P4 INFRASTRUCTURE

Fiscally Responsible *and* Better-Than-Expected Stormwater Infrastructure *through* Sensor Systems

Joseph Diekfuss, PhD, PE, MASCE

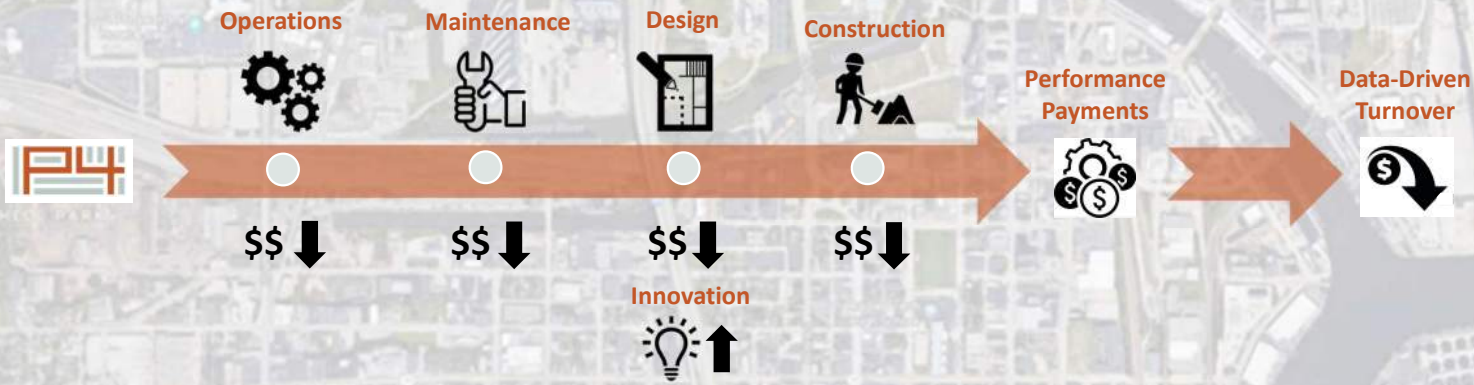
ASCE Southeast Branch Member Meeting | August 12, 2021

P4 Infrastructure, Inc.
622 N. Water Street, Suite 406
Milwaukee, WI 53202
www.p4i.io
info@p4i.io

P4 → Products for Public Private Partnerships

P4** lives at the **intersection** of **innovation** and **technology

P4** creates **products** that **address** the **elephant in the room



***P4** is building **products** that **connect people with infrastructure**.*

***P4** is **building** the **Internet of Infrastructure** to make **civil infrastructure as a service** a reality.*

P4 INFRASTRUCTURE

P4 DEVICES

Rain mX

LIQUA-Level

INFIL-Tracker

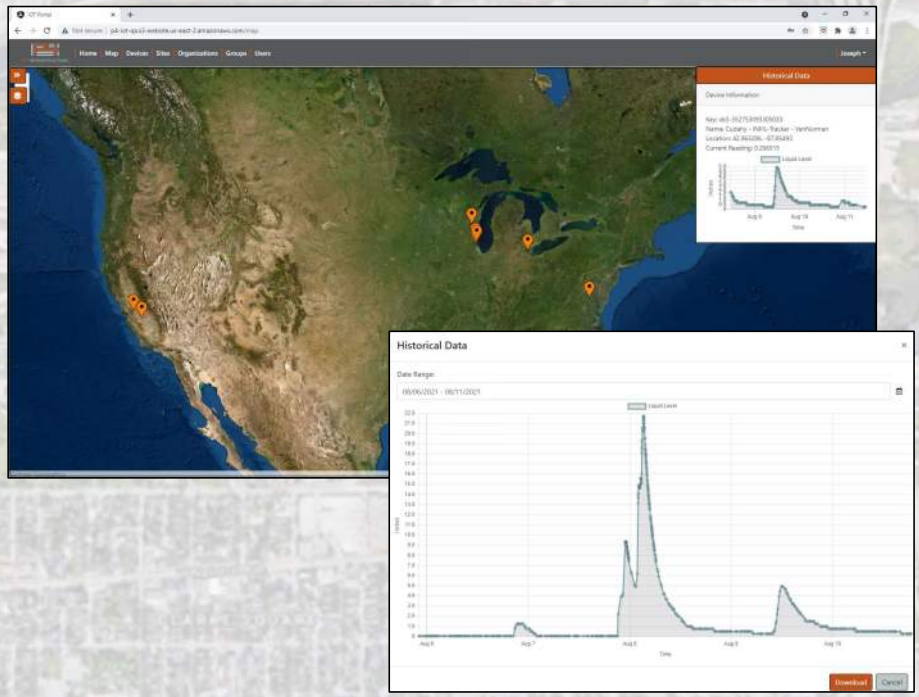
PRESS

Flow-RTC

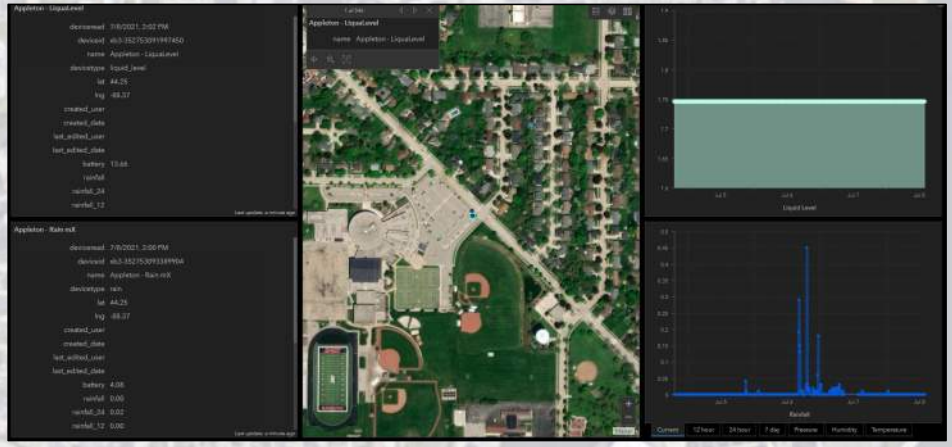
P4 INFRASTRUCTURE

P4 Dashboard

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



ESRI-Based Dashboard
Available thru Separate Subscription



P4 INFRASTRUCTURE

City of Appleton
- Appleton, WI
- Rain mX – **1**
- LIQUA-Level – **1**

Parjana
- Pensacola, FL
- Rain mX – **1**
- PRESS – **1**

City of Cudahy
- Cudahy, WI
- Rain-mX – **1**
- INFIL-Tracker – **3**

Paxon Investments
- Stockton, CA
- Rain-mX – **1**
- PRESS – **1**

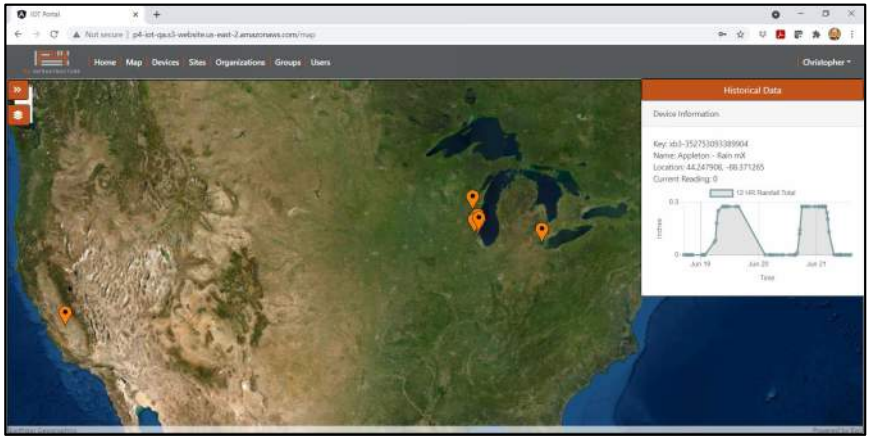
Consulting Firm/GC
- Milwaukee, WI
- LIQUA-Level – **2**

Parjana
- Grosse Point, MI
- LIQUA-Level – **1**

Parjana
- Merced, CA
- Rain-mX – **1**
- LIQUA-Level – **3**

Green Tech Station
- Milwaukee, WI
- Rain-mX – **1**
- LIQUA-Level – **1**

Ernest Meier
- Bladensburg, MD
- Rain-mX – **1**
- LIQUA-Level – **1**



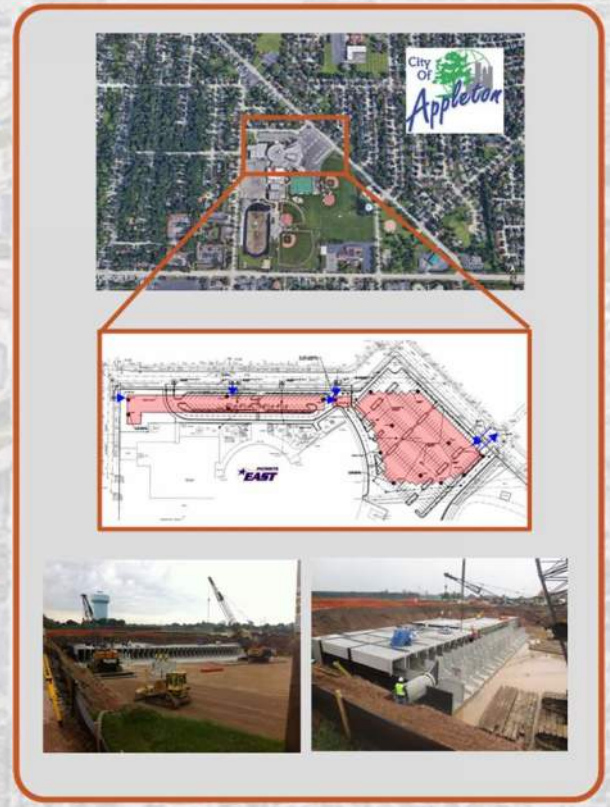
7 Customers
- Non-Profit
- Municipality
- Private Company
- General Contractor

National Scope
- 4 States

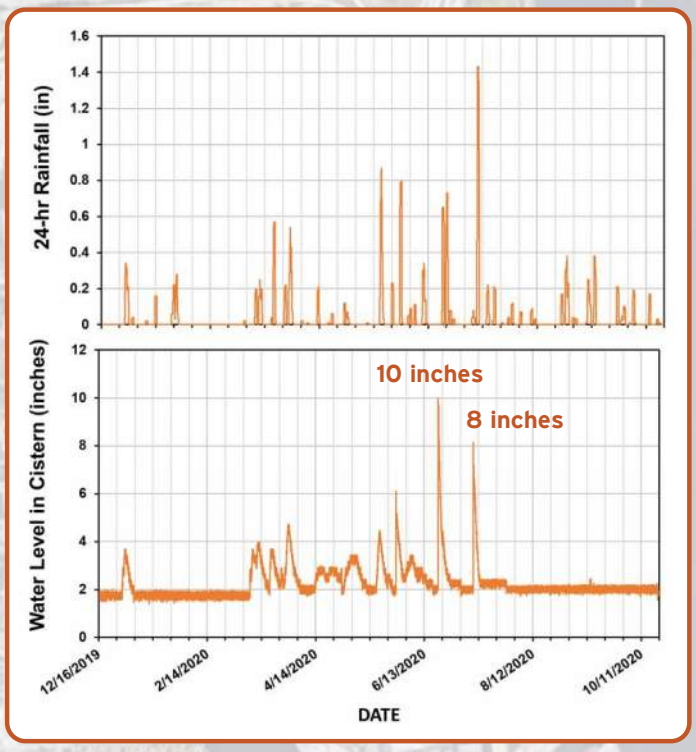
21 Sensor Systems
- Infiltration Basins
- Underground Harvesting
- Liquid Level
- Infiltration
- Underground Detention

P4 INFRASTRUCTURE

MONITORING and MODELING



Rain-mX + **LIQUA-Level**



P4 INFRASTRUCTURE

TRANSPARENCY and EDUCATION

NORTHWEST SIDE COMMUNITY DEVELOPMENT CORPORATION
Community Reinvestment at Work

THE WATER COUNCIL

Green Tech Station
Milwaukee, WI

Rain-mX + **LIQUA-Level**

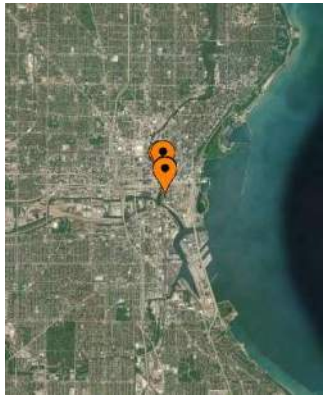
P4 INFRASTRUCTURE

SELF INSURANCE

WI Consulting Firm and General Contractor

Basement of a Building Milwaukee, WI

LIQUA-Level



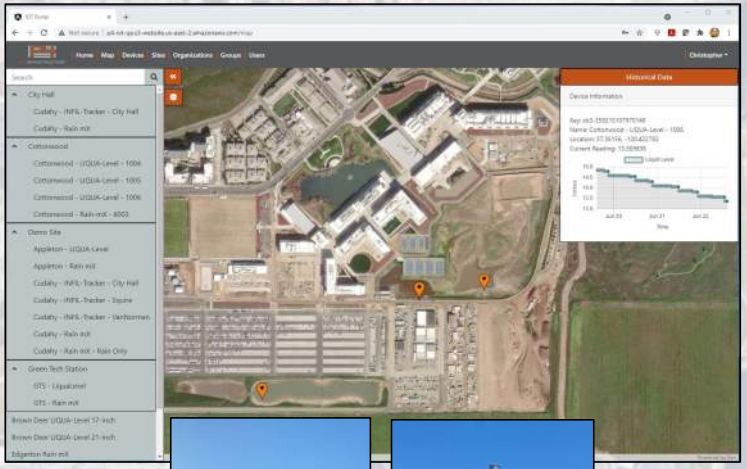
P4 INFRASTRUCTURE

INFILTRATION and AQUIFER RECHARGE

PARJANA

University of California - Merced Stormwater Retention Basins

Rain-mX + **LIQUA-Level**



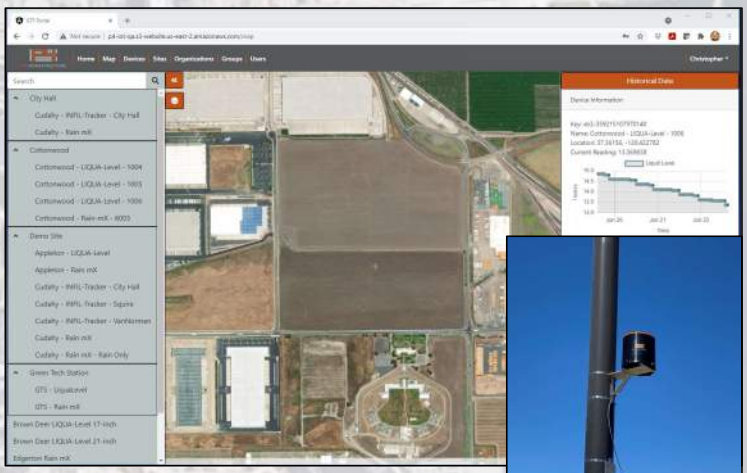
P4 INFRASTRUCTURE

INFILTRATION and AQUIFER RECHARGE

PARJANA

Amazon Distribution Facility
Stockton, CA

Rain-mX + **PRESS**



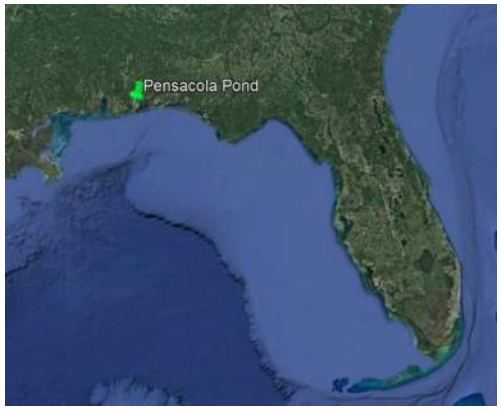
P4 INFRASTRUCTURE

INFILTRATION and VOLUME CONTROL

PARJANA

Stormwater Retention Basins
Pensacola, FL

Rain-mX + **PRESS**



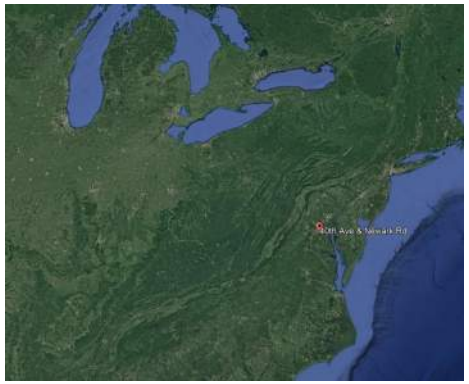
P4 INFRASTRUCTURE

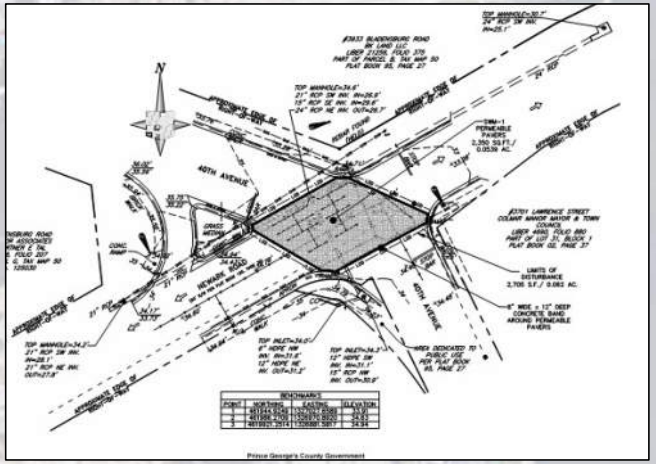
INFILTRATION

ERNEST MAIER Inc.

PaveDrain Permeable Pavement
Bladensburg, MD

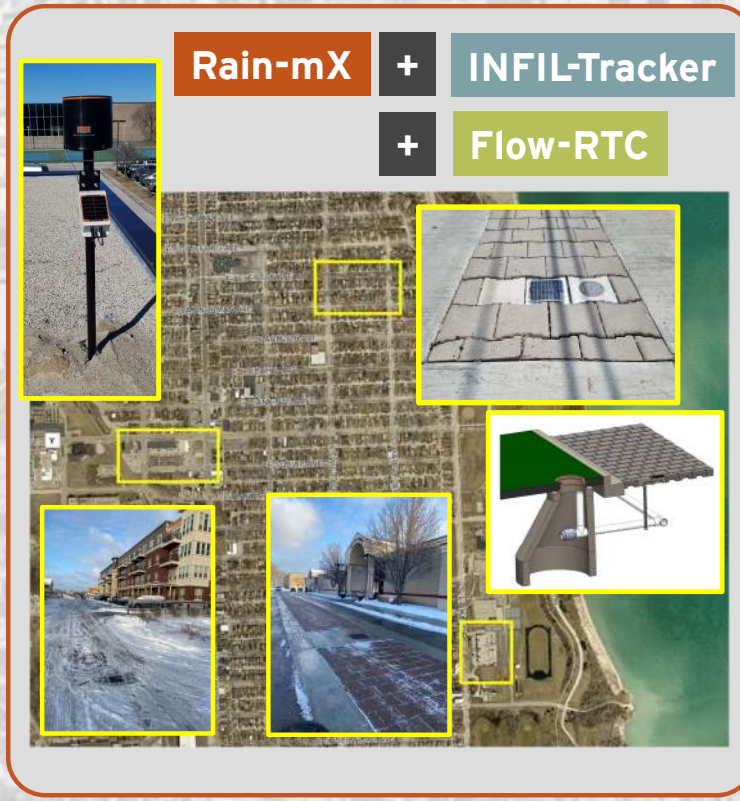
Rain-mX + **INFIL-Tracker**





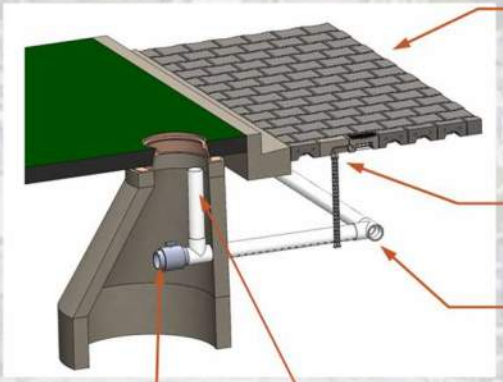
P4 INFRASTRUCTURE

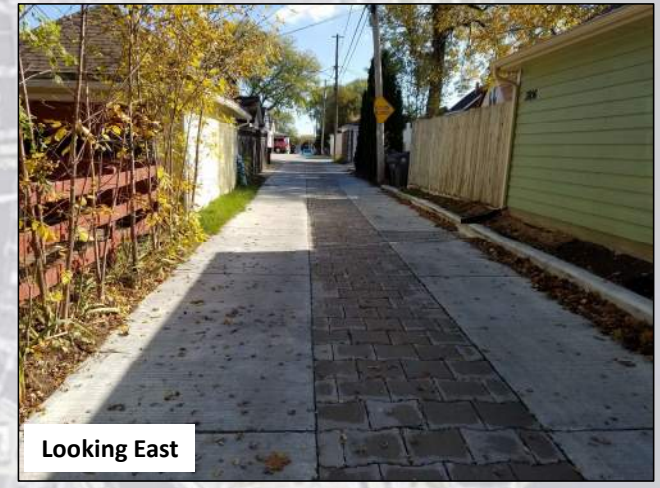
REDUCED INFRASTRUCTURE SPENDING: CUDAHY CASE STUDY



P4 INFRASTRUCTURE

VAN NORMAN ALLEY - CUDAHY, WI





P4 INFRASTRUCTURE

Tech Standards/Guidance
(WI DNR)

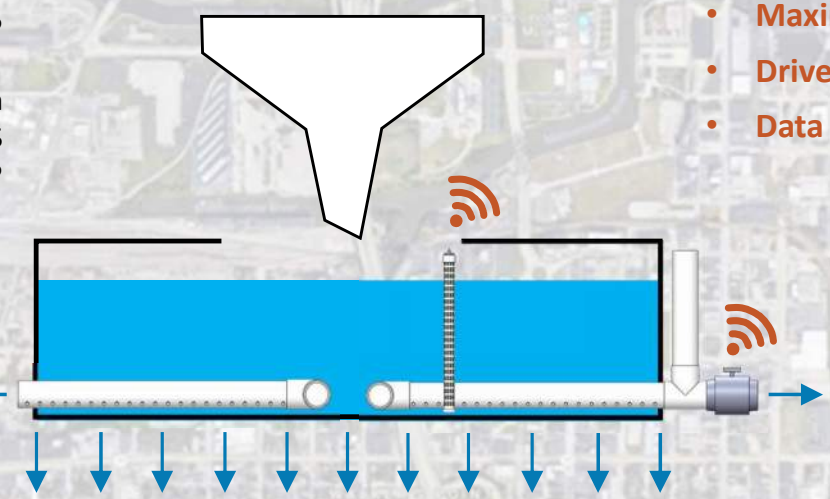
Pollutant Removal Efficiency

Underdrain Present
65% TSS
35% TP

No Underdrain
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**



Filter/Drain
65% TSS
35% TP

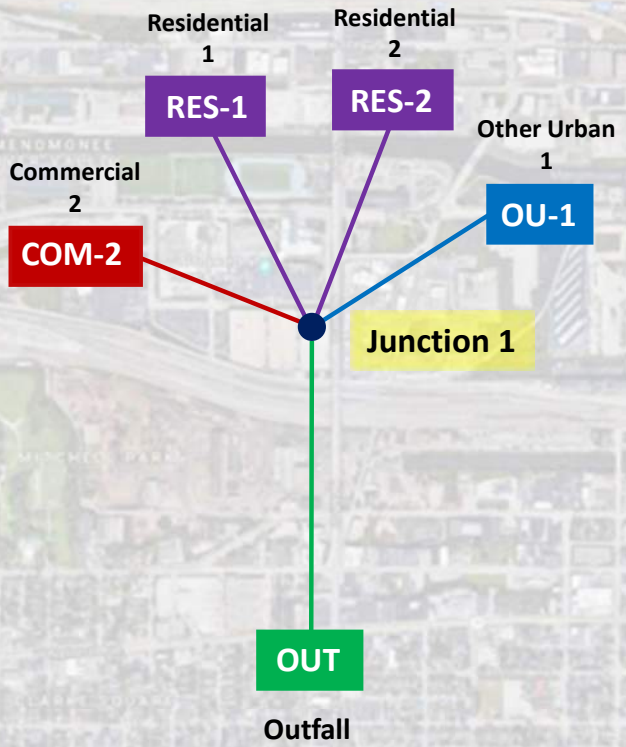
Drain Only when Required
65% TSS (100% TSS when infiltrating)
35% TP (100% TP when infiltrating)

May/May Not Infiltrate
100% TSS
100% TP

Infiltrate for Drawdown Period
100% TSS
100% TP

P4 INFRASTRUCTURE

Source Load and Management Model



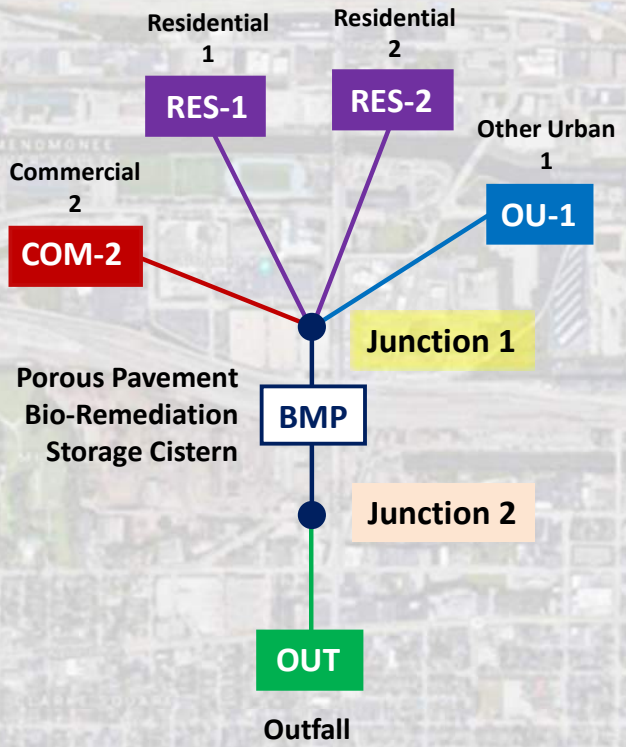
Land Use
- Pollutant Source
- Pollutant Load (lbs/cf)

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

Baseline Pollutant Concentration (lbs/cf)

P4 INFRASTRUCTURE

Source Load and Management Model



Land Use
- Pollutant Source
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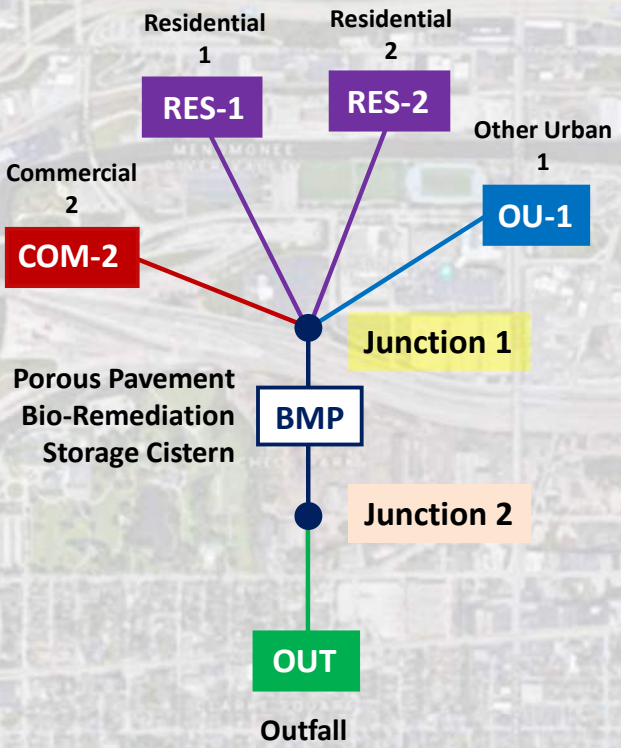
Stormwater and Pollutant Quantity
- Rainfall Volume
- Runoff Coefficient
- **Stormwater Runoff Volume (cf)**
- Pollutant Load (lbs)

Baseline Pollutant Concentration (lbs/cf)

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

P4 INFRASTRUCTURE

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. Yield Units	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 %

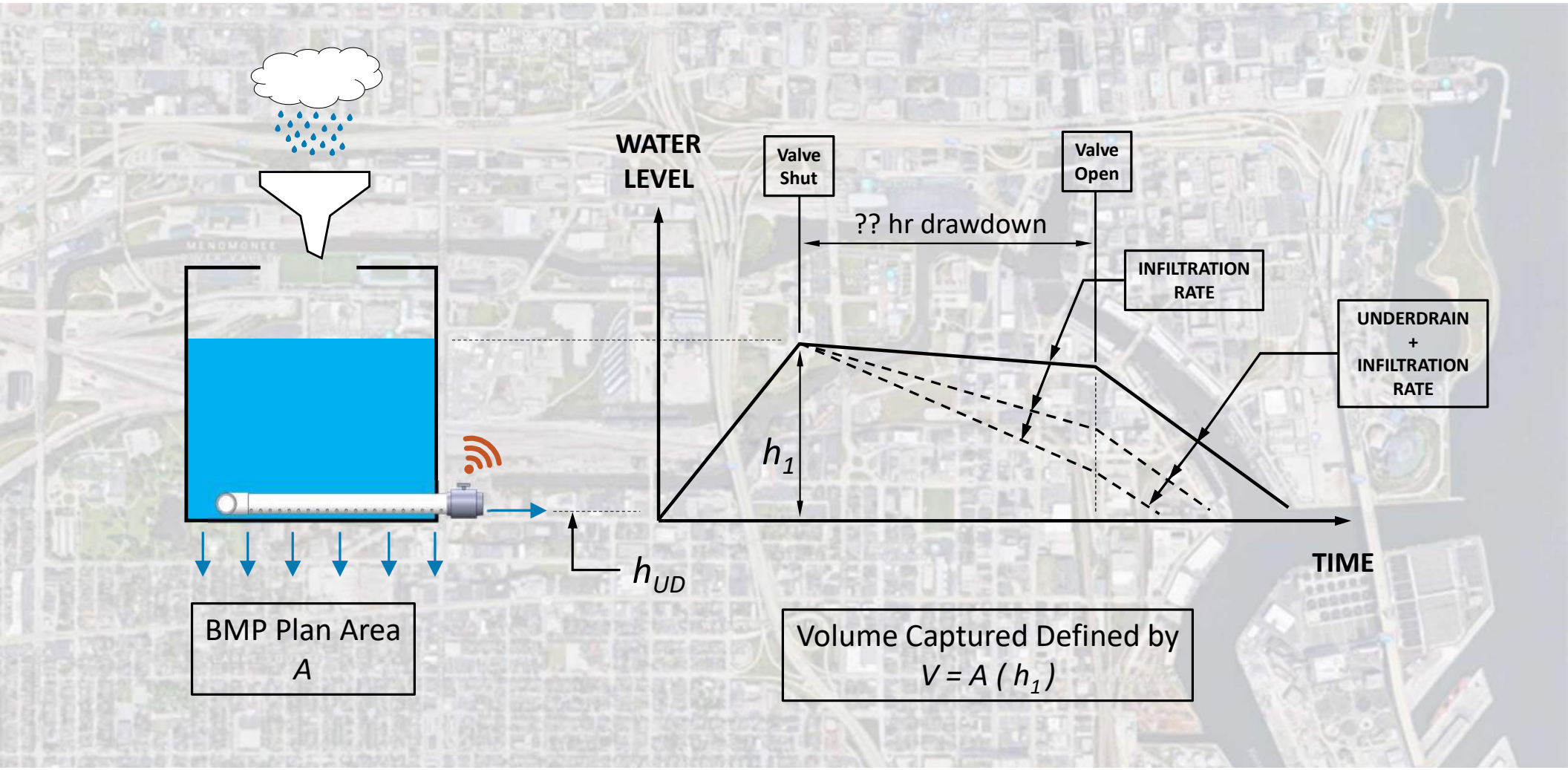
Permeable Pavement | UD@Bottom | Subgrade Seepage = 1.34 in/hr

WinSLAMM Output Summary

	Runoff Volume (cu ft)	Percent Runoff 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:	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. Yield Units	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 %

P4 INFRASTRUCTURE



P4 INFRASTRUCTURE

REGULATORY BODY APPROVAL

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
Waukesha Service Center
141 NW Barstow St., Room 180
Waukesha, WI 53188

Tony Evers, Governor
Preston D. Cole, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

WISCONSIN DEPT. OF NATURAL RESOURCES

September 9, 2020

Josepha A. Diekfuss, PhD, PE
Vice President, Engineered Systems
P4 Infrastructure
622 N. Water Street, Suite 406
Milwaukee, WI 53202

Dear Mr. Diekfuss,

The Department supports the use of site-specific monitoring data and real time control technology to enhance pollutant reductions. The Department appreciates that the use of monitoring technology, such as the P4 INFIL-Tracker system, will assist in improved management of MS4 systems and optimization of pollutant removal. This is especially important in highly developed urban areas with large pollutant reduction goals where availability of land to add additional runoff controls is limited.

The Department does not approve specific proprietary products or devices that are used to address runoff water quality. The exception is water quality treatment additive products, which are given a water quality use restriction to protect against aquatic toxicity. As a result, upon review of the information you provided related to the P4 INFIL-Tracker System, the Department does not consider this system as an additive product, and therefore, does not require formal review prior to use. As with other products, the Department does not limit its use in appropriate settings as long as it is done in accordance with applicable rules, regulations, and technical standards.

The white paper provided by P4 on July 24, 2020 outlined methodology for calculating additional pollutant removal from BMP devices after data is collected using the INFIL-Tracker System. In general, the Department will allow real time control BMPs to improve treatment and infiltration under the following design conditions:

- BMPs are designed, installed, and maintained in accordance with applicable technical standards.
- Each BMP is evaluated individually using site-specific data collection from said BMP.
- Monitoring will occur over the life of the BMP device.
- For infiltration devices, the 24 hour (surface) and 72 (subsurface) drawn down times from the end of a rainfall event shall be maintained.

Please let me know if you have any other questions.

Sincerely,

Jacob Zimmerman, PE
Stormwater Engineer

CC: Christopher Foley, PhD, PE, FASCE – P4 Infrastructure
Todd Weik, PLA, CPESC – CBC Engineering and Associates, Ltd
Benjamin Benninghoff – WI DNR
Eric Rortvedt, PE – WI DNR

dnr.wi.gov
wisconsin.gov

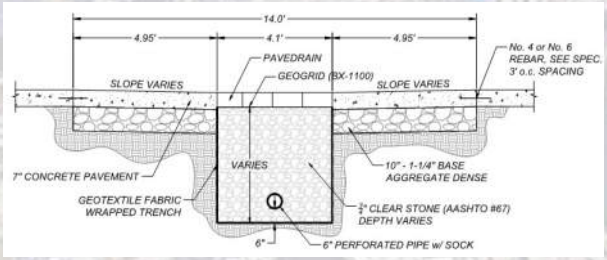
Naturally WISCONSIN

State of Wisconsin
Department of Natural Resources

P4 systems approved for pollutant removal collection and documentation

P4 INFRASTRUCTURE

Van Norman Alley
Cudahy, Wisconsin



Garbage Truck Traffic – Permeable Strip (ACB)

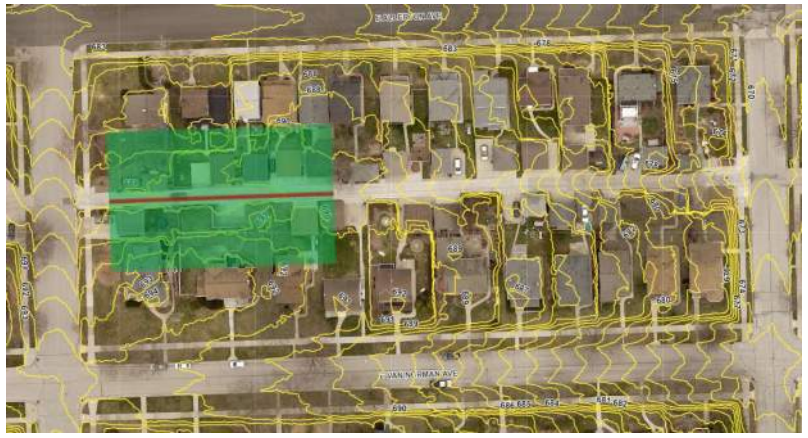
Alley receives topographic runoff.

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

P4 INFRASTRUCTURE

Hydrology *driven by* **Topography**

Storm Sewer Design *driven by* **Hydrology**

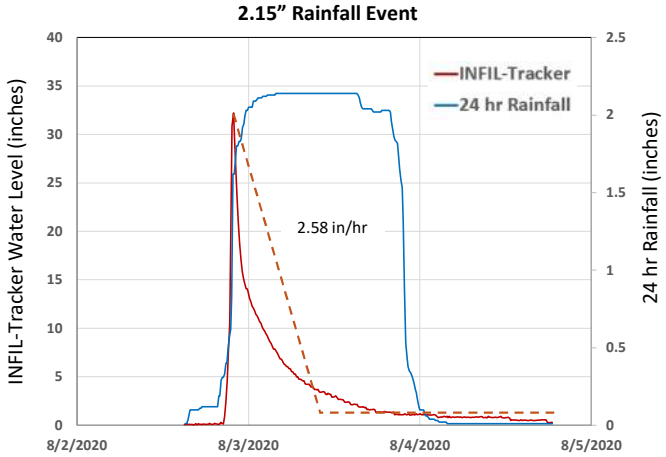


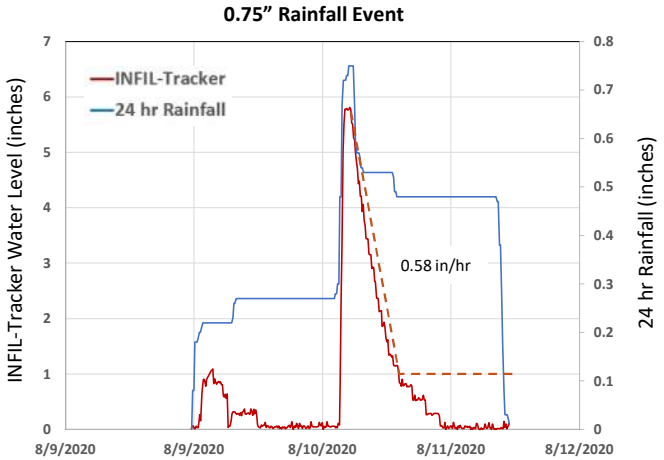
Permeable Pavement
846.7 ft²

5:1 Run-on Drainage Area
4,233 ft²

33:1 Run-on Drainage Area
27,939 ft²

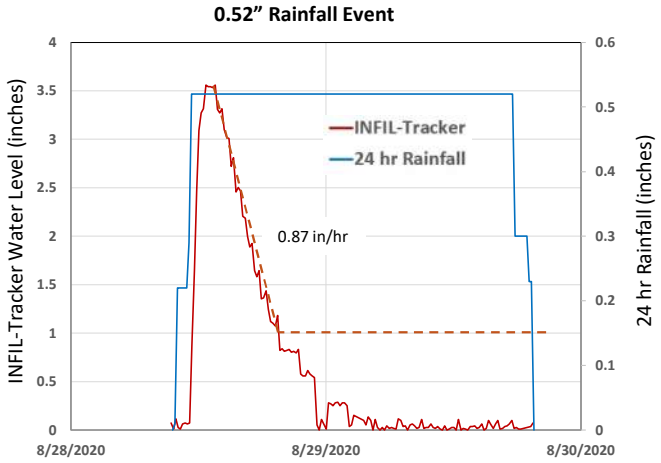
Permeable Surface Design *analogous with* **Storm Sewer Design**

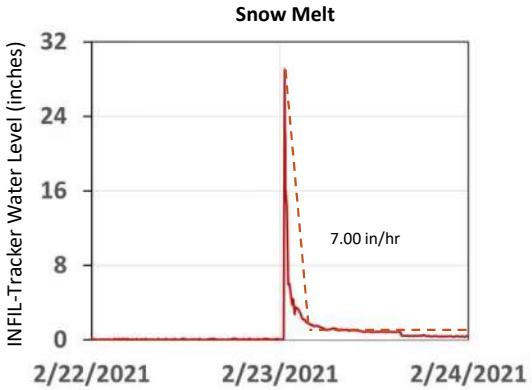


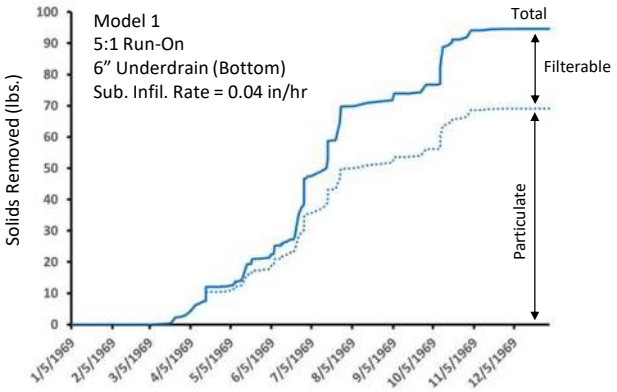


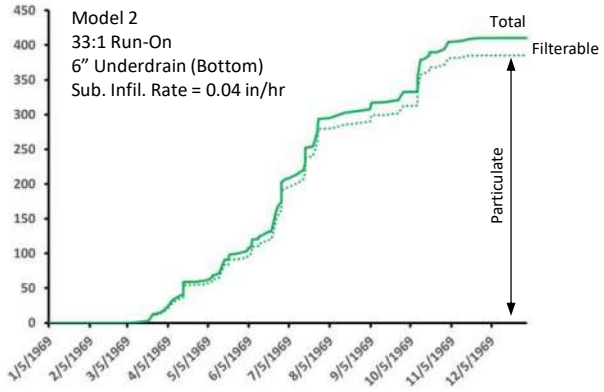
Avg. = 1.34 in/hr
(without snow melt)

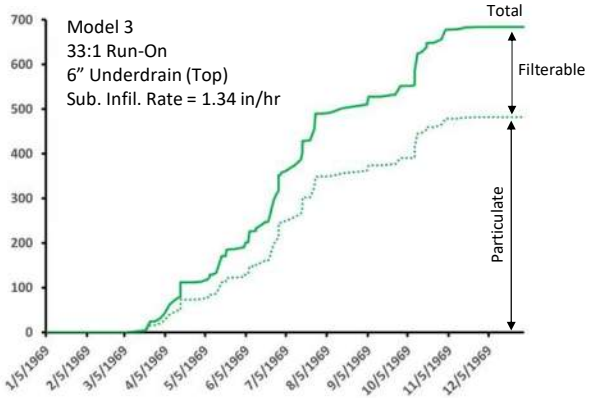
Avg. = 2.76 in/hr
(with snow melt)







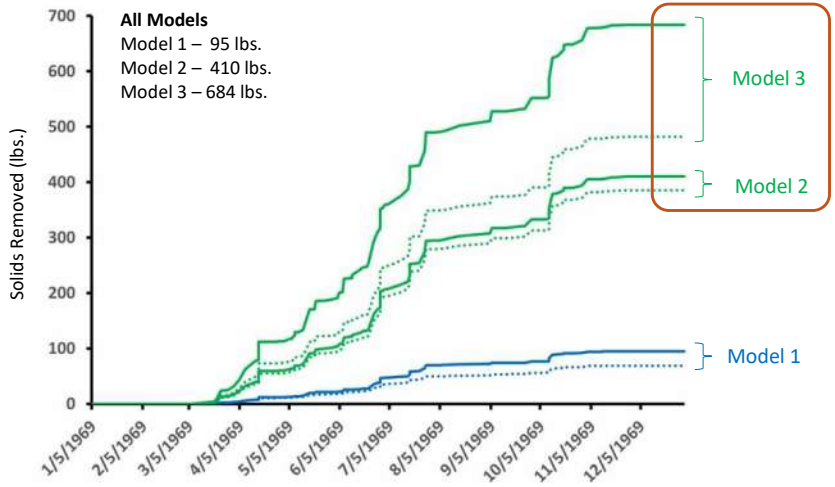




Permeable Pavement
846.7 ft²

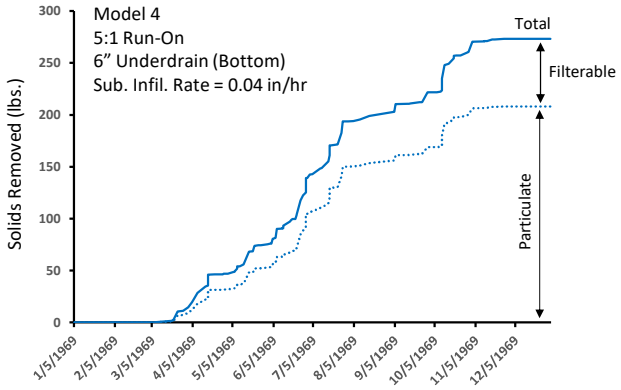
5:1 Run-on Drainage Area
4,233 ft²

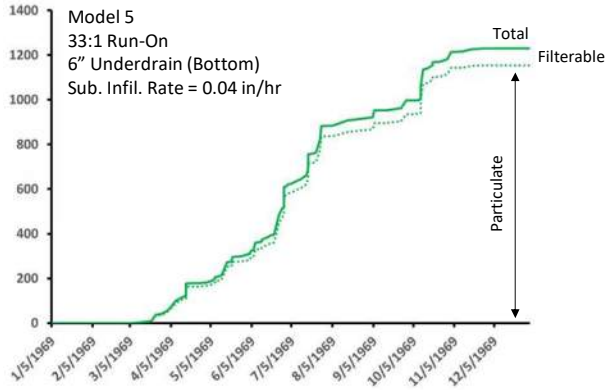
33:1 Run-on Drainage Area
27,939 ft²

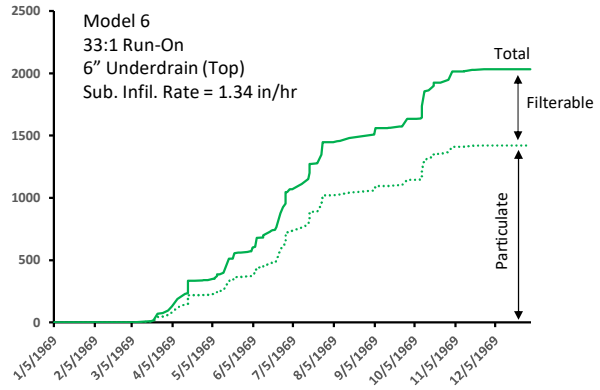


IMPACT of P4 Systems (INFIL-Tracker & Flow-RTC)

67% increase in solids removed.



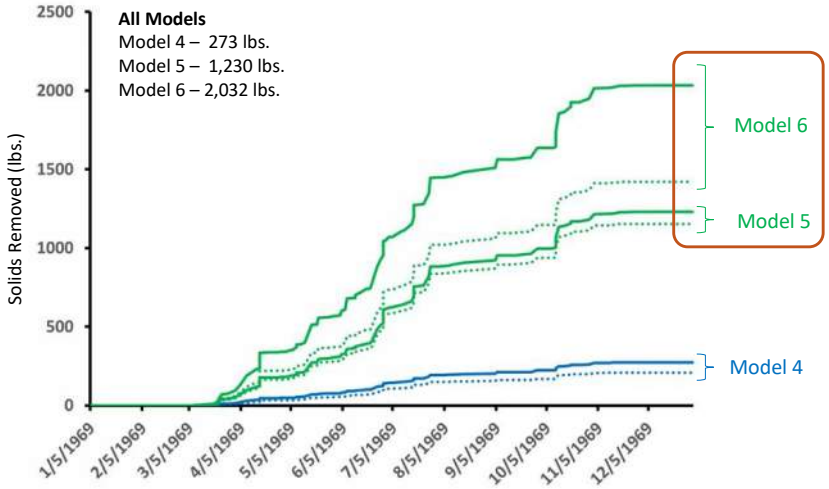




Permeable Pavement
2,538 ft²

5:1 Run-on Drainage Area
12,690 ft²

33:1 Run-on Drainage Area
83,565 ft²



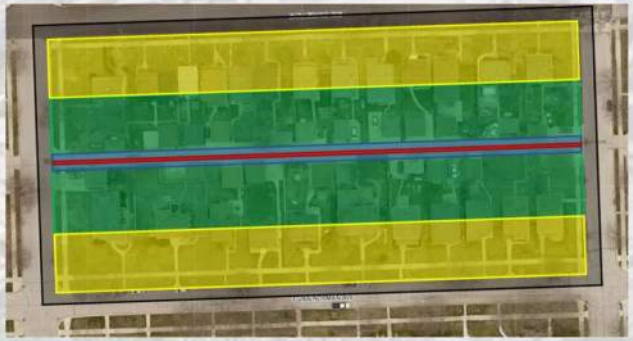
IMPACT of P4 Systems (INFIL-Tracker & Flow-RTC)

65% increase in solids removed.

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**
WDNR Guidance	**282 lbs/yr**	**$100/lb**	1.2 lbs/yr	$23,525/lb
ACB Powered by P4	**2,047 lbs/yr**	**$14/lb**	8.9 lbs/yr	$3,172/lb
Annual Pollutant Removal Gaps				
WDNR Guidance	**4,075 lbs/yr**		12.5 lbs/yr	
ACB Powered by P4	**2,310 lbs/yr**		4.8 lbs/yr	
Cost to Close Gap				
WDNR Guidance	**$407,500 /yr**		$294,063 /yr	
ACB Powered by P4	**$32,340 /yr**		$15,226 /yr	

P4 INFRASTRUCTURE

P4 INFRASTRUCTURE

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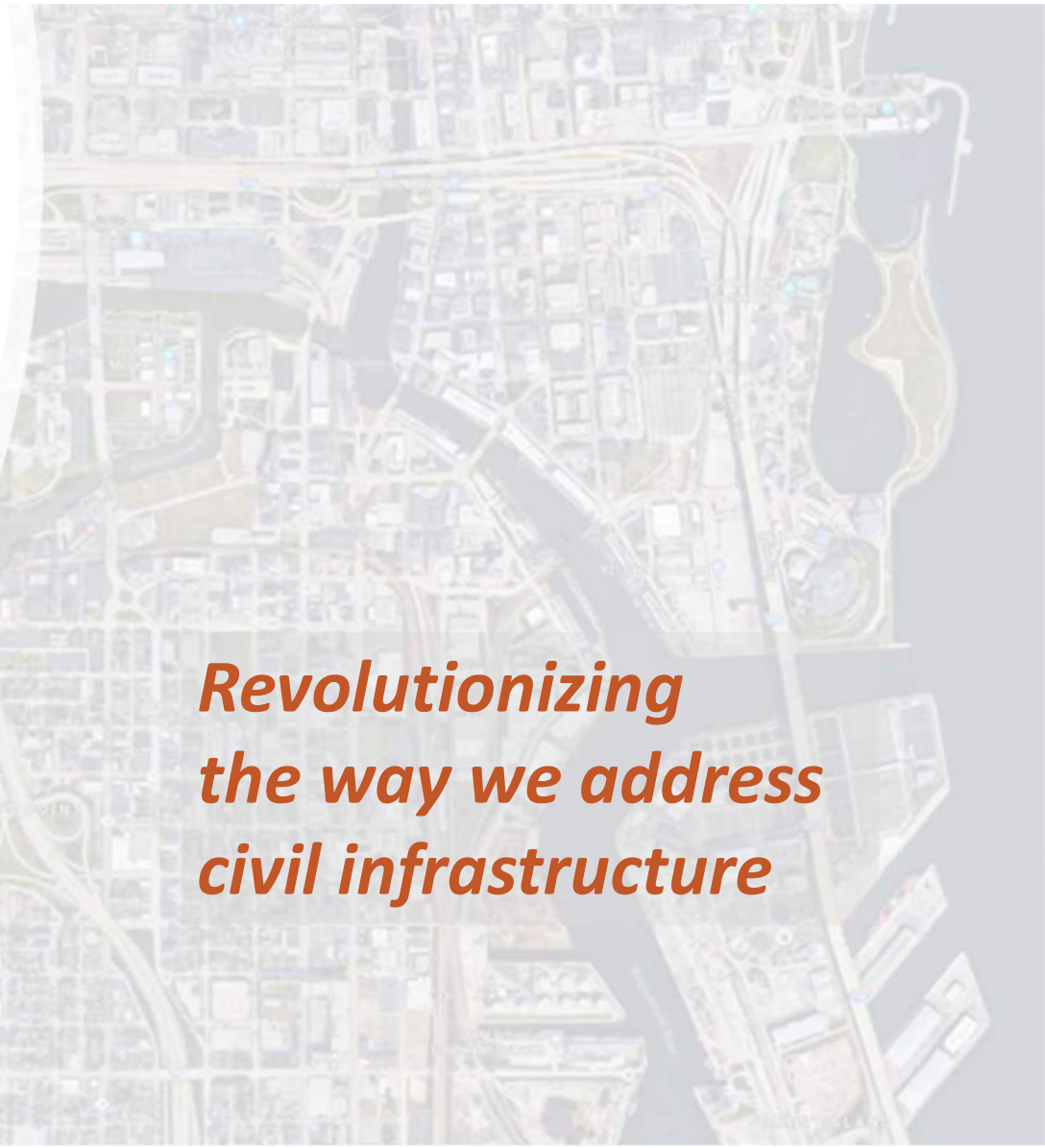

Revolutionizing the way we address civil infrastructure