

Impacts of Waynesboro Wastewater Treatment Plant Upgrades on South River: 1-yr Update

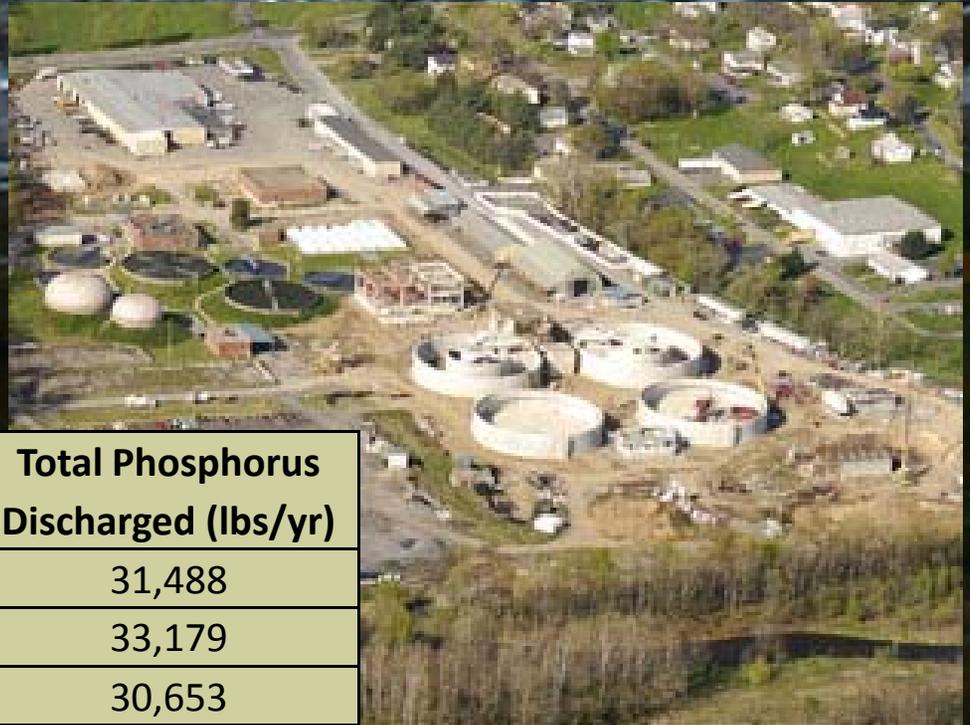
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October 12, 2011



Waynesboro WWTP Upgrades

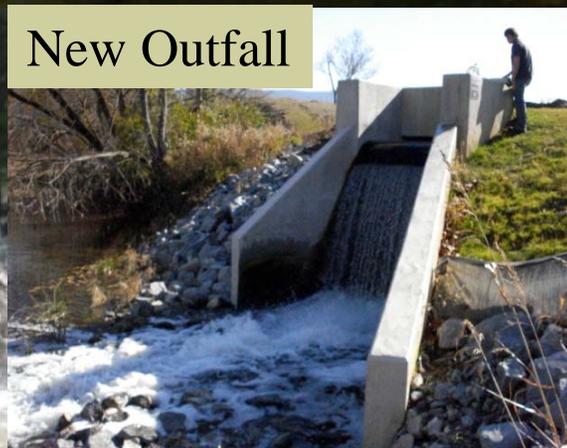
- Biological Nutrient Removal (BNR) installed
- Large reductions in nitrogen and phosphorus expected



Year	Total Nitrogen Discharged (lbs/yr)	Total Phosphorus Discharged (lbs/yr)
2007	156,602	31,488
2008	130,199	33,179
2009	131,121	30,653
Average (2007-2009)	139,307	31,773
Permit Limits for 2011	48,729	3,655
Anticipated Reduction (%)	65%	88%

Impacts on South River

- 4 sites chosen to bracket outfall (from 250 ft upstream to 1 mile downstream)
- Sites monitored during 6 week pre-upgrade period and 6 week post-upgrade period



Experimental Design

Schedule	Water Quality Analysis				Periphyton Analysis		
	DO, pH, Cond., Temp.	Cl, NO3, PO4, SO4, TP	TSS	THg (filt & unfilt), MeHg (filt & unfilt)	Biomass	Colonized THg, MeHg	Natural THg, MeHg
Prior to Upgrades							
Week 1	x	x					
Week 2	x	x			x		
Week 3	x	x					
Week 4	x	x	x	x	x		
Week 5	x	x					
Week 6	x	x	x	x	x	x	
After Upgrades							
Week 1	x	x					
Week 2	x	x			x		
Week 3	x	x					
Week 4	x	x	x	x	x		
Week 5	x	x					
Week 6	x	x	x	x	x	x	x
Samples	60	55	13	60	120	40	12
Parameters	4	4	1	4	1	2	2
Total Data Points	240	220	13	240	120	80	24
						Sum =	937

Monitoring Periods

2010

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

					Pre-upgrade Monitoring	Upgrades	Post-upgrade Monitoring	
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2011

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

						1-yr Post- upgrade Monitoring				
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New Site Added

- In 2011 (1-yr Post-upgrade monitoring) a new site was added at the Augusta Forestry Center (AFC)
- In association with another project (mesocosm study), mercury uptake data in 6-wk colonized algae was collected in 2010 from this site



Algae Colonization

- 8 Replicate trays of 4 rocks placed at each site
- Rock sampled for biomass at 2, 4, and 6 weeks colonization



Dealing with “Vandalism”

Please do not disturb. These rock baskets are part of a scientific experiment performed by James Madison University and the South River Science Team.



Biomass Sampling

- Fixed area sampled for biomass using cookie cutter, toothbrush, funnel, squirt bottle
- Scraped material processed for dry weight and ash-free dry weight



Mercury Sampling

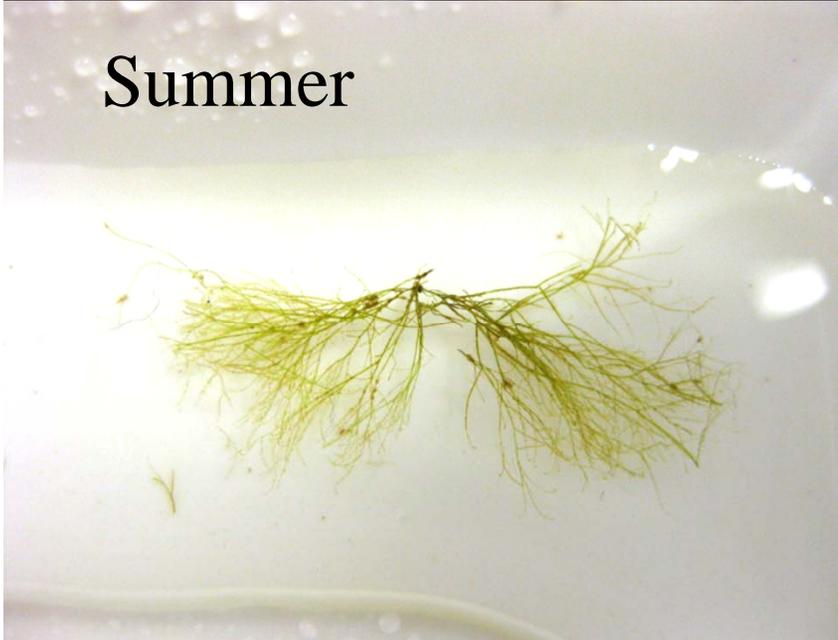
- Attached algae scraped with stainless steel spatula
- Rinsed and sorted in plastic tray to remove sediment and macroinvertebrates



Mercury Sampling

- Goal was to just sample attached algae
- Composition of colonized algae in fall did not allow this separation
- This was the main impetus for 1-yr post-upgrade monitoring in Summer 2011

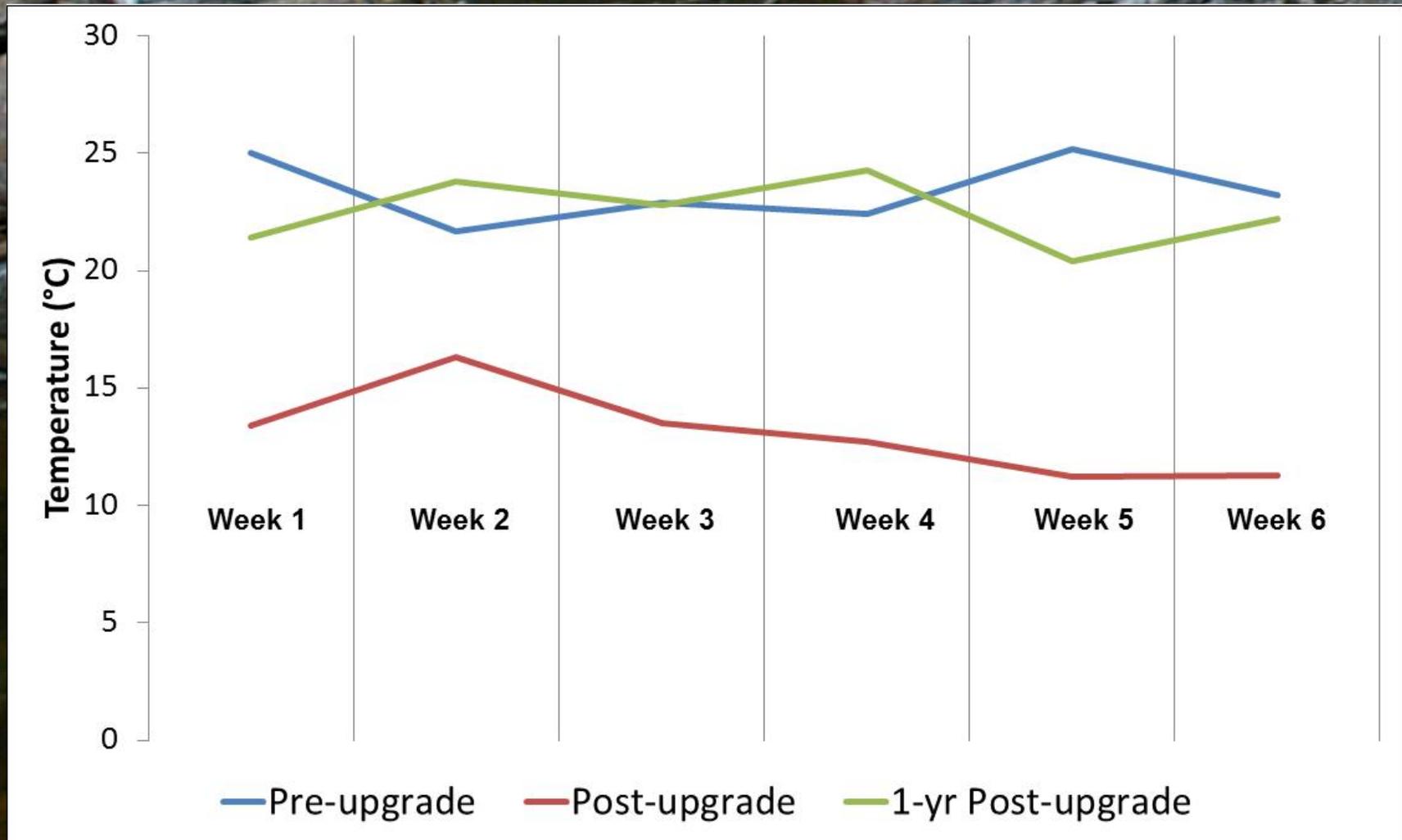
Summer



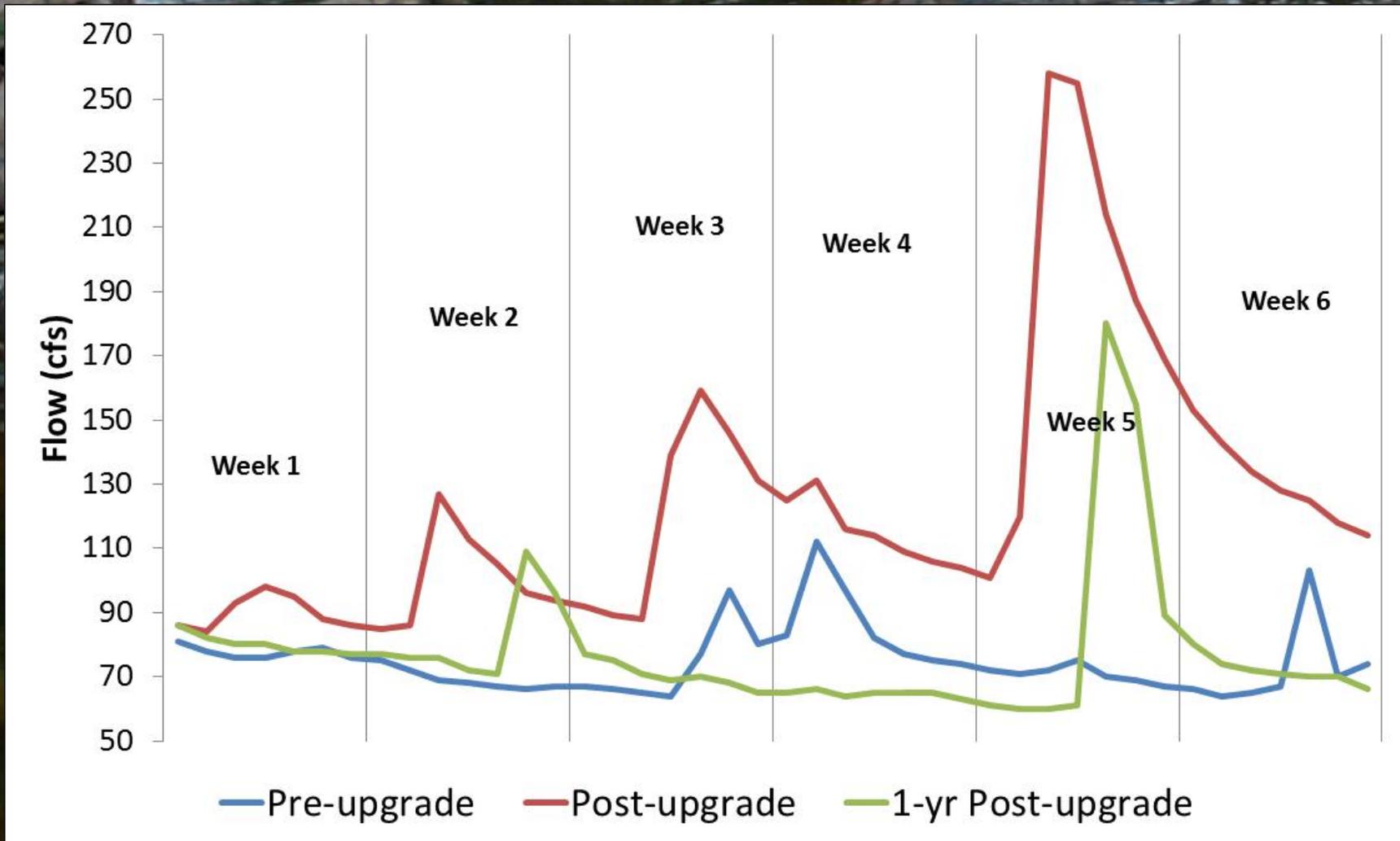
Fall



Temperature During Monitoring Periods



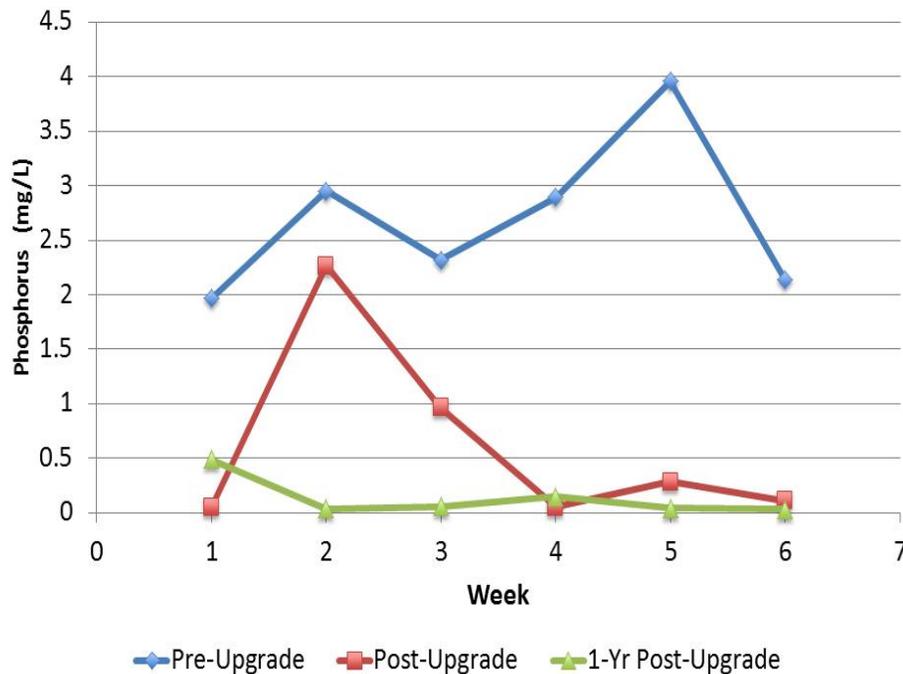
Flow During Monitoring Periods



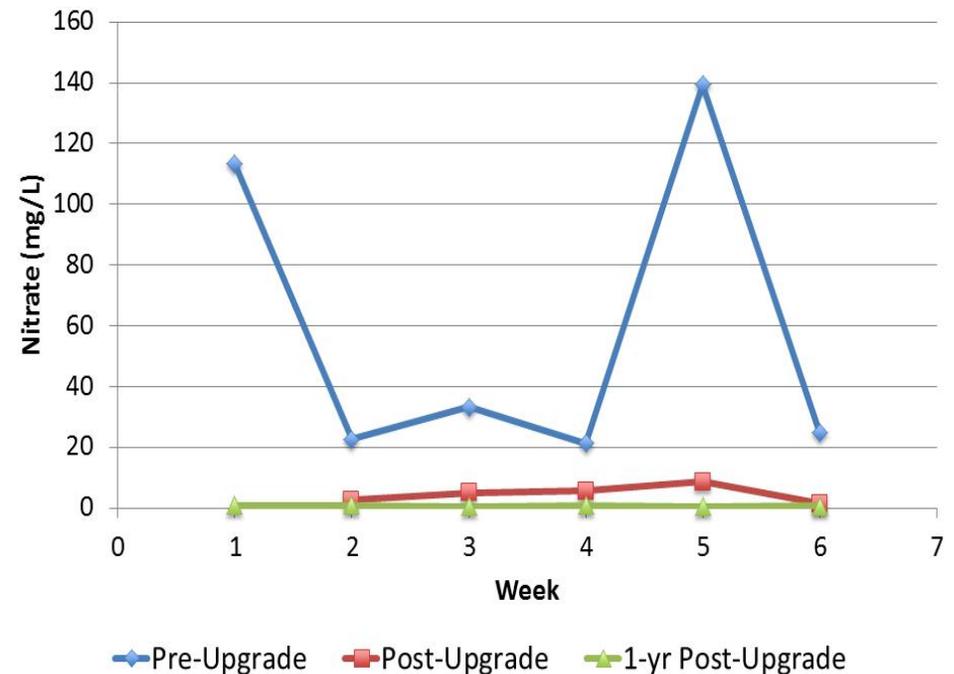
Nutrient Levels in Discharge

- Average phosphorus levels dropped 95% following upgrades (from 2.7 to 0.62 to 0.13 mg/L)
- Average nitrate levels dropped 99% following upgrades (from 59 to 4.7 to 0.78 mg/L)

Effluent Phosphorus

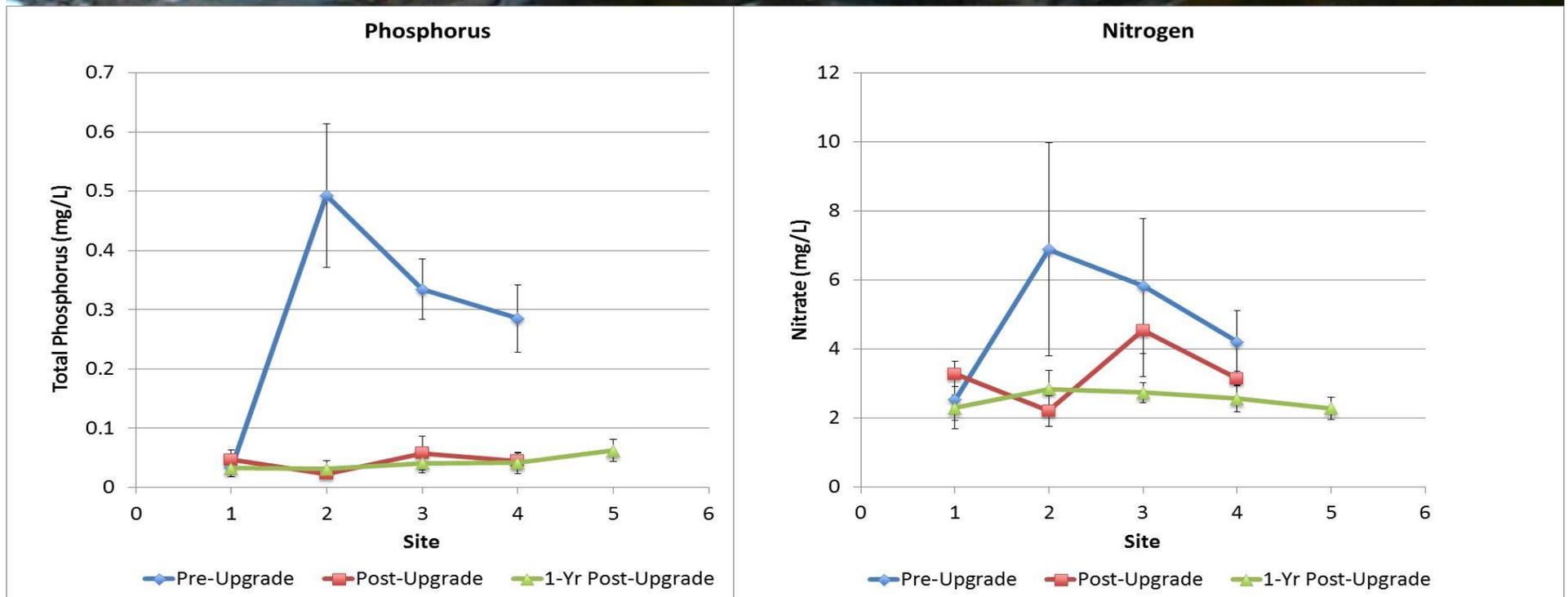


Effluent Nitrogen



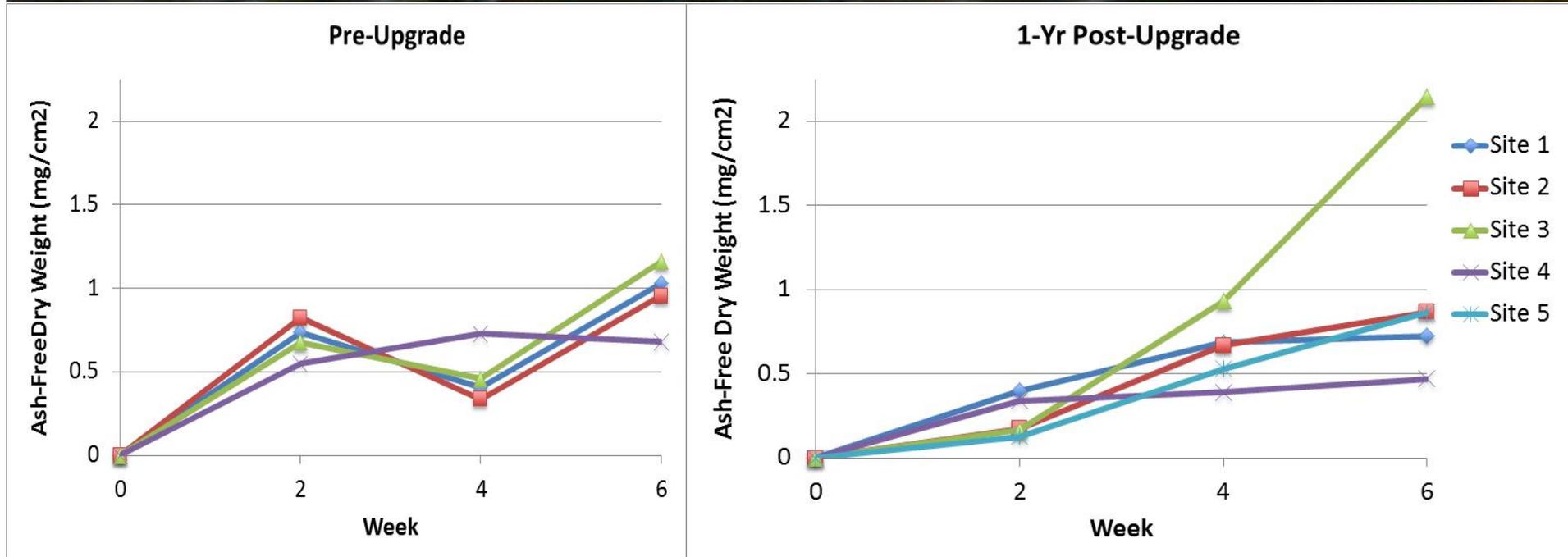
Nutrient Levels in South River

- Phosphorus levels decreased significantly by 85-88% at downstream sites
- Nitrate levels decreased only 39-53% at downstream sites
- Nonpoint source contribution of nitrogen much larger than phosphorus



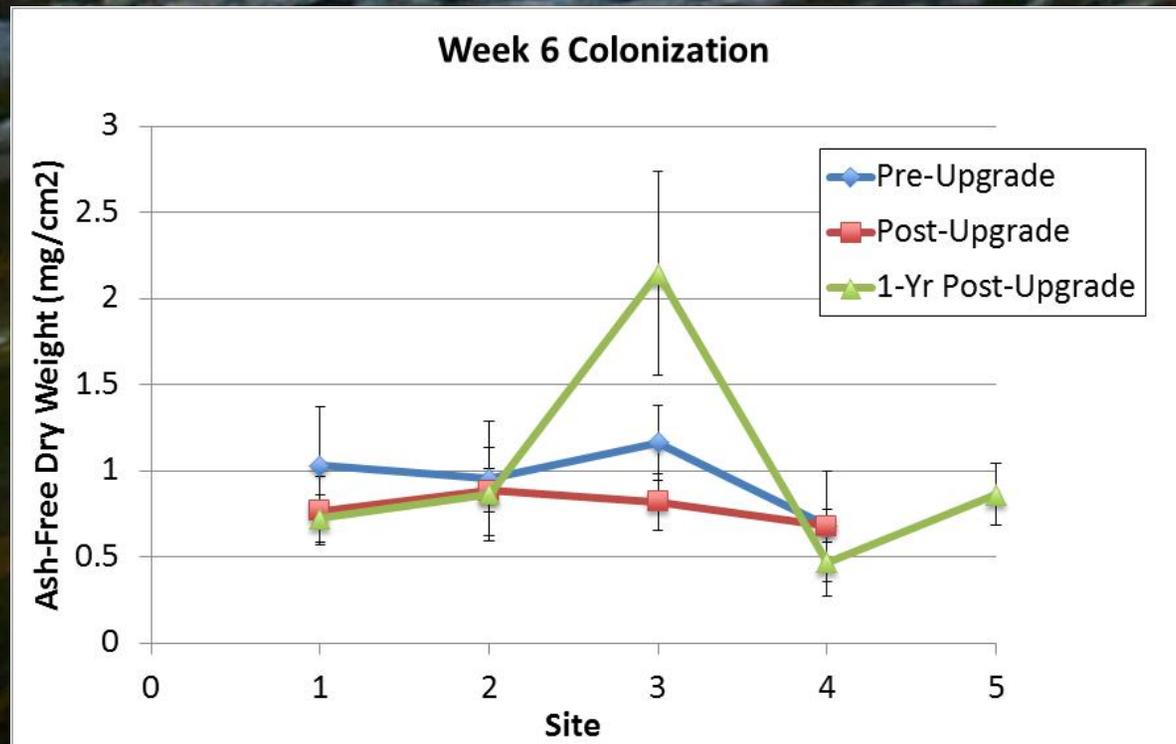
Periphyton Growth

- Periphyton growth rates were similar during pre-upgrade and 1-yr post-upgrade monitoring
 - Except for Site 3
- Decrease in periphyton biomass between week 2 and 4 pre-upgrade possibly due to scouring from storm event



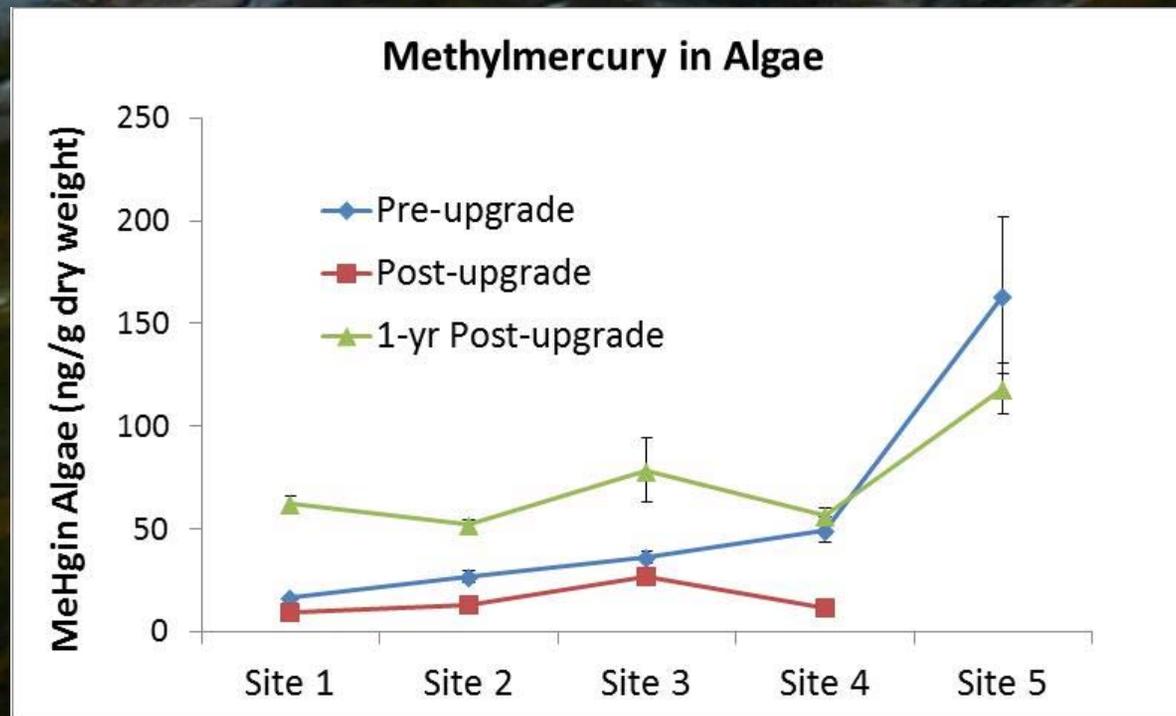
Periphyton Biomass

- Decreased nutrient levels do not appear to have reduced periphyton growth and biomass
 - Pre and post-upgrade biomass was similar at Sites 1, 2, and 4
 - 1-yr post-upgrade biomass was higher at Site 3 than pre-upgrade biomass
 - Increase at Site 3 could be due to ammonia-nitrogen in discharge



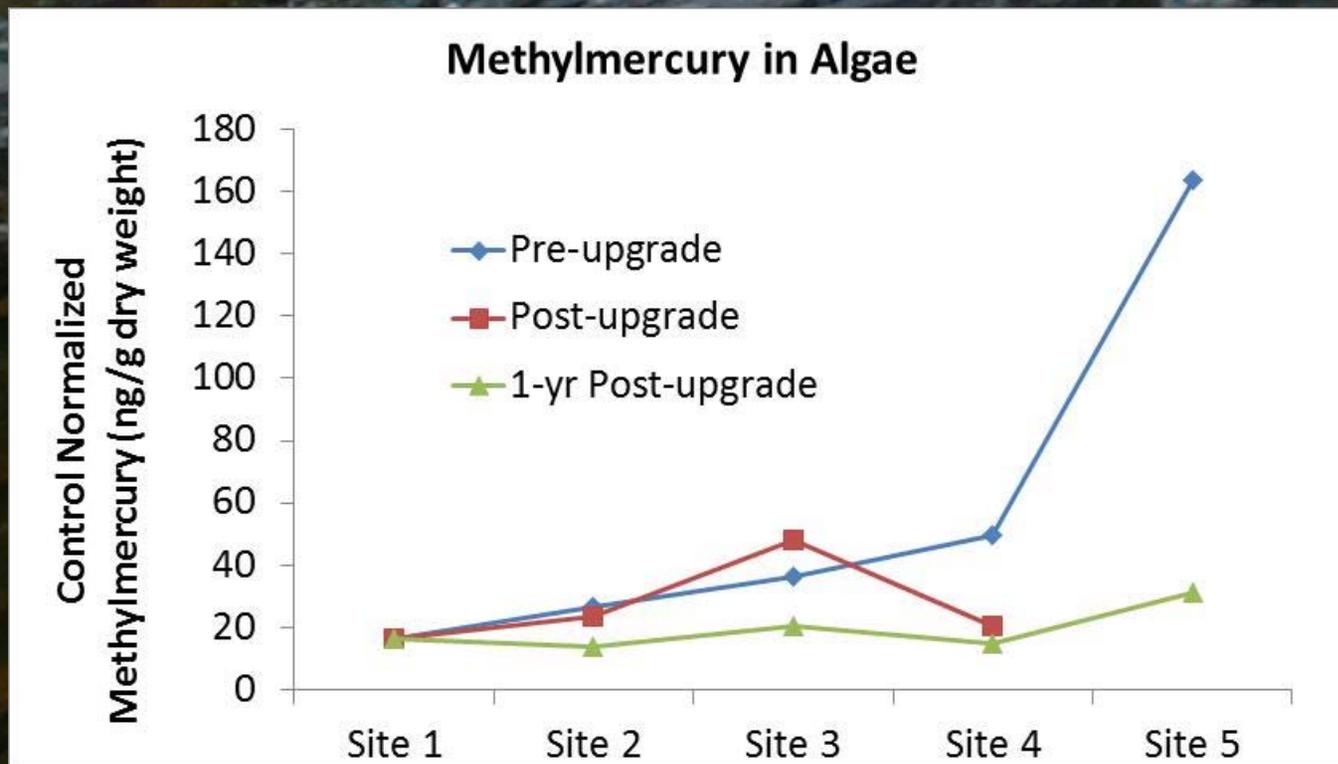
Mercury in Algae

- Methylmercury in algae was generally higher in 1-yr post-upgrade monitoring than in pre-upgrade monitoring (at 4 of 5 sites)
 - This includes Site 1, upstream from STP (280% increase in methylmercury)
 - Other factors that contribute to annual variability of mercury source loadings or uptake are likely more important than impacts of reduced nutrient levels



Mercury in Algae

- When normalized by annual effects at the Site 1 Control, nutrient reductions appear to have reduced methylmercury accumulation in algae
 - Normalized methylmercury concentrations in algae decreased by 44%, 70%, and 81% at Sites 3, 4, and 5



Conclusions

- Upgrades at the Waynesboro WWTP greatly reduced nutrient levels (nitrogen and phosphorus) in the effluent
- Upgrades significantly reduced downstream phosphorus concentrations in the river
- Nitrogen levels in the river were reduced to a lesser extent
 - Due to influence of background non-point sources of nitrogen

Conclusions

- Nutrient reductions resulting from the upgrade did not significantly decrease periphyton biomass in the river
 - Reductions had little effect at Sites 2 and 4
 - Background non-point sources of nutrients high enough that nutrients are not limiting factor in periphyton growth
 - Increases in periphyton biomass at Site 3 may be due to increased ammonia discharge
- After accounting for annual variability, upgrades likely contributed to reduced methylation or methylmercury uptake in periphyton, but...
 - Other factors that contribute to the annual variability are more important than impacts of reduced nutrient levels