TECHNICAL REPORT ON TRASH BEST MANAGEMENT PRACTICES

Submitted by
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DEPARTMENT OF PUBLIC WORKS
WATERSHED MANAGEMENT DIVISION
Water Quality Section

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TABLE OF CONTENTS

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BEST MANAGEMENT PRACTICES

I INTRODUCTION

This report has been prepared in response to a Request for Technical Report issued to all Los Angeles County MS4 permittees by the Los Angeles Regional Water Quality Control Board on Oct. 22, 2003 (attached). The letter states that, "by potentially justifying the use of BMPs in lieu of numerical effluent limitation, the technical report could provide a substantial benefit to MS4 dischargers by providing them greater flexibility in meeting TMDL implementation provisions than if strict numerical water quality-base effluent limitation were deemed necessary and appropriate." A follow-up meeting with Regional Board staff and interested cities was held at Public Works Headquarters on December 10, 2003, to further define the scope of the response. It was agreed that the purpose of the request was to "solicit alternative ways to meet the terms of the Trash TMDL through the installation of Best Management Practices." A subsequent letter from the Regional Board extended the deadline for submittal of the report to July 30, 2004.

The County of Los Angeles Department of Public Works (DPW) is responding to the request for technical information even though the response is voluntary. DPW believes that the enforcement of TMDL standards through the implementation of Best Management Practices to the maximum extent practicable in the MS4 permit[1] is the most equitable solution for all concerned. DPW believes that there are effective alternatives to meeting the goals of the Trash TMDL for Los Angeles River and Ballona Creek. Public Works, in this report, will address the following issues, numbered as they appear in the RWQCB's Oct. 22 letter:

(1) BMPs the discharger is implementing to address the trash wasteload reductions.

(2) New BMPs the discharger proposes to implement the requirements of the trash wasteload reductions.

(5) Assumptions about the efficacy of BMPs or other similar requirements that could be implemented, enhanced, or refined to reduce trash discharges from the MS4. The Regional Board requests that a discharger's technical report focus on the quantitative assumptions about how much trash that BMPs and other similar requirements would prevent from being discharged to waters of the State. Ideally, the information should demonstrate that the suite of BMPs will be sufficient to implement the trash wasteload reductions.

In general, the science and technology of stormwater Best Management Practices is only emerging. Furthermore, because trash was only identified as a pollutant of concern in 2000, the understanding of anthropogenic trash, its sources, loads, and treatment in Los Angeles County,

[1] State of California; California Regional Water Quality Control Board; Los Angeles Region; Order No. 01-182, NPDES Permit No. CAS004001; Waste Discharge Requirements for Municipal Storm Water and Urban Runoff Discharges with the County of Los Angeles, and the Incorporated Cities Therein, Except the City of Long Beach; December 13, 2001.

has only been developing during recent years.

Nonetheless, DPW has been at work meeting the MS4 trash requirements as well as testing the effectiveness and maintainability of new TMDL technologies. Early voluntary trash abatement efforts by DPW included the construction of floating trash nets in Ballona Creek , Los Angeles River, and other open channels. One of the MS4 trash-related requirements involves identifying and prioritizing "A, B, and C" catch basins within the County based on the catch basins' trash accumulation. Another MS4 trash requirement, falling under the Municipal Activities Program calls for the placement of trash cans at public transit stops. The final MS4 requirement[2] involves baseline monitoring within the Los Angeles River and Ballona Creek watersheds of the accumulation of trash by 5 land use types:

- commercial;
- high density single family residential;
- industrial;
- low density single family residential; and
- park/open space.

[2] Los Angeles Region Monitoring and Reporting Program - CI6948 for Order No. 01-182, NPDES No. CAS004001, Section II E, p. T-12.

II TRASH BMPs *CURRENTLY* IN USE BY COUNTY PUBLIC WORKS: (RWQCB's ISSUE #1)

The following table represents the number and types of trash management BMPs currently in use by County Public Works:

TABLE 1

Device/Practice	Total No. Installed as of July, 2004	No. Installed in L.A.R. Watershed	No. Installed in Ballona Ck. Watershed	No. Installed in All Other Watersheds
Curb Inlet Catch Basin Insert	702	378	324	
Grated Drop Inlet Filter Insert	8	8		
Curb Inlet Catch Basin Retractable Screens	200 (100 automatic and 100 manual)	200		
"Full Capture" Hydrodynamic Separators	13	6	4	3
End-of-Pipe Screen or Sock	2	2		
In-Stream Floating Boom or Net	23	17	1	5
Catch Basin Cleanouts	Over 75,000 county-owned catch basins are cleaned out at least once a year countywide. Of these, there are 1,618 "Priority A" and 470 "Priority B" catch basins that are cleaned out more frequently, as required by the MS4 Permit.			
Catch Basin Stenciling and Access Signage	"No Dumping–Drains to Ocean" stencils have been painted and maintained on over 75,000 county-owned catch basins and right-of-way access points throughout the County, as required by the MS4 Permit.			
Parking Lot Sweeping	Certain DPW yards and facilities are cleaned at least once per week (more often than required by the MS4 Permit) and are visually inspected and cleaned more often if required. Other DPW yards and facilities are swept at a minium in accordance with the requirements of the MS4 Permit.			
Street Sweeping	DPW operates 32 conventional sweepers, 6 air sweepers, 6 self-propelled pull-brooms countywide. DPW sweeps streets in the unincorporated areas at least once per week (more often than required by the MS4 Permit).			

Device/Practice	Total No. Installed as of July, 2004	No. Installed in L.A.R. Watershed	No. Installed in Ballona Ck. Watershed	No. Installed in All Other Watersheds
Open Channel Sweeping	During dry weather, DPW sweeps and cleans out portions of the San Gabriel River, Coyote Creek, Los Angeles River, Alhambra Wash, Sawpit Wash, Walnut Creek, Arcadia Wash, Arroyo Seco, Big Dalton Wash, Eaton Wash, Little Dalton Wash, Puente Creek, Rubio Wash Santa Anita Wash, Proj. 21, Proj. 130, Dominguez Channel, Ballona Creek, Centinela Creek, PD 669, Proj. 9, Proj. 1232, Santa Monica Cyn., Sepulveda Channel, Wilmington Drain, Aliso Creek, Bell Creek, Browns Creek, East Canyon Channel, Pacoima Wash, Tujunga Wash, and Verdugo Wash where the bottoms are concrete-lined and wide enough for a street sweeper, and where there is not too much dry weather flow.			
Performance-Based Open Channel Trash Removal Contracts	DPW has 6 “zero tolerance” contracts countywide with private trash collectors to remove debris from lined open channels within 48 hours whenever there are at least 33 gallons of trash visible in any 300 ft. reach. Performed during dry weather, April thru December.			
Trash Can Receptacles	Over 1,085 county-maintained receptacles throughout the county.			
Public Education/Hot Line	The first year of a pilot outreach program showed an increase in public participation and a decrease in trash accumulation.			
No-Litter Law	The County has and enforces in its stormwater ordinance (Title 12, Chapter 12.80.440) a countywide anti-litter regulation.			

III TRASH BMPs EXPECTED TO BE USED IN THE *FUTURE* BY COUNTY PUBLIC WORKS: (RWQCB's ISSUE #2)

The following table represents the number and types of structural and management BMPs expected to be used in the future by County Public Works:

TABLE 2

Device/Practice	Planned for the Future
Curb Inlet Catch Basin Insert	600
Grated Drop Inlet Filter Insert	Uncertain at this time. A County ordinance to retrofit catch basins with BMPs on private retail/commercial/industrial property is being investigated.
Curb Inlet Catch Basin Automatic and Manually Retractable Screens	2400: 1200 in 2004-2005, plus up to an additional 1200 in the L.A. River and Ballona Ck. watersheds as the result of DPW's offer to retrofit County "Priority A and B" catch basins within incorporated cities.
"Full Capture" Hydrodynamic Separators	At least 1 more.
End-of-Pipe Trash Rack, Screen or Sock	At least 1 trash sock is planned. DPW also foresees the upgrading of trash racks at up to 44 pump plant forebays to "full capture" capability. "Full capture" trash removal devices are planned for approved sub-regional multi-use stormwater facilities, such as Peck Pit, Sun Valley, and Florence/Firestone projects.
In-Stream Floating Boom or Net	At least 1 more (in Dominguez Channel watershed).
Catch Basin Cleanouts	Maintain the current frequency. DPW foresees the adjusting of contracted cleanouts to occur later in the year just before the storm season
Catch Basin Stenciling	Maintain the current application.
Parking Lot Sweeping	Maintain the current frequency.
Street Sweeping	Maintain the current frequency. DPW foresees the possibility of adjusting street sweeping schedules to occur immediately after trash pick-up days, stricter enforcement of no-parking during street sweeping days, and encouraging and sponsoring more public cleanup events.
Open Channel Sweeping	
Trash Can Receptacles	
Public Education/Hot Line	
Performance-Based Open Channel Trash Removal Contracts	The 6 individual countywide contracts will be merged into 3 contracts upon renewal.

Device/Practice	Planned for the Future
No-Litter Law	Maintain the enforcement of current ordinances. The County passed a no-smoking ban at County beaches. DPW foresees the possibility of an ordinance prohibiting certain products, such as cigarette butts, Styrofoam cups, etc., at other recreational areas. DPW also foresees the possibility of product market-based reduction incentives and product substitution.

IV EFFECTIVENESS OF TRASH REMOVAL BMPs (RWQCB's ISSUE #5)

Total Maximum Daily Loads (TMDLs) are imposed on water bodies listed as impaired on the EPA's 303(d) list. The Los Angeles River and major tributaries as well as the Ballona Creek and major tributaries have been designated as impaired due to man-made trash. Similar designations for Dominguez Channel and San Gabriel River lakes are expected in the near future.

The Trash TMDL for Ballona Ck. requires the reduction of trash loadings to the impaired water bodies by 10% per year until discharges of man-made trash reach "zero" by 2012. In addition, compliance will be considered achieved if "full capture" trash BMP systems are installed. In these cases, the amount of trash collected will not have to be reported, but maintenance records must be available for inspection by the Regional Board. The settlement agreement[3] for the Trash TMDL defines "full capture" as:

> Any single device or series of devices that traps all particles retained by a 5 mm mesh screen and has a design treatment capacity of not less than the peak flow rate (Q) resulting from a one-year, one-hour storm in the subdrainage area....

The Los Angeles River, and especially Ballona Creek, drain the oldest and some of the most urbanized areas of Los Angeles County. The population density (1990 census) of the Los Angeles River watershed is approximately 5,100/sq. mile, while the density of the Ballona Ck. watershed is approximately 17,000/sq. mile[4].

In order to understand the possible effectiveness of BMPs in meeting the trash removal needs in Los Angeles County, it is important to understand the hydrologic and physical factors that contribute to the effectiveness of structural BMPs, namely:

- the storm drain system;
- the relationship between rainfall and runoff;
- trash generation and loading--the relationship between trash sources and land use types;
- "natural" debris vs. man-made trash;
- trash particle sizes;
- performance and maintainability; and
- the types of proprietary and nonproprietary BMPs currently available.

This section will discuss these contributing factors.

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[3]Settlement Agreement Re TMDL for Trash in the L.A. River Watershed and Ballona Creek and Wetland Watershed, Attachment A, Sept. 5, 2003.

[4]Los Angeles County 1994-2000 Integrated Receiving Water Impacts Report, July 31, 2000.

The Flood Control System

The backbone of the flood control system in Los Angeles County, dating back to the 1930's, is designed, constructed, maintained, and monitored by the Los Angeles County Flood Control District, represented by the County of Los Angeles Department of Public Works. Other flood control systems, either in whole or in part, are the jurisdiction of other permittees, Caltrans, or the U.S. Army Corps of Engineers.

Typically, underground storm drains are designed to carry the runoff from up to a 10-year storm. Open channels are typically designed to carry the runoff from up to a 50-year storm, and in some cases, this design flow rate is augmented to accommodate debris-laden flows[5]. The rate of runoff a drain can safely convey, expressed in cubic feet per second, is called its peak capacity. While a drain's capacity will not diminish over the years, the amount of runoff generated by a given storm event can increase over the years. This increase is due to a number of factors: an increase in the amount of development and impervious surface within the tributary area, and/or; the addition of smaller upstream tributary drains that deliver runoff more quickly to the collecting drain. Thus, the storm drain's "level of protection" diminishes. That is, a storm drain that at one time could convey runoff from a 10-year storm might now only convey runoff from a 1-year storm.

Any device or series of devices introduced into an older, under-capacity drain could have significant hydraulic impact on the drain's ability to collect and convey peak flows. These impacts are especially significant if a device or devices are to be installed within the drain itself. If such were the case, the design would typically call for a low weir, or "diversion dam," installed across the bottom of the drain. The weir would be high enough to divert lower flows up to the runoff from a 1-year storm into the treatment device. Water returning from the treatment device then returns to the drain downstream of the intake. The depth of the device determines how far downstream the return is located.

In some cases, the low weir could cause runoff to back up in the drainage system, causing localized flooding. To minimize this problem, enlargement of the drain at and upstream of the diversion site would be required. Physical constraints, such as adequate rights of way and interference from adjacent underground utilities may prohibit reasonable installation. If in-line installation within the drain is not feasible, other solutions with less hydraulic impact might take the form of catch basin or inlet exclusion devices, such as permanent, semi-permanent, or retractable screens, or end-of-pipe containment devices, such as trash racks, mesh screens and socks. Except in the case of systems of seriously limited capacity, the latter devices are perceived to have less hydraulic impact.

The Relationship Between Rainfall and Runoff

[5]Hydrology and Sedimentation Manual, Los Angeles County Department of Public Works, 1991.

Storms are commonly referred to by their "frequency." For example, a 1-year storm, having a long-term probability of happening at least once a year, is a very common occurrence. On the other hand, a 50-year storm event is a much rarer occurrence, with a long-term probability of occurring only once in 50 years.

The actual rate of runoff from storms of a given size or frequency depends on a number of factors, including the intensity and duration of the rainfall, the size of the tributary area, the topography, the soil types within the tributary drainage area, and the overall connected imperviousness of the tributary area.

Because the definition of "full capture" in the Trash TMDL settlement agreement includes reference to runoff from a certain storm event, it may be worth investigating if this runoff could possibly be reduced. Reducing the runoff would reduce the loading as well as the size of the treatment device(s).

One way to reduce the runoff rate from a given storm in a given tributary area is to retroactively reduce the amount of impervious cover. This impervious cover is produced by the roofs, streets, sidewalks, parking areas, and other hardscaped areas in a tributary drainage area. When roof runoff collects into downspouts, which then discharge onto driveways or parking lots, which in turn drain to catch basins and drop inlets that outlet into storm drains and channels, the impervious areas are said to be "hydraulically connected." If the connection of impervious surfaces could in some way be broken without inflicting flooding damage when a large storm occurs, a lower runoff rate could be achieved during small storms.

Lower runoff rates could also be achieved through the replacement of impervious pavement with porous pavement where possible. Hydraulic disconnection of impervious areas and replacement of impervious pavement is more feasible on publicly owned property. Lightly used publicly owned parking lots are prime candidates. The roofs of publicly owned buildings might also be candidates for retrofitting of so-called "green roofs," plantings that absorb light rainfall and thereby reduce runoff. Such green roofs have not been tested in semi-arid areas like Los Angeles to our knowledge[6]. Privately owned impervious surfaces will be more of a challenge to replace or retrofit, but incentives to do so might be established.

Trash Generation and Loading--the Relationship Between Trash Sources and Land Use

[6] Best Management Practices Web Survey, June 10, 2002, conducted by Los Angeles County Public Works. Results published at http://ladpw.org/wmd/bmp/Summary.htm.

Types

The amounts of trash generated based on land use were addressed in a report[7] required by the MS4 permit and submitted by Public Works to the Regional Board on May 3, 2004. The report described the accumulation and cleanout of man-made trash, sediment, and natural vegetation in 500 catch basin inserts and 5 hydrodynamic separators in the Ballona Creek and Los Angeles River watersheds between Nov.11, 2002 and March 20, 2004. This period included 15 storm and one dry weather cleanouts.

Land Use Type Distribution: The Integrated Impacts Report[8] identifies the distribution of land uses in the Ballona Creek and Los Angeles River watersheds tributary to the mass emission monitoring stations as follows:

TABLE 3

Distribution of Land Use Types, Acres

	Ballona Ck. Watershed	L.A. River Watershed
Commercial	5,646	19,062
Industrial	1,959	26,614
High Density Single Family Residential	22,722	151,435
All Other Land Uses Types	26,517	329,295
Total Area Tributary to Mass Emission Station	56,844	526,406

[7] Trash Baseline Monitoring Results (Supplemental), Los Angeles River and Ballona Creek Watersheds, May 3, 2004, Los Angeles County Department of Public Works

[8] 1994-2000 Integrated Receiving Water Impacts Report, Los Angeles County Dept. of Public Works, July 31, 2000.

Land Use Types with Highest Litter Generation per Acre: In terms of pounds of man-made trash per acre of drainage area, commercial land use was the highest contributor in the Ballona Creek watershed both years of the baseline study. The contribution from commercial land use was at least twice as great from all other land use types for Ballona Creek. In the Los Angeles River watershed, industrial land use was the worst contributor in both years; however, commercial land use was a close second during the first year of sampling. This information is shown in the following table, but should be considered preliminary:

TABLE 4

Land Use Types with Highest Litter Generation per Acre, 2002-2004	
Ballona Ck. Watershed	L.A. River Watershed
Commercial	Industrial

"Natural" Debris vs. Man-made Trash: The following table shows the percentage of man-made litter to the total amount of litter removed from the catch basin inserts during the 2-year period, dry and wet weather, of the baseline study, but should be considered preliminary:

TABLE 5

Percentage of Man-Made Litter Compared to Total Trash, 2002-2004		
Land Use Type	Ballona Ck. Watershed	L.A. River Watershed
Commercial	12%	11%
Industrial	7%	16%
High Density Single Family Residential	8%	3%
Low Density Single Family Residential	5%	0.5%
Open Space/Park	7%	1.5%

Trash Particle Sizes

The definition of "full capture" in the Trash TMDL settlement agreement includes reference to a maximum allowable trash particle size of less than 5mm. The 5mm size limit is approximately the diameter of a pencil or cigarette butt. A smaller particle size implies a smaller filtering mesh or screen size, and a smaller mesh or screen size implies more resistance to the flow passing through it. Assuming that a certain percentage of a screen would be blocked by trash during a storm event, the total area of the screen openings would have to be larger than the area of the drain's cross section by that percentage.

Performance and Maintainability

The RWQCB has judged that certain proprietary structural trash BMPs meet the definition of "full capture" (see attachment). In addition to the requirement of removing litter 5mm and above from flows up to the runoff from a 1-year storm, the Board takes into account monitoring data, reliability and performance sensitivity under varying loads. To date, however, the procedures for a device to meet these criteria have not been published.

DPW, through its own maintenance pilot studies and with input from State Health Services[9], has decided that trash devices that are to be maintained by the County should meet the following minimum criteria:

- it must not adversely affect the level of flood protection provided by the drainage system;
- it should be vector-resistant, or not pond water for more than 72 hours after the end of a storm;
- it should not worsen water quality by resuspending trash, sediments, or bacteria, or by leaching heavy metals or semi-volatile organic compounds;
- if it is to be an underground device with access shafts, it must meet or exceed APWA standards, have ladder rungs, and have the ability to withstand lateral soil pressures;
- it should have no plastic or fiberglass interior parts that would break or shatter in the path of direct flow
- its pipes, conduits and vaults should not be more than 32 feet below ground, be easily accessible by a vacuum truck hose for clean-out, be reasonably accessible by a qualified maintenance worker, have provisions for confined space entry and safety guard rails around the rim; and
- it should provide means to block off the inflow and tail water backflow to isolate the device for safe maintenance and repair of the unit.

[9]Metzger, Marco E., PhD. January 2004. *Managing Mosquitoes in Stormwater Treatment Devices*. University of California Department of Agriculture and Natural Resources.

Effectiveness[10] of Proprietary and Nonproprietary BMPs Currently Available: The following is a table outlining the various advantages and disadvantages of the BMPs presented previously:

TABLE 6

DEVICE/ PRACTICE	PROs	CONs
Curb Inlet Catch Basin Filter Insert (Proprietary)	Some models are also adapted for capturing hydrocarbons from the first portion of runoff; might be worthy of "full capture" application in L. A. if used as part of a system of BMPs	Moderate sediment and gross pollutants removal; can contain hydrocarbon by-products, requiring disposal as a hazardous waste; loss of drain capacity may be significant; peak flows could reintroduce trash into the water body if not designed properly; vacuum clean-out equipment can be noisy
Grated Drop Inlet Filter Insert (Proprietary)	Some models are also adapted for capturing hydrocarbons from the first portion of runoff; might be worthy of "full capture" application in L. A. if used as part of a system of BMPs	Susceptible to clogging under high loading; moderate sediment and gross pollutants removal; loss of drain capacity may be significant; peak flows could reintroduce trash into the water body if not designed properly; vacuum clean-out equipment can be noisy
Curb Inlet Catch Basin Manually Removable Screens (Proprietary and Non-proprietary)	Can be effective for keeping trash out of the storm drain system; should require little monitoring if working properly; loss of drain capacity would be minor during dry weather flows; might be worthy of "full capture" application in L. A. if used as part of a system of BMPs	Must be removed before storm season; parked vehicles may disrupt removal schedule or impede removal during emergencies; unexpected storm could cause flooding problems

[10] Sources: USEPA web site http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post.cfm and unpublished LACDPW report, *8-Point Evaluation Plan of Trash BMPs.*

DEVICE/ PRACTICE	PROs	CONs
Curb Inlet Catch Basin Automatically Retractable Screens (Proprietary)	Can be effective for keeping trash out of the storm drain system; should require little monitoring if working properly; loss of drain capacity may be minor; might be worthy of "full capture" application in L. A. if used as part of a system of BMPs	If not designed or installed properly, may jam open or open prematurely or jam closed or close prematurely; peak flows could reintroduce trash into the water body if not designed properly;
Hydrodynamic Separator (Proprietary)	Requires less space than linear settling devices; internal screens can be custom sized; contents can be removed via pumping; one manufacturer has earned "full capture" certification in L. A.	Some devices have sumps with standing water, potential vector and bacteria/pathogens problems; decomposing and leaching of waste material in standing water could introduce dissolved pollutants; it may be necessary to remove and dispose of floatables separately due to presence of petroleum product; confined underground spaces may require specially trained crews; loss of drain capacity may be significant if not designed properly; vacuum clean-out equipment can be noisy
Linear Radial Separator (Proprietary)	Installations can be shallow, open to air, eliminating need for confined entry; relatively inexpensive; relatively easy maintenance; screen openings can be custom sized; end of pipe applications demonstrate low head loss; could be worthy of "full capture" certification in L. A.	Pilot applications only in existence; vacuum clean-out equipment can be noisy
End-of-Pipe Sock (Proprietary)	Visible, easy to maintain and monitor; mesh size can be custom sized; relatively inexpensive; loss of drain capacity may be minor with proper design; could be worthy of "full capture" certification in L.A.	Smaller mesh sizes could impede capacity of storm drain system if not designed properly; breaking away of sock during peak flows might reintroduce trash into the water body if not designed or installed properly;
End-of-Pipe Screen (Proprietary)	Visible, easy to monitor; mesh size can be custom sized; loss of drain capacity may be minor if properly designed; could be worthy of "conditional full capture" certification in L.A.	Smaller screen opening sizes could impede capacity of storm drain system if not designed properly; peak flows could reintroduce trash into the water body if not designed properly;

DEVICE/ PRACTICE	PROs	CONs
In-Stream Floating Boom or Net (Proprietary and Non-proprietary)	Visible, relatively easy to maintain and monitor; might be worthy of "full capture" application if used as part of a system of BMPs	Only protects the water body downstream of its location; smaller mesh sizes could impede capacity of storm drain system if not designed properly; breaking away of net, either deliberately or accidentally, could reintroduce trash into the water body if not designed properly;
Parking Lot Sweeping (Non-proprietary)	Can be effective at preventing trash from getting into the storm drain system; sweeping already being performed in many cities; might be worthy of "full capture" application if used as part of a system of BMPs	High capital costs associated with equipment; if not properly performed, sweeping only moves trash from one area to another, or into catch basins; mechanical sweeping can be noisy
Street Sweeping (Non-proprietary)	Can be effective at preventing trash from getting into the storm drain system; sweeping already being performed in many cities; might be worthy of "full capture" application if used as part of a system of BMPs	High capital costs associated with equipment; if not properly performed, sweeping only moves trash from one area to another, or into catch basins; mechanical sweeping can be noisy
Open Channel Sweeping	Can be a practical mitigative measure during dry weather; improves the appearance of the channel reach as well as reducing downstream loads when storms occur; can be relatively inexpensive if sweepers are already owned and available	Only implementable where open channels are wide enough, dry enough, and accessible; can be expensive if new equipment must be purchased or services contracted; mechanical sweeping can be noise; reactive rather than preventive
Performance-Based Open Channel Trash Removal Contracts	Can be a practical mitigative measure during dry weather; improves the appearance of the channel reach as well as reducing downstream loads when storms occur	Only implementable where open channels are dry enough and accessible; reactive rather than preventive
Trash Can Receptacles (Non-proprietary)	Can be effective at preventing trash from getting into the storm drain system; relatively inexpensive; visible, easy to maintain and monitor; might be worthy of "full capture" application if used as part of a system of BMPs	Maintenance can be labor intensive; receptacles may need frequent replacing; may invite scroungers

DEVICE/ PRACTICE	PROs	CONs
Public Education (Non-proprietary)	Can be effective at preventing trash from getting into the storm drain system; can be targeted at problem populations or areas; might be worthy of "full capture" application if used as part of a system of BMPs	Purchasing broadcast media time can be very expensive; difficult to quantify trash reduction
Dedicated Hot Line (e.g. 800-NO- TRASH) (Non-proprietary)	Can be effective at preventing trash from getting into the storm drain system; stormwater hot lines already in use in many cities; might be worthy of "full capture" application if used as part of a system of BMPs in L.A.	Toll-free telephone numbers can be expensive; difficult to quantify trash reduction
Subregional Solutions (Non-proprietary)	Focuses maintenance at one location, making maintenance easier and reducing maintenance costs.	If open, can be a temporary eyesore until cleanout is completed.

Ease of Implementation, Relative Costs and Benefits[11]: The following table lists the relative ease of implementation, relative costs, and relative benefits of trash-reduction practices:

TABLE 7

Practice	Relative Ease of Implementation	Relative Cost	Relative Benefit
Mid-Drain Structural Device Retrofit	Not Easy in Many Situations	High	High, but only if obstacles can be overcome
Start-of-Pipe Structural Device Retrofit (e.g. catch basin opening screens and excluders)	Moderately Easy in Many Situations	Moderate	High, especially if it qualifies as a stand-alone "full capture" device
End-of-Pipe Structural Device Retrofit (e.g. trash racks, fabric mesh socks and wire screens)	Very Easy in Certain Situations	Moderate to Low	High

[11] Ibid.

Practice	Relative Ease of Implementation	Relative Cost	Relative Benefit
Hydraulic Disconnection and/or Replacement of Impervious Surfaces	Disconnection Moderately Easy in Some Situations Repaving Moderately Easy for Public areas	Moderate	Low to High, depending on percentage of impervious surface disconnected or replaced
Street Sweeping	Moderately Easy	Moderate	High
Adjustment of Street Sweeping Contracts, Stricter Enforcement of No-Parking During Street Seeping Days, and Encouraging/Sponsoring More Public Cleanup Events.	Moderately Easy	Low	Moderate
Open Channel Sweeping	Moderately Easy	Moderate to High	High
Performance-Based Open Channel Trash Removal Contracts	Easy	Low	High
Private and Public Parking Lot Sweeping	Moderately Difficult for private lots, moderately easy for public lots	Moderate	High
Retrofit of Catch Basins on Private Parking Lots	Moderately Difficult	Low for General Public, Moderate to High for Property Owners	High
Increased or Focused Public Education	Moderately Easy	Moderate	Moderate
Dedicated Hot Line and Response	Very Easy	Moderate	Moderate
No-Litter Laws Prohibiting Certain Products at Recreational Areas, such as Cigarette Butts, Styrofoam Cups, etc.	Moderately Difficult	Moderate	Moderate
Product Market-Based Reduction Incentives and Product Substitution.	Moderately Difficult	Moderate	Moderate

Practice	Relative Ease of Implementation	Relative Cost	Relative Benefit
Subregional Trash Control Facilities	Moderately Easy in New Development, Difficult in Developed Areas	High	High

V CONCLUSIONS

This technical report has shown that the County of Los Angeles Department of Public Works is very active in the struggle to keep litter out of local water bodies. DPW's mandated and voluntary programs, aimed at litter prevention, monitoring and removal, are evidence that a "Best Management Practices" approach is feasible and desirable for TMDL compliance in lieu of numeric limits.

For trash related structural Best Management Practices to be effective in Los Angeles County, they must be capable of being retrofitted into the existing storm drain system. Unlike post-construction types of BMPs that are associated with new and redevelopment, BMPs installed for TMDL implementation must be inserted into a drainage system not originally designed for such installation, and typically in densely urbanized areas. These urban areas have the oldest infrastructure, have the oldest drains and have the least expansion and maintenance right of way. While these restrictions limit the range of suitable BMPs, "full capture" solutions are available nonetheless.

The results of DPW's MS4 programs and voluntary litter reduction projects indicate the following:

- Los Angeles County Department of Public Works has installed and maintains over 2000 structural trash control BMPs within the County. The vast majority of these devices are in the Ballona Creek and Los Angeles River watersheds.
- If a structural device is to be installed mid-drain, the storm drain system must have sufficient capacity, or the storm drain must be modified to maintain sufficient capacity. These practices are technically feasible in certain circumstances.
- The trash BMPs that are relatively very easy and moderately easy to implement while at the same time having the highest relative benefit are: start-of-pipe structural retrofit devices, end-of-pipe structural retrofit devices, hydraulic disconnection and/or replacement of impervious surfaces, street sweeping, open channel sweeping, performance-based channel cleaning, and private and public parking lot sweeping.
- Start-of-pipe (e.g. catch basin opening screens and excluders) or end-of-pipe (e.g. trash racks, fabric mesh socks and wire screens) devices may have less impact on hydraulic drain capacity under certain hydraulic conditions than devices installed mid-pipe.
- Street sweeping, open channel sweeping, and parking lot sweeping are moderate cost/high benefit trash BMPs. County DPW is already implementing these BMPs to a maximum practicable extent that maximizes its efficiency.
- Overall, flows from small storms can be reduced by "hydraulically disconnecting" impervious surfaces in the tributary drainage area, or by increasing pervious surfaces, or by a combination of both. These practices are feasible in certain

circumstances, and most easily accomplished on public property.

- The smaller the amount of flow a retrofitted device or system must treat, the less hydraulic impact it will have on the storm drain system.
- Commercial and industrial land use types generate the most man-made trash, according to the Ballona Creek and Los Angeles River watersheds 2-year baseline monitoring study.
- The 2-year baseline study in the Ballona Creek and Los Angeles River watersheds showed the ratio of man-made trash to the total debris loading to be small, varying between 0.5% and 16%.
- There is not enough information regarding the size distribution of trash particles present in stormwater and urban runoff, which could help in the optimal design and location of best management practices.
- Cost, performance and maintainability are probably the most important features of any structural BMP.
- Local jurisdictions are deciding their own rules for operation and maintenance of the devices.
- If the RWQCB were to clarify the “full capture” verification process, it is believed that there would be less confusion and more competition in the market place, resulting in improved BMP design and lower costs.
- Assuming the same trash generation rates for commercial, industrial, and high density single family residential land use type, the same annual rainfall amounts as those measured in the 2002-2004 baseline trash study, and assuming that it would be technically and economically feasible to install a “full capture” system in drains that drain those land use types, up to 78 tons/year of man-made trash would be captured in the Ballona Ck. watershed and up to 764 tons/year would be captured in the Los Angeles River watershed.

VI RECOMMENDATIONS

- Trash and runoff source control BMPs should be utilized in areas tributary to trash-impaired water bodies to the maximum extent practicable. The best candidate BMPs for this task are hydraulic disconnection and/or replacement of impervious surfaces, increased street sweeping, and increased private and public parking lot sweeping if not already implemented.
- When the best candidate trash and runoff source control BMPs cannot be utilized, the second best source controls should be utilized to the maximum extent practicable. The second best source control BMPs are adjustment of street sweeping contracts, stricter enforcement of no-parking regulations, encouragement/sponsorship of more public cleanup events, increased or focused public education, and a dedicated hot line and response.
- In high trash generation areas, which in the Ballona Creek and Los Angeles River watersheds appear to be commercial and industrial land uses respectively, start-of-pipe structural retrofit devices (e.g. catch basin opening screens and excluders), end-of-pipe structural retrofit devices (e.g. trash racks, fabric mesh socks and wire screens), hydraulic disconnection and/or replacement of impervious surfaces, increased street sweeping, increased performance-based channel cleaning, and increased private and public parking lot sweeping should be implemented to the maximum extent practicable.
- The performance-based channel cleaning contracts were deemed so effective that similar contract-based operations should be introduced for streets in developed areas.
- Newer storm drain systems in high trash generation areas are good candidates for BMP retrofit and should be refitted accordingly where technically and economically feasible.
- Some older storm drain systems should be retrofitted with trash removal devices where suitable technical and economic conditions exist.
- More information should be gathered regarding the distribution of particle sizes in trash to determine if particle size might vary by land use type, storm intensity, etc., in order to better design and locate BMPs.
- Since the RWQCB is driving the technology by writing the mandates; it should clarify the “full capture” verification process. Clarification would open the process up to more BMP manufacturers and thereby improve design and lower costs.
- The RWQCB should also consider a category of “potentially full capture” for those products that show promise, but lack sufficient testing. This category would allow agencies to justify the installation of certain products more easily under pilot programs.
- Because of vector concerns, the RWQCB should take into account before certifying if any BMP has the ability to pond water for more than 72 hours.
- If any BMP has the ability to worsen the concentration of impairing pollutants via leaching, resuspension, or regrowth, it should not be certified, or be conditionally certified pending proof that it will not do so.