

CASE STUDY INFIL-Tracker and Flow-RTC Van Norman Alley Cudahy, WI

Many communities across the nation are faced with growing pressures to meet Total Maximum Daily Load (TMDL) and Municipal Separate Storm Sewer System (MS4) compliance. These communities utilize similar planning and implementation tools that typically include engineering documents filled with watershed delineations, hydrologic, hydraulic and water calculations as well as BMP toolboxes; all applied in an effort to meet compliance goals. The one element that most of these plans lack is how to strategically locate BMPs in a cost-effective way to meet compliance.

The City of Cudahy is no different than the rest of the country in how it has historically implemented gray and green infrastructure. It is based upon a city-wide stormwater management plan including regular maintenance, BMP construction/replacement, and new development opportunities. However, with the introduction of a TMDL requiring the City to reduce Total Suspended Solids (TSS) by 80% and Total Phosphorus (TP) by 88%, relative to baseline conditions (*i.e.* relative to no stormwater management controls in place), the City became concerned about how they would endeavor to meet compliance goals, how much it was going to cost, and how they would determine when they've reached their goals.

The City agreed to implement a pilot program utilizing P4's INFIL-Tracker, Rain-mX and Flow-RTC systems on three PaveDrain permeable pavement installations located throughout Cudahy in Fall 2019. This case study highlights data from one of these sites – Van Norman Alley.



Van Norman Alley is over 600 feet long and it was completely reconstructed in 2017. As part of the reconstruction, a four-foot-wide, 206-foot-long strip of PaveDrain permeable pavement was installed down the center of the alley to collect, filter and infiltrate stormwater runoff before it enters the City's MS4.

Van Norman Alley was analyzed using a source loading and management modeling software package, WinSLAMM. The watershed properties and BMP design parameters are included in the tables.

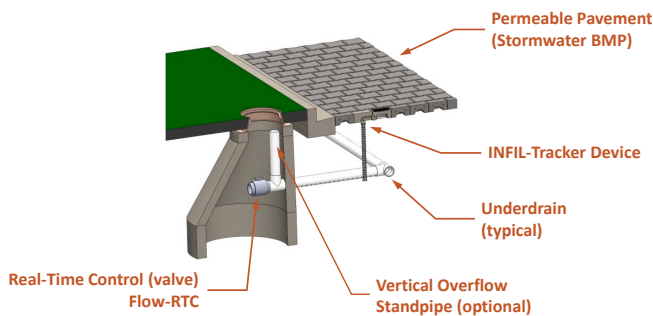
In January 2020, the site was retrofitted with P4's Rain-mX and INFIL-Tracker systems to monitor local rainfall and resulting water levels under the pavement. P4's Flow-RTC system was installed in July 2020.

Watershed Properties		
Area	0.438	acre
Runoff Volume	22678	cf
TSS Load	286	lbs
TP Load	0.654	lbs
TSS _{conc}	0.0126	lbs/cf
TP _{conc}	0.000029	lbs/cf

BMP Design Parameters		
Permeable Pavement Width	4.1	ft
Permeable Pavement Length	206.5	ft
Storage Gallery Depth	37	in
Porosity of Storage Gallery Aggregate	0.4	
Number of Underdrain(s)	1	
Underdrain Diameter	6	in
Subgrade Seepage Rate	0.04	in/hr

The installation of the INFIL-Tracker and Flow-RTC systems within a permeable pavement BMP is shown below. The system includes the permeable pavement surface, the INFIL-Tracker device, underdrain, a vertical overflow standpipe

(where required), and a control valve (Flow-RTC). Rain-mX was installed on the rooftop of Cudahy City Hall located less than one mile away.

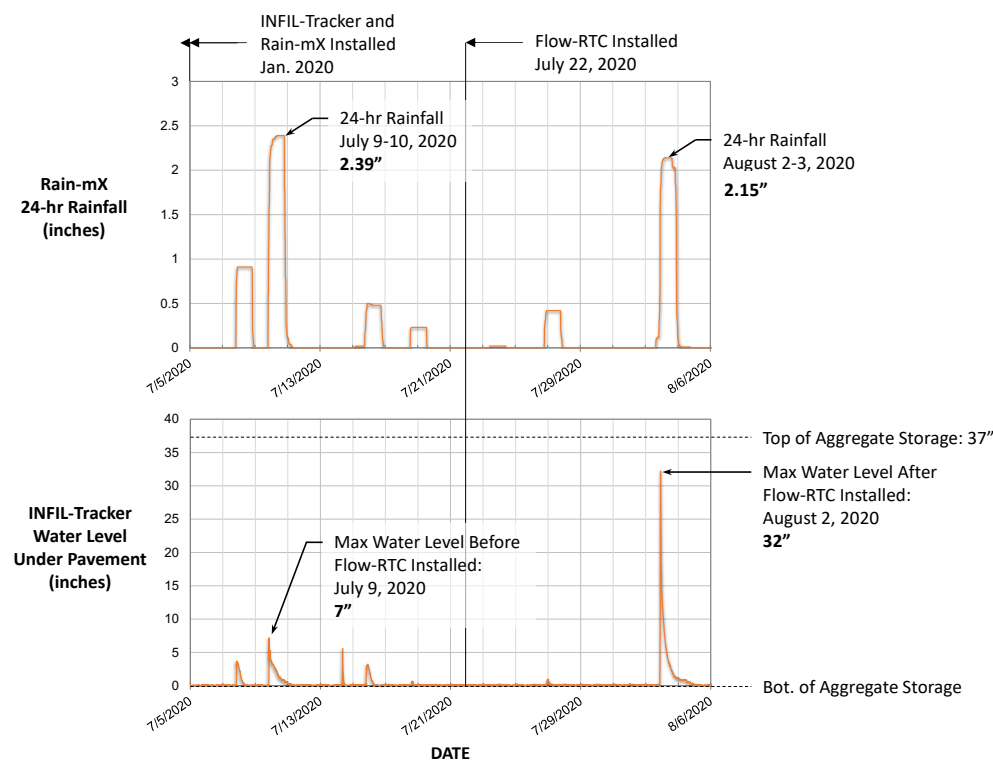


The impact Flow-RTC has on the performance of the BMP can be seen by comparing two similar 24-hr rain events: 2.39" on July 9 and 2.15" on August 2, 2020. The water level rose to 7" on July 9th because water was allowed to exit freely through underdrain during the event. After installing Flow-RTC, a similar (but slightly smaller) rain event caused a 32" rise in water level under the pavement. The important thing to note is that all water entering the system prior to installation of Flow-RTC received 65% pollutant removal credit for TSS and 35% pollutant removal credit for TP. After Flow-RTC was installed, both removal efficiencies increased to 100% because the stormwater has infiltrated into the subgrade rather than being discharged through underdrain.

The graphs on the following page illustrate how the Van Norman Alley BMP with INFIL-Tracker and Flow-RTC performed during three rain events with different 24-hour rainfall totals. These graphs also serve as the foundation for computing stormwater volumetrics and resulting pollutant load removals. Pollutant loads are assumed to be proportional to concentrations associated with land use contributing to the BMP.

Modeled and measured pollutant loads removed by the Van Norman Alley BMP for each of these rain events are shown

35% pollutant removal credit for TP. After Flow-RTC was installed, both removal efficiencies increased to 100% because the stormwater has infiltrated into the subgrade rather than being discharged through underdrain.



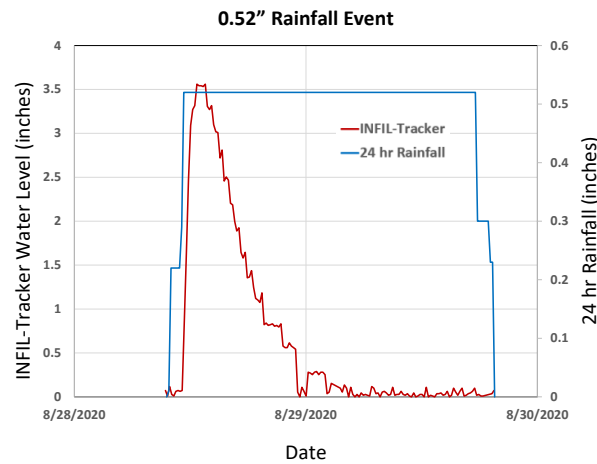
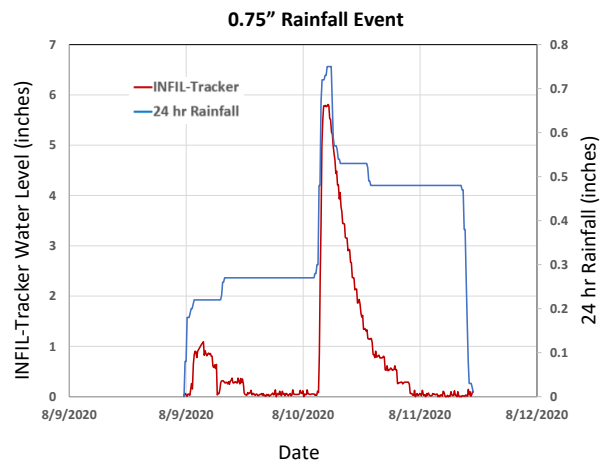
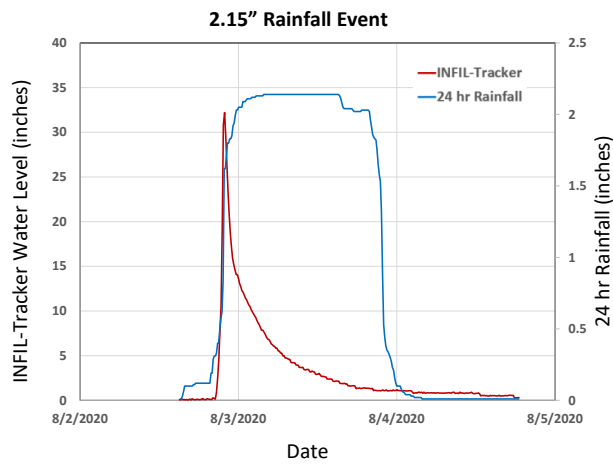
in the table on the following page. Also shown is the expected annual performance using WinSLAMM parameter files to estimate annual rainfall, stormwater runoff and corresponding pollutant load.

With P4's INFIL-Tracker, Rain-mX and Flow-RTC systems in place, the Van Norman Alley BMP is expected to increase in value by over \$11,000 each year. Taken over 10 years, that value translates to more than \$112,000.

If the City implemented P4's systems on 10 similar sized permeable pavement sites with similar watershed characteristics for a period of 10 years, savings tally to over \$1.1 million dollars realized in the form of increased value.

The capital expenditure return on investment (ROI) for one BMP is just over 1 year and the 10-year ROI on 10 BMPs is over 600%.

These systems are changing how stormwater infrastructure is managed and doing it in a way that saves communities and taxpayers a lot of money. These systems also become the foundation for pollutant credit trading.



Rainfall	Modeled Removals		Measured Removals		Increased BMP Value	
	TSS (lbs)	TP (lbs)	TSS (lbs)	TP (lbs)	TSS	TP
2.15"	8.6	0.0118	11.4	0.026	\$ 79	\$ 288
0.75"	1.8	0.0025	2.5	0.006	\$ 17	\$ 62
0.52"	0.9	0.0013	1.2	0.003	\$ 9	\$ 31
Annual	185.9	0.2289	286	0.654	\$ 2,778	\$ 8,502

Annual Increased Value \$ 11,280
 10-Year Increased Value \$ 112,798

10-Year Increased Value on 10 Permeable Pavement BMPs \$ 1,127,978

P4 Devices Capital Expenditure \$ 12,000
 Annual Data Subscription \$ 600

CapEx ROI on 1 BMP 1.1 yrs
 10 Year ROI on 10 BMPs 627%