

A Suite Of Stormwater Management Solutions In Anne Arundel County, MD

Maryland Association of Floodplain and Stormwater Managers Conference
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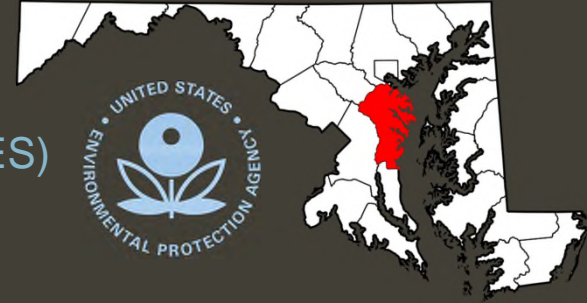
Anne Arundel County (AACo)

WHY

- National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4)
- Chesapeake Bay Total Maximum Daily Load (TMDL)

HOW

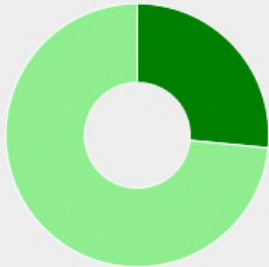
- AACo Watershed Protection & Restoration Program (WPRP)
 - Watershed Assessment & Planning
 - Restoration Implementation
 - Ecological Assessment & Evaluation
 - Education & Outreach



AACo WPRP

WPRP Restoration Project Goals

(Number of projects completed/anticipated)



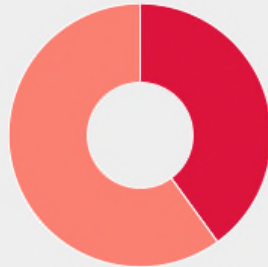
Stream & Wetland
Restoration

13 out of 49 Completed



Stormwater Pond
Retrofits

**85 out of 144
Completed**



Stormwater Outfall
Repairs

16 out of 40 Completed

WPRP MS4 Attainment Goals

(acres to date/projected acres)



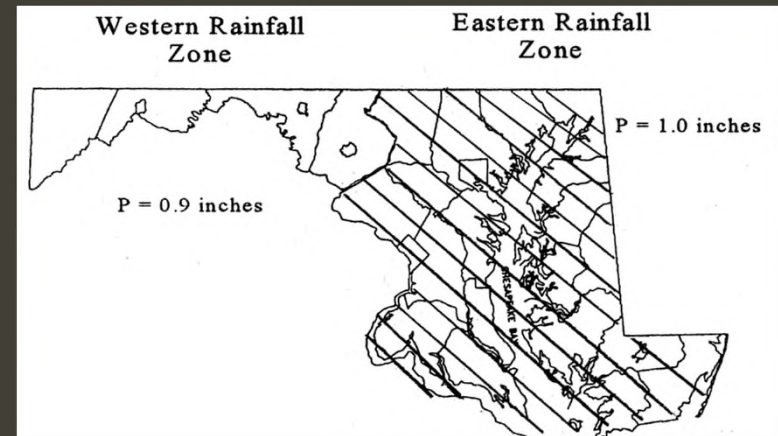
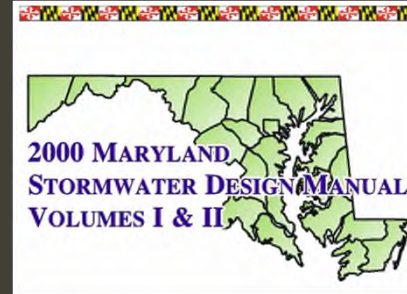
MS4 Permit Progress Tracking

2627 out of 4996 Completed

AACo WPRP & AKRF

GOALS

- Water Quality
 - Stormwater Retrofits
 - SWM standards to the maximum extent practicable
 - Chesapeake Bay TMDL (Nitrogen, Phosphorous, TSS)
- Quantity Control & Flood Mitigation
- Stability & Function of Outfalls & Waterways



Estimate Load Reduction

Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated

Guidance for National Pollutant Discharge Elimination System Stormwater Permits

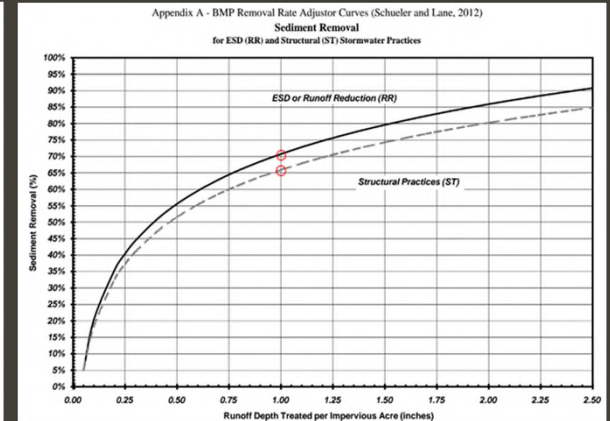
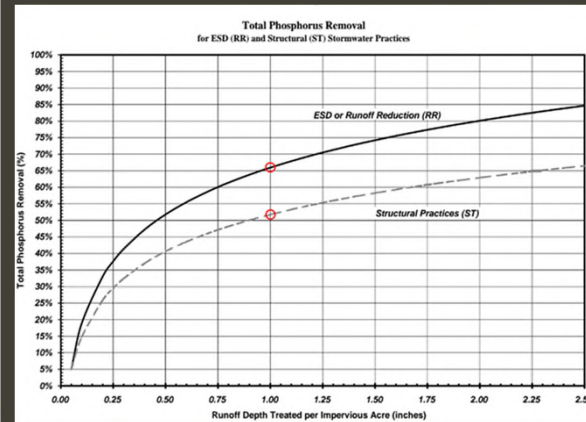
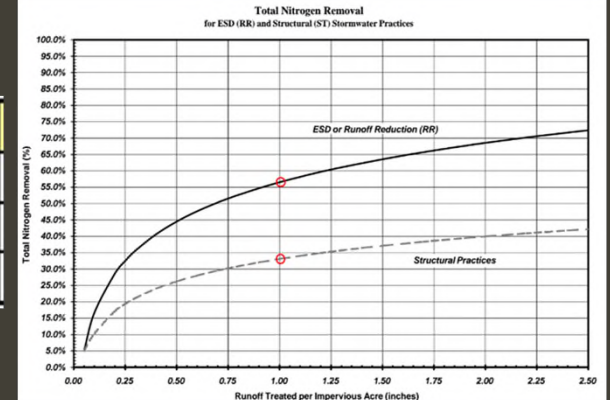
August 2014



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410-537-3000 | 800-633-6101 | TTY Users 800-735-2258

Larry Hogan, Governor | Boyd Rutherford, Lt. Governor | Ben Grumbles, Secretary

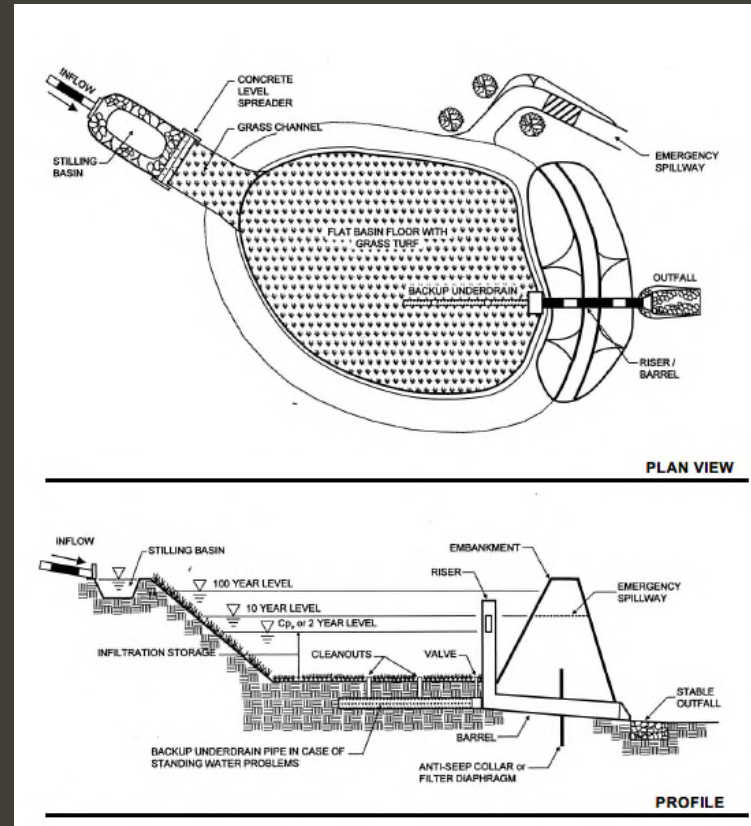
Parameter	Urban Impervious
TN (lbs)	15.3
TP (lbs)	1.69
TSS (tons)	0.44



The Suite of Solutions

INFILTRATION BASIN

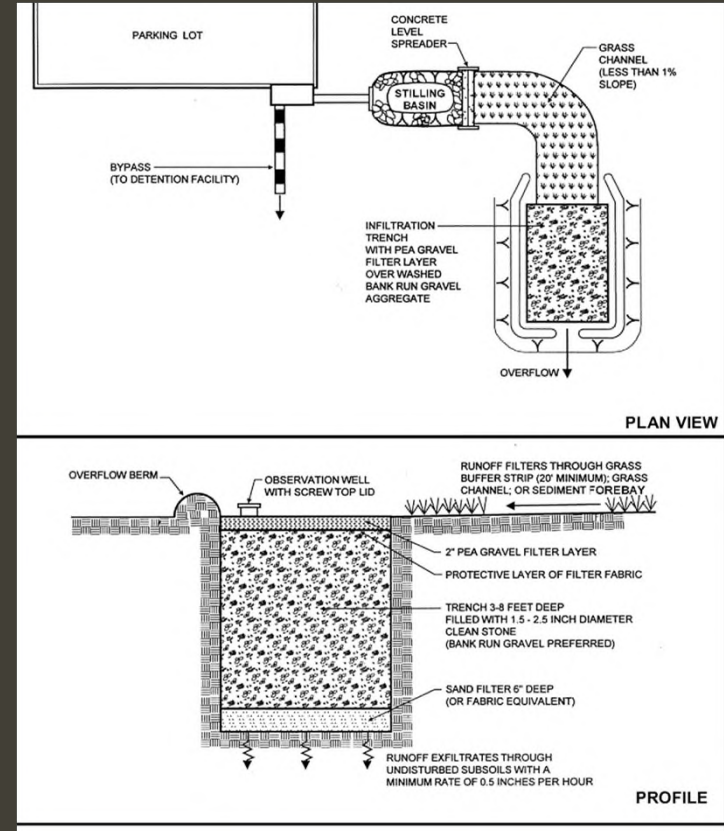
- Depressed area for temporary storage of Water Quality Volume (WQv)
- Facilitate infiltration / recharge
- Channel protection
- Flood protection



The Suite of Solutions

INFILTRATION TRENCH

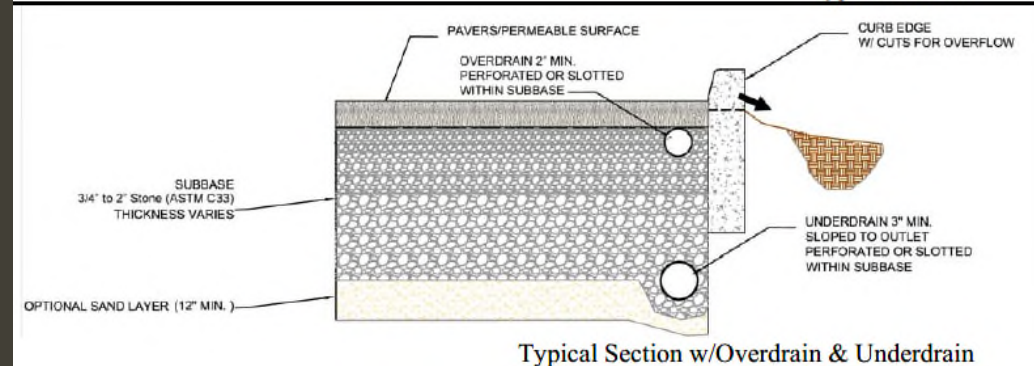
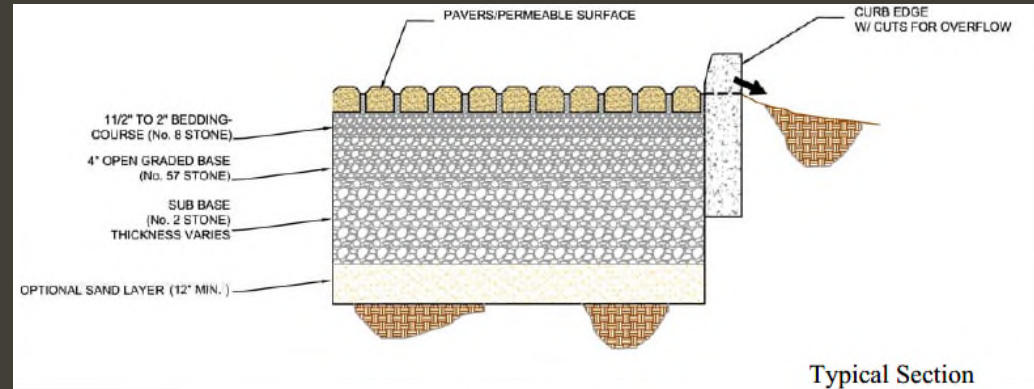
- Capture and temporarily store WQv within the void space of material
 - Typically stone
- Facilitate infiltration / recharge
- Channel protection
- Flood protection



The Suite of Solutions

PERMEABLE PAVEMENT

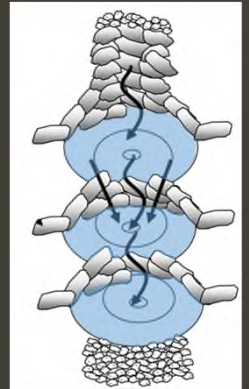
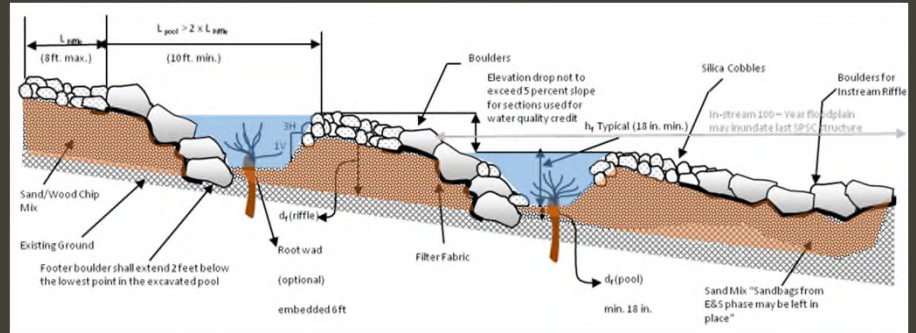
- Alternative surfacing material
 - Porous asphalt
 - Pervious concrete
 - Interlocking pavers
- Open graded stone base/subbase
- Promote groundwater recharge
- Mitigate temperature increases



The Suite of Solutions

STEP POOL STORM CONVEYANCE (SPSC)

- Ephemeral or intermittent channels
- Surface step pools and subsurface sand seepage filter
- Convert surface flow to shallow groundwater flow
- Energy reduction
- Habitat benefits



The Suite of Solutions

REGENERATIVE STREAM CONVEYANCE (RSC)

- Similar in design to SPSC
- Perennial channels
- Restore ecosystem functions of streams, floodplains, & wetlands
- Network of systems
 - seepage berms
 - pools
 - cobble weirs
 - floodplain & wetland connections



Project Examples

- Patapsco Non-Tidal Untitled Tributary Project
 - Performing Arts Center (PAC)
 - Brooklyn Park (BP)
 - Riverside Park (RP)
- Najoles Road Pond Retrofit & Stream Restoration Project
- General Outline
 - Site Overview
 - Stormwater Management (SWM) Opportunities
 - Site Challenges
 - Design Overview
 - Statistics

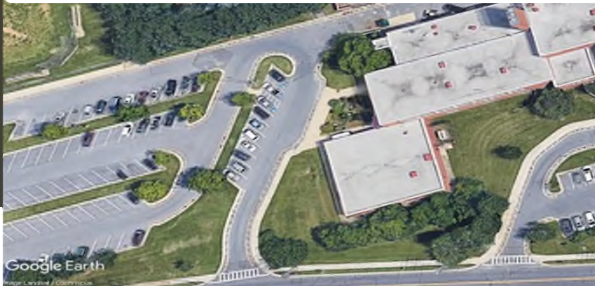
Performing Arts Center

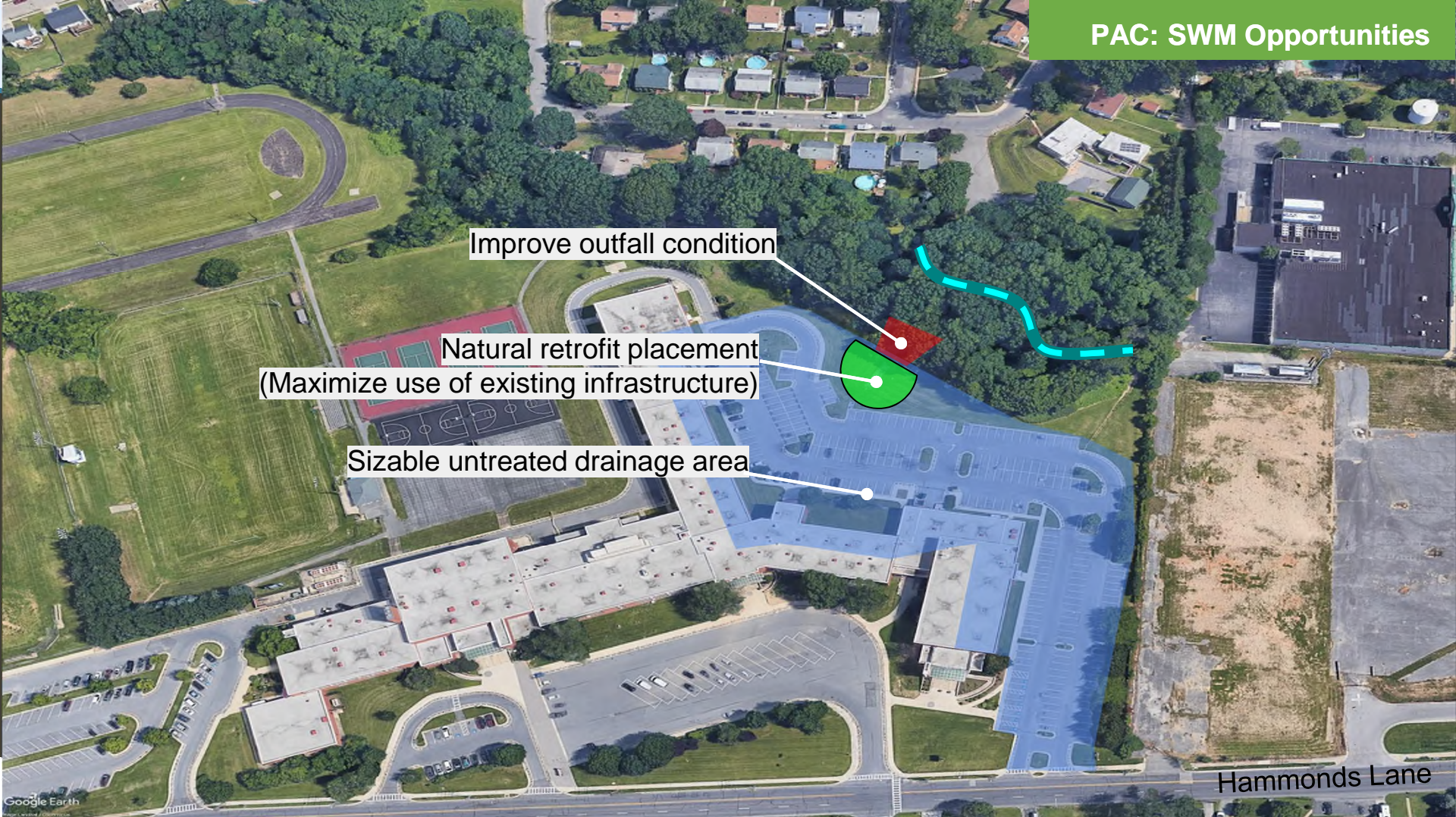




Hammonds Lane

PAC: Site Overview





Improve outfall condition

Natural retrofit placement
(Maximize use of existing infrastructure)

Sizable untreated drainage area

Hammonds Lane

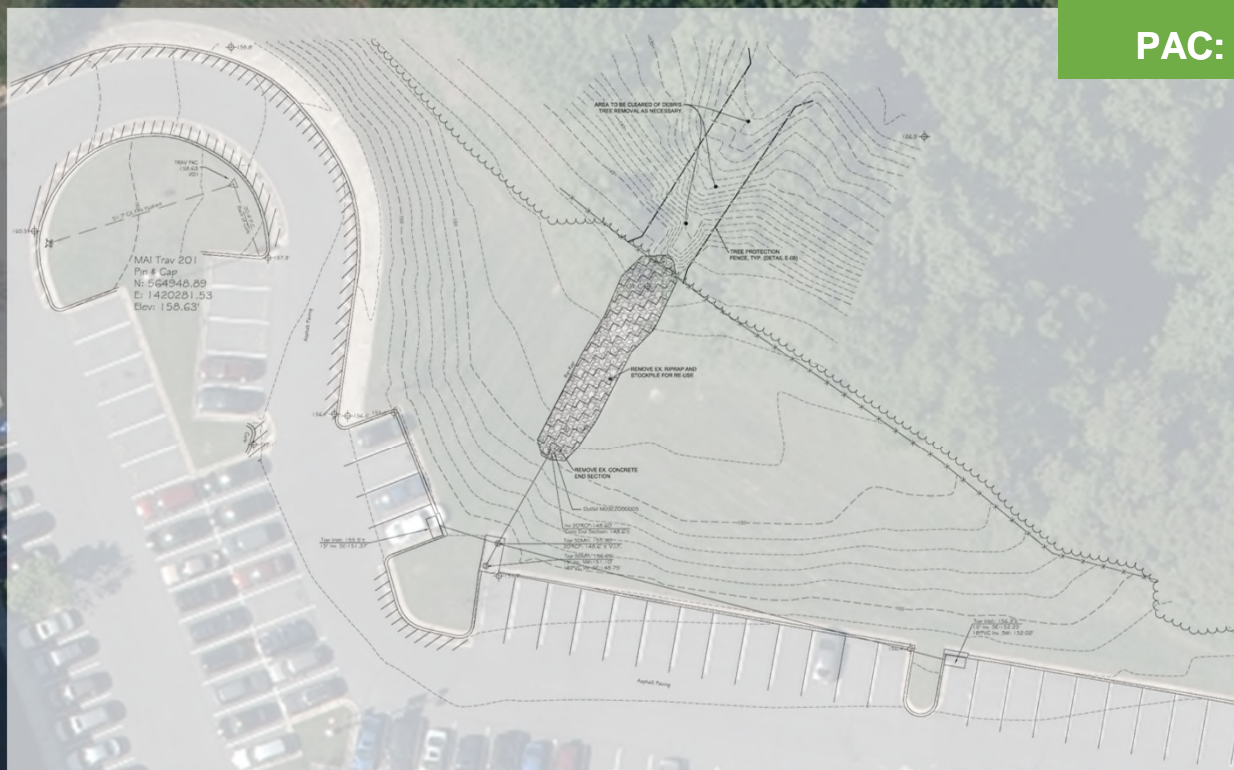
Performing Arts Center

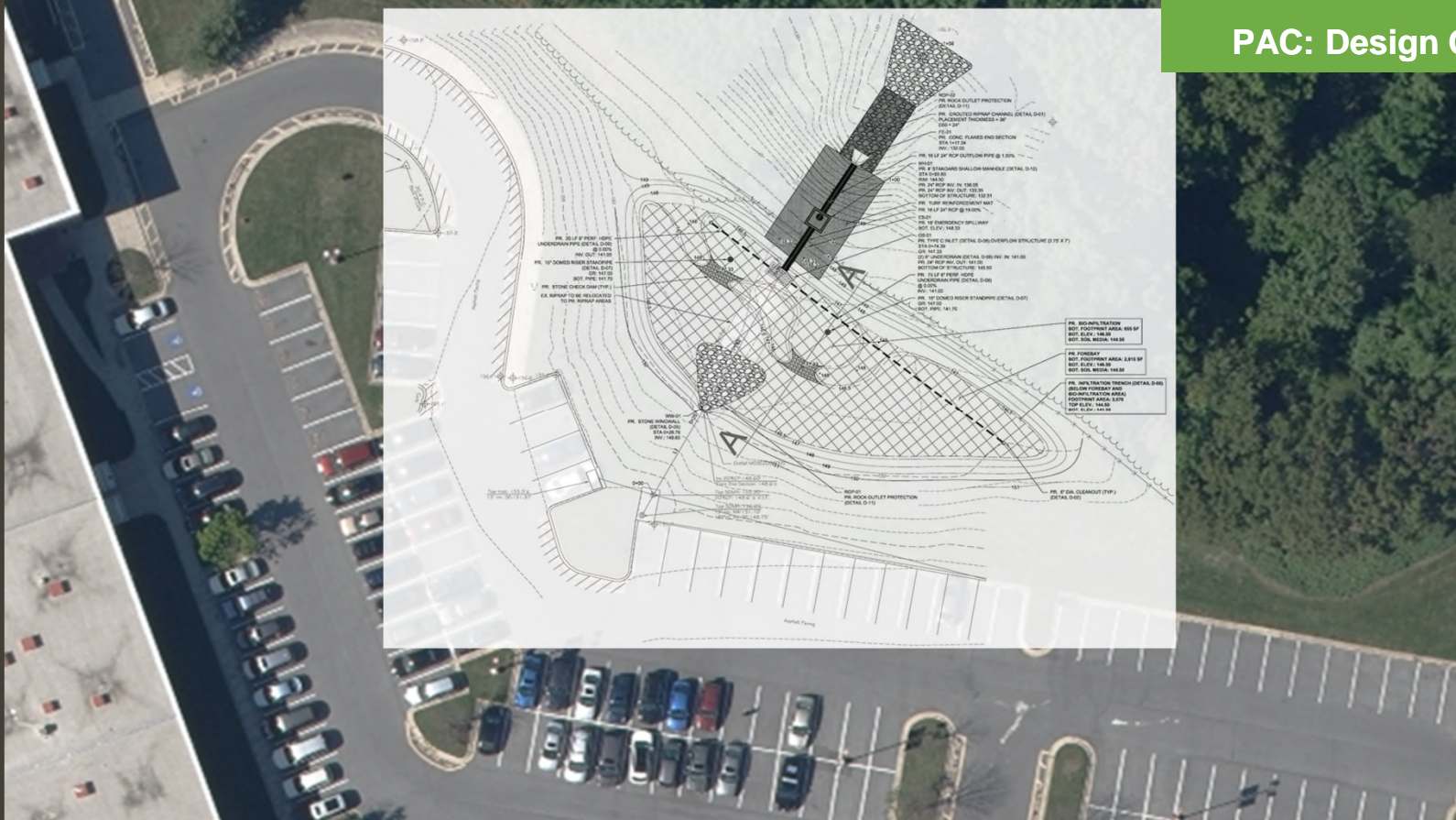
SITE CHALLENGES

- Maintain stability and function of outfall
- Conserve forest resources

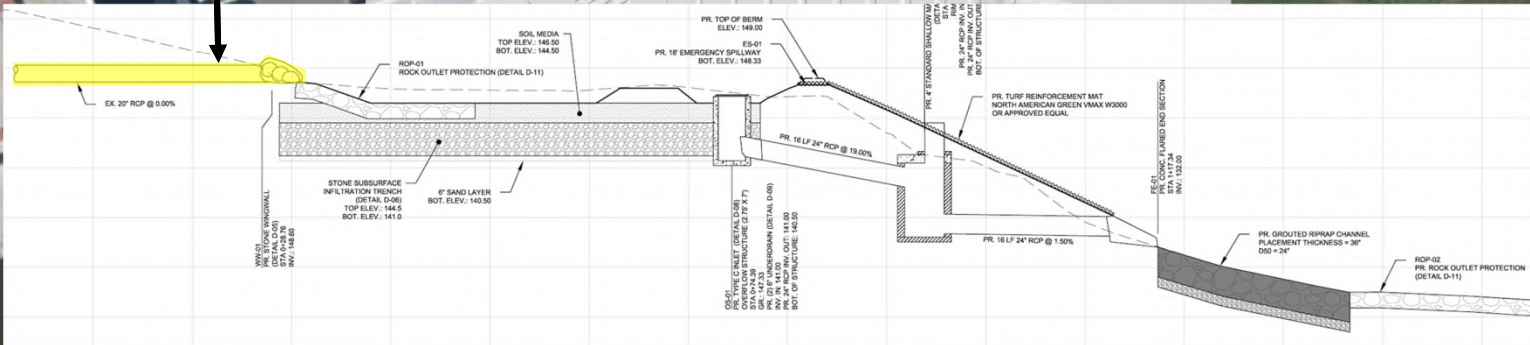
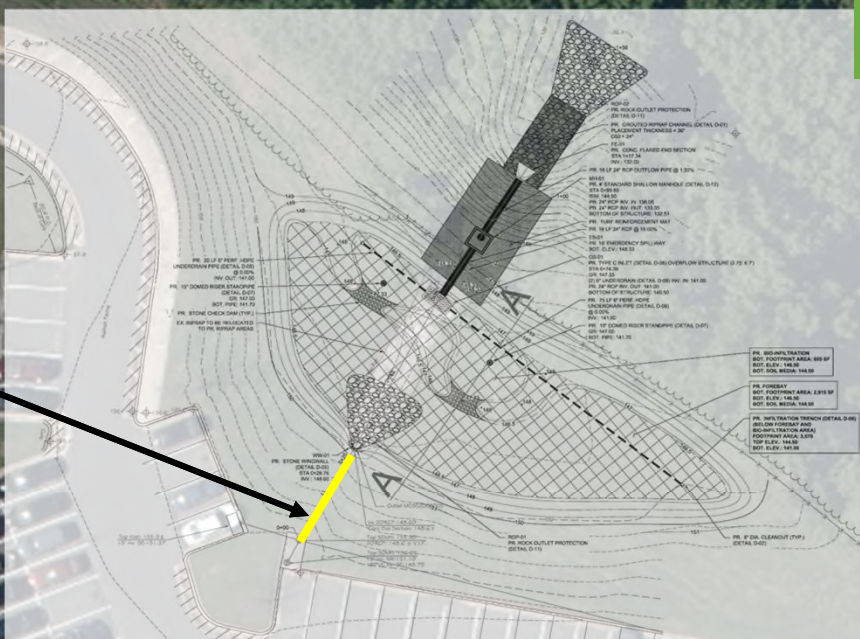


PAC: Design Overview

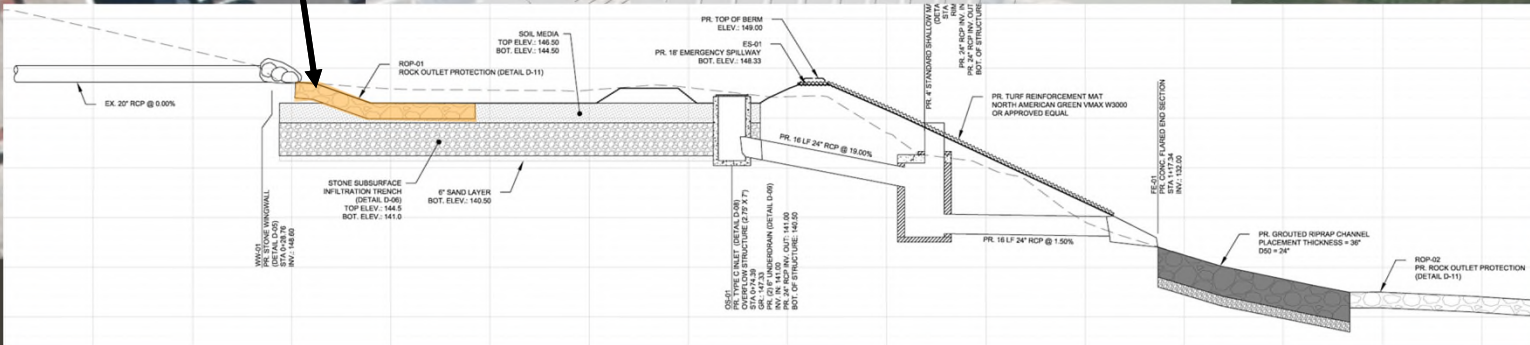
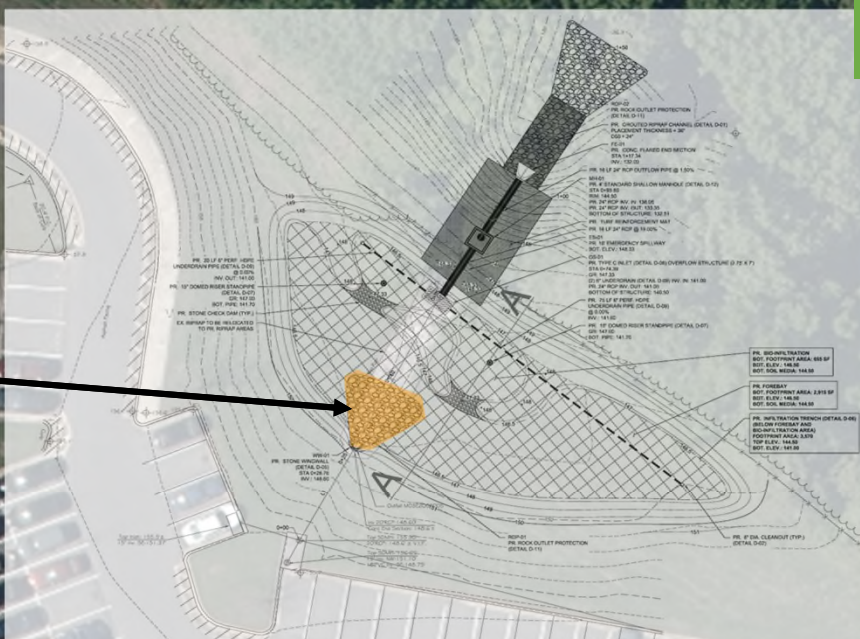




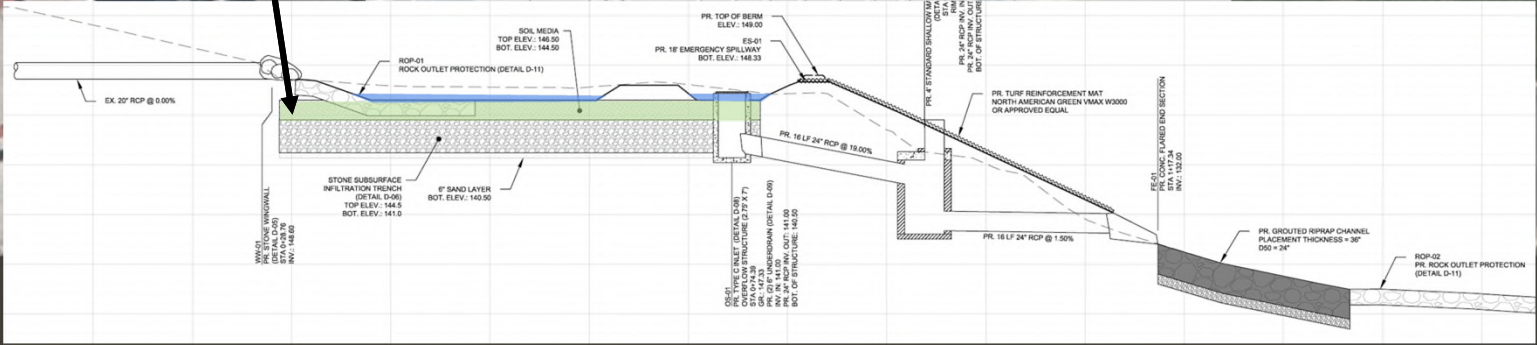
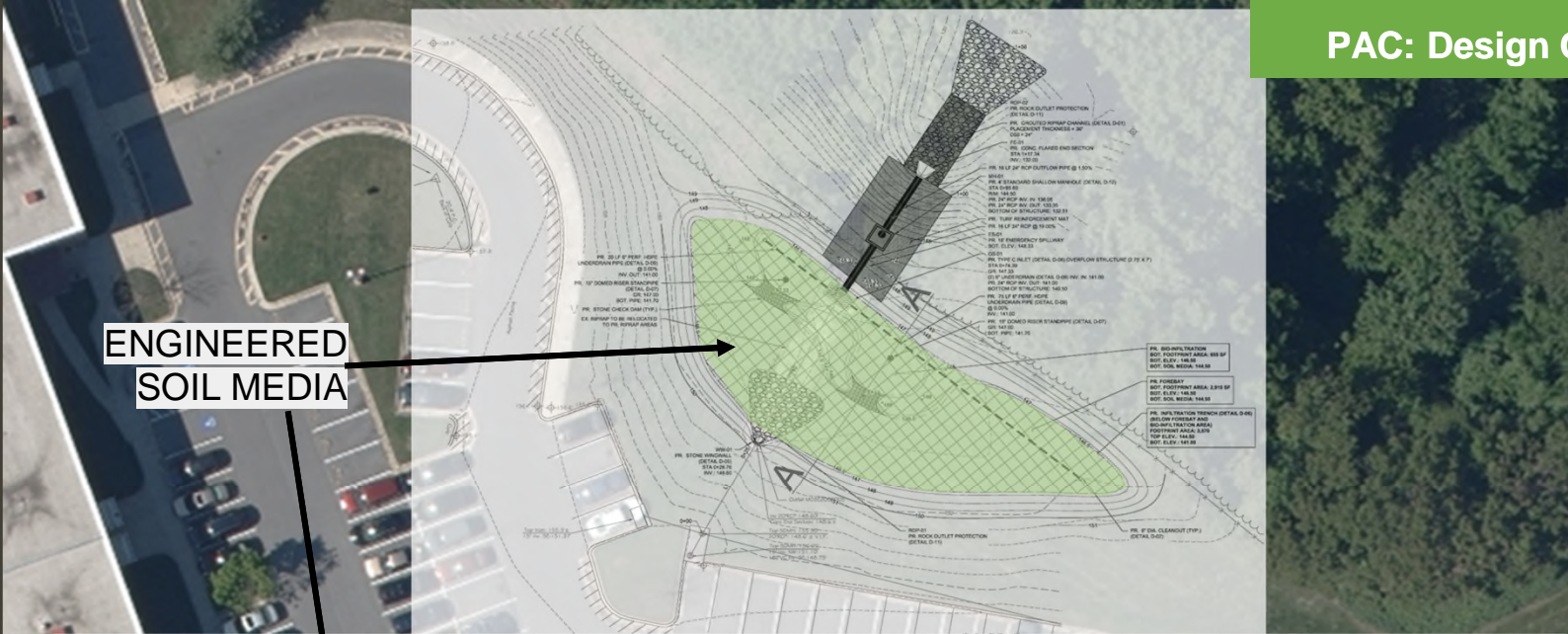
EXISTING INFLOW PIPE



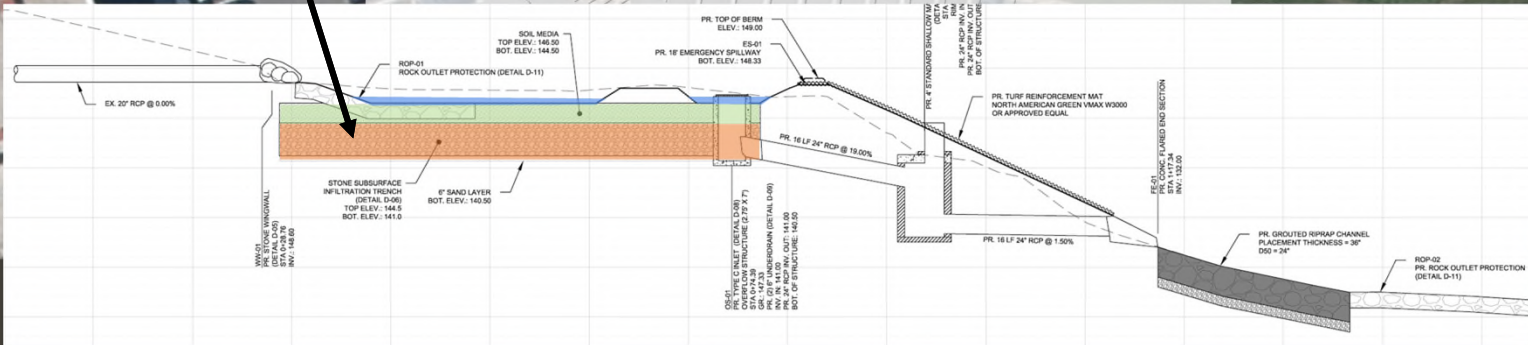
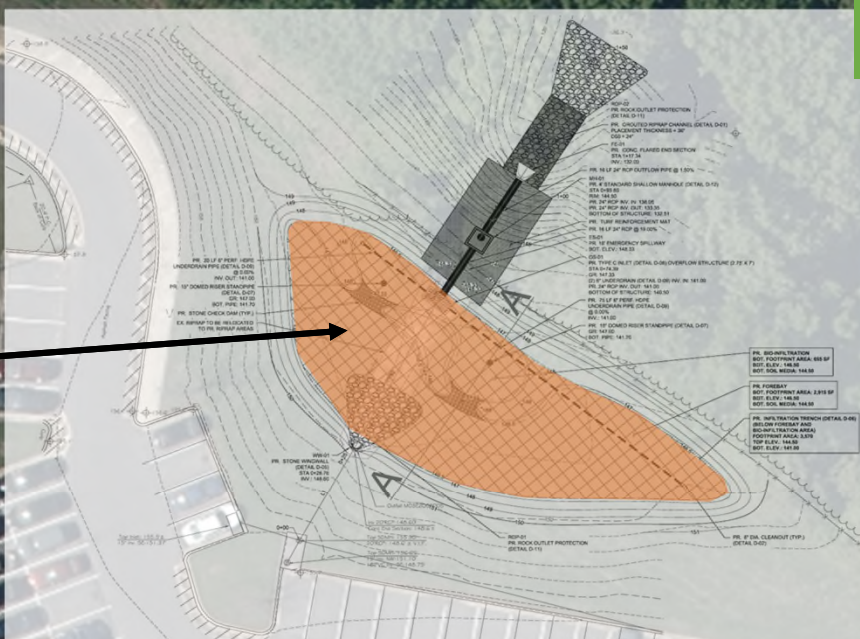
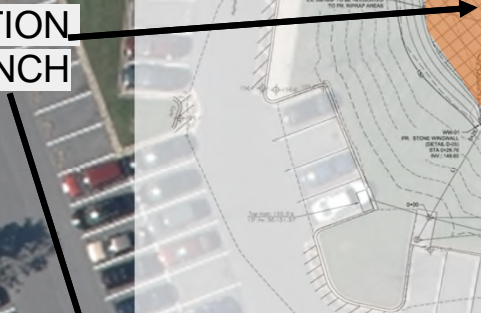
ROCK ENERGY DISSIPATOR (REUSE EXISTING ROCK)



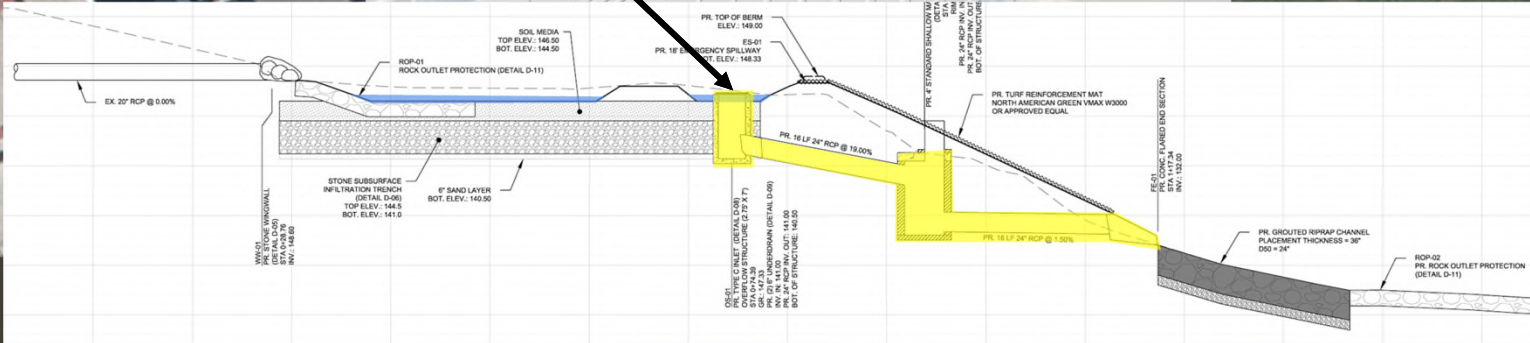
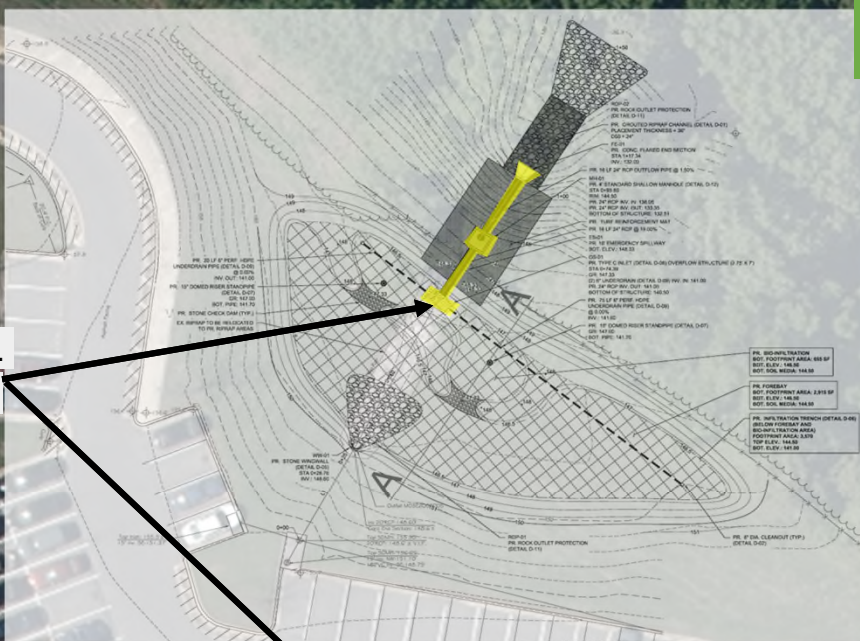
**ENGINEERED
SOIL MEDIA**



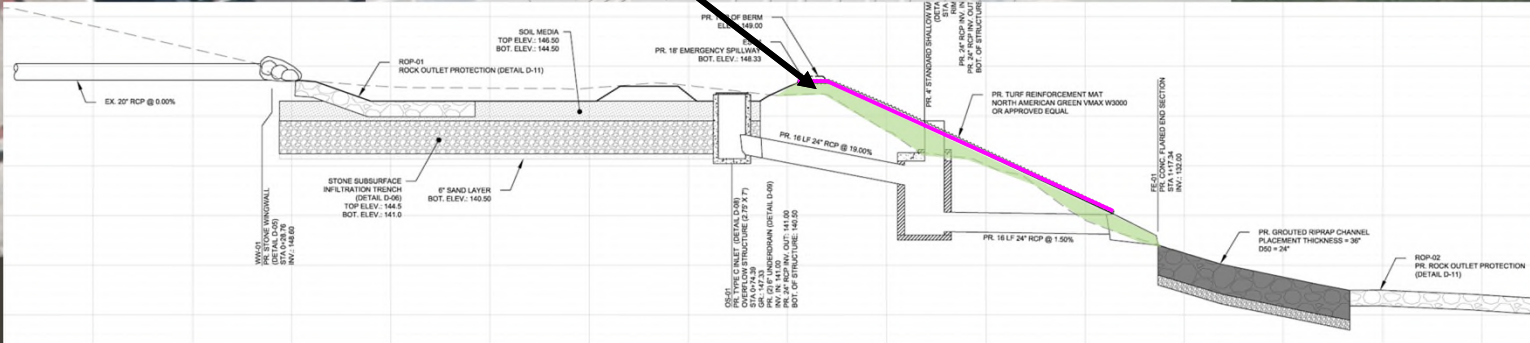
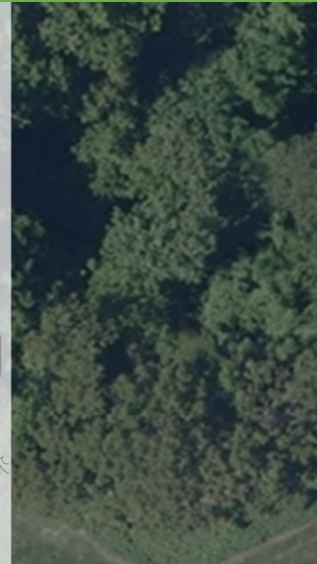
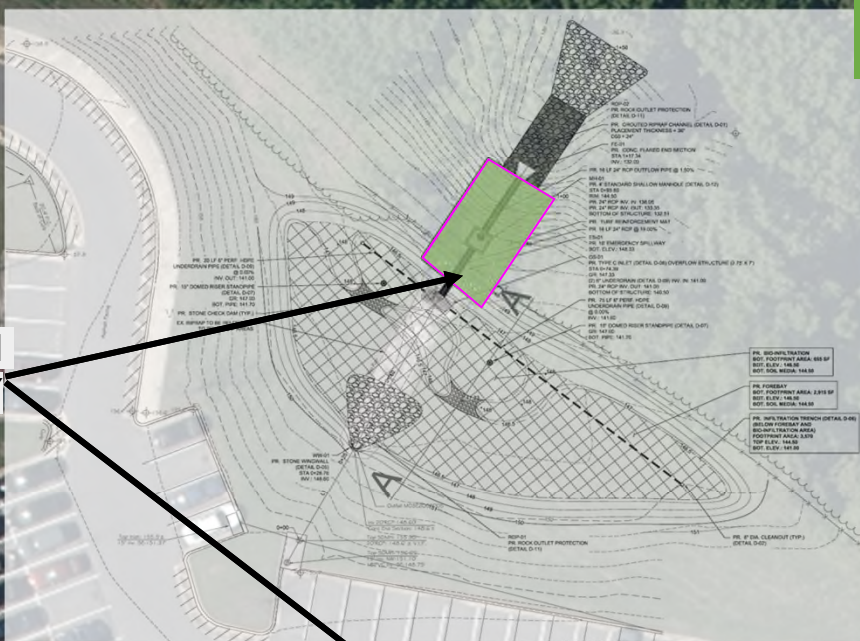
STONE INFILTRATION TRENCH

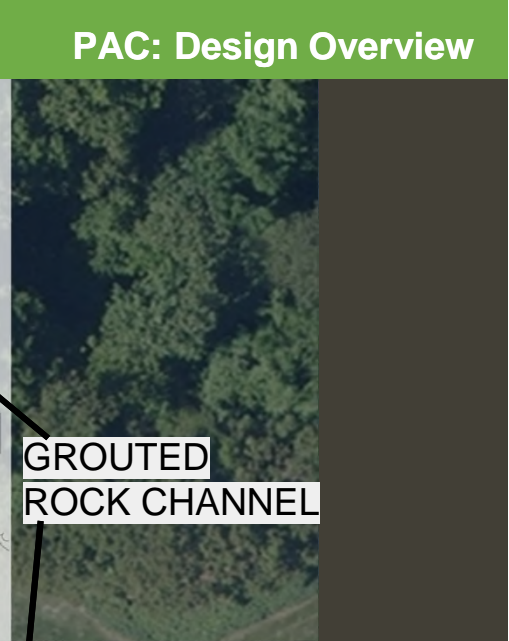
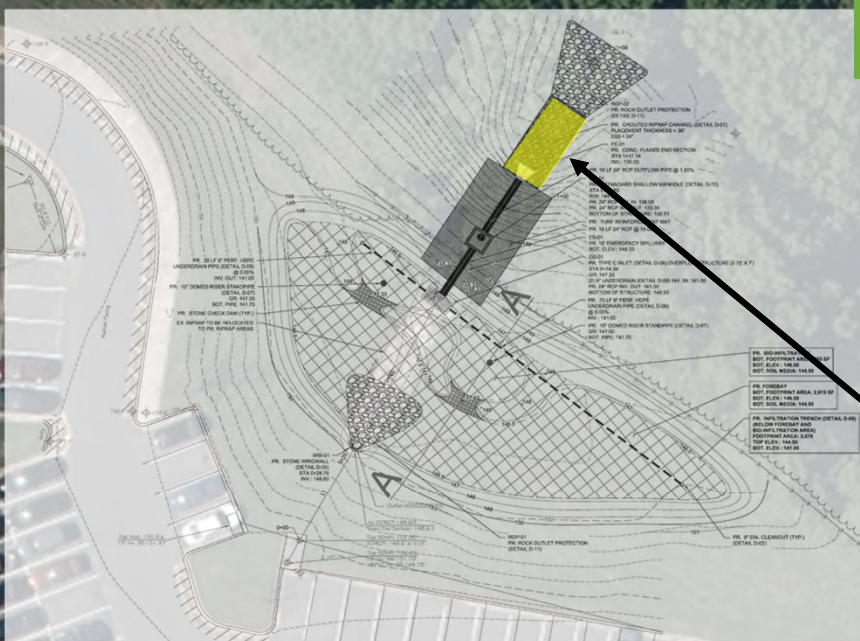


OUTLET CONTROL
STRUCTURE

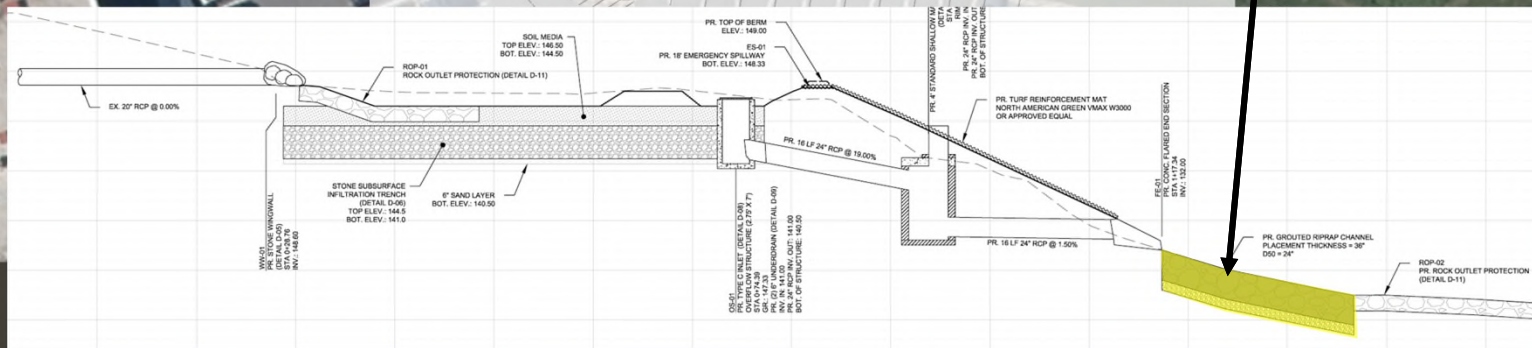


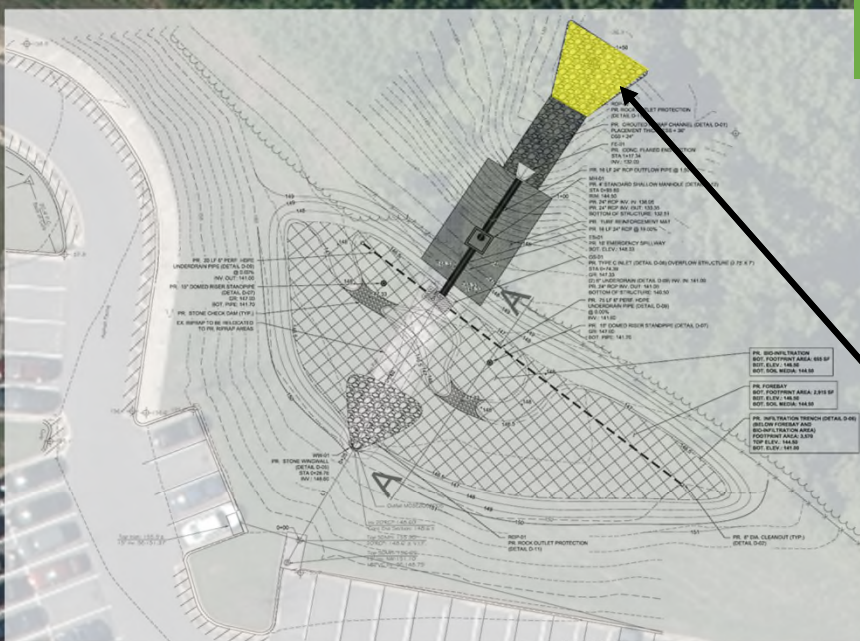
REINFORCED EARTHEN
SPILLWAY



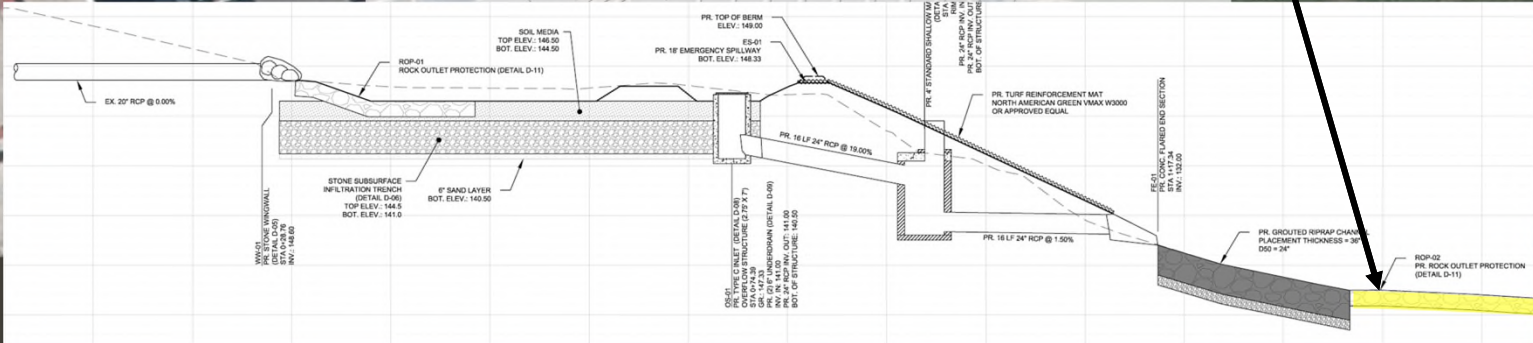


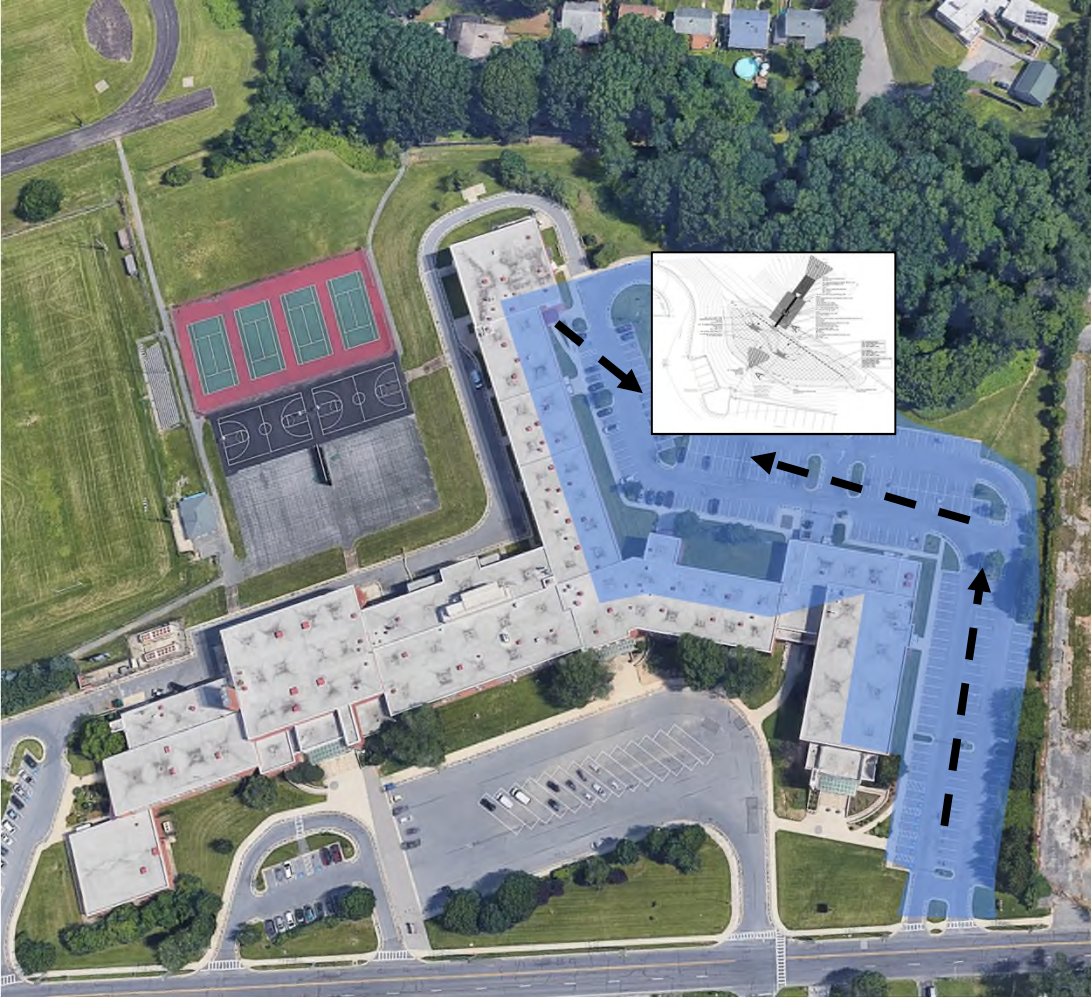
GROUTED
ROCK CHANNEL





ROCK OUTLET PROTECTION





Total Drainage Area	4.09 AC
Treated Impervious Area	2.64 AC
Water Quality Volume	9,367 CF

	TN	TP	TSS
Pollutant Removal Efficiencies	58%	67%	73%
Annual Pollutant Load	40 lbs	4 lbs	2,323 lbs
Annual Pollutant Load Removal	23 lbs	3 lbs	1,696 lbs



Brooklyn Park





MD 8852.D01

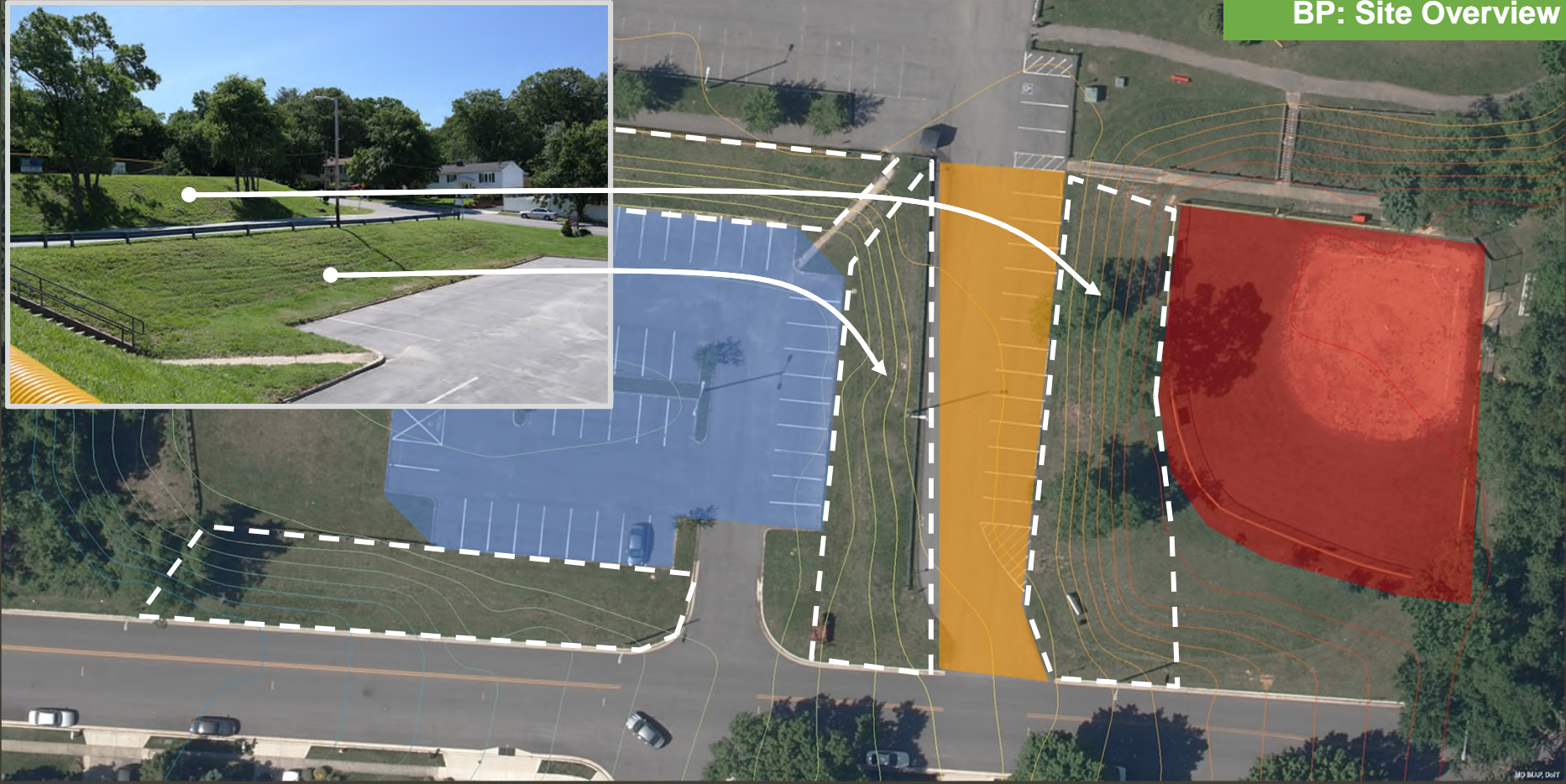






MO MAP, D&T





Brooklyn Park

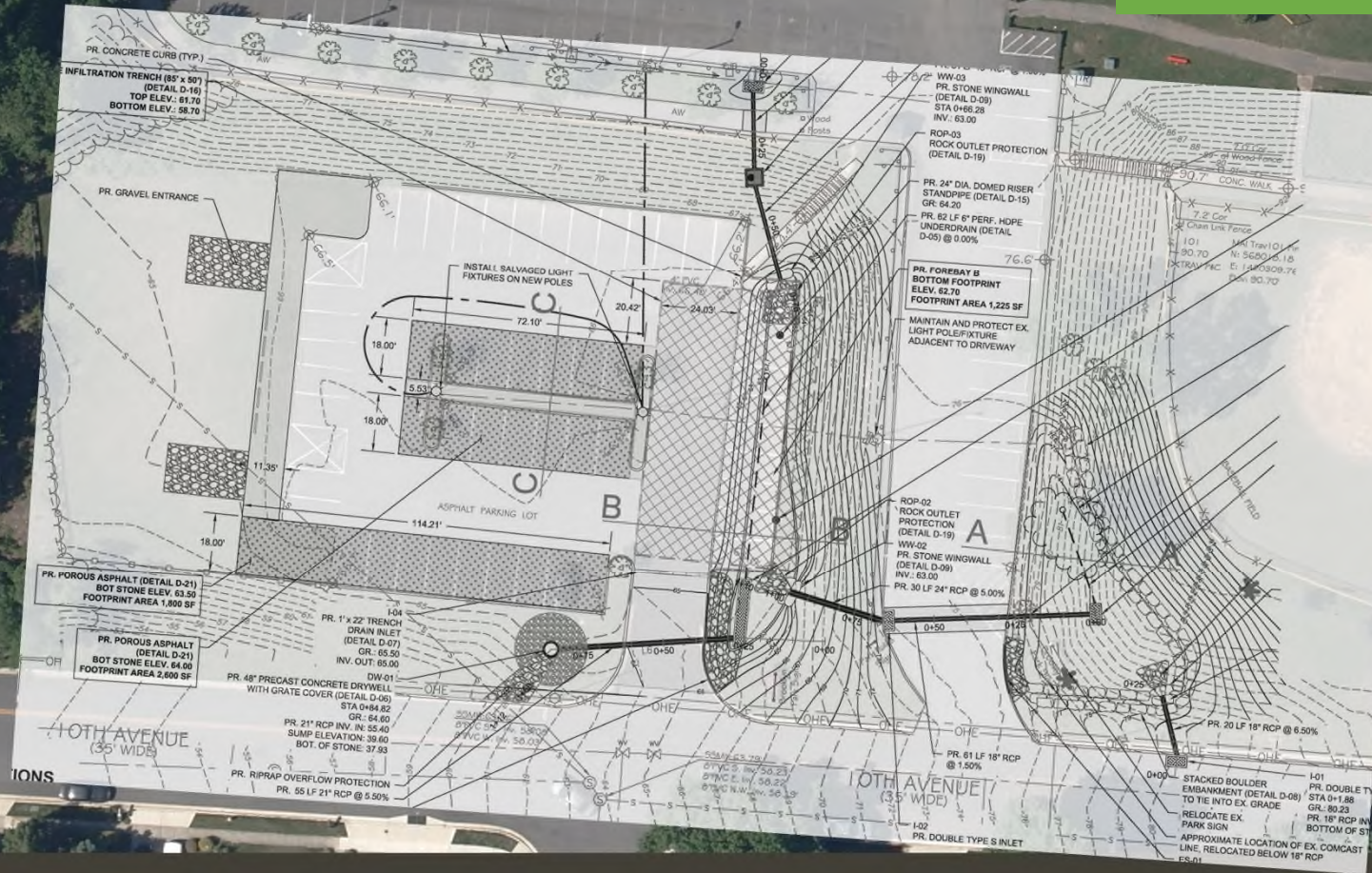
SWM OPPORTUNITIES

- Manage untreated drainage area
- Mitigate roadway flooding
- Public exposure to County SWM initiatives
- Drywell pilot

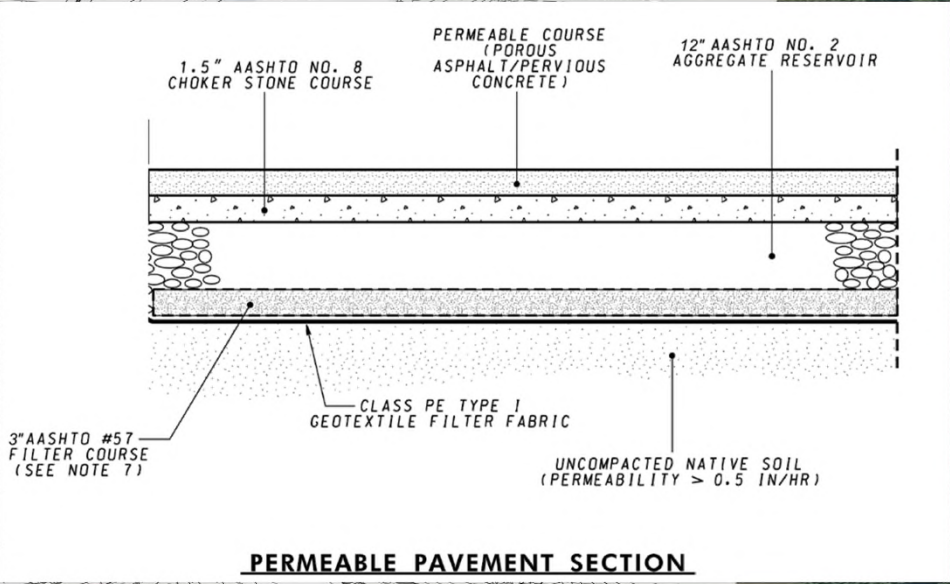
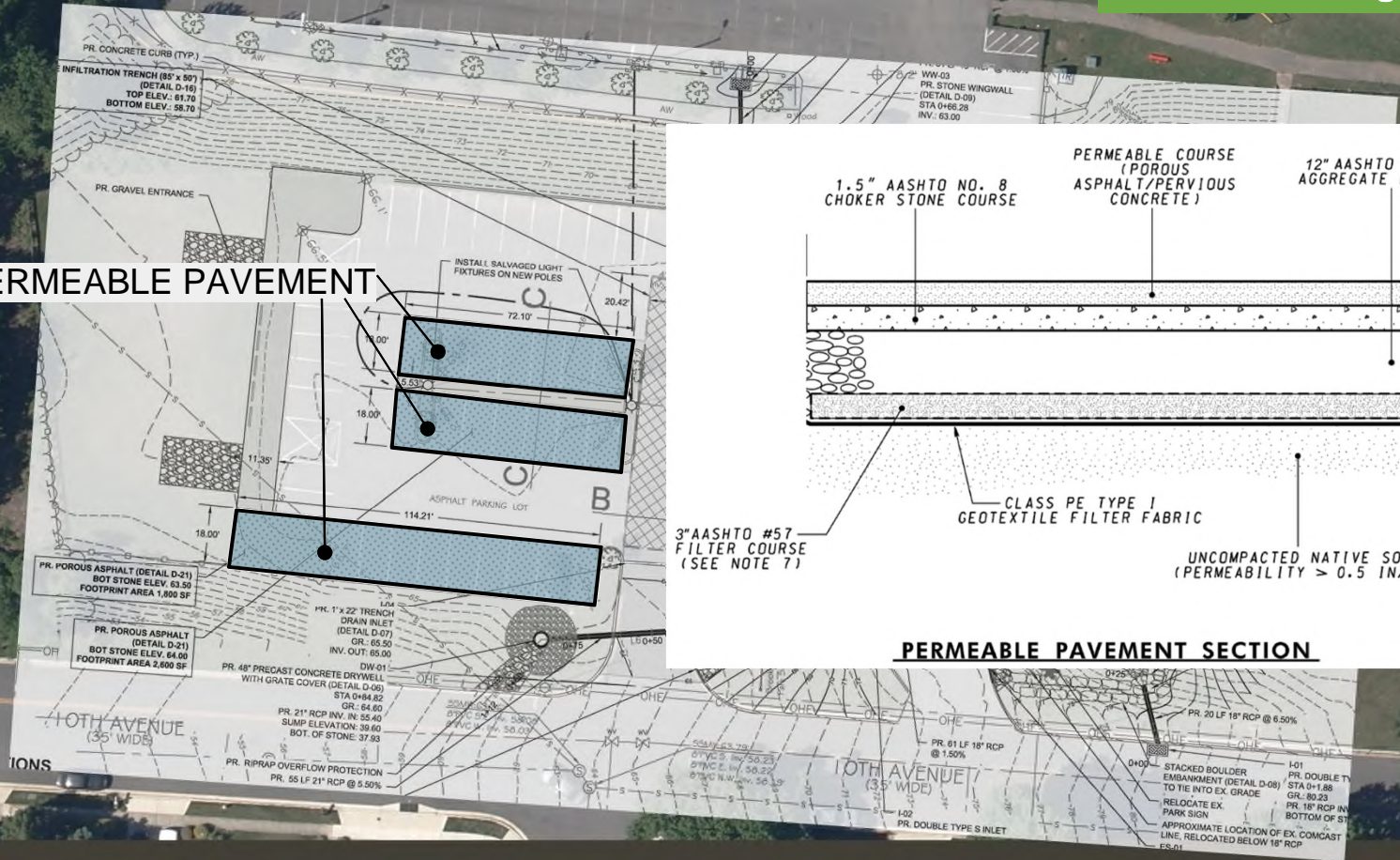
SITE CHALLENGES

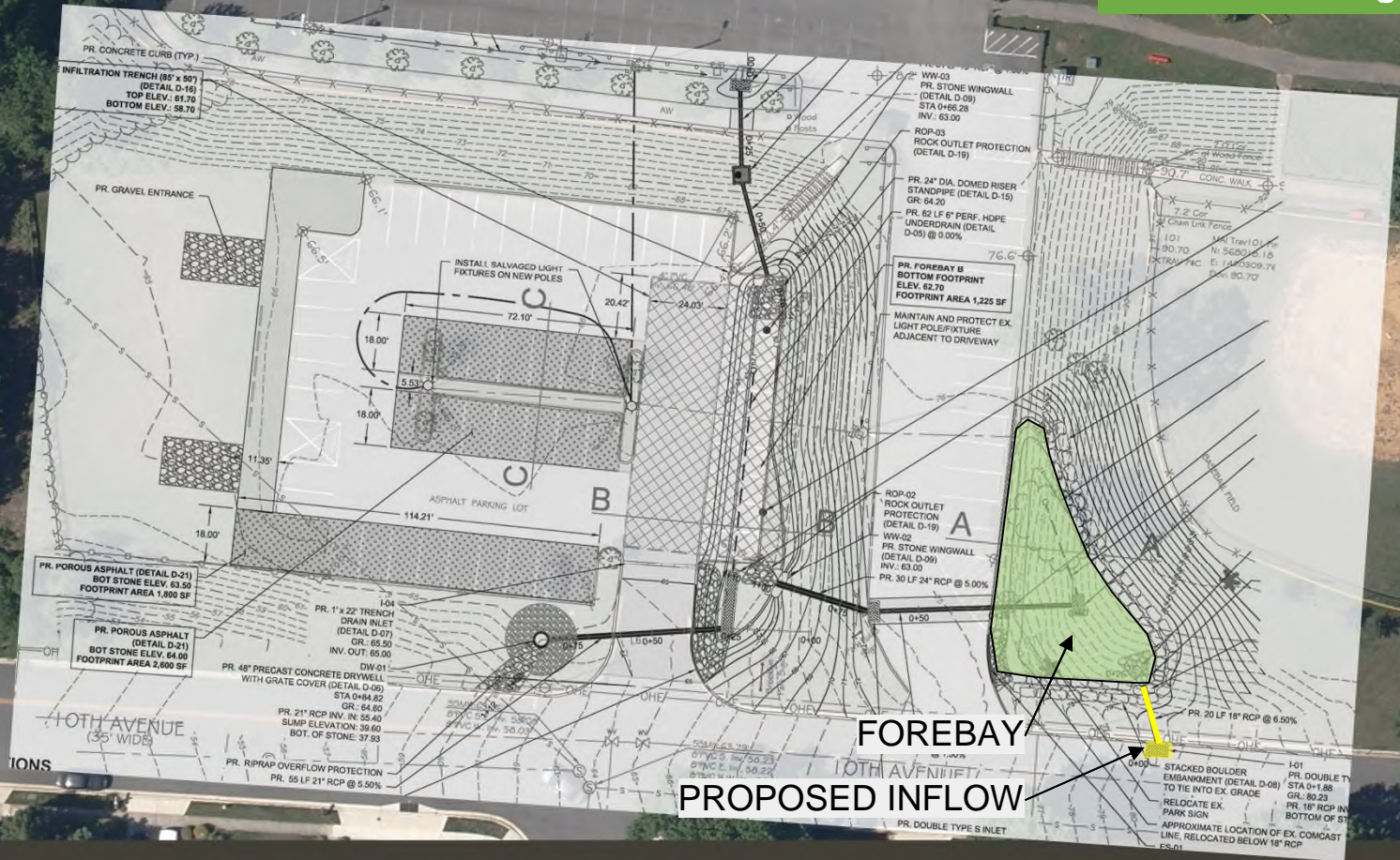
- Site constraints for SMP location
 - Steep grades
- Safe conveyance of overflow (no public storm sewer)
- Construction timing



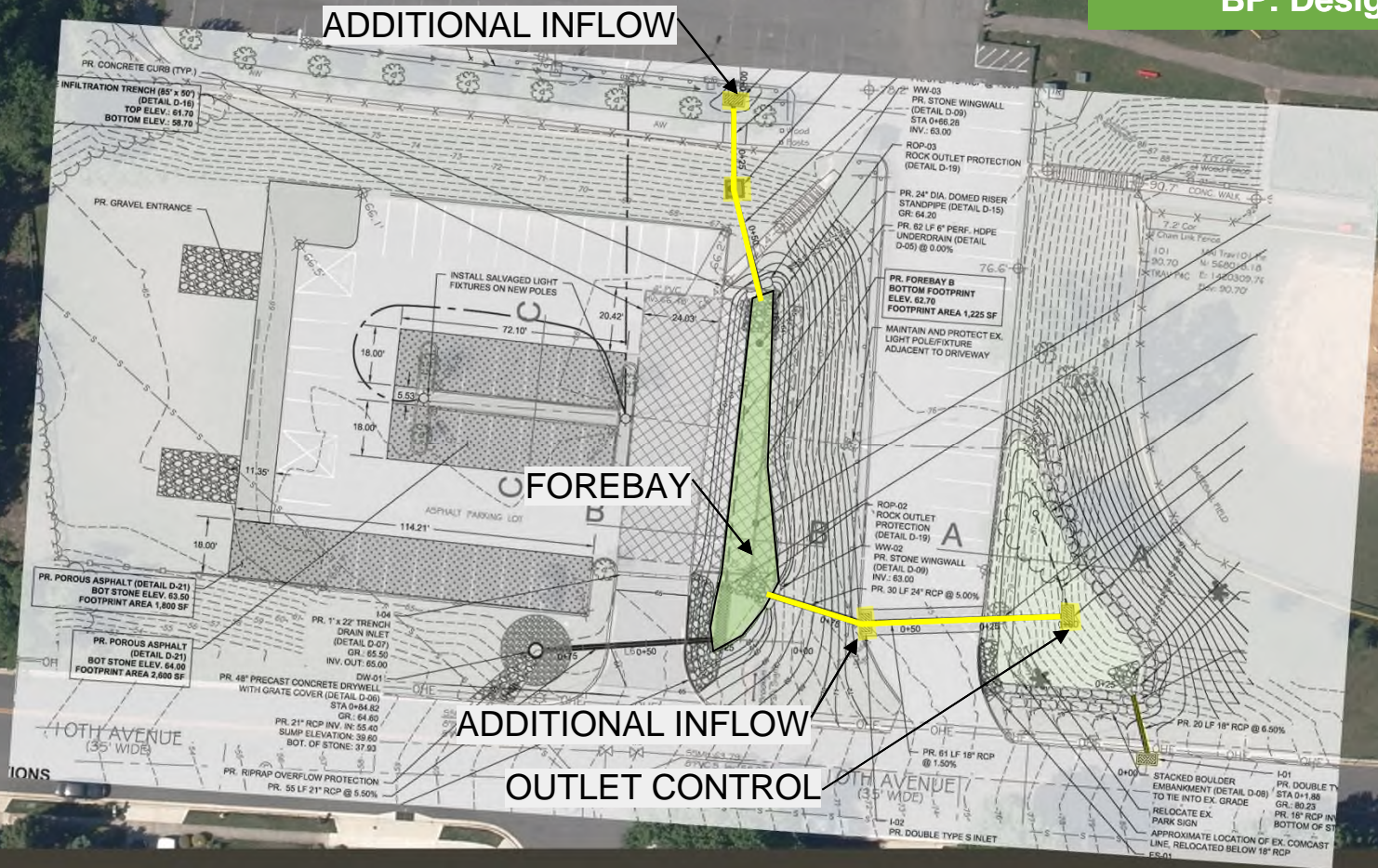


PERMEABLE PAVEMENT





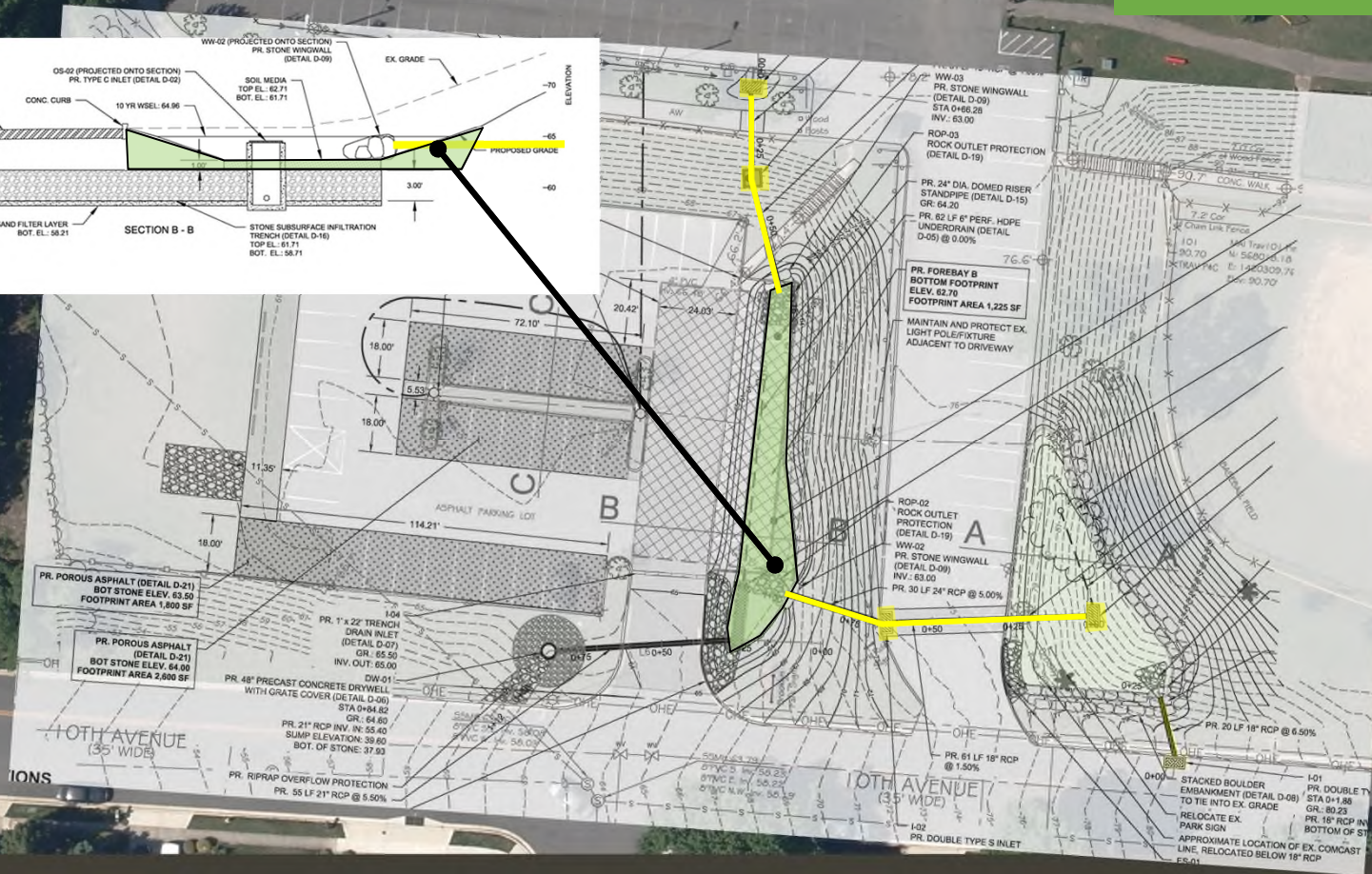
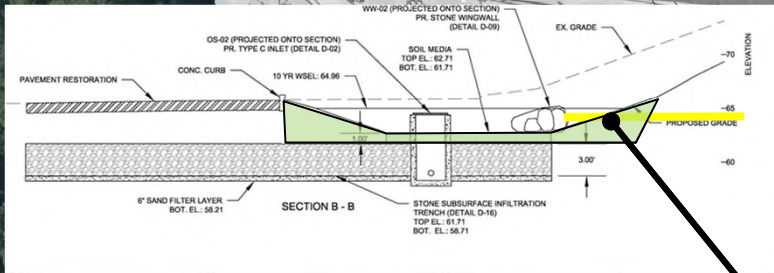
FOREBAY
PROPOSED INFLOW



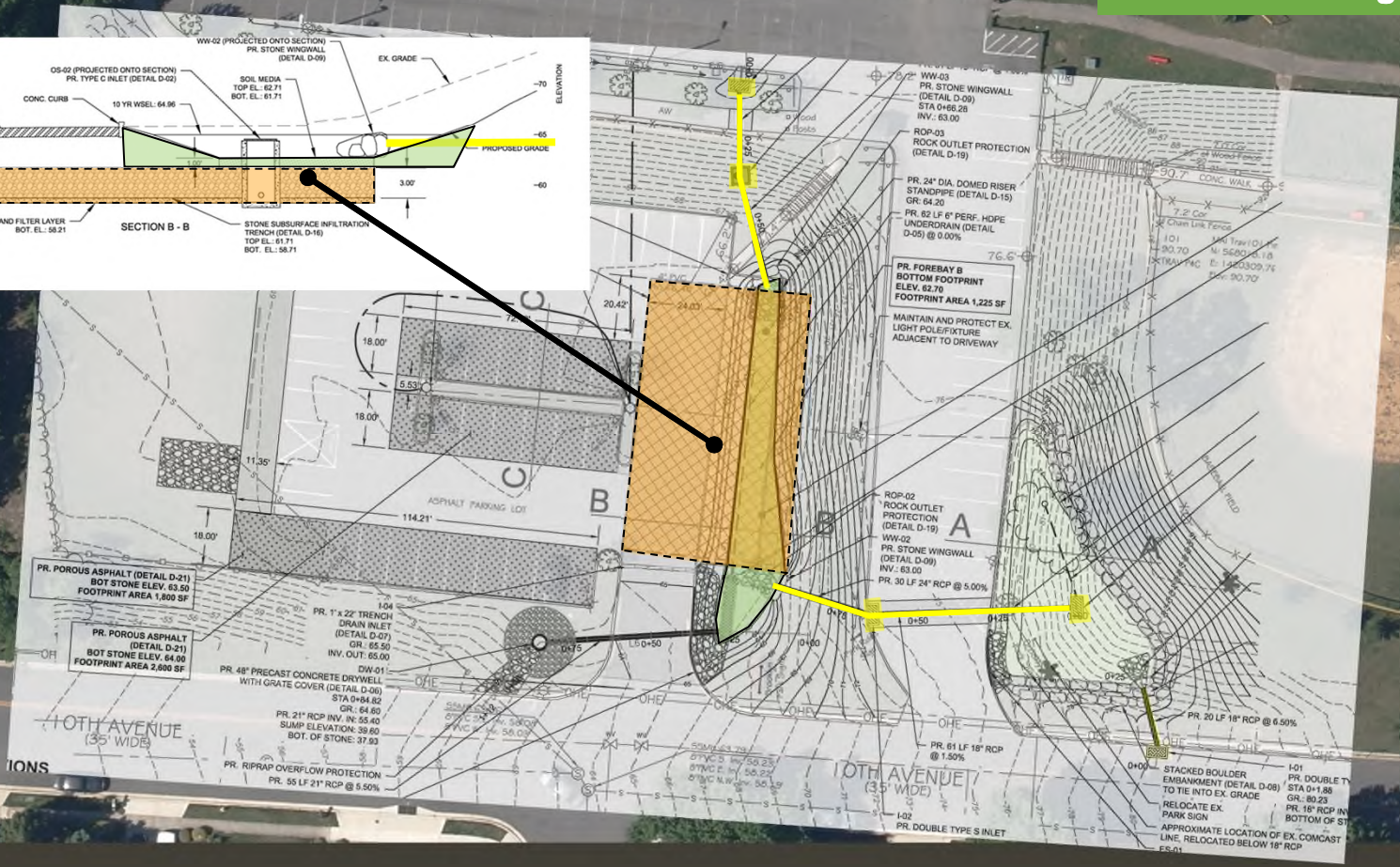
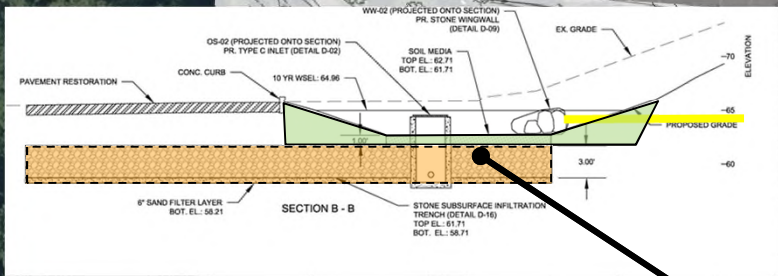
ADDITIONAL INFLOW

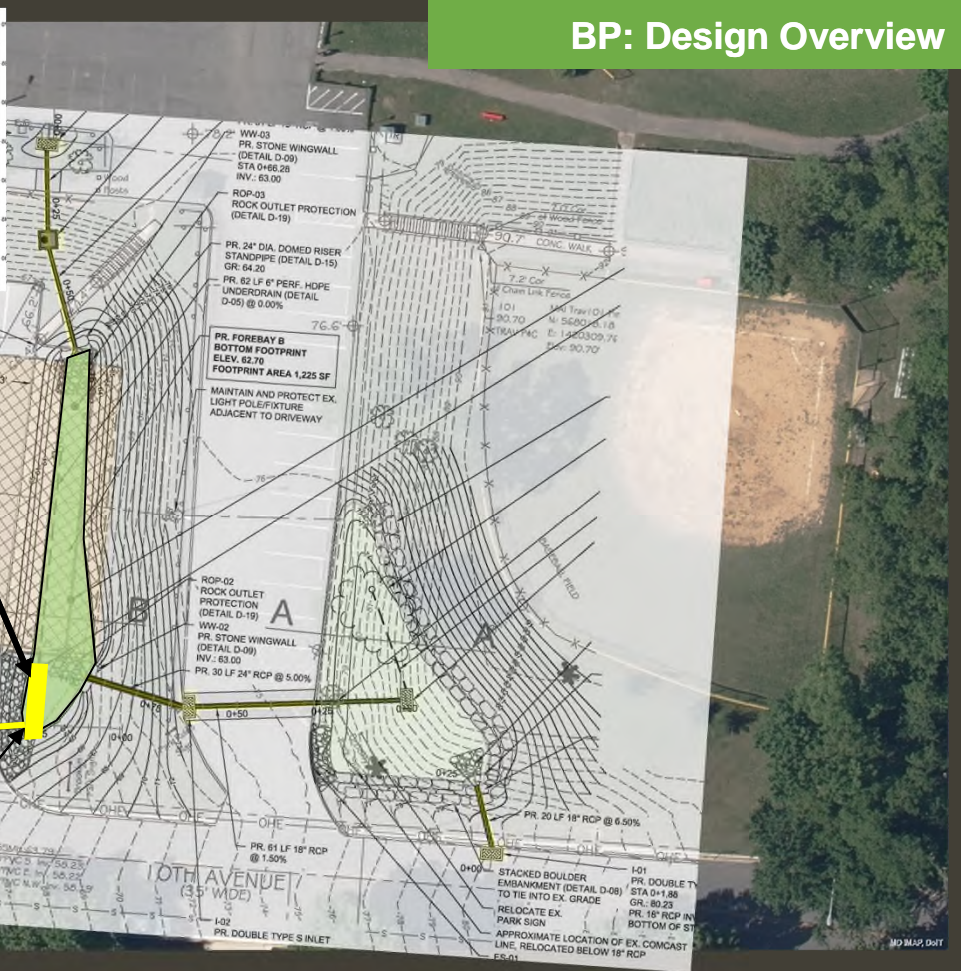
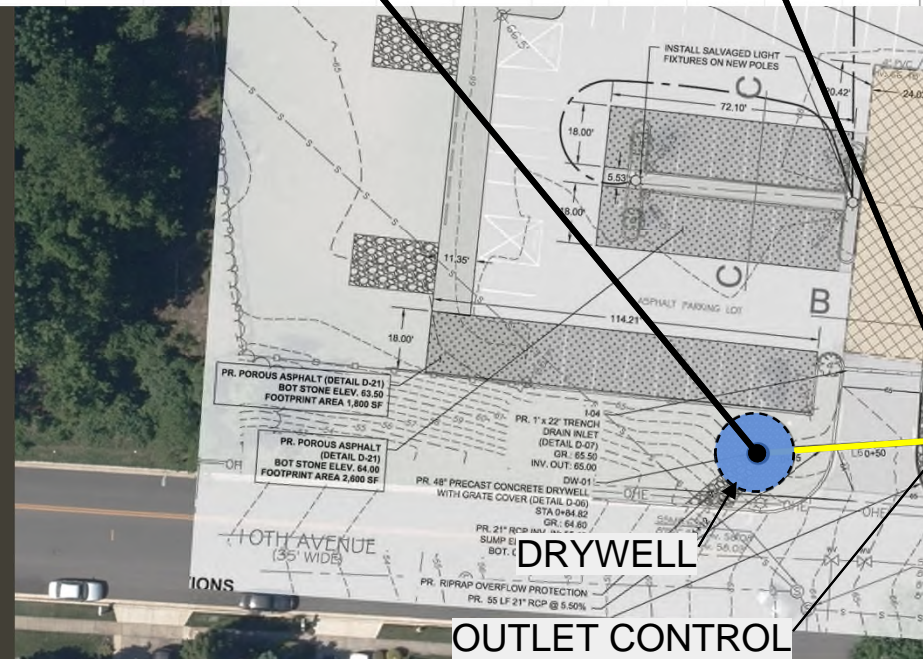
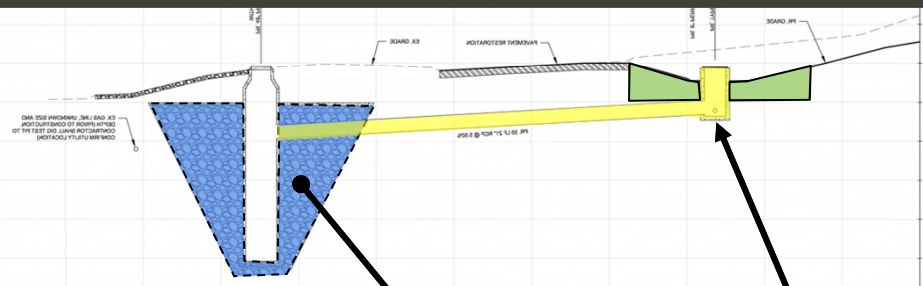
FOREBAY

ADDITIONAL INFLOW
OUTLET CONTROL



MO BMAP, D&T

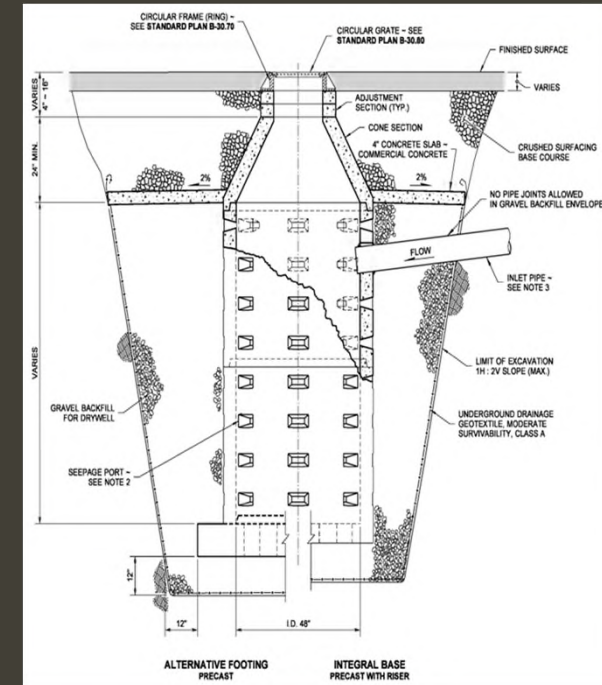
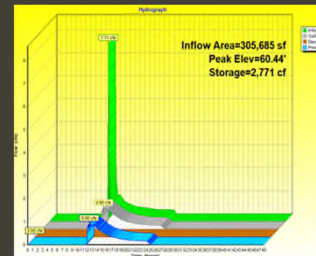




DRYWELL PILOT

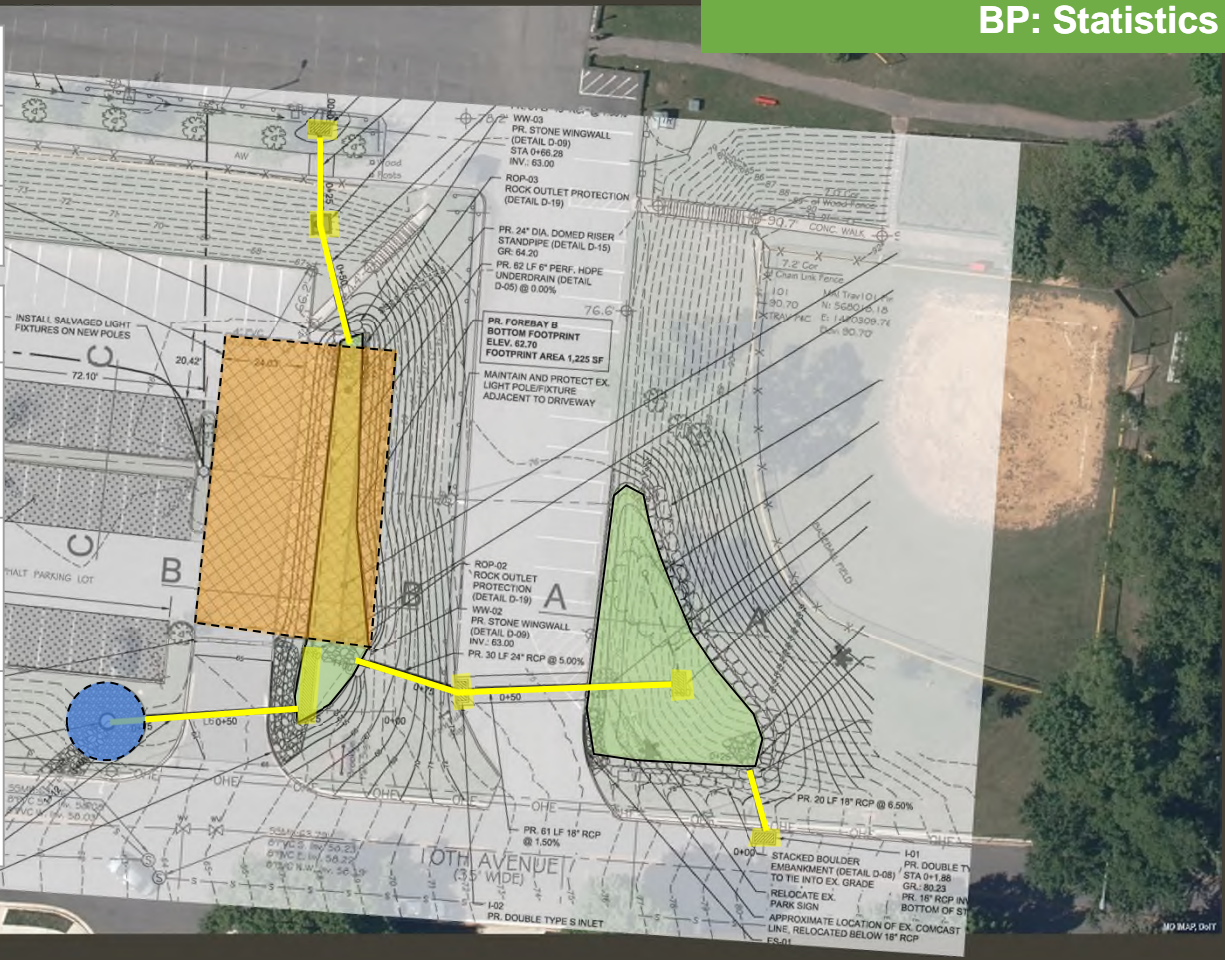
- Washington DOT Drywell Detail
- Manhole embedded in stone
- Typical depth: 10 FT - 30 FT
- AACo Drywell Pilot
 - Storage volume for 2-year storm
 - Overflow via surcharge

STORM	RAINFALL DEPTH	REQ. DRYWELL(S)
1YR - 24HR	2.70 IN	(1) 10-FT Drywell
2YR - 24HR	3.30 IN	(1) 20-FT Drywell
10YR - 24HR	5.20 IN	(6) 20-FT Drywells



Total Drainage Area	7.05 AC
Treated Impervious Area	2.76 AC
Water Quality Volume	10,200 CF

	TN	TP	TSS
Pollutant Removal Efficiencies	58%	68%	73%
Annual Pollutant Load	42 lbs	5 lbs	2,432 lbs
Annual Pollutant Load Removal	25 lbs	3 lbs	1,775 lbs



Riverside Park





OUTFALL PIPE FROM I-895



12 FT WIDE CONCRETE CHANNEL



Riverside Park

STORMWATER MANAGEMENT OPPORTUNITIES

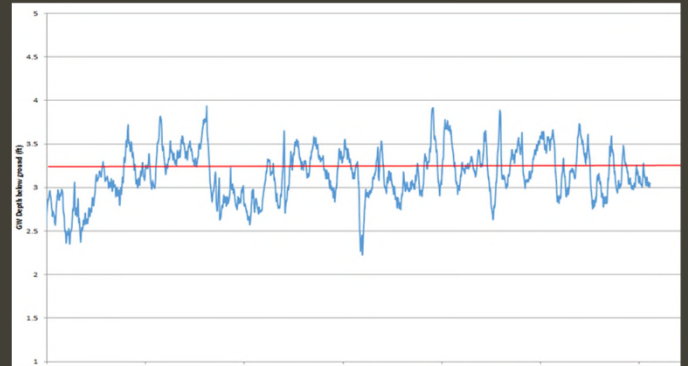
- Ephemeral channel well suited for SPSC
- Convert impervious concrete swale into pervious, naturalized step-pool channel system
- Remove invasive plants and establish native landscaping



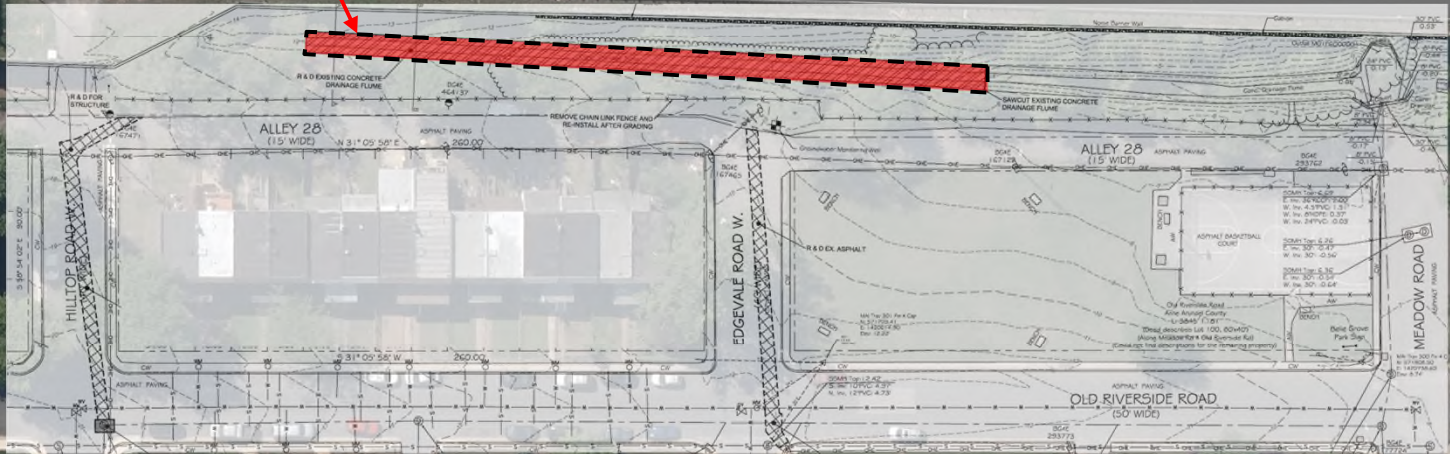
Riverside Park

SITE CHALLENGES

- Physical space
- I-895 noise wall foundation
- Shallow groundwater table



REMOVE SEGMENT OF CONCRETE CHANNEL



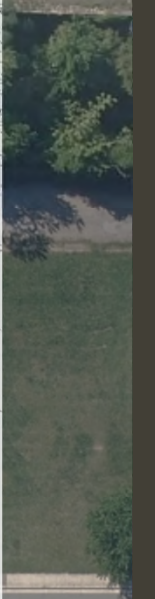
I-895 INFLOW

EXISTING STORM SEWER

DIVERSION STRUCTURES

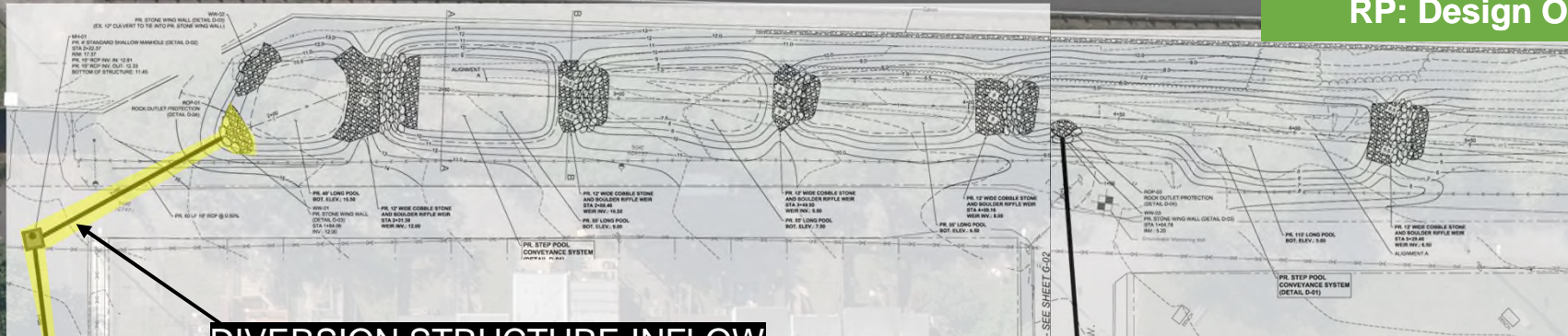


RP: Design Overview

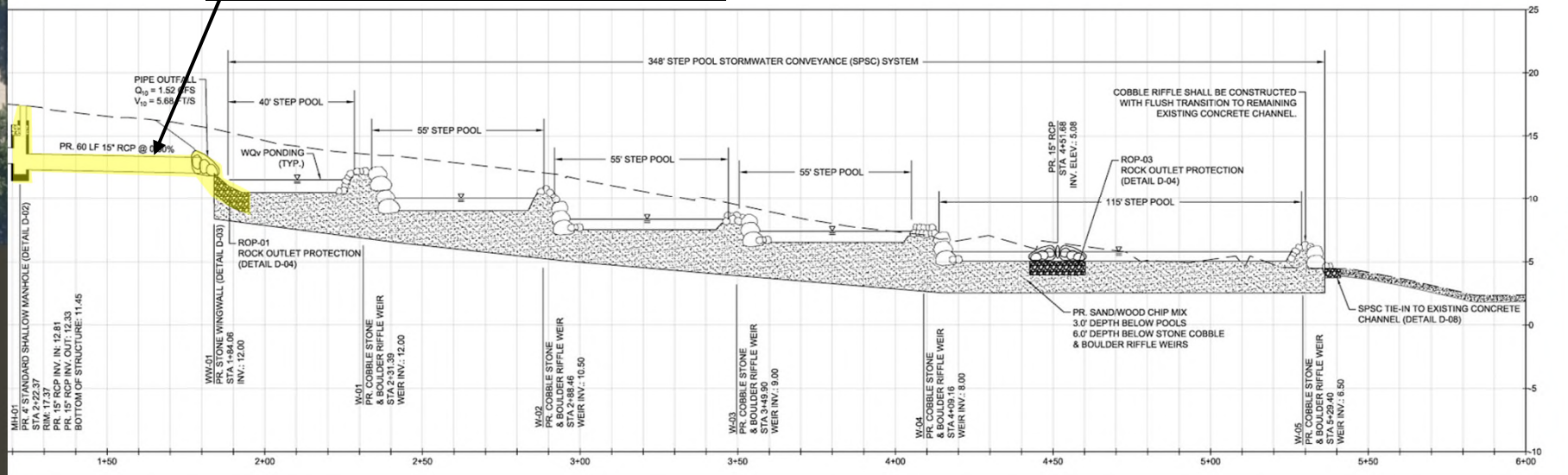


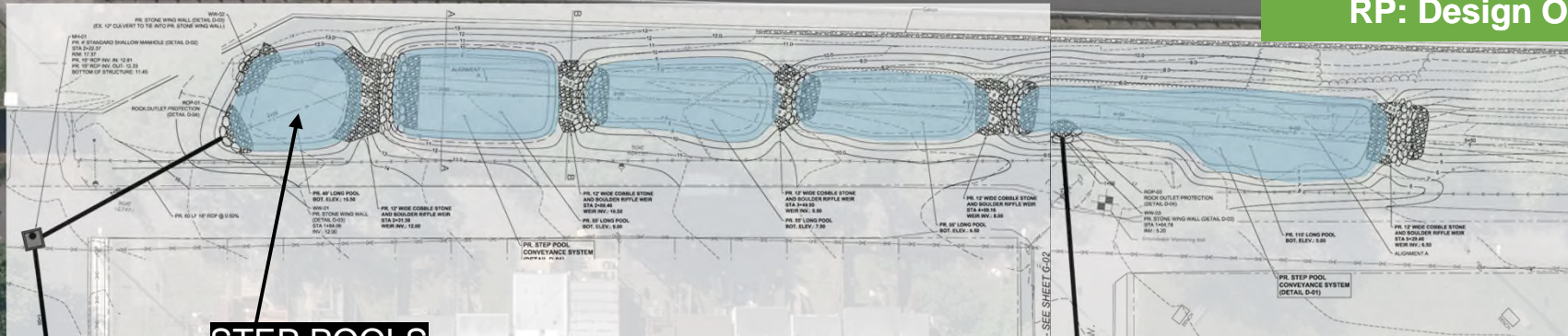
MD MAP 2-17



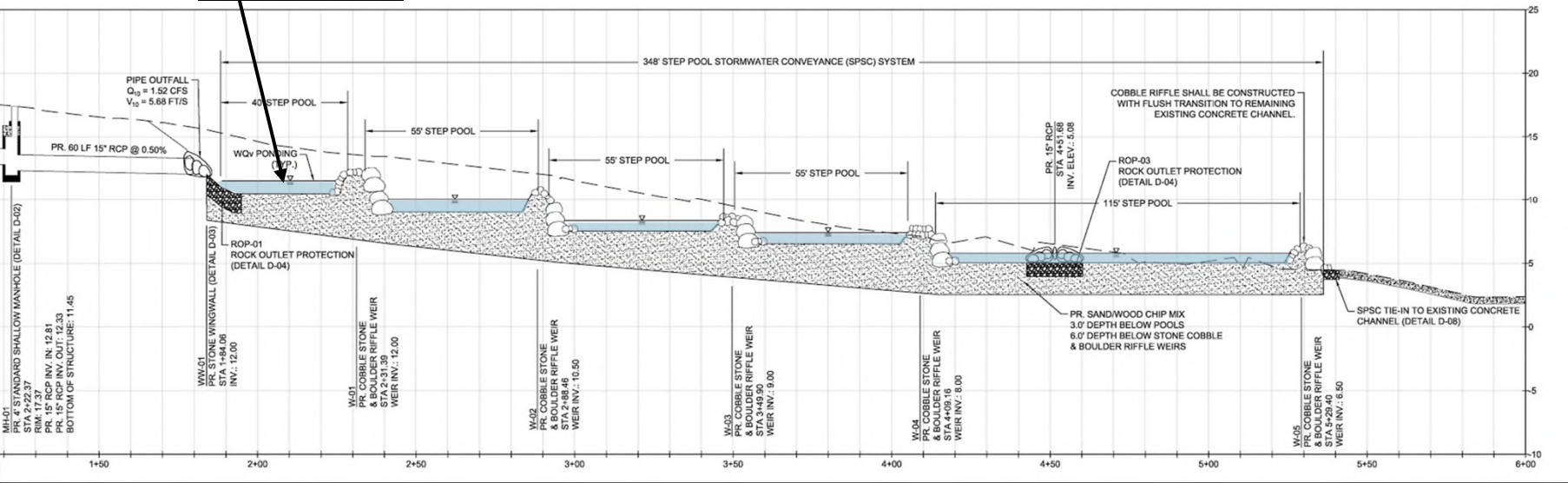


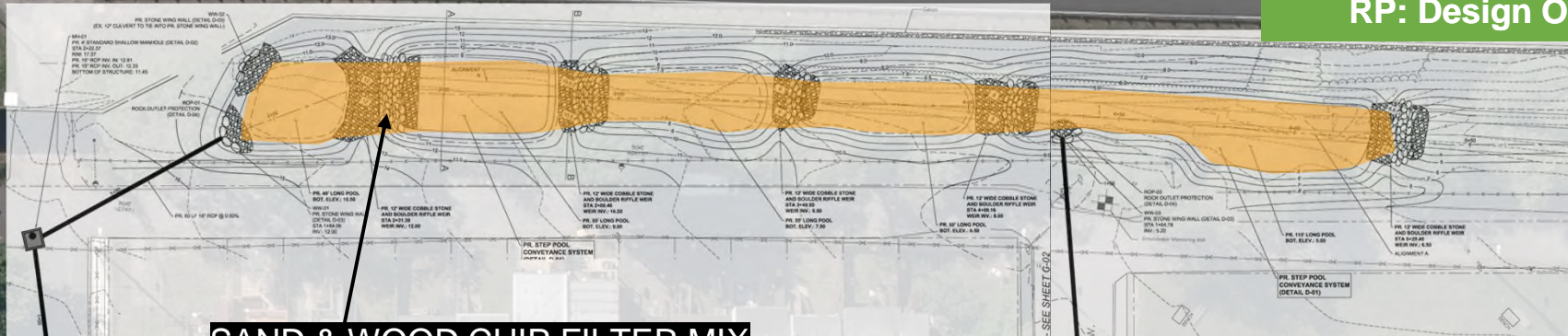
DIVERSION STRUCTURE INFLOW



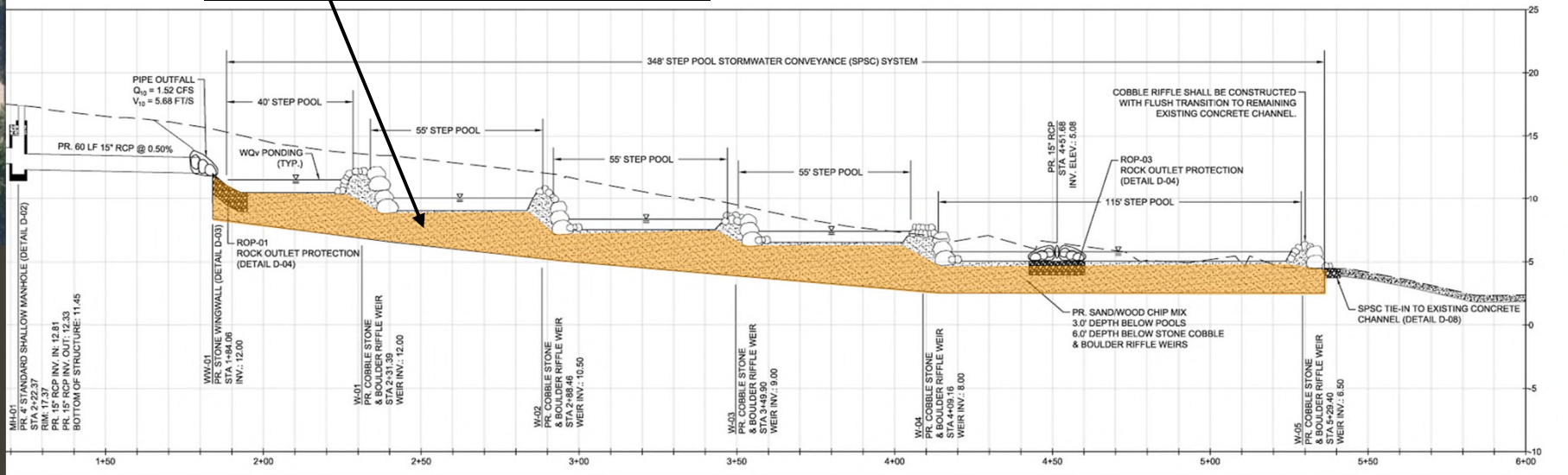


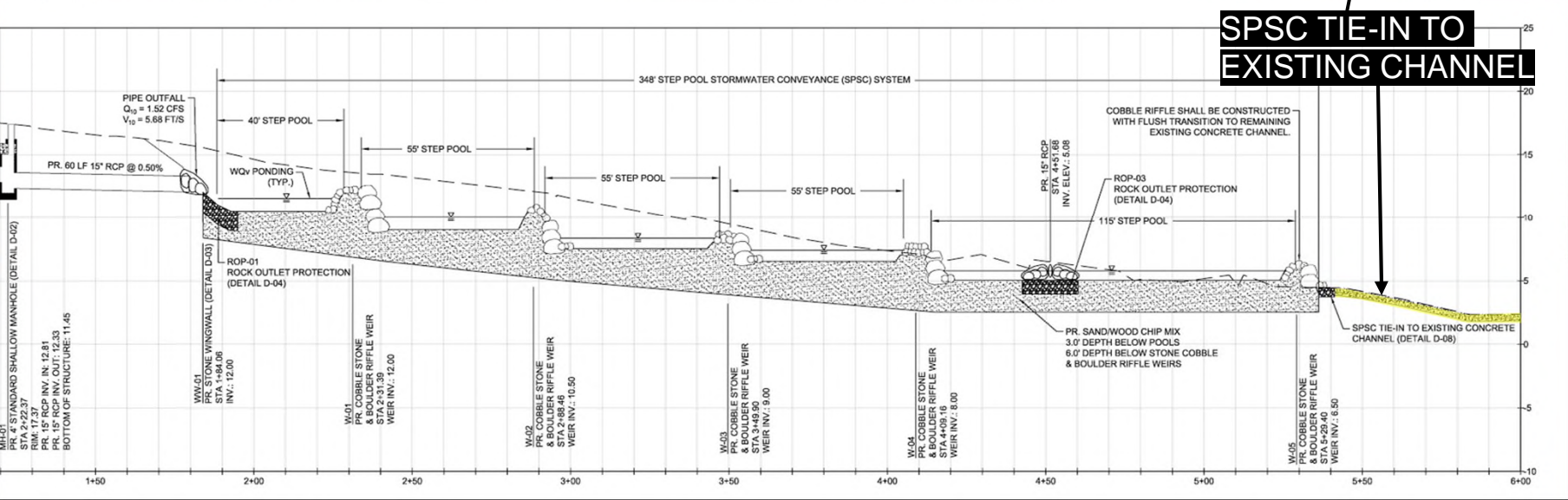
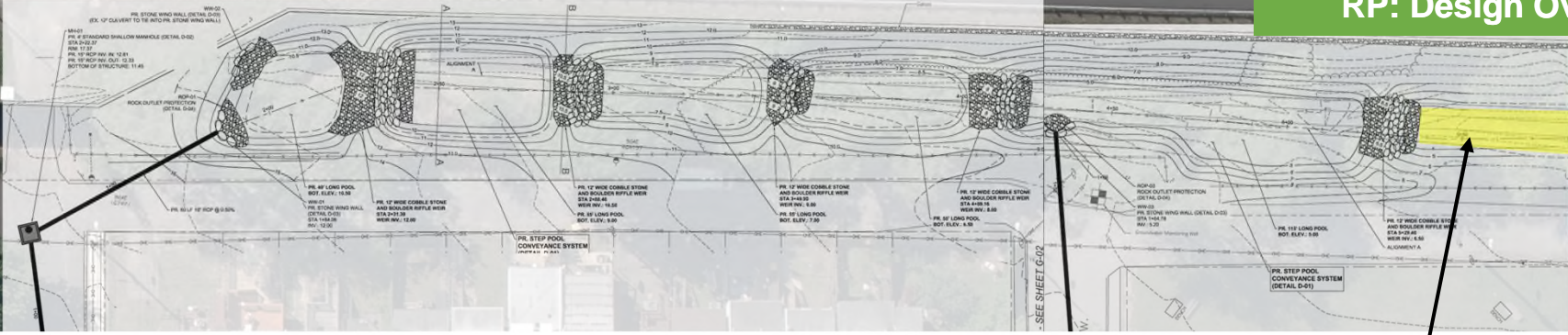
STEP POOLS





SAND & WOOD CHIP FILTER MIX

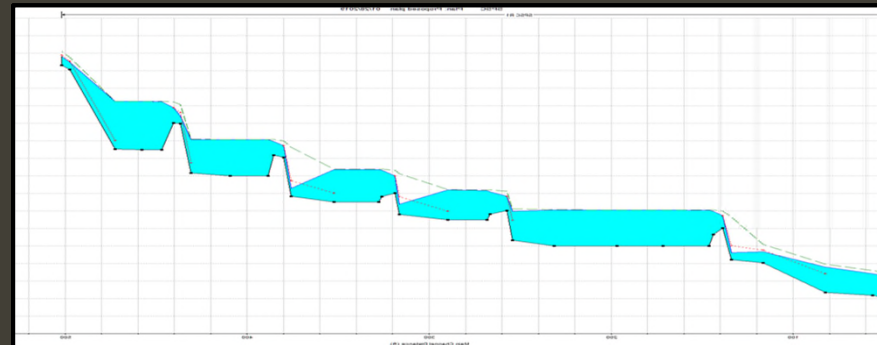




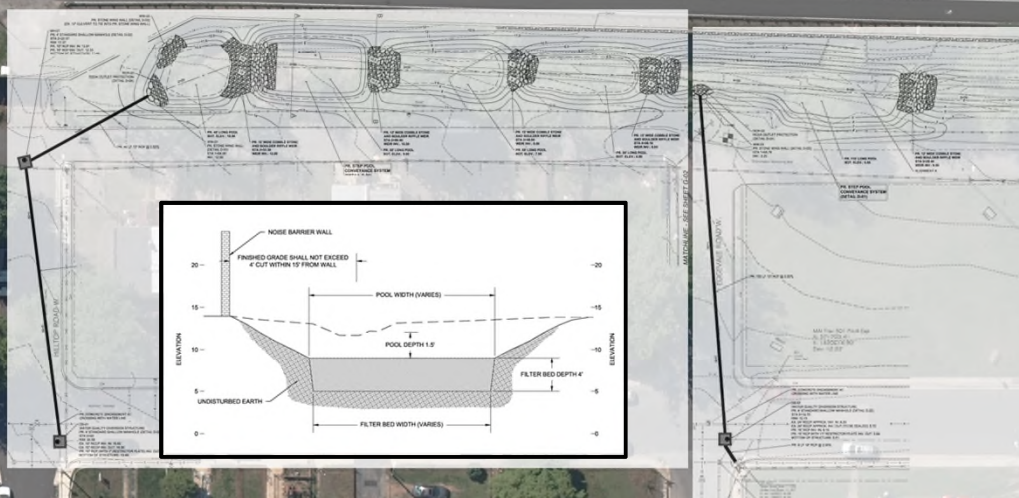
SPSC TIE-IN TO EXISTING CHANNEL

ADDITIONAL ANALYSIS

- 1-D steady state HEC-RAS modeling of SPSC
- Propose to line 5 FT of pool with cobble material



Total Drainage Area	8.72 AC
Treated Impervious Area	4.75 AC
Water Quality Volume	17,060 CF



	TN	TP	TSS
Pollutant Removal Efficiencies	58%	68%	73%
Annual Pollutant Load	71 lbs	8 lbs	4,089 lbs
Annual Pollutant Load Removal	41 lbs	5 lbs	2,985 lbs



Najoles Road Pond Retrofit and Stream Restoration



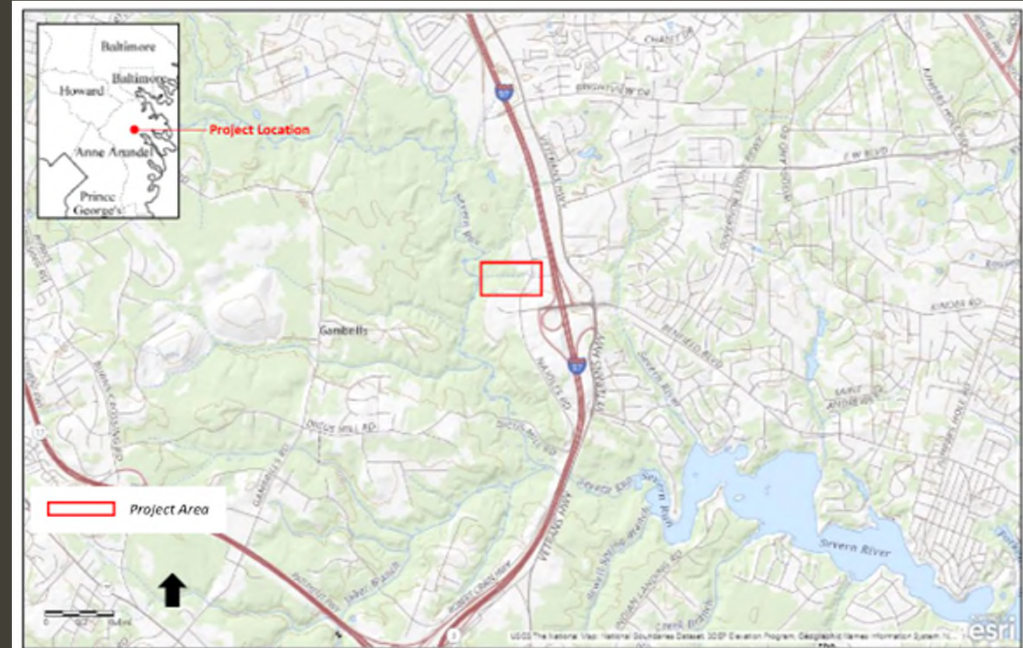
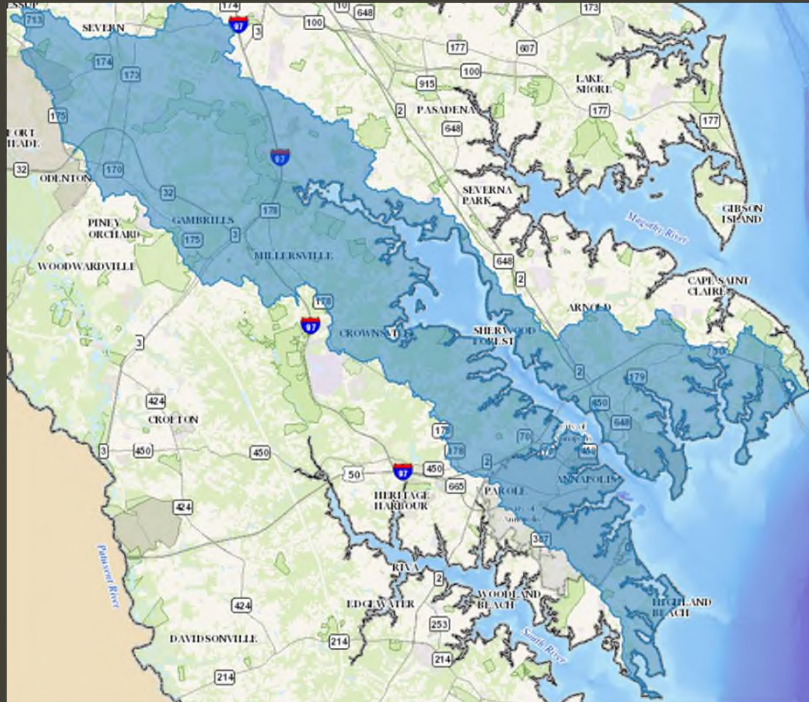
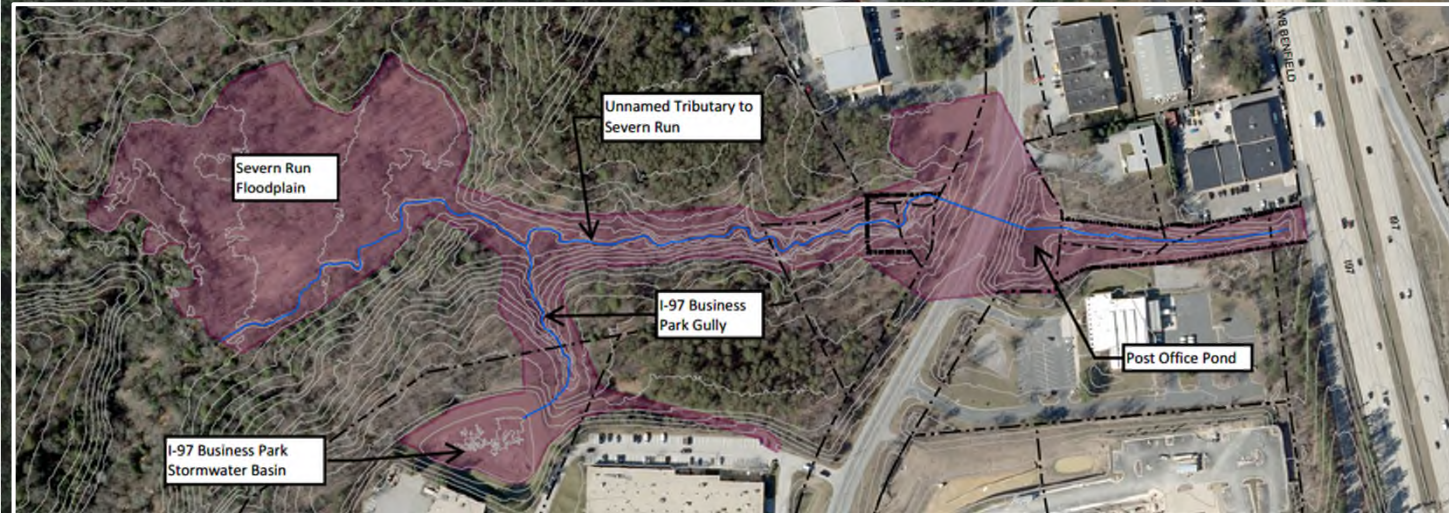


Figure 1: Project Vicinity Map



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, MD MAP, DOT



- Pond constructed in 1990s for I-97
 - Potentially for sediment control
- Does not provide water quality treatment
- UNT to Severn Run
 - First order stream, Class IV tributary to SR, approx. 1800 LF to SR Floodplain
 - Tall banks severely eroded, sediment being mobilized to SR Natural Environment Area owned by MD DNR
- Gully from adjacent I-97 Business Park



Najoles Road



SITE CHALLENGES

- Topography; access
- Temporary dewatering of pond and UNT to SR
- Floodplain tie-in to Severn Run (work near delineated wetland)
- Climbing Fern (*Lygodium palmatum*)
 - G4-S2 State Threatened Plant

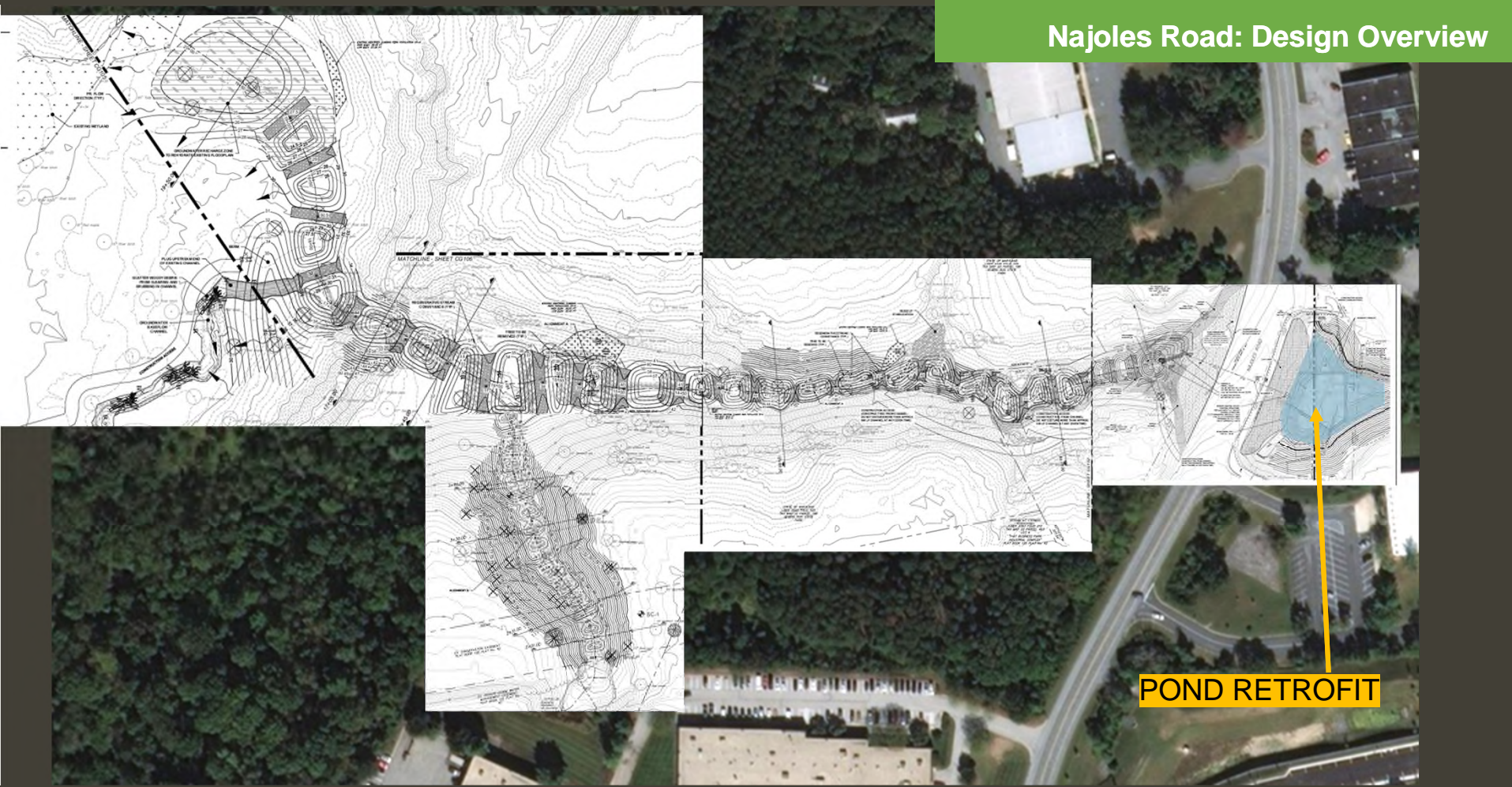
Najoles Road



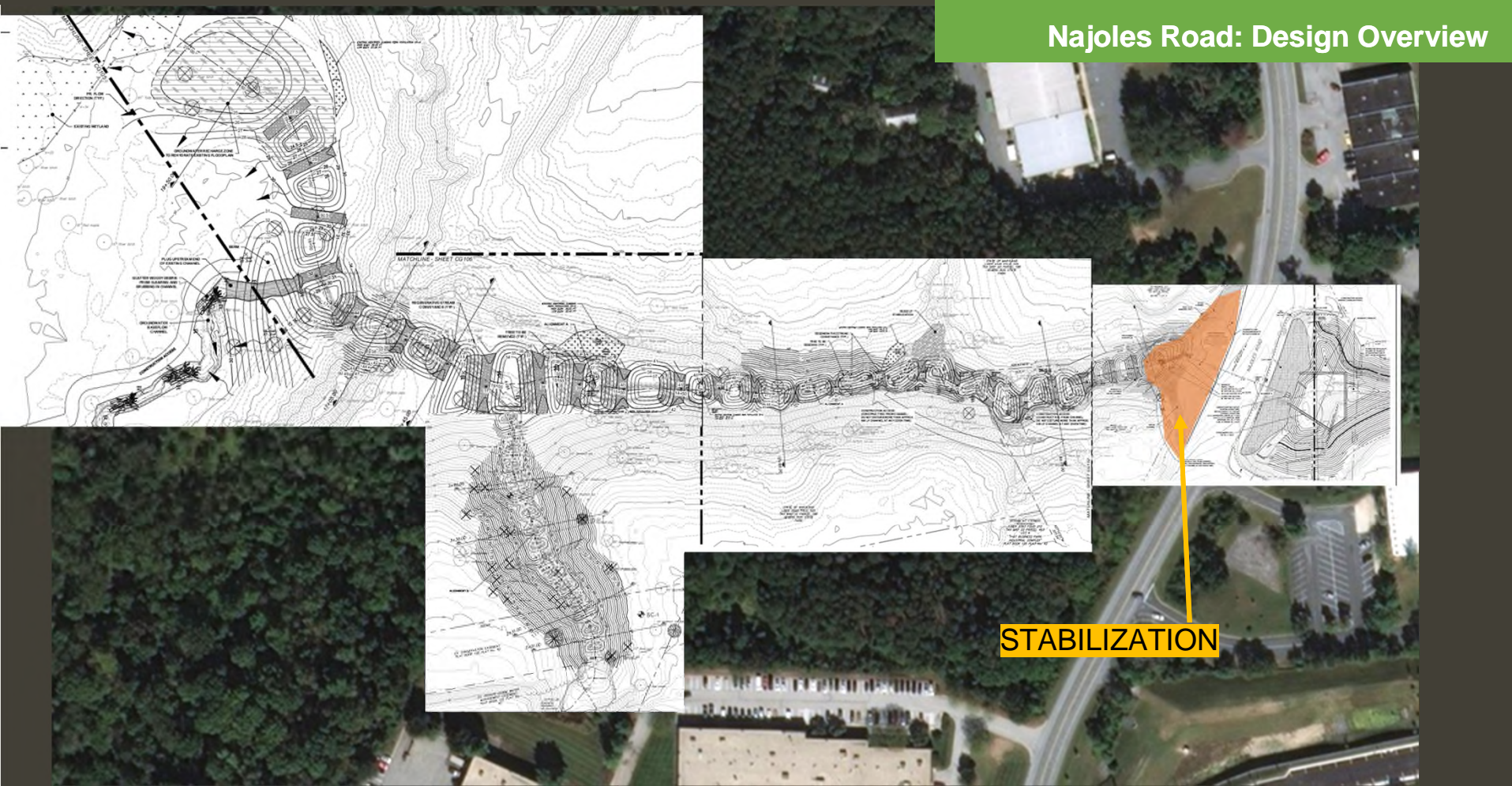
SWM OPPORTUNITIES

- Retrofit wet pond to current standards for WQv treatment
- Stabilize eroding banks
- Stream restoration using RSC
- Gully stabilization using SPSC
- Groundwater reconnection within Severn Run Floodplain
- Remove transient sediment deposits from upstream bank erosion

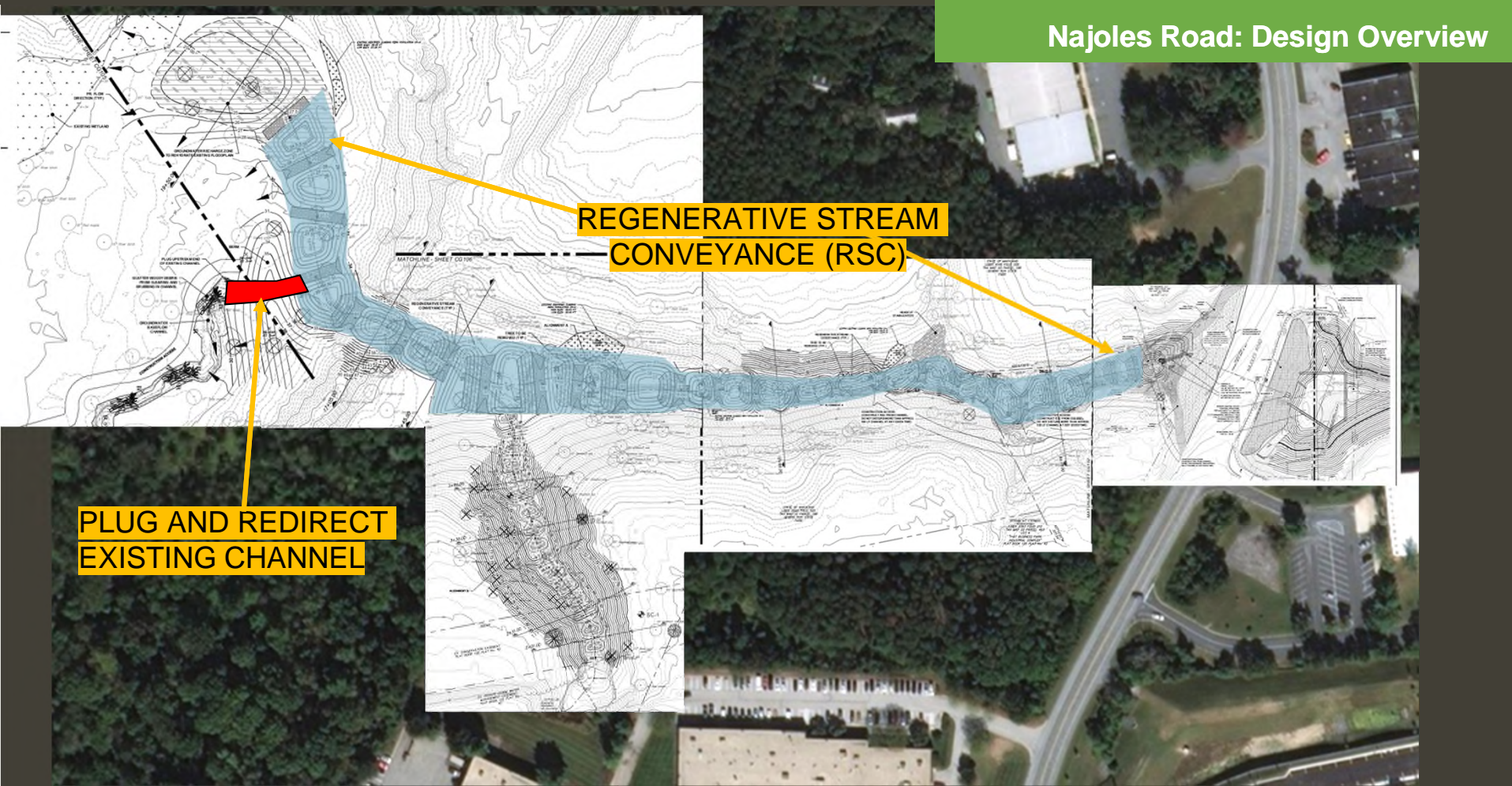
Najoles Road: Design Overview

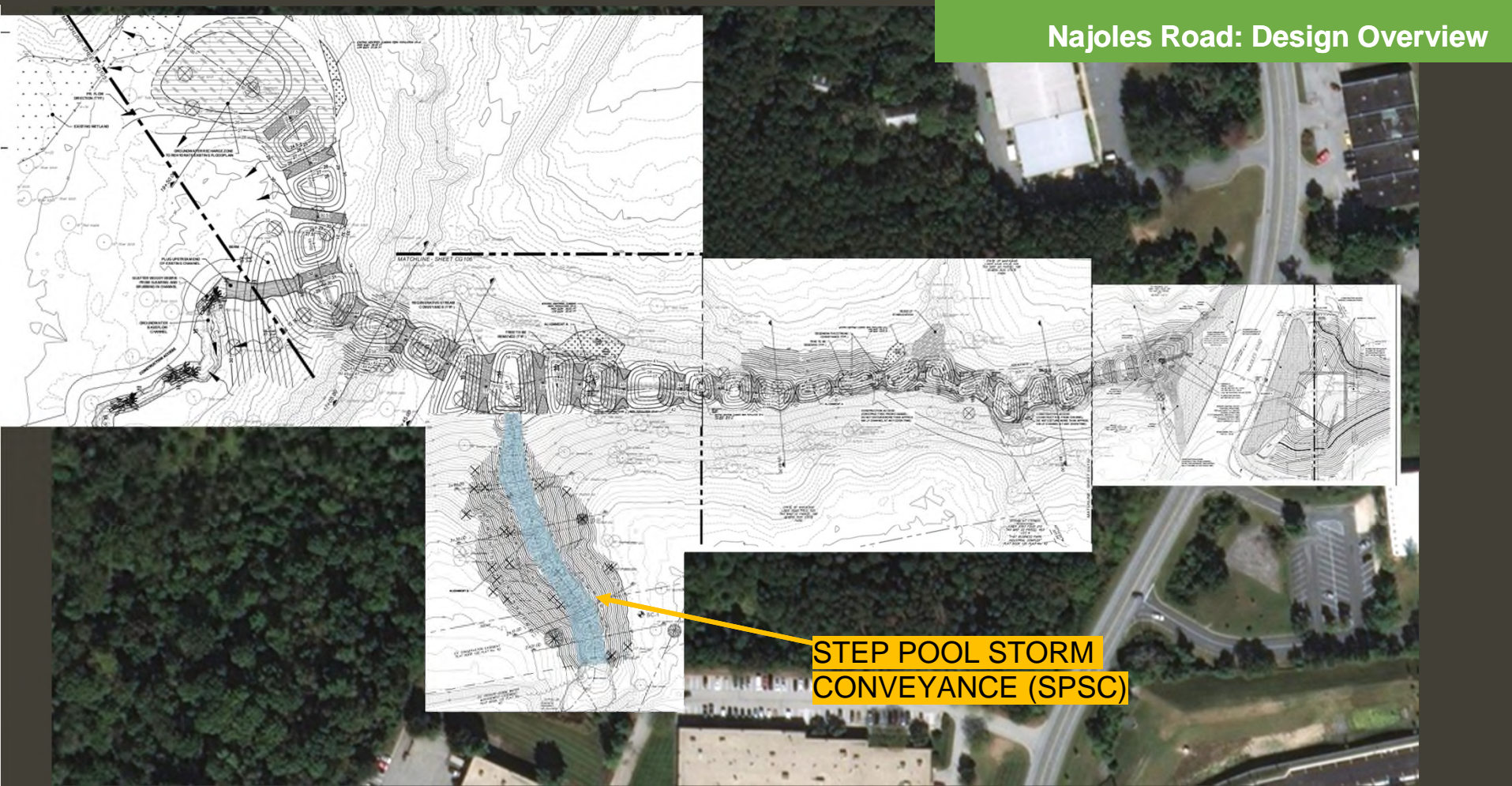


Najoles Road: Design Overview

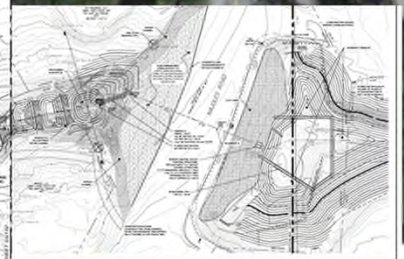
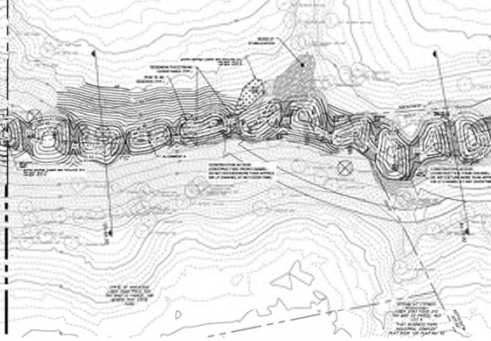
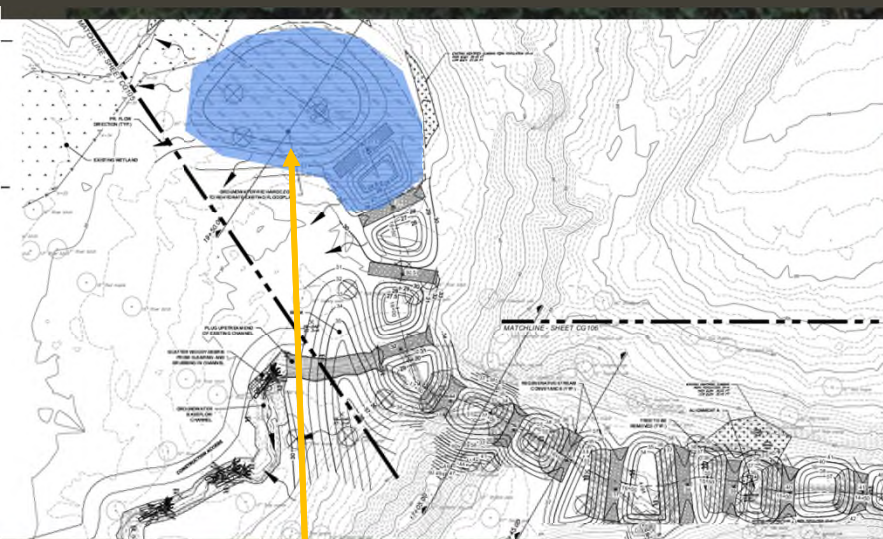


STABILIZATION

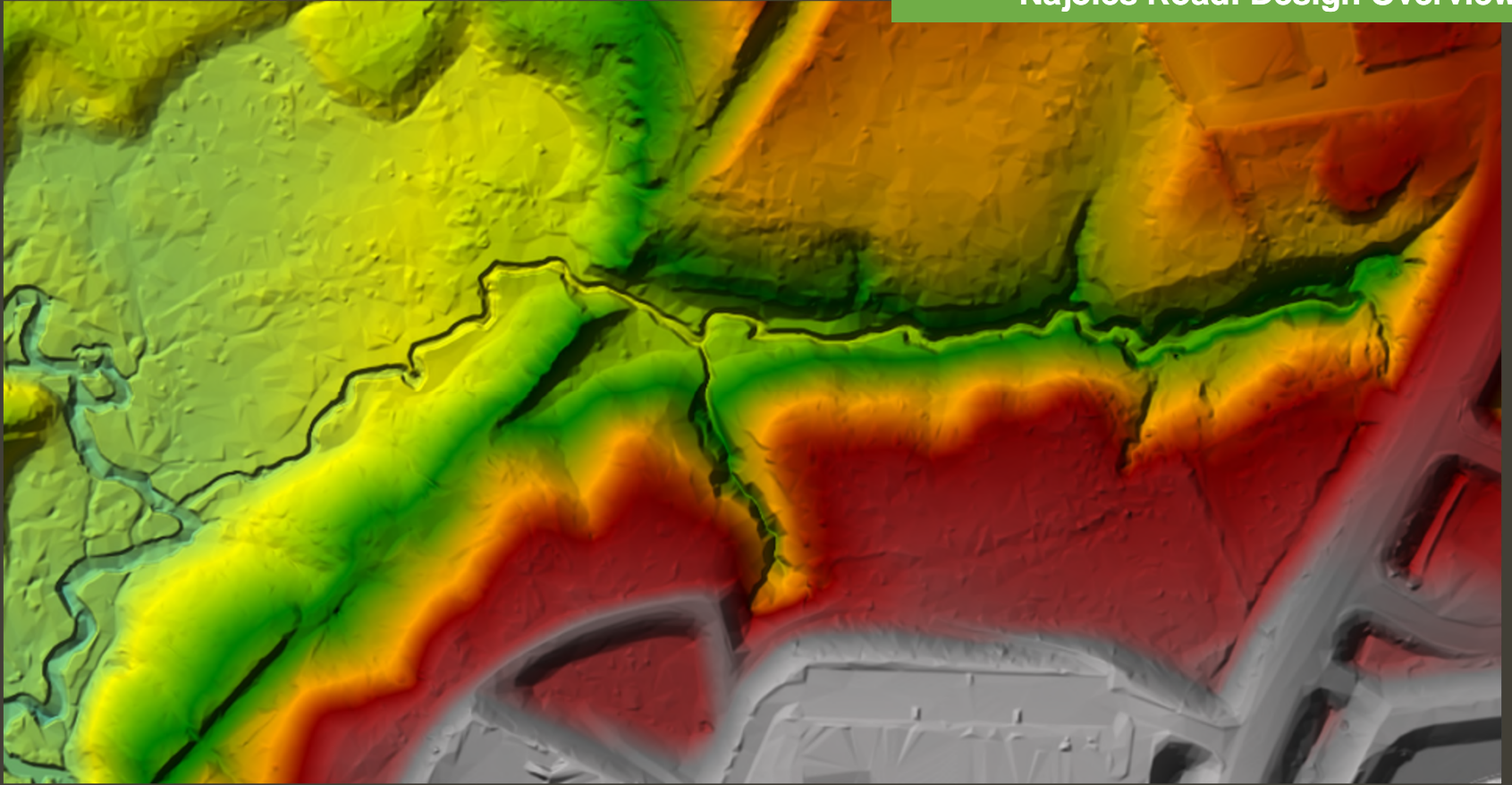


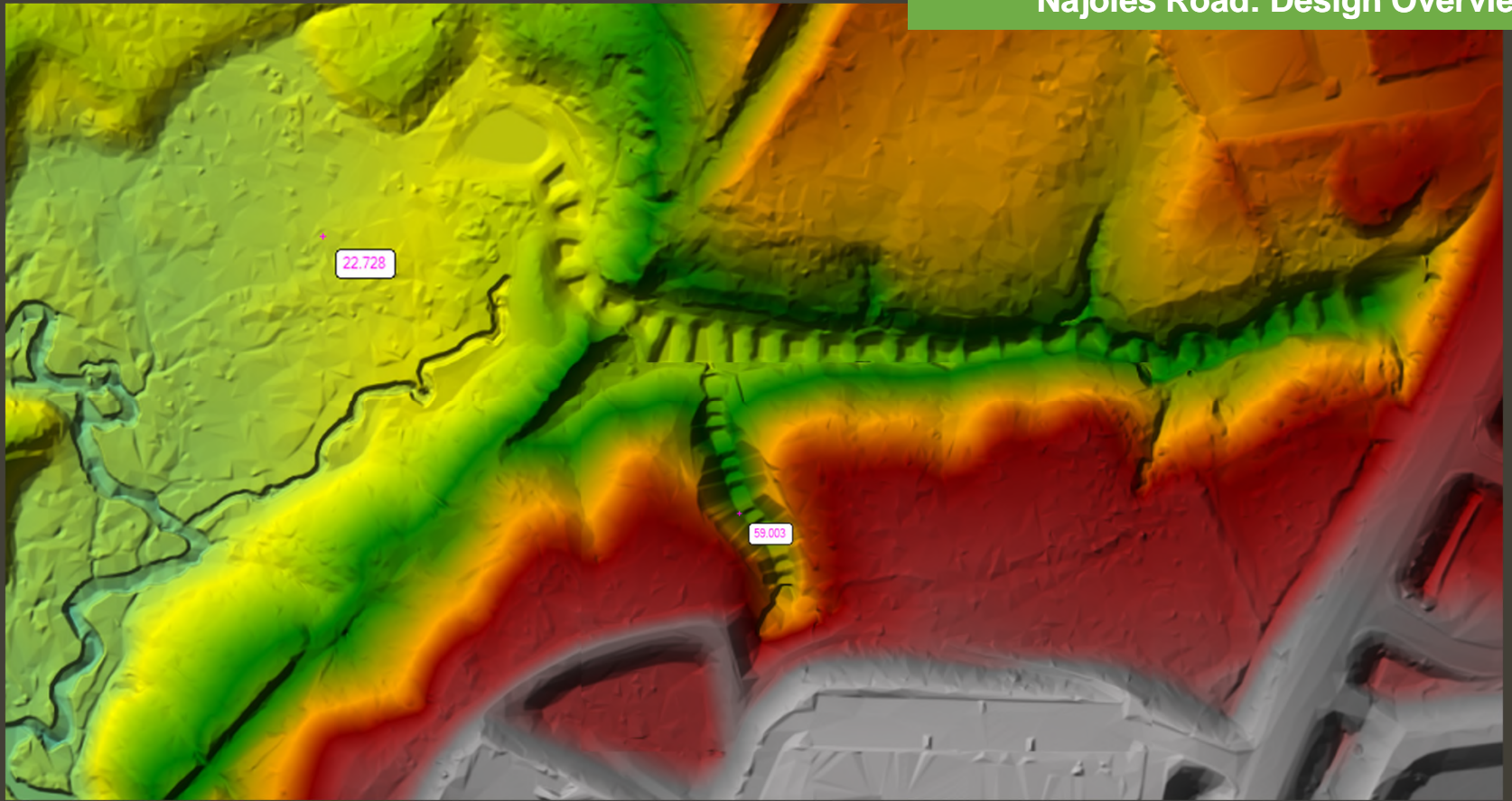


**STEP POOL STORM
CONVEYANCE (SPSC)**

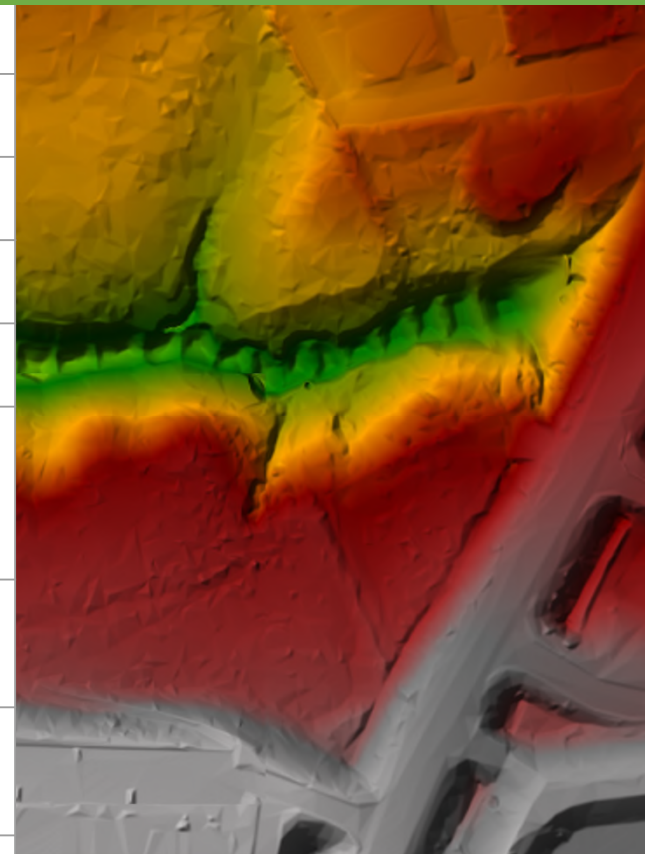


FLOODPLAIN TIE-IN





Drainage Area	130 AC		
Impervious Area Treated	56.5 AC		
Water Quality Volume	176,461 CF		
ANNUAL POLLUTANT REMOVAL (LBS)			
	TN	TP	TSS
Wet Extended Detention Pond Retrofit	234	41	26,960
Regenerative Stream Conveyance	404	129	2,251,700
Step Pool Storm Conveyance	46	6	3,360
TOTAL	685	176	2,282,000



Summary

STORMWATER RETROFITS

- Variety of System Options & Combinations
 - Hybrid BMP configurations
 - Infiltration Basin
 - Infiltration Trench
 - Permeable Pavement
 - Step Pool Storm Conveyance
 - Regenerative Storm Conveyance
- Achieve Improved:
 - Water Quality
 - Quantity Control, Flood Mitigation
 - Waterway and Outfall Stability
 - Functional Uplift
 - Native Vegetation Establishment



source: Underwood & Associates

Thank You

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2000 Maryland Stormwater Design Manual Vol. I & II

<https://mde.maryland.gov/programs/Water/StormwaterManagementProgram/Documents/www.mde.state.md.us/assets/document/sedimentstormwater/MD%20SWM%20Volume%201.pdf>

Severn Run Riverkeeper Program Regenerative Stream Conveyance (RSC) Fact Sheet

<https://www.aacounty.org/departments/public-works/wprp/forms-and-publications/RSC%20Fact%20sheet.pdf>

Anne Arundel County Regenerative Step Pool Storm Conveyance (SPSC) Design Guidance

<https://www.aacounty.org/departments/public-works/wprp/forms-and-publications/SPSCdesignguidelinesDec2012Rev5a.pdf>

Anne Arundel County Department of Public Works (DPW) Design Manual

<https://www.aacounty.org/departments/public-works/engineering/design-manual/index.html>

Severn Run Riverkeeper Program Regenerative Stream Conveyance (RSC) Frequently Asked Questions (FAQ)

<https://static1.squarespace.com/static/5055233ce4b0088c255cf31/t/52cf0d00e4b043c17001192e/1389300992835/RSC+FAQ.pdf>

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