Report on Nutrient Synoptic Survey in the Port Tobacco River Watershed, Charles County Maryland, March, 2005 as part of a Watershed Restoration Action Strategy.

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Cover photo: Pages Swamp at Billingsley Rd. by Niles Primrose

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Executive Summary

A nutrient synoptic survey was conducted during March, 2005 in the Port Tobacco watershed as part of the Port Tobacco Watershed Restoration Action Strategy (WRAS). Water samples were analyzed for dissolved nutrients from 44 sites throughout the watershed. Nitrate/nitrite concentrations were found to be excessive (>5 mg/L) in one subwatershed, moderately elevated (1-3 mg/L) seven, and baseline (<1 mg/L) in the remaining thirty-six subwatersheds. Instantaneous nitrate/nitrite yields were found to be excessive (>.03 Kg/Hectare/day) in four subwatersheds, high (.02-.03 Kg/Hectare/day) in five, moderate (.01-.02 Kg/Hectare/day) in eight, and baseline (<.01 Kg/Hectare/day) in the remaining twenty-seven. Excessive concentrations (>.015 mg/L) of orthophosphate were found in three subwatersheds, high concentrations (.01-.015 mg/L) in eight, moderate concentrations (.005 -.01 mg/L) in twenty-five, and the remaining eight below baseline (<.005 mg/L). Orthophosphate yields were found to be moderate (.0005-.001) Kg/Hectare/day) in one watershed, and baseline (<.0005 Kg/Hectare/day) in the remaining forty-three. No significant anomalies were found in the insitu measurements of dissolved oxygen, or temperature. Depressed ph values (<5.5) were found in four subwatersheds. Seventeen subwatersheds in the Port Tobacco watershed had low specific conductivity (<.1 umohs/mm), and two subwatersheds in this drainage had relatively high conductivity (>.5 umohs/mm). Bacteria sampling found four sites with 'Most Probable Number' (mpn) results over the 200 mpn standard for water contact recreation. Experimental sampling for optical brightener found higher values in the upper portion of the watershed. There are no guidelines or standards for brightener values at this time. The Port Tobacco watershed does not have a significant problem with dissolved nutrients. Moderately elevated nitrate/nitrite concentrations and yields may be associated with communities on well and septic. Moderately elevated orthophosphate yields in one subwatershed may be associated with the La Plata WWTP discharge. Moderately elevated pH and specific conductivity, as well as the heavy algal growth, in this same subwatershed may also be associated with the La Plata WWTP discharge. The average nutrient concentration and yield from the Port Tobacco watershed was low compared to other WRAS watersheds. Sampling for *E.coli* bacteria and optical brighteners was inconclusive in attempting to locate a source for bacteria contamination.

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Introduction

A nutrient synoptic survey was conducted during March, 2005 in the Port Tobacco watershed as part of the Port Tobacco Watershed Restoration Action Strategy (WRAS).

Nutrient synoptic sampling was scheduled for early spring to coincide with the period of maximum nitrogen concentrations in the free flowing fresh water streams. The major proportion of the nitrogen compounds are carried dissolved in the ground water rather than in surface runoff. The higher nitrogen concentrations in the late winter and early spring reflect the higher proportion of nitrogen rich shallow ground water present in the base flow at this time of year. Nitrogen concentrations are reduced in summer as the proportion of shallow ground water is reduced through plant uptake, and replaced by deeper ground water that may have lower nitrate concentrations, or has been denitrified through interaction with anoxic conditions in the soils below the streambed. Point sources can also contribute to in stream nitrate concentrations.

Orthophosphate is generally transported bound to suspended sediments in the water column. In stream orthophosphate concentrations can also be produced through mobilization of sediment bound phosphorus in anoxic water column and/or sediment conditions, sediment in surface runoff from areas having had surface applied phosphorus, ground water from phosphorus saturated soils, and point source discharges.

Ranges used for nutrient concentrations and yields (Table 1) were derived from work done by Frink (1991). The low end values are based on estimated nutrient exports from forested watersheds, and the high end values are based on estimated nutrient exports from intensively agricultural watersheds. As an additional benchmark, the Chesapeake Bay Program uses 1 mg/L total nitrogen as a threshold for indicating anthropogenic impact. The dissolved nitrogen fraction looked at in these synoptic surveys constitutes approximately 50% to 70% of the total nitrogen.

Table 1. Nutrient Ranges and Rating

Rating	NO2+NO3 Concentration mg/L	NO2+NO3 Yield Kg/ha/day	PO4 Concentration mg/L	PO4 Yield Kg/ha/day
Baseline	<1	<.01	<.005	<.0005
Moderate	1 to 3	.01 to .02	.005 to .01	.0005 to .001
High	3 to 5	.02 to .03	.01 to .015	.001 to .002
Excessive	>5	>.03	>.015	>.002

A Note of Caution

Estimates of annual dissolved nitrogen loads/yields from spring samples will result in inflated load estimates, but the relative contributions of subwatersheds should remain reasonably stable. More accurate nitrate/nitrite load/yield estimates need to include sampling during the growing season to account for potential lower concentrations and discharges. Storm flows can also significantly impact loads delivered to a watershed outlet.

The tendency of orthophosphate to be transported bound to sediments makes any estimates of annual orthophosphate loads/yields derived from base flow conditions very conservative. More accurate estimates of orthophosphate loads/yields in a watershed *must include samples from storm flows that carry the vast majority of the sediment load of a watershed. Residual suspended sediments from recent rains, or instream activities of livestock or construction can produce apparently elevated orthophosphate concentrations and yields at base flow.*

Charles County has had an ongoing problem with bacterial contamination in the Port Tobacco watershed. In an effort to try and identify source locations, *E. coli* and optical brightener samples were collected at the same location and time as the nutrient samples. These two constituents are potential indicators of septic or sewage contamination in a stream. Optical brighteners (also known as fluorescent whitening agents) are substances that are added to household detergents like laundry soap to increase the appearance of whiteness and brightness after washing. Optical brighteners are also used in paper and textiles for this purpose. Since optical brighteners are used in most laundry detergents, and detergents are a component of wastewater from clothes washing, it has been thought that they may be useful for the detection of sewage leaks from failing on-site wastewater treatment (septic) systems. Optical brighteners fluoresce when exposed to ultraviolet (UV) light.

METHODS

Water Chemistry Sampling

Synoptic water chemistry samples were collected in early spring throughout the watershed. Sampling was halted for a minimum of 24 hours after rainfall events totaling more than .25 inches. Grab samples of whole water (500 ml) were collected just below the water surface at mid-stream and filtered using a 0.45 micron pore size (Gelman GF/C) filter. The samples were stored on ice and frozen on the day of collection. Filtered samples were analyzed by the Nutrient Analytical Services Laboratory at the University of Maryland's Chesapeake Biological Laboratory (CBL) for dissolved inorganic nitrogen (NO_3, NO_2), and dissolved inorganic phosphorus (PO_4). All analyses were conducted in accordance with U.S. Environmental Protection Agency (EPA) protocols. Stream discharge measurements were taken at the time of all water chemistry samples. Water temperature, dissolved oxygen, pH, and conductivity were measured in the field with a Hydrolab Surveyor II at selected sites at the time of water quality collections. Watershed areas used to calculate nutrient yields per unit area were determined from a digitized watershed map using Arcview software.

Where sites are nested in a watershed the mapped concentration data for the downstream site is shown only for the area between the sites. Yield calculations for a downstream site are based on the entire area upstream of the site, but are mapped showing just the area between sites. The downstream sites therefore illustrate the cumulative impact from all upstream activities.

Samples for bacterial analysis were collected at mid stream just below the water surface in factory sterilized bottles. Samples were immediately placed on ice being sure to keep bottles from contacting meltwater in cooler. Samples were delivered by courier to the State Department of Health and Mental Hygiene laboratory in Baltimore for analysis within six hours of collection.

Samples for optical brighteners were collected at mid stream just below the water surface in dark bottles and immediately placed on ice. Samples were delivered to the Maryland Department of the Environment Field Office in Annapolis for analysis. Samples were analyzed within 24 hours of collection using a Turner Designs 10-AU Field Fluorometer fitted with the lamp and filters contained in the Long Wavelength UV

Optical Kit fluorometer calibrated to a wavelength of between 410 and 430 nanometers. The fluorescence level that indicates the presence of optical brighteners is still being determined.

RESULTS

A nutrient synoptic survey was conducted during March, 2005 in the Port Tobacco watershed as part of the Port Tobacco WRAS. Water samples were collected and analyzed from 44 sites throughout the watershed. Sampling site locations are noted in Table 2 and mapped with subwatersheds in Figure 1. Dissolved nutrient concentrations and yields from all sites are noted in Table 3.

Nitrate/nitrite concentrations were found to be excessive in one subwatershed, moderately elevated in seven, and baseline in the remaining thirty-six subwatersheds (Figure 2). Instantaneous nitrate/nitrite yields were found to be excessive in four subwatersheds, high in five, moderate in eight, and baseline in the remaining twenty-seven (Figure 3). Excessive concentrations of orthophosphate were found in three subwatersheds, high concentrations in eight, moderate concentrations in twenty-five, and the remaining eight below baseline (Figure 4). Orthophosphate yields were found to be moderate in one watershed, and baseline in the remaining forty-three (Figure 5). Temperature, dissolved oxygen, pH, and specific conductivity values are noted for all sites in Table 4. No significant anomalies were found in the insitu measurements of dissolved oxygen, or temperature. Depressed ph values (<5.5) were found in four subwatersheds (Figure 6). The seventeen subwatersheds in the Port Tobacco watershed had low specific conductivity (<.1 umohs/mm), and two subwatersheds in this drainage had relatively high conductivity (>.5 umohs/mm) (Figure 7).

Bacteria sampling found four sites with 'Most Probable Number' (mpn) results over the 200 mpn standard for water contact recreation (Table 5 and Figure 8).   There are no standards for the brightener values at this time

Table 2. Port Tobacco WRAS Nutrient Synoptic Survey
March, 2005 - Sampling Site Locations

ID	Location	Lat	Long
0	UT to Port Tobacco at Chapel Pt Rd	38.468740	77.024100
1	UT to Wills Br at Purcell Rd	38.483760	77.014500
2	UT to Wills Br at Purcell Rd	38.481200	77.006160
3	Wills Br at Purcell Rd	38.481200	77.006160
4	Wills Br at Chapel Pt Rd	38.481930	77.016690
6	UT to Port Tobacco at Chapel Pt Rd (N)	38.499950	77.018120
7	UT to Wills Br at Edelen property	38.494730	77.003000
8	UT to Port Tobacco at Rt 6 (W)	38.518230	77.015790
9	UT to Port Tobacco at Rt 6 (E)	38.520360	77.014110
10	UT to #9 at King Edward Pl	38.510000	77.000000
11	UT to #9 at Mudd Farm La	38.510000	77.000000

12	UT to Port Tobacco at Valley Rd	38.523000	77.014000
13	UT to #12 at Quailwood Pkwy (S)	38.525560	77.007500
14	UT to #12 at Quailwood Pkwy (N)	38.527400	77.006000
15	UT to #12 off Hill Spring Dr. (Wood prop)	38.527400	77.006000
16	Port Tobacco at Rt 225	38.543020	77.017420
17	UT to Port Tobacco at Rt 225	38.543550	77.014830
18	Jennie Rn at Mitchell Rd	38.547310	77.015030
19	UT to Jennie Rn at Mt Carmel Rd	38.555930	77.002380
20	UT to Jennie Rn off Silver Oak Rd	38.558740	76.997930
21	Jennie Rn off Mimosa Dr	38.559430	76.993860
22	Jennie Rn at Mitchell Rd	38.566540	76.986990
23	Pages Swamp off Turkey Hill Rd	38.582000	76.986580
24	UT to Pages Swamp off Turkey Hill Rd		
25	Pages Swamp at Rt 227	38.589780	76.969920
26	UT to Pages Swamp at Griffith Rd	38.591850	76.957650
27	UT to Pages Swamp off Billingsley (Moore prop)		
28	Pages Swamp off Billingsley (Moore prop)		
29	UT to # 26 at Billingsley Rd	38.600490	76.942840
30	Pages Swamp at Billingsley Rd	38.609820	76.970210
31	UT to Port Tobacco from Tech Cntr	38.565740	77.017820
32	Port Tobacco from Tech Cntr	38.565610	77.016430
33	UT to Port Tobacco at Bilbury La	38.543990	77.021660
34	UT to Port Tobacco from Hawthorne Rd	38.537630	77.017440
35	Port Tobacco from Hawthorne Rd	38.537630	77.017440
36	Port Tobacco at Port Tobacco Rd	38.514100	77.020000
37	Hoghole Rn at Port Tobacco Rd	38.512230	77.028480
38	Hoghole Rn from Stone Historic Site	38.524630	77.034110
39	UT to Port Tobacco at Shirley Blvd	38.510500	77.029210
40	UT to Port Tobacco at Shirley Blvd	38.509000	77.028400
41	UT to Port Tobacco at Shirley Blvd		
42	UT to Port Tobacco at Shirley Blvd		
43	UT to Port Tobacco off Deepwater Ct (Mona prop)		
44	UT to Port Tobacco off Wooddy Rd (James prop)	38.483000	77.045210
45	UT to Goose Cr at Brentwood Rd	38.465640	77.066390
46	Wills Br on Edelen prop	38.493450	77.002230
47	Jennie Rn off Silver Oak Rd	38.558880	76.997350
48	UT to Jennie Rn off Mimosa Dr	38.559430	76.993860
49	Port Tobacco at Tolbert prop		
50	UT to Port Tobacco at Chapel Pt Rd	38.490660	77.016680

51	UT to Port Tobacco at Chapel Pt Rd (S)	38.496040	77.016430

Figure 1. Port Tobacco WRAS Nutrient Synoptic Survey March, 2005
Nutrient Synoptic Sites and Subwatersheds

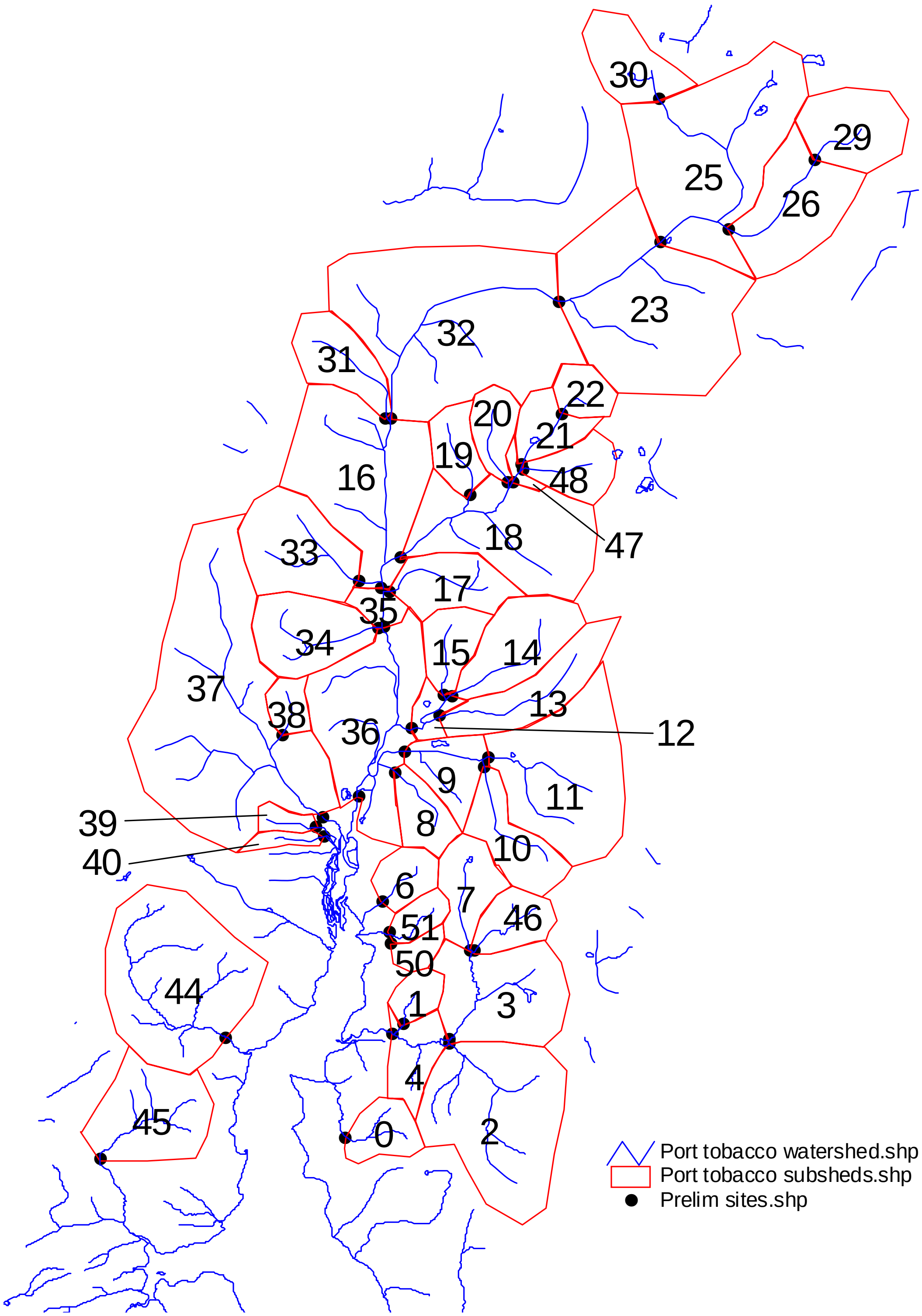

Table 3. Port Tobacco WRAS Nutrient Synoptic Survey March, 2005 – Dissolved Nutrient Concentrations and Yields

Subshed	Date	PO4 mg/l	NO23 mg/l	Discharge L/sec	Area Hectares	PO4 Yield Kg/H/day	NO2+NO3 Yield Kg/H/day
0	03/21/05	0.005	0.14	6	82	0.000032	0.000903
1	03/21/05	0.005	0.56	2	47	0.000023	0.002564
2	03/21/05	0.009	0.75	44	434	0.000079	0.006602
3	03/21/05	0.007	0.12	53	466	0.000068	0.001172
4	03/21/05	0.005	0.46	104	994	0.000045	0.004168
6	03/21/05	0.006	0.17	8	71	0.000055	0.001554
7	03/21/05	0.009	0.01	9	104	0.000071	0.000078
8	03/21/05	0.033	0.22	5	83	0.000166	0.001108
9	03/21/05	0.007	0.70	64	629	0.000061	0.006106
10	03/22/05	0.008	0.39	14	136	0.000070	0.003413
11	03/22/05	0.007	0.64	39	389	0.000061	0.005587
12	03/22/05	0.011	1.25	87	478	0.000173	0.019673
13	03/22/05	0.013	1.43	80	171	0.000525	0.057716
14	03/22/05	0.005	0.32	16	178	0.000039	0.002485
15	03/22/05	0.015	0.51	5	91	0.000078	0.002652
16	03/30/05	0.009	0.53	1822	2889	0.000490	0.028878
17	03/30/05	0.014	1.21	38	135	0.000343	0.029613
18	03/30/05	0.009	0.96	357	764	0.000363	0.038716
19	03/31/05	0.008	1.38	16	81	0.000134	0.023162
20	03/31/05	0.010	7.34	.4	78	0.000005	0.003717
21	03/31/05	0.008	1.92	58	142	0.000282	0.067628
22	03/30/05	0.003	1.34	10	61	0.000141	0.063020
23	03/31/05	0.003	0.43	486	1604	0.000079	0.011268
25	03/31/05	0.003	0.50	306	1090	0.000073	0.012141
26	03/30/05	0.002	0.55	171	405	0.000073	0.020016
29	03/31/05	0.002	0.01	73	165	0.000077	0.000383
30	03/31/05	0.001	0.01	58	137	0.000037	0.000367
31	04/04/05	0.005	0.63	9	130	0.000030	0.003795
32	04/04/05	0.005	0.40	1345	2332	0.000249	0.019938
33	03/30/05	0.013	0.62	65	225	0.000326	0.015566
34	03/30/05	0.018	0.13	3	179	0.000029	0.000208
35	03/30/05	0.008	0.56	1608	2926	0.000380	0.026597
36	03/22/05	0.008	0.73	638	4601	0.000096	0.008742
37	03/22/05	0.005	0.07	92	869	0.000046	0.000641
38	03/22/05	0.009	0.01	2	46	0.000041	0.000046
39	03/22/05	0.003	0.50	1	29	0.000013	0.002173

40	03/22/05	0.006	1.61	1	25	0.000026	0.007047
44	04/04/05	0.011	0.40	203	480	0.000403	0.014651
45	04/04/05	0.010	0.28	50	234	0.000184	0.005146
46	03/21/05	0.011	0.05	5	132	0.000034	0.000154
47	03/31/05	0.007	0.65	34	249	0.000083	0.007713
48	03/31/05	0.006	0.41	36	93	0.000201	0.013717
50	03/21/05	0.012	1.41	1	33	0.000047	0.005480
51	03/21/05	0.003	0.74	8	46	0.000043	0.010718

Figure 2. Port Tobacco WRAS Nutrient Synoptic Survey
March, 2005
Nitrate/Nitrite (NO2+NO3) Concentration (mg/L)

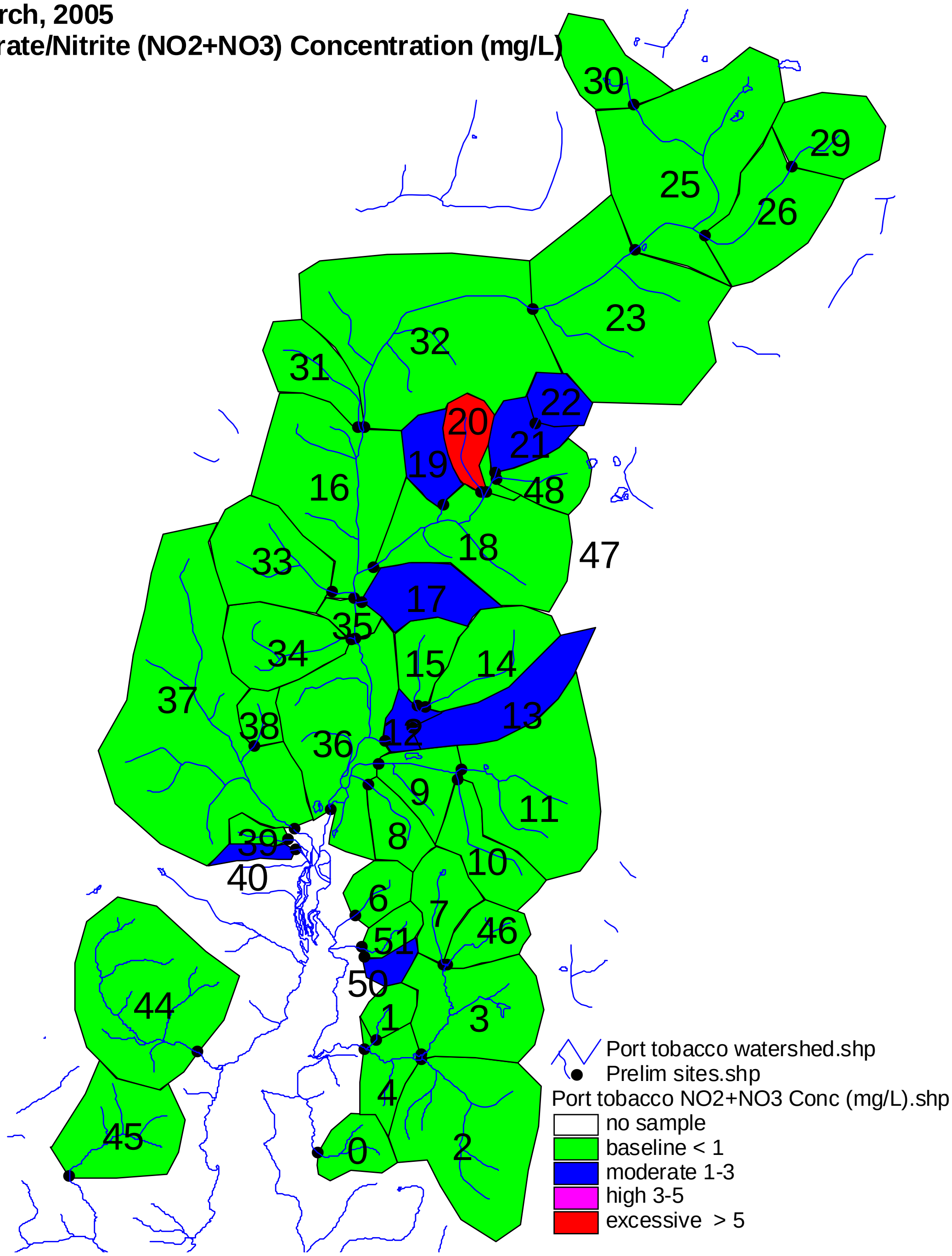

Figure 3. Port Tobacco WRAS Nutrient Synoptic Survey
March, 2005
Nitrate /Nitrite (NO2+NO3) yield (Kg/H/day)

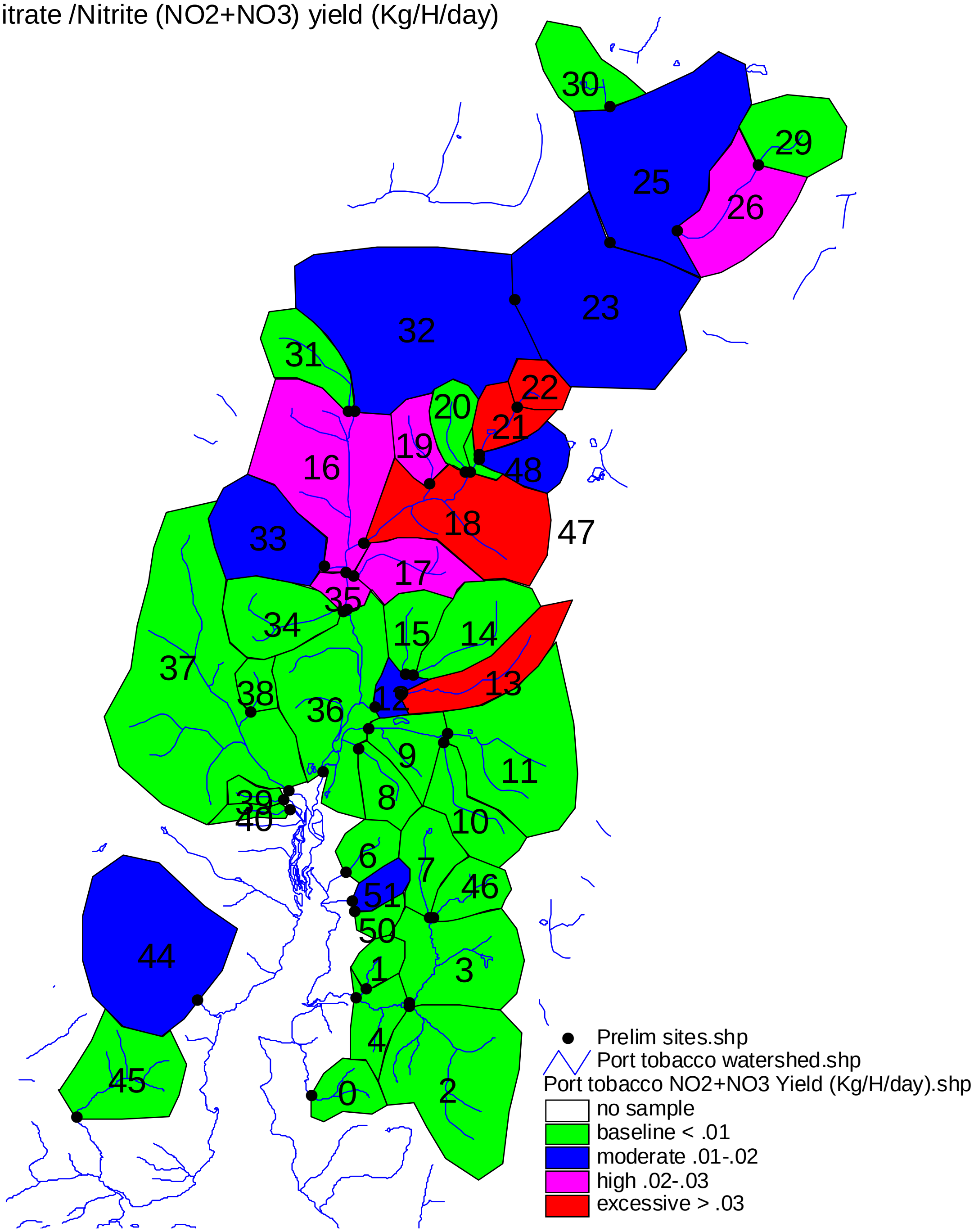

Figure 4. Port Tobacco WRAS Nutrient Synoptic Survey
March, 2005
Orthophosphate (PO4) Concentration (mg/L)

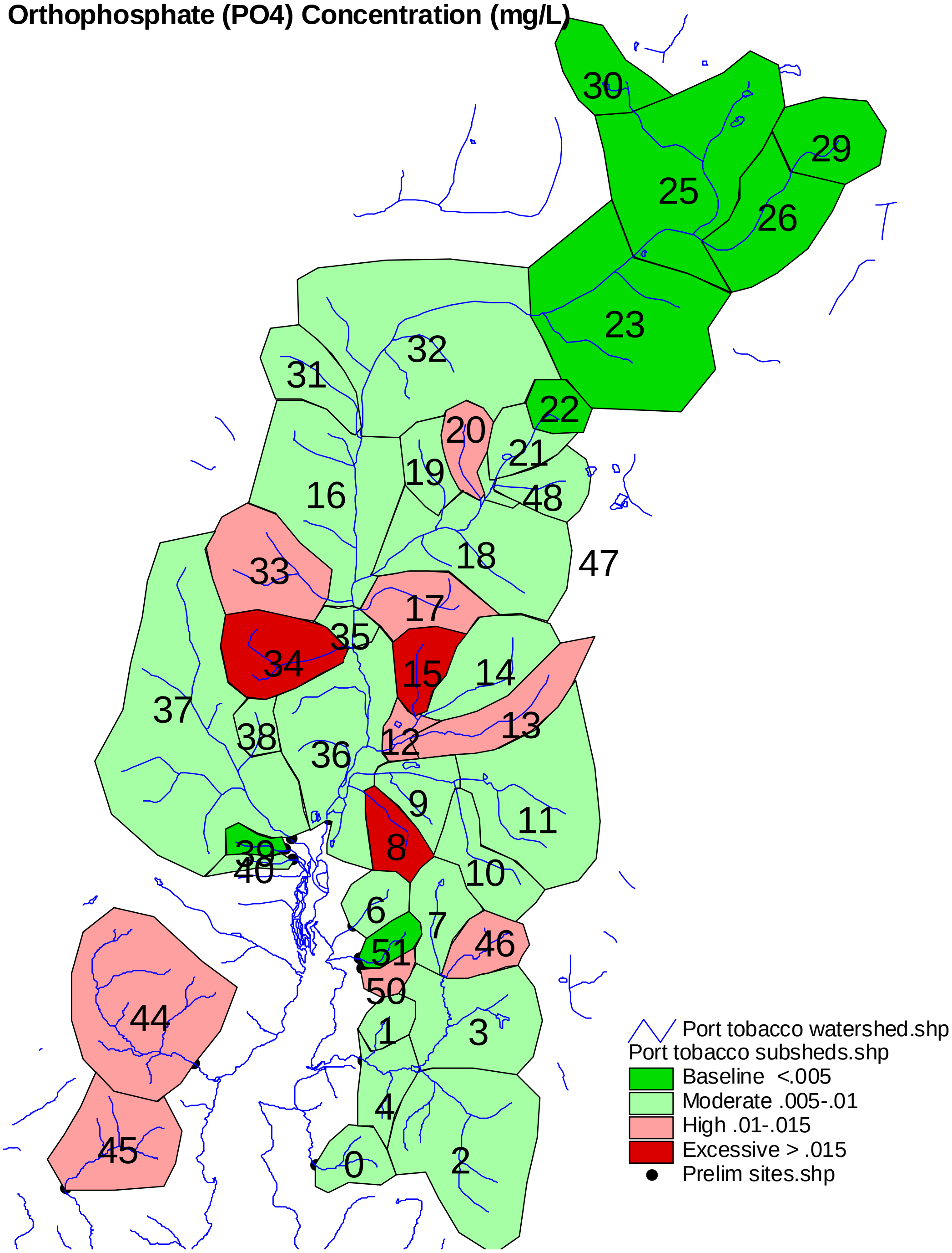

Figure 5. Port Tobacco WRAS Nutrient Synoptic Survey
March, 2005
Orthophosphate (PO4) Yield (Kg/H/day)

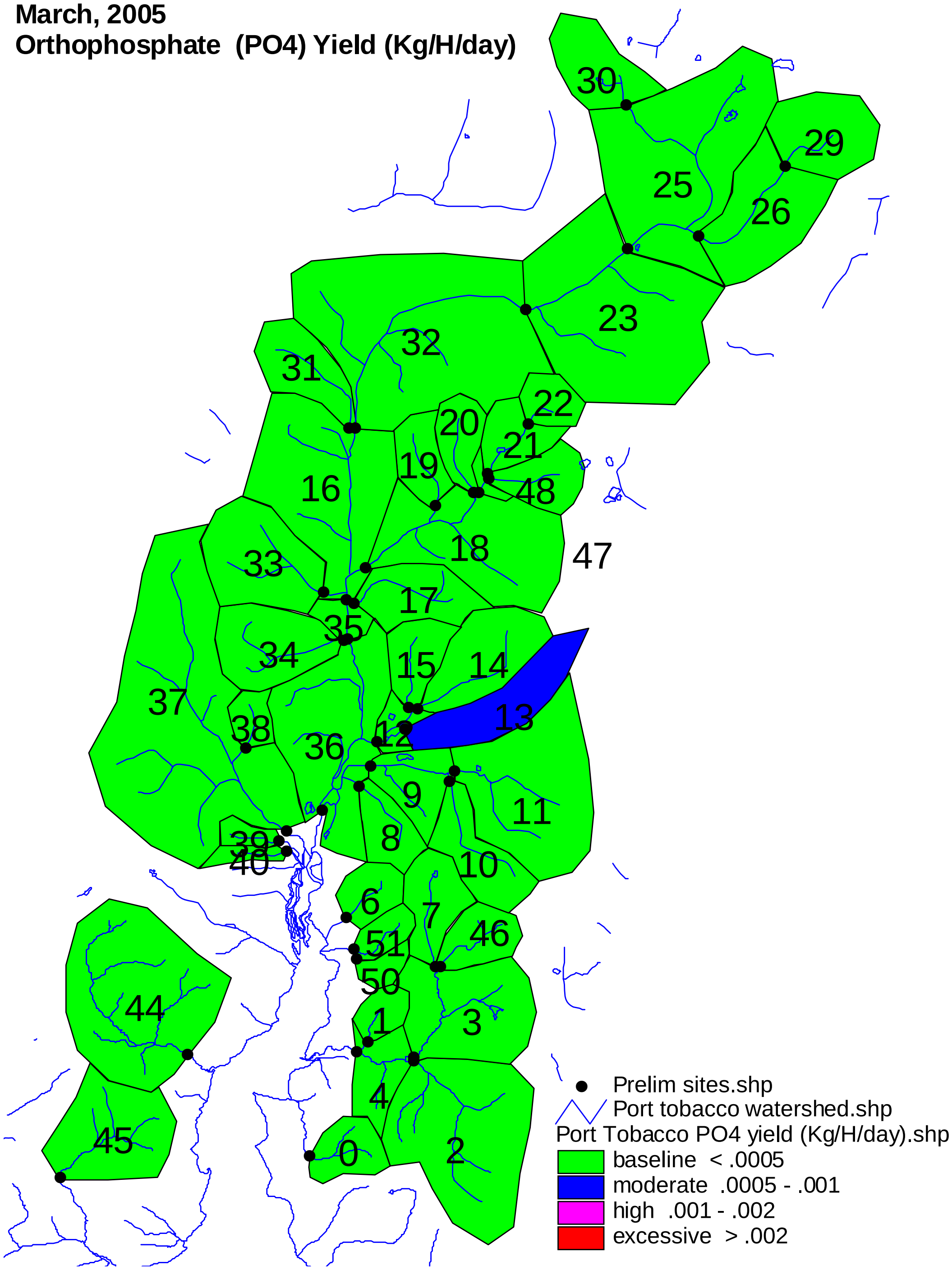

Table 4. Port Tobacco WRAS Nutrient Synoptic Survey March, 2005
Insitu Water Quality Parameters

Station	Date	Time	Temp C	pH	Dissolved Oxygen mg/L	Specific Conductance mmohs/cm
0	03/21/05	0850	6.30	6.27	10.99	69
1	03/21/05	0940	7.63	6.30	10.69	71
2	03/21/05	0950	7.05	6.44	11.00	135
3	03/21/05	1000	6.85	6.30	11.26	137
4	03/21/05	0910	6.39	6.43	10.89	129
6	03/21/05	1050	7.68	5.88	7.22	92
7	03/21/05	1115	9.39	5.49	10.46	87
8	03/21/05	1230	8.10	5.91	10.54	85
9	03/21/05	1210	7.78	6.23	11.07	183
10	03/22/05	0830	4.44	5.93	12.36	74
11	03/22/05	0835	4.69	6.65	12.10	211
12	03/22/05	0916	6.96	7.89	12.55	372
13	03/22/05	1025	9.60	7.99	13.20	481
14	03/22/05	0944	6.79	6.97	11.30	167
15	03/22/05	1000	5.85	6.38	11.92	113
16	03/30/05	1040	9.09	6.51	13.16	117
17	03/30/05	1025	10.01	6.24	12.49	70
18	03/30/05	1000	8.66	6.63	12.90	161
19	03/31/05	0930	9.05	6.26	11.97	199
20	03/31/05	1000	8.21	5.62	10.16	76
21	03/31/05	1045	9.14	6.64	12.70	206
22	03/30/05	1230	12.17	6.20	12.37	165
23	03/31/05	1230	10.24	6.35	11.60	97
25	03/31/05	1200	10.58	6.28	11.67	105
26	03/30/05	1215	12.94	6.14	11.92	127
29	03/31/05	1145	9.93	4.69	10.33	83
30	03/31/05	1130	9.91	4.59	9.66	64
31	04/04/05	0930	7.12	5.91	8.83	178
32	04/04/05	0910	6.87	6.18	10.28	43
33	03/30/05	1100	10.99	6.65	13.05	102
34	03/30/05	1115	9.76	5.89	11.23	105
35	03/30/05	1130	9.76	6.55	11.91	118
36	03/22/05	1050	7.42	7.05	11.62	194

37	03/22/05	1100	6.78	6.54	11.88	65
38	03/22/05	1200	10.62	5.81	9.50	88
39	03/22/05	1230	8.08	6.28	10.44	244
40	03/22/05	1140	9.71	6.67	10.40	265
44	04/04/05	1100	9.77	5.77	9.63	79
45	04/04/05	1035	8.58	5.89	9.93	71
46	03/21/05	1125	8.91	5.32	10.54	46
47	03/31/05	0945	9.04	5.94	12.24	112
48	03/31/05	1030	9.69	6.87	12.52	301
50	03/21/05	1015	7.49	6.32	10.33	127
51	03/21/05	1035	7.84	6.17	10.45	175

Figure 6. Port Tobacco WRAS Nutrient Synoptic Survey
March, 2005
pH

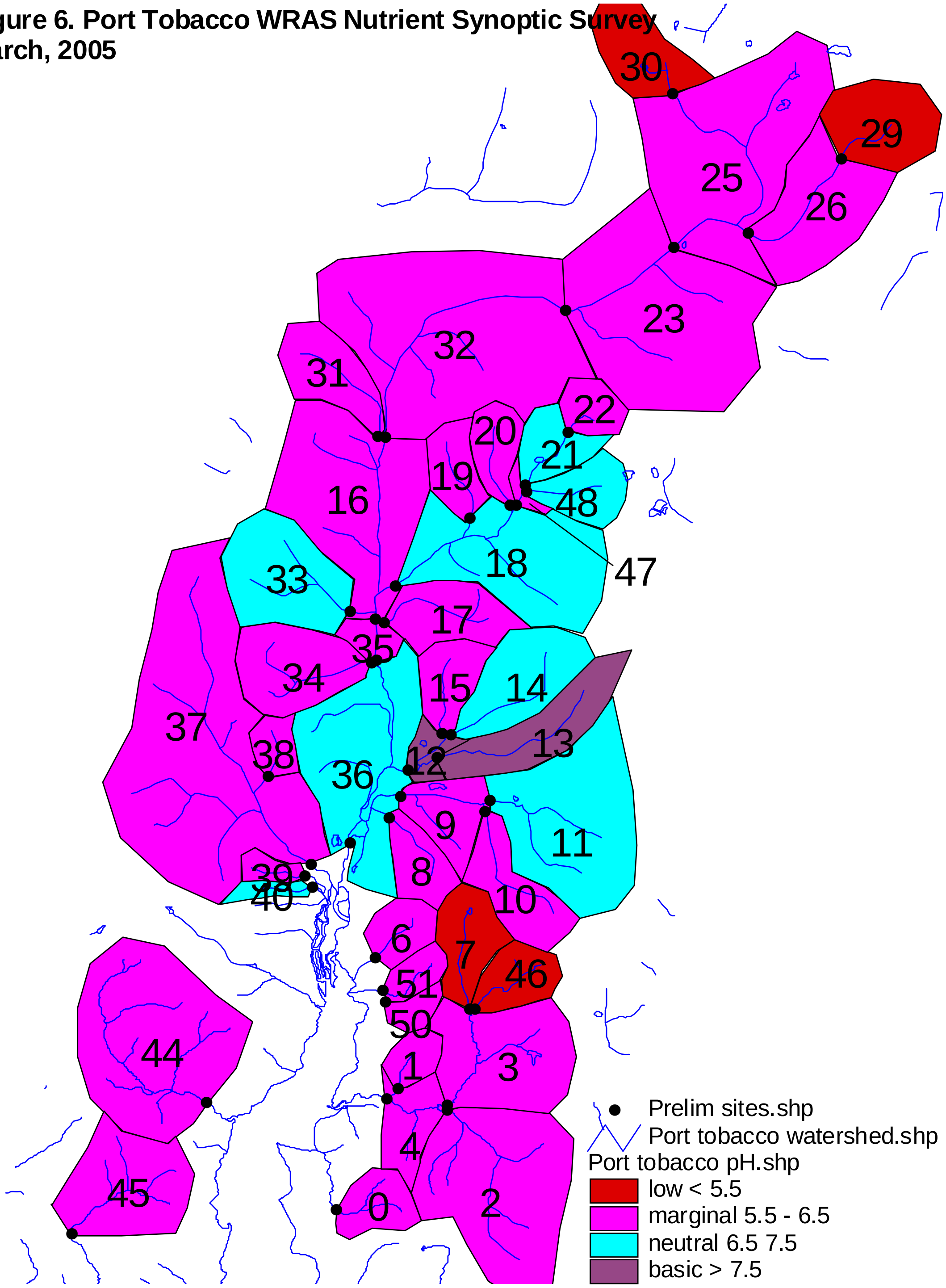

Figure 7. Port Tobacco WRAS Nutrient Synoptic Survey
March, 2005
Specific Conductivity (micromohs/cm)

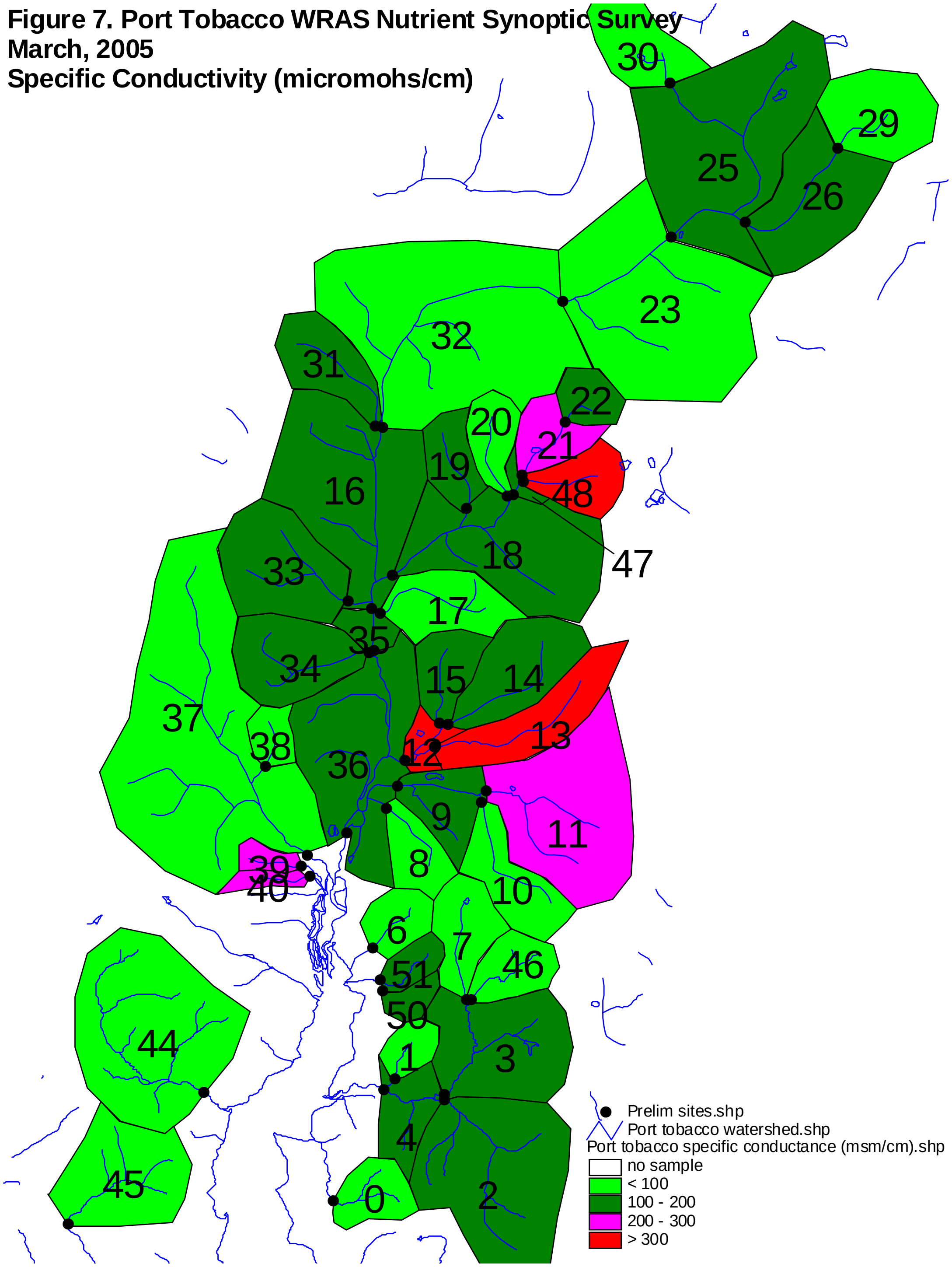

Table 5. Port Tobacco WRAS March, 2005
***E. coli* bacteria and Optical Brightener results**

Station	Date	MPN	Fluorescence (ppm)
0	3/21/2005	16	45.0
1	3/21/2005	6	55.6
2	3/21/2005	11	45.6
3	3/21/2005	22	53.8
4	3/21/2005	12	51.0
50	3/21/2005	36	56.0
51	3/21/2005	79	37.4
6	3/21/2005	276	44.1
7	3/21/2005	2	47.0
8	3/21/2005	17	64.9
9	3/21/2005	12	62.9
10	3/22/2005	17	49.7
11	3/22/2005	11	53.5
12	3/21/2005	14	143.0
13	3/22/2005	86	176.0
14	3/22/2005	1	
15	3/22/2005	11	
16	3/30/2005	687	192.00
17	3/30/2005	120	129.00
18	3/30/2005	28	91.80
19	3/31/2005		63.60
20	3/31/2005		61.80
21	3/31/2005		70.50
22	3/30/2005	5	103.00
23	3/31/2005		213.00
25	3/31/2005		226.00
26	3/30/2005	43	296.00
29	3/31/2005		277.00
30	3/31/2005		333.00
31	4/4/2005	15	117.00
32	4/4/2005	80	229.00
33	3/30/2005	10	101.00
34	3/30/2005		96.70
35	3/30/2005	980	187.00
36	3/22/2005	37	99.00
37	3/22/2005	64	64.80
38	3/22/2005	51	54.20
39	3/22/2005	40	50.40
40	3/22/2005	201	95.90
44	4/4/2005	17	84.10

45	4/4/2005	42	98.30
46	3/21/2005	10	75.20
47	3/31/2005		74.70
48	3/31/2005		84.10
50	3/21/2005		56.00
51	3/21/2005		37.40

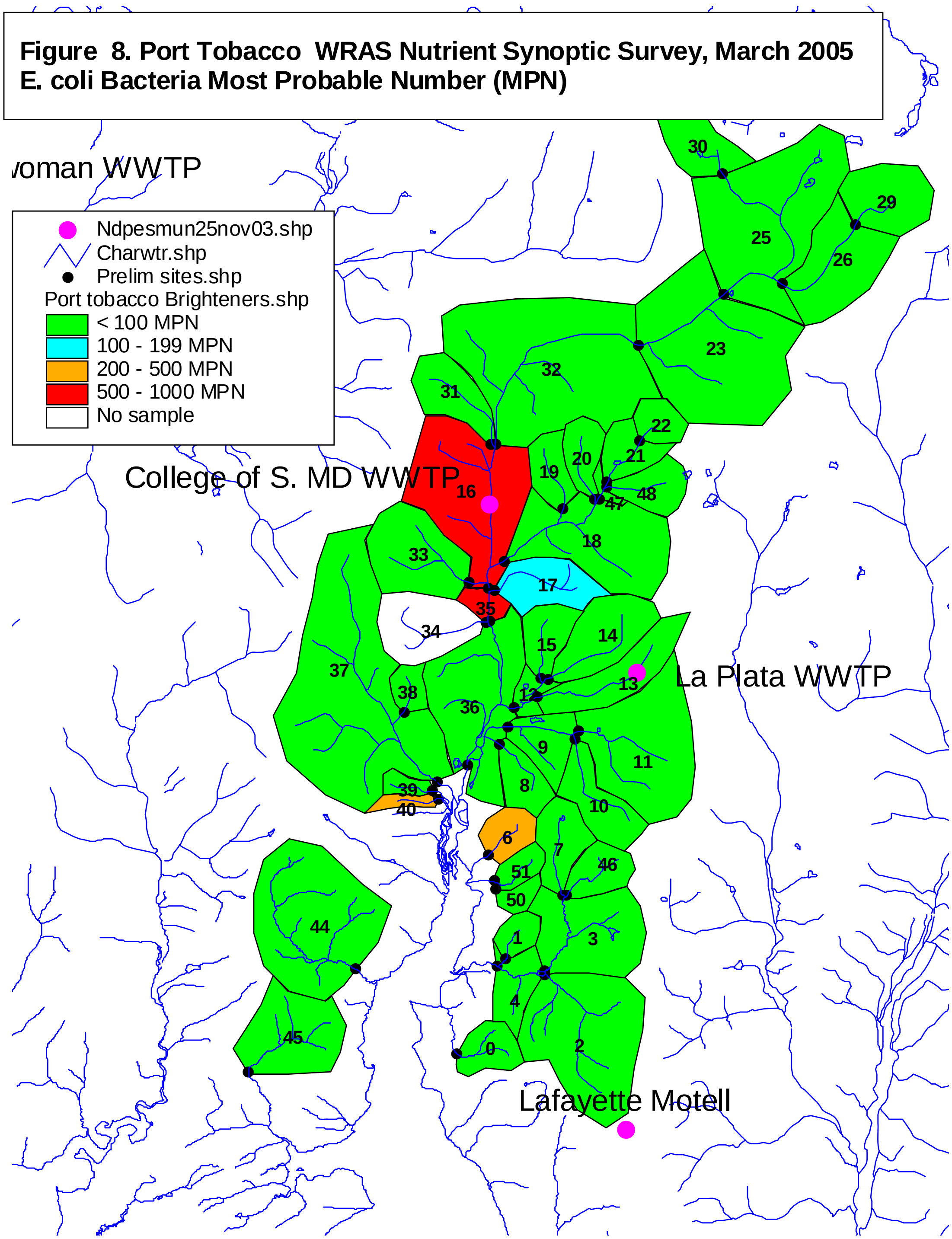

Figure 8. Port Tobacco WRAS Nutrient Synoptic Survey, March 2005
E. coli Bacteria Most Probable Number (MPN)

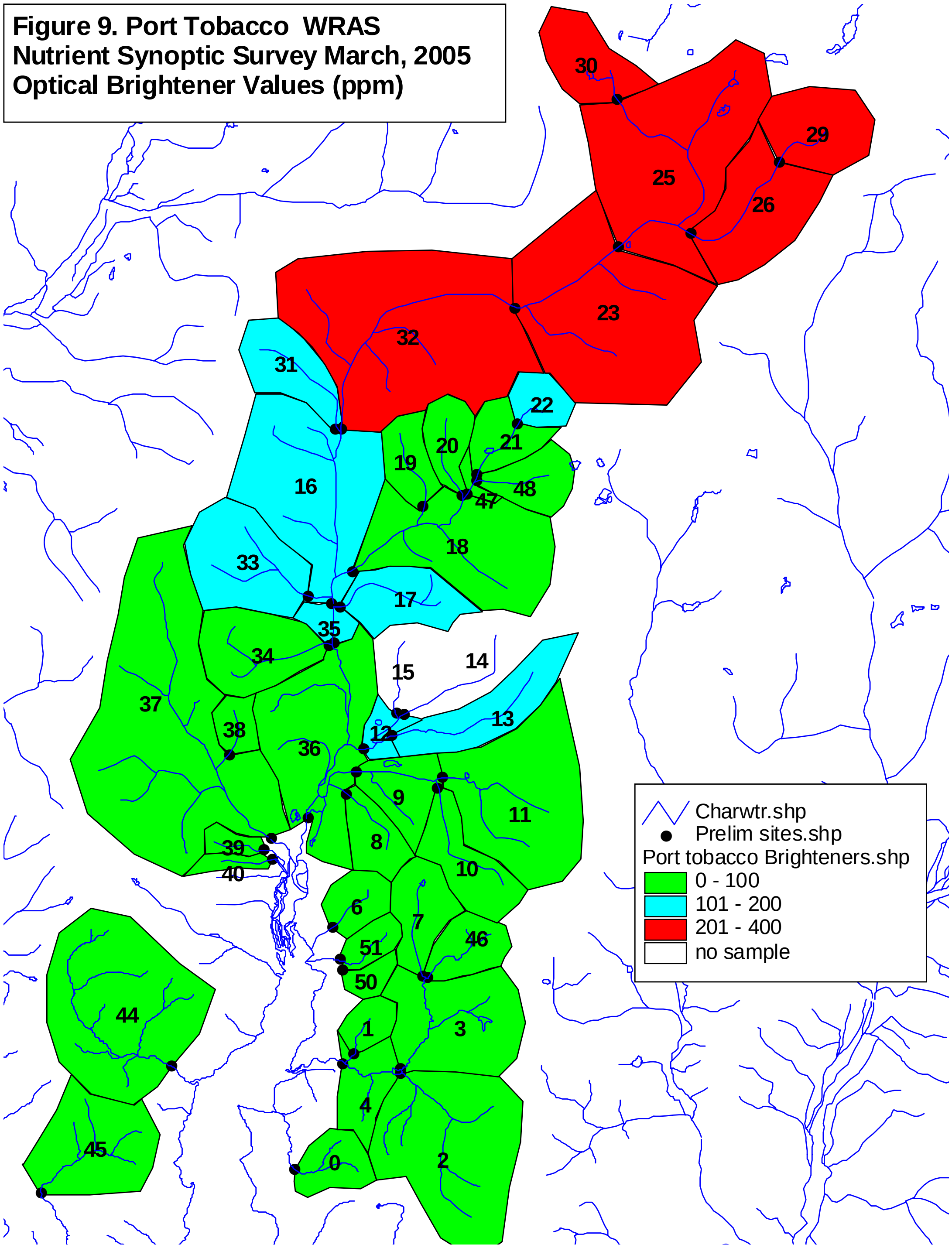

Figure 9. Port Tobacco WRAS
Nutrient Synoptic Survey March, 2005
Optical Brightener Values (ppm)
Charwtr.shp
Prelim sites.shp
Port tobacco Brighteners.shp
0 - 100
101 - 200
201 - 400
no sample
30
29
25
26
23
32
31
22
21
20
19
48
47
16
18
33
17
35
34
15
14
37
13
38
12
36
9
11
39
40
8
10
6
7
51
46
50
44
1
3
4
45
0
2

Discussion

The dissolved nutrient results shown above do not indicate a significant problem with nutrients in the Port Tobacco watershed. As noted in Table 3, the one subwatershed with an excessive nitrate/nitrite concentration had a very minor discharge contribution. This subwatershed, and the several adjacent subwatersheds with moderate nitrate/nitrite concentrations, appear to have developments on well and septic within their boundaries. Nutrient signals from septic systems have been noted in a number of other WRAS watersheds including the Lower Patuxent, Chester, and coastal bays. The moderately high nitrate/nitrite concentrations in subwatersheds 12 and 13 may be associated with the La Plata WWTP. Heavy filamentous green algal growth was noted at both sampling sites in these subwatersheds and nowhere else.

As noted previously, orthophosphate generally travels bound to sediment particles. Thus any suspended sediment, including fine clay, could result in elevated orthophosphate concentrations. A wet spring resulting in almost continuous discharges from sediment control structures could have contributed to the prevalence of moderate orthophosphate concentrations.

Nutrient yields (contributions per unit of watershed area) are heavily dependent on stream discharge. The one subwatershed with an excessive nitrate/nitrite concentration (#20) had a yield below baseline because of the low discharge. Other streams with relatively low concentrations come up with elevated yields due to elevated discharges. The elevated discharges could be due to runoff from recent rains, or enhanced baseflow. A review of the rainfall record showed approximately 2 inches of rain fell between the sampling on 21 and 30 March. While sampling on the 30th was two days after a one inch rainfall, residual runoff could have enhancing baseflow. The enhanced baseflow would create the elevated yields found for subwatersheds sampled on the 30th. Subwatersheds 12 and 13 were sampled on the 21st, before the rain, thus enhancement to baseflow in these subwatersheds would most likely be from the La Plata WWTP effluent. Watersheds with concentrations of septic systems will also show evidence of enhanced baseflow due to inputs to groundwater over and above normal rainfall.

The probable enhancement to baseflow in subwatershed 13 also appears to have created a moderately elevated orthophosphate yield. The source of the orthophosphate in this subwatershed is unknown.

The average nitrate/nitrite concentration found in the Port Tobacco watershed is relatively low compared to other WRAS watersheds (Table 6). The lower concentrations are associated with watersheds with considerable urban or undeveloped forest land use.

Table 6. Annual & Spring Nutrient Concentration Averages from Other Nutrient Synoptic Surveys

Mg/L	Piney	German Br.	Pocomoke	Lower Monocacy	Western Branch	Upper Patuxent	Upper Monocacy	**Port Tobacco**
NO2+NO3 Spring	3.742	3.832	3.734	3.11	0.214	0.439	1.731	**.751**
NO2+NO3 Annual	4.823	4.704	2.384					
PO4 Spring	0.800	0.043	0.028	0.013	0.005	0.012	0.019	**0.008**
PO4 Annual	1.177	0.067	0.022					

Few anomalies were found with the insitu water chemistry samples. There were several low pH headwater streams that appear to be associated with wooded wetlands that naturally produce tannic acid. The combination of low pH and low specific conductivity makes the biota in these streams susceptible to impacts from low ph precipitation events. Subwatershed 13 again comes to the fore with a moderately elevated pH. The heavy filamentous algal growth in this stream could be the major cause. The several subwatersheds with elevated specific conductivity, a measure of dissolved salts, appear to be associated with major highways or road systems where dissolved road salt can be moving from the shallow groundwater into the streams. The La Plata WWTP may also be contributing to the elevated specific conductivity in subwatersheds 12 and 13.

Watershed stakeholders expressed an interest in having bacteria samples collected throughout the watershed in an effort to try and locate a source of bacterial contamination found previously. The elevated *E.coli* levels found in subwatersheds 16 and 35 appear to be intermittent and possibly storm related. As with the nutrient samples, bacteria samples were collected over several days. The samples from subwatersheds16 and 35 were collected two days after a weeklong series of rainstorms dropped approximately two inches of rain. Samples collected downstream of these sites the week prior to the rain showed no significant bacteria levels. The two other subwatersheds with elevated bacteria had no stations downstream, but were collected prior to the rain event, thus might be considered chronic. Sources of the bacteria within these subwatersheds could include any warm blooded animal such as wildlife, pets, livestock, or humans.

In an effort to help isolate human sources of bacteria, an experimental sampling for optical brighteners, a detergent additive, was conducted. Unfortunately, with no benchmarks or standards to compare to, conclusions are difficult to draw. Table 7 provides some comparisons to help judge the highest and lowest values found in Port Tobacco. Confounding these results is the presence of brighteners in a large number of products that come in contact with water, including white PVC pipe. Note that the sample from a PVC well had a value close to the higher ones from Port Tobacco.

Table 7. Port Tobacco WRAS March, 2005
Optical Brightener Value Comparisons

Balto. City tap water deionozed by filter	0.913
Wash water from washing machine	OVER 1000*
Caroline Co. deep well (@400 ft.) tap water	247
unnamed trib to Tuckahoe	91
unnamed trib to Monocacy w/high conductivity	65
Ben's Br at Lake Linganore	132
Trib to Deep Rn (Howard Co) w/high conductivity	165
Trib to Monocacy from Sugarloaf Mt. No humans upstream	67
Port Tobacco # 26	296
Port Tobacco # 29	277
Port Tobacco # 30	333
Port Tobacco # 51	37

* several orders of magnitude higher

Conclusions

The Port Tobacco watershed does not have a significant problem with dissolved nutrients. Moderately elevated orthophosphate yields in one subwatershed may be associated with the La Plata WWTP discharge. Moderately elevated nitrate/nitrite concentrations and yields may be associated with communities on well and septic. Moderately elevated pH and specific conductivity, as well as the heavy algal growth may also be associated with the La Plata WWTP discharge. The average nutrient concentration and yield from the Port Tobacco watershed was low compared to other WRAS watersheds. Sampling for *E.coli* bacteria and optical brighteners was inconclusive in attempting to locate a source for bacteria contamination.

Literature Cited

Frink, Charles R.. 1991. *Estimating Nutrient Exports to Estuaries*. Journal of Environmental Quality. 20:717-724.