WATER QUALITY REPORT

FOR

THE MOBILE BAY NATIONAL ESTUARY PROGRAM PROJECT

Based on the water data collected from the field during the study period 9/19/2014 to 10/26/2016 (Figure 1), along the Toulmins Spring Brach Watershed (On average, 36.4% of surfaces are impervious. Soil type within the watershed is mostly sandy, and 93% of the study area is developed), it seems that there is no nutrients problem. Figure 2 shows the time series of nitrate+nitrite and phosphate concentrations. Figure 3 provides a summary. Median nitrate and nitrite concentration is below the EPA water quality criteria for nitrogen (Nitrate, Nitrite, and Ammonia), which is 10 mg/L for domestic water supply (health), for Toulmins Spring Branch Watershed according to the QUALITY CRITERIA for WATER 1986 published by EPA (Table 4 and 5). Nitrates/Nitrites section is the pages between 233 and 238. Rose (2002) analyzed the major ion stream chemistry for the Peachtree Creek basin, 54.7 % urbanized, in the Atlanta (Georgia, USA) metropolitan region. He found that combined baseflow and stormflow NO_3 mean concentration is 2.4-2.8 mg/L. Schoonover et al., (2005) found that NO_3 mean concentration data for combined baseflow and stormflow for is 1.67 – 2.04 mg/L in the middle Chattahoochee River Watershed in western Georgia, 47.95% of the watershed is urban development. Franklin et al., (2002) found that median stream nitrate concentration in the Rose Creek (Southern Piedmont watersheds) is 0.83 mg/L. According to Schoonover, J. E., & Lockaby, B. G., (2006), median NO_3 concentration is founded 1.93 mg/L in 3 county study area (Muscogee, the city of Columbus occupied most of Muscogee County, which was the most highly urbanized county, Harris, and Meriwether) in west–central Georgia. Felton et al., (2007) studied the effects of poultry litter stockpiles on nutrient availability and movement were evaluated for two soils from the major poultry-producing region in Maryland. An upland Coastal Plain soil (Evesboro sandy loam) and a lowland Coastal Plain soil (Othello silt loam) are used. Average NO_3–N concentrations ranged from 2.75 to 9.80 mg/L, and for the sandy loam soil and average PO_4–P concentration ranged from 0.21 to 10.78 mg/L. Lee and Bang (2000) investigated the characteristics of pollutants overflow on storm events, relationships between pollutant load and runoff, and the first flush effect in urban areas. They found that highly urbanized watersheds, during the storm events, measured concentration ranges of NO_3-N is 0.01-4.32mg/L and PO_4-P is 0.89-21.05 mg/L, respectively. Igbinosa, E. O., & Okoh, A. I., (2009) studied the qualities of the treated final effluents of a wastewater treatment plant located in a rural community of the Eastern Cape Province of South Africa. They found that nitrate is 1.82-13.14 mg/L, orthophosphate is 0.07 - 4.81 mg/L.

Based on the USGS National Water-Quality Assessment (NAWQA), urban rivers and streams across the United States average mean NO_3+NO_2 concentration is 1.53 mg/L and the average median is NO_3+NO_2 concentration is 0.8 mg/L in urban streams. Some of the urban streams in the United States are shown at Table 1 (http://cida.usgs.gov/quality/rivers).

Table 1. NO_3+NO_2 concentration some urban streams across the US from 1992 to 2014

Station	Station Name	Site Type	NO3+NO2 (Concentration)		Time
			Mean (mg/L)	Median (mg/L)	
01654000	Accotink Creek near Annandale, VA	Urban	0.64	0.6	1992-2014
04161820	Clinton River at Sterling Heights, MI	Urban	1.34	1.11	1992-2014
06713500	Cherry Creek at Denver, CO	Urban	1.84	1.59	1992-2014
08057200	White Rock Creek at Dallas, TX	Urban	1.93	1.80	1992-2014
10168000	Little Cottonwood Creek at Salt Lake City, UT	Urban	0.55	0.47	1992-2014
14206950	Fanno Creek at Durham, OR	Urban	0.63	0.53	1992-2014

In addition to this, ADEM published a draft delisting decision for Toulmins Spring Branch for Ammonia in 2013. According to the draft, ADEM has determined that impairment due to ammonia does not exist from an examination of all available water data for Toulmins Spring Branch. Therefore, ADEM did not develop a TMDL for ammonia for TSB.

Phosphorus is of concern in surface waters because it can lead to eutrophication. Phosphorus is also a concern because phosphate levels greater than 1.0 mg/l may interfere with coagulation in drinking water treatment plants (Bartenhagen et al., 1994). Some research studies are currently underway to decrease the amount of P in livestock manure, primarily through enzymes and animal ration modifications that make phosphorus in the feed more available (and usable) by the animal.

Freshwater system impacts: Generally, phosphorus (as orthophosphate) is the limiting nutrient in freshwater aquatic systems. Many bodies of freshwater are currently experiencing influxes of phosphorus and nitrogen from outside sources. The increasing concentration of available phosphorus allows plants to assimilate more nitrogen before the phosphorus is depleted. Thus, if sufficient phosphorus is available, elevated concentrations of nitrates will lead to algal blooms. Although levels of 0.08 to 0.10 mg/l orthophosphate may trigger periodic blooms, long-term eutrophication will usually be prevented if total phosphorus levels and orthophosphate levels are below 0.5 mg/l and 0.05 mg/l, respectively (Dunne and Leopold, 1978).

On the other hand, site 4 (Toulmin Ct) and 5 (W Prichard Ave), which are mostly upstream sites, have a higher PO_4 concentration (site 4 is 0.4 mg/L and 5 is 0.16 mg/L) compared to the most downstream (Site 1, 2, and 3) is shown Table 2 and 3. However, as seen in Figures 2 and 3, when we move from upstream to downstream, the phosphate concentration drops. As reported by ADEM, there are no continuous NPDES discharges located in the TSB watershed. For the non-continuous point sources, the TSBW qualifies as a Municipal Separate Stormwater Sewer System (MS4) area (ADEM, 2009). Sanitary sewer overflows (SSOs) have the potential to severely impact water quality and can often result in the violation of water quality standards. In urban areas, P sources are generally runoff from golf courses, residential lawns, construction sites, sewage overflow, and septic system drainage (Dubrovsky and Hamilton, 2010). During our field visits, we have seen some sanitary sewer overflows during very big events next to site 5 and site 4, and it was flowing to the stream (Figure 4). Wastewater inputs into TSBW are the result of big rain events that triggered the overflow of combined storm and sanitary sewers which is seen upstream of the watershed and the subsequent discharge of untreated wastewater into the creek as seen the Figure 4. Therefore, there is a correlation between increased phosphate concentration and the combined sewer overflows. Death animals and debris near or in the creek as shown in Figures 5 and 6 were not uncommon in the study watershed. I believe that as it is mentioned above, sanitary sewer overflow, occasional death animals, and debris would contribute the increased phosphate concentration of site 4 and 5. Ultimately, as a result of the phosphate concentration is lowest at the most downstream TSB stream.

In conclusion, based on the literature and similar studies, there is no nutrients problem within the Toulmins Spring Branch watershed.

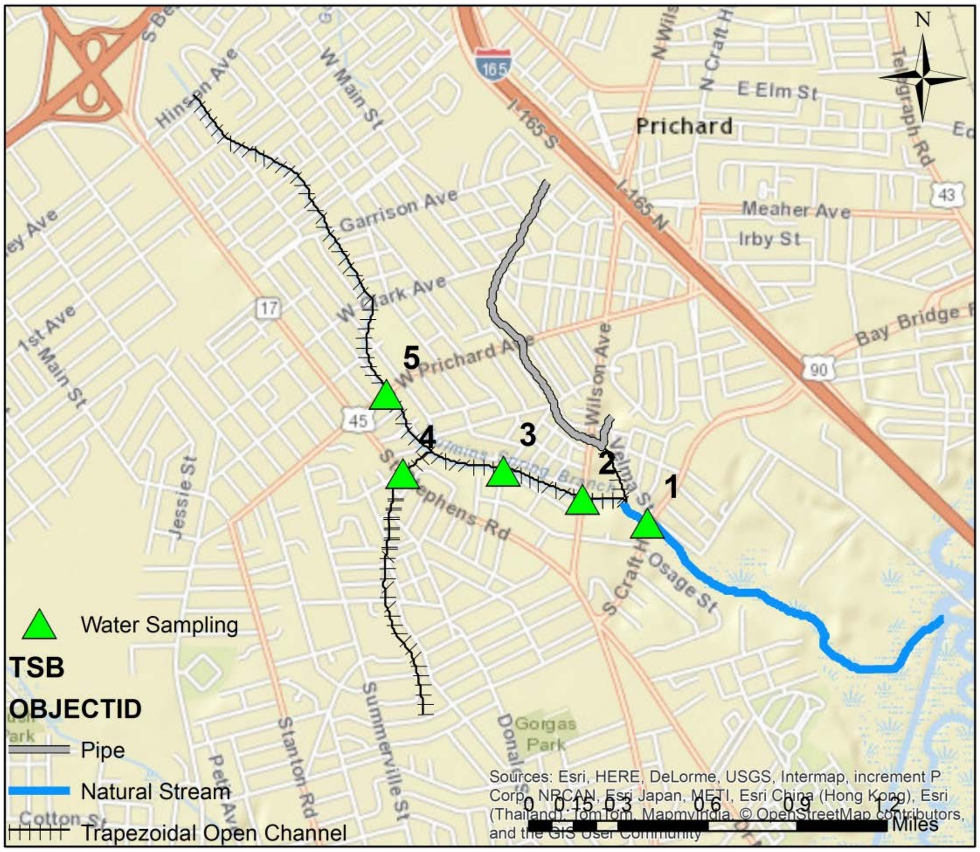


Figure 1. Water sampling locations within the Toulmins Spring Branch Watershed

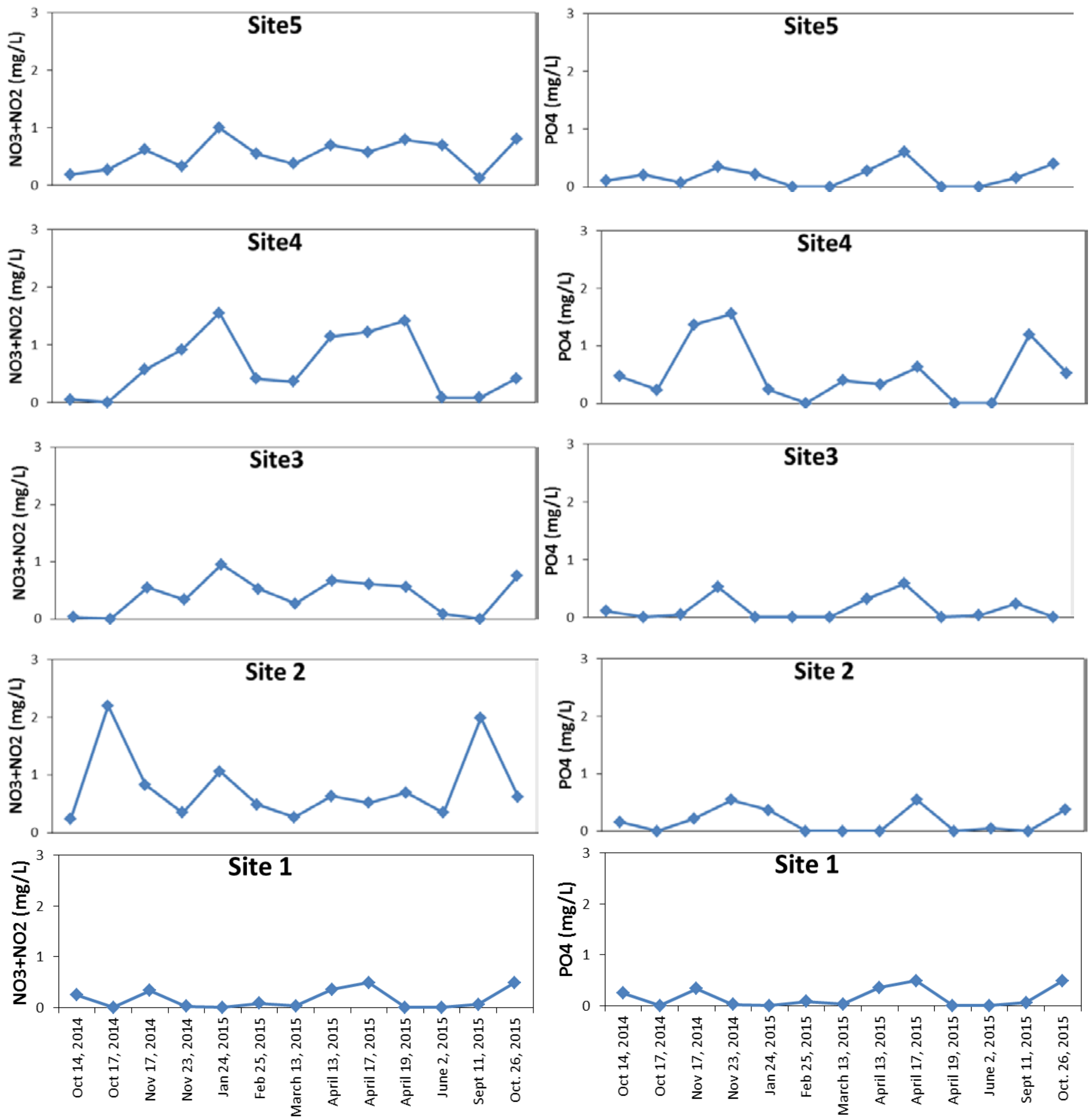
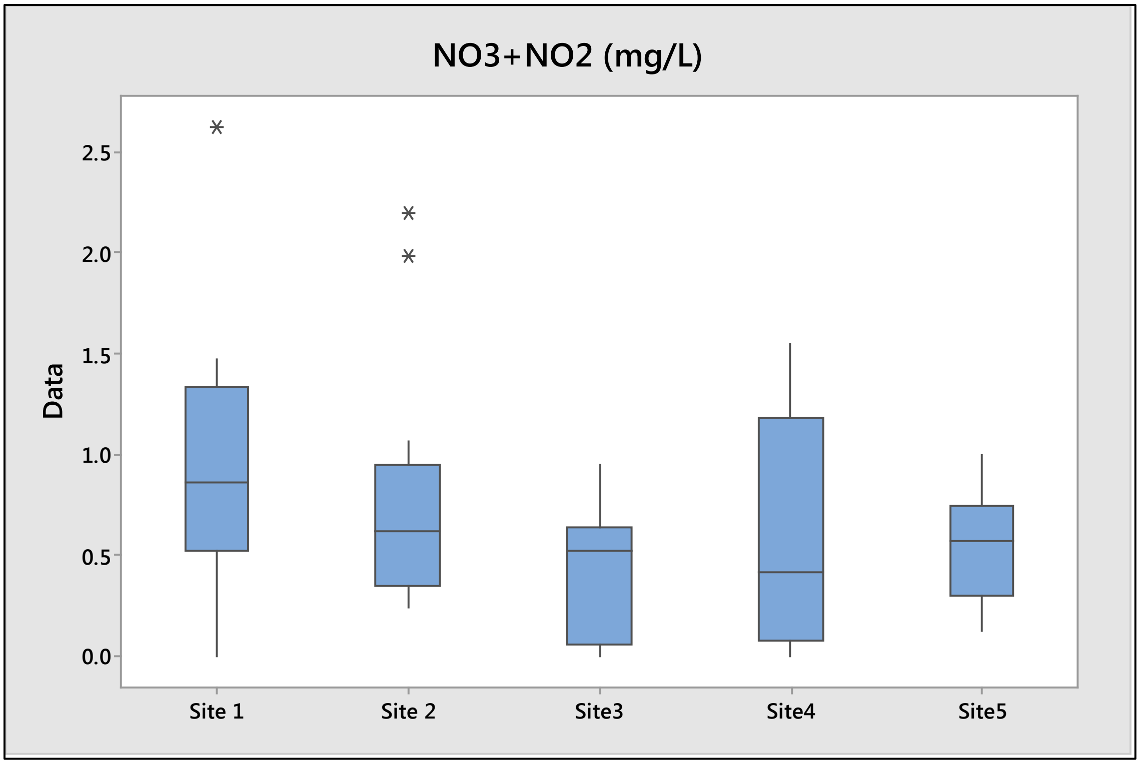


Figure 2. The NO_3+NO_2 and PO_4 concentrations in time. Site 5 is the most upstream site, whereas Site 1 is the most downstream.



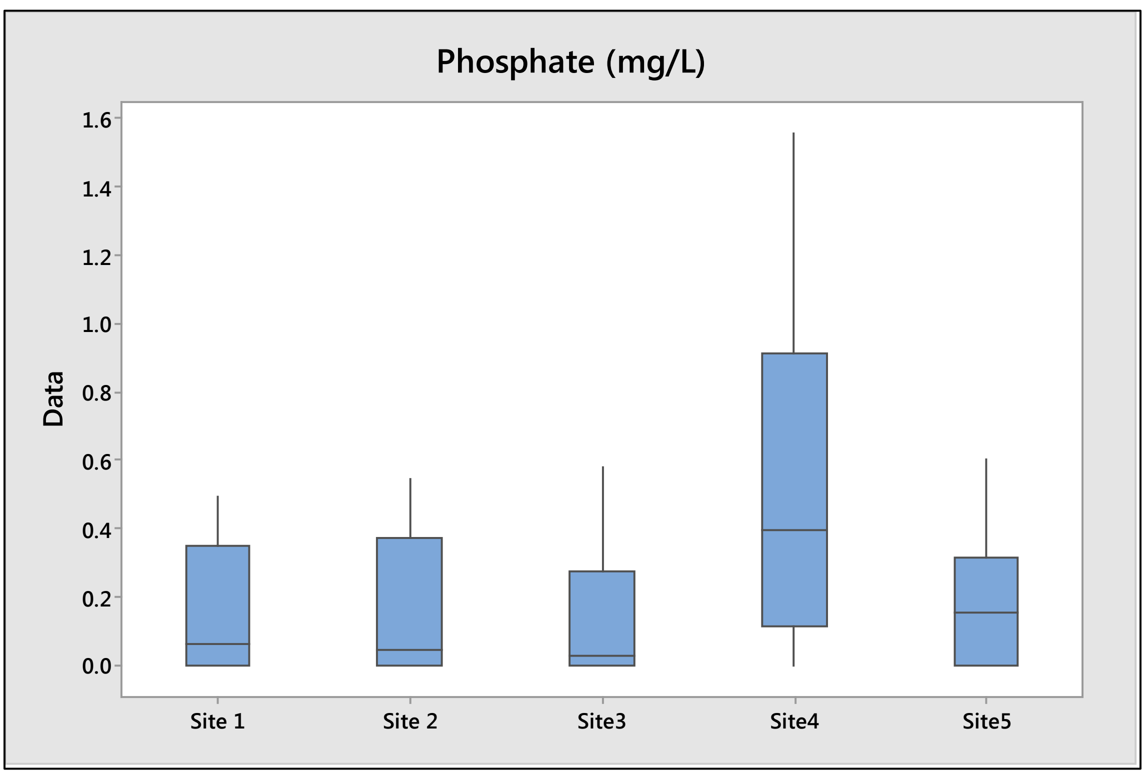


Figure 3. Average NO_3+NO_2 and PO_4 concentrations.

Table 2. Median and mean PO4 (mg/L) concentration

PO_4 (mg/L)					
Date	**Site 1**	**Site 2**	**Site3**	**Site4**	**Site5**
Oct 14, 2014	0.24	0.16	0.10	0.47	0.11
Oct 17, 2014	0.00	0.00	0.00	0.23	0.21
Nov 17, 2014	0.34	0.22	0.04	1.37	0.08
Nov 23, 2014	0.03	0.54	0.52	1.55	0.35
Jan 24, 2015	0.00	0.36	0.00	0.24	0.22
Feb 25, 2015	0.08	0.00	0.00	0.00	0.00
March 13, 2015	0.03	0.00	0.00	0.40	0.00
April 13, 2015	0.36	0.00	0.32	0.33	0.28
April 17, 2015	0.49	0.54	0.58	0.63	0.60
April 19, 2015	0.00	0.00	0.00	0.00	0.00
June 2, 2015	0.00	0.05	0.03	0.00	0.00
Sept 11, 2015	0.06	0.00	0.23	1.19	0.16
Oct. 26, 2015	0.49	0.38	0.00	0.53	0.40
Median	**0.06**	**0.05**	**0.03**	**0.40**	**0.16**
Mean	**0.16**	**0.17**	**0.14**	**0.53**	**0.18**

Table 3. Median and mean PO4 – P equivalent (mg/L) concentration

PO4-P Equivalent					
Date	**Site 1**	**Site 2**	**Site3**	**Site4**	**Site5**
Oct 14, 2014	0.08	0.05	0.03	0.15	0.04
Oct 17, 2014	0.00	0.00	0.00	0.08	0.07
Nov 17, 2014	0.11	0.07	0.01	0.45	0.02
Nov 23, 2014	0.01	0.18	0.17	0.51	0.11
Jan 24, 2015	0.00	0.12	0.00	0.08	0.07
Feb 25, 2015	0.03	0.00	0.00	0.00	0.00
March 13, 2015	0.01	0.00	0.00	0.13	0.00
April 13, 2015	0.12	0.00	0.10	0.11	0.09
April 17, 2015	0.16	0.18	0.19	0.20	0.20
April 19, 2015	0.00	0.00	0.00	0.00	0.00
June 2, 2015	0.00	0.02	0.01	0.00	0.00
Sept 11, 2015	0.02	0.00	0.08	0.39	0.05
Oct. 26, 2015	0.16	0.12	0.00	0.17	0.13
Median	**0.02**	**0.02**	**0.01**	**0.13**	**0.05**
Mean	**0.05**	**0.06**	**0.05**	**0.17**	**0.06**

Table 4. Median and mean NO3+NO2 (mg/L) concentration

NO_3+NO_2 (mg/L)					
Date	**Site 1**	**Site 2**	**Site3**	**Site4**	**Site5**
Oct 14, 2014	0.74	0.24	0.03	0.05	0.18
Oct 17, 2014	2.62	2.19	0.00	0.00	0.27
Nov 17, 2014	1.33	0.83	0.55	0.57	0.61
Nov 23, 2014	1.47	0.35	0.33	0.91	0.32
Jan 24, 2015	1.14	1.06	0.95	1.55	0.99
Feb 25, 2015	0.53	0.49	0.52	0.41	0.54
March 13, 2015	0.26	0.27	0.27	0.36	0.37
April 13, 2015	0.68	0.63	0.67	1.14	0.70
April 17, 2015	0.50	0.52	0.61	1.22	0.57
April 19, 2015	1.34	0.69	0.56	1.42	0.78
June 2, 2015	1.07	0.35	0.08	0.08	0.69
Sept 11, 2015	0.00	1.99	0.00	0.08	0.12
Oct. 26, 2015	0.86	0.62	0.75	0.42	0.80
median	**0.86**	**0.62**	**0.52**	**0.42**	**0.57**
mean	**0.96**	**0.79**	**0.41**	**0.63**	**0.54**

Table 5. Median and mean NO3- N equivalent (mg/L) concentration

NO_3-N Equivalent					
Date	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**
Oct 14, 2014	0.14	0.02	0.01	0.00	0.02
Oct 17, 2014	0.49	0.48	0.00	0.00	0.06
Nov 17, 2014	0.28	0.18	0.00	0.12	0.13
Nov 23, 2014	0.27	0.06	0.07	0.19	0.06
Jan 24, 2015	0.24	0.22	0.20	0.33	0.21
Feb 25, 2015	0.10	0.09	0.10	0.06	0.11
March 13, 2015	0.05	0.05	0.05	0.07	0.07
April 13, 2015	0.14	0.13	0.14	0.24	0.14
April 17, 2015	0.11	0.11	0.12	0.25	0.11
April 19, 2015	0.28	0.14	0.12	0.30	0.16
June 2, 2015	0.24	0.08	0.02	0.02	0.15
Sept 11, 2015	0.00	0.44	0.00	0.02	0.03
Oct. 26, 2015	0.19	0.14	0.17	0.09	0.18
Median	**0.19**	**0.13**	**0.07**	**0.09**	**0.11**
Mean	**0.20**	**0.17**	**0.08**	**0.13**	**0.11**

Figure 4. Combined Sewer Overflows side by site 5.

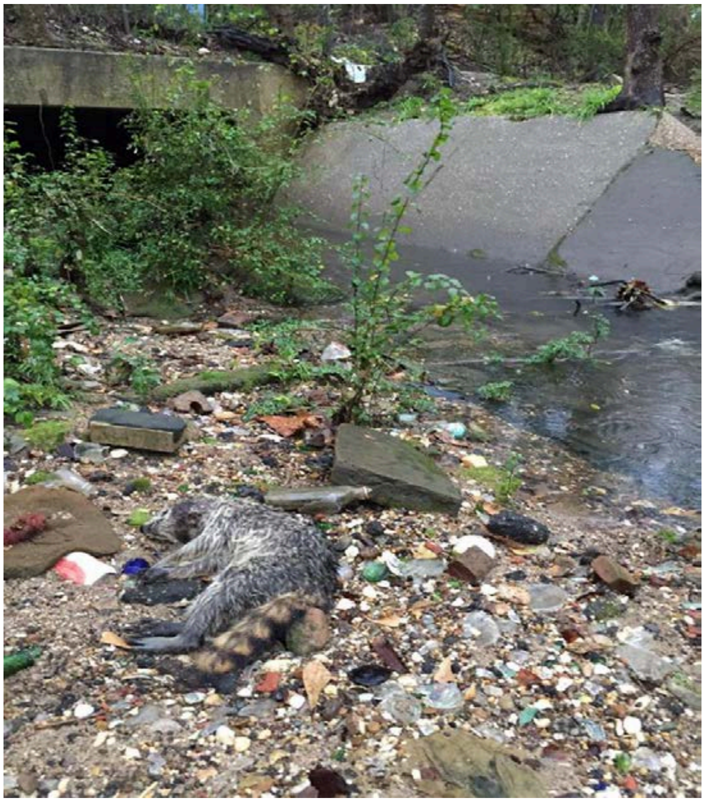


Figure 5. Death of an animal along the stream

Figure 6. The channel is clogged by debris at the site 5

Water depth vs PO_4 and NO_3+NO_2 (mg/L) concentrations are shown in figure 7 and 8.

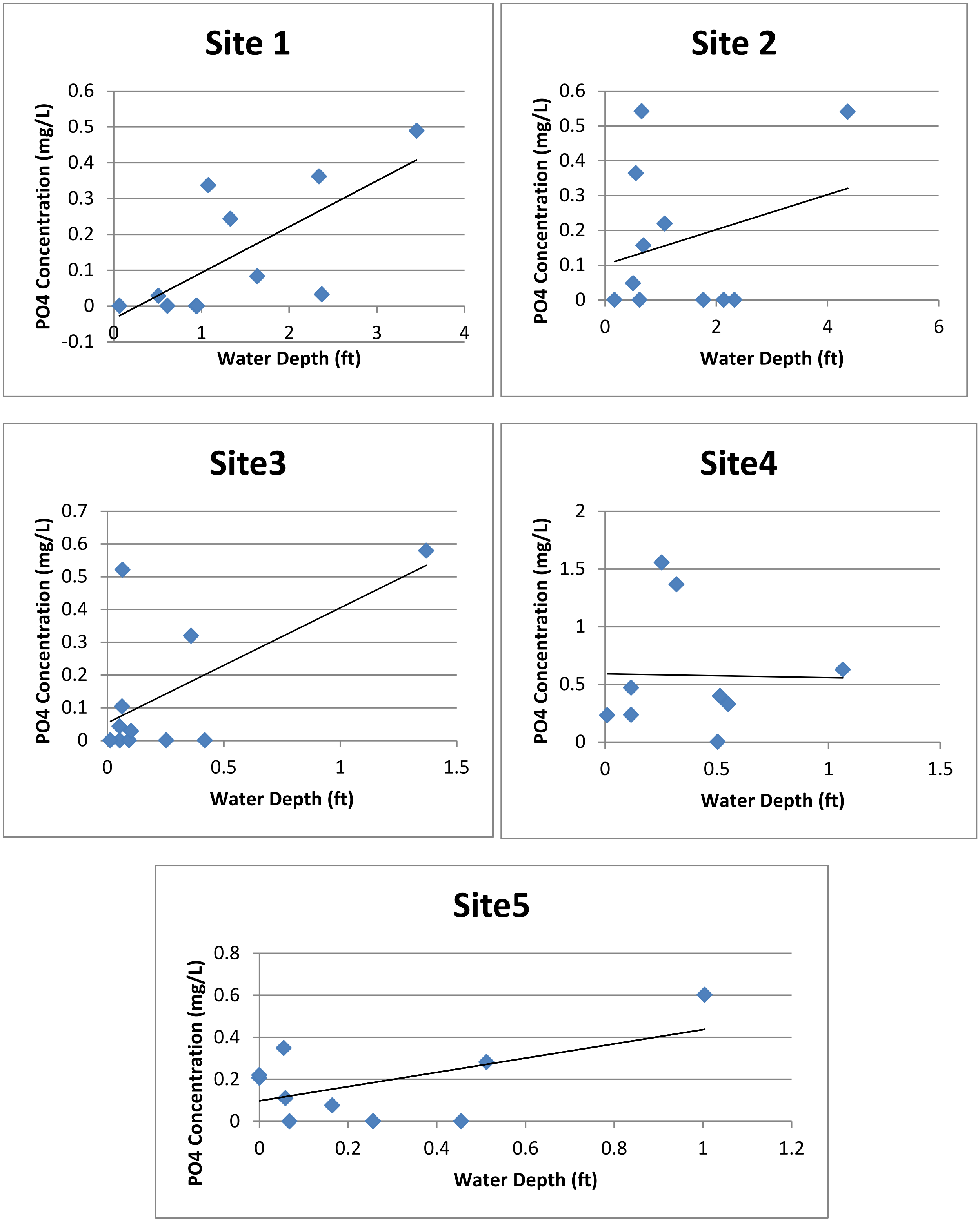


Figure 7. Water depth vs PO_4 concentration

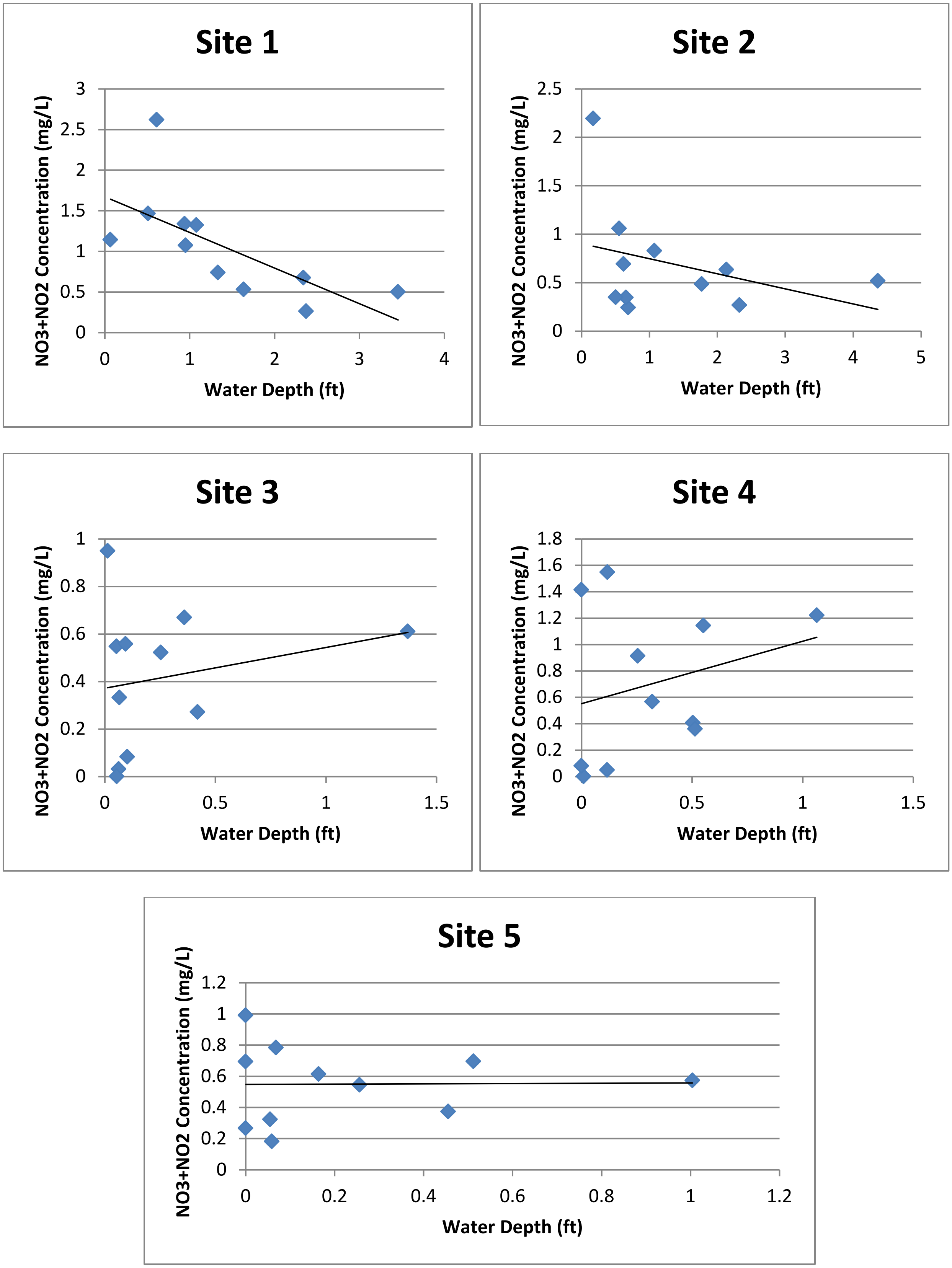


Figure 8. Water depth vs NO_3+NO_2 (mg/L) concentration

E.Coli sampling in the Toulmins Spring Branch Watershed

E.coli is one subgroup of fecal coliform bacteria. Even within this species, there are numerous different strains, some of which can be harmful. However, the release of these naturally-occurring organisms into the environment is generally not a cause for alarm. But, other disease-causing bacteria, which can include some pathogenic strains of E. coli or viruses may also be present in these wastes and pose a health threat. The EPA has determined that E. coli are one of the best indicators for the presence of potentially pathogenic bacteria (EPA, 2002b). Because E. coli monitoring does not measure the actual pathogens, the assessment is not foolproof, however, it is a useful approach for assessing the likelihood of risks to human health.

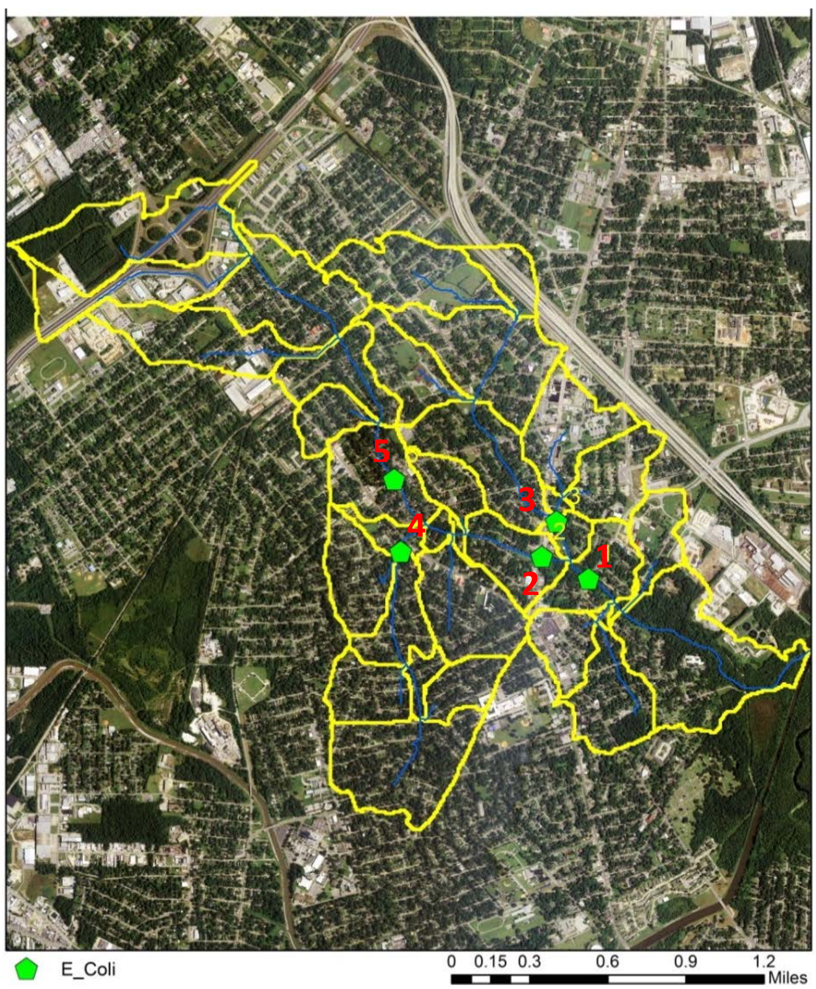
Common sources of E. coli

Bacteria in water can originate from the intestinal tracts of both humans and other warm-blooded animals, such as pets, livestock, and wildlife. Human sources include failing septic tanks, leaking sewer lines, wastewater treatment plants, combined sewer overflow (CSOs), boat discharges, swimming “accidents” and urban storm water runoff. In urban watersheds, fecal indicator bacteria are significantly correlated with human density (Frenzel and Couvillion, 2002). Animal sources of fecal coliform bacteria include manure spread on land, livestock in runoff or in streams, improperly disposed of farm animal wastes, pet wastes (dogs, cats), wildlife (deer, elk, raccoons, etc.), and birds (geese, pigeons, ducks, gulls, etc.)

Toulmins Spring Branch has been identified as being impaired by pathogens (fecal coliform) by the State of Alabama. The §303(d) listing was originally reported on Alabama’s 2004 List of

Impaired Waters. The sources of the impairment are listed as urban runoff and storm sewers. USGS collected fecal coliform data on Toulmins Spring Branch at Graham Avenue (#0247101550) in 2000 and 2001. Out of the seven samples collected over that period, four exceeded the single-sample maximum criterion of 2,000 colonies/100 mL (ADEM 2009).

During this project, water samples were taken for *Escherichia coli* (*E.coli*) twice after the rain events (Figure 9). The results are shown in Table 6.



Site 1 at S Craft Hwy
Site 2 at S Wilson Ave
Site 3 at Velma St
Site 4 at Toulmin Ct
Site 5 at W Prichard Ave

Figure 9. E.coli sampling stations in Toulmins Spring Branch Watershed

Table 6. E.coli results at 5 sites

Date	Site 1	Site 2	Site 3	Site 4	Site 5
11/23/2014	152 MPN/100mL	4730 MPN/100mL	1120 MPN/100mL	10800 MPN/100mL	20800 MPN/100mL
2/15/2016	360 *E.coli* colonies /100mL	2100 *E.coli* colonies /100mL	3260 *E.coli* colonies /100mL	4330 *E.coli* colonies /100mL	2760 *E.coli* colonies /100mL

Table 7 shows the Alabama Water Watch (AWW) standards summarizing relatively safe and unsafe levels of *E.coli* in water. Note that the value of 200 *E. coli* /100mL level defining safe versus unsafe water corresponds closely with EPA's and ADEM's criteria of 235 *E. coli* /100 mL Statistical Threshold Value (based on a single sampling event) (Bacteriological monitoring 2016).

Table 7: The Alabama Water Watch (AWW) E.coli in water

	Number of *E. coli* per 100 mL
Safe for human contact	<200
Risk for human illness	200-600
Unsafe for human contact	>600

As seen the Table 6, most upstream sites are at the higher presence of generic E.coli. The reason mostly is animal sources (Figure 6), leaking sewer lines, wastewater treatment plants, and combined sewer overflow (Figure 5). These might be the same factors causing increased phosphate concentration at the Site 4 and 5 as we discussed above. However, Site 1, the most downstream site, is safe for human contact according to these two events.

Based on these limited data all the sites, except Site 1 (most downstream), are highly unsafe for humans. It would be worth following up this study with another one to trace the sources of *E.coli*.

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