Pollution Prevention Under Tropical Rain Storms

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Where intense tropical rain meets rapid urban development, the loser is frequently the local water course, into which all the trash, silts, hydrocarbons and other pollutants are discharged with the stormwater runoff. The sea is the final recipient, and riverine silts and sediments can be detected and often still seen many miles out from the estuaries of large tropical rivers.

To help mitigate this pollution, recent trials of Hydro International's Downstream Defender® by the National Hydraulic Research Institute of Malaysia (NAHRIM) have shown promise in an installation close to the capital, Kuala Lumpur. This Gross Pollutant Trap (GPT) based on a hydro-dynamic vortex separation process has demonstrated the value of advanced design and proven performance in reducing gross pollution from storm flows.

The trials, in a new urban area close to Kuala Lumpur, demonstrated effective performance in retaining hydrocarbons, trash floatables, silts and sediments from storm drains. Conducted by infrastructure and hydrological engineers Weida (M) Bhd for NAHRIM, the trial report1 concluded that the Downstream Defender® is an effective gross pollutant trap which captured and stored nearly all gross pollutants carried in the storm drain over the trial period.

"These trials are encouraging because they are helping to test the Downstream Defender®'s ability to provide "first flush" treatment in intense storm conditions, even though the device was originally developed for more temperate US and UK climates," said Hydro Export Manager Graeme Fenton.

"We are very hopeful that the trials will help this promising technology to gain acceptance as a much-needed answer to a problem not only in Malaysia, but throughout the region, where conditions are similar."

Reducing Urban Impact on Stormwater Pollution

Malaysia's Department of Irrigation and Drainage has recognised for decades that the rapid urbanisation which accompanies strong economic growth can exacerbate water pollution problems. As a result a series of measures have been put in place to guide stormwater volume and quality control measures, culminating in 2001 in the Manual Sahran Mesra Alam Malaysia (MSMA) for Storm Water Management.

MSMA emphasises the need for storm water control, at or near source, as an effective and efficient method of improving storm water run off quality, and mitigating the effects of storm flows on rivers.

The onset of rapid urban development in parts of Malaysia has increased areas of impervious surfaces which deliver high flash flow conditions under intense rain storms. Urbanisation also increases the amounts of discarded waste such as polystyrene food trays and other packaging, and organic pollutants such as food, cooking oil and hydrocarbons from vehicle facilities.

Rainfall is a major factor in transporting this pollution into the storm drains. For example, Kuala Lumpur has an annual rainfall of nearly 2400mm, with peaks up to 280mm in April and November; short duration showers can also realise 100mm or more in an hour in Kuala Lumpur. East Coast areas can double these figures.

Finding Effective Solutions

In a thriving economy such as Malaysia, investment in drainage infrastructure and stormwater pollution reduction techniques has to look at the most effective designs from across the world, in order to assist the search for best practice and greatest efficiency.

Urban Malaysia's typical storm drainage comprises deep road side drains which discharge into high volume monsoon drains, and eventually into the river. After storm events, the heavy load of silt and trash is visually evident in the rivers.

Real Condition Trials

As a leading hydrodynamic vortex separator, the Downstream Defender® has low maintenance and minimal power requirement advantages, which have been well proven under temperate conditions. To examine the effective performance of the Downstream Defender® under tropical urban conditions, Weida (M) Bhd., one of Malaysia's leading water utilities and infrastructure specialist engineers, oversaw a trial installation under actual street conditions in collaboration with NAHRIM.

The objectives of the trial were to examine the performance of the Downstream Defender® in separating and retaining floatables, oil and grease and sediment from contaminated stormwater.

The site for the trial was in the old town of Seri Kembangan south of Kuala Lumpur, which has been recently engulfed by rapid industrialization and urbanization. It is a mix of small and medium industries, intermingled with residential, retail and open shop lots where informal commercial activity can take place.

Additionally, a morning market operates throughout the week, and a night market opens on Monday evenings; both combine food and cooking stalls with sales of other goods. Activity is thus distributed over the whole week and encompasses a wide variety of possible pollutant sources.

The drains in the area comprise a mix of improved natural and man-made structures. In the trial a 1.2m diameter Downstream Defender® was installed under a tarmac road, and connected offline to a roadside drain carrying stormwater runoff and effluent from the housing, wet market, restaurant and shops from the north.

After treatment in the Downstream Defender®, the effluent is discharged back into the same drain downstream, before the water empties into the main monsoon drain. A weir wall is used to direct flow into the Downstream Defender®.

Sampling and Measuring

Sampling of pollution for several weeks between 7 May 2010 and 27 August 2010, before and after the Downstream Defender® installation, was carried out at a point five metres downstream of the outlet point from the Downstream Defender®.

Trash was collected in a vertical net at this point, while silt / sediment samples were collected in a drainage sump. Once the Downstream Defender® had been installed, both trash and silt were also collected direct from the Downstream Defender® sump by a standard vacuum suction pump for comparison with the results at the downstream netting point.

Oil and grease and were collected with a manual scoop at the netting point before and after the Downstream Defender® installation and the density of hydrocarbons per litre of water analysed to measure the effectiveness of the Downstream Defender® trap.

For measurement purposes, pollutants were separated into floatables (including trash) and sediments, which were each wet-weighed both on site and in the laboratory, and oils and grease which were analysed and their density measured in the laboratory. The following table is summarised from tables in the NAHRIM report[1].

5 Day Weekday Collection	Oil / Grease From Net Point mg/l		Trash and Floatables From Net Point Wet Weight kg			Silt / Sediments From Frainage Sump Wet Weight kg		
	Before DDF	**After DDF**	**Before DDF**	**After DDF**	**Direct DDF**	**Before DDF**	**After DDF**	**Direct DDF**
Av. Amount	171.7	14.6	1.125	0	8.1	2.444	0	9.8
Range variation; min/max	59 / 487	9 / 22	0.379 / 3.154	0	0.946 / 42.0	1.083 / 4.983	0	*NB. Only 1 collection after 6 weeks*
Weekend								
	Before DDF	**After DDF**	**Before DDF**	**After DDF**	**Direct DDF**	**Before DDF**	**After DDF**	**Direct DDF**
Amount	271.9	18	0.873	0	1.992	2.127	0	*Incl. in single collection as above*
Range Variation; min/max	24 / 1530	5 / 37	0.249 / 1.632	0	1.233 / 2.598	0.879 / 7.154	0	*Incl. in single collection as above*

N.B. The samples were taken on Fridays to examine weekday pollution over 5 days, and on Mondays to examine weekend pollution. Due to various factors which affected the possible sampling times for different categories, the number of weeks used to calculate the averages ranged between 5 and 10.

Results of Trial Collection

The before and after installation figures clearly show:
Substantial amounts of oil and grease pollution are removed from stormwater in the drain by the Downstream Defender®; with both the average amount collected at the net point and the peaks of pollution greatly reduced.
The Downstream Defender® seems to be effective in trapping virtually all the trash and floatables, despite high peaks in loading, for example, in floatable trash.
The Downstream Defender® is also efficiently trapping up to 100% of silt and sediment.

NAHRIM Recommendation

NAHRIM1 concluded that the Downstream Defender® is an effective gross pollutant trap which captured and stored nearly all gross pollutants carried in the storm drain over the trial period.
It also concluded that the trial results substantiated statements made after independent trials in the USA, and in results presented by the manufacturer, Hydro International.

In addition, in its recommendation, NAHRIM pointed out that it was easy to maintain the Downstream Defender® with a vacuum suction truck and, in the Seri Kembangan Downstream Defender® installation, that would be required at least twice a year for the observed pollutant accumulation; or manual collection would be required twice a month. More installations would substantially reduce the maintenance cost of deploying a truck per unit.

Consulting Engineer's Conclusion

Calista Kim Kher San, Project Engineer for Weida who installed and monitored the Downstream Defender® installation for NAHRIM, has added the following comments.

"The NAHRIM report has endorsed the effectiveness of the Downstream Defender®, and there are more installations planned to start protection of the rivers around Kuala Lumpur, such as the Gombak and the Klang. We have also installed one unit at the main bus station in Petaling Jaya, a large urban area contiguous with Kuala Lumpur, where a substantial reduction in oil and grease pollution has been achieved.

"A main strength of the Downstream Defender® is its ability to retain pollutants and prevent re-entrainment even at maximum flow volumes; this is better than other designs. The Downstream Defender® is also very effective in trapping the large amounts of big floatables, such as litre plastic bottles and polystyrene foam blocks, which are more commonly found in the drains here than in many Western countries. These frequently have to be manually scooped out, rather than with a standard suction truck.

"Prospects for further use of the Downstream Defender® in Malaysia are very promising.
The Downstream Defender®'s versatility is also interesting, and we are currently developing river cleaning stations and on site detention centres using it in conjunction with additional pollution handling equipment."

Technical Note

The Downstream Defender® is an advanced hydrodynamic separator designed to remove sediment, floatables and associated pollutants from stormwater.

The Downstream Defender® provides greater pollutant removal and retention in a smaller footprint compared to conventional gravity or simple swirl-type devices. Flow modifying components create a stable hydrodynamic flow regime that is ideal for solids / liquid separation and preventing washouts over a wide range of flow rates.

Captured sediments are contained in an isolated storage area. A built-in trap retains oil and floatables. These key features prevent re-entrainment of pollutants even under extreme surcharge conditions.

Hydro International, which has offices in the UK, USA and Ireland, provides cost effective solutions for controlling the quantity and improving the quality of water with minimal maintenance.
Hydro products have won international awards for outstanding contributions and technical innovation in the water industry. Hydro operates in the water and wastewater sector and the stormwater sector for the construction industry and, offers an enhanced coverage of treatment solutions to the municipal sector.

Hydro is a leading international provider of sustainable products for the control and treatment of stormwater and wastewater.

For more information about the Downstream Defender or any of Hydro's technologies visit the website www.hydro-international.biz, contact +44 (0)800 269371 or +44(0)1275 878371.
Email enquiries@hydro-international.co.uk.

[1] *NAHRIM: Study on the Effectiveness of the Downstream Defender; November 2010*