2014 Mid-Season Water Monitoring Update

Monitoring Activities

Dakota County Soil and Water Conservation District staff continued to monitor Chub Creek at the permanent monitoring station on Dixie Avenue on a monthly basis through the monitoring season (snowmelt through October). Equipment was installed in April to continuously measure level and temperature. Manual flow measurements were conducted on two occasions and four water samples have been collected, to date.

On February 12, 2014 nitrate samples were collected at four springs and three stream sites in the Trout Brook watershed. A full report is available on the North Cannon River WMO website.

Right: Field staff collect nitrate samples at a spring in the Trout Brook Watershed.

Chub Creek Flow and Weather

About a year ago, the United States Geological Survey (USGS) installed a permanent stream gaging station on Chub Creek at County Highway 47 upstream of Randolph, MN. Stream level is continuously monitored and used to calculate stream flow (cubic feet per second or cfs). Instantaneous data can be accessed at waterdata.usgs.gov using the station ID 05355038.

This spring has been much wetter than a typical year. Each month this year has had above average rainfall. Altogether, this adds up to close to 10 inches above average for the year, to date.

Figure courtesy of USGS.

Prepared July 2014
Sampling Dates and Interpretation Considerations

Sample data shown here were collected on 4/17 and 5/15. Precipitation in the Chub Creek watershed this spring was much higher than normal. When these samples were collected, Chub Creek was at low and high flows. Season and flow conditions play a role in stream dynamics and should always be considered when interpreting results. Samples were also collected on 6/16 and 7/16; however, data are still being processed and are not yet available.

**E. coli Bacteria**

The two bacteria samples that have been analyzed to date have values of 48 and 118 organisms/100mL. This is within the approved state standard of 126 organisms/100mL. Additionally, these values are much lower than the historical average which is near 1,000 organisms/100mL.

**Total Suspended Solids and Turbidity**

Samples of suspended solids and turbidity were low for the spring season with total suspended solids ranging from 12 to 17 mg/L (within the proposed standard) and turbidity ranging from 5 to 12 NTU (within the approved standard).

**Nutrients**

Both the April and May samples had phosphorus values within the proposed range (0.094 and 0.142 mg/L, respectively).

Springtime nitrate values were only available for the April sample which was within the approved drinking water standard at 3.23 mg/L. Nitrate tends to decrease as flows increase. Low values measured here may be due to the wet spring.

The Minnesota Pollution Control Agency is currently re-evaluating nitrate standards to protect aquatic life. Once approved, Chub Creek nitrate levels will be re-assessed.

**Dissolved Oxygen, pH, Transparency, Conductivity**

**Dissolved oxygen** (8.97 - 7.91 mg/L). These values seem a little low for early spring, but are still acceptable.

**pH** (7.74 - 7.81 S.U.). These values are typical of Minnesota streams.

**Transparency** (41 - 22 cm). Water was not as clear as usual for the spring. Rain decreased transparency in May.

**Conductivity** (413.5 - 508.9 µS/cm). These values are typical of warm water streams.
Nitrate in Trout Brook

Dakota County, Minnesota

Prepared by Dakota County Soil and Water Conservation District, March 2014

Introduction
Trout Brook is a trout stream in Dakota County, Minnesota. It is of particular interest for nitrate monitoring because of its historical data record spanning back to 1985 and, according to the Minnesota Pollution Control Agency (MPCA); it has some of the highest stream baseflow nitrate concentrations in southeastern Minnesota.

Several samples from Trout Brook indicate that the baseflow nitrate concentrations consistently exceed the standard which applies to public drinking water sources, and in Minnesota all trout streams are protected as potential drinking water sources. The maximum contaminant level allowed is 10 mg/L nitrate-nitrogen, and consuming water with elevated nitrate could cause serious health problems, particularly for infants (National Primary Drinking Water Regulations, United States Environmental Protection Agency). Nitrate is just one form of nitrogen, which can occur in several forms.

Trout Brook is found in a karst landscape, characterized by underground caves, sinkholes, and springs. These features have a profound impact on the rate of infiltration and the flow path of water, which can be very different from what the surface topography might suggest. As a result, these systems tend to be more susceptible to contamination. Additionally, understanding contaminant sources and movement in a karst system can be quite challenging.

For decades, pollution from surface runoff has been at the forefront of water conservation efforts; however, nitrogen pollution is quite different in that nearly all of it enters streams, lakes, and wells from a groundwater pathway. There are two main ways in which groundwater contamination may occur; 1) leaching into groundwater which then moves to a stream, lake, or well. Groundwater might come to the surface through springs or shallow seepage (both of which contribute to the flow in Trout Brook). Nitrogen may also enter by 2) leaching into subsurface drainage systems which then discharge directly into surface waters. According to the MPCA “Nitrogen in Minnesota Surface Waters” report (2013), only 9% of nitrogen pollution in lakes, streams, and wells comes from surface runoff, with the majority of the pollution coming from groundwater pathways.

Several springs have been identified in the Trout Brook watershed, four of which have become sentinel nitrate monitoring sites. Another three stream sites also have a relatively long period of record and are routinely monitored. These seven monitoring sites are shown in Figure 1.

The North Cannon River Watershed Management Organization (NCRWMO) recognizes that nitrate contamination is a concern, particularly in Trout Brook, and has made a commitment to better understand how nitrate moves through this subwatershed by sponsoring continued monitoring, as outlined in their new Watershed Plan adopted in 2013.
Figure 1. Map of spring and surface water monitoring sites for Trout Brook, Dakota County, Minnesota.
Methods
On February 12, 2014, with funding from the NCRWMO, baseflow samples were collected from three streams sites and four contributing springs along Trout Brook. These data were analyzed and interpreted along with past baseflow samples collected at these same sites. Groten and Alexander (2013) collected samples in 2011 and 2012, Dakota County Soil and Water Conservation District collected samples in 2001, 2002, 2006, and 2010. Lastly, Spong (1995) collected data in 1985 at the four sentinel spring sites and at the Swede and LeDuc springs only in 1995. This monitoring record, spanning almost thirty years, is unique in its temporal extensiveness and extremely valuable in understanding nitrate movement in a complicated karst landscape.

It should be emphasized here that these samples represent baseflow conditions; when springs and distributed groundwater inputs have the largest contribution to surface stream flow. Nitrate concentrations tend to be highest during baseflow conditions.

Results
Nitrate data for surface monitoring sites and for spring monitoring sites are shown in Figures 2 and 3, respectively.

In the surface monitoring sites, baseflow nitrate concentrations exceeded the 10 mg/L standard at all three sites. At the Main Branch (TB3) monitoring site, the nitrate concentration had increased at a rate of about 0.11 mg/L/year from 2001 to 2014. The West Branch (TB2) monitoring site had the highest concentration of the surface monitoring sites and had increased at a rate of about 0.37 mg/L/year from 2001 to 2014. The East Branch (TB1) had increased at a rate of about 0.11 mg/L/year from 2001 to 2006, and then decreased from 2006 through 2014 at a rate of about -0.37 mg/L/year. In 2014, the nitrate concentration at the East Branch (TB1) was roughly half the concentration of the West Branch (TB2), with the trends at each these branches going in opposite directions. The reason for the recent decreasing trend at the East Branch (TB1) has not been thoroughly investigated. Groten and Alexander (2013) have compared the changes in flow regime between 1985 and 2011 and concluded that the East Branch contributed more flow to Trout Brook than the West Branch in 1985, but that by 2011 that had shifted and the West Branch was contributing more flow than the East Branch. The authors further suggest that these changes in flow regime could be attributed to ‘climate, anthropogenic activities such as irrigation, changes in land use, or from changes in the steam channel itself by major floods.’

All four spring monitoring sites show increasing nitrate concentration trends over time. The Fox Spring, which feeds the West Branch of Trout Brook had the highest concentrations of nitrate and is increasing at the fastest rate, about 0.40 mg/L/year. The LeDuc Spring, upstream of the East Branch surface monitoring site is increasing at the slowest rate, about 0.11 mg/L/year. The Beaver and Swede springs, both of which enter the Main Branch of Trout Brook upstream of the Main Branch surface monitoring site are increasing at rates of about 0.26 mg/L/year and 0.18 mg/L/year, respectively. Swede Spring has the lowest nitrate values, which may be because it is lower in the stratigraphic section and has a greater proportion of deeper, regional water input to dilute the nitrate-polluted water. Runkel et al. (2013) point out that this less contaminated deep water is finite and diminishing, and that the buffering capacity may be lost in the future as water is used up and contaminated water infiltrates from above.
Figure 2. Baseflow nitrate data from surface monitoring sites, Trout Brook’s West (TB2), East (TB1), and Main (TB3) branches.
Figure 3. Baseflow nitrate data from spring monitoring sites; Fox, Beaver, LeDuc, and Swede.
**Conclusions**

Trout Brook is of great interest for nitrate monitoring because it has some of the highest measured nitrate in Southeastern Minnesota, it has an established historical record, and the karst landscape in which it is found increases its susceptibility to pollution.

Nitrate concentrations in springs contributing to Trout Brook have been increasing at rates of 0.11 to 0.40 mg/L/year from 1985 to 2014. The surface water monitoring sites also show increasing trends of nitrate concentrations at the Main Branch and West Branch from 2001 to 2014, with the nitrate concentrations decreasing at the East Branch since about 2006.

Groten and Alexander (2013) suggest that row crop agriculture and animal feedlots are the likely sources of nitrate contamination in Trout Brook, although the proportion attributed to each source is difficult to determine. In addition to monitoring nitrate, Groten and Alexander had measured other anions and the data were indicative of animal waste sources. Lastly, Watkins (2011) showed that nitrate concentrations in Southeastern Minnesota trout streams are strongly correlated with the percentage of row crop acres in a watershed; a conclusion which Trout Brook data supports.

**Recommendations**

- Long historical records of water quality data are rare. Continued monitoring will be important for increasing understanding of nitrate sources and movement in Trout Brook.
- Understanding pollution movement and susceptibility in karst landscapes is complicated. The rate and direction of water movement underground can be very different than what surface topography suggests. Continued work to delineate springsheds would help to determine the types and percentages of land use that may be impacting Trout Brook. This information could then be used to determine groundwater management areas, which may be quite different than surface watersheds.
- Continued education and assistance to local land owners and land users. Provide technical assistance and cost sharing for Best Management Practices which reduce nitrate pollution, targeting identified sources including row crop agriculture and animal feedlot operations.

**References**


**Figure 4.** Beaver Spring, February 12, 2014.