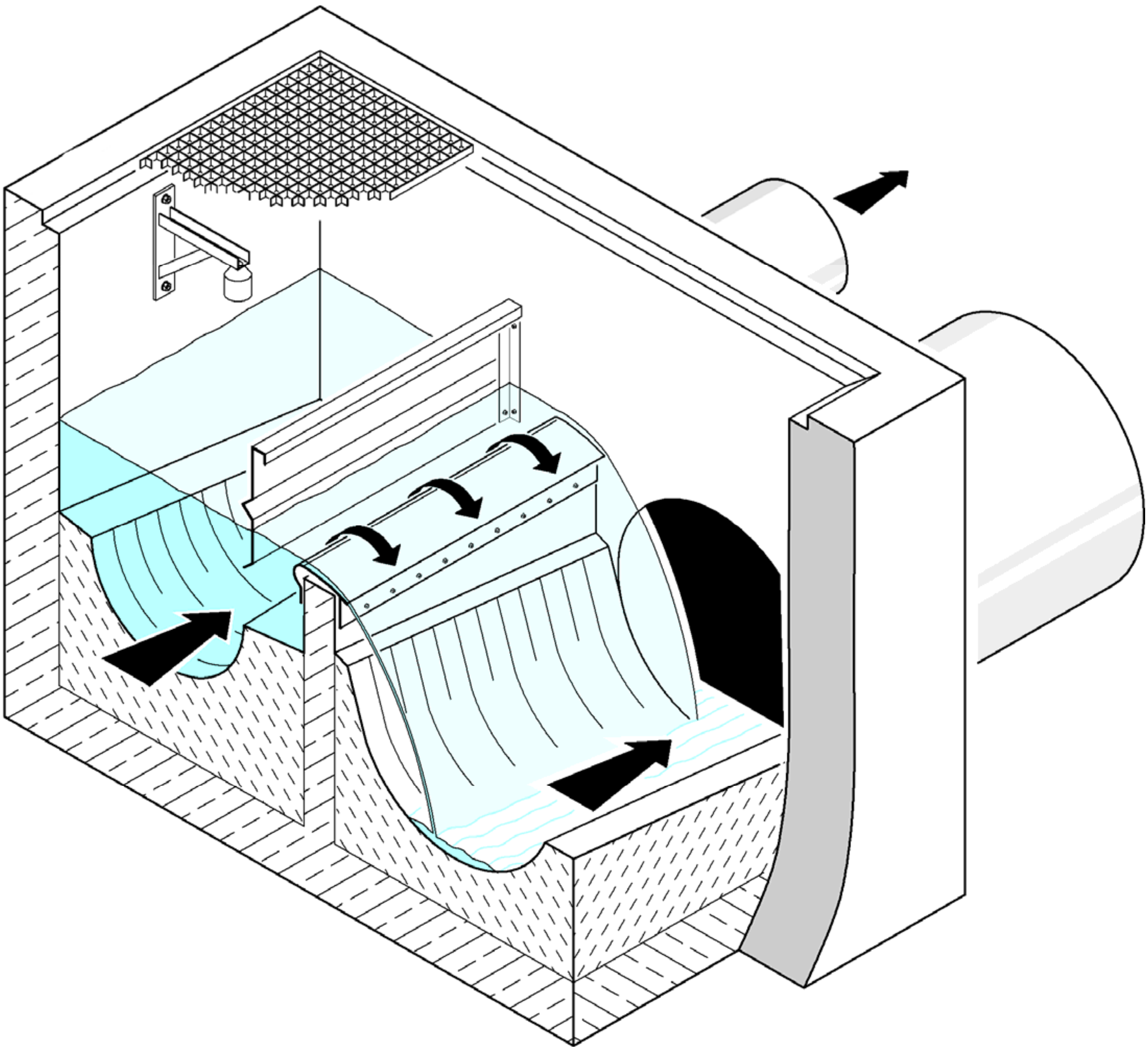
CSO/STORMWATER MANAGEMENT

® HYDROVEX®

*Fluid*Wing Overflow Weir Profile



JOHN MEUNIER

APPLICATION

Precision measurement of the overflow activity at Combined or Sanitary Sewer Overflow sites is paramount to maintaining a good record of each site overflow in the receiving waters. This recording requirement is imposed by National and most State regulations. It is particularly important to maintain good records according to the NPDES permits.

Usually, the recording of overflow activity is based on measuring the water level on top of the overflow weir. Once the level is measured, it is assimilated to a discharge head and computed into an actual overflow value. However, the problem comes from the fact that more than 50% of the combined sewer overflow events generate less than 1½” of head on the overflow weir, granting 0.2 MGD/foot of weir length or less of actual overflow. Conversely, any overflow weir will very rarely reach its peak design condition over an annual recording period.

In order to prevent floatables or oil and grease to escape from sewer systems, design often includes baffle arrangements right in front of the weir. This is a further hydraulic complication, as the baffle arrangement requires very quiet and non turbulent flow conditions in order to become efficient.

In existing regulations, the actual solution is not clearly defined. Regulatory agencies require the use of sharp crested weirs as a general practice. These weirs relate to Rehbock's measuring weirs from 1929. These weirs are not considered as good measuring devices in any water or wastewater applications for water levels of less than 1½”. Uncontrollable variations and noise in the recording of the water head on the weir create variations of the flow and consequently hysteresis in the discharge curve. This problem was evaluated in UFT’s (Germany) hydraulic laboratory. Increased result accuracy cannot be reached by measuring the lower portion of the overflow jet pattern. With overflow heads under ⅜”, there is also a problem with maintaining the surface tension of the overflow water. The overflow water fragments itself in multiple small overflow areas over the length of the weir, making recording of the actual activity impossible.

Technical literature grants information on various positions for the baffle arrangement, depending on distance and submergence from the weir. These positions are difficult to adapt in practice, as sometimes the clearance under the baffle is too shallow or the distance from the weir becomes too large. This problem cannot be simply solved unless expensive mobile baffle arrangements are considered.

ADVANTAGES

- Minimum hydraulic resistance to flow
- Gentle overflow pattern
- Hysteresis-free hydraulic behavior
- No mobile or mechanical parts required
- No electricity required to operate
- High measuring accuracy with small overflow head
- Small flow resistance with large overflows
- Alternatively with and without baffle
- Hydraulic calculation procedure available
- Calibrated by an independent University Hydraulic Department
- Easy to assemble and adjust
- Installation can be modified later on without major efforts
- Supply of the integrated level metering instrument
- Simple maintenance

Following a battery of tests, we designed a very stable overflow weir device, combining very stable overflow pattern and easy recording of low flow conditions with a baffle arrangement. Since discharge heads of up to 1½” are very frequent over an average year, we assumed that an overflow weir capacity enhancing device was required, particularly if a baffle arrangement was required.

The lab tests led to a full-scale evaluation of the installation, with and/or without baffle. The calibration tests were done at the Hydraulic Department of the University of Stuttgart 9 on a 1:1 scale.

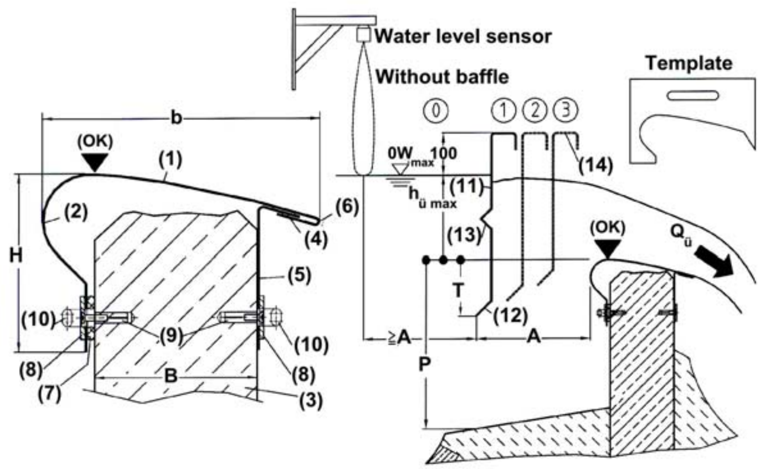
CONSTRUCTION

The overflow device consists of a precisely formed and highly polished stainless steel profile, with the point marked (**OK**) defining the actual weir crest (see **Figure 1**). The topside of the weir is gently arched in the form of an airplane wing. The extrados (**1**), with a large radius, exceeds clearly in front and at the back of the concrete weir (**3**). Uneven or rough weir top edges are now covered and their headloss effect can simply be neglected.

The metal weir profile (**1**) ends by a precision folded section (**4**). The folded section accepts the back support (**5**) that defines precisely the weir rear edge (**6**) level. The back support (**5**) also compensates the weir thickness (**B**) tolerances. The metal weir (**1**) is sealed upstream with a rubber seal (**7**). Metal weir (**1**) and back support plate (**5**) are anchored to the concrete weir wall, only when the perfect elevation is reached. The units are held on the wall by mounting rails (**8**) and anchors (**9**) that are bolted in the weir surface. Final adjustment or modification of the weir upper edge (**OK**) is possible by shifting the measuring profile in the slots (**10**) made in the metal parts.

If required, the installation of an upstream baffle (**11**) will be at a distance ***A*** from the weir's leading edge (**2**) and a submergence ***T*** under the weir crest (**OK**).

Figure 1: Hydrovex® FluidWing Installation



Measuring resistance Type TFM…			150 (6")	200 (8")	250 (10")	300 (12")	350 (14")	400 (16")
Dimensions measuring resistance	b	mm (in.)	243 (9.6)	316 (12.4)	389 (15.3)	475 (18.7)	548 (21.6)	633 (24.9)
	H	mm (in.)	157 (6.2)	204 (8.0)	251 (9.9)	306 (12.1)	353 (13.9)	408 (16.1)
	B*	mm (in.)	135-160 (5.3-6.3)	188-212 (7.4-8.4)	235-265 (9.3-10.4)	282-318 (11.1-12.5)	330-370 (13.0-14.6)	375-425 (14.8-16.7)
	P	mm (in.)	≥400 (15.8)	≥520 (20.5)	≥640 (25.2)	≥780 (30.7)	≥900 (35.4)	≥1040 (40.9)
Without baffle	A	mm (in.)	∞	∞	∞	∞	∞	∞
	T	mm (in.)	0	0	0	0	0	0
	h_u, max	mm (in.)	225 (8.9)	293 (11.5)	360 (14.2)	439 (17.3)	506 (19.9)	585 (23.0)
	q_u, max	**l/s-m (cfs)**	**240 (8.5)**	**355 (12.5)**	**485 (17.1)**	**653 (23.1)**	**809 (28.6)**	**1005 (35.5)**
Baffle In Position 1	A	mm (in.)	266 (10.5)	346 (13.6)	426 (16.8)	519 (20.4)	599 (23.6)	692 (27.2)
	T	mm (in.)	134 (5.3)	174 (6.9)	214 (8.4)	261 (10.3)	302 (11.9)	348 (13.7)
	h_u, max	mm (in.)	210 (8.3)	273 (10.8)	336 (13.2)	410 (16.1)	473 (18.6)	546 (21.5)
	q_u, max	**l/s-m (cfs)**	**180 (6.4)**	**267 (9.4)**	**364 (12.9)**	**490 (17.3)**	**607 (21.4)**	**754 (26.6)**
Baffle In Position 2	A	mm (in.)	194 (7.6)	252 (9.9)	310 (12.2)	378 (14.9)	437 (17.2)	504 (19.8)
	T	mm (in.)	97 (3.8)	126 (5.0)	155 (6.1)	189 (7.4)	218 (8.6)	252 (9.9)
	h_u, max	mm (in.)	205 (8.1)	267 (10.5)	328 (12.9)	400 (15.8)	461 (18.2)	533 (21.0)
	q_u, max	**l/s-m (cfs)**	**169 (6.0)**	**251 (8.9)**	**342 (12.1)**	**460 (16.2)**	**571 (20.2)**	**709 (25.0)**
Baffle In Position 3	A	mm (in.)	122 (4.8)	159 (6.3)	195 (7.7)	238 (9.4)	275 (10.8)	317 (12.5)
	T	mm (in.)	61 (2.4)	79 (3.1)	98 (3.9)	119 (4.7)	137 (5.4)	159 (6.3)
	h_u, max	mm (in.)	190 (7.5)	247 (9.7)	304 (12.0)	371 (14.6)	428 (16.9)	494 (19.5)
	q_u, max	**l/s-m (cfs)**	**139 (4.9)**	**206 (7.3)**	**281 (9.9)**	**378 (13.3)**	**468 (16.5)**	**581 (20.5)**

Table 1: Hydrovex® FluidWing Weir

The water depth upstream from the weir cannot be less than ***P***. Otherwise the suction effect becomes too important and sediments (bed load) could be sucked out of the sewer system.

To minimize the headlosses induced by the baffle and to help capture floating material, the baffle lower portion is folded forward (**12**), pointing upstream. Deep baffles have one or more long stiffening bends (**13**) to sustain the pressure loads at higher flow regime. The upper portion of the baffle usually rises up 4” higher than the maximum upstream water level OW_{max}. This upper portion has a structural U-shaped upper edge (**14**). We evaluate the actual design and calculations of the baffle for each application.

The overflow weir profile (TFM) is divided into six standard sizes, from model 150 to model 400 (see **Table 1**). We integrate the actual weir configuration and concrete weir thickness ***B*** as defined by the customer. Adding the four possible baffle positions for each model, we have 24 standard possible combinations. Individual project configurations guide our selection towards the appropriate selection. Based on this information, we can define the actual project flow curve and level metering position.

OPERATION & HYDRAULIC BEHAVIOR

The weir overflow begins at approximately 1/16” of head h_u higher than the crest level **OK**. The upper surface tension is not strong enough to uniformly maintain the flow pattern over the smooth and bright surface of the metal overflow weir profile. The flow will slide on the extrados of the profile, collapsing only downstream from the weir profile.

Starting at roughly ¼” of head, the flow will be continuous and create a water film over the weir, which will fall from the rear edge of the weir, creating a smooth and gentle fall at the back of the unit (see **Figure 2a**). The precise measurement of such a small overflow pattern is impossible with a sharp crested weir arrangement.

The actual overflow values are reproducible and can be fully measured (see **Figure 3**) for fractional discharge heads down to roughly ¼”. This is an unexpected and very important progress in the actual metering of small overflow levels with weirs.

During large hydraulic load conditions, the baffle section can sustain important flow conditions and can accept large specific discharge, with relatively small loss of head (see right, the rising part of the curves in **Figure 3**).

As pictures **2a** to **2c** show, measuring the flow conditions with the **HYDROVEX® *Fluid*Wing** is very easy on a discharge ratio up to $Q_{max}/Q_{min} = 200$. The system is sufficiently precise to guaranty more precise sizing of the installation.

Adding a baffle to the **HYDROVEX® *Fluid*Wing** works hydraulically well only if the distance ***A*** is not too small and the discharge head is not larger than the applicable maximum. The curves of the μ-value are bending to the left as the head increases. This is shown in **Figure 3**. Unstable behavior occurs with very close baffle arrangements, which is shown with the jagged arrow. The baffle position ***4*** was therefore abandoned and forbidden in **Table 1.**

The discharge behavior of the overflow wier profile does not show any jerk of the underwater flow pattern, as long as the water does not fall from the weir’s rear edge (**6**).

You can perform a pre-selection of the unit, based on the project data and the values in **Table 1**. The required information is the specific maximum threshold load $q_{ümax}$ (l/s per meters length), as well as the concrete wall thickness ***B***. **Table 1** will then supply all the dimensions and baffle positions. We can perform a complete hydraulic calculation upon request.

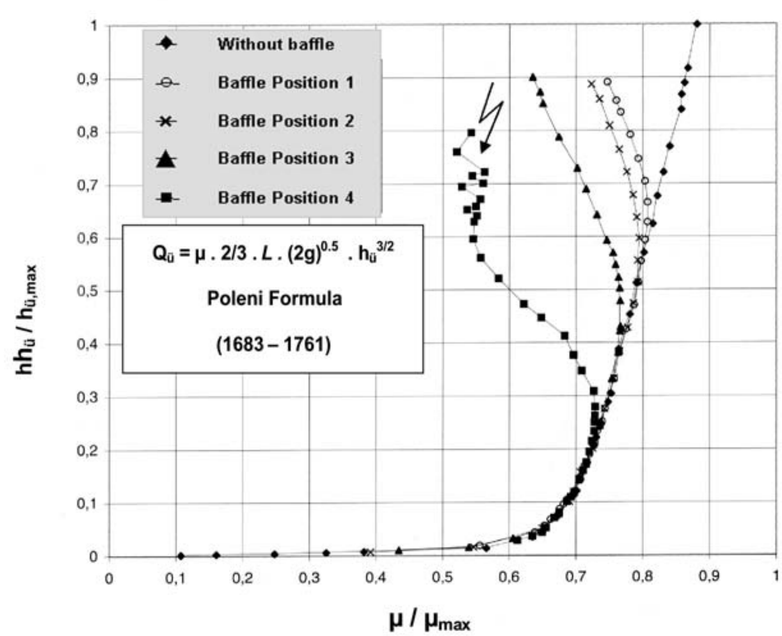


Figure 3:* *Measured discharge

PHOTO 2A:

Overflow Weir Profile type TFM 150 in the laboratory of the Stuttgart University. Discharge with specific hydraulic loads of only 1 l/(s-m). The discharge jet is the very small head of ¼", with already continuous and constant flow pattern.

PHOTO 2B:

Overflow with specific hydraulic load of 30 l/(s-m). The baffle can be seen at the left of the picture.

PHOTO 2C:

Discharge with specific hydraulic load of 100 l/(s-m)

DISCHARGE MEASUREMENT AND EVALUATION

The water level is measured at least with one or more water level sensors, at a minimum distance ***A*** upstream from the overflow weir. We supply the hydraulic characteristics in the form of a flow curve with overflow head versus flow coefficient with $h_{ü} = f(Q_{ü})$ for the project specific data. This data added up directly to that local level sensor results as basis for the conversion of water level into flow value. Consequently, the conversion of the large raw data and discharge flow is more easily handled and more precise, as the data can be compiled directly with a spreadsheet program.

Upon request, we can supply complete instrumentation for the **HYDROVEX®** ***Fluid*****Wing** installation. This would include the instrumentation and also the laptop interface to download the information. We can also provide the SCADA system to compile the data from a remote station.

ASSEMBLY

We require that the contractor send us precise site measurements of the prepared concrete overflow weir crown. We require a precision of at least 1/16" for field measurements. This will guaranty that the **HYDROVEX®** ***Fluid*****Wing** weir elevation (**OK ONE**) can be aligned with a laser at a precision of ±⅛". We will verify the actual precision of the assembly with a 1:1 Gauge made of stainless steel (see **Figure 1** on the top right).

John Meunier Inc.
ISO 9001 : 2000

Head Office
4105 Sartelon
Saint-Laurent (Quebec) Canada H4S 2B3
Tel.: 514-334-7230 www.johnmeunier.com
Fax: 514-334-5070 cso@johnmeunier.com

Ontario Office
2000 Argentia Road, Plaza 4, Unit 430
Mississauga (Ontario) Canada L5N 1W1
Tel.: 905-286-4846 www.johnmeunier.com
Fax: 905-286-0488 ontario@johnmeunier.com

USA Office
2209 Menlo Avenue
Glenside, PA USA 19038
Tel.: 412- 417-6614 www.johnmeunier.com
Fax: 215-885-4741 asteele@johnmeunier.com

Revised : 2008-10-01