Receiving Streambank Regeneration Through Upland Hydrologic Restoration

CWEA Webinar

August 10, 2017

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Byron Madigan

NPDES & TMDL Compliance

Modified, Enhanced, and Enlarged Sand Filters as Retrofits of Existing Stormwater Management Ponds

As of 2016
25 Carroll County Modified Sand Filters

FACILITY	DRAINAGE AREA	IMPERVIOUS AREA	INCHES OF TREATMENT	TN REDUCTION (LBS/YEAR)	TP REDUCTION (LBS/YEAR)	TSS REDUCTION (TONS/YEAR)
Marriott Wood I Facility #1	3.00	0.56		11.52	1.04	0.28
Hickory Ridge	23.75	4.80	3.80	116.80	10.73	2.92
Bateman SWM Pond	47.25	7.40	6.80	228.31	19.56	5.14
Marriott Wood I Facility #2	7.12	2.04	4.63	36.15	3.72	1.07
Marriott Wood II	11.62	1.92	6.19	56.34	4.89	1.30
Elderwood Village	15.28	4.94	2.22	76.77	8.32	2.38
Collins Estate	32.68	6.36	2.99	160.26	14.56	3.94
Oklahoma II Foothills	23.72	6.06	2.36	102.04	9.99	2.81
Oklahoma Phase I	24.44	7.27	3.99	124.60	12.98	3.74
Edgewood	38.00	12.12	2.70	195.27	20.86	6.07
Upper Patapsco Phase I -Naganna Pond	24.50	10.00	2.70	130.03	15.27	4.60
High Point	9.40	1.82	2.58	46.08	4.18	1.13
Westminster High School	115.00	42.12	3.38	601.25	67.66	20.09
Brimfield	34.69	17.23	4.12	189.93	24.18	7.48
Upper Patapsco Phase II -Hoff Pond	77.30	2.98	52.57	356.27	24.42	5.54
Heritage Heights	21.40	4.10	6.96	104.82	9.48	2.56
Clipper Hills - Gardenia	33.19	11.08	3.13	171.49	18.49	5.46
Clipper Hills - Hilltop	43.82	13.40	3.47	224.09	23.40	6.82
Wilda Drive	6.75	1.60		26.43	2.56	0.70
Diamond Hills Section 5	51.80	16.26	2.16	259.37	27.37	7.91
Carrolltowne 2A Gemini Drive	87.73	34.43	2.56	463.02	53.12	16.05
Benjamin's Claim	47.10	15.78	2.31	237.67	26.09	7.58
Eldersburg Estates 3-5	34.90	8.16		136.50	13.15	3.61
Benjamin's Claim Basin B	1.33	0.55		5.56	0.66	0.20
Braddock Manor West	49.30	7.65		187.07	16.04	4.15
Totals	865.00	240.00		4248.00	433.00	124.00

History
Began in 2000

Modified Sand Filters
(or the Herring/Frock Method)

- Myron Frock (who had worked with S.C.S. for many years) pointed out that grassed waterways used in agriculture to prevent soil erosion in fields also proved remarkably effective at filtering the water, particularly when underlain with drain “tile.”
- The typical agricultural waterway consists of a perforated HDPE pipe surrounded by 4-inches to 6-inches of stone and overlain by sod.

Modified Sand Filters
(or the Herring/Frock Method)

To modify the agricultural waterway for stormwater treatment we:

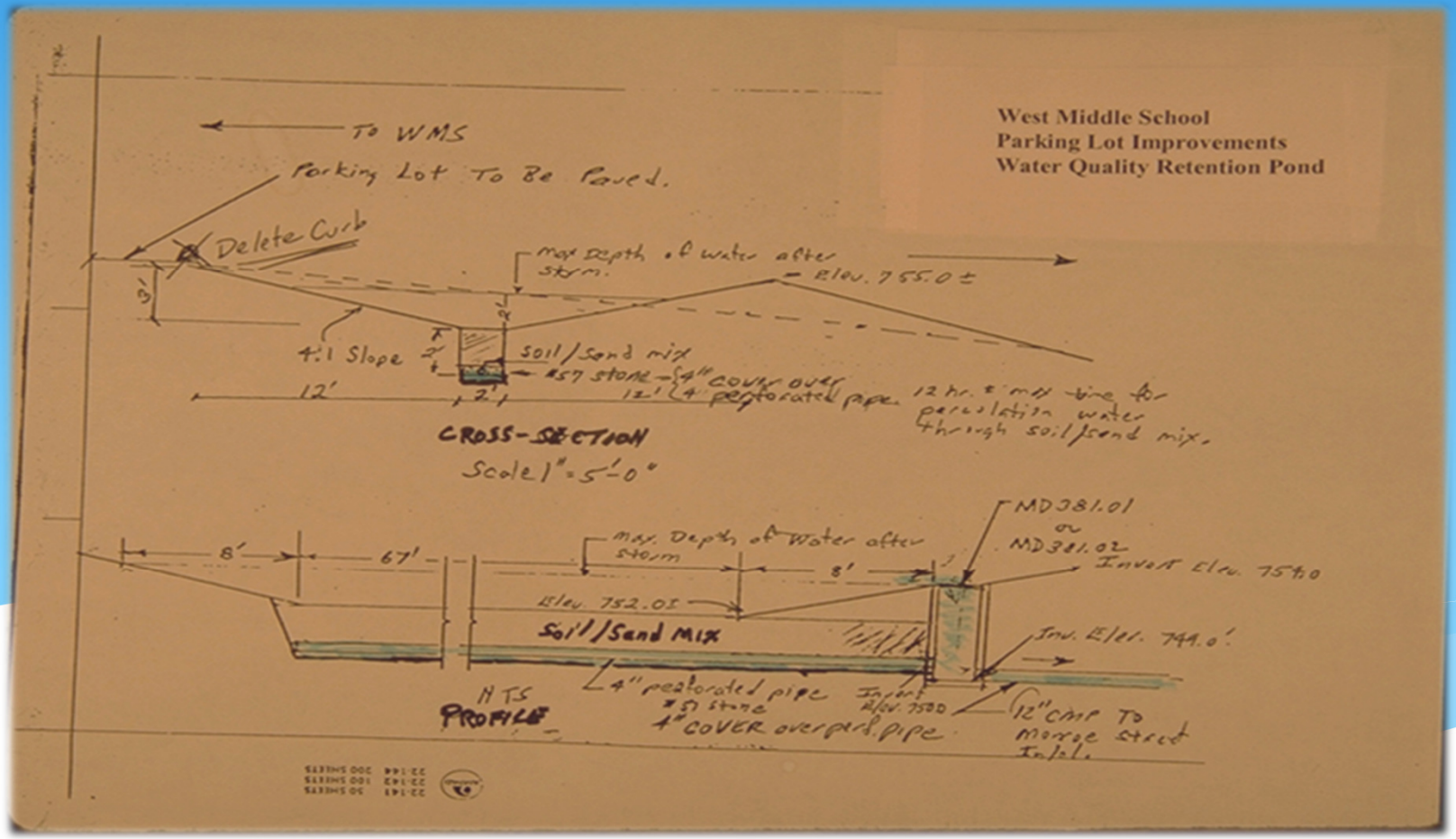
- added 2 feet of stone below the underdrain
  - This creates an underground reservoir of water that will infiltrate if the soil conditions permit.

- Mixed 2 parts construction sand to one part native soil above the underdrain.
  - This creates a man-made sandy loam conducive to infiltration.

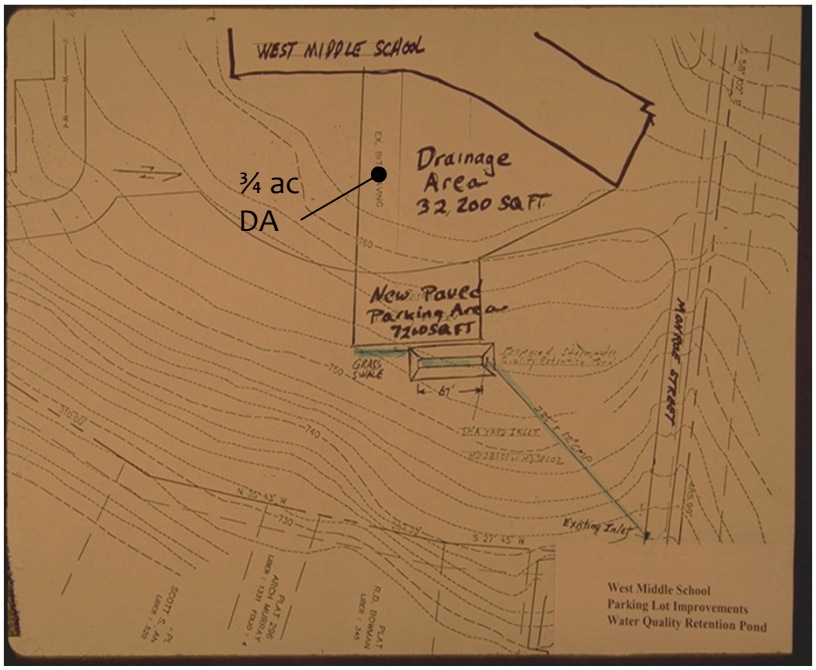
First Facilities

West Middle School

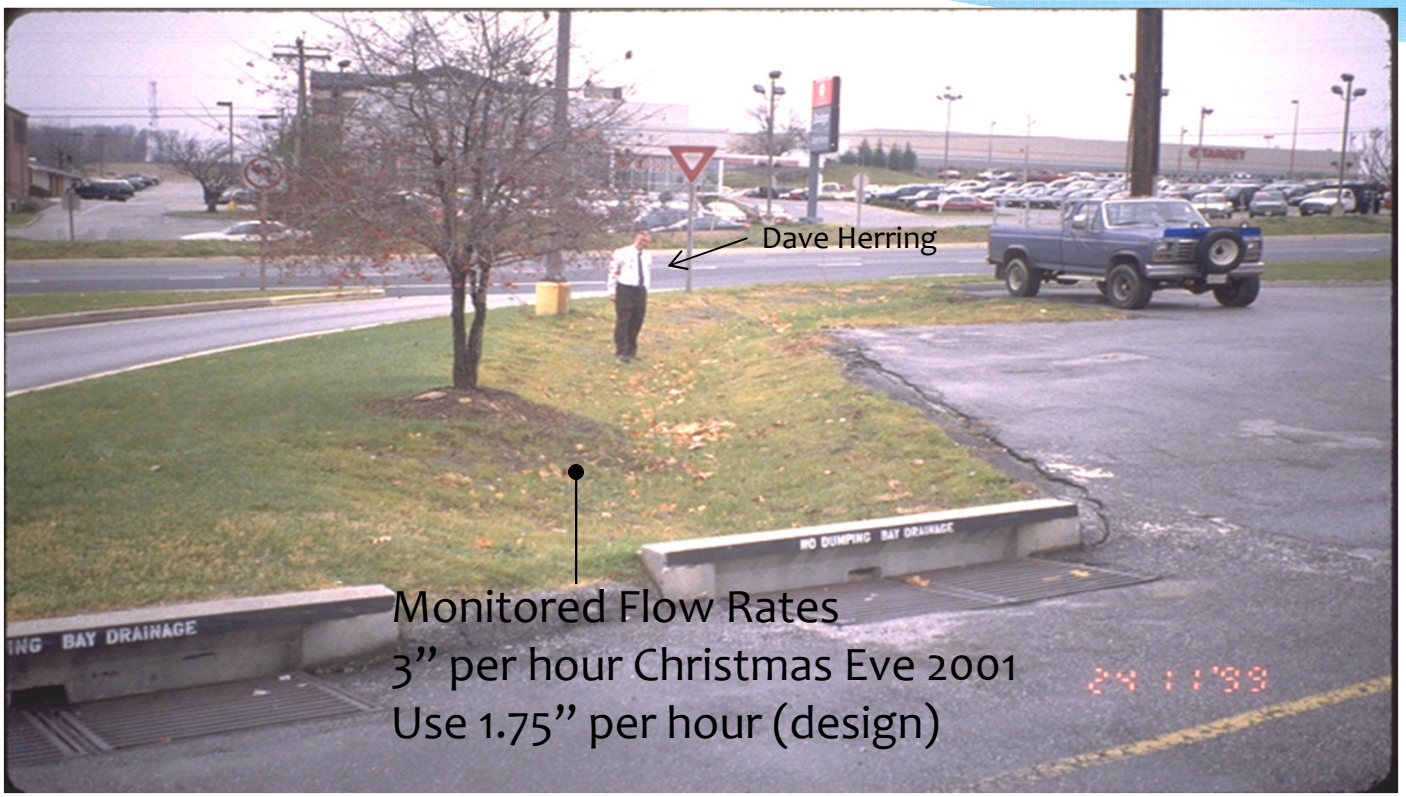
(Dave Herring)



West Middle School



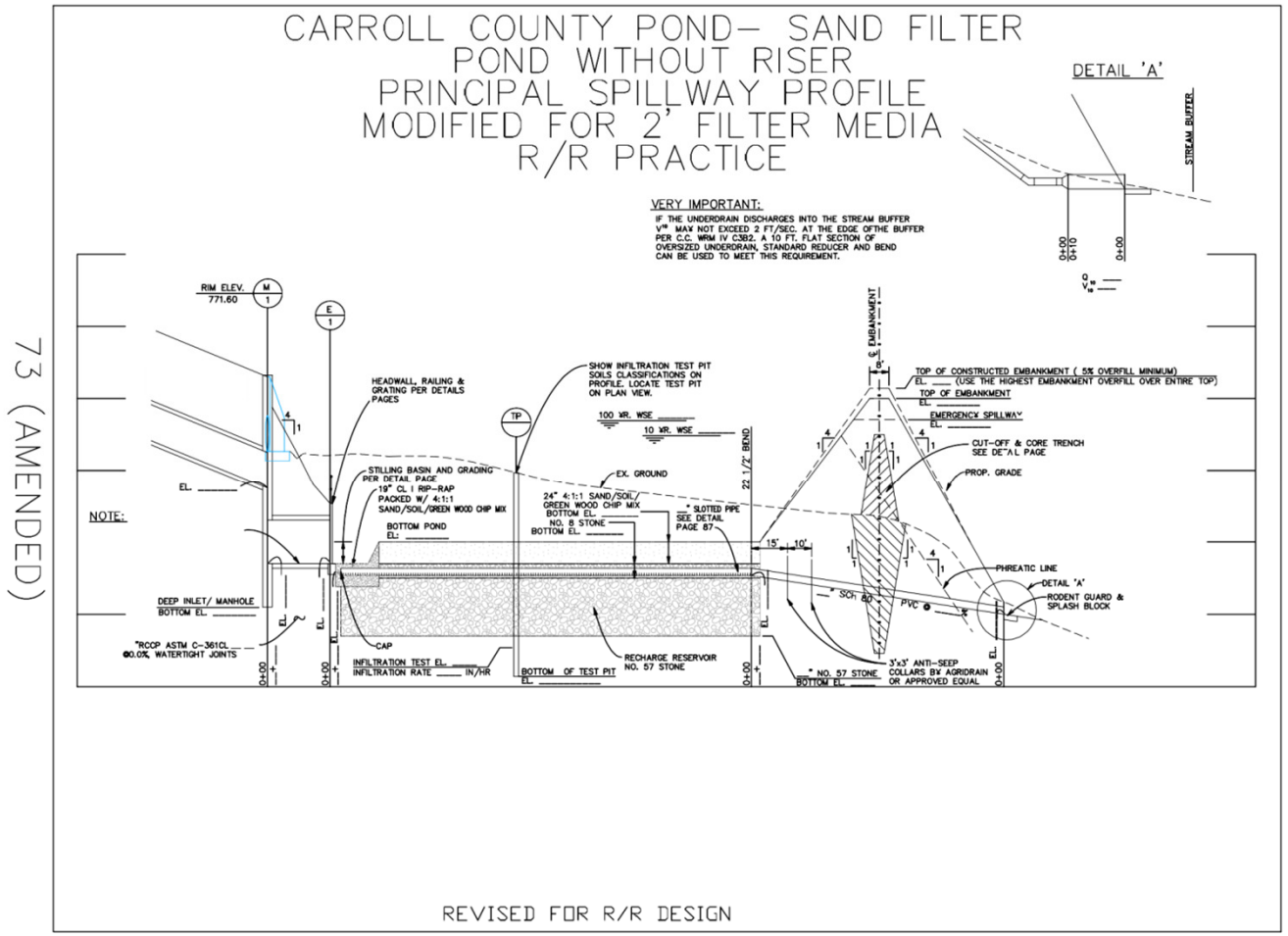
Friendly's Retrofit



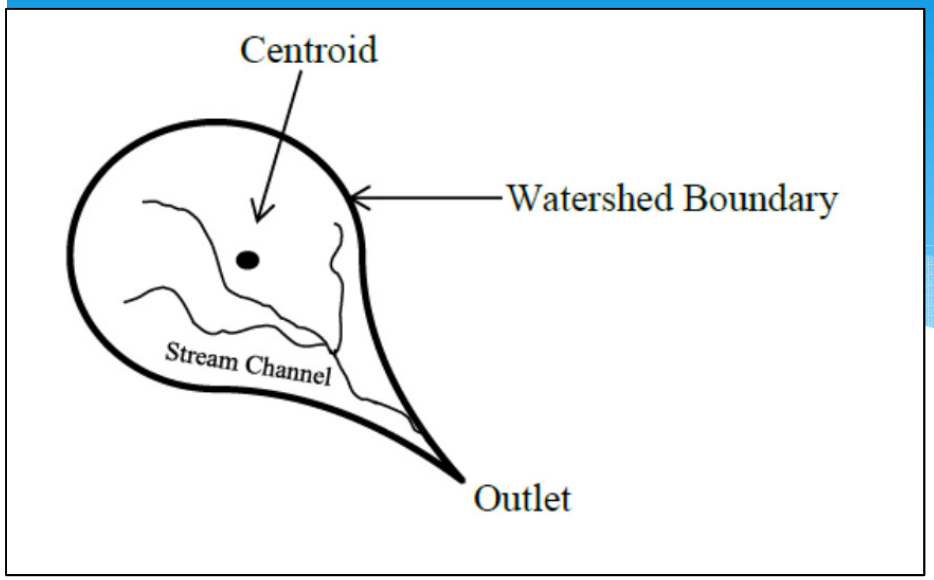
Current Design 2016

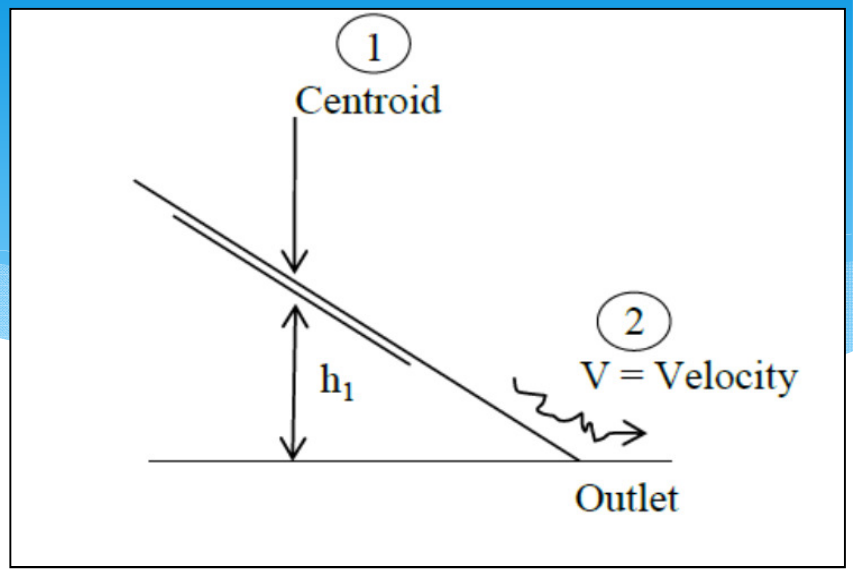
Unique Characteristics:

1. No Riser- all design flows through sand control
2. Drop Structures and Level Pipes – No rip-rap inflows and Forebays in facility
3. Total Capture of 2 year storm, difference in 10 year runoff volume
4. Sand layer across entire bottom of facility
5. No limit on drainage area size
6. Q_{10} captured and conveyed to pond

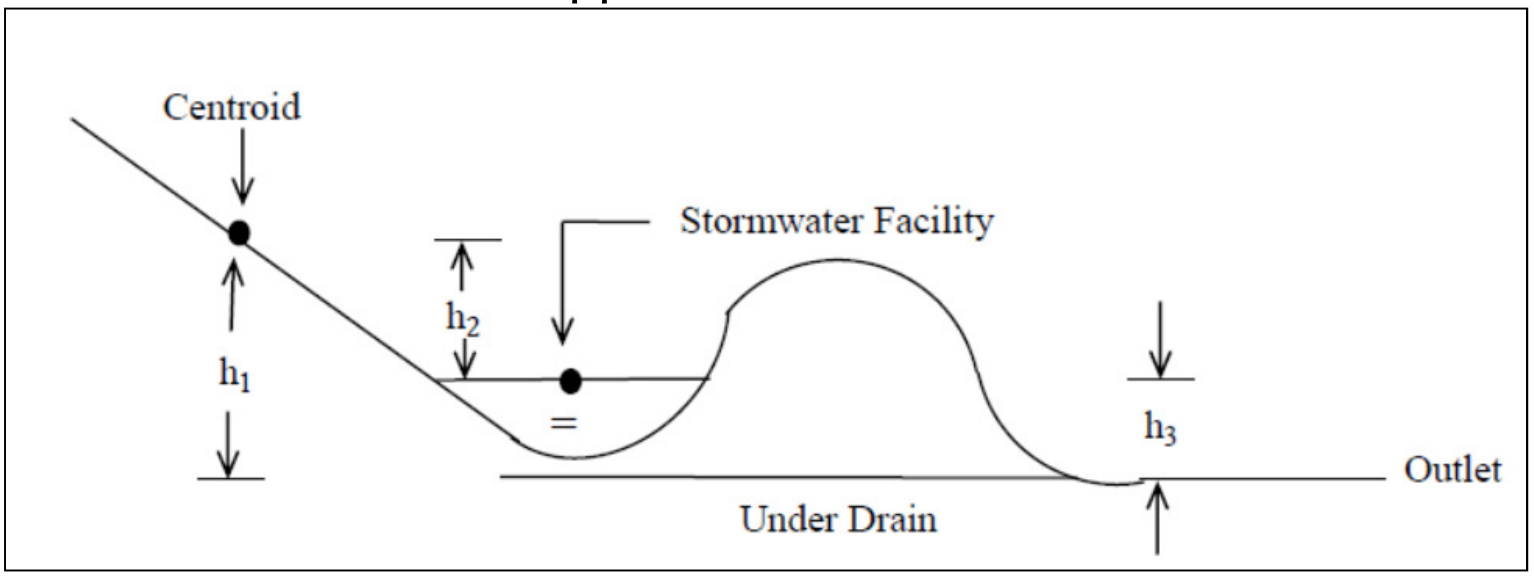


Bernoulli's Equation





Application of Bernoulli's



Hydrologic Results

Bankful "Channel Shaping" Flow

(Wolman & Leopold, 1957)

- 1.07 to 2.7 years (agricultural watersheds)
- (USGS, 554) reduced to 0.7 years with 20% impervious

Carrolltowne 2A

2.5" Volume Sand Filter

Completed: 2013

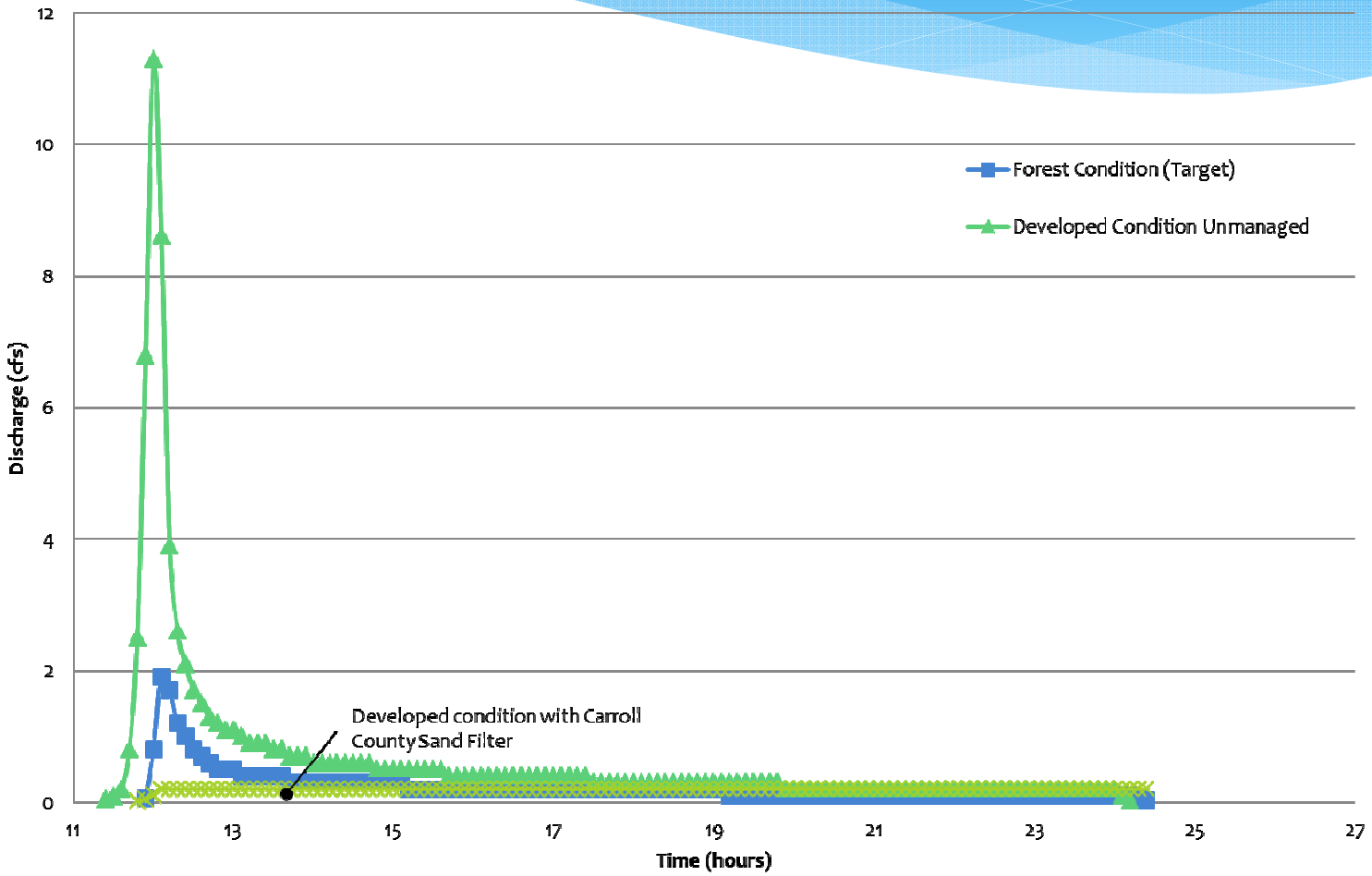
Drainage Ares: 88 Acres

Impervious: 34 Acres (~39%)

Hydrologic Results

Figure 5

2 Year Storm Runoff - 10 Acre - B Soil
Forest vs 30% Impervious (Developed) Unmanaged & Managed



Extreme Extended Detention

- Thermal Impacts?
- See 5.6.5 "Additional Techniques for Mitigating Thermal Impacts"
- "Use the enhanced filter option"

Downstream Impacts

Seeing is Believing

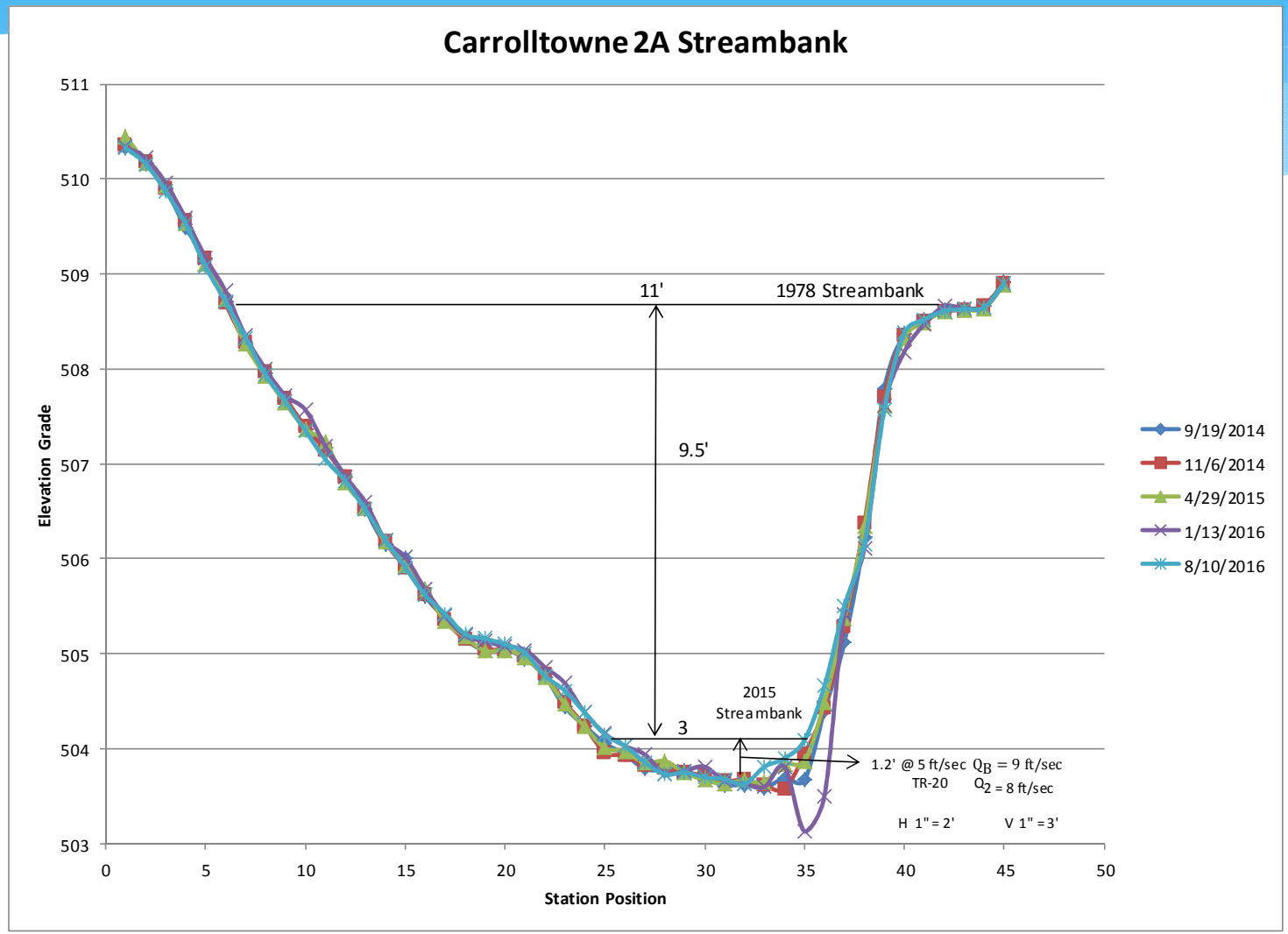
Carrolltowne 2A Before

2014

Carrolltowne 2A After

2016

Carrolltowne 2A



If the Width is larger than necessary for quasi-equilibrium, the unused parts of the wide channel are taken over by vegetation which not only tends to stabilize the places where the roots are present, but the vegetation itself induces deposition. The establishment of vegetation in unused parts of a natural channel provides a slow but effective way of reducing a width which has been made excessive during high flows.

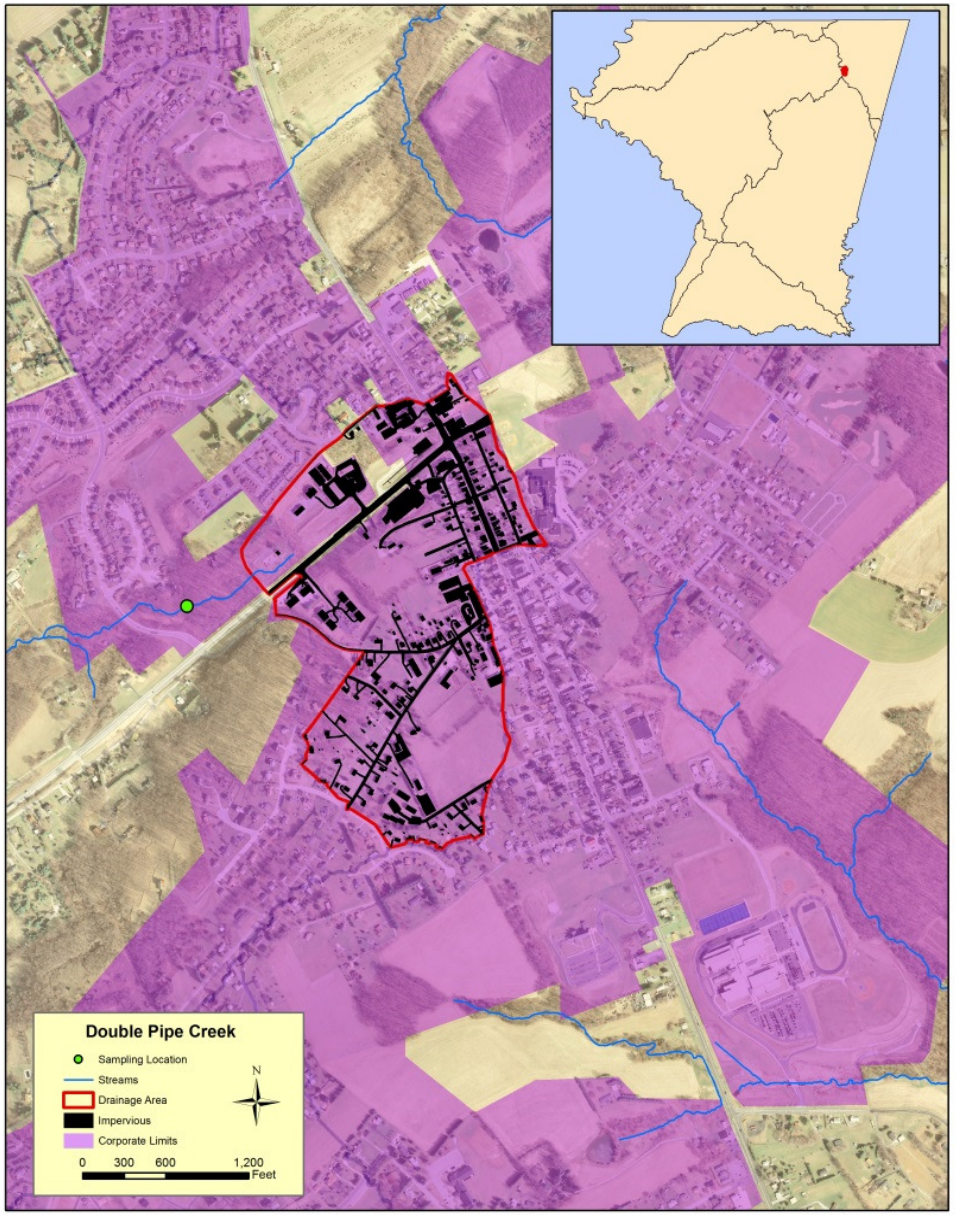
Wolman & Leopold, 1957

Byron Madigan
Water Resources Supervisor
Carroll County Government

Retrofit Monitoring

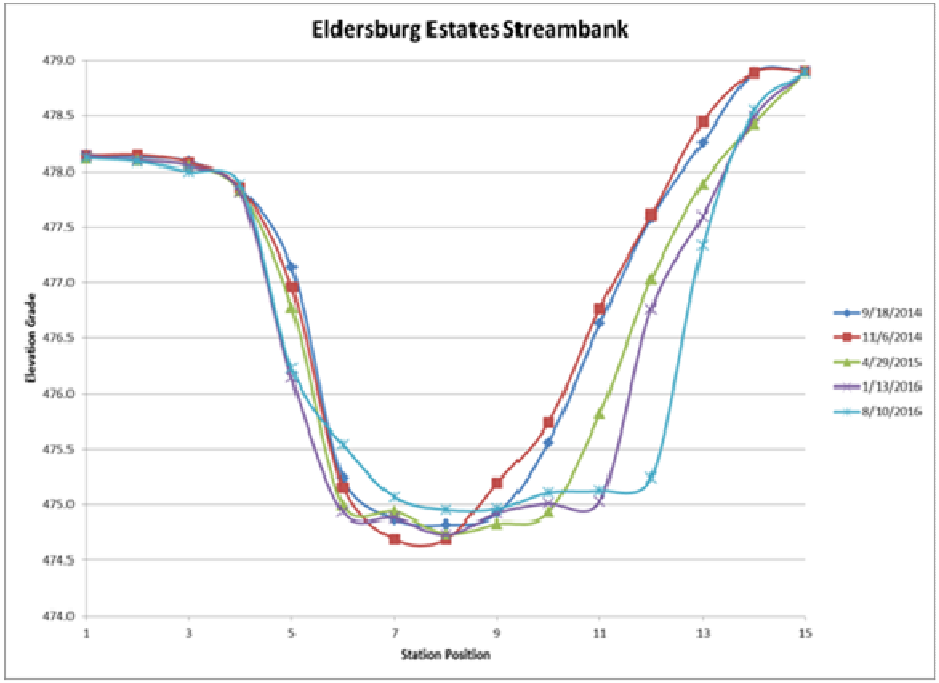
Data Collection:

- Low flow discharge w/ grab
- Targeted storm events
- Stage height analysis
- TSS, OP, NO32, TP, TKN
- Spring MBSS



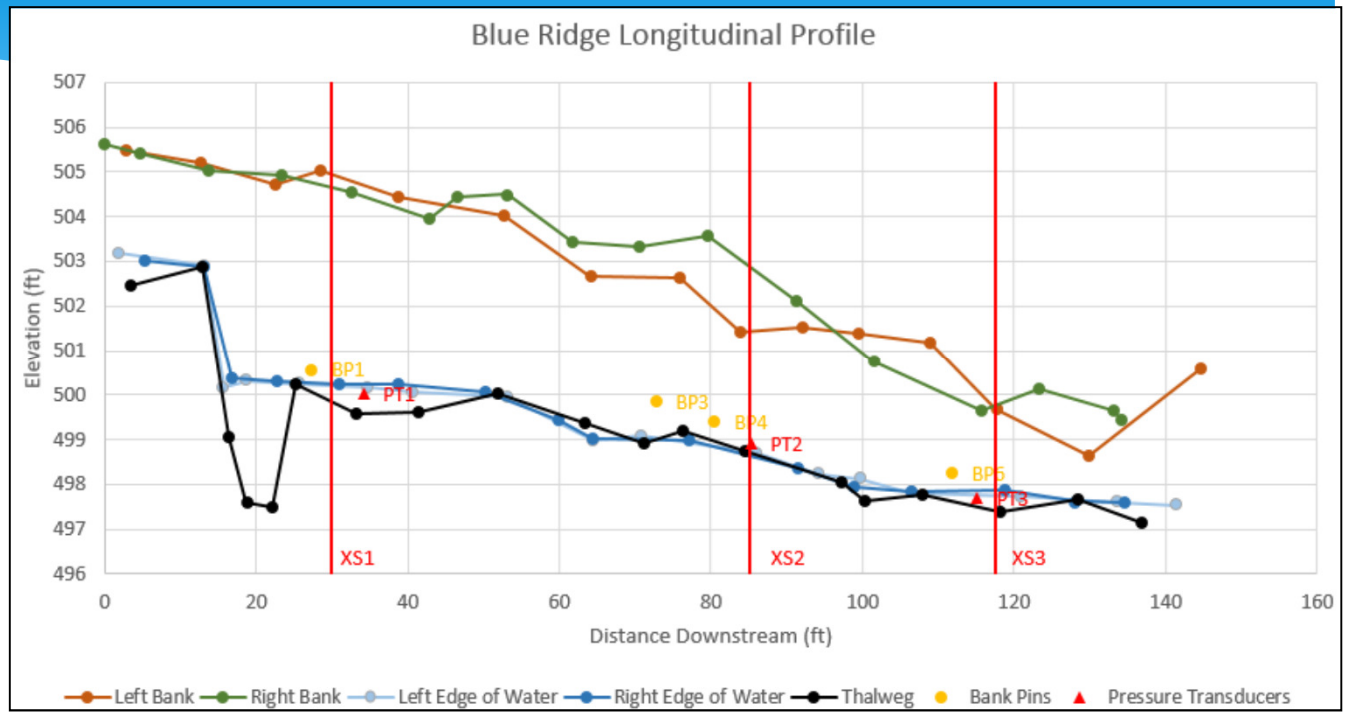
Stream Channel Stability

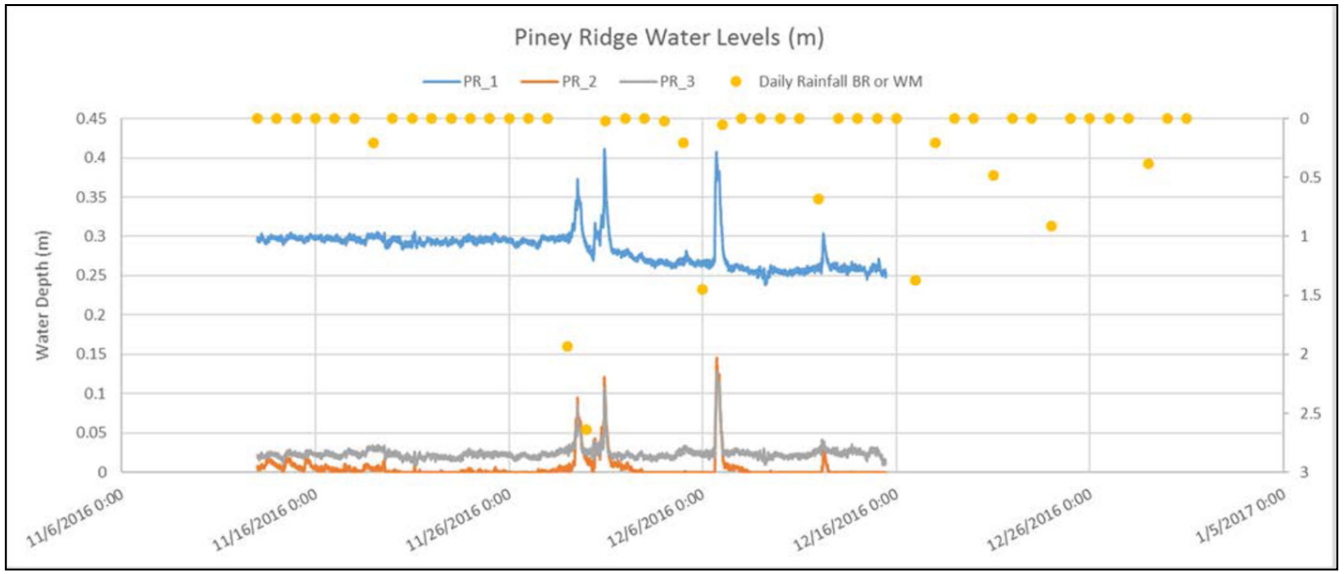
- Cross Section Surveys
- Bank Pins
- Stage Height Analysis



Physical Monitoring

- Geomorphic Mapping
- Cross Section Surveys
- Bank Pins
- Stage Height Analysis
- Longitudinal Profiles
- Bulk Density
- Riparian Analysis





Restoration Research Grant

Monitoring Plan Hypotheses:

Hypothesis 1

The implementation of BMPs as retrofits will modify the runoff response from the watershed (hydrograph) resulting in a reduction of the magnitude, duration and frequency of erosive flow rates that meet and or exceed Maryland Department of Environment (MDE) performance standards for stream channel protection.

Hypothesis 2

The implementation of BMPs as retrofits will create hydraulic conditions that lead to self-recovery of channel stability.

Hypothesis 3

The implementation of BMPs will decrease sediment loadings downstream as a result of reduced bank erosion rates.

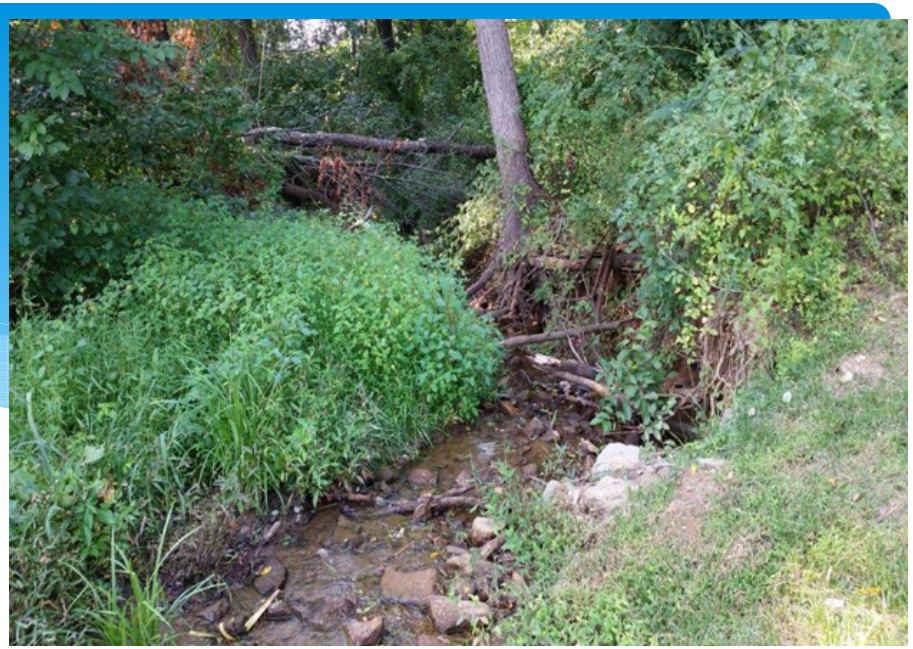
Carrolltowne 2A

2.5” Volume Sand Filter

Completed: 2013

Drainage Ares: 88 Acres

Impervious: 34 Acres (~39%)

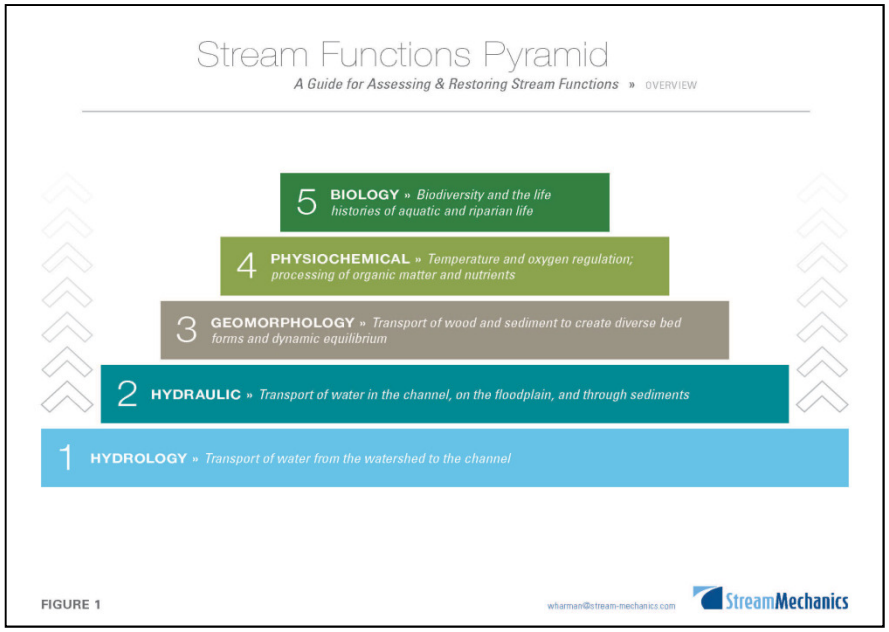


Spring MBSS

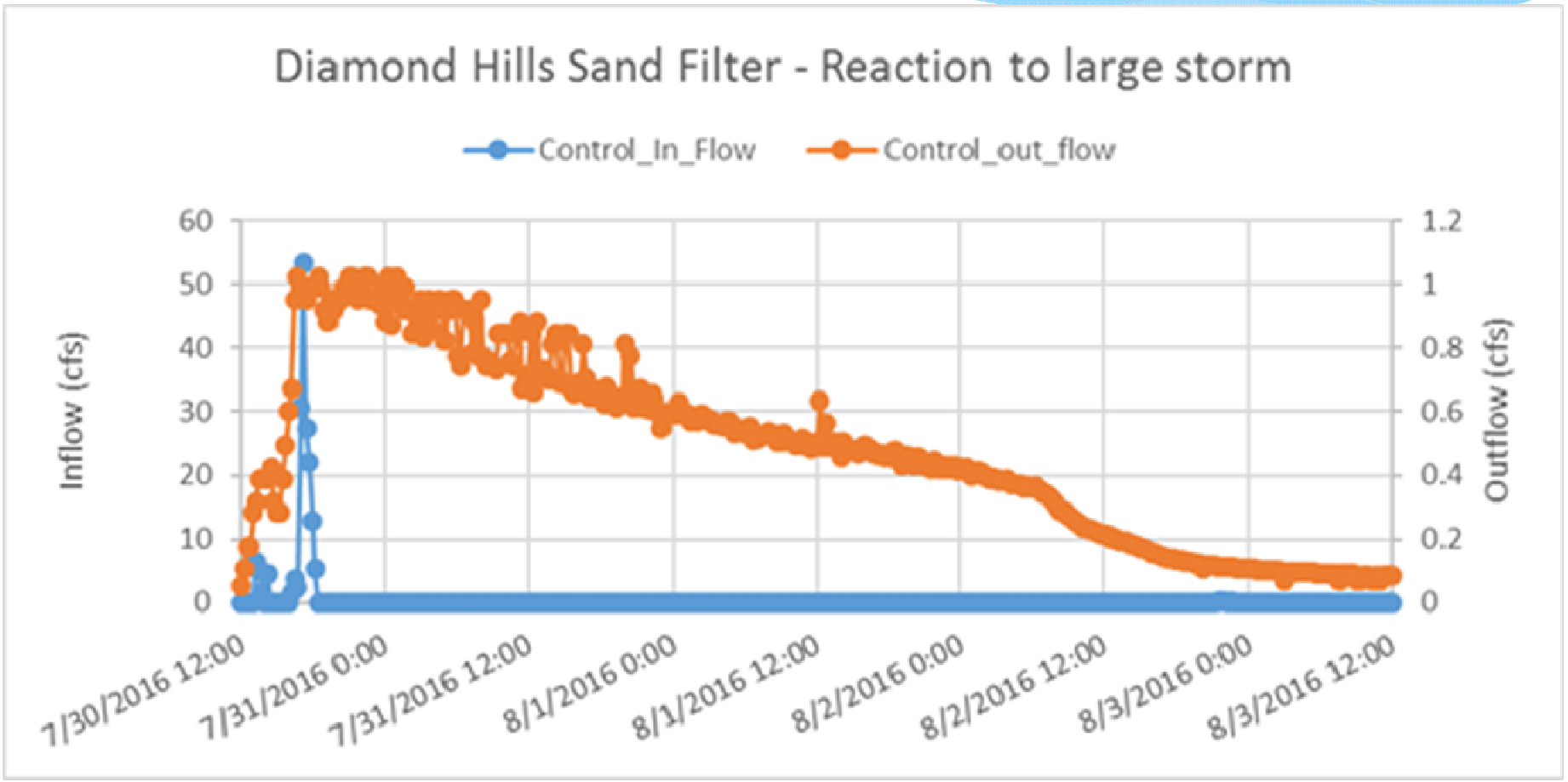
2011: 2.67 - Poor IBI

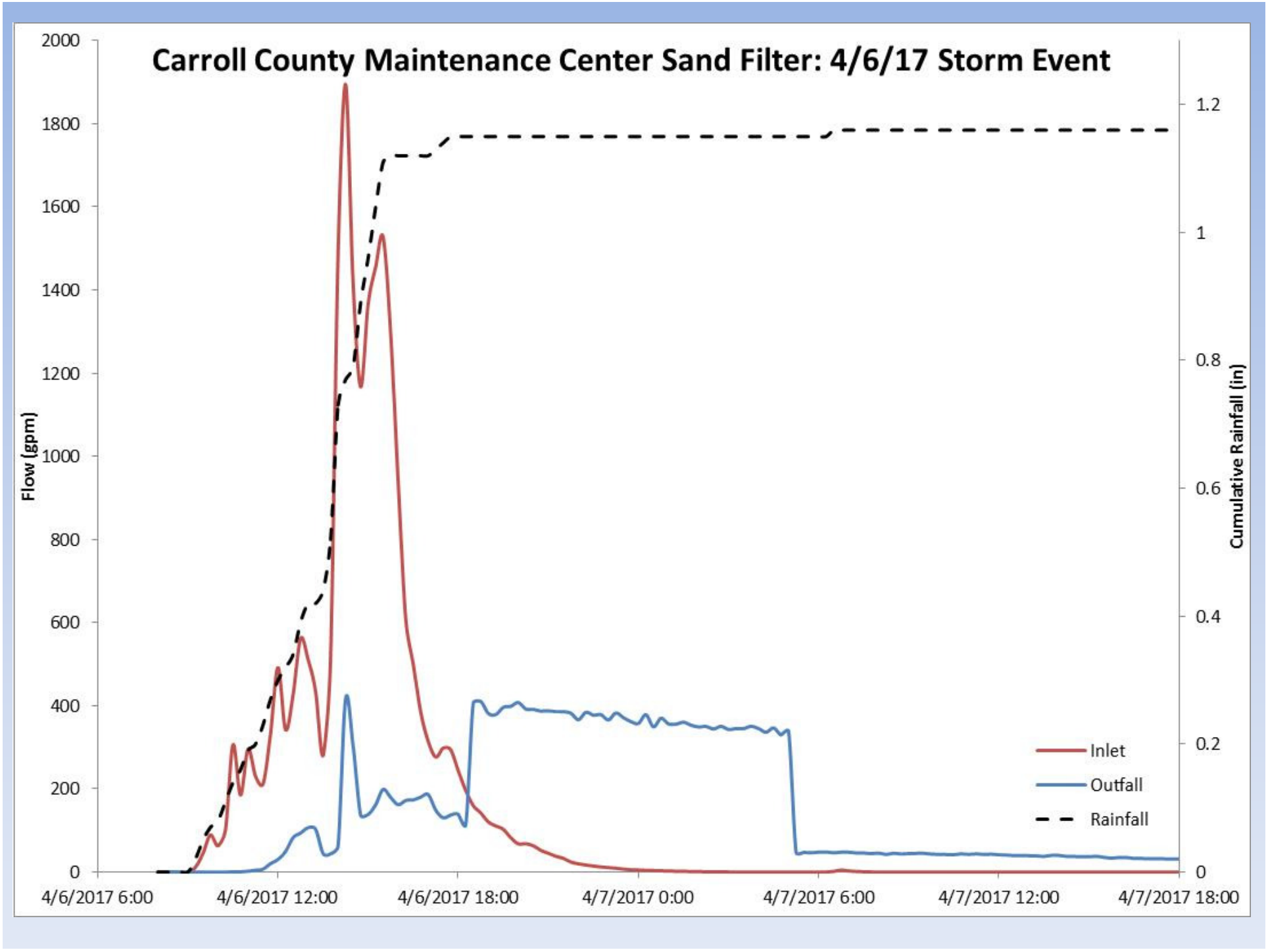
2014: 3.33 – Fair IBI

2017: Sampled March, 30th



Diamond Hills




Carroll County Maintenance Center Sand Filter: 4/6/17 Storm Event
Flow (gpm)
Cumulative Rainfall (in)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1.2
1
0.8
0.6
0.4
0.2
0
4/6/2017 6:00
4/6/2017 12:00
4/6/2017 18:00
4/7/2017 0:00
4/7/2017 6:00
4/7/2017 12:00
4/7/2017 18:00
Inlet
Outfall
Rainfall

Accounting for Stormwater Wasteload Allocations & Impervious Area Treated (2014)

2.5” Volume Sand Filter Carrolltowne 2A

38 Years

• Impervious Area to Pond	34.4 acres
• 2014 Runoff Reduction “Bonus”	6 acres
• Length of Hydrologically Restored Downstream Channel	1,100 feet
• Stream Restoration Credit MDE 2011	11 acres
• Prevented Streambank Erosion Credit	52 acres

Westminster High School Pond Retrofit

Information

DA - 115 acres IA - 42 acres

Volume to Spillway 3.4”/IA

	ST Practice	RR Practice
TN	601 lbs/year	781 tons/year
TP	67 lbs/year	80 tons/year
TSS	20 tons/year	21.5 tons/year

Constructed in 2013

Cost $1,100,00

$26,000/IA

Westminster High School – Receiving Stream
May, 2017

Downstream

Upstream

Questions?

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http://ccgovernment.carr.org/ccg/resmgmt/doc/Forms/swm.supplement.pdf?x=1464697527476