How effective is ESD/GSI in achieving stormwater management objectives in the Upper Little Patuxent River Watershed, Howard County, MD?

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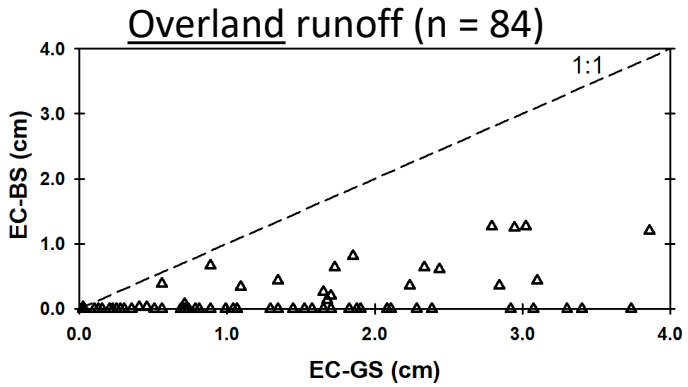
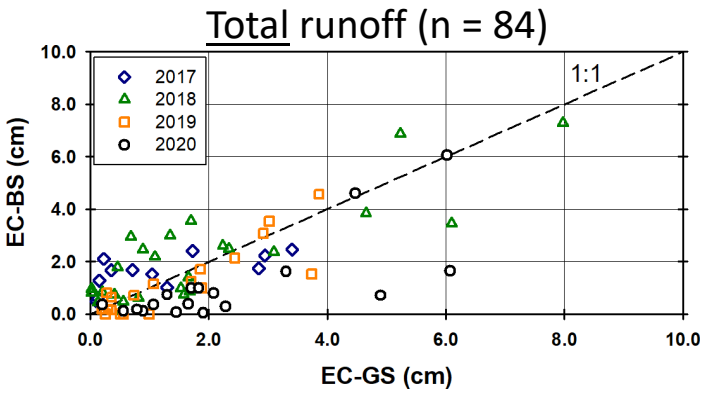
Pooled Monitoring Forum: Restoration research to make science and regulatory connections (June 16, 2021)

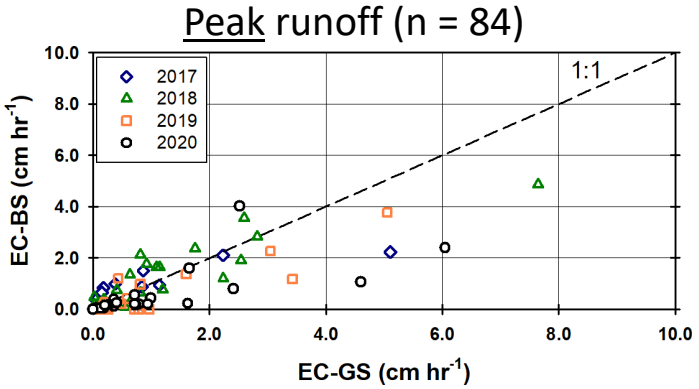
Outline

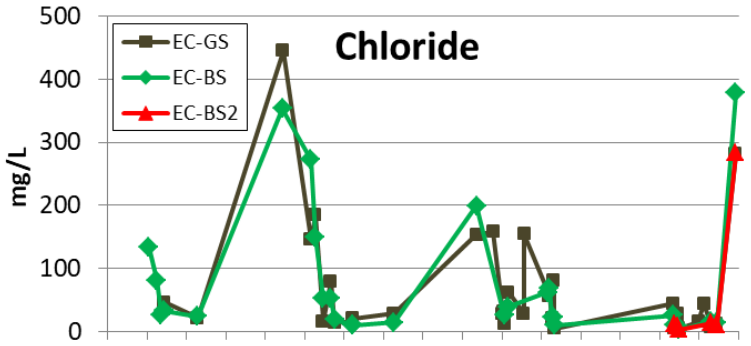
- Motivation
- Research question/hypotheses
- Experimental design: study watersheds and data collection
- Progress-to-date
- Preliminary results
- Next steps

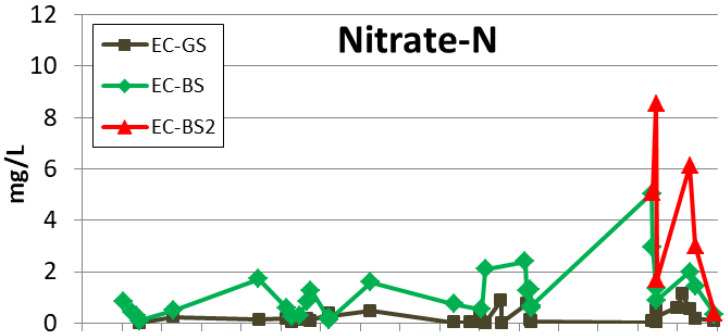
Grassed swale (GS)/bioswale (BS) results: 2017-20

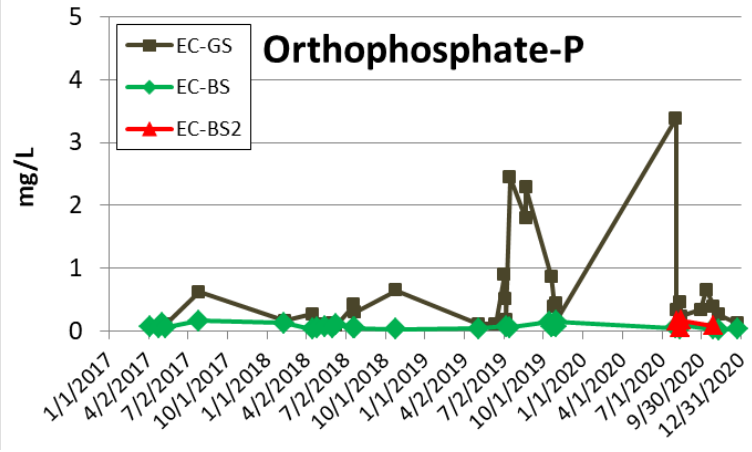










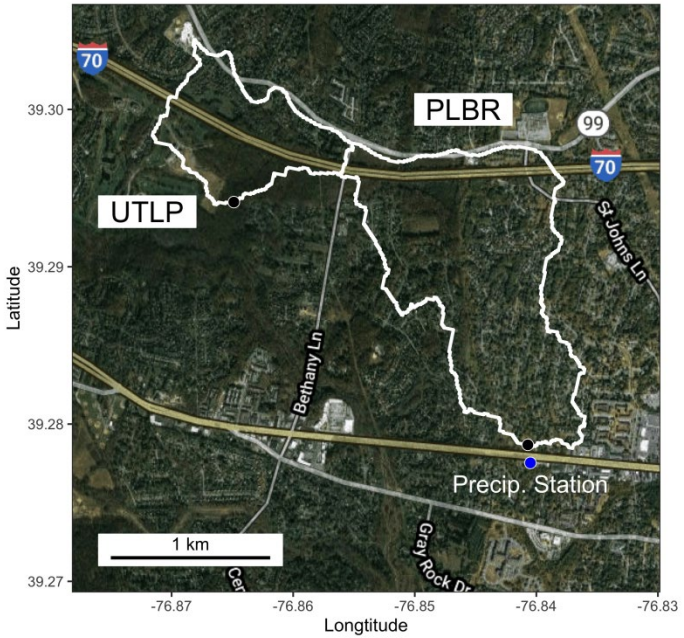


Research question/hypotheses

- Research question: What is the spatially-aggregated effectiveness of ESD BMP's at the watershed scale in achieving four primary stormwater management goals?
  - protection of receiving surface waters from nonpoint source pollution;
  - attenuation of stormwater discharge peaks;
  - diminishment of stormwater runoff volumes; and
  - enhancement of the recharge/discharge behavior of shallow groundwater
- Hypotheses:
  - A watershed developed using ESD will be characterized by
    - *lower stormflow runoff;*
    - *higher baseflow runoff;*
    - *lower peak discharges;*
    - *lower runoff coefficients;*
    - *longer centroid lag times;*
    - *more attenuated unit-graphs; and*
    - *lower EMC's and EL's of N and P pollutants*

    than a comparable "control" watershed with traditional stormwater management (all else equal).

Experimental design: paired watershed study



PLBR stormwater monitoring station, Howard County, MD

- <u>Plumtree Branch</u> (PLBR; area = 2.15 km^2)
  - "Developed" watershed
  - Conventional SWM
- <u>Unnamed Tributary to Little Patuxent River</u> (UTLP; area = 0.80 km^2)
  - "Developing" watershed
  - Green stormwater infrastructure (GSI)
- <u>Common equipment includes:</u>
  - Stilling well (w/intake) and instrument shelter housing Unidata digital water level recorder
  - InSitu AquaTroll 500 and "tube" for transmitting data to HydroVu website

UTLP stormwater monitoring station, Howard County, MD

Development in UTLP



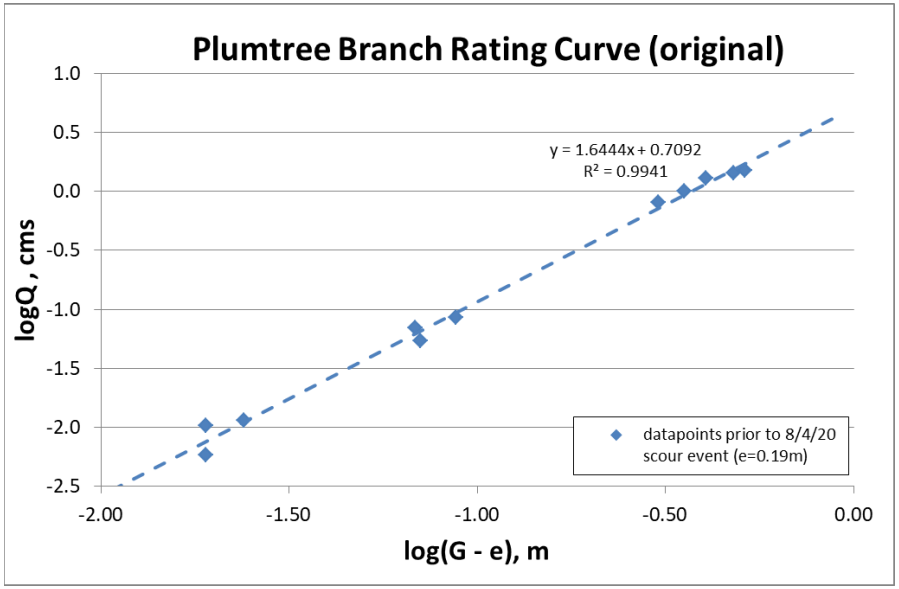


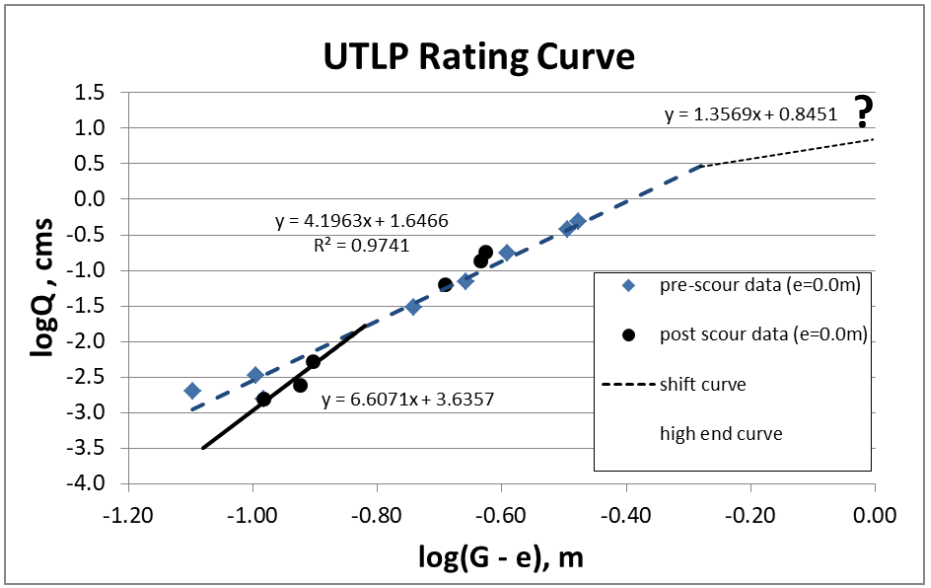

- Stream channel and wetlands protection (“buffers”)
- Erosion and sediment control
- Green stormwater infrastructure (e.g., bioretentions, dry wells)

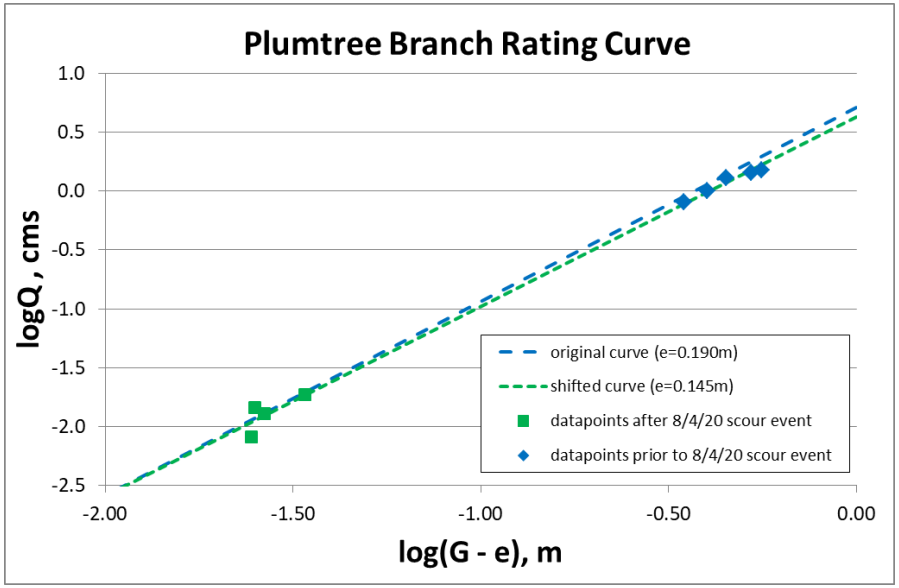
Progress-to-date

- Site Selection/Permits/Instrumentation
  - PLBR station installed November 2019 on HOCO property (MOU)
  - UTLP station installed March 2020 on HOCO property (David Force Park, MOU)
  - Nov. 2019 – Mar. 2020: "pilot period" used to refine sampling methods and logistics
- Hydrology
  - Continuous 5-min stream stage records: *100% complete*
  - Continuous 5-min discharge records based on rating curves derived from field discharge measurements (wading velocity-area method): *100% complete*
    - 8/4/20 scour event caused a section control change @ PLBR (rating curve shift)
    - 6/22/20 flash flood event required reconstruction of section control @ UTLP (rating curve shift)
  - Continuous 15-min precipitation records from tipping bucket gages (from February 2020): *100% complete*
- Water Quality
  - Continuous 5-min *in situ* level, specific conductance, temperature, and turbidity data (from AquaTroll 500's): *88% complete* for PLBR; *84% complete* for UTLP (bioturbation, sedimentation, battery failures, data transmission failures)
  - 524 discrete samples analyzed for SC, TSS, major anions, TN, N species, TP, P species (38 baseflow "grabs", 486 stormflow "ISCO's"): 16 events @ PLBR; 12 events @ UTLP

Rating Curves







Preliminary results: water balance

Station	Annual precipitation (m), 2021 WY = May 2020 – April 2021	Annual precipitation (m), normal (1981 – 2010)	Notes
BWI AIRPORT, MD (NWS)	1.415	0.983	2021 WY was ~44% wetter than normal
DAMASCUS, MD (NWS)	1.116	1.085	2021 WY was ~3% wetter than normal
PLUMTREE BRANCH (THIS PROJECT)	**1.187**	N/A	
"DELTA" (NATIONAL PIKE AT MARRIOTTSVILLE RD)	**1.017**	N/A	

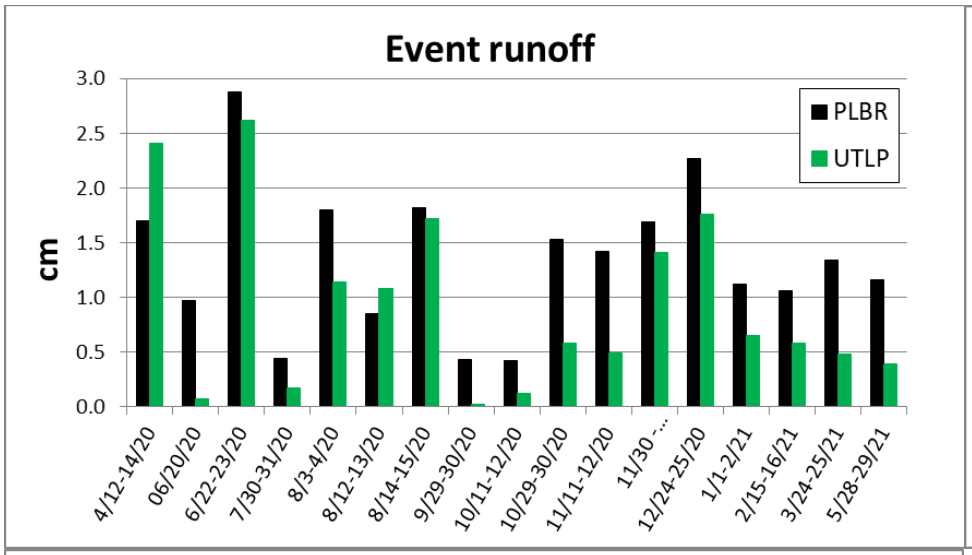
Watershed	Gaging station # (USGS)	Area (mi^2)	Annual runoff (m), 2021 WY = May 2020 – April 2021)	Annual runoff (m), long-term normal	Notes
LITTLE PATUXENT RIVER AT GUILFORD, MD	01593500	38.0	0.59	0.47	Preliminary USGS data for 2021
LITTLE PATUXENT RIVER AT SAVAGE, MD	01594000	98.4	0.53	0.46	Preliminary USGS data for 2021
CATTAIL CREEK NEAR GLENWOOD, MD	01591400	22.9	0.43	0.45	Preliminary USGS data for 2021
PATUXENT RIVER NEAR UNITY, MD	01591000	34.8	0.47	0.45	Preliminary USGS data for 2021
HAWLINGS RIVER NEAR SANDY SPRING, MD	01591700	27.0	0.42	0.44	Preliminary USGS data for 2021
PLUMTREE BRANCH (PLBR)	N/A	0.83	**0.43**	N/A	Preliminary data (this project)
UNNAMED TRIBUTARY TO LITTLE PATUXENT RIVER (UTLP)	N/A	0.31	**0.27**	N/A	Preliminary data (this project)

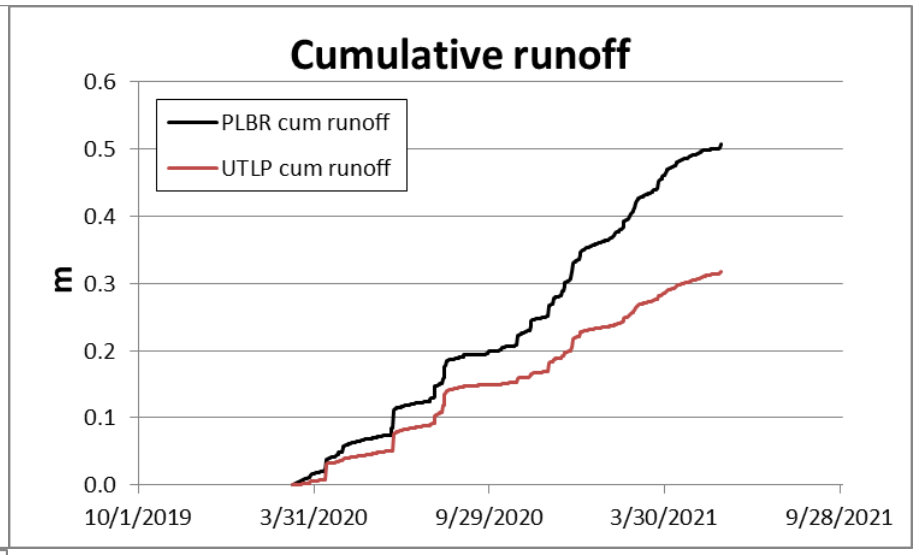
Storm summary (March 2020 - present)

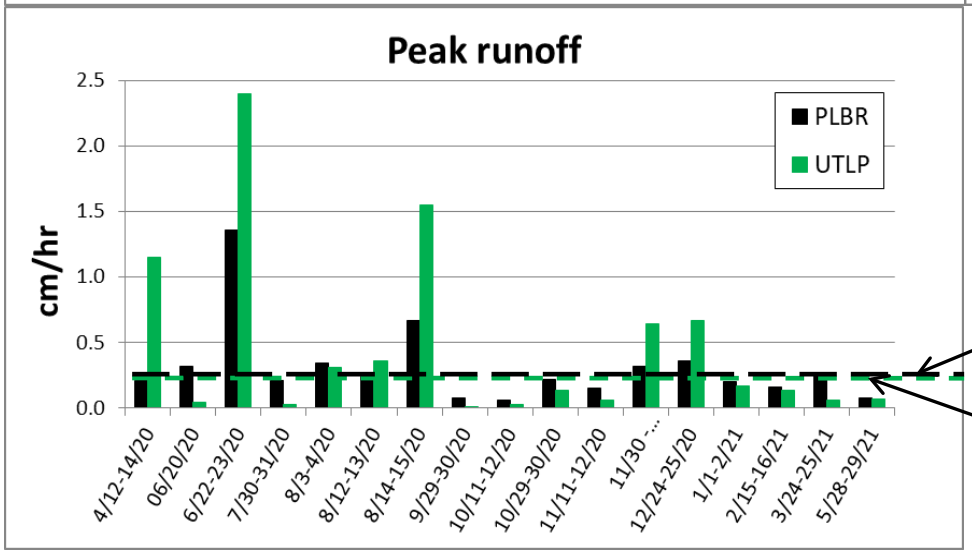
Storm ID	Date(s)	1-hr rainfall (cm)	2-hr rainfall (cm)	24-hr rainfall (cm)	R.I. (yr)-1 hr*	R.I. (yr)-2 hr*	R.I. (yr)-24 hr*
N/A	4/12-14/20	1.02	1.55	***5.46***	<1	<1	<1
N/A	06/20/20	***4.62***	***4.85***	***4.90***	5	3.5	<1
N/A	6/22-23/20	***5.97***	***6.07***	***6.07***	25	10	<1
"E"	7/30-31/20	***2.31***	2.36	3.12	<1	<1	<1
"F"	8/3-4/20	1.55	***2.95***	***8.00***	<1	<1	2
N/A	8/12-13/20	1.14	1.30	2.84	<1	<1	<1
N/A	8/14-15/20	***2.36***	2.49	2.82	<1	<1	<1
"G"	9/29-30/20	1.65	1.65	2.39	<1	<1	<1
"H"	10/11-12/20	0.61	1.12	2.54	<1	<1	<1
"J"	10/29-30/20	1.19	2.21	***5.66***	<1	<1	<1
"K"	11/11-12/20	0.94	0.94	4.88	<1	<1	<1
N/A	11/30 - 12/1/20	1.73	2.31	4.57	<1	<1	<1
"L"	12/24-25/20	0.89	1.40	4.57	<1	<1	<1
N/A	1/1-2/21	0.84	1.50	3.28	<1	<1	<1
"N"	2/15-16/21	0.41	0.71	2.54	<1	<1	<1
N/A	3/24-25/21	1.63	***2.87***	4.78	<1	<1	<1
"R"	5/28-29/21	***2.26***	***2.79***	4.29	<1	<1	<1
Min		0.41	0.71	2.39			
Max		5.97	6.07	8.00			
Median		1.55	2.21	4.57			

*Estimated from Bonnin *et al.* (NOAA Atlas 14, Point precipitation frequency estimates: Ellicott City, MD)

Hydrologic responses (March 2020 - present)





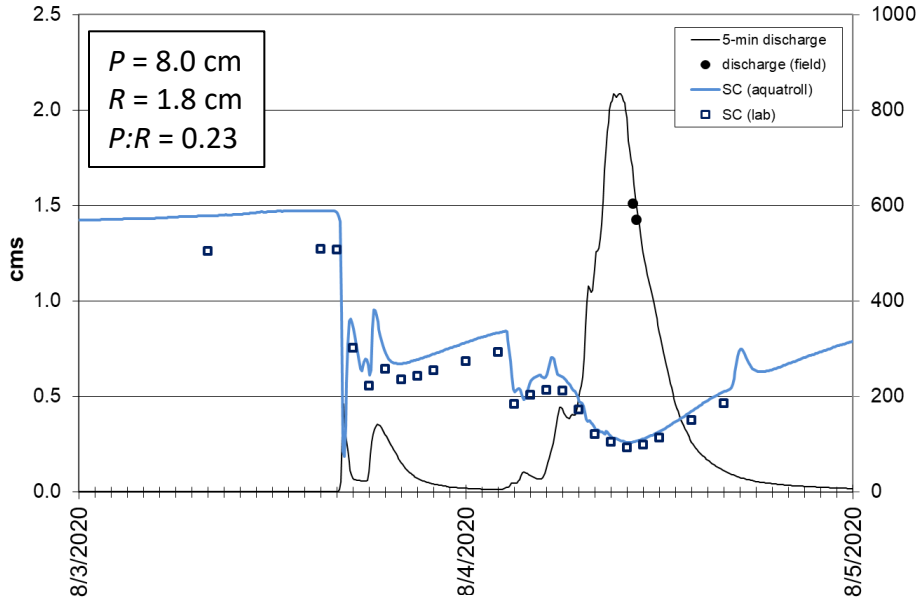


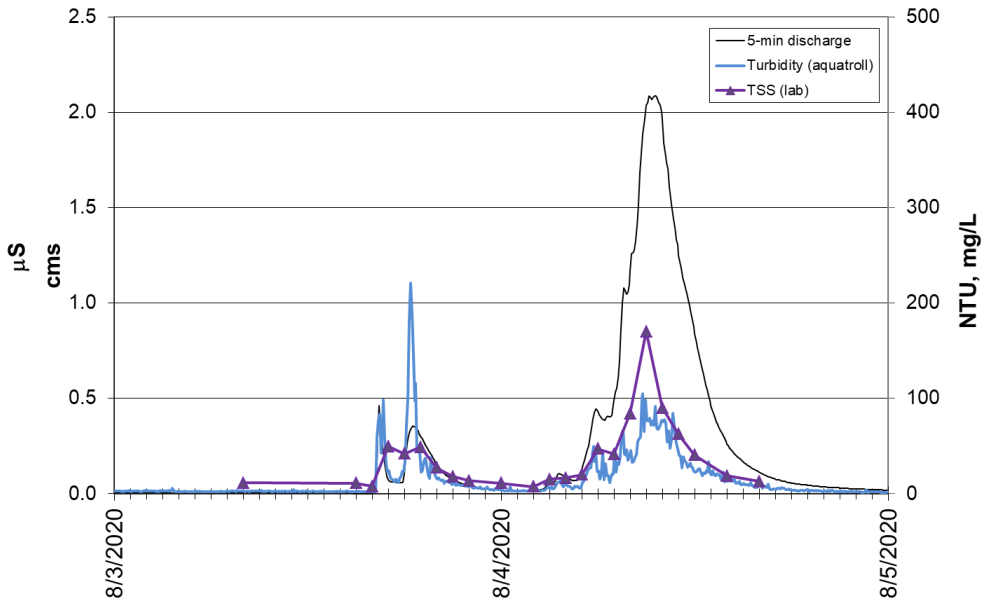
highest discharge measurement to date @ PLBR = 0.25 cm/hr

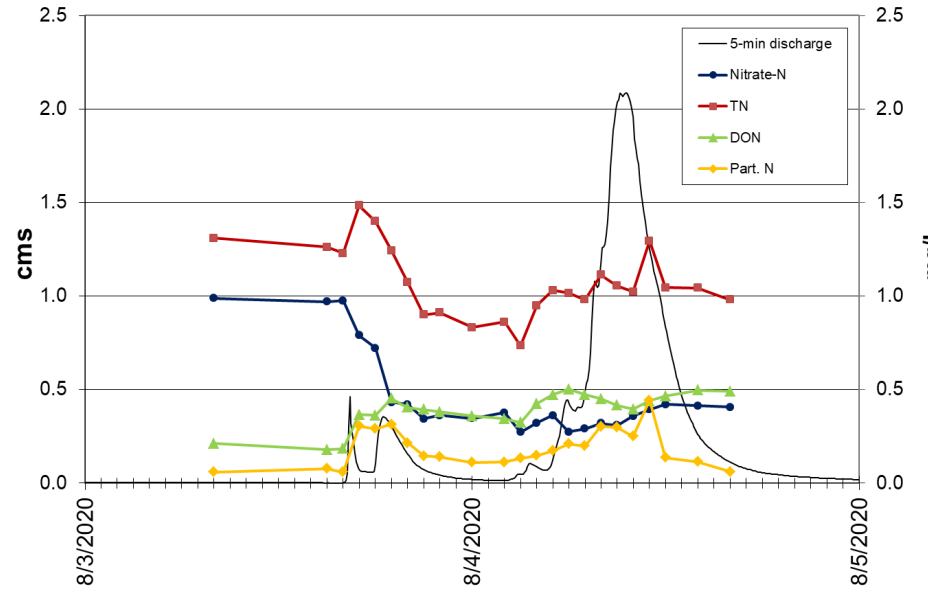
highest discharge measurement to date @ UTLP = 0.22 cm/hr

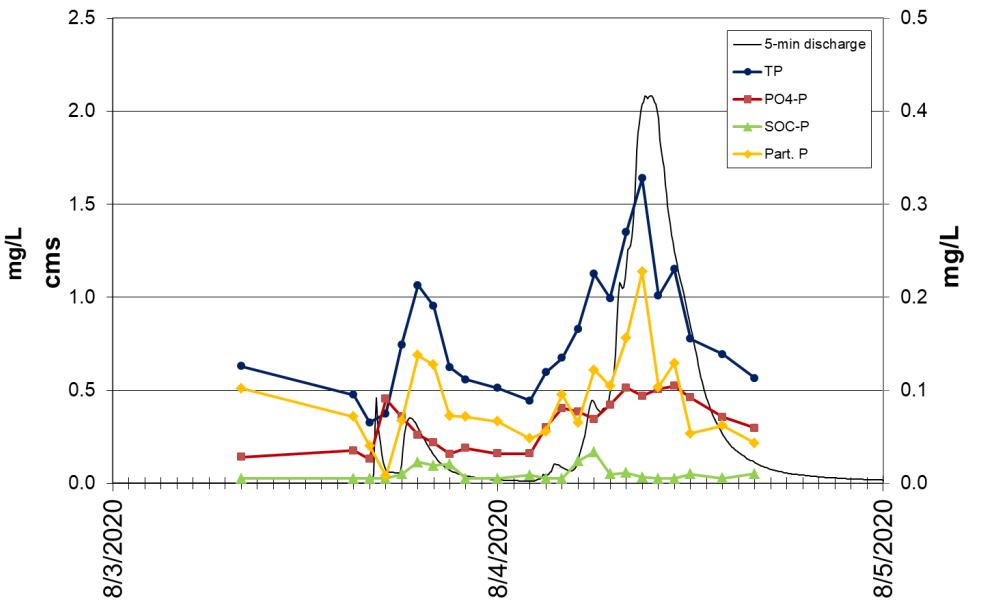
Plumtree Branch (Event F: T.S. Isaias):

1-hr *P* = 1.6 cm; 2-hr *P* = 3.0 cm; 24-hr *P* = 8.0 cm

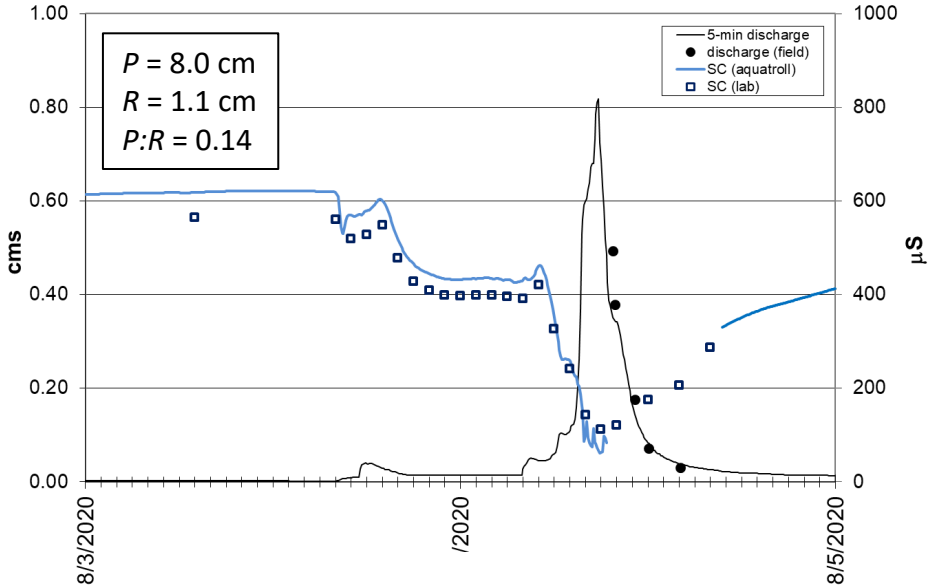


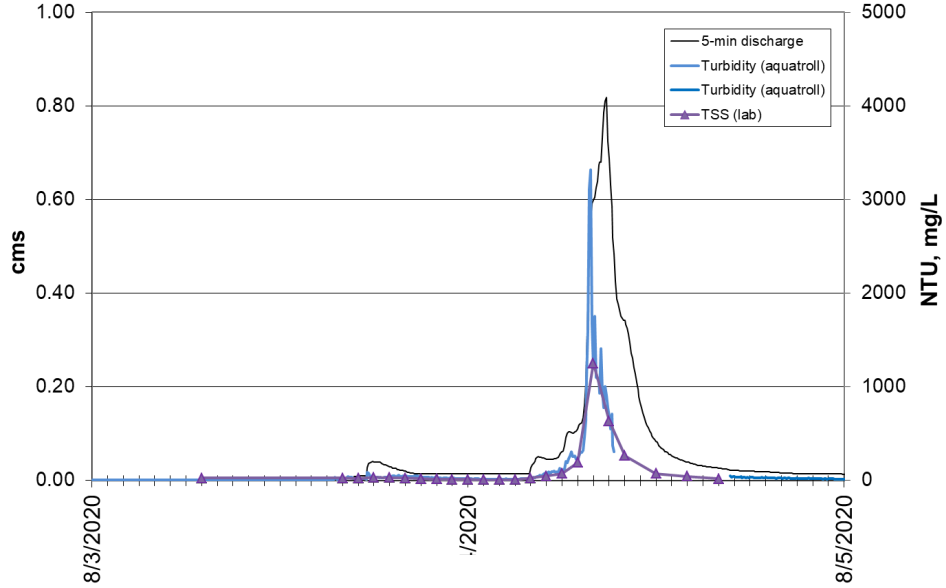


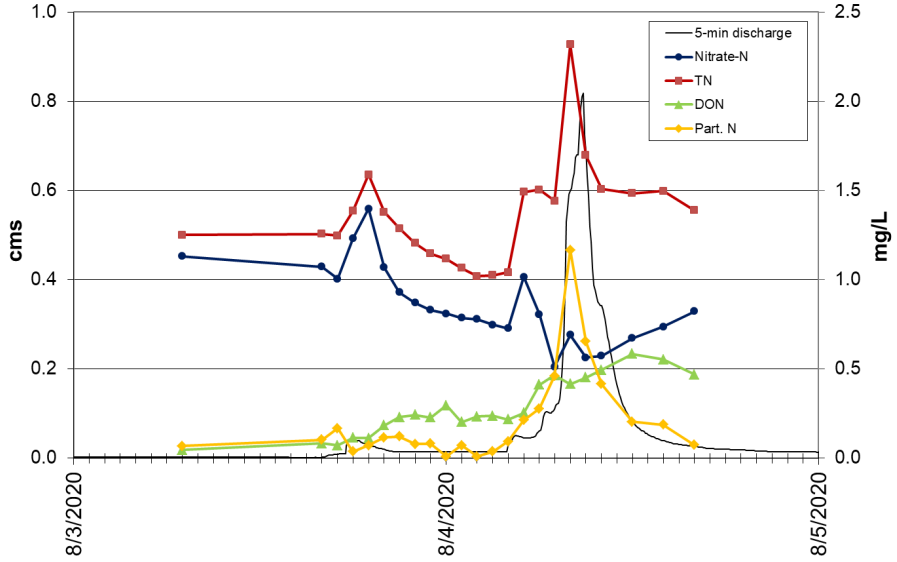


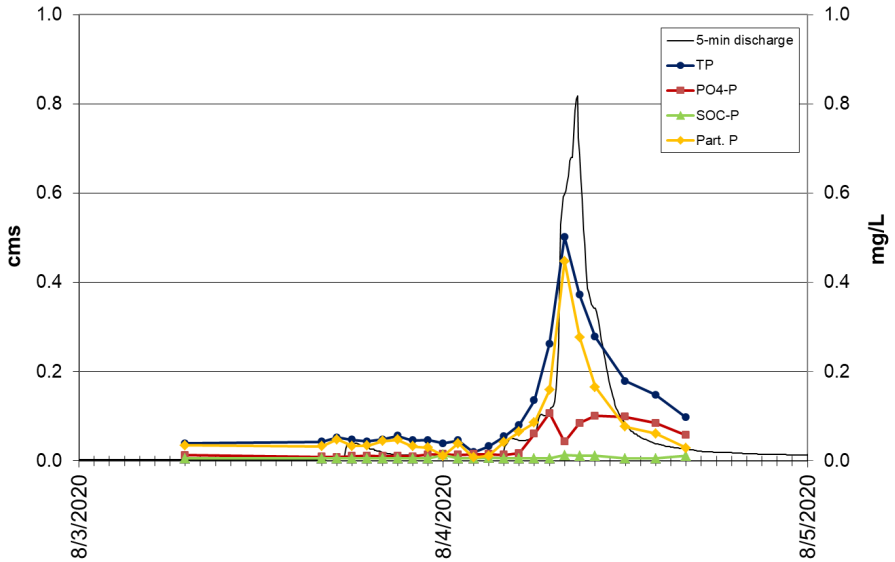


UTLP (Event F: T.S. Isaias):
1-hr *P* = 1.6 cm; 2-hr *P* = 3.0 cm; 24-hr *P* = 8.0 cm









Next Steps

- Data collection to continue through end of calendar year 2022
  - *Greater attention to stream gaging (especially high flows @ UTLP)*
- First report to CBT (8/2021) focused on “during” phase of residential development and GSI implementation
- Expect to transition to “after” phase by end of calendar year 2021
- Expanded data analysis including computation and statistical comparisons of:
  - *Unit hydrographs*
  - *Pollutant loads*
  - *Event mean concentrations*

Acknowledgments

- Chesapeake Bay Trust/Maryland DNR: primary sponsorship
- Howard County (Mark Richmond *et al.*): permits, site development plans
- Briana Rice (AL)
- Katie Kline (AL)
- Jim Garlitz (AL)
- Joel Bostic (AL)
- Elizabeth Eshleman
- Neal Eshleman