7. Booms and baffles

7.1 Introduction

As was shown in Section 4, bed-load will be trapped behind a weir, and flotsam will be trapped behind a boom or suspended baffle wall, provided the flow velocities are low enough to:

1. allow desegregation; and

2. prevent wash-over / wash-under

and provided further that there is no hydraulic interference between the different structural elements increasing the vorticity.

The following devices will be discussed in this section:

7.2 the Sydney Harbour Litter Booms;

7.3 other floating boom installations; and

7.4 the In-line Litter Separator (ILLS)

Further applications of booms and baffles will be discussed in Section 8 in conjunction with detention / retention ponds and wetlands.

7.2 The Sydney Harbour Litter Booms

In 1990, the Sydney Water Board (now called Sydney Water) installed pollution control booms at the outlets of four stormwater channels: Hawthorne Canal, Dobroyd Canal, Rushcutters Bay and Blackwattle Bay. These locations are all on Sydney Harbour and are subject to tidal movement. The objectives of the boom installation (Sydney Water Board, 1993) were:

1. interception of floating litter and other debris in the stormwater canals before it entered the receiving waters; and

2. to raise community awareness of litter in the urban waterways as an environmental problem.

The booms consist of buoyant segments which float on top of the water, with an attached skirt or curtain, made from a solid PVC type material, hanging below. The booms are attached at their ends to stainless steel rings which are free to slide up and down a stainless steel rod. This allows the segment strings free movement in response to changes in the water level (see Figure 7-1).

Figure 7-1 : View of a typical floating boom (Rushcutters Bay)

A performance assessment of the booms carried out by Gamtron Pty. Ltd for the Sydney Water Board (Gamtron, 1992) revealed inter alia:

- It was extremely important that the design of the end connections ensured that the ends of the booms were always lying along the surface, as any catching of the ends would suspend the booms allowing litter to escape on falling flood levels;

- When the tide started to come in, stormwater tended to roll over the top of both the boom and the denser incoming salt water. This sometimes caused a temporary sinking of the boom to just under the water surface. This also made free movement at the end connections imperative;

- Apart from organic material (mostly leaves) which comprised 71% of all rubbish caught in the traps, plastic items were the most prevalent item of litter captured (13%), followed by paper (7%), glass (2%) and metal items (1%). It was observed that this type of trap could not be expected to catch items which do not generally float;

- The booms were prone to vandalism: a rowing club had unfastened one boom to paddle through; the same boom on another occasion was weighed down with bricks; shackles were stolen off another; and someone had damaged a flotation chamber by running over a boom in a power boat. The recommendation was that signs be provided indicating that power boats cannot pass through the booms, but rowing boats may actually row over the top of the booms without harm to them;

- The turbidity of the water appeared to reduce markedly between the inside and the outside of the booms;

- The booms required periodic removal for repair and maintenance - in particular because of barnacle growths which tended to weigh down the booms. The problem of barnacle growth might be solved by painting the booms with anti-fouling paint such as that used on the bottom of boats;

- The functioning of the booms was severely disrupted by high flows. Possible improvements to the booms could include: increasing the strength of the side anchorage; increasing the depth and weight of the skirt; and increasing the skirt gauge to reduce resistance against flow.

Gamtron concluded that there are a number of considerations that need to be kept in mind when considering the installation of booms:

- The booms should be kept floating at all times;

- They are only suitable for trapping small light-weight floatable objects such as leaves and lunch packaging;

- They should not be installed in channels or near outlets which are frequently subjected to high velocity flows;

- Special attention should be paid to the end connections which should be strong enough to withstand the flow forces, and have sufficient side slack to allow the booms to move up and down with changes in water level;

- There needs to be boat access for cleaning and maintenance; and

- Ideally the channel should be orientated parallel to the direction of the prevailing winds (to ensure that the litter travels down the channel to the booms).

7.3 Other floating boom installations

A review of other floating boom installations reveals similar experiences.

On the River Tame in Britain, there is a structure comprising of four rigid floating steel booms arranged in a "V" configuration with sloping front faces designed in such a way that flotsam is swept along the face into collection zones adjacent to access ramps. The structure appears to work well at low river flows, but the restraint system had to be redesigned after the booms were partially washed away at a higher flow. The modified booms were reported to operate satisfactorily up to a stream flow of approximately 75 m^3/s (a 1 in 10 year recurrence interval event). It is not certain from the description by

Keiller and Ackers, 1982 whether the point in the River Tame where the boom was installed was tidal.

Molinari and Carleton, 1987 compared the advantages and disadvantages of the standard type of in-line screens with booms, using information from previous literature and field trials in the Cooks River catchment in Sydney. They found booms to be the more appropriate of the two structures where an existing urban area drains to an estuary, harbour or lake.

Neilson and Carleton, 1989 examined a boom at Muddy Creek and two conventional in-line screens in the Cooks River catchment to determine the composition of litter collected. They concluded that the boom and screens differed in their ability to collect different components of litter and consequently the choice of the most suitable litter interception device should be governed by the litter composition at a particular site. The booms appeared to be effective in retaining smaller floating and partially submerged objects eg. garden refuse and small bits of polystyrene, whereas the screens captured larger portions of fully or partially submerged objects such as bags and sheets of paper. The rubbish retaining performance of the boom was however reduced at high flows due to litter being forced under and over the boom.

A number of somewhat unusual floating debris collection traps designed by Bandalong Engineering of Melbourne in conjunction with Melbourne Parks and Waterways have reportedly reduced the amount of floating debris in the Yarra River (Vallance, 1996). The trap is comprised of two polyethylene pontoons which give buoyancy to the structure, whilst adjustable boom arms on the upstream side helps direct litter and debris into the trap via a swinging gate. The rear of the trap contains a drop gate enabling easy removal of the litter by boat. A special feature of the trap is its ability to perform in tidal reaches of a river system so that entrapped litter does not escape once the tide turns. This is achieved through the aluminium swing gate which is counterweighted to react to a reversal in the stream-flow direction and “lock in” entrapped litter (Bandalong Engineering). A vertical skirt 150 mm in depth lies below the storage compartment to prevent buoyant items escaping underneath the pontoons. Strategically placed on bends in the river where the prevailing winds and surface currents tend to direct the flotsam, the device is surprisingly effective in reducing visual pollution in the river. It is unknown as to how much bed-load and suspended material escapes the trap.

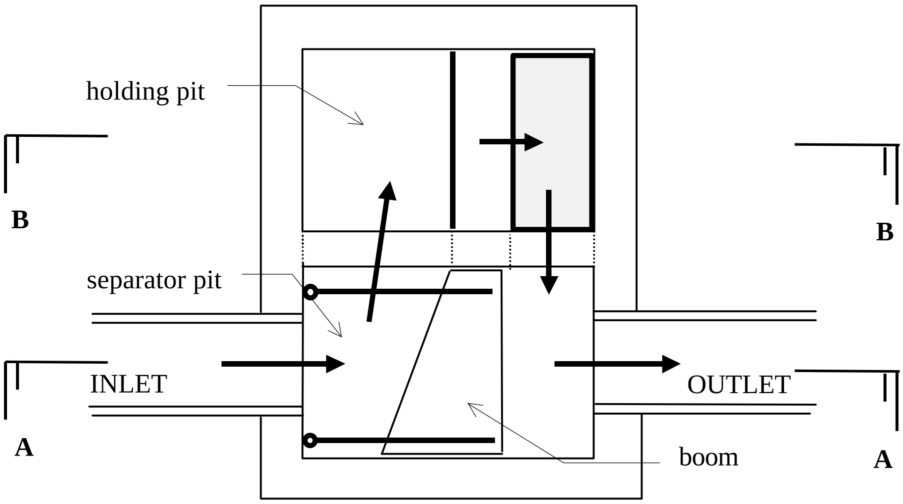
Probably the most appropriate use for booms is for containing and absorbing oil slicks but this is beyond the scope of this report.

7.4 The In-line Litter Separator (ILLS)

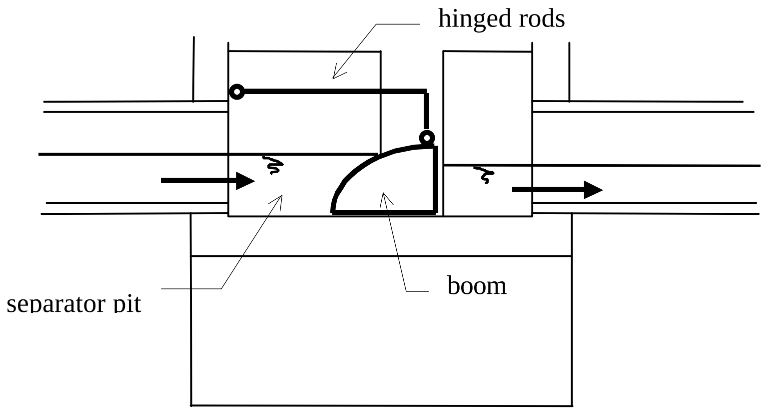
The In-line Litter Separator (ILLS) is designed for the removal of litter from underground stormwater conduits up to a diameter of about 750 mm with minimal loss of head.

It comprises a separator pit and a variable sized holding pit. A carefully shaped boom situated in the separator pit deflects the flow into the holding pit. Once in the holding pit, the flow is forced down under a suspended baffle wall and up over a weir before being returned to the separator pit downstream of the boom. The relatively large plan area of the holding pit ensures that the average vertical flow velocities are low enough to prevent carry-through of those objects, such as plastic bags, that have a negligible settling velocity (positive or negative).

a) Plan



b) Section A-A



b) Section B-B

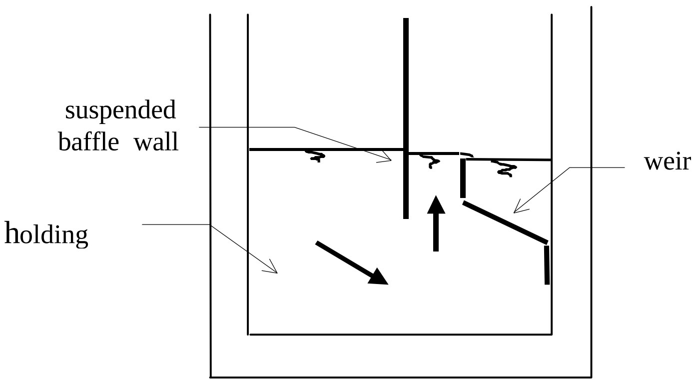


Figure 7-2 : Plan of and cross-sections through the In-line Litter Separator (ILLS)

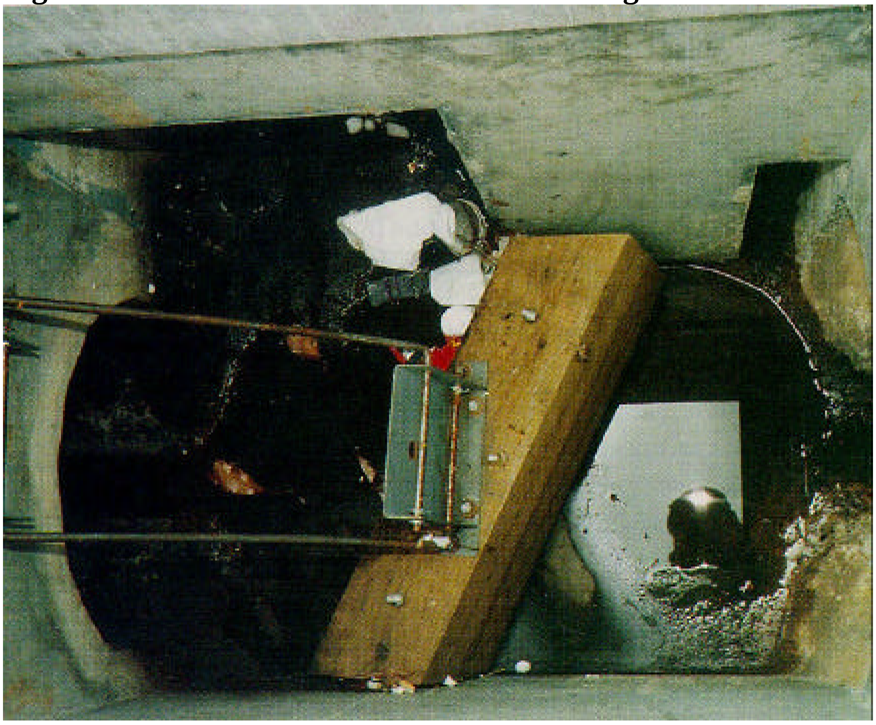


Figure 7-3 : View of the In-line Litter Separator (ILLS) (Flow from left to right)

In the event of particularly high flows through the stormwater conduit, the increased water levels on both sides of the boom causes it to float out of the way, ensuring that upstream flood levels are not affected by the structure, and the litter already trapped in the holding pit is not washed out. The boom is restrained by rods, which are attached to its upper surface and the walls of the chamber above the pipe inlet, in such a way that the boom is free to rotate about a hinge at the wall. See Figures 7-2 and 7-3.

For pipes up to 450 mm diameter, a 600 x 900 mm separator pit is used, while for pipes from 525 to 750 mm, a 900 x 900 mm pit is needed. The holding pit may comprise 600 x 900 mm, 900 x 900 mm, 900 x 1200 mm or even 1200 x 1200 mm pits of varying depth. The size of the holding pit depends on many factors including the area served, the nature of the businesses in that area, the frequency of street sweeping, and the frequency of litter removal (Swinburne University of Technology, 1996).

In many ways, the ILLS is similar to the UWEM concept described in Section 6.6 above, except in this case the flow velocities are reduced to the point that there is no longer any need for screens. Clearly, use of the ILLS is limited to pipes, whilst the UWEM approach is more appropriate for canals. A potential weakness of the ILLS is the possibility of litter fouling the hinge mechanism and thereby preventing the boom from lifting (or dropping) in the event of high flows.

More information may be found in Appendices A.3 and A.4.