Monitoring Water Quality in the Rush River Watershed: 2006 RappFLOW Program, Results, and Assessment of the Program

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Introduction:

Throughout the fall and winter of 2005 and into the spring of 2006, RappFLOW volunteers designed a water quality monitoring program. After research and consultation with the Virginia Department of Environmental Quality (DEQ), they decided to focus the pilot study on chemical and bacterial monitoring of the Rush River subwatershed. Reasons for monitoring included: establishing baseline water quality data, identifying possible sources of contamination and evaluating solutions, measuring long-term improvements in the water quality, raising awareness of water quality issues in Rappahannock County, and refining methods for collecting, analyzing, and interpreting measures of water quality, in preparation for an ongoing volunteer monitoring program in Rappahannock County.

The parameters measured included dissolved oxygen, pH, temperature, and E. coli bacteria. Transparency was added later in the season. The Rush River subwatershed was chosen for a variety of reasons. The Rush River is within the Upper Thornton subwatershed, which is entirely contained within Rappahannock County and is the focus of a larger RappFLOW study funded by the National Fish and Wildlife Foundation. The Rush River ranked as one of the least protected subwatersheds in the Upper Thornton and a segment is listed on the Federal 303(d) list of impaired waters for bacteria. In addition, the town of Washington was proposing a new wastewater treatment facility that would discharge into the Rush River.

Methods:

At the recommendation of the DEQ, RappFLOW purchased meters for measuring dissolved oxygen and pH, and ColiScan equipment for measuring E.Coli. In March of 2006, three RappFLOW volunteers met with James Beckley of the DEQ to learn the protocols for quality assurance in using the monitoring equipment. (See attachments for quality assurance logs.) Dissolved oxygen was monitored using a YSI 200 DO meter, pH was monitored using a YSI 100 pH meter, temperature was recorded using both these meters, E. coli was measured with ColiScan from Micrology Laboratories, and transparency was measured with a 60cm transparency tube. RappFLOW staff wrote a volunteer handbook and, with the help of volunteers, conducted two training sessions. The first session outlined the monitoring program with a PowerPoint presentation and the second session provided hands-on training to citizens interested in being involved in the program.

The original design of the program was to have two teams. Each team would sample every other month to avoid burnout and would have a team leader. The team leader

would coordinate the sampling, run the E. coli test after sampling and read it the next day, transfer supplies to the other team leader after the sampling session, coordinate with RappFLOW staff to transfer completed field data sheets and calibration forms, and share ideas and concerns with RappFLOW staff.

Map 1 shows the monitoring sites. They were chosen based on accessibility and information provided. The primary focus area was the impaired section of the Rush, just upstream and downstream of the impairment, and tributaries flowing into the impaired portion. Many sites were at the confluence of two tributaries. Several were just upstream or downstream of the Town of Washington for baseline information and to address concerns about leaking septic systems. Sites were added and changed throughout the season based on findings and the need for additional information.

Attachment A shows the form used to document observations and data recorded at each sampling site.

A team of 3-6 volunteers sampled all sites once each month from April through August of 2006, with the exception of June. They met at the County Park to assign roles and calibrate the equipment. From there they proceeded to each site to make observations of the stream conditions, take measurements and collect samples. After the last site, they gathered at one volunteer's home to plate out and incubate the E. coli samples. The following day, they met again to read and record the number of colonies in each E. coli sample.

The data were then converted to a format for mapping. Symbols were designed to communicate the data for educational purposes. As an example, Map 2 shows the data for August 2006.

Standards

For reference, DEQ standards for pH are between 6 and 9 units. Since pH is on a logarithmic scale with a reading of 7 as neutral, a reading of 6 is ten times more acidic than a reading of 7 and a reading of 8 is ten times more basic than a reading of 7. A reading of 9 would, therefore, be 100 times more basic than a reading of 7.

To meet DEQ dissolved oxygen standards, the reading must be 5 mg/L or higher. Many fish and macroinvertebrates are unable to live in streams with less dissolved oxygen than this. Dissolved oxygen levels are linked to water temperature (colder water holds more oxygen) and photosynthesis and respiration by plants (when plants photosynthesize they produce oxygen; when they respire, they use oxygen).

To meet DEQ standards for temperature the water cannot exceed 31 degrees Celsius. 31 degrees Celsius is equivalent to 87.8 degrees Fahrenheit and is intolerable to most fish and macroinvertebrates.

If an E. coli reading exceeds 235 colonies per 100 ml of water, the water is considered impaired by the DEQ. If the geometric mean of multiple readings exceeds 126 colonies per 100 ml of water, the water is also considered impaired. E. coli bacteria can enter the water from a variety of sources, including human sewage from leaky septic tanks or wastewater treatment facilities, livestock, domestic pets, and wildlife. A high E. coli reading is an indicator that other potentially harmful pathogens are present in the water.

DEQ does not have standards for transparency. The transparency tube is only comparable to itself and has a maximum reading of 60cm. Any reading of 60cm was considered healthy.

Results

Map 2 shows dissolved oxygen level readings for August. Map 23 shows E. coli levels for July.
Attachment 2 shows the data collected.

For a discussion of the data, I have divided the sites into 4 subsections: the Rush River, several unnamed tributaries to the Rush, Big Branch (a large tributary to the Rush), and an unnamed tributary to the Big Branch.

Rush River:
On the Rush River, pH, dissolved oxygen, and temperature never fell below the standards set by the Virginia DEQ. The lowest pH recorded on the Rush River was 6.95 units and the highest was 8.08 units. Most readings were in the 7 range. Dissolved oxygen on the Rush ranged from 7.91 to 12.22 mg/L. Temperature never exceeded 24.6 degrees Celsius. Transparency was always greater than 60cm.

E. coli bacteria was above DEQ standards at three sites on the Rush River. The farthest upstream site that had bacteria exceeding DEQ standards was at the sharp bend in Harris Hollow Road adjacent to the drinking water treatment facility for the Town of Washington (the high reading has no influence on the drinking water for Washington). It exceeded standards both times it was sampled, with a high of 1816 colonies per 100ml of water. Downstream of that site, Coopers Hole where the Rush crosses Fodderstack Road had readings that exceeded DEQ standards three of the four times it was sampled. The high was 1900 colonies per 100 ml of water. At the site below Coopers Hole, Old Mill Road exceeded standards two of the five times it was sampled, with a high of 1525 colonies per 100 ml of water. This site is also sampled by the DEQ.

Nutrient data was collected in July at the Old Mill Road site on the Rush River and sent to ESS Laboratory in Culpeper. The total phosphorus reading was below the detection limit of 0.05 mg/L. Total Kjeldahl Nitrogen (TKN) was 0.61 mg/L and combined nitrate and nitrite was 0.16 mg/L. Total nitrogen, combined from these above two readings, was 0.77 mg/L. There are no nutrient standards for rivers and streams in Virginia. However, in this region, Ecoregion IX, the EPA recommends that total phosphorus should be at or below 0.36 mg/L and total nitrogen should be at or below 0.70 mg/L. Since total

phosphorus is the primary cause of algae blooms in the area, James Beckley of the DEQ feels that total nitrogen readings of less that 1.0 mg/L should not be of concern.

Tributaries to the Rush River:
Of the tributaries flowing into the Rush River that were sampled, none exceeded pH or temperature standards set by the DEQ and transparency was always greater than 60cm. The lowest reading for pH was 6.23 units and the highest was 7.40 units. Temperature ranged from 5.4 to 27.1 degrees Celsius. In July and August, dissolved oxygen fell below standards at one site on tributary T10. The tributary at this site, adjacent to the Baptist Church on Fodderstack Road upstream of Washington, is more of a wetland than a stream which would explain the low dissolved oxygen during the hotter months of the year.

Downstream of Washington where T10 crosses Tiger Valley Road, E. coli was well above DEQ standards every time it was tested (twice in April and once in May, July, and August). The lowest reading was 725 colonies per 100 ml. Three of the readings exceeded 1300 colonies per 100 ml. One possible cause could be the cows grazing in and around the creek each time it was sampled. Upstream of this site by the Washington firehouse, E. coli exceeded standards once in July with a reading of 400 colonies per 100 ml.

Big Branch:
Two sites were sampled on the Big Branch, a large tributary that flows into the Rush River south of the Town of Washington- one where Big Branch crosses lower Main Street in Washington and a second near the confluence with the Rush. Dissolved oxygen, pH, and temperature were all within DEQ standards. Transparency was below 60cm at both sites, indicating high sediment loads. E. coli readings were high at both sites in July (8150 colonies per 100ml at Main Street and 325 colonies per 100 ml downstream near the confluence). The Main Street site was also high in August with a reading of 416 colonies per 100 ml. The site near the confluence was only sampled in July. Cattle in or near the stream is a possible cause.

Unnamed Tributary to the Big Branch:
Tributary BB T02 runs through the west side of the Town of Washington and joins the Big Branch downstream of Washington. Three sites were sampled on this tributary- at Piedmont Street, downstream of the pond on Mt. Prospect, and across from Baldwin's Market on Main Street. Transparency was always greater than 60cm and pH and temperature were within DEQ standards at all the sites. Dissolved oxygen was below standards both times it was sampled (July and August) at the Mt. Prospect site. Since the site is downstream of a pond which has less movement and higher temperatures, this is not surprising. Dissolved oxygen was also below standards at Piedmont Street in August. This is a small tributary with less water, less movement and higher temperatures later in the summer, all factors that lead to low dissolved oxygen.

E. coli readings were quite low at the two upstream sites- Piedmont Street and Mt. Prospect. However, they were consistently high, except in August, downstream of

Washington at Baldwin's Market. There frequently was a strong smell of raw sewage, which could be due to one or more leaky septic systems. No livestock were visible from this site, although their contribution cannot be ruled out.

Discussion

When collecting chemical and bacterial data it is important to remember that readings can fluctuate dramatically based on a variety of conditions such as rainfall, temperature, time of day, and flow rate. Therefore, to draw any concrete conclusions about the data, each site must be sampled consistently throughout all four seasons for a number of years, ideally at least ten. The more frequent the samples, the more conclusive the data. That said, the data collected by RappFLOW in this pilot study will serve to highlight potential problem areas and healthy areas.

Based on this season of sampling, pH does not appear to be a concern in the Rush River subwatershed. It stayed within DEQ standards at every site, every month. Temperature also was within DEQ standards at every site, although some sensitive species of fish such as brook trout would not have survived at a number of the sites based on the temperature. (For brook trout, maximum temperature for survival for a short exposure is 24 degrees Celsius and for growth the weekly average needs to be above 19 degrees Celsius, which the DEQ standard of 31 degrees Celsius does not take into account.) Dissolved oxygen only fell below DEQ standards in July and August and only on the smallest tributaries, most likely due to low flow and high temperatures. Transparency, using the transparency tube, was above 60cm at every site except on the Big Branch where sedimentation seems to be somewhat of a problem. Larger buffers and fencing cattle out of the creeks could help.

In a 2005 pilot study of the Thornton River and Beaverdam Creek bacteria levels, we took water samples to a professional laboratory for testing. This method is too expensive for an ongoing volunteer water quality monitoring program. While bacteria source tracing methods are needed to identify with full confidence the origin of the E. coli bacteria, the ColiScan method is a relatively quick and inexpensive way to detect areas of general concern and need for further study. As stated earlier, the segment of the Rush River from the confluence with the Big Branch upstream 4.55 river miles to an unnamed tributary above the Town of Washington is listed on the 303(d) list as impaired. This listing is based only on data collected at the DEQ monitoring station downstream of the bridge on Old Mill Road in Washington. Monitoring within, upstream, downstream of the impaired segment and on the tributaries of the Rush River, RappFLOW was able to provide a fuller picture of the true impairment. Since not every site was monitored every month, it is difficult to compare between all the sites- factors such as rainfall, grazing patterns, flow, and temperature play a large role in bacteria counts and fluctuate regularly. However, there were a number of sites that were consistently high and should be evaluated for further study. Sites with high bacteria counts where cattle were grazing in the stream, such as on the Big Branch off Main Street in Washington and on tributary T10 on Tiger Valley Road, are ideal candidates for a discussion about riparian buffers and government incentive programs. Other sites, such as across the road from Baldwin's Market, may be

a good location for bacterial source tracing since the cause could be leaky septic systems, but may be something else. The data collected was provided to the DEQ to incorporate into the Total Maximum Daily Load (TMDL) study for bacteria impairment on the Rush River.

Assessing the Pilot Study

One of the goals of this RappFLOW pilot study was to refine methods for collecting, analyzing, and interpreting measures of water quality, in preparation for an ongoing volunteer monitoring program in Rappahannock County. While our methods of collecting data were informative, they were not sustainable and did not offer room for expansion into other subwatersheds in the county.

While the monitoring program had several extraordinarily dedicated volunteers, we were not able to form two teams due to a lack of enough people. As a result, every volunteer was called on to sample once each month, instead of every other month as originally anticipated. In addition to the frequency of the time commitment, the number of hours required per sampling session was too high. Since we only had one set of DO and pH meters, every volunteer had to go to every site, which, in addition to calibrating the meters, took up to 5 hours to complete. After being in the field all morning, the volunteers then had to convene to plate out the bacteria, taking several more hours of the day. After the bacteria had incubated over night, the volunteers reconvened to count and record bacteria. Last, all the data needed to be entered into a spreadsheet and distributed to interested people. With multiple teams or fewer sampling days, this monitoring program could have been sustainable, but as it was, it led to burnout.

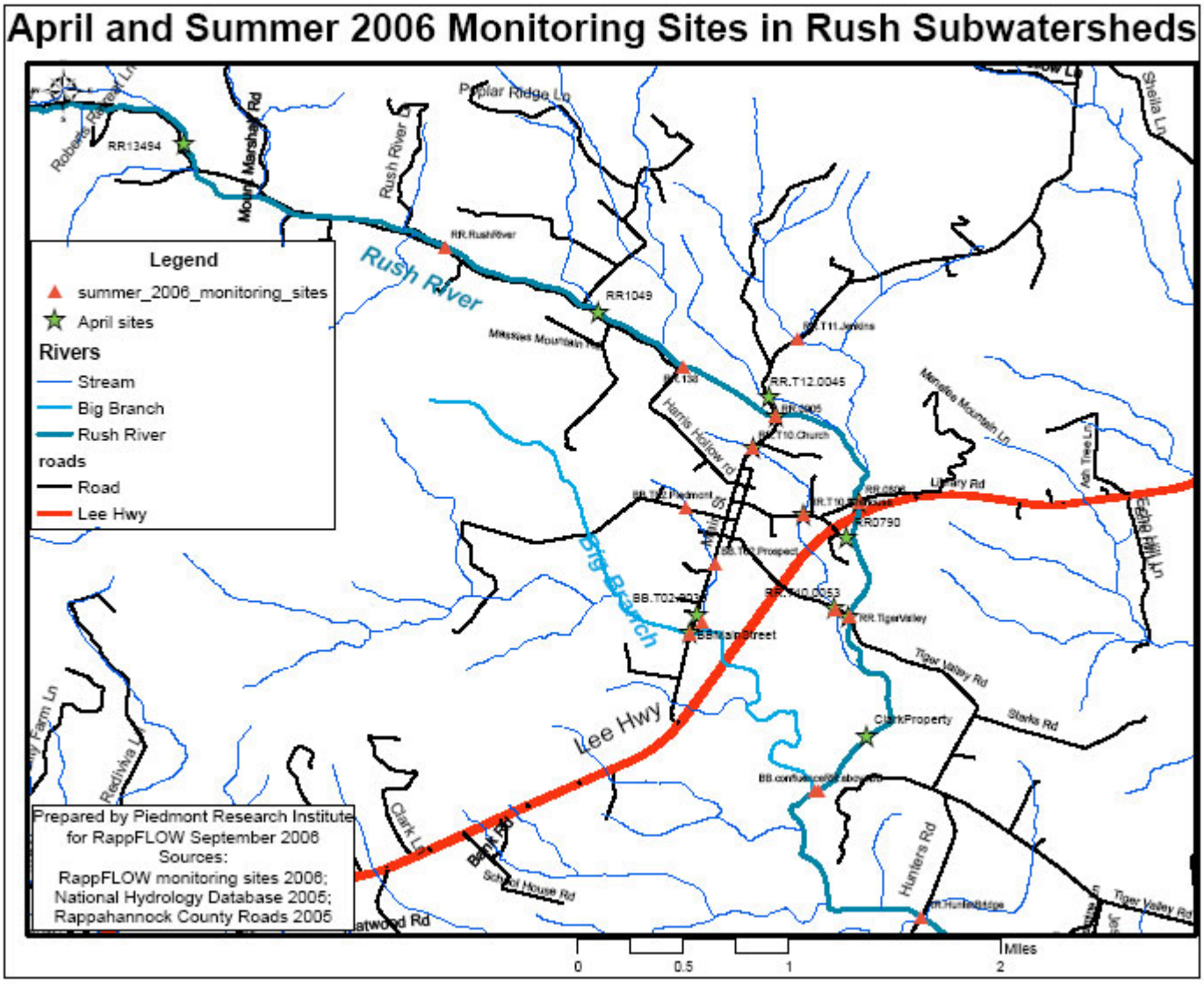
The other lesson learned from the pilot study was that our methodology was not conducive to expansion into the other subwatersheds of Rappahannock County unless we stopped monitoring the Rush River and chose a new subwatershed each year. Many people were interested in monitoring near their house or in their subwatershed. An ideal program perhaps would have sites throughout the county; however, by using the meters we were limited in the scope of coverage. While there are other methods of collecting the data, the DEQ only accepts pH data collected using a meter. At the time, it was our understanding that this was true of dissolved oxygen data as well. Logistics and coordinating efforts for either localized or county-wide monitoring would require more time than most volunteers could commit.

At the August 2006 RappFLOW monthly meeting, a large group of volunteers met to discuss the future of the monitoring program. We brainstormed on our goals of monitoring water quality and what type of program could be sustainable over a longer period of time. After much discussion, monitoring macroinvertebrates using the Virginia Save Our Streams (VA SOS) methodology seemed to make the most sense. The program is not contingent on the number of volunteers involved since sampling is done in teams of two, with only one team member needing to be certified. Another advantage is that sites can be spread throughout the county depending on where certified volunteers are located.

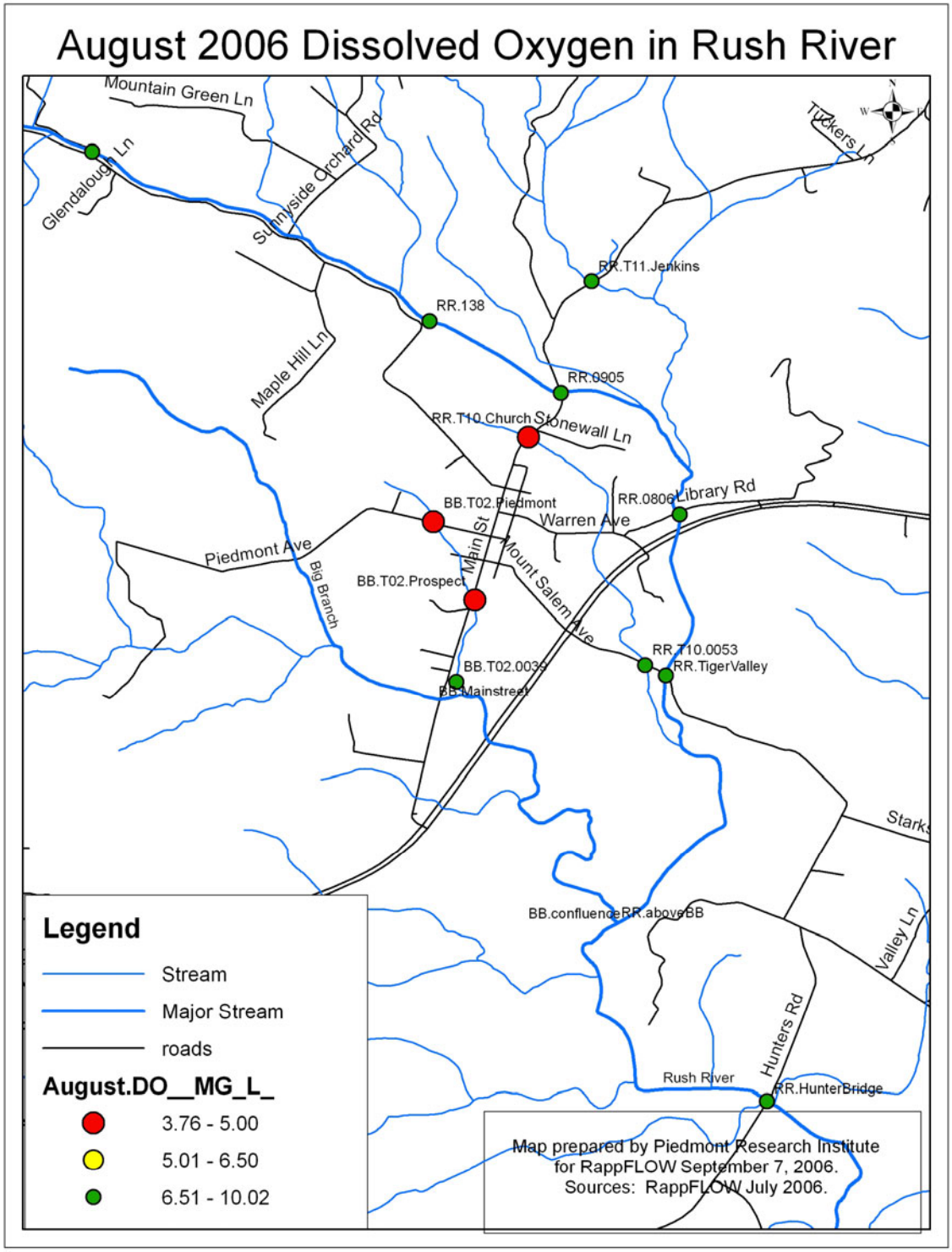
Except for the certification process, the amount of coordination is minimal, which is necessary for an all volunteer-run program. The equipment purchased for the pilot study will useful in follow-up studies of sites that appear impaired based on the macroinvertebrate surveys. RappFLOW so far has received extensive support and training from the Culpeper Soil and Water Conservation District, a small grant from the DEQ (starting in January 2007), and will be part of a state-wide effort through the VA SOS program.

Thanks

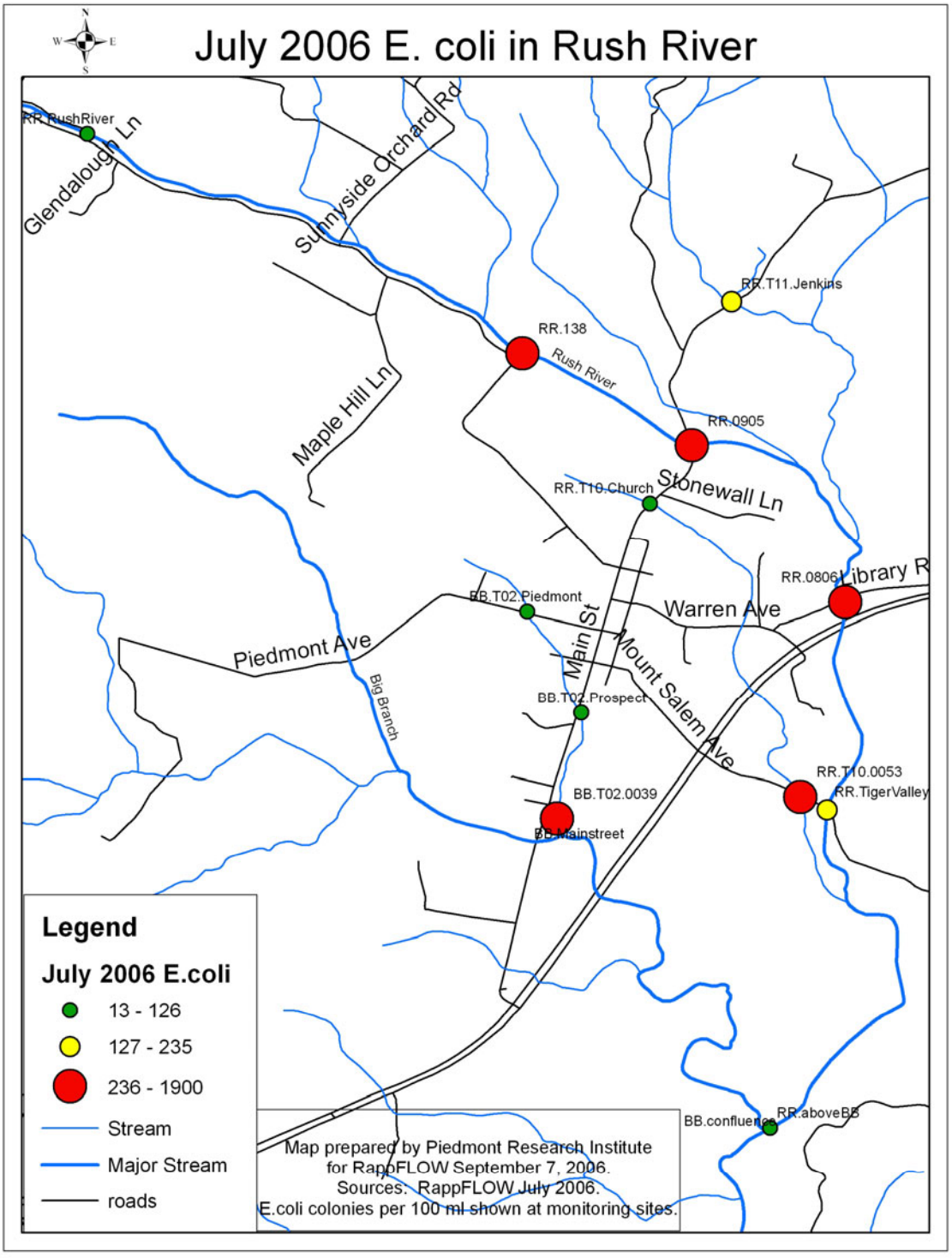
A number of people were very involved in the RappFLOW monitoring program. Kenny Giles and Beverly Hunter spent many hours designing the program. Kenny and Ellie Clark also made the time commitment of being team leaders. Kenny, Ellie, and Peter Hansen constituted the 2006 core team of volunteers. Other volunteers who put in large amounts of time in the 2005 pilot study were Jill Keihn, Cliff Miller, Hal Hunter, and Sarah Gannon and Beverly Hunter; in 2006 Don Loock, Mary Beth Martin, and Jean Pfefferkorn. RappFLOW gathered a large amount of valuable data thanks to the efforts of these volunteers.



Map 1: Monitoring sites 2006



Map 2: Dissolved Oxygen levels in Rush River and Tributaries in August 2006



Map 3: July 2006 E.Coli levels in Rush River and tributaries

Citizen Monitoring Program
Field Data Sheet

Site Name and #: _____ GPS Waypoint: _____ Monitoring Date: _____
Site Description: _____
Monitors: _____ Time: _____ (military time)

WEATHER AND SITE OBSERVATIONS

WIND: ☐Calm ☐Slight breeze ☐ Moderated winds ☐Gusty ☐Strong gusts

WEATHER: ☐ Sunny ☐ Partly cloudy ☐ Overcast ☐ Fog/Haze ☐ Drizzle
☐Intermittent rain ☐ Rain ☐Sleet ☐ Snow

GENERAL WEATHER LAST 3 DAYS:
DATE: _____ WEATHER _____
DATE: _____ WEATHER _____
DATE: _____ WEATHER _____

DATE OF LAST RAINFALL OF ¼" OR MORE
_____(estimate)

RELATIVE FLOW: ☐ Very Low ☐ Low ☐ Average ☐ High ☐ Very High

SPEED OF WATER: ☐Fast ☐Moderate ☐Slight ☐Almost Still

WATER CLARITY: ☐ Clear ☐ Suspended ☐ Solids/murky ☐ Slightly turbid ☐ Highly cloudy

WATER COLOR: ☐ Clear ☐ Tan ☐ Green tint ☐ Green ☐ Brown ☐ Blue-green ☐ Red ☐ Other _____

INDICATORS: ☐ Algae ☐ Aquatic plants ☐ Bank Erosion ☐ Abnormal Color ☐ Dead fish/ Animals
☐Wildlife Sightings ☐ Foam ☐ Scum ☐ Pollen ☐ Bubbles ☐ Debris ☐ Odors
☐ Oil on surface ☐ Potential Pollution ☐ Land Clearing ☐ Waste Outfall Pipes ☐ Other
Explain any checked indicator: _____

SAMPLES COLLECTED FOR LABORATORY ANALYSIS

☐ Total Suspended solids ☐ Phosphorous _____ ☐ Nitrogen _____ ☐ Other _____

FIELD MEASURES (Remember to calibrate meters before use):

Water Clarity:
Transparency tube: _____._____ cm
(to nearest tenth of cm)
☐ Check if the actual transparency reading was greater than the value entered.

Dissolved oxygen meter:
DO in mg/L: _____mg/L
DO in % Sat. _____%
Temperature: _____°C

pH meter:
pH reading: _____ (Std. units)
Temperature: _____°C

E. coli Bacteria Measurement (using Coliscan Easygel™ plates)

Were samples collected for lab comparison? ☐ Yes ☐ No Rainfall within 48 hours prior to sampling: _____mm
Incubation time: _____hours (to nearest hour) Incubation temp: _____°C
Amount of water sample added to media bottle (max 5ml per Rep): Rep 1: _____ (A1) Rep 2: _____ (A2)
Total # of purple or dark blue colonies on plate: Rep 1: _____ (B1) Rep 2: _____ (B2)
Note: disregard any pink, blue-green, or white colonies- these are not E. coli bacteria

To calculate the Total Colonies of E. coli bacteria per 100 ml of water:
1. Divide 100 by the ml of water used. 2. Multiply this quotient by the number of purple colonies counted
Rep1: ([100 / A1] * B1) = _____ (C1) Rep 2: ([100/A2] * B2) = _____(C2)
Average of both Reps = (C1 + C2) / 2 (Report this value) _____

GENERAL COMMENTS: _____

Attachment 1: Field data sheet.

RappFLOW Volunteer Monitoring Program
Water Quality Data (2006)

Rush River (downstream to upstream)												
Date	ID	Description	Time	Coliscan Col./100mL	Lab Col./100mL	pH	Temp (pH)	DO (mg/L)	DO % Sat	Temp (DO)	Trans	
08/12/06	RR.HunterBridge	DS of confluence with Big Branch at Hunter Bridge	11:30	0	na	8.02	21.9	9.45	107.7	22.0	60.0	±
04/09/06	RR.Clark	219 Tiger Valley Rd (Clark Property)	7:50	na	na	7.44	6.3	11.45	na	6.7		
04/09/06	RR.Clark	219 Tiger Valley Rd (Clark Property)	10:20	25	na	na	na	12.22	na	7.2		
05/13/06	RR.Clark	219 Tiger Valley Rd (Clark Property)	7:38	75	na	7.42	12.7	10.09	95.5	12.2		
08/12/06	RR.Clark	219 Tiger Valley Rd (Clark Property)	11:08	37.5	na	7.68	19.4	8.38	91.6	19.5	60.0	±
04/07/06	RR.TigerValley	Crossing of Rush River and Tiger Valley Rd	11:33	0	30	na	na	na	na	na		
04/09/06	RR.TigerValley	Crossing of Rush River and Tiger Valley Rd	8:20	175	na	7.53	6.3	11.47	na	6.5		
05/13/06	RR.TigerValley	Crossing of Rush River and Tiger Valley Rd	8:02	125	na	6.95	12.4	10.10	94.9	12.6		
07/18/06	RR.TigerValley	Crossing of Rush River and Tiger Valley Rd	11:09	200	na	7.74	22.7	9.27	107.4	22.9	60.0	
08/12/06	RR.TigerValley	Crossing of Rush River and Tiger Valley Rd	10:31	75	na	7.55	19.7	8.24	90.2	19.9	60.0	±
04/09/06	RR.0790	Rec Center on 211	7:30	na	na	7.37	6.4	11.31	na	6.5		
05/13/06	RR.0790	Rec Center on 211	7:10	100	na	6.95	12.3	10.03	93.8	12.3		
04/07/06	RR.0806	DS bridge Old Mill Rd	10:36	75	50	na	na	na	na	na		
04/09/06	RR.0806	DS bridge Old Mill Rd	8:39	325	na	7.35	6.2	11.68	na	6.3		
05/13/06	RR.0806	DS bridge Old Mill Rd	8:31	200	8	7.44	12.4	10.41	97.5	12.5		
07/18/06	RR.0806	DS bridge Old Mill Rd	10:45	1525	na	7.57	22.7	9.17	106.3	22.7	60.0	
08/12/06	RR.0806	DS bridge Old Mill Rd	10:15	125	na	7.31	19.9	7.91	86.8	20.0	60.0	±
04/07/06	RR.0905	Fodderstack Rd. Coopers Hole	10:45	87.5	na	na	na	na	na	na		
04/09/06	RR.0905	Fodderstack Rd. Coopers Hole	8:55	na	na	7.50	6.3	11.98	na	6.4		
05/13/06	RR.0905	Fodderstack Rd. Coopers Hole	9:07	825	na	7.73	12.7	10.79	101.6	12.8		
07/18/06	RR.0905	Fodderstack Rd. Coopers Hole	9:00	1900	na	7.79	21.8	9.30	106.0	21.9	60.0	
08/12/06	RR.0905	Fodderstack Rd. Coopers Hole	8:38	325	na	7.63	18.6	8.52	91.1	18.6	60.0	±
07/18/06	RR.138	At sharp bend in Harris Hollow Rd at water treatment facility	8:20	575	na	7.56	21.2	8.84	99.5	21.3	60.0	
08/12/06	RR.138	At sharp bend in Harris Hollow Rd at water treatment facility	8:15	1816	na	7.66	18.8	8.51	91.3	18.9	60.0	±

Attachment 2: Data Collected

Dissolved Oxygen Form for QA/QC

	Probe OK							Probe service needed soon				Flag data and service probe		
Date	Temp C In Morning	Barometric Pressure (mBar)	DO theoretical value (ppm)	DO calibrated value (ppm)	% Sat after Cal	Difference mg/L (do not overwrite)	Midday Calibration Check (95-105% sat)	Temp C at End of Day	Barometric Pressure End of Day (mBar)	Theoretical DO Level End of Day (ppm)	Actual DO Level End of Day (ppm)	Difference ppm (do not overwrite)	Initials	Notes
1/1/2004	20.2	761.1	8.64	8.94		0.30	100	21.4	751.4	8.9	8.76	0.14	JEB	This is example delete
1/2/2004	20.4	720	8.76	8.6		0.16	95	22.1	721.1	7.84	8.3	0.46	JEB	This is example delete
1/3/2004	20.1	741	8.65	8.8		0.15	92	20.5	742.1	8.15	8.77	0.62	JEB	This is example delete
4/9/2006	5.8	1016	12.57	12.61		0.04	102.3	11.3	1016	11	10.67	0.33	CBL	
						0.00						0.00		
						0.00						0.00		
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						0.00						0.00		
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DEQ Dissolved Oxygen Calibration Sheet

Directions- To calculate the theoretical DO saturation level, multiply the O2 concentration value (found in the top chart) by the barometric pressure correction factor (bottom chart)

Temp in ^{O}C	O_2 concentrations in mg/l									
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
5	12.75	12.71	12.68	12.65	12.61	12.58	12.55	12.52	12.48	12.45
6	12.42	12.39	12.36	12.32	12.29	12.26	12.23	12.2	12.17	12.14
7	12.11	12.08	12.05	12.02	11.99	11.96	11.93	11.9	11.87	11.84
8	11.81	11.78	11.758	11.72	11.69	11.67	11.64	11.61	11.58	11.55
9	11.53	11.5	11.47	11.44	11.42	11.39	11.36	11.33	11.31	11.28
10	11.25	11.23	11.2	11.18	11.15	11.12	11.1	11.07	11.05	11.02
11	10.99	10.97	10.94	10.92	10.89	10.87	10.84	10.82	10.79	10.77
12	10.75	10.72	10.7	10.67	10.65	10.63	10.6	10.58	10.55	10.53
13	10.51	10.48	10.46	10.44	10.41	10.39	10.37	10.35	10.32	10.3
14	10.28	10.26	10.23	10.21	10.19	10.17	10.15	10.12	10.1	10.08
15	10.06	10.04	10.02	9.99	9.97	9.95	9.93	9.91	9.89	9.87
16	9.85	9.83	9.81	9.79	9.76	9.74	9.72	9.7	9.68	9.66
17	9.64	9.62	9.6	9.58	9.56	9.54	9.53	9.51	9.49	9.47
18	9.45	9.43	9.41	9.39	9.37	9.35	9.33	9.31	9.3	9.28
19	9.26	9.24	9.22	9.2	9.19	9.17	9.15	9.13	9.11	9.09
20	9.08	9.06	9.04	9.02	9.01	8.99	8.97	8.95	8.94	8.92
21	8.9	8.88	8.87	8.85	8.83	8.82	8.8	8.78	8.76	8.75
22	8.73	8.71	8.7	8.68	8.66	8.65	8.63	8.62	8.6	8.58
23	8.57	8.55	8.53	8.52	8.5	8.49	8.47	8.46	8.44	8.42
24	8.41	8.39	8.38	8.36	8.35	8.33	8.32	8.3	8.28	8.27
25	8.25	8.24	8.22	8.21	8.19	8.18	8.16	8.15	8.14	8.12
26	8.11	8.09	8.08	8.06	8.05	8.03	8.02	8	7.99	7.98
27	7.96	7.95	7.93	7.92	7.9	7.89	7.88	7.86	7.85	7.83
28	7.82	7.81	7.79	7.78	7.77	7.75	7.74	7.73	7.71	7.7
29	7.69	7.67	7.66	7.65	7.63	7.62	7.61	7.59	7.58	7.57
30	7.55	7.54	7.53	7.51	7.5	7.49	7.48	7.46	7.45	7.44

Barometric Pressure Correction factor:

mmHg (mBar)	Corr. Factor	mmHg (mBar)	Corr. Factor	mmHg (mBar)	Corr. Factor	mmHg (mBar)	Corr. Factor
775-771 (1033-1028)	1.02	750-746 (1000-995)	0.987	725-721 (967-961)	0.953	700-696 (934-928)	0.92
770-766 (1027-1021)	1.014	745-741 (994-988)	0.98	720-716 (960-955)	0.947	695-691 (927-921)	0.914
765-761 (1020-1014)	1.007	740-736 (987-981)	0.973	715-711 (954-948)	0.94	690-686 (920-915)	0.907
760-756 (1013-1008)	1	735-731 (980-975)	0.967	710-706 (947-941)	0.934	685-681 (914-908)	0.9
755-751 (1007-1001)	0.993	730-726 (974-968)	0.96	705-701 (940-935)	0.927	680-676 (907-901)	0.893

*** To calculate barometric pressure from inHg into mmHg--- mmHg= inHg x 25.4**
**** To calculate barometric pressure from inHg into mBar--- mBar= inHg x 33.864**

Field Probe pH Calibration Form for QA/QC

The morning cal and end of day check should never exceed ±0.2 SU. If greater than ±0.2 SU, flag the data

🟩	0.00-0.15 S.U. Probe OK	🟨	0.151- 0.20 S.U. Probe service needed	🟥	>0.20 S.U. Flag data and service probe

Date	Temp C in Morning	Pre cal pH 7	Cal to 7 Buffer	Pre Cal pH 4	Cal to 4 Buffer	Temp C at End of Day	pH 7 Check End of Day	pH 4 Check End of Day	Difference for 7 Buffer (do not overwrite)	Difference for 10 Buffer (do not overwrite)	Initials	Notes
01/01/04	20.20	6.87	7.04	4.05	4.01	21.40	7.20	4.11	0.16	0.1	JEB	This is example delete
01/02/04	19.50	7.00	7.01	4.55	4.00	20.40	7.60	4.21	0.59	0.21	JEB	This is example delete
01/05/04	20.00	7.50	7.04	3.99	4.05	21.10	7.05	4.21	0.01	0.16	JEB	This is example delete
01/09/06	13.90	7.04	7.04	4.07	3.99	17.90	7.03	3.95	0.01	0.04	CFB	
									0	0		
									0	0		
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