 1983; Young and Stoddard 1996; Bulley et al. 2007). Cluster analysis is an exploratory technique designed to visualize patterns on complex multivariate data sets, particularly aimed at identifying unique groupings (i.e., Clusters) within the data set, based on the combined differences of multiple attributes. In ecology, cluster analysis is frequently performed to generate categories of habitats, or other groupings of sampling events, based on overall patterns of species abundance and distribution. In the present exercise, we use this technique to categorize watersheds in sections of San Francisco Bay, based on available land use, land cover, and other environmental data. The intent is to form a basis for developing a sampling scheme to evaluate contaminant and suspended sediment loading in relation to the TMDLs and MRP permit provision C.8.

Methods

Watershed boundary delineation

In order to generate statistical characteristics of Bay Area watersheds as basic input data for a cluster analysis, a series of spatial data layers were retrieved from local, state and federal agencies. Central to this analysis was a watershed boundary layer, the modern form of which has been in development for several decades. The challenge with urban watershed boundaries is that much of the drainage system is underground and only loosely follows topographic landscape features. Since the early 1990s, the RMP, BASMAA, and Bay Area flood control agencies have been involved in an effort to collate a geographic information system (GIS) map of the urban drainage infrastructure for the Bay Area at a regional scale. At present, watershed boundaries have been generated for most watersheds in western Contra Costa County, Alameda County, Santa Clara County, and San Mateo County and are downloadable from a range of locations on the internet including SFEI (http://www.sfei.org/projects/3051). Additional watershed boundary information was provided from the Contra Costa County Watershed Atlas for eastern Contra Costa County. The area of the present study includes a total of 185 watersheds in these counties, for which high quality watershed boundary information is readily available (Figure 1, Appendix A).

Watershed boundaries and drainage areas of the 185 watersheds were modified to remove tidally-influenced portions of the watersheds and areas upstream of major dams. Bayland portions of the watersheds with tidal influence were removed from this analysis using the EcoAtlas Modern Bayland Habitat layer. Areas upstream of major dams were treated as separate subwatersheds in this analysis, as these were assumed to trap all sediments and associated contaminants and, therefore, not be valid as future study locations for assessment of contaminant loads impacting San Francisco Bay. Therefore, these areas would not be selected for sampling, regardless of the statistical analysis output. To identify and remove drainage areas above dams, a point file from the National Inventory of Dams was sorted by the size of the drainage into the reservoir. All points with a drainage area over 20 square miles (approximately 50 square kilometers) were considered consistent with the previous work of Davis et al. (2000), resulting in the removal of the areas above 10 major dams in the study area. The upstream portions of the watersheds were digitized using the 10 meter Digital Elevation model (DEM), 10 meter DEM hillshade, USGS Topoquads, and the National Hydrologic Dataset (NHD) flow lines including the South Bay storm drains. Area was then calculated for each watershed polygon. The total area delineated upstream of these points is 1,597 km^2.

The resulting GIS boundary layer shape file includes 185 watersheds ranging in size from 0.023 to 962 km^2 and covering a total area of 5,630.5 km^2 in the counties of Contra Costa, Alameda, Santa Clara, and San Mateo (Appendix A). Watersheds in the jurisdictions of Fairfield and Suisun were not included because high quality data have not yet been assembled on watershed boundaries and other attributes.

GIS watershed attributes

Statistics for each watershed were generated for human population, land use types including modern and historical industrial area and rail transport lines, areas of greater likelihood of PCBs and Hg contamination (for example auto-wrecking yards), areas of greater PCB use (e.g. PG&E facilities), and other relevant layers thought to be useful for classifying watersheds in relation to PCB and Hg loading studies (McKee et al. 2006). Each of these layers, and their basis for inclusion, are described in more detail below.

Population: Population was calculated from the 2000 Census Block Groups shapefile. The Block Group polygons were split by watershed boundaries. The resulting split population polygon populations were recalculated by multiplying the area of the split polygon by the population per unit area. Population was then summed for each watershed.

Land use and cover:
Land use: Land use was calculated from the Assocation of Bay Area Governments (ABAG) 1995 Regional Existing Land Use dataset (ABAG 1997). The land use polygons were split by watershed boundaries. Land use was categorized into industrial, residential, commercial, open space and agriculture. Null land use values were excluded from analysis. These null values were generally Bayland features, upland reservoirs, and portions of the watershed outside the boundaries of the land use dataset. The area per watershed of each land use type was attributed to each watershed.

Historic industrial land use: PCBs and Hg are classified as legacy contaminants. Although small amounts are still in use today, the peak use of both substances occurred more than three decades ago. Both substances were used in industrial applications; consequently, soils and sediments in historic industrial areas are often contaminated (van Geen and Luoma 1999; Kuzyk et al. 2005b; SFBRWQCB 2006, 2008). The historic industrial land use dataset was based on land use that is classified "urban" in 1954 USGS reference maps and "industrial" in current ABAG reference maps (ABAG 1997). The 1954 reference maps do not distinguish industrial land uses from other urban uses (e.g. residential, commercial). In order to estimate historic industrial land use, we made the assumption that any areas that are currently industrial land use that intersect with the historic urban land use layer were historically industrial. This was assumed because it is unlikely that residential, commercial, agricultural or open space land use would be converted to industrial land use given trends in the Bay Area are dominantly towards urban residential and commercial land uses. This data layer was split by watershed boundary, and historic industrial land use area was summed by watershed.

Impervious surface: The volume of runoff that occurs in urban areas is influenced by the area of impervious surfaces. Since PCBs and Hg are predominantly transported into San Francisco Bay during rain storms and stormwater runoff (McKee et al. 2005), permeability is a potential indicator of PCB and Hg loads. The NLCD 2001 Impervious layer [National Land Cover Dataset (NLCD) 2001] was converted to polygons to calculate percent permeable surfaces. This polygon layer was then split by watershed boundary. The polygon area was calculated for each permeability value polygon and this area was multiplied by the percent permeability to create the amount of impervious surface. The amount of impervious surface was then summed by watershed.

Railroads: Soils in areas around railroads have been identified as having greater concentrations of PCBs and Hg (McKee et al. 2005). This is probably due to a variety of reasons including incidental spillage during loading and transport, the use of both PCBs and Hg in electrical applications such as switching and motive power, and the use of used industrial oils for dust suppression (McKee et al. 2006). Railroad data layers were compiled separately for current and historic railroads focusing on the period of greater PCBs and Hg use (1950-1990). The current railroad layer was created by the USGS as part of the digital line graphic database. The historic railroads layer was created using rectified 1951 to 1961 USGS topographic quads. The rail lines that were not included in the current-day rail lines were digitized using the heads-up methodology (i.e., directly traced on the computer screen using scanned raster images as a backdrop). Each railroad data layer was split by watershed boundary and then the length was summed by watershed. A total rail length per watershed was calculated and used as input data.

Auto dismantlers: Both PCBs and Hg were used heavily in the auto industry. PCBs were used in electrical starters, capacitors, and as flame retardants in upholstery, whereas Hg was used in electrical components including switches, thermostats, and halogen lights. Areas in the urban landscape where vehicles are recycled, refurbished or disposed of are likely to be subjected to contamination. An auto dismantlers data layer was created representing the active auto and truck dismantling facilities (i.e., auto wreckers and junk yards) listed in Water Board records in October 2002. These facilities can be a source of ground and surface water contamination and are thus closely monitored by the Water Board. The facility locations have been determined by address-match geocoding supplemented by hand-plotting using aerial photographs and maps, but the data has not been error-corrected. The number of locations were counted and attributed to watershed.

Pacific Gas and Electric (PG&E) Facilities: The largest use of PCBs (60% in the US) was in the power generation and transmission industry. The USEPA PCB self-reporting data base (http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/data.htm) lists about 260,000 kg (580,000 lb) of PCBs currently being cycled out of use in California. While PG&E is cleaning up their facilities in compliance with current laws and regulations, legacy contamination in soils is still present on PG&E properties at concentrations that while legal, may be slowly being dispersed off site by wind, water, wheel- and foot-tracking and entering the local stormwater conveyance (SFEI 2010). These areas are known to have concentrations greater than TMDL targets (McKee et al. 2006). PG&E Facilities data were compiled from a PG&E database for the Bay Area obtained by the Water Board in 2002. The number of locations were counted and attributed to each watershed.

Pump stations: Many urban watersheds in the Bay region drain areas on the Bay margin that are near or even below sea level or where stormwater, on its way to the Bay, must pass below infrastructure such as freeways and railways. These physio- and socio-graphic features in the urban landscape have necessitated the use of pumps to lift stormwater out to the Bay. These areas are often current or historical industrial areas and are often also in close proximity to wastewater treatment facilities. Provisions C.11.f. and C.12.f. of the MRP call for permittees to implement five pilot projects to divert dry weather and first flush flows to wastewater treatment plants to address these flows as a source of PCBs and Hg to receiving waters. While there are other reasons, it is primarily the proximal relationship between industrial land uses, pump stations, and wastewater treatment facilities that make this option seem attractive. For these reasons, we chose to include information on pump stations as a factor of influence for future watershed loads monitoring. The Pump Stations data layer was developed in a collaborative effort of SFEI, BASMAA, and the Water Board. The Water Board requested information from Phase 1 permittees during the fall of 2007 and from Caltrans in 2009. SFEI organized the information into a database and GIS shapefile in March of 2009. The number of locations were counted and attributed to each watershed.

Precipitation: Precipitation is a major driver in the transport of POCs to San Francisco Bay. For example it has been estimated that >99.5% of Hg loads entering the Bay from the Guadalupe River watershed during an average year do so during the wet season (McKee et al. 2005). A precipitation layer was obtained from http://frap.cdf.ca.gov/ . This layer represents lines of equal rainfall (isohyets) based on long-term mean annual precipitation data. These data were collected over a sixty year period (1900-1960), over a minimum mapping unit of 1000+ acres. Data were compiled from USGS, California Department of Water Resources, and California Division of Mines map and information sources. Source maps are based primarily on U.S. Weather Service data for approximately 800 precipitation stations, and supplemented by county and local agency precipitation data. These data were split by watershed boundary. Average rainfall per watershed was calculated by summing each rainfall value polygon multiplied by polygon area and dividing it by total watershed area.

Suspended sediment data: Both PCBs and Hg are transported into the Bay predominantly associated with sediment particles. As a result, the RMP make considerable annual effort to measure or improve estimates of suspended sediment loads entering the Bay (McKee et al. 2005; McKee et al. 2006; David et al. 2009; Lewicki and McKee 2009). Recently, suspended sediment load estimates were generated for small tributaries in Bay Area (Lewicki and McKee 2009). These were obtained and used here.

Contaminant data

Watersheds: The history of urbanization and industrial land use in the Bay Area has lead to residues of PCBs and Hg in urban soils and in the sediments of the stormwater conveyance system. Knowledge about the distribution of soil and sediment contamination may provide a basis for estimating which watersheds may have greater loads. Consequently, over the past 10 years, BASMAA and SFEI have been gradually collecting information on soil and sediment contaminant concentrations. Presently, Hg and/or PCB concentrations are reported for over 700 data points disbursed throughout the counties of San Francisco, San Mateo, Santa Clara, Alameda, Contra Costa and Solano (no data points are located in the counties of Marin, Napa, or Sonoma). This watershed PCB and Hg in sediment point data layer includes data from multiple studies regarding the concentrations of pollutants in street and storm drain sediments around the San Francisco Bay Area (Gunther et al. 2001; EOA Inc. 2002; KLI and EOA Inc. 2002; Salop et al. 2002a; Salop et al. 2002b; City of San Jose and EOA Inc. 2003; EOA Inc. 2004; Kleinfelder Inc. 2005, 2006; EOA Inc. 2007). The most recent version of this dataset was compiled as part of the San Francisco Estuary Institute's "Regional Stormwater Monitoring and Urban BMP Evaluation [b]. Each data point was attributed and averaged by watershed.

[b] http://sfei.org/stormwaterbmps/gis_data/Soil_dust_drop_inlet_sediment_Hg_PCB_concentrations.zip

Bay margins: A goal of the STLS is to identify tributaries having controllable sources that exert a disproportionately large influence on loads and impacts on the Bay margin. As the RMP continues to support process studies for contaminant uptake into the food web, this watershed classification study will help identify high leverage areas on the Bay margin likely to have relatively large food web impacts. Given these broader objectives and synergies between RMP strategies, we included knowledge of Bay margin characteristics in the present data compilation. A within-Bay sediment Hg data layer includes Hg data from multiple studies regarding the concentration of Hg in San Francisco Bay sediments. This dataset (N = 699 points total) was compiled in 2009 (Greenfield et al. 2009) with additional data added in February of 2010. Data sources include studies by the RMP, CALFED, USGS, the South Bay Mercury Project, the PRISM Program, and other unpublished data sets. Each point was spatially joined with the nearest individual watershed within a 500 meter search radius limit. A total of 98 of the 700 points were attributed to specific watersheds.

Data processing

Prior to statistical analyses, data for several parameters were modified or transformed. The percent water land cover was removed from the analysis, as 182 of 185 results were zeros, and the remaining three values were less than 0.1% of total land cover. The two historical railroad results were summed into a single historic railroad category. Also removed from the statistical analysis were parameters that were not available for all watersheds: subtidal sediment Hg, watershed soil Hg, and model predicted watershed suspended sediment loading.

Parameters were transformed to improve results of distance calculation measurements and obtain multivariate normality, linearity, and consistent scales among the parameters. Proportions were arcsin(square-root) transformed[c], population was square-root transformed, and other parameters were log transformed. Precipitation and geospatial coordinates (UTM northing and easting) were approximately normally distributed, and therefore not transformed. To maintain the presence of zero values in the data set, log transformations were adjusted following the procedure of zero conversion described in Chapter 9 of McCune and Grace (2002). All results were then scaled from 0 to 1. Examination of bivariate scatter plots and histograms confirmed approximate multivariate normality and linearity of residuals.

Statistical analysis

Three clustering methods were used to categorize watersheds based on available information and data describing land use, land cover, and other environmental conditions. Two of the methods were performed by applying two types of dissimilarity measures to

[c] Arcsin(square root) transformations are commonly performed to improve normality of proportion or percentage data.

the converted data set: relative Euclidian dissimilarity (i.e., standardized to the sum of squares to achieve maximum values of square root and Bray-Curtis dissimilarity (i.e., Sørensen index). Hierarchical clustering was performed on each dissimilarity matrix using Ward s minimum variance method as the linkage method (McCune and Grace 2002). Other methods were attempted (average linkage, single linkage, and complete linkage) but dendograms indicated poorly defined clusters with substantial chaining (addition of single items to existing groups). The third clustering method was performed using the clues algorithm, which uses an automated combination of partitioning and shrinking to optimize cluster number (Chang et al. 2010). The clues method was implemented with a Euclidian distance dissimilarity measurement, and the Silhouette index to optimize cluster number. Silhouette and CH indices were evaluated to compare the clustering methods. Silhouette index compares the dissimilarity of each point within clusters to all of the points in the nearest neighboring cluster. CH index is the ratio of variation within clusters to variation between clusters (Chang et al. 2010).

The data set was also evaluated using an ordination method called Non-Metric Multidimensional Scaling (NMDS), performed with the metaMDS algorithm (Minchin 1987; Cox and Cox 1994, 2001), and based on Bray-Curtis dissimilarity. The NMDS was applied to our dataset to describe the underlying variance structure of a data set and the main variables contributing to differences among watersheds. It is superior to Principal Components Analysis and other parametric methods in having few data structure requirements to result in successful ordinations. NDMS was performed assuming two axes. MetaMDS uses random starting configurations to avoid local optima and find the global best solution. A convergent solution was not found after 20 iterations, when comparing solutions using Procrustes rotation, suggesting that a stable solution may not exist, and warranting caution in interpretation. However, all solutions resulted in highly similar stress. Statistical analyses were performed in R (version 2.10.1), using the vegan, clues, and MASS packages.

Results and Discussion

Cluster analysis results

This analysis is intended to differentiate the 185 watersheds into a tractable number of categories based on an appropriate clustering approach. Given this objective of the study, the results of the clues algorithm, results of dendograms using the different clustering methods (e.g., Figures 2 and 3), and the attributes of resulting clusters, eight categories were selected as the appropriate number for interpretation.

Silhouette and CH indices were similar among the three clustering methods, suggesting that they exhibited a similar ability to partition the data set into unique, compact, and dissimilar clusters. Measures of similarity among cluster results only indicated moderate correspondence among the methods. This was corroborated by graphical analysis of NMDS results (presented later) and suggests that the successful partitioning of this data set is not robust to different clustering methods.

Graphical analyses of box and whiskers plots were performed for each clustering method. Each of the cluster categories were compared among the eighteen predictor variables used in the clustering (Figures 4 through 6). The intent here was to identify the unique attributes of each watershed category. A secondary goal was to determine which clustering method was most effective at generating environmentally meaningful differences among categories. Examining these plots, it was apparent that the Bray-Curtis dissimilarity method (Figure 4) was superior to the relative Euclidian distance (Figure 5) and clues methods (Figure 6). The latter two methods resulted in several categories that were poorly differentiated in important attributes, such as population density, imperviousness, and industrial land use (Figures 5 and 6). Based on these observations, we focus the discussion of watershed categorization results primarily on the Bray-Curtis clustering output.

Description of cluster categories

The eight Bray-Curtis cluster categories vary considerably in their watershed attributes (Table 1). This variation pertains largely to watershed size, spatial location, population density, and land cover (Figure 4, Figure 7).

Clusters 1, 2, and 3 are similar to each other in all having relatively high residential, commercial, and industrial land cover and consequently, high surface imperviousness. Combined, these clusters include 119 watersheds, and could therefore be described as typical watersheds for the study area. These clusters generally include densely populated, low-lying areas that drain into South Bay and Central Bay (Figure 7).

The 41 watersheds in Cluster 1 average 42% residential, 23% industrial, and 13% historic industrial land cover. Cluster 1 has the second highest industrial and historic industrial land cover among all clusters, and is also high in impervious surfaces and historic railroads. It includes the previously monitored industrial locations of Zone 4 Line A, and the Ettie Street Pump Station (both in Alameda County) and Richmond Inner Harbor (Contra Costa County). Other representative watersheds in this Cluster include Calabezas Creek (Santa Clara County), and Burlingame Creek (San Mateo County) Sampling in these watersheds could be anticipated to indicate runoff patterns typical of small, relatively urbanized watersheds.

The primary distinction between Clusters 1 and 2 is that the 43 watersheds in Cluster 2 have higher residential land cover (57%) and one to four PG&E substations, whereas Cluster 1 watersheds all lack PG&E substations. Thus, comparing watersheds among these clusters might distinguish among potential contaminant loads associated specifically with the presence of PG&E substations. The other difference between 1 and 2 is that watersheds in 2 are often larger in area than 1, though this is not consistently the case (Figures 4 and 7). Representative watersheds in Cluster 2 are Meeker Slough (Contra Costa County), Cordonices Creek (Alameda County), Sunnyvale East (Santa Clara County), and San Bruno Creek (San Mateo County).

The 35 watersheds in Cluster 3 average 45% residential, 13% industrial, and 5% historic industrial land cover. Compared to Clusters 1 and 2, Cluster 3 has lower historic industrial land cover, corresponding to a general absence of historic railroads or water pumping stations in Cluster 3. The other difference is that watersheds in Cluster 3 are generally smaller than in 1 or 2, and often contain Baylands, exposed areas, and sloughs or lagoons. Examples include Point Isabel (Alameda County), Moffett West (Santa Clara County), Foster City Lagoon (San Mateo County), and several unnamed watersheds in Contra Costa County. If the goal were to target monitoring towards historic pollutants due to industrial sources, it would appear that Cluster 1 may be more suitable than Cluster 3, due to the higher density of historic industry and railroads.

Clusters 4 through 8 were much more distinct than Clusters 1, 2, and 3, each characterized by a fairly unique combination of land cover and other attributes. Eleven small to very small watersheds comprise Cluster 4, and with one exception, these are all on or abutting San Francisco International Airport (San Mateo County). These watersheds are all characterized by very high current (68%) and historic (73%) industrial land cover. They consequently have the highest imperviousness among all watersheds, and also have relatively low population density. If any of these watersheds were to contain an untreated and accessible discharge point to the Bay, it would be an interesting candidate for monitoring and characterizing industrial sources.

Clusters 5 and 6 are similar to each other in having high open land cover (61% and 63% open, respectively) and consequently low imperviousness (Figure 4). Cluster 5 watersheds have very low residential (11%) or commercial (1%) development, and consequently the lowest population density of all watersheds (Figure 4). These watersheds also contain no historic or modern railroads. The 11 watersheds in Cluster 5 include three watersheds that are above reservoirs (Alameda Creek, Guadalupe River, and Coyote Creek, above the respective reservoirs), that do not directly drain into the Bay, and are therefore inappropriate for sampling. The remaining eight watersheds in Cluster 5 are small, nearshore areas, generally comprising reclaimed Baylands and other open spaces. Examples include Bay Farm Island (referred to as AC_unk23), the Palo Alto Golf Course, and Bayfront Park (adjacent to Atherton Creek). It appears that the watersheds in Cluster 5 would be generally inappropriate for stormwater sampling at the Bay margin.

Cluster 6 contains 22 watersheds, which generally comprise the largest watersheds in the study area (Figure 4, Figure 7). Watersheds in Cluster 6 generally extend to the upland areas, such as the East Bay hills. Examples include the heavily sampled Guadalupe River (Santa Clara County), San Francisquito Creek (San Mateo County), San Lorenzo Creek (Alameda County), and Wildcat Creek (Contra Costa County). These watersheds have low to moderate residential development (averaging 24%), low imperviousness, and low residential land cover. Cluster 6 watersheds contain a high density of PG&E substations (only exceeded by Cluster 2) and moderate to high modern and historic railroad cover. Given their large area, Cluster 6 watersheds are expected to contain high spatial variability in land cover composition, with higher urban density and impacts in the low-lying areas.

Cluster 7 is the only group containing notable agricultural land cover (43% on average). All but one of these 17 watersheds are in Contra Costa County and drain to Suisun Bay. They would be candidates for monitoring if legacy agricultural sources were of interest. Notable watersheds in Cluster 7 include Mallard Slough, E and W Antioch, Walnut Creek, and Crandall Creek/Zone 5 Line P. Creeks in some of these watersheds have been observed to have elevated pyrethroid pesticides and impacts to local benthic fauna (Amweg et al. 2006).

Cluster 8 is also unique, consisting of just five tiny unnamed watersheds alongshore of the Carquinez Strait. These watersheds average 97% open land cover, and likely represent undeveloped parklands with no current local pollutant sources. One of these watersheds could be a candidate for monitoring as a control site indicative of sediment or pollutant loading due to natural sources and atmospheric deposition.

NMDS results and comparison to cluster analysis

NMDS was applied to the dataset to evaluate which variables best characterize differences among watersheds, how these variables are related to each other, and how successful different clustering methods were at generating distinct and compact clusters. When NMDS ordinations are performed, a calculation is performed of the mismatch between overall distance in the original data set and distance in the ordination results. This calculation, referred to as stress, is minimized to obtain the optimal ordination. The final stress is used as a diagnostic indicator of the overall success of the NMDS at characterizing the underlying variation in the data. Stress is measured on a scale from 0 to 100. Stress values above 20 are generally considered to be poor outcomes, and subject to lower interpretive confidence. In our study, the final NMDS stress results were just above 22. Hence, the NMDS results should be interpreted with caution.

Results of the NMDS ordination of the dataset, compared to three clustering outcomes, are presented in Figures 8, 9, and 10. The arrows on these figures indicate the direction and relative strength of selected variables in the ordination. Based on the arrows following the x-axis, the watersheds may generally be distinguished on this axis based on a gradient from industrial land cover with high imperviousness (towards the left) to open land cover. Bray-Curtis Clusters 4 and 8 fit this pattern, as they were previously described as the outlier watersheds in these attributes, having almost exclusively industrial and open cover, respectively.

The y-axis appears to correspond to specific industrial developments within the watershed, such as historic railroad and PG&E facilities. This explains the primary difference between Cluster 3 and Clusters 1 and 2 though all three of these clusters contain moderate to high industrial land cover, watersheds in Cluster 3 do not contain railroads or PG&E facilities. We speculate that some of the watersheds in Cluster 1 constitute the watersheds with greatest overall potential to have legacy contaminant hotspots, associated with historic human activity. This hypothesis is based on the observation of Cluster 1 watersheds being located in the direction of industrial activity, impervious surfaces, PG&E facilities, and historic railroads.

Examining Figures 8 through 10, there is a generally weak correspondence among the different clustering methods in characterizing the gradient described in the NMDS. This is consistent with the weak results of the relative Euclidian and clues clustering (Figures 5 and 6), as well as the high stress of the NMDS. The clues method did a particularly poor job, as evident from the broad spread and overlapping pattern of Clusters 1, 5, and 6 in this output (Figure 10). In contrast, the Bray-Curtis output performed relatively well in generating fairly compact and distinct clusters (Figure 8). This finding supports the prior decision to focus on the Bray-Curtis results for characterizing these watersheds (Table 1).

There were some clusters that were consistent among methods. In particular, Clusters 3, 4, and 7 in the Bray-Curtis output corresponded fairly well to clusters 5, 7, and 4 in the Euclidian distance method (Figures 8 and 9). This finding suggests that the small urbanized watersheds (BC Cluster 3), agricultural watersheds (BC Cluster 7), and the industrial watersheds near SF Airport (BC Cluster 4) are clearly distinct from the other watersheds in the study area.

Bivariate approaches to watershed classification

The strength of a clustering approach is its ability to incorporate the information from the multiple attributes that vary across the data set (i.e., the multiple arrows in Figures 8 through 10). The NMDS and cluster analysis results suggest that a complete partitioning of this data set depends on information contained in multiple attributes. For example, clusters 1 through 3 all contain high residential land cover and imperviousness but are differentiated based on railroads, historic industry, and PG&E substations. In contrast, clusters 6 and 7 are characterized by high open and agricultural land cover (Table 1).

Nevertheless, if management considerations dictate that classification should be based on only one or two of the attributes, this may be readily accomplished with the data set assembled. For example, a bivariate approach would generate a set of categories based on two of the available attributes. To illustrate the concept, we partitioned the data set according to a combination of percent imperviousness and one other attribute. Percent imperviousness was selected because of its importance for watershed contaminant loading, and because it explains a relatively high proportion of the variation in the data set. This relatively high importance is illustrated in the long arrow for this attribute in Figures 8 through 10.

To most effectively partition the variance in the data set, the second variable should explain substantial additional variation beyond that explained by percent imperviousness. This is apparent in the NMDS plots as arrows perpendicular to the percent imperviousness arrow. Historic railroads and PG&E facilities both fit this criterion, being largely vertical, whereas percent imperviousness is horizontal (Figure 8).

We generated a six category classification based on percent imperviousness and PG&E facilities (Figure 11). Three category divisions were made for percent imperviousness (A: < 30%; B: >=30% to < 50%; and C: >=50%). Within each of these categories, two subdivisions were generated based on either presence (1) or absence (0) of PG&E facilities. We generated a separate six category classification based on percent imperviousness and historic railroads (Figure 12). For this scheme, the three categories described above for percent imperviousness (i.e., A, B, and C) were each divided into two subcategories based on either presence (1) or absence (0) of any historic railroads within the watershed.

The resulting bivariate classifications (Figures 11 and 12) corresponded to some extent to the cluster analysis map (Figure 7). In particular, many of the large watersheds in clusters 5, 6, and 8 also fell into the low imperviousness category. However, some of the information in the cluster analysis was missing from the bivariate results. For example, percent agricultural land cover clearly differentiated cluster 7 from the other clusters, and this attribute would appear important for certain kinds of contaminants.

Conclusions

This cluster analysis watershed classification scheme provides planning level information for efforts aimed at selecting watersheds for subsequent contaminant concentration and loads monitoring. The classification supports the goal of targeting specific land attributes and thus, potential historic and current sources. For historic pollutants with industrial sources (e.g., PCBs), candidate watersheds would contain areas of historic industrial land use and activities. These include watersheds found in Clusters 1, 2, 4, and 6. We speculate that Cluster 1 watersheds have the greatest overall potential for legacy contaminant hotspots and high-leverage contaminant loading due to historic human activity. This hypothesis is based on Cluster 1 watersheds combined industrial activity, impervious surfaces, PG&E facilities, and historic railroads.

Additional watershed selection considerations include watershed sizes, impervious cover, and other determinants of contaminant loading. Characterization of the full range of watershed sizes and impervious cover, will inform on the relative severity of contamination and loading from high-leverage tributaries. For example, small, open-space watersheds would provide a baseline for comparison, because contamination in these watersheds is dominated by atmospheric deposition and natural attenuation.

Tables

Table 1. Description of eight watershed clusters generated using Bray-Curtis distance with Ward's linkage method.

Cluster #	Number of watersheds	Description
1	41	High commercial and residential land cover and imperviousness. High historic industry and railroads. No PG&E facilities. Moderate area.
2	43	High commercial and residential land cover and imperviousness. High historic industry and railroads. One to four PG&E facilities. Large area.
3	35	High commercial and residential land cover and imperviousness. Low historic industry or railroads. Smaller area.
4	11	Small, sparsely populated, predominantly industrial, highest historic industrial and imperviousness. Located around San Francisco Airport and Brisbane.
5	11	Sparsely populated, low development, high open land cover, no railroads, "green space." Located adjacent to Bay or in undeveloped uplands.
6	22	Largest watersheds, with moderate population density, high open land cover, and low imperviousness.
7	17	High agricultural land cover, lower rainfall, draining to Carquinez Strait and Suisun Bay.
8	5	Small, sparsely populated, predominantly open, containing historic railroad, and draining to Carquinez Strait.

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Appendix A

Numbered watershed names and categories in Figures 7, 11, and 12

ID Number Fig. 7, 11, 12	Watershed Name	Figure 7 Category Bray Curtis Clusters	Figure 11 Category Impervious and PG&E	Figure 12 Category Impervious and railroad
1	ACFC_Zone 4 Line A	1	C.0	C.1
2	ACFC_Zone 5 Line F-1	1	C.0	C.1
3	ACFC_Zone 5 Line J-3 Pump Station	1	C.0	C.0
4	ACFC_Zone 5 Line P and Zone 6 Line N	2	B.1	B.1
5	AC_unk01	3	B.0	B.0
6	AC_unk02	3	B.0	B.0
7	AC_unk03	1	C.0	C.1
8	AC_unk04	1	C.0	C.1
9	AC_unk05	3	B.0	B.0
11	AC_unk07	3	B.1	B.0
12	AC_unk08	3	C.0	C.0
13	AC_unk09	2	C.1	C.1
15	AC_unk11	2	C.1	C.1
16	AC_unk12	4	C.0	C.1
17	AC_unk13	1	C.0	C.1
18	AC_unk14	1	C.0	C.1
19	AC_unk15	1	C.0	C.1
20	AC_unk16	3	B.0	B.0
21	AC_unk17	1	C.0	C.1
22	AC_unk18	3	C.0	C.0
23	AC_unk19	3	B.0	B.0
24	AC_unk20	3	C.0	C.0
25	AC_unk22	3	C.0	C.0
26	AC_unk24	1	C.0	C.1
27	AC_unk25	5	A.0	A.0
29	AC_unk27	5	C.0	C.0
30	AC_unk28	2	C.1	C.1
36	Adobe Creek	6	A.1	A.1
37	Agua Fria and Torogas Creek and Scott Creek	6	A.1	A.1
38	Arroyo Viejo	2	A.1	A.1
39	Atherton Creek	2	B.1	B.1
40	Barron Creek	1	B.0	B.1
41	Baxter Creek	2	C.1	C.1
42	Bayfront Park	5	A.0	A.0
43	Belmont Creek	2	B.1	B.1
44	Belmont Slough	3	B.0	B.0
45	Blackberry and Marin Creeks_A	2	B.1	B.1
46	Bockman Canal	2	C.1	C.1
47	Borel Creek	2	B.1	B.1
48	Burlingame Creek	1	A.0	A.1
49	Cerrito Creek	2	B.1	B.0
50	Coast Casey Forebay	3	C.0	C.1
51	Codornices Creek	2	A.1	A.1
52	Colma Creek	2	B.1	B.1
53	Cordilleras Creek	2	A.1	A.1

ID Number Fig. 7, 11, 12	Watershed Name	Figure 7 Category Bray Curtis Clusters	Figure 11 Category Impervious and PG&E	Figure 12 Category Impervious and railroad
54	Crandall Creek and ACFC_Zone 5 Line P	7	B.0	B.0
56	Derby and Potter Creeks_A	2	C.1	C.1
57	Easton Creek	2	B.1	B.1
58	Elmhurst Creek_A	2	C.1	C.1
59	Estudillo Canal	2	C.1	C.1
60	Ettie Street Pump Station_A	1	C.0	C.1
61	Garrity Creek	1	B.0	B.1
62	Glen Echo Creek	3	B.0	B.0
63	Green Hills Creek	2	B.1	B.1
64	Guadalupe River	6	B.1	B.1
65	Guadalupe Valley Creek	1	A.0	A.1
66	Herman Slough and Castro Creek	1	C.0	C.1
67	Hoffman Channel	2	B.1	B.0
68	Agua Caliente	6	A.1	A.1
69	Laurel Creek	1	B.0	B.1
70	Leslie Creek	1	C.0	C.1
71	Lion Creek	1	B.0	B.1
72	Upper Coyote Creek (above Anderson Dam)	5	A.1	A.0
73	Lower Sulphur Creek	1	C.0	C.1
74	Mallard Slough	7	A.0	A.0
75	Marina Lagoon	3	C.0	C.0
76	Matadero Creek	1	A.0	A.1
77	Meeker Slough	2	C.1	C.1
78	Millbrae Creek	1	C.0	C.1
79	Mills Creek	1	B.0	B.1
80	Treasure Island	3	C.0	C.0
81	West Antioch	7	A.1	A.0
83	Moffett West	3	B.0	B.1
85	Oyster Point	4	C.0	C.0
86	Palo Alto Golf Course	5	B.0	B.0
87	Peralta and Courtland and Seminary Creeks	2	C.1	C.1
88	Permanente Creek	6	A.1	A.1
89	Pinole Creek	6	A.0	A.1
90	Pinole Shores	1	B.0	B.1
91	Point Isabel	3	C.0	C.0
92	Point Richmond	1	B.0	B.1
93	Point San Pablo Peninsula North	1	A.0	A.1
94	Poplar Creek	2	B.1	B.1
95	Pulgas Creek	2	B.1	B.1
96	Redwood Ck and Arroyo Ojo de Agua Ck	2	B.1	B.1
97	Redwood Shores Lagoon Water	3	B.0	B.0
98	Refugio Creek	2	A.1	A.1
99	East Antioch	7	B.1	B.0
101	Richmond Inner Harbor	1	C.0	C.1
102	SMC_unk01	2	B.1	B.1
103	SMC_unk02	1	A.0	A.1
105	SMC_unk04	4	C.0	C.0
106	SMC_unk05	4	C.0	C.0

ID Number Fig. 7, 11, 12	Watershed Name	Figure 7 Category Bray Curtis Clusters	Figure 11 Category Impervious and PG&E	Figure 12 Category Impervious and railroad
107	SMC_unk06	4	C.0	C.1
108	SMC_unk07	4	C.0	C.1
109	SMC_unk08	4	C.0	C.1
110	SMC_unk09	4	C.0	C.0
111	SMC_unk10	3	B.0	B.0
112	SMC_unk11	3	C.0	C.0
113	SMC_unk12	1	C.0	C.1
114	SMC_unk14	3	C.0	C.0
115	SMC_unk15	1	C.0	C.1
116	SMC_unk16	2	B.1	B.1
117	SMC_unk17	1	A.0	A.1
118	SMC_unk18	3	C.1	C.1
119	SMC_unk19	1	C.0	C.1
120	San Bruno Creek	2	B.1	B.1
121	San Francisco International Airport A	4	C.0	C.0
122	San Francisco International Airport B	4	C.0	C.0
123	San Francisquito Creek	6	A.1	A.1
124	San Leandro Creek Above Lake Chabot	6	A.1	A.0
125	San Lorenzo Creek	6	A.1	A.1
126	San Mateo Creek Above Reservoir	6	A.1	A.0
127	San Pablo Creek Above Reservoir	6	A.1	A.0
128	San Tomas	1	B.0	B.1
129	Sanchez Creek	2	A.1	A.1
130	Sanjon de los Alisos A	2	C.1	C.1
131	Santa Fe Channel	2	C.1	C.1
132	Sausal Creek	2	A.1	A.1
133	Schoolhouse Creek	1	B.0	B.1
134	Seal Slough	3	C.0	C.0
135	Sewage Treatment Plant	5	A.0	A.0
136	Walnut Creek	7	A.1	A.0
137	Stevens Creek	6	A.1	A.1
138	Strawberry Creek	2	B.1	B.0
140	Temescal Creek	2	A.1	A.1
141	Unknown_240	3	B.0	B.0
142	Unknown_241	3	B.0	B.0
143	Unknown_244	3	B.0	B.0
144	Unknown_245	3	A.0	A.0
145	Unknown_246	3	B.0	B.0
146	Unknown_247	3	B.0	B.0
147	Unknown_248	5	A.0	A.0
148	Unknown_251	8	A.0	A.1
151	Alhambra Creek	6	A.1	A.1
152	Unknown_256	7	A.0	A.0
153	Unknown_257	7	A.0	A.0
154	Unknown_258	8	A.0	A.1
155	Unknown_259	7	A.0	A.0
156	Unknown_260	7	A.0	A.0
157	Unknown_261	3	B.0	B.0

ID Number Fig. 7, 11, 12	Watershed Name	Figure 7 Category Bray Curtis Clusters	Figure 11 Category Impervious and PG&E	Figure 12 Category Impervious and railroad
158	Unknown_262	7	A.0	A.0
159	Unknown_263	2	B.1	B.1
160	Unknown_264	8	A.0	A.1
161	Unknown_265	3	B.1	B.0
162	Unknown_266	7	B.0	B.0
163	Unknown_267	7	A.0	A.0
164	Unknown_268	7	B.1	B.0
165	Unknown_272	7	A.0	A.0
166	Unknown_273	7	A.0	A.0
167	Unknown_274	7	A.0	A.0
168	Unknown_275	7	A.0	A.0
174	Unknown_284	3	A.0	A.0
175	Visitacion Point	1	C.0	C.1
176	Ward and Zeile Creeks	2	B.1	B.1
177	Yerba Buena Island	3	A.0	A.0
178	Mount Diablo Creek	6	A.0	A.0
179	Kirker Creek	6	A.0	A.0
180	Unknown_271	2	C.1	C.0
181	Alameda Creek Above Reservoir	5	A.0	A.0
182	Point San Pablo Peninsula West	1	A.0	A.1
183	AC_unk23	5	B.0	B.0
184	AC_unk21	5	A.0	A.0
185	SMC_unk13	3	A.0	A.0
186	Foster City Lagoon Water	3	C.0	C.0
187	Rodeo Creek	6	A.1	A.1
188	Canada del Cierbo	6	A.0	A.1
189	Wildcat Creek	6	A.0	A.1
190	Rheem Creek	1	B.0	B.1
191	Point Pinole	2	A.1	A.1
203	San Leandro Creek Below Lake Chabot	2	C.1	C.1
294	Guadalupe River Above Reservoir	5	A.0	A.0
295	Lower Coyote Creek (below Dam)	6	A.1	A.1
296	San Mateo Creek	2	A.1	A.1
297	Alameda Creek	6	A.1	A.1
299	San Pablo Creek	6	A.1	A.1
341	Sunnyvale West	1	C.0	C.1
342	Sunnyvale East	2	C.1	C.1
343	Calabazas Creek	1	B.0	B.1
345	Refugio North	1	A.0	A.1
349	Davis Point	1	A.0	A.1
None	Unknown_253MergeManual	8	A.0	A.1
None	Unknown_252MergeManual	8	A.0	A.1
None	Unknown_278MergeManual	6	A.1	A.1
None	SMC_unk03MergeManual	4	C.0	C.1

Appendix B

Background Information

Coastal ecosystems around the world are the focus of urbanization, industrialization, agriculture, transport (rail, road, and shipping) and waste disposal and as such are subject to loads of suspended sediments, nutrients, pathogens, and trace organic and metallic wastes (Haycock et al. 1993; Lauenstein and Daskalakis 1998; Smith 1998; Covelli et al. 2001; Linkov et al. 2002; Trimble 2003; Bridges et al. 2005; Kuzyk et al. 2005b). In the recent century, the advancement of chemical process technology lead to the use and synthesis of a number of persistent metals including mercury (Hg), copper, lead, zinc and silver and organic compounds including polyaromatic hydrocarbons (PAHs), organochlorine (e.g. DDT), organophosphate (e.g. melathion), and synthetic pyrethroid pesticides (e.g.), polychlorinated byphenyls (PCBs), and polybrominated diphenylethers (PBDEs). Although these substances have provided for many useful lifestyle improvements, they have also lead to many well documented ecosystem impacts worldwide (Anderson et al. 1975; Eisler 1987; Collier et al. 1998; Kannan et al. 1998; Kennish and Ruppel 1998; Covelli et al. 2001; Strom and Graves 2001; Tay et al. 2003; Gergel et al. 2004; Kuzyk et al. 2005a; Amweg et al. 2006; Brown et al. 2006; Suchanek et al. 2009). San Francisco Bay is one such ecosystem where the balance between technological and economic advancement and ecosystem preservation have resulted in increased concentrations of multiple pollutants (Hornberger et al. 1999; van Geen and Luoma 1999), with effects to local fish and wildlife (Thompson et al. 2007; Ackerman et al. 2008; Brar et al. 2010).

In 2006, in compliance with the Clean Water Act overseen by the U.S. Environmental Protection Agency (U.S. EPA), the state of California included all or some areas of San Francisco Bay[d] on the 303(d) list of water quality limited segments. The current listings are based on organochlorine pesticides (DDT, chlordane, dieldrin), dioxin compounds, exotic species, furan compounds, lead, mercury, nickel, polyaromatic hydrocarbons (PAHs), polychlorinated biphenyl s (PCBs), sediment toxicity, selenium, and zinc (State Water Resources Control Board 2009). In the 1990s, the California Office of Health Hazard Assessment (OHHA) issued health warnings to those people of catch and consume fish from San Francisco Bay (OEHHA 1997; Davis et al. 2002).

[d] I.e., Central San Francisco Bay and subembayments (e.g., Oakland Inner Harbor, San Leandro Bay, and Central Basin), San Pablo Bay, Suisun Bay, and Carquinez Strait

Figure Captions

Figure 1. Map of the study area.

Figure 2. Dendogram of cluster analysis using Bray-Curtis dissimilarity measure, with rectangles indicating the 8 clusters selected.

Figure 3. Dendogram of cluster analysis using relative Euclidian distance dissimilarity measure, with rectangles indicating the 8 clusters selected.

Figure 4. Box and whiskers plots for the eight clusters selected in the Bray-Curtis dissimilarity cluster analysis. Each plot indicates the results of one of 18 numeric metrics. Metrics were all transformed and rescaled to range from 0 to 1, as described in methods.

Figure 5. Box and whiskers plots for the eight clusters selected in the relative Euclidian dissimilarity cluster analysis.

Figure 6. Box and whiskers plots for the seven clusters selected in the clues algorithm cluster analysis.

Figure 7. Map of the study area, indicating the watershed categorization among clusters. Results are for the Bray-Curtis dissimilarity cluster analysis (Figures 1 and 3), with color coding indicating which cluster each watersheds falls into.

Figure 8. NMDS ordination results with Bray Curtis clustering outcomes indicated by symbols. Arrows indicate direction and relative magnitude of labeled variables. Variables listed with arrows in Figures 7 to 9 were chosen because they were strongly associated with clustering or to illustrate specific gradients (e.g., agricultural land cover, PG&E facility).

Figure 9. NMDS ordination results with Relative Euclidian distance clustering outcomes indicated by symbols. Arrows indicate direction and relative magnitude of labeled variables.

Figure 10. NMDS ordination results with Clues algorithm clustering outcomes indicated by symbols. Arrows indicate direction and relative magnitude of labeled variables.

Figure 11. Bivariate classification results based on percent imperviousness and PG&E facilities.

Figure 12. Bivariate classification results based on percent imperviousness and presence of historic railroads.

Figures

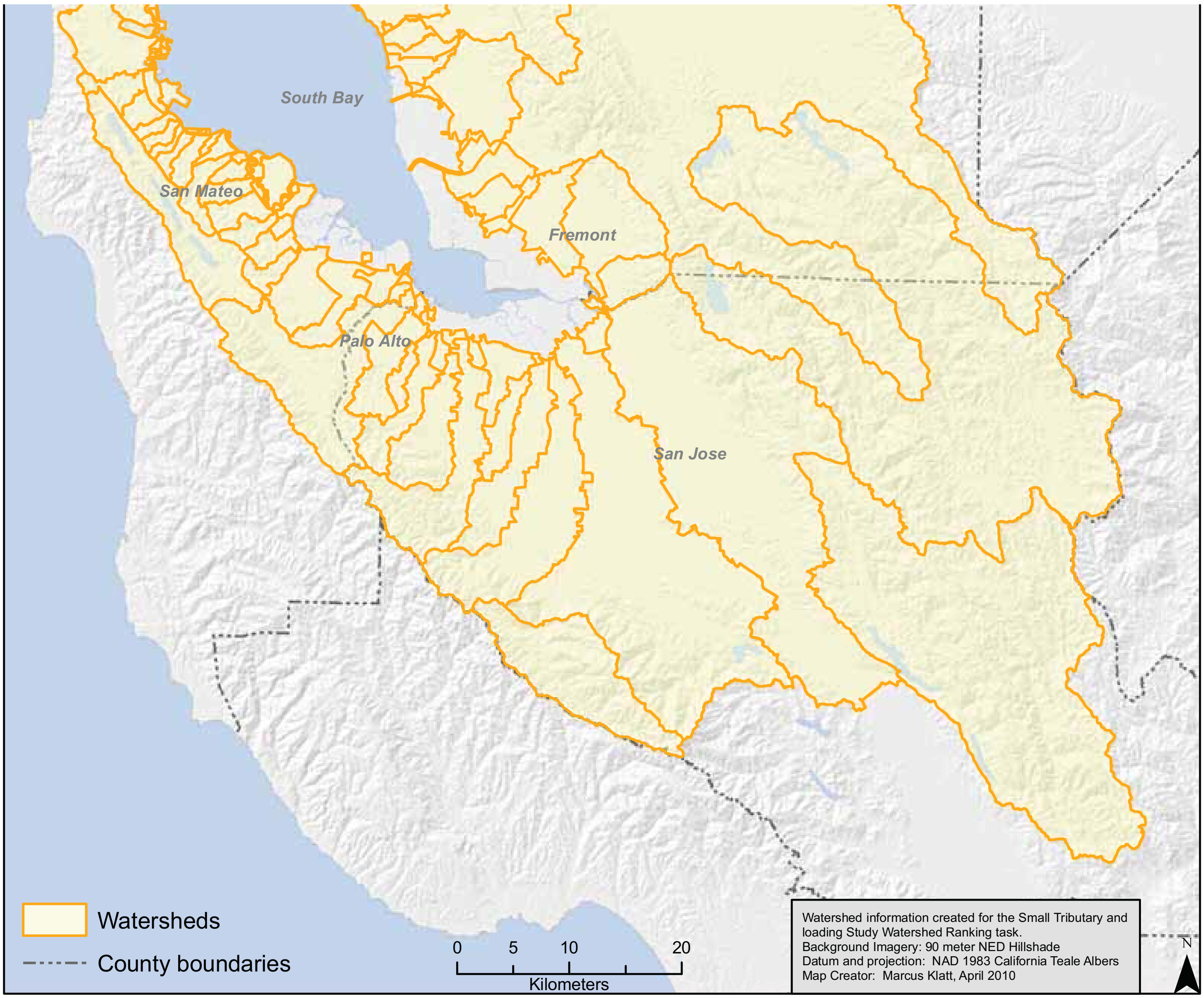

South Bay
San Mateo
Fremont
Palo Alto
San Jose
Watersheds
County boundaries
0 5 10 20
Kilometers
Watershed information created for the Small Tributary and loading Study Watershed Ranking task.
Background Imagery: 90 meter NED Hillshade
Datum and projection: NAD 1983 California Teale Albers
Map Creator: Marcus Klatt, April 2010
N

Figure 2

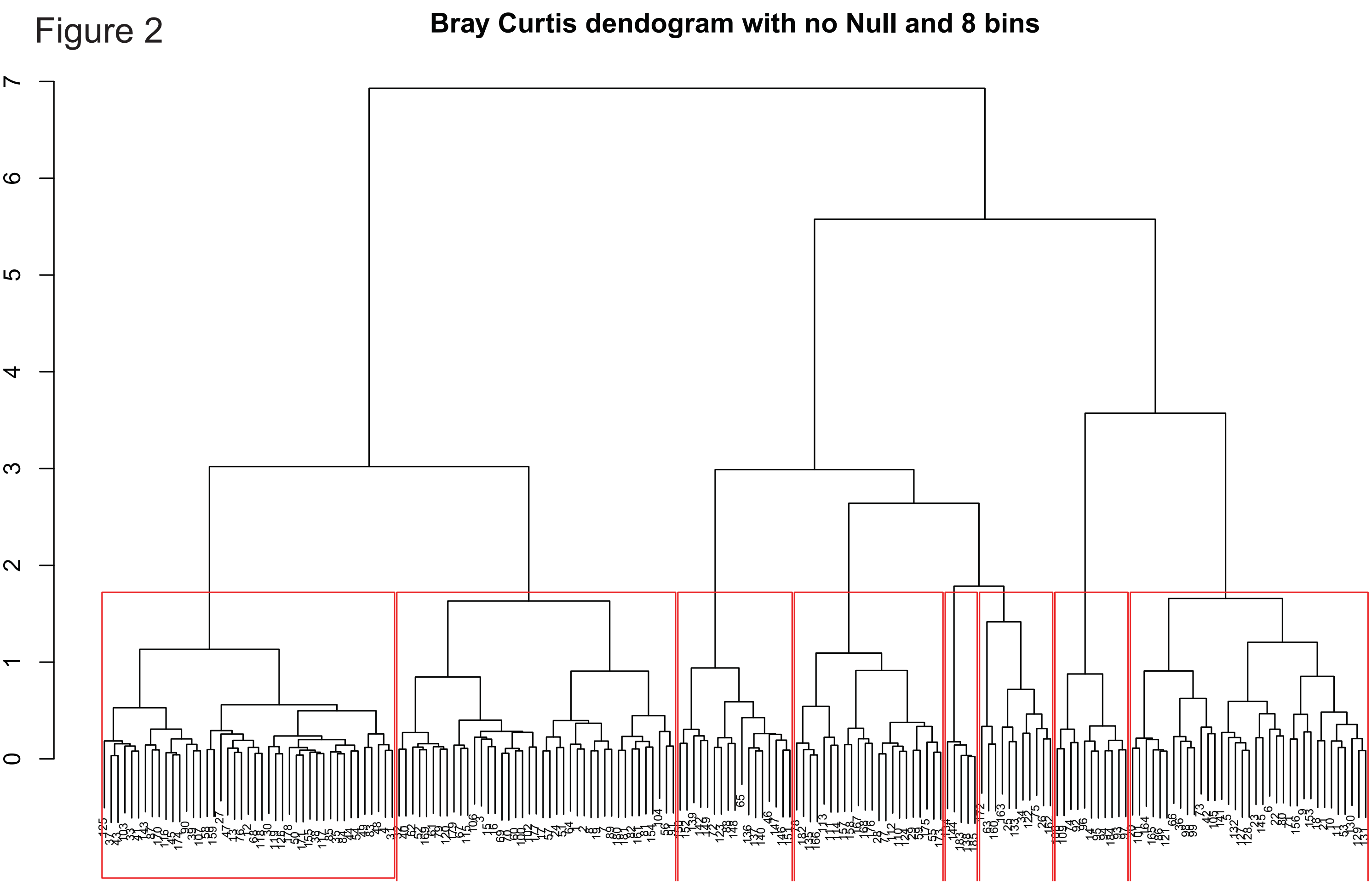
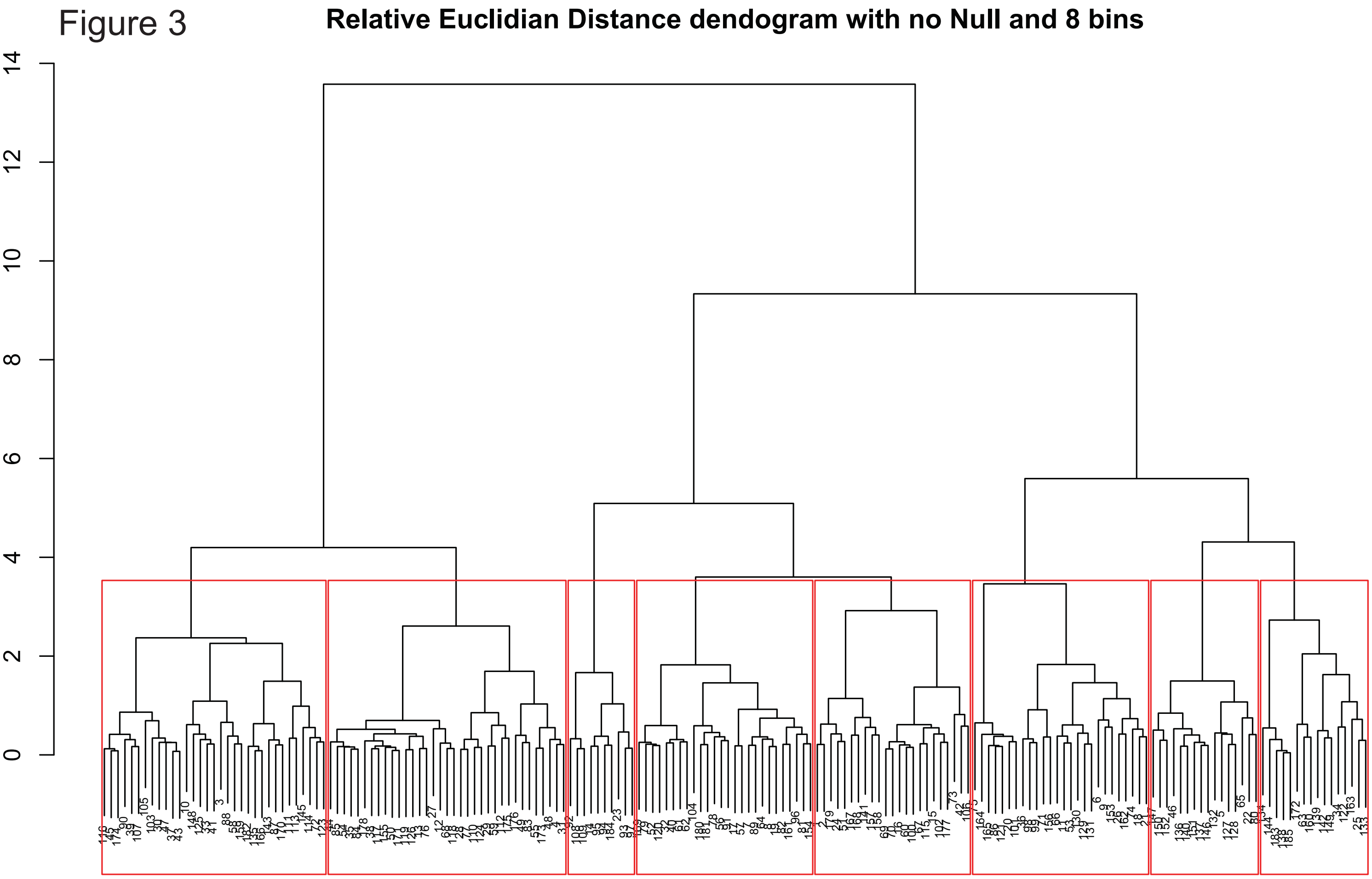


Figure 3


Relative Euclidian Distance dendogram with no Null and 8 bins
0
2
4
6
8
10
12
14

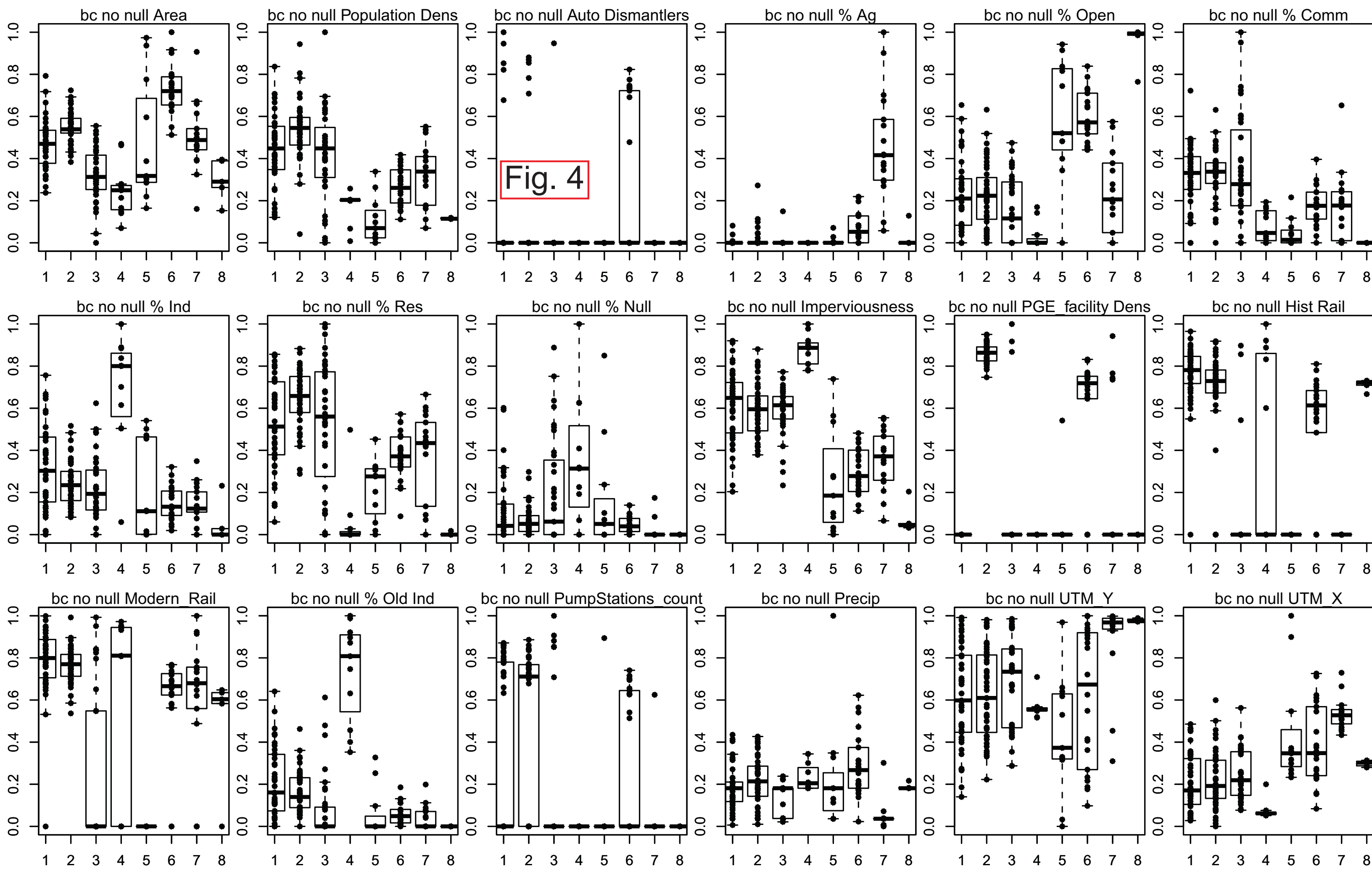
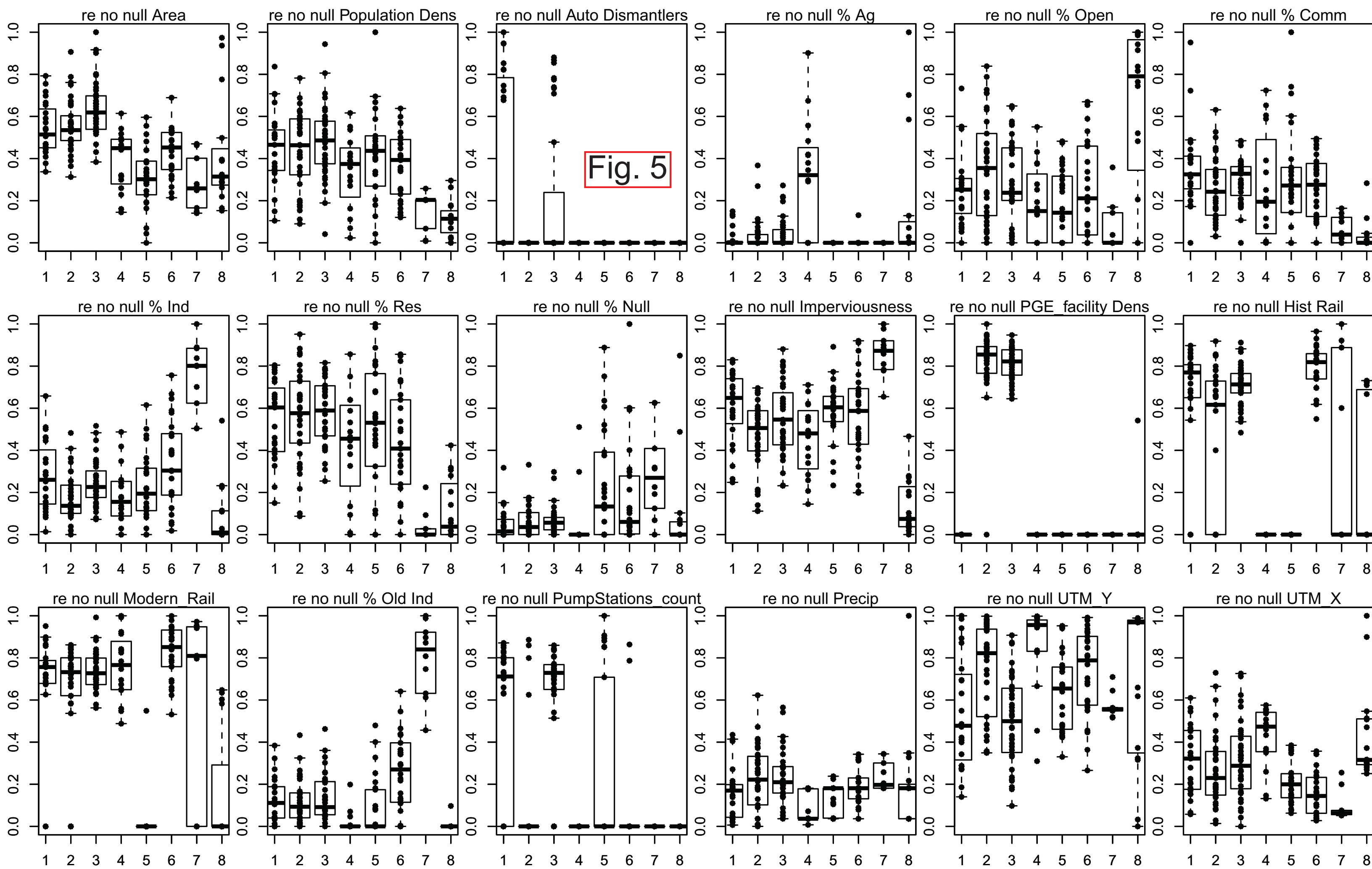

bc no null Area
bc no null Population Dens
bc no null Auto Dismantlers
bc no null % Ag
bc no null % Open
bc no null % Comm
bc no null % Ind
bc no null % Res
bc no null % Null
bc no null Imperviousness
bc no null PGE_facility Dens
bc no null Hist Rail
bc no null Modern_Rail
bc no null % Old Ind
bc no null PumpStations_count
bc no null Precip
bc no null UTM_Y
bc no null UTM_X

Fig. 4


re no null Area
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re no null Auto Dismantlers
Fig. 5
re no null % Ag
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re no null % Null
re no null Imperviousness
re no null PGE_facility Dens
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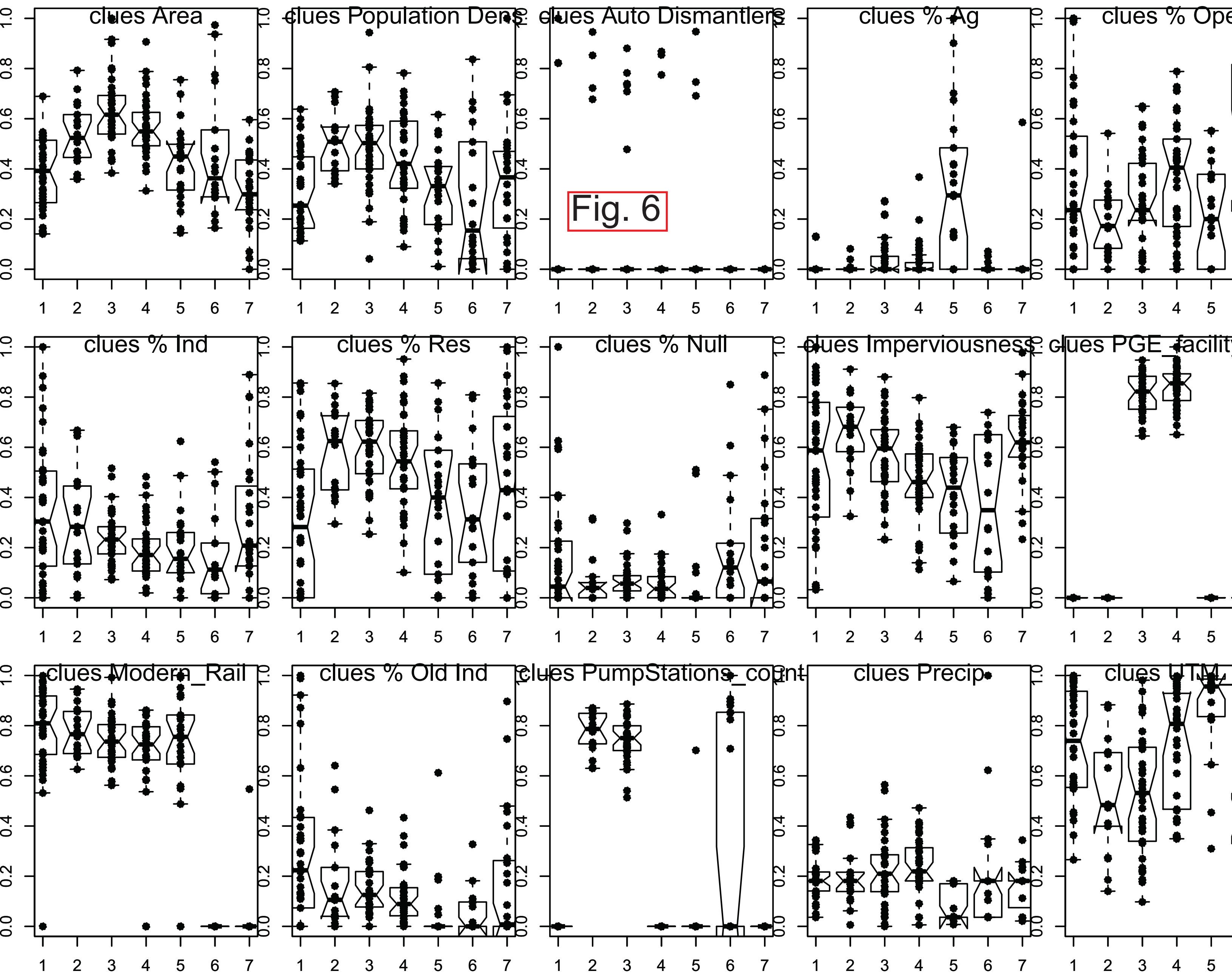
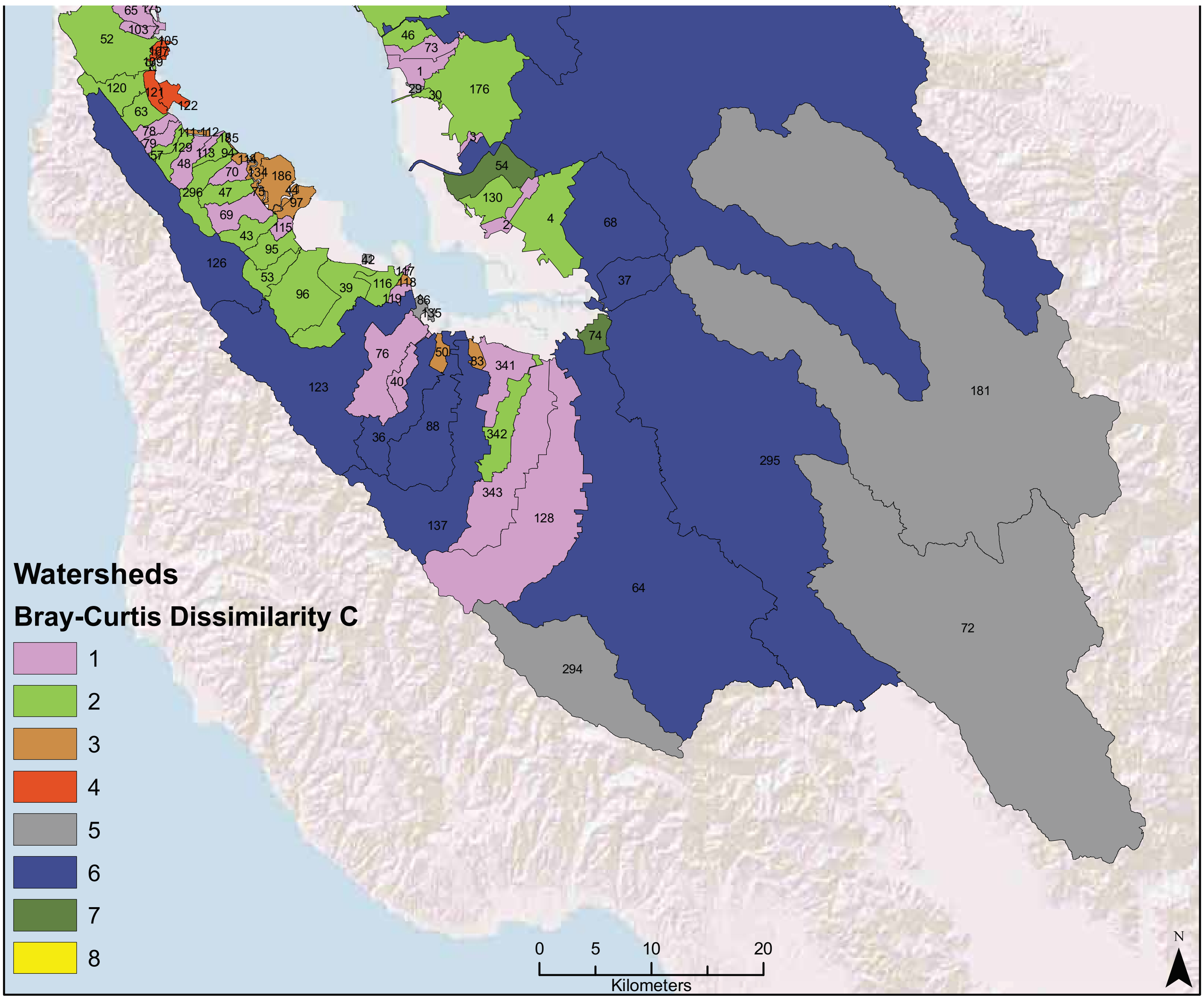
re no null UTM_X



clues Area
clues Population Dens
clues Auto Dismantlers
clues % Ag
clues % Ope
Fig. 6
clues % Ind
clues % Res
clues % Null
clues Imperviousness
clues PGE_facility
clues Modern_Rail
clues % Old Ind
clues PumpStations_count
clues Precip
clues UTM_



Watersheds
Bray-Curtis Dissimilarity C
1
2
3
4
5
6
7
8
0
5
10
20
Kilometers
N

Figure 8

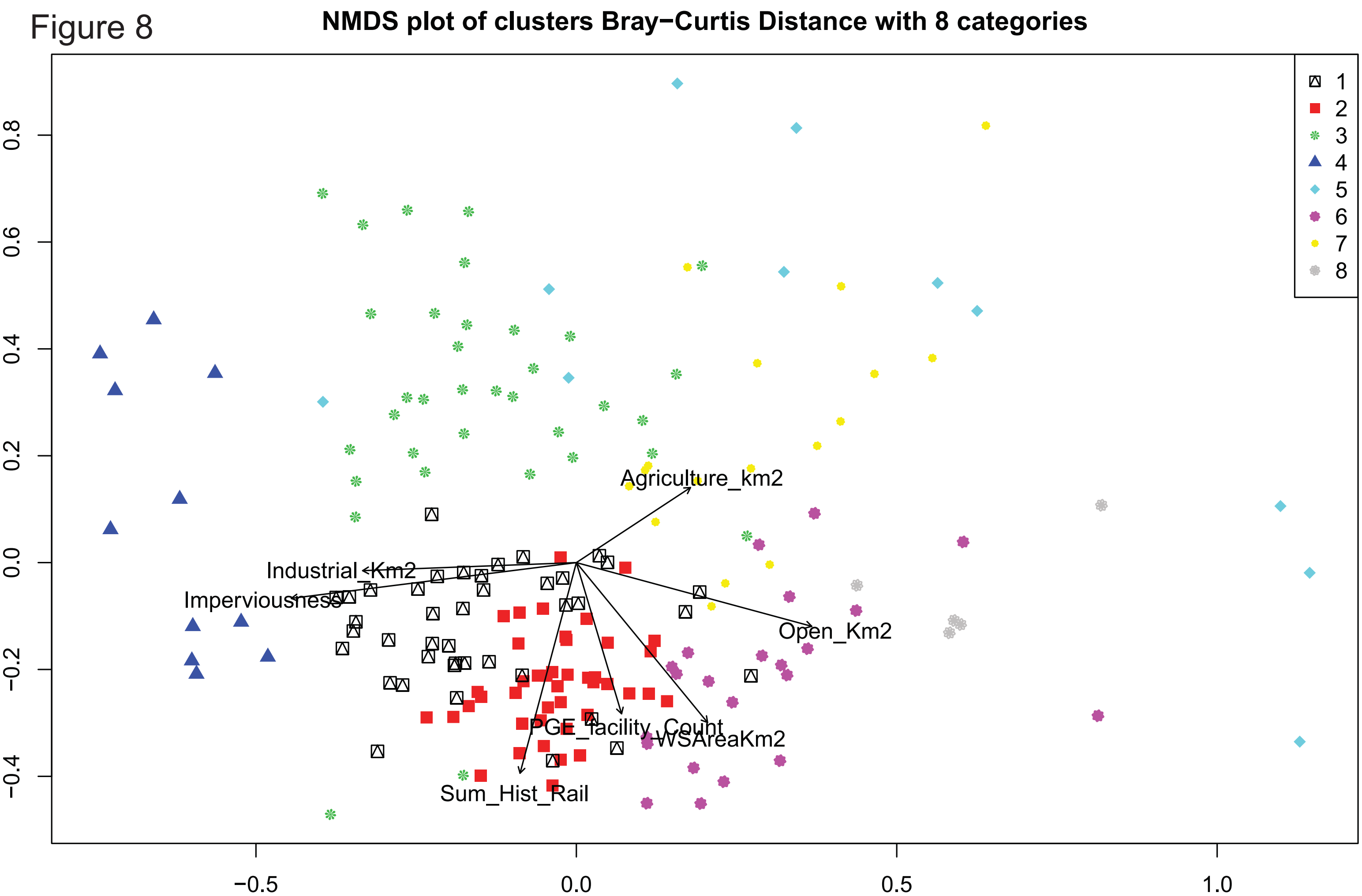

NMDS plot of clusters Bray−Curtis Distance with 8 categories
1
2
3
4
5
6
7
8
Agriculture_km2
Industrial_Km2
Imperviousness
Open_Km2
PGE_facility_Count
WSAreaKm2
Sum_Hist_Rail
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.5
0.0
0.5
1.0

Figure 9

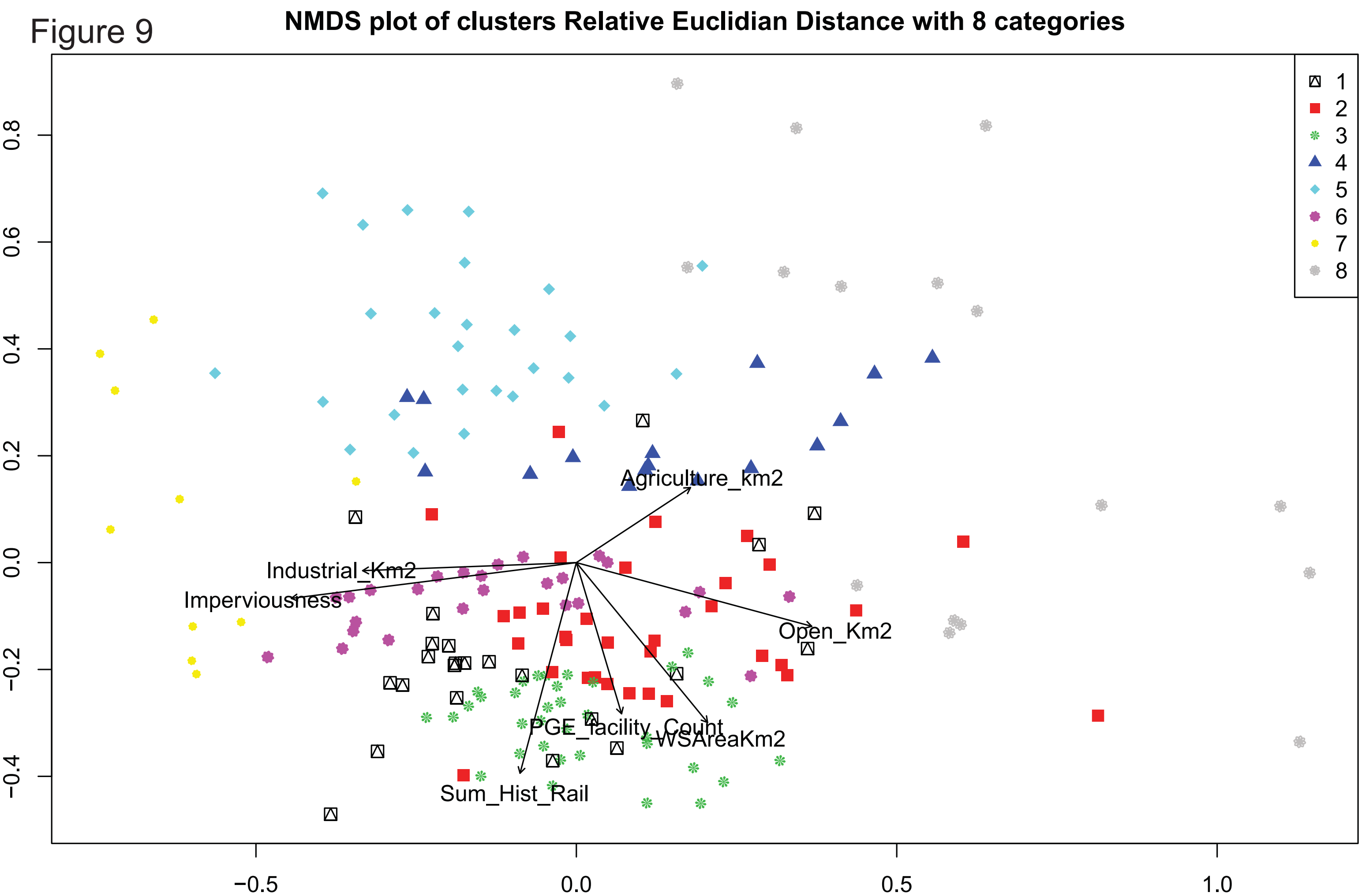
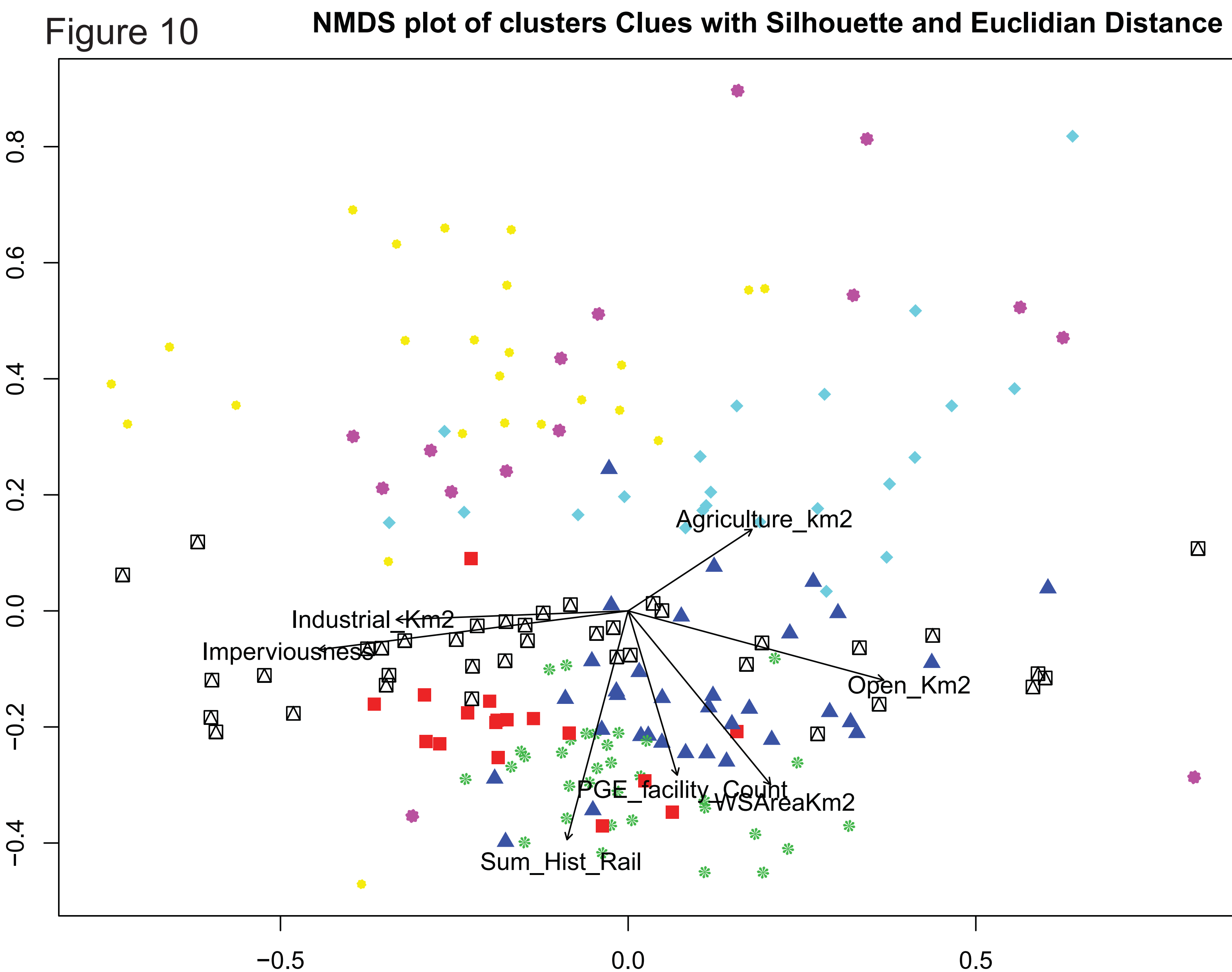

NMDS plot of clusters Relative Euclidian Distance with 8 categories
1
2
3
4
5
6
7
8
Agriculture_km2
Industrial_Km2
Imperviousness
Open_Km2
PGE_facility_Count
WSAreaKm2
Sum_Hist_Rail
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.5
0.0
0.5
1.0

Figure 10



NMDS plot of clusters Clues with Silhouette and Euclidian Distance
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.5
0.0
0.5
Agriculture_km2
Industrial_Km2
Imperviousness
Open_Km2
PGE_facility_Count
WSAreaKm2
Sum_Hist_Rail

Figure 11

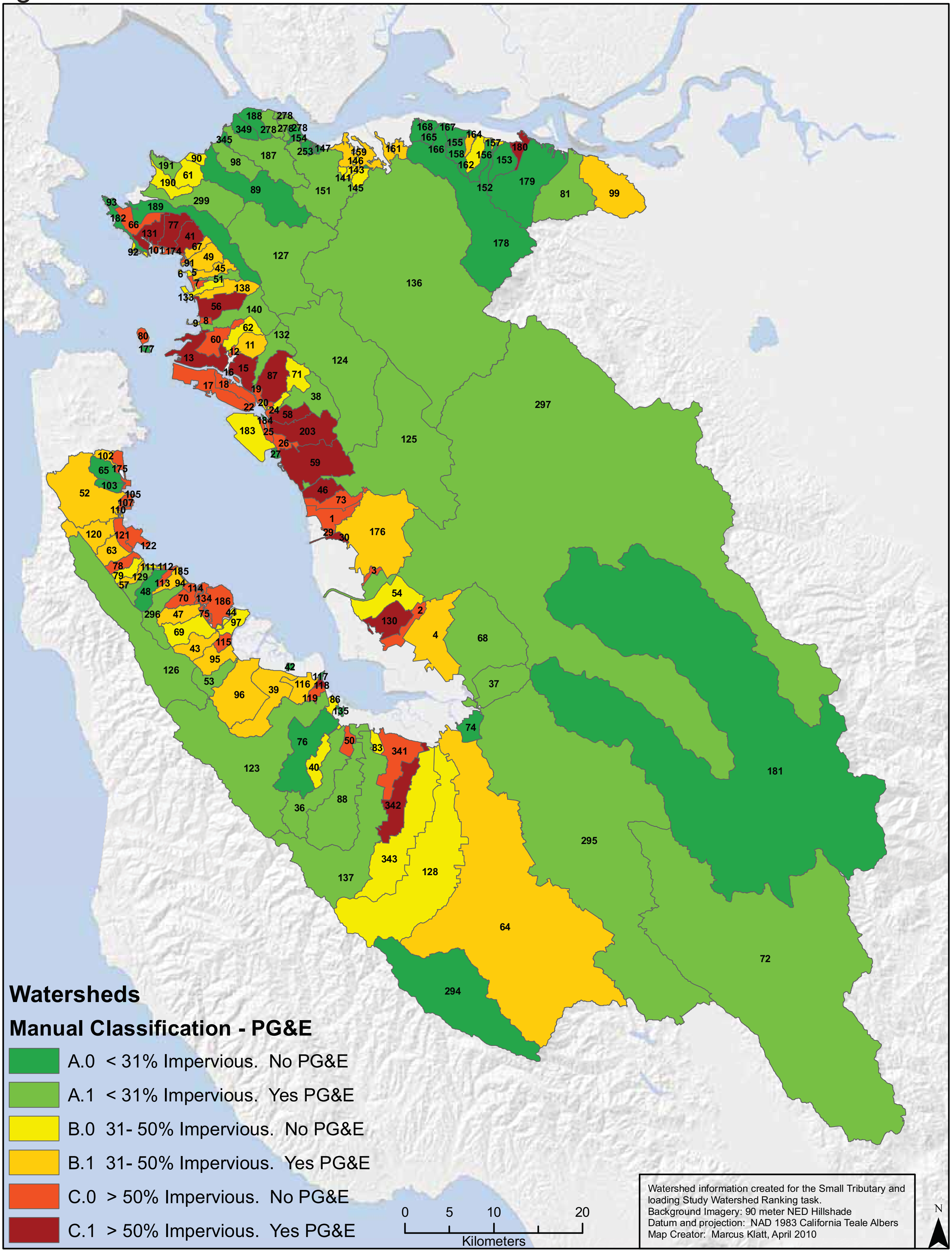
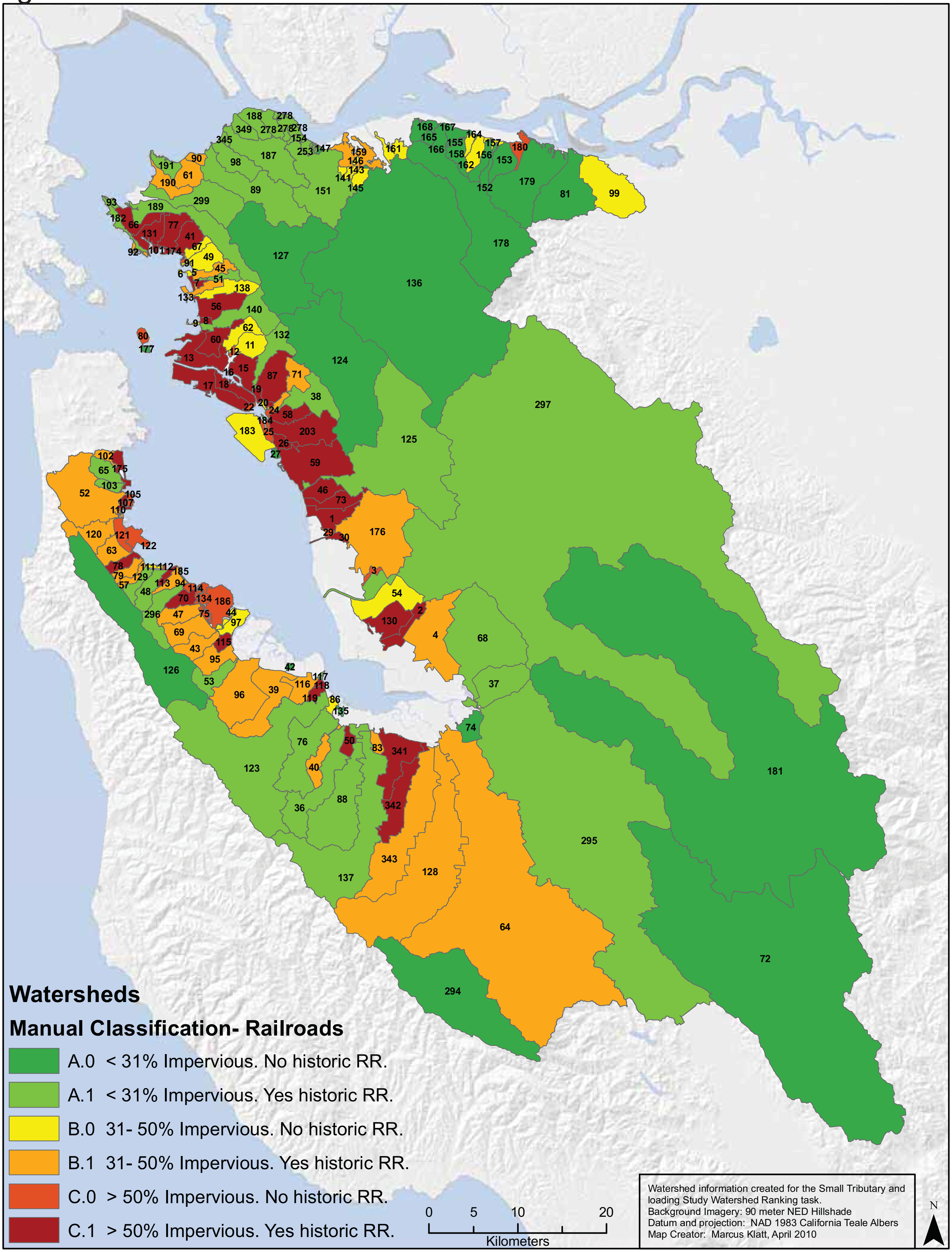

Watersheds
Manual Classification - PG&E
A.0 < 31% Impervious. No PG&E
A.1 < 31% Impervious. Yes PG&E
B.0 31- 50% Impervious. No PG&E
B.1 31- 50% Impervious. Yes PG&E
C.0 > 50% Impervious. No PG&E
C.1 > 50% Impervious. Yes PG&E
0 5 10 20
Kilometers
Watershed information created for the Small Tributary and loading Study Watershed Ranking task.
Background Imagery: 90 meter NED Hillshade
Datum and projection: NAD 1983 California Teale Albers
Map Creator: Marcus Klatt, April 2010
N

Figure 12


Watersheds
Manual Classification- Railroads
A.0 < 31% Impervious. No historic RR.
A.1 < 31% Impervious. Yes historic RR.
B.0 31- 50% Impervious. No historic RR.
B.1 31- 50% Impervious. Yes historic RR.
C.0 > 50% Impervious. No historic RR.
C.1 > 50% Impervious. Yes historic RR.
0 5 10 20
Kilometers
Watershed information created for the Small Tributary and loading Study Watershed Ranking task.
Background Imagery: 90 meter NED Hillshade
Datum and projection: NAD 1983 California Teale Albers
Map Creator: Marcus Klatt, April 2010
N

Watershed Characterization Field Study

Appendix E to Small Tributaries Loading Strategy Multi-Year Plan

Version 2011

The RMP budgeted $300,000 in 2011 funds for small tributaries monitoring with the assumption that Water Year 2010-11 would be the start-up year for POC Loads Monitoring to comply with the MRP. However at the June 14, 2010 Small Tributaries Loadings Strategy (STLS) Team meeting, it was concluded that there was insufficient evidence to confidently select a group watersheds to monitor beginning October 2010. Instead, the Team supported a wet season reconnaissance sampling study as an alternative use of the budgeted funds[1]. Details of the sampling design were developed during July-September 2010, starting from the following general outline:

- **Watershed selection:** The STLS Team screened sites within a framework based on the Greenfield et al. (2010) classification in particular the more frequent watershed clusters #1, #2, #3, and #6). Within strata factors were considered such as %old industrial, %imperviousness, soil and sediment concentrations, known watersheds where greater management effort is likely, existing flow data, logistics, statistical validity, and other factors such as local knowledge of hot spots.
- **Number of stations:** Within budget limits try for an average of 4 stations per strata but perhaps 3 stations in several strata and 5-6 stations in the other two strata.
- **Sampling method:** Manual depth-integrated grabs similar to previous sampling at Guadalupe River and Zone 4 Line A.
- **Sampling Frequency:** Minimum of 5 samples per station (better 6 or 7) during storm flow (ideally 1 storm) resulting from (predicted) 0.25 inches of rain in the urbanized (usually lower elevation) portion of the watershed. Focus would be on storms prior to January 31st from prior evidence that these are the "dirtiest" and to get early results.
- **Analyte list:** Default is MRP category 1 analytes only; Logistically the analytical list would ideally be smaller for small watersheds and could be more inclusive (for example include dioxins) in larger or selected watersheds.
- **Ancillary data:** Turbidity (grab), stage (manually read staff plate installed before wet season), velocity if possible (in larger watersheds where logistics allow)
- **Data interpretation:** Primary method is envisioned to be graphical as from the Z4LA first-year report, but the collection of stage data might also allow rudimentary flow-weighting of samples (knowing that at a minimum flow increases by a factor of stage

[1] This redirection is allowed by MRP Provision C.8.a, which indicates that initiation of the required POC loads monitoring can be deferred to October 2011 if the stormwater Permittees are participating in a regional collaborative process to plan and conduct the monitoring.

squared). Watersheds would be assigned preliminary rankings based on this storm data from most contaminated to least contaminated for each analyte. The STLS Team expected to be statistically able to group the watersheds in to high, medium and low categories.

A total of 16 tributaries were sampled during one or two storms that occurred in FY 2010-11 and water samples were analyzed for a number of POCs, including PCBs, total mercury, PBDEs, polycyclic aromatic hydrocarbons (PAHs) and selenium. Preliminary results were presented to the STLS Team and the Sources, Pathways and Loadings Workgroup (SPLWG) in spring 2011.

Table E-1 shows the watersheds selected for the characterization study, along with a summary of some of their key attributes. Criteria for the composition of the sampling list included the following:

- Multiple representatives of the most common small to medium sized watershed classes 1-3, distributed throughout the four counties (Contra Costa, Alameda, Santa Clara, and San Mateo) where loads monitoring is required by the MRP.
- A few representatives of the medium to large watershed classes.
- Smaller catchments, generally heavily urban with industrial land uses, where stormwater programs are planning enhanced management actions to reduce PCB and mercury discharges.
- Other watersheds with distinctive histories of mercury or PCB occurrence, or related management concerns.

Figure E-1 shows the general locations of the study watersheds and the drainage areas above the initially selected monitoring locations. Some of the monitoring station locations were adjusted after field reconnaissance. Table 4 lists watersheds considered but not selected for the study, and also watersheds excluded from the study because of the availability of significant amounts of previously collected PCB and mercury data.

In June 2011 the STLS Team reviewed the results of the WY2011-12 sampling. Analytes measured at each sampling site varied depending on budget and Water Board management questions (Table E-2). Between 4 and 7 PCB, total mercury, SSC and organic carbon samples were collected at each site. PBDE and PAHs were collected at a subset of sites chosen based on logistics (essentially randomly from a water quality perspective). Selenium data were only measured at Contra Costa sampling locations.

Table E-1. Watersheds sampled during reconnaissance characterization study of Water Year 2011.

Watershed/ station	Area (km^2)	Prelim, Cluster No.	Percent Impervious	Percent Old Industrial	Reconnaissance Feasibility/ Safety	PCB-Hg attributes
Ettie Street Pump Station	4.0	1*	73.4**	28.60**	Good/Good	PCB P13 Cluster, CW4CB pilot watershed
Pulgas Creek	7.1	2	28.2		Good/Good	CW4CB pilot watershed
Sunnyvale East Channel	18.0	2	59.7	3.47	Good/Good	PCB P13 Cluster
Santa Fe Channel	2.64	2	70.3	3.6	Poor-Medium/ Good	Confirm proposed station vs. locations of CW4CB pilot watersheds
Lower San Leandro Creek	8.9	2	37.5	2.96	Good/Good	PCB spill into creek in 1995
Stevens Creek	73.7	6	15.8	0.24	Good/Good	Within airshed of Lehigh-Hanson Cement Manufacturer
Zone 5 Line M	8.1	*	33.5	3.15	Good/Good	Hg P13 Cluster
Lower Marsh Creek	97.5	?	14.7		Good/Good	Drains historic Hg mine
San Lorenzo Creek	124.8	6	13.2	0.50	Medium/Good	
Walnut Creek	318.7	7	16.6	0.72	Good/Good	
Lower Penitencia Creek	12.0	*	67.1	7.14	Good/Good	
Belmont Creek	7.2	2	27.4	0.00	Medium/Good	
Borel Creek	3.2	2	31.4	1.57	Medium/Good	
Calabazas Creek	52.9	1	45.6	0.44	Good/Good	
Glen Echo Creek	5.4	3	39.3	0.80	Good/Good	Hg P13 Cluster
San Tomas Creek	114.1	1	34.4	0.35	Good/Good	

* Catchment does not correspond to a polygon used in cluster analyses
** Estimated for larger polygon used in cluster analyses

Figure E-1. Watersheds sampled in Water Year 2010-11 reconnaissance characterization study.

Table E-2. Summary of analytes collected during the water year 2010-11 reconnaissance characterization study.

Analytes	MRP Category	Number of Samples
PCB	Category 1	91
Total Mercury	Category 1	91
SSC	Category 1	91
Total Organic Carbon	Category 1	91
PBDE	Category 2	22
PAH	Category 2	22
Total Selenium	Category 2	30
Dissolved Selenium	Category 2	30

Maximum total mercury concentrations varied from 19-1740 ng/L (about 100x) between sites in relation to suspended sediment concentration and watershed characteristics. Given that SSC was a strong driver on the magnitude of concentrations, concentrations relative to particles (normalizing for SSC) was recommended as a better way of reviewing the data set in support of management questions and sampling decisions (Table E-3). Methylmercury did not relate directly to either maximum total mercury or median normalized (HgT/SSC) observed at each site and more likely is influenced by factors other than urban land use or Hg sources and uses in these watersheds.

Maximum PCB concentrations varied from 1,851 - 467,696 pg/L (Table E-4) a variation of about 250x. In the case of PCBs, data on SSC were not collected instantaneously with the PCB data; instead turbidity was used to normalize the data to remove the effects of sediment on preliminary interpretations. Organizing the data in this manner reveals a different pattern; the Santa Fe channel still appears to be the most contaminated of the sites sampled but the Ettie Street Pump Station watershed comes in second on the list and Glen Echo which was second comes in fifth. Also notable is that the patterns for PCBs and Hg are different; consistent with our conceptual model of differing use patterns and sources. Data for the other analytes have not yet passed through final quality assurance. Final results will be provided in a 2012 version of this Appendix.

Table E-3. The ratio of total mercury to suspended sediment concentration for the water year 2010-11 reconnaissance characterization study.

Watershed	Median HgT/SSC (ng/mg)	Max HgT (ng/L)	Median MeHgT/SSC (ug/kg)
Walnut Creek	0.077	181	0.066
Calabazas Creek	0.15	89	-
Lower Penetencia Creek	0.16	19	1.96
Borel Creek	0.18	74	0.91
San Lorenzo Creek	0.18	77	2.36
Stevens Creek	0.25	121	1.62
Belmont Creek	0.25	59	0.78
San Tomas Creek	0.26	129	0.38
Zone 5 Line M	0.31	1740	1.95
Sunnyvale East Channel	0.35	151	0.96
Glen Echo Creek	0.36	179	4.70
Pulgas Creek Pump Station - North	0.45	27	4.23
San Pedro Storm Drain	0.63	499	4.10
Santa Fe Channel	0.70	217	2.06
Ettie Street Pump Station	0.78	73	3.86
Pulgas Creek Pump Station - South	0.80	28	0.47
San Leandro Creek	0.82	477	5.63

Table E-4. Maximum concentrations of PCBs for the reconnaissance characterization.

Watershed	Maximum PCB concentration (pg/L)
Lower Penetencia Creek	1,851
Lower Marsh Creek	4,136
San Tomas Creek	4,372
Belmont Creek	4,909
Borel Creek	8,671
San Lorenzo Creek	20,421
Stevens Creek	22,554
Walnut Creek	24,396
Calabazas Creek	24,765
Zone 5 Line M	25,091
San Leandro Creek	31,336
Pulgas Creek Pump Station - South	53,894
Sunnyvale East Channel	67,462
Ettie Street Pump Station	68,996
Pulgas Creek Pump Station - North	84,490
Glen Echo Creek	85,815
Santa Fe Channel	467,696

Table E-5. Summary of PCB and Hg results organized by PCB/turbidity ratio.

Site	PCB/Turb Avg Ratio (pg/NTU)	HgT/SSC Avg Ratio (ng/mg)	PCB Rank	Hg Rank	Rank Sum	Feasibility Constraint?
Santa Fe	2882	0.68	1	4	5	Tidal
Ettie St	1097	0.78	2	3	5	Access time restricted
Pulgas North	822	0.47	3	5	8	Extremely flashy
Pulgas South	639	0.83	4	1	5	Extremely flashy
Glen Echo	443	0.38	5	7	12	Underground downstream
Sunnyvale Channel	369	0.34	6	8	14	Bridge narrow
San Leandro	98	0.8	7	2	9	
Z5LM	84	0.41	8	6	14	SSC > 1800 mg/L
San Lorenzo	74	0.28	9	9	18	
Stevens	33	0.26	10	11	21	
Calabazas	29	0.16	11	16	27	
Walnut	21	0.1	12	17	29	SSC > 1800 mg/L, 12-24 hour hydrograph – sample preservation
San Tomas	21	0.27	13	10	23	
Lower Penetencia	20	0.16	14	15	29	
Borel	17	0.17	15	14	29	
Belmont	15	0.24	16	12	28	
Lower Marsh	4	0.2	17	13	30	SSC > 1800 mg/L, Remote, access by Hwy 4, sample preservation

For the most part, sampling logistics at these sites were taken into account is part of the decisions made prior to the reconnaissance study. However, there were some additional lessons learned during the reconnaissance study about feasibility and potential sampling constraints that are worth noting (TableE-5). The tidal nature of Santa Fe channel, although it was sampled during low tide, will challenge the measurement of discharge if loads at this site are desired in the future; acoustic Doppler technology at a greater cost would be needed. Three locations (Zone 5 Line M, Walnut and Lower Marsh) had observed turbidities that exceed the use of the DTS12 turbidity sensors employed previously at Guadalupe and Zone 4 Line A; sensor technology that ranges to 4000 NTU is available but with some loss of sensitivity at lower the ranges (<50 NTU). The narrow sampling platform at Sunnyvale East Channel adds challenges for sampling equipment and safety due to lack of space. Sampling locations such as Walnut and Guadalupe with hydrographs that span a day or more may add sample preservation challenges if ice melts before samples can be retrieved following storm events. Lower Marsh Creek is a challenging location due to travel time to the site and the same kinds of preservation challenges.

Sampling and Analysis – Quality Assurance

Appendix F to Small Tributaries Loading Strategy Multi-Year Plan

Version 2011 PROGRESS

A major objective of the STLS is consistency between monitoring data from the stations operated by the RMP and those operated by Bay Area stormwater programs to comply with the Municipal Regional Stormwater Permit.

Table 8.4 in MRP Provision C.8.e describes a basic approach using autosamplers and minimum storm capture per 40 CFR 122.21(g)(7)(ii), and target Reporting Limits and Data Quality Objectives (DQOs) established by SWAMP. MRP Table 8.4 also specifies collection and analysis of methylmercury samples as grab samples to be collected and analyzed four times each year (two wet season and two dry season), However RMP monitoring on small tributaries through 2009 used different sampling methods and performance-based selection of laboratories. This Appendix presents some background information used to develop the MYP's sampling and analysis approach, and identifies further activities for assuring consistent practices and data quality. Updates in 2012 will describe Quality Assurance / one Quality Control (QA/QC) and Standard Operating Procedures (SOPs) in more detail

Sampling and Analysis

The MRP specifies that default standards for monitoring data quality be consistent with the latest version of the Quality Assurance Program Plan (QAPrP; SWAMP 2008) adopted by the Surface Water Ambient Monitoring Program (SWAMP). The QAPrP adopts a performance-based approach with target Reporting Limits (RL) for a large list of analytes in water and sediment, as well as other matrices.

The RMP has not specified target Reporting Limits for most analytes in its Status and Trends Program or Special Studies. In previous stormwater monitoring studies SFEI has utilized laboratory services that provide much lower method detection limits (MDL) for some analytes than those that would be associated with the SWAMP Target RLs.

The STLS team reviewed the differences between default SWAMP RLs and performance of labs in actual RMP monitoring.results for Zone 4 Line A, summarized in Table F-1. The RMP laboratories typically obtained much higher frequencies of detection with much lower detection levels for the organic compounds. The STLS Work Group agreed to continue using the laboratories with demonstrated consistency in low-range detection, but also reviewed considerations of costs of these analyses as well as logistical issues before agreeing on the sampling approach summarized in Table F-2.

Table F-1. Default SWAMP Reporting Limits for MRP analytes compared to RMP performance-based results for stormwater samples collected at Zone 4 Line A. See text for notes.

MRP Category (Table 8.4)	Analyte	SWAMP RL	Z4LA Concentration range	Fraction Z4LA data detected >RL using SWAMP RLs	Actual RL	Percent Z4LA data detected >RL using Actual RLs
1	Cu (T)	0.01 µg/L	2.26-50 µg/L	45/45	0.03-0.1 µg/L	100%
1	Cu (D)	0.01 µg/L	1.44-10.9 µg/L	11/11	0.1 µg/L	100%
1	Hg	0.0002 µg/L	0.00143-0.147 µg/L	112/112	0.0002 µg/L	100%
1	meHg	0.00005 µg/L	0.000032-0.00130 µg/L	55/56	0.00002 µg/L	99%
1	PCB congeners	0.02 µg/L[1]	0.000332-0.109336 µg/L	20/77	NA	
1	SSC	0.5 mg/L	1.415-2744 mg/L	392/392	0.6 mg/L	99%
1	TOC	0.6 mg/L	3.39-22.54 mg/L	40/40	0.3-2.4 mg/L	100%
1	Nitrate as N	0.01 mg/L	0.0043-0.656	10/12	NA	
1	Hardness (as CaCO3)	1 mg/L	-		NA	
2	Se (T)	0.3 µg/L	0.053-2.86 µg/L	15/30	0.045-1 µg/L	36%
2	Se (D)	0.3 µg/L	0.041-0.101 µg/L	0/5	0.045-0.053 µg/L	66%
2	PBDEs	NL (assume=PCB)	0.000348-0.141218 µg/L	18/36	NA	(75%)
2	PAHs (std list)	10 µg/L	0.01-23 µg/L	3/21	NA	(99%)
2	DDTs	0.002 µg/L[2]	0.000411-0.059480 µg/L	14/20	NA	(100%)
	Chlordane	0.002 µg/L[2]	0.000349-0.016400 µg/L	13/20	NA	(100%)
	Dieldrin	0.002 µg/L[2]	0.000276-0.004590 µg/L	3/20	NA	(100%)
2	Pyrethroids	NL			NA	
	Bifenthrin		0.183-46.3 ng/L	-	NA	
	Delta/Tralomethrin		0.464-5.49 ng/L	-	NA	
	Permethrin, total		1.57-285 ng/L	-	NA	
2	Carbaryl	NL	-		NA	
2	Fipronil	NL	-		NA	
2	Phosphorus (T)	NL	-	-	NA	
2	Phosphorus (D)	(mg/L)	0.0242-0.236	-	NA	
1	Aquatic Toxicity?	(Not sampled at Zone 4 Line A)-				

Notes:
[1] With exception of PCB 189, which has a target RL of 1µg/L. SWAMP congener list differs slightly from the 40-congener list used by the RMP.
[2] With exception of DDT (p,p'), which has a target RL of 0.005 µg/L

Table F-2. Target sampling design and configuration of ISCO autosamplers at each STLS watershed monitoring station.

MRP Category	Parameter	No. Storms/ year	Type	Recom-mended Lab[1]	avg. no. samples/ storm[2]	No. Duplicates /season	Field samples /season	Container Size (L)	ISCO unit no.
1	PCBs (40 congener)	4	Discrete	AXYS	4	1	17	1.8	1
1	Total Mercury	4	Discrete	MLML	4	1	17	0.35	2
1	Dissolved Cu	4	Composite	BRL	1	1	5	1.8	4
1	Total Cu	4	Composite	BRL	1	1	5	1.8	4
1	Hardness	4	Composite	BRL	1	1	5	1.8	4
1	SSC (GMA)	4	Discrete	EBMUD	8	2	34	0.35	2
1	Nitrate as N and Total Phosphorous	4	Discrete	EBMUD	4	1	17	0.35	2
2	Dissolved phosphorus	4	Discrete	EBMUD	4	1	17	0.35	2
1	TOC	4	Discrete	CAS?	2.5	1	11	0.35	2
1	Toxicity – water column	4	Composite	TBD	1	0	4	3.8	3
2	Pyrethroids	4	Composite	AXYS?	1	1	5	1.8	4
2	Carbaryl	4	Composite	DFG – WPCL?	1	1	5	1.8	4
2	Fipronil	4	Discrete	DFG – WPCL?	1	1	5	1.8	4
2	Chlordane, DDTs, Dieldrin	0	--	--	0	0	--	--	--
2	Dissolved Se (collect with Dissolved Cu)	4	Composite	BRL	(1)	(1)	(5)	--	(4)
2	Total Se (collect with Total Cu)	4	Composite	BRL	(1)	(1)	(5)	--	(4)
2	PBDE	2	Discrete	AXYS	1	1	3	1.8	1
2	PAH	2	Discrete	AXYS	1	1	3	1.8	1

[1] as of mid-July 2011; question marks indicate contacts to be followed up. [2]non- blank samples

Table F-1 shows preliminary results using available data. The RMP does not require laboratories to submit RLs, but some do provide them in which case the RLs are stored in database. For analytes reported without RL's, a percentage of detection is shown within parentheses, based on valid results greater than the sample-specific MDL.

Several of the analyses that were quantified by RMP labs would have been qualified or reported as non-detects by laboratories meeting but not exceeding SWAMP targets, especially PCBs and some of the other organic pollutants For some parameters (e.g. selenium, for which a few samples did not meet SWAMP RLs) different laboratories were used in different sampling seasons. Limited or no Zone 4 Line A data were available for pyrethroids, carbaryl or fipronil. Analytical methods for some of these pesticides have lagged behind their increasingly wide use in California, as indicated in reports prepared for the urban pesticides committee, e.g. TDC Environmental (2008) which recommends the following detection limits in water, based on available aquatic toxicity data:

- Each individual pyrethroid –as close to 1 nanograms/liter as available
- Carbaryl – 0.5 ug/liter
- Fipronil and degradates – 0.002 ug/liter

While improved water column methods have since been developed for fipronil (Hladik 2006, cited in TDC 2007), analytical capability to meet recommended detection limits has not been advertised by commercial laboratories. A few have informally indicated they would be able to provide these services given adequate market demand. SFEI is exploring agreements with these labs.

Key considerations in finalizing Table F2 included

- Obtaining the 16 samples per season recommended for loads estimation is a high priority for mercury PCBs and SSC. The design further increases the seasonal number of SSC samples since the turbidity surrogate is linked to SSC.
- Shifting to the lowest practicable detection limits is most important for PCBs PBDE and PAHs but also results in much higher laboratory analysis cost per sample.
- Sample volumes are constrained by available bottle configurations for the iSCO autosamplers; to make efficient use of no more than four samplers per station, analytes were grouped by container size and sample type, subject to the assignment of each sample bottle to a single analytical laboratory. Field duplicates can be collected wants per season for each analyte, rotating the assignment of duplicates among different events.
- Sampling for Category 2 pollutants was averaged out to be the same for each year, rather than being focused in alternating years.
- Tracking copper loads to the Bay is not a high priority in the near term[1], so the sampling effort for dissolved and total copper was kept at the MRP level of four composite samples

[1] Copper Site-Specific Objectives adopted for the Bay required a Copper Action Plan involving a variety of source control actions by dischargers. The largest source of copper to urban runoff, vehicle brake pads, is expected to be effectively phased out over the next 10-25 years as mandated by California SB 346, enacted in 2010.

per season, to allow consolidation into the same sampling containers as dissolved and total selenium.

For pesticides, sampling design was driven by priorities other than loads to San Francisco Bay:

- Recent data on organochlorine pesticides in the Bay suggest a recovery trajectory that will not require development of a TMDL. Load estimates from small tributaries are thus not a pressing priority and chlordane, DDTs and dieldrin were removed from the analyte list.
- The remaining Category 2 pesticides are primarily of concern as potential causes of toxicity in freshwater streams and water bodies. Thus the STLS will collect samples with the same type and frequency for these pesticides and for water column toxicity. Since toxicity effects are a function of integrated exposure over time,

Quality Assurance

A Quality Assurance Project Plan (QAPP) and Field Manual (FM) are being developed with BASMAA funding, concurrent with planning and setup for the WY 2011-12 monitoring season. The MRP does not require submission of a QAPP so for the purposes of the STLS the term "QAPP" is used in a flexible sense, not strictly tied to the rigid content and format in the templates generated by SWAMP. These documents will describe:

- Program management: roles and relationships between BASMAA programs and the RMP
- Data quality objectives.
- Standardized approaches to data management, quality assurance and reporting
- Coordination between the QAPP, the Field Manual and additional SOPs

The Field Manual for Watershed Stormwater Monitoring will describe all methods and procedures, with reference to existing SOPs and procedures already produced or in development by BASMAA or SFEI. Table F-3 provides a working outline of its contents.

Review of the first year's data may involve reexamination and updating of some aspects of the QAPP and Field Manual. Additional QA issues that may be reviewed in the future include:

- Comparison of different turbidity sensors. Past RMP monitoring has used one instrument type (Forest DTS-12), but a different model capable of reading higher turbidity levels will be deployed at STLS sites with high turbidity readings during WY2011-12. Raw turbidity readings from different types of probes may not be directly comparable due to differences in design features such as sensor type, wavelength of light and algorithm used to calculate turbidity.
- Suspended Sediment Concentration calibration. An articulated boom provides continuous depth integration for both the continuous turbidity sensor and SSC sample collection. WY2011-12 plans do not include calibration of the depth-integrated sample across the cross-section, assuming that the channels are sufficiently well-mixed at the sampling locations.

Table F-3. Main content of STLS Field Manual for Watershed Stormwater Monitoring, including additional Standard Operating Procedures (SOPs)

Section	Main contents
1. Introduction	• NPDES municipal permit to discharge storm water (CS / AF) • RMP STLS (SFEI / CS / AF) • MRP Requirements from Table 8.4 as adapted by STLS (PS / SFEI) • SOP background - application of manual and SOPs
2. References to existing SOPs (e.g. developed for other RMC or RMP programs	• Collection of grab samples • Clean hands grab sampling, • Data processing, analysis and interpretation • Development of stream rating curves by project-specific gauging methods • Flow measurement methods
3. Special Cautions and Considerations; Health and Safety	• Introduction • Hazard identification • Health and safety practices
4. Methods / Procedures	• Monitoring station description • Instrument programming, calibration and maintenance • Storm monitoring • Field data management • Field quality assurance and quality control • Equipment maintenance
5. Quality Assurance / Quality Control	• Training • Internal Reporting
6. References	
7 Additional SOPs	1. Cleaning procedure for sample intake tubing and intake strainers 2. Cleaning procedures for composite and discrete sample bottles 3. Determination of flow / turbidity-triggers for sampling or sample pacing 4. Station preparation for event sampling 5. Changing a composite bottle set during a storm 6. Discharge measurement procedures 7. Sample Container, Handling, and Hold Time

References

TDC Environmental (2007) Urban Use of the Insecticide Fipronil--Water Quality Implications, Memorandum to the Urban Pesticide Committee from Kelly D. Moran, TDC Environmental, June 18, 2007.

TDC Environmental (2008). Pesticides in urban surface water- annual review of new scientific findings 2008. Prepared for the San Francisco Estuary Project, April 2008.