



P4 INFRASTRUCTURE



StormTrap®
MODULAR CONCRETE
STORMWATER MANAGEMENT



**Kalahari Resort and Conference Center
Sandusky, Ohio**

Fiscally Responsible and Better-than-Expected Stormwater Infrastructure using Sensor Systems

May 12, 2022

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P4 Infrastructure

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CBC Engineers & Associates

Matthew Kamenick, PE

StormTrap

P4 Infrastructure

www.p4i.io

414-877-0620

Technology for Increasing BMP Efficiency and Monitoring

- Theory based approaches – Hydrology, Hydraulic and Water Quality
- Decisions are made that affect – Ordinances, Design Standards, Utility Rates and Credits, Municipal Budgets, Maintenance and Permit Compliance
- Unknown functionality of facilities has economic implications
- Volumetric monitoring will provide the real time data needed to make informed decisions that will save money and provide an informed path to regulatory pollutant removal compliance



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P4 DEVICES

Rain mX



LIQUA-Level



INFIL-Tracker



PRESS

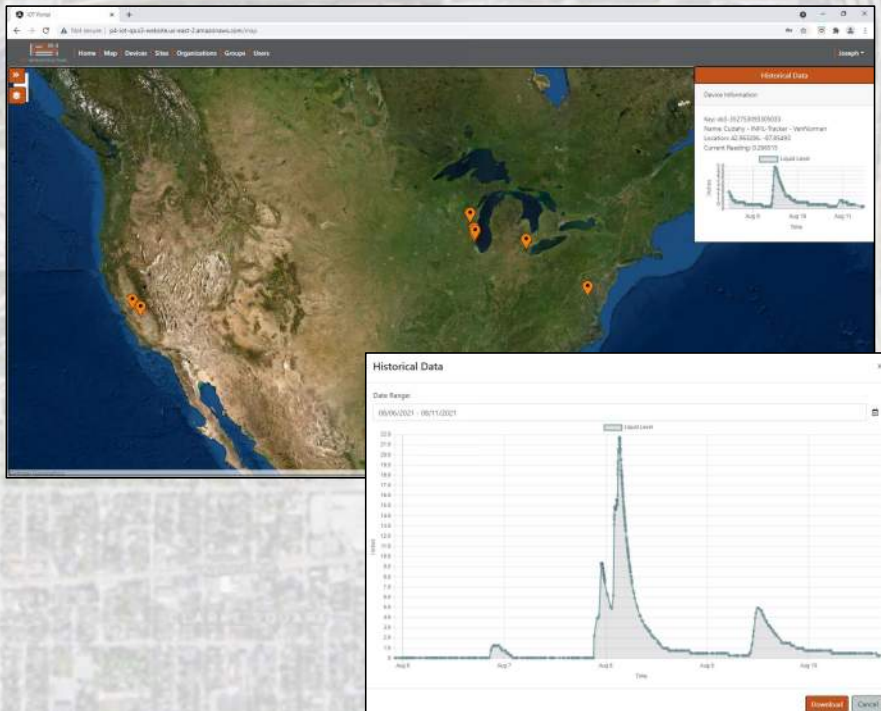


Flow-RTC

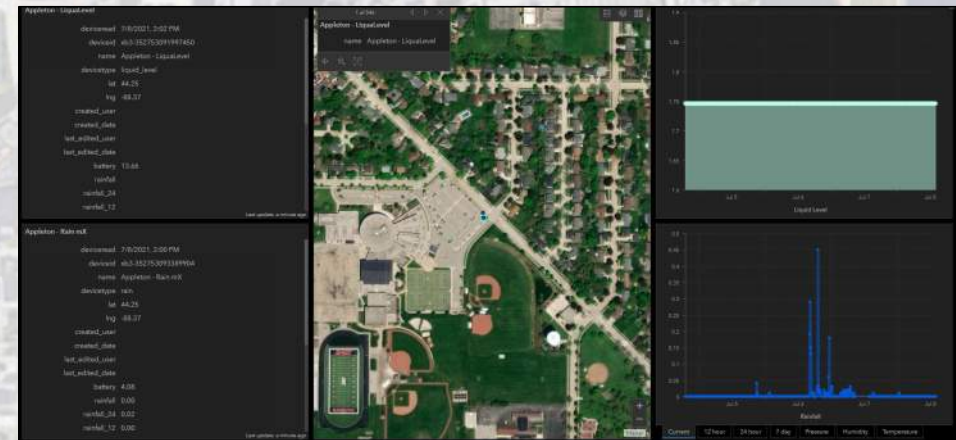


P4 Dashboard

Basic viewing and downloading of data is available as soon as device is turned on.



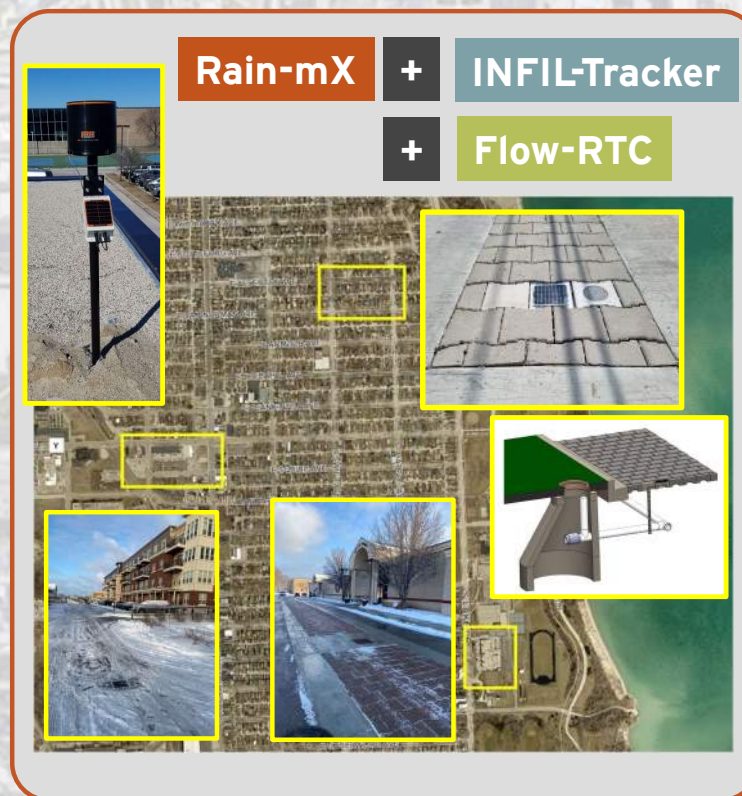
ESRI-Based Dashboard
Available thru Separate Subscription



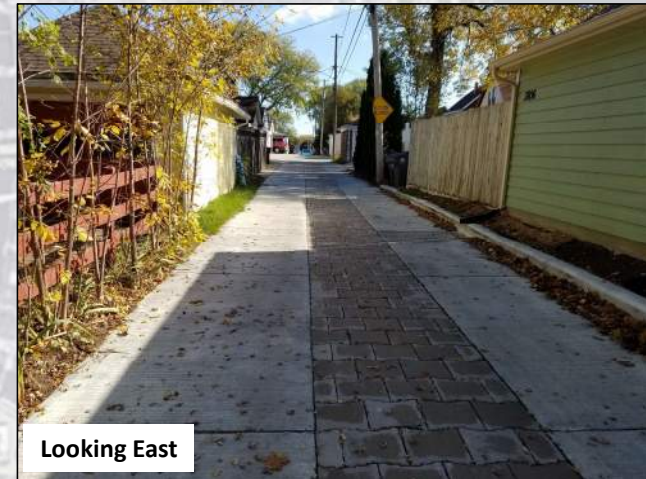
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REDUCED INFRASTRUCTURE SPENDING: CUDAHY CASE STUDY



VAN NORMAN ALLEY - CUDAHY, WI



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Tech Standards/Guidance
(WI DNR)

**Pollutant
Removal
Efficiency**

Underdrain Present
65% TSS
35% TP

No Underdrain
100% TSS
100% TP

Filter/Drain
65% TSS
35% TP

May/May Not Infiltrate
100% TSS
100% TP

Infiltrate for Drawdown Period
100% TSS
100% TP

P4 Products and Systems

- **DOCUMENT FULL VALUE** of BMPs
- **Data for BMP Modeling**
- **Maximize Pollutant Capture per Dollar**
- **Drive Maintenance Intervention**
- **Data for Water Quality Trading**

Drain Only when Required

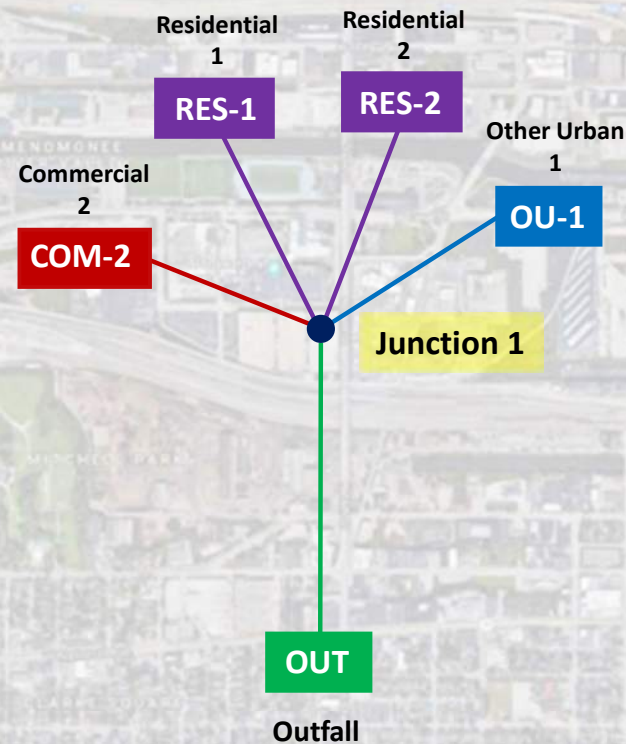
65% TSS (100% TSS when infiltrating)
35% TP (100% TP when infiltrating)



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Source Load and Management Model



Land Use

- Pollutant Source
- Pollutant Load (lbs/cf)

Stormwater and Pollutant Quantity

- Rainfall Volume
- Runoff Coefficient
- Stormwater Runoff Volume (cf)
- Pollutant Load (lbs)

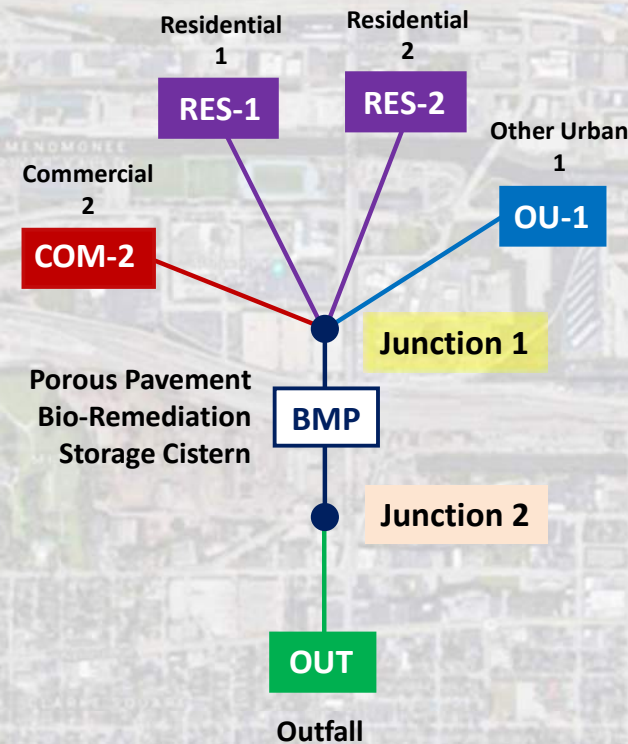
Baseline
Pollutant
Concentration
(lbs/cf)



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Source Load and Management Model



Land Use

- Pollutant Source
- Pollutant Load (lbs/cf)

Stormwater and Pollutant Quantity

- Rainfall Volume
- Runoff Coefficient
- **Stormwater Runoff Volume (cf)**
- Pollutant Load (lbs)

Baseline
Pollutant
Concentration
(lbs/cf)

Pollutant Treatment

- Gallery Media
- Underdrain
- Infiltration (cf)
- **Stormwater Pass-Through Volume (cf)**
- Pollutant Load (lbs) at Outfall

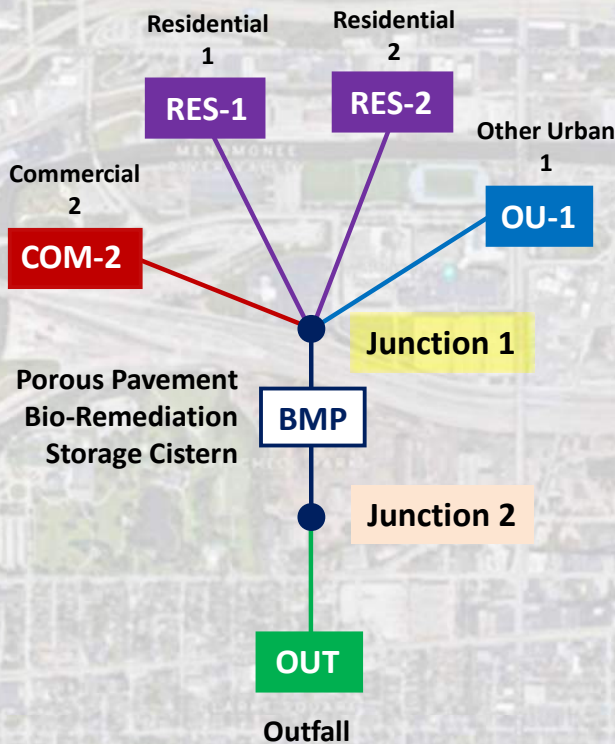


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Source Load and Management Model

Permeable Pavement | UD@Bottom | Subgrade Seepage = 0.04 in/hr



WinSLAMM Output Summary		Runoff Volume (cu ft)	Percent Runoff Volume Reduction	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction	
Total of all Land Uses without Controls:		113630	-	106.4	754.8	-	
Outfall Total with Controls:		107304	5.57%	31.44	210.6	72.10%	
Annualized Total After Outfall Controls:		110952			217.8		
Pollutant	Concentration - No Controls	Concentration - With Controls	Conc. Units	Pollutant Yield No Controls	Pollutant Yield With Controls	Pol. Y Units	Yield Percent Reduction
Particulate Solids	106.4	31.44	mg/L	754.8	210.6	lbs	72.10 %
Filterable Solids	64.24	64.24	mg/L	455.7	430.3	lbs	5.57 %
Total Solids	170.6	95.68	mg/L	1210	640.9	lbs	47.05 %
Particulate Phosphorus	0.3019	0.09285	mg/L	2.141	0.6220	lbs	70.95 %
Filterable Phosphorus	0.1219	0.1219	mg/L	0.8650	0.8163	lbs	5.63 %
Total Phosphorus	0.4238	0.2147	mg/L	3.006	1.438	lbs	52.16 %

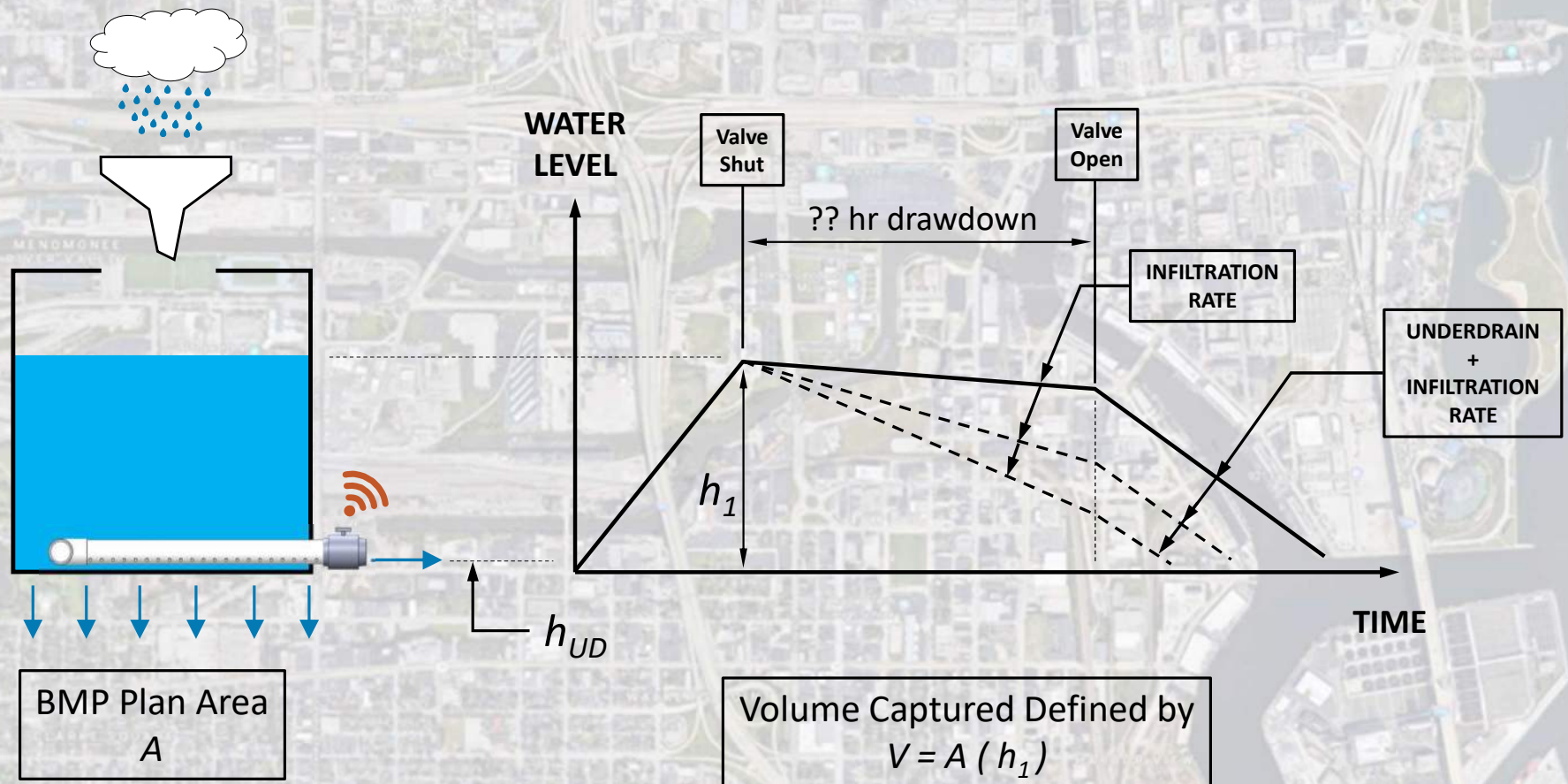
Permeable Pavement | UD@Bottom | Subgrade Seepage = 1.34 in/hr

WinSLAMM Output Summary		Runoff Volume (cu ft)	Percent Runoff Reduction	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction		
Total of all Land Uses without Controls:		113630	-	106.4	754.8	-		
Outfall Total with Controls:		27878	75.47%	32.26	56.14	92.56%		
Annualized Total After Outfall Controls:		28825			58.05			
Pollutant	Concentration - No Controls	Concentration - With Controls	Conc. Units	Pollutant Yield No Controls	Pollutant Yield With Controls	Pol. Unit	Yield	Percent Reduction
Particulate Solids	106.4	32.26	mg/L	754.8	56.14	lbs	92.56	%
Filterable Solids	64.24	65.07	mg/L	455.7	113.3	lbs	75.15	%
Total Solids	170.6	97.33	mg/L	1210	169.4	lbs	86.01	%
Particulate Phosphorus	0.3019	0.09589	mg/L	2.141	0.1669	lbs	92.21	%
Filterable Phosphorus	0.1219	0.1256	mg/L	0.8650	0.2185	lbs	74.74	%
Total Phosphorus	0.4238	0.2214	mg/L	3.006	0.3854	lbs	87.18	%



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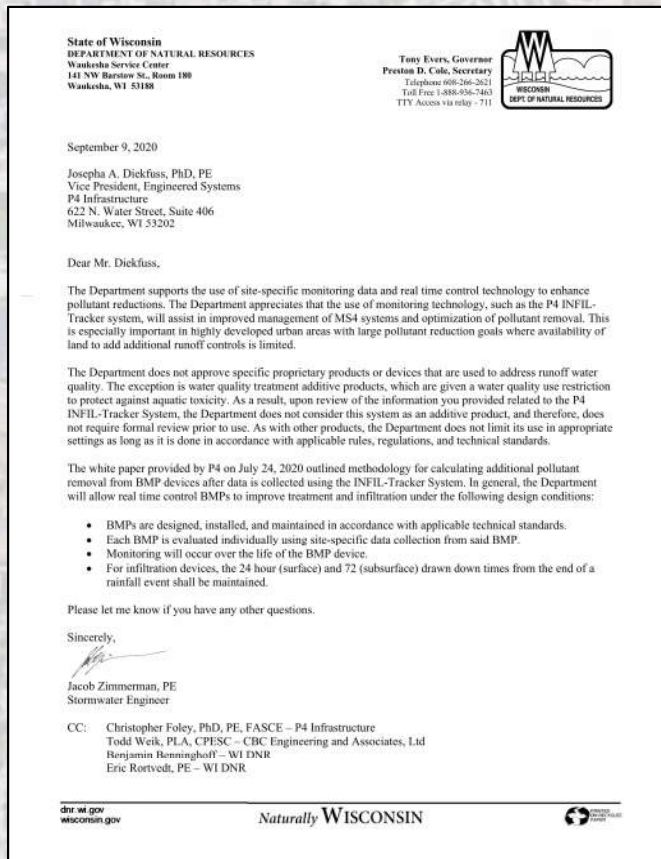




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REGULATORY BODY APPROVAL



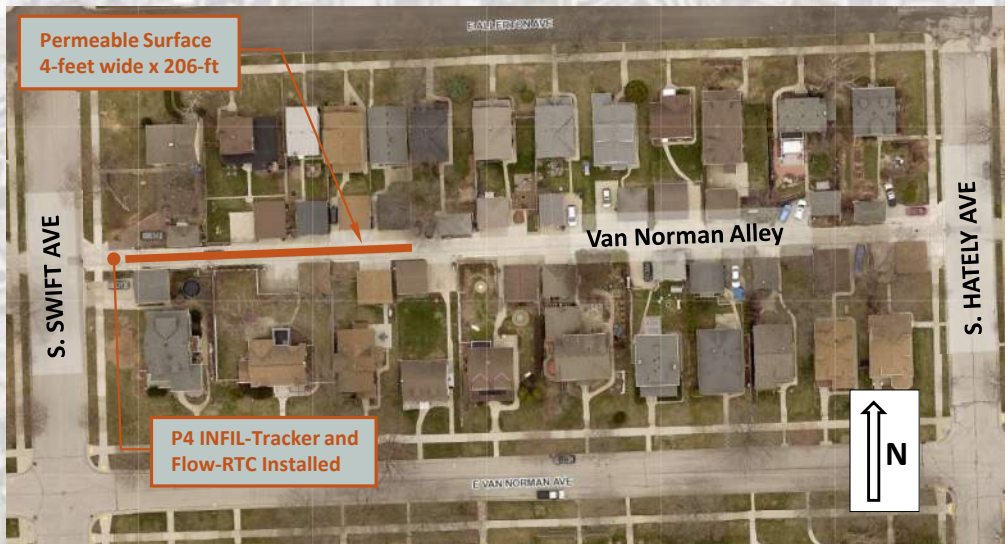
State of Wisconsin
Department of Natural Resources

P4 systems approved for pollutant
removal collection and documentation

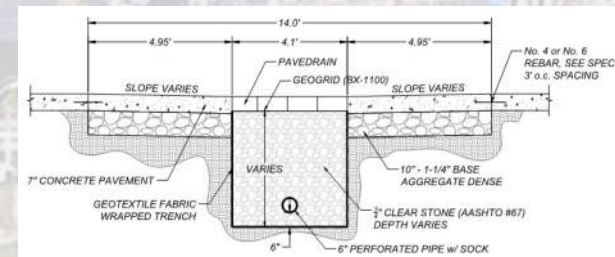


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Van Norman Alley Cudahy, Wisconsin



Garbage Truck Traffic – Permeable Strip (ACB)
Alley receives topographic runoff.

The alley turned out to be an **INCREDIBLY VALUABLE** experiment.



Hydrology driven by Topography

Storm Sewer Design driven by Hydrology



Permeable Pavement
846.7 ft²

5:1 Run-on Drainage Area
4,233 ft²

33:1 Run-on Drainage Area
27,939 ft²

Permeable Surface Design *analogous* with Storm Sewer Design

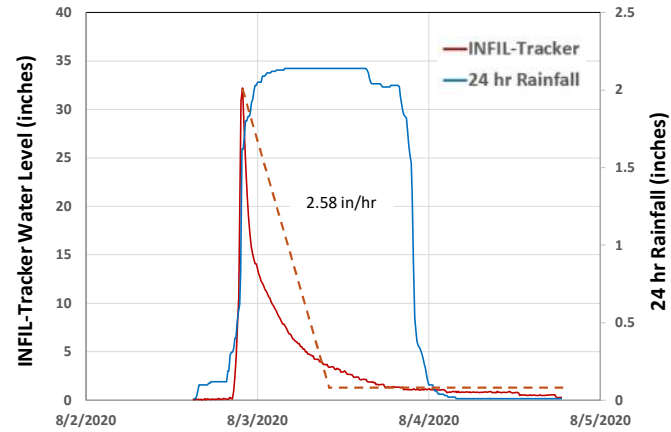


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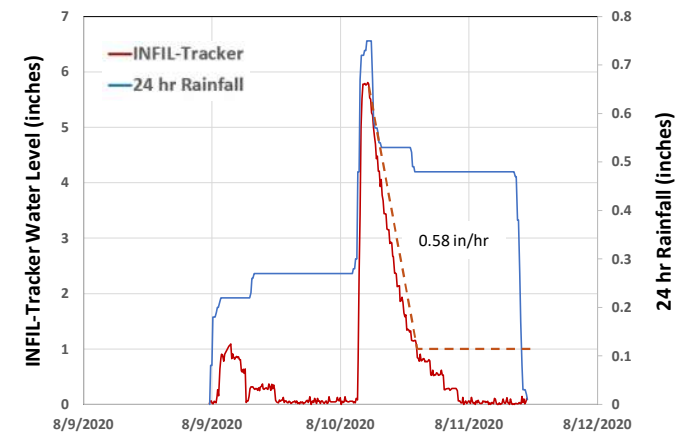




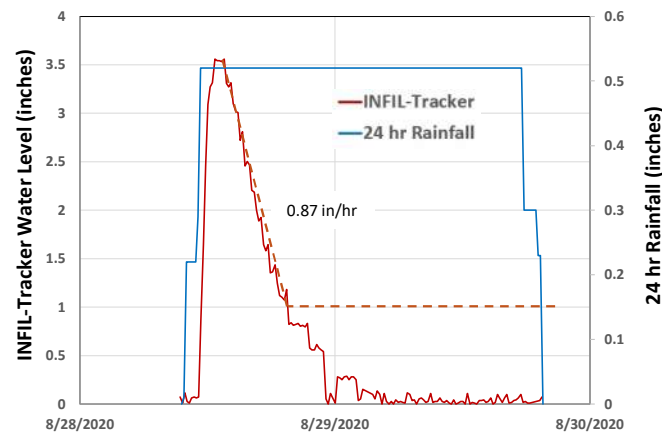
2.15" Rainfall Event



0.75" Rainfall Event



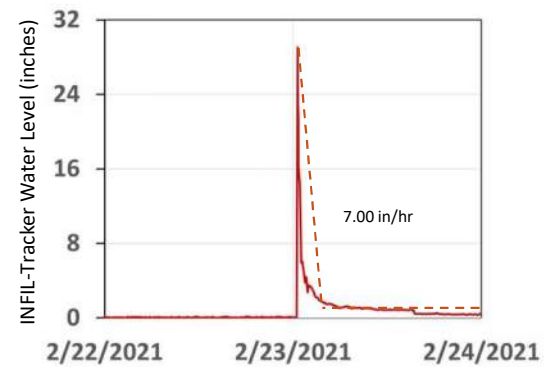
0.52" Rainfall Event

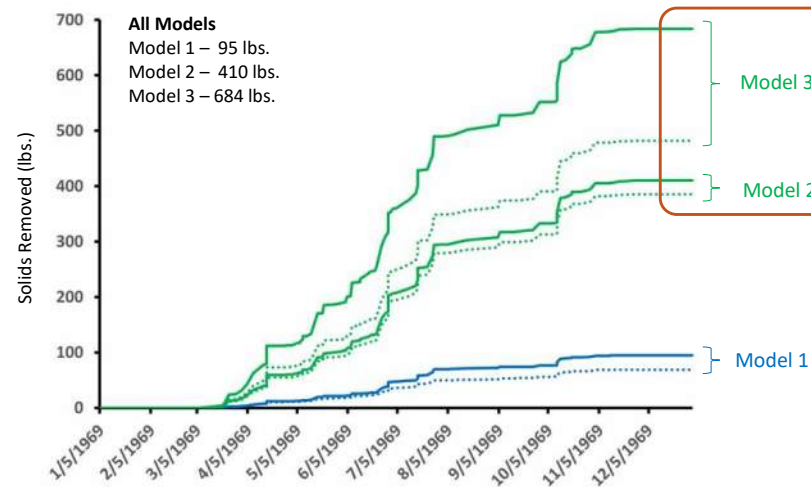
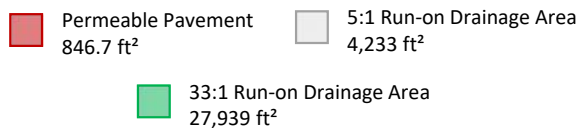
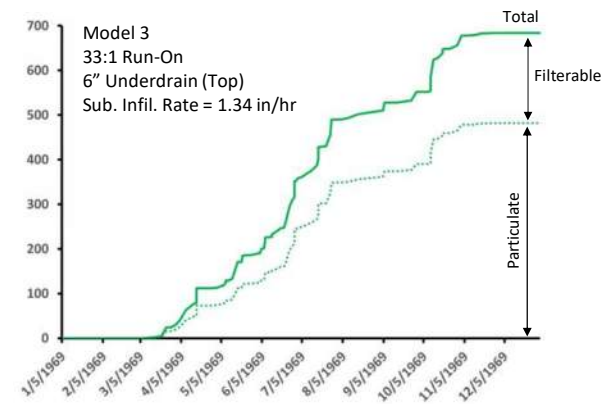
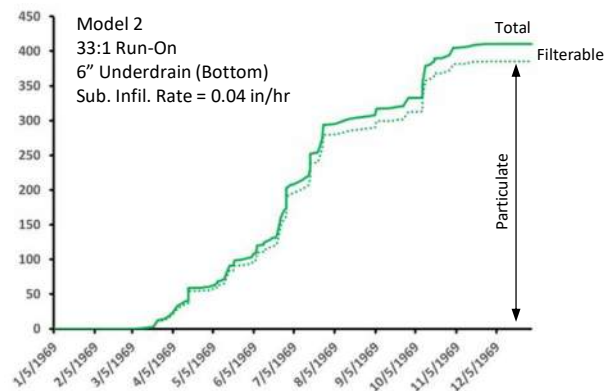
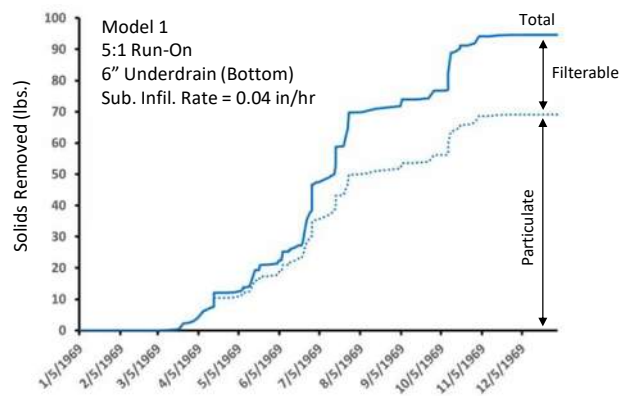


Avg. = 1.34 in/hr
(without snow melt)

Avg. = 2.76 in/hr
(with snow melt)

Snow Melt





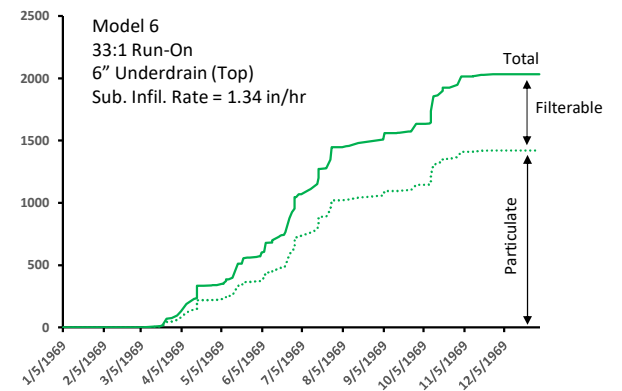
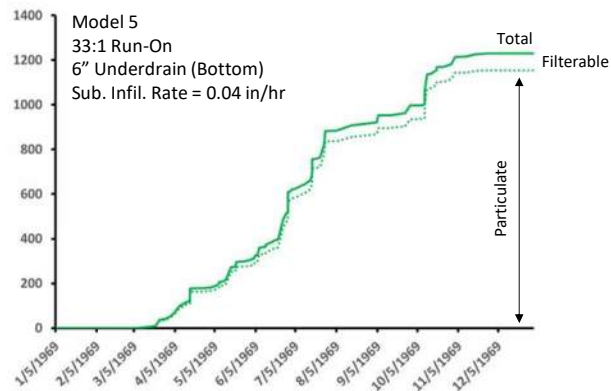
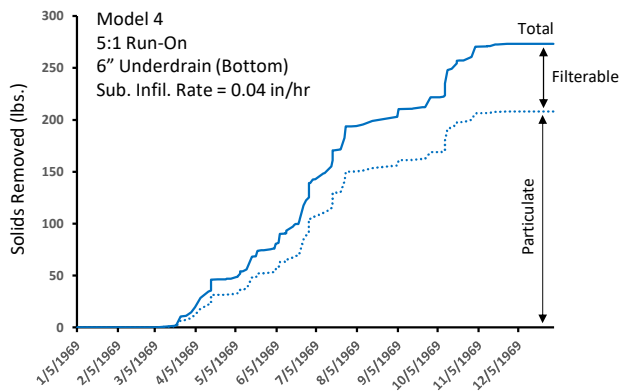
**IMPACT of P4 Systems
(INFIL-Tracker & Flow-RTC)**

67% increase in solids
removed.

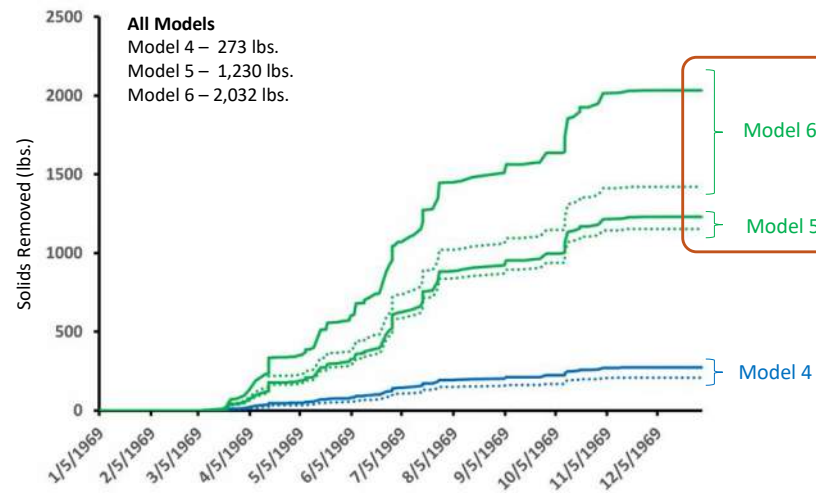


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■ Permeable Pavement
2,538 ft²
■ 5:1 Run-on Drainage Area
12,690 ft²
■ 33:1 Run-on Drainage Area
83,565 ft²



**IMPACT of P4 Systems
(INFIL-Tracker & Flow-RTC)**
**65% increase in solids
removed.**



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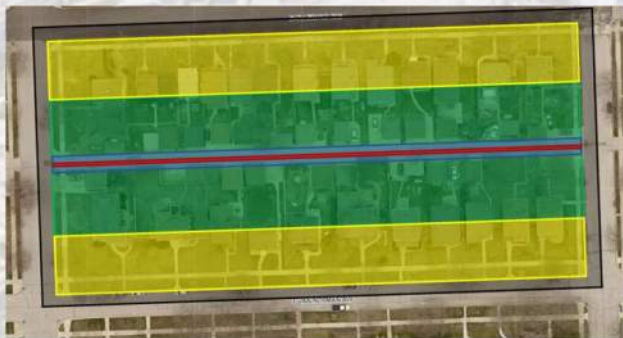


Van Norman CapEx: \$ 420,000
 20-year service life: n = 20
 Interest Rate: i = 3%



Annualized Expense
 \$ 28,230/year

20-Year Service Life (and Simulation)



	TSS		TP	
20-Year Simulation	Amount		Amount	
Baseline Load	116,177 lbs.		507.5 lbs.	
TMDL Reduction Goal (75% TSS, 54% TP)	87,132 lbs.		274 lbs.	
Annualized Reduction Goal	4,357 lbs/yr		13.7 lbs/yr	
Pollutant Removals	Annual Amount	Cost	Annual Amount	Cost
5:1 Run-On No Monitoring	282 lbs/yr	\$100/lb	1.2 lbs/yr	\$23,525/lb
33:1 Run-On Monitored by P4	2,047 lbs/yr	\$14/lb	8.9 lbs/yr	\$3,172/lb
Annual Pollutant Removal Gaps				
5:1 Run-On No Monitoring	4,075 lbs/yr		12.5 lbs/yr	
33:1 Run-On Monitored by P4	2,310 lbs/yr		4.8 lbs/yr	
Cost to Close Gap				
5:1 Run-On No Monitoring	\$407,500 /yr		\$294,063 /yr	
33:1 Run-On Monitored by P4	\$32,340 /yr		\$15,226 /yr	



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TRANSPARENCY and EDUCATION



Green Tech Station Milwaukee, WI

Rain-mX + LIQUA-Level



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SELF INSURANCE

**WI Consulting Firm and
General Contractor**

**Basement of a Building
Milwaukee, WI**

LIQUA-Level



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INFILTRATION and AQUIFER RECHARGE

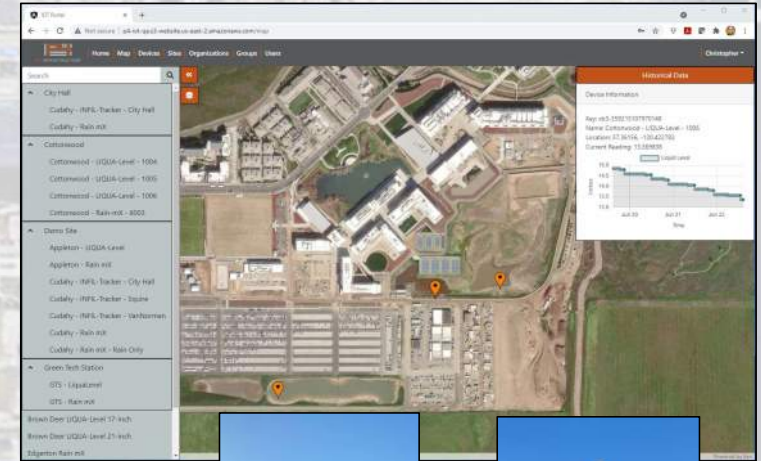
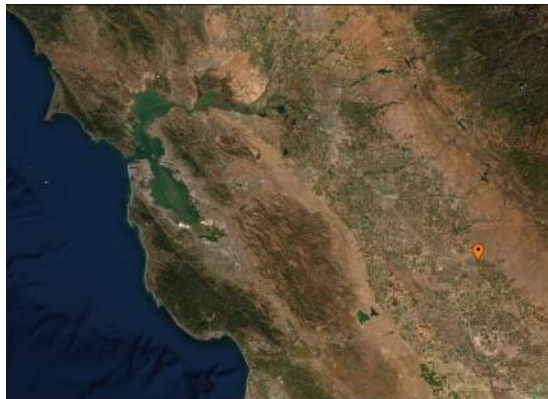


University of California - Merced
Stormwater Retention Basins

Rain-mX

+

LIQUA-Level



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INFILTRATION and AQUIFER RECHARGE

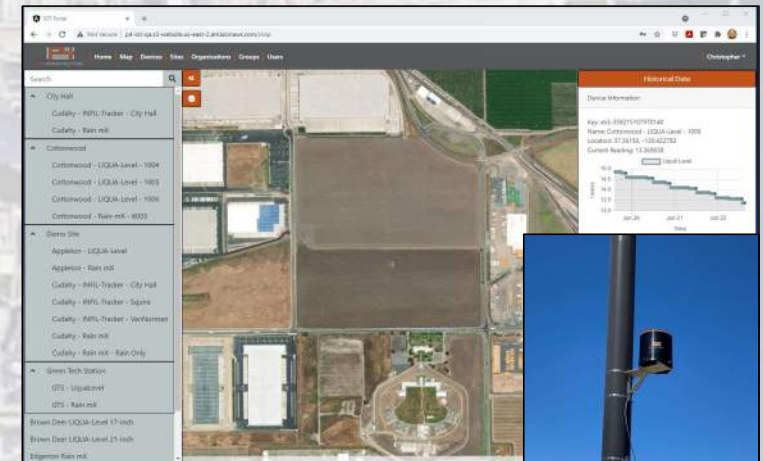


Amazon Distribution Facility Stockton, CA

Rain-mX

+

PRESS

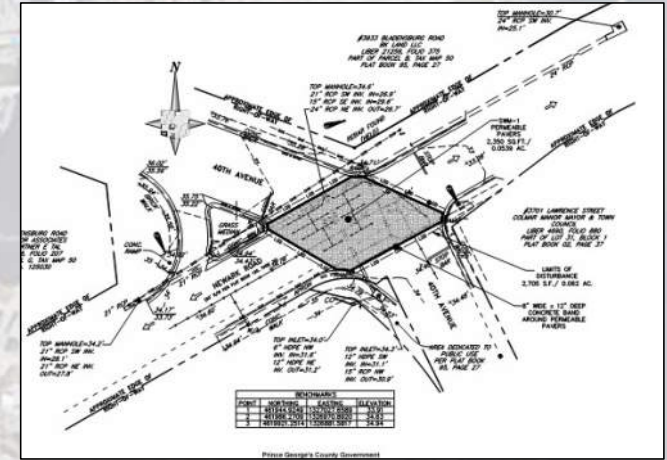
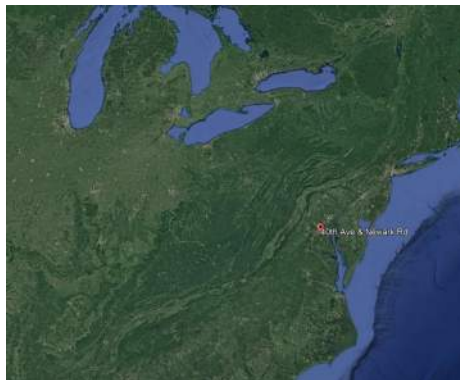


INFILTRATION

ERNEST MAIER Inc.

PaveDrain Permeable Pavement Bladensburg, MD

Rain-mX + INFIL-Tracker



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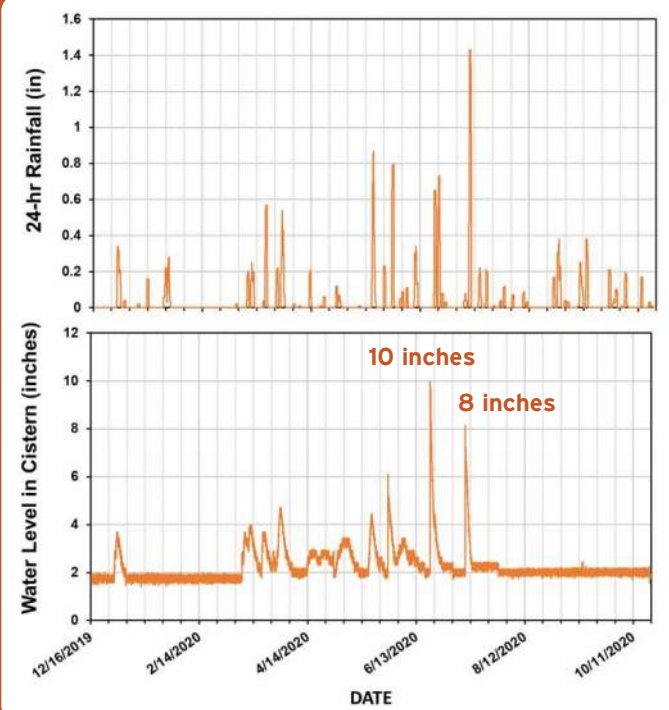


MONITORING and MODELING

Rain-mX

+

LIQUA-Level



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Thank You



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