Trash Load Reduction Tracking Method

Technical Memorandum #1 - Literature Review

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1. INTRODUCTION

The Municipal Regional Stormwater NPDES Permit for Phase I communities in the San Francisco Bay (Order R2-2009-0074), also known as the Municipal Regional Permit (MRP), became effective on December 1, 2009. The MRP applies to 76 large, medium and small municipalities (cities, towns and counties) and flood control agencies in the San Francisco Bay Region, collectively referred to as Permittees. Permit Provision C.10 (Trash Load Reduction) requires Permittees to implement control measures to reduce trash loads from municipal separate storm sewer systems (MS4s) by 40 percent by 2014, 70 percent by 2017 and 100 percent by 2022. As part of the process of demonstrating progress towards trash load reduction goals, Permittees are required to develop a trash load reduction tracking method that will be used to account for trash reductions due to actions taken by Permittees. A description of a trash load reduction tracking method is required to be submitted to the Water Board by February 1, 2012; and a progress report is required by February 1, 2011. The tracking method for Permittees can be developed collaboratively or individually.

Permittees have decided to work collaboratively to develop a trash load reduction tracking method through the Bay Area Stormwater Management Agencies Association (BASMAA). The tracking method includes developing formulas to quantify load reductions, baseline information and determining future data needs (i.e., identification of information needed to populate formulas). In combination with the *Baseline Trash Loading Estimate* (being developed under a separate project), the tracking method will assist Permittees in demonstrating progress towards MRP trash load reduction goals (i.e., 40 percent, 70 percent and 100 percent) through quantification of the effectiveness of trash load reduction activities (i.e., best management practices or control measures). The tracking method will be developed through a step-wise regional collaborative process with oversight from the BASMAA Trash Committee. Trash load reduction tracking method development will consist of four tasks resulting in four separate deliverables: 1) Technical Memorandum #1 – Literature Review; 2) Technical Memorandum #2 – Draft and Final Load Reduction Tracking Method; 3) Technical Report #1 – Final Load Reduction Tracking Method and Supporting Material; and 4) Trash Loads Reduced Calculator.

1.1. PURPOSE AND SCOPE OF TECHNICAL MEMORANDUM

This technical memorandum serves as the first deliverable (Task #1) of the BASMAA project to develop a trash load reduction tracking method. The purpose of this technical memorandum is to document the results of the literature review conducted to identify:

- Methods employed by public agencies, non-profit organizations and private entities in California, the United States. and internationally to assess the effectiveness of control measures associated with trash;
- The level of effort necessary to track information needed to assess effectiveness and quantify trash loads reduced; and,
- The degree and extent of information tracking related to trash control measure effectiveness that were recently or are currently implemented by San Francisco Bay Area Permittees.

The intent of identifying these methods, efforts and information is to assist Permittees in determining which control measures are most conducive to develop quantification methods used to calculate trash loads reduced; and those that are more suitable for establishing agreeable loads reduced credits developed through a regional stakeholder process.

1.2. LIST OF POTENTIAL TRASH/LITTER CONTROL MEASURES REVIEWED

The first step in developing a trash load reduction tracking method was to identify a list of potential control measures to consider for loads reduction tracking. This list is presented in Table 1-1. Based on the list, a literature review was conducted to evaluate quantification methods used by others to assess control measure effectiveness or progress towards quantitative goals. Results of the literature review are documented within this technical memorandum.

Table 1-1. Trash/litter control measures reviewed.

Section	Trash/Litter Control Measures
2	Trash Treatment Devices (Full and Partial-Capture)
3	Stormwater Conveyance System Maintenance
4	Street Sweeping
5	Product Bans (e.g., plastic grocery bags)
6	Creek/Channel/Shoreline Cleanups (Volunteers and/or Municipal)
7	On-land Litter Pickup/Removal (Volunteer and/or Municipal)
8	Public Education and Outreach Programs
9	Improved Municipal Trash Bin/Container Management
10	Additional Fees at Landfills for Unsecured Loads
11	Anti-Littering and Illegal Dumping Enforcement Activities
12	Free Trash Pickup/Drop Off Days (e.g., Bulky Days)
13	Solid Waste Recycling and Diversion Programs
14	Litter Fees on Businesses
15	Storm Drain Signage/Inlet Marking
16	Improved Trash Collection Methods/Equipment

1.3. MEMORANDUM ORGANIZATION

This memorandum is organized into the following sections:

- Section 1: Introduction, background and purpose;
- Sections 2 through 16: Literature review results of trash/litter control measures;
- Section 17: Recommendations; and
- Section 18: References for all citations.

2. TRASH TREATMENT DEVICES (FULL AND PARTIAL-CAPTURE)

A trash treatment device is a single or series of structural devices which capture trash transported by a stormwater conveyance system or a receiving water body; and retain trash until removed through maintenance practices. These devices may be installed at many points within the stormwater conveyance system or within a water body. For example, curb inlet screens can be used at the start of the stormwater conveyance system (i.e., storm drain); connector pipe screens are placed inside a storm drain; hydrodynamic (vortex) separators (e.g., continuous deflective separation units) can be placed in stormwater conveyance system lines; netting devices can be placed at outfalls to receiving water bodies; and litter booms are placed within receiving water bodies to collect trash already present in creeks and rivers. Figure 2-1 provides an illustration of the points along the stormwater conveyance system and within receiving waters at which trash treatment devices can be installed.

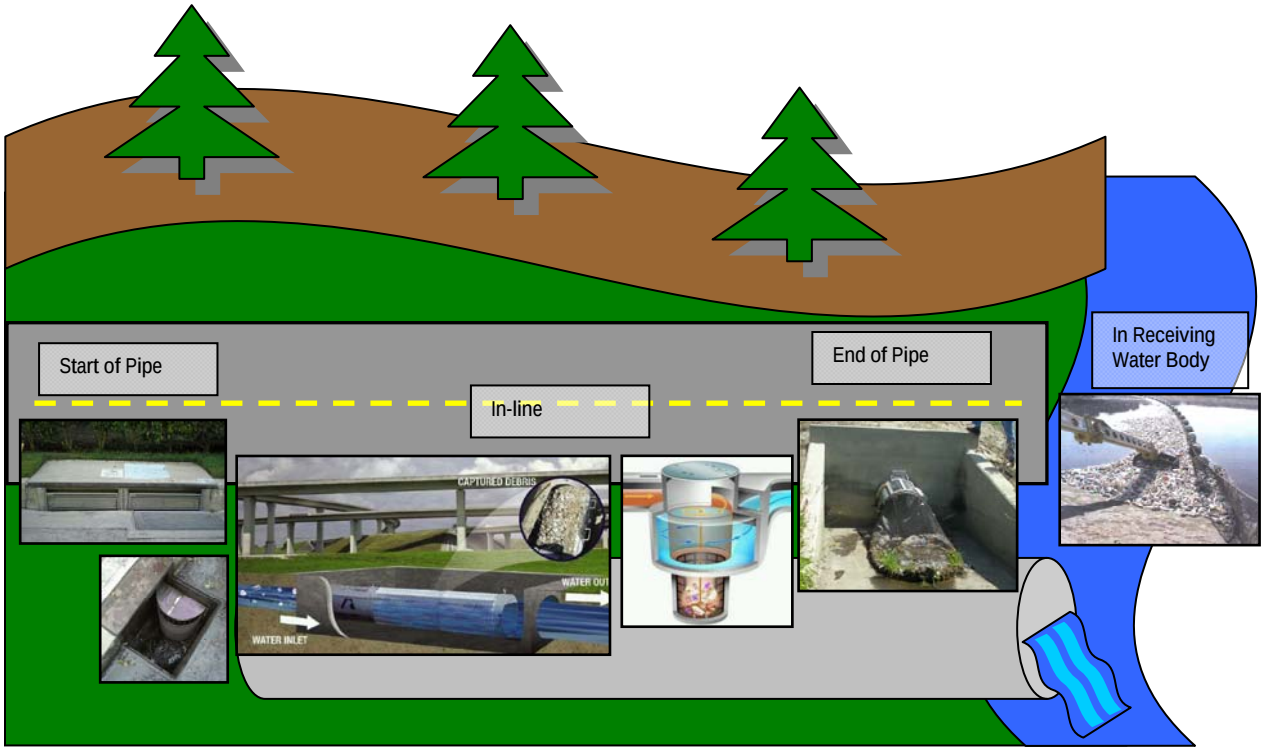

Figure 2-1. Implementation points for trash treatment devices within the stormwater conveyance system

Trash treatment devices can be classified as "full-capture" or "partial-capture". Based on the definition developed by the Los Angeles Regional Water Quality Control Board (Los Angeles Water Board) and incorporated into the Municipal Regional Stormwater Permit (MRP) by the San Francisco Bay Regional Water Quality Control Board (San Francisco Bay Water Board), a full capture device is any device (or series of devices) that meets the design standard described in the next section. For the purpose of describing the "effectiveness" of full and partial-capture treatment devices, the following terms embraced by the *International Stormwater BMP Database* are used throughout this section:

- Performance - measure of how well a trash capture device meets its goals for stormwater that it is designed to treat.
- Effectiveness - measure of how well a trash capture device meets its goals in relation to all stormwater flows.

At the time this memorandum was completed, a number of devices were approved by the San Francisco Bay Water Board as full-capture. These devices are presented in Table 2-1. Trash treatment devices which have not been approved as full-capture by the San Francisco Bay Water Board are defined as partial-capture devices. Current examples include litter booms and curb inlet screens. Both full and partial-capture devices are described below.

Table 2-1. Devices approved by San Francisco Bay Water Board as full-capture.

Storm Drain Inserts	Hydrodynamic Separators
Advanced Solutions AS-1 Stormtek ST3 AS-2 Stormtek ST3-G Bio Clean Environmental Services, Inc. BC-1 Grate Inlet Skimmer Box (square design) BC-2 High Capacity Round Grate Inlet Skimmer Box BC-3 Modular Connector Pipe Screen BC-4 Trash Guard Ecology Control Industries (American Stormwater) ECI-1 Debris Dam G2 Construction, Inc. G2-1 Collector Pipe Screen G2-1R Collector Pipe Screen Removable Gentile Family Industries (Waterway Solutions) GFI-1 *WAVY* GRATE Trash Catcher KriStar Enterprises, Inc. KS-1 Flo Gard Plus Storm drain inlet Filter Insert, combination inlet style – C3 (stainless steel) KS-2 Flo Gard Plus Storm drain inlet Filter Inserts, flat grated inlet style, rectangular or round – C3 (stainless steel) KS-3 FloGard Storm drain inlet Outlet Screen Insert Revel Environmental Manufacturing, Inc. REM-1 Triton Bioflex Drop Inlet Trash Guard United Stormwater, Inc. USW-1 Connector Pipe Screen West Coast Storm, Inc. WCS-1 Connector Pipe Screen	Contech Construction Products CCP-1HF Continuous Deflective Separator (CDS) KriStar Enterprises, Inc. KS-6HF Downstream Defender KS-7HF FloGard Dual-Vortex Hydrodynamic Separator **In-line Netting** Fresh Creek Technologies, Inc. FCT-1HF Inline Netting Trash Trap KriStar Enterprises, Inc. KS-10HF Nettech Gross Pollutant Trap - In Line **End-of-Pipe Netting** Fresh Creek Technologies, Inc. FCT-2HF End of Pipe Netting Trash Trap KriStar Enterprises, Inc. KS-11HF Nettech Gross Pollutant Trap- End of Line **Other In-line Devices** Bio Clean Environmental Services, Inc. BC-5HF Nutrient Separating Baffle Box KriStar Enterprises, Inc. KS-5HF CleansAll KS-8HF FloGard Perk Filter KS-9HF FloGard Swirl-Flo Screen Separator Roscoe Moss Company RMC-1HF Storm Flo Screen

2.1. FULL-CAPTURE DEVICES

A full capture system or device is any single device or series of devices that traps all particles retained by a 5 mm mesh screen and has a design treatment capacity of not less than the peak flow rate (Q) resulting from a one-year, one-hour, storm in the sub-drainage area. The Municipal Regional Stormwater Permit (MRP) requires population-based Permittees to install and maintain a minimum number of full-capture devices by July 1, 2014 to treat runoff from an area equivalent to 30 percent of retail/wholesale land that drains to MS4s within their jurisdictions. All installed devices that meet the full capture definition may be counted toward this requirement regardless of date of installation. A population-based Permittee with a population less than 12,000 and retail/wholesale land less than 40 acres, or a population less than 2,000, is exempted from this requirement. Non-population-based Permittees are also required to install and maintain a minimum number of trash capture devices.

A number of case studies have been conducted to assess the effectiveness of full capture devices in capturing trash in stormwater conveyance systems. The following section provides a summary of case studies reviewed during this literature review. These studies are organized by device type.

2.1.1. Storm Drain Inserts

Storm drain inserts are baskets, trays, bags, or screens placed inside the inlet or at the outlet of a storm drain inlet to capture trash. Storm drain inserts are also known as storm drain inlet inserts, storm drain inlet filter inserts, connector pipe screens, litter traps, and side-entry catchpit traps. The following case studies provide information regarding the effectiveness of storm drain inserts in removing trash from stormwater conveyance systems.

City of Los Angeles (City of Los Angeles 2006a)

The Watershed Protection Division (WPD) of the City of Los Angeles Department of Public Works, Bureau of Sanitation conducted a study to determine the trash capture effectiveness of storm drain inlet inserts during a typical calendar year (City of Los Angeles 2006a). The study location was a high trash generation area adjacent to the Los Angeles Memorial Coliseum/Exposition Park and had a drainage area of approximately 138 acres. To determine the effectiveness, a total of fifty (50) storm drain inlets were retrofitted with full-capture storm drain inlet inserts developed by Practical Technology, Inc. This type of device was a basket placed at the inlet of the storm drain inlet. The study location also included one CDS unit. Field measurements from all storm drain inlets and the CDS unit were obtained during the FY 2005-2006 wet season after every storm greater than 0.25 inches. Measurements only occurred for storm events occurring ten or more days apart.

The overall trash capture effectiveness of the storm drain inlet inserts was determined by visual observations and field measurements using the following equation (City of Los Angeles 2006a):

$$TC_{Effectiveness} = \frac{\sum_{i}^{n} CB_{trash}}{\sum_{i}^{n} CB_{trash} + CDS_{trash}}$$

The CB_{trash} and CDS_{trash} are the trash quantities for the storm drain inlet inserts and CDS unit. These quantities are expressed in weight (pounds) and in-place-volume based on the height of the trash and cross-sectional area of the units. During this study, however, only floatable trash was removed from the CDS unit while settleable trash in the sump was not collected and measured.

The effectiveness of storm drain inlet inserts in capturing trash during a storm greater than 0.25 inches was determined to be 80 to 90 percent. During dry days, the trash capture effectiveness is 100 percent since there are no flows to transport trash. A typical year in Los Angeles includes approximately 25 wet days and 340 dry days. Therefore, over the course of the entire calendar year, storm drain inlet inserts were determined to have a 99.2 percent effectiveness rate. The following equation was used to calculate effectiveness (City of Los Angeles 2006a):

$$\frac{(340\ dry\ days \times 100\%) + (25\ wet\ days \times 92\%)}{365 \frac{days}{year}} = 99.2\%$$

Since trash was not removed and measured from the CDS sump, the effectiveness calculation is only considering a portion of total trash removed from the unit. It is estimated that approximately 20 percent of trash is floatable, while the majority settles in the sump (Allison et al. 1998a). Assuming that only 20 percent of trash was removed from the unit, the adjusted storm drain insert effectiveness for wet days is 73.2 percent on average, which corresponds to a 98.2 percent annual effectiveness.

As of September 2008, the City of Los Angeles has installed over 7,700 storm drain inserts in high trash generating areas; and 14,900 storm drain inserts in high and medium trash generating areas. Accordingly to the City of Los Angeles, storm drain inserts are maintained after every storm greater than 0.25 inches.

Victoria, Australia (Allison et al. 1998a)

Allison et al. (1998) studied the effectiveness of side entry catchpit traps (SECTs) installed in an urban watershed in Victoria, Australia. Side entry catchpit traps were installed in all municipally-owned storm drain inlets within a catchment area of 50 hectares (123.5 ac). The catchment area was 65 percent residential and 35 percent commercial land uses (Allison et al 1998a). The study also included a CDS unit downstream of all SECTs to measure effectiveness.

Effectiveness was calculated by comparing the dry mass collected by SECTs with the mass of material collected in the downstream CDS unit over the same period. It should be noted that SECTs were not installed at privately-owned storm drain inlets. Therefore, it is not possible to fully estimate all material captured by the downstream CDS unit to material lost by one or more SECTs. Observations made at various SECTs suggest that bypassing the devices did occur but the proportion of loss is unknown (Allison et al 1998a).

Allison et al. (1998) concluded that SECTs captured up to 73 to 85 percent of the total amount of trash loaded to the entire stormwater system, but only if inserts are installed in all storm drain inlets. The study noted that the total amount of trash retained by inserts within a stormwater system will vary according to the number of inserts installed and their locations. As a result, the siting of inserts can have an impact on overall effectiveness.

Urban Litter Removal Study (Armitage et al. 2000)

The Water Research Commission of South Africa funded a four-year study to evaluate the design and removal effectiveness of litter traps. The study indicated that SECTs had a varying degree of effectiveness based on the percentage of catchment covered. A catchment area that had SECTs at every storm drain inlet indicated an effectiveness of 76 percent. However, a catchment area that had SECTs at half the storm drain inlets indicated an effectiveness of 59 percent (Armitage et al 2000). The study also indicated that effectiveness related to cleaning frequency, runoff flow rates and SEPT site location (Armitage et al 2000).

2.1.2. Hydrodynamic Separators

Hydrodynamic separators (HDS), also known as vortex separators or swirl concentrators, use the tangential forces created by the incoming flow of water to separate trash, debris, oil and other pollutants from stormwater. While there is a range of proprietary designs, all HDS devices rely on a circular chamber to swirl the stormwater flow and a settling or separation unit to remove pollutants. The devices are available in a range of sizes/treatment capacities depending on the manufacturer. The following case studies provide information regarding the effectiveness of HDS devices in removing trash from stormwater conveyance systems.

Southern California Freeways (Caltrans 2004)

The California Department of Transportation (Caltrans) conducted a study of a particular brand of HDS devices (i.e., Continuous Deflection Separator or CDS unit) in Southern California to determine their effectiveness at removing trash from freeways. Two CDS units were installed near freeway sites. The total wet and dry weight, volume of floatables, settleable materials, material contained in the weir box, and bypass material were measured following each clean out. Effectiveness was calculated as the mass retained relative to the sum of the mass retained; and the mass of material passing, times 100. It was determined that the CDS units captured between 85 and 92 percent of trash and debris by weight (Caltrans 2004). Approximately 93 percent of the material retained was vegetative material while the remainder was trash and litter.

Melbourne, Australia (Allison et al. 1998a)

Allison et al. (1998) conducted a study of CDS performance within a 50 ha (123.5 acre) catchment area in a suburb of Melbourne, Australia. The CDS unit included a screen size (4.7 mm) smaller than the "full capture" definition for trash and litter (5mm). To determine effectiveness, discharges and water levels upstream and downstream of the unit were measured; and material was collected from the CDS unit after every storm event and analyzed (i.e., sorted and weighted). Effectiveness was determined by measuring how much and how often storm flows bypassed the diversion weir; and comparing that to discharges passing through the CDS unit. When storm flows did not bypass the diversion weir, the only pathway for material was through the CDS screen. Results indicated that during twelve months of monitoring, less than one (1) percent of stormwater flowed over the weir and bypassed the CDS unit. In estimating the amount of trash that bypassed treatment, the authors assumed that the amount was proportional to the discharge that bypassed the system. Therefore, the authors estimated that CDS performance was approximately 99 percent during the study (Allison et al 1998a).

2.1.3. In-line Screening Devices

Storm drain systems can also be modified with vaults configured with screens to hold trash for later removal. Examples include a series of inline screening devices developed by the California Department of Transportation (Caltrans). These devices, which are named Gross Solids Removal Devices (GSRDs), were developed in response to the trash TMDL instituted in the Los Angeles River and Ballona Creek Watersheds.

California Department of Transportation (Caltrans 2003)

Caltrans tested a variety of GSRDs and configurations in preparation for submitting a request for full capture certification from the Los Angeles Water Board. Multiple configurations were designed for each device and pilot tested at various sites between 2000 and 2002. In addition to meeting the full-capture definition, Caltrans required that all GSRDs meet the following criteria:

- Capture 100 percent of material greater than 5 mm;
- No clogging of screens;
- Ability to convey a 25-year peak flow;
- Drain within 72 hours; and,
- Requires cleaning only once per year (i.e., has a capacity to hold the total annual load of gross solids) and does not require additional maintenance (Caltrans 2003a).

To calculate effectiveness, the amount of trash and debris captured and the total amount loading to each device were measured on an annual basis. The amount of captured trash and debris was defined as the total mass and volume of material removed from within the device during the annual cleaning or, if necessary, incremental cleanings. The total loading was the sum of captured material and bypassed material (i.e., gross solids that bypassed by way of overflow or material that passed the device screen and was captured in a mesh bag and/or mesh screen box located downstream of the pilot device) (Endicott et al 2002).

Four types of GSRDs with multiple configurations were tested over two years (2000-2002):

- Linear Radial Screens (LR);
- Inclined Screens (IS);
- V-Screens (VS); and,
- Baffle Boxes (BB).

Results indicate that device effectiveness differed greatly over the test period (Table 2-2). Effectiveness values ranged from 8.9 percent by weight (44 percent by volume) to 100 percent (by weight or volume). These differences were solely attributed to differences in loading. Although some loading values exceeded the design capacity, there was no relationship between loading and effectiveness (Caltrans 2003a, b and Caltrans 2005 a, b).

Table 2-2. Removal efficiencies for Caltrans in-line screening devices (i.e., Gross Solids Removal Devices).

Device		Removal Effectiveness	
Type	Configuration	% by Weight	% by Volume
Inclined Screen (IS)	1	100	100
	2	73 - 100	69 – 100
	3	90 - 96	90 – 95
	4	46	68
Linear Radial (LR)	1	100	100
	2	87 - 100	56 – 100
	3	9	44
Vertical Screen (VS)	1	98	88
	2	93 - 98	91 – 95
Baffle Boxes (BB)	1	93 - 97	87 – 90
	2	100	97 – 100

Although many of the devices met the full-capture device definition, many experienced high bypass proportions, screen clogging, and/or required too frequent maintenance. As a result, these devices did not meet the Caltrans criteria. Three units consistently met the Caltrans criteria, IS-1, LR-1 and IS-4. Two of these devices (LR-1 and IS-1) were recommended by Caltrans for certification as full capture by the Los Angeles Water Board (LARWQCB 2004).

2.1.4. Netting Devices

Netting devices are used to capture trash and floatables from the end of stormwater outfalls or within the stormwater conveyance system (e.g., prior to entering stormwater pump stations). These systems rely on the force of flowing water to trap floatables in disposable nylon mesh bags of varying mesh sizes and storage volumes. Netting devices, also known as release nets, remain on the end of outfalls or within pipes until water levels upstream rise sufficiently to release a catch that holds the net in place. The water level may rise from the bag being too full to allow sufficient water to pass or from a disturbance during very high flows. When the nets release, they are attached to the side of the pipe by a steel cable (i.e., for certain designs). As nets are washed downstream, they are tethered off so that trash is not released to the receiving water body.

The following case studies provide information regarding the effectiveness of netting devices in removing trash from stormwater conveyance systems.

New York and New Jersey (USEPA 1999a)
The Fresh Creek Netting Trash Trap™, an end-of-pipe trash net developed and sold by Fresh Creek Technologies, Inc., was pilot-tested at one location in New York and two locations in New Jersey from 1997 through 1999. The goals of the pilot demonstration projects were: to evaluate the technology for eliminating floatables during combined sewer overflow (CSO) events; to define conditions under which the technology should perform; and to obtain capital and operation and maintenance (O&M) cost data. Device effectiveness was evaluated using a secondary boom with an attached curtain to capture any floatables that bypassed the nets.

Over two years, the New York site captured an average of 4,250 pounds of trash and debris per net. At the two New Jersey sites, the average total weight captured per net was 2,626 pounds and the average weight caught per ten million gallons of discharge was 947 pounds. Effectiveness ranged from 90 to 97 percent (USEPA 1999a).

Anacostia River, Maryland (Guillozet, Trieu and Galli 2001)
The Fresh Creek Netting Trash Trap™ was also pilot-tested on the Anacostia River. During the Anacostia River study, effectiveness was determined by subtracting the amount of floatables captured by an experimental outer boom from the total weight of material captured inside the nets. Researchers monitored ten net changes between 2000 and 2001. As nets were removed, the wet weight of the full nets was measured. The weight of all floatables within the experimental boom area (collected with a skimmer net) was also measured. The material captured by the nets was sorted into categories and identified.

During a nine month period, the wet weight of captured materials was 4,078 pounds. Effectiveness was determined to average 86 percent (Guillozet, Trieu and Galli 2001). The researchers also performed a 'mark-recapture' study, during which they released marked plastic balls of known sizes into the drainage system immediately upstream of the nets. The capture rate of the marked balls was 83 percent (Guillozet, Trieu and Galli 2001).

2.2. PARTIAL-CAPTURE DEVICES

Partial-capture devices are treatment devices that have not been approved as full capture by the San Francisco Bay Water Board, but capture trash at a known effectiveness value. Partial-capture devices may be similar to full capture devices described in the previous section, but do not meet the full-capture definition due to engineering challenges; or they may be completely different types of devices. Case

studies that attempted to assess the effectiveness of partial-capture devices are described below.

2.2.1. Curb Inlet Screens

Curb inlet screens are perforated screens or evenly spaced bars that are designed to fit outside or immediately within the storm drain curb opening. Inlet screens may be fixed or retractable. Retractable screens open either manually or hydraulically when a storm flow/volume is detected. Since curb inlet screens block trash and debris from entering the storm drain inlet or storm drain, trash remains in the street and is removed by regular street sweeping.

Based on an evaluation of existing storm drain infrastructure and installed full-capture devices within the City of Los Angeles, the Watershed Protection Division (WPD) of the City of Los Angeles Department of Public Works, Bureau of Sanitation decided that the most practical and cost-effective approach for achieving TMDL compliance is the installation of connector pipe screens and curb inlet screens.

City of Los Angles (City of Los Angeles 2006b)

The WPD conducted a study to determine the trash capture effectiveness of storm drain inlet opening screen covers during a typical calendar year. The study location was as high trash generation area in the Westlake neighborhood, west of downtown Los Angeles and has a drainage area of approximately 55 acres. To determine effectiveness, a total of twenty-four (24) storm drain inlets were retrofitted with opening screen covers having diamond shape opening measuring one inch in the longitudinal direction by ¾ inch in the vertical direction. Covers remain in the closed position and release when runoff builds up to approximately 60 percent of the curb height (City o Los Angeles 2006b). Once the flow diminishes, the covers close into the locked position. The study location also included one CDS unit. Field measurements from all storm drain inlets and the CDS unit were obtained during the FY 2005-2006 wet season after every storm greater than 0.25 inches. Measurements only occurred for storm events occurring ten or more days apart.

The overall trash capture effectiveness of the storm drain inlet opening screen covers was determined by visual observations and field measurements. The effectiveness determination considered the sum of historical data (i.e., trash collected from the CDS unit and those storm drain inlets which drained into the CDS unit); and current data (i.e. trash collected from the CDS unit and those storm drain inlets retrofitted with opening screen covers which drained into the CDS unit). The overall trash capture effectiveness of the opening screen covers ($SC_{effectiveness}$ %) was determined by visual observations and field measurements using the following equation (City of Los Angeles 2006b):

$$SC_{effectiveness}\ \% = (TH_{rCDS + CBs} - TC_{rCDS + CBst} / TH_{rCDS + CBs}) \times 100$$

$$TH_{CDS + CBs} = Trash\ Historical_{rCDS + CBs}$$
$$= 860\ lbs\ (based\ on\ average\ 2003/2004\ wet\ season\ cleaning)$$
$$TC_{CDS + CBs} = Trash\ Current_{CDS + CBs}$$

The effectiveness of opening screen covers in deflecting trash during a storm greater than 0.25 inches was determined to be 58 to 79 percent (City of Los Angeles 2006b). During dry days, the trash deflection effectiveness of the opening screen covers is considered to be 85 percent since the screens remained in the closed position and only trash smaller than one inch entered the storm drain inlet (City of Los Angeles 2006b). A typical year experiences approximately 25 wet days and 340 dry days (City of Los Angeles 2006b). Using a 1:9.3 weighted average over the course of the entire calendar year, storm drain

inlet opening screen covers were determined to have an 86 percent effectiveness rate (City of Los Angeles 2006b). However, the historical CDS data and current CDS data from this study only included the removal of floatable trash while settleable trash in the sump was not collected and measured. Similar to the storm drain inlet insert study performed by WPD, effectiveness was recalculated and determined to be 83.2 to 84.6 percent.

In early 2010, the WPD installed approximately 710 storm drain inlet opening screen covers within the City of Los Angeles (Sedrak, M. pers. comm. 2010)[1].

2.2.2. Litter Booms and Curtains

Litter booms are floatation structures with suspended curtains used to collect floating trash. They are placed downstream of one or more outfalls usually in slow moving waters. Trash and debris collects in the area with the highest water flow velocity (i.e., middle of the boom). Litter booms have been shown to trap large quantities of floatable materials. However, a significant portion of trash in urban runoff is likely not caught since booms are designed to capture floatable trash (Gordon and Zamist 2006). Study results and antidotal information regarding the performance and/or effectiveness of litter booms is described below.

City of Oakland (2006)

A sea curtain/trash boom was installed on the Oakland Slough in 1999. The City of Oakland Public Works Department removes debris an average of eighteen times per year. This frequency was higher in the early years of installation. The average amount of debris removed per cleaning is approximately 16 cubic yards (Bavinger, M. pers. comm. 2007)[2].

Litter booms are also installed in Lake Merritt. Staff and volunteers of the Lake Merritt Institute routinely remove trash from the litter booms. According to Dr. Richard Bailey, Executive Director of the Lake Merritt Institute, litter booms:

- Only allow floating trash to be easily removed (some trash becomes waterlogged and sinks where it is hard to remove);
- Can be overtopped by high flows, especially if the barrier is too small for the outfall;
- Allow some material to flow underneath;
- Leak at the sides where they are attached. This is especially true because water level rises and falls. If the barrier at the attachment point does not rise and fall with the water, it will be submerged and trash will flow out; and
- Sometimes break and needs to be repaired or replaced (Bailey, R. pers. comm. 2007)[3].

County of Los Angeles (2003)

The County of Los Angeles Department of Public Works tested a litter boom at the mouth of the Los Angeles River between 2000 and 2003. During the first two years of the testing, the litter boom trapped approximately 150 tons of trash and debris (County of Los Angeles 2003). County of Los Angeles staff estimates that litter boom performance is approximately 80 percent. Historical trash collection data

[1] Morad Sedrak. City of Los Angeles, Department of Public Works, Watershed Protection Division. March 2010.
[2] M. Bavinger. City of Oakland, Environmental Services Division. April 2007.
[3] Dr. Richard Bailey. Executive Director, Lake Merritt Institute. January 2007.

indicates a large variation in the volume of trash harvested after each storm event. Approximately 90 percent of trash harvested from the first storm is vegetation. The remaining 10 percent is mostly Styrofoam™ and plastics (Teren, E. pers. comm. 2007)[4].

Queens, New York (USEPA 1999b)

A four-boom containment system was tested in Jamaica Bay (Queens, New York) during a two-year pilot study. Floatables were contained by booms and collected with a skimmer vessel. Boom effectiveness was determined by measuring the quantities of floatable materials present in the water and on the shorelines before and after boom installations. Results showed substantial improvements from pre-boom installations with booms collecting approximately 75 percent of floatables. During the two-year test period, approximately 44.8 tons of trash was removed from the containment area (USEPA 1999b).

Albuquerque, New Mexico (Ho 2005)

A study performed in Albuquerque, New Mexico (Ho 2005) evaluated the hydraulic performance of various boom designs in an experimental flume. Researchers found that a 30° boom barrier approach angle works better than a 45° approach angle because the smaller angle makes a longer and better performing screening area. In addition, when bending the pier 15° from vertical to the flow direction, the boom is able to move easier (Ho 2005). As a result, the angle and manner that a boom is attached to the shore can have an impact on its overall performance. The researchers also recommended a high buoyancy boom for easy floating but cautioned that turbulent flows make boom movement unstable, reducing debris-collection capacity.

Melbourne, Australia (McKay and Marshall 1993)

A Melbourne, Australia study released tagged litter items upstream of litter booms to determine floating boom performance. The results varied from 12 percent to 50 percent recapture. These values were considered preliminary due to the low number of items released in the boom catchments. In addition, the items released in the study were highly floatable and do not represent the complete range of items found in urban runoff. It is expected that the figures determined by McKay and Marshall (1993) are higher than those expected for the total trash and debris load (i.e., including submerged material) (Allison et al 1998a). Other Australian studies have reported capture rates of 24 to 71 kilograms per hectare from four booms in Sydney (Gamtron 1992).

2.2.3. Pump Station Trash Racks

Stormwater pump stations transport stormwater from areas where gravity drainage is impossible or impractical (USDOT 2001). However, stormwater pumps are designed to pass solids up to 2 to 3 inches (SCVURPPP 2009) and cannot pass large debris which may be suspended in stormwater flows. Trash racks located at the intake to the pump station or inside the wet well are installed to protect pumps and prevent fish from entering pump stations. Trash racks consist of steel bars spaced 4 to 10 centimeters (1.57 to 3.94 inches) apart (Allison et al. 1998b) and provide a physical barrier to floating and submerged pollutants. Trash racks can remove 80 to 100 percent of large, hard trash and 40 to 100 percent of soft, deformable trash, such as plastic bags (Nielsen and Carleton 1989 in Fletcher et al. 2004). For floatables, the removal effectiveness is suggested to be 5 to 14 percent (McKay and Marshall 1993 in Allison et al 1998b).

The United States Department of Transportation (USDOT) states that trash racks are “essential” since they screens out large objects capable of damaging pumps (USDOT 1982).

[4] Ed Teren. County of Los Angeles, Department of Public Works, Flood Maintenance Division. May 2007.

2.3. SUMMARY OF PERTINENT FINDINGS

2.3.1. Full-capture Devices

Findings regarding the performance or effectiveness of full-capture trash treatment devices installed within California and internationally are provided below.

- A number of devices have been approved by the Los Angeles and/or San Francisco Bay Water Boards as meeting the full-capture design standard. Therefore, with adequate maintenance, the performance (i.e., how well the device meets its goal that it was designed to treat) is assumed to be 100 percent. The effectiveness of these devices is dependent on the device type, engineering design, flow and other site specific characteristics.
- Many types of connector pipe screens have been approved as full-capture devices by the San Francisco Bay Water Board, and with adequate maintenance, can continue to meet the full-capture design standard.
- A pilot study conducted by the Watershed Protection Division of the City of Los Angeles Department of Public Works, Bureau of Sanitation indicated that storm drain inlet inserts are approximately 98.2 percent effective in retaining trash over the course of one year (City of Los Angeles 2006a).
- A study of side entry pit traps in Victoria, Australia indicated that these devices captured 73 to 85 percent of the total amount of trash loaded to the entire stormwater system, but only if they are installed in all storm drain inlets (Allison et al 1998a).
- Armitage et al determined that side entry catchpit traps (SECTs) had an effectiveness of 76 percent when installed at all storm drain inlets within a catchment area; and an effectiveness of 59 percent when installed at half the storm drain inlets within a catchment area. The study also indicated that effectiveness related to cleaning frequency, runoff flow rates and SECT site location (Armitage et al 2000).
- Hydrodynamic separators (HDS) appear to be one of the most effective devices in removing trash from stormwater conveyance systems. Available study results indicate that the effectiveness of HDS devices ranges from 85 to 99 percent (Caltrans 2004).
- Through various studies of in-line screening devices installed in Southern California, Caltrans has determined that certain types of gross solids removal devices (GSRDs) can be very effective in removing trash from discharges of highway stormwater runoff. Effectiveness of all types of GSRDs ranges between 44 and 100 percent (by volume) (Caltrans 2003a, b and Caltrans 2005 a, b).
- Netting devices can also be highly effective at removing trash from stormwater conveyance systems. The effectiveness of netting devices installed in New York, New Jersey and Maryland ranged from 83 and 97 percent (USEPA 1999a and Guillozet, Trieu and Galli 2001).

2.3.2. Partial-capture Devices

Findings regarding the performance and/or effectiveness of partial-capture trash treatment devices installed within California, the United States and internationally are provided below.

- A pilot study conducted by the Watershed Protection Division of the City of Los Angeles Department of Public Works, Bureau of Sanitation indicated that storm drain inlet openings

screen covers prevent approximately 83.2 to 84.6 percent of trash from entering the storm drain inlet over the course of one year (City of Los Angeles 2006b).

- A pilot study of a litter boom conducted by the County of Los Angeles Department of Public Works indicated that litter boom performance is approximately 80 percent. A four-boom containment system tested in Jamaica Bay (Queens, New York) during a two-year pilot study indicated that boom effectiveness was 75 percent. In addition, a Melbourne, Australia study (McKay and Marshall 1993) released tagged litter items upstream of litter booms to determine floating boom performance. The results varied from 12 percent to 50 percent recapture.

2.3.3 Pump Station Trash Racks

- Trash racks at pump stations are very common and are "essential" since they screen out large objects capable of damaging pumps (USDOT 1982).

- Trash racks can remove 80 to 100 percent of large, hard trash and 40 to 100 percent of soft, deformable trash (e.g., plastic bags) (Nielsen and Carleton 1989 in Fletcher et al. 2004).

- Trash rack removal effectiveness of floatables is suggested to be 5 to 14 percent (McKay and Marshall 1993 in Allison et al 1998b).

3. STORMWATER CONVEYANCE SYSTEM MAINTENANCE

Stormwater conveyance system maintenance activities involve routine inspection and cleaning of storm drain inlets, storm drain lines, drainage ditches and pump stations to maintain hydraulic capacity and prevent flooding. Stormwater conveyance systems are usually cleaned once or twice annually, depending on need and available resources. Since heavy leaf litter may enter the stormwater conveyance system during the autumn months, maintenance of storm drainage facilities occurs before the wet season (October to April). Prior to MRP adoption, Permittees inspected and cleaned storm drains in their jurisdiction on a regular basis and reported maintenance activities within their Annual Reports.

A series of case studies designed to assess the effectiveness of maintenance activities in reducing trash discharged from the stormwater conveyance system are described below.

3.1. SUMMARIES OF CASE STUDIES

Chesapeake Bay Basin (Law et al. 2008)

The removal effectiveness for nitrogen and phosphorus, not trash, from street sweeping and storm drain maintenance activities was estimated in two catchments. One hundred (100) storm drain inlets located within two land use types (residential and combined industrial and commercial) were sampled once during the spring and fall. Once the depth of storm drain inlet debris was determined, the debris was removed for volume measurements.

The mean bulk density of removed storm drain inlet debris was 331 pounds per cubic yard, with an annual accumulation of 13.4 pounds per year for residential areas and 53.7 pounds per year for commercial/industrial areas. On average, 8.9 percent of debris removed from storm drain inlets was trash. Trash was 0.3 to 15.4 percent of debris removed from storm drain inlets in residential areas. However, trash was 4.9 to 16.7 percent of debris removed from storm drain inlets in commercial/industrial areas. In addition, the study estimated an accumulation rate of 0.003 cubic feet per day, on average, in residential areas and 0.012 cubic feet per day, on average, in the commercial/industrial areas.

Storm drain inlets retain a small proportion of total solid material (including trash). Once removed, it represents a small fraction of the total pollutant load. The pollutant removal efficiencies of storm drain inlet cleanouts can be estimated through annual and semi-annual cleanouts. However, targeting hot spots yields a higher effectiveness. In reality, not all storm drain inlets accumulate material uniformly.

Alameda County, California (Minert and Singh 2000)

Alameda County agencies studied sediment removal from the monthly, quarterly, semi-annual and annual cleanout of sixty (60) storm drains located in residential, commercial and industrial areas. Trash was found in 60 percent of all residential storm drain inlets; 63 percent of commercial storm drain inlets; and 52 percent of industrial storm drain inlets. While the focus of the study was not trash, it found that monthly cleanouts removed the maximum annual sediment volume (3 to 5 cubic feet per year). Quarterly, semi-annual and annual cleanouts removed about half as much sediment (1.5 to 2.5 cubic feet per year). Figure 3-1 shows the mass of sediment removed in storm drains as a function of cleanout frequency.

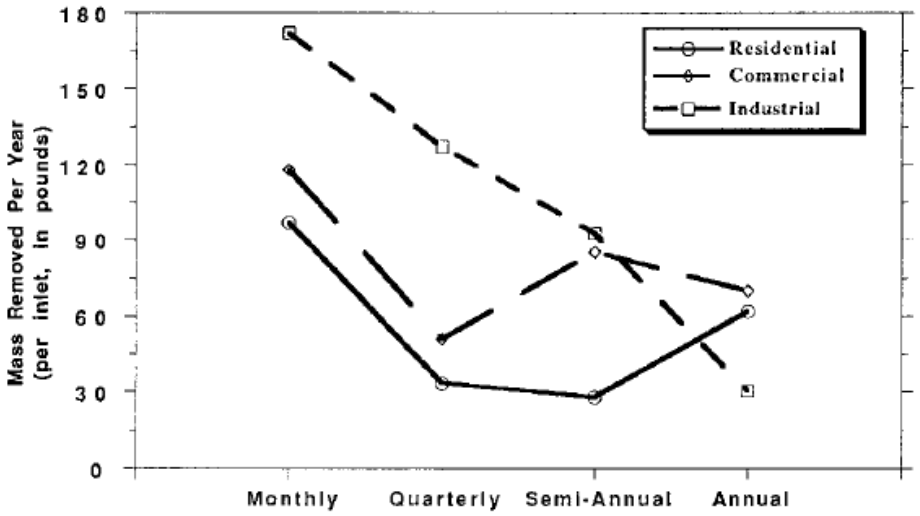

Figure 3-1. Mass of sediment removed in storm drains as a function of cleanout frequency.

Fremont, Newark, and Union City (Minert and Singh 1994)

The FY 1992-1993 Annual Monitoring Report for Alameda County estimated that in residential, commercial and industrial land use areas, semi-annual storm drain cleanouts removed approximately 30 percent more material, by mass, as compared to annual cleanouts. For industrial areas, semi-annual cleanouts removed over three times more material, by volume, as compared to annual cleanouts. Results were based on five annual and seven semi-annual cleanouts in Fremont, Newark and Union City.

Assuming the amount of trash is proportional to the total amount of material removed for all storm drain cleanouts within residential, industrial, and commercial areas, it is estimated that 30 percent more trash, by mass, would be removed when cleaning frequency is increased from annually to semi-annually.

3.2. LEVEL OF IMPLEMENTATION IN SAN FRANCISCO BAY AREA

Even though the reporting of storm drain maintenance and the mass/volume of debris removed is not required by the MRP, most Bay Area municipalities inspect storm drainage facilities at least once a year and clean, as needed. The majority of maintenance activities are completed in the fall before the wet season, with an emphasis on problem areas. Municipalities record the number or length of storm drain conveyance facilities cleaned annually. Table 3-1 provides the type of stormwater conveyance system infrastructure maintained by San Francisco Bay area stormwater programs.

3.2.1. Alameda County Clean Water Program

Prior to MRP adoption, Alameda Countywide Clean Water Program (ACCWP) Permittees inspected and cleaned storm drainage facilities within their jurisdictions at least once a year (EOA 2008). Several storm drainage facilities were inspected and cleaned each month and maintenance was reported on a standardized data collection form. All forms for a specific fiscal year were included in individual Annual Reports. During monthly maintenance, select storm drains, cross culverts, conduits, and/or culverts used to convey stormwater around street corners were inspected and cleaned. The total number inspected and cleaned is reported on the monthly data collection form. Similarly, the miles of V-ditches, storm drain lines, channels, creeks, and the linear feet of culverts inspected and cleaned are also reported each month. The number of junction boxes, and pump stations inspected and cleaned are also noted.

Finally, the volume (in cubic yards) or weight (in tons) of material removed each month from the above locations was estimated and noted on the data collection form (EOA 2008).

3.2.2. Contra Costa Clean Water Program

In accordance with the most recent Contra Costa Clean Water Program (CCCWP) municipal maintenance performance standards stipulated that public storm drainage facilities (i.e., inlets, V-ditches, pump stations, open channels, and watercourses) should be inspected and cleaned, once a year as needed (CCCWP 1999). When cleaning storm drains and lines, all material should be removed at the nearest access point to minimize discharges to watercourses. Public storm drainage facilities that have been identified to accumulate excessive pollutants should be inspected and cleaned, twice a year as needed. Inspections should occur before and after the wet season to prevent flooding and discharge of pollutants. During the wet season, storm drains in areas suspected of illegal dumping should be inspected monthly and cleaned, as needed.

Prior to MRP adoption, CCCWP Permittees reported the number of storm drains, culverts, pump stations and trash racks; and miles of V ditches/roadside ditches, constructed channels[5], and natural watercourses[6] that were inspected and cleaned each year by land use. In addition, the amount of material (and type) removed is estimated and reported for each land use. This information was reported within individual Annual Reports.

[5] Constructed channel is a constructed pathway for conveying stormwater runoff. It may be earthen rock or concrete lined. It is differentiated from a V ditch in so much as it has a defined bed.

[6] Natural watercourse is a natural pathway for conveying stormwater runoff within defined bed and banks.

Table 3-1. Tracking of stormwater conveyance system maintenance conducted by San Francisco Bay area stormwater programs.

City	Type of Stormwater Conveyance System								Amount of Trash
	Storm Drain inlet or curb inlets/outlets	Pump Stations	V ditches	Storm Drain Lines	Channels	Creeks	Culverts, Cross-Culverts, Pipes	Junction Boxes	
Alameda Countywide Clean Water Program	✓	✓	✓	✓	✓	✓	✓	✓	
Contra Costa Clean Water Program	✓	✓	✓	✓	✓	✓			✓
San Mateo Countywide Water Pollution Prevention Program	✓	✓	✓	✓	✓	✓	✓	✓	
Santa Clara Valley Urban Runoff Pollution Prevention Program	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fairfield-Suisun Urban Runoff Management Program	✓		✓	✓	✓	✓			✓

3.2.3. Fairfield-Suisun Urban Runoff Management Program

In the FY 2007-2008 Annual Report, the Fairfield-Suisun Urban Runoff Management Program Permittees (i.e., Cities of Fairfield and Suisun City; and the Fairfield-Suisun Sewer District) implemented municipal maintenance performance goals (FSURMP 2008). One of the goals was to document the following maintenance activities on a monthly basis: volume of material removed from storm drainage facilities (storm drain inlets, lines, channels, watercourses, etc.), management practices, observations of illegal discharges and areas. The Cities inspect storm drains, culverts, ditches, channels and watercourses at least once per year; and clean as needed. When cleaning storm drains and lines, all material is removed at the nearest access point to minimize discharges to watercourses. In addition, flushing of storm drain lines is minimized. If lines are blocked, material is retrieved downstream during non-emergency periods. The Fairfield-Suisun Sewer District inspects pump stations at least once per week and cleans them, as needed. Prior to MRP adoption, the City of Fairfield reported the number of storm drains; and the acres of V ditches, storm drain lines, channels, creeks, detention basins and other facilities inspected and cleaned each month. The total volume of material removed each month (in cubic yards) was also reported. Similarly, the City of Suisun City reported the number of storm drains, the feet of V ditches, storm drain lines, and channels; miles of creeks inspected and cleaned each month; and the total volume of material removed.

3.2.4. San Mateo Countywide Water Pollution Prevention Program

Prior to MRP adoption, most San Mateo Countywide Water Pollution Prevention Program (SMCWPPP) Permittees inspected and cleaned storm drainage facilities (inlets, culverts, V ditches, pump stations, open channels, and water courses) at least once per year, on average, in accordance with its Stormwater Management Plan (July 1998-June 2003) (SMCSPPP 1998). Inspections and necessary cleaning were to occur prior to the wet season. SMCWPPP Permittees use a similar data collection form implemented by ACCWP, thus reporting the same information listed in Section 3.2.1. In addition, when cleaning storm drains and lines, all material is removed at the nearest access point to minimize discharges to watercourses.

3.2.5. Santa Clara Valley Urban Runoff Pollution Prevention Program

In accordance with the storm drain system operation and maintenance performance standards (March 1999) developed by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), Permittees have implemented storm drainage facilities maintenance at either a Tier 1 or Tier 2 level, depending on individual characteristics and resources (SCVURPPP 1999). Tier 1 entails inspecting and cleaning as needed, all storm drains at least once every other year. However, all storm drains and lines in problem areas are inspected and cleaned at least one a year. Sumps and debris racks at pump stations, detention basins, drainage ditches and debris basins are inspected and cleaned throughout the year. While cleaning activities occur on a year round basis, problem areas are targeted prior to the wet season and facilities affected by emergency response activities are inspected and cleaned, as needed. Timing is the same for Tier 2 implementation but frequency is augmented. Storm drains are cleaned at least once a year, with problematic storm drains cleaned more than once a year. In mid-2006, SCVURPPP Permittees responded to a survey regarding their existing storm drainage inspection and maintenance practices (SCVURPPP 2006). Their responses, which are summarized in Table 3-2, show the frequency of maintenance and inspection for the various storm drainage facilities maintained within their jurisdictions.

Table 3-2. Stormwater conveyance system maintenance and inspection frequencies for SCVURPPP Permittees (SCVURPPP 2006).

City	Storm Drainage Facility								
	Storm Drain inlet or curb inlets/outlets	Pump Stations	V ditches	Storm Drain Lines	Channels	Creeks	Culverts, Cross-Culverts, Pipes	Junction Boxes	Record amount per cleanout of material? Trash?
Cupertino	900 per year		Once per year		Once per year	Once per year	Once per year	Once per year	Yes Yes
Campbell	½ of City per year			½ of City per year			½ of City per year		Yes No
Los Altos Hills	Prior, during and after storm and rains		Some in Town's storm drain easement	Prior, during and after storm and rains			Per request and per hot-spot	Per request	No Yes
Los Altos	Annual insp. & cleaning, and cleaning as needed		Annual insp. & cleaning, and cleaning as needed	As needed TV work			Annual insp. & cleaning, and cleaning as needed		No No
Los Gatos	½ of Town per year			½ of Town per year			½ of Town per year		Yes No
Milpitas	Annually	Every weekday	Annually	Annually	Weekly during winter	Monthly, during storms	Annually	Annually	No No
Monte Sereno	Once per year			Once per year			Once per year		Yes No
Mountain View	Annually in identified areas	As needed. Wet wells pumps and sediment		Annually in identified areas depending on pipe diameter				Quarterly trash removal	No No
Palo Alto	Annually and as needed	Weekly, monthly and daily as required	Annually and as needed	Annually and as needed		Annually and as needed	Annually and as needed		No No
San José	Annually	Weekly		As Required for service request only		Only if on City owned parcel	As required for service request only	In coordination with a pump station	Yes No

City	Storm Drainage Facility								
	Storm Drain inlet or curb inlets/outlets	Pump Stations	V ditches	Storm Drain Lines	Channels	Creeks	Culverts, Cross-Culverts, Pipes	Junction Boxes	Record amount per cleanout of material? Trash?
Santa Clara (city)	Twice a year (Fall and Spring)	Daily by full time employee	Twice a year (Fall and Spring)	Inspect once a week. Clean twice a year			Twice a year (Fall and Spring)	Twice a year (Fall and Spring)	No Yes
Santa Clara (county)	In the course of other work and in the fall	In the course of other work and in the fall	In the course of other work and in the fall	In the course of other work and in the fall	In the course of other work and in the fall		In the course of other work and in the fall	In the course of other work and in the fall	No No
SCVWD	At least quarterly	Monthly	Monthly	Annually	Monthly	Monthly	Monthly		Yes No
Saratoga	½ of City per year			½ of City per year			½ of City per year		Yes No
Sunnyvale	Annually, before and during the winter	Weekly & before and after a storm		As needed			As needed	As Needed	No No

3.3. SUMMARY OF PERTINENT FINDINGS

The most pertinent findings regarding trash removal from stormwater conveyance system maintenance include the following:

- By mass, approximately 10 percent of material removed during storm drain cleaning is trash. However, the material retained in storm drains accounts for a small fraction of the total pollutant load.
- Assuming trash is proportional to the total volume of material removed from storm drain cleanouts, monthly cleanouts can double the total amount of material removed each year (3 to 5 cubic feet per year) when compared to cleanouts conducted on an annual, semi-annual or quarterly basis (1.5 to 3 cubic feet per year) (Minert and Singh 2000).
- Permittees in the Bay Area have tracked, on an annual basis, the amount of material removed through stormwater conveyance system maintenance. As a result, Permittees should be familiar with tracking and reporting procedures associated with this data.

4. STREET SWEEPING

Most, if not all, Bay Area municipalities have active and extensive street sweeping programs. Although the effectiveness of these programs varies widely, street sweeping can remove a large percentage of the debris (e.g., trash and leaf litter) deposited onto street surfaces. The effectiveness of street sweeping as a trash control measure is heavily dependent upon the following factors:

- Sweeping frequency;
- Rainfall;
- Presence of parked cars,; and
- Sweeper type.

In addition, land uses and proximities to trash sources and hot spots may also influence the amount of trash removed. Street sweeper types and practices are shown in Table 4-1.

Table 4-1. Descriptions of different street sweeper types and practices (Schilling 2005).

Type	Description
Mechanical Sweepers	This is most common type of street sweeper. Rotating gutter brooms remove particles from street gutters. Material is then swept onto a conveyor belt and into a storage hopper. Water spray is used to control dust.
Vacuum-assisted Sweepers	A gutter broom pushes particles from the street into the path of a vacuum intake that transports the dirt to the hopper. The transported dirt can be saturated with water.
Regenerative Air Sweepers	Regenerative air sweepers use re-circulated air to blast the pavement, dislodging litter before it is swept by rotating brushes towards a vacuum for pick-up. This sweeper also uses water sprays for dust suppression.
Scrubbers and Captive Hydrology (High Efficiency) Sweepers	These sweepers, mainly used in Britain, include brooms directed into pick-up heads with a high-pressure washer system followed by intensive vacuum pressure. Water is recycled within the machine.
Tandem Sweeping	One sweeper immediately follows another. Usually, a less efficient sweeper (e.g. mechanical) is followed by a more efficient type (e.g. vacuum-assisted or regenerative air)

Numerous scientific studies designed to quantify the effectiveness of street sweeping at removing various pollutants have been performed over the last 30 years. The majority of street sweeping studies have focused on the effectiveness of removal of sediments and the pollutants associated with those sediments. However, some have focused on gross pollutants including trash. The following sections provide an overview of the street sweeping studies reviewed.

4.1. STREET SWEEPING FREQUENCY CASE STUDIES

New York City Floatables Control (Newman et al. 1996)

The impact manual trash removal has on floatable trash loads was studied on a 15-blockface area in New York City. For one month, the test area received one of the following degrees of cleaning:

1. Baseline is the standard street sweeping practices already in place that entails two (2) mechanical sweeps per week.
2. Level 1 augments the baseline with four (4) manual sweeps per week. Each blockface is swept once a day for six (6) days.

3. Level 2 augments the baseline with 10 manual sweeps per week. Each blockface is swept twice per day for six (6) days.

Samples were collected once a week with a broom and did not include vegetation, sediment and other items under parked vehicles. The collected material was weighed, sorted into 13 categories and evaluated as floatable. Item counts, total weights, wetness, and loose pack density were also measured. Overall, there was a much greater difference in trash reduction from the baseline to Level 1 than from Level 1 to 2. The incremental percent reduction in baseline street floatables by item count, surface area and weight for different land use types is provided in Table 4-2

Table 4-2. Incremental percent reduction in baseline street floatables by items count, surface area and weight for different land use types.

Predominant Land Use Type	# Blockfaces	Incremental % Reduction in Baseline Street Floatables					
		Item counts		Surface Area		Weight	
		Level 1[a]	Level 2[b]	Level 1	Level 2	Level 1	Level 2
Low Density Residential	2	3	47	10	36	48	11
High Density Residential	3	46	10	51	10	54	23
Commercial	4	42	0	47	0	69	-8
Industrial	2	64	2	70	2	78	-15
Vacant/Parking Lots	1	72	12	66	18	83	9
Parks/Institution	1	58	-9	88	-20	95	-5

[a] (Baseline-Level 1)/Baseline*100
[b](Level 1-Level 2)/Baseline*100

On average, there was at least a 50 percent reduction in floatables when blockfaces were swept six times per week (Level 1) to blockfaces swept twice per week (Baseline). The incremental increase from Level 1 (six times per week) to Level 2 (12 times per week) was at most 10 percent. Levels 1 and 2 had little impact on low density residential areas (with very low loads) and had the most impact on streets near vacant lots where the highest loads were observed. Several blockfaces in Business Improvement Districts (BIDs) were included in the study. It was found that those blocks had a 75 percent reduction in item counts (at the Baseline level) compared to those without BIDs.

Caltrans Litter Management Pilot Study (Lippner et al. 2001)

The Caltrans Litter Management Pilot Study (LMPS) was conducted in Los Angeles to test the performance of five (5) best management practices (BMPs) at reducing trash into highway storm drains. Two of the five BMPs tested were increased street sweeping (from monthly to weekly) and increased manual pick-up (monthly to weekly). The study used a paired watershed approach with one watershed receiving the weekly sweeping or manual pick up paired with a control watershed receiving monthly sweeping. Mesh bags were installed to outfalls before each storm event with a 70 percent probability of more than 0.2" of rainfall. After each storm event, the wet and dry weight and volume of the collected material were measured; and items were counted.

Effectiveness was defined as the difference between treatment and control for dry weight, volume and count expressed as a percentage of the control. Hypothesis testing was done using Wilcoxon Rank-Sum Test. While increased manual pick-up showed an apparent reduction in dried weight (2 to 29 percent), volume (7 to 32 percent) and count (19 to 28 percent), the authors concluded that increased street sweeping was not more effective in this study – dry weight increased 29 to 59 percent, volume decreased 5 to 3 percent, and count increased 5 to 25 percent. However, the null hypothesis (the treatment amount was equal to the control amount) could not be rejected.

Alameda County, California (Salop and Akashah 2004)

This study reviewed the source control options for polychlorinated biphenyls (PCBs) and mercury (Hg); and the reductions that can be achieved from enhancements. Two enhancements introduced include the use of higher efficiency street sweepers and an increase in street sweeping frequency. When this study was conducted, the estimated average effectiveness of street sweepers used in Alameda County was 23 percent. When current equipment was replaced with equipment with a 50 percent pickup effectiveness, there was a substantial increase in the mass of PCBs (i.e., 133 to 165 percent increase) and mercury (i.e., 167 to174 percent increase) removed. When current equipment was used and sweeping frequency was increased from monthly to weekly in 20 percent of roads in each municipality, there was roughly a 30 percent increase in the mass of PCBs and mercury removed.

Assuming that trash removal is proportional to PCB and mercury removal for enhanced sweeping controls, it can be estimated that doubling the current sweeper fleet effectiveness will result in a 170 percent increase in the trash mass removed. In addition, 30 percent more trash by mass will be removed through increasing the sweeping frequency in high priority areas from monthly to weekly.

Broom Sweeper Pickup Ability (Lippner and Moeller 2000)

This study was conducted to evaluate the reduction potential of a mechanical broom sweeper on highway trash using a triplicate paired watershed approach. The authors did not choose a regenerative-air sweeper because during field tests, large material often became lodged in the air intake hose of air sweepers. When air sweepers become clogged, other material is pushed along the street (causing a 'snow plow' effect) until it passes over and is deposited into a storm drain. This effect is reduced when sweepers are run in tandem. Instead, a Mobil model M-8A broom sweeper swept three (3) watersheds monthly and the other three (3) were swept weekly. A comparison of the end-of-pipe discharge was made using mesh bags (with one-quarter inch openings) attached to outfalls for two rainy seasons and 21 storms (October 1998 to April 2000).

The study found that most trash collected was less than 1.5 inches in size, the same size as the drain inlet grate spacing. As a result, the grates were effective at prevent larger trash from entering storm drains. The total end-of-pipe load was 60 to 90 percent vegetation by weight and volume. Cardboard, paper, plastic and Styrofoam™ made up 50 percent of the trash by weight and volume. The most numerous item, cigarette butts, accounted for 35 percent by count. Weekly sweeping was considered effective if the reduction of trash (by volume, weight and count) was statistically significant at the 95 percent level. However, the analysis determined that the reduction of litter was not statistically significant. There were instances where weekly sweeping elevated the litter discharged to the storm drain.

Alameda County (EOA 1999)

Alameda Countywide Clean Water Program member agencies document monthly sweeping and submit the data as part of their Annual Report. Agencies use a standard form to record the volume of material (cubic yards) and miles swept (curb-miles) for residential, commercial, industrial and other areas by

sweeper type. The distance swept is measured by broom odometer or by tracking mileage when sweeping. The volume collected is determined by visually estimating the cubic yards of material in the sweeper hopper. Cities who measure weight of material (Albany, Dublin, Fremont, and Pleasanton) obtain weight tags from landfills or transfer stations where the material is disposed. This study found that sweeping twice a month did not affect material removal rates. Therefore, the maximum accumulation period of material is less than 2 weeks.

Cape Town Case Study (Marais et al. 2004)

Over a two-year long period, trash in storm drain inlets was quantified and profiled in nine (9) different catchments in Cape Town, South Africa with different demographics and land uses. While trash in waterways was the focus of this study, the effectiveness of street sweeping in three Central Business District catchments was determined from measurements taken from six measurements and annualized. Streets were swept by hand two to three times per day on weekdays in the morning and afternoon. In high litter areas, streets were swept mechanically late at night or very early morning.

Considering the combined amount of trash removed from municipal trash bin pickup, side entry catchpit traps (SECTs) and street sweeping, only one to three percent of the trash (by mass) was collected by SECTs in the Central Business Districts. Therefore, up to 99 percent of trash was removed by sweeping and trash services. Another study in Springs, South Africa by the same authors found that 83 percent of trash was removed when streets were swept once a day (Armitage 1998 in Marais et al 2004) as compared to 99 percent of trash removed from sweeping two to three times a day in Cape Town (Marais and Armitage 2004).

4.2. RAINFALL CASE STUDIES

City of Cape Town and Rainfall (Marais and Armitage 2004)

This study proposes guidelines for reducing trash into stormwater systems by focusing on source control of urban trash. The authors reviewed international and local practices and drew from the results of a study performed in the City of Cape Town described above (Marais et al. 2004). The most relevant finding was that the efficiency of street sweeping is less than 50 percent once the frequency of street sweeping is greater than the number of dry days between rainfall events. The relationship between street sweeping efficiency and antecedent dry days is shown in Figure 4-1.

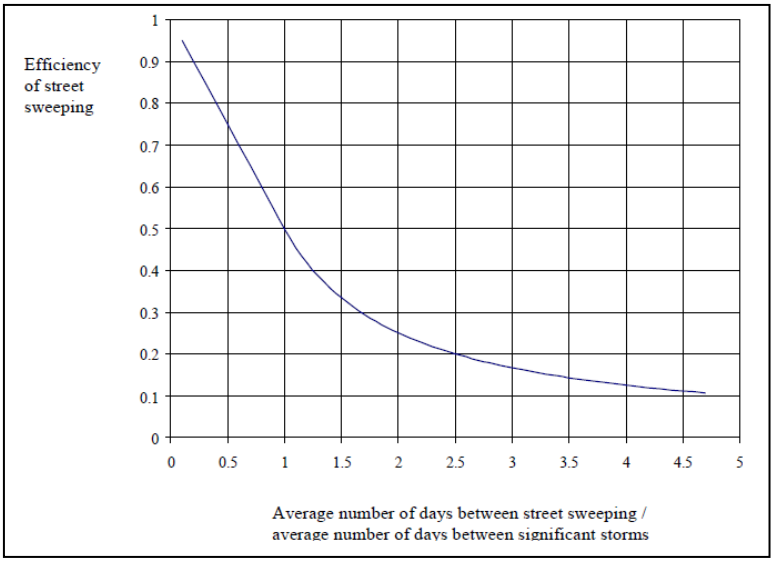

Figure 4-1. Maximum expected efficiency of street sweeping.

Review of Street Sweeping Knowledge (Sartor and Gaboury 1984)

In the late 1970s, street sweeper effectiveness began to be measured in terms of reduction in end-of-pipe runoff concentrations and loads rather than by specific equipment. Dominant influences on sweeping effectiveness are time intervals, specifically inter-storm and sweeping intervals. If the average time between runoff events is much less than the sweeping interval, street contaminants would be routinely washed away. For sweeping to be "efficient" (approximately 30 percent), sweeping must be at most two (2) times the inter-storm period. To achieve higher removal rates (greater than 50 percent), the sweeping interval must be ½ to 1 times the inter-storm period.

Based on 28 years of hourly rainfall records in San Francisco, the mean rainfall volume was 0.78 inches per event, with a coefficient of variation of 1.4. The mean time between storms was 21.0 days (with a covariance of 0.7). On average, the region has 17 rainfall events each year.

4.3. PARKED CARS

New York City Computer Model (Riccio and Litke 1986)

The objective of this study was to determine the increase in sweeping effectiveness from reducing the number of illegally parked cars on a street block. Using a computer model, litter (pieces and piles) and cars were randomly placed on a block. Litter was "measured" using a scoring system from 1.0 (no litter) to 3.0 (continuous litter) where 1.5 was acceptably clean. Previous studies found that street sweeping removes 90 to 98 percent of all trash when there are no obstacles (e.g., parked cars), and the sweeper is traveling at the standard operating speed. The model was run at a constant 90 percent effectiveness. Table 4-3 shows the increase in probability that a street will be made acceptably clean (score of 1.5) after street sweeping from a one car reduction.

Table 4-3. Increase in the probability that a street will be made acceptably clean after street sweeping from a one car reduction.

Initial # Cars	Remaining # Cars	Initial Dirtiness				
		1.6	1.7	1.8	1.9	2.0
4	3	0	3	11	27	28
5	4	4	8	21	24	12
6	5	7	15	25	16	4
7	6	10	22	17	6	1
8	7	15	14	12	4	0
9	8	13	16	5	2	1
10	9	14	9	4	0	0

Reducing one parked car per block, from four to three can increase the probability that a street will be made acceptably clean by 28 percent (when the initial street dirtiness is 2.0). A one-car reduction had the greatest impact on the dirtiest streets when few cars were parked.

City of Palo Alto (Teresi 2008)

In the City of Palo Alto, residential areas are swept weekly and business districts are swept three times a week using five (5) regenerative-air sweepers and three (3) broom sweepers. However, the residential areas next to the business districts are a problematic due to the presence of parked cars on sweeping days. Originally, temporary "No Parking" signs were posted every 5 weeks to prohibit parking on one side of the street. Because temporary signs were determined to be ineffective and costly, the City conducted a trial signage program in 2004. The program involved posting signage on trees which restricted parking for two hours per week within a 10 square block area (40 acres). After three months,

the time was reduced to one hour. The trial signage program led to an additional 40 cubic yards of debris collected over a six-month period. In early 2005, one permanent "No Parking" sign was posted per block restricted parking for one hour, alternating sides of the street each week. In 2006, the area was expanded to 145 acres. Approximately 3.5 hours of police staff time is spent each sweeping day, at an annual cost of $6,500. However, parking enforcement has resulted in an additional $120,000 in annual revenue from more than 3,000 violations issued. Due to permanent signage, an additional 350 cubic yards of street sweeping debris has been collected annually within the 145-acre area.

4.4. SWEEPER TYPE CASE STUDIES

Pickup of High Efficiency Sweepers (Kidwell-Ross 2000)

When a high-efficiency sweeper (Schwarze Model EV2) was operated in tandem behind a mechanical broom sweeper (Schwarze M5000), the EV2 picked up 141 percent more than the mechanical broom. Similarly, the EV2 was operated in tandem behind a regenerative air sweeper (Schwarze A7000) and picked up 44 percent more than the regenerative air sweeper. The debris removed by the high-efficiency sweeper is likely composed primarily of smaller particles.

Real World Street Cleaning Pickup Performance Testing (Sutherland 2011)

Street dirt pickup performance tests for five different Elgin sweeper models was conducted over three days on a curbed test track under a tent within a parking lot. While trash was not considered in this study, the particles collected were separated into seven (7) different size ranges from smaller than 63 microns to 6370 microns (6.37 mm). Often, trash can fall into the coarsest size range. The pickup performance efficiencies by particle size range for the five sweepers are shown in Table 4-4. The regenerative air and vacuum sweepers are comparable, and both types are more efficient than the mechanical broom sweeper. For the mechanical broom sweeper (Eagle with water), the use of water spray to control dust reduces the sweeper's ability to pickup particulate material.

Table 4-4. Sweeper pickup performance efficiency (%) by particle size range.

Size Range (microns)	**Crosswind (NX)** Regenerative	**Crosswind** Regenerative	**Whirlwind (MV)** Vacuum	**Eagle (FW)** Mechanical	**Eagle (FW) w/water** Mechanical
2000-6370	99.4	99.4	99.3	95.9	95.8
1000-2000	98.5	98.7	98.2	93.3	91.2
600-1000	97.8	98.1	96.3	93.1	88.3
250-600	97.9	97.6	93.5	93.4	84.2
125-250	97.7	95.7	89.6	91.1	72
63-125	97	93	86.5	89.9	68.7
<63	90.8	89.4	93.5	78.1	68.2

Street Sweeping can be an Effective BMP (Sutherland and Jelen 1997)

The authors evaluated the abilities of several different sweeping technologies to remove accumulated sediment of various sizes using a computer model to simulate interactions of sediment accumulation, washoff and street sweeper pickup over a period of time, calibrated from real data. Similar to the previous study, this study does not discuss trash. However, some trash falls into two largest size ranges considered.

Sweeping removes little, if any, material below a certain base threshold. The amount of sediment removed by sweeping is linearly related to the initial accumulation by the base residual and sweeping efficiency. The calibrated base residual is shown in Table 4-5 and calibrated sweeper efficiencies are shown in Table 4-6.

Table 4-5. Sweeper base residual (pounds per paved acre) by particle size ranges.

Size Range (microns)	1988 Mobil Mechanical	Tandem*	Elgin Crosswind Regenerative	Enviro-Whirl Vacuum
<63	5.8	2.0	0.0	0.0
63-125	5.8	2.0	0.0	0.0
125-250	5.3	2.3	0.9	0.0
260-600	2.5	2.3	1.9	0.0
600-1000	0.4	0.8	0.7	0.0
1000-2000	0.5	0.6	0.7	0.0
2000-6370	0.3	0.5	0.0	0.0
>6370	0.0	0.0	0.0	0.0

*** Mobil mechanical broom sweeper followed by TYMCO vacuum-assisted sweeper**

Table 4-6. Sweeper efficiencies (%) by particle size ranges.

Size Range (microns)	Tandem Sweeping	Regenerative Air	Enviro-Whirl
<63	93	32	70
63-125	95	71	77
125-250	93	94	84
260-600	89	100	88
600-1000	84	100	90
1000-2000	88	100	91
2000-6370	98	94	92
>6370	87	92	96

4.5. GENERAL CASE STUDIES

Seattle Street Sweeping Study (SPU and HEC 2009)

In 2006, the Seattle Public Utilities (SPU) and Seattle Department of Transportation (SDOT) conducted a study to determine if street sweeping can significantly reduce the mass of pollutants discharged to receiving waters while reducing storm drain inlet cleaning frequency. The study included two residential areas (with major arterials) and one light industrial area (without major arterials). Each area was divided into swept (test) and unswept (control) site pairs consisting of similar land uses, topography and number of storm drain inlets. The study involved sweeping each side of the street (i.e., test sites) on alternating weeks using a Schwarze Model A8000 regenerative air sweeper each week. As a result, the overall sweeping frequency for each side was once every two weeks. Streets designated as control sites were not swept during this study. The study was designed to calculate a mass balance for the following components of street dirt and sediment:

- Dirt remaining on street (i.e., street dirt)
- Dirt removed by street sweeper (i.e., sweeping debris)
- Dirt that accumulates in storm drain inlets (i.e., storm drain inlet sediment)
- Dirt exported from the site in urban runoff (estimated through mass balance).

Street dirt samples were collected from both test and control sites every four weeks using a Shop-Vac™ industrial vacuum cleaner one to two days prior to sweeping; weighed and archived. Samples were collected from alternate sides of the street on each consecutive sampling event to coincide with street sweeping events. In addition, sweeping debris was collected every four weeks and stored in separate dumpsters assigned to each test site. Debris greater than 2 centimeters in diameter was removed and weighed separately to determine the proportion of debris in the sweeping debris. Twelve (12) storm drain inlets were also sampled (i.e., debris removed for analysis) every four weeks at each test/control site. Collected storm drain inlet samples were also archived. At the end of each quarter, a single composite sample of each media type was prepared from the archived samples and analyzed.

Analytical results indicated that there were no significant differences in street dirt or sweeping debris between the three study areas. Monthly street dirt yields were significantly different between swept and unswept areas for the two residential areas. The median percent reduction in street dirt (dry weight) was 48 percent at the industrial site; and 74 to 90 percent at the two residential areas. Since cars parked in sweeping areas were not ticketed at the beginning of the study, the number of parked vehicles in the test areas steadily increased until ticketing was initiated in the eighth month. Ticketing led to a 57 to 63 percent reduction in the number of parked cars in the residential areas.

Effectiveness of Street Sweeping for Stormwater Pollution Control (Walker and Wong 1999)

The objective of this study was to examine effectiveness of street sweeping for controlling gross pollutants (all solids greater than 5 mm in diameter, including trash) and sediment (and associated pollutants). The authors interpreted Australian and other field data on street sweeping and gross pollutants. A survey of Melbourne (Australia) municipalities found that residential areas are swept every two weeks to every six weeks; commercial areas are swept daily to every two weeks; and shopping and commercial are swept once or twice a day in busy areas and once or twice a week in less popular areas.

The authors define street sweeping effectiveness as the reduction in the end-of-pipe runoff pollution concentrations and loads, and not the effectiveness of specific equipment. Street sweeping effectiveness is more dependent on land-use activities, inter-event dry period, street sweeping frequency and timing, access to source areas and sweeper operation than the actual street sweeping mechanism efficiency. Other pertinent findings include the following:

- There is a minimum threshold load of sediment on the street surface before mechanical and regenerative air sweepers become effective. The threshold can be three times higher for mechanical sweepers;
- The performance of regenerative air sweepers is better than mechanical sweepers;
- Significant amounts of gross pollutants are mobilized into stormwater conveyance systems during bursts of rain and/or wind;
- Street sweeping effectiveness increases with particle size and can be up to almost 80 percent for particles greater than 2mm under ideal conditions (when sweeping is more frequent than rainfall occurrence and parking restrictions are in place);
- If sweeping occurs at longer intervals than inter-event dry periods, there is a higher likelihood that pollutants will be flushed into stormwater conveyance systems before being collected by sweepers;
- Gross pollutant wash off becomes significant for storm events larger than 3.7 mm in rainfall and 0.70 mm of runoff;

- The limiting mechanism affecting the amount of gross pollutants entering the stormwater conveyance system is dependent on rainfall (for re-mobilization and transport) not on source loading;
- There is a clear relationship between gross pollutant loads in stormwater conveyance systems and the magnitude of storm events. It is a monotonically increasing logarithmic function and indicates a possible upper limit; and
- Commercial areas produce twice the gross pollutants of residential areas and three times more than light industrial areas, despite higher sweeping frequencies.

Water Pollution Aspects of Street Surface Contaminants (Sartor et al. 1974)

The three main objectives of this study were to (1) determine amounts and types of material commonly collected on streets; (2) determine the effectiveness of conventional public works practices in preventing this material from polluting receiving waters, and (3) evaluate the significance of this source of water pollution when compared with other sources. Methods included field measurements, sample collection, sample analysis, experimental studies, literature reviews and questionnaire surveys.

While the parameters of concern were water pollution parameters, heavy metals, PCBs and total fecal coliform bacteria, the study found that most of the material found in urban and suburban storm drain inlets consisted of litter, leaves, and oil. The removal effectiveness of litter and debris was 95 to 100 percent. In addition, the rate at which rainfall washes loose particulate matter from street surfaces depends on rainfall intensity, street surface characteristics and particle size. Factors affecting loading intensity include land use, elapsed time since streets were last cleaned, local traffic volume and character, street surface type and condition, public works practices and season. The presence of parked cars on sweeping days is one of the biggest factors influencing effectiveness. Results also show that industrial areas have substantially heavier loads than commercial and residential areas. Heavy industrial areas had the heaviest loads and medium industrial areas had the lowest loads. Commercial areas had the lowest loads. Newer, more affluent neighborhoods were cleaner than other residential areas. Recommendations from this study include operating sweepers at a slower speed, conducting multiple passes and restricting parking.

Contra Costa County (EOA 2007)

Cities in Contra Costa County (Richmond, Martinez, Concord, Pinole, Orinda, Walnut Creek, and Brentwood) sweep streets in accordance with current Co-permittee practices using broom and regenerative air sweepers. The collected material was transported to a municipal facility and deposited in an isolated area where a visual trash assessment was performed. The presence or absence of trash was recorded and the percentage by volume of trash (dense and light) sediment, leaves, and other vegetative matter was estimated. On average, zero percent of the total volume was dense trash and one percent was found to be light trash.

4.6. SAN FRANCISCO BAY AREA PRACTICES

All San Francisco Bay Area municipalities sweep streets on a regular basis. Sweeping in residential areas ranges from quarterly to weekly, while commercial and industrial areas are typically swept three times a week to once a month. Total miles swept and miles swept by land use are often recorded as well as the volume of material collected. Street sweeping information tracked by San Francisco Bay area stormwater programs is shown in Table 4-7.

Table 4-7. Tracking of street sweeping information by San Francisco Bay Area stormwater programs.

Program	Total Mileage of Curbed Street	Res	Com	Ind	City-owned Parking	Major Arterials	Total Volume or Mass Removed
Alameda Countywide Clean Water Program	✓	✓	✓	✓	✓		✓
Contra Costa Clean Water Program	✓	✓	✓	✓	✓	✓	✓
San Mateo Countywide Water Pollution Prevention Program	✓	✓	✓	✓	✓		✓
Santa Clara Valley Urban Runoff Pollution Prevention Program	✓	✓	✓	✓	✓	✓	✓
Fairfield-Suisun Urban Runoff Management Program	✓	✓	✓	✓	✓		✓
City of Vallejo and Vallejo Sanitary District							

4.7. SUMMARY OF PERTINENT FINDINGS

Street sweeping is an effective trash control measure that can reduce 80 to 99 percent of trash in streets. Street sweeper efficiencies increase with particle size. The most pertinent findings regarding the effectiveness of street sweeping at intercepting and removing trash in streets prior to entering MS4s are provided below:

- **Frequency** – Street sweeping was determined to be more effective when increased from monthly to weekly**.** Additionally, an increase in street sweeping frequency from twice weekly to daily (for six days) can reduce the floatable material by at least 50 percent (Newman et al. 1996). A study conducted in Seattle indicated that the amount of street dirt conducted monthly from swept and unswept streets was "significantly different" (SPU and HEC 2009). Walker and Wong (1999) concluded that commercial areas produce twice the gross solids of residential areas and three times more than light industrial areas, despite higher sweeping frequencies.
- **Rainfall** –Dominant influences on sweeping effectiveness are time intervals, specifically inter-storm and sweeping intervals (Sartor and Gasboury 1984). Therefore, sweeping is only effective at preventing pollutants from entering storm drains if the sweeping frequency is more often than the frequency of rainfall events. Once rainfall events are more frequent, the effectiveness drops below 50 percent (Marais and Armitage 2004). Walker and Wong (1999) concluded the following: If sweeping occurs at longer intervals than inter-event dry periods, there is a higher likelihood that pollutants will be flushed into stormwater conveyance systems before being collected by sweepers; gross pollutant wash off becomes significant for storm events larger than 3.7 mm in rainfall and 0.70 mm of runoff; the limiting mechanism affecting the amount of gross pollutants entering the stormwater conveyance system is dependent on rainfall (for re-mobilization and transport) not on source loading; and that there is a clear relationship between gross pollutant loads in stormwater conveyance systems and the magnitude of storm events.
- **Parked cars** - The presence of parked cars during sweeping can greatly reduce sweeping effectiveness. The reduction of one parked car on a block can increase the effectiveness by as much as 28 percent (Riccio and Litke 1986).
- **Sweeper Type and Practice** - Regenerative-air and vacuum assisted sweepers are more efficient than mechanical broom sweepers. Tandem sweeping is very effective at removing material in dirty areas. Wet cleaning should be avoided, and dry methods should be used. The use of water with a mechanical broom sweeper can decrease a sweeper's effectiveness by up to 10 percent for small particles (Sutherland 2011). Walker and Wong (1999) concluded that there is a minimum threshold load of sediment on the street surface before mechanical and regenerative air sweepers become effective with the threshold up to three times higher for mechanical sweepers; and the performance of regenerative air sweepers is better than mechanical sweepers.

5. PRODUCT BANS (E.G., PLASTIC GROCERY BAG)

Government agencies around the world are instituting legislative bans on products which are single-use, commonly observed in the environment as litter, not recyclable and/or not easily biodegradable. The two most common products banned worldwide are polystyrene foam (i.e., Styrofoam™) distributed by the food service industry and single-use plastic bags distributed by retail businesses. Both products are persistent in the environment and have been shown to have a negative effect on wildlife when ingested. Most government agencies are considering product bans to meet waste reduction goals, protect the environment and reduce litter.

5.1. POLYSTYRENE FOAM BANS

Polystyrene foam is used as food ware in the food service industry. According to EPA, polystyrene foam (i.e., Styrofoam™) is a persistent environmental pollutant with physical properties that "can also have serious impacts on human health, wildlife, the aquatic environment and the economy" (City of Oakland 2006). Due to its nature, polystyrene foam used as food ware is typically not recycled. Since 1990, over 100 government agencies within the United States, including over twenty within the Bay area have enacted full or partial bans on polystyrene foam food ware. Bay area cities and counties banning polystyrene foam food ware (with their effective date) are provided within Table 5-1.

Table 5-1. Bay area cities and counties with polystyrene foam food ware bans.

City or County	Effective Date
Alameda	July 2008
Albany	September 2008
Berkeley	January 1990
Emeryville	March 2007
Fairfax	1993
Fremont	January 2011
Hayward	October 2010
Hercules	May 2008
Marin County	January 2010
Millbrae	January 2008
Oakland	January 2007
Pacifica	November 2009
Palo Alto	April 2010
Pittsburg	1991
Richmond	April 2009
San Bruno	April 2010
San Francisco	June 2007
San Mateo County	April 2008
Sonoma County	June 1989
South San Francisco	October 2008

While there are several cities and counties with bans, the effectiveness of these bans is unknown, with the exception of the City of San Francisco, described below.

City of San Francisco

On June 1, 2007, City of San Francisco food vendors were no longer permitted to use polystyrene foam food ware. Instead, vendors are required to use compostable or recyclable, disposable food service ware or to-go containers unless there are no suitable alternatives (i.e., products which are within 15 percent of the cost of non-compostable or non-recyclable alternatives) (San Francisco 2006).

In 2007, 2008 and 2009, HDR/BVA Engineering, Inc. conducted litter audits to determine the types of litter accumulating on the streets of San Francisco. Litter audit results indicated an 41 percent reduction in polystyrene litter observed on San Francisco streets in 2009 when compared to polystyrene litter observed in 2007 (HDR/BVR Engineering et al. 2009).

5.2. SINGLE-USE PLASTIC BAG BANS

The process of enacting a single-use plastic bag ban is difficult due to intense scrutiny and opposition from public interest groups and lobbyists representing plastic bag manufacturers, distributors, and retailers. The main opponents are the American Chemistry Council[7], which represents plastic manufacturers and Save the Plastic Bag Coalition[8], an association of plastic bag manufacturers, distributors, and retailers. In most cases, most opposition groups are pressing for the development of an Environmental Impact Report (EIR) in accordance with the California Environmental Quality Act (CEQA). In September 2010, the California Legislature rejected Assembly Bill 1998, a state-wide ban on single-use plastic bags. Around the world, there are over 70 bans on single-use plastic bags, with 16 in the United States and six (6) in California. Examples of single-use plastic bag bans that have been enacted or are in the process of being enacting in California are provided below:

City of San Francisco

On March 27, 2007, the San Francisco Board of Supervisors passed the "Plastic Bag Reduction Ordinance" to ban the distribution of single-use plastic bags at large supermarkets over $2 million in gross annual sales receipts and retail pharmacies with at least five locations within the City's geographical limits under the same ownership (San Francisco 2007). This ordinance, which became effective in December 2007 allowed regulated businesses to only distribute compostable plastic bags, recyclable paper bags made with a minimum 40 percent post consumer recycled content, or reusable bags.

In 2007, 2008 and 2009, HDR/BVA Engineering, Inc. conducted litter audits to determine the types of litter accumulating on the streets of San Francisco. Litter audit results indicated an 18 percent reduction in plastic bags observed on San Francisco streets in 2009 when compared to plastic bags observed in 2007 (HDR/BVR Engineering et al. 2009).

City of Palo Alto

On March 30, 2009, the City of Palo Alto adopted Chapter 5.35 of Title 5, Health and Sanitation of the Palo Alto Municipal Code banning the distribution of single-use plastic bags by large grocery stores by September 18, 2009. Instead, large grocery stores may only distribute reusable bags or paper bags. The ban was enacted to promote the use of reusable bags and reduce the impact of plastics in the local environment (Palo Alto 2009).

[7] The Plastic Division includes Ashland Distribution Company, BASF Corporation, Bayer Material Science LLC, Braskem America, Dow Chemical Company, DuPont, ExxonMobil Chemical Company, LyondellBasell, SABIC Innovative Plastics, Solvay America, Inc., Styron , TOTAL Petrochemicals USA, Inc., Vinyl Institute (American Chemistry Council 2010).

[8] The Coalition includes Elkay Plastics, Command Packaging, Grand Packaging, Inc. and Crown Poly, Inc. (Save the Plastic Bag Coalition 2008)

On April 21, 2009, The Save the Plastic Bag Coalition filed a lawsuit against the City regarding its single-use plastic bag ban. The case was settled on July 28, 2009. The City agreed to not ban plastic bags at additional stores without first preparing an EIR in accordance with CEQA. The current ban regulates four large grocery stores (Save the Plastic Bag 2010).

City of Malibu (City of Malibu 2008)

On May 27, 2008 the City of Malibu adopted Ordinance 323 which added "Chapter 9.28 Ban on Plastic Shopping bags" to the Malibu Municipal Code. The ordinance prohibits retail establishments, restaurants, vendors and non-profit vendors from providing plastic bags or compostable bags at the point-of-sale. In addition, it also prohibits the distribution of plastic bags or compostable bags at any City facility or at any event held on City of Malibu property, effective June 2008.

Town of Fairfax (Town of Fairfax 2008)

In November 2008, voters in the Town of Fairfax approved the "Plastic Bag Reduction Ordinance", Chapter 8.18 of the Municipal Code. The ordinance, which came effective in April 2009, requires all stores, shops, eating places and food vendors to only provide recyclable paper bags or reusable bags at the point-of-sale.

City of San José (City of San José 2010)

On December 14, 2010, the City of San José adopted an ordinance banning the distribution of single-use carryout bags at the point-of-sale for all commercial retail businesses, except restaurants and non-profit secondhand stores. An exception is made for paper bags containing a minimum of 40 percent post-consumer recycled content. The ordinance will become effective on January 1, 2012, to allow for more public outreach.

Retail businesses who decide to offer recycled paper bags at the point-of-sale must collect $0.10 from customers. The fee is retained by the retailers to cover the cost of the bag. This fee increases to $0.25 in 2014. Food stamp recipients are exempted from the fee through December 31, 2013. Retail businesses that violate the ordinance are subject to fines of $500 to $1,000.

As part of the ordinance approval process, the City of San José developed an EIR in accordance with CEQA. The City completed the draft EIR in July 2010; and incorporated public comments into the final EIR in October 2010. On November 17, 2010, the City of San José certified the EIR. On December 14, 2010, the City of San José conducted an administrative hearing on an appeal of the certification of the EIR; and adopted the ordinance the same day.

County of Los Angeles

On January 22, 2008, the County of Los Angeles adopted a voluntary Single Use Bag Reduction and Recycling Program (Program). This Program is a partnership with supermarkets and retailers, environmental groups, the plastic bag industry, local governments and the public. The goals of the Program are to reduce the impacts of litter from single-use bags, encourage shoppers to use reusable bags, and enhance the recycling of single-use plastic and paper bags (County of Los Angeles 2010). On July 17, 2008, the Save the Plastic Bag Coalition sued the County of Los Angeles. The lawsuit states that the County should have prepared an EIR under CEQA; and that it does not have the authority to ban plastic bags. However, due to the voluntary nature of the Program, it was not classified as a project under CEQA (Save *the Plastic Bag Coalition v. County of Los Angeles et al*., Los Angeles County Superior Court Case No. BS115845).

After preparing an extensive EIR, the Los Angeles County Board of Supervisors voted 3-1 on November 16, 2010, to ban single-use plastic carry-out bags at certain stores in the County unincorporated area; and charge a 10-cent surcharge per paper bag. The first phase of the ban takes effect in July 2011 and affects 67 large supermarkets and pharmacies. The ban will cover 1,000 stores in unincorporated areas throughout the County of Los Angeles by January 2012 (Lin 2010).

5.3. SINGLE-USE PLASTIC BAG BANS IN LITIGATION

Several cities in California have attempted to pass ordinances to ban the distribution of single-use plastic bags and have faced opposition from the Save the Plastic Bag Coalition. Current unresolved litigation includes cases with the Cities of San Diego, Santa Monica, Morgan Hill, Mountain View, Encinitas, Oakland and Manhattan Beach. The latter two cases are described below.

City of Oakland (*Coalition to Support Plastic Bag Recycling v. City of Oakland, et al.*, Alameda County Superior Court Case No. RG07-339097)

On July 17, 2007, the City of Oakland adopted Ordinance No. 12818 banning the distribution of plastic bags by retailers in Oakland whose sales meet or exceed $1,000,000 annually. However, the Coalition to Support Plastic Bag Recycling petitioned for a Writ of Mandate against the City. The Alameda Superior Court invalidated the ordinance on April 17, 2008.

City of Manhattan Beach (*Save the Plastic Bag Coalition v. City of Manhattan Beach*, Los Angeles County Court of Appeal Case No. B215788)

On July 15, 2008, the City of Manhattan Beach adopted Ordinance No, 2115 banning all point-of-sale plastic carry-out bags within the City. An initial study found that the ordinance would not have a significant effect on the environment and would be exempt from further analysis under CEQA. However, the Save the Plastic Bag Coalition filed a lawsuit against the City for adopting the ordinance without first preparing an EIR. On February 20, 2009, the Los Angeles Superior Court ruled against the City. The trial court found substantial evidence supporting the argument that the ordinance may cause increased use of paper bags and that an EIR should have been prepared. It also vacated the ordinance and disallowed reenactment pending an EIR. Regarding the ruling, the Save the Plastic Bag Coalition states on its website, "SaveThePlasticBag.com believes that an EIR would have shown that plastic bags are far better for the environment than paper bags." The City appealed the ruling, but the Court of Appeal affirmed the prior ruling on January 27, 2010. In early 2010, the California Supreme Court accepted the case for review and will provide a decision sometime in 2011.

5.4. SINGLE-USE BAG FEES

Another approach to reducing the use of single-use plastic bags is to enact legislation which charges a fee for their distribution at the point-of-sale. This option is not permitted in California due to Assembly Bill 2449, approved and filed September 20, 2006, which preempts a point-of-sale fee for plastic bags and requires store operators to establish an at-store recycling program for six years, beginning July 1, 2007 until January 1, 2013 (State of California 2006). This fee is uncommon in the United States but is very common in the other countries around the world. A few cases of successful single-use bag fee implementation are provided below.

District of Columbia

On June 16, 2009, the Washington, D.C. council unanimously passed the Anacostia River Clean Up and Protection Act of 2009. This Act, which went into effect on January 1, 2010, requires businesses that sell food or alcohol to charge $0.05 for each plastic or paper bag distributed at the point-of-sale. The

business keeps $0.01 to $0.02 of the fee, and the remainder fee is placed in a special fund used to restore and protect the Anacostia River. Projects funded with the fee include trash removal; wetlands restoration; public education and outreach; purchase of trash traps and storm drain screens; and distribution free reusable bags (Trash Free Anacostia 2010). The bag fee is the first of its kind in the nation and does not apply to bags used for newspapers, produce, hardware, frozen foods, plants, bakery items or prescription drugs.

The adoption of the bag fee has proven to be an immediate success. In the first month, businesses reported a 50 to 80 percent decrease in bag demand with nearly $150,000 collected for the special fund. (Trash Free Anacostia 2010). The D.C. Office of Tax and Revenue estimated that during January 2010, the first month of implementation, food and grocery establishments gave out approximate 3 million bags. Before the fee took effect, the Office of the Chief Financial Officer stated that 22.5 million bags were issued in each month in 2009 (Craig 2010). This difference corresponds with an 87 percent decrease in plastic bags.

Ireland

On March 4, 2002, the Irish government introduced a €0.15 (US$0.22) "PlasTax" per plastic bag issued to customers at the point-of-sale. This tax was six times higher than the average consumer's willingness to pay, which was around € 0.024. As a result, there was a 94 percent reduction in the number of bags distributed with €12 million collected the first year (Convery et al 2007). In addition, a project between the Irish Business Against Litter and An Taisce (the National Trust of Ireland), found that the number of "clear" areas in the landscape (i.e., areas with no evidence of plastic bag litter) increased by 21 percent; and the number of areas without "traces" (defined as up to five items over a linear distance of one meter) increased by 56 percent (Convery et el 2007). Prior to the PlasTax, plastic bags accounted for five percent of the nation's trash composition. After PlasTax, it was reduced to 0.32 percent in 2002, 0.25 percent in 2003 and 0.22 percent in 2004 (Litter Monitoring Body 2004, 2005).

According to Department of the Environment, Heritage and Local Government (2007), the annual per capita bag usage was estimated at 328 prior to the tax and decreased to 21 once the fee was implemented. However, over the course of 2006, the annual per capita usage rose to 30 bags. The Irish Business Against Litter (2006) estimated that the number of plastic bags used in 2006 was almost 50 million more than when the tax was first implemented. As a result, the fee per plastic bag issued was raised from € 0.15 to € 0.22 (US$0.31) on July 1, 2007, the maximum fee that can be implemented under the current legislative provisions (Department of the Environment, Heritage and Local Government 2007). After the increasing the fee to € 0.22, the annual per capita plastic bag usage decreased 24 percent in the first ten months (AP EnvEcon 2008). The percent of national trash composition observed to be plastic bags decreased to 0.29 percent in 2007, down from a post-levy high of 0.52 percent in 2006 (Litter Monitoring Body 2008).

City of Toronto

On June 1, 2009, the City of Toronto implemented a minimum CAD$0.05 fee on each plastic bag issued at the point-of-sale. Retail businesses that do not offer or provide plastic retail shopping bags are required to offer or provide alternatives (i.e., cardboard boxes or paper bags) at no charge. Effective June 1, 2010, retailers are prohibited from offering or providing customers plastic bags that are incompatible with the City of Toronto's recycling programs (e.g., biodegradable, compostable bags or plastic bags with "metal detailing or grommets, rope or hard plastic handles") (City of Toronto 2010).

After introducing the fee, one Ontario grocery chain observed a 70 to 80 percent reduction in the use of plastic bags; and another noticed a 72 percent drop. A third chain began charging CAD$0.05 per bag at all its locations and noticed a 55 percent drop in national plastic bag distribution in 2009, (Draaisma 2010).

Denmark (Williams 2004)

In 1994, Demark implemented a tax on all packaging, including single-use plastic and paper bags. The tax, which was only assessed to retailers when they purchased the bags, resulted in a 66 percent drop in plastic and paper bags issued at the point-of-sale.

Taiwan (McLaughlin 2004)

In 2001, Taiwan implemented tough restrictions (i.e., large fines) on the free distribution of plastic bags, utensils, and Styrofoam™ and plastic food containers. The final phase of the three-stage restrictions became effective in January 2003. In June 2004, the Taiwan Environmental Protection Administration reported a 69 percent reduction in plastic bag usage since January 2003. Factoring the heavier use of paper bags, the agency estimates that the overall waste from shopping bags has dropped by 65 percent. Overall, it is estimated that Taiwan has reduced its solid waste generation by approximately 25 percent since the implementation of these restrictions. Taiwan has not banned the use of plastic bans. Each plastic bag distributed at the point-of-sale costs one New Taiwan dollar (US$0.03).

Hong Kong (Hong Kong Environmental Protection Department 2010)

On July 7, 2009, Hong Kong implemented a HK$0.50 (US$0.06) tax on each plastic bag distributed at 3,000 major or chain supermarkets, convenience stores and personal health and beauty stores. One year after implementing the fee, Hong Kong saw a 90 percent decrease in the number of plastic shopping bags distributed at the point-of-sale.

China (Watts 2009)

Prior to the 2008 Summer Olympic Games, China banned the sale and use of plastic bags thinner than 0.025mm; and banned the free distribution of plastic bags at retail stores. A survey conducted by the China Chain Store and Franchise Association indicated that plastic bag usage decreased by 66 percent in the first year. The Association estimates that China did not use or distribute 40 billion plastic bags, the equivalent of 1.6 million metric tons of oil.

South Africa (Fourie 2004)

In May 2003, South Africa banned the production of plastic bags thinner than 0.024mm; and prohibited the free distribution of plastic bags at the point-of-sale. Bag manufacturers saw a 90 percent decrease in sales.

5.5. VOLUNTARY REDUCTION IN SINGLE USE PLASTIC BAG USAGE

Environmental education and public sentiment may reduce plastic bag usage. The results of a voluntary push by Australian retailers to reduce consumption are provided below.

Australia (Environment Protection and Heritage Council 2008)

To reduce plastic bag usage, the Australian Retailers Association, in association with the Australian Environment Protection and Heritage Council, implemented the voluntary "Australian Retailers Association Code of Practice for the Management of Plastic Bags" (Retailers Code) from 2003 through 2005, with a commitment to phase out plastic bags by January 1, 2009. Retailers encouraged customers to minimize the use of thin high-density polyethylene (HDPE) bags and switch to other alternatives (e.g.,

reusable bags); and promoted bag recycling (Australian Retailers Association 2003). As part of this voluntary practice, bag consumption was tracked and reported semiannually. The annual bag consumption for the three trial years (2003-2005) and subsequent years with the percent reduction from the 2002 baseline levels are shown in Table 5-2.

Table 5-2. HDPE bag consumption in Australia and the percent reduction from 2002 levels.

Year	HDPE Bag Consumption (billions)	Percent Reduction from 2002 Consumption Levels
2002	5.95	
2003	5.24	11.9
2004	4.77	20.4
2005	3.92	34.2
2006	3.36	43.6
2007	3.93	33.9

There was a steady reduction in HDPE bag consumption each year during the Retailers Code, with a 34.2 percent reduction from 2002 levels at the end of the trial period. A year after the end of the Retailers Code trial period, consumption reached an all-time low (43.6 percent lower than 2002 bag consumption), but rebounded to 2005 levels in 2007.

5.6. SUMMARY OF PERTINENT FINDINGS

Table 5-3 provides a summary of product bans and/or fees with reduction percentages as they relate to decreases in consumption or decreased presence in the environment.

Table 5-3. Product bans and/or fees with reduction percentages.

City	Action	Implementation	Reduction (Consumption unless noted)
San Francisco	Ban on polystyrene food ware	June 2007	41%[1]
	Ban on plastic bags	December 2007	18%[1]
Washington D.C.	$0.05 per bag (plastic & paper)	January 1, 2010	87%
Ireland	€0.15 per plastic bag	March 2002	94 % 21%[1] 96%[2]
	€0.22 per plastic bag	July 2007	94%[2]
Toronto	CAD$ 0.05 per plastic bag	June 2009	70-80%
	Ban on non-biodegradable, non-compostable or non-reusable bags	June 2010	Unknown
Denmark	Packaging Tax	1994	66%
Taiwan	TWD$1 per plastic bag	January 2003	69%
Hong Kong	HK$ 0.50 per plastic bag	July 2009	90
China	Ban on plastic bags thinner than 0.025mm and free plastic bags	June 2008	67%
South Africa	Ban on plastic bags thinner than 0.024mm and free plastic bags	May 2003	90%[3]
Australia	Voluntary reduction of HDPE bags by retailers	2002-2005	33.9 (2007)

[1]Decreased presence in the environment
[2] Reduction of national trash composition percentage that was plastic bags
[3]wholesale sales

Polystyrene Foam

- Polystyrene foam used as food ware is not typically recycled and is environmentally-persistent.
- The City of San Francisco reports a 41 percent reduction in polystyrene litter observed on San Francisco streets in 2009 when compared to polystyrene litter observed in 2007 (HDR/BVR Engineering et al. 2009).
- Polystyrene foam bans have come under less scrutiny and opposition when compared to single-use plastic bag bans or fees. More than 100 government agencies within the United States have banned the use of polystyrene foam as a food ware.

Single-use Plastic Bags

- Single-use plastic bag bans are enacted to reduce plastic bag use, achieve waste reduction goals, reduce plastic litter and protect wildlife.
- Single-use plastic bag bans have come under intense scrutiny and opposition from public interest groups and lobbyists representing plastic bag manufacturers, distributors, and retailers.
- The reductions in plastic bag consumption due to plastic bag fees at the point-of-sale range from 66 to 94 percent.
- Product bans and fees appear to be an effective method in reducing the amount of targeted products observed within the environment. The fees on plastic bags in Ireland led to a 21 percent reduction in their presence in the environment, while a ban on plastic bags in San Francisco led to an 18 percent reduction.
- Voluntary efforts to reduce the use of plastic bags can also be effective and led to a 33.9 percent reduction in high-density polyethylene bags usage in Australia.
- Prior to the implementation of a plastic bag fee in Ireland in 2002, plastic bags had been 5 percent of litter seen in the national trash composition. After implementation, this composition dropped to a low of 0.22 percent in 2004, a 94 percent reduction.

6. CREEK/CHANNEL/SHORELINE CLEANUPS (VOLUNTEER AND/OR MUNICIPAL)

Creek cleanups have been successful in removing large amounts of trash from local creeks and waterways; and increasing citizen's awareness of trash issues within their communities. Creek cleanups are conducted as single-day events or throughout the year by volunteers and municipal agencies.

In accordance with the Permit Provision C.10.b. of the MRP, Permittees are required to annually clean a minimum number of trash hot spots within their jurisdictions. The volume and type of trash collected from this effort is quantified. The MRP also requires Permittees to support watershed stewardship collaborative efforts of creek groups; support citizen involvement events (e.g., creek cleanups); and assess and clean a minimum number of trash hot spots within their jurisdictions. Due to the nature of having the common goal of clean creeks, the efforts of both volunteers and municipal agencies sometimes overlap. This is most apparent with municipal agencies using volunteers to help assess and clean designated trash hot spots during single-day volunteer events. In most cases, creek cleanups are an effort of "last resort" since all other control measures have failed. Due to the increased expense and difficulty of removing trash in creeks, source controls are ideally the preferred option.

6.1. VOLUNTEER CREEK CLEANUPS IN SAN FRANCISCO BAY AREA

Volunteer creek cleanups involve the meeting of individuals, creek and watershed groups, civic organizations, businesses and others at designated or "adopted" creek sites to remove trash and debris.

6.1.1. Single-day Volunteer Efforts

Each year, large numbers of volunteers within the San Francisco Bay area and throughout the country participate in National River Cleanup Day (held the third Saturday in May) and Coastal Cleanup Day (held the third Saturday in September). These single-day events are usually the largest volunteer creek cleanup events conducted within a specific locale each year. Examples of agencies or organizations coordinating one or both events within the San Francisco Bay area include:

Creek Connections Action Group (CCAG 2010a)

In Santa Clara County, the Creek Connections Action Group (CCAG), a consortium of public agencies and non-profit organizations, coordinate both single-day events each year. Coordinating agencies include the Santa Clara Valley Water District, Santa Clara County Parks and Recreation and the City of San José. The CCAG was formed in the fall 1995 by several local agency staff whose goal was to better coordinate their creek cleanup efforts. To attract volunteers, event dates are publicized. The CCAG provides trash bags, gloves, first aid supplies and water for each event. The CCAG requires that each cleanup site have a registered coordinator. Site coordinators are responsible for overseeing the cleanup event; estimating the total amount of trash collected during the event; and providing creek cleanup data to the CCAG program coordinator. Site cleanup results for both single-day events are reported on the CCAG website (www.cleanacreek.org)

City of Oakland Public Works Agency, Department of Facilities and Environment (City of Oakland 2011)

The City of Oakland Public Works Agency, Department of Facilities and Environment coordinate Creek to Bay Day, Oakland's version of California Coastal Cleanup Day. Each designated cleanup site is assigned a site coordinator which is responsible for managing the cleanup event; estimating the total amount of trash collected; and completing a project summary of the event. In addition, the site coordinator is

responsible for recruiting volunteers and distributing outreach materials for the event; and picking up and returning any borrowed tools to the Department of Facilities and Environment. Other organization and agencies coordinating cleanups on Creek to Bay Day include the East Bay Regional Parks District and the Port of Oakland.

6.1.2. On-going Volunteer Efforts

Adopt-a-Creek Programs

Adopt-A-Creek programs are established to encourage volunteers to take an active role in maintaining neighborhood creeks over a specified time period. Adopt-a-Creek volunteers adopt a public area of creek and commit to removing litter, debris and weeds; and planting native flora. In most cases, a local agency supports the program by providing garbage bags, gloves, tools and safety vests; and arranging pick-up and disposal of collected trash. Adopting individuals or groups are recognized with a placement of a sign near the adopted site. Some local agencies supporting Adopt-a-Creek Programs within the Bay area include the Santa Clara Valley Water District, City of Oakland Public Works Agency and Alameda County Public Works Agency.

Creek and Watershed Groups

Many creek and watershed groups in the Bay area are involved in the preservation, enhancement and restoration of local creeks and watersheds. These groups, which consist mostly of volunteers, conduct habitat and channel restoration; weed abatement; native flora planting; evasive species removal; litter and trash removal; and other creek side management activities.

Most creek and watershed groups actively participate in both single-day cleanup events or conduct on-going litter and trash removal throughout the year. On-going litter and trash removal is common at creeks in highly urbanized areas. Examples of Creek and Watershed Groups conducting litter and trash removal within the Bay area include: Friends of Sausal Creek, Friends of Five Creeks, Friends of Alhambra Creek, Friends of San Leandro Creek, Friends of Coyote Creek, Friends of Stevens Creek Trail and the Guadalupe-Coyote Resource Conservation District.

Save the Bay

Save The Bay is a non-profit, regional organization working to preserve, protect and restore San Francisco Bay. As part of their commitment to eliminating trash from San Francisco Bay, Save the Bay asked Bay area residents to vote for one of seven selected Bay area trash hot spots that they will "adopt" for a series of volunteer cleanups through 2011. The seven sites under consideration are in proximity to high-use areas and major transportation corridors; may provide habitat for endangered species; and have persistence of levels of trash (Save the Bay 2011). The trash hot spot receiving the most votes will be the adopted site. In October 2010, voters selected Redwood Creek in Redwood City as the winner. In February 2011, Save the Bay partnered with Redwood Creek Preservation Trust and cleaned the trash hot spot. Three additional hot spot cleanups of Redwood Creek will occur during 2011 (Chan, A., *pers. comm*. 2011)[9].

6.2. MUNICIPAL CREEK CLEANUPS IN SAN FRANCISCO BAY AREA

As part of on-going creek maintenance operations, municipal agencies within the San Francisco Bay Area routinely clean trash problems areas at creeks where trash and debris is illegally dumped, prone to collect or left behind from homeless encampments. Municipal agencies also respond to the illegal

[9] Allison Chan. Save the Bay. February 2011.

dumping of trash and debris at City-owned creek sites. Complaints are usually received from toll-free telephone hotlines and/or reported on websites maintained by municipal agencies.

6.2.1. Permittee Creek Cleanups in Accordance with Municipal Regional Permit

Provision C.10.b of the MRP requires each Permittee to identify and select a required number of trash hot spots in creeks or shorelines that will be the focus of required annual trash assessments and cleanups. Each Permittee submitted a final list of selected trash hot spots to the Water Board by July 1, 2010.

The MRP also requires Permittees to cleanup trash hot spots to a level of "no visual impact" at least one time per year for the term of the permit (December 1, 2009 through November 30, 2014). In addition, Permittees are required to quantify the volume of material removed from each annual cleanup event; and identify the dominant types of trash (e.g., glass, plastics, paper) removed and their sources to the extent possible. Documentation of the creek condition (with relevance to trash) before and after cleanup events using photo documentation with a minimum of one photo per fifty (50) feet of hot spot length is also required. Countywide stormwater programs have developed or in the process of developing data collection tools and management procedures to gather and mange this information.

Based on discussions with lead Water Board staff[10,] trash hot spot cleanups and assessments will be conducted each calendar year during the term of the permit (i.e., 2010 through 2014). The timing of annual cleanups will vary between hot spots. Timing will likely depend on the location of the hot spot, potential for natural resource impacts, crew availability and other site-specific factors.

6.2.2. Other Municipal Creek Cleanup Efforts

Santa Clara Valley Water District Clean, Safe Creeks and Natural Flood Protection Plan - Good Neighbor Program

In November 2000, a ballot measure was approved which created a countywide special parcel tax to fund the Santa Clara Valley Water District Clean, Safe Creeks and Natural Flood Protection Plan. This Plan contains four outcomes. All four outcomes are expected to be completed over the course of a fifteen-year period. Outcome 2, Activity 2.4 supports the Santa Clara Valley Water District Good Neighbor Program (Good Neighbor Program) by funding trash removal from neighborhood creeks and graffiti removal from bridges and floodwalls (SCVWD 2007). Clean-up activities supported by the Good Neighbor Program include the following (SCVWD 2010a):

- Inspecting creeks in response to complaints regarding illegal dumping;
- Conducting four trash removal events (routes) per year on visible reaches (within 150' of bridges, along trails, and along frontage roads) of creeks where the Santa Clara Valley Water District (SCVWD) has easement or fee title;
- Performing monthly graffiti and trash removal in areas of extreme problems;
- Responding to complaints of trash and graffiti within five days; and
- Supporting the SCVWD Adopt-a-Creek Program by picking up trash following a cleanup, installing signs and participating with the Adopt-a-Creek group.

[10] Communications with Dr. Tom Mumley, Assistant Executive Officer of the Water Board, at multiple Board of Directors meetings of the Bay Area Stormwater Management Agencies Association.

City of San José and Santa Clara Valley Water District – Memorandum of Agreement for Trash Prevention and Removal Services (City of San José 2010)

In September 2004, the City of San José and the SCVWD entered into a Memorandum of Agreement for Trash Prevention and Removal Services (Trash MOA). The Trash MOA was revised in February 2008 to formalize monthly and weekly encampment cleanups; to increase the number of additional partnered cleanups; and to track and report costs associated with conducting cleanup activities. Other trash prevention and removal activities included in the original Trash MOA are also included in the revised Trash MOA. The Trash MOA is implemented by the Joint Trash Team, a working group of staff from both the City of San José and SCVWD. Oversight of the Joint Trash Team is provided by the Executive Committee, consisting of management from the City of San José and SCVWD.

The Trash MOA requires the development of an Annual Work Plan and Report. The Annual Work Plan includes planning for the following five tasks:

- Monthly Encampment Cleanup Program – This task focuses on the removal of active illegal encampments. It occurs approximately one day per month with a maximum of ten events per year. It is conducted by the City of San José.
- Weekly Encampment Cleanup Program – This task focuses on the removal of inactive illegal encampments, in most cases, but may include cleaning active illegal encampments. It occurs approximately one day per week. It is conducted by the SCVWD, in accordance with the Good Neighbor Program, with assistance from the San José Police Department, as needed.
- Partnered Cleanup Projects Program – This task involves the cleanup of trash accumulation areas which are not covered under the Monthly and Weekly Encampment Cleanup Programs. Areas are usually hard to access and clean; and have significant amounts of trash and litter. Partnered cleanups are coordinated by the Joint Trash Team. Up to five partnered cleanups may occur per year.
- Other Trash Prevention and Removal Activities – This task includes maintaining a Program list; enforcement and education; coordinating operations with both entities; participation in countywide stormwater program activities; and other trash prevention and removal program activities.
- Development of Annual Trash MOA Work Plans and Reports – The Joint Trash Team is required to develop and submit an Annual Trash MOA Work Plan and Report to the Executive Committee by August 31 of each year.

6.2.3. Removal of Homeless Encampments at Creeks

Other municipal agencies within the San Francisco Bay area focus on the removal of trash and debris from active and inactive homeless encampments at creek sites. Trash and debris removal, which is conducted by municipal maintenance staff with assistance from their Police Department, occurs on an as needed basis throughout the year. Cleanups are conducted to prevent flooding and the transport of trash within the watershed.

6.2.4. Creek Maintenance Activities

To prevent flooding, some municipal agencies within the San Francisco Bay area routinely conduct creek maintenance activities. Major maintenance activities include levee safety, sediment removal, vegetation management and bank protection. Minor maintenance activities include trash and debris removal, fence and access repair, and managing watershed vegetation.

6.2.5. Hotlines and Websites to Report Illegal Dumping at Creeks

Municipal agencies within the Bay area maintain toll-free telephone hotlines and/or websites for the reporting of illegally dumped trash and debris at creeks. Once a complaint is received, the appropriate organization with the agency (e.g., Public Works Agency or Maintenance Division) is notified. A response is typically initiated within five days to remedy the dumping complaint. Municipal agencies who maintain illegal dumping hotlines and/or websites include the Contra Costa Clean Water Program and SCVWD. Websites maintained by the Santa Clara Valley Urban Runoff Pollution Prevention Program (www.scvurppp.org) and San Mateo Countywide Water Pollution Prevention Program (www.flowstobay.org) provide telephone numbers for reporting illegal dumping to member agencies.

6.3. SUMMARY OF PERTINENT FINDINGS

- **Creek cleanups have been conducted for many years –** Since the late 1980's, volunteers within the Bay area have conducted creek cleanups at various levels of effort. Most municipal agencies started coordinating single-day creek cleanups in the mid 1990's; and removing homeless encampments and remedying illegal dumping sites at creeks around 2000.
- **Large volumes of trash are removed from creek cleanups –** Volunteers and municipal agencies remove large volumes of trash from single-day volunteer and ongoing creek cleanups. For example, more than 805,382 pounds of trash have been removed from National River Cleanup Day and Coastal Cleanup Day volunteer events held in Santa Clara County since September 1998 (SCVURPPP 2010). In addition, the California Coastal Commission estimated that more than 250,000 pounds of trash and recyclables were removed from Bay area watersheds during the 2009 Coastal Cleanup Day volunteer event (Save the Bay 2010). Municipal creek cleanups conducted in accordance with the City of San José and SCVWD Memorandum of Agreement for Trash Prevention and Removal Services indicated that approximately 3,196 CY of debris with a total weight of 421.95 tons was removed from January 2008 through June 2010 (City of San José 2008, 2009 and 2010). Since 2001, the Santa Clara Valley Water District Good Neighbor Program has removed approximately 41,651 cubic yards of litter from Santa Clara Valley creeks and streams (SCVWD 2010b).
- **Large numbers of volunteers and all municipal agencies conduct creek cleanups within the Bay Area –** Each year, large numbers of volunteers adopt and clean creek sites of interest within their communities. Creek sites are cleaned during single-day events and/or throughout the year. Most Bay area municipalities are coordinating the two largest single-day events, National River Cleanup Day and Coastal Cleanup Day. Since 1998, over 22,000 volunteers have cleanup 588 sites within Santa Clara County (SCVURPPP 2010). During the 2009 Coastal Cleanup Day event, over 22,000 volunteers cleaned sites around San Francisco Bay (Save the Bay 2010). Creek and watershed groups play a large role in protecting creeks and streams from the impacts of trash and litter throughout the year. A short list of groups conducting litter and trash removal within the Bay area include: Friends of Sausal Creek, Friends of Five Creeks, Friends of Alhambra Creek, Friends of San Leandro Creek, Friends of Coyote Creek, Friends of Stevens Creek Trail and the Guadalupe-Coyote Resource Conservation District. Many other creek and watersheds groups within the Bay area conduct this activity. In accordance with the MRP, all municipal agencies are required to clean a minimum number of trash hot spots within their jurisdictions. Prior to the MRP, most municipal agencies conducted ongoing creek maintenance activities to remove trash from illegal dumping and homeless encampments.
- **There has been an increased focus on creek cleanups in recent years –** An increase in environmental stewardship the last few years has resulted in an increase of people participating in single-day volunteer creek cleanup efforts. The California Coastal Commission reports that there has been a 60 percent increase in the number of volunteers participating in the Coastal Cleanup Day event since

2006 (California Coastal Commission 2010). In accordance with the MRP, creek cleanups are required by all municipal agencies within the Bay area. Prior to the MRP, some Permittees assessed creeks and performed cleanups to determine changes of trash condition over time. These efforts also increased interest from local environmental groups. Save the Bay has been interested in trash hot spots at creeks for the last several years. Their interest includes developing a list of Bay area trash hot spots for the last five years; and recently agreeing to clean Redwood Creek in Redwood City four times during 2011. Some creek and watershed groups have also started conducting creek cleanups in response to water quality impacts.

- **Municipal agencies and volunteer groups collect limited data during municipal creek cleanup efforts** Municipal agencies within the Bay area collect limited data during municipal creek cleanup efforts. Information collected and reported may include: the number of cleanups conducted, number of locations, and estimated volume (in cubic yards) and/or total weight of trash and debris removed. Total weight (in tons) is obtained from landfill tipping receipts. Regarding complaint calls, municipal agencies usually track the number of complaints received and the response time to address and/or remedy each complaint. In most cases, the amount of trash and debris removed from this activity is not tracked. In addition, creek and watershed groups typically do not quantify the volume of trash removed from ongoing creek cleanups. Rather, the types of trash removed are reported with a description of the total quantity removed (e.g., several bags, large amounts, etc.).
- **Data collection is not conducted in a standardized fashion for single-day volunteer efforts –** A review of forms used to collect and/or report the amount of trash removed from single-day volunteer efforts indicated that data is not collected in a standardized fashion. Table 6-1 provides a comparison of what data is collected and/or reported for single-day volunteer events. When conducting single-day creek cleanups, Creek Connections Action Group (CCAG) members use a one-page form (i.e., Data Reporting Form) to collect and report information to the CCAG coordinator. CCAG members are also encouraged to use the International Coastal Cleanup Data Card developed by the Ocean Conservancy during Coastal Cleanup Day. National Rivers Cleanup Day organizers at the national level request that local organizers provide cleanup results through an on-line survey. Information identified below is what is requested on-line. A review of the Organizer's Handbook for National Rivers Cleanup Day indicated that there is not a standardized approach for collecting cleanup results.

Table 6-1. Summary of data collected and/or reported for single-day volunteer events.

Data Field	CCAG Data Collection Form	Coastal Cleanup Day	National Rivers Cleanup Day
Cleanup category		√	
Cleanup type		√	
Site name	√	√	
Site location		√	
Site number	√		
Site coordinator	√	√	√
Contact information		√	√
Number of volunteers	√	√	√
Distance cleaned	√	√	√
Number of trash bags filled		√	√
Estimated weight of trash (in pounds)	√	√	√
Estimated weight of recyclables (in pounds)	√		
Estimated time spent on cleanup		√	
Most unusual items	√	√	
Items collected		√	
Entangled animals		√	
Types of media coverage			√
Comments	√		√

The CCAG Data Reporting Form requests that trash and recyclables (in pounds) be calculated for each creek cleanup site. Due to time constraints and other limitations, recyclables and trash are not always separated during the cleanup process. To estimate total pounds of recyclables and trash collected during a creek cleanup, the total number of filled bags collected is multiplied by thirty pounds, the average weight of a filled garbage bag (CCAG 2010b). To estimate individual weights of recyclables and trash collected, the typical breakdown of contents of a garbage bag are considered. Table 6-2 provides the typical breakdown (in percentages and pounds) of contents of a garbage bag from a creek cleanup.

Table 6-2. Typical breakdown of contents of a garbage bag from a creek cleanup (CCAG 2010b).

Collected Material	Percentage	Pounds
Paper	40	12
Recyclable Plastic	25	7.5
Glass	15	4.5
Other	8	2.5
Aluminum	6	2
Newsprint	4	1
Other Metals	2	0.5
Fabrics	2	0.5

However, according to the SCWVD, this estimation is done more frequently at Coastal Cleanup sites than at National Rivers Cleanup sites (Slama,K., *pers.comm*.2010)[11]. Since an estimation of recyclables and

[11] Kate Slama. Volunteer Coordinator, Santa Clara Valley Water District. September 2010.

trash collected is not done for all sites, it is more appropriate to compare the sum total of recyclables and trash collected rather than their individual totals.

7. ON-LAND LITTER PICKUP/REMOVAL (VOLUNTEER AND/OR MUNICIPAL)

On-land cleanups have been successful in removing trash and litter from identified trash hot spots and engaging local citizenry in improving their communities. On-land cleanups discussed in this section include those conducted by municipal agencies and volunteers. Municipal agencies have several programs in place to address on-land trash and litter. Municipal efforts relate to ongoing beautification of impacted areas and coordination of cleanup events. Volunteer on-land cleanups involve the meeting of individuals, creek and watershed groups, civic organizations, businesses and others at designated or ”adopted” on-land sites to remove trash and debris. On-land cleanups are conducted as single-day events or throughout the year.

7.1. EXAMPLES WITHIN THE UNITED STATES

7.1.1. Keep America Beautiful, Inc. (KAB 2010)

Keep America Beautiful, Inc. (KAB) is a national network of over 1,000 certified affiliates and participating organizations which encourages community stewardship in three main areas: litter prevention, recycling and waste reduction, and beautification and community greening. Beautification activities conducted by KAB affiliates include litter and illegal dump cleanups; tree planting; and graffiti removal and prevention. KAB also offers a range of other educational products including school curricula and educational/program materials. Local KAB affiliates include the City of San José and City of Oakland.

To improve methods for controlling litter in the nation’s urban areas, KAB and the United States Conference of Mayors formed the Urban Litter Partnership. One goal of the Urban Litter Partnership is to develop and implement litter measurement tools that allow municipalities to identify trash problems, establish baselines and track trends over time. These tools are designed to measure and assess litter, evaluate prevention programs and address a city’s interest in cost-effective, easy-to-implement litter control methods.

KAB has developed the following three litter assessment tools: 1) the KAB Litter Index; 2) the “Windshield Survey” method, which also use the “Neighborhood Spotter Checklist”; and 3) the Photometric Index. Each tool requires the collection and removal of litter. However, each tool does not quantify the amount of litter collected.

7.1.2. State Adopt-a-Highway Programs

The Texas Department of Transportation initiated the first Adopt-a-Highway program in 1985 due to concerned citizens wanting to clean littered highways. Today, every state but one has an Adopt-a-Highway program. Each state calculates value received from volunteer efforts of adopting groups. Examples of State Adopt-a-Highway programs include:

California (Caltrans 2010a)

In 1989, Caltrans began coordinating California's Adopt-a-Highway Program. Since its inception, more than 120,000 volunteers have cleaned and enhanced over 15,000 shoulder-miles of California roadside. Its annual budget funds advertisements, plastic bags, safety goggles, orange vests, gloves and signs. Volunteers remove litter, plant trees, remove graffiti and control vegetation. Collected trash is properly disposed by Caltrans. It is not known if Caltrans quantifies the amount of trash disposed.

Washington (WSDOT 2010)

Washington's Adopt-a-Highway program, which is administered by the Washington State Department of Transportation (WSDOT), began in 1990. As of October 2010, approximately 1,400 groups have adopted and are picking up litter along highways within the State of Washington. Each volunteer group must register with a local coordinator. After a litter cleanup is conducted, groups are asked to submit a written activity report of how much litter was collected; or provide these results on an Online Activity Report. This information is used to track how often groups are picking up litter; how much is collected; and when WSDOT needs to collect filled bags. In 1997, WSDOT started a corporate sponsorship program that allows corporations to use private contractors to pick up and dispose collected litter and trash.

7.1.3. Business Improvement Districts

Business Improvement Districts (BIDs) are special assessment districts which business owners agree to initiate, manage and finance supplement services or enhancements of the business area above existing municipal services. Assessments are paid directly to the city or town in which the business is located. A BID performs a wide variety of activities which include the following: litter and graffiti removal; weed abatement; safety services (e.g., security), washing sidewalks, landscaping improvements, promotion and marketing. Within the Bay area, BIDs have been created in the Cities of San José, Oakland, Berkeley and Walnut Creek, just to name a few. In most cases, the amount of trash removed each year from BID litter removal activities is not quantified.

7.2. EXAMPLES WITHIN THE BAY SAN FRANCISCO BAY AREA

7.2.1. City of San José - Parks, Recreation and Neighborhood Services

To ensure clean parks, open spaces and other recreation areas, the City of San José Department of Parks, Recreation and Neighborhood Services performs several on-land trash and litter removal activities. The completion of these activities is administered by two programs within the Department, the City of San José Anti-Litter Program and Parks Maintenance Program. Cleanup efforts are conducted by municipal staff, volunteers and/or other labor sources.

City of San José Anti-Litter Program

In April 2002, the City of San José initiated its Anti-Litter Program, a program modeled after the City's successful anti-graffiti Program. The Anti-Litter Program incorporates existing resources from several participating programs and agencies; and volunteers. It focuses on three major areas (i.e., community involvement, eradication and enforcement) to address litter. Enforcement activities conducted by the City of San José are not discussed in this technical memorandum.

Community Involvement

Pick-up San José and Adopt-a-Hot Spot Volunteers

The City of San José has identified 150 on-land litter "hot spots" based on complaints from each of the ten (10) City Council Districts. Litter hot spots are adopted and periodically cleaned (i.e., at least once per month) by volunteers through the efforts of two City programs, Pick-up San José and Adopt-a-Hot Spot. In 2009, a total of 128 of 150 on-land litter hot spots were adopted and cleaned (Samonsky, E., *pers.comm.* 2010)[12]. In addition, volunteers removed litter from other sites not formally identified on

[12] Ella Samonsky. City of San Jose, Environmental Services Department. September 2010

the City Council lists. The majority of cleanup sites are within residential areas. In some instances, cleanups may occur more frequently than once per month (Samonsky, E. *pers.comm*.2010).

Volunteers who adopt and clean litter hot spots are provided a "clean-up" kit from the City. The kit includes litter bags, gloves and litter stickers to place on full litter bags (Samonsky, E. *pers.comm*.2010).. To ensure proper disposal of bags, the City picks up "stickered" bags with residential trash service, free of charge. Each year, City of San José staff tracks the number of volunteers participating and the number of bags collected (Samonsky, E. *pers.comm*.2010).

Equipment Loan Program ('Shed' Program)

To assist volunteers with cleaning on-land litter areas, the City of San José loans tools and equipment (e.g., litter sticks, rakes, hoes, brooms and safety equipment); and provides supplies (e.g., litter bags, gloves and stickers) (City of San José 2010). Most volunteers borrowing tools are performing less frequent cleanups (e.g., usually one day per year) of selected residential sites (Samonsky, E. *pers.comm*.2010). To ensure proper disposal of bags, the City picks up "stickered" bags with residential trash service, free of charge. The amount of litter removed each year is not quantified (Samonsky, E. *pers.comm*.2010).

Adopt-A-Park and Adopt-A-Trail Programs (City of San José 2009a)

To assist in the general care and maintenance of neighborhood parks, trails, and other City-owned property, City of San José Anti-Litter Program staff actively recruits and trains volunteers for their Adopt-A-Park (AAP) and Adopt-A-Trail (AAT) programs. Potential volunteer activities include litter and leaf pickup, graffiti removal, weed abatement and planting native flora. Both programs also educate the general public about creating and preserving parks and trails.

Litter collected from designated AAP and AAT sites is left on-site and picked up by City of San José staff for proper disposal; or placed in waste containers present at each site. The amount of litter removed each year from designated sites is not quantified. The City requires that volunteers track their hours and report them to Anti-Litter Program staff on a monthly basis. The tracking of volunteer hours assists with future planning needs and ensures proper recognition of participants.

Annual Great American Pickup Event

Each spring, the City of San José Anti-Litter Program coordinates a one-day litter pickup event of neighborhoods, parks, streets and other littered areas within each City Council District. A maximum of 150 volunteers participate at pre-selected areas within each District (City of San José 2010). To assist volunteers with cleaning on-land litter areas, the City of San José provides litter bags. Litter collected from the event is placed in a designated collection area and picked up by City of San José staff for proper disposal. The amount of litter removed from this event is not quantified (Samonsky, E. *pers.comm*.2010).

Eradication

Illegal Dump Site Correction

City of San José Anti-litter Program staff regularly monitors illegal dump sites to stop illegal dumping. Unwanted items usually dumped include construction and demolition waste, mattresses, couches, appliances, other large household items and trash. In 2009, a total of 27 chronic illegal dump sites were monitored and periodically cleaned by Anti-litter Program staff (Samonsky, E. *pers.comm*.2010). When necessary, unwanted items are collected and transported to a City-owned yard for temporary storage and final disposition. The amount of unwanted items removed each year is not quantified (Samonsky, E. *pers.comm*.2010). Sites are removed from the correction list after a period of monitoring shows no further dumping.

Weekend Juvenile Offender Program

During weekends, the San José Anti-litter Program uses juvenile offenders to cleanup identified on-land litter hot spots or other littered areas. Collected litter is left on-site and removed by City of San José staff for proper disposal. During 2009, juvenile offenders logged in 4,853 service hours and collected 2,983 bags of litter (City of San José 2010).

Parks Maintenance Program

The City of San José Department of Parks, Recreation and Neighborhood Services Parks Maintenance Program provides maintenance services at City-owned parks; and responds to illegal dumping in City parks and along park trails. Maintenance and trash cleanup is conducted, as required. The amount of trash removed each year from park maintenance activities are not quantified (Samonsky, E. *pers.comm*.2010).

7.2.2. City of San José - Department of Transportation

The City of San José Department of Transportation (San José DOT) is also responsible for administering certain efforts relating to on-land litter cleanups. These efforts are conducted by municipal staff, volunteers and other labor sources. They include the following:

General Complaint Response

In response to complaint calls, San José DOT dispatches staff to remove large household items, debris, used oil, hazardous waste, tires and other unwanted items illegally dumped along City maintained streets and roads. The amount of illegally dumped items removed each year is not quantified (Samonsky, E. *pers.comm*.2010).

Landscape Maintenance

As part of on-going maintenance activities, San José DOT staff removes litter and debris from City-landscaped medians and backups. The goal of this effort is to ensure that landscaped areas are in good aesthetic condition. The amount of litter removed each year is not quantified (Samonsky, E. *pers.comm*.2010).

Adopt-A-Street Program (City of San José 2009a)

Similar to the Adopt-A-Park and Adopt-A-Trail programs mentioned above, volunteers may adopt and maintain a City-owned, landscaped-area along a street right-of-way. Volunteers who adopt and clean streets are provided litter bags, gloves and safety vests. If necessary, volunteers may loan supplies and equipment (e.g., litter sticks, rakes, hoes, brooms, and shovels). Collected litter is left on-site and removed by City of San José staff. The City requires that volunteers track their hours and report them to Adopt-A-Street Program staff on a monthly basis. Each year, San José DOT staff track the number of volunteers participating. However, the amount of litter removed each year is not quantified (Samonsky, E. *pers.comm*.2010).

Alternate Work Program

The Alternate Work Program uses Santa Clara County Department of Corrections labor to assist with the cleanup of homeless encampments, illegal dumping sites and litter along roads, vacant lots, landscaped areas and other littered areas within the City (City of San José 2010). Litter cleanups are conducted, as necessary. San José DOT staff supervises the laborers conducting cleanups. The amount of litter removed each year is not quantified (Samonsky, E. *pers.comm*.2010).

7.2.3. City of San José and San José Redevelopment Agency

Strong Neighborhoods Initiative

The Strong Neighborhoods Initiative (SNI) is a partnership of the community, City of San José, and San José Redevelopment Agency to build clean, safe, and attractive neighborhoods with independent and capable neighborhood organizations (Strong Neighborhoods 2010). One major SNI component is Clean Neighborhoods. This component focuses on removing blight from neighborhoods, conducting neighborhood cleanups, and implementing anti-litter and anti-graffiti campaigns. City of San José Code Enforcement Division staff works with resident volunteers to conduct these activities. The amount of litter removed each year from neighborhood and litter cleanups are not quantified (Samonsky, E. *pers.comm*.2010).

7.2.4. City of Oakland- Keep Oakland Clean and Beautiful Division

The Keep Oakland Clean and Beautiful (KOCB) Division of Oakland's Public Works Agency is responsible for maintaining and enhancing the City's aesthetics. On-land litter cleanup activities conducted by KOCB include the following:

Response to Complaint Calls

In response to complaints calls, the City of Oakland Public Works Agency dispatches staff to remove illegally dumped items along City maintained streets and roads. It appears that the amount of illegally dumped items removed each year appears is not quantified.

Parks Maintenance

The City of Oakland Public Works Agency provides maintenance services and responds to illegal dumping in City-owned parks. Maintenance and trash cleanup is conducted, as required. It appears that the amount of trash removed each year from park maintenance activities is not quantified.

7.2.5. Other Efforts

In addition, many municipal agencies and volunteer groups within the San Francisco Bay area conduct on-land trash and litter cleanups. Activities are conducted throughout the year or as single-day events. Municipal agency efforts may include:

- Litter pickup and control within downtown districts, roadsides, parks, public facilities, bus stops, and other on-land trash hot spots;
- Removing homeless encampments on public right-of-ways and greenbelts;
- Removing trash and large household items from illegal on-land dump sites,
- Coordinating interagency on-land cleanup efforts; and
- Coordinating and participating in the Great American Litter Pickup Event.

Volunteer efforts may include

- Participating in Adopt-a-spot, Adopt-a-Highway, Adopt-a-Trail and other on-land trash hot spot "adoption" programs;
- Participating in the Great American Litter Pickup Event and other single-day cleanup events; and
- Conducting routine (i.e., daily or weekly) on-land cleanups of selected hot spots (e.g., bus stops, parks, trails, etc.).

In most cases, the amount of litter and trash removed each year from these activities is not quantified.

7.3. SUMMARY OF PERTINENT FINDINGS

- **Municipal agencies have several programs in place to address on-land trash and litter –** Municipal agencies within the Bay area have several programs in place to effectively address on-land trash and litter. For example, the City of San José Anti-Litter Program coordinates three different volunteer on-land cleanup programs, Pick-up San José and Adopt-A-Spot, Adopt-A-Park and Adopt-a-Trail; coordinates the annual Great American Pickup Event; monitors and cleans illegal dump sites; manages the Equipment Loan Program; and coordinates the Weekend Juvenile Offender Program. The City of San José Parks Maintenance Program removes trash and litter from City-owned parks. In addition, the City of San José Department of Transportation responds to illegal dumping sites; removes litter from City-landscaped medians; coordinates Adopt-A-Street; and coordinates the Alternate Work Program. Other Bay area municipal agencies have on-land trash and litter programs managed and/or coordinated in a similar fashion.
- **Large numbers of volunteers conduct on-land cleanups –** Each year, large numbers of volunteers adopt and clean on-land sites within Bay area communities. During 2009, a total of 2,198 residents volunteered 8,379 service hours to clean parks and trails through Adopt-A-Park and Adopt-A-Trail programs coordinated by the City of San José (City of San José 2010). In addition, a total of 41 volunteer groups borrowed tools to perform residential cleanups within the City of San José (City of San José 2010); and hundreds of people participate locally in Caltrans' Adopt-A-Highway Program. In some communities, volunteers conduct routine (i.e., daily or weekly) on-land cleanups of selected hot spots (e.g., bus stops, parks, trails, etc.). The Texas Department of Transportation estimates that approximately 1.3 million volunteers participate in Adopt-A-Highway Programs nationwide (TXDOT 2010).
- **The volumes of trash and litter collected from on-land cleanups are not usually quantified –** Many municipal agencies and volunteer groups remove large volumes of trash and litter from single-day and ongoing on-land cleanups. However, the amounts of litter and trash removed from specific on-land cleanup efforts are not usually quantified. For example, the City of San José Anti-Litter Program only tracks the number of bags of trash collected from Pick-up San José and Adopt-A-Hot Spot volunteer events. It does not quantify the amount of trash and litter collected from other City of San José Anti-Litter Program activities. In addition, the City of San José Department of Transportation and City of Oakland Public Works Agency- Keep Oakland Clean and Beautiful Division do not quantify amounts of trash and litter collected from cleanup efforts. Local Business Improvement Districts, the City of San José Strong Neighborhoods Initiative and Keep America Beautiful litter assessment events do not quantify amounts collected. In most cases, quantification is viewed as not necessary since trash and litter are removed for aesthetic reasons. In some instances, municipal agencies do track the amounts of litter and trash removed from certain efforts, mainly from litter pickup and control efforts. Amounts collected are provided within individual Permittee Annual Reports submitted to the Water Board each September.
- **Keep America Beautiful, Adopt-A-Highway and other volunteer on-land cleanup save taxpayers significant amounts of money –** Volunteer on-land cleanup efforts save taxpayers significant amounts of money since this activity is usually conducted by government entities. Each year, the California Adopt-a-Highway Program saves California's taxpayers approximately $11.28 million (Caltrans 2010b).

8. PUBLIC EDUCATION AND OUTREACH PROGRAMS

Many municipal agencies have used public outreach campaigns to inform residents about stormwater issues such as pollutants of concern, watershed awareness, pollution prevention, etc. Public outreach efforts include developing and distributing brochures; posting messages on websites and social networking media (Facebook, Twitter etc.); attending community events; and conducting media advertising.

The goal of anti-litter public education campaigns is to increase public awareness about the impacts of litter on their communities and water quality; and to encourage the public to stop littering. Some evaluation mechanisms used to evaluate the effectiveness of anti-litter campaigns are described below:

- Pre and post campaign public opinion surveys – Public opinion surveys conducted by telephone, online or in-person are used to track public awareness about litter issues and public perception about littering.
- Impressions made by advertising – Advertising campaigns are often evaluated by measuring gross impressions (the sum of the average audience for all advertisements within a given schedule; average persons multiplied by the number of total spots equals gross impressions). A large number of gross impressions equates to a large number of people be reached by the campaign.
- Website visits – Since more residents rely on online sources for information compared to the past, tracking website visits and downloads before, during and after a campaign provides a good measure of effectiveness.
- Partnership development – The number of partners (community or commercial organizations) who distribute campaign messages through newsletters or provide "freebies" (e.g., free advertisements, discounted products, etc.) are used to measure effectiveness.
- Monitoring litter along roads, streets , highways or water bodies – Monitoring litter hot spots to determine reductions in litter after public education campaigns is a way of measuring effectiveness.

Permit Provision C.7.b. of the MRP requires Permittees to participate in an advertising campaign which focuses on reducing trash/litter in waterways with the goal of significantly increasing the overall awareness of the litter issue.

This section summarizes some anti-litter campaigns conducted by agencies within and outside the San Francisco Bay area; and the techniques used to measure effectiveness.

8.1. ANTI-LITTER CAMPAIGNS FROM OTHER COUNTRIES

City of Dublin, Ireland - "If You Behave Like A Piece Of Filth, That's How The World Sees You" (Dublin City Council 2008)

As part of its Litter Management Plan, the Dublin City Council launched a high-profile anti-litter campaign in 2007. The campaign was specifically targeted at teenagers and young adults. As a precursor to developing the campaign, a research study was conducted to identify the attitudes, causes and behaviors that result in littering; and identify the key target group on which to focus the campaign. The campaign ran through 2008 and included the targeted placement of promotional and advertising material in internet cafés and on social networking websites. The next phase of the anti-litter campaign is focusing on specific litter streams and target groups (e.g., cigarette litter, chewing gum, food and drink packaging and dog litter).

The anti-litter campaign evaluation is included in the overall evaluation of the Litter Management Plan. Example assessment questions for the anti-litter campaign included the following:

- Is there a system in place for identifying when major public events will be taking place in the local authority's administrative area?
- Does the Plan describe a regular environmental, waste-related newsletter or other publication which can be used to disseminate information related to litter?
- Is there evidence that the local authority has developed and disseminated any other advice sheets (e.g. to skip-hire contractors and fast-food outlets)?
- Has the local authority conducted surveys of public opinion and awareness in the past, and are the results of such surveys discussed in the Plan?
- Does the Plan imply that surveys of public opinion and awareness are planned for the future?
- Does the Plan describe a system for giving talks on waste and litter-related issues to schools and representative bodies?

8.2. ANTI-LITTER CAMPAIGNS FROM OTHER STATES

State of Texas – "Don't Mess with Texas "

This is an anti-highway litter campaign conducted by the Texas Department of Transportation in collaboration with Texas Adopt-a-Highway and Keep Texas Beautiful. The campaign has been ongoing for approximately 15 years. This is one of the few campaigns that have measured success of outreach by measuring the amount of litter reduced along the highway.

The Texas Department of Transportation (TXDOT) conducts periodic evaluations to track effectiveness of the campaign. In 2009, TXDOT commissioned two studies to gather updated information about litter in Texas:

- Litter Attitudes and Behaviors (LA&B), a statewide telephone and online survey of Texans conducted in December 2009 (EnviroMedia and Stadia 2010); and
- Visible Litter Study (VLS), an analysis of litter and accumulation on Texas roadsides conducted November 2008 – May 2009 (EnviroMedia and NuStats 2010).

Highlights from the study findings are described below:

- Awareness of the *Don't Mess with Texas* campaign remains high at 95 percent (LA&B).
- More Texans than ever now know what *Don't Mess with Texas* means. Approximately 8 out of 10 (82 percent) Texans know the slogan means do not litter. In 2007, only 68 percent knew the meaning of the slogan (LA&B).
- Large items (e.g., food-related trash) decreased from 29 percent of the litter total in 2005 to 7 percent in 2009 (VLS).
- In 2009, approximately 1.1 billion pieces of litter accumulated on Texas-maintained highways. While litter increased 33 percent since 2005 (827 million items), it decreased by 11 percent since 2001 (1.237 billion items)(VLS).
- Cigarette butts are the main cause for an increase in litter on Texas roads. Tobacco trash, including nearly 400 million cigarette butts, made up 43 percent of the 1.1 billion pieces of trash estimated on Texas roads in 2009 (VLS).
- The Average Daily Traffic (ADT) counts on sampled roads increased 9 percent overall from 2003 to 2007. The Visible Litter Study shows a clear connection between traffic volume and the

amount of litter on the road; In other words, more traffic equates to more litter. In addition, the Texas population grew 7.8 percent between 2004 and 2008, and the number of people of legal driving age grew 4.6 percent to nearly 18 million.

State of Washington – "Litter and it Will Hurt " (WSDE 2005)

In the spring of 2002, the Washington State Department of Ecology (WSDE) launched a targeted advertising effort to reduce litter generation in Washington, using the results of a litter study conducted in 1999. A new slogan, "Litter and it will Hurt", aimed at the demographic group most likely to litter: males and young adults, was created. The slogan appeared statewide on billboards, freeway signs and litterbags. In 2004, the target expanded to include the two most frequent littering behaviors, cigarette butt disposal and unsecured loads.

A study conducted to evaluate campaign effectiveness found that between 1999 and 2004:

- The estimated amount of litter on roadways decreased from 8,322 tons to 6,315 tons; and
- The estimated amount of litter on interchanges decreased from 617 tons to 443 tons in 2004.

Overall litter generation on interchanges and on county roads exhibited a strong downward trend, but there was no statistically significant decrease in litter generation on all roadways combined, or on individual roadways. Several components of litter showed statistically significant decreases on all roadways combined including:

- All beverage containers combined (43 percent reduction);
- Glass beverage containers (47 percent reduction);
- All alcoholic beverage containers combined (30 percent reduction); and
- Glass alcoholic beverage containers (30 percent reduction).

Due to budget cuts, July 1, 2009 campaign funds were transferred to the State General Fund to meet other state priorities. Between July 1, 2009 and June 30, 2011, $4.4 million is cut from the litter account. This is about a quarter of the total litter budget. As a result, most of the *Litter and it will Hurt* campaign has been suspended. Only the toll-free hotline, roadway signs and WSDE hosted website have remained.

City of Philadelphia – "UnLitter Us" (Philadelphia Streets Department 2010)

The Philadelphia Streets Department launched an anti-litter initiative in May 2010. The public outreach component of this initiative consists solely of spoken word compositions and performances of five Philadelphia street poets.

The enlistment of authentic Philadelphia street poets derives from the idea that litter is corrosive to a community's emotional well-being; and that any effective voice for its elimination must be emotional and peer-to-peer. From the many spoken word performers (identified mostly through neighborhood high school and college poetry programs, and on late-night public radio) who composed and auditioned their own anti-litter messages, five (5) were selected. Their 27-second poems (longer for online distribution) make up the total campaign. Its only other words are the closing tag, "Unlitter Us."

8.3. ANTI-LITTER CAMPAIGNS WITH CALIFORNIA

State Water Resource Control Board – "Erase the Waste" (Mays 2005)

In 2003, the State Water Resource Control Board started the "Erase the Waste" campaign within the Los Angeles region. The two-year outreach campaign encouraged County of Los Angeles residents to take ownership of their communities; reduce stormwater pollution from the local landscape; and be part of the "pollution solution" by adopting simple, everyday actions.

The *Erase the Waste* campaign used several mechanisms to evaluate effectiveness. They include the following:

- Conducted a public opinion survey in August 2004 that showed that:
  - Approximately one-third of Los Angeles County residents have changed at least one of their polluting behaviors in the past year;
  - Approximately 50 percent of residents have been more active in neighborhood clean-up activities in response to messages they have seen/heard;
- Garnered media coverage surrounding the campaign that reached an approximate audience of 3.5 million with an advertising equivalency of more than $150,000. More than 70 percent of all Los Angeles County adults ages 25 to 54 and men 18 to 24 were reached through the campaign's multimedia advertising.
- Secured more than $550,000 in advertising added value elements (i.e., airing of public service announcements, web site placements, on-air promotions), extending the campaign's reach by another 33 million impressions.
- Reached more than 225,000 residents through participation in key community events.
- Distributed an initial 15,000 Neighborhood Action Kits countywide.

City of Fresno - "Don't Trash Fresno" (Caltrans 2003)

In 2002 and 2003, the California Department of Transportation 's (Caltrans) stormwater program conducted a Public Outreach Research Study (PERS) in the Fresno Metropolitan Area (FMA) to deliver anti-littering messages to a target audience consisting of single 18 to 24 year old men and women, and overall to people aged 25 to 34.

To track program performance, 830 residents (English and Spanish speakers) were interviewed prior to the education campaign and two years later. The main goal of the evaluation was to understand if the residents' knowledge and attitudes had been impacted by the education campaign. With English speakers, there was a statistically significant increase in two areas: the number of people who thought litter was bad; and the number of people who recognized that cigarette butts are the most commonly littered item. With Spanish speakers, there was only a statistically significant increase in the number of people who thought litter was a major problem. At the end of two years, there was no statistically significant increase in the number of people who could identify the fines associated with littering. There was also no increase in the number of people who were aware that litter can end up in the stormwater conveyance system.

The PERS initially included a monitoring component to evaluate the success of the campaign. However, the monitoring (or end of pipe measurement tool) was ended because litter loads were highly variable with more seasonal and site specific variability than anticipated. Research showed that a relatively long-term monitoring program would be necessary to detect even small changes in litter volumes.

Another means of evaluation was the collaboration success of the PERS program with sprots teams (Fresno Grizzlies and Falcons) and corporate sponsorships (McDonalds and car rental agencies). Program partners spread campaign messages and reduced program costs.

Following the success of the Don't Trash Fresno campaign, Caltrans launched the campaign statewide as the *Don't Trash California* campaign.

8.4. ANTI-LITTER CAMPAIGNS WITH THE SAN FRANCISCO BAY AREA

Contra Costa Clean Water Program – "Litter travels but it can stop with you" (CCCWP 2010)
In FY 2008-2009, Contra Costa Clean Water Program (CCCWP) launched a multi-media anti-litter campaign designed to educate Contra Costa County residents about the impacts of trash and litter in waterways and how they can help address the problem. This multi-media campaign included television, radio, billboard advertisements and website promotions.

The results of the May 2010 CCCWP post-campaign survey, when compared to the pre-campaign focus groups conducted in February 2009, showed that while overall awareness of the slogan "Litter travels but it can stop with you" increased, most other awareness levels and levels of concern were shown to have decreased from 2009 to 2010. For example, fewer respondents (77 percent) said that they think litter impacts/pollutes local water bodies than in 2009 (88 percent). In addition, almost the same number of people are very or somewhat concerned about litter polluting water as were in 2009, with a small number more who are not at all concerned than in 2009.

This decrease was unexpected and not consistent with increased traffic to the CCCWP website. In FY 2009-2010, the Program's website received a total of 18,504 unique visitors, 15,868 or 86 percent of which visited between October 5, 2009 and April 17, 2010, the dates when the campaign was running. Website traffic increased from the typical 10 to 15 visitors a day to as much as 150 a day, with a few days spiking to near 300 during the media launch period.

BASMAA – "Beautiful Watershed/Trash" (Astone 2007)
The Bay Area Stormwater Management Agencies Association (BASMAA) ran anti-littering television advertisements on litter during FY 2004-2005. The advertisements used trash/litter to make the connection between how pollutants flow through the stormwater conveyance system to reach local creeks or the Bay.

8.5. OTHER ANTI-LITTER CAMPAIGNS

- **Don't Be a Litterbug (www.litterbug.org)** - Anti-litter campaign developed by the Pennsylvania Resources Council, Inc. This campaign is known for its caricature of a litterbug with a fuzzy body and mischievous look. The caricature has been used by Keep America Beautiful, Inc. and the Pennsylvania Department of Environmental Protection in other anti-litter campaigns.
- **Bag Versus Bay (www.savesfbay.org)** - An online education campaign developed by Save the Bay to inform residents about litter caused by plastic grocery bags.
- **Watershed Watch Campaign (www.mywatershedwatch.org)** - Since 2002, the Santa Clara Valley Urban Runoff Pollution Prevention Program's Watershed Watch Campaign has included anti-litter advertisements as part of its overall outreach on stormwater issues. Advertisements have been placed on radio, television, print, transit (bus back posters) and online media.
- **Don't Trash Arizona (www.donttrashaz.org)** - In 2006, the Maricopa Association of Governments launched the Don't Trash Arizona campaign to address roadway litter. The goal is to increase awareness of the roadway litter condition in Arizona and begin to reduce the severity of the problem. The strategy is to focus on education, awareness and partner participation.
- **No MOre Trash (http://extra.mdc.mo.gov/nomoretrash)** - The Missouri Departments of Transportation (MoDOT) and Missouri Department of Conservation (MDC) launched the No MOre Trash campaign to educate 16-22 year olds across the state about litter prevention.

8.6. SUMMARY OF PERTINENT FINDINGS

- **Many government and non-government agencies are conducting anti-litter outreach campaigns –** Most agencies recognize that litter is an aesthetic and water quality issue; and are conducting outreach to raise awareness which encourages anti-littering behaviors.
- **Many anti-litter campaigns are focusing on specific audience groups -** A number of studies have indicated that the population group most likely to litter is males between the ages of 18-24 years. Many campaigns, such as *Erase the Waste, Litter and it Will Hurt*, and *Don't Trash California* have targeted this group. BASMAA's upcoming litter outreach campaign will also target this population.
- **Public opinion surveys can measure an increase in awareness following an anti-litter campaign** – Pre and post campaign surveys have been successfully used to measure the awareness of a particular anti-litter campaign or to track if residents are aware of a litter problem in the neighborhood. For example, the *Don't Mess with Texas* campaign's 2009 public opinion survey indicated that public awareness of the *Don't Mess with Texas* campaign remains high at 95 percent. In addition, more Texans than ever now know what *Don't Mess with Texas* means. Approximately 8 out of 10 (82 percent) Texans know the slogan means do not litter. In 2007, only 68 percent knew the meaning of the slogan.
- **Public opinion surveys can not measure or track behavior changes -** While public opinion surveys are a good way to evaluate many issues, very few people will admit to littering when asked directly. The results of questionnaires may indicate that messages are reaching large numbers of people, but the behavior of people does not always match their responses. For example, a 2007 BASMAA Public Opinion Survey asked respondents if they have often, sometimes or rarely littered, intentionally or unintentionally, in the past 90 days. Not surprisingly, 62 percent of respondents say that they rarely litter, 30 percent never do, 6 percent sometimes do and 3 percent do so often. A 2009 Study conducted by Keep America Beautiful, Inc. (KAB) found similar results. KAB conducted intercept interviews with 102 individuals and asked questions about attitudes, motivation and past littering behavior. Among the individuals they interviewed, 23 percent were recently observed to be littering. Of these observed litterers, 35 percent denied littering in the past month, despite the fact that they were just observed (KAB 2009).
- **Effectiveness can be evaluated using indirect measuring techniques –** Many public outreach campaigns use techniques such as increased website traffic, number of secured partners, gross impressions made by advertising, and free advertising support provided by partners and media companies to measure effectiveness. Some examples are provided below:
    - The *Erase the Waste* campaign secured more than $550,000 in advertising added value elements (i.e., airing of public service announcements, web site placements, on-air promotions), extending the campaign's reach by another 33 million impressions.
    - For the *Don't Trash Fresno* campaign, Caltrans partnered with McDonald's to distribute two-sided tray liners that educated adults and children about stormwater pollution. The McDonald's sponsorship enabled Caltrans to disseminate campaign messages at a fraction of the cost.
    - The Contra Costa Clean Water Program's website received 18,504 unique visitors in FY 2008-2009, 15,868 or 86 percent of which visited between October 5, 2009 and April 17, 2010,the dates when the campaign was running.

- The *UnLitter Us* campaign, launched in May 2010 by the Philadelphia Streets Department (http://www.philadelphiastreets.com), already has 2,412 followers on Facebook, a social networking site.

- **Long-term monitoring is needed to relate campaign success to actual litter reductions -** During the Caltrans pilot program in Fresno, an attempt was made to rigorously quantify if the education program was reducing the amount of litter in the stormwater conveyance system. Monitoring nets were placed at outfalls and in storm drain inlets at fourteen highway locations. Debris captured in the nets were regularly collected, dried and weighed. Data indicated that loadings to these sites actually increased over the study period. However, Caltrans found that factors including increases in traffic confounded the analysis. Furthermore, the statistical analysis showed that four to five years of post-program monitoring would be required to properly evaluate the program's performance (Caltrans 2003).

9. IMPROVED MUNICIPAL TRASH BIN/CONTAINER MANAGEMENT

Municipal trash bins are publically-owned containers used for the disposal of waste products. Potential management options for reducing trash in the environment include increasing the density, size and/or shape of bins, adding lids and frequent maintenance. Recent studies have shown mixed results regarding changes in bin management.

Municipal trash bins keep trash contained prior to collection thus reducing discharges to the stormwater conveyance system and receiving waters. The placement of trash bins, particularly in high traffic areas (major intersections, bus stops, commercial districts, and near convenience stores) helps contain trash since the public have additional disposal opportunities. In addition, changing bin design (i.e., adding covers) helps reduce the escapement of trash from bins. The use of trash bins is a relatively inexpensive litter control method, even though prices may vary depending on design and size. Prices can be as a high as $700 per bin (Trash Can Depot 2007). In the City of Los Angeles, the cost per bin was $67. Associated operation and maintenance cost were $750/bin/year (City of Los Angeles 2002).

9.1. CASE STUDIES ON THE NUMBER OF BINS AND LITTERING BEHAVIOR

9.1.1. Beverage Industry Environment Council

One of the most extensive reviews of littering behavior was conducted by the Beverage Industry Environment Council, Sydney, Australia (BIEC, 1997, cited in Taylor and Wong 2002). The BIEC conducted a literature review (12 studies) to determine if providing public trash bins had an effect on littering behavior. The results showed that simply increasing the number of bins did not necessarily result in less littering. Half the studies indicated that littering is reduced when bins are provided. Five studies found that providing bins had no impact. The final study found that providing bins with unusual designs resulted in decreased littering within the immediate environment.

The BIEC also initiated studies that used observational and survey methods to understand littering behavior. The studies found that a lack of bins was not a major factor in littering as most littering occurred on average within five meters of a bin (Taylor and Wong 2002). However, this distance can change depending on the location of the bin (Sustainability Victoria 2007). For example, people at public transport terminals and shops are more likely to place trash in bins when they are within 3.5 meters of bins. In contrast, people at beaches will walk up to 17 meters to properly dispose litter (Sustainability Victoria 2007). The BIEC study also found approximately half the survey respondents did not consider placing items next to an overflowing bin to be littering. Since people are more likely to litter when litter is already present, the presence of additional bins that are full may actually create additional littering (Taylor and Wong 2002).

In 1997-1998, BIEC conducted a research study in Sydney, Australia to further evaluate what effect additional bins had on littering (BIEC, 1999). The study used a combination of litter surveys, bin audits, structured observations and attitude surveys. The study, which generated mixed results, found an associated increase in the percent of items placed in bins; and a slight decrease in the percent of items littered (28 percent to 24 percent) when recycling facilities/bins were installed in public places. However, the study ultimately found that the performance of any new bin depends on placement and design; and the nature of the site in which the bin is placed (BIEC 1999).

9.1.2. City of Los Angeles

The City of Los Angeles determined that there was a net benefit to the stormwater conveyance system when the number of trash bins was increased. The City conducted a pilot study to assess the performance of placing additional trash bins on streets. The difference in the amount of trash captured in storm drain inlet inserts before and after the placement of additional bins (one per block) was monitored. Trash bins were emptied weekly. Results indicated that additional trash bins can be highly beneficial if located in strategic areas. Additional trash bins performed best when placed in areas of mixed commercial and residential land use (City of Los Angeles 2004 cited in Gordon and Zamist 2007). To significantly reduce littering rates, trash bins have to be part of the overall trash management strategy.

9.2. BUSINESS IMPROVEMENT DISTRICTS

Establishing Business Improvement Districts [13](BIDs) is one way of improving how public trash bins are managed. For example, BIDs in the City of Los Angeles have reduced the amount of illicit trash along selected commercial strips. Most BIDs in the City of Los Angeles incorporate sidewalk sweeping, litter pickup and trash bin maintenance. The motivation for establishing BIDs is that commercial strips become more attractive to customers when the amount of visible trash is reduced (City of Los Angeles 2002). Several cities within the Bay area have BIDs (e.g., three in San José; two in Berkeley and one each in San Francisco, Oakland, Palo Alto and Sunnyvale.

9.3. NEW TECHNOLOGIES TO REDUCE BINS

New technologies have been developed to reduce the cost of adding trash bins. Big Belly Solar, Inc. has developed a solar-powered trash compactor designed specifically for municipal and public use. A 32-gallon Big Belly Solar Compactor can hold 150 to 200 pounds of trash and runs on a battery, which is charged by a solar panel. The battery reserve lasts for a couple weeks without any sunlight. Due to compaction, recyclable items (e.g., cans and bottles) will not be casually recycled. While the Big Belly Solar Compactor costs more than a regular trash can (a unit costs between $3,600 and $3,900; Redorbit 2007), it reduces collection events which saves money for municipal operations.

The City of Philadelphia installed 500 Big Belly Solar Compactors and 210 matching single-stream recycling containers replacing 710 wire mesh litter baskets. This installation increased capacity by approximately five times compared to the City's wire mesh litter baskets. As a result, the City of Philadelphia was able to reduce its collection frequency from seventeen times per week to five times per week; reduce staffing from 33 to 9 people, operating on a single-shift rather than three (Big Belly Solar 2009). The annual cost of collection with the Big Belly Solar Compactor is estimated to be 70 percent less than using wire mesh litter basket (Big Belly Solar 2009).

Big Belly Solar Compactors have been installed in several other cities across North America, including Oakland, CA; Boston, MA; Portland, OR; Tempe, AZ and Banff, Alberta.

[13] BIDs are districts or areas in central cities in which the private sector delivers services for revitalization beyond what the local government can reasonably be expected to provide. The property or business owner within the BID pays a special tax or assessment to cover the cost of services. Cities provide some oversight but the BID controls its finances.

9.4. SUMMARY OF PERTINENT FINDINGS

- The performance of municipal trash bins depends on placement and design; and the nature of the site in which the bin is placed (BIEC 1999).
- Full bins may actually create additional littering (Taylor and Wong 2002).
- Additional trash bins can be highly beneficial if located in strategic areas.
- Trash bin lids help reduce trash dispersion.
- Less trash has been observed in storm drain inlet inserts in areas where additional bins were added (City of Los Angeles 2004 cited in Gordon and Zamist 2007).
- Business Improvement Districts (BIDs) provide additional maintenance of municipal trash bins.
- BIDs are reducing the amount of visible trash in commercial strips.
- New technologies (e.g., Big Belly Solar Compactors) have been developed to reduce the cost of adding trash bins.

10. ADDITIONAL FEES AT LANDFILLS FOR UNSECURED LOADS

One of the main trash sources categories to urban creeks is vehicles; specifically, vehicles who do not secure or cover their loads when transporting litter and debris. Land areas that generate trash from vehicles include roads, highways (on/off ramps, shoulders or median strips) and parking lots. This trash source is chronic in nature and may be a large contributor of trash observed on the urban landscape. To help address the dispersion of trash from unsecured or uncovered vehicles destined for landfills, many municipalities have enacted new regulations that impose additional fees when trucks arrive with unsecured or uncovered loads. Additional fees have also been instituted to prevent accidents caused by litter and debris falling out of trucks with unsecured loads.

10.1. IMPLEMENTATION IN SAN FRANCISCO BAY AREA

City of Palo Alto

The City of Palo Alto passed a new regulation and additional fee to address the amount of windblown litter and debris observed on public roadways leading to the City-owned landfill. This fee was in addition to established disposal fees. On July 1, 2009, all vehicles with open loads entering the landfill without a tarp were charged an additional $20. In addition, each customer was given a City of Palo Alto Debris Hauling Requirements handout written in both English and Spanish. The handouts were accompanied with a tarp. Signs were also placed at the toll booth informing customers of the new regulation and additional fee. From July to December 2009, 199 tarps were distributed (City of Palo Alto 2009). Landfill employees promote that the tarp be used on all future visits to the landfill. Since the implementation of this new regulation and additional fee, City staff has observed less trash and debris on public roadways leading to the landfill (City of Palo Alto 2009). There have been no reported customer complaints to the City of Palo Alto regarding the new regulation and fee.

10.2. IMPLEMENTATION IN OTHER MUNICIPALITIES

The additional fee instituted by a municipality for an unsecured or uncovered load varies between jurisdictions. Table 10-1 provides examples of municipalities who charge additional fees for uncovered loads.

Table 10-1. Examples of municipalities who charge additional fees for uncovered loads.

Municipality	Additional Fee
Los Angles County Sanitation District	$4.40/ton surcharge; $4.40 minimum
Monterey Regional Waste Management District	Double the disposal fee
San Bernardino County, CA	Double the disposal fee
Lake County, CA	
--Trucks (≥ 25,000 pounds)	$100.00
--Trucks (≤ 25,000 pounds)	$10.00
Butte County, CA	$8.11
Mecklenburg County, NC	50 % of normal tipping fee
New South Wales, Australia	$500.00
Fredrick County, MD	$100.00
Clinton County, IA	$25.00
Tompkins County, NY	
--First Offense	$10.00
--Second Offense	$20.00
--Subsequent Offenses	$40.00
Kitsap County, WA	$10.00
Walla Walla, WA	$70.00

10.3. VISIBLE LITTER STUDY- KEEP AMERICA BEAUTIFUL, INC.

In 2009, Keep America Beautiful, Inc (KAB) sponsored a visible litter study which focused on trash composition in streets and roads within the United States. One part of the study examined litter generation in proximity to solid waste and recycling facilities. Study results indicated that there is a strong negative correlation between trash generation (number of pieces per mile) and distance from these facilities (i.e. more trash closer to the facility); and that an increase in the number of nearby solid waste or recycling facilities also correlates to more litter generation (MSW 2009). In addition, the results also suggest that uncovered waste and recycling vehicles are contributing to local litter rates. This is consistent with qualitative littering field observations made in prior litter surveys (MSW 2009).

10.4. SUMMARY OF PERTINENT FINDINGS

- Additional fees for unsecured loads at landfills have been effective at reducing road and highway litter within many jurisdictions.
- Additional fees have also been instituted to prevent accidents caused by litter and debris falling out of trucks with unsecured loads.
- Additional fees may be used to defray the added costs of litter abatement and removal with a jurisdiction.
- Additional fees are typically not punitive and vary significantly between jurisdictions.
- A visible litter study sponsored by KAB indicated that uncovered loads are contributing to local litter rates (MSW 2009).

11. ANTI-LITTERING AND ILLEGAL DUMPING ENFORCEMENT ACTIVITIES

Successful anti-littering and illegal dumping enforcement activities include laws or ordinances that make littering or dumping of trash illegal. Laws are enforced by various municipal agency staff (e.g., police, sheriff and public works department staff) who issue citations in response to citizen complaints or other enforcement methods (e.g., surveillance cameras and /or signage installed at illegal dumping hot spots). In some California jurisdictions, the minimum fine for littering is $500 and the maximum penalty for highway littering is $1000 (City of San Francisco 2001). However, it is difficult to enforce small littering events unless they are witnessed or solid proof exists linking the offender to the litter. As a result, enforcement tends to focus on larger scale illegal dumping activities.

11.1. ENFORCEMENT ACTIVITIES

City of Oakland

The City of Oakland enforces illegal dumping and blight laws on public property. Depending on implementation/strictness, litter enforcement programs may result in large numbers of citations. For example, the City of Oakland cited 1,784 people for littering or illegal dumping between January 2002 and July 2006. By November 2006, the number of citations issued increased to 2,250 (Lewis, R. 2007). However, the issuing of citations does not necessarily lead to penalties. One in five citations issued by the City of Oakland was dismissed. The combination of dismissals, reduced fines and offenders who either cannot pay or cannot be located has resulted in only $250,000 of a possible $2.1 million in fines being collected from the 1,784 citations. Each year, the City of Oakland Public Works Agency collects over 3,900 tons of illegally dumped appliances, furniture, tires and household trash (City of Oakland 2007).

City of San Francisco Department of Public Works

With the hope of improving its enforcement program, the San Francisco Department of Public Works (DPW) increased the publicity of its litter hotline (415-28-CLEAN). This hotline receives approximately 4,500 complaints per month (City of San Francisco 2001). Every day, DPW staff is dispatched to resolve and clean sites identified by resident's complaints; and patrol illegal dumping locations. DPW staff spends approximately 30 to 60 minutes per site collecting evidence from illegally dumped piles in an attempt to identify offenders. DPW also increased the number of Environmental Control Officers (ECOs) who issue littering fines from 14 to 22, which results in two enforcement officers for each supervisory district. DPW recognized that the processing of littering and illegal dumping citations was slow since they were heard as misdemeanor citations in the regular court system. Since the severity of this infraction is low compared to other cases, it receives low priority in the justice system. In 2000, the City of San Francisco set up the California Community Dispute Services (CCDS) to adjucate the infractions issued by the ECOs and others for litter and illegal dumping. Between January 2000 and February 28, 2001, a total of 2985 citations were referred to the CCDS. Violators elected to appear in 1748 cases at the CCDS or at one of the Community Courts (City of San Francisco 2001). Littering citations range from $80 to $1,000.

During 2003, DPW instituted a program to curb illegal dumping at a portion of chronic illegal dump sites identified by DPW (City of San Francisco 2003). During the program, DPW staff extensively monitored these sites and removed illegally dumped material (over 2,500 person-hours were spent monitoring sites and 1,900 person-hours were spent removing trash). These activities resulted in 488 investigations, which involved educational contacts, warnings and citations. Over 900 letters, which

provided instructions on how to resolve the investigation, were sent to property owners. DPW received over 250 responses from property owners interested in resolving outstanding issues. It is estimated that costs associated with targeting these chronic illegal dumping sites was $1,355,230 (City of San Francisco 2003).

In 2005, the City of San Francisco announced it would train 400 City employees from 43 different classifications and give them the authority to issue litter citations. The new citation officers focus their administrative citations on individuals who actually litter, levying fines intended to lead to behavior change (City of San Francisco 2005).

Washington State Department of Ecology

Toll-free litter hotlines are a key tool in the enforcement of litter laws. In 2002, Washington State Department of Ecology (WSDE) initiated a litter hotline. Hotline calls increased from 6,060 in 2002 to 13,877 in 2006. Citizens who witness littering can report the license plate number when calling the hotline. The Washington State Patrol sends the vehicle owner a notification stating that they were observed littering. An associated fine schedule is attached to the letter. In 2005, WSDE included a survey questionnaire in the letters. A large majority of survey respondents (92 percent) admitted to be cognizant of littering fines. An equal proportion of respondents stated that they would unlikely litter again after being caught (Warfield 2006).

State of Florida (Florida Center for Hazardous Waste Management 1998)

The Florida Center for Hazardous Waste Management conducted a litter study in Florida from 1994 through 1997. One part of the study examined the level of enforcement of the Florida litter law. It was determined that the costs associated with litter enforcement are primarily associated with staffing, establishing and maintaining hotlines, and creating outreach materials. Municipalities should not expect that money collected from fines will recoup the costs of implementing enforcement programs. For example, Florida counties incurred $1,476,960 in costs but only received $128,309 in collected fines (FCSHWM 1998).

11.2. SURVEILLANCE CAMERAS AT ILLEGAL DUMP SITES

The use of surveillance cameras to deter and prosecute illegal dumping at chronic sites has become increasingly common throughout the world. Examples of municipalities who have installed surveillance cameras and known results are provided below:

Sonoma County, California (Road Warrior 2010)

With a grant received from the California Integrated Waste Management Board, Sonoma County installed ten (10) solar-powered, motion-detector cameras at various roadside locations to monitor illegal dumping. The cameras have a 100-foot range and are mounted in boxes high in trees. There are 58 sites in Sonoma County with signs warning that the area is under surveillance; the 10 cameras mounted at these sites. As of December 2010, four people have been convicted of illegal dumping. Since posting signs and/or installing cameras, illegal dumping has decreased at the 58 sites.

San Antonio, Texas (Davila 2010)

In 2010, the City of San Antonio installed motion-sensor cameras on poles 30 to 40 feet high in undeveloped urban areas. The cameras have a 100-yard range, can focus on license plates, and have a voice feature that informs offenders that their activity is illegal and that they are being photographed. Once a car or person is detected, the camera takes several images and the voice message starts to play.

Prior to installing motion-sensor cameras, “No Dumping” signs were used to deter dumping. However, signage proved ineffective since it did not deter dumping.

Sequim, Washington (Gawley 2009)

Within four months of installing cameras adjacent to Johnson Creek, an illegal dump site in Sequim, WA, authorities caught seven people driving into the area with full trailers or trucks and leaving the area with empty trailers or trucks. Using their license plate information, the offenders were contacted, fined and required to properly dispose all illegal dumped items.

Springfield, MA (MassDEP 2010*)*

In 2005, the Massachusetts Department of Environmental Protection began a “Candid Camera” program, which partners with municipalities to monitor illegal dump sites in the state. In conjunction with local police and the parks department, the program installed two cameras at a wooded area in Springfield, MA. The battery-operated cameras are capable of taking tens of thousands of high resolution pictures over the course of several weeks; and have infrared night vision to capture nocturnal dumping. One camera is specifically designed to read license plates at night. Between March and October 2010, a total of 14 illegal dumping instances have been photographed in Springfield resulting in citations.

South Australia (Castello 2010)

Near Adelaide, Australia, the City of Mallala has six mobile motion-sensitive Closed Circuit Television (CCTV) cameras placed in vegetation to deter illegal dumping. The cameras were installed with road signs warning people that they are under video surveillance. Since camera installation, there has been a 40 percent reduction in illegal dumping in some hot spots even though cameras are not actually recording anyone. Several other cities in the Adelaide area have purchased or are considering similar cameras.

Ireland

In Ireland, illegal dumping of household garbage has become a serious problem at “bring banks”, recycling centers with bins for recyclable items only. To prevent illegal dumping, CCTVs have been installed to monitor bring banks. In Kerry County, the cameras have proved to be a deterrent (Hickey 2010), however, according to the Dublin City Council, only one in ten instances of illegal dumping have been captured due to cameras being focused only on a single small area. In addition, the only successful way to identify offenders has been through the car’s license plate number observed through CCTV surveillance (Murphy 2008).

Kuala Lumpur, Malaysia (The Star Online 2009)

Residential complexes in Kuala Lumpur have been overflowing with commercial and industrial trash illegally dumped by local businesses who did not want to pay for trash disposal. Similarly, trash has been disposed of in storm drains. To deter illegal dumping, the National Solid Waste Management Department of Malaysia and Alam Flora, a private company contracted to manage solid waste, have jointly installed CCTVs at several locations in Kuala Lumpur.

11.3. SUMMARY OF PERTINENT FINDINGS

Although enforcement is widely cited as a measure used to help combat litter and illegal dumping, there is little information on its performance as a control measure. While it is possible to determine the number of citations issued, there is very little information indicating if citations change behavior or result in less trash accumulating in waterways. Littering or dumping is very difficult to enforce unless witnessed. As a result, public outreach and education is a key component of any successful enforcement program.

The use of signage and surveillance cameras to monitor dumping sites has been effective at deterring illegal dumping. Identifying offenders by license plates is much easier than facial recognition.

12. FREE TRASH PICKUP/DROP OFF DAYS (E.G., BULKY DAYS)

Some municipalities offer their residents the opportunity to recycle or dispose items that are too large to fit into trash bins, trash bags or recycling containers. These events, which are known as free trash pickup/drop off or "bulky" days are usually offered by request or occur once or twice a year. Unwanted items recycled or disposed of include mattresses, couches, appliances, yard waste, furniture, carpet, cardboard, tires, electronic waste, construction and demolition debris, etc. Unwanted items are collected from the curbside by the municipality or delivered by the resident to a designated site. Free trash pickup/ drop off days are offered to reduce the amount of large items improperly disposed of. However, not all municipalities offer free trash pickup/ drop off days due to the expense of administering events and disposing large items.

12.1. EXAMPLES WITHIN CALIFORNIA

City of Santa Clara

The City of Santa Clara conducts an annual clean-up campaign over a four-week period each year. The annual clean-up campaign, which started in 1960, picks-up all bulky items including construction and demolition debris, yard waste, etc. It is free of charge and intended for City of Santa Clara residents only. Unwanted items are collected from the curbside. The City of Santa Clara has divided the City into four collection areas. Each area is assigned a different collection week. During FY 2009-2010, the annual clean-Up campaign tonnage declined to approximately 6,200 tons, off from historical averages of 8,500-9,000 tons per year (Staub, D. pers. comm. 2010)[14]. In addition, there was a drop in construction and demolition debris, large furniture and appliances. The amount of yard waste is approximately 600-700 tons per year (Staub, D. pers. comm. 2010).

The City of Santa Clara also has two free resident-only dump days at the Mission Trail Transfer Station. These events typically draw 150-200 residents per event and generate approximately seven to ten tons per event (Staub, D. pers. comm. 2010). Attendance at these events has declined by about 50 percent in recent years due to a reduced level of publicity.

City of Oakland

The City of Oakland picks-up large or bulky household items (i.e., mattresses, couches, appliances, yard waste, furniture, carpet, cardboard, tires, etc.) from residents free of charge. Unwanted items are collected from the curbside on regular trash collection day. Residents are required to schedule an appointment for pick-up. However, residents of apartments and condos are required to contact their property owners/managers to arrange pick-up. The City of Oakland limits the number of pick-ups each year. Residents of one to four unit residences are allowed a maximum of two pickups each year, limited to the first 500 requests. The City of Oakland offers 1,100 bulky pickups for five to nine multi-family residences on a first-come, first-served basis (City of Oakland 2011). There is a three cubic yard limit for non-recyclable items.

City of San José

The City of San José picks-up bulky household items (e.g., mattresses, sofas, refrigerators or tires) from residents for a small fee. Unwanted items are collected from the curbside. Residents are required to schedule an appointment for pick-up. However, residents of apartments and condos are requested to contact their property owners/managers to arrange pick-up. The City of San José has determined that a

[14] Dave Staub. Superintendent of Solid Waste & Storm Drains, City of Santa Clara. August 2010.

yearly cleanup program for all residents is too expensive and that a low-cost collection program is more practical (City of San José 2010).

City of Milpitas

The City of Milpitas offers a household dump day for residents the second and fourth Saturdays of each month. Unwanted items must be delivered to a designated site. Residents must provide documentation (e.g., municipal services bill) showing that they reside in Milpitas or items will not be accepted. In addition, a total of four cubic yards (one ton maximum) may be disposed of at one time unless two valid municipal services bills are presented (City of Milpitas 2010). Residents are required to pay additional charges for the following items: monitors, televisions, tires, Freon-containing items, auto batteries and mattresses.

City of Los Angeles

The City of Los Angeles, Department of Public Works Bureau of Sanitation picks-up large or bulky household items (i.e., mattresses, couches and other furniture, etc.) from all residents serviced by the City of Los Angeles free of charge. Unwanted items are collected from the curbside on regular trash collection day. Arrangements for pickup must be made at least one day before regular trash collection day. An itemized list must also be provided when making the request. Items that are not collected include automotive parts, construction materials, commercial materials and cardboard (City of Los Angeles 2010).

12.2. SUMMARY OF PERTINENT FINDINGS

- Free trash pickup/drop off days are an effective way to reduce the amount of large or "bulky" items improperly disposed by residents.
- In most cases, the number of trash pickup/drop off days offered by municipalities during the year is limited due to administrative, recycling and disposal costs. However, the City of Los Angeles offers this service throughout the year (City of Los Angeles 2010).
- Most municipalities offer trash pickup/drop off days only on a request basis.
- Most municipalities do not quantify the amount of large items collected during free trash pickup/ drop off days.
- Trash pickup/drop off days are not widely publicized to the general public.
- Some municipalities charge additional fees for certain environmentally sensitive items disposed of at free trash pickup/ drop off day events.

13. SOLID WASTE RECYCLING AND DIVERSION PROGRAMS

Solid waste recycling and diversion programs involve a range of initiatives aimed at reducing waste generation and disposal. Initiatives involve local governments setting formal waste diversion goals with associated programs for increasing the level of municipal, residential and commercial recycling. Waste diversion programs have been quite successful at decreasing the total amount of waste disposed. Programs are cost-effective and can offer a net economic benefit to municipalities.

Source controls may be implemented by passing legislation with specific goals to reduce or divert waste from landfills through recycling programs; or by prohibiting wastes that are commonly disposed and are not environmentally friendly. Solid waste recycling and diversion programs have targeted a wide variety of waste streams over the last twenty years and include the following examples:

13.1. MAJOR CALIFORNIA RECYCLING LAWS

Several major recycling laws are driving solid waste recycling and diversion programs within California. They are discussed below; however, other recycling legislation does exist.

AB 939 – Integrated Waste Management Act (RecycleWorks 2011)

In 1989, Assembly Bill (AB) 939 was passed due to an increase in waste generation and a decrease in landfill capacity. AB 939, also known as the Integrated Waste Management Act created the California Integrated Waste Management Board (CIWMB). AB 939 required municipalities to meet diversion goals of 25 percent by 1995 and 50 percent by 2000. It also established a disposal reporting system with CIWMB oversight; and established an integrated framework for program implementation, solid waste planning, and solid waste facility and landfill compliance. Since 1989, Bay area municipalities have implemented a variety of programs to address waste generation. Programs implemented under AB 939 include curbside recycling, yard waste collection, commercial recycling, household hazardous waste collection, construction and demolition recycling and green building requirements.

It has been difficult for many municipalities to calculate their baseline from early base year studies. As a result, past diversion rates may not have reflected the correct diversion status of some municipalities. To get accurate diversion rates, municipalities have had to correct data and/or conduct new diversion studies. Municipalities have acted in good faith to meet required diversion rates. To address how the diversion rates were calculated, Senate Bill (SB) 1016 was passed in February 2007. It included a new per capita disposal and goal measurement system which moved the emphasis from an estimated diversion measurement number to using an actual disposal measurement number. SB 1016 also required an evaluation of program implementation efforts.

AB 2020 - California Beverage Container Recycling and Litter Reduction Act

The California Beverage Container Recycling and Litter Reduction Act (AB 2020) was enacted in 1987 to promote the returns of bottles and cans through the payment of a redemption value. Consumers pay a refund value when they purchase beverages from a retailer, which is refunded when they redeem the containers at a recycling center. In January 2007, the cash refund consumers received when returning California Redemption Value (CRV) bottles and cans to recycling centers increased (DOC 2007a). Legislation raised the refund received from California recycling centers to a nickel for containers less than 24 ounces and a dime for containers 24 ounces and larger.

The Act sets processing fees, which are paid to recyclers to cover their recycling costs. To facilitate the program, a network of 5,400 recycling centers was established (DOC 2007b). By law, unredeemed funds

are directed towards supporting the Community Conservation Corps and grants and payments to private and public organizations for recycling-related projects. In addition, funds help container manufacturers reduce costs and save jobs, and have helped communities finance curbside recycling programs (DOC 2007b).

The California Universal Waste Law (RecycleWorks 2011)

The California Universal Waste Law went into effect in February 2006. Universal wastes include batteries, fluorescent tubes and certain electronic devices that contain mercury, lead, cadmium, copper and other substances. Universal wastes are considered hazardous and may not be disposed in solid waste landfills. To encourage recycling and recovery of metals, universal wastes are recyclable and can be managed under less stringent requirements from other hazardous wastes.

13.2. PROGRAMS WITHIN THE SAN FRANCISCO BAY AREA

Alameda County - Recycled Content Procurement and Source Education Policy Waste Reduction and Recycling Act (Measure D) (Brown, Vence & Associates 2002)

In November 1990, voters in Alameda County approved Measure D. This established the Alameda County Source Reduction and Recycling Board. Measure D describes countywide goals for the reduction and diversion of non-hazardous solid waste from landfills; created a framework for comprehensive source reduction and recycling programs; imposed a surcharge (which increased to $6.59 per ton effective January 1, 2002) on waste landfilled in the unincorporated county; and established an Alameda County Source Reduction and Recycling Board (Recycling Board) to oversee the distribution of funds and implementation of countywide programs. Measure D also required the Recycling Board to establish recycling programs which meet and/or exceed recycling policy goals set forth in the initiative and those mandated by State law.

Santa Clara Valley Water District - Clean Safe Creeks and Natural Flood Protection Program (Measure B) (SCVWD 2007)

The Santa Clara Valley Water District (SCVWD) has increased trash awareness, abatement and outreach through the implementation of Measure B (a special parcel tax which includes the Clean, Safe Creeks and Natural Flood Protection) and its “Adopt-a Creek” program. Measure B provides resources that allow the SCVWD to conduct four major cleanup events a year (or 60 over 15 years) within three different watersheds and maintain response times of less than five days to remove litter and graffiti. The “Adopt-a-Creek” program encourages community groups to care for a designated section of creek. Groups remove trash at least two times a year at creek locations not included in the major creek cleanups.

Alameda County (www.StopWaste.Org)

StopWaste.Org consists of the Alameda County Waste Management Authority and the Alameda County Source Reduction and Recycling Board. These organizations operate as one public agency to implement programs that achieve waste reduction and diversion goals.

City of Oakland - Waste Reduction Resolution (No. #77500 C.M.S., 2002)

In alliance with the Alameda countywide waste reduction goal of 75 percent, the City of Oakland established a 75 percent waste reduction goal (by 2010) for wastes going to landfills.

City of Oakland - Zero Waste Resolution (No. #79774 C.M.S., 2006)

The City of Oakland adopted a zero waste goal by 2020. This resolution directs the Public Works Agency, in concert with the Mayor's Office, to develop a zero waste strategic plan to achieve the City's goal.

13.3. SUMMARY OF PERTINENT FINDINGS

13.3.1. General Findings for Solid Waste Recycling and Diversion Programs

Through the implementation of cost-effective recycling programs, several municipalities across the United States have been successful at diverting wastes sent to landfills (USEPA 1999). USEPA profiled eighteen communities that achieved high diversion rates and found that they achieved waste reduction levels of 40 to 65 percent (USEPA 1999). One of the communities profiled was the City of San José. In 1993, San José implemented its Recycle Plus Program. Prior to the program, residents disposed of unlimited amounts of trash (for a flat monthly fee) and recycled only five material categories. The new program increased the number of recyclable material categories; offered multi-family dwellings with recycling and yard debris collection services; and paid recycling contractors per household and per ton recycled. The net result of the program showed that from 1992 to 1996, single-family household participation increased from 66 percent to 83 percent; and single-family waste reduction level increased from 33 percent to 55 percent. In FY 1997-1998, the City of San José diverted 45 percent of its residential waste and 42 percent of its commercial waste to recycling or composting. Overall diversion was 43 percent (34 percent was recycled and 9 percent was composted) (USEPA 1999).

Other recycling initiatives within the Bay Area have shown equal levels of success at diverting waste from landfills. For example, through its Zero Waste campaign, the City of Oakland has increased its diversion rate from 10 percent in 1990 to approximately 60 percent in 2005. In addition, the City of San José achieved a 44 percent diversion rate in 2005 (CIWB 2006).

Maintaining a convenient recycling program is necessary to achieving high participation and high waste reduction. For example, in Worcester, MA residential recovery increased from 41 percent to 52 percent when collection switched from biweekly to weekly (USEPA 1999). Other ways to increase the perceived ease of programs is to allow residents to commingle their recyclables. Research indicates that higher rates of recycling participation (90 percent vs. 77 percent) and additional recyclables are recovered (32.1 gallons vs. 5.5 gallons per household per week) are achieved when commingling is permitted (Oskamp et al 1996). Other factors which increase performance include supporting markets for recycled materials (USEPA 1999). This includes identifying and securing agreements with materials brokers and end users. Recycling collection programs can only be as successful as the recycling marketing program. Consequently, market analysis must be included in the planning stages and be maintained throughout the program (USEPA 1999). For programs to be ultimately successful, recycling or waste diversion must be considered an integral part of a municipalities' overall waste management strategy.

In addition to reducing waste management costs, it is estimated that recycling can also contribute to local economies through job creation and other benefits. The California Integrated Waste Management Board estimates that meeting the AB 939 requirement of a 50 percent recycling goal will add $2 billion to California's economy and create over 45,000 new jobs. In 1992, the City of San José projected that developing the industrial capacity to absorb its recovered materials would support 40 facilities and 775 manufacturing jobs. The City of San José estimated $109 million in value added, $9.4 million in avoided landfill costs and $88.4 million in production cost savings (CAW 2007).

13.3.2. AB 2020 - California Beverage Container Recycling and Litter Reduction Act

Another example of a highly successful program for diverting waste from landfills is AB2020, California's Beverage Container Bill. Since the Bill was enacted in 1987, the recycling rate for beverage containers

has more than doubled (California Resource Recovery Association 2007). When beverage containers are not returned to retail outlet recycling centers, but placed in a curbside recycling bins, the deposit value is kept by the curbside recycling program. Curbside programs receive $23 million in retained redemption values and $9 million in processing fees, administrative fees and grants each year (California Resource Recovery Association 2007). Seven million California grocery-store based convenience recycling centers recycle the containers of seven million Californians. In fact, consumers are choosing to recycle 23 percent of all beverage containers at grocery-store convenience recycling centers (by comparison, curbside recycling programs collect only 7 percent of beverage containers). A UC Berkeley study (Berck and Goldman 2003) found that the best way to increase participation in the beverage container redemption program was to increase the redemption value. In January 2007, redemption values were increased.

14. LITTER FEES ON BUSINESSES

A very limited number of states and cities within the United States have instituted litter fees or taxes to pay for public education and outreach; litter abatement and removal; and recycling programs. Litter fees or taxes are directly paid to the state or local taxing agency on annual basis. In most cases, fees or taxes are based on the gross proceeds from the manufacture, wholesale, distribution or retail of certain products which are disposable in nature or typically seen as litter on streets and highways. In other cases, a flat litter tax is imposed to all regulated businesses regardless of their total revenue.

14.1. EXAMPLES WITHIN THE SAN FRANCISCO BAY AREA

Oakland Excess Litter Fee Program Ordinance 12727

On February 21, 2006, the City of Oakland adopted Ordinance 12727, enacting an Excess Litter Fee on fast food businesses, convenience stores, gasoline station markets and liquor stores. This ordinance is intended to maintain litter-free streets, sidewalks and public spaces by assessing a fee on businesses known to generate high amounts of disposable products that result as litter. The fee will be used to support the collection and disposal of trash; and to help keep trash and litter from entering the City's stormwater conveyance system (City of Oakland 2007).

Every eligible business is required to file an excess litter fee declaration and pay an annual fee before September 30 of each year. To file, businesses must submit their gross receipts, except receipts for the sale of alcohol, gasoline, automotive services and automotive products. Eligible businesses that pay into a Business Improvement District (BID) are required to pay 50 percent of the litter fee. The annual excess litter fee is based on the gross receipts (Table 1) (City of Oakland 2007). Businesses with annual gross receipts less than $4,999 are exempt from the litter fee.

Table 14-1. Excess litter fees for businesses - City of Oakland.

Business Type	Annual Gross Receipts	Litter Fee
Large Business	≥ $1,000,000	$3,815
Medium Business	$500,000 to $999,999	$910
Small Business	$5,000 to $499,999	$230

Over 75 percent of businesses in the City of Oakland will pay $230 a year. During FY 2008-2009, approximately $400,000 was collected to support Oakland's Excess Litter Fee Program (Chan, A. *pers. comm*. 2010). Monies collected fund new litter abatement programs rather than established programs.

14.2. EXAMPLES WITHIN THE UNITED STATES

Nebraska Litter Fee (Nebraska DOR 2009)

The State of Nebraska imposes an annual litter fee on businesses who manufacture, wholesale, distributes or retails any of the following products:

- food for human or pet consumption;
- food or food products in large quantities that are packaged or sub-packages in containers suitable for sale;
- cigarettes and tobacco products;
- soft drinks and carbonated waters;
- beer and other malt beverages;
- wine;
- paper products and household paper;

- glass containers ;
- metal containers;
- plastic or fiber containers made of synthetic material;
- cleaning agents and toiletries;
- non-drug drugstore sundry products; and
- kitchen supplies

Businesses which have annual gross proceeds of $100,000 or more from sales in Nebraska are subject to the litter fee and are required to obtain a litter fee license. The litter fee is calculated on the total gross proceeds from the sale of products from a twelve-month period; and is imposed at the rate of $175 per $1,000,000 of gross proceeds. The purpose of the litter fee is to fund litter reduction and recycling grants within the State of Nebraska. Funds are awarded within three grant categories: public education, cleanup, and recycling.

Virginia Litter Tax

An annual litter tax is imposed on any business within the Commonwealth of Virginia who manufactures, wholesales, distributes or retails any of the following products:

- food for human or pet consumption;
- groceries;
- cigarettes and tobacco products;
- soft drinks and carbonated waters;
- beer and other malt beverages ;
- wine;
- newspapers and magazines;
- motor vehicle parts;
- paper products and household paper;
- glass containers;
- metal containers;
- plastic or fiber containers made of synthetic material;
- cleaning agents and toiletries;
- non-drug drugstore sundry products; and
- distilled spirits

The purpose of the annual litter tax is to fund non-competitive litter prevention and recycling grants (based on population and road miles) for each locality within the Commonwealth of Virginia (Virginia DOT 2011). The grants have been awarded annually since 1980 for program implementation, continuation and/or expansion. The annual litter fee is $10.00 per year for each location of manufacturers, wholesalers, distributors or retailers of consumer products. An additional $15.00 per year per location is collected where groceries, soft drinks and beer are sold. In FY 2009-2010, the litter tax generated $975,621 (Virginia DEQ 2011).

14.3. SUMMARY OF PERTINENT FINDINGS

- Litter fees or taxes are enacted to defray the added costs of litter abatement and removal with a jurisdiction.
- Litter fees or taxes are strictly imposed on businesses who manufacture, wholesale, distribute or retail products which are disposable in nature or typically seen as litter rather than on individual consumers.

- In most cases, litter fees or taxes pay for public education and outreach, litter abatement and recycling programs typically not funded from other revenue sources.
- Litter fees or taxes may be enacted to encourage businesses to stop manufacturing, wholesaling, distributing and retailing products which are currently taxed.
- Litter fees or taxes are usually not popular with businesses.

15. STORM DRAIN SIGNAGE/INLET MARKING

Storm drain signage/marking consists of labeling storm drains with simple, clear messages (e.g., "Drains to Bay" or "Only Rain Down the Drain") reminding citizens not to dispose of or wash unwanted materials into the stormwater conveyance system. Storm drains may be labeled by municipal staff or volunteers. However, there are only a few studies that evaluate the performance and/or effectiveness of signage/marking in increasing awareness, changing behaviors or reducing the amount of trash from entering the stormwater conveyance system.

15.1. STORM DRAIN SIGNAGE/MARKING PRACTICES

Municipalities can initiate storm drain marking projects throughout the community, particularly in high trash or other pollutant generating areas. To reduce costs, municipalities should prioritize which drains to mark first. Drains should be carefully selected to reach the maximum number of citizens; and include drains which lead to water bodies where illegal dumping has been identified as a pollution source (USEPA 2011).

There are two ways to mark storm drains. Messages may be painted onto the curb using a plastic or metal stencil; or a pre-cast ceramic, metal, or plastic tile/plaque is glued to the curb. The pre-cast plaques typically last longer than the stenciled messages (TNRCC 1996). The City of Plano, TX uses ceramic tiles to mark storm drains with the expectation that tiles will last five to ten years (TNRCC 1996). The City of Sunnyvale uses metal plaques to mark storm drains. These plaques are expected to last longer than stenciling - 7 to 10 years for plaques as opposed to 3 to 5 years for messages painted with stencils (McCumby,K. pers. comm. 2007)[15]. ACP International, which produces storm drain plaques, offers a ten year warranty (ACP International 2007).

Total costs for storm drain signage and marking is quite low. Mylar stencils cost about 45 cents per linear inch and can be used for 25 to 500 stencilings, depending if paint is sprayed or applied with a brush or roller. Permanent adhesive plaques have higher initial capital costs. For example, ceramic tiles that are glued to curbs can cost $5 - $6 each (TNRCC 1996). Other costs to consider include hiring staff to manage and maintain programs; and the monitoring of storm drains with plaques or stencils. Despite higher initial capital costs, plaques may be less expensive than painted messages in the long term due to their longer lifespan and reduced maintenance requirements. Municipalities may also prefer permanent tiles/plaques over stencils since they are neater and easier to read from a distance. In addition, the legibility of plaques and signs must be maintained. If a storm drain marking program is run as a volunteer program, coordinators must be skilled at recruiting and organizing volunteers to provide adequate coverage in larger communities.

15.2. SUMMARY OF PERTINENT FINDINGS

Municipalities within California have been successful at labeling their storm drains with signage. For example, the San José Conservation Corps, under contract with the City of San José, stenciled approximately 24,000 inlets between 2002 and 2005 (City of San José 2005). In addition, the County of Los Angeles has labeled over 75,000 County-owned storm drain inlets; while the City of Los Angeles has applied thermoplastic labels to all 36,000 City-owned basins (Gordon and Zamist 2007). Methods to evaluate the performance and/or effectiveness of signage/marking include the following:

[15] Kristy McCumby. City of Sunnyvale. April 2007.

15.2.1. Surveys

Surveys are one of the best methods to determine if storm drain signage/inlet marking programs are effective. Surveys may be conducted to determine public recognition of the storm drain message; or if stenciling/marking is changing behaviors. Examples of studies include:

University of Wisconsin Cooperative Extension Service Study (U. Wisconsin. 1999)

Few studies have been conducted to determine if storm drain signage/inlet marking change people's understanding of the linkages between the stormwater conveyance system and receiving waters, or their behavior. One study conducted by the University of Wisconsin Cooperative Extension Service indicated that stenciling can increase people's awareness of the linkages between storm drains and receiving waters. The University of Wisconsin study surveyed two Wisconsin neighborhoods, one with stenciled storm drains and one without. Researchers observed a significant difference in understanding the relationship between storm drains and water bodies between those who had seen the markers and those who had not. Seventy-one (71) percent who said they had seen the stenciled message understood in subsequent questioning that storm drain pipes lead directly to the nearest water body. Only 40 percent of those who had not seen the storm drain stencil said they knew storm drains emptied into nearby water bodies. Other survey findings indicated that labeling storm drains raised awareness in a broader area than just the intended neighborhood. In addition, all survey respondents indicated that stenciled messages were more influential than television, direct mail, conversations with neighbors and/or conversations with agency representatives in raising awareness of general stormwater issues.

Contra Costa County Public Opinion Survey Study (CCCWP 2005)

In 2005, Contra Costa County conducted a public opinion survey to determine if its citizens understand key water issues. Key findings include the following:

- Approximately the same percentage of respondents remembered advertisements on stormwater pollution as in 2004. There was significant increase in respondents who recognized the newer message, "Don't pour toxins into the storm drains".
- Almost two-thirds of respondents indicated that they had seen the information on television or in the newspaper. There was a significant increase in responses indicating that they had seen messages on stenciled storm drains.
- A growing percentage (2004: 22 percent; 2005: 25 percent) were able to correctly answer that the contents of their storm drains go directly to surrounding water bodies without being treated.

15.2.2. Water Quality Sampling

The effectiveness of storm drain signage/inlet marking programs may be determined by periodically sampling discharges from targeted storm drain outfalls. If the level of pollutants has been reduced after storm drains have been marked, it can be assumed that labeling was effective in deterring improper discharges to the stormwater conveyance system.

15.2.3. Increase in Properly Disposed Waste

Municipalities can also equate storm drain marking success from increases in the volume of used oil and other hazardous substances delivered to household hazardous waste collection centers, especially following a storm drain marking event (USEPA 2011).

15.2.4. Number of Drains Marked and Number of Volunteers

Municipalities can measure effectiveness by how many storm drains are marked and the number of requests received from volunteers groups to participate in storm drain signage/inlet marking programs.

16. IMPROVED TRASH COLLECTION METHODS/EQUIPMENT

Many municipalities within the United States are implementing automated waste collection systems to improve the safety and effectiveness of solid waste collection. With this system, residents use specially-designed, heavy-duty plastic wheeled trash containers with hinged lids. On trash collection day, containers are rolled to the curb and a truck with a mechanical/robotic lifting device lifts the container and places the trash in the truck. Automated waste collection systems are either semi-automated or fully-automated. Both systems eliminate manual trash collection and require residents to use wheeled trash containers supplied by the municipality.

16.1. AUTOMATED COLLECTION PRACTICES

Automated collection is a technologically advanced system of trash collection. Automated waste collection systems are either semi-automated or fully-automated. A description of both systems and equipment used is provided below:

Semi-automated Collection – This system involves trash collection personnel rolling the container to the front or back of a garbage truck, where a mechanical lifting device lifts the container and places the trash in the truck.

Fully-automated Collection - This system involves the truck driver using a remote-controlled mechanical/robotic lifting device to place trash in the truck. The truck pulls next to the wheeled trash container placed on the curb by the resident. The lifting device, which is usually an articulated arm, is extended to grab the container and empty trash into the truck. The truck driver does not have to leave the truck. With this system, a specialized truck and a physical environment conducive to this type of collection (i.e., plenty of off-street parking, uncongested streets, relatively flat street and sufficient clearance from overhead utility lines and trees) is required (City of Cincinnati 2002). To ease trash collection, residents must place trash containers away from parked cars and other fixed objects. Most municipalities use fully-automated collection systems and realize cost savings after implementation.

Carts - Both systems require the use of specially-designed, heavy-duty plastic wheeled trash containers with hinged lids. The most commonly used size is 96 gallons, which is equivalent to three regular garbage cans of trash. On trash collection day, which is usually once a week, containers are rolled to the curb. Due to potential equipment compatibility issues with trash collection trucks, residents are required to use wheeled-containers supplied by the municipality. The use of containers with lids greatly reduces waste storage problems (e.g., spilled trash), eliminates animals from disturbing trash and prevents rainwater from entering the container.

16.2. SUMMARY OF PERTINENT FINDINGS

- Fully-automated collection is designed to improve effectiveness and reduce operating costs. For example, an automated system allows one operator to collect 30 percent more trash than a three-person manually operated vehicle (City of Cookesville 2010).
- Fully-automated collection eliminates the need to manually handle trash containers, thereby reducing labor costs and the opportunity for job-related injuries.
- Plastic wheeled trash containers are easy to manage thus encouraging the proper disposal of solid waste.

- The use of plastic wheeled trash containers protects public health by keeping trash away from animals.
- One plastic wheeled trash container placed on the curb is more aesthetically pleasing compared to several plastic bags and other containers previously placed on the curb.
- The municipality or designated trash collector will only collect residential trash placed in the plastic wheeled trash container.
- Since trash is stored in containers with lids, landfill tipping fees are typically less resulting in cheaper trash disposal rates compared to municipalities who do not require the use of containers with lids (The Berlin Citizen 2009).

17. RECOMMENDATIONS

17.1. CONTROLS RECOMMENDED FOR DEVELOPMENT OF QUANTIFICATION FORMULAS

The following trash/litter control measures are recommended for quantification formula development:

- Trash Treatment Capture Devices (Full and Partial-Capture)
- Stormwater Conveyance System Maintenance
- Street Sweeping
- Product Bans (e.g., Plastic Grocery Bag)
- Creek/Channel/Shoreline Cleanups (Volunteer and/or Municipal)
- On-land Litter Pickup/Removal (Volunteer and/or Municipal)

17.2. CONTROLS RECOMMENDED FOR DEVELOPMENT OF LOAD REDUCTION CREDITS

The following trash/litter control measures are recommended for load reduction credit development:

- Public Education and Outreach Programs
- Improved Municipal Trash Bin/Container Management
- Additional Fees at Landfills for Unsecured Loads
- Anti-littering and Illegal Dumping Enforcement Activities

17.3. CONTROLS THAT HAVE LIMITED OR NO BENEFIT FOR DEVELOPMENT OF FORMULAS AND CREDITS

The following trash/litter control measures have limited or no benefit to quantify or credit. As a result, formulas and/or credits will not be developed.

- Free Trash Pickup/Drop Off Days (e.g., Bulky Days)
- Solid Waste Recycling and Diversion Programs
- Litter Fees on Businesses
- Storm Drain Signage/Inlet Marking
- Improved Trash Collection Methods/Equipment

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Trash Load Reduction Tracking Method- Technical Memorandum #1 - Literature Review Comments

Commenter: **Jameson Crosby**

Report Section and/or Page #	Comment	BASMAA Response
Section 1, Page 1	Page 1, top of the page, second sentence. Include the word "small" when referring to cities. "The MRP applies to all 76 small, medium and large municipalities…."	The word "small" was added to the description.
Section 2	Literature review only focuses on performance of devices and effect of full capture. It is missing the cost benefit analysis component and should also consider maintenance costs.	While costs are a very important consideration when selecting a control measure, evaluation of costs was not within the scope of this technical memo and therefore was not included.
Section 4, Page 31	Section 4.7. 1st bullet of "frequency". Cities are uncomfortable with the statement that street sweeping is much more effective when increased from monthly to weekly. Need to mention that diminishing marginal returns are reached at some point.	Text will be added to suggest that diminishing returns will likely occur at an unknown frequency.
Section 11.1, Page 64	For more examples in CA, the city of Pittsburg has an excellent illegal dumping/pick up program. We would appreciate a brief description of this program included in this section. For more information you can contact Laura Wright at 925-252-4114.	We could not find any additional information on this program, and therefore it was not added to literature review. If additional information can be provided by the commenter, we will consider incorporating it into the memorandum.

Trash Load Reduction Tracking Method- Technical Memorandum #1 - Literature Review Comments

Commenter: **Elisa Wilfong**

Report Section and/or Page #	Comment	BASMAA Response
Section 1, Page 1	Comment on the sentence: "The MRP applies to 76 large and medium municipalities (cities and counties) and flood control agencies in the San Francisco Bay Region, collectively referred to as Permittees." Please include 'Towns' in the list of types of municipalities.	The word "town" was added to the description.
Section 2	I agree with incorporating a cost/benefit analysis somehow into the findings.	While costs are a very important consideration when selecting a control measure, evaluation of costs was not within the scope of this technical memo and therefore was not included.
Section 2. Page 3.	Comment on the following definition: "Effectiveness - measure of how well a trash capture device meets its goals in relation to all stormwater flows." I am having problems with this statement. Can you rephrase it so it is clearer? In relation to other devices in the area?	The definitions of performance and effectiveness were embraced by the *International Stormwater BMP Database* and are used within this memorandum to ensure consistency. In layperson terms regarding trash, effectiveness is the volume or weight of trash captured by a treatment device divided by the volume or weight of trash captured plus the trash that got by the treatment system via overflow/bypass.
Section 6.1, Page 39	No mention of the bans of Styrofoam by the City of Richmond in the appropriate section. And I think you missed the "Don't Trash CA" campaign but I could be remembering wrong.	The Sytrofoam ban instituted by the City of Richmond was added to Table 5.1 (formerly Table 6-1). Don't Trash California Campaign is included.

Commenter: **Roger James**

Report Section and/or Page #	Comment	BASMAA Response
Sections 1.1 and 1.7.2	Sections1.1. and 17.2. Suggest that the permittees will be able to "negotiate" waste load reduction credits with the RWQCB staff. This is perhaps a poor choice of words, but to suggest that compliance with the MRP can be achieved in "behind closed doors" negotiations with RWQCB staff is nefarious at best and in violation of the public participation process. Any reductions must be scientifically based, peer reviewed and documented by third party monitoring through a process that is open to the public.	The text within Section 1.1 was updated to state the following: …"and those that are more suitable for establishing agreeable loads reduced credits developed through a regional stakeholder process."
Section 1.2, Table 1-1	Table 1-1 in section 1.2. identifies Trash Removal from Water Bodies as a trash control measure. This activity like booms are only mitigation measures for discharges that have occurred in violation of the MRP prohibitions and water quality standards. Once trash has been discharged it has already damaged the environment and trash removal cannot be considered as a control measure. Development and implementation of programs to control discharges of trash to MS4s from private property and public schools should be included as a trash control measure.	The purpose of the literature review was to summarize information on existing/previous program that have attempted to implement and quantify/assess the effectiveness of trash control measure. Our review was not limited to MS4s but also to receiving waters. The BASMAA Trash Committee agreed to constrain the literature review to those control measures included in Table 1-1, and therefore these were the control measures reviewed.
Section 2	The introductory paragraph of section2 needs to be expanded to clarify that structural devices must also retain trash until removed through maintenance practices.	The introductory text within section 2 was updated to state the following: "A trash treatment device is a single or series of structural devices which capture trash transported by a stormwater conveyance system or a receiving water body; and retain trash until removed through maintenance practices."
Table 2-1	Table 2-1 lists a number of devices approved by San Francisco Bay Water Board and a number much greater than certified by the Los Angeles RWQCB Executive Officer. The Los Angeles RWQCB Executive Officer was formally delegated in the Trash TMDL to approve full capture devices provided he make certain findings. . To my knowledge the San Francisco Bay Regional Board has not approved these devices as full capture devices and that the approval may have been by lower level staff as a convenience to expedite the San Francisco Estuary Project's Trash Capture Demonstration Project. At a minimum the Regional Board's Executive Officer would be the authority to approve and provide the sign off on the devices and this written approval should be obtained by the Project before permittees rely on these devices for compliance with the MRP…	This comment is not germane to the literature, but more pertinent to the Water Board approval process. Therefore, it has been forwarded to the Water Board staff for review and comment, if they deem necessary.

Commenter: **Roger James**

Report Section and/or Page #	Comment	BASMAA Response
	Given that the Regional Board's analyses and approval of the devices may not have been thorough It would be prudent for the Project to independently conduct a more thorough review of the design, operational characteristics and performance effectiveness to ensure that all devices meet the full capture criteria.	
Section 2.1	The criteria listed in section 2.1. does not reflect all the requirements developed by the Trash TMDL and they should be listed… Many of the devices listed in Table2-1 do not comply with the plugging or blockage criteria.	This section pertains only to the full capture aspects of the LA Trash TMDL Implementation. Therefore, other TMDL as not pertinent to this section.
Section 2.1.1	Section 2.1.1 indicates that side-entry catchpit traps (SECTS) meet the definition of full capture based on literature reviewed in the section; however, the summarized reports indicate that efficiencies are about 75% at best. The Project needs to review Armitage (ref 6) and Allison (ref 5) which describe the blockage of screens and the SECTS and sets their efficiency at approximately 75% even when every inlet in a catchment has a SECT.	See definitions of effectiveness and performance. 75% refers to the effectiveness of SECTs.
Section 2.2	Section 2.2 should describe the engineering challenges so they can be considered when permittees evaluate potential devices.	The purpose of the literature review was to summarize information on existing/previous programs that have attempted to quantify/assess the effectiveness of trash control measure. Our review was not intended to describe engineering challenges to inform selection of individual devices, other than with respect to effectiveness assessments. The request change was not made.
Section 2.2.1	Section 2.2.1. should include a discussion of the ramifications of using curb inlet screens when trash remains in the streets including the "broken window" theory1 where the presence of litter can lead to the deterioration of neighborhoods and exacerbation of the litter problem	The purpose of the literature review was to summarize information on existing/previous programs that have attempted to quantify/assess the effectiveness of trash control measure. Our review was not intended to describe issues associated with individual devices, other than with respect to effectiveness assessments. The request change was not made.
Sections 2.2.2 and 2.3.2	Sections 2.2.2. and 2.3.2. regarding litter booms should be moved to a section that addresses mitigation of trash discharges rather than in this section on partial and full capture devices because the presence of litter in the receiving waters is recognition that a violation of the discharge prohibition has occurred.	For the purposes of the literature review, litter booms are considered partial capture devices. Therefore, the description of the effectiveness of these devices is appropriate in this section.

[1] City of Los Angeles Department of Public Works, Bureau of Sanitation, High Trash-Generation Areas and Control Measures, January 2002

Trash Load Reduction Tracking Method- Technical Memorandum #1 - Literature Review Comments

Commenter: **Roger James**

Report Section and/or Page #	Comment	BASMAA Response
Section 2.3.1	Section 2.3.1 should refer to the earlier comments on the status of and concerns with the regional boards certification programs. This entire section should be rewritten to reflect the above comments and citations.	This comment is not germane to the literature, but more pertinent to the Water Board approval process. Therefore, it has been forwarded to the Water Board staff for review and comment, if they deem necessary.
Section 2.3.1	The findings in section 2.3.2 need to be deleted or at least qualified considering the above comment on section 2.2.1.	See comment re: 2.2.1
Section 3.2.5, Table 3.2	The level of detail in section 3,2,5 and Table3.2. needs to be developed for all municipalities covered by the MRP.	The information in Table 3.2 was readily available. Data from other permittees was not at the time the memo was written. Through the development of Trash Load Reduction Tracking method, additional data will likely be gathered.
Section 3.3	Section 3.3 should state that the current level of maintenance programs including street sweeping, storm drain and inlet cleaning , etc are reflected in the baseline loading and increases or decreases in the level of effort of these control measures must be incorporated in a new estimates of loadings.	The point the commenter is making is consistent with the preliminary development of the Trash Load Reduction Tracking method that has occurred since the draft technical memorandum has been reviewed. Therefore, we do not feel that this point needs to be made in this technical memorandum, but will be included in the method due to the Water Board by 2/1/2012.
Section 4.0	Section 4. should indicate that most street sweeping studies have focused on the effectiveness of removal of sediments and the pollutants associated with those sediments rather than on gross pollutants including trash.	The introductory text within section 4 was updated to state the following: "The majority of street sweeping studies have focused on the effectiveness of removal of sediments and the pollutants associated with those sediments. However, some have focused on gross pollutants including trash."
Section 4.3	Section 4.3 should also include the City of Seattle's study[2] that investigated whether street sweeping can reduce the mass of pollutants discharged and reduce the frequency of cleaning catch basins. The study investigated the impacts of parking management and compliance with parking restrictions.	The City of Seattle study was reviewed and a write-up is included within Section 4.5.
Section 4.7	Section 4.7 should indicate that Bay Area municipalities are implementing effective street sweeping programs and that baseline loading estimates would reflect those practices. Changes in trash loadings are not expected unless budget constraints reduce the sweeping programs or enforcement of parking restrictions are curtailed.	Potential enhancement to street sweeping may be considered by Permittees to meet their 40% trash reduction goal in the MRP. Therefore, guidance on effectiveness assessments associated with street sweeping is germane to the literature review.
Section 5	Section 5 should make clear that these measures are mitigation of discharges of trash in violation the MRP prohibitions and water	For the purposes of the literature review volunteer cleanups are considered a applicable control measure. Therefore, the description

[2] Seattle Public Utilities and Herrera Environmental Consultants, Seattle Street Sweeping Pilot Study, Monitoring Report, April 22, 2009

Commenter: **Roger James**

Report Section and/or Page #	Comment	BASMAA Response
	quality standards and should not be viewed as measures that to comply with baseline loading reduction requirements. While volunteer cleanup efforts achieve a heighten public awareness of the impacts of trash it also can impact beneficial water uses when cleanup occurs in sensitive habitats3.	of the effectiveness of these actions is appropriate in this document.
Section 8.2	Section 8.2 discusses a number of programs that have been implemented by the City of San Jose and to a lesser extent by the city of Oakland to control and mitigate the impacts of trash; however, it is doubtful that these programs are widely implemented throughout the Bay Area. In presenting this information the project is establishing a baseline program for other municipalities. Is that the intent?	The intent of including these programs is only to provide examples of municipalities that are implementing applicable programs. Inclusion of these programs is not intended to set baseline, which will be set on a Permittee-by-Permittee basis.
Section 9	Section 9 should include a discussion of the observations of trash flying out of solid waste transfer trucks and the need for more effective containment of trash during these operations. Driving on Highways 580 and 680 behind these transfer trucks on their way to landfills in Solano County and the Altamonte Pass suggest that these could be significant sources of trash on local roads and freeways. A study4 conducted for Keep America Beautiful suggests that litter generation around solid waste and recycling facilities could be targeted for more effective litter control strategies.	The Keep America Beautiful study prepared by Municipal Solid Waste Consultants was reviewed and a write-up is included within Section 10.3.

[3] David Seideman, Snow Patrol, Audubon, November-December 2010
[4] Mid Atlantic Solid Waste Consultants, 2009 National Visible Litter Survey and Litter Cost Study, September 18,2009