The Effect of Land Use on Water Quality

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Introduction

There are many factors that indicate stream health, specifically carbon dioxide, dissolved oxygen, pH, nitrates, water temperature, water transparency, and conductivity. Carbon dioxide (CO_2) is a colorless, odorless, non toxic gas which is composed of one carbon and two oxygen atoms ("Carbon dioxide (CO_2)," 2015). Carbon makes its way into waterways through numerous paths. Most of it washes in from the land surrounding it, especially in the form of organic carbon. Some carbon makes its way up from the soil under the waterways and some from the air and some from the water—to produce new organic carbon. When organic carbon enters a stream, aquatic life can break it down further, creating carbon dioxide. Some of the carbon dioxide remains in the water and washes out to the ocean, but a large amount escapes into the atmosphere (Schrope, 2012).

Dissolved oxygen (DO) refers to the level of non-compound oxygen present in water and other liquids, it is the amount of gaseous oxygen dissolved into the water ("Dissolved Oxygen," 2015). Dissolved oxygen is extremely important in an aquatic system because animals and plants need oxygen to survive. Low levels of oxygen in the water are a sign that a habitat is polluted or stressed out. Most organisms will not be able to live with dissolved oxygen levels less than 3.0 mg/L, dissolved oxygen levels that drop lower than 5.0 mg/L are very concerning for stream health ("Hydrosphere," 2015).

pH is the measure of the concentration of hydrogen ions of a solution. Solutions with high concentrations of hydrogen ions tend to have a lower pH (acidic) and solutions with low concentrations of hydrogen ions have a higher pH (basic) ("What Is pH," 2015). The meaning of basic or base is any substance that will accept a proton (7.0 or lower) and acidic, or acid, is any substance that will donate a proton (7.0 or higher, can go up to 14). When in water, acids break apart to form hydrogen ions where bases break apart to form hydroxide ions (Bogren, 2015). pH is crucial in an aquatic system because as the ph drops, so does the biodiversity of the stream, gradually leaving fewer and fewer species (Beck,Dobson, and Gilpin,1999).

Water temperature is a measure of the average kinetic energy of the water molecules and it influences the diversity of the aquatic life in a body of water because different organisms can survive in different temperatures.

Nitrates are a form of nitrogen, which is found in several different forms in aquatic systems. These forms of nitrogen include ammonia (NH3), nitrates (NO3), and nitrites (NO2). Nitrates are essential plant nutrients, but in excess amounts they can cause significant water quality problems. Excess nitrates can cause hypoxia (which are low levels of dissolved oxygen) and can become toxic to warm-blooded animals at higher concentrations (10 mg/L or higher) under certain conditions. The natural level of ammonia or nitrate in surface water is typically low (less than 1 mg/L). Sources of nitrates include wastewater treatment plants, runoff from fertilized farmland, runoff from animal manure storage areas and animal waste from stream inhabitants (fish excrement, etc...) ("5.7 Nitrates," 2012).

Conductivity measures the amount of electricity conducted through 2.54 cm of water. Conductivity is affected by the temperature of the water: the warmer the water gets, the higher the conductivity. Conductivity in streams is primarily affected by the geology, or land use, of the area where the water flows. The conductivity of rivers in the U.S. usually ranges from 50 to 1500 microsiemens/cm. Conductivity outside this range could indicate that the water is not suitable for some species of fish ("5.9 Conductivity," 2012).

Water transparency is the clearness of the water decreasing with the increasing amount of sediments, molecules, and particles that are being absorbed and scatter light ("Hydrosphere," 2015). Water transparency is very important because the more sediments in the water, the less light that can get through therefore decreasing the amount of living organisms and the reduction of visibility prevents fish and other creatures from seeing their prey and predators ("Home," 2015).

This study was prompted by questioning the water quality of the local streams and whether or not they were contributing harmful water to the Chesapeake Bay. Land use was also evaluated to determine if questionable water quality levels were the result of runoff and/or industry pollution. It is important for all streams within the Chesapeake Bay watershed to be monitored and work towards contributing clean water to the Bay to help save the Bay and all its resources.

Lesa Bird, GLOBE Program trainer and scientist from Advancing Science with Gettysburg College initially advised on determination of testing site location and properly implementing GLOBE protocols and use of instruments. After data was collected, Mrs. Bird suggested new graph comparisons of data to better understand relationship between variables tested, specifically dissolved oxygen and temperature, conductivity and nitrate levels, and conductivity and transparency levels. Lesa Bird and Todd Toth of NASA Goddard Space Flight Center trained student and teacher on GLOBE protocols and Data Entry on GLOBE data base.

Problem Statement

This experiment focuses on the question: How does land usage affect the water quality of Rock Creek?

Hypothesis

If the testing site of the stream is changed from rural upstream, upstream of the wastewater treatment plant, downstream of the wastewater treatment plant, and downstream rural that has passed through the town, then the chemical parameters that indicate stream health: dissolved oxygen, nitrate, pH, water temperature, conductivity and water transparency, would be in the healthiest range upstream rural because as the water is moving downstream into the city, the stream may pick up more waste and pollutants from the land use and other merging streams as it travels through the town.

About the Experiment

This experiment is designed to test the effect of land usage on the health of the stream/creek. The independent variable tested is the location along the stream being tested. The dependent variables that will be measured are the levels of dissolved oxygen, nitrates, pH, water temperature, conductivity, and water transparency. Dissolved oxygen will be measured in mg/L. Nitrates will be measured in mg/L. pH will be measured in the logarithmic scale from 0-14. Water temperature will be measured in degrees Celsius. Conductivity will be measured in microsiemens/cm. Water transparency will be measured in centimeters. The controls for this experiment are the day all the testing will take place, the time the tests are completed, and how samples are collected and tested.

Material

- 1 Vernier Lab Quest
- 1 HACH Oxygen, dissolved kit
    i. 0.2-2.0 mg/l
    ii. model OX-2p

- 1 Vernier pH sensor
- 1 Temperature Probe
- 1 HACH Nitrate kit
    i. For "Water, Water Everywhere"
- 1 API Freshwater Master kit
    i. Nitrate test only
- 1 Vernier conductivity probe
- 1 Transparency tube
    i. Home made, based on transparency tube used in GLOBE Transparency Tube protocol
- Timer

Procedures

A. Go to the first stream site (downstream rural)

Test Stream Temperature, pH and Conductivity Levels

1. Prepare the Vernier Lab Quest.
    a. Take out the Vernier Lab Quest, turn on by pressing the silver power button in the upper left hand corner.
    b. Plug the Vernier pH sensor into channel one of the Vernier Lab Quest.
    c. Plug the temperature probe into channel two of the Vernier Lab Quest.
    d. In channel three of the Vernier Lab Quest plug in the Conductivity probe.

i. Nothing will show up so take the stylist and tap

Sensors at the top of the screen.

ii. Next the screen will look like this :

Sensor Setup
Data Collection
WDSS Setup
Change Units
Calibrate
Zero
Reverse

iii. Tap Sensor Setup

iv. A page will pop up and channel three will not have any word in the box, click on the box and a list of parameters will appear.

v. Scroll down and tap conductivity and make sure it is set to 2000

2. Place the 2 probes and 1 sensor directly into stream and allow time for results to stabilize.

3. Record the pH, temperature and conductivity results in logbook.

Test Dissolved Oxygen Levels

1. Fill Dissolved Oxygen bottle (round bottle with glass stopper) with water to be tested by submerging the round bottle into the water and turning upright so that all bubbles can escape and insert stopper quickly. If any bubbles are trapped in the bottle, start over.

2. Open one each of the dissolved oxygen 1 and 2 powder pillows. Add the contents each carefully to the bottle. Put the stopper in bottle carefully to exclude air bubbles. Grip the bottle and stopper firmly and vigorously shake to mix. A

flocculant precipitate will be formed.

3. Allow the sample to stand until the floc has settled half way, leaving the upper half clear. Once it has settled shake the bottle again vigorously. Again, let it stand and wait for 5 minutes.

4. Open 1 dissolved oxygen 3 powder pillow, add the contents to the sample and carefully re-stopper the bottle. Shake to mix, the floc will dissolve and a yellow color will develop if oxygen is present.

` 5. Fill the plastic measuring tube, level full of the prepared sample. Pour this into the square mixing bottle.

6. Add Sodium Thiosulfate Solution drop by drop into the square bottle with the sample, counting each drop and swirling to mix after each drop. Hold the dropper vertically above the bottle and continue until the yellow turn perfectly clear.

   a. Tip: hold eye dropper straight up and down when releasing drops, eye dropper's position will affect the size of the drop! Also, do not let the eye dropper touch the side of the bottle.
   b. If the sample has been properly prepared it should never result in more than 20 drops being added.
   c. Each drop used to bring about the color change in step 11 is equal to 1mg/L of dissolved oxygen.

7. Record results in logbook and dispose of chemicals in waste container that will be disposed of properly (in this case, Gettysburg College).

Test Transparency of Water

1. Take the transparency tube and gallon milk jug filled with water sample.

2. In the shade, begin to pour sample water from milk jug into transparency tube, checking frequently to see if the design is still visible.

3. Test is over once design is no longer visible or transparency tube is filled to 120 cm.

4. Repeat steps 1-3 for Test Transparency of Water a total of 3 times, find the average of results.

5 Write all results in logbook.

Test Nitrate Levels 1

1. Fill 1 container to the 10 mL with sample water.
2. Add 1 packet of Nitra Ver 5.
3. Shake vigorously for 1 minute (use timer).
4. Wait 5 minutes.
5. While waiting fill container 2 will 10 mL with untreated sample water.
6. Colorimeter set up.
    a. Press **EXIT** to turn on the Colorimeter.
    b. Press **PRGM** the display will show: **PRGM?**
    c. Press **51 ENTER** the display will show **mg/L, NO3-N** and the **ZERO** icon.
7. At 5 minutes take samples to Colorimeter and take off cover.
8. Place untreated sample in the Colorimeter and cover. Press **ZERO**, once results register, remove untreated sample.
9. Place treated sample in the Colorimeter and cover sample, press **READ**
10. Once results register record in logbook.

Test Nitrate Levels 2

1. Fill clean test tube with 5ml of water to be tested (to the line on the tube).

2. Add 10 drops from the Nitrate Test Solution Bottle #1, holding dropper bottle upside down in a completely vertical position to assure uniformity of drops added to the water sample.

3.Cap test tube and invert tube several times to mix solution. (Do not hold finger over the open end of the tube as it may affect test results)

4. Vigorously shake the Nitrate Test Solution Bottle #2 for at least 30 seconds (this step is extremely important to ensure accuracy of test results).

5. Now add 10 drops from Nitrate Test Solution Bottle #2, holding dropper bottle upside down in a completely vertical position to assure uniformity of drops added to the water sample.

6. Cap the test tube and shake vigorously for one minute (this step is extremely important to ensure accuracy of test results).

7. Wait 5 minutes for color to develop.

8. Read test results by matching the color of the solution against those on the Nitrate Test Color Chart (color comparison are best made in a well-lit area, the closest match indicates the ppm (mg/L) of nitrates in the water sample).

B. Drive to site 2 (Quarry, upstream wastewater treatment plant) and repeat steps above for testing Temperature, pH levels, Conductivity, Dissolved Oxygen levels, Transparency and Nitrate levels four more times for a total of five trials on Mondays and Wednesdays.

C. Drive to site 3 (downstream from wastewater treatment plant) and repeat steps above for testing Temperature, pH levels, Conductivity, Dissolved Oxygen levels, Transparency and Nitrate levels four more times for a total of five trials on Mondays and Wednesdays.

D. Drive to site 4 (upstream rural) and repeat steps above for testing Temperature, pH levels, Conductivity, Dissolved Oxygen levels, Transparency and Nitrate levels four more times for a total of five trials on Mondays and Wednesdays.

Data

Site 1	Dissolved Oxygen (mg/L)	Nitrate (mg/L)	pH (the logarithmic scale from 0-14)	Water Temp (Celsius)	Conductivity (microsiemens/cm)	Transparency (cm)
Week 1	9	4.7	7.00	21.1	unable to test	unable to test
Week 2	11	5.0	7.67	18.7	452	120
Week 3	10	5.0	7.48	16.3	461	120
Week 4	10	5.0	6.97	16.4	472	120
Week 5	11	5.0	7.70	15.8	534	120

Table 1. Measured weekly levels from site 1 (rural downstream) of dissolved oxygen, nitrates, pH, water temperature, water transparency, and conductivity. Conductivity and transparency were unable to be tested in week one due to unavailable testing materials.

Site 2	Dissolved Oxygen (mg/L)	Nitrate (mg/L)	pH (the logarithmic scale from 0-14)	Water Temp (Celsius)	Conductivity (microsiemens/cm)	Transparency (cm)
Week 1	8	2.2	8.02	21.2	unable to test	unable to test
Week 2	11	5.0	8.10	18.6	522	93.5
Week 3	11	5.0	7.97	17.5	551	91.3
Week 4	10	5.0	7.44	17.5	552	98.0
Week 5	10	5.0	7.53	15.7	614	120.0

Table 2. Measured weekly levels from site 2 (downstream of the wastewater treatment plant) of dissolved oxygen, nitrates, pH, water temperature, water transparency, and conductivity.

Conductivity and transparency were unable to be tested in week one due to unavailable testing materials.

Site 3	Dissolved Oxygen (mg/L)	Nitrate (mg/L)	pH (the logarithmic scale from 0-14)	Water Temp (Celsius)	Conductivity (microsiemens/cm)	Transparency (cm)
Week 1	5	0.7	7.92	20.8	unable to test	unable to test
Week 2	12	5.0	7.80	18.7	400	77.3
Week 3	11	5.0	5.77	17.1	466	78.8
Week 4	11	5.0	5.22	17.3	462	82.3
Week 5	10	5.0	7.36	15.6	487	85.7

Table 3. Measured weekly levels from site 3 (upstream of the wastewater treatment plant) of dissolved oxygen, nitrates, pH, water temperature, water transparency, and conductivity. Conductivity and transparency were unable to be tested in week one due to unavailable testing materials.

Site 4	Dissolved Oxygen (mg/L)	Nitrate (mg/L)	pH (the logarithmic scale from 0-14)	Water Temp (Celsius)	Conductivity (microsiemens/cm)	Transparency (cm)
Week 1	7	3.8	8.27	20.7	unable to test	unable to test
Week 2	10	5.0	8.07	18.0	387	60.0
Week 3	9	5.0	6.98	16.2	415	59.2
Week 4	9	5.0	6.55	16.1	404	61.0
Week 5	9	5.0	7.28	15.5	437	81.3

Table 4. Measured weekly levels from site 4 (upstream rural) of dissolved oxygen, nitrates, pH, water temperature, water transparency, and conductivity. Conductivity and transparency were unable to be tested in week one due to unavailable testing materials.

Results/Data Analysis

Data was recorded in logbook over a five week experimentation period. Each trial was recorded in the logbook. The data was placed into a *Google sheets* spreadsheet. The five weeks of data were analyzed and graphed in a line graph. The results show that: As shown in Figure 1A and 1B, Dissolved Oxygen (DO) increased and peaked at all sites on week 2. The level of DO then decreased slightly during the remaining weeks. Nitrate levels (fig. 2A and 2B) varied between sites during week one. Data collected during weeks 2-5 is inconclusive due to change in available testing materials. pH levels showed a decrease at all sites during week 4 (fig 3A and 3B) with the most dramatic decrease being found at site 4. Water temperature levels (fig 4A and 4B) showed that during testing time the temperature decreased as weeks went on in correspondence with the decreasing air temperature. Conductivity levels (fig 5A and 5B) showed that during the testing time it rose slightly as the weeks progressed, peaking during week five. There was a slight outlier during week five at site 2. Transparency levels (fig 6A and 6B) showed that during the week there was a slight increase peaking at the end of the week. Site 1 had a consistent level during the whole testing period.

	Site 1 Dissolved Oxygen (mg/L)	Site 2 Dissolved Oxygen (mg/L)	Site 3 Dissolved Oxygen (mg/L)	Site 4 Dissolved Oxygen (mg/L)
Week 1	9	8	5	7
Week 2	11	11	12	10
Week 3	10	11	11	9
Week 4	10	10	11	9
Week 5	11	10	10	9

Figure 1A. Dissolved Oxygen Levels of Stream at Rock Creek Gettysburg, PA (using HACH Oxygen, dissolved kit)

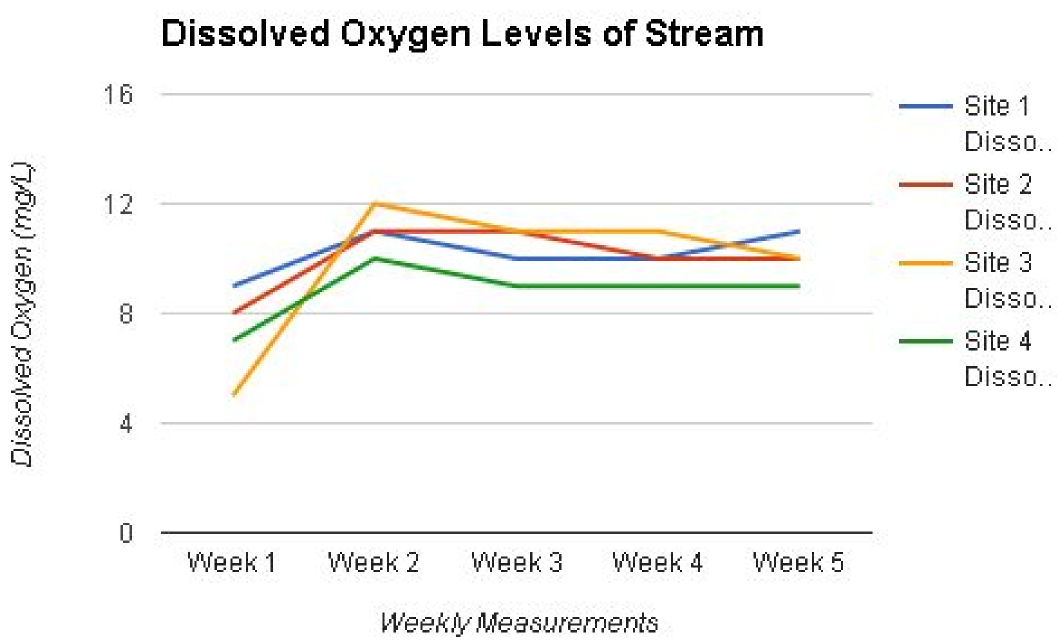

Figure 1B. Dissolved Oxygen Levels of Stream at Rock Creek Gettysburg, PA (using HACH Oxygen, dissolved kit)

	Site 1 Nitrate (mg/L)	Site 2 Nitrate (mg/L)	Site 3 Nitrate (mg/L)	Site 4 Nitrate (mg/L)
Week 1	4.7	2.2	0.7	3.8

Figure 2A. Nitrate Levels of Stream at Rock Creek Gettysburg, PA (using HACH Nitrate kit)

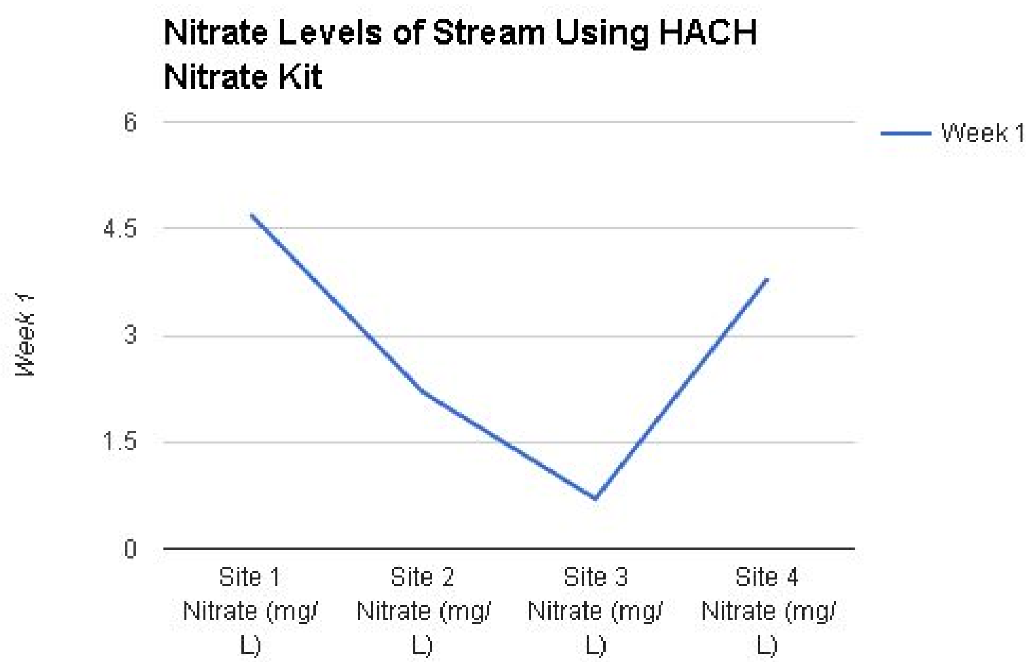

Figure 2B. Nitrate Levels of Stream at Rock Creek Gettysburg, PA (using HACH Nitrate kit)

	Site 1 Nitrate (mg/L)	Site 2 Nitrate (mg/L)	Site 3 Nitrate (mg/L)	Site 4 Nitrate (mg/L)
Week 1				
Week 2	5	5	5	5
Week 3	5	5	5	5
Week 4	5	5	5	5
Week 5	5	5	5	5

Figure 2C. Nitrate Levels of Stream at Rock Creek Gettysburg, PA (using API Freshwater Master kit)

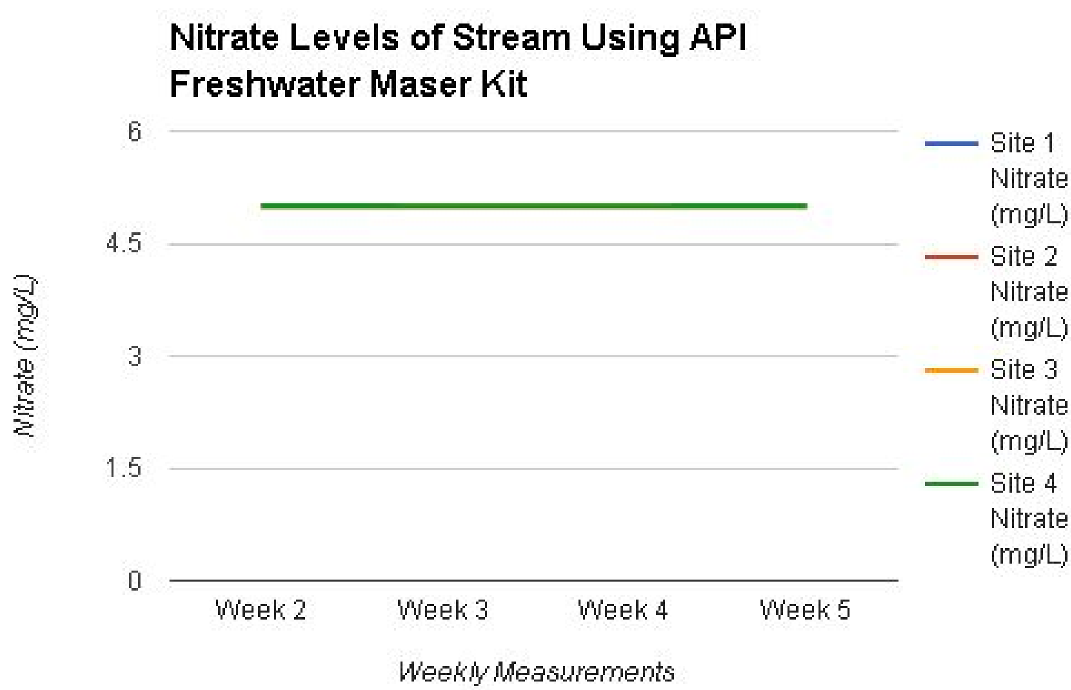

Figure 2D. Nitrate Levels of Stream at Rock Creek Gettysburg, PA (using API Freshwater Master kit)

	Site 1 pH (the logarithmic scale from 0-14)	Site 2 pH (the logarithmic scale from 0-14)	Site 3 pH (the logarithmic scale from 0-14)	Site 4 pH (the logarithmic scale from 0-14)
Week 1	7.00	8.02	7.92	8.27
Week 2	7.67	8.10	7.80	8.07
Week 3	7.48	7.97	5.77	6.98
Week 4	6.97	7.44	5.22	6.55
Week 5	7.70	7.53	7.36	7.28

Figure 3A. pH Levels of Stream at Rock Creek Gettysburg, PA (using Vernier pH sensor)

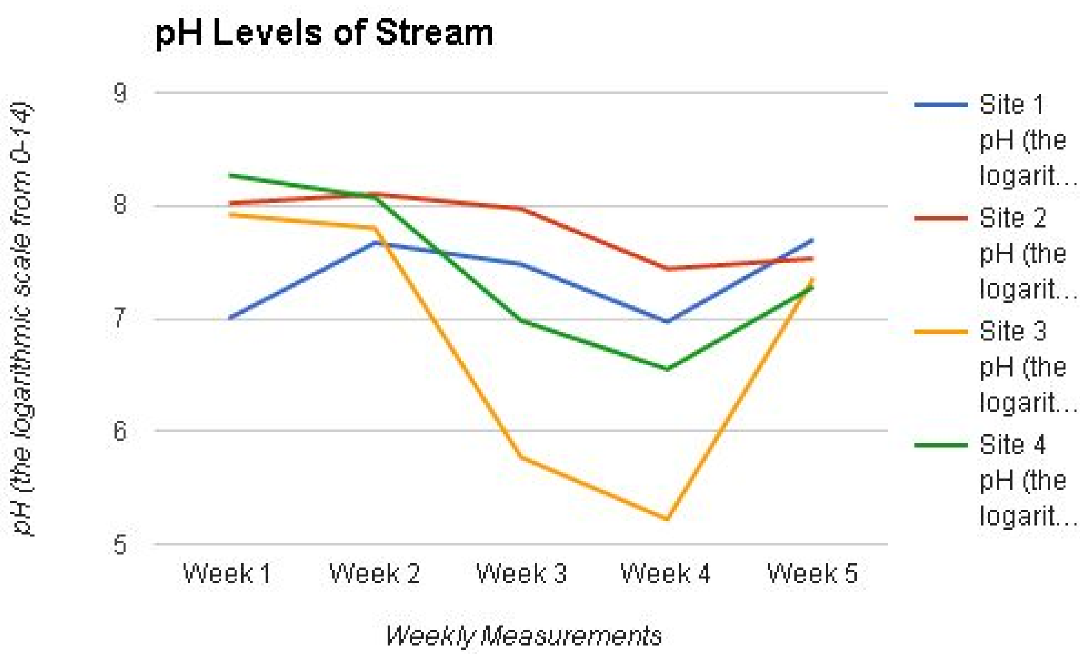

Figure 3B. pH Levels of Stream at Rock Creek Gettysburg, PA (using Vernier pH sensor)

	Site 1 Water Temp (Celsius)	Site 2 Water Temp (Celsius)	Site 3 Water Temp (Celsius)	Site 4 Water Temp (Celsius)
Week 1	21.1	21.2	20.8	20.7
Week 2	18.7	18.6	18.7	18
Week 3	16.3	17.5	17.1	16.2
Week 4	16.4	17.5	17.3	16.1
Week 5	15.8	15.7	15.6	15.5

Figure 4A. Water Temp. Levels of Stream at Rock Creek Gettysburg, PA (using Temperature probe)

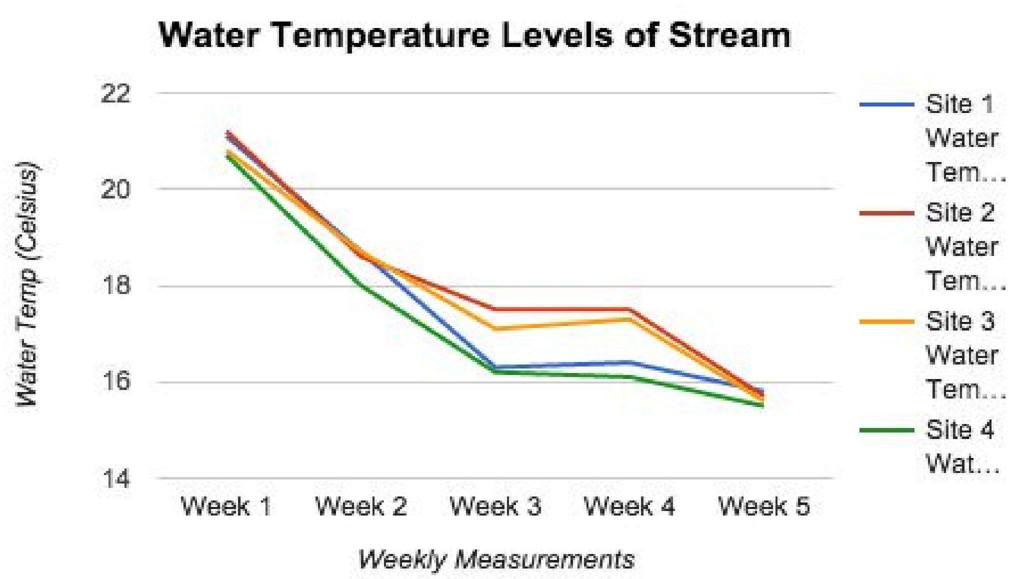

Figure 4B. Water Temp. Levels of Stream at Rock Creek Gettysburg, PA (using Temperature probe)

	Site 1 Conductivity (microsiemens/cm)	Site 2 Conductivity (microsiemens/cm)	Site 3 Conductivity (microsiemens/cm)	Site 4 Conductivity (microsiemens/cm)
Week 1	unable to test	unable to test	unable to test	unable to test
Week 2	452	522	400	387
Week 3	461	551	466	415
Week 4	472	552	462	404
Week 5	534	614	487	437

Figure 5A. Conductivity Levels of Stream at Rock Creek Gettysburg, PA (using Vernier conductivity probe)

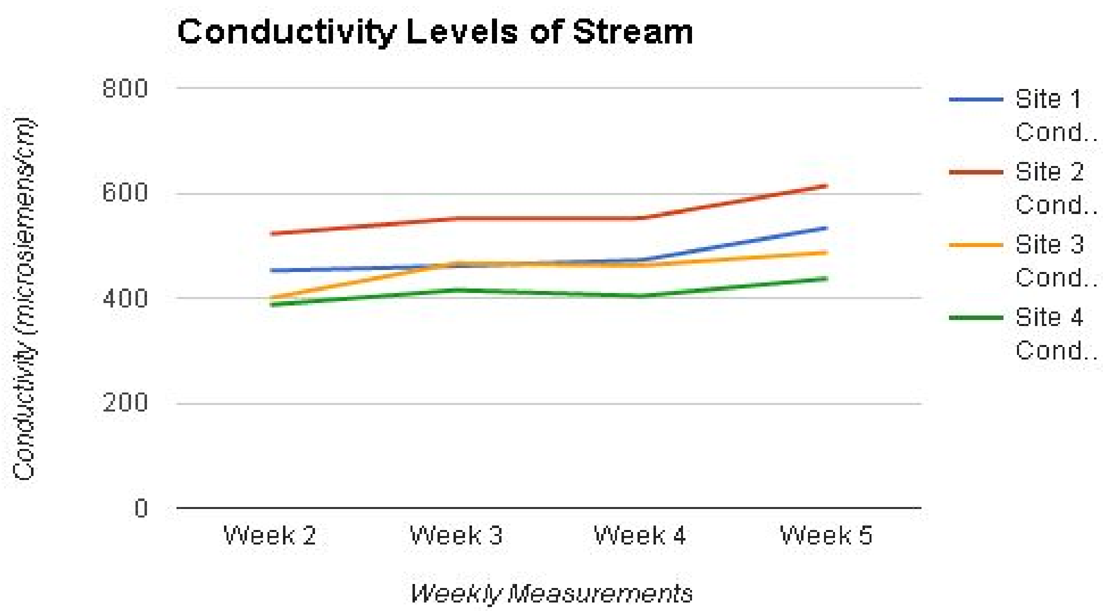

Figure 5B. Conductivity Levels of Stream at Rock Creek Gettysburg, PA (using Vernier conductivity probe)

	Site 1 Transparency (cm)	Site 2 Transparency (cm)	Site 3 Transparency (cm)	Site 4 Transparency (cm)
Week 1	unable to test	unable to test	unable to test	unable to test
Week 2	120	93.5	77.3	60
Week 3	120	91.3	78.8	59.2
Week 4	120	98	82.3	61
Week 5	120	120	85.7	81.3

Figure 6A. Transparency Levels of Stream at Rock Creek Gettysburg, PA (using Transparency tube)

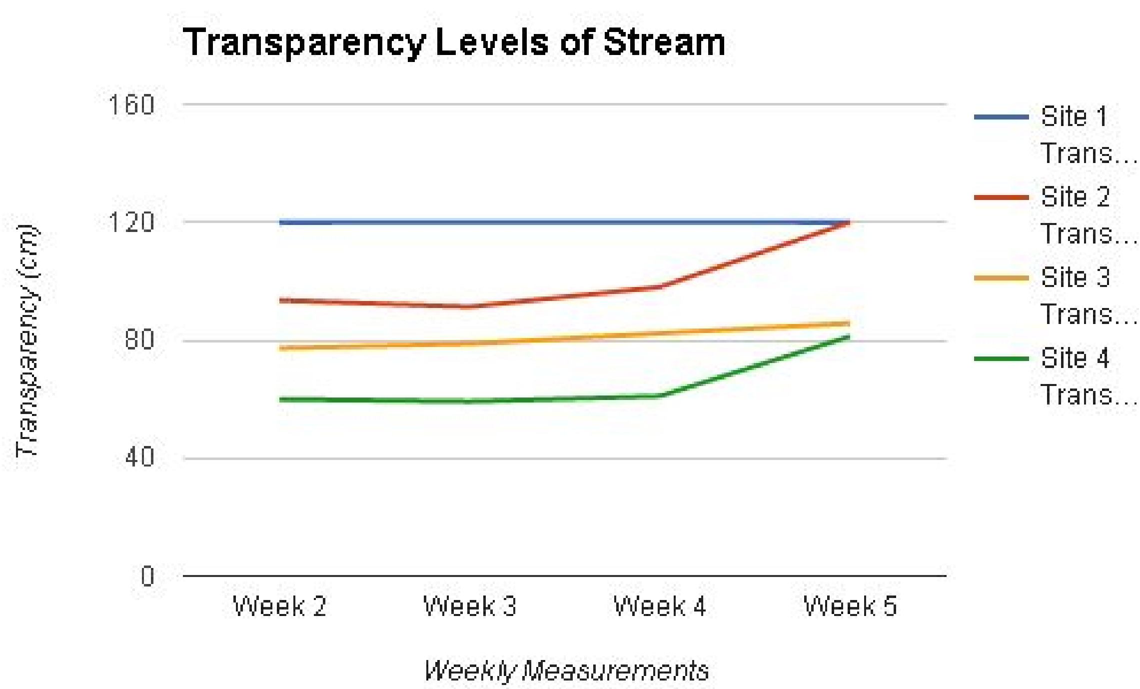

Figure 6B. Transparency Levels of Stream at Rock Creek Gettysburg, PA (using Transparency tube)

Site 1	Dissolved Oxygen (mg/L)	Water Temp (Celsius)
Week 1	9	21.1
Week 2	11	18.7
Week 3	10	16.3
Week 4	10	16.4
Week 5	11	15.8

Figure 7A. Comparison of dissolved oxygen (mg/L) and water temperature (Celsius) levels of Rock Creek Gettysburg, PA at site 1 (downstream rural)

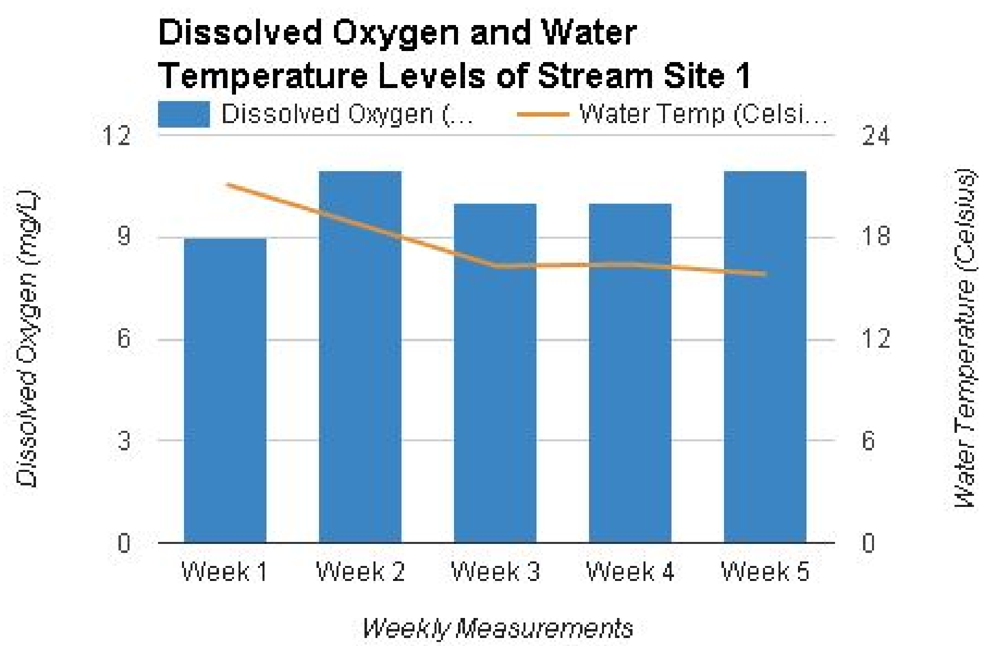

Figure 7B. Comparison of dissolved oxygen (mg/L) and water temperature (Celsius) levels of Rock Creek Gettysburg, PA at site 1 (downstream rural)

Site 1	Nitrate (mg/L)	Conductivity (microsiemens/cm)
Week 1	4.7	unable to test
Week 2	5	452
Week 3	5	461
Week 4	5	472
Week 5	5	534

Figure 8A.Comparison of nitrate (mg/L) and conductivity (microsiemens/cm) levels of Rock Creek Gettysburg, PA at site 1 (downstream rural)

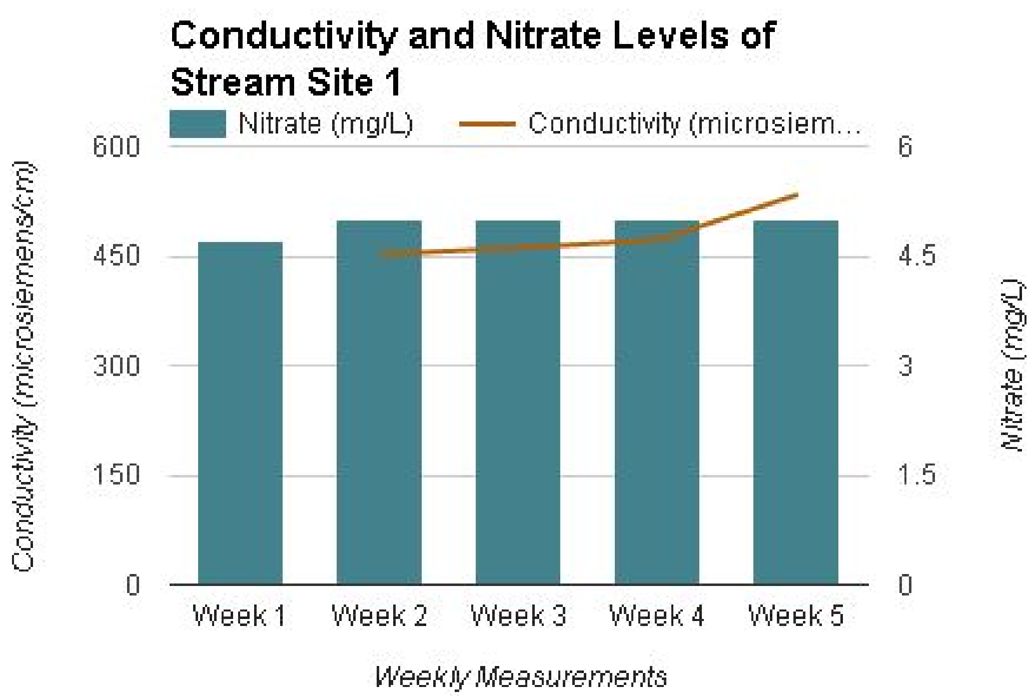

Figure 8B.Comparison of nitrate (mg/L) and conductivity (microsiemens/cm) levels of Rock Creek Gettysburg, PA at site 1 (downstream rural)

Site 1	Conductivity (microsiemens/cm)	Transparency (cm)
Week 1	unable to test	unable to test
Week 2	452	77.3
Week 3	461	78.8
Week 4	472	82.3
Week 5	534	85.7

Figure 9A.Comparison of conductivity (microsiemens/cm) and transparency (cm) levels of Rock Creek Gettysburg, PA at site 1 (downstream rural)

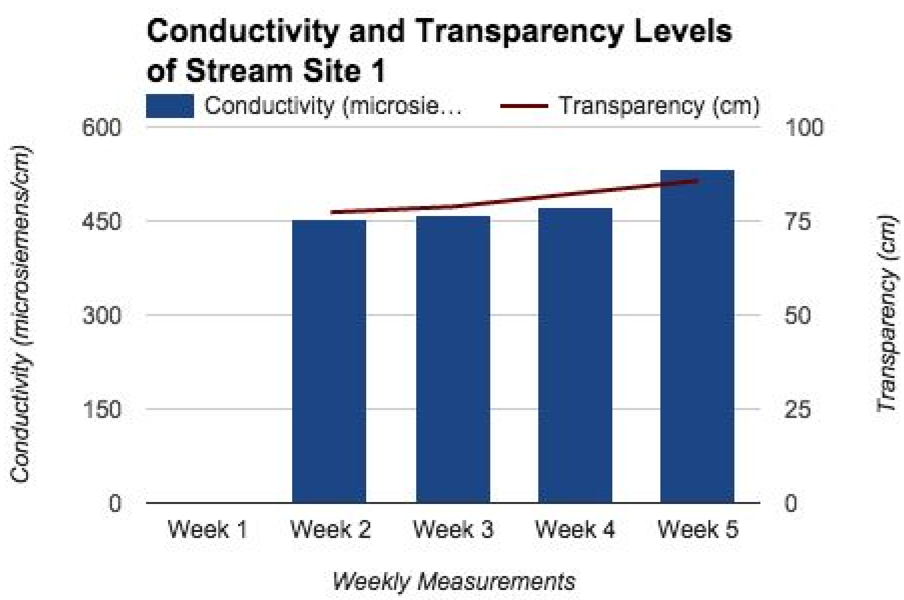

Figure 9B.Comparison of conductivity (microsiemens/cm) and transparency (cm) levels of Rock Creek Gettysburg, PA at site 1 (downstream rural)

Site 2	Dissolved Oxygen (mg/L)	Water Temp (Celsius)
Week 1	8	21.2
Week 2	11	18.6
Week 3	11	17.5
Week 4	10	17.5
Week 5	10	15.7

Figure 10A.Comparison of dissolved oxygen (mg/L) and water temperature (Celsius) levels of Rock Creek Gettysburg, PA at site 2 (downstream wastewater treatment plant)

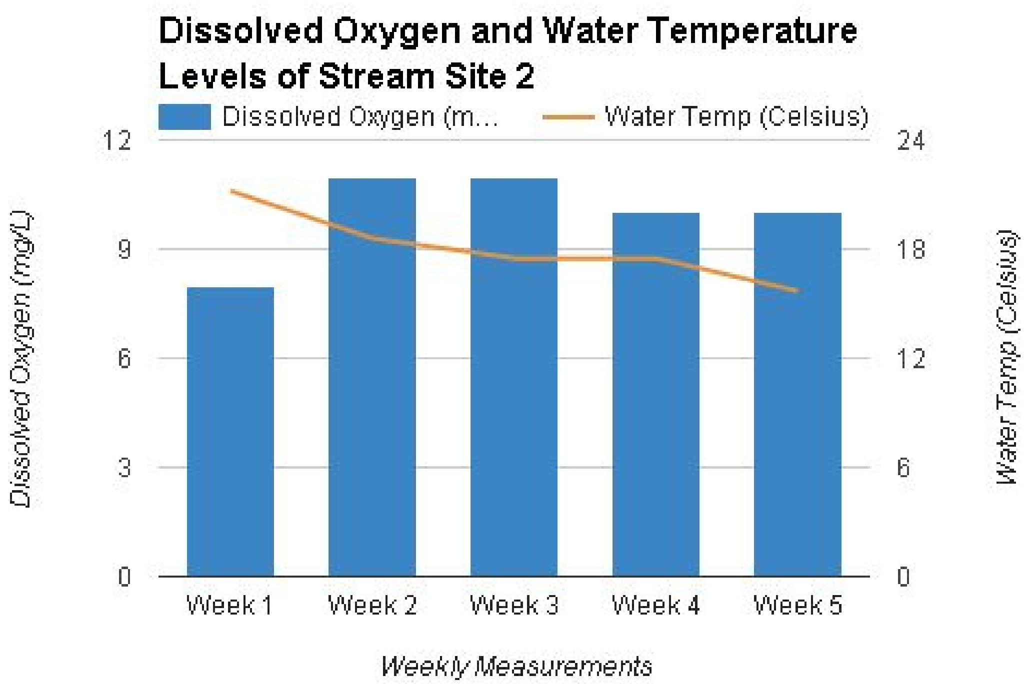

Figure 10B.Comparison of dissolved oxygen (mg/L) and water temperature (Celsius) levels of Rock Creek Gettysburg, PA at site 2 (downstream wastewater treatment plant)

Site 2	Nitrate (mg/L)	Conductivity (microsiemens/cm)
Week 1	2.2	unable to test
Week 2	5	522
Week 3	5	551
Week 4	5	552
Week 5	5	614

Figure 11A.Comparison of nitrate (mg/L) and conductivity (microsiemens/cm) levels of Rock Creek Gettysburg, PA at site 2 (downstream wastewater treatment plant)

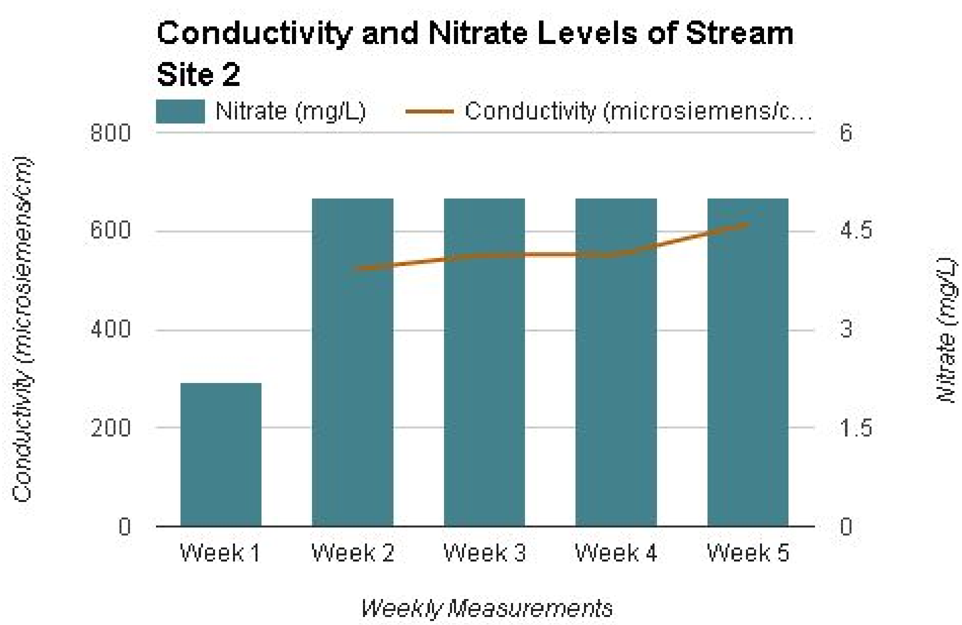

Figure 11B.Comparison of nitrate (mg/L) and conductivity (microsiemens/cm) levels of Rock Creek Gettysburg, PA at site 2 (downstream wastewater treatment plant)

Site 2	Conductivity (microsiemens/cm)	Transparency (cm)
Week 1	unable to test	unable to test
Week 2	522	93.5
Week 3	551	91.3
Week 4	552	98
Week 5	614	120

Figure 12A.Comparison of conductivity (microsiemens/cm) and transparency (cm) levels of Rock Creek Gettysburg, PA at site 2 (downstream wastewater treatment plant)

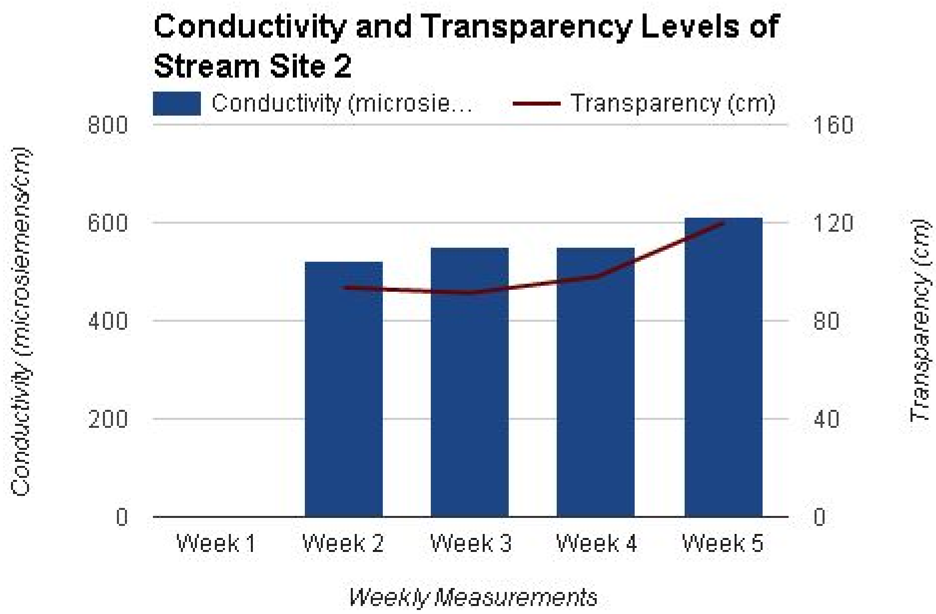

Figure 12B.Comparison of conductivity (microsiemens/cm) and transparency (cm) levels of Rock Creek Gettysburg, PA at site 2 (downstream wastewater treatment plant)

Site 3	Dissolved Oxygen (mg/L)	Water Temp (Celsius)
Week 1	5	20.8
Week 2	12	18.7
Week 3	11	17.1
Week 4	11	17.3
Week 5	10	15.6

Figure 13A.Comparison of dissolved oxygen (mg/L) and water temperature (Celsius) levels of Rock Creek Gettysburg, PA at site 3 (upstream wastewater treatment plant)

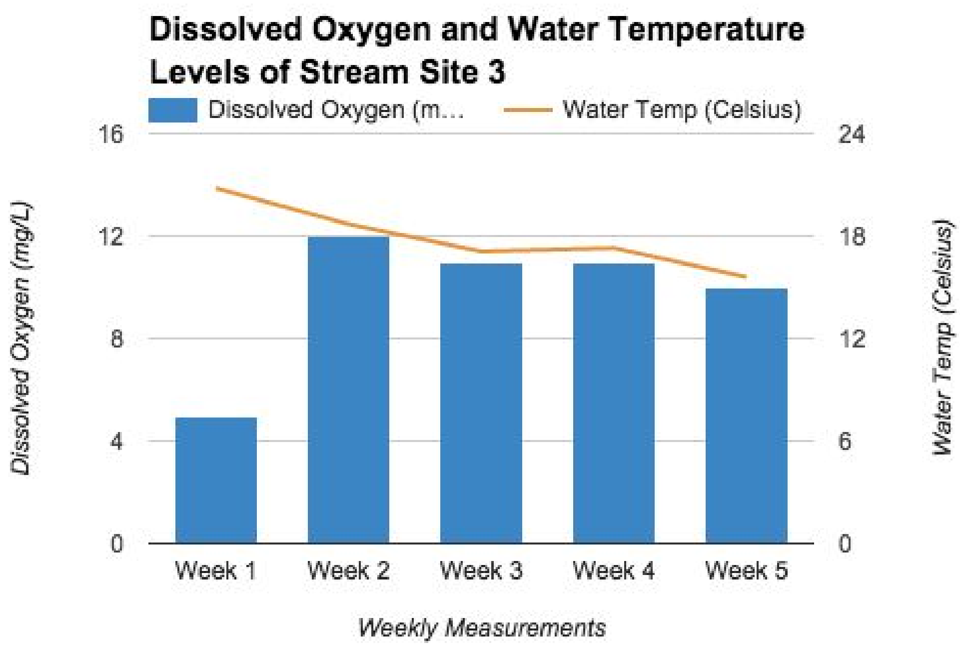

Figure 13B. Comparison of dissolved oxygen (mg/L) and water temperature (Celsius) levels of Rock Creek Gettysburg, PA at site 3 (upstream wastewater treatment plant)

Site 3	Nitrate (mg/L)	Conductivity (microsiemens/cm)
Week 1	0.7	unable to test
Week 2	5	400
Week 3	5	466
Week 4	5	462
Week 5	5	487

Figure 14A. Comparison of nitrate (mg/L) and conductivity (microsiemens/cm) levels of Rock Creek Gettysburg, PA at site 3 (upstream wastewater treatment plant)

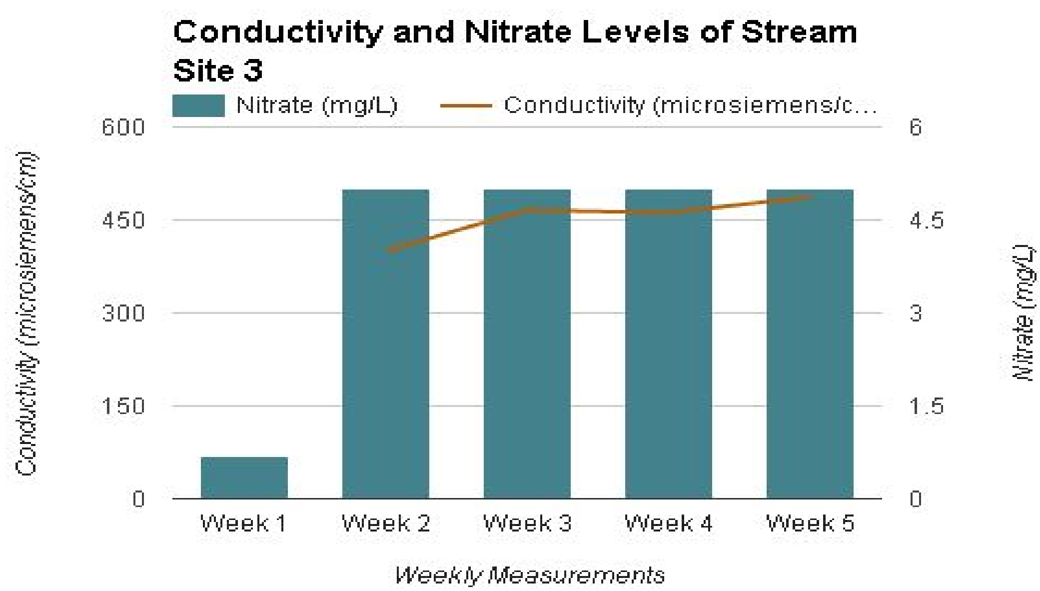

Figure 14B. Comparison of nitrate (mg/L) and conductivity (microsiemens/cm) levels of Rock Creek Gettysburg, PA at site 3 (upstream wastewater treatment plant)

Site 3	Conductivity (microsiemens/cm)	Transparency (cm)
Week 1	unable to test	unable to test
Week 2	400	77.3
Week 3	466	78.8
Week 4	462	82.3
Week 5	487	85.7

Figure 15A. Comparison of conductivity (microsiemens/cm) and transparency (cm) levels of Rock Creek Gettysburg, PA at site 3 (upstream wastewater treatment plant)

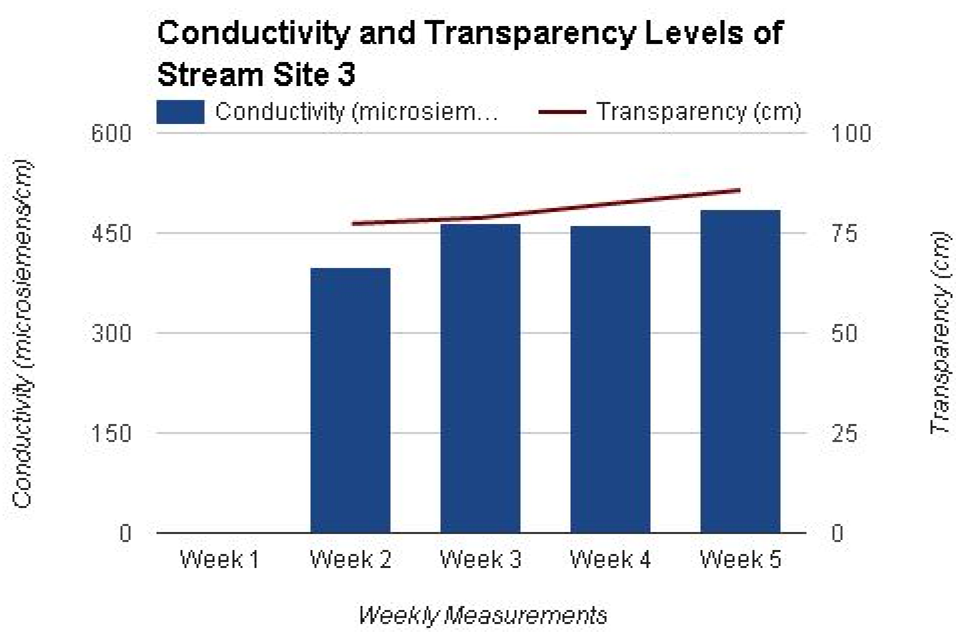

Figure 15B. Comparison of conductivity (microsiemens/cm) and transparency (cm) levels of Rock Creek Gettysburg, PA at site 3 (upstream wastewater treatment plant)

Site 4	Dissolved Oxygen (mg/L)	Water Temp (Celsius)
Week 1	7	20.7
Week 2	10	18
Week 3	9	16.2
Week 4	9	16.1
Week 5	9	15.5

Figure 16A. Comparison of dissolved oxygen (mg/L) and water temperature (Celsius) levels of Rock Creek Gettysburg, PA at site 4 (upstream rural)

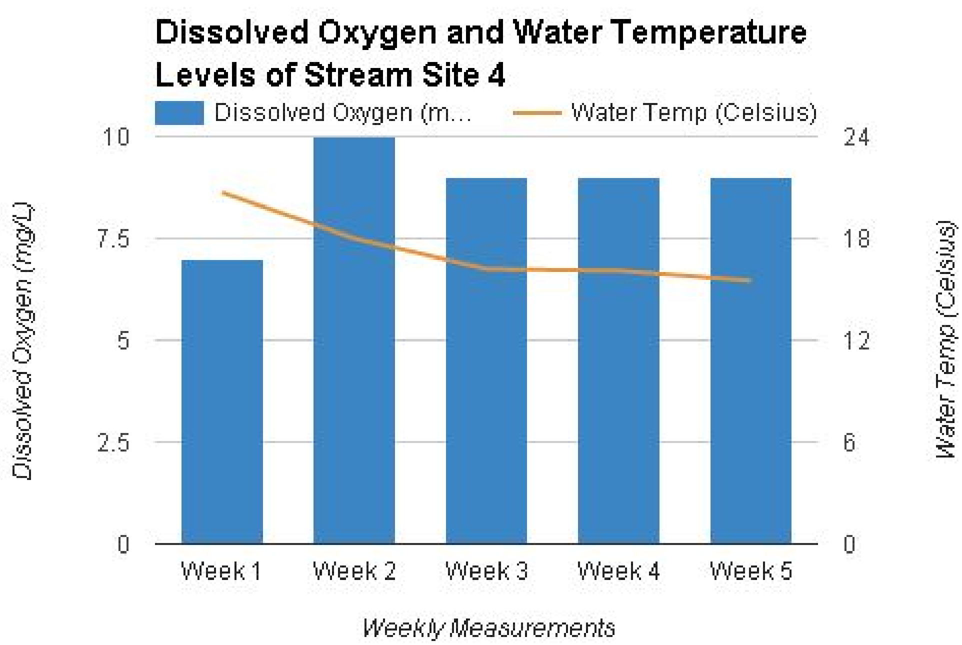

Figure 16B. Comparison of dissolved oxygen (mg/L) and water temperature (Celsius) levels of Rock Creek Gettysburg, PA at site 4 (upstream rural)

Site 4	Nitrate (mg/L)	Conductivity (microsiemens/cm)
Week 1	3.8	unable to test
Week 2	5	387
Week 3	5	415
Week 4	5	404
Week 5	5	437

Figure 17A. Comparison of nitrate (mg/L) and conductivity (microsiemens/cm) levels of Rock Creek Gettysburg, PA at site 4 (upstream rural)

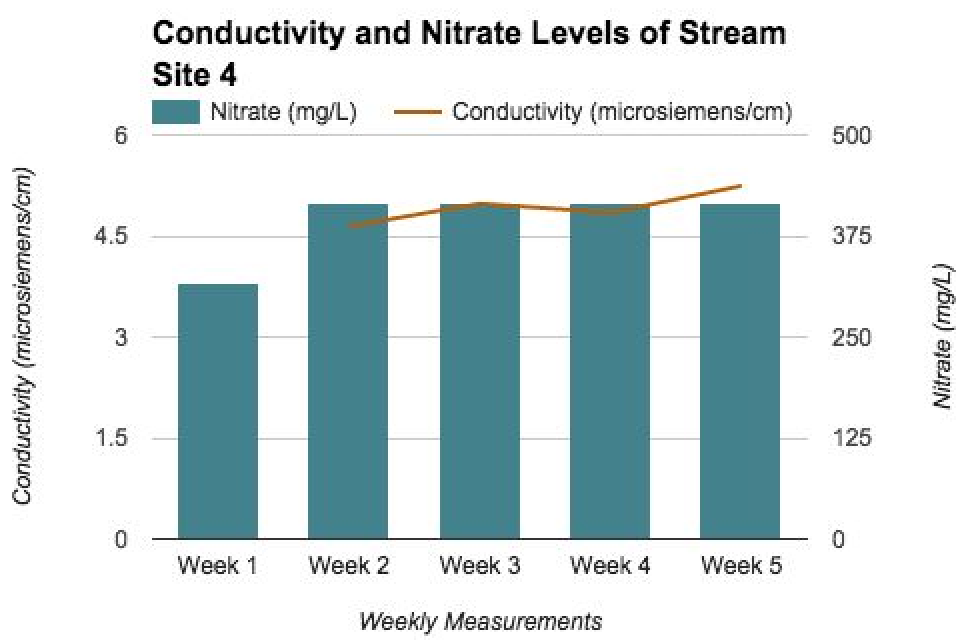

Figure 17B. Comparison of nitrate (mg/L) and conductivity (microsiemens/cm) levels of Rock Creek Gettysburg, PA at site 4 (upstream rural)

Site 4	Conductivity (microsiemens/cm)	Transparency (cm)
Week 1	unable to test	unable to test
Week 2	387	60
Week 3	415	59.2
Week 4	404	61
Week 5	437	81.3

Figure 18A. Comparison of conductivity (microsiemens/cm) and transparency (cm) levels of Rock Creek Gettysburg, PA at site 4 (upstream rural)

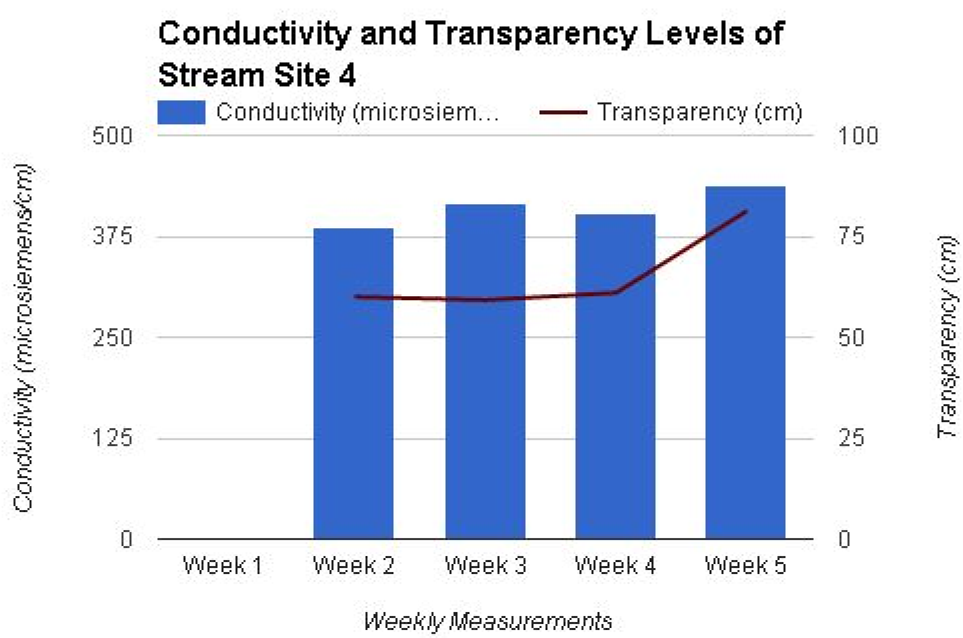

Figure 18B. Comparison of conductivity (microsiemens/cm) and transparency (cm) levels of Rock Creek Gettysburg, PA at site 4 (upstream rural)

Conclusion

This experiment focuses on determining the effect of land use on water quality. The results of the experiment support the hypothesis that states if the testing site of the stream is changed from rural upstream, upstream of the wastewater treatment plant, downstream of the wastewater treatment plant, and downstream rural that has passed through the town, then the chemical parameters that indicate stream health: dissolved oxygen, nitrate, pH, water temperature, conductivity and water transparency, would be in the healthiest range upstream rural because as the water is moving downstream into the city, the stream may pick up more waste and pollutants from the land use and other merging streams as it travels through the town. The dissolved oxygen for site 1 had the highest levels of 9, 11, 10, 10, and 11 mg/L and close behind was site 2 with levels of 8, 12, 11, 11, and 10 mg/L. Site 4 ended up having the lowest levels of 7, 10, 9, 9, and 9 mg/L, but all are still tolerable for most aquatic life. The nitrate for site 1 had the highest levels of 4.7, 5, 5, 5, and 5 mg/L followed by site 4 with levels of 3.8, 5, 5, 5, and 5 mg/L, which are higher than average, but still within parameters. Site 3 had the lowest levels of nitrate of 0.7, 5, 5, 5, and 5 mg/L which is very good. Site 1 had the most neutral pH levels of 7.00, 7.67 , 7.48, 6.97, and 7.70 and site 4's levels of 8.27, 8.07, 6.89, 6.55, and 7.28 were very close to neutral. There were outliers for site 3, week 3 and week 4, which had more acidic levels. This outlier was most likely caused by a change in dissolved oxygen levels. The water temperature levels all consistently dropped while the outside temperature dropped. The conductivity for site 2 was the highest with levels of 452, 461, 472, and 534 microsiemens/cm, but all other sites had relatively close levels as well. Site 1 had the highest transparency levels of 120 cm throughout the whole testing period and site 4 had lowest levels of 60, 59.2, 61, ands 81.3 cm. However, levels at all sites showed high transparency.

The dissolved oxygen and temperature graphs, as shown in Figures 7 A&B, 10 A&B, 13 A&B and 16 A&B , show that for the most part, as the temperature dropped, the dissolved oxygen went up. There was an outlier in site 2, where the dissolved oxygen levels were very high. This outlier could have been caused by an increase in nitrates in the water for that site. The nitrate and conductivity graphs show in Figures 8 A&B, 11 A&B, 14 A&B, and 17A&B that when the nitrate levels were at 5, generally the conductivity levels were in the 400's. There was a slight outlier at site 2 where the levels were a bit higher than the overage. The conductivity and transparency graphs showed, in Figures 9 A&B, 12 A&B, 15 A&B, and 18 A&B, that the higher the conductivity levels, the higher the transparency levels.

Four stream sites were tested over a period of 5 weeks for dissolved oxygen, pH, nitrates, water temperature, conductivity and transparency. Results were analyzed and compared to land use data using FieldScope 5.0. The streams tested were rural upstream, upstream wastewater treatment plant, downstream wastewater treatment plant and rural upstream. As the water is moving downstream into the city, the stream may pick up more wastes and pollutants from the land use and other merging streams as it travels through town.The land around site 1 is mainly deciduous forest, low intensity developed and woody wetlands. The population density around site 1 is 0-400. The land around site 2 is low intensity developed and cultivated cropland. The population density around site 2 is 0-400. The land around site 3 is deciduous forest, low intensity developed and grassland. The population density around site 3 is 0-400. The land around site 4 is deciduous forest and low intensity developed. The population density around site 4 is 0-400.

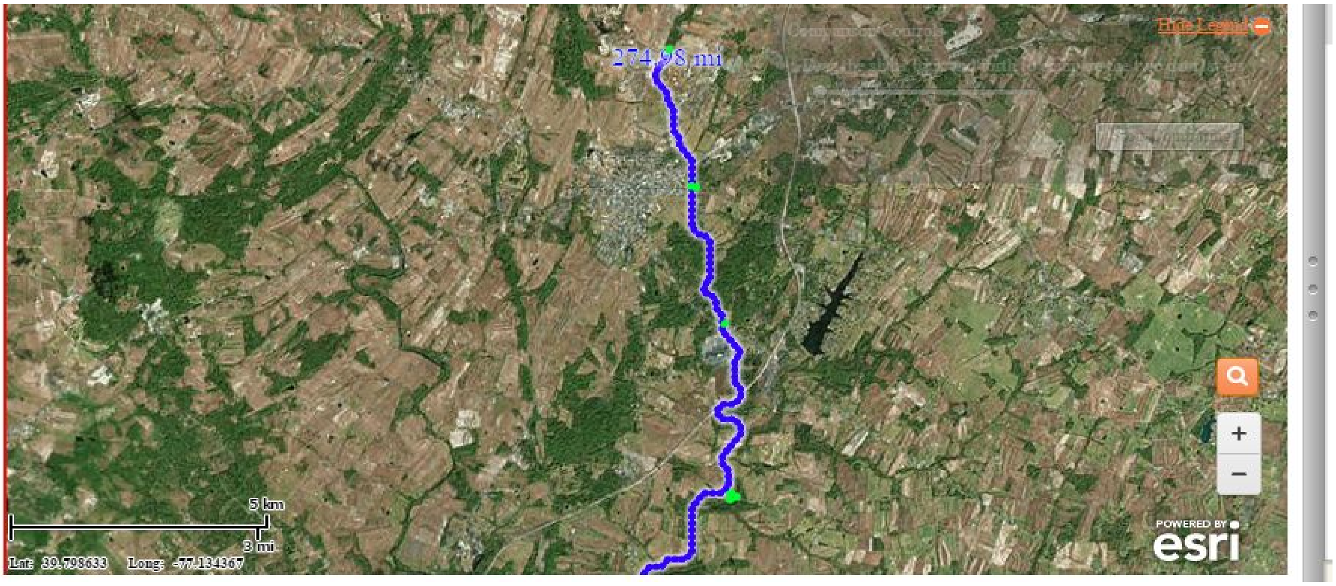

Figure 19. Overhead view of the testing sites along Rock Creek using FieldScope 5.0

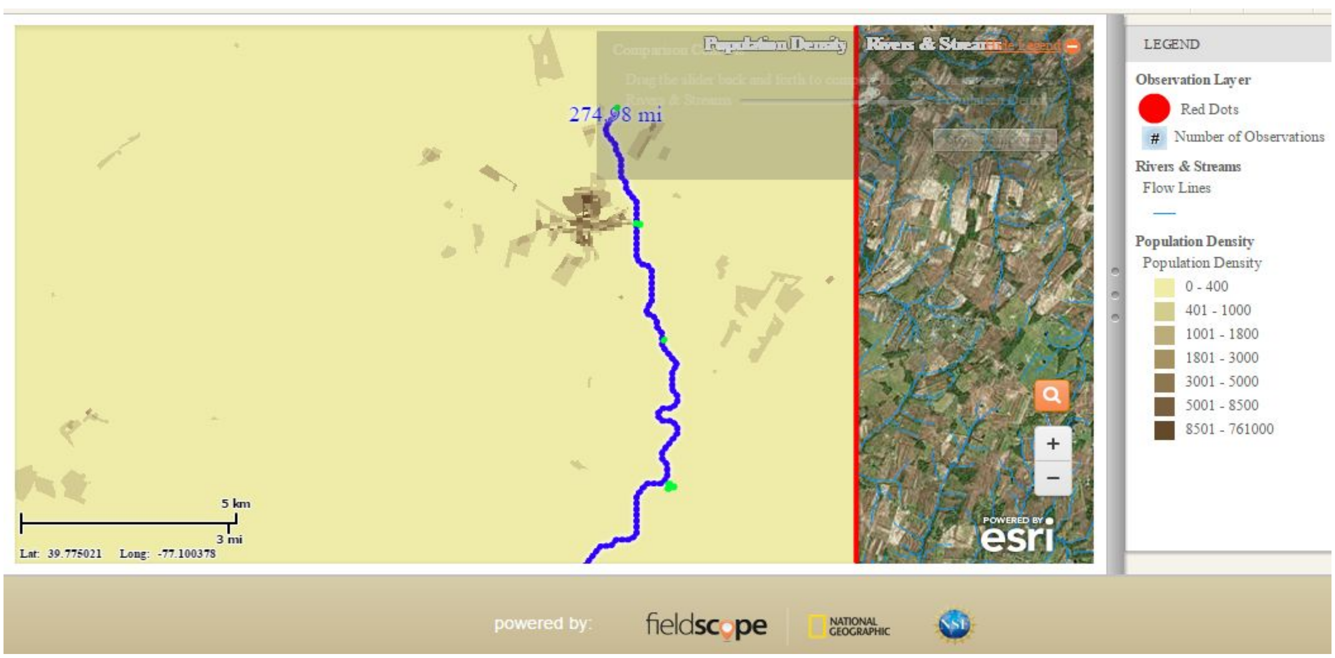

Figure 20. Overhead view of the population density of Rock Creek using FieldScope 5.0

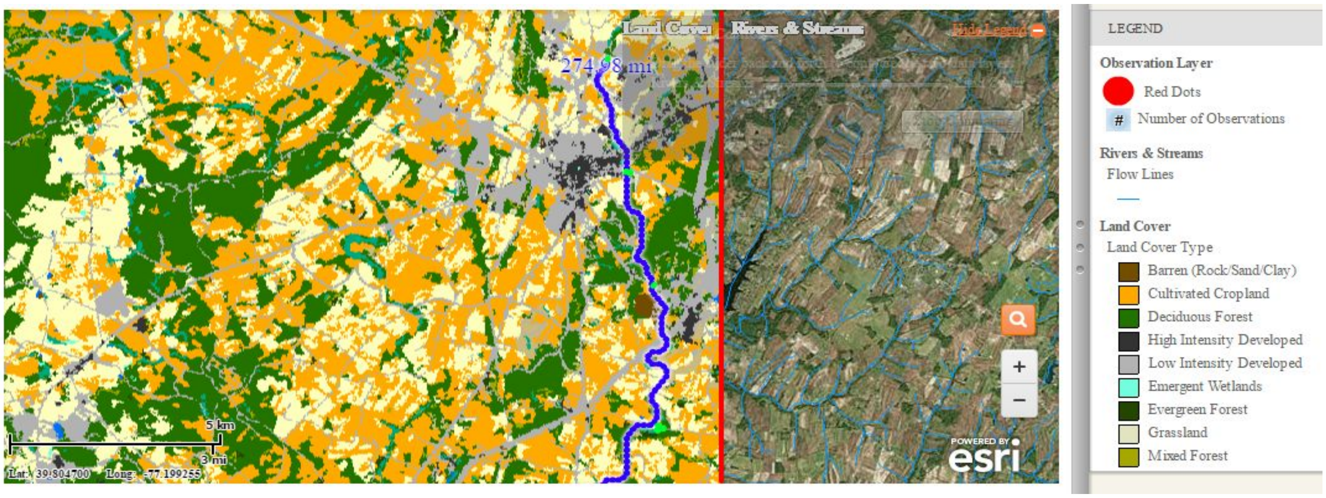

Figure 21. Overhead view of the land use of Rock Creek using FieldScope 5.0

A future experiment would be extending the testing process and seeing if the results keep the same consistency over a longer period of time and through the changes in season specifically involving weather events such as snow and other changes in farming practices over the seasons. If this experiment were to be repeated, the test would be done consistently two times a week for a month to see the changes throughout the month. Rainfall events would also be monitored and analyzed to determine if there is a correlation with changes in pH, conductivity, and transparency. The wastewater treatment plant would be interviewed and a request for discharge and quality data would be made. Blasting times and location from the nearby quarry would be requested, documented and analyzed for correlation to trends or outliers in stream quality measurements. Statistical analysis such as a T test would also be performed to look at outliers and accuracy. Further experiments may test the effect of other water quality parameters and macro invertebrates to set a long term picture of the health of the creek. Alkalinity would be tested to evaluate pH and streambed geologic makeup. A map of the rocks and minerals of the Rock Creek stream bed and watershed would be analyzed to better understand data trends. Other creeks in the area would be monitored as well to compare the health of all creeks in Adams

County.

Stream health is important in Adams County because streams are living systems, and have the ability to clean themselves, but if they get damaged too much, they may not be able to recover. They are home to many aquatic animals as well as a source of water for many land animals and even humans. If the streams are polluted, then many organisms will be negatively affected throughout the entire Chesapeake Bay watershed, causing disruptions within the ecosystems and the economy. Continued monitoring is important in case industry, farming, and individual practices need to be adjusted to help minimize pollution and maintain healthy ecosystems.

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