

MUNICIPAL BEST MANAGEMENT PRACTICES FOR CONTROLLING TRASH AND DEBRIS IN STORMWATER AND URBAN RUNOFF



California Coastal Commission

Algalita Marine Research Foundation



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This document is intended to provide a range of information related to controlling trash and plastic debris in stormwater and urban runoff. Information about a particular practice, strategy, method, technology or system for controlling trash and debris, including non-proprietary and proprietary systems, is not to be construed as an actual or implied endorsement, warranty or recommendation for use by the California Coastal Commission, the Algalita Marine Research Foundation, the State Water Resources Control Board or the authors of this report. Users of this document are responsible for determining the appropriate site-specific methodology, systems, and commercial products and should seek the advice of a stormwater quality professional in selecting systems, products, or technologies for controlling trash and debris in stormwater and urban runoff. Users of this report assume all liability directly or indirectly arising from use of the information contained herein. This disclaimer is applicable whether information from this report is obtained in hard copy form or downloaded from the Internet.

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I. INTRODUCTION

Approximately 80 percent of marine debris in the world's oceans originates from land-based sources- primarily trash and debris in stormwater and urban runoff. Studies conducted by the Algalita Marine Research Foundation (AMRF) and the Southern California Coastal Water Research Project (SCCWRP) have found that significant quantities of small plastic debris originating in urbanized land areas pollute the Pacific Ocean both near-shore and on beaches and segments of the ocean thousands of miles away from human habitation.¹ In 1999, AMRF and SCCWRP found that the quantity of small plastic debris outweighed plankton by 6 times on the surface of the North Pacific Central Gyre.² Studies of debris in Southern California coastal waters demonstrate that significant quantities of trash and debris originate from urban areas and are comprised of pre-production plastics from plastic industrial facilities, trash and litter from urban areas, and boating and fishing-related debris.³

Impacts of larger debris have been well-documented over the years, including marine mammal, fish and seabird mortalities caused by ingestion causing starvation and suffocation, and entanglement⁴. Research into the impacts of smaller debris is emerging, but it is known already that small plastic debris is ingested by marine life at all levels of the marine food web, from zooplankton to the largest marine mammals.

A wide array of action is needed to reduce the flow of trash and human-made debris from urban areas to the marine environment, including preventive and end-of-pipe actions. Several stakeholder groups, including the public, industry, government agencies, and research scientists, should be involved in implementing solutions to the marine debris problem. For years, state and local government have implemented anti-litter efforts (including trash collection, street sweeping and public education campaigns) that have helped to prevent the flow of trash into local waterways. Despite these efforts, in 2001, the Los Angeles Regional Water Quality Control Board (RWQCB) determined that the amount of trash reaching coastal waters and impacting coastal resources within its

¹ Moore, C.J., et al, "Density of Plastic Particles found in Zooplankton Trawls from Coastal Waters of California to the North Pacific Central Gyre," and "Working Our Way Upstream: A Snapshot of Land-Based Contributions of Plastic and Other Trash to Coastal Waters and Beaches of Southern California," in *Proceedings of the Plastic Debris Rivers to Sea Conference*, September 2005, www.plasticdebris.org.

² Moore, C.J., Moore, S.L., Leecaster, M.K., Weisberg, S.B. 2001. A comparison of plastic and plankton in the North Pacific central gyre. *Marine Pollution Bulletin* 42:1297-1300.

³ Moore, C.J., Moore, S.L., Weisberg, S.B., Lattin, G., Zellers, A. 2002. A comparison of neustonic plastic and zooplankton abundance in southern California's coastal waters. *Marine Pollution Bulletin* 44(10):1035-1038. Moore, S.L., Allen, M.J. 2000. Distribution of anthropogenic and natural debris on the mainland shelf of the Southern California Bight. *Marine Pollution Bulletin* 40(1):83-88.

⁴ Laist, D.W. 1997. Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. pp. 99-140. In: J.M. Coe and D.B. Rogers (eds.), *Marine Debris: Sources, Impacts, and Solutions*. Springer-Verlag. New York, NY.

jurisdiction was significant and increasing and posed a serious threat to marine and coastal resources.

In response to the trash problem, the Los Angeles Regional Water Quality Control Board (L.A. RWQCB) implemented a Total Maximum Daily Load (TMDL) regulation for trash on September 19, 2001. As a result, municipalities as well as the California Department of Transportation (CalTrans) that are subject to this regulation are implementing new programs to control trash in urban runoff. Their stormwater programs rely on an emerging set of methods, known as Best Management Practices (BMPs), that both prevent trash from entering the storm drain system or treat storm water to remove trash from the system. These municipalities and CalTrans are at the cutting edge of controlling the trash and debris that enters the ocean eco-system and becomes marine debris and therefore their experiences in implementing trash removal technologies are highlighted in this report.

Under current state water quality regulations, municipalities with populations greater than 100,000 are required to prevent both the flow of trash through storm drain systems as well as industrial discharges of plastic debris. Municipalities that are trying to comply with the TMDL imposed by the L.A. RWQCB have become experts in preventing trash and litter from entering storm drain systems and cleaning trash from storm drain systems. This report presents methods currently being implemented in California for controlling trash and debris in stormwater and urban runoff. It focuses largely on the methods that have been implemented in response to the TMDL, but also addresses the traditional methods that municipal programs have implemented and new methods for controlling smaller plastic debris not addressed by the TMDL.

The trash TMDL implemented by the L.A. RWQCB addresses man-made trash greater than 5mm. However, recent research conducted by the AMRF in Southern California and the Pacific Ocean illustrates that a significant portion of marine debris from land-based sources is smaller than 5mm.⁵ The AMRF and California Coastal Commission joint program, the *Plastic Debris, Rivers to Sea Project*, worked closely with the plastics industry in California (2003-2005) to assess the operational practices at plastics processing, transport, and packaging facilities that result in significant discharges of small plastic debris (pre-production plastics) to urban waterways. The *Project* contributed to improvements in the industry's recommended BMPs for preventing the release of pre-production plastics to the marine environment. This report also presents the combined industry and *Project* recommendations for preventing the discharge of pre-production plastics (smaller than 5mm) in stormwater and urban runoff.

The *Project* developed this report to provide assistance to municipal stormwater programs in areas facing the prospect of impending trash TMDLs as well as municipalities with high trash generation problems that wish to control trash in urban runoff even without a TMDL requirement to do so. The report was also developed with

⁵ Moore, C.J., et al, 2001, 2002, 2005 (cited in footnotes 1 and 2).

the general goal of increasing general awareness of the many methods that are currently being implemented to control trash in stormwater and urban runoff.

This report does not make recommendations as to the most effective means of controlling trash in urban runoff since the most effective overall strategy will depend on the particular conditions within each jurisdiction. Similarly, this report does not recommend any particular strategy or combination of strategies because selecting appropriate strategies depends on the conditions of the site, the type of debris, the resources available for maintenance of the system, and the financial resources available. This report does not provide any evaluation techniques or performance measurements.

Instead, this report is an overview of BMPs that are being implemented. It provides some of the insight and conclusions of the implementing agencies about the effectiveness of particular strategies and technologies in cases where these reflections have either been communicated directly to the *Project* or provided in publicly available documents. In addition, this report is designed to aid the user in identifying where to go to learn more about current practices and programs.

II. BEST MANAGEMENT PRACTICES FOR TRASH CONTROL

Structural Versus Institutional Controls

Generally, the methods used to control trash and debris in urban runoff are characterized as “Best Management Practices” or “BMPs.” A stormwater BMP is an action or device that improves or prevents the pollution of urban runoff and stormwater. Stormwater programs categorize BMPs differently. Some distinguish between BMPs that range from “physical controls” or “structural controls” to “institutional controls.” A structural control BMP is defined as a physical device that is retrofitted into a municipal storm drain system, thus modifying the physical and hydraulic characteristics of the system.⁶ An institutional BMP is characterized as an operational or behavioral control to reduce trash prior to its being discharged into the storm drain system.⁷

Some programs also describe BMPs in terms of “source control” and “treatment control”. Source control BMPs are activities or systems that prevent pollution from occurring in the first place or prevent pollutants from entering the storm drainage system.⁸ These are akin to institutional controls. Treatment controls are a form of physical or structural control including treatment. In the following pages, BMPs are categorized as “structural controls” and “institutional controls”.

Most municipalities that are addressing trash and debris in urban runoff are using a combination of structural control and institutional control BMPs. No single stormwater BMP provides a comprehensive solution. Municipalities are employing BMP “treatment trains” in which BMPs are arranged in a series in order to adequately address a pollution problem.⁹

Because the TMDL for trash addresses trash greater than 5mm in size, most of the structural BMPs developed in response to the trash TMDL address non-industrial discharges. BMPs that address industrial discharges are discussed in Chapter VI.

Trash TMDLs Require BMP Implementation

A number of BMPs for controlling plastic and trash in urban runoff are designed to meet the requirements of the trash TMDL established by the Los Angeles RWQCB in 2001 for the Los Angeles River and Ballona Creek. The trash TMDL establishes a waste load allocation of zero by September 2013. Therefore, operators of storm drain systems discharging to the selected waterways must achieve a 10 percent reduction in trash running through their systems each year for 10 years. Trash is defined in the TMDL as

⁶ City of Los Angeles, Watershed Protection Division, Department of Public Works, Bureau of Sanitation, *Technical Report: Best Management Practices for Implementing the Trash Total Maximum Daily Loads*, January 2004, ES-1.

⁷ Id.

⁸ Bill DePoto, “Stormwater Best Management Practices: A Primer,” in *WatershedWise*, 9/1-2, Summer/Fall 2005, p.10.

⁹ Bill DePoto, “Stormwater Best Management Practices: A Primer,” in *WatershedWise*, 9/1-2, Summer/Fall 2005, p.15.

litter and particles that can be retained by a 5-mm mesh screen.¹⁰ The TMDL defines litter per Government Code Section 68055.1(g):

“Litter means all improperly discarded waste material, including, but not limited to, convenience food, beverage, and other product packages or containers constructed of steel, aluminum, glass, paper, plastic, and other natural and synthetic materials, thrown or deposited onto the lands of waters of the state, but not including the properly discarded waste of the primary processing of agriculture, mining, logging, sawmilling or manufacturing...”

Stormwater BMPs are a relatively new water pollution response and are in the formative stages of development. Municipal stormwater programs are struggling to learn as much as possible about the performance, reliability, and maintenance requirements for each BMP.¹¹

III. REGULATORY REQUIREMENTS¹²

The framework for controlling stormwater pollution was established by the 1972 federal Clean Water Act (CWA), as amended in 1987.

Federal NPDES Programs

The CWA prohibits the discharge of pollutants to waters of the United States from any point source, unless the discharge is in compliance with a National Pollutant Discharge Elimination (NPDES) permit. The 1987 amendments to the CWA added Section 402(p), which established a framework for regulating municipal, industrial, and construction stormwater discharges under the NPDES program. In 1990, the US EPA published final Phase I regulations that established application requirements for stormwater permits for municipal separate storm sewer systems (MS4s) serving a population of over 100,000 and certain industrial facilities, including construction sites greater than 5 acres. In 1998, the US EPA published the final Phase II regulations for communities under 100,000 and operators of construction sites between 1 and 5 acres.

State NPDES Programs

The State Porter-Cologne Act (Water Code 13000, et seq.) is the principal legislation for controlling stormwater pollutants in California. The Act requires development of Basin Plans for drainage basins within California. Each plan serves as a blueprint for protecting water quality within a particular watershed. These basin plans are used to identify more specific controls that are implemented through permits called Waste Discharge

¹⁰ Los Angeles Regional Water Quality Control Board (September 19, 2001), *Trash TMDL for the Los Angeles River Watershed*.

¹¹ *Id.*

¹² Discussion of regulatory requirements is adapted from: California Stormwater Quality Association, *California Stormwater Best Management Practice Handbook- Municipal*, April 2003, pp.1-7 – 1-9. www.cabmphandbooks.com

Requirements. In California, the State Water Resources Control Board (SWRCB), through the nine RWQCBs, administers the federal NPDES stormwater permitting by issuing joint Waste Discharge Requirements and NPDES permits. The SWRCB and RWQCBs use three types of NPDES permits to regulate stormwater discharges: (1) individual permits, (2) area wide permits, and (3) general permits.

Municipal NPDES Stormwater Programs

Municipalities with a population of over 100,000 or that have been determined to be a significant contributor of pollutants are required to obtain an individual NPDES stormwater permit. These municipalities are classified as Phase I communities and, if they have separate storm drains, are typically referred to as MS4s (municipalities with separate storm and sewer systems). To meet CWA Section 402(p) requirements, Phase I MS4s are required to implement a stormwater management programs that address:

- **Program Management:** program structure, institutional arrangements, legal authority, and fiscal resources
- **Illicit Discharges:** prohibition of illicit connections and dumping, and enforcement procedures.
- **Industrial / Commercial Discharges:** identification of sources, BMPs, outreach, inspections, staff training, and coordination with state General Permit.
- **New Development and Re-development:** planning processes, local permits, staff training, post-construction structural BMPs, and outreach.
- **Construction:** erosion and grading permits, construction BMPs, site inspections, enforcement, and coordination with state General Permit.
- **Public Agency (Municipal) Operations:** inventory and BMPs for corporation yards, parks and recreation, storm drain system operation and maintenance, streets and roads, flood control, public facilities, and ponds, fountains and other public water bodies.
- **Public Information and Participation:** general and focused outreach, school education programs, citizen participation, and effectiveness evaluation of the public information program.
- **Program Evaluation:** performance standards, annual and sub-annual reports, internal reporting and record keeping, and Stormwater Management Plan revisions.
- **Monitoring:** system characterization, source identification, control measure effectiveness, pollutant loading, and data management.

Smaller, Phase II communities (under 100,000 population) are covered by a General Permit. Phase II communities are required to develop and implement a stormwater management plan with the following six minimum control measures:

- **Public Education and Outreach** - Distributing educational materials and performing outreach to inform citizens about the impacts polluted stormwater runoff discharges can have on water quality.
- **Public Involvement and Participation** - Providing opportunities for citizens to participate in program development, implementation, and review, including effectively publicizing public hearings or participation.
- **Illicit Discharge Detection and Elimination** - Developing and implementing a plan to detect and eliminate illicit discharges to the storm drain system including illicit connections and illegal dumping.
- **Construction Site Runoff Control** - Developing, implementing, and enforcing an erosion and sediment control program for construction activities that disturb one or more acres of land.
- **Pollution Prevention / Good Housekeeping for Municipal Operations** - Developing and implementing a program to prevent or reduce pollutant runoff from
- **Post-Construction Stormwater Management in New Development and Redevelopment** - Developing, implementing, and enforcing a program to address discharges of stormwater runoff from new and redevelopment areas.

In addition to the six measures listed above, the stormwater management plan must identify measurable goals (or performance standards) for each minimum control measure. Measurable goals will be used by the MS4 and the RWQCB to gauge compliance and evaluate the effectiveness of individual BMPs or control measures and the stormwater management program as a whole. Phase II communities must also monitor their efforts and prepare annual reports demonstrating that the community has implemented the minimum control measures and complied with the measurable goals.

Total Maximum Daily Loads

Section 303(d) of the CWA requires that the State identify a list of impaired water-bodies and develop and implement Total Maximum Daily Loads (TMDLs) for these water bodies (33 U.S.C. §1313(d)(1)). A TMDL specifies the maximum amount of a pollutant that can be discharged to receiving water and still meet applicable water quality standards. A TMDL includes the allocation of loads to the various dischargers and is the sum of allowable loads of a single pollutant from all contributing point and non-point sources. In a 303(d) list prepared by the California State Water Resources Control Board, at least 36 water bodies were identified as being impaired by trash or litter.¹³ On September 19, 2001, the Los Angeles RWQCB adopted amendments to the Basin Plan to incorporate TMDLs for trash in the Los Angeles River (Resolution No. 01-013) and Ballona Creek (Resolution No. 01-014). These TMDLs require regulated municipalities to reduce trash discharges to the river by 10 percent per year for a period of 10 years to get to zero discharge within 10 years.

¹³ California State Water Resources Control Board, *1998 California 303(d) list and TMDL priority schedule*, 1999. www.swrcb.ca.gov/tmdl/docs/303d98.pdf.

IV. STRUCTURAL CONTROLS FOR TRASH IN URBAN RUNOFF

The City and County of Los Angeles, and other municipalities and agencies involved in meeting the LA RWQCB trash TMDL have adopted an “iterative process” for BMP implementation. Thus, BMP implementation will be conducted in tandem with assessment and evaluation of the effectiveness and performance of each measure. Over time, BMP implementation will be adjusted as understanding of the effectiveness of each strategy is gained. Many of the BMPs discussed in this report are being used either independently or in tandem to achieve the best results.¹⁴

Determining which BMPs to Implement

The methods typically employed in determining which BMPs to implement in particular locales typically include:

- (1) identifying the trash “hot spots” and spatial distribution of trash throughout the targeted watershed;
- (2) determining the land-uses associated with the hot spots and other areas where trash enters the storm drain system;
- (3) determining the socio-economic demographics of the population surrounding the areas where trash enters the storm drain system;
- (4) tailoring the BMPs implemented to the surrounding land-uses and demographics in high trash generating areas.

Any online BMP (hydrodynamic separators, netting systems) introduces significant headloss. Therefore, if such a device is being installed in an existing system, upstream conditions need to be considered to ensure that hydraulic parameters are not adversely impacted.

Full Capture Devices

For the purposes of the trash TMDL, the RWQCB has determined that compliance is automatically achieved if a “full capture” trash BMP system is installed. In these cases, the amount of trash collected will not have to be reported, but maintenance records of the full capture system must be available for the RWQCB to inspect.¹⁵ The settlement agreement for the trash TMDL defines “full capture” as:

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 subdrainage area...

¹⁴ County of Los Angeles Department of Public Works, *Technical Report on Trash Best Management Practices*, August 2004.

¹⁵ *Id.*

A General Description of BMPs for Trash Implemented in California

There are several categories of structural BMPs that are being used to control trash and debris, including:

- Catch basin opening covers
- Catch basin inserts
- Hydrodynamic separators/vortex separators/nutrient separating baffle boxes
- End-of-pipe screening, basket and netting devices
- Litter booms

Most of these are “proprietary” BMPs. Many of the companies that manufacture the proprietary BMPs have some type of absorbent or adsorbent filter that also captures oil and grease.

There are other structural BMPs that are primarily designed to capture sediment, nutrients, metals, bacteria, oil and organics. Retention/irrigation systems, wet ponds, extended detention basins, vegetated swales and buffer strips, and bioretention systems are non-proprietary and are best incorporated into a plan which includes another BMP structured towards capturing debris.

Numerous structural BMPs have been installed in California, in urban areas; almost all are proprietary systems. The advent of structural stormwater BMPs is a relatively new industry starting about ten years ago as a result of the EPA NPDES guidelines dated September 1992. Under stormwater permits, new development and redevelopment require some kind of long term post-construction BMP. Retro-fitting existing stormdrains can be expensive for a municipality. An overview of the relative costs and benefits of implementing various BMPs to control trash were outlined by the County of Los Angeles in a table provided in Appendix 1.

The products of about twenty different companies are represented in California. These companies are listed in Appendix 2. Appendix 3 provides a directory of devices and vendors for trash and litter control BMPs prepared by the County of Los Angeles. This directory includes information about where some of these devices have been installed throughout the world. United Stormwater lists about 50 municipal and private sites where their DrainPac products are installed. CDS Technologies installed 1,730 hydrodynamic separator units between March 1998 and November 2005 in about 1,000 separate sites in California.

Specific BMPs that Have Been Implemented in California

The following section describes the systems, both proprietary and non-proprietary, that have been installed in California to control trash and debris. It is not necessarily comprehensive, although likely fairly close to comprehensive. It was developed based on research into the trash control practices of several municipal stormwater programs in California. Additional information was obtained by a literature search. The resources

identified in this literature search are provided in the reference list at the end of this document.

CATCH BASIN OPENING SCREEN COVER (Proprietary and Non-Proprietary)

Catch basin opening covers are perforated or expanded metal screens that are either designed to fit outside or within the storm drain curb opening. They can be either manual or automatically retractable screens. The proprietary models generally have a filter to capture oil and grease as an optional feature. Regular street cleaning is necessary to keep debris from clogging the face of the screens and to prevent the standing debris from blowing away.

Examples:



REM Curb Protector



United Stormwater Screen Cover



Kristar FloGard Debris Curb Guard



American Stormwater Surf-gate



Practical Technology Opening Screen Cover

Performance

The City of Los Angeles TMDL implementation pilot program assessed screen covers at 50 catch basins for their performance in preventing trash from entering the catch basin and to determine whether the units caused localized flooding. The City found that catch basin screen covers can be effective in preventing trash from entering the storm drain system. Local street ponding was a problem during rain events at sites fitted with fixed catch basin opening covers. The City concluded that future applications should investigate the conjunctive use of this system with other BMPs, and should investigate alternative closing mechanisms of screen covers (e.g. magnetic or flow activated mechanisms).¹⁶ The automatically retracting screens, if not designed or installed properly, can jam open or close prematurely. Peak flows will reintroduce trash into the water body if not designed properly.¹⁷

Maintenance

Fixed catch basin opening screen covers should be removed or opened prior to the storm season. Some designs are retractable, however they require more maintenance to ensure they work properly and do not jam open or closed. Parked vehicles can impede regular cleaning and maintenance of the screen covers. Unexpected storms can cause flooding problems if manually removable screens are not removed in time.¹⁸ Flooding may be a problem in locations with fixed screen covers that are not appropriately maintained. Sites retrofitted with retractable screens have been found by some jurisdictions to have a lesser likelihood of flooding.¹⁹

¹⁶ City of Los Angeles at p. 1-5 to 1-7.

¹⁷ County of Los Angeles at p.14.

¹⁸ County of Los Angeles at p.13.

¹⁹ Comment by Alfredo Magallanes, PE, Watershed Protection Division,, Bureau of Sanitation, City of Los Angeles

CURB OR GRATE INLET CATCH BASIN INSERTS (Proprietary and Non-Proprietary)

Catch basin inserts are manufactured frames that typically incorporate filters or fabric and placed in a curb opening or drop inlet to remove trash, sediment, or debris. They can also be perforated metal screens placed horizontally or vertically within a catch basin. They are generally capable of catching smaller and larger debris. There are a multitude of inserts of various shapes and configurations, typically falling into one of four different groups: socks, boxes, trays, and screens.

The sock consists of a fabric, usually constructed of polypropylene. The fabric may be attached to a frame or the grate of the inlet holds the sock. Socks are meant for vertical (drop) inlets.

Boxes are constructed of plastic or wire mesh. Typically a polypropylene “bag” is placed in the wire mesh box. The bag takes the form of the box. Most box products are one box; that is, the settling area and filtration through media occur in the same box. Hydrocarbons are removed by the media as the storm water passes through the box, while trash, rubbish, and sediment remain in the box itself as water exits.

Some products consist of one or more trays or mesh grates. The trays may hold different types of media. The top tray serves as an initial sediment trap with the underlying trays composed of media filters. The City of Los Angeles has found that sock, box, and tray inserts have very limited trash capture volume and thus become fill quickly (one or two storm events). Once filled they are no longer effective in trash capture. Additionally, maintenance of these inserts is difficult since many are attached to the walls of the catch basin thereby making placement off an 8” vacuum hose nearly impossible if coming in through either the maintenance hole or curb opening.²⁰

Metal screening inserts have also been deployed in a vertical or horizontal configuration within the catch basin for the retention of trash. These inserts maximize much of the existing catch basin volume and concurrently provide flow pass through ability. Companies such as American Stormwater, Practical Technologies, and Advanced Solutions are marketing these types of devices.

Grate inserts are typically be found in parking lots, alleys, and sloping streets. Inserts installed in these basins mainly capture trash smaller than an inch due to the standardized grating spacing. Inserts designed for curb opening basins are best suited for capturing larger debris like water bottles and plastics bags, as the opening under the curb may range from four to eight inches.

²⁰ Comment by Alfredo Magallanes, PE, Watershed Protection Division,, Bureau of Sanitation, City of Los Angeles.

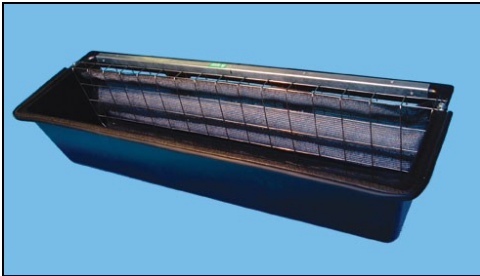
Examples:



Kristar FloGard Plus Catch Basin Insert



REM Geo-Trap Filter Catch Basin Insert



REM Triton Curb Inlet Filter Insert



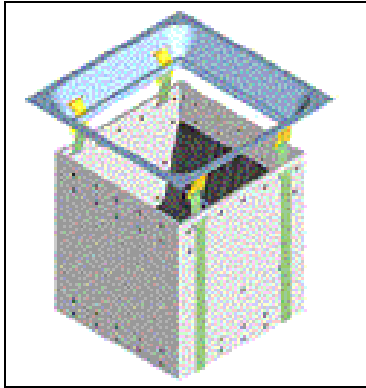
Clearwater Curb Inlet Insert



United Stormwater Drainpac Curb Inlet Filter



United Stormwater Drainpac Drop Inlet Filter



Abtech Ultra –Urban Filter



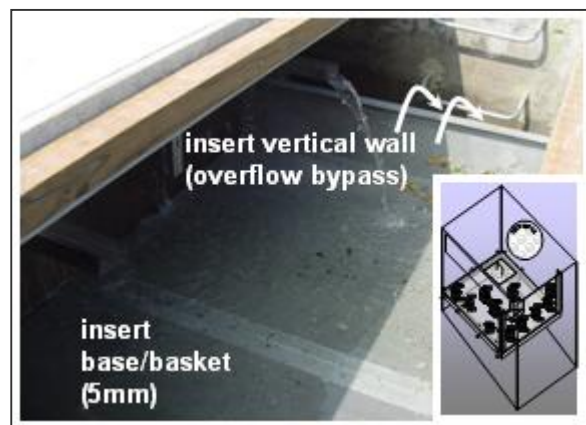
**Bio Clean Curb Inlet Simmer Basket
Drain Inlet Series**



Bio Clean Grate Inlet Skimmer Box



American Stormwater Debris Dam



Practical Technology Catch Basin Insert

Performance

Loss of drainage capacity due to the insert can be significant, thereby causing local flooding. Peak flows will likely reintroduce trash into the water body if the insert is not designed and maintained properly. In the City of Los Angeles pilot study, the inserts were observed to be overwhelmed with trash during storm events and as a result trash escaped over the inserts. The City concluded that the box and the tray inserts had limited volume capacity and therefore could not be considered full capture systems. The City also found that the geotextile liners may clog due to blockage from sediment and vegetation. Furthermore, these inserts were problematic in maintenance since they tended to clog the vacuum operation (e.g., the material was being vacuumed by the cleaning hose).. Future applications, the City concluded, need to have greater volume capacity and should investigate the most cost effective fabrication material and optimum mesh / trash openings.²¹ Filtering media that capture hydrocarbons require disposal as a hazardous waste.

Maintenance

Catch basin inserts are usually maintained with a vacuum truck to remove the debris and trash. Depending on the configuration of the insert, maintenance is either through the curb opening or the maintenance hole. A major part of the maintenance cost is the investment in the vacuum truck that can cost between \$120,000 and \$150,000 and the increase of time required to achieve the cleaning of the catch basin. The cleaning process can be noisy. Cleaning is recommended at least semi-annually. Studies have found that the more frequently they are cleaned, the more efficiently the catch basins perform.

Cost

There are many manufacturers of curb and catch basin inserts. The designs are slightly different. The cost ranges from \$400 for a “drop-in” type to as much as \$10,000 or more for a more elaborate pre-cast design.

²¹ City of Los Angeles at p. 1-8 to 1-10.

HYDRODYNAMIC SEPARATORS (Proprietary)

Also known as Separators or Swirl Concentrators

Hydrodynamic separators are widely used in stormwater treatment. Systems such as the CDS unit are certified as “full capture” systems by the RWQCB if designed to treat the one year storm and properly maintained. They are flow-through structures with a settling or separation unit to remove sediments and other pollutants. No outside power source is required, because the energy of the flowing water allows the trash and sediments to efficiently separate. Depending on the type of unit, this separation may be by means of swirl action or indirect filtration. A swirl action will only be achieved if the inlet pipe is carrying full pipe flow. The swirl action also provides the self-cleaning aspect of the hydrodynamic separators. Thus, for small to moderate storms where full pipe flow is not achieved the hydrodynamic separators don’t act as separators but more like vertical shafts with metals screens that screen out or filter trash.²²

Hydrodynamic separators are most effective where the materials to be removed from runoff are heavy particulates - which can be settled - or floatables - which can be captured, rather than dissolved pollutants or solids with poor settlability. In addition to the standard units, some vendors offer supplemental features to reduce the velocity of the flow entering the system. This increases the efficiency of the unit by allowing more sediment to settle out. Internal screens can be custom sized. The contents can be removed via pumping.

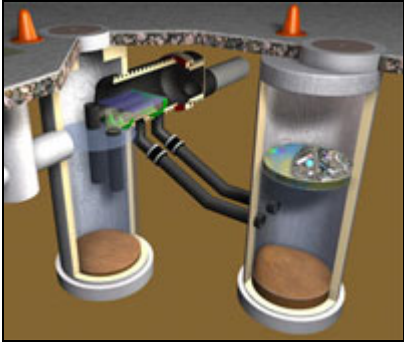
This technology may be used by itself or in conjunction with other storm water BMPs as part of an overall storm water control strategy. Hydrodynamic separators come in a wide size range and some are small enough to fit in conventional manholes. This adaptability can make hydrodynamic separators suitable for areas where land availability is limited. In the appropriate conditions, they can be placed in almost any specific location within a system.

In this category there are also numerous manufacturers. Devices can be installed as inline/online or offline units; and can be pre-cast or cast-in-place. The cast-in-place models are meant to handle greater flows. This also means that construction cost will rise since these are deep installations that will result in increase shoring, traffic control, and mitigation of excavation conditions (e.g., groundwater, etc.). The inline or online type is set beneath a grate, whereas the offline type is situated where some (if not all) of the water within the stormwater system is specifically directed to it.²³

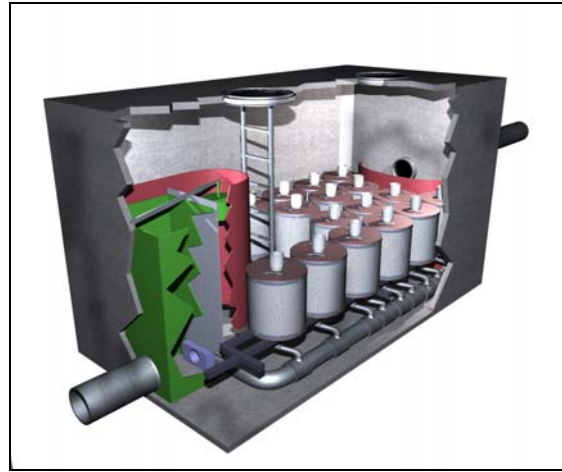
²² Comment by Alfredo Magallanes, PE, Watershed Protection Division,, Bureau of Sanitation, City of Los Angeles

²³ United States Environmental Protection Agency, *Storm Water Technology Fact Sheet: Hydrodynamic Separators*, September 1999, Washington, D.C. EPA 832-F-99-017- <http://www.p2pays.org/ref/17/16116.pdf>

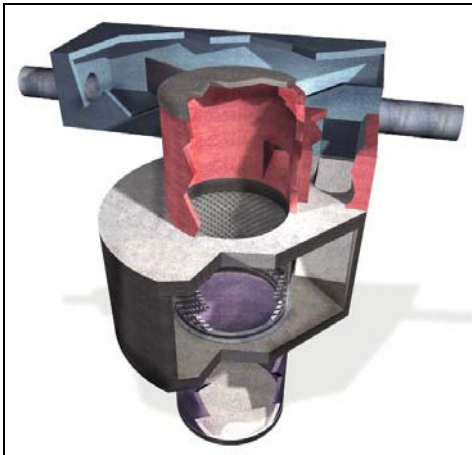
Examples:



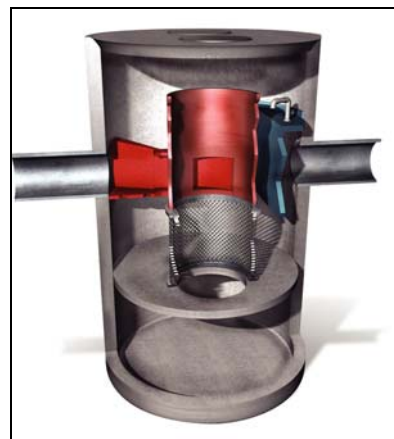
Baysaver Separation System



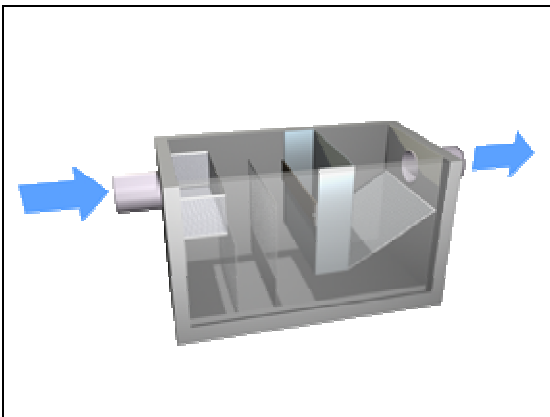
CDS Media Filtration System



CDS Offline Unit



CDS Inline Unit



CrystalStream Water Quality Vault

Performance

Some devices impact the hydraulic characteristics of the storm drain and may result in a backup of flow and upstream flooding. Results of the City of Los Angeles pilot study indicate that full capture hydrodynamic separators, such as the CDS and Fresh Creek Technology systems, have limited application and should only be considered case by case for smaller size storm drains in high trash generation areas due to their high cost and some operational considerations. Existing storm drains were not designed to accommodate additional hydraulic losses such as those imposed by a hydrodynamic separator device. The diversion structure required for offline treatment flow is also a limiting factor in the installation.²⁴

Maintenance

Repairs can be minimal as there are no moving parts. The EPA recommends that they be frequently inspected and closely in the first year of installation to establish a capacity benchmark. The length of time it takes to reach capacity will depend on the site. The unit is full when the sediment level comes within one foot of the unit's top. This is recognized through experience or the use of a "dip stick" or rod for measuring the sediment depth. When the unit reaches capacity, it must be cleaned out. This is done using a sump vacuum or vacuum truck.²⁵ Some devices have sumps with standing water. This can pose vector control and/or bacteria /pathogens problems.²⁶ However, in urban areas where oily sheens frequently cover the surface of the device, the presence of vectors is often not observed.

Cost

Costs for hydrodynamic separators vary depending on conditions, such as: the amount of runoff required to be treated, the amount of land available, and any other treatment technologies used in conjunction with the system. Capital costs can range from \$2,300 to \$40,000 per pre-cast unit. Units that are site-specifically designed, typically cost more. Operation and maintenance costs vary based on the company contracted to clean out the unit, and may depend on travel distances and cleaning frequency. These costs generally are low (maximum of \$1,000 a year) and vary from year to year.²⁷

²⁴ City of Los Angeles, at 1-14.

²⁵ United States Environmental Protection Agency, *Storm Water Technology Fact Sheet: Hydrodynamic Separators*, September 1999, Washington, D.C. EPA 832-F-99-017- <http://www.p2pays.org/ref/17/16116.pdf>

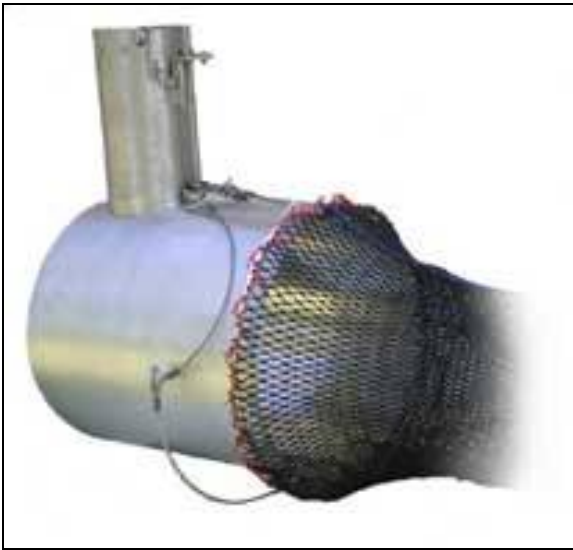
²⁶ County of Los Angeles at p.14.

²⁷ U.S. EPA, *Stormwater Technology Fact Sheet: Hydrodynamic Separators*

END-OF-PIPE DEVICES (Proprietary)

Netting, sock, screen, and basket devices can be installed at the end of storm water pipes. They can be installed either at the end of the pipe discharge or in underground concrete vaults that hold one or more nylon mesh bags and a metal frame and guide system to support the nets. The mesh netting is sized according to the volume and types of floatables intended for capture. Smaller mesh sizes could impede capacity of storm drain system if not designed properly.

Examples:



Kristar Net Technology

Performance

A City of Los Angeles pilot program assessed 3 screen barriers and 2 screen baskets with 5mm mesh openings to determine performance during intense rain events. The barrier was set 2 to 3 feet downstream of the discharge opening while the basket was anchored onto the wall of the channel directly in front of the opening.

The systems were effective in capturing large quantities of trash and debris in river outlets. However, the City felt these systems were problematic because the small openings caused them to clog quickly. The City concluded that appropriateness of use at river outlets is limited due to space limitations and reduced maintenance accessibility. The City concluded socks and screens could reintroduce trash into the water body if not designed properly.²⁸ Recently, the City determined that it would not pursue this type of

²⁸ County of Los Angeles at p.14.

system in the future. The City will rely on catch basin inserts and opening covers and other structural BMPs to meeting the trash milestones.²⁹

Maintenance

Inspection is required after every storm greater than 0.25 in and cleaned subject to inspection results. When the nets or baskets are full the net and its entire contents are removed. This type of BMP requires a high amount of maintenance, which is site-specific depending on frequency and volume of overflows, the volume of floatables, and the overall water quality. Disposal may be necessary even if the nets are not full to remove captured waste before it gets old and moldy.³⁰ End-of-pipe socks and screens are visible and easy to inspect. Appropriate siting of the BMP can make maintenance easier.

Cost

There are many different devices in this category, several of which have not been implemented in California. The StormScreen™ system cost \$15,000 to \$50,000 for a precast unit. The costs also do not reflect what would likely be the more difficult and therefore expensive conditions faced with the retrofitting of ultra urban areas or highways.³¹ The Baramy GPT™ system is a declined trash rack used for treating flows end-of-pipe. This product has been developed in Australia and currently the only installations of the product are in Australia. The cost for this product in Australia ranges from US\$3,000 to US\$23,000.

²⁹ Comment by Alfredo Magallanes, PE, Watershed Protection Division,, Bureau of Sanitation, City of Los Angeles

³⁰ U.S. Environmental Protection Agency

³¹ Orange County Stormwater Program, “Trash and Debris Best Management Practice Evaluation,” Appendix E2, p. 10

http://www.ocwatersheds.com/Stormwater/PDFs/2003_Appendix_E/2003_Appendix_E2_Trash_Debris_BMP_Eval.pdf

LINEAR RADIAL GROSS SOLIDS REMOVAL DEVICE (GSRD)

This is a non-proprietary device that utilizes a modular and linear screen cage constructed of rigid mesh or louvered well casing contained in a vault. Trash is retained within the screen cage. Flows enter the screen cage aligned parallel to the direction of flow and exit the device by passing radially through the cage screens and into the vault. The screen has a smooth, solid bottom section to facilitate movement of trash towards the downstream end of the screen cage.³² Litter and solids are trapped in the casing and the smooth bottom conveys litter to the end of the device. This device can be placed in an open channel or vault. Installations can be shallow, open to the air, thus eliminating the need for confined entry. Screen openings can be custom sized.³³

Installations require adequate space for maintenance. Vacuum trucks and other trash removal equipment are required to clean the units. The linear radial device may also be designed so 1.2 meter modules can be removed with a hoist for cleaning. A linear radial device requires low hydraulic head to operate. It is suited for narrow and flat rights-of-way with limited space.

CalTrans conducted a pilot study of GSRDs during the 2000-2001 storm seasons at sites within the Caltrans District 7 and Los Angeles River watershed. The devices included two types of linear radial devices, two types of included screen devices, and one baffle box device. All of the devices were designed to convey the peak discharge from the 25-year design storm, and with the capacity to hold one year's estimated accumulation of trash. They were also designed to drain quickly to prevent mosquito breeding, and for easy access and maintenance. Mesh bags were installed at the outlets of the drainage systems downstream of each GSRD in order to determine the capture efficiency of each device. The linear radial and incline screen devices proved to be effective in capturing litter and other trash. Removal efficiencies ranged from 83 to 100 percent by weight. Two types of GSRDs are approved for use by Caltrans: the linear radial device and the inclined screen device.

Examples:



Roscoe Moss linear radial device



Door at the end opens for cleaning

³² J. Endicott et al, Design and Performance of Non-Proprietary Devices for Highway Runoff Litter Removal, CSUS Office of Water Programs- presented at American Society of Civil Engineers 9th International Conference on Urban Drainage, Sept. 2002.

³³ County of Los Angeles at p. 14.

Performance

The linear radial device and the next two gross solids removal devices presented have been developed and were pilot tested by Caltrans. The conclusions and key findings of the pilot study are that:

- These devices can be effective to very effective in removing litter from discharges of highway stormwater runoff;
- For compliance with the trash TMDL of the L.A. River, a device must incorporate a screen of adequate size to prevent clogging and litter bypass during overflow events;
- GSRDs are sensitive to trash loading rates;
- Design loading rates must consider total trash, including solids, vegetation, and litter;
- Litter is a relatively small component of gross solids on both a total mass and a total volume basis;
- Gross solids loading rates require further study to define the average and range of expected values;
- Screen clogging and subsequent bypass are the most common causes of failure;
- Gross solids storage and screen clogging prevention must be individually considered during design of such a device.³⁴

The linear radial device was found to remove 98% of litter by weight and removed 92% of litter by volume.³⁵

Maintenance

Maintenance is relatively easy using vacuum cleanout. Sufficient screen area and volume is provided to accommodate a once-per-year maintenance cycle without plugging. The vault is sloped towards the outlet to provide positive drainage. The vault can be configured with grates or covers, load-rated if necessary, to enable access for cleaning.³⁶ The linear radial GSRD devices require maintenance at the end of the wet season. This maintenance includes the removal of the accumulated gross solids from the device, disposal of material and the inspection of the devices for structural damage. It requires about 10 man-hours for cleanout.³⁷

Cost

The linear radial device cost \$48,300 to construct and treated 3.7 acres. These devices are non-proprietary and cost is depended on size, type of material, access, etc.³⁸

³⁴ J. Endicott, et al.

³⁵ Orange County Stormwater Program, p.22

³⁶ J. Endicott et al.

³⁷ Orange County Stormwater Program, p. 22

³⁸ J. Endicott, et al.

INCLINED SCREEN GROSS SOLIDS REMOVAL DEVICE (GSRD)

This is a non-proprietary device that is fairly compact compared to other gross solids removal devices. It allows for retrofit siting in space-constrained highway right-of-ways, especially fill sections with sufficient energy to provide a drop, usually 0.9m (3 ft) across the inclined screen. An inclined screen device requires about 1.5 m (5 ft) of hydraulic energy and is well suited for fill sections. Litter can accumulate quickly in these systems therefore they should be sited in areas with easy access for maintenance.

This system utilizes an inclined screen constructed of parallel wires or bars contained in a vault. Trash is retained in a storage area of the vault located at the bottom of the inclined screen. Flows enter the device through a trough and weir that distribute inflow across the top of the inclined screen. The trough captures the heavier solids such as gravel and sand. Flows exit the device by passing through the inclined screen. The screen has a smooth surface that allows water flowing down the screen to push gross solids downward towards the vault's gross solids storage area. The inclined screen open area is sized to accommodate the design storm discharge from the tributary drainage area. The gross solids storage area is sized to accommodate a once-per-year removal cycle. The influent trough is drained through a series of weep holes. The gross solids storage area is sloped towards a grate-covered drainpipe. Like the linear radial GSRD above, this can also be configured with grates or covers for easy access.³⁹

Maintenance

The inclined screen GSRD requires maintenance at the end of the wet season. Maintenance includes the removal of the accumulated gross solids and trash from the device, disposal of material and the inspection of the devices for structural damage. It requires about 10 man-hours for cleanout.⁴⁰

Performance

Cal Trans conducted evaluation of the effectiveness of this device for removal of highway litter and gross solids. The inclined screen device was found to remove 100% of litter by weight and removed 100% of litter by volume.⁴¹

Cost

These devices are non-proprietary therefore the cost to construct such a system depends on the size, type of material collected and access. The inclined screen device tested by CalTrans cost \$82,800 to construct and treated 2.5 acres.⁴²

³⁹ Id.

⁴⁰ Orange County Stormwater Program, p.24

⁴¹ Orange County Stormwater Program, p.22

⁴² Orange County Stormwater Program, p.25

BAFFLE BOX (proprietary and non-proprietary)

This is a device that is suited to locations with adequate space for a large system. They can either be located in-line or at the end of storm pipes. Baffle boxes are concrete or fiberglass structures containing a series of sediment settling chambers separated by baffles. Baffle boxes remove pollutants, primarily trash and suspended solids, by slowing the flow velocity through the box, thereby allowing solids and associated pollutants to settle to the bottom of the box. As stormwater enters the box and begins to fill the first chamber, it encounters the baffles and flow velocity decreases, thereby allowing particles with a settling velocity greater than the horizontal flow velocity to settle to the bottom of the box. In addition to decreasing flow velocities, the baffles impede particle movement. As suspended solids strike the baffles they begin to settle. Larger particles usually settle in the first chambers. Smaller particles usually settle in subsequent chambers.⁴³

Trash is retained in three storage areas: in the top and bottom of the first chamber for floatable and settleable materials respectively; and beneath the bar rack in the bottom of the second chamber. Flows enter the device through the first chamber. A weir wall and baffle create a standing pool. Flows then continue through the unit to the second chamber by passing under the baffle and over the weir wall. Then flows exit the unit by passing upward through the bar rack.

The baffle, weir and screen are designed to accommodate the storm discharge based on a once per year gross solids removal cycle. The second chamber is dewatered using drain holes or a sump pump. The vault can be configured with either grates or covers, and can be designed either for traffic or non-traffic. This device can only be sited in areas large enough to accommodate a relatively large footprint and with either sufficient hydraulic energy to allow for gravity dewatering or power available for a sump pump.⁴⁴

Baffle boxes provide a simple, inexpensive, and effective method for the removal of sediment and suspended solids from stormwater. They can be retrofitted into existing storm lines and allow the installation within existing rights-of-way. This is especially important in areas where land is unavailable or too expensive for other stormwater BMPs that require more space. Typical baffle boxes are 10 to 15 feet long, 2 feet wider than the pipe, and 6 to 8 feet high. Weirs are usually set at the same level as the pipe invert to minimize hydraulic losses.⁴⁵

⁴³ U.S. Environmental Protection Agency, *Stormwater Technology Fact Sheet: Baffle Boxes*, EPA 832-F-01-004 September 2001. http://www.epa.gov/owm/mtb/baffle_boxes.pdf

⁴⁴ Orange County Stormwater Program, p.25

⁴⁵ Id.

Examples:



Bio Clean Nutrient Separating Baffle Box

Performance

In general, modeling results show that baffle boxes are more effective at removing larger particles than smaller particles. Baffle boxes are an effective BMP to remove sediments from storm water. Baffle boxes have been shown to remove from 225 to 22,500 kilograms (500 to 50,000 pounds) of sediment per month, depending on the sediment load feeding into the baffle box. However, pollutant removal efficiencies depend on factors such as land use, drainage basin area, soil types, storm water velocities through the box, and the frequency and thoroughness of box cleaning. Limited data exists on the pollutant removal efficiencies of baffle boxes.⁴⁶

Maintenance

Baffle boxes require significant maintenance to remove accumulated sediment. If the boxes are not cleaned regularly, subsequent storms may re-suspend the accumulated sediment and carry it out of the box. Also, because many trash racks installed in baffle boxes are hinged at the top to prevent damage from high hydraulic pressure, they may release accumulated trash during high flows. Manholes are set over each chamber to allow easy access for cleaning and maintenance. Manholes should be located within 15 feet of a paved surface to allow access by vacuum trucks for box maintenance. During a baffle box clean out, vacuum truck operators access the chambers through manholes set above each compartment. Boxes cannot be cleaned out if base flow remains in the inlet pipes. To block incoming flow, inflatable plugs or sandbags can be placed in the inflow pipe or in the manhole upstream. If the box is below the outfall level, additional plugs will be needed to prevent backflow.

Maintenance schedules depend on individual site characteristics, including typical sediment loads, the size of the sewershed, flow rates, land use in the area, and the size of

⁴⁶ Id.

the box. It is recommended that the boxes be inspected and cleaned every two to three months during the dry season, and every month during the wet season.⁴⁷

Cost

Installation costs for most pre-cast baffle boxes run between \$20,000 and \$30,000, depending on utilities that must be relocated to accommodate the box. The average clean out cost for a baffle box is \$450. An average vacuum truck can clean two baffle boxes per day.⁴⁸

⁴⁷ Id.

⁴⁸ Id.

LITTER OR TRASH BOOMS (Proprietary and Non-Proprietary)

Booms are floatation structures with suspended curtains that can be used to contain floating trash. They are also often designed using hydrophobic absorbent materials to collect oil and grease from the water's surface. To collect trash and debris from a waterway, booms are typically anchored to a shoreline structure and the bottom, and they can be located downstream or one or more outfalls. The size of a boom depends on the volume of floatables released during a design storm-event.⁴⁹

Site conditions such as receiving water velocity should be considered when evaluating boom design, placement and anchoring. Although booms will float and therefore accommodate water level fluctuations, high river velocities and winds may dislodge them. Booms cannot be employed during the winter in waters that are subject to freezing.⁵⁰

Orange County purchases booms from an outside fabricator and has the connectors fabricated during construction. These are continually improved with each contract. Most trash and debris booms are installed with have the boom attached to points on the opposite sides of the channel with sufficient slack to allow the boom to form a semi-circle. This shape results in trash and debris accumulating in the center of the boom, which is generally located at the center of the channel and is the region of highest water flow velocity. High velocities can drag collected litter under the boom. The County found that a better design is one that angles the boom across the channel to allow the collected trash to accumulate on one side of the channel, away from the high velocity region.⁵¹

Examples:



Kepner Plastics Sea Curtain Debris Barrier

⁴⁹ United States Environmental Protection Agency, *Combined Sewer Overflow Technology Fact Sheet-Floatables Control*, September 1999, EPA 832-F99-088- <http://www.epa.gov/owm/mtb/floatctrl.pdf>

⁵⁰ Id.

⁵¹ Orange County Stormwater, p. 39

Maintenance

Containment booms should be cleaned after each storm event. The floating trash and debris can be removed manually or with a vacuum truck or a skimmer vessel.⁵²

Performance

Containment booms can range from 60 to 90 percent in efficiency.⁵³ However, they only protect the water body downstream of its location. The breaking away of a boom or attached net can reintroduce trash into the water body if not properly designed.⁵⁴ According to Orange County, the success of trash and debris booms to date has been mixed. Floating booms collect floating material and are largely ineffective in capturing material that is waterlogged and neutrally buoyant. Laboratory testing of gross solids showed that typically only 20 percent of the litter and less than 10 percent of the vegetation floats.⁵⁵ Since booms are only designed to capture floatable trash, a significant portion of trash in stormwater is not caught using these devices.

⁵² U.S. EPA, *Combined Sewer Overflow Technology Fact Sheet-Floatables Control*

⁵³ *Id.*

⁵⁴ County of Los Angeles at p. 15.

⁵⁵ Orange County Stormwater, p. 39.

NETTING (Proprietary and Non-Proprietary)

Three types of netting systems are used to collect floatable trash in a combined sewer system and they can be adapted for use in a separate storm drain system. The netting types include: (1) in-line netting, (2) floating, and (2) end-of-pipe systems.⁵⁶ In-line netting is installed in underground concrete vaults containing one or more mesh bags and a metal frame and guide system to support the nets. Floating units consist of an in-water containment area that funnels water flow through a series of large nylon mesh nets. End-of-pipe netting is installed at the end of the pipe. These units are often installed as a retrofit to an existing outfall structure. Designing a netting system appropriate for a given situation depends on: (1) the peak flow expected, (2) the maximum flow velocity, and (3) the volume of floatable material per million gallons of water flow.

Moffatt & Nichol performed a study for the City of Seal Beach to develop a design for a debris collection system to reduce debris flows within the San Gabriel River watershed. The main goal of the project was to propose an effective design for decreasing the debris load at the mouth of the San Gabriel River, and in particular to decrease the quantity of debris that is washed up onto Seal Beach. Three debris net buoy designs were tested during the study: spherical buoys (to replicate performance of the pre-existing debris net), cylindrical buoys, and tetrahedral buoys. Results of the test were reported at the *Plastic Debris, Rivers to Sea Conference*.⁵⁷ The City considered installing the cylindrical buoy net until public safety issues associated with implementation of the net in the proposed channel location caused the City not to implement the installation.

Examples:



Fresh Creek Technologies Netting Trash Trap

⁵⁶ U.S. Environmental Protection Agency, *Combined Sewer Overflow Technology Fact Sheet Netting Systems for Floatables Control*, EPA 832-F-99-037 September 1999, p.1 <http://www.epa.gov/owm/mtb/nettrash1.pdf>

⁵⁷ Russell Boudreau, "Debris Nets in the San Gabriel River-Design and Physical Modeling," Moffat & Nichol, September 2005, www.plasticdebris.org/WhitePapers/Russell_Boudreau/pdf.

Maintenance

The nets are single use and are typically removed and taken to a disposal area. They are relatively easy to maintain.⁵⁸ Inspection should be conducted after every storm greater than 0.25” and nets should be replaced where necessary. During the dry season, nets should be cleaned and/or replaced towards the end of the season.⁵⁹ In line and end of pipe nets can be removed by a boom truck crane and placed in a carting container for proper disposal.⁶⁰ Floating systems can be serviced in several ways. Skimmer boats can be used for water based servicing. The full nets are floated out the back end of the units and are lifted onto the workboat for transport to an off loading facility. Shore based servicing can be done using a boom truck with sufficient reach.⁶¹

Performance

As an example, in tests performed by Fresh Creek Technologies and the U.S Environmental Protection Agency, the Netting TrashTrap™ system was 93-97% effective at removing trash from combined sewer overflow discharge.⁶²

Cost

An example is the Netting TrashTrap™ system.⁶³ Costs for planning and construction of a Netting TrashTrap™ system are likely to range from \$75,000 to \$300,000, depending on site conditions. A typical two- net system with 1.4 cubic meters (50 cubic feet) capacity, handling about 227 kilograms (500 pounds) of damp weight per net and spanning 4.5 meters (15 feet) of combined sewer overflow outfall, has an estimated capital cost of \$125,000. This includes the cost of fabrication and installation, which can take three to six months. The land-based materials handling system (trash collection/disposal) associated with the system has an additional estimated capital cost of \$25,000 to \$75,000.⁶⁴ Disposal costs for captured materials and nets should also be considered when calculating operation and maintenance costs.

⁵⁸ U.S. Environmental Protection Agency, *Combined Sewer Overflow Technology Fact Sheet Netting Systems for Floatables Control*, p. 1

⁵⁹ Comment by Alfredo Magallanes, PE, Watershed Protection Division,, Bureau of Sanitation, City of Los Angeles

⁶⁰ U.S. Environmental Protection Agency, *Combined Sewer Overflow Technology Fact Sheet Netting Systems for Floatables Control*, p. 3

⁶¹ Orange County Stormwater Program, “Trash and Debris Best Management Practice Evaluation,” Appendix E2, p. 10

http://www.ocwatersheds.com/Stormwater/PDFs/2003_Appendix_E/2003_Appendix_E2_Trash_Debris_BMP_Eval.pdf

⁶² U.S. Environmental Protection Agency, *Combined Sewer Overflow Technology Fact Sheet Netting Systems for Floatables Control* at p. 5

⁶³ County of Los Angeles, p. 15.

⁶⁴ United States Environmental Protection Agency, *Combined Sewer Overflow Technology Fact Sheet Netting Systems for Floatables Control*, p. 5.

IV. INSTITUTIONAL CONTROLS FOR TRASH IN URBAN RUNOFF

ANTI-LITTERING ENFORCEMENT

Most municipalities in California have anti-littering provisions in the municipal code. These provisions authorize local enforcement agencies, often including the police, sheriff, fire, parks, and public works departments, to prevent littering along city streets or in public parks by issuing citations for littering. They may also have anti-dumping and /or nuisance and abatement ordinances. These ordinances specify procedures for issuing notices of violation and provide authority to issue citations and fines.

In addition, many municipalities regulate commercial and new development activities through the planning development review process and business permits. Cities may authorize building inspectors and other enforcement officials to inspect construction sites to ensure that measures to prevent trash from migrating off-site are implemented.

BANS, PROHIBITIONS, TAXES, FEES

An increasing number of local jurisdictions are attempting to control trash and debris in their communities by implementing bans on specific products, placing taxes on businesses that are the source of litter, or attaching fees to products that become litter.

Prohibitions on expanded polystyrene foam and disposable plastics

The City of Malibu has implemented an expanded polystyrene foam ban for all food vendors, restaurants, and city-operated facilities. The City of Berkeley has a prohibition on expanded polystyrene foam related to take-out food containers in food service establishments. The County of Ventura enacted a prohibition on expanded polystyrene foam by vendors, franchisees, lessees, contractors, and other commercial food and beverage purveyors at the County Harbor, Parks, and at the Government Center, as well as at special events held at county facilities that are sponsored or co-sponsored by the County.

Outside of Los Angeles County, the City of Laguna Hills was the first to ban the use of expanded polystyrene foam at City-owned facilities on April 13, 2004. Similar bans on the use of expanded polystyrene foam have been established by five additional resolutions adopted by other cities/agencies within Orange County including: City of San Juan Capistrano, City of Laguna Woods, City of Huntington Beach, City of San Clemente, City of Laguna Beach, and Santa Margarita Water District.

Smoke-free beaches

In October 2003, Solana Beach was the first California city to ban smoking at the beach. Since the Solana Beach effort, an additional 15 California cities have enacted or are considering bans on smoking at the beach. The County of Los Angeles also passed a

smoking ban on beaches within its jurisdiction. Cigarette butt litter on beaches originates both from beach-visitor littering and litter in urban runoff (from streets). Litter characterization studies conducted state-wide by the California Department of Transportation (CalTrans) have found cigarette butts to be the number one littered item along highways.⁶⁵

Litter tax on fast food

In order to address the City's growing litter problem, the City of Oakland enacted (February 2006) the first tax on fast food restaurants and convenience stores in the nation. The tax ranges from \$230 to \$3,815 per year, depending on the size of the business, and targets businesses in areas around high schools and junior high schools, where most of the trash is generated. The City will use the estimated \$237,000 a year it raises from the fees to hire crews to clean up the litter.

Proposed fees on litter-prone items

Several local jurisdictions and a few state legislators have proposed assessing fees on products that become litter. In 2004-2005, the City of San Francisco considered attached a \$0.17 fee on the distribution of plastic and paper grocery bags at the check out counter. Members of the California State Legislature have proposed fees attached to plastic bags and polystyrene cups. To date, none of these fees have been implemented.

LOCAL WASTE RECYCLING AND REDUCTION

In order to accomplish the state-wide goal of 50% diversion of waste from landfills, local governments provide various types of solid waste recycling, collecting different types of materials using differing methods from one jurisdiction to the next. Some counties have set high goals for diversion. Los Angeles County anticipates reaching a 75 % diversion rate. The City of San Francisco established a zero waste ordinance, aiming for 100% diversion. Jurisdictions that use curbside collection generally achieve higher rates of recycling. Many urban areas face the challenge of collection from multi-unit dwellings, and large venues are increasingly becoming a focus for helping achieve higher recycling and diversion rates.

The first bag-to-bag recycling program in the nation was established by the City of San Juan Capistrano. The program is a cooperative effort between the City of San Juan Capistrano, the City's waste hauler (CR&R), and Hilex Poly Company, the largest carryout grocery bag manufacturer in the U.S. The City collects the bags, sells the material to Hilex, and Hilex recycles the bags back into new bags for retail customer purchase and public use. Bags that are collected in this program are re-used in the manufacture of new bags. Many communities see this "cradle to cradle" effort as a possible solution to bag litter.⁶⁶ The Progressive Bag Alliance, which initiated this

⁶⁵ www.dontrashcalifornia.info/pdf/Statistics.pdf

⁶⁶ The concept of "cradle to cradle" materials production was developed and described by William McDonough and Michael Braungart in *Cradle to Cradle: Remaking the Way we Make Things* North Point Press, 2002. The concept is

program, is helping other cities and counties develop bag-to-bag programs. Other cities are developing “bag-in-bag” programs, which provide curbside collection for plastic bags but recycle the plastic in various markets, not just film plastics, thus it is not a closed loop type of recycling program.

In October 2005, the City of San Francisco entered into a cooperative agreement with the large grocery chains that serve most of the City’s population to achieve a ten million-bag reduction within a year. This initiative was developed in response to the proposed \$0.17 per bag fee that the City considered imposing on the use of plastic and paper grocery bags at checkout counters at the same grocery store chains.

BEACH CLEANUPS

Bringing volunteers to beaches and inland waterways was initially considered a public education strategy. Increasingly, however, local government and nonprofit organizations in urban watersheds throughout the State are adopting shorelines and beaches and cleaning more frequently, such that some programs may be considered cleanup and abatement efforts as well as efforts to promote environmental awareness.

The California Coastal Commission has been organizing California’s Coastal Cleanup Day since 1985. Many municipal agencies participate by helping to organize local beach cleanups on this event that occurs annually on the third Saturday of every September. It is the largest volunteer event in the state. In 2005, 48,250 volunteers helped to remove 970,748 pounds of debris from 2,028 linear miles of shoreline (both inland and coastal areas). Since 1985, California Coastal Cleanup Day has involved nearly 700,000 volunteers and a total of 11,023,594 pounds of debris has been removed.



California Coastal Cleanup Day, Ocean Beach, San Francisco 2005

similar to closed loop recycling. It eliminates waste (as in the traditional “cradle to grave” system of waste management) because waste products are used to remake the same type of product.

TRASH RECEPTACLES

Trash receptacles placed at major intersections, bus stops, in commercial districts, and other high trash areas provide a relatively inexpensive method for preventing trash from entering the storm drain system. Maintenance labor can be expensive but trash receptacles are easy to maintain and monitor.⁶⁷

The City of Los Angeles pilot study evaluated the effectiveness of placing additional trash receptacles on streets. The City assessed the difference in trash accumulation in catch basin inserts before and after the additional receptacles were placed (one per block) on the street. Trash receptacles were emptied weekly. Results indicated that additional trash receptacles can be highly beneficial if located in strategic areas. The surrounding land use is a determining factor in effectiveness for trash receptacles. The pilot study found that trash receptacles were most effective when placed in areas of mixed commercial and residential land use.⁶⁸

STREET SWEEPING

Street sweeping is an effective urban BMP for reducing trash and total suspended solids from urban streets. It is accomplished using motorized sweeping to sweep streets and municipal parking lots. Street sweeping is well-suited in ultra urban environments where space for structural stormwater controls is limited. It is applicable in commercial business districts, industrial sites, and intensely developed areas near receiving waters. Street sweepers can also be used for highway litter control in areas where safety is not a concern, such as, road shoulders, rest stop parking areas, and maintenance yards.⁶⁹

Types of Street Sweepers:

Mechanical sweepers- The most common type of street sweeper. A rotating gutter broom removes particles from street gutter and a water spray controls dust. The particles removed are placed in front of a cylindrical broom that rotates to carry the material onto a conveyor belt and into a storage hopper.

Vacuum-assisted sweepers- These units are generally more efficient than the mechanical sweeper. The gutter broom removes particles from the street and places them in the path of a vacuum intake that transports the dirt to the hopper. The transported dirt is usually saturated with water. The overall efficiency is higher than a mechanical cleaner, especially for particles and dust larger than about 3mm.

Tandem sweeping-These units employ a mechanical sweeper (a broom and conveyor belt system) followed immediately by a vacuum-assisted sweeper.

⁶⁷ Id.

⁶⁸ City of Los Angeles at 1-15 to 1-16.

⁶⁹ Id.

Regenerative air sweepers- These systems blow air onto the pavement and then vacuum it back to capture the accumulated sediments. They include a dust separation system. These units are considered effective for removing fine sediment and dust.

Vacuum-assisted dry sweepers- These units combine the elements of a tandem sweeper into a single unit. This system is useful at industrial sites where it is necessary to have complete removal of particulate matter without leakage. A continuous filtration system prevents fine particulates from leaving the unit.⁷⁰

Maintenance

Mechanical sweepers have greater requirements for maintenance than vacuum-assisted and regenerative sweepers since they possess more moving parts that require periodic replacement. Water-based sweepers require water loading and therefore have reduced operational time.

Performance

Recent studies have shown that street sweeping programs that use the latest technologies of street sweepers can remove as much as 80% of annual total suspended solids and associated pollutants.⁷¹ Vacuum assisted and regenerative air sweepers are generally more effective than mechanical sweepers at removing fine sediments.⁷² Street sweeper performance can be optimized by operating them at optimal speeds (6-8 mph), ensuring that the brushes are properly adjusted, and using appropriate rotation rates and patterns. Factors that limit overall effectiveness of street sweepers include:

- Parked cars and traffic congestion
- Poor road surface and curb conditions
- Presence of construction projects nearby

The selection of a certain type of sweeper depends on specific conditions prevailing at sites targeted for sweeping. In general, mechanical sweepers are best suited to larger debris and conditions involving wet streets. These sweepers create large amounts of airborne dust. Vacuum assisted and regenerative air sweepers are more effective at removing fine particulates but are not effective in wet conditions. They are also often noisier than mechanical sweepers, thereby, more restricted in terms of the hours of operation. A mechanical sweeper may need to be deployed prior to a vacuum or regenerative air sweeper to pick up larger debris.⁷³

⁷⁰U.S. Department of Transportation, Federal Highway Administration, *Stormwater Best Management Practices an Ultra-Urban Setting: Selection and Monitoring*, “Fact Sheet- Street Sweepers” – www.fhwa.dot.gov/environment/ultraurb/3fs16.htm

⁷¹ *Id.* at p. 1.

⁷² *Id.* at p.2

⁷³ *Id.*

Costs

Conventional sweepers range in cost from \$69,000 to \$127,000 (as of 1995). The higher end of this range is associated with vacuum-assisted and regenerative sweepers. The sweepers last approximately 4 to 7 years and the operating costs have been estimated at about \$70 per hour (1996 dollars). The capital cost of a vacuum-assisted sweeper is approximately \$170,000 (1996 dollars) with a projected life-span of 8 years and operating costs of approximately \$35 per hour (1996 dollars).⁷⁴

CATCH BASIN CLEANOUTS

Contractors or stormwater agency maintenance crews conduct cleaning out catch basins. Catch basins are typically inspected at regular intervals depending on the quantity of trash collected.

OPEN CHANNEL CLEANOUTS

Cleaning out open channels is a dry-weather measure that reduces downstream loads when storm events occur. This measure is only practicable where open channels are dry enough and accessible. Some Southern California municipalities maintain contracts for channel trash removal.

PUBLIC EDUCATION AND OUTREACH

Information about effective anti-littering public education and outreach strategies in California was derived from a 1997 study performed by the County of Los Angeles. The County's segmentation study characterized the residents of the County into six different categories of behavior related to litter and other stormwater pollutants. The study identified the *Rubbish Rebels* as the group most likely to engage in littering and illegal dumping of used motor oil. This group comprised 9% of the County's population and accounted for 41% of the volume of litter dropped on the ground each month, 68% of trash blown out of their control, 42% of ashtray debris dumped on the street, and 62% of the litter thrown directly into the storm drain system.

Rubbish Rebels are generally single males in their teens and twenties. One third of the members of this group are unemployed and most are not college graduates. A large portion of the group is Hispanic and 25% speak Spanish at home. A predominant portion of the group are car enthusiasts and account for 28% of improperly disposed used motor oil in the County. *Rubbish Rebels* demonstrate a low regard for environmental protection. They tend not to recycle and care little about the effects of pollution on the environment.

A 2002 survey conducted by the City of Los Angeles Stormwater Public Education Program was designed to obtain additional information about *Rubbish Rebels* and the messages and public education strategies most likely to effect behavior change.⁷⁵ The

⁷⁴ Id.

⁷⁵ Id. at 1-17 to 1-19.

results of the survey lead the City to conclude that the following should be considered in developing and outreach plan to address the most significant polluters within the community:

- *Rubbish Rebels* would be most likely to reduce their littering if they knew they were going to receive tickets and penalties for littering;
- *Rubbish Rebels* would be concerned about the impact of littering on local beaches;
- *Rubbish Rebels* would more readily respond to anti-litter messages conveyed by peers than by municipal / government representatives;
- They care little about the impacts of trash on a neighborhood, or about the threat of harm trash poses to children;
- Most members of the group speak English as a first language and Spanish as a secondary language.

The survey concluded that the best mode for conveying anti-littering messages is through mass media advertising, and that brochures, leaflets and flyers should be avoided as they have a high likelihood of being littered.

Catch basin stenciling has been universally employed as a public education tool. Volunteers and municipal stormwater programs have stenciled “no-dumping-drains to ocean” (or “drains to Bay” or “...to River”) signs in many urban areas. Los Angeles County has such signs painted over 75,000 County-owned catch basins and right-of-way access points, for example.⁷⁶ The City of Los Angeles applied thermoplastic labels with a similar message in all 36,000 City-owned basins.



Some of the other typical public education strategies Employed by state and local government, as well as non-profit agencies, to prevent littering include billboard advertisements, bus stop and bus advertising, posters, brochures, television advertising, radio public service announcements. A few examples of well-funded and/or well-organized government anti-litter campaigns in California are available at the following locations:

- The State Water Resources Control Board’s Erase the Waste Campaign: <http://www.swrcb.ca.gov/erasethewaste/>
- The California Department of Transportation “Don’t Trash California” program- <http://www.dontrashcalifornia.info/>

⁷⁶ County of Los Angeles Department of Public Works at p.3.

- The County of Los Angeles Stormwater Program “Can It” Advertising Campaign and litter prevention programs: <http://ladpw.org/prg/stormwater/>
- Keep California Beautiful: <http://www.keepcaliforniabeautiful.com/>

VI. BMPS TO CONTROL INDUSTRIAL DISCHARGES FROM PLASTICS FACILITIES

AMRF conducted studies of plastic debris from industrial facilities in the Los Angeles and San Gabriel River watersheds 2004 and 2005 as part of the *Plastic Debris, Rivers to Sea Project*. The research and findings of the project are provided at www.plasticdebris.org. AMRF's research has demonstrated that industrial discharges of plastic debris from plastics processing, transportation, and packaging facilities contribute significant quantities of plastic debris to urban waterways that flow to the ocean.

Addressing Industrial Discharges and Debris Smaller than 5mm

According to state regulations, municipalities with populations over 100,000 and separate storm and sewage conveyances (Phase I MS4s) must control commercial and industrial discharges through education and enforcement, requiring industrial dischargers to implement BMPs to control their stormwater discharges. Recent investigations by AMRF and the SCCWRP have shown that industrial stormwater discharges of pre-production plastic resins are a significant source of pollution in the San Gabriel and Los Angeles River watersheds.⁷⁷ California has the greatest number of plastics facilities in the nation, including plastic resin processors, transporters, and packagers. Estimates of the numbers of facilities in Southern California (primarily in Los Angeles, Orange counties) range from 2,000 to 8,000, but no agency or association has a complete inventory.⁷⁸ These facilities range in size from small operations with only 3 or 4 employees on one shift per day, to much larger operations working 24 hours a day, 7 days a week.

Stormwater management programs of Phase I MS4 permittees should monitor plastics manufacturing facilities within their jurisdictions to make sure they are not sources of plastic debris discharge to local waterways. These programs can require that industrial facilities implement BMPs. Industry-recommended BMPs for the plastics facilities are discussed in this report. Some of the BMPs used to control discharges smaller than 5mm at industrial facilities can be applied to controlling debris smaller than 5mm at non-industrial sites.

Pre-production plastics (in the form of pellets or powders) are discharged to waterways during the transport, packaging, and processing of plastics when BMPs (i.e., proper housekeeping practices) are not adequately employed. For pellets transported by rail, cars are emptied via a tubular valve that connects to a conveyance hose. The valve should be capped when not in use. Caps are sometimes improperly replaced causing pellet loss within the rail yard adjacent to a facility. A similar conveyance system exists for resins transported by hopper trucks. Pellets and powders escape when hoppers are emptied through pipes connected to tubular valves at the bottom of the truck. Valves are

⁷⁷ S. Moore et al, 2001, "Composition and Distribution of Beach Debris in Orange County, California," *Marine Pollution Bulletin*, 42:3, 241-245; see also C.J. Moore, et al, "Density of Plastic Particles found in Zooplankton Trawls from Coastal Waters of California to the North Pacific Central Gyre," and "Working Our Way Upstream: A Snapshot of Land-Based Contributions of Plastic and Other Trash to Coastal Waters and Beaches of Southern California" in *Proceedings of the Plastic Debris Rivers to Sea Conference*, 2005 www.plasticdebris.org

⁷⁸ Based on telephone comments from the Society of the Plastics Industry, Feb. 16, 2006.

sometimes improperly closed after unloading, causing spillage to the yard.

When handled improperly, resin pellets and powders are released from conveyance mechanisms. In addition to plastic resins, additives used for coloring or creating specific characteristics of processed plastics are also delivered in pellet and powder form. The discharges to local waterways often include colorants and additives, not just plastic resins. Ground plastic parts and fragments from the processing of plastics are often part of the mix of debris that is conveyed by wind, storm water, or runoff from plastics facilities to storm drains and nearby waterways.

Pellets, powders, and fragments are widely dispersed from their places of origin. The impacts of powders and plastic debris smaller than pellets are not known but ingestion by plankton and other small marine organisms does occur.⁷⁹ The impacts of pelletized and powdered plastic additives, such as colorants and chemicals, in the marine environment are not well understood as research is in the initial phases.

Operation Clean Sweep (OCS) is a program of voluntary BMPs that was first developed in 1980 by SPI. It was recently revised and improved by a collaborative effort between APC and SPI to conduct outreach effort about *OCS* to plastics facilities in California. The program is supported in California by a multi-media effort to boost its outreach, including web-based materials (www.opcleansweep.org), trade show displays, rail car stickers, and training workshops.

As part of the *Plastic Debris, Rivers to Sea Project*, the California Coastal Commission and Algalita Marine Research Foundation reviewed the *OCS* program and related materials. After extensive work in the field, touring and monitoring stormwater discharges at many facilities along the Los Angeles and San Gabriel Rivers, the Project gained intimate knowledge of the practices of the industry. Through interviews, research, and field observation, the Project developed expertise about the necessary housekeeping practices for preventing pellet and powder loss. The Project concluded that, if adequately implemented, the *OCS* program can be effective in controlling pellet loss. Therefore, the Project recommends that municipalities use the program for guidance as to the BMPs that can be used to prevent pellet loss and plastics industrial facilities.

How *Operation Clean Sweep* Addresses the Problem

The *OCS* program is web-based. It provides a manual that sets forth the principles and approaches of the program. Facility operators are expected to read the manual, use the checklists provided in the manual, and sign the zero pellet loss pledge. Once they sign the pledge and return it to the *OCS* program, their company is listed on the website. The process that the program prescribes for company management is the following:⁸⁰

⁷⁹ Thompson, R.C.

⁸⁰ Adapted from the *OCS* manual – www.opcleansweep.org

- 1. Commit to making zero pellet loss a priority.**
Sign the “Pledge to Prevent Resin Pellet Loss” (available at www.opcleansweep.org)

- 2. Assess your company’s situation and needs.**
 - Comply with all environmental laws and regulations that address pellet containment.
 - Conduct a site audit.
 - Determine if you have appropriate facilities and equipment.
 - Determine if employees have and are following appropriate procedures.
 - Identify problem areas and develop new procedures to address them.
 - Communicate your experiences to peers in the industry.

- 3. Make needed upgrades in facilities and equipment as appropriate.**
- 4. Raise employee awareness and create accountability.**
 - Establish written procedures (The procedures and checklists in this manual may be modified to suit your needs. They are available online at www.opcleansweep.org).
 - Make certain the procedures are readily available to employees.
 - Conduct regular employee training and awareness campaigns on Operation Clean Sweep.
 - Assign employees the responsibility to monitor and manage pellet containment.
 - Encourage each worker to sign the employee commitment pledge.
 - Solicit employee feedback on your program.
 - Use workplace reminders such as stickers, posters, etc.

- 5. Follow up and enforce procedures — when management cares, employees will, too.**

Conduct routine inspections of the facility grounds — production areas and parking lots, drainage areas, driveways, etc. Continuously look for ways to improve the program. Share best practices through the Operation Clean Sweep web site: www.opcleansweep.org.

VII. CONCLUSIONS

To be effective, municipal stormwater programs must first assess the sources, land uses, locations, quantities, and composition of trash and debris. After conducting this assessment, stormwater programs must choose solutions that are best suited based on the information gained in the assessment, plus an understanding of the frequency and intensity of stormwater flow, site characteristics and siting limitations, maintenance feasibilities, and budget considerations.

There is no one method for completely controlling trash and debris in stormwater and urban runoff. Institutional controls may provide the best long-term solutions, especially those focused on prevention. However, depending on the magnitude of the problem, institutional controls may be inadequate. Focusing on enforcement of litter laws is considered by many to provide the most “bang for the buck.” However, most urban municipalities will have to do more to physically capture and control trash in urban waterways or to prevent it from reaching the waterway.

The field of trash control is new and emerging. This report provides a snapshot of the innovative practices that are currently being implemented by local jurisdictions in Southern California. The *Plastic Debris, Rivers to Sea Project* is committed to seeing a future in which urban communities no longer discharge plastics and trash to the ocean environment. This is an ambitious vision. It will require participation by all stakeholders in the litter and marine debris problem: government, industry, the environmental community, homeowners, motorists, and commercial enterprise.

Appendix 1. BMP EASE OF IMPLEMENTATION- Relative Costs and Benefits⁸¹

Practice	Relative Ease of Implementation	Relative Cost	Relative Benefit
Mid-Drain Structural Device Retrofit	Not Easy in Many Situations	High	High, but only if obstacles can be overcome
Start-of-Pipe Structural Device Retrofit (e.g. catch basin opening screens and excluders)	Moderately Easy in Many Situations	Moderate	High, especially if it qualifies as a stand-alone “full capture” device
End-of-Pipe Structural Device Retrofit (e.g. trash racks, fabric mesh socks and wire screens)	Very Easy in Certain Situations	Moderate to Low	High
Hydraulic Disconnection and/or Replacement of Impervious Surfaces	Disconnection Moderately Easy in Some Situations Repaving Moderately Easy for Public areas	Moderate	Low to High, depending on percentage of impervious surface disconnected or replaced
Street Sweeping	Moderately Easy	Moderate	High
Adjustment of Street Sweeping Contracts, Stricter Enforcement of No-Parking During Street Seeping Days, and Encouraging/Sponsoring More Public Cleanup Events.	Moderately Easy	Low	Moderate
Open Channel Sweeping	Moderately Easy	Moderate to High	High
Performance-Based Open Channel Trash Removal Contracts	Easy	Low	High
Private and Public Parking Lot Sweeping	Moderately Difficult for private lots, moderately easy for public lots	Moderate	High
Retrofit of Catch Basins on Private Parking Lots	Moderately Difficult	Low for General Public, Moderate	High

⁸¹ Copied from: County of Los Angeles Department of Public Works Technical Report on Trash Best Management Practices Aug. 5, 2004 Pages 16 &17

		to High for Property Owners	
Increased or Focused Public Education	Moderately Easy	Moderate	Moderate
Dedicated Hot Line and Response	Very easy	Moderate	Moderate
No-Litter Laws Prohibiting Certain Products at Recreational Areas, such as Cigarette Butts, Styrofoam Cups, etc.	Moderately difficult	Moderate	Moderate
Product Market-Based Reduction Incentives and Product Substitution.	Moderately Difficult	Moderate	Moderate
Sub-regional Trash Control Facilities	Moderately Easy in New Development, Difficult in Developed Areas	High	High

**Appendix 2 - Overview of
Devices and Vendors of
Structural BMPS**

BMP	BRAND/TRADEMARK NAME	COMPANY
Curb Guard/Screen Cover	Bio Curb Guard Curb Protector - CP DrainPac™ Curb Mesh Screen/Curb Cover FloGard+Plus® Ultra-CurbGuard	Bio-Clean Environmental Services, Inc. Revel Environmental Manufacturing, Inc. United Storm Water, Inc. Kri Star Enterprises, Inc. UltraTech International, Inc.
Curb Inlet	Bio-Clean Clean Water System ClearWater BMP DrainPac™ Curb Inlet EnviroPod™ Inceptor® P2 Filter Triton Filter™ Curb Inlet Insert - TRC	Bio-Clean Environmental Services, Inc. Clearwater Solutions, Inc. United Storm Water, Inc. Stormwater 360 Stormdrain Solutions P2 Filter Revel Environmental Manufacturing, Inc.
Grate Catch Basin Insert	Bio-Clean Grate Inlet Skimmer Basket DrainPac™ Drop Inlet FloGard+Plus® Geo-Trap Filter - GT Inceptor® Ultra-Urban® Filter	Bio-Clean Environmental Services, Inc. United Storm Water, Inc. Kri Star Enterprises, Inc. Revel Environmental Manufacturing, Inc. Stormdrain Solutions AbTech Industries
Hydrodynamic Separator	BaySaver Separation Unit Continuous Deflective Separator CrystalStream Water Quality Vault FloGard Dual Vortex® Stormceptor® Vortechs® System VortSentry® VortCapture®	BaySaver Technologies, Inc. CDS Technologies, Inc. CrystalStream Technologies Kri Star Enterprises, Inc. Rinker Materials Hydro Conduit Division Stormwater 360 Stormwater 360 Stormwater 360
End-of-Pipe Netting Device	Netting TrashTrap® Net Tech™	Fresh Creek Technologies, Inc. Kri Star Enterprises, Inc.
Linear Radial Screen Device	Storm Flo™ Screen	Roscoe Moss Company
Litter or Trash Booms	SeaCurtain™ Debris Barrier	Kepner Plastics Fabricators, Inc.
Media Filtration	VortFilter®	Stormwater 360
Litter Collection Screen/Net	StormScreen	Storm Water Systems Stormwater 360
Nutrient Separating Baffle Box	Bio-Clean NSBB Unit	Bio-Clean Environmental Services, Inc.
Service and Maintenance Provider	Bio Clean Environmental Services, Inc. Drainage Protection Systems	Bio-Clean Environmental Services, Inc. Kri Star

Appendix 3 LA County DPW Directory of Devices and Vendors

Excerpts from the Los Angeles County Department of Public Works BMP Yellow Pages regarding trash and litter control BMPs <http://ladpw.org/wmd/bmp/YellowPages>

The BMP Yellow Pages are a list of proprietary and nonproprietary products, activities, and services that are meant to improve or eliminate pollution associated with urban runoff and stormwater. Usage of the term “Best Management Practice” does not imply that some products, activities, or services are better than others, nor that the County of Los Angeles evaluates or decides which product, activity, or service should be listed. The inclusion of manufacturers, consultants, products, or services on this list in no way represents an endorsement or guarantee of effectiveness as a result of the use of these products. Please consult the vendor and follow the manufacturers' specifications for preparation, installation, and maintenance of these products.

Floating Trash Booms

Nautilus Marine Protection, Inc.

David Bilicki

d.bilicki@verizon.net

562-437-5844

PO Box 20099, Long Beach, CA 90801

LACDPW pilot installation at mouth of Los Angeles River, Long Beach, CA.

Brash Industries

Helix Boom System

brashind@aol.com

310-305-8637

4635 Admiralty Way, Marina del Rey, CA 90292

Kepner Plastic Fabricators, Inc.

SeaCurtain

Ben Cowart, Sales Rep.

ben@kepnerplastics.com

310-325-3162

3131 Lomita Bl., Torrance, CA 90505

www.kepnerplastics.com

Trash Excluder, Catch Basin

U.S. Enviro-Net Services

OCEAN-Pro Debris Gate

Trash Excluder, Catch Basin

Eric Taylor
team@usenvironet.com
714-526-8020
717-H So. State College Blvd., Fullerton, CA 92831
www.usenvironet.com

Asbury Environmental Services
Clean Screen
Shannon Munger
smunger@asburyenv.com
909-356-0245
13579 Whittram Ave., Fontana, CA 92335
LACDPW pilot installations on 91 catch basins county-wide.

National Inlet Protection, Inc.
Inlet Guard
Billy Mossburg
301-762-1500
PO Box 7125, Gaithersburg, MD 20898
www.nip1.com/welcome.htm

CSM Corp.
Insert 2400
csm_corp@yahoo.com
845-641-7259

Advanced Solutions
StormTek
Octavio Lugo
advanced.solutions@sbcglobal.net
714-457-3283
Installed in City of L.A. catch basins.

American Storm Water
Surf-Gate
Terry Flury
americanstormwater@yahoo.com
310-261-1570
Torrance, CA
www.americanstormwater.com
Installations in Huntington Beach, Garden Grove, and Los Angeles, CA.

Trash Sock, End of Pipe

StormWater Systems (Australia)

PT2000

Anto Pratten

antopratten@stormwater.com.au

www.stormwater.com.au

LACDPW pilot installation at Compton Ck. retention basin, Rancho Dominguez, CA

NSW, LLC.

Copasacs Stormwater Screens

netting@nswplastics.com

800-368-3610

530 Gregory Ave., Roanoke, VA 24016

www.nswplastics.com

Trash and Gross Pollutants Separation

Best Management Products

Snout

T.J. Mullin, Pres.

tjm@bestmp.com

800-504-8008

www.bestmp.com

Roscoe Moss Co.

Storm Flo Litter Screen

Tim Lynch, V.P.

info@roscoemoss.com

323-263-4111

4360 Worth St., L.A., CA 90063

www.roscoemoss.com/gsr.html

Installed and evaluated by Caltrans in Los Angeles and San Diego Counties. Believed to be "Certified Full Capture" by the L.A. Regional Board.

Stormwater Management, Inc.

StormGate Separator

Will Harris, Senior Reg. Mgr.

willh@stormwaterinc.com

877-446-7250

13876 Comanche Court, Yucaipa, CA 92399

www.stormwaterinc.com

Installations in City of Long Beach, City of Elk Grove, Sacramento County, Placer County

Stormwater Management, Inc.

StormScreen

Will Harris, Senior Reg. Mgr.

willh@stormwaterinc.com

877-446-7250

13876 Comanche Court, Yucaipa, CA 92399

www.stormwaterinc.com

Installations in City of Simi Valley, City of Thousand Oaks, Ventura County.

Manufacturer claims the device has drain-down capability.

Ski-Jump Runoff Services

Ski-Jump Silt and Litter Trap

Doug Nicholas

srsnicholas@bigpond.com

61 2 94274910

11 Angus Ave, Lane Cove, NSW 2066, Australia

www.users.bigpond.com/srsnicholas/

United Storm Water, Inc.

DrainPac

Tony Figueroa

tfigueroa@unitedstormwater.com

877-717-8676

14000 E. Valley Blvd., Ste. B, City of Industry, CA 91746

www.unitedstormwater.com

Installed at LACDPW maintenance yards and catch basins in Malibu, Lawndale, Quartz Hill, Baldwin Park, CA, and nationwide. In use in L.A. County's trash baseline monitoring study.

Maintenance available from vendor.

Jensen Precast

StormVault

Alistair Muller, Sales Engineer

800-257-6100

14221 San Bernadino Ave. Fontana, CA 92335

www.stormvault.com

Vortechnics

Vortechs

John Stiver, Western Zone Mgr.

jstiver@vortechnics.com

877-907-8676

200 Enterprise Dr., Scarborough, ME 04074

www.vortechnics.com

Installed in Oxnard, Broadus School Pacoima, San Ramon, City of Los Angeles maintenance yard, CA.

Rinker Materials

Stormceptor

Jim Johnston, Area Mgr.

jjohnston@rinker.com

909-277-2420 Ext. 302

23200 Temescal Cyn. Rd., Corona, CA 92878-0939

www.rinkerstormceptor.com

Installation at Sunset Millenium, W. Hollywood, CA; Carson Tower Center, Carson, CA;

Cities of Los Angeles, Malibu, Irvine, Seal Beach, Huntington Beach, Ventura, and Santa Barbara, CA.

Pilot installation at LACDPW maintenance yard.

Hydro International

Downstream Defender

Pamela Deahl, V. Pres.

pdeahl@hil-tech.com

207-756-6200 x 204

94 Hutchins Dr., Portland, ME 04102

www.hydro-international.biz

Installation in Huntington Beach

Hydro International

Storm King

Pamela Deahl, V. Pres.

pdeahl@hil-tech.com

207-756-6200 x 204

94 Hutchins Dr., Portland, ME 04102

www.hil-tech.com

BaySaver

www.baysaver.com

Installed at Rose Crossing Shopping Ctr, Oxnard, CA; Sierra Pacific Power Co., So. Lake Tahoe, CA

CDS Technologies

Walter Stein, Engineering Sales

wstein@cdstech-us.com

408-779-6363

16375 South Monterey Rd., Unit C, Morgan Hill, CA 95037

www.cdstech.com

LACDPW pilot installations at: Branford Spreading Basin, Sun Valley; Marine Stadium and Alamitos

Bay pump plant, Long Beach. Believed to be "Certified Full Capture" by the L.A. Regional Board.

Fresh Creek Technologies

Netting TrashTrap

John Meakim, CEO

jtmeakim@freshcreek.com

973-237-9099

1425 Pompton Ave., Ste. 1-2, Cedar Grove, NJ 07009
www.freshcreek.com

LACDPW pilot installation in Hamilton Bowl Pump Plant forebay, Long Beach, CA. Believed to be "Certified Full Capture" by the L.A. Regional Board.

BioClean Environmental Services, Inc.

Baffle Box

Janet Kent, V.P.

jkent4@cox.net

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www.biocleanenvironmental.net

Over 90 installations in Florida. Maintenance available from vendor.

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jjohnston@rinker.com

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www.rinkerstormceptor.com

Installations in Australia.

Bio-Microbics, Inc.

BioSTORM

onsite@biomicrobics.com

913-422-0707

8450 Cole Pkwy., Shawnee, KS 66227

www.biomicrobics.com

American Marine Oil Systems

End of Line Collection System

Dan West, Pres.

info@americanmarineoil.com

877-582-5823

P.O. Box 1021 Newport Beach, CA. 92659

www.americanmarineoil.com

Installation in Newport Beach, CA. Company also provides maintenances services.

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onsite@biomicrobics.com

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www.biomicrobics.com/index.html

Manufacturer also makes oil and grease separators, filter media, and onsite wastewater treatment systems.

CrystalStreams Technologies
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bradcrouch@crystalstream.com
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Vortechnics
VortSentry
John Stiver, Western Zone Mgr.
jstiver@vortechnics.com
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John Stiver, Western Zone Mgr.
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www.stormwaterinc.com

Installations in City of Long Beach, City of Elk Grove, Sacramento County, Placer County

Trash Excluder with Treatment

Stormwater Treatment Systems

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Sameer Etman

sameeretman@hotmail.com

626-644-0973

1101 E Loma Alta Dr, Altadena, CA 91001

www.stormwatertreatmentsystems.com

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