SCOTT WMO WATER QUALITY MONITORING REPORT

ROBERTS CREEK 2010

Scott County Government Center

200 Fourth Avenue West

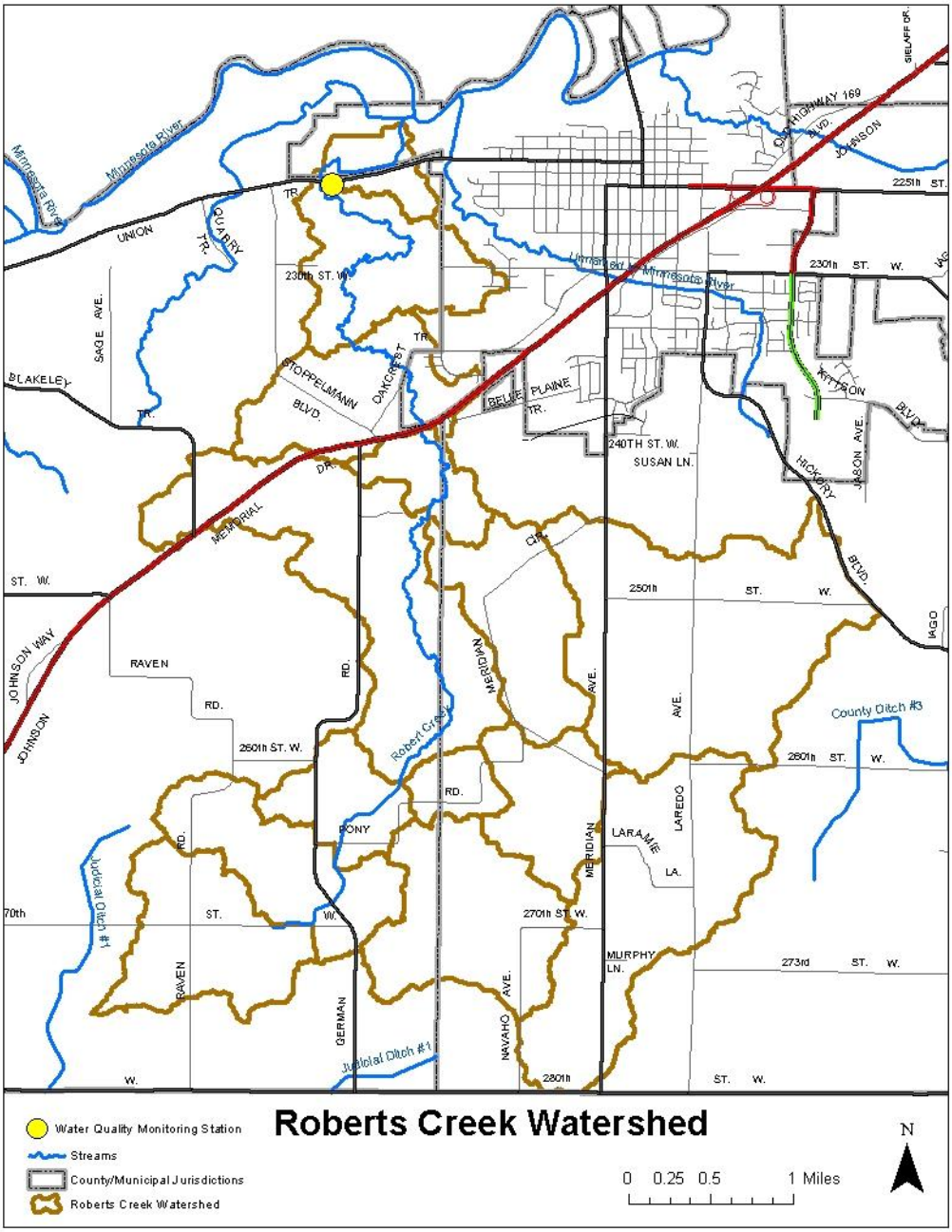
Shakopee, MN 55379

952-496-8054

February 2013

INTRODUCTION

This report presents and assesses water quality data collected from Roberts Creek in 2010. Roberts Creek is located in southwest Scott County (Figure 1). The Roberts Creek watershed is 7,670 acres (just under 12 square miles) of primarily agricultural land. The Creek flows north from the Le Sueur County boundary and discharges to the Minnesota River just a few miles southwest of the City of Belle Plaine.



METHODS

Grab samples and field measurements were collected at one site on the creek from snow melt until late fall (i.e., March through October). The site is located 0.8 miles upstream of the confluence with the Minnesota River near County Road 6. Field (in-situ) measurements were taken for temperature, dissolved oxygen, pH, turbidity, conductivity, and transparency. Stage readings were also taken and flow measured during each sampling event. Grab samples were transported on ice to the Met Council laboratory for analysis of Total Suspended Solids (TSS), Volatile Suspended Solids (VSS), turbidity, Total Phosphorus (TP), Total Dissolved Phosphorus (TDP), Nitrate (NO3), Nitrite (NO2), Total Ammonia, Chlorophyll-a, and Total Kjeldahl Nitrogen (TKN). Standard Operating Procedures use for the collection of these samples and environmental data are given in the "Minnesota Pollution Control Agency Water Quality Programs Sampling and Monitoring Standard Operating Procedures" (SOPs) manual (2006) and the "Sand Creek Watershed TMDL and Impaired Waters Resources Investigations Project Quality Assurance Project Plan (QAPP)" (MPCA, 2007).

RESULTS AND DISCUSSION

Discussion of the results is organized by parameter and includes comparison with applicable water quality standards and with other streams. Roberts Creek is in the North Central Hardwoods Forest ecoregion, but many watershed characteristics are similar to the Western Corn Belt Plains streams, and thus both ecoregions are presented.

Backwater effects and beaver activity prevented the development of a rating curve at the sampling site, and thus a hydrograph and loads were not developed. Flow, however, were measured for each sampling event allowing some analysis and comparison of concentrations versus for some of the parameters. Raw data is available on request.

Solids and Turbidity

Total suspended solids (TSS) and volatile suspended solids (VSS) were analyzed in all grab samples. Turbidity measurements were taken both in the field and from the samples in the laboratory. Data presented in Table 1 from Roberts Creek, however focuses on the laboratory turbidity measurements.

Table 1: TSS, VSS and Turbidity Roberts Creek 2010

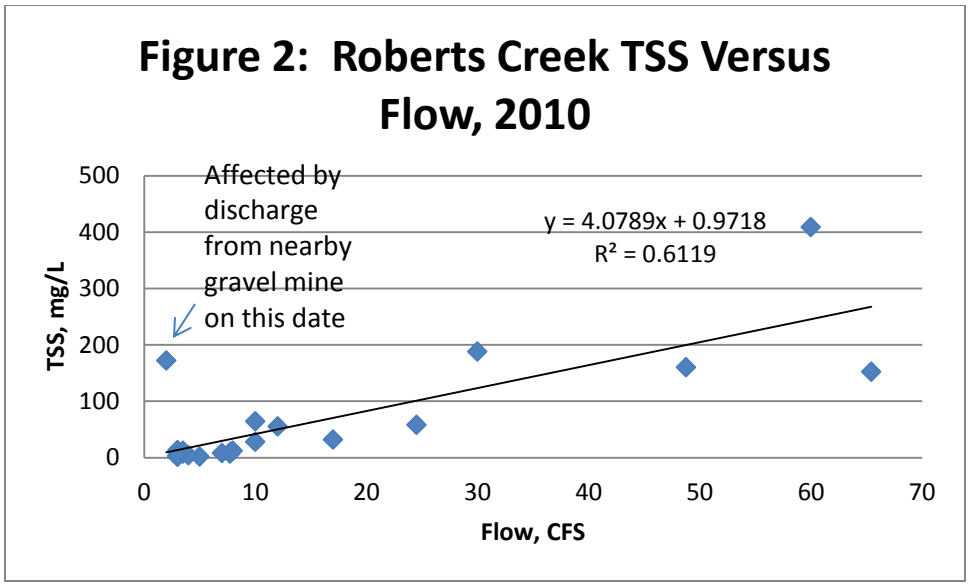
	Roberts Creek			Minimally Impacted Streams**			
				North Central Hardwood Forest Ecoregion		Western Corn Belt Plains Ecoregion	
	TSS, mg/L	VSS, mg/L	Turbidity NTU*	TSS, mg/L	Turbidity NTU	TSS, mg/L	Turbidity NTU
Average	63.7	8.3	20.1	13.7	7.1	45.3	16.8
95th Percentile	376	38.4	95.7	41	18	130	41
75th Percentile	86	13.5	21.4	16	8.5	61	22
Median	12.5	2	5.8	8.8	5.1	27	12
25th Percentile	6.2	1	3	4.8	3	10	5.2
5th Percentile	1	1	1.6	2	2.1	3	2.6
N	22	21	23				

* Converted from lab results in NTRU to NTU per Johnson (2007).

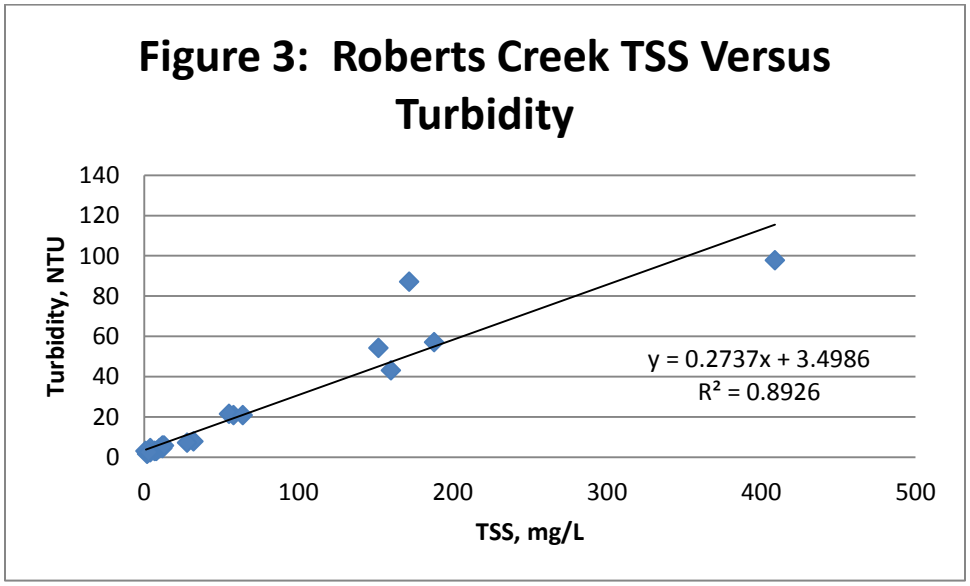
**Ecoregion Values from McCollor and Heiskary (1993).

Total suspended solids are the amount of suspended solid material in the water column. These suspended materials can be inorganic solids like sand or clay, or organic material like dead plant material or algae. Volatile suspended solids is the amount of suspended materials in the water column that can be burned or volatilized, and is representative of the organic fraction of TSS. Turbidity is an optical parameter that measures the transparency of water. Turbidity in water is caused by suspended soil particles, algae, etc., that scatter light in the water column making the water appear cloudy. There is frequently a quantifiable relationship between TSS and turbidity. In addition, there are water quality standards set by the state for turbidity but not for TSS and VSS. For streams in the Scott WMO the turbidity standard is 25 Nephelometric Turbidity Units (NTU). A stream is considered impaired if the 25 NTU standard is exceeded 10% or more of the time.

Total suspended solids concentrations in Roberts Creek are higher than the concentrations in minimally impacts streams of both eocregions. This is not surprising since Roberts Creek has a high gradient upstream of the sampling site where it cuts through the Minnesota River valley bluff. The high gradient provides more energy for material to be suspended. Volatile suspended solids concentrations are fairly low with VSS, on the average, 13% of TSS. This means that TSS is largely inorganic sediment, with little organic matter. TSS is also related to flow (Figure 2). This is not surprising since higher flows have more energy to cause erosion and suspend particles.



Turbidity readings in Roberts Creek were also higher than readings from minimally impacted stream of both ecoregions. In fact it appears that the turbidity standard of 25 NTU is exceeded about 20% of the time. There is a strong relationship between turbidity and TSS in Roberts Creek (Figure 3). It can therefore be concluded that for 2010 Roberts Creek exceeded the turbidity water quality standards, and that the high turbidity levels were from inorganic sediment.



Dissolved Oxygen

The dissolved oxygen (DO) standard for warm water streams, like Roberts Creek, in Scott County is not less than 5 mg/L as a daily minimum. The minimum DO recorded in 2010 was 6.93 mg/L. Thus, all of the 2010 measurements were above the standard (i.e., met the standard; see Table 2). DO, is however, quite dynamic and varies throughout the day depending particularly on temperature, decomposition rates and algae. Thus, these monitoring results are not completely definitive that the standard is being

met. However, results all met the standard. Roberts Creek near the monitoring site is high gradient contributing to good mixing and reaeration, and there are no waste water discharges to the creek. For these reasons it is concluded that DO is not a stressor for aquatic life.

Table 2: Dissolved Oxygen Roberts Creek 2010

	DO, mg/L
Average	9.8
95th Percentile	13.6
75th Percentile	10.9
Median	10.1
25th Percentile	8.1
5th Percentile	7
N	23

Nutrients

A number of forms of phosphorus and nitrogen were analyzed from the collected samples. The following discussion focuses on total phosphorus and total dissolved phosphorus (TP and TDP, respectively), total ammonia and nitrate.

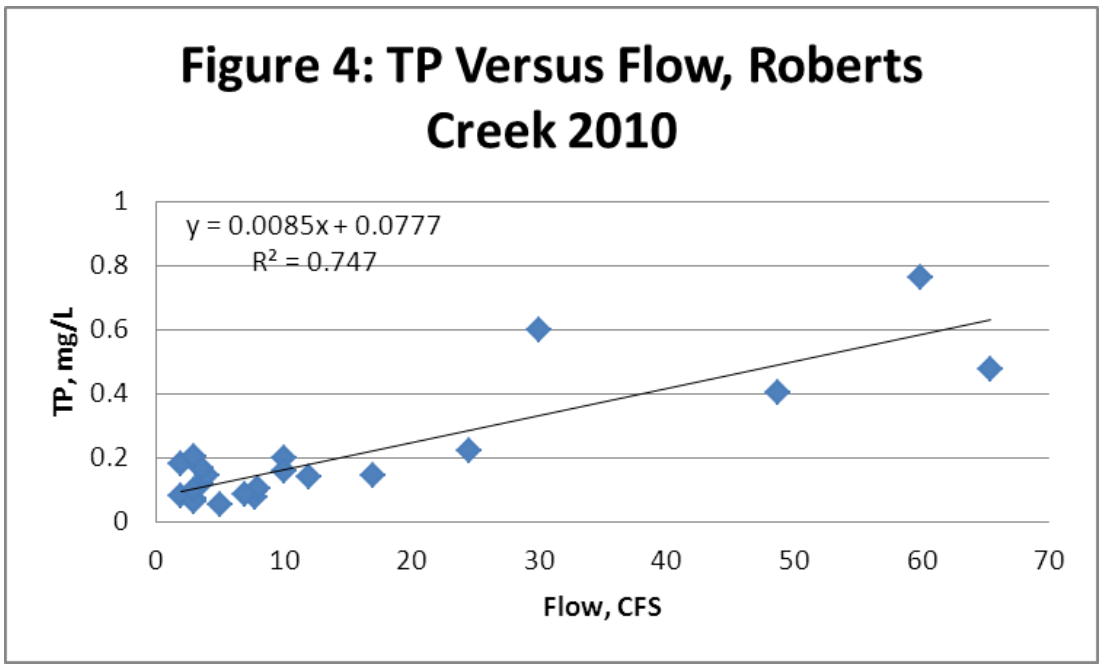
TP and TDP results are summarized in Table 3. Comparison of the Roberts Creek TP values with minimally impacted stream ecoregion values shows that median and low percentile values compare well with values from the North Central Hardwood Forest Ecoregion. However, high percentile values compare more closely to Western Corn Belt Plains Ecoregion minimally impacted streams. This may be due to the high TSS concentrations in Roberts Creek particularly in higher flows. During these flows TP is likely in particulate form associated with sediment. Roberts Creek is in the North Central Hardwood Forest Ecoregion and thus TP concentrations appear to be slightly elevated.

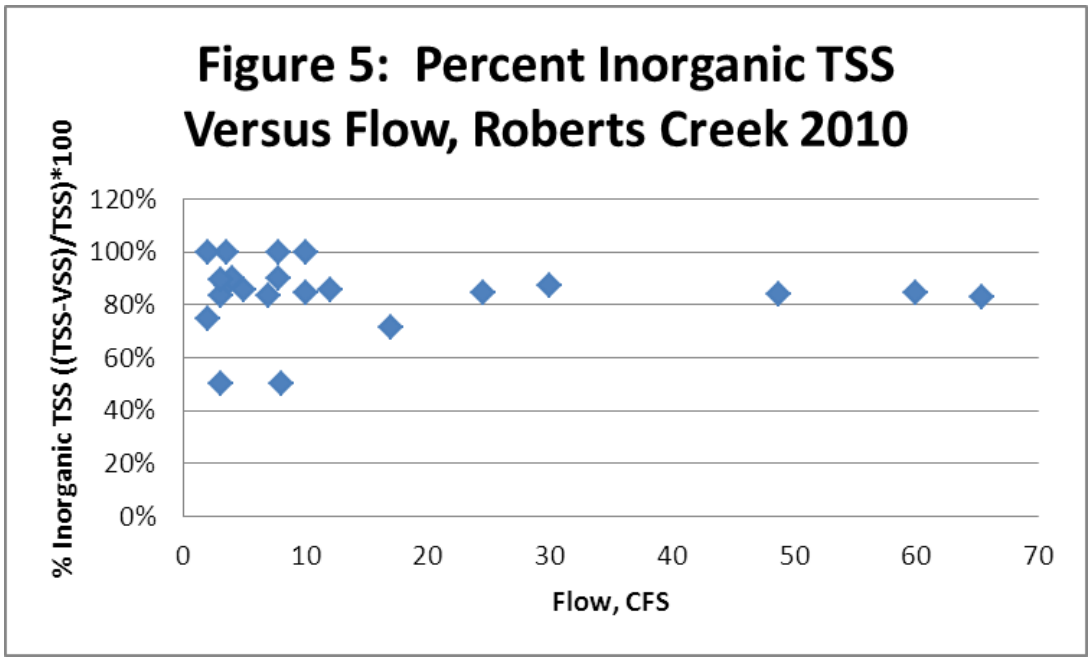
Most of the TP is in dissolved form (TDP). The lowest fraction of dissolved occurs in the 5th percentile. This is somewhat unexpected since the 5th percentile should represent lower flows which would have less energy to suspend particulate forms of phosphorus (Figure 4). Some of this could be caused by organic particulates, like algae, that float or maintain suspension during lower flows thereby contributing particulate phosphorus. Figure 5 shows that there is more variability in the percentage of inorganic TSS at lower flows. If phosphorus becomes a management objective, the relationship between particulate and dissolved forms of phosphorus need to be better understood in order to figure out whether dissolved forms need to be specifically targeted or whether more traditional management approaches focusing on erosion and sediment control (and associated forms of phosphorus) will be sufficient to achieve desired outcomes.

Table 3: TP and TDP, Roberts Creek 2010

	Roberts Creek			Minimally Impacted Streams*	
				North Central Hardwood Forest Ecoregion	Western Corn Belt Plains Ecoregion
	TP, mg/L	TDP, mg/L	% TDP	TP, mg/L	TP, mg/L
Average	0.203	0.133	66%	0.130	0.280
95th Percentile	0.729	0.375	51%	0.360	0.560
75th Percentile	0.204	0.181	89%	0.150	0.330
Median	0.144	0.092	64%	0.090	0.240
25th Percentile	0.087	0.073	84%	0.060	0.160
5th Percentile	0.058	0.025	43%	0.040	0.09
N	23	22			

*Ecoregion Values from McCollor and Heiskary (1993).





Total ammonia and nitrate (NO3) results are summarized in Table 4. These forms of nitrogen are readily available for biological uptake. Total ammonia in Roberts Creek in 2010 is lower than the minimally impacted streams. In fact nine of the sample results for total ammonia were below the laboratory detection limit. Nitrates, however, were very high in Roberts Creek in 2010. Values observed exceeded nitrate + nitrite (NO3 + NO2) concentrations of minimally impacted stream in both ecoregions. Currently, there is no surface water quality standard for nitrate. However, one is expected to be developed within the next 5 years. There is, however, a maximum drinking water standard of 10 mg/L. Roberts Creek is not used as a drinking water supply. However, high concentrations in the Creek could indicate a potential future problem if surface waters infiltrate and recharge ground water supply aquifers. The potential for this is unknown and depends on aquifer recharge characteristics and the presence or absence of confining layers. What is known is that nitrate concentrations in well water are not currently high in the area. Rural well monitoring completed by the Scott WMO in 2011, including several wells in the Roberts Creek watershed, did not find any concentrations exceeding 5 mg/L. Conversations with the City of Belle Plaine documented that the most recent sample from their supply well was around 3 mg/L.

Table 4: Total Ammonia and Nitrate, Roberts Creek 2010

	Roberts Creek		Minimally Impacted Streams**			
			North Central Hardwood Forest Ecoregion		Western Corn Belt Plains Ecoregion	
	Total Ammonia, mg/L*	NO3, mg/L	Total Ammonia, mg/L	NO3 + NO2, mg/L	Total Ammonia, mg/L	NO3 + NO2, mg/L
Average	0.044	10.8	0.2	0.16	0.4	4.8
95th Percentile	0.198	16.4	0.46	0.46	1.3	12
75th Percentile	0.06	13.8	0.2	0.26	0.4	7.4
Median	0.03	9.7	0.2	0.1	0.2	3.9
25th Percentile	0.02	8.3	0.1	0.04	.15	1.4
5th Percentile	0.02	4	0.04	0.01	0.04	0.01
N	23	21				

* Nine observations were less than the laboratory detection limit of 0.020 mg/L. Assumed values less than detection were at the detection limit.

** Ecoregion Values from McCollor and Heiskary (1993).

Toxic Parameters

The only toxic parameter analyzed was un-ionized ammonia. Ammonia (NH3) at elevated levels in the un-ionized form is toxic to aquatic life. The fraction of total ammonia in the un-ionized form in water is dependent on ambient pH and temperature. Equations for calculating un-ionized ammonia from total ammonia, pH and temperature were used from Minnesota Rule 7050. The chronic un-ionized ammonia standard for Roberts Creek is 0.040 mg/L. Analysis of the data showed that the standard was not exceed in 2010 in Roberts Creek. In fact of the 19 samples analyzed the highest concentration of un-ionized ammonia calculated was 0.003 mg/L, and as discussed above nine of the total ammonia concentrations observed were less than detection.

CONCLUSIONS

Monitoring data collected from Roberts Creek in 2010 show that turbidity and total suspended solids are high. Data also show that these high values are primarily from inorganic sediment. This is not surprising since land use in the Roberts Creek watershed is primarily agriculture and the creek has a steep grade as it cuts through the Minnesota River valley bluff just upstream of the monitoring site. Total phosphorus is slightly elevated compared to minimally impacted stream. It is also mostly in dissolved form. Total ammonia and un-ionized ammonia concentrations are very low. However, nitrate concentrations are

very high in the creek. Drinking water supply concentrations of nitrate from wells in the area are currently well below the drinking water standard. However, the high surface water concentrations observed warrant some discussion and management consideration from the perspective of preventing elevated levels in drinking water aquifers.

REFERENCES

McCollor S., and S. Heiskary, 1993. Selected Water Quality Characteristics of Minimally Impacted Stream from Minnesota's Seven Ecoregions. MPCA Water Quality Division. Addendum to : Descriptive Characteristics of the Seven Ecoregions of Minnesota.

Minnesota Pollution Control Agency, 2006. Water Quality Programs Sampling and Monitoring Standard Operating Procedures (SOPs): Revision 3.

Minnesota Pollution Control Agency, 2007. Sand Creek CWP Project Quality Assurance Project Plan.