Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Litter Booms

Tuffboom (courtesy of Worthington Products, Inc.).

TC-5 Treatment Control

Litter Boom Manufacturers/ Examples

- Applied Fabric Booms
- Elastec, Inc.
- Kepner Plastics Debris Barrier
- Nautilus Marine Protection, Inc.
- Slickbar Products Co.
- Stormwater Systems Inc. (Bandalong Floating Debris Trap)
- Worthington Products, Inc. (Tuffboom)

Summary

Litter booms are floatation structures with suspended curtains that are used to contain floating trash. Booms are best suited to slow-moving waters. Since more pollutants sink than float, they are only useful for trapping highly buoyant materials and can miss most of the gross solids[1] load. Maintenance is done manually, with a boom truck or with a skimmer vessel. Capital costs can range from $100,000 to $150,000 per site.

Description/Design

Litter booms are floatation structures with suspended curtains that can be used to contain floating trash (USEPA 1999, Gordon and Zamist 2006). Booms were initially designed as oil slick retention devices (Allison et al 1998) and are still often designed using absorbent materials to collect oil and grease from the water's surface (Gordon and Zamist 2006). The size of a boom depends on the expected volume of floatables released during a storm event. Newer Australian designs use floating polyethylene boom arms with fitted skirts to deflect floating debris through a flap gate into a storage compartment (Allison et al 1997). Litter booms have a five to seven year lifespan before they are deteriorated by ultraviolet light, or are torn by captured debris (RBF Consulting 2003).

Most litter booms are installed with the boom attached to points on the opposite side of the channel with sufficient slack to allow the boom to form a semicircle. Booms are placed downstream of one or more outfalls, preferably in slow moving

Implementation Point

In Street	
Start of Pipe	
In Pipe	
End of Pipe	✓
In Creek	✓
Dispersed	

[1] Gross solids are defined as "litter, vegetation, and other particles of relatively large size" (Caltrans 2003 Phase 1 Pilot Study). Litter is subsequently defined as "manufactured items made from paper, plastic, cardboard, glass, metal, etc. that can be retained by a 5 mm (0.2 in nominal) mesh screen". This definition is understood to be consistent with the LA River Trash TMDL definition of litter.

waters (Allison et al 1997). This results in trash and debris accumulating in the middle of the boom, which is generally located in the middle of the channel, the region of highest water flow velocity. High velocities can drag collected litter under the boom. Orange County found that performance is improved by angling the boom across the channel. This allows trash to accumulate on one side of the channel, away from the high velocity region (Gordon and Zamist 2006).

- Applied Fabric Booms
- Elastec, Inc.
- Kepner Plastics Debris Barrier
- Nautilus Marine Protection, Inc.
- Slickbar Products Corp.
- Stormwater Systems, Inc., Banadalong Floating Debris Trap
- Washington Products, Inc. Tuffboom

Figure 1. Debris Boom In-Take (courtesy of Slickbar Products Corp.).

Figure 2. Bandalong Floating Debris Trap (courtesy of Stormwater Systems, Inc.).

Applicability/Siting

Litter booms are best suited for very slow moving waters (Allison et al 1998). Despite early claims of performance (Allison et al 1998), it was later recognized that trash and debris performance is greatly reduced during high flows. This reduction is due to material being forced over and under the boom (Allison et al 1998) or the boom breaking away from the banks. Litter boom performance can be enhanced by angling booms across to the current, and by using mesh skirts. Problems still persist during high flows (Allison et al 1998). As a result, one of the most important factors to consider when siting booms is the receiving water velocity. Booms float and can move with water level fluctuations, but they can be dislodged by high river velocities and winds (USEPA 1999). Special consideration should be given to booms located in highly visible public areas. Booms potentially create unsightly conditions near outfalls and may be inappropriate in areas with waterfront development (USEPA 1999).

Maintenance

Litter booms are cleaned manually with a vacuum truck or a skimmer vessel (Allison et al 1998, USEPA 1999). Special attention should be given to booms located in highly visible public areas (USEPA 1999). Maintenance of small booms can be achieved by pulling the boom to the bank and accessing the material from land. This method of maintenance has been conducted for some small booms but not for most installations (Allison et al 1998). The recommended cleaning frequency is every two to four weeks (Allison et al 1998). Containment booms must be cleaned after storm events. To help control floatables within Lake Merritt, the City of Oakland has installed litter booms. The Lake Merritt Institute (LMI) is under contract with the City of Oakland to coordinate litter removal. Every week, volunteers remove litter from the entire shoreline. LMI also removes trash from litter booms on a weekly basis or as needed. For some litter booms, LMI has to remove the barrier and scrape off mussels every year or two, or they will sink (Bailey R[2]. *pers. comm*.2007).

Performance and/or Effectiveness

Results of performance and/or effectiveness studies have been mixed. Booms have been shown to trap large quantities of floatable materials. The County of Los Angeles Department of Public Works pilot tested a litter boom system at the mouth of the Los Angeles River in Long Beach. During the first two years of the pilot testing period, the litter boom system trapped approximately 150 tons urban trash and debris (County of Los Angeles 2003). Approximately 1252 tons of trash has been harvested since the installation of the litter boom system in April 2000 (Teren, E[3]. *pers. comm*. 2007). County of Los Angeles Public Works Department staff estimates that system performance is

[2] Dr Richard Bailey, Executive Director of the Lake Merritt Institute, January 2007
[3] Ed Teren, County of Los Angeles Department of Public Works Flood Maintenance Division, May 2007.

approximately 80%. During FY 2006-2007, approximately 155 tons of trash was harvested from the system. Historical trash collection data indicates a large variation in the volume of trash harvested after each storm event. Approximately 90% of trash harvested from the first storm is vegetation. The remaining 10% is mostly Styrofoam and plastics (Teren, E[3]. *pers. comm*. 2007).

Figure 3. Los Angeles River litter boom system (courtesy of Los Angeles Department of Public Works).

In contrast, a Melbourne, Australia study (McKay and Marshall 1993, cited in Allison et al 1998) used tagged litter items, released upstream of litter booms to determine floating boom performance. The results varied from 12% to 50% recapture. These values were considered preliminary because of the low number of items released in the boom catchments. In addition, the items released in the study were highly floatable and do not represent the complete range of items found in urban stormwater. It is expected that the figures quoted by McKay and Marshall (1993) are higher than those expected for the total trash and debris load (i.e., including submerged material) (Allison et al 1998). Other Australian studies have reported capture rates of 24 to 71 kilograms per hectare (2.47 acres) from four booms in Sydney (Gamtron 1992 in Allison et al 1998).

A four-boom containment system was tested by New York City during a two-year pilot study in Jamaica Bay, NY. Floatables were contained by the booms and collected using a skimmer vessel. An assessment of boom effectiveness was made by measuring the quantities of floatable material in the waters and on the shorelines before and after boom installations. Results showed substantial improvements from pre-boom conditions, and indicated that containment booms provide a floatables retention of approximately 75%[4]. During the two-year test period, approximately 40,640 kilograms (44.8 tons) of trash were removed from the containment area (USEPA 1999).

Alameda County installed a sea curtain/litter boom on the Oakland Slough in 1999. The City of Oakland Public Works Department removes debris an average of eighteen times per year. This frequency was higher in the early years of installation. The average amount of debris removed per cleaning is 16 cubic yards. The total debris removed to date is in excess of 3000 cubic yards. The unit has now reached its useful life and needs to be replaced (Bavinger, M[5]. *pers. comm*. 2007).

The angle and manner that a boom is attached to the shore can have an impact on its overall performance (Table 1). A recent study performed at the University of New Mexico (Ho 2005[6]) evaluated the hydraulic performance of various boom designs in an experimental flume. The study used models of the North Pino Arroyo at two different scales. Experimental booms were constructed from various materials and tested in a rectangular flume at a scale of 1:18 under four flow conditions and in a trapezoidal flume at a 1:8 scale. To simulate the boom holding piers, screws were placed into the bottom of the flume. Major design differences include the style of connection to anchor the experimental boom. Test booms were either anchored using a hinge or by drilling a hole through the boom and pinning it. Researchers found that a 30° boom barrier approach angle works better than a 45° model because the smaller angle makes a longer and better performing screening area. In addition, when bending the pier 15° from vertical to the flow direction, the boom is able to move easier (Ho 2005). The researchers also recommended a high buoyancy boom for easy floating but cautioned that turbulent flows make boom movement unstable, reducing debris-keeping capacity. Moreover, it was found that cantilevered booms with piers did not perform well because of the disturbance of the boom movement from both boom cantilevering and piers. The hinge connected boom barrier without piers, which was installed at the sidewall, showed better performance in aspects of debris retention and model simplicity (Ho 2005).

[4] This study did not attempt to evaluate all litter and trash, only the floatable portion.
[5] M. Bavinger, Watershed Program Specialist, Environmental Services Division, City of Oakland, April 2007.
[6] Authors do not give details on how debris trapping was evaluated.

Table 1. Floating boom scaled Arroyo task scenarios (1:8 scale) (Ho 2005).

Run#	Approach	Pier Bend	Boom Design	Results
1	45°	Vertical	PVC	Booms are submerged. All debris is passed.
2	45°	15°	PVC, Barriers	Booms move easier. Side boom barrier works.
3	30°	Vertical	PVC, Barriers	Approach angle 30° is better than 45°.
4	30°	15°	PVC, Barriers	Best boom setup. 43% of debris is excluded.
5	30°	15°	PVC, Barriers	Similar results as #4. No intake entry influence.

Allison et al (1998) found that only 20% of captured litter and less than 10% of the captured vegetation floats[7]. Since booms are only designed to capture floatable trash, a significant portion of trash in stormwater is likely not caught using these devices (Gordon and Zamist 2006). Staff and volunteers at the LMI have noted this particular problem and others with the booms installed in Lake Merritt. According to Dr. Richard Bailey, Executive Director of the Lake Merritt Institute, litter booms:

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

Costs

The New York City studies found that the installed cost of a containment boom can range from $100,000 to $150,000 per site (USEPA 1999). Capital costs for the four-boom system pilot-tested in New York City (excluding engineering costs) was $240,000, while O&M costs were $5,000 over eighteen months, not including the cost of removing the captured floatables. The capital costs for skimmer vessels used to collect captured floatables ranged from $300,000 to $700,000, including shore conveyers for transporting the vessel from site to site. Annual operating costs average $75,000 to $125,000 per boat and include vessel maintenance and repair, crew wages, fuel, insurance and disposal fees for the collected material. Disposal costs for removing floatables are heavily dependent on the type of system used for removal, boom accessibility, travel time between locations and fuel use.

According to the Los Angeles County Department of Public Works, the purchase cost of the Los Angeles River litter boom system was $48,000. The amount of money encumbered for the annual operation, maintenance (i.e., collection and disposal) and monitoring of this system is $450,000 (County of Los Angeles 2003). A contractor is responsible for operating and maintaining the litter boom system. The contractor is paid monthly for operation, maintenance and repair; and paid separately for the quantity of trash harvested. The cost of operation and maintenance and the rate for each ton of trash harvested is the following:

[7] This experiment used a CDS™ unit to evaluate how much captured gross solids were buoyant vs. non-buoyant.

Table 2. Operation and maintenance costs and rate paid for each ton of trash harvested from the Los Angeles River litter boom system.

Season	Time Period	Cost
Wet Season	(10/15-4/15)	$12,992
Dry Season	(4/15-10/15)	$8,500
Trash Harvested	**(Per Ton)**	$1,071

The capital costs of the sea curtain installed at the Oakland Slough was $36,000 including purchase, installation and access improvements[8] (Bavinger, M[9]. *pers. comm*). The average cost per cleanout is approximately $3,378. Average annual cleanout costs are approximately $61,000. Other factors (e.g., hazardous materials disposal, access road maintenance, sea curtain repair and adjustment, vegetation removal to maintain operation of curtain) add an additional $16,000 annually to operation and maintenance expenses. Since 1999, total costs for installation, debris removal, repair of the sea curtain, hazardous material disposal, access maintenance (new road), crane for removal, etc. is in excess of $650,000 (Bavinger, M[10]. *pers. comm*).

Pros

Litter booms are relatively easy to install and come in a wide range of sizes and models to accommodate different situations. Litter booms can trap large quantities of floatable materials. Individual maintenance (i.e., collection and disposal) is relative simple and does not require any confined space entry.

Cons

Litter booms do not necessarily perform well. They are designed to capture only the floatable portion of gross solids loading, which might be a very low fraction of the total loading. Smaller mesh sizes could impede capacity of the storm drain system if not designed properly. Nets which break away could reintroduce trash into the water body if not designed properly. Booms are relatively expensive and can be maintenance intensive.

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[8] Costs for labor and fees to acquire permits, design and inspect project are unknown.
[9] Ibid
[10] Ibid

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