TECHNICAL BULLETIN NO. 4

Modeling Long Term Load Reduction: The Rational Rainfall Method

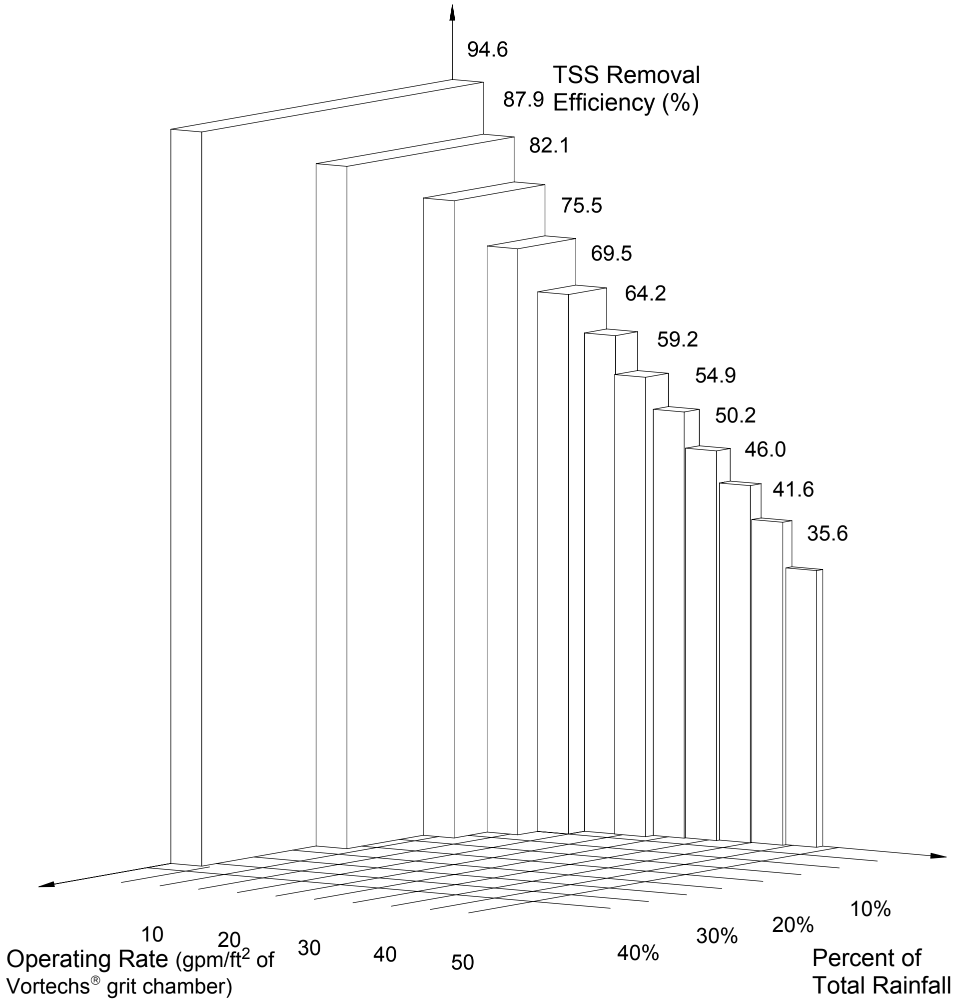

Figure 4.1

Technical Bulletin No. 4 describes the process by which Vortechnics estimates net annual total suspended solids (TSS) removal efficiency. Differences in local climate, topography and scale make every site hydrologically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. To estimate efficiencies as accurately as possible, Vortechnics has developed the Rational Rainfall Method which combines site-specific information with laboratory generated performance data (Technical Bulletin No. 1), and local historical precipitation records.

Short duration rain gauge records from across the United States and Canada were analyzed by Vortechnics to determine the percent of the total annual rainfall that fell at a range of intensities. At US stations depths were totaled every 15 minutes or hourly and recorded in 0.01-inch increments. Depths were recorded hourly with 1 mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and intense storms contributed relatively little to the total depth.

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These intensities along with the total drainage area and runoff coefficient for each specific site are translated into flow rates using the Rational Method. The flow rates are then used to calculate operating rates for a proposed Vortechs® System. Finally, operating rates are paired with their corresponding removal efficiencies. Figure 4.1 graphically illustrates this relationship between operating rate, removal efficiency and intensity distribution using rain gauge records from Portland, Maine. Table 4.1 builds on this information by calculating a relative efficiency at each intensity. The relative efficiencies are then summed to produce a net annual TSS removal efficiency.

VORTECHS® SYSTEM NET ANNUAL TSS REMOVAL EFFICIENCY

Portland, Maine

Model 5000

Design Ratio[1] = $\frac{(4.5 \text{ acres}) \times (0.95) \times (449 \text{ gpm/ft}^2)}{(38.5 \text{ sf})} = 50$

Rainfall Intensity "/0.25 hr	"/hr	Operating Rate[2] gpm/ft²	% Total Rainfall Volume[3]	Rmvl. Effcy[4] (%)	Relative Efficiency (%)
0.02	0.08	4	36.9%	94%	34.7%
0.04	0.16	8	21.9%	88%	19.3%
0.06	0.24	12	11.9%	82%	9.8%
0.08	0.32	16	7.6%	76%	5.8%
0.10	0.40	20	5.0%	70%	3.5%
0.12	0.48	24	2.9%	64%	1.9%
0.14	0.56	28	3.0%	60%	1.8%
0.16	0.64	32	2.0%	55%	1.1%
0.18	0.72	36	1.8%	51%	0.9%
0.20	0.80	40	1.4%	46%	0.7%
0.22	0.88	44	1.2%	41%	0.5%
0.24	0.96	48	0.8%	36%	0.3%
				Subtotal	80.2%

% rain falling at >0.96"/hr =	3.5%
Assumed Removal Efficiency of remaining % =	0.0%
Net Annual TSS Removal Efficiency =	**80%**

1 - Design Ratio = (Total Drainage Area)x(Runoff Coefficient)x(cfs to gpm conversion) / Grit Chamber Area
- The Total Drainage Area and Runoff Coefficient are specified by the site engineer.
- The conversion factor from cfs to gpm is 449.

2 - Operating Rate (gpm/ft²) = intensity ("/hr) x Design Ratio

3 - Based on 5 years of rainfall data recorded at fifteen minute intervals, in Portland, ME.

4 - Based on Vortechnics laboratory verified removal of 50 micron particles (see Technical Bulletin No. 1).

Table 4.1

This same process was used to develop the Vortechnics sizing methodology described in Technical Bulletin No. 3. The design ratio (See footnote 1 of Table 4.1) was created as a tool to help calculate an operating rate from an intensity. Maximum design ratios for different geographic regions across North America have been determined through analysis of historical precipitation records archived by the National Climatic Data Center. Depending on climatic regime, design ratio thresholds vary, with higher design ratio thresholds in areas like the Gulf Coast where high intensity precipitation is common and lower thresholds in areas like the Pacific Northwest where the vast majority of rain falls at very low intensities.