Rice Creek (Spring Brook) Water Quality Assessment Project Report August 2008

Cannon River Watershed Partnership
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Northfield, MN 55057

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Project Summary

“It’s the connection between the land and the water.”
Jay Michels

Rice Creek, known locally and hereafter in this report as Spring Brook, is a designated trout stream that drains a small watershed (4130 acres) in north-central Rice County. A map of the watershed is shown in Figure 1. It is the only coldwater fishery in the county and one of few in the Cannon River watershed. In the past, the Minnesota Department of Natural Resources (DNR) used stock from Spring Brook in its hatchery and stocking efforts around the state. The watershed is in the urban expansion areas of the cities of Northfield and Dundas and is located within Bridgewater Township. Agriculture is the predominant land use in the watershed; however, it is likely that suburban development will occur in the next decade. Figure 2 shows the land use in the watershed and Figure 3 shows the urban expansion boundaries of Northfield and Dundas. At present, much of the watershed is planted in corn and soybean row crops with two beef cattle feedlots/grazing operations located between Decker Avenue and Armstrong Road. The upper portion of the watershed is County Ditch 22. The trout stream portion of the watershed begins at Cates Avenue and continues downstream to the mouth at the Cannon River.

Figure 1 – Spring Brook Watershed
Figure 2 – Land use in the Spring Brook Watershed

Figure 3 – Urban Expansion Zones of Northfield and Dundas
Cannon River Watershed Partnership (CRWP) began work to foresee protection for Spring Brook in 1997 with assistance from the Legislative Commission on Minnesota Resources. A “Spring Brook Committee” of citizens, elected officials, and public and private agency personnel was formed and produced a preliminary report on the health of the stream and its watershed. Recommendations of that report included further water quality data collection. The problem addressed by this project was to help fill the gap of water quality and quantity data by performing some basic monitoring at two sites in the watershed: Armstrong Rd (Dundas Blvd) and Cates Avenue.

Grant funds for this project were available from July 1, 2006 through June 30, 2008. In order to complete two full seasons of monitoring, CRWP plans to continue to collect data, using other funding, through October 2008. We will only be reporting data through early June 2008 in this report.

Sample sites for the project included Armstrong Rd (Dundas Blvd), site number S001-445, and Cates Avenue, site number S001-446. A map of the sites is shown in Figure 4 and photos of the sites in Figures 5 and 6. The site numbers correspond to the STORET identification numbers used by the Minnesota Pollution Control Agency (MPCA) and the US Environmental Protection Agency for surface water sampling sites. Water samples were analyzed for total suspended solids (TSS), total phosphorus (TP). E. coli samples were collected as part of a separate CRWP project. Carleton College conducted a Nitrate-N monitoring project in 2006. Field measurements for transparency were collected by volunteer citizen monitors at Decker Avenue (located between Cates and Armstrong) and Armstrong Road. CRWP staff collected transparency data at Cates and Armstrong sites in 2007 and 2008. Continuous monitoring equipment was used to measure level, flow, and temperature in 2007 and level and temperature in 2008. A wading rod was used to measure flow in June 2008.

CRWP has been working on a River Friendly Farmer Project with funds from the Bush Foundation. Part of this project involves working with landowners and operators to review their existing farming practices and consider changes that could be made that would improve water quality. Data has been collected about land use, cropping, and other parameters that will be beneficial to understanding the inputs to Spring Brook.

The staff at CRWP hopes that the information collected during this project will be useful to all our partners as we work toward protecting and improving the water quality and habitat of the Spring Brook watershed. All appropriate stream sample data has been submitted to the MPCA STORET database. Continuous temperature data is provided on the CD that accompanies this report and will be available to DNR in electronic format in the future if requested.

**Figure 4 – CRWP and Citizen Volunteer Water Quality Monitoring Sites**
Figure 5 – Armstrong Rd Sample Site (S001-445) – April 2008

Figure 6 – Cates Avenue Sample Site (S001-446) – April 2008
What makes a “Healthy” Trout Stream?

In order for trout populations to thrive the conditions in the stream must meet certain criteria.


Table 1 – Characteristics of a Healthy Trout Steam (Trout Unlimited)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat Diversity</td>
<td>Roughly equal numbers of pools, riffles and runs should be present. Complex braided channels are preferred over simple, straight streams.</td>
</tr>
<tr>
<td>Large wood</td>
<td>Downed trees and other large woody debris functions to create pools, store sediments, and act as a source of needed organic matter.</td>
</tr>
<tr>
<td>Water quality</td>
<td>Cool, pollutant–free water is critical to spawning juvenile rearing and adult resting habitat for many fish species. Generally, $&lt; 16$ °C (60.8 °F) is needed for spawning, and $&lt; 18$ °C (64.4 °F) for rearing.</td>
</tr>
<tr>
<td>Flow regime</td>
<td>The hydrograph is similar in intensity and flow amounts to historical conditions. Minimum flows are important but high flows may be required at certain times to dig pools and move sediment.</td>
</tr>
<tr>
<td>Riparian vegetation</td>
<td>Adequate riparian vegetation is needed to shade streams, protect banks from severe erosion, and provide nutrients.</td>
</tr>
<tr>
<td>Deep pools</td>
<td>Sufficient deep pools are necessary as thermal refuges and holding habitat for many fish species.</td>
</tr>
<tr>
<td>Width to depth ratio</td>
<td>Generally, deeper and narrower streams provide better habitat than shallower, wider streams.</td>
</tr>
<tr>
<td>Bank stability</td>
<td>Banks should be 80-90% stable. Some erosion is needed, but too much is detrimental.</td>
</tr>
<tr>
<td>Fine sediments</td>
<td>Stream substrates should not exceed 20% fine materials (clay, silt and sand) in riffles. Most streams suffer from high loads of sediment.</td>
</tr>
</tbody>
</table>

The scope of this project was to gather data for temperature, flow and water level changes, and some water chemistry parameters. Physical characteristics of the stream such as erosion, vegetation, and bank stability were beyond the scope of this project. In depth analysis of data was also beyond the scope of this project, however some commentaries are made when possible.

Several walking surveys were conducted on parts of the stream between Cates Ave and Armstrong Rd in 2007 and 2008. We noted the presence of deep pools, sharp turns, and sinuosity in the channel, lots of downed trees and overhanging vegetation that would provide good trout habitat and help keep the water cool. Figure 7 shows some of the downed trees with a turtle sunning itself on a rock. We also noted undercut banks, erosion, agricultural drainage tile, and the presence of cows grazing next to the stream on many occasions (Figure 8). These conditions are not conducive to good trout habitat.
Figure 7 – Downed trees over stream - May 2008

Figure 8 – Cows grazing next to Spring Brook
Water Level and Flow Data

Background
As stable flows are important to a healthy trout stream, we endeavored to collect continuous level and flow data on Spring Brook. By having this level and flow data, we hoped to be able to develop a rating curve that could be used to estimate flows in the future based off water level measurements.

Methods
Continuous water level was measured at the Cates and Armstrong sites using a Druck PDCR 1830 depth/level pressure transducers and Campbell Scientific CR510 dataloggers. The program for recording data was provided to CRWP by the MPCA. The pressure transducer was placed between the downstream side of the road culvert and railroad bridge at Armstrong Rd, and downstream of the three road culverts at Cates Ave. Water level was recorded every fifteen minutes. The monitoring period in 2007 was from April 30 to October 15. Due to dry conditions, the Cates site did not have flow from late July thru mid-August.

Tape-down measurements were taken, when samples were collected, at both sites to determine stage and verify that the pressure transducer readings were on target. A reference point of 20.0 was assigned to the Armstrong site. The tape down measurement was recorded from the top of the wooden rail of the bike bridge from the center of the bridge at a marked spot. A reference point of 5.0 was assigned to the Cates site. The tape down measurement was recorded from the downstream side of the center culvert at a marked spot at the top center of the culvert.

Continuous flow was measured at the Armstrong Rd site using an ISCO 4150 AV flowlogger in 2007. The sensor was placed in the road culvert on the east side. The culvert is a circular, corrugated metal culvert pipe with a diameter of 9.5 feet. The water level, volume and flow were recorded every two minutes. No flow monitoring was conducted at the Cates Avenue site in 2007. The level and flow data from these devices were used to develop a rating curve to estimate flow at various stages.

Due to the short time of the grant project in 2008 (ending June 30, 2008) a Pygmy meter on a wading rod and an Aqua Calc were used to measure flow at both sites under various flow conditions.

Results
The flow in Spring Brook was extremely low in late July of 2007 and had dried up between Cates Ave and Decker Ave due to very little rainfall. Walking this stretch, CRWP was able to determine where the springs were contributing to the base flow conditions present at Decker Avenue. There was water flowing at Lat 44°26.861'/Lon -93°13.148’ but was only puddles at Lat 44°26.882'/Lon -93°13.220’ and beyond upstream. The springs are located in the western portion of the stream where there is a trout fishing easement. A flood in August of 2007 produced very high water levels.

A complete set of all the level and flow data collected is provided in electronic format in Appendix C of the CD provided with this report. Analysis of flow and level data for 2007 was primarily completed by Natural Resources Information Providers.

An important aspect to consider when using data is the quality of the data. If the data quality is not good, then the data should not be used. This appears to be the case with the water level data collected at Armstrong Road with the pressure transducer. Beginning on 6/12/07, the stage record recorded by the Druck pressure transducer (Figure 9) at the Armstrong site appears to become invalid. This date (6/12) was also first time that offset was changed in the field (and thus abrupt drop in stage is accounted for). After initial offset change, stage was basically a flat line - changing only at points of subsequent offset changes (7/3, 7/17, 8/21, 9/4, 9/18). This suggests that an inadvertent programming change or a transducer malfunction fouled operation. The value of this stage record is minimal.

The Druck pressure transducer at the Cates Ave site tracked well throughout the 2007 field season (Figure 10), according to the recorded stage data and the field notes. It exhibited some drift during low flow, but was very close to measured stages at medium and high flows. There were no discharge measurements made at this site in 2007.
Figure 9 – Stage record from Druck pressure transducer at Armstrong Road - 2007

Spring Brook at Armstrong Road
Mean Daily Stage (series 200 values from logger)
Day 114 to 287

Figure 10 – Cates Avenue water level data 2007
The ISCO device in the culvert at Armstrong Road tracked fairly well for much of the 2007 season. The velocity record (Figure 11) took on a new pattern on 5/29/07; the daily range of values increased. It is not clear why this occurred. However, a field visit was recorded on 5/29/07. CRWP staff confirmed that an attempt to reprogram the logger was made on that day. The generally receding velocity record corresponds to the generally receding stage record of early summer. The velocity values at first glance seem to be very high (7-8 ft/sec), but considering the speed at which water enters the culvert, the values are in the range of possibility. CRWP staff verified (in June 2008) by way of a site visit that these velocities seem reasonable. The stage record (Figure 12) is somewhat fragmented but seems to have captured the overall seasonal variation.

![Figure 11 – Water velocity data at Armstrong Road measured with ISCO device - 2007](image)

The tape-down values do not exhibit the same numerical changes recorded by the ISCO, but the regression of tape-down values and ISCO stage is fair (Figure 13). The tape-down reference point was at the bottom of the culvert slope (adjacent to the plunge pool), and the ISCO AV sensor was at the top of the culvert (the culvert is sloped); it follows then that a given change in surface water elevation at the RP may not necessarily correspond to precisely the same change in surface water elevation over the AV sensor. The reference point at the bottom of the culvert was chosen to track the Druck pressure transducer, which was mounted in the plunge pool. It should not be used then to correct the level data recorded by this ISCO; however, that there is a fair correlation between the tape-down values and ISCO stage lends some credibility to the ISCO data.

Figure 14 provides a summary of the 2007 flow (cfs) at Armstrong Road. At the peak flow during the August 2007 flood, the maximum water level recorded at the head of the culvert was approximately two feet; the maximum velocity reached 10 feet per second; the maximum computed flow was approximately 110 cfs.
Figure 12 – Stage (water level) data at Armstrong Road measured with ISCO device - 2007

Spring Brook at Armstrong Road
Level Data
4/30/07 to 9/20/07 (half hour intervals extracted)

Figure 13 – Relationship between ISCO stage and Tape-Down measurements at Armstrong Rd - 2007

Spring Brook at Armstrong Road Level Data
Tape-Down vs ISCO Stage

y = 1.4756x - 8.3415
R^2 = 0.6833
The relationship between stage and discharge, as recorded by the ISCO device, appears to be sound. Over the range of values recorded, the relationship is approximately linear. A rough approximation of flow through the culvert at Armstrong Road could be achieved with the following equation: \( \text{Flow (cfs)} = 50 \times \text{water level (feet)} - 10 \). Figure 15 provides a rating curve using a linear regression. Using the ISCO AV sensor has provided a continuous record of velocities and discharges at the mouth of the stream over a good range of stage values.
Due to the flashiness of this stream, it may be difficult to record discharge measurements with a standard flow meter. Since the 2008 portion of this project was limited we decided to try using the wading rod rather than installing the ISCO sensor. Table 2 displays the results from that effort.

<table>
<thead>
<tr>
<th>Date</th>
<th>Flow (cfs)</th>
<th>Stage (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 5, 2008 (Armstrong)</td>
<td>10.65</td>
<td>6.10</td>
</tr>
<tr>
<td>June 11, 2008 (Armstrong)</td>
<td>7.63</td>
<td>6.36</td>
</tr>
<tr>
<td>June 18, 2008 (Armstrong)</td>
<td>8.45</td>
<td>6.28</td>
</tr>
<tr>
<td>June 27, 2008 (Cates)</td>
<td>1.24</td>
<td>1.76</td>
</tr>
</tbody>
</table>

**Water Chemistry Data**

**Background**

Spring Brook was added to the State of Minnesota 303(d) Impaired Waters list in 2006 for a turbidity impairment affecting aquatic life. Sediment and high turbidity affect the biological communities of streams in a variety of ways such as:

1. Increased turbidity reduces the ability of organisms to visually locate food. This is important for predatory fish.
2. Loss of spawning habitat, especially in trout waters, as they require gravel substrate which is easily covered by sediment.
3. Sedimentation affects the distribution of fish/macroinvertebrate species because each species possesses different levels of tolerance. This results in an unbalanced biological community.
4. Sedimentation leads to less riffle, pool, run habitat types, which support the greatest species diversity. (Allan, 1995).

Nutrients, such as nitrogen and phosphorus, should not typically affect trout directly, with the exception that high ammonia levels could be toxic to fish (Mike Swift, personal communication July 23, 2008). However, excess nutrients can lead to algae blooms and reduced dissolved oxygen levels. In a shallow, low order stream, nutrients will influence growth of periphyton (algae that attach to substrates). Excessive periphyton can affect spawning habitat and may have an overall impact on the food chain in the stream (Steve Heiskary, personal communication, July 23, 2008). The presence of E. coli indicates that animal and/or human wastes, that contain nutrients, are getting into the stream.

**Methods**

Water samples were collected by CRWP on a weekly basis and after rainfall events when possible from April – October 2007 and April – early June 2008. In 2007 samples were analyzed for total suspended solids (TSS) and total phosphorus (TP) as well as E. coli bacteria. The E. coli samples were part of a separate grant that CRWP received from the MPCA, but as the data is relevant to this project it is being reported here as well. Samples were analyzed by state certified laboratories MVTL Labs in New Ulm, Minnesota and RMB Environmental Labs in Detroit Lakes, Minnesota.

CRWP measured transparency using a transparency tube at both sites in 2007 and 2008. In 2007 a 60 cm transparency tube was used and in 2008 a 100 cm transparency tube was used, thus the differences that can be seen in the results. A volunteer citizen monitor collected this data at the Armstrong Rd site in 2006. Transparency data was collected by a CRWP citizen volunteer monitor at the Decker Avenue site in 2006, 2007 and 2008 as well as for years prior to the start of this project.
The Carleton College Geology Department conducted a study in the summer of 2006 looking at Nitrate-N values in Spring Brook, an agricultural drain tile discharging to Spring Brook at Cates Avenue, and ultimately into the Cannon and Mississippi Rivers. Sites were sampled weekly or bi-weekly from June through August. Nitrate-N was measured in the field using a Nitrate Ion Specific Electrode Sensor.

The Minnesota Department of Agriculture, under the direction of Mark Dittrich, is conducting a project to evaluate the used of wood chips in removing nitrates from agricultural drainage tile water. The project is taking place on the Schroeder farm in the Spring Brook watershed. The tile line discharges to the County Ditch 22 portion of Spring Brook. CRWP has provided financial support to this project. The MDA has been monitoring the water quality in the tile line and in the ditch upstream and downstream of the tile line. As of the writing of this report, data was not yet available from the MDA but they will provide results to CRWP upon completion of their project.

Results

A summary of the sample results are provided in tables 3 – 5 below. Graphs illustrating this data and the full data set are provided in Appendix A. Site S001-445 is Armstrong Rd, Site S001-446 is Cates Avenue, and Site S001-444 is Decker Avenue. All water sample data collected by CRWP for 2007 has been submitted to the MPCA STORET database. Data for 2008 will be submitted in November 2008. A summary of the data from the Carleton project is presented in Table 6 and a map of the sites is in Figure 16 below. A copy of the complete report is included as Appendix D.

Table 3 – Spring Brook Water Chemistry Data Summary – Armstrong Rd and Cates Ave Sites - 2007

<table>
<thead>
<tr>
<th>2007 Sample Summary</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Median</th>
<th>Average</th>
<th>Range</th>
<th># of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>S001-445</td>
<td>6.5</td>
<td>8.7</td>
<td>&gt;60</td>
<td>&gt;60</td>
<td>51</td>
<td>52.3</td>
</tr>
<tr>
<td>S001-446</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>54.5</td>
<td>43.6</td>
</tr>
<tr>
<td>Transparency (cm)</td>
<td>6.5</td>
<td>8.7</td>
<td>&gt;60</td>
<td>&gt;60</td>
<td>51</td>
<td>52.3</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>123</td>
<td>40</td>
<td>13.15</td>
<td>8.8</td>
</tr>
<tr>
<td>TP (mg/L)</td>
<td>0.022</td>
<td>0.026</td>
<td>0.487</td>
<td>0.511</td>
<td>0.127</td>
<td>0.188</td>
</tr>
<tr>
<td>E. coli (MPN/100 ml)</td>
<td>69.7</td>
<td>4.1</td>
<td>&gt;2419.6</td>
<td>727</td>
<td>248.1</td>
<td>2350</td>
</tr>
</tbody>
</table>

Table 4 – Spring Brook Water Chemistry Data Summary – Armstrong Rd and Cates Ave Sites - 2008

<table>
<thead>
<tr>
<th>2008 Sample Summary</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Median</th>
<th>Average</th>
<th>Range</th>
<th># of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>S001-445</td>
<td>17.2</td>
<td>16</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>81.9</td>
<td>85.1</td>
</tr>
<tr>
<td>S001-446</td>
<td>15.2</td>
<td>1.2</td>
<td>97</td>
<td>&gt;100</td>
<td>83.8</td>
<td>84</td>
</tr>
<tr>
<td>Transparency (cm)</td>
<td>17.2</td>
<td>16</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>81.9</td>
<td>85.1</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>49</td>
<td>25</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>TP (mg/L)</td>
<td>0.021</td>
<td>0.037</td>
<td>0.22</td>
<td>0.189</td>
<td>0.006</td>
<td>0.007</td>
</tr>
<tr>
<td>E. coli (MPN/100 ml)</td>
<td>1</td>
<td>1</td>
<td>344.8</td>
<td>1299.7</td>
<td>53.05</td>
<td>13.8</td>
</tr>
<tr>
<td>Nitrate- N (mg/L)</td>
<td>2.06</td>
<td>2.32</td>
<td>16.6</td>
<td>17.7</td>
<td>11.6</td>
<td>12.1</td>
</tr>
</tbody>
</table>
Table 5 – Transparency Tube Data – Decker Ave Site – 2007 and 2008

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Median</th>
<th>Average</th>
<th>Range</th>
<th># of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transparency (cm)</td>
<td>6</td>
<td>4</td>
<td>60</td>
<td>60</td>
<td>46</td>
<td>54</td>
</tr>
</tbody>
</table>

Table 6 – Carleton College Research Project - Nitrate-N (mg/L) values in Spring Brook June – August 2006

<table>
<thead>
<tr>
<th>Site</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Median</th>
<th>Average</th>
<th>Range</th>
<th>Number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, Bachrach Ave</td>
<td>1.26</td>
<td>19.55</td>
<td>3.35</td>
<td>7.36</td>
<td>18.30</td>
<td>8</td>
</tr>
<tr>
<td>2, Millersburg Blvd</td>
<td>1.39</td>
<td>17.22</td>
<td>3.18</td>
<td>6.70</td>
<td>15.84</td>
<td>8</td>
</tr>
<tr>
<td>3, W of Cates Ave</td>
<td>2.65</td>
<td>14.00</td>
<td>5.13</td>
<td>6.87</td>
<td>11.36</td>
<td>10</td>
</tr>
<tr>
<td>4, Cates Tile Line*</td>
<td>17.51</td>
<td>23.74</td>
<td>21.92</td>
<td>21.04</td>
<td>6.23</td>
<td>5</td>
</tr>
<tr>
<td>5, E of Cates (S001-446)</td>
<td>2.49</td>
<td>16.20</td>
<td>5.02</td>
<td>7.49</td>
<td>13.71</td>
<td>10</td>
</tr>
<tr>
<td>6, Decker Ave (S001-444)</td>
<td>12.07</td>
<td>16.64</td>
<td>15.07</td>
<td>14.89</td>
<td>4.58</td>
<td>8</td>
</tr>
<tr>
<td>7, Dundas Blvd(S001-445)</td>
<td>13.92</td>
<td>16.96</td>
<td>15.45</td>
<td>05.57</td>
<td>3.05</td>
<td>8</td>
</tr>
</tbody>
</table>

*Water was not flowing in tile line after July 21, 2006.

Figure 16 - Carleton College Nitrate Sample Sites 2006
Under low and normal flow conditions the stream is typically clear as can be seen by the maximum and median values of transparency and TSS. Storm events can produce significant increases in turbidity that carry and deposit sediment on the stream bed. This results in habitat degradation and causes problems for aquatic life trying to find food. In 2007, transparency and TSS data exhibited a range of values at both sites; however the Armstrong site had a much higher range of TSS values. Land use practices between the Cates and Armstrong sites may be contributing to this condition.

Figures 17 – 19 illustrate the condition of the water after a storm event on October 1, 2007.

**Figure 17- Cates Ave – October 1, 2007 storm**

**Figure 18 – Water sample and transparency tube from Cates Ave, October 1, 2008**
Typical stream water quality conditions in the Western Cornbelt Plains Ecoregion, where Spring Brook is located, are: TSS = 10 – 61 mg/L, TP = 0.16 – 0.33 mg/L, Fecal Coliform bacteria 70-790 (organisms/100 ml), and NOx = 1.4-7.4 mg/L (MPCA website, accessed 7/28/08). Median values for TSS, TP, and E. coli at both sites were below to within the typical ranges. However, the maximum TSS value at Armstrong Rd in 2007 greatly exceeded the typical range. The maximum TP and E. coli values at both sites in 2007 were also far in exceedance of the typical values. Median and maximum nitrate values measured by CRWP in April through early June 2008 at both sites were greater than typical values as well. Individual E. coli data were much higher at the Armstrong site indicating the two feedlots between Decker Avenue and Armstrong Road are having an impact on the water quality.

The Carleton College project found nitrate median values within typical range in the county ditch upstream of Cates Ave drain tile input and values just within and above the typical range downstream of this location. Decker Avenue and Dundas Blvd (Armstrong Rd) had median and maximum levels that were much greater. Based on this data, it appears that the agricultural drainage tile at Cates Ave and other drainage and agricultural practices between Cates and Decker are causing elevated nitrate levels in the stream.

**Water Temperature Data**

**Background**

According to the Minnesota DNR, trout need cold water and cannot tolerate temperatures above 75°F for extended periods of time (MN DNR, “Trout and the Stream Environment”). Cool, pollutant-free water is critical to spawning, juvenile rearing, and adult resting habitat for many fish species. Generally, 60.8 °F is needed for spawning, and 64.4 °F for rearing (Trout Unlimited, 2006)

**Methods**

Continuous temperature monitoring was conducted from May through October 2007, and from April to early June 2008. Temperature data was collected using HOBO®U22 Water Temp Prov2 loggers. The loggers were set to record water temperature every fifteen minutes in degrees Fahrenheit. One logger was installed at the Cates Ave site in the pool next to the pressure transducer (level monitor). The logger was reinstalled in April 2008 at this site. One logger was installed at the Armstrong Rd site in the pool upstream of the road culvert. After a very large rainfall in August we were not able to locate the logger as it either was washed away or buried in sediment. A new logger was loaned to CRWP for this site in
2008 by the DNR Fisheries office in Waterville, MN. This time it was installed in the stream next to the pressure transducer and attached in a manner that should be more secure.

**Results**

Rainfall and flow were very low in 2007 and the Cates Ave site dried up for a portion of the season so there is a gap in the data record. The temperature logger at the Armstrong site was lost after the August floods so that record ends August 6, 2007. The data from 2008 is from April 19 – June 6.

The entire set of sample data are provided as an electronic file attachment to this document. A summary of the data is presented in Table 7. Average and maximum daily temperatures are displayed in Figures 20 through 23.

<table>
<thead>
<tr>
<th>Site/Year</th>
<th>Min</th>
<th>Median</th>
<th>Max</th>
<th>Average</th>
<th>Range</th>
<th># of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armstrong 2007 (5/1 – 8/6)</td>
<td>46.62</td>
<td>61.29</td>
<td>74.73</td>
<td>61.01</td>
<td>28.11</td>
<td>9370</td>
</tr>
<tr>
<td>Armstrong 2008 (4/19 – 6/9)</td>
<td>37.47</td>
<td>51.63</td>
<td>63.18</td>
<td>51.34</td>
<td>25.71</td>
<td>5014</td>
</tr>
<tr>
<td>Cates 2007 (5/1-6/29) &amp; (8/23 – 10/9)</td>
<td>44.90</td>
<td>61.46</td>
<td>79.74</td>
<td>61.56</td>
<td>34.84</td>
<td>10294</td>
</tr>
<tr>
<td>Cates 2008 (4/19 - 6/9)</td>
<td>37.42</td>
<td>51.72</td>
<td>67.11</td>
<td>51.48</td>
<td>29.70</td>
<td>5025</td>
</tr>
</tbody>
</table>

**Figure 20 – Daily Average Water Temperature – Armstrong Rd and Cates Ave Sites – 2007 (May – October)**

![Average Daily Water Temperature (°F) Comparison Armstrong and Cates Sites - 2007](image-url)
Figure 21 – Daily Average Water Temperature – Armstrong Rd and Cates Ave Sites – 2008 (April – June)

Figure 22 – Daily Maximum Water Temperature – Armstrong Rd and Cates Sites – 2007 (May – October)
The average daily temperature at Cates Ave is almost always higher than the Armstrong Rd site by anywhere from 0.5 to 6.0 °F. This makes sense as the water that flows to the Cates site is from County Ditch 22 and drain tile. There is no tree cover along this area which allows the water to warm up more quickly. The section from Cates to Decker is known to contain springs that would bring more cold water to the stream. This area also has tree cover helps keep the water cool.

The maximum temperature recorded at Armstrong Rd in 2007 was 74.73°F and Cates Ave was 79.74°F. The daily maximum temperatures at Cates exceeded 75°F for a week straight in June and several days in August. The daily maximum temperature at Armstrong road was close to 75°F for a day in June and several in July but did not exceed this temperature. The number of days with maximum temperatures above 75°F at both locations may have been greater, however due to low flow and loss of equipment the entire season was not able to be recorded. As noted above, these temperatures cannot be tolerated by trout for long. During the course of this study, no fish were seen swimming up to the Cates avenue site; temperature may have been one reason. The daily average temperatures were 61.01°F at Armstrong and 61.56°F at Cates. These temperatures are within the range noted by Trout Unlimited as being acceptable for trout spawning and rearing.

The spring of 2008 was colder than usual and that is reflected in the water temperature. The average daily temperature ranges between 50 – 52 °F from mid April through early June. Data for the complete 2008 season will be available from CRWP at the end of October 2008.

As the cities in the watershed look to develop land thereby adding impervious surfaces, it will be very important to keep stormwater runoff to a minimum. The water temperature in this stream will rise above what is already noted if increased runoff from impervious surfaces enters the stream. An increase in temperature could be detrimental to the trout population.
Macroinvertebrate Data

Background
Benthic macroinvertebrates are used in many stream water quality assessment studies. The animal species that inhabit a particular section of stream are indicators of present and past physical, chemical, and biological conditions (Zischke, 1996). Sediment affects macroinvertebrates by filling in the areas used for habitat (Waters, 1995). Trout feed heavily on the immature and adult forms of aquatic insects – mayflies, caddis flies, stoneflies, and several others. (MN DNR, “Trout and the Stream Environment”).

The text Living Waters: Using Benthic Macroinvertebrates and Habitat to Assess Your River’s Health (River Watch 1997) lists the following as important characteristics to look at when evaluating the condition of the stream:

“Abundance: the number of organisms present. Nutrient and food enriched streams will usually have a greater abundance of benthic macroinvertebrates. Both toxicity and physical habitat degradation (silt or sand erosion) will usually decrease the abundance.

Diversity: the number of different types of organisms present. Usually the greater the number of types, the healthier the stream.

Composition: the types of organisms that make up the community. In general, the mayflies, stoneflies, and caddisflies should be well-represented. If any of these groups are absent, it indicates there may be a problem.”

Methods
For this project, macroinvertebrate samples were collected from the Armstrong Rd and Cates Ave sites three times: October 24, 2006, May 8, 2007, and October 9, 2007. Students from the St. Olaf College Field Ecology class along with CRWP staff collected the October samples (Figures 24 and 25). The May sampling event was done by CRWP staff only. Samples were collected using D-frame nets from the following habitats: riffle, pool, leaf pack, submerged vegetation, bank vegetation and snags where available. The May sampling at Armstrong Rd did not include the pool. We attempted to sample each habitat proportionate to its prevalence at the sample site. Samples were preserved with alcohol and taken back to the St. Olaf College laboratories for analysis.

Figure 24 – St. Olaf students collecting macroinvertebrate samples at Cates Avenue, October 24, 2006
Identification of the samples was conducted to the level possible by the students, CRWP staff and volunteer, with some assistance from St. Olaf Biology department professors using a dichotomous key entitled *Guide to Aquatic Invertebrates of the Upper Midwest: Identification Manual for Students, Citizen Monitors, and Aquatic Professionals* (Bouchard, 2004, University of Minnesota). This key includes tolerance values used to evaluate water quality. Invertebrates are given a number 0 – 10 rating them as being intolerant (lower numbers) or tolerant (higher numbers to pollution. Values of 0-3 are considered indicative of a low tolerance to stress, values of 4 through 6 a moderate tolerance, and values of 7 through 10 a high tolerance. Bouchard bases these tolerance values on organic pollution and not on organism’s tolerance to heavy metals or toxic chemicals. The values are based primarily on those of Hilsenhoff (1988) as well as from Barbour et al. (1999).

**Results**

Table 8 below is a summary of the macroinvertebrate data collected in 2006 and 2007.

Overall the macroinvertebrate community was acceptable (Mike Swift, personal communication 7/23/08). There are many sensitive species among the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). Usually the when there are more of these families present the water quality and habitat are better (River Network, 1997). We were able to find members of the EPT families at both sites, although not each time we sampled and locations. This may have been due to the timing of sample collection. The October samples may have been too late in the season. Tolerance values can range within orders and families. As we were not able to identify the specimens to family level or below in all cases tolerance values should be looked at cautiously. Mayflies, megaloptera, and caddisflies were found. Most families within these orders are intolerant to organic pollution.
### Table 8 – Macroinvertebrate data from Armstrong Rd and Cates Avenue sites – 2006 and 2007

<table>
<thead>
<tr>
<th>Taxonomic Group</th>
<th>Cl = class, O = order, F = family</th>
<th>Tolerance Value</th>
<th>Armstrong Rd</th>
<th>Cates Ave</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cl. Oligochaeta (Aquatic Earthworms)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cl. Hirudinea (Leeches)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>O. Isopoda (Aquatic Sow Bugs)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>O. Amphipoda (Scuds &amp; Side-Swimmers)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Gammaridae</td>
<td>4</td>
<td>44</td>
<td>149</td>
<td>5</td>
</tr>
<tr>
<td><strong>O. Plecoptera (Stoneflies)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Taeniopterygidae (Winter stoneflies)</td>
<td>2</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>O. Ephemeroptera (Mayflies)</strong></td>
<td>range 1 - 7</td>
<td>29</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>O. Odonata (Dragonflies and Damselflies)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>subO. Anisoptera (Dragonflies)</td>
<td>range 1 - 9</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>O. Megaloptera (Fishflies, Alderflies &amp; Dobsonflies)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Corydalidae (Dobsonflies, Fishflies)</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>O. Trichoptera (Caddisflies)</strong></td>
<td>range 0-6</td>
<td>1</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>F. Brachycentridae (Humpless Case-Maker Caddisflies)</td>
<td>1</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Hydroporidae (Common Net-Spinner Caddisflies)</td>
<td>4</td>
<td>21</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>F. Odontoceridae (Strong Case-Maker Caddisflies)</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Hydroptilidae (Micro Caddisflies)</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>F. Phryganeidae (Giant Case-Maker Caddisflies)</td>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>O. Coleoptera (Aquatic Beetles)</strong></td>
<td>range 4-7</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Elmidae (Riffle Beetles)</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>F. Haliplidae (Crawling Water Beetles)</td>
<td>7</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Dryopidae (Long-Toed Water Beetle)</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>O. Diptera (Aquatice &amp; Semiaquatic True flies)</strong></td>
<td>range 0-10</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Tipulidae (Crane Flies)</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>F. Simuliidae (Black Flies; Buffalo Gnats)</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F. Chironomidae (Non-biting Midgees)</td>
<td>8.8</td>
<td>20</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>F. Tabanidae (Horse Flies; Deer Flies)</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F. Stratiomyidae (Soldier Flies)</td>
<td>8</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cl. Gastropoda (Snails and Limpets)</strong></td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><strong>Grand Total Per site</strong></td>
<td>122</td>
<td>36</td>
<td>95</td>
<td>209</td>
</tr>
<tr>
<td><strong>Percent of Stoneflies</strong></td>
<td>5%</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Percent of Mayflies</strong></td>
<td>24%</td>
<td>0</td>
<td>11%</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Percent of Caddisflies</strong></td>
<td>18%</td>
<td>33%</td>
<td>33%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Samples composite from Riffle and Pool. Tolerance Value include Leaf pack, bank snag, sub. Veg where available (from Bouchard Manual).
**Fish Survey Data**

**Background**
Southeastern Minnesota brook trout average less than 10 inches, although brook trout up to 17 inches are occasionally caught. “Brookies” can tolerate only the cleanest and clearest water (MN DNR website accessed 7/22/08: [http://www.dnr.state.mn.us/fishing/trout_streams/trout_species.html](http://www.dnr.state.mn.us/fishing/trout_streams/trout_species.html)).

**Methods**
On September 26, 2007 some seining and electroshocking was done at Decker Avenue and Armstrong Road sites to get a general idea of fish species. Dr. Patrick Ceas, an Ichthyologist at St. Olaf College, was contracted with to work on this sampling along with assistance from a St. Olaf student and CRWP staff.

**Results**

**Decker Ave:**
Johnny Darter  
Black Nose Dace  
Brook Stickleback  
Creek Chub  
Brook Trout

**Armstrong Road:**
Brook Trout  
Mudminnow  
Common Shiner  
Sand Shiner  
Bigmouth Shiner  
Spotfin Shiner  
Creek Chub  
Blacknose Dace  
Longnose Dace  
Bluntnose Minnow  
Fathead Minnow  
Hornyhead Chub  
White Sucker  
Yellow Bullhead  
Green Sunfish  
Orangespotted Sunfish  
Pumpkinseed  
Bluegill  
Largemouth Bass  
Smallmouth Bass  
White Crappie  
Johnny Darter  
Brook Stickleback

Figures 26-31 are photos of some of the species found in September 2007. Some of these species at the Armstrong Road site were only collected downstream of a culvert under the road that impedes fish passage and are therefore coming up from the Cannon River. Dr. Ceas reported that “The little creek surprised me – more species than I expected…… If the erosion/siltation problems can be minimized then this stream has the potential to be a real jewel.”
Figure 26 - Brook Trout

Figure 27 - Green Sunfish
Figure 30 - Mudminnow

Figure 31 - Orangespotted Sunfish and Bluegill
**DNR Fish Data**

The most recent DNR Stream Population Assessment was conducted in June 2001 and is provided as an attachment to this report. The survey was conducted at Decker Avenue. The following is the discussion of the Fishery:

“Brook trout abundance was relatively high; even the minimum estimate of 615/mile adults was greater than the 517/mile previously sampled in 1998. Although there were no fish over 10 inches sampled, their density was also relatively low in 1998 at 31/mile. Fingerlings were also absent in both years, likely because they were too small this early in the year. Abundance was high in the lower reach at that time, and in the upper station the stream was extremely low and all fish appeared to be concentrated in one or two deep pools. Conditions at the upper station could have limiting effects on the population.”

Brook trout were also collected later in the year for genetics testing. John Hoxmeier, Research Scientist with the Minnesota DNR, Lake City office reporting the following regarding the genetic testing results as of July 2008 (email communication July 18, 2008):

“The best information we have now on Spring Brook suggests it is not a remnant stock of brook trout. The brook trout genetics in Spring Brook are more closely related to populations from New York than to populations found elsewhere in SE Minnesota. This does not give any less reason for protection of this resource however, given that the brook trout in Spring Brook appear to be well adapted to their environment. We are continuing with our genetic collections of brook trout in the southeast. Until this is completed, we will not have a definitive answer on how all of our populations are related to each other. We anticipate having all of our brook trout populations sampled by next fall.”

**Agricultural Practices in the Watershed**

CRWP is carrying out two separate projects, the River Friendly Farmer Project and the Agricultural Shoreland Management Project, that have provided information about land use and agricultural practices in the Spring Brook watershed. This is an important topic to consider as what happens on the land directly affects the water.

Much of the land in this watershed is in row crop production, primarily corn and soybeans, and has been for some time. These crops can be raised using different types tillage methods, fertilizer and herbicide applications. Some methods, such as mold board plowing and ripping expose sediment during the time of year when crop cover has not emerged. No-till and strip till practices keep more previous crop cover on the land and hold soil in place until the new crop grows. The more exposed soil the greater potential for erosion during snow melt and rain events. Based on the surveys conducted by the River Friendly Farmer staff and a windshield survey of fields, ripping is used most in the watershed. Moldboard plowing also occurs. Figure 32 shows the tillage practice taking place in the fall of 2006.

Many of the fields have had drainage tile installed. The tile lines drain water from the fields faster and through direct points as opposed to overland flow (Figure 33). For the most part, the water coming out of the tile lines does not contain much sediment but it does contain nutrients. Locations of all the drainage tiles are not public information as they are installed on private land; however during our walking survey in 2008 we noted at least three tile discharge lines between Cates Avenue and Decker Avenue. A large tile line is located upstream of the Cates Avenue site and was monitored by Carleton College in 2006 (see above). The volume and speed of the water in the stream increases during storm events as water is funneled through the tile lines rather than infiltrating into the ground slowly or running off over the land surface. This results in more stream bank erosion, bank cutting and slumping.
Figure 32 – Tillage survey of Spring Brook Watershed - Fall 2006

Figure 33 – Agricultural Drainage Tile in Spring Brook Watershed.
The state of Minnesota requires a 50 foot wide buffer on shoreland in agricultural areas. The buffer must be maintained in perennial vegetation. This perennial vegetative buffer slows runoff down, allows sediment to drop out, and allows plant uptake of nutrients. It has been estimated that a 50 foot wide buffer can reduce sediment by 87%, total phosphorus by 71%, total nitrogen by 42%, and nitrate by 39%. Figure 34 below shows the buffer widths on agricultural shoreland in the Spring Brook watershed based on 2007 Rice County air photos. Ground truthing was also conducted during walking surveys of parts of the stream. The stretch of stream that is County Ditch 22 has buffers although not all are meeting the 50 foot rule. Much of the shoreland on the downstream end is forested land which slows runoff as well.

![Agricultural shoreland buffers based on 2007 Rice County air photo](image)

Grazing of beef cattle takes place along the stream in the segment from Decker Avenue to Armstrong Road. At present, the cattle are allowed access to the stream. Based on the E. coli, TSS and transparency data collected during this project, it is clear that the land use practices in this area have an affect on water quality. Rotational grazing that would only allow the cattle limited access of the stream should be pursued if cattle are to continue to be raised in this area.

**The Future**

As others have written before, Spring Brook is a “gem” in this community and should be protected and if possible improved. The future will hold many choices for landowners, the public, and the government with regard to how land is used which will determine the water quality and habitat of Spring Brook. Positive choices could include:

1. **Land preservation**
   
   a. As parcels come up for sale near the stream, they could be purchased by the state (DNR), cities, county, township, or land trusts and returned to natural condition. It is much easier and less expensive to preserve than restore land and water. The existing forested areas should remain. The city of Northfield has a park trail proposed in its park plan that would be a benefit to the public and the water.
b. Landowners may also choose to individually protect land along the stream by planting trees, native vegetation, and the like. Some landowners have done this by enrolling land in conservation programs such as Reinvest In Minnesota (RIM) and the federal Conservation Reserve Program (CRP). In May 2008 CRWP used our River Friendly Farmer program to help fund the conversion of 12 acres of tillable acres along the stream to perennial cover.

2. Zoning ordinances – as cities expand it could be beneficial to have some sort of zoning category created that would limit development close to the stream. This approach was tried a decade ago but met with limited success. However, it may be possible to improve upon the original ordinance proposal and try again.

3. Agricultural practices that have minimal impact on the water. As agriculture is important to the community it must take place at the same time as water quality needs to improve. Many practices are possible that can result in good crop production and allow for animal husbandry while still protecting the water. Producers could be offered incentive payments or other sorts of incentives to switch to these practices.

4. Restoration of wetlands. Wetlands act as a sink and hold water during rain and after rain then release it slowly to the system as opposed to tile lines flushing water. Landowners could try to restore wetlands in areas where it existed in the past. Figure 35 shows possible areas where wetlands could be restored based on work done by the US Fish and Wildlife Service and Ducks Unlimited.

Figure 35 – Restorable Wetlands in the Spring Brook Watershed
References


Minnesota DNR website accessed 7/22/08: [http://www.dnr.state.mn.us/fishing/trout_streams/trout_species.html](http://www.dnr.state.mn.us/fishing/trout_streams/trout_species.html).

Minnesota DNR. Trout and the Stream Environment. No publication date on document.

Minnesota Pollution Control Agency website” Guide to Typical Minnesota Water Quality Conditions” accessed 7/28/08: [http://www.pca.state.mn.us/data/eda/wqguide.html#westernplains](http://www.pca.state.mn.us/data/eda/wqguide.html#westernplains)

