ORANGE COUNTY STORMWATER PROGRAM

APPENDIX E2

TRASH AND DEBRIS

BEST MANAGEMENT PRACTICE (BMP) EVALUATION

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A cooperative project between the County of Orange, Orange County Flood Control District and the incorporated cities of Orange County.

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EXECUTIVE SUMMARY

Trash and debris within stormwater is a significant problem in the municipal areas of southern California. Trash and debris in surface waters can inhibit the growth of aquatic vegetation, harm aquatic organisms by ingestion or entanglement, convey other pollutants, such as toxic substances, and cause aesthetic problems on shorelines. A major source of trash in the rivers, channels and beaches results from litter that is intentionally or accidentally discarded in watershed drainage areas. This trash is then transported in storm drains to the creeks, rivers and oceans during and after rainstorms. Recently the State Water Resources Control Board has imposed a monitoring list designation for trash on the Orange County coastline, with the potential for subsequent 303(d) listing as an impairment of beneficial uses. Orange County jurisdictions must maintain effective programs to prevent the deposit of trash and the removal of it from the drainage systems.

The objectives of this report is to 1) review characterization information on trash and debris in Orange County and 2) identify potential structural BMP devices available and review performance and cost-effectiveness. This study is being conducted in partial compliance with requirements of the current Region 8 National Pollutant Discharge Elimination System (NPDES) stormwater permit.

Litter is defined as 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 on the lands and waters of the state. Trash is defined as useless waste material or rejected matter 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. Organic material is defined as vegetation or other natural material such as leave, twigs, flowers, fruit and grass.

For purposes of this report, litter is considered particles made from paper, plastic, cardboard, glass, metal, etc. that can be retained by a ¼-inch mesh screen. This includes material such as cups, napkins, and cigarette butts. This definition excludes sediment, oil and grease, and vegetation, except for yard waste that is illegally disposed of in the storm drain system. Litter should be quantified by 24-hour air-dried volume and weight measurements.

The debris characterization study done to determine the source of the trash and debris flowing into San Diego Creek from the El Modena-Irvine and Peters Canyon Wash channels indicated the amount of orga nic materials found at El Modena-Irvine (18%) was significantly less than the 47% observed at Santa Ana-Delhi. The amount of plastic materials found at El Modena-Irvine (48%) was higher than the average (34%) at Santa Ana-Delhi. The composition of rubber materials for El Modena-Irvine (16%) is much higher than the average for Santa Ana-Delhi (4.9%).

Floating boom systems are intended for trapping floating litter and organic debris and consist of a hanging mesh skirt. They are usually anchored to a shoreline structure and are placed across channels or creeks to collect floating debris. Trash racks involve the use of closely spaced vertical rods as a screen to trap gross solids. Litter baskets consist of wire mesh baskets. There are also floating net units made up of an in-water containment area that channels flow through a series of large nylon mesh nets. There are also hydrodynamic units that use hydrodynamic forces for separating solids and floatable material. When water enters the unit on a tangential plane, a circular flow pattern is established by the cylindrical shape of the unit, creating a vortex.

There have been several trash and debris BMPs implemented in areas of Orange County. These include over 1,500 catch basin inserts and catch basin screens, twelve in-line treatment units and nine trash and debris booms

The selection of the proper trash and debris BMP is dependent on numerous factors including regulatory issues, watershed characteristics, site constraints such as available head and available footprint. It is preferred but not always possible to base BMP selection primarily on the efficiency to reduce the trash and debris loads for the local receiving water. In many cases, the physical characteristics of a site drive the selection process.

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List of Acronyms

BMP	Best Management Practice
CDS	Continuous Deflective Separators
CEQA	California Environmental Quality Act
CWA	Clean Water Act
DAMP	Drainage Area Management Plan
DII	Drain Inlet Insert
EPA	Environmental Protection Agency
GPTs	Gross Pollutant Traps
GSRDs	Gross Solids Removal Device
MEP	Maximum Extent Practicable
NPDES	National Pollutant Discharge Elimination System
OC	County of Orange
SCAG	Southern California Association of Governments
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
UV	Ultraviolet

1 INTRODUCTION

Trash and debris within stormwater is considered to be a significant problem in the municipal areas of southern California. Trash and debris in surface waters can inhibit the growth of aquatic vegetation, harm aquatic organisms by ingestion or entanglement, convey other pollutants, such as toxic substances, and cause aesthetic problems on shorelines. Recently the State Water Resources Control Board has imposed a monitoring list designation on the Orange County coastline, with the potential for a subsequent 303 (d) listing as an impairment of beneficial uses. Jurisdictions in Orange County must maintain effective programs to prevent and remove trash from the drainage systems. The trash and debris characterizations and structural BMP evaluation is being conducted in partial compliance with requirements of the current Region 8 NPDES stormwater permit.

The objective of the trash and debris BMP evaluation is to assess the cost-effectiveness and efficiency of the various structural trash BMPs that are currently being used locally or otherwise to treat storm water runoff for trash / debris. Their applicability for site-specific implementation within Orange County was considered as well as a determination of their long-term effectiveness. The work completed as part of this study included:

1. A review of the technical literature was done on the design, siting, performance, maintenance requirements, and costs of these devices. The goal of the review was to identify candidate BMPs.

2. A review of existing programs and demonstration projects in Southern California was done to identify and assess the effectiveness of BMPs currently in use in Orange County to remove trash and debris from storm water such as catch basin inserts, CDS™ type units and trash / debris booms (Peter's Canyon Channel, El Modena-Irvine, Santa Ana / Delhi Channels, Newport Bay and Huntington Harbor). The goal of the review was to determine the actual effectiveness of the candidate BMPs in removing trash and debris under a variety of field conditions.

3. Source characterization and identification methods were recommended based upon the literature review and the evaluation of the existing BMPs that are being implemented within Orange County for trash / debris control. Methodologies for source characterization and identification are identified.

This report provides recommendations based upon supportable technical information to allow the Orange County Permittees to properly select, site, design, construct, maintain and assess the long term effectiveness of the implemented BMPs. Based upon the characterization of the trash and debris collected, the report also provides recommendations on source identification methodologies.

2 SOURCE CHARACTERIZATION AND IDENTIFICATION

The major source of trash in Orange County receiving waters results from litter, which is intentionally or accidentally, discarded in watershed drainage areas. This trash is then transported in storm drains to the creeks, rivers and oceans during and after rainstorms.

2.1 Definition of Litter

Litter is defined in California Government Code Section 68055.1(g) as:

> 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 on the lands and waters of the state, but not including the properly discarded waste of the primary processing of agriculture, mining, logging, sawmilling or manufacturing […].

Trash is defined as "Useless waste material or rejected matter 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"

Organic material is defined as vegetation or other natural material such as leave, twigs, flowers, fruit and grass.

For purposes of this report, litter is considered particles made from paper, plastic, cardboard, glass, metal, etc that are retained by a ¼ inch mesh screen. This includes material such as cups, napkins, and cigarette butts. This definition excludes sediment, oil and grease, and vegetation, except for yard waste that is illegally disposed of in the storm drain system. Litter should be quantified by 24-hour air-dried volume and weight measurements. Litter and debris are also referred to as "gross solids" in Australian scientific literature.

2.2 Recommended Litter Sampling Protocols

2.2.1 Sampling and Analysis Protocols

There are numerous factors that can affect the amount of trash and debris in stormwater. These factors may include:

- Land use type
- Rainfall intensity
- Population
- Management Practices (street sweeping, recycling program)
- Education and Awareness Programs
- Antecedent Dry Period
- Size and Geometry of the Storm Drain
- Physical Drainage Area Characteristics (size, slope, vegetation)

To determine the amount and the characteristics of litter in the storm drain system litter samples should be collected. Litter samples may be collected by attaching a ¼-inch mesh bag to the pipe outfall. Outlet pipe diameters between 12 and 24 inches work best. Litter and organic debris is collected as the storm water drains through the mesh. Clean bags should be placed on each pipe before each predicted storm event. At the conclusion of each storm event, the bags should be retrieved and the captured material analyzed.

To investigate how litter is conveyed from the drain inlet to the outfall, labeled items may be placed in the inlets by hand prior to each storm event. These items are then recovered as part of the characterization of the litter sample. The labeled items indicate how fast litter is transported through the piping system. They may also provide a quality control check of the sampling equipment and analysis procedures.

2.2.2 Past Study Findings

The Santa Ana-Delhi debris characterization study was done by the County of Orange in 1998-2000 (County of Orange 2000). A debris containment system was installed within the flood control channels in the San Diego Creek watershed consisting of an 18" wide net suspended below a floating boom that extends the span of the flood control channel. Although this type of debris containment system captures a considerable amount of trash and debris, its' efficiency is limited by the fact that it can only remove floating materials within a vertical span of 18".

Trash and debris collected in the floating booms were separated into seven defined categories based on previous trash and debris studies. These categories are: Organic, Plastic, Glass, Rubber, Metal, Paper and Cloth. Items that do not fit into these seven categories are put in the "Other" category. Items in the "Other" category are items that are large, unusual or are made of materials in several categories. Items in the “Organic” categories included leaves, twigs, branches, grass clippings, as well as pencils, chair legs, etc. After the trash and debris were segregated they were bagged separately by category and then weighed. The sums of all the categorized bag's weights were added to determine the total weight of trash and debris removed from the debris containment system. For selected category samples, subset samples were obtained in order to determine other characteristics of the collected trash and debris.

Since the collected trash and debris items were wet and some items had sediment attached to the surface, water content and sediment weight subset samples were collected from selected category samples. Water content subset samples, collected from selected categorized samples, were used to estimate the amount of water absorbed within the trash and debris items. A small subset sample was obtained from each category and placed in a small aluminum tray. The trays of subset samples were weighed to obtain the wet weights. The subset samples in the trays were then dried in an oven at 60 degrees Celsius to remove water and moisture. After drying for 24 hours, the subset samples in the trays were re-weighed to determine the dry weights. The difference in the wet and dry weights of a specific category is the amount of water associated with that category.

Sediment weight subset samples, used for the estimation of sediment attached to Organic and Plastic trash and debris items, were obtained from the segregated Plastic and Organic categories only. These categories were selected based on previous study findings that these two categories make up the majority of the trash and debris collected and therefore most affected by the amount of attached sediment.

For the sediment subset sampling, one subset sample bag of Organic and one subset sample bag of Plastic were selected and weighed. The contents of these subset sample bags were then separately placed into large crates that have quarter inch diameter holes at the bottom. The crates serve as strainers to allow the sediment to be washed from the pieces of Organic and Plastic items. In some instances, scrubbing and flushing is necessary to remove the sediment. After the washing and straining, the items were shaken vigorously in the crate to remove excess wash water. The items were then placed into two separate clean bags and small holes were punctured in the bottom of the bags to allow excess water to drain. After draining, the subset samples were re-weighed. The difference in the weights before and after washing the subset samples is the weight of the sediment attached to the Plastic and Organic materials.

The debris characterization study done to determine the source of the trash and debris flowing into San Diego Creek from the El Modina-Irvine and Peters Canyon Wash channels indicated the amount of organic materials found at El Modena-Irvine (18%) was significantly less than the 47% observed at Santa Ana-Delhi. The amount of plastic materials found at El Modena-Irvine (48%) was higher than the average (34%) at Santa Ana-Delhi. The composition of rubber materials for El Modena-Irvine (16%) is much higher than the average for Santa Ana-Delhi (4.9%).

2.3 Litter Characterization

Litter and debris collected should be weighted and volume should be measured. The litter should be separated from the vegetative / organic matter and placed on drying racks. After drying on the racks for 24 hours, the litter should be sorted and classified into the following 10 categories:

- Plastic
- Paper
- Rubber
- Glass
- Styrofoam
- Metal
- Cloth
- Wood debris (pencils, furniture)
- Cigarette butts
- Other

These categories are similar to the categories used in Caltrans Litter Study (2000) and Australian litter studies.

Litter should be characterized by weight, volume, and number of items. Air-dried weight obtained using a digital scale; volume estimated by placing the litter samples into graduated containers; and the number of items determined by manual count. Table 2-1 identifies types of materials that would fall under each category.

Each type of litter may be divided into prior usage categories – food -related, smoking-related and other. Because it is difficult to associate litter with its prior use simply by looking at it, these are the only three category definitions. By categorizing litter as food related and smoking related these results can be used to compare the effectiveness of source control programs targeted to these activities and locations where these activities take place.

Based on the results from sampling litter in the drainage areas of Orange County a source control campaign may used to target those areas where trash is largely generated. Studies (Allison 1998, Armitage 1998) have shown that higher amounts of litter are accumulated in commercial areas than in residential areas. This suggests that commercial areas should be targeted for non-structural reduction strategies and BMP implementation.

Important considerations for selecting the appropriate BMP also involve the watershed characteristics. Research of trash and debris characteristics has shown that storm water gross solids are composed of approximately 10-20% litter and 80-90% organic material for floatable and settable material (Allison et al., 1998; Caltrans, 2002). However trash and debris BMPs cannot distinguish between litter and organic material therefore, all debris must collected. Less than 20% of litter is transported as floating material; the bulk is either entrained in the flow or sinks. Studies by Allison et al. (1998) suggest a nominal annual gross solid load for a typical mixed-use watershed (material greater than 5 mm) of approximately 80 lb/ac/yr, wet weight. Typical pollutant density (wet) of 15.5 lb/ft^3 and a wet to dry mass ratio of 3.3 to 1 were also found. Table 2-2 presents gross solid load approximations that may be used for sizing BMPs when actual loading rates for a watershed are not available.

Table 2-1 Recommended Trash and Debris Characterization Categories

Category	Items
Vegetative Matter	Leaves, twigs, branches, grass clippings, flowers, fruit, seeds, pine cones, bark
Plastic	Plastic: bags, pens, wrappers, caps, straws, balls, sports bottles, plastic water and beverage bottles, unidentified plastic ends, six pack beverage container holders, fruit juice containers, misc. hard plastic items
	Foamed Plastics: plates, cups and lids, peanuts for packaging, surfboard foam, foam packaging materials
Paper	Newspaper, cardboard, fast food cups, white paper
Rubber	Tennis balls, racket balls, balloons, gloves, inner tubes, misc. Rubber pieces
Glass	Beverage bottles, light bulbs, misc. glass pieces,
Styrofoam	Food containers, beverage containers, misc. Styrofoam pieces.
Metal	Aerosol containers, aluminum beverage cans, foil gum wrappers
Cloth	Fabrics, clothing remnants, cotton / nylon strings
Wood Debris	Lumber materials, pencils, misc. wood pieces.
Cigarette butts	Cigarette butts

SOURCE: Caltrans 2000, Allison 1998

Table 2-2 Gross Solid Load Approximations

Land Use Type	Gross Solid Volume	Gross Solid Volume (Design values)
Commercial	7.6 ft^3 / ac / year	15.2 ft^3 / ac / year
Residential	4.0 ft^3 / ac / year	8.0 ft^3 / ac / year
Light-Industrial	2.1 ft^3 / ac / year	4.2 ft^3 / ac / year

SOURCE: Melbourne 2001, Caltrans 2000, Allison 1998

3 LITERATURE REVIEW

This chapter presents the results of an international literature review of the siting, design, performance (mass of gross solids retained / total mass of gross solids load), maintenance and cost of various proprietary and non-proprietary trash and debris removal devices. These devices use trash racks, litter baskets, screens, nets and sedimentation as mechanisms to trap and intercept litter at drain inlets, in-pipe, end-of-pipe and along open watercourses. The following criteria were used to identify practices that are included in this review:

- The practice must be a structural control.
- The practice must remove trash and debris.

The following gross solid removal products were reviewed:

- Fresh Creek Netting TrashTrap®
- NetTech GPI™
- Cleansall™ Gross Pollutant Trap
- Ski-Jump Silt and Litter Trap®
- CDS™
- Baramy GPT™
- StormScreen™
- Caltrans Linear Radial GSRD
- Caltrans Inclined Screen GSRD
- Inlet Screens
- Baysaver®
- Vortechs™
- Drain Inlet Inserts
- Litter Booms

These candidate BMPs are described and reviewed under their respective functional category as follows: (1) netting devices; (2) litter baskets; (3) screen devices; (4) separation / hydrodynamic devices; (5) drain inlet inserts ; and (6) litter booms.

3.1 Netting Devices

Some gross pollutant traps (GPTs) are located 'in-line' within a storm water pipe. In-line netting can be mounted at strategic locations. The device can be installed either at 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. The nylon mesh bags are changed after every sizable storm event.

There are also floating net units made up of an in-water containment area that channels flow through a series of large nylon mesh nets. The mesh netting is sized according to the volume and types of floatables intended for capture. The nets are for single use and are discarded after a sizable stormwater event. These devices may not have extensive application in Orange County as many channels do not have flow throughout the year.

3.1.1 Fresh Creek Netting TrashTrap®

3.1.1.1 Introduction

Netting TrashTrap® systems capture and remove trash and floatables using the natural energy of the flow to trap trash, floatables and solids in disposable mesh nets. Knotless, knitted mesh nets are manufactured to proprietary Fresh Creek standards. Standard nets are rated for 500 pounds or 25 cubic feet of captured pollutants. A range of special sizes and heavy -duty nets having even larger capacities and handling higher flow and velocities are available. When filled with captured debris, the nets are removed from the system and disposed of in a sanitary landfill. Nets have an opening of either 0.25 inch or 0.50 inch. Figure 3-1 shows a schematic of the device.

3.1.1.2 Siting

There are three types of Fresh Creek Netting Trash Trap®s. The In-Line Netting Trash Trap is a concrete chamber containing the structure that holds the disposable bags. This system is located between the regulator and the outfall. The End-of-Pipe Netting Trash Trap is installed at the end-of-pipe usually at the existing outfall structure. The Floating Netting Trash Trap is a pontoon structure that floats at the end of the outfall.

Accumulation of litter and debris in these systems can be very rapid and greatly reduce the capacity of the devices. Consequently, they must be installed at sites with easy access for maintenance crews and their equipment. Required equipment often includes a crane for removing nets.

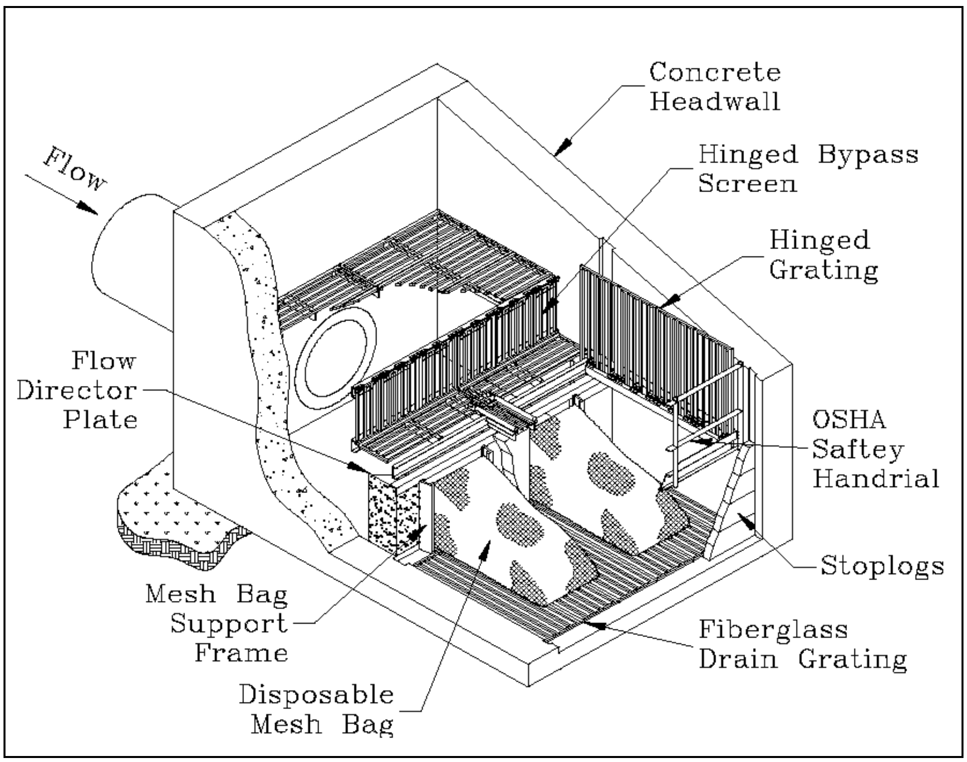

Figure 3-1 Fresh Creek Netting Trash Trap® End-of-Pipe Schematic

3.1.1.3 Design

The system consists of a structure to hold the framework for the nets. There is also a bypass screen above or below the bags to screen the entire flow in the event of backup. These screens are designed with shear pins for the larger, infrequent events.

3.1.1.4 Performance

Field tests sponsored by U.S. EPA indicate that Netting TrashTrap® technology can provide removal efficiencies of greater than 90% for trash and floatables when properly operated and maintained. (EPA 1999). Removal efficiencies were determined by the equation:

$$\text{Removal Efficiency (\%)} = \frac{\text{(Mass retained)}}{\text{(Mass retained + Mass passing)}} * 100$$

3.1.1.5 Maintenance

Maintenance of the Netting Trash Trap is done by replacing the disposable nets following events where sufficient quantities of floatables have been captured. This is usually determined by visual inspection. In-line and end-of-pipe systems are serviced with a boom truck. This requires a minimum crew of two people. The change out procedure for one net can usually be completed in 30 minutes.

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.

The used nets are disposed of by transporting them to a licensed landfill. In southern California nets may need to be changed following every storm event, which may be as frequently as 10 to 20 times per year depending on site-specific litter conditions and rainfall conditions. Where floatable volumes are lower, nets should be changed at least once per month to remove captured waste. Disposable nets are intended for single use only for sanitary and economic reasons and for ease of maintenance.

3.1.1.6 Costs

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 50 cubic feet capacity, handling about 500 pounds of damp weight per net and spanning 15 feet of 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.

Replacement nets designed to capture a high velocity discharge cost $100 per net. Disposal costs for captured materials and nets should also be considered when calculating O&M costs. The quantity of captured floatables will vary from site to site; within southern California there may be a need for net change out approximately 10 times per year.

3.1.2 NetTech GPI™

3.1.2.1 Introduction

The Net Tech GPI™ is a net system used to remove trash and debris from storm water. The Net Tech GPI™ requires little or no structural changes to the existing storm water system. The device works with a float operated release system that allows the net to detach and choke off when flows exceed capacity. Over 500 units have been installed in Australia. Figure 3-2 shows a picture of the device.

3.1.2.2 Siting

The NetTech GPI™ is attached to an existing storm drain outlet to a creek or channel. It is designed to treat flow end-of-pipe. They may be appropriate in residential subdivisions, commercial areas and in retrofits to existing storm water drainage systems.

Accumulation of litter and debris in these systems can be very rapid and greatly reduce the capacity of the devices. Consequently, they must be installed at sites with easy access for maintenance crews and their equipment. Required equipment often includes cranes for removing nets with accumulated trash and debris.

3.1.2.3 Design

The NetTech GPI™ consists of a marine grade stainless steel pipe extension with a heavy duty, UV stabilized polyethylene net. The pipe extension incorporates a release mechanism that allows the net component to release in the event that it becomes fouled with intercepted rubbish. The net can be designed to suit various flow rates and volumes of litter.

Figure 3-2 Net Tech GPI™

3.1.2.4 Performance

Research on the device has been carried out at the University of South Australia in their hydraulics lab. This research will be published in 2003.

3.1.2.5 Maintenance

Given the limited field performance data for this device and the fact that litter accumulation varies by location, inspections should be scheduled after each storm during the first wet season after installation to ensure adequate performance. Quarterly inspections are probably sufficient for the dry season. After the first year, inspection frequency can be reduced if experience warrants.

When the net is full of debris the float operated release detaches the net and chokes it off. Maintenance involves removing the net, attaching a clean net and the full net is emptied at a waste facility. The net can then be reused at the next servicing.

3.1.2.6 Costs

Currently the manufacturer is negotiating with a distributor within California for distribution to the United States.

3.2 Litter Baskets

Litter baskets consist of wire mesh baskets. These devices trap large litter and debris. They may be located in-line or end-of-pipe.

3.2.1 Cleansall™ Gross Pollutant Trap

3.2.1.1 Introduction

The CleansAll™ system consists of precast sections fitted with traps to capture pollutants, large and small, as well as sediment and oil and grease. It can treat flows in-line or end-of-pipe. The litter is contained in a basket that is then removed and emptied. Stormwater enters the inlet chamber, where it is diverted by a by-pass weir into the treatment chamber. Figure 3-3 shows a schematic of the device.

3.2.1.2 Siting

The CleansAll™ system is used for treating flows in-line or end-of-pipe. They may be appropriate in residential subdivisions, commercial areas and in retrofits to existing storm water drainage systems. It is designed for use in space-constrained installations. It has a footprint of 36 ft^2 to 335 ft^2. This system is completely enclosed and may be placed under sidewalks or in other areas where the public has access.

Accumulation of litter and debris in these systems can be very rapid and greatly reduce the capacity of the devices. Consequently, they must be installed at sites with easy access for maintenance crews and their equipment. Required equipment often includes vacuum trucks for removing accumulated trash and debris.

3.2.1.3 Design

This device has a low headloss and can be designed to treat large flows in-line or end-of-pipe. It is designed to capture all gross solids exceeding 2 mm in diameter. The CleansAll™ GPT is designed for ease of assembly. The unit is made up of basic 'building block' components that are craned into an excavated pit and bolted together. The basic elements of the trap are made from reinforced concrete. The collection baskets are manufactured from stainless steel.

It can treat flows from 3 cfs to 96 cfs. The standard units can be retrofitted into pipe sizes from 300 mm to 1650 mm. Customize sizes are also available.

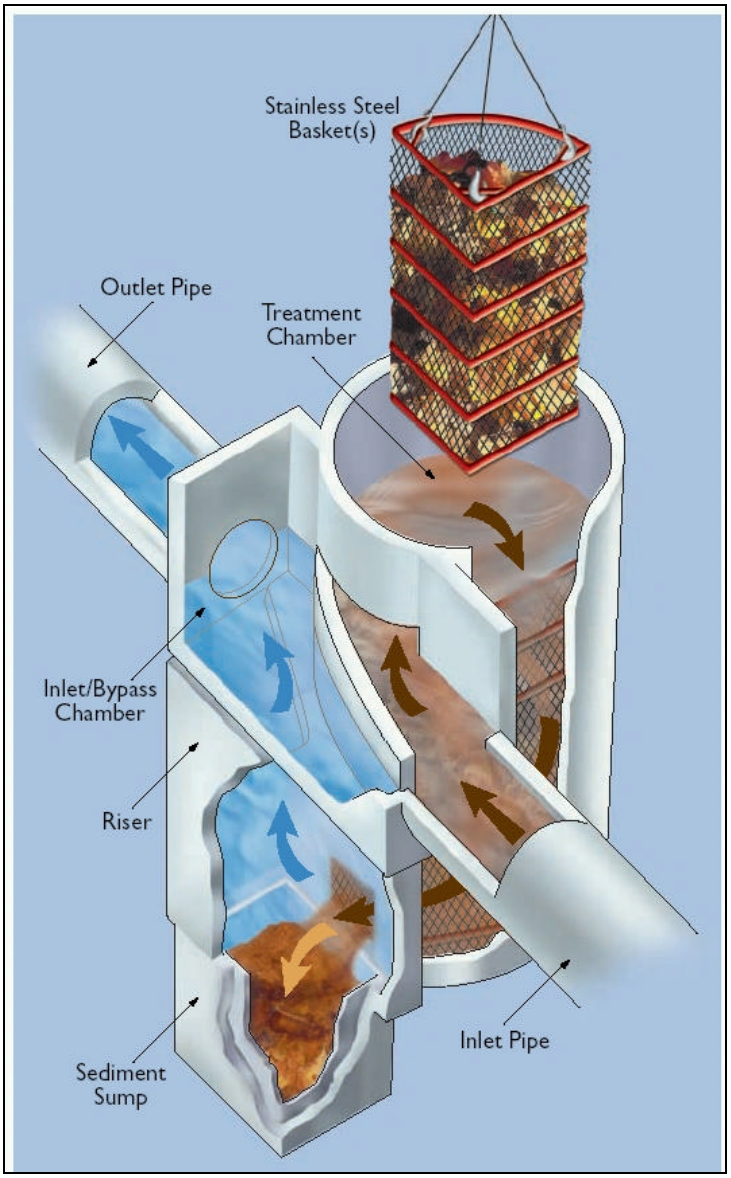

Figure 3-3 Cleansall™ Gross Pollutant Trap Schematic

3.2.1.4 Performance

Testing in currently being done at the Urban Water Resources Centre at the University of South Australia. The preliminary results of this testing has shown that it captures up to 100% of gross solids. The Cleansall™ GPT has a by-pass weir that is generally sized for storms up to a 1-yr, 24-hr event and allows larger infrequent storms to bypass without releasing any previously captured materials.

3.2.1.5 Maintenance

Given the limited field performance data for this device and the fact that litter accumulation varies by location, inspections should be scheduled after each storm during the first wet season after installation to ensure adequate performance. Quarterly inspections are probably sufficient for the dry season. After the first year, inspection frequency can be reduced if experience warrants.

The CleansAll™ is cleaned by lifting out stainless steel baskets or by vacuum extraction. Basket removal is the typical method of cleaning. The removable basket is lifted out and emptied on to a truck. Quarter-size baskets are supplied with larger units for easy lifting using a standard truck-mounted crane.

The CleansAll™ units hold a permanent pool of water. This pool has the potential for mosquitoes breeding and therefore requires additional inspection be the vector control agencies to insure there is no mosquito breeding occurring or to provide abatement.

3.2.1.6 Costs

The CleansAll™ product is currently only available in Australia. They intend to launch the product in the United States in 2003.

3.2.2 Ski-Jump Silt and Litter Trap®

3.2.2.1 Introduction

This is a galvanized steel trap that uses screening, flow-separation, and energy dissipation to remove litter and debris from storm water. The screens capture all particles larger than 5 mm. A trash rack inclined towards the flow collects pollutants during low flows. During large flows, the collected pollutants are pushed downstream into a collection chamber. Several units have been installed in New South Wales. Figure 3-4 shows the device at an installation in Australia.

3.2.2.2 Siting

The trap can either be applied to the existing pipe system or built into new works. The best sites for the trap have a drop of 300 to 400 mm at the pipe outfall to ensure free drainage of the flume and basket and provide a good stilling volume for sediment capture and storage. Installation is possible with a drop of only 100 mm but with some compromise in efficiency and convenience. An extended, shallower basket is recommended in such cases to raise the floor well above surface water to allow captured material to drain thoroughly and to minimize its decomposition.

Accumulation of litter and debris in these systems can be very rapid and greatly reduce the capacity of the devices. Consequently, they must be installed at sites with easy access for maintenance crews and their equipment.

Figure 3-4 Ski Jump Silt and Litter Trap®

3.2.2.3 Design

The Ski Jump can be bolted-on to a headwall and apron in a few hours. Base preparation requires reasonable precision. Less than a week is normally needed for site preparation with the trap being added two weeks later after proper curing and strength gain at anchor points.

3.2.2.4 Performance

In most events the trap captures all the litter larger than its 5 mm apertures. It also filters smaller particles through the already trapped materials, which layer its surfaces. In major events, with the trap full, the flume cover automatically releases to allow the flood peak to bypass. A small head-loss may occur before catch release. Currently there are 127 units installed all in Australia.

3.2.2.5 Maintenance

Given the limited field performance data for this device and the fact that litter accumulation varies by location, inspections should be scheduled after each storm during the first wet season after installation to ensure adequate performance. Quarterly inspections are probably sufficient for the dry season. After the first year, inspection frequency can be reduced if experience warrants. The trap is designed to be serviced by a one-man crew with rake or shovel. A vacuum truck may also be used.

3.2.2.6 Costs

This product has been developed in Australia and currently the only installations of the product are in Australia. There Ski-Jump does have a US patent and the manufacture is currently in contact with the US EPA, Caltrans and the City of Los Angeles for possible installations within the US. The cost for this product within Australia is $2,800 to $17,000 US dollars. The cost within the US is not known at this time.

3.3 Trash Racks or Screen Devices

Screening devices involve the use of screens to trap gross solids. They may be located in-line or end-of-pipe.

3.3.1 Baramy GPT™

3.3.1.1 Introduction

Flow is dropped over a declined trash-rack. The trash moves down an inclined screen with the force of the water, pushing pollutants onto a holding shelf for collection. The litter-free water either flow under the collection shelf or around it. Units have been installed in New South Wales, Australia. Figure 3-5 is a schematic of the device.

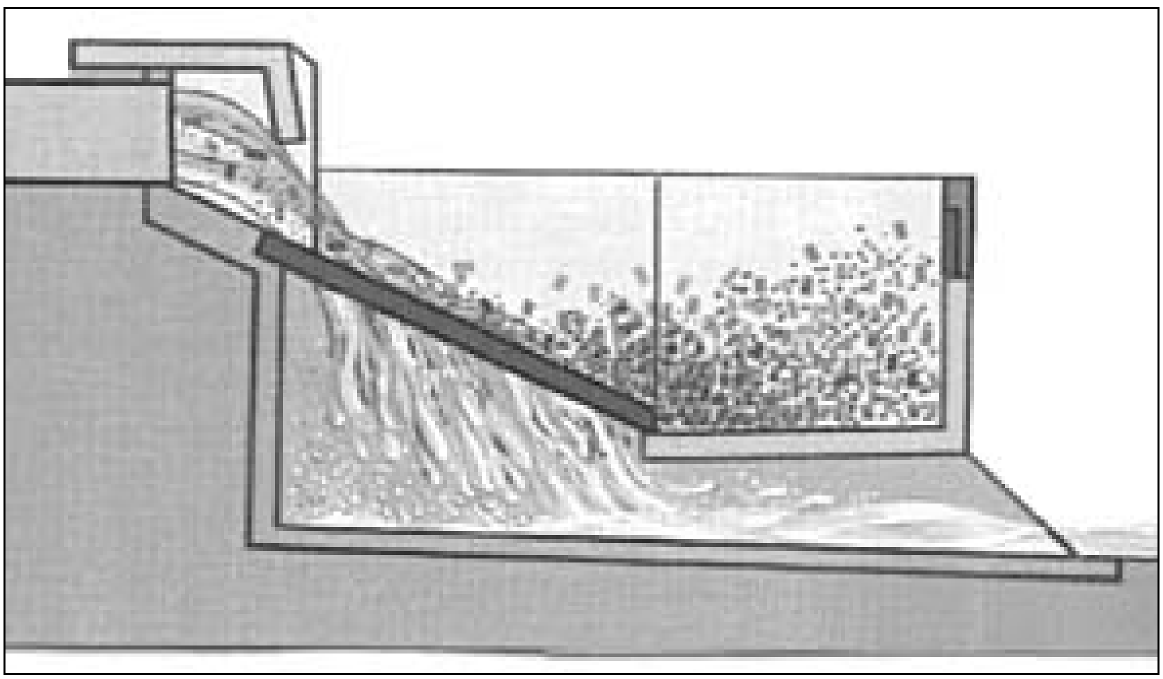

Figure 3-5 Baramy GPT™

3.3.1.2 Siting

The Baramy GPT™ system is used for treating flows end-of-pipe. They may be appropriate in residential subdivisions, commercial areas and in retrofits to existing storm water drainage systems. It is designed for use in space-constrained installations. It has a footprint of 6.75 ft^2 to 13.75 ft^2. This system is exposed.

Accumulation of litter and debris in these systems can be very rapid and greatly reduce the capacity of the devices. Consequently, they must be installed at sites with easy access for maintenance crews and their equipment. Required equipment often includes vacuum trucks for removing accumulated trash and debris.

3.3.1.3 Design

The Baramy GPT™ requires a minimum of headloss of one meter (from inlet invert to exit) and can handle very high flow rates. They can be design to be installed above ground or below ground using safety mesh or grated trafficable lids for access. The Baramy GPT™ can treat flow rates of up to 24 m^3/sec.

3.3.1.4 Performance

The Australian Design Awards (ADA), established by the Industrial Design Council of Australia, awarded the Baramy GPT™ with the design award in 1998. They found the installation of three traps to the present date indicate that performance criteria has been successful. All units were modeled and tested prior to submission to clients. Monitoring of performance will be carried out over a period of time.

3.3.1.5 Maintenance

Given the limited field performance data for this device and the fact that litter accumulation varies by location, inspections should be scheduled after each storm during the first wet season after installation to ensure adequate performance. Quarterly inspections are probably sufficient for the dry season. After the first year, inspection frequency can be reduced if experience warrants. The GPT is designed to be serviced either manually or by vacuum truck. Large units may be cleaned manually, by vacuum truck, or by excavator.

3.3.1.6 Costs

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.

3.3.2 StormScreen™

3.3.2.1 Introduction

The StormScreen™ system is a structural BMP that removes trash and debris by combining direct screening and settling. Figure 3-6 shows a schematic of the device.

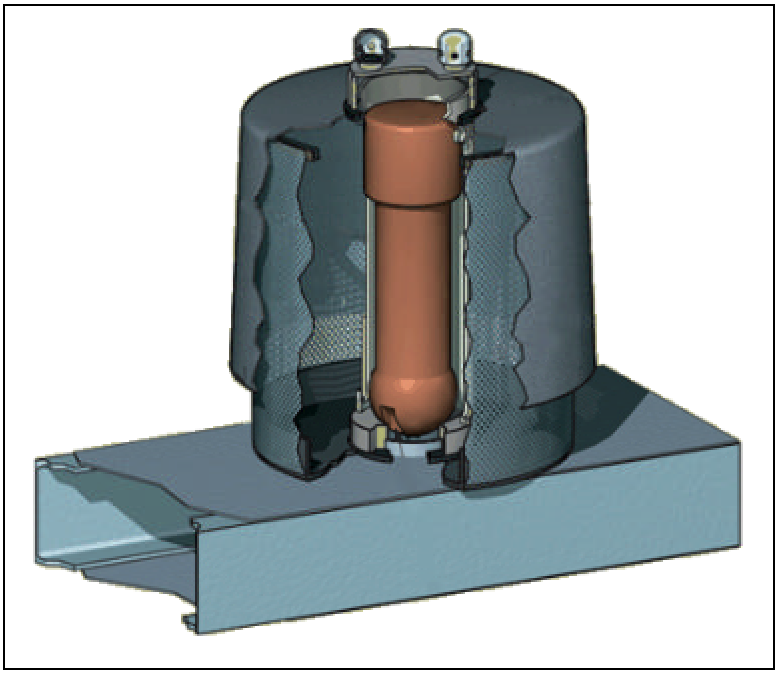

Figure 3-6 StormScreen™

3.3.2.2 Siting

The StormScreen™ system is used for treating flows in-line or end-of-pipe. They may be appropriate in residential subdivisions, commercial areas and in retrofits to existing storm water drainage systems. It is designed for use in space-constrained installations. It has a footprint of 63 ft^2 to 440 ft^2. This system is completely enclosed and may be placed under sidewalks or in other areas where the public has access.

Accumulation of litter and debris in these systems can be very rapid and greatly reduce the capacity of the devices. Consequently, they must be installed at sites with easy access for maintenance crews and their equipment. Required equipment often includes vacuum trucks for removing accumulated trash and debris.

3.3.2.3 Design

The StormScreen™ system provides treatment by direct screening of drainage as it passes through the StormScreen™ cartridges and by settling of solids within the concrete vault. The standard cartridge screen has a pore opening of 2.4 mm (2400 microns) that ensures the capture of all solids of greater size.

All captured solids are collected in a large sump area on the floor of the vault below an elevated discharge flume that supports the cartridges. This sump may be equipped with a dewatering mechanism to provide for ease of maintenance and vector control.
A primary feature of the StormScreen™ product is that the use of a screen allows for a much higher treatment rate per cartridge. Each StormScreen™ cartridge is designed to treat a peak rate of 0.5 cfs (225 gpm). A minimum 2 feet head loss is needed.

3.3.2.4 *Performance*

The StormScreen™ is untested at this time. Studies have been performed on the StormFilter™, which uses media in the canisters to filter stormwater. Performance of litter and debris removal has not been tested on the StormFilter or the StormScreen™.

3.3.2.5 *Maintenance*

Given the limited field performance data for this device and the fact that litter accumulation varies by location, inspections should be scheduled after each storm during the first wet season after installation to ensure adequate performance. Quarterly inspections are probably sufficient for the dry season. After the first year, inspection frequency can be reduced if experience warrants. Maintenance may only be needed every 1 to 2 years. Maintenance should be performed when there is one foot of trash and debris on the floor of the basin. Maintenance can be performed by dewatering the unit if needed and then removing large loose debris and trash using a pole with a grapple or net on the end.

In addition the StormScreen™ units hold a permanent pool of water. This has the potential for mosquitoes to breed and therefore requires additional inspection be the vector control agencies to insure there is no mosquito breeding or to provide abatement.

3.3.2.6 *Costs*

The StormScreen™ system cost $15,000 to $50,000 for a precast unit. The costs should be considered planning level costs and may differ significantly for a particular site. 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.

3.3.3 Caltrans Linear Radial GSRD

3.3.3.1 *Introduction*

Caltrans has developed two types of litter removal devices, which they refer to as Gross Solids Removal Devices or GSRDs. The first type is the Linear Radial device. For this device the flow in the pipe enters the screens contained in a vault. These screens and vault are aligned parallel to the direction of flow. To enter the effluent pipe the flow must pass radially through the screens and into the vault. Gross solids are retained within the screen. The screen has a smooth, solid bottom section to move settled litter toward the downstream end of the screen during low flow conditions. Sufficient screen area and volume is provided to accommodate a once-per- year maintenance cycle without plugging. The vault can be configured with grates or covers, load-rated if necessary. Figure 3-7 shows a schematic of the Linear Radial GSRD.

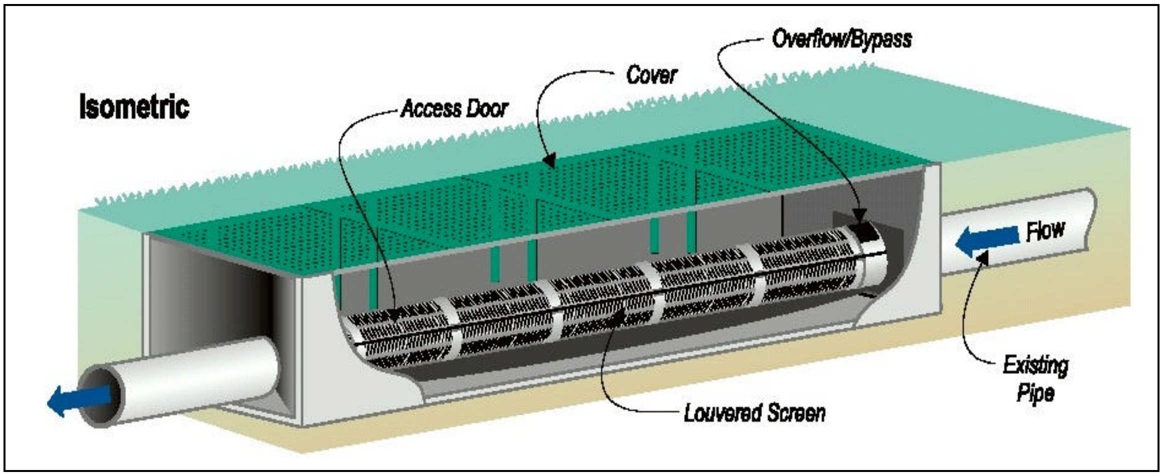

Figure 3-7 Linear Radial GSRD

3.3.3.2 Siting

GSRDs are best suited at sites that have sufficient space to safely allow construction and maintenance. They should have a clear unobstructed space and generally met the preliminary physical attributes shown on Table 3-1. The linear radial GSRD requires very little head and is well suited for narrow and relatively flat areas.

Table 3-1 GSRD Physical Site Attributes

GSRD Type	Site Selection Criteria				
	Minimum Upstream Drain Inlets	**Maximum Pipe Diameter (in.)**	**Maximum Depth to Invert (ft)**	**Minimum Pipe Slope (%)**	**Minimum Head Required (ft)**
Linear Radial	= 5	= 36	= 8	1	N / A

Accumulation of litter and debris in these systems can be very rapid and greatly reduce the capacity of the devices. Consequently, they must be installed at sites with easy access for maintenance crews and their equipment. Required equipment often includes vacuum trucks for removing accumulated trash and debris.

3.3.3.3 Design

Area litter accumulation data is desirable for sizing the GSRD. For a typical urban roadway the loading rate of 10 ft^3/ac/yr could be used if no data is available. This number will be higher for commercial shopping center parking lots.

The linear radial GSRD uses a modular and linear screen cage constructed of rigid mesh or louvered well casing contained in a vault. Gross solids are retained within the screen cage. Key design and operational concepts are as follows:

- Flows enter the device through a screen cage aligned parallel to the direction of flow.
- Flows exit the device by passing radially through the cage screen and into the vault.
- The screen has a smooth, solid bottom section to facilitate movement of gross solids towards the downstream end of the screen cage.
- The screen cage open area and interior volume should be sized to accommodate the design storm discharge from the tributary drainage area and a once-per-year gross solids removal cycle.
- The vault should have sufficient volume to reduce flow velocities to allow solids to settle.
- The vault should be sloped towards the outlet to provide positive drainage.
- The vault can be configured with grates or covers, traffic or non-traffic rated, depending upon location.

3.3.3.4 Performance

Studies on these two GSRDs were performed by Caltrans during 2000-2001. The litter removal efficiency was calculated as the amount of material captured by the device divided by the total amount of material captured, both by the device and by overflow capture mechanisms. The Linear Radial device was found to remove 98% of litter by weight and removed 92% of litter by volume.

3.3.3.5 Maintenance

The linear radial GSRD devices required maintenance at the end of the wet season. This maintenance included the removal of the accumulated gross solids from the device, disposal of material and the inspection of the devices for structural damage. It required about 10 man-hours for cleanout.

3.3.3.6 Costs

The Linear Radial device cost $48,300 to construct and treated 3.7 acres. This is the only cost data available. These devices are non-proprietary and cost is depended on size, type of material, access, etc.

3.3.4 <u>Caltrans Inclined Screen GSRD</u>

3.3.4.1 Introduction

Caltrans has developed two types of litter removal devices, which they refer to as Gross Solids Removal Devices or GSRDs. The second device is the Inclined Screen. This device works has a trough that distributes flow along the length of the screen. The trough is drained by a series of weep holes. The number and size of weep holes is determined by a 72-hr drain time. The material captured by the screen is pushed down to the litter storage area by the storm water runoff, especially during large storm events. The litter storage area is sloped and configured with a drainpipe and inlet grate to allow the litter storage area to drain between storm events. The vault can be configured with grates or covers, load-rated if necessary. Figure 3-8 shows a schematic of the Inclined Screen GSRD.

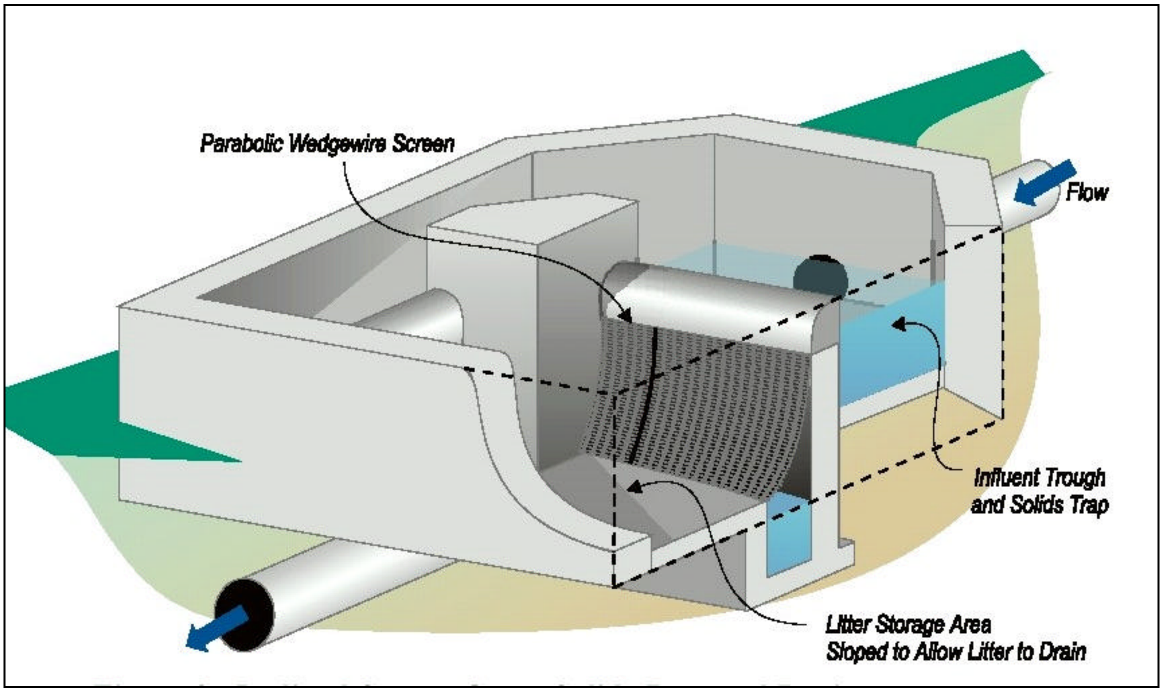

Figure 3-8 Inclined Screen GSRD

3.3.4.2 Siting

GSRDs are best suited at sites that have sufficient space to safely allow construction and maintenance. They should have a clear unobstructed space and generally met the preliminary physical attributes shown on Table 3-2. The inclined screen requires three feet of head is well suited for fill sections.

Table 3-2 GSRD Physical Site Attributes

GSRD Type	Site Selection Criteria				
	Minimum Upstream Drain Inlets	**Maximum Pipe Diameter (in.)**	**Maximum Depth to Invert (ft)**	**Minimum Pipe Slope (%)**	**Minimum Head Required (ft)**
Inclined Screen	= 5	= 36	= 8	1	3

Accumulation of litter and debris in these systems can be very rapid and greatly reduce the capacity of the devices. Consequently, they must be installed at sites with easy access for maintenance crews and their equipment. Required equipment often includes vacuum trucks for removing accumulated trash and debris.

3.3.4.3 Design

Area litter accumulation data is desirable for sizing the GSRD. For a typical urban roadway the loading rate of 10 ft^3 / ac / yr could be used if no data is available. This number will be higher for commercial shopping center parking lots.

The inclined screen GSRD uses an inclined screen constructed of parallel wires or bars contained in a vault. Gross solids are retained in a storage area of the vault located at the bottom of the inclined screen. Key design and operational concepts are as follows:

- Flow enters the device through a trough and weir that distributes inflow across the top of the inclined screen. The trough captures the heavier solids such as gravel and sand.
- Flow exits 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 should be sized to accommodate the design storm discharge from the tributary drainage area.
- The gross solids storage area should be 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 should be sloped towards a grate-covered drainpipe.
- The vault can be configured with grates or covers, traffic or non-traffic rated, depending upon location within the right-of-way.
- The compact footprint of this device facilitates retrofit siting in space-constrained areas, especially areas with sufficient head to provide a drop, usually 0.9 m (3 ft) across the inclined screen.

3.3.4.4 Performance

Studies on these two GSRDs were performed by Caltrans during 2000-2001. The litter removal efficiency was calculated as the amount of material captured by the device divided by the total amount of material captured, both by the device and by overflow capture mechanisms. The Inclined Screen was found to remove 100% of litter by weight and removed 100% of litter by volume.

3.3.4.5 Maintenance

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

3.3.4.6 Costs

The Inclined Screen device cost $82,800 to construct and treated 2.5 acres. This is the only cost data available. These devices are non-proprietary and cost is depended on size, type of material, access, etc.

3.3.5 <u>Inlet Screens</u>

3.3.5.1 Introduction

Grate and inlet screens consist of sturdy metal screens that cover the entrance to the drainage network. Water passes between the screen bars, while gross solids are prevented from entering. Particularly suited to trapping large litter items, grate and inlet screens are typically used to prevent drain blockages.

3.3.5.2 Advantages

- Inexpensive and easy to install;
- Prevents drain blockages; and
- Suitable for targeting specific problem areas.

3.3.5.3 Limitations

- Only separates out large trash and debris items;
- Relies on effective street cleaning for pollutant removal;
- Local flooding can occur if blocked; and
- Smaller items of debris may be pushed through the grating by traffic.

3.3.5.4 Design

Entrance grates should be located in areas that are prone to pipe blockages or are known to contribute large amounts of gross solids. These include shopping centres and other busy commercial areas.

3.3.5.5 Performance

The key function of entrance screens is to prevent pipe blockages by excluding gross solids from the drain network. Their performance efficiency depends heavily on effective street cleaning practices-infrequent street cleaning can lead to dispersion of trapped pollutants by either wind or traffic.

3.3.5.6 Maintenance

Inspections for blocked screens may be necessary if flooding is a potential problem.

3.3.5.7 Cost

Installation costs of entrance grate and screens are low. If cleaning can be incorporated into regular street cleaning, no additional maintenance cost need apply.

3.4 Separation/Hydrodynamic Devices

There are also hydrodynamic units that use hydrodynamic forces for separating solids and floatable material. When water enters the unit on a tangential plane, a circular flow pattern is established by the cylindrical shape of the unit, creating a vortex. The flow at the outer edge of the tank moves at a higher velocity than the flow in the center, and thus is more turbulent. As the flow spirals inward and upward the velocity slows down and becomes more stable. In general, the vortex flow tends to move denser material downward in the center, whereas floatables rise towards the surface on the outside of the flow.

3.4.1 CDS™

3.4.1.1 Introduction

The CDS™ unit is a proprietary storm water treatment device developed in Australia and is marketed through CDS™ Technologies in the US. They are hydrodynamic devices. Figure 3-9 shows a schematic of the device.

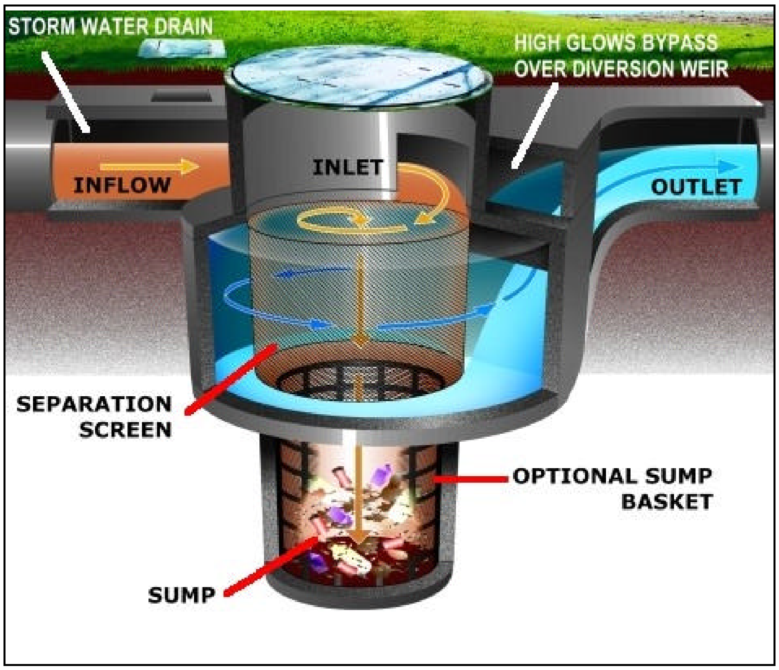

Figure 3-9 CDS™ Unit Schematic

3.4.1.2 Siting

CDS™ units are a below grade end-of-pipe device that have a relatively small footprint, 25 ft^2 to 1,320 ft^2. As a result, they are especially suited to locations where surface use must be maintained, and in locations where space to accommodate a BMP is limited. CDS™ devices can be designed to incorporate multiple drain inlets to centralize maintenance activities and provide access in a location that may be more conducive from a personnel safety or site operation perspective.

Siting criteria for CDS™ units include sufficient space for maintenance access and sufficient space to construct the unit. The CDS™ system is used for treating flows in-line or end-of-pipe. The design of the unit is flow-based; the manufacturer makes several standard unit sizes that can accommodate a wide range of subcritical discharges. They may be appropriate in residential subdivisions, commercial areas and in retrofits to existing storm water drainage systems.

Accumulation of litter and debris in these systems can be very rapid and greatly reduce the capacity of the devices. Consequently, they must be installed at sites with easy access for maintenance crews and their equipment. Required equipment often includes vacuum trucks for removing accumulated trash and debris.

3.4.1.3 Design

The CDS™ units work by diverting flow from the storm drain system via a weir into the unit separation chamber and sump. Flow must be subcritical in the storm drain system for the diversion weir to function effectively. These hydrodynamic units are designed to introduce the flow in a direction tangent to the arc of the separation chamber. Using this approach, the dominant velocity vector is parallel to the unit screen, which tends to keep the screen from blocking with debris. Water passes through the 4.7-mm screen to an outer peripheral chamber where it reverses direction and flows back into the storm drain system. The screen retains trash and debris from the diverted flow except for material smaller than the openings in the screen.

3.4.1.4 Performance

Caltrans performed a two year study on two CDS™ units installed along the highway in southern California. These devices were found to remove 85% to 92% of gross solids by weight. Most of the material that bypassed the system was due to one large storm event. Several other studies have been performed on CDS™ units. In Australia, Allison et al. (1998) performed a study on CDS™ units and found removals of trash and debris of up to 100%.

3.4.1.5 Maintenance

The maintenance of the CDS™ units involves the inspection of the unit for damage to the structure and screen and to determine if it has met the manufacturer's threshold for removal of gross solids, which is 85% full. The experience in the Caltrans Retrofit Pilot Study indicated that maintenance was needed before the 85% threshold was met. During the study when the units reached 50% full there was the potential during the next large event that the unit would become overwhelmed. The criterion developed by Caltrans was to clean the unit when it was 50% full during two consecutive monthly inspections.

These units are cleaned using a crane to lift the basket full of pollutants, empty it and replace the basket. The inspection and maintenance of CDS™ units takes approximately 44 man-hours per year. Maintenance can also be performed on these units by using a vacuum truck.

In addition the CDS™ units hold a permanent pool of water. This has the potential for mosquitoes to breed and therefore requires additional inspection by the vector control agencies to insure there is no mosquito breeding or to provide abatement.

3.4.1.6 Costs

The estimated construction cost for a CDS™ unit was found to be $25,800 / acre of drainage area. The costs should be considered planning level costs and may differ significantly for a particular site. 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.

3.4.2 Baysaver®

3.4.2.1 Introduction

The Baysaver® Stormwater treatment system consists of two standard manholes. The first manhole removes sediment and separates the floatables, which are diverted into the second manhole for storage. Figure 3-10 shows a schematic of the device.

3.4.2.2 Siting

The Baysaver® is an in-line two manhole system. It is used for treating flows in-line or end-of-pipe. They may be appropriate in residential subdivisions, commercial areas and in retrofits to existing storm water drainage systems. It is designed for use in space-constrained installations. It has a footprint of 140 ft^2 to 235 ft^2. This system is completely enclosed and may be placed under sidewalks or in other areas where the public has access.

Accumulation of litter and debris in these systems can be very rapid and greatly reduce the capacity of the devices. Consequently, they must be installed at sites with easy access for maintenance crews and their equipment. Required equipment often includes vacuum trucks for removing accumulated trash and debris.

3.4.2.3 Design

The primary manhole is a standard precast structure used to remove coarse sediments and is generally installed in-line with the storm drain. The second manhole is for storage and acts as a secondary treatment device for the collection of free oils, fine sediment and floatables. The storage manhole stores the pollutants offline to prevent resuspension.

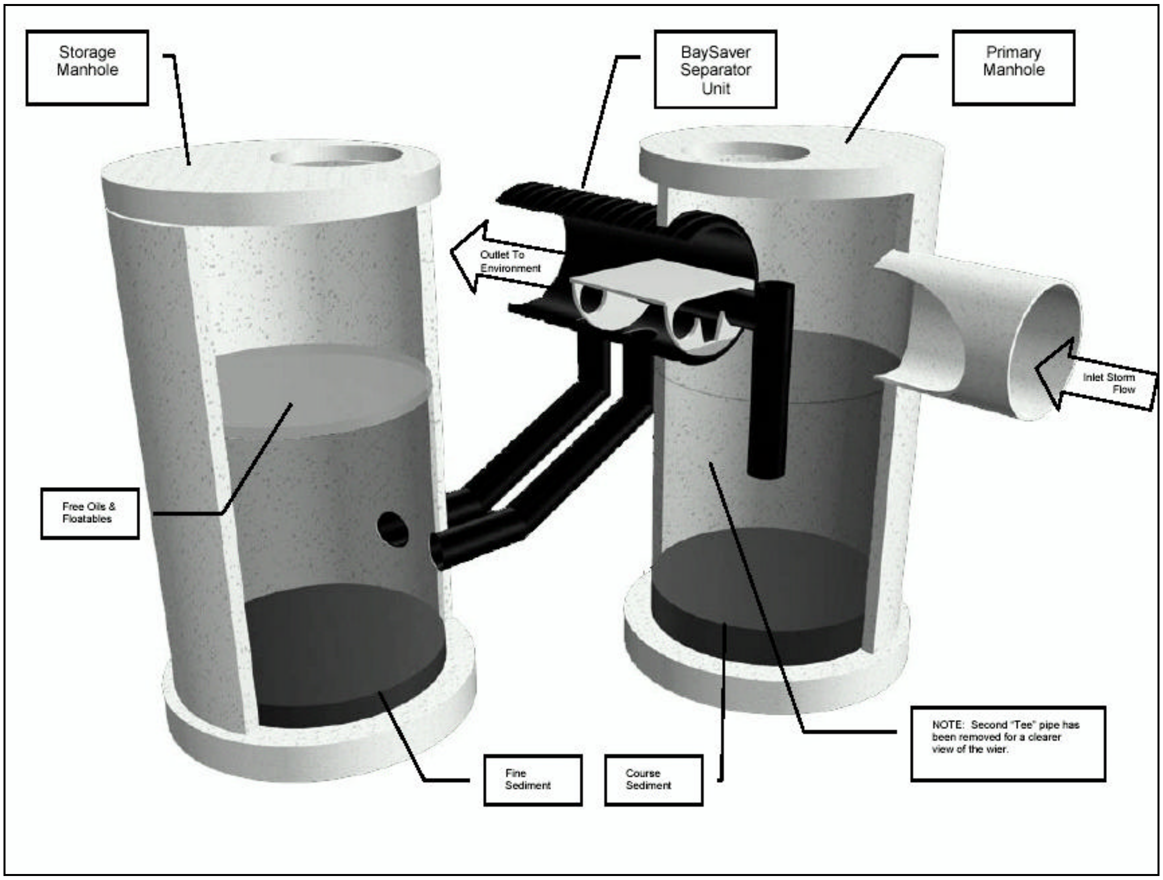

Figure 3-10 Baysaver® Schematic

3.4.2.4 Performance

The Baysaver® system is essentially untested at this time. One study has been conducted on the hydraulics of the system; however no litter studies have been performed.

3.4.2.5 Maintenance

Given the limited field performance data for this device and the fact that litter accumulation varies by location, inspections should be scheduled after each storm during the first wet season after installation to ensure adequate performance. Quarterly inspections are probably sufficient for the dry season. After the first year, inspection frequency can be reduced if experience warrants.

Maintenance should be conducted when any of the following conditions are met.

- When sediment levels in either manhole has reached a height of two feet or more from the floor of the manhole.
- When any evidence of a chemical spill exists
- When any evidence of a oil/fuel spill exists

Maintenance is performed using a vacuum truck. The manhole cover is removed and the contents are vacuumed up. This procedure typically takes 2 to 4 hours depending on the size of the system.

In addition the Baysaver® units hold a permanent pool of water. This has the potential for mosquitoes to breed and therefore requires additional inspection be the vector control agencies to insure there is no mosquito breeding or to provide abatement.

3.4.2.6 Costs

The Baysaver® system costs between $7,000 to $10,000 for the smallest model and between $13,000 to $20,000 for largest model. Installation cost is 30 to 50% of the product cost. The costs should be considered planning level costs and may differ significantly for a particular site. 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.

3.4.3 Vortechs™

3.4.3.1 Introduction

The Vortechs™ Storm water Treatment System is a hydrodynamic separator designed to use gravitational separation of floating and settling materials from storm water flows. Figure 3-11 shows a schematic of the device.

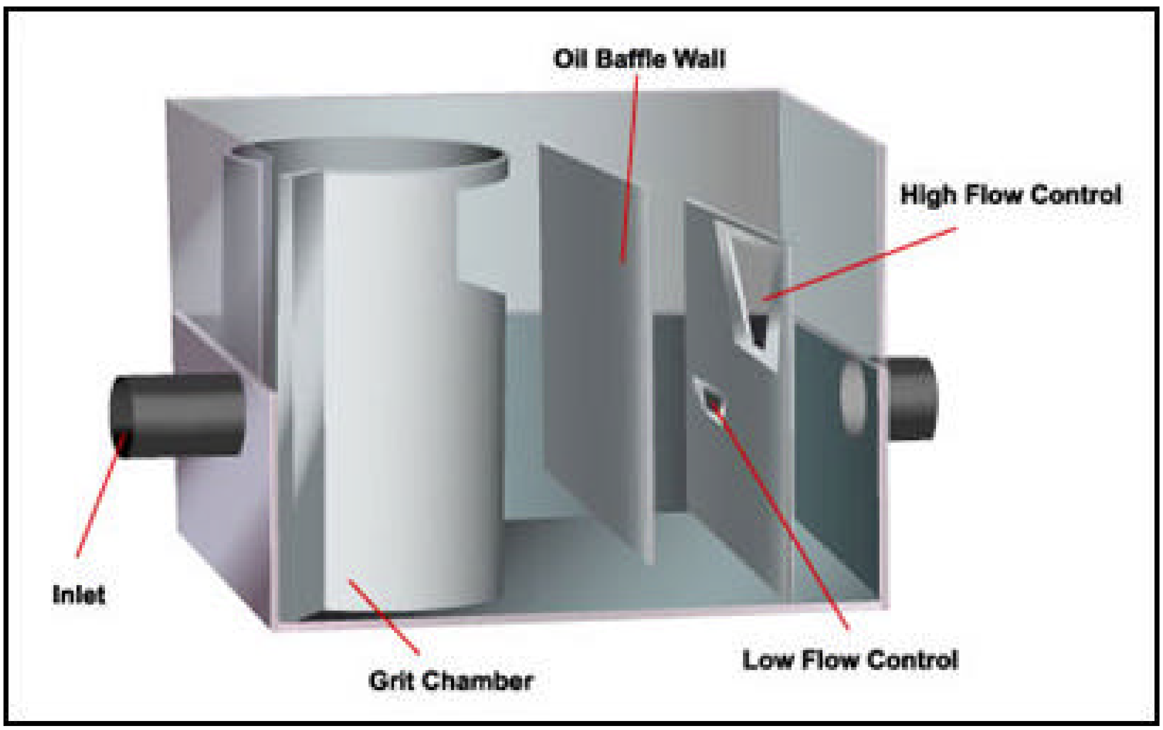

Figure 3-11 Vortech™

3.4.3.2 Siting

The Vortech™ system is used for treating flows in-line or end-of-pipe. They may be appropriate in residential subdivisions, commercial areas and in retrofits to existing storm water drainage systems. It is designed for use in space-constrained installations. It has a footprint of 27 ft^2 to 216 ft^2. This system is completely enclosed and may be placed under sidewalks or in other areas where the public has access.

Accumulation of litter and debris in these systems can be very rapid and greatly reduce the capacity of the devices. Consequently, they must be installed at sites with easy access for maintenance crews and their equipment. Required equipment often includes vacuum trucks for removing accumulated trash and debris.

3.4.3.3 Design

Storm water flows enter the unit tangentially to the grit chamber, which allows a gentle swirling motion. As polluted water circles within the grit chamber, pollutants migrate toward the center of the unit where velocities are the lowest. The majority of settable solids are left behind as storm water exits the grit chamber through two apertures on the perimeter of the chamber. There is a 5 mm mesh screen sloped between the grit chamber and the oil baffle wall to separate the trash and debris. Next, buoyant debris and oil and grease are separated from water flowing under the baffle wall due to their relatively low specific gravity. As storm water exits the system through the flow control wall and ultimately through the outlet pipe, it is relatively free of floating and settling pollutants. Over time a conical pile tends to accumulate in the center of the unit containing sediment and associated metals, nutrients, hydrocarbons and other pollutants. Floating debris and oil and grease form a floating layer trapped in front of the baffle wall.

3.4.3.4 Performance

The one study of this system sampled seven storms, but the samples were not flow-weighted composite. No studies have been done on the trash and debris removal efficiency.

3.4.3.5 Maintenance

Given the limited field performance data for this device and the fact that litter accumulation varies by location, inspections should be scheduled after each storm during the first wet season after installation to ensure adequate performance. Quarterly inspections are probably sufficient for the dry season. After the first year, inspection frequency can be reduced if experience warrants. Cleanout of the Vortechs™ system with a vacuum truck is generally the most effective method of excavating pollutants from the system. The pollutants can be assessed through access manholes over each chamber. Maintenance is typically performed through the manhole over the grit chamber. A “clamshell” grab may also be used.

In addition the Vortechs™ units hold a permanent pool of water. This has the potential for mosquitoes to breed and therefore requires additional inspection be the vector control agencies to insure there is no mosquito breeding or to provide abatement.

3.4.3.6 Costs

The Vortechs™ product cost range from $10,500 to $40,000. This does not include the cost for installation of the product, which could be as much as 50% the product cost. The costs should be considered planning level costs and may differ significantly for a particular site. 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.

3.5 Drain Inlet Inserts

There are also several drain inlet inserts available that can capture trash and debris. These inserts are not designed to capture large quantities of trash and debris. They require frequent maintenance, with cleanouts following every storm event and depending on the site characteristics.

3.5.1 <u>Introduction</u>

There are two main types of drain inlet inserts (DIIs). One consists of a metal tray that covers the entrance to the drainage network. Water passes over the tray, while trash and debris are prevented from entering. The second consists of a fabric sock that covers the entrance to the drainage network. Water passes over the fabric, while trash and debris are retained in the sock. There are five drain inlet inserts primarily used through out Orange County. They are listed and described in the next section.

3.5.2 <u>Types</u>

The FloGard™ is an adaptable device designed for storm water drop inlets. The design includes a trough shaped tray that directs flow through media with a high flow bypass incorporated in the center of the tray. The FloGard™ is well suited for treating runoff from small impervious surfaces. While they can be used for road and highway treatment, maintenance demands are high. The FloGard™ adapts to any size or shape inlet, allowing for easy retrofit. It uses an approved inert filter absorbent that is non-leaching, allowing for easy disposal. It may have limited roadway application because of clogging by trash and debris. It does not work in areas where storm water is not channelled and primarily targets petroleum hydrocarbons and sediment.

Figure 3-12 FloGard™ Insert

The DrainPac™ is a flexible storm drain catchment and filtration liner designed to filter pollutants, debris, and solids prior to discharge into storm drain systems. The filters must be cleaned, possibly after each rainfall, with a truck-mounted vacuum so that the debris does not clog storm drain. The DrainPac™ adapts to any size or shape inlet. It may have limited roadway application because of clogging. It targets heavy sediments, oil and grease.

Figure 3-13 DrainPac™ Insert

The UltraUrban Filter™ is drop inlet insert primarily designed for the removal of oil and grease. It is a rigid plastic tray filled with an absorbent "Soft Sponge" filtration media. A screen is included to help remove trash and other debris. It is well suited for treating runoff from small impervious areas such as parking lots. While UltraUrban Filters™ can be used for road and highway runoff, maintenance requirements are high. It is adaptable to most existing drop inlets and effective for oil and grease removal. It may have limited roadway application because of clogging. It does not work in areas where storm water is not channeled. It targets heavy sediments, oil, and grease.

Figure 3-14 UltraUrban™ Insert

The BioClean™ is a drop inlet insert. Water flows over the weir and into the removable basket, filtering trash and debris. Hydrocarbon booms catch hydrocarbons entering the storm drain. The basket is located directly under the manhole. The BioClean™ can be cleaned by removing the manhole lid and vacuum or remove the basket. For installation into a square catch basin there is a left half and a right half that telescope together to adjust for size, which make up the main body of the insert and mounts solidly to the catch basin wall with either drive pins. The Curb Inlet Basket is made from the high quality marine grade fiberglass and stainless steel. It is designed to prevent floatables from escaping during heavy flows.

Figure 3-15 BioClean™ Insert

The SIFT™ is a drop inlet insert device designed to be inserted into storm water inlets to remove sediment, debris, and hydrocarbons from incoming flows. The SIFT™ filter is designed to treat runoff from small impervious surfaces. While they can be used for road and highway treatment, maintenance demands are high. It is easy to install and maintain. It is adaptable to most existing drop inlets and designed to accommodate high flows. The filter medium is manufactured of non-hazardous absorbent material. It may have limited roadway application due to high maintenance demands. It targets heavy sediments, oil, and grease.

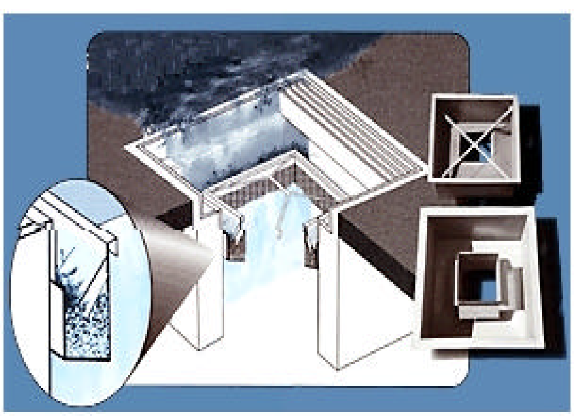

Figure 3-16 SIFT™ Insert

3.6 Litter Booms

3.6.1 Introduction

Floating boom systems are intended for trapping floating litter and organic debris and consist of a hanging mesh skirt. They are usually anchored to a shoreline structure and are placed across channels or creeks to collect floating debris. They are sized according to the expected volume of floatables that occur during a storm event.

3.6.2 Types

The Floating Net Booms manufactured by Elastec Inc./ American Marine Inc. are used for controlling trash and debris, water vegetation, and marine life. They are manufactured in different materials depending on their purpose, common net materials include stainless steel, and marine grade coated nylon netting. They can be custom made to depth and strength requirements.

Figure 3-17 Elastec™ Floating Net Boom

The Debris/Ice Barrier Boom manufactured by Slickbar Products Co. is a permanent boom is designed to assist in deflecting floating debris and ice away from areas that typically experience extreme congestion from floating objects. It is 24"long x 10.5" high Solid Molded Closed Cell Polyethylene Foam or Fiberglass Shell with Urethane foam filled with UV Inhibitors and Anti-Oxidants incorporated for durability.

Figure 3-18 Slickbar™ Debris Barrier Boom

The MK RB River Boom, manufactured by Slickbar Products Co. has been engineered to deflect oil to quiet recovery areas. It is more appropriate than the MK debris boom for controlling debris of smaller size. It is constructed with an internal secured float system which allows for a smooth exterior float chamber.

Figure 3-19 MK RB™ River Boom

4 EXISTING PROGRAMS AND EFFECTIVENESS (ORANGE COUNTY)

Trash and debris BMPs have been implemented in several areas of Orange County. These include over 1,500 catch basin inserts and catch basin screens, twelve in-line treatment units and nine trash and debris booms. Each of these BMPs will be discussed in detail in the following sections. Table 4-1 provides information on grant-funded projects within Orange County. Specific details on the costs of individual project implementation and maintenance activities are not available.

4.1 Catch basin inserts

Drain inlet inserts designed to capture trash and litter are individually effective but require good coverage to have a significant regional impact. They may be most appropriate in urban catchments near high litter source areas such as food courts and shopping centers. They require regular maintenance, monthly during the wet season at a minimum. There are over 1,500 catch basin inserts and catch basin screens installed in Orange County. The inserts primarily used are manufactured by FloGard™, DrainPac™, and UltraUrban™. Also used are the SIFT™ and BioClean™.

Anaheim has seven FloGard™ drain inlet inserts installed in their maintenance yards. The maintained of these inserts varies, some are cleaned annual and others, located close to street sweeper debris, require monthly clean out.

Dana Point has 525 drain inlet inserts installed throughout the city. They are both Fossil Filters™ and DrainPac™. These inserts are inspected quarterly, and maintenance is performed on the inserts that as needed, approximately 300 at any given time. During 2000-2001, 56 tons of material was collected. During 2001-2002, 68 tons of material was collected.

San Clemente has over 450 drain inlet inserts within the city. These inserts are not part of the public system but rather operated and maintained by the homeowner associations. The city does not keep records of the maintenance of these inserts.

Seal Beach had 97 DrainPac inserts installed throughout the city as of October 2001. They were initially maintained by United Stormwater. The city now has a contract with an environmental company to provide the cleanout of the inserts. They have been cleaned out 4 times since their installation.

La Habra has a few drain inlet inserts installed at the city maintenance yards but has found that these backup and cause flooding during numerous rain events each year. They also have a few screens installed around the city. These were installed 10 years ago and have been found to work successfully. They consist of screens with larger holes near the top so when the flow depth gets higher more flow can enter the storm drain. They are maintained weekly by street sweepers. Street sweepers are required to drive slower near the screen and are capable of sweeping up the trash and debris collected. The city has plans to install many more screens throughout the city.

Other cities with drain inlet inserts include Laguna Hills, Laguna Niguel, Mission Viejo, Newport Beach, Fullerton, Cypress, Laguna Beach, Lake Forest, Westminster, Yorba Linda and Orange

Table 4-1 Urban Runoff Grant Funding for BMPs (1999-2002)

Permittee	Grant Funded Project	Grant Funding Amount
Anaheim	CDS™ Unit Installation	$29,400
Brea	Catch Basin Filter Installation	$29,400
	Catch Basin Filter Installation	$41,650
Costa Mesa	Catch Basin Filter Installation	$41,650
Dana Point	Stormceptor™ Installation	$29,400
	Stormceptor™ Installation	$19,350
Fountain Valley	Catch Basin Filter Installation	$29,400
	Catch Basin Filter Installation	$41,650
Garden Grove	Catch Basin Filter Installation	$41,650
Huntington Beach	CDS™ Unit Installation	$61,000
Irvine	Stormceptor™ Installation	$29,400
	Stormceptor™ Installation	$18,500
La Habra	Catch Basin Guard Installation	$24,000
Laguna Hills	Catch Basin Filter Installation	$61,000
Laguna Niguel	Catch Basin Filter Installation and	$41,650
	Stormwater Treatment Unit Installation	$19,350
Laguna Woods	Catch Basin Filter Installation	$41,650
Los Alamitos	Catch Basin Filter Installation	$29,400
Newport Beach	CDS™ Unit Installation and	$41,650
	Catch Basin Filter Installation	$19,350
Orange	Catch Basin Filter Installation and Clarifier Installation	$41,650
Placentia	Catch Basin Filter Installation	$29,400
	Catch Basin Filter Installation	$61,000
Rancho Santa Margarita	Catch Basin Filter Installation	$61,000
San Clemente	CDS™ Unit Installation and	$29,400
	Stormwater Treatment Unit Installation	$41,650
	Stormwater Treatment Unit Installation	$19,350
San Juan Capistrano	Catch Basin Filter Installation and	$41,650
	Debris Screen Installation	$19,350
Santa Ana	Catch Basin Filter Installation	$41,650
Seal Beach	Catch Basin Filter Installation	$29,400
	Catch Basin Filter Installation and	$37,500
	CDS™ Unit Installation	$19,350
Tustin	Catch Basin Filter Installation	$29,400
	Catch Basin Filter Installation	$41,650
Villa Park	Catch Basin Filter Installation	$41,650
Yorba Linda	Trash Booms and	$41,650
	Debris Screen Installation	$19,350

4.2 Hydrodynamic units

There are about six hydrodynamic units installed in Orange County. There are two Stormceptors installed in Aliso Viejo. Their installation was required during construction of a new housing development. They are maintained by the private homeowners association and require annual cleanout. Depending on rainfall and loadings they may be cleanout more frequently.

There are two CDS™ units installed in Anaheim. One was just recently installed by the city of Anaheim and no maintenance has been performed on the device yet. The second was installed near Downtown Disney and is maintained by Disney.

Dana Point recently installed a CDS™ unit and it is operational. There are plans to include dry weather diversion along with the CDS™ treatment in April 2003. The city of Dana Point plans to install many more CDS™ units. Many privately owned CDS™ units are located in Dana Point. They city encourages the homeowner associations to clean these units biannually.

There is one Stormceptor in Irvine. This device is designed for TSS and hydrocarbon removal and has a side benefit of capturing some trash and debris. The city of Irvine views this device as a sediment and hydrocarbon removal device. It is cleaned out at least annually along with the catch basins throughout the city.

The cities of La Habra, Seal Beach and San Clemente have plans to install Stormceptors or CDS™ units in the near future.

4.3 Trash and Debris Booms

Trash and debris booms are typically installed across a waterway to collect floating and partially submerged trash and debris. 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. This has implications for traps designed to catch only floating material (Allison et al., 1997).

Most trash and debris boom installations 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 also the center of the channel and the region of highest velocity. High velocities can drag collected litter under the boom. A better design is to angle the boom across the channel to allow the collected trash to accumulate on one side of the channel, away from the high velocity region.

The County has several trash and debris booms that have been installed in flood control channels and harbors to remove floatable material. Table 4-2 provides summary of these trash and debris booms currently installed throughout Orange County. A brief description of booms currently located throughout Orange County is provided below.

Table 4-2 Trash and Debris Booms within Orange County

Watershed	Channel / Bay	Location
Westminster	Federal Channel	Near 22 and 405
Westminster	East Garden Grove-Wintersberg Channel	At Farm Bridge, PCH
Westminster	Bolsa Chica Channel	Upstream of Edinger
	Bolsa Chica Channel	At Seabring Ave
Talbert / Lower Santa Ana River Watershed	Greenville-Banning Channel	Upstream of Hamilton in the Greenville Banning Channel
Newport Bay	Upper Newport Bay	Near Sunset Aquatic Center
	Santa Ana-Delhi Channel	Downstream of Mesa Drive
San Diego Creek	El Modena – Irvine Channel	At confluence of Peters Canyon Channel
	Peters Canyon Channel	At confluence of El Modena – Irvine Channel

Seal Beach
A boom was installed and is maintained by the County Flood Control District in Federal Channel located near the intersection of the 22 and 405 freeways.

Huntington Watershed
Debris booms have been deployed at three locations in the Bolsa Chica Channel at: 1) upstream of Edinger, 2) at the confluence of Westminster Channel and 3) at Seabring Ave. They are all maintained by the County Flood Control District.

East Garden Grove-Wintersberg Trash Booms
One boom in the East Garden Grove-Wintersberg Channel that was installed near Farm Bridge at Pacific Coast Highway to remove trash and debris entering Huntington Harbor. It is maintained by the County Flood Control District.

Talbert/Lower Santa Ana River Watershed
A debris boom was installed upstream of Hamilton in the Greenville Banning Channel/Lower Santa Ana River. It is maintained by the County Flood control District.

Upper Newport Bay

The City of Newport Beach installed a log boom in the 1980s made of telephone poles connected together with chains in the Upper Newport Bay to reduce the amount of trash and debris entering Newport Harbor. Three years ago the boom was damaged by the El Nino rainstorms and was replaced by a new conventional trash debris boom.

Another boom is located upstream of Newport Bay in the Santa Ana-Delhi Channel. This boom, installed and maintained by the OCFCD, has been in operation for many years. This system consists of an 18" wide net suspended below a floating boom that extends the span of the flood control channel. This type of debris containment system captures a considerable amount of trash and debris; however it is limited because it can only remove floating materials within a vertical span of 18". Heavier trash and debris can pass underneath the net and the turbulence within the channel can cause the trash and debris to be pushed under or over the net. Figure 4-1 shows a picture of this debris boom.

Figure 4-1 Santa Ana – Delhi Channel Debris Boom

Newport Watershed

Debris booms are installed in El Modena-Irvine and Peters Canyon Channel in August 1999. They are maintained by County Flood Control District. The El Modena Irvine channel is a 65.25-foot wide rectangular section with a 17-inch high sidewall. The design 100-year discharge is 8917cfs. The Peters Canyon Channel is a 55-foot wide rectangular section with a 17-inch high sidewall. The design 100-year discharge is 10,947 cfs. Since installation in August 1999 through January 2001, 10.8 tons of debris has been contained and removed. During this same time frame a total of 24,012 acre-feet of water passed through these channels.

Nine of the ten trash and debris booms are maintained by the County Public Facilities & Resources Department. They are inspected after every rain event. When a substantial amount of debris has collected behind the boom, the materials are removed and disposed of at the local landfill. During the dry season and periods of extended dry weather the booms are inspected monthly to ensure that they are in place, are not full of silt, and capable of floating. The booms have a five to seven year lifespan before they are deteriorated by UV light, or are torn by captured debris. Huntington Beach maintains the most downstream boom on the Bolsa Chica channel.

5 BMP RECOMMENDATIONS AND SELECTION PROCEDURE

Trash and debris within stormwater is considered to be a significant problem in the municipal areas of southern California. Trash and debris in surface waters can inhibit the growth of aquatic vegetation, harm aquatic organisms by ingestion or entanglement, convey other pollutants, such as toxic substances, and cause aesthetic problems on shorelines. Jurisdictions in Orange County must maintain effective programs to prevent and remove trash from the drainage systems.

Litter characterization may help determine the source of litter and identify areas that can be targeted for pollution prevention, source control and structural BMPs. Litter characterization also will help document the program performance effectiveness.

Structural trash and debris BMPs should be considered primarily on performance effectiveness and on site-specific watershed characteristics, available hydraulic head and footprint, and maintenances ease. However, certain regulatory-related issues should also be considered with respect to the advisability of structural controls, or the selection of one structural device over others.

5.1 Regulatory Issues

5.1.1 Monitoring List

Water bodies are placed on the Monitoring List when more information is needed determine whether water quality standards and beneficial uses are being met. Based on the findings a decision can be made on whether to list the receiving water as impaired under section 303(d) of the Clean Water Act. At the February 4, 2003 Board Meeting, SWRCB adopted the 2002 section 303(d) list of water quality limited segments. The water bodies placed on the monitoring list within Orange County were, Newport Bay, Upper (Ecological Reserve), Orange County Coastline (within Region 8 and 9) and Santa Ana River, Reach One. These water bodies will be monitored to further determine the impacts from trash and debris.

5.1.2 Vector Management

Some trash and debris BMPs contain permanent or semi-permanent standing water and may present opportunities for vectors to establish themselves and potentially spread disease to the general public. Within the loose framework provided by the applicable public health statutes, the BMPs may be viewed as “threats to public health.” In this situation, mosquitoes are the most important threat to public health and comfort.

The laws and regulations that govern or relate to mosquito and vector control in California are found principally in the sections of the California Health and Safety Code, Civil Code, Food and Agricultural Code. Health and Safety Code Sections 2270-2294 describe “District Powers.” The Public Health and Safety Code has legal precedence over many other regulations. Legal opinions regarding issues relating to priority of enforcement for Public Health and Safety Code Sections 2200 and 2292 versus other statutes determined that, with adequate notice, vector control agents had enforcement priority and that other agencies could be held criminally liable for interference with vector control efforts.

The health code statutes, as written, give vector control district managers wide latitude in determining what constitutes a public health threat. If these statutes are interpreted narrowly, it is conceivable that the mere presence of "open, standing water" could be construed as a threat to public health, and may be abated accordingly. As such, only *prima facie* evidence of breeding (i.e. the presence of only one mosquito larva) is required for abatement. Under these conditions, it is the vector control district managers who largely determine under what conditions abatement will occur. The vector control districts in Orange County have established an abatement threshold of one larva for the BMPs. With this threshold, these districts can abate when one larva is collected from a site.

Recommendations of the vector control districts regarding BMP implementation are summarized below:

- Vector control strategies should concentrate on physical measures, minimizing the amount standing water present in the devices, rather then biological and chemical treatment. Standing water that persists for three days (72 hours) or longer, especially during warm periods, is likely to produce adult mosquitoes.
- Access to some BMPs will be provided through manholes or grates; vectors will readily enter and exit the structures. Any access cover should be free of apertures large enough to allow entry of adult mosquitoes if a permanent pool of water is maintained in the structure.

Dry Systems

Structures should be designed such that they do not hold standing water for more than 72 hours (the minimum length of time for mosquito development). Provisions to prevent or reduce the possibility of clogged discharge orifices (e.g. debris screens) should be incorporated into the design. The use of weep holes are not recommended due to rapid clogging when adjacent to or within a sediment-laden area. These measures can easily be implemented for the trash and debris BMPs that do not contain a sump or permanent pool.

Systems with Sumps or Permanent Pools

Structures designed with sumps or basins that retain water permanently or semi-permanently (e.g. CDS™, Vortechs™, canister-type filters) should be sealed completely against adult mosquitoes. Adult female mosquitoes may utilize openings as small as 1/16th of an inch to access water for egg laying.

Structures should be designed with the appropriate pumping, piping, valves, or other necessary equipment to allow for easy dewatering of the unit if necessary. If the sump or basin is completely sealed, with the exception of the inlet and outlet, the inlet and outlet should be fully submerged so that female mosquitoes have access to only a limited surface area of water for egg-laying. These measures can easily be implemented for the trash and debris BMPs that do contain a sump or permanent pool.

5.2 BMP Selection Process

5.2.1 Site Selection Strategy

There are two primary considerations in determining the type of trash and debris BMPs to install: the device performance efficiency and the maintenance requirements. Although it is preferred to base BMP selection primarily on the ability to reduce the trash and debris loads for the local receiving water, this is not always possible. In many cases, the physical characteristics of a site drive the selection process. Important characteristics include the available hydraulic head, footprint requirements and available maintenance access. Table 5-1 presents the data for all the trash and debris BMPs discussed in this report.

It is important to consider the watershed litter characteristics when considering a trash and debris BMP. The amount and type of trash and debris generated in a watershed will be a factor in determining the size of BMP needed and the frequency of maintenance that would be needed. Ideally a BMP would be sized to minimize the amount of maintenance needed. Available space and required head constraints may require the size of BMP to be reduced and frequency of clean out to be increased. Table 5-2 compares the categories of trash and debris BMPs. This table shows the relative removal efficiency of each device and the installation and maintenance cost associated with each device. This table can be used to determine which type of trash and debris BMP is best suited give the removal efficiency desired, funds available and head requirement.

Table 5-1 Trash and Debris BMP Device Summary Information

DEVICE	REMOVAL MECHANISM	SITING LOCATION	TREATMENT FLOW CAPACITIES	NEEDED HYDRAULIC HEAD	DEVICE HOLDS STANDING WATER
CleansAll™	Litter Collection Basket	In-line	3.2 to 96.5 cfs	4 " to 31"	Yes
CDS™	Circular Screen	In-line	1.1 cfs to 300 cfs	4" to 31"	Yes
Baysaver®	Separation / Sedimentation	In-line	2.4 cfs, 7.2 cfs and 11.1 cfs	5" to 12"	Yes
Fresh Creek	Nets	In-line End-of-Pipe	30 cfs per net	1" to 4"	No
Ski-Jump	Litter Collection Basket	End-of-Pipe	14 cfs to 254 cfs	4" to 16"	No
NetTech GPI™	Nets	End-of-Pipe	30 cfs and up	1" to 4"	No
Baramy GPT™	Inclined Screen	End-of-Pipe	85 cfs	27.5" to 59"	No
StormScreen™	Screen	In-line	0.5 cfs and up	24"	Yes
Vortechs™	Hydrodynamic	In-line	1.6 to 25 cfs	4" to 19"	Yes
GSRD Linear Radial	Return Flow Litter Basket	In-line End-of-Pipe	Size for 25 year event	Minimal	No
GSRD Inclined Screen	Inclined Screen	In-line	Size for 25 year event	36"	No
DII – Tray	Tray	Inlet	Capacity of Inlet	Minimal	No
DII – Sock	Sock	Inlet	Capacity of Inlet	Minimal	No
Inlet Screen	Screen	Inlet	Capacity of Inlet	Minimal	No
Trash Boom	Boom	In-Channel	Varies	Minimal	No

Table 5-2 Trash and Debris BMP Removal Summary

REMOVAL MECHANISM	GROSS SOLID REMOVAL EFFICIENCY (MASS RETAINED / TOTAL MASS)	INSTALLATION COST	MAINTENANCE COST	HEAD REQUIREMENT
Netting	Medium High	Low	Low Medium	Low
Inclined Screen	High to Very High	Medium High	Low Medium	High
Separation / Hydrodynamic	Low Medium	High	Low Medium	Low
Litter Collection Basket	Medium High	Medium High	Medium High	Medium High
Circular Screen	Very High	High	Medium	Low
Screen	Medium	High	Low Medium	Medium
Return Flow Litter Basket	Very High	Medium High	Low Medium	Low
DII – Tray	Low	Low	Medium High	Low
DII – Sock	Medium	Low	Medium High	Low
Inlet Screen	Medium	Low	Low Medium	Low
Boom	Medium (Floatables)	Low	High	Low

5.2.1.1 General Siting Issues

All forms of trash and debris BMPS involve the placement of the BMP across the flow path of the stormwater. As a result, the reduction of the discharge capacity of the drainage system where these BMPs are placed is a primary consideration when selecting appropriate types of trash and debris BMP. Accumulation of litter and debris in these systems can be very rapid and greatly reduce the capacity of the devices. Consequently, they must be installed at sites with easy access for maintenance crews and their equipment.

Drain inlet inserts are generally designed to be installed in existing drain and curb inlets; consequently, initial cost of this technology is extremely low in comparison to many other alternatives. Important operational considerations include potential clogging of the device with litter and debris, which can reduce the hydraulic capacity of the inlet and result in street flooding. The hydraulic capacity also limits the maximum drainage area to a given inlet.

5.2.1.2 Footprint/Hydraulic Requirements

The amount of the available hydraulic head is an especially important factor in determining whether certain trash and debris BMPs can be successfully installed. Some devices require up to 3 feet of head (elevation difference between inlet and outlet). Retrofit situations often have very limited head, which limits the types of BMPs that are appropriate.

The amount of footprint available is an important factor when considering implementation of trash BMP devices. All the trash and debris BMPs have a relatively small footprint and should easily fit in most situations; however, some devices require less area then others.

Other considerations include the upstream impacts on flow and increased upstream water levels due to installation of a trash and debris BMP. Some devices, such as sock drain inlet inserts, increase local flooding near the inlet. Other devices may cause backup of water upstream and increase water elevations upstream.

5.2.1.3 Maintenance Access

Operation and maintenance requirements are necessary for proper performance of stormwater BMPs; consequently, proper maintenance access should be available at locations where trash and debris BMPs are being considered. Some devices require a vacuum truck to remove the accumulated debris. This requires the truck to get within 20 feet of the device and must be considered when choosing a BMP. Depending on watershed litter accumulation characteristics maintenance may need to be preformed more frequently and therefore access should be carefully considered.

5.2.2 Address Trash and Debris

Where the physical characteristics of a site are appropriate for implementation of several different trash BMPs, the gross pollutant removal efficiencies of trash and debris BMPs, relative to each other, should be the primary criterion for device selection.

5.2.3 Aesthetic Considerations

Aesthetics can be an important factor when the BMP will be clearly visible. Many of the trash racks, baskets and nets lack aesthetic appeal. However, the high visibility of the trash accumulation may have a benefit in promoting public awareness of the problem with litter and debris entering the storm drain system.

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GLOSSARY

- **Best Management Practice**
  Best practical and economically achievable measures to control the addition of pollutants to the waters of the United States through the application of pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives.

- **Clean Water Act and Amendments**
  The Federal Pollution Control Act (Public Law 92-500), as amended (33 U.S.C. 1251 et seq.). Federal regulation mandating a National Pollutant Discharge Elimination System permit for discharges into the Waters of the United States. The goals of the act are to restore and maintain the chemical, physical and biological integrity of the nation's waters.

- **Litter**
  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 on the lands and waters of the state, but not including the properly discarded waste of the primary processing of agriculture, mining, logging, sawmilling or manufacturing.

- **Maximum Extent Practicable**
  To the maximum extent possible, taking into account equitable consideration of synergistic, additive and competing factors; including, but not limited to, gravity of the problem, fiscal feasibility, public health risks, societal concerns and social benefits.

- **National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit**
  A provision of the CWA, section 402, that identifies municipal stormwater as a point source subject to regulation under the NPDES Permits.

- **NPDES Stormwater Program**
  The program designed by the Orange County Permittees for compliance with the NPDES permits.

- **Permittees**
  The cities of Anaheim, Brea, Buena Park, Costa Mesa, Cypress, Dana Point, Fountain Valley, Fullerton, Garden Grove, Huntington Beach, Irvine, Laguna Beach, Laguna Hills, Laguna Niguel, Laguna Woods, La Habra, La Palma, Lake Forest, Los Alamitos, Mission Viejo, Newport Beach, Orange, Placentia, Rancho Santa Margarita, San Clemente, San Juan Capistrano, Santa Ana, Seal Beach, Stanton, Tustin, Villa Park, Westminster, and Yorba Linda; the County of Orange; and the Orange County Flood Control District and any subsequently

incorporated cities that become subject to the NPDES permit. Each Permittee is individually responsible for the implementation of the program elements within its jurisdiction.

- **Principal Permittee**
  The County of Orange is the Permittee designated with the responsibility to manage the NPDES Municipal Stormwater Program on behalf of the Permittees.

- **Regional Water Quality Control Boards**
  The Santa Ana and San Diego Regional Water Quality Control Boards are agencies that implement and enforce Clean Water Act Section 402(p) NPDES permit requirements, and are issuers and administrators of these permits on behalf of EPA within Orange County.

- **Santa Ana Board**
  The Regional Board that issues the NPDES Municipal Stormwater Permit for Orange County from the northern Los Angeles County border down to approximately El Toro Road. Its jurisdiction includes the cities of Anaheim, Brea, Buena Park, Costa Mesa, Cypress, Fountain Valley, Fullerton, Garden Grove, Huntington Beach, Irvine, La Habra, La Palma, Lake Forest, Los Alamitos, Newport Beach, Orange, Placentia, Santa Ana, Seal Beach, Stanton, Tustin, Villa Park, Westminster, and Yorba Linda.

- **San Diego Board**
  The Regional Board that issues the NPDES Municipal Stormwater Permit for Orange County from approximately El Toro Road down south to the San Diego County border. Its jurisdiction includes the cities of Dana Point, Laguna Beach, Laguna Hills, Laguna Niguel, Laguna Woods, Mission Viejo, Rancho Santa Margarita, San Clemente and San Juan Capistrano.

- **State Water Resources Control Board**
  State agency that sets statewide policy for the nine Regional Water Quality Control Boards.

- **Total Maximum Daily Loads (TMDL)**

A written, quantitative plan and analysis for attaining and maintaining water quality standards in all seasons for a specific waterbody and pollutant.

APPENDIX A

Storm Water Permit Sections Relating to Trash and Debris BMP

VII. ILLEGAL CONNECTIONS; LITTER, DEBRIS AND TRASH CONTROL

1. The permittees shall continue to prohibit all illegal connections to the MS4s through their ordinances, inspections, and monitoring programs. If routine inspections or dry weather monitoring indicate any illegal connections, they shall be investigated and eliminated or permitted within 120 days of discovery and identification.

2. All reports of spills, leaks, and/or illegal dumping shall be promptly investigated and, where appropriate, reported to the Executive Officer within 24 hours (those incidents which may pose an immediate threat to human health or the environment, e.g., sewage spills that could impact water contact recreation, an oil spill that could impact wild life, a hazardous substance spill where residents are evacuated, etc.) by phone or e-mail, with a written report within 5 days. At a minimum, all sewage spills above 1,000 gallons and all reportable quantities of hazardous waste spills as per 40CFR 117 and 302 shall be reported within 24 hours and all other spill incidents shall be included in the annual report. The permittees may propose a reporting program, including reportable incidents and quantities, jointly with other agencies, such as the County Health Care Agency, for approval by the Executive Officer.

3. The permittees shall continue to implement appropriate control measures to reduce and/or to eliminate the discharge of trash and debris to waters of the U.S. These control measures shall be reported in the annual report.

4. By July 1, 2003, the permittees shall review their litter/trash control ordinances to determine the need for any revision. The permittees are encouraged to characterize trash, determine its main source(s) and develop and implement appropriate BMPs to control trash in urban runoff. The findings of this review shall be included in the annual report for 2002-2003.

5. By July 1, 2003, the permittees shall determine the need for any additional debris control measures. The findings shall be included in the annual report for 2002-2003.

F.3.a.(5) Maintenance of Municipal Separate Storm Sewer System (Municipal)

(a) Each Copermittee shall implement a schedule of maintenance activities at all structural controls designed to reduce pollutant discharges to or from its MS4s and related drainage structures.

(b) Each Copermittee shall implement a schedule of maintenance activities for the municipal separate storm sewer system.

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i. The maintenance activities must, at a minimum, include: Inspection and removal of accumulated waste (e.g. sediment, trash, debris and other pollutants) between May 1 and September 30 of each year;

ii. Additional cleaning as necessary between October 1 and April 30 of each year;

iii. Record keeping of cleaning and the overall quantity of waste removed;

iv. Proper disposal of waste removed pursuant to applicable laws;

v. Measures to eliminate waste discharges during MS4 maintenance and cleaning activities.

APPENDIX B

Manufacturers' Information on Proprietary Devices

Acrobat Document