Next Generation, Reduced Maintenance Permeable Pavement

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Primer on P-ACB Systems

PAVE DRAIN
STORMWATER'S ARCH ENEMY

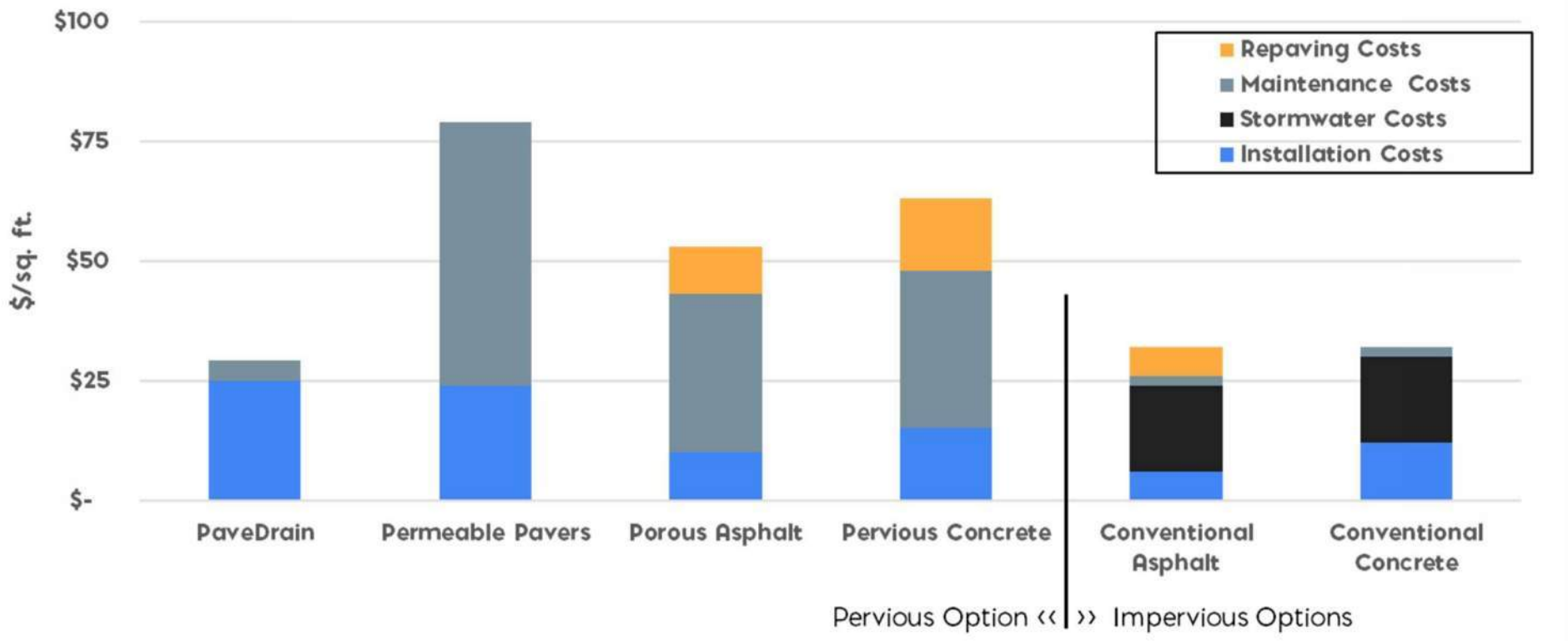
Monitoring and Compliance with Real Time Sensors

P4 INFRASTRUCTURE

Case Studies from Orlando, FL

Kimley»Horn
Expect More. Experience Better.

Total Costs @ 10 Years



PRIMER ON PERMEABLE ARTICULATING CONCRETE BLOCK (P-ACB) SYSTEMS

City of Goshen, Indiana – Jefferson Street

What is a Permeable Articulating Concrete Block?

- Matrix of interconnected concrete block units
- Interlocking Mechanism
  - Geometry
  - Cables
  - Geofabrics
- Form a Hard, yet Pervious Surface via Open Joints

P-ACB and Pavers

similar, but not the same

P-ACB & Pavers: Similarities

- Made from concrete
  - Concrete unit is impervious
  - Can be basically any color, just like concrete
- Form hard, yet permeable surfaces to prevent erosion
- Design and installation of the base is critical to performance of the pavement surface
  - Compaction
  - Geofabrics
- Stone base can be used to handle stormwater (including run-on) via soil infiltration

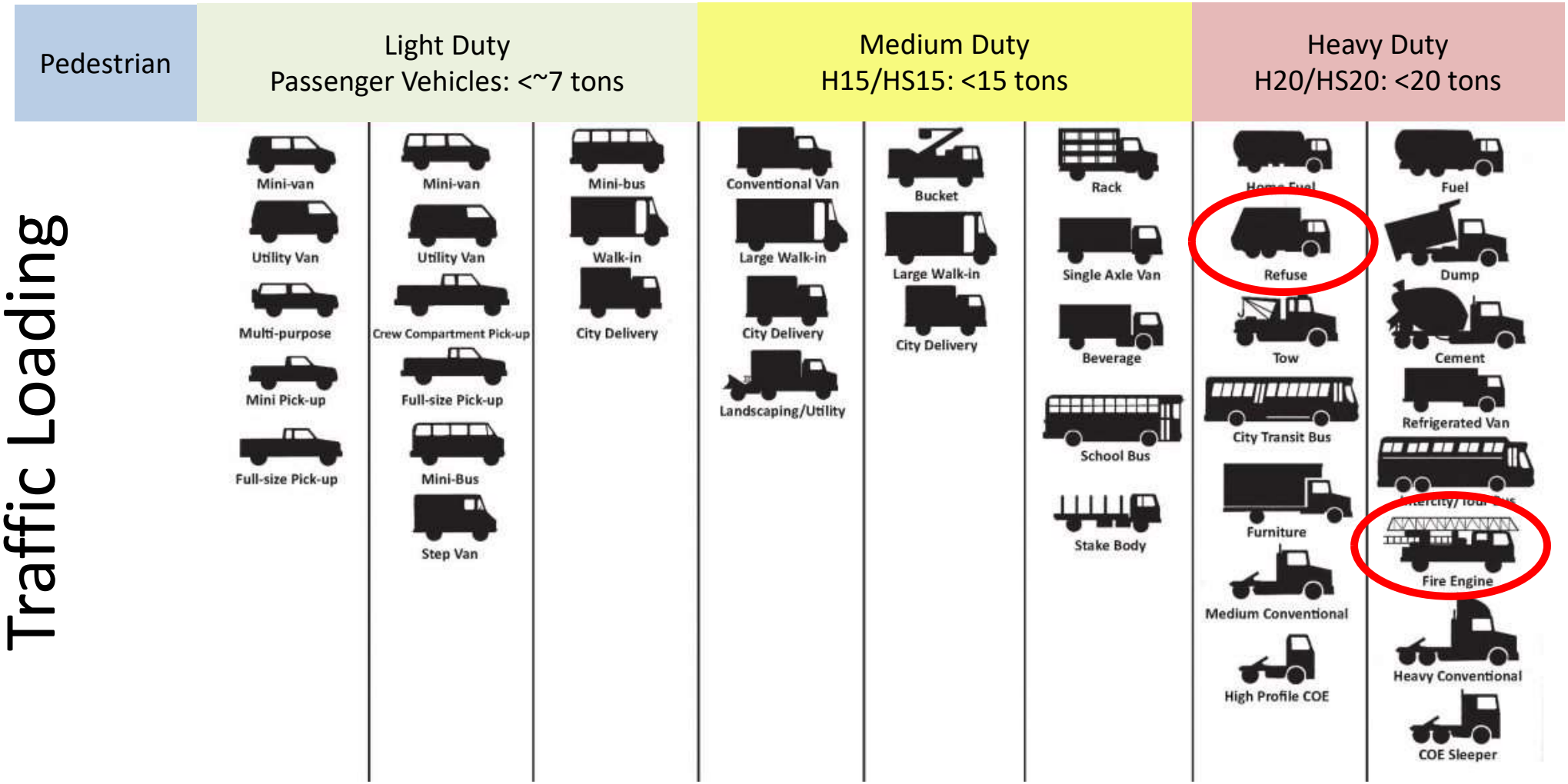
P-ACB and Pavers: Differences

	P-ACB	Pavers
Governing ASTM Standard	D6684	C936
Joints	Open	Filled
Interlocked	Yes	Sometimes
Bedding	57 Stone	89 Stone

Impact of Differences

- Strength
- Cost
- Performance
- Maintenance
- Use

Traffic Loading



The P-ACB Difference: HEAVY Applications

Permeable Roadway Options with P-ACBs

INSTALLATION OF P-ACB

Ideal Installation Sequence

1. Plan out the system
2. Place and compact the base (including geofabrics)
3. Place the blocks
   - Blocks can be cut to fit curves
   - Use half blocks to create the edge of a form (recommended)
4. Place and pave asphalt/concrete
   - No need for ribbon curbs

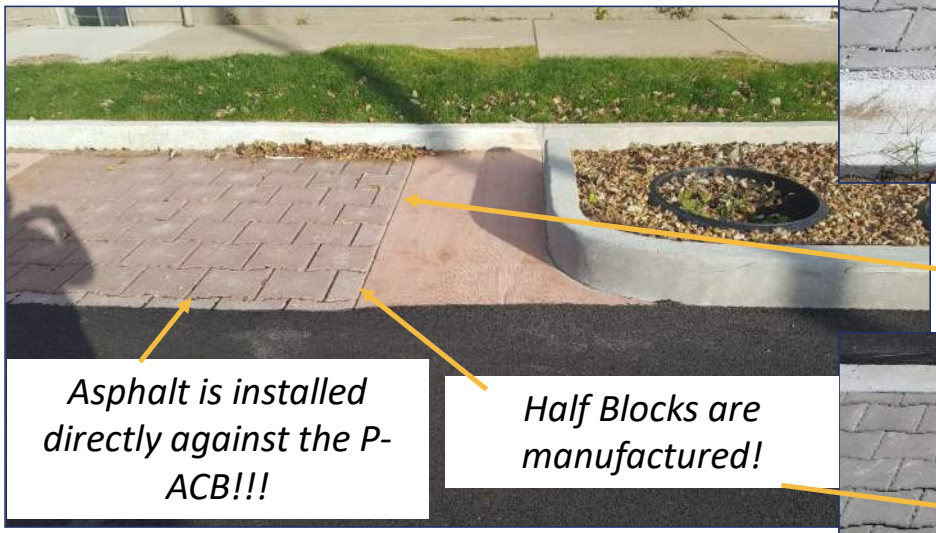
The P-ACB System: Machine Lay Installation

Exponentially easier, faster and cheaper to POUR concrete on a curve than cut and install individual P-ACB.

P-ACB is its OWN Form… BEFORE

AFTER

NOTE: Expansion Joint is up to the EOR/Designer



Asphalt is installed directly against the P-ACB!!!

Half Blocks are manufactured!

MINIMAL BLOCK CUTTING

The P-ACB System: Installation Benefits

Green Infrastructure

Green Infrastructure was $105,000 LESS than traditional infrastructure

- NO inlets
- NO Ribbon Curb
- Sanitary Pipe Only
- Easily Repaired
- *Asphalt lasting longer…?*

Traditional Infrastructure

- 20 Inlets $3500 Ea. ✕
- Storm PIPE ✕
- Detention POND(s) ✕
- Faster Asphalt Deterioration
- More Maintenance?!?!

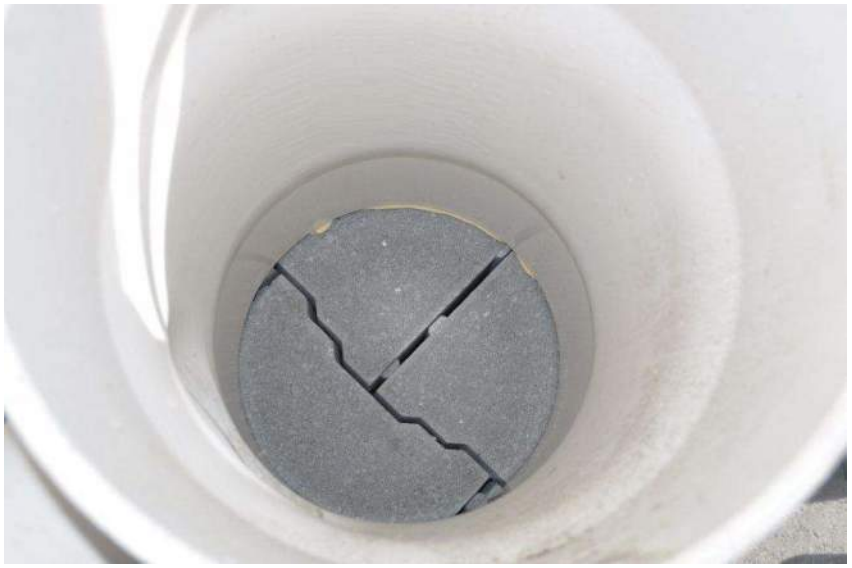
PERFORMANCE AND MAINTENANCE OF P-ACB

Usually the bane of stormwater BMPs

P-ACB System: Infiltration Demonstration

The P-ACB System: Infiltration Demonstration

Permeable Surface Infiltration Rate Comparison



1,640 in/hr

Open Joints = High Infiltration Rates

Table 1: Summary of Infiltration Rates Tested of Various Surfaces

Surface Material	Infiltration rate (in/hr)	Mass of infiltrated water (lb)	Diameter of infiltration ring (in)	Time (sec)
P-ACB	1,640	40.0	12.187	19.53/18.42/24.53
Porous pavers	3.2	2.54	12.187	683
Porous concrete	2.4	3.80	12.187	1,380
Porous asphalt	3.1	5.58	12.187	1,515

ASTM C1701/C1781: Standard Test Methods Infiltration Rates of In-Place Pervious Concrete

Abuse Test at Univ. of Central FL

Brought back to 90+% of original infiltration rate

Thank You

Dr. Aaron Fisher PhD

VP of Business Development

PAVE DRAIN

afisher@emcoblock.com

(202) 510-5545

pavedrain.com

PAVE DRAIN®

STORMWATER'S ARCH ENEMY

P4 INFRASTRUCTURE

Permeable Pavement Systems Clean Water Faster and for Less Money

April 27, 2022

Joseph Diekfuss, PhD, PE
VP - Engineered Systems

P4 Infrastructure www.p4i.io 414-877-0620

Products for Public Private Partnerships

Design

$$ ⬇

⬆

Construction

$$ ⬇

Operations

$$ ⬇

Maintenance

$$ ⬇

Infrastructure As A Service

Performance Payments → **Data-Driven Turnover**

Stormwater & Groundwater Exchanges
(volume & pollutant)

 © P4 Infrastructure, Inc.

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P4 DEVICES

Rain mX

LIQUA-Level

INFIL-Tracker

PRESS

Flow-RTC

 © P4 Infrastructure, Inc.

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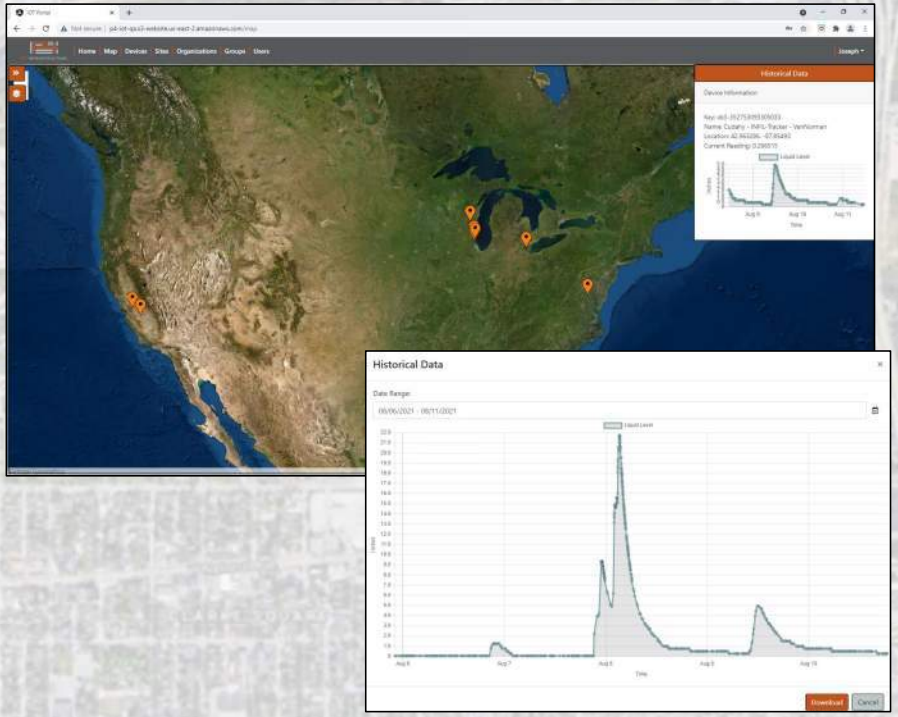
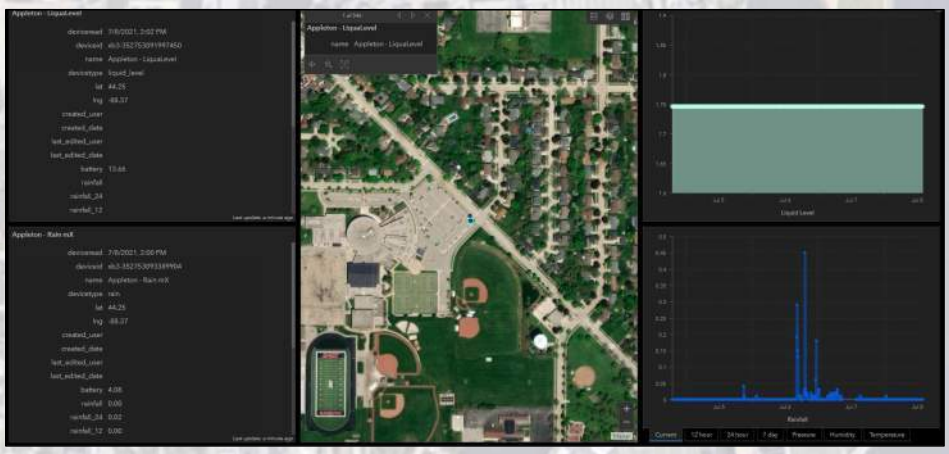
P4 Dashboard

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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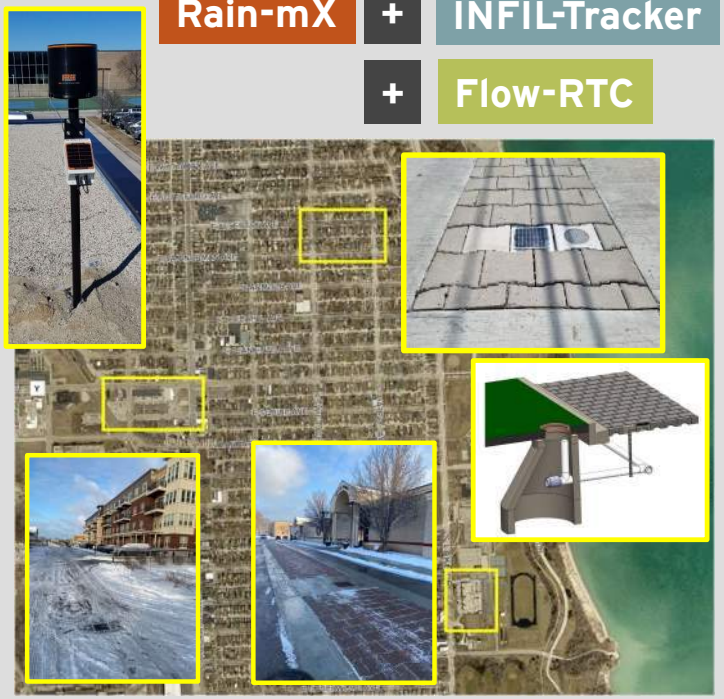
REDUCED INFRASTRUCTURE SPENDING: CUDAHY CASE STUDY

CUDAHY
EST. 1906

Rain-mX + INFIL-Tracker + Flow-RTC



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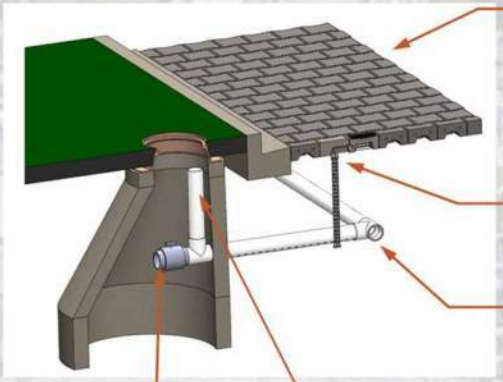
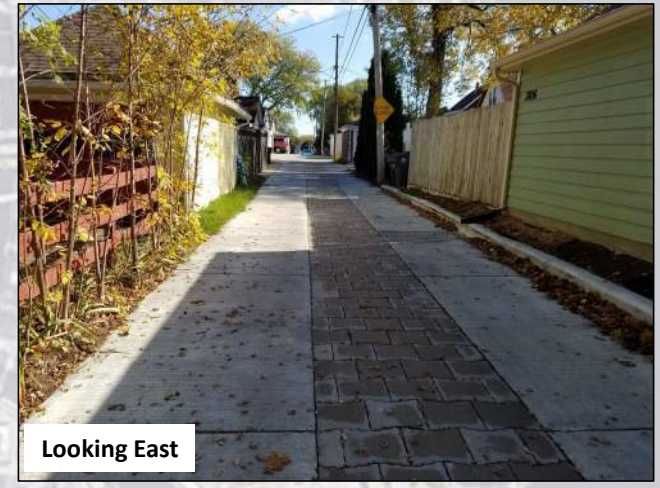
VAN NORMAN ALLEY - CUDAHY, WI





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Tech Standards/Guidance
(WI DNR)

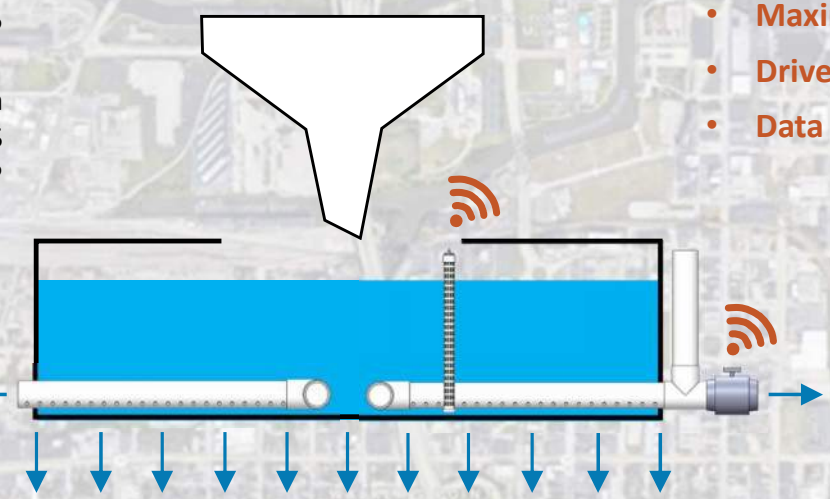
Pollutant Removal Efficiency

Underdrain Present
65% TSS
35% TP

No Underdrain
100% TSS
100% TP

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

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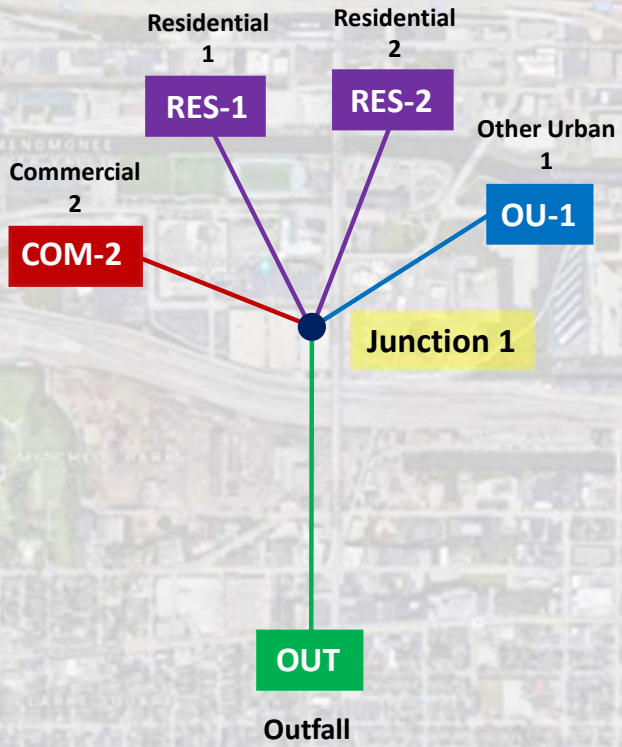
Source Load and Management Model



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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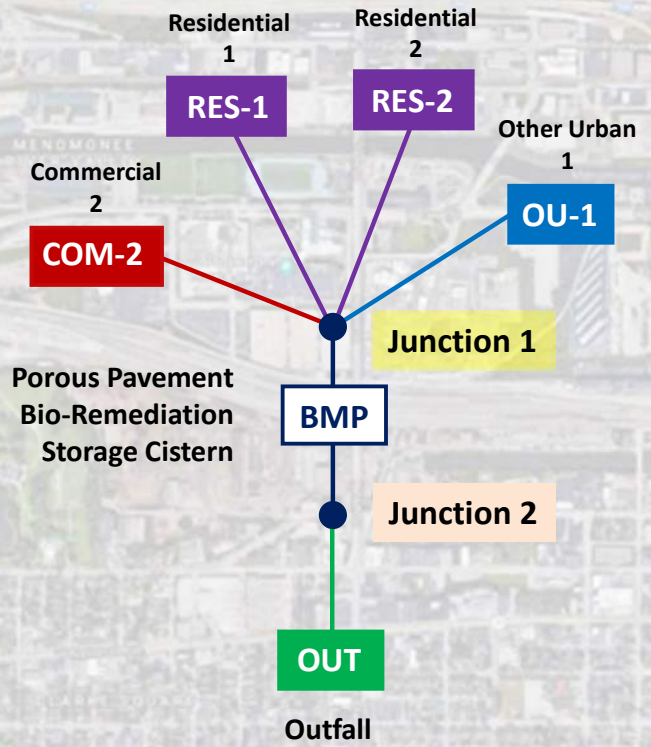
Source Load and Management Model



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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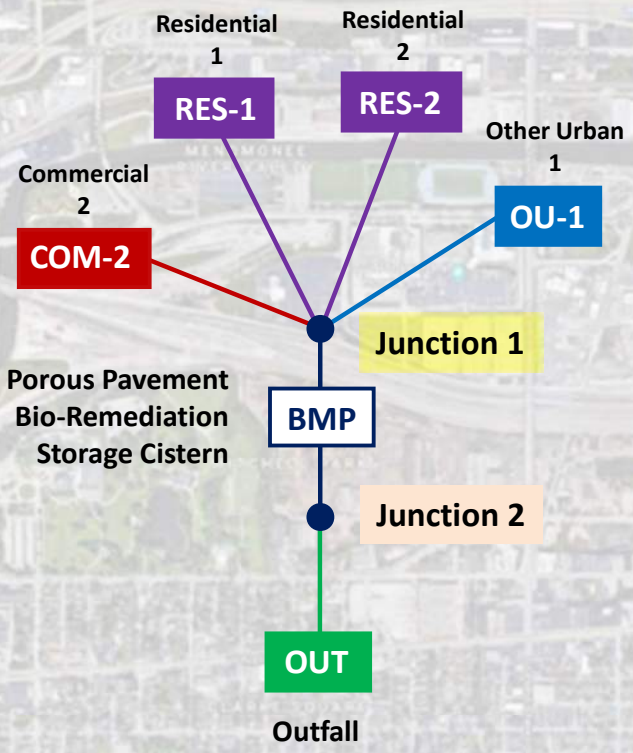
Source Load and Management Model



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. 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 %

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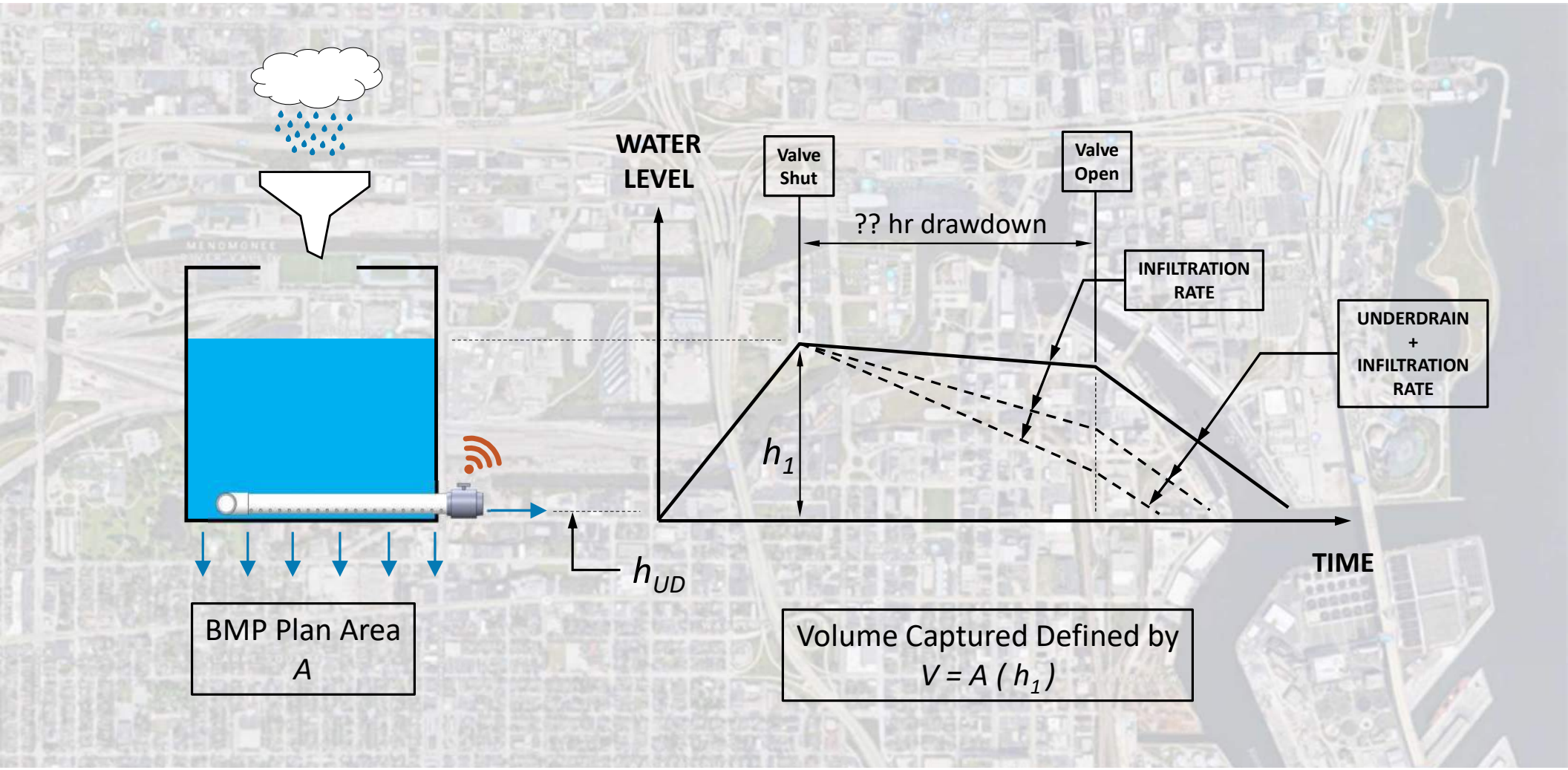

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REGULATORY BODY APPROVAL

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

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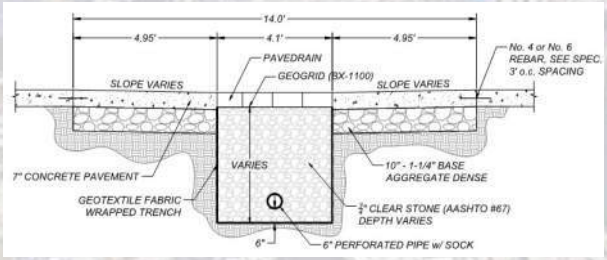
Van Norman Alley
Cudahy, Wisconsin



Garbage Truck Traffic – Permeable Strip (ACB)

Alley receives topographic runoff.

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

 © P4 Infrastructure, Inc.

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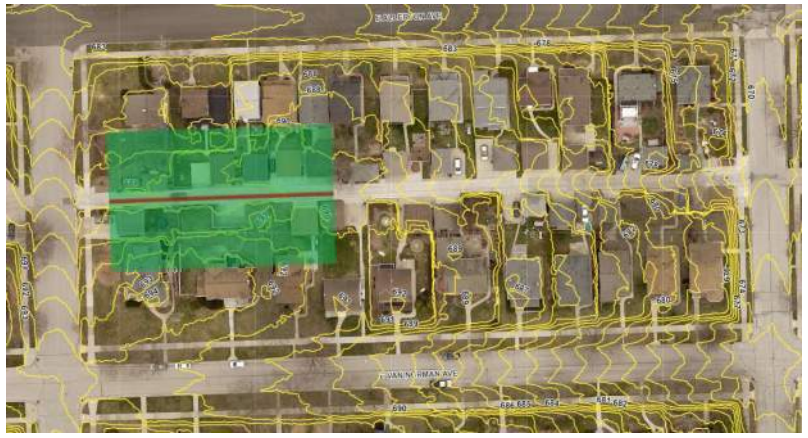
Hydrology *driven by* **Topography**

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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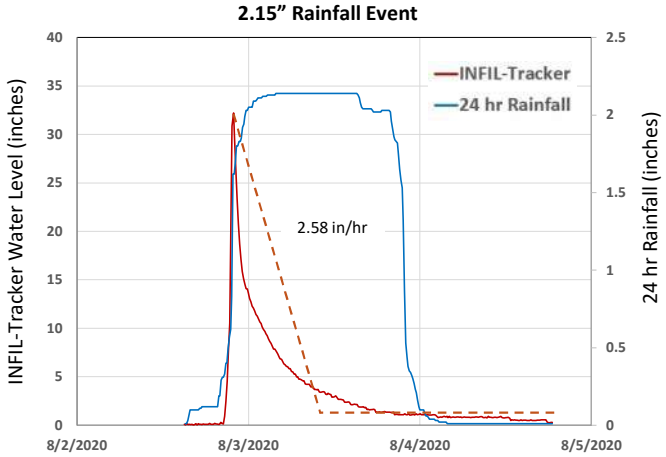
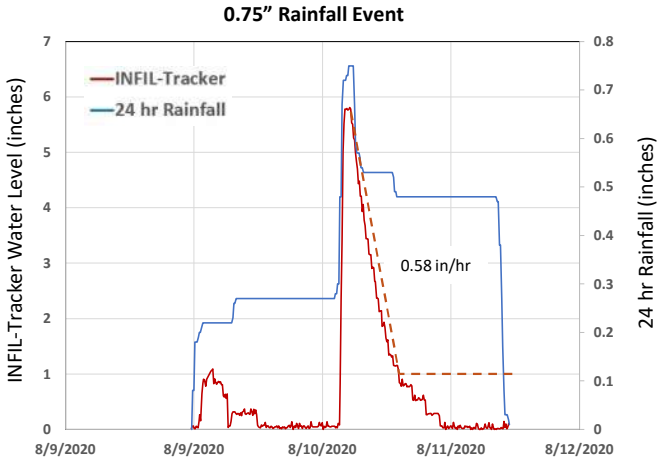
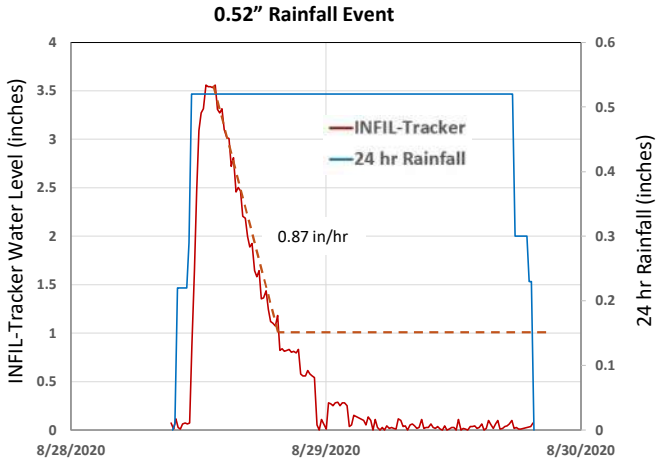
P4 INFRASTRUCTURE

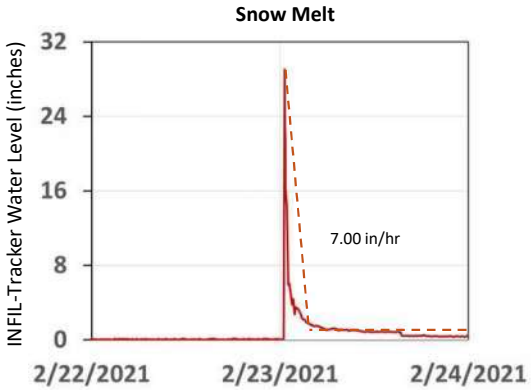




Avg. = 1.34 in/hr
(without snow melt)

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





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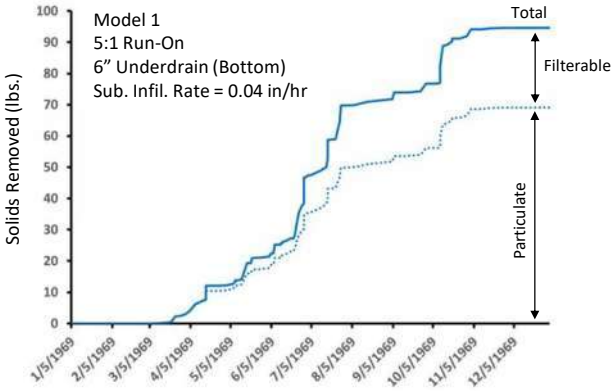
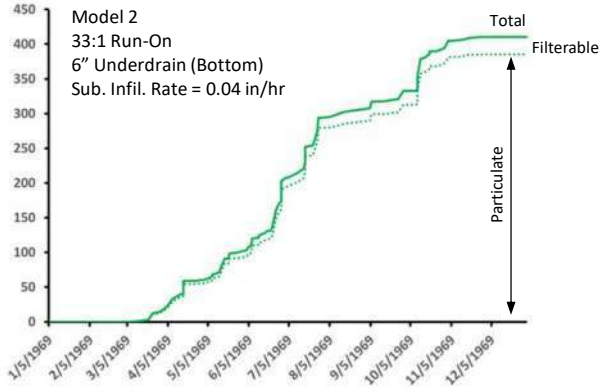
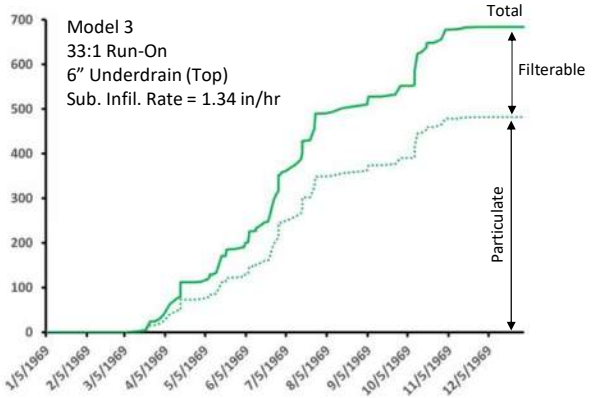


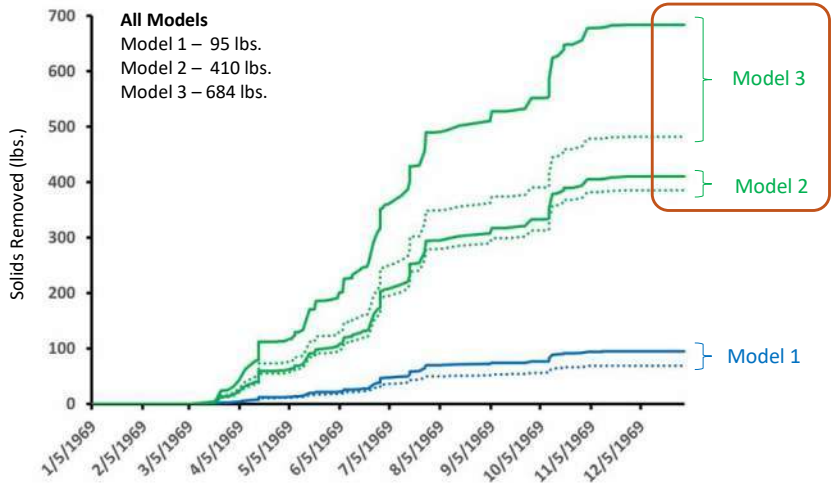




Permeable Pavement
846.7 ft²

5:1 Run-on Drainage Area
4,233 ft²

33:1 Run-on Drainage Area
27,939 ft²

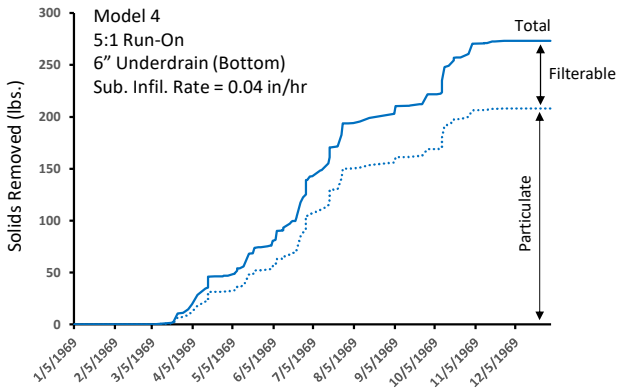


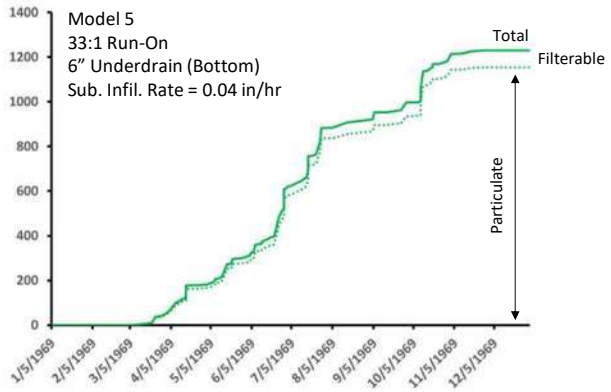
IMPACT of P4 Systems (INFIL-Tracker & Flow-RTC)

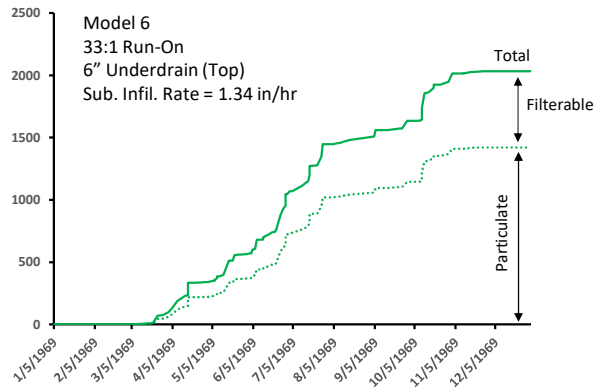
67% increase in solids removed.

© P4 Infrastructure, Inc.

P4 INFRASTRUCTURE



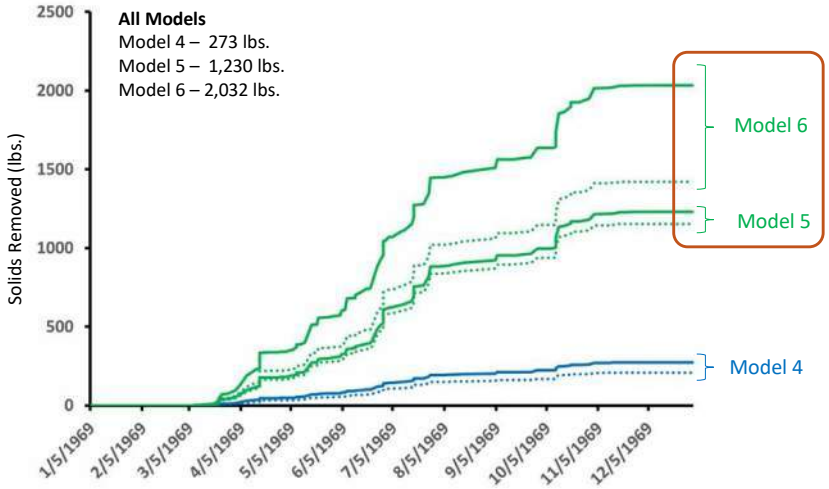




Permeable Pavement
2,538 ft²

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.

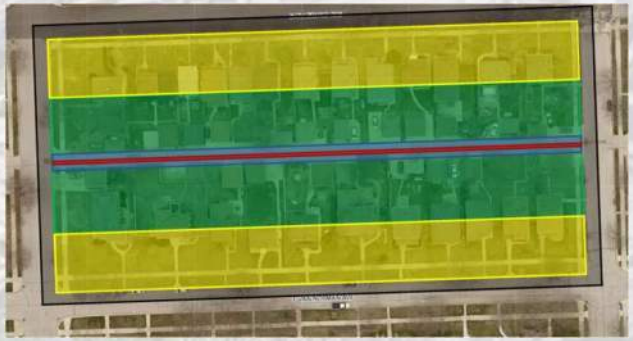
© P4 Infrastructure, Inc.

P4 INFRASTRUCTURE

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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P4 INFRASTRUCTURE

Thank You

P4 INFRASTRUCTURE

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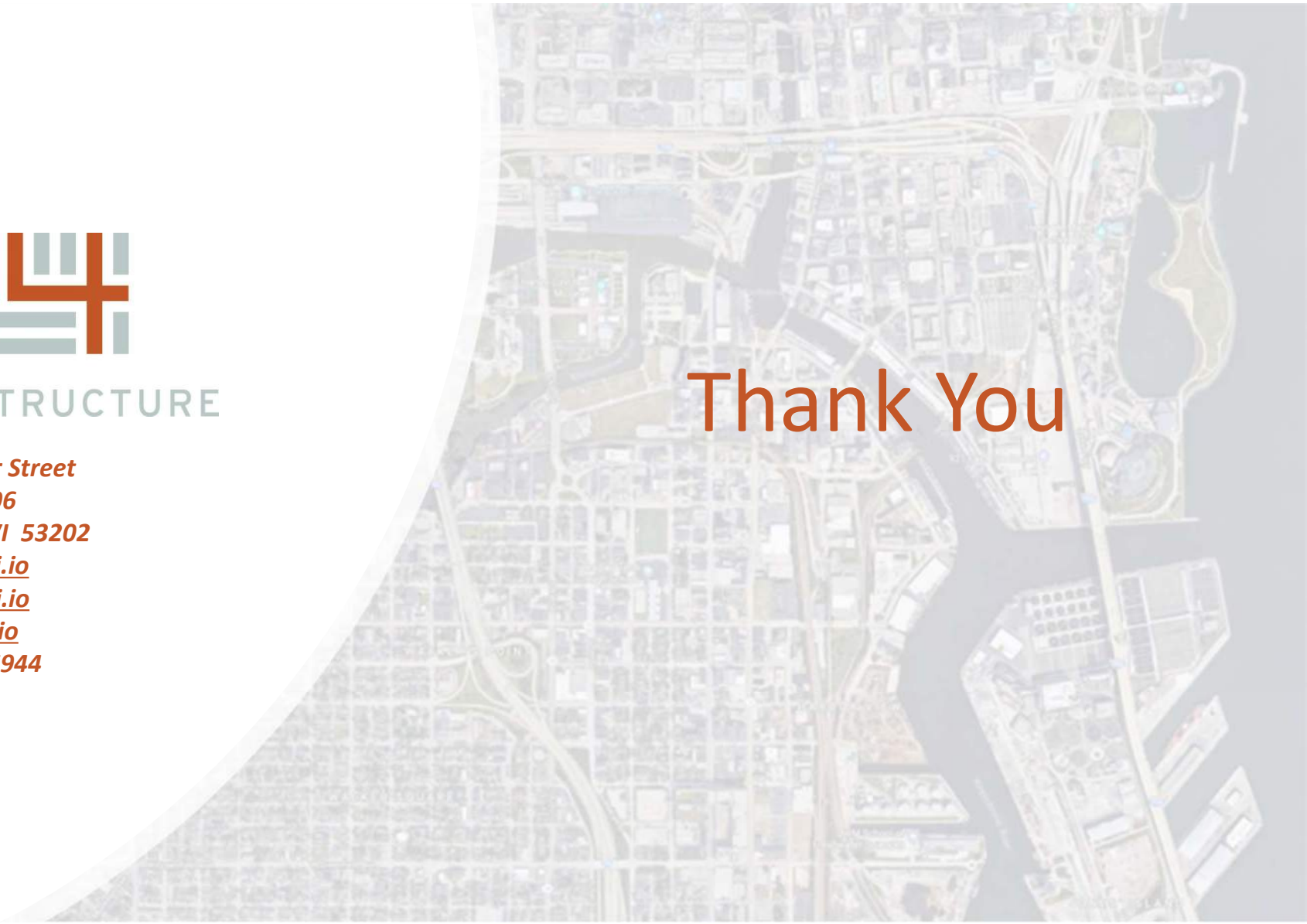

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Expect More. Experience Better.

PAVE DRAIN

STORMWATER'S ARCH ENEMY

Presented by

Matthew Gillespie, P.E.

PAVE DRAIN
STORMWATER'S ARCH ENEMY

- Fashion Square Shoppes Redevelopment Orlando, FL
- Thousand Trails RV Resort, Clermont, FL
- Tropical Palms RV Resort, Kissimmee, FL

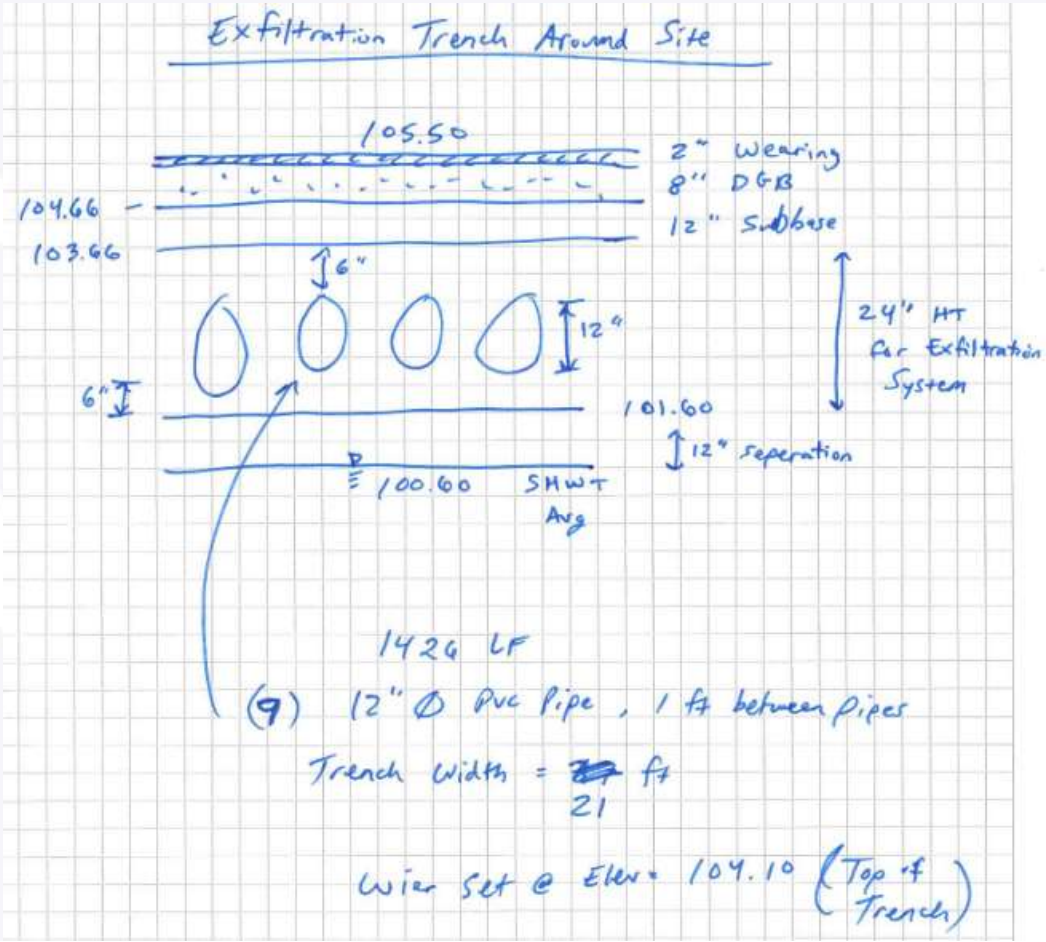
Fashion Square Shoppes

Project Challenges

- Redevelop the old Sears area into a new shopping center
- Bring site up to current parking code and drainage standards
- SJRWMD/City of Orlando/FDOT Jurisdictions
- High water table
- Limited Construction Extents
- Match Existing Surrounding Grades
- Match Existing Storm Sewer Pipe Outfall
- Existing Flooding Problems along Colonial Drive

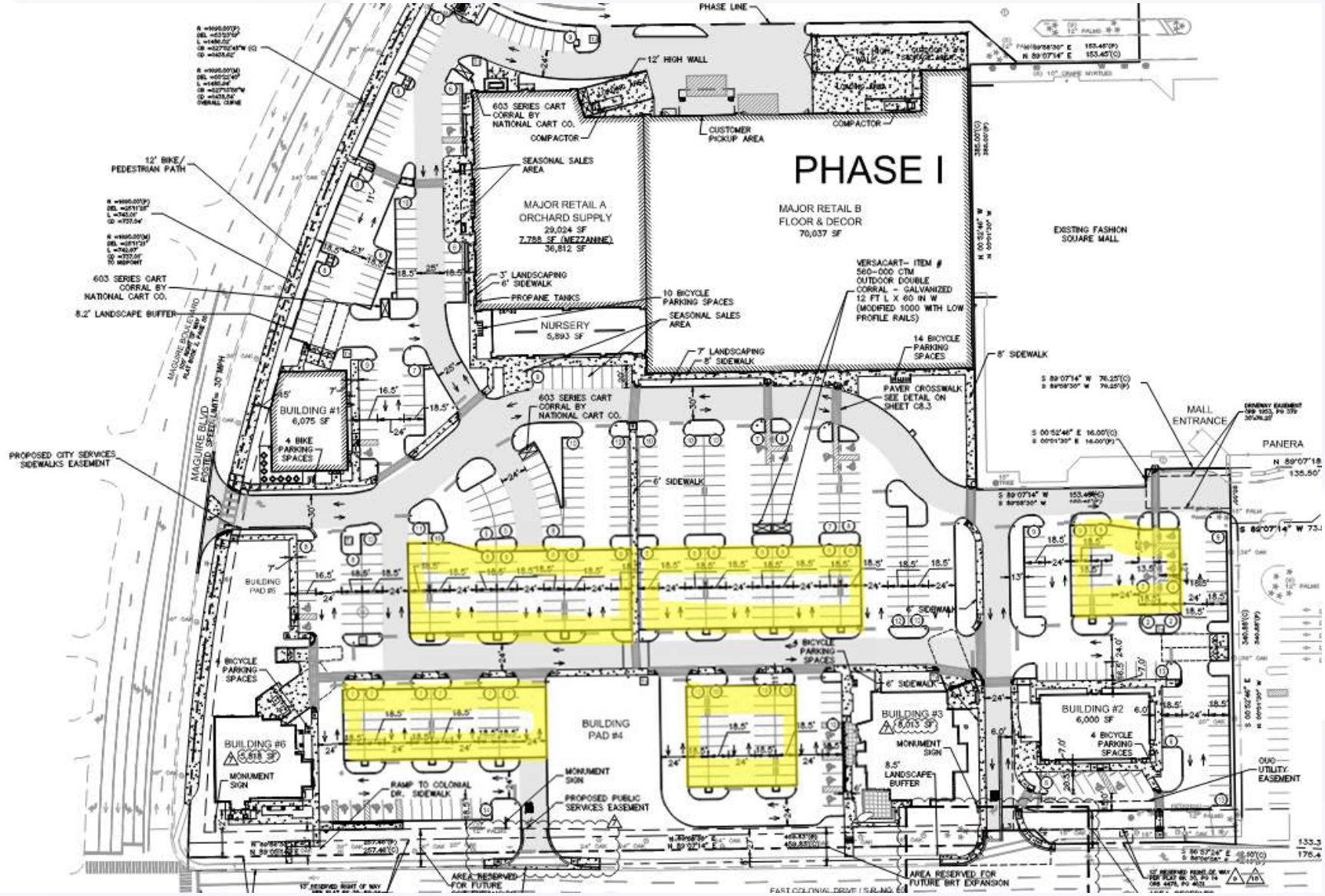
Typical Underground Detention Options Explored First

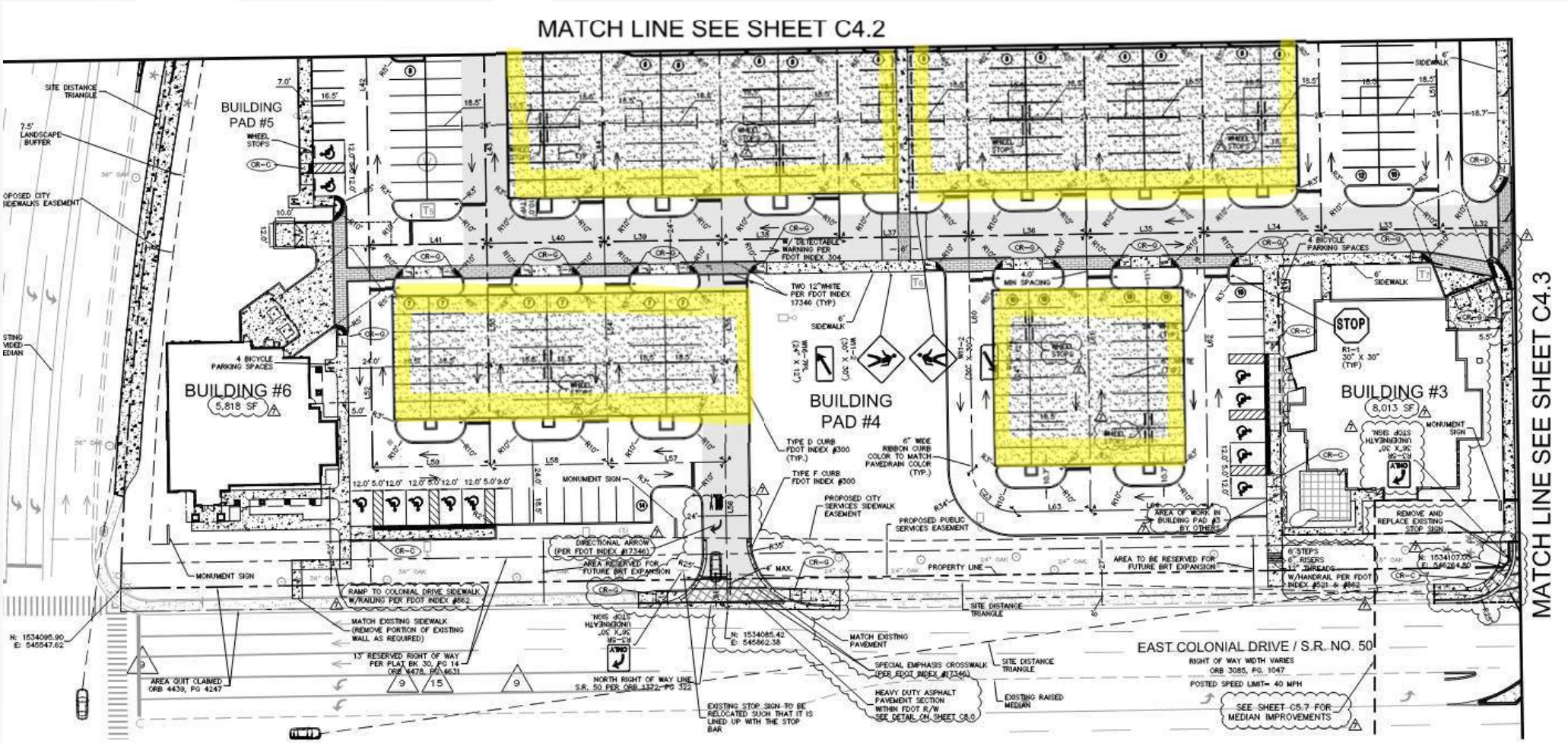
- Explored perforated pipes and StormTech Chambers to compare costs/options
- High water table resulted in minimal storm pipe storage above water table and large flooding on parking areas
- 0.90 Ac-Ft of Treatment Volume Needed
- Site would have to be raised to a minimum elevation of 105.50 with the FFE of adjacent buildings at 106.0 leaving no room for flooding during larger events
- System failed to meet SJRWMD recovery criteria for treatment volume
- Needed to elevate the storage volume higher above the water table and reduce the costs of the storm sewer detention system



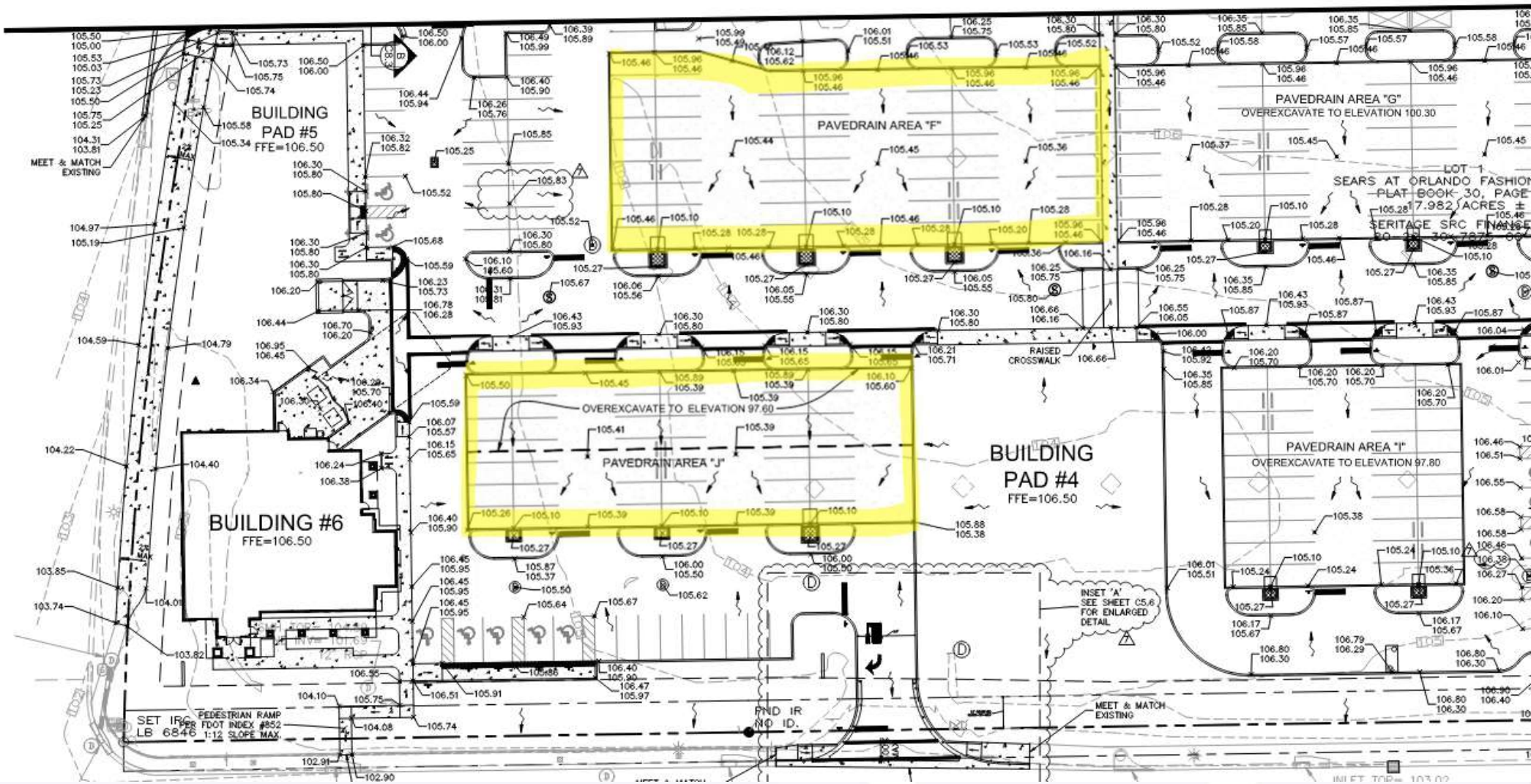
Solution: PaveDrain

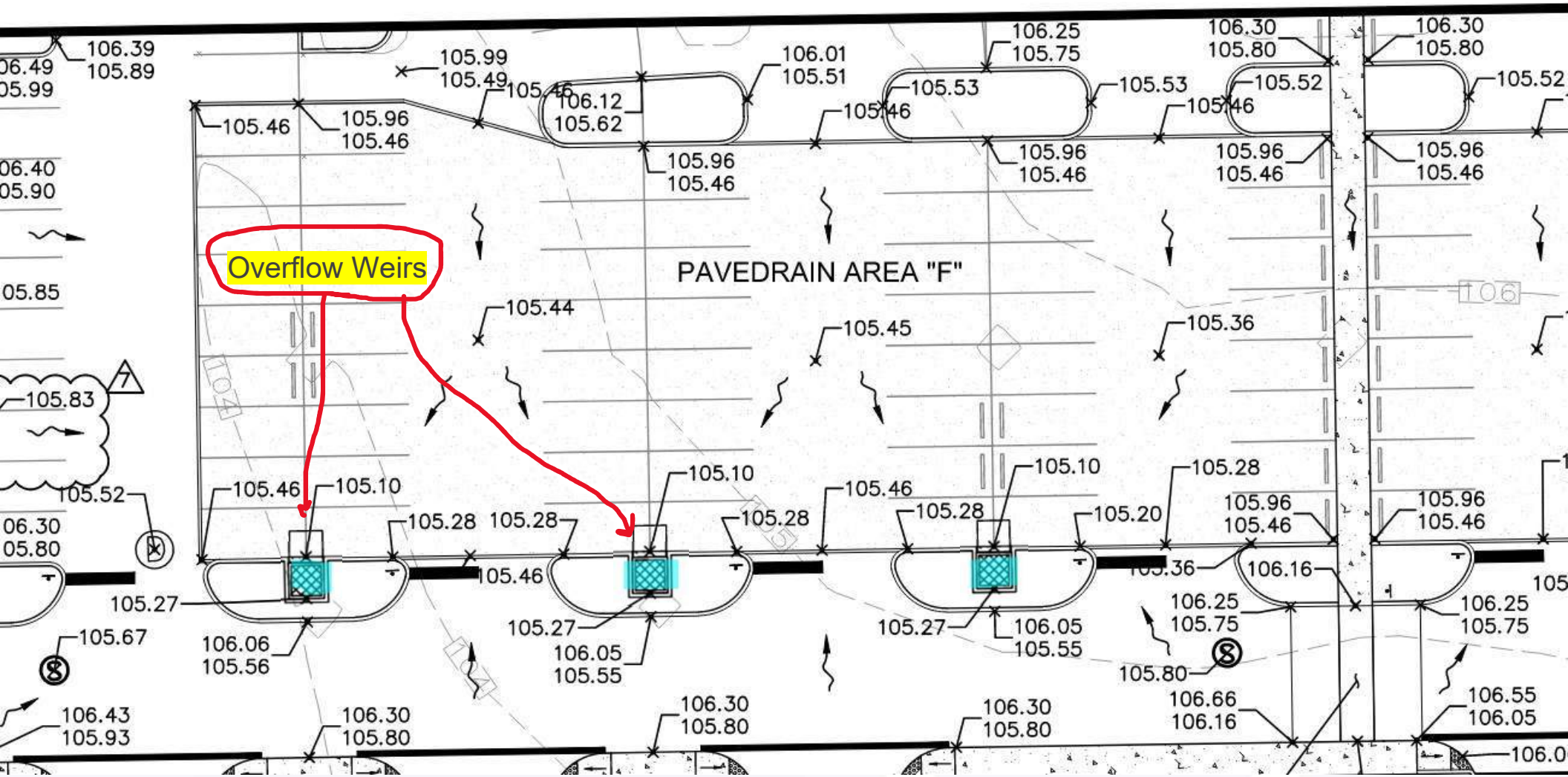
- PaveDrain 5.6” Block
- Geogrid
- 6” #57 Stone
- 18” #2 Stone
- Filter Fabric
- Existing Ground

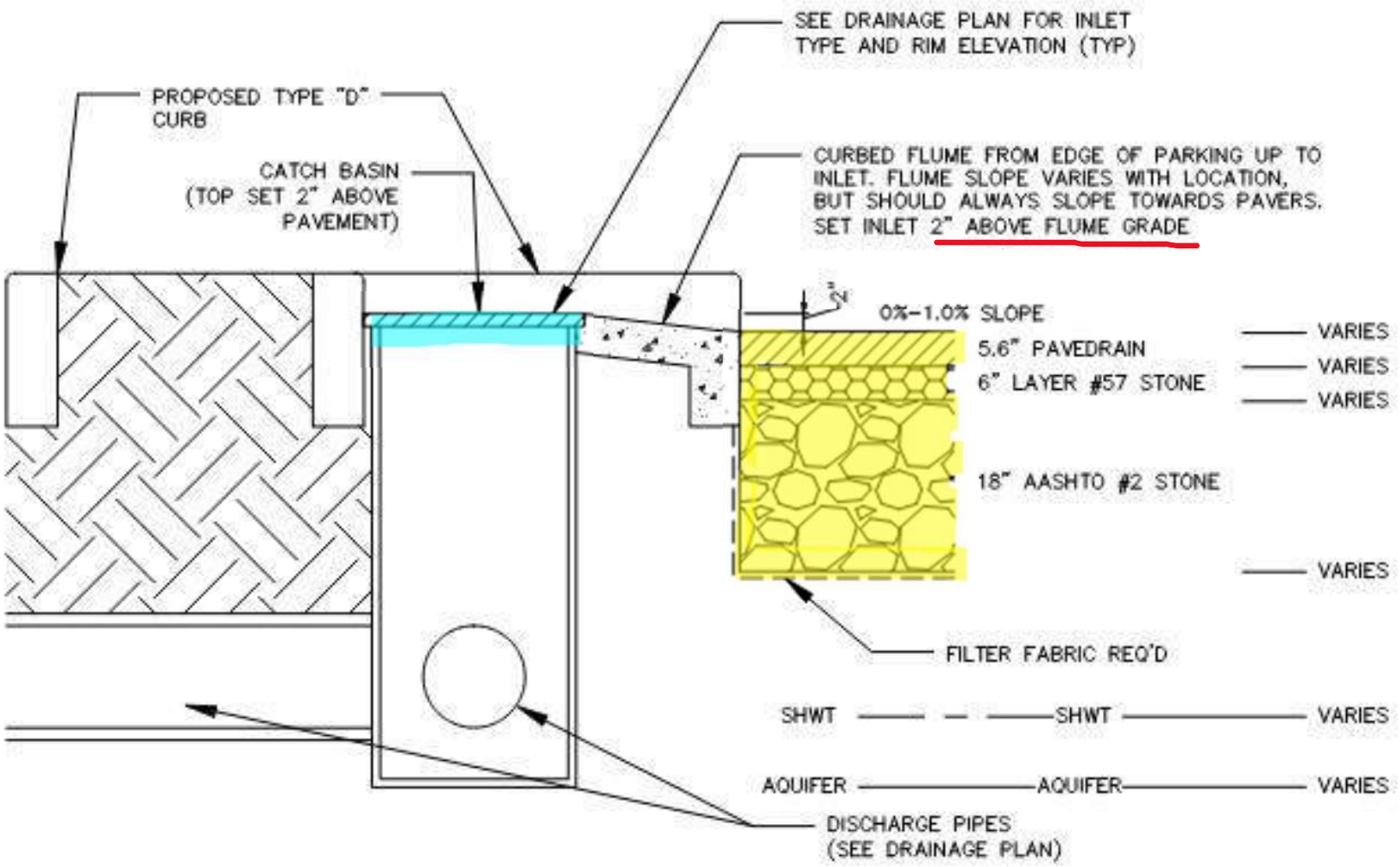

PHASE I
PHASE LINE
12' HIGH WALL
603 SERIES CART CORRAL BY NATIONAL CART CO.
COMPACTOR
CUSTOMER PICKUP AREA
SEASONAL SALES AREA
MAJOR RETAIL A
ORCHARD SUPPLY
29,024 SF
7,788 SF (MEZZANINE)
36,812 SF
MAJOR RETAIL B
FLOOR & DECOR
70,037 SF
EXISTING FASHION SQUARE MALL
12' BIKE/ PEDESTRIAN PATH
603 SERIES CART CORRAL BY NATIONAL CART CO.
8.2' LANDSCAPE BUFFER
3' LANDSCAPING
6' SIDEWALK
PROPANE TANKS
10 BICYCLE PARKING SPACES
NURSERY
5,893 SF
VERSACART- ITEM # 560-000 CTM OUTDOOR DOUBLE CORRAL - GALVANIZED 12 FT L X 60 IN W (MODIFIED 1000 WITH LOW PROFILE RAILS)
14 BICYCLE PARKING SPACES
7' LANDSCAPING
8' SIDEWALK
PAVER CROSSWALK SEE DETAIL ON SHEET C8.3
MAGUIRE BOULEVARD
POSTED SPEED LIMIT= 30 MPH
BUILDING #1
6,075 SF
4 BIKE PARKING SPACES
PROPOSED CITY SERVICES SIDEWALKS EASEMENT
MALL ENTRANCE
PANERA
BUILDING PAD #5
BICYCLE PARKING SPACES
BUILDING PAD #4
BUILDING #6
6,618 SF
MONUMENT SIGN
RAMP TO COLONIAL DR. SIDEWALK
PROPOSED PUBLIC SERVICES EASEMENT
BUILDING #3
6,013 SF
8.5' LANDSCAPE BUFFER
BUILDING #2
6,000 SF
4 BICYCLE PARKING SPACES
OUC UTILITY EASEMENT
AREA RESERVED FOR FUTURE BRT EXPANSION
AREA RESERVED FOR FUTURE
EAST COLONIAL DRIVE / S.R. NO. 50

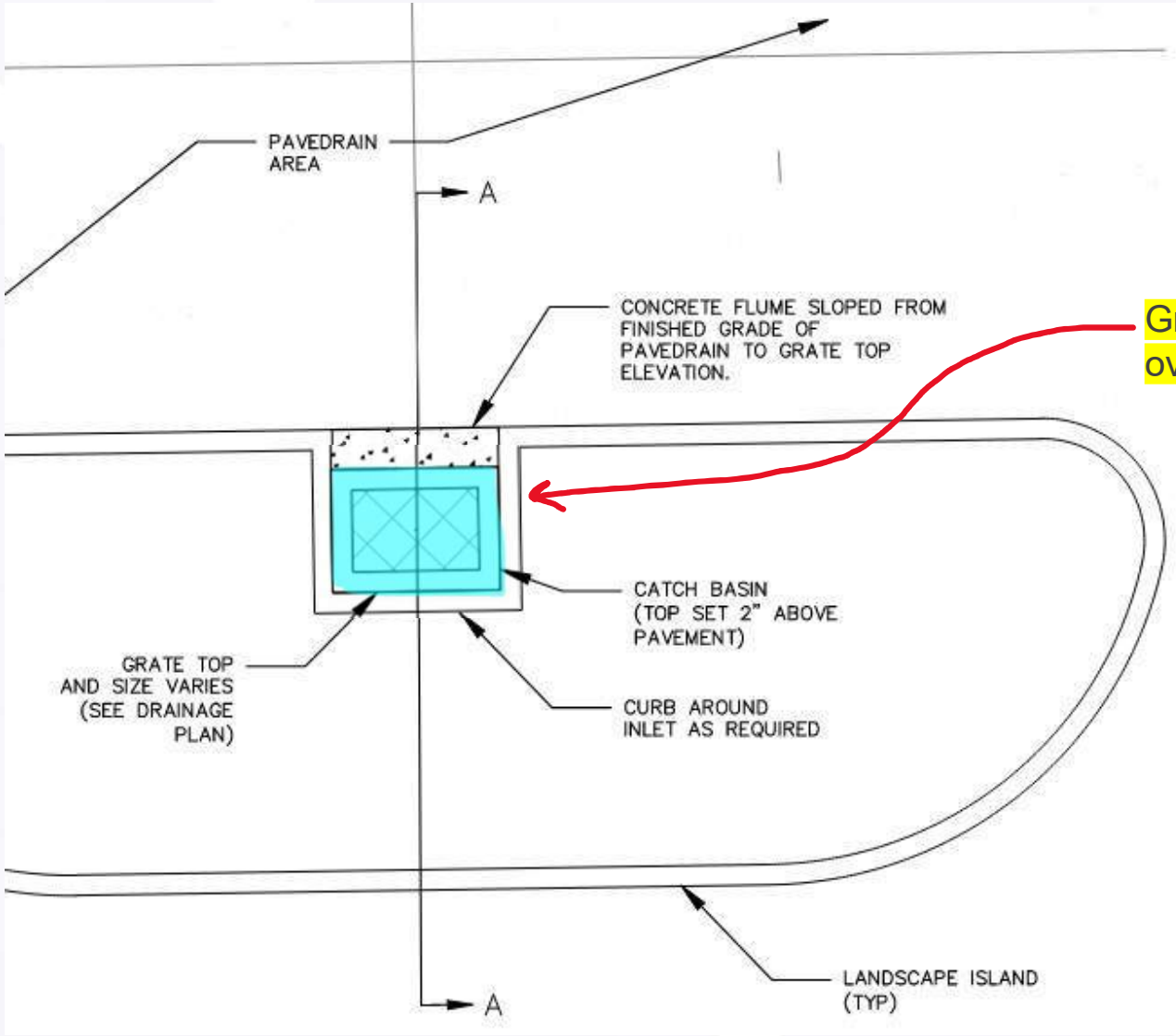

MATCH LINE SEE SHEET C4.2
MATCH LINE SEE SHEET C4.3
BUILDING PAD #5
BUILDING #6
5,818 SF
BUILDING PAD #4
BUILDING #3
8,013 SF
SITE DISTANCE TRIANGLE
7.5' LANDSCAPE BUFFER
WHEEL STOPS
4 BICYCLE PARKING SPACES
TWO 12" WHITE PER FDOT INDEX 17346 (TYP)
6' SIDEWALK
W/ DETECTABLE WARNING PER FDOT INDEX 304
TYPE D CURB FDOT INDEX #300 (TYP.)
TYPE F CURB FDOT INDEX #300
6" WIDE RIBBON CURB COLOR TO MATCH PAVEDRAIN COLOR (TYP.)
MONUMENT SIGN
PROPOSED CITY SERVICES SIDEWALK EASEMENT
PROPOSED PUBLIC SERVICES EASEMENT
AREA OF WORK IN BUILDING PAD #3 BY OTHERS
AREA TO BE RESERVED FOR FUTURE BRT EXPANSION
DIRECTIONAL ARROW (PER FDOT INDEX #17346)
RAMP TO COLONIAL DRIVE SIDEWALK W/RAILING PER FDOT INDEX #862
MATCH EXISTING SIDEWALK (REMOVE PORTION OF EXISTING WALL AS REQUIRED)
13' RESERVED RIGHT OF WAY PER PLAT BK 30, PG 14 ORB 4478, PG 4631
AREA QUIT CLAIMED ORB 4439, PG 4247
NORTH RIGHT OF WAY LINE S.R. 50 PER ORB 1372, PG 322
EXISTING STOP SIGN TO BE RELOCATED SUCH THAT IT IS LINED UP WITH THE STOP BAR
MATCH EXISTING PAVEMENT
SPECIAL EMPHASIS CROSSWALK (PER FDOT INDEX #17346)
HEAVY DUTY ASPHALT PAVEMENT SECTION WITHIN FDOT R/W SEE DETAIL ON SHEET C8.0
EXISTING RAISED MEDIAN
EAST COLONIAL DRIVE / S.R. NO. 50
RIGHT OF WAY WIDTH VARIES ORB 3085, PG. 1047
POSTED SPEED LIMIT= 40 MPH
SEE SHEET C5.7 FOR MEDIAN IMPROVEMENTS
STOP
R1-1 30" X 30" (TYP)
6 STEPS 6" RISERS 12" TREADS W/HANDRAIL PER FDOT INDEX #521 & #862
REMOVE AND REPLACE EXISTING STOP SIGN
N: 1534095.90 E: 545547.62
N: 1534085.42 E: 545862.38
N: 1534107.05 E: 546264.50

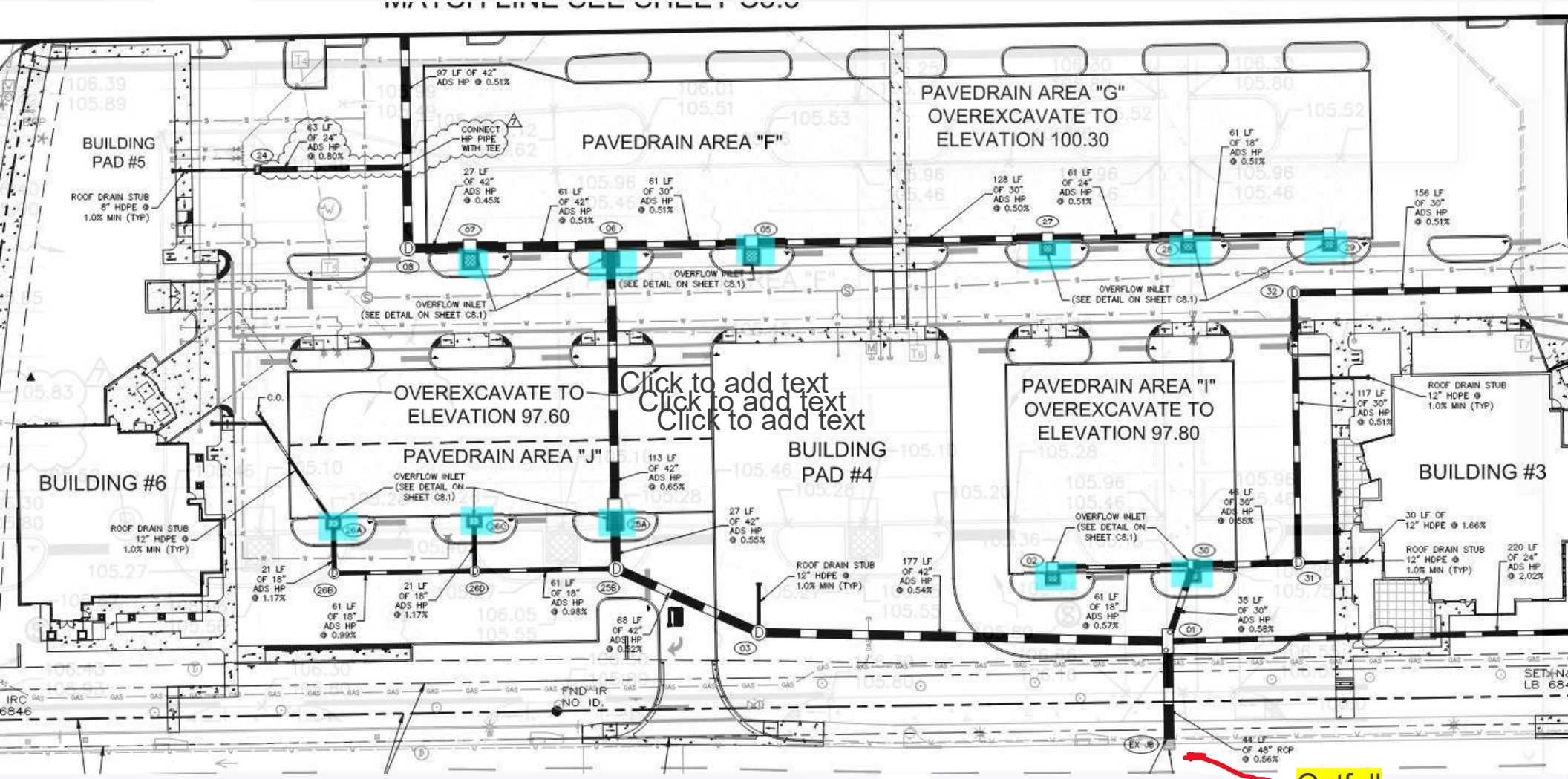
MATCH LINE SEE SHEET C5.0




Overflow Weirs
PAVEDRAIN AREA "F"
106.39
105.89
105.99
105.49
106.01
105.51
106.25
105.75
106.30
105.80
105.46
105.96
105.46
106.12
105.62
105.53
105.52
105.44
105.45
105.36
105.83
105.10
105.28
105.20
106.16
105.27
106.06
105.56
106.05
105.55
105.67
106.43
105.93
106.30
105.80
106.66
106.16
106.55
106.05


SEE DRAINAGE PLAN FOR INLET TYPE AND RIM ELEVATION (TYP)
PROPOSED TYPE "D" CURB
CATCH BASIN (TOP SET 2" ABOVE PAVEMENT)
CURBED FLUME FROM EDGE OF PARKING UP TO INLET. FLUME SLOPE VARIES WITH LOCATION, BUT SHOULD ALWAYS SLOPE TOWARDS PAVERS. SET INLET 2" ABOVE FLUME GRADE
2"
0%-1.0% SLOPE
5.6" PAVEDRAIN
6" LAYER #57 STONE
18" AASHTO #2 STONE
VARIES
VARIES
VARIES
VARIES
FILTER FABRIC REQ'D
SHWT
SHWT
VARIES
AQUIFER
AQUIFER
VARIES
DISCHARGE PIPES (SEE DRAINAGE PLAN)


PAVEDRAIN
AREA
A
CONCRETE FLUME SLOPED FROM
FINISHED GRADE OF
PAVEDRAIN TO GRATE TOP
ELEVATION.
Grates Modeled as
overflow weirs
CATCH BASIN
(TOP SET 2" ABOVE
PAVEMENT)
GRATE TOP
AND SIZE VARIES
(SEE DRAINAGE
PLAN)
CURB AROUND
INLET AS REQUIRED
LANDSCAPE ISLAND
(TYP)
A



Click to add text
Click to add text
Click to add text


STOP

Benefits of PaveDrain

- All PaveDrain areas have been assigned a CN of 47 per the study published in the June 2010 ASCE Journal of Hydrologic Engineering. This is lower runoff as compared to the traditional CN of 98 for paved surfaces.
- Works well in areas of high water tables
- Provides Water Quality Treatment
- H-20 Load rated
- Gap distance in blocks meets ADA standards
- Reduces Pavement Costs
- Geogrid prevents single block settling/pot holing
- KH's view is not exceed a 2:1 ratio of drainage basin area to PaveDrain Area

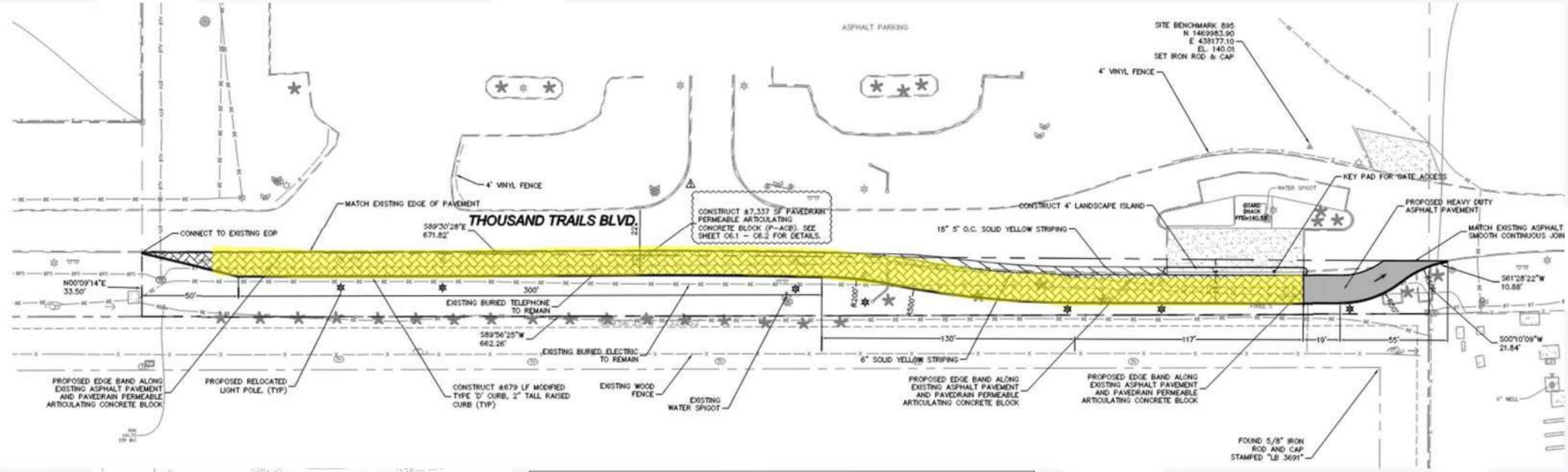
Thousand Trails RV Resort

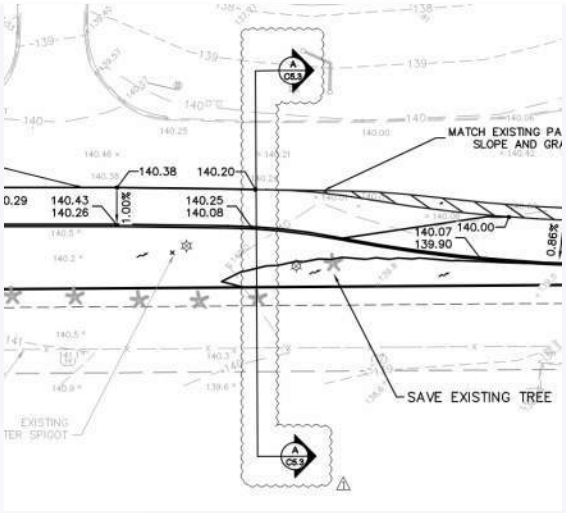
Project Challenges

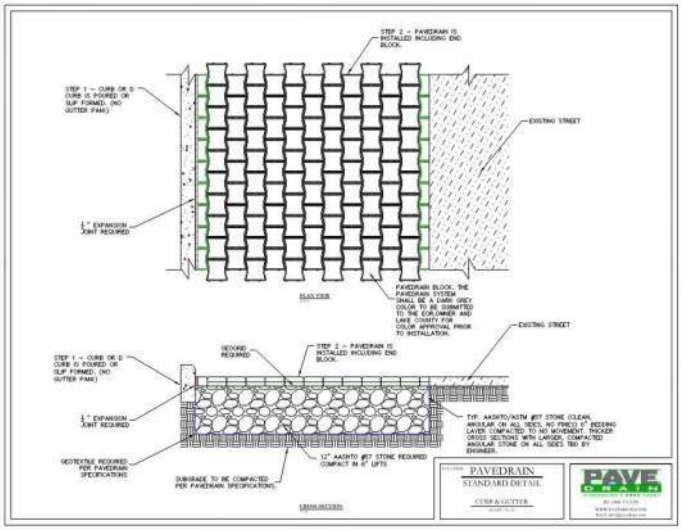
- No room for a stormwater pond
- No storm sewer pipe outfall
- SJRWMD/Lake County Jurisdictions
- Heavy RV Traffic
- Large Queue Lines full of heavy RV’s
- Pre vs. Post Runoff Had to be met
- Water Quality had to be provided

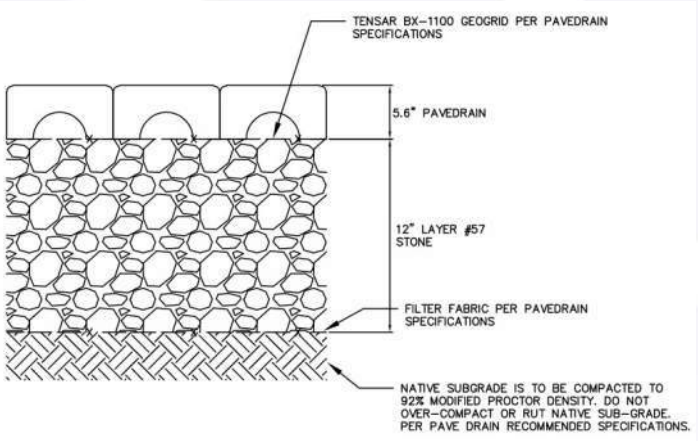
Solution: PaveDrain

- PaveDrain 5.6” Block
- Geogrid
- 12” #57 Stone
- Filter Fabric
- Existing Ground


ASPHALT PARKING
SITE BENCHMARK 895
N 1469983.90
E 438177.10
EL. 140.01
SET IRON ROD & CAP
4' VINYL FENCE
KEY PAD FOR GATE ACCESS
CONSTRUCT 4' LANDSCAPE ISLAND
PROPOSED HEAVY DUTY ASPHALT PAVEMENT
MATCH EXISTING ASPHALT SMOOTH CONTINUOUS JOIN
18" 5' O.C. SOLID YELLOW STRIPING
4' VINYL FENCE
MATCH EXISTING EDGE OF PAVEMENT
THOUSAND TRAILS BLVD.
CONNECT TO EXISTING EOP
CONSTRUCT ±7,337 SF PAVEDRAIN PERMEABLE ARTICULATING CONCRETE BLOCK (P-ACB). SEE SHEET C6.1 - C6.2 FOR DETAILS.
S89°30'28"E
671.82'
N00°09'14"E
33.50'
50'
300'
EXISTING BURIED TELEPHONE TO REMAIN
S89°56'25"W
662.26'
EXISTING BURIED ELECTRIC TO REMAIN
CONSTRUCT ±679 LF MODIFIED TYPE 'D' CURB, 2" TALL RAISED CURB (TYP)
PROPOSED RELOCATED LIGHT POLE. (TYP)
PROPOSED EDGE BAND ALONG EXISTING ASPHALT PAVEMENT AND PAVEDRAIN PERMEABLE ARTICULATING CONCRETE BLOCK
EXISTING WOOD FENCE
EXISTING WATER SPIGOT
6" SOLID YELLOW STRIPING
130'
117'
19'
55'
S61°28'22"W
10.88'
S00°10'09"W
21.84'
PROPOSED EDGE BAND ALONG EXISTING ASPHALT PAVEMENT AND PAVEDRAIN PERMEABLE ARTICULATING CONCRETE BLOCK
PROPOSED EDGE BAND ALONG EXISTING ASPHALT PAVEMENT AND PAVEDRAIN PERMEABLE ARTICULATING CONCRETE BLOCK
FOUND 5/8" IRON ROD AND CAP STAMPED "LB 3691"


MATCH EXISTING PA
SLOPE AND GR
140.38
140.20
0.29
140.43
140.26
1.00%
140.25
140.08
140.07
139.90
140.00
0.86%
SAVE EXISTING TREE
EXISTING
TER SPIGOT


STEP 2 - PAVEDRAIN IS INSTALLED INCLUDING END BLOCK.
STEP 1 - CURB OR D CURB IS POURED OR SLIP FORMED. (NO GUTTER PAN)
EXISTING STREET
½" EXPANSION JOINT REQUIRED
PAVEDRAIN BLOCK. THE PAVEDRAIN SYSTEM SHALL BE A DARK GREY COLOR TO BE SUBMITTED TO THE EOR/OWNER AND LAKE COUNTY FOR COLOR APPROVAL PRIOR TO INSTALLATION.
GEOGRID REQUIRED
TYP. AASHTO/ASTM #57 STONE (CLEAN, ANGULAR ON ALL SIDES, NO FINES) 6" BEDDING LAYER COMPACTED TO NO MOVEMENT. THICKER CROSS SECTIONS WITH LAYOUT, COMPACTED ANGULAR STONE ON ALL SIDES TBD BY ENGINEER.
GEOTEXTILE REQUIRED PER PAVEDRAIN SPECIFICATIONS
12" AASHTO #57 STONE REQUIRED COMPACT IN 6" LIFTS
SUBGRADE TO BE COMPACTED PER PAVEDRAIN SPECIFICATIONS.
PAVEDRAIN
STANDARD DETAIL
CURB & GUTTER
PAVE DRAIN


TENSAR BX-1100 GEOGRID PER PAVEDRAIN SPECIFICATIONS
5.6" PAVEDRAIN
12" LAYER #57 STONE
FILTER FABRIC PER PAVEDRAIN SPECIFICATIONS
NATIVE SUBGRADE IS TO BE COMPACTED TO 92% MODIFIED PROCTOR DENSITY. DO NOT OVER-COMPACT OR RUT NATIVE SUB-GRADE. PER PAVE DRAIN RECOMMENDED SPECIFICATIONS.

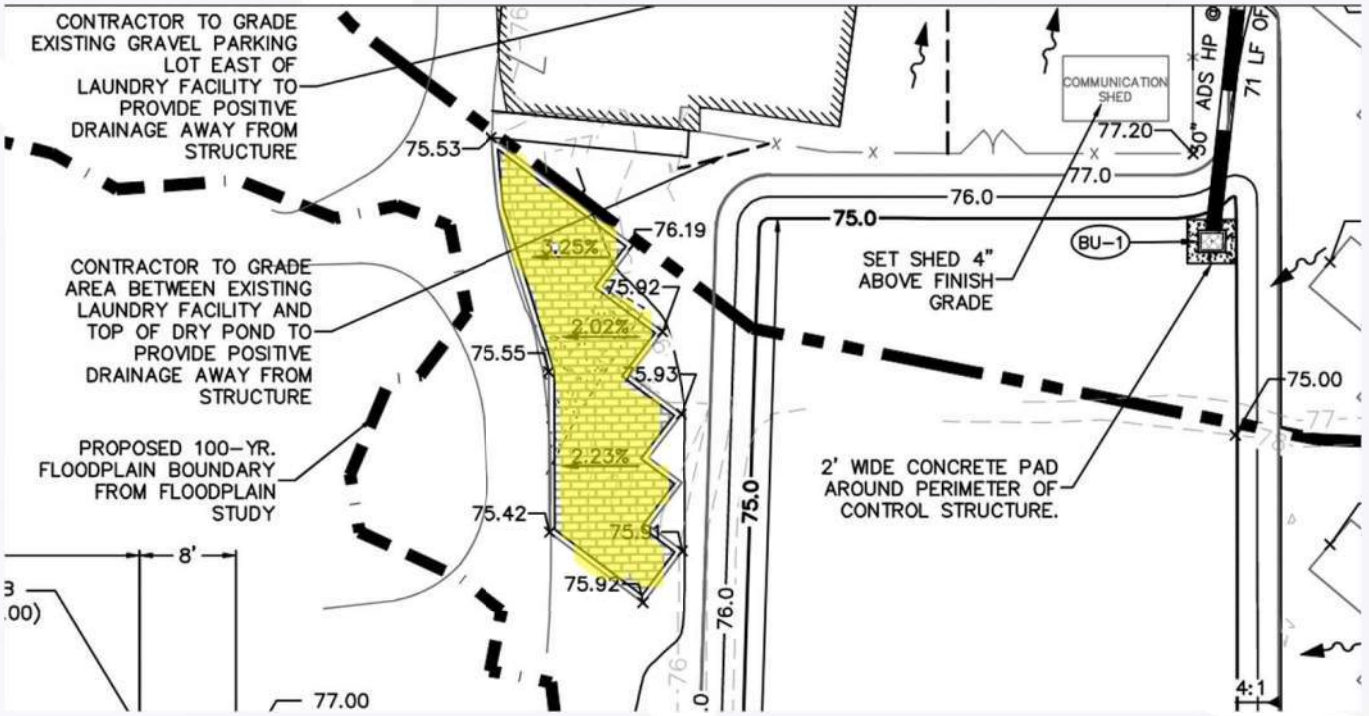
Tropical Palms RV Resort

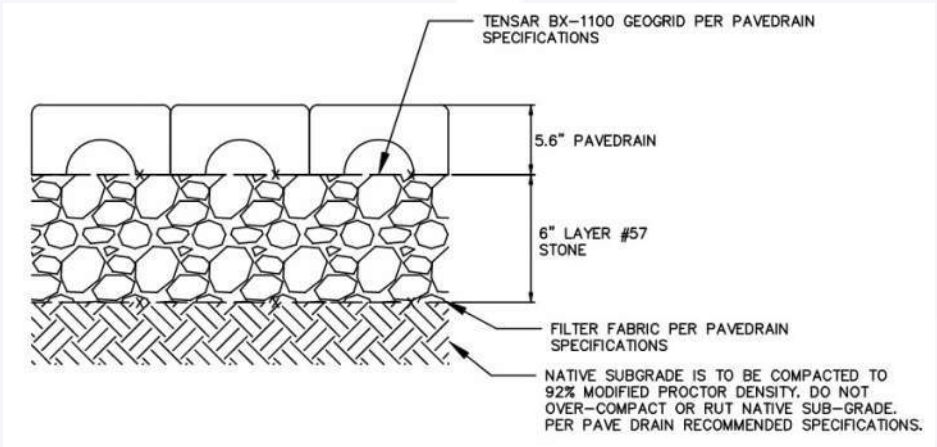
Project Challenges

- Existing Stromwater Pond was maxed out
- Client wanted additional parking for staff
- SJRWMD/Osceola County Jurisdictions
- Small Area of Pavement to mobilize a paving crew
- No storm sewer piping in the immediate area
- Pre vs. Post Runoff Had to be met
- Water Quality had to be provided

Solution: PaveDrain

- PaveDrain 5.6” Block
- Geogrid
- 6” #57 Stone
- Filter Fabric
- Existing Ground


CONTRACTOR TO GRADE EXISTING GRAVEL PARKING LOT EAST OF LAUNDRY FACILITY TO PROVIDE POSITIVE DRAINAGE AWAY FROM STRUCTURE
CONTRACTOR TO GRADE AREA BETWEEN EXISTING LAUNDRY FACILITY AND TOP OF DRY POND TO PROVIDE POSITIVE DRAINAGE AWAY FROM STRUCTURE
PROPOSED 100-YR. FLOODPLAIN BOUNDARY FROM FLOODPLAIN STUDY
COMMUNICATION SHED
SET SHED 4" ABOVE FINISH GRADE
2' WIDE CONCRETE PAD AROUND PERIMETER OF CONTROL STRUCTURE.
BU-1
30" ADS HP @
71 LF OF
75.53
76.19
75.92
75.55
75.93
75.42
75.91
75.92
77.20
77.0
76.0
75.0
75.00
3.25%
2.02%
2.23%
8'
77.00
4:1


TENSAR BX-1100 GEOGRID PER PAVEDRAIN SPECIFICATIONS
5.6" PAVEDRAIN
6" LAYER #57 STONE
FILTER FABRIC PER PAVEDRAIN SPECIFICATIONS
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Kimley»Horn

Expect More. Experience Better.

QUESTIONS:

Presented by

Matthew Gillespie, P.E.

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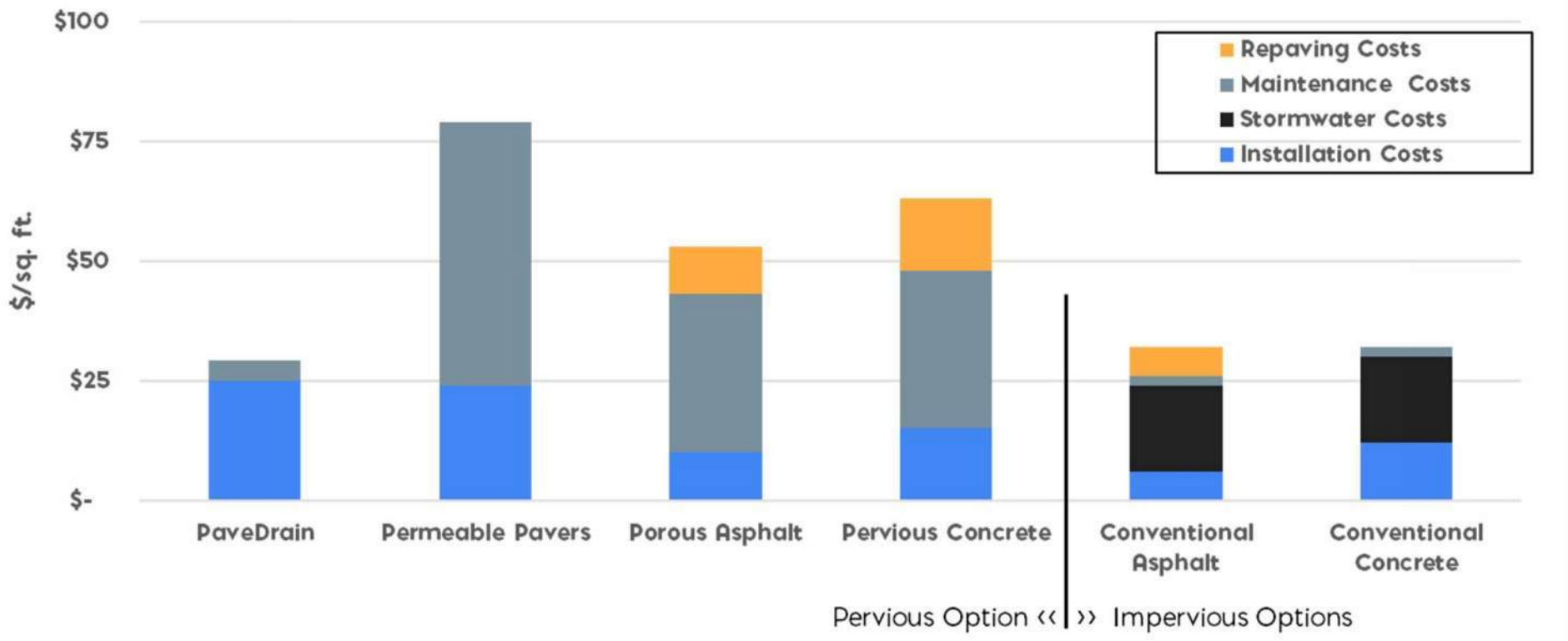
Total Costs @ 10 Years

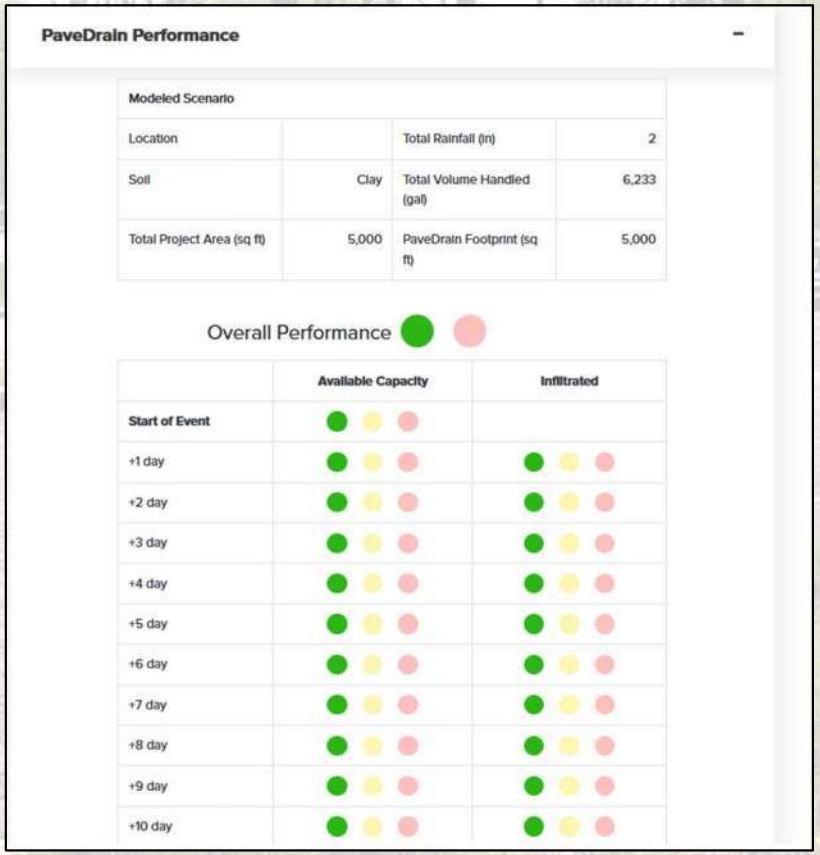


Infiltration Calculator

Model Your Scenario

- Rainfall via Location
  - 10-year event
  - 100-year event
  - 1,000-year event
  - Choose your own
- Area of permeable cover
- Area of impermeable cover (run-on)
- Soil
- Depth of Base

www.pavedrain.com/infiltrationcalculator



PaveDrain Performance

Modeled Scenario			
Location		Total Rainfall (in)	2
Soil	Clay	Total Volume Handled (gal)	6,233
Total Project Area (sq ft)	5,000	PaveDrain Footprint (sq ft)	5,000

Overall Performance

	Available Capacity	Infiltrated
Start of Event		
+1 day		
+2 day		
+3 day		
+4 day		
+5 day		
+6 day		
+7 day		
+8 day		
+9 day		
+10 day		

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VP Engineered Systems
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Matthew Gillespie, PE
Associate
matthew.gillespie@kimley-horn.com (407) 898-1511

END

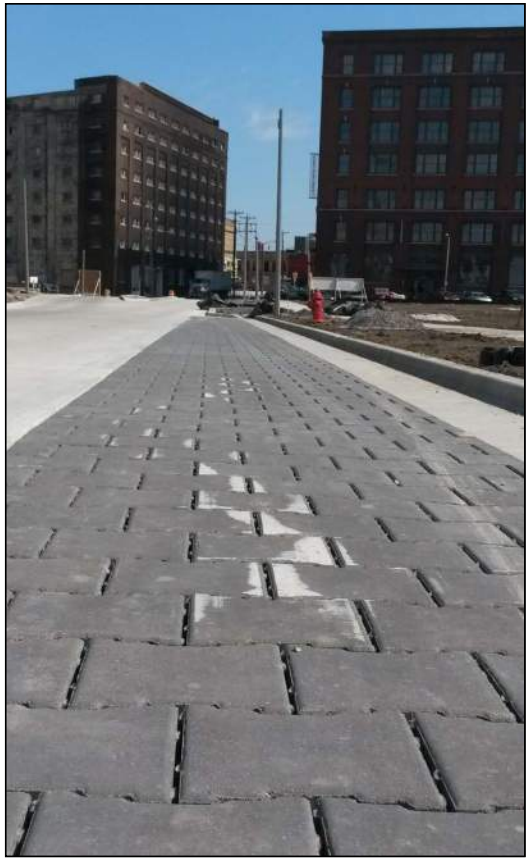
ADA Compliance

- **Guidelines specify openings <1/2”**

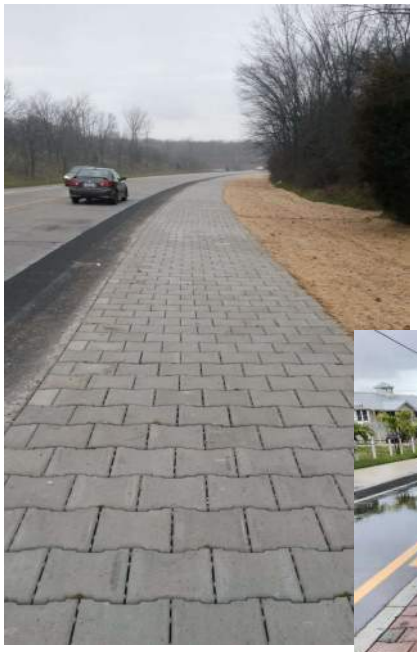
Rest of presentation will focus only on Permeable-ACB (P-ACB) systems used as permeable pavement systems

All corners are rounded so that no “edge” is created to catch on a snowplow.

Steel Snowplow Blade
Freshwater Way
Milwaukee



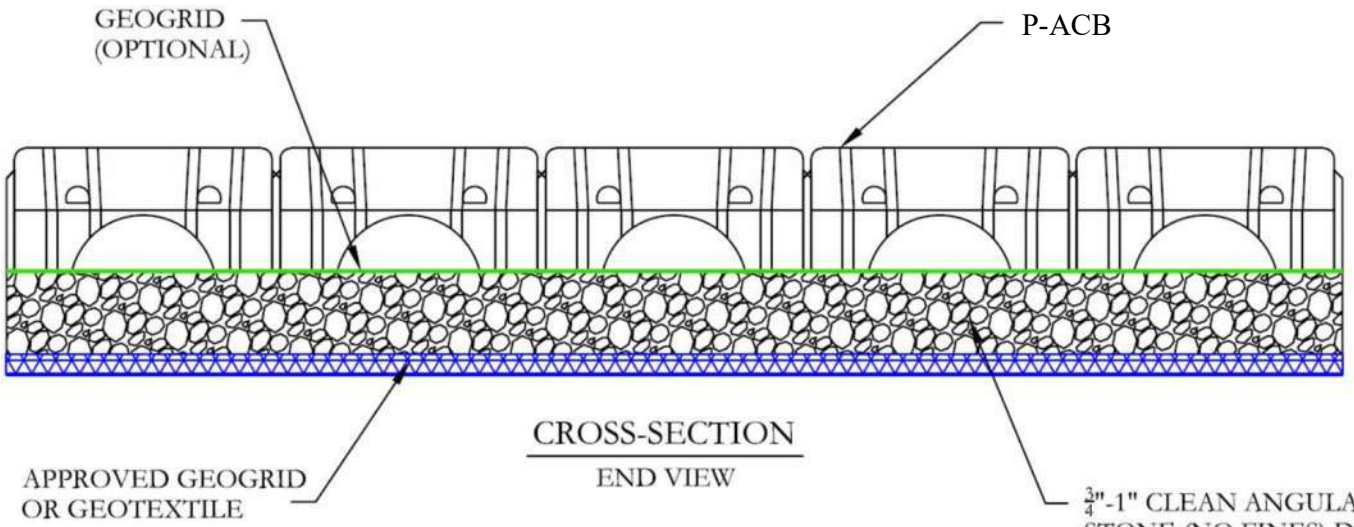
Decentralized Stormwater Management



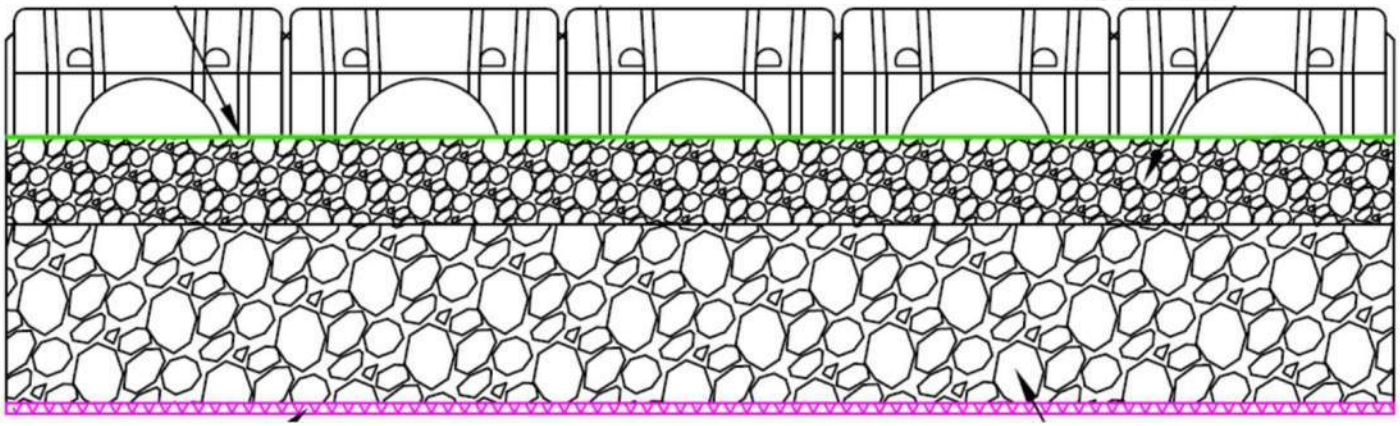
Other P-ACB Benefits

- Never have to replace joint filler (sand/stone dust)
- High void space avoids freeze-thaw and frost heaving challenges
- Able to function in high water levels (e.g., sunny day flooding)
- Long lifetime of concrete (40 years)
- Single person can replace an ACB unit with a block extractor
- Increases resiliency of traditional paving surfaces

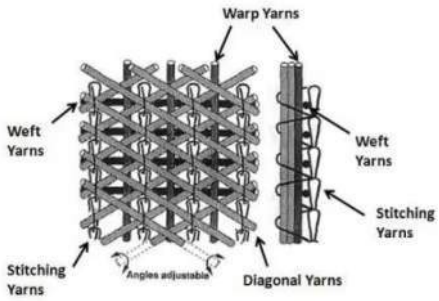
Typical P-ACB Cross- Section(s)



NO rock chips to set P-ACB on



Geotextiles



Type	Water Permeable	High Strength	Common Use
Non-Woven	Yes	No	Landscape fabric
Woven: Slit Tapes	No	Yes	Erosion control
Woven: Mono/Multi-Filaments	Yes	Yes	Erosion control
Knitted	Yes	Yes	Soil stabilization

Recommended speaking with the relevant manufacturer to identify the right geotextile for your application

The P-ACB System: Multiple Installation Methods

Hand Placed Installation

Machine Lay

Sequencing P-ACB Installation: City Streets

The P-ACB System: Multiple Installation Methods

The P-ACB System: Multiple Installation Methods

NO RIBBON CURB!!

Potential LEED Credits v4.1

Sustainable Sites

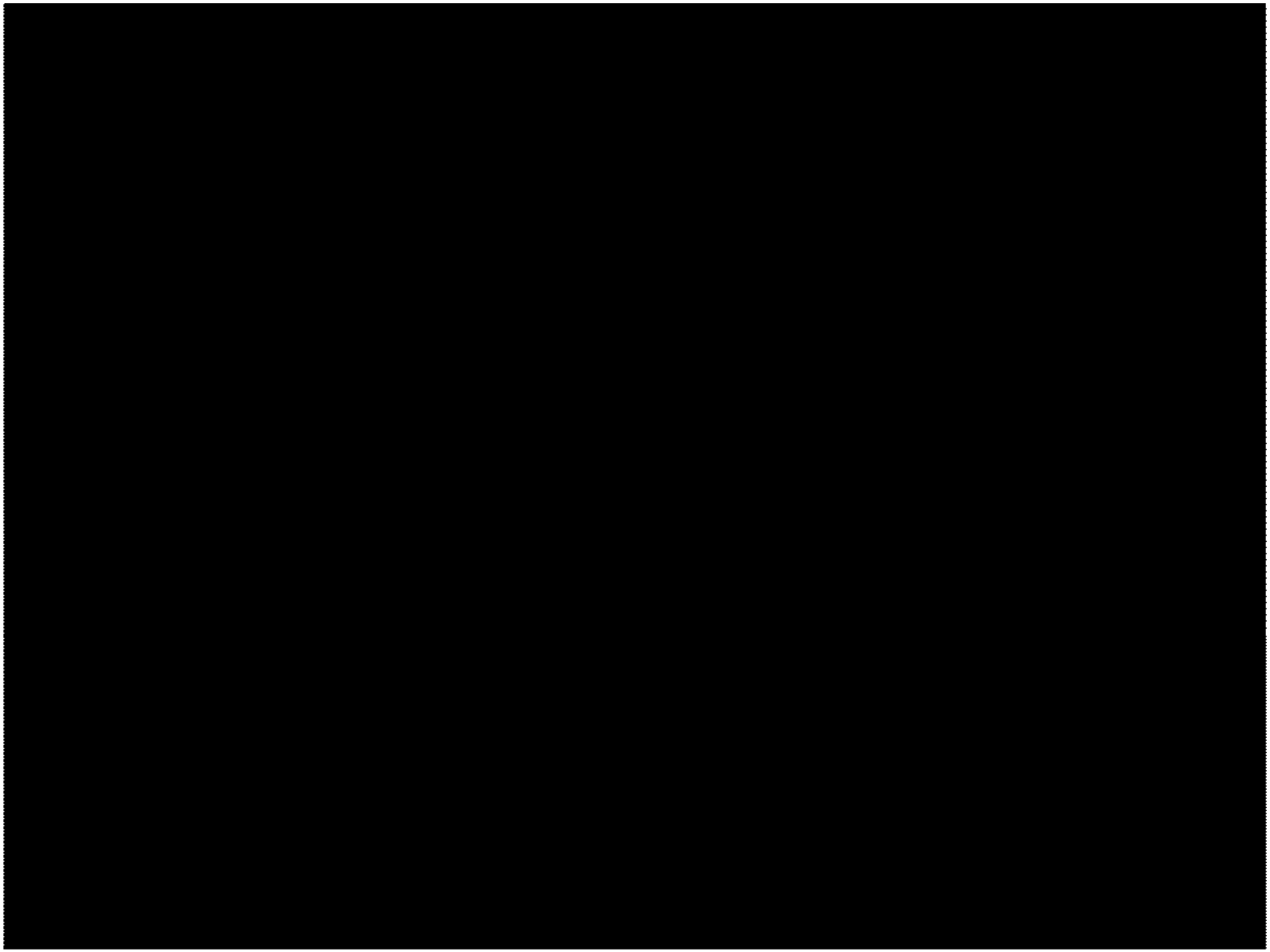
- Rainwater Management — up to 3 Points
  - Reduce runoff volume and improve water quality
- Heat Island Reduction, Non Roof — up to 2 Points
  - Paving material with high initial solar reflectance
- Protect or Restore Habitat — up to 2 Points
  - Managing stormwater within existing pavement footprint

Water Efficiency

- Outdoor Water Use Reduction — up to 2 points
  - Reduced outdoor water consumption

Materials & Resources

- Speak with manufacturer about EPD's and materials sourcing



P-ACB Maintenance: Elgin Whirlwind VACUUM Truck

PRIOR TO CLEANING

First Pass