INNOVATIVE TECHNOLOGIES FOR STORMWATER AND COMBINED SEWER MANAGEMENT

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INTRODUCTION

Stormwater flows have historically been considered as harmless by the general public and system designers. Recent studies have shown that these flows cannot be dismissed as easily. Chebbo (1992), Marsalek (1997) and Valiron (1992) have shown that stormwater is a source of diffuse pollution with a high source of suspended solids (SS), adsorbed hydrocarbons (HC), nutrient loads (N, P, etc.) and heavy metals (Pb, Cr, etc.), which ultimately influence the quality of the receiving body of water. Since 1994, the USEPA has enforced stringent new rules concerning stormwater management (USEPA, 1994). In Canada, the same tendency toward legislation is felt. Some municipalities require controlling their stormwater flowrates and perhaps even treating them. This article presents novel technologies for the management of stormwater flows and how they can mitigate the impact on the collection system.

PROBLEM

Municipal managers and operators of urban drainage systems are recognizing the importance of controlling and managing stormwater flows in order to limit the damages of a rapid and important stormwater runoff (Brière, 1994). In delaying or reducing the speed of stormwater flows, it becomes possible to free additional volumes in the system and consequently limit sewage overflow during storms. When stormwater flows exceed the outlet capacity of a combined sewer system, the exceeding water overflows directly into a receiving medium (rivers, lakes, creeks, etc.). It is estimated that 95% of sanitary overflows occur during storm events. (WPCF, 1989). These flows pollute the vegetation, beaches/coasts and banks of the receiving body of water.

POSSIBLE SOLUTIONS

There are different solutions to manage stormwater flows in combined networks.

_Installing larger diameter collection system piping._ This solution can be implemented during initial construction should funding be sufficient. However, replacing existing infrastructure with larger diameter piping presents its share of disadvantages. Due to the fact that the existing pipe has...
has to be excavated, the cost of this alternative is very high, often causing this option to be disregarded. (WPCF, 1989).

Separating the sanitary and stormwater networks. This solution also involves an important monetary and labour investment (WPCF, 1989). It is often the alternative taken in new subdivision and land developments, but totally impractical in older municipalities where combined sewers are installed.

Control of the flowrate entering the combined networks. This solution requires managing stormwater flows entering combined sewer networks (Stahre et al. 1990). It is possible to limit the inflow of stormwater to an acceptable maximum by retaining stormwater runoff. This approach is based on the principal of controlling the stormwater flows entering the combined sewer networks.

INNOVATIVE TECHNOLOGIES

Several technologies have been conceived to control and slow the flow of stormwater into the combined sewer networks:

1. Vortex Flow Regulator
2. Basin Flow Regulator
3. Circular Check Valve
4. Infiltration Flow Regulator

Hydrovex® Vortex Flow Regulator

Principle. The vortex flow regulator design is based on the fluid mechanics principle of the forced vortex. The operation of the regulator depends on the upstream head. Up to a certain static water head, the unit orifice will regulate the flow. When the flow exceeds the capacity of the Hydrovex® VHV, the water level rises in the catch basin. This static water head will create a throttling effect in the vortex valve, thus limiting the flow to the municipal sewer. A central air core is created in the orifice. This air core reduces the outlet orifice area, thus diminishing the discharged flowrate. Furthermore, the volume of the catch basin is used as a retention chamber to dampen the effect of the incoming runoff waters in the combined sewer.

Benefits. The manhole is used as a small retention basin, dampening the effect of the stormwater runoff and regulating flows going downstream toward the interceptor. Although the concept is quite simple, over 12 years of research have been carried out, and still continue, in order to further improve performance.

A vortex flow regulator will not block under normal conditions in a storm sewer. This is due to the fact that the outlet diameter of the vortex flow regulator is between 4 and 6 times larger than the equivalent orifice, under the same hydraulic conditions.

Typical applications. Controlling stormwater runoff into the main interceptor, flow regulation in manholes of urban areas, new developments and subdivisions, parking lots.
**Hydrovex® Basin Flow Regulator**

*Principle.* This equipment is a modified version of the vortex flow regulator, similarly based on the forced vortex principle. This regulator has an extended vertical inlet pipe and a funnel, as seen in figure 2. The weir created by the funnel of the unit defines the water level in the basin. Once the water begins to overflow into the regulator, the water head is large enough to create a full vortex.

*Benefits.* Permanent controlled overflow in the basin. Once the water level exceeds the desired level, the outflow is controlled using the vortex principle and not orifice flow.

*Typical Applications.* Retention basins, wetlands, retention in manholes.

**Hydrovex® Circular Check Valve**

*Principle.* Circular check valves are not a recent invention. They allow flow in one direction while hindering the flow in the opposite direction. Water tightness is paramount for the proper functioning of the valve. This system could prevent the rising of waters and the flooding of homes. An example of a Circular Check Valve with a flexible membrane is presented in Figure 3.

*Benefits.* The valve protects the upstream from backward flow. The flexibility of the membrane allows the system to be water tight. The solids wedged between the membrane and the lid of the valve will be sheared by the pressure of water on the membrane, thus ensuring an efficient and tight seal.

*Typical Applications.* Discharge to municipal sewer, discharge to river, infrastructure protection against flooding.

**Hydrovex® Infiltration Flow Regulator**

*Principle.* Infiltration of rain water is a widely popular method to reduce the load on combined sewage networks (Sieker, 1998). The German method of "Mulden-Rigolen-System" is one of these methods. This method uses the soil retention capacity to percolate rain water, as shown in Figure 4. Using an infiltration flow regulator, retention time of rain water by the soil is increased thus maximizing the percolation. Figure 5 shows such a regulator.

*Benefits.* The system allows maximum percolation of water and reduces rain water quantities discharged in rain and combined sewage networks. The example of the city of Hameln (Germany) is mentioned in Sieker (1998). Instead of building a retention tank to reduce overflow events, the same goal has been achieved by disconnecting 170 houses from the combined sewage network and retaining and percolating the rain water.

*Typical Applications.* Stormwater runoff originating from urban parks, infiltration trenches, urban discharge reduction.
Conclusion

Stormwater management is a topic of growing concern in developed urban areas. Managers and designers of municipal stormwater systems recognize the importance of regulating stormwater as far upstream as possible in order to prevent any physical damage (sewer back-ups, overflows, etc.). By throttling and slowing down the volume of runoff from the collection system, additional retention capacity is indirectly created in the sewer. In doing so, sewer overflows can be limited. Multiple methods and technologies developed in Europe and now used in North America can help mitigate stormwater issues. Four methods have been presented in this article.

References


Chebbo G. (1992) Solides des rejets pluviaux urbains: Caractérisation et traitabilité, École Nationale des Ponts et Chaussées, Thèse de Doctorat, 413 pages


Figure 1. Typical view of a Hydrovex® vortex flow regulator

Figure 2. Typical view of a Hydrovex® basin flow regulator
Figure 3. Typical view of a Hydrovex® circular check valve

Figure 4. German "Mulden-Rigolen-System" for stormwater infiltration (from Sieker, 1998)
Figure 5. Typical view of a Hydrovex® infiltration flow regulator