Indian Springs Creek Dye Trace Report
Houston County, Minnesota

Trace:
October 25th 2010

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Cascade downstream of Indian Springs- the headwater of Indian Springs/Thompson Creek (DNR).

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Introduction

The karst lands of southeast Minnesota contain more than one hundred trout streams that receive perennial discharge from Paleozoic bedrock springs. Several of the Paleozoic bedrock units that provide discharge are conduit-flow dominated aquifers. Field investigations into the flow characteristics of these formations have been conducted using fluorescent dyes to map groundwater springsheds and characterize groundwater flow velocities for use in water resource protection. Indian Springs Creek is one of these designated trout streams. The creek is located roughly 8.5 kilometers (5.1 mi.) northeast of Caledonia, Minnesota in northern Houston County (Figure 1) in the Root River watershed. This trace was completed to add to delineated springsheds of the region as part of the Environmental and Natural Resources Trust Fund (ENRTF) Springshed Mapping project.

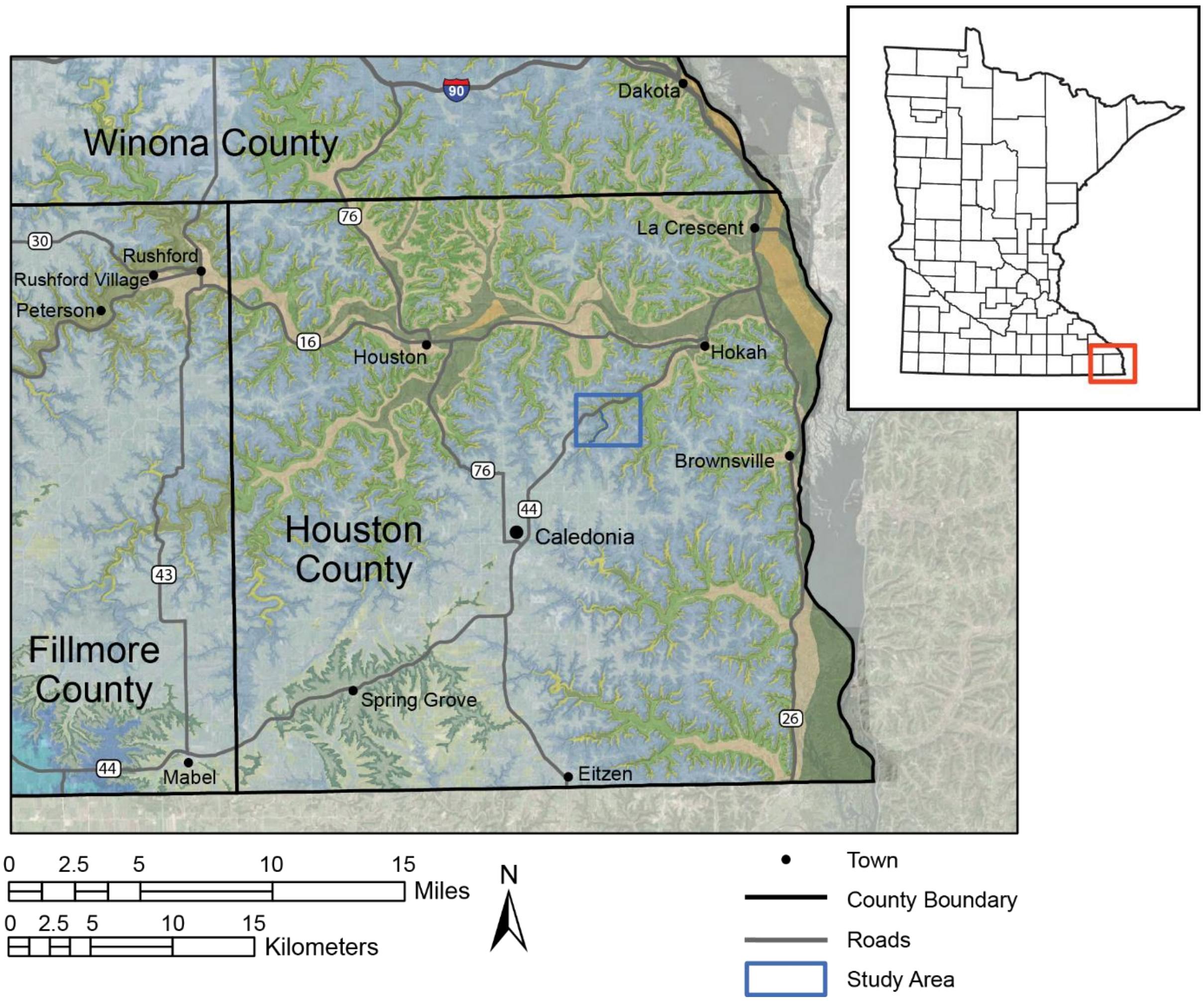

Figure 1. *Location of Indian Springs Creek*

In Houston county, bedrock units from the Upper Cambrian through the Upper Ordovician are generally within 15 meters of the land surface and are capped by unconsolidated sediments such as loess, sand, and colluvium (Steenberg, 2014; Lusardi et al., 2014).

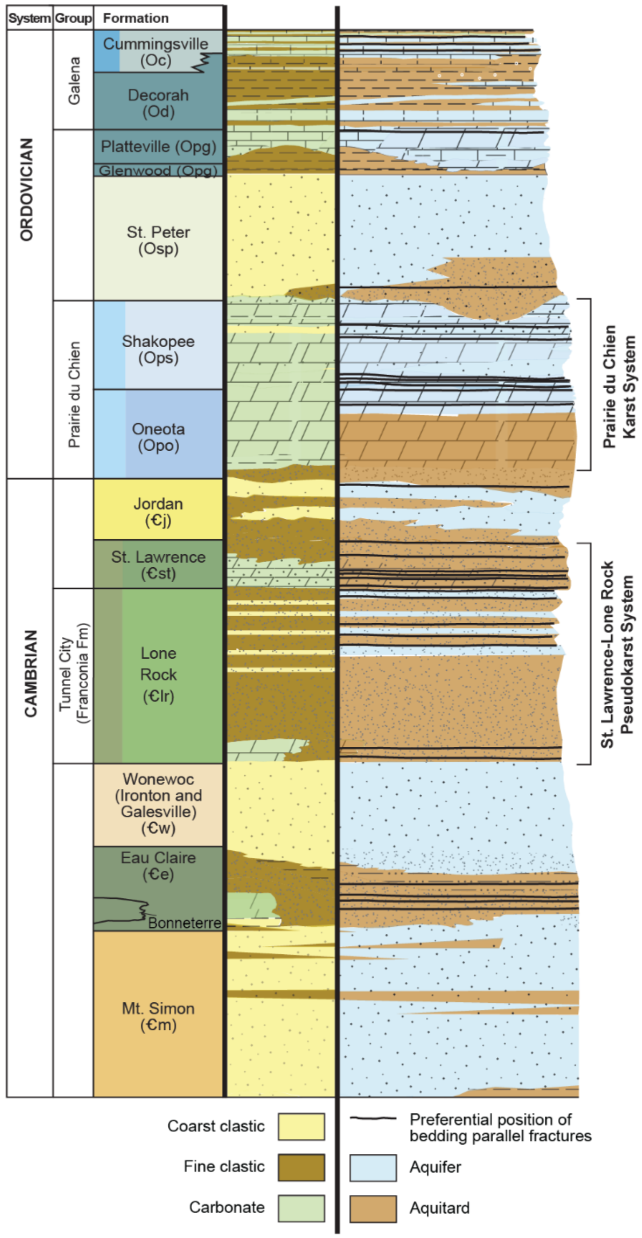

Figure 2. *Geologic and hydrogeologic attributes of Paleozoic rocks in southeastern Minnesota. Modified from Runkel et. al. 2013*

The topography is dominated by a broad plateau of resistant dolostone of the Ordovician Prairie du Chien Group (OPDC). A geologic column for Houston County (Figure 2) shows lithostrati-graphic and generalized hydro-stratigraphic properties for each of the units (modified from Runkel et. al. 2013). Hydro-stratigraphic attributes have been generalized into either aquifer or aquitard based on their relative permeability. Layers assigned as aquifers are permeable and easily transmit water through porous media, fractures or conduits. Layers assigned aquitard have lower permeability that vertically retards flow, effectively hydrau-lically separating aquifer layers. However, layers designated as aquitards may contain high permeability bedding plane fractures conductive enough to yield large quantities of water.

The Indian Springs Creek dye trace documented surface water-groundwater interaction and sub-terranean flow in hydrostratigraphic units of the Upper Cambrian.

Indian Springs Creek begins at the Indian Springs. The springs emanate at the uppermost Jordan

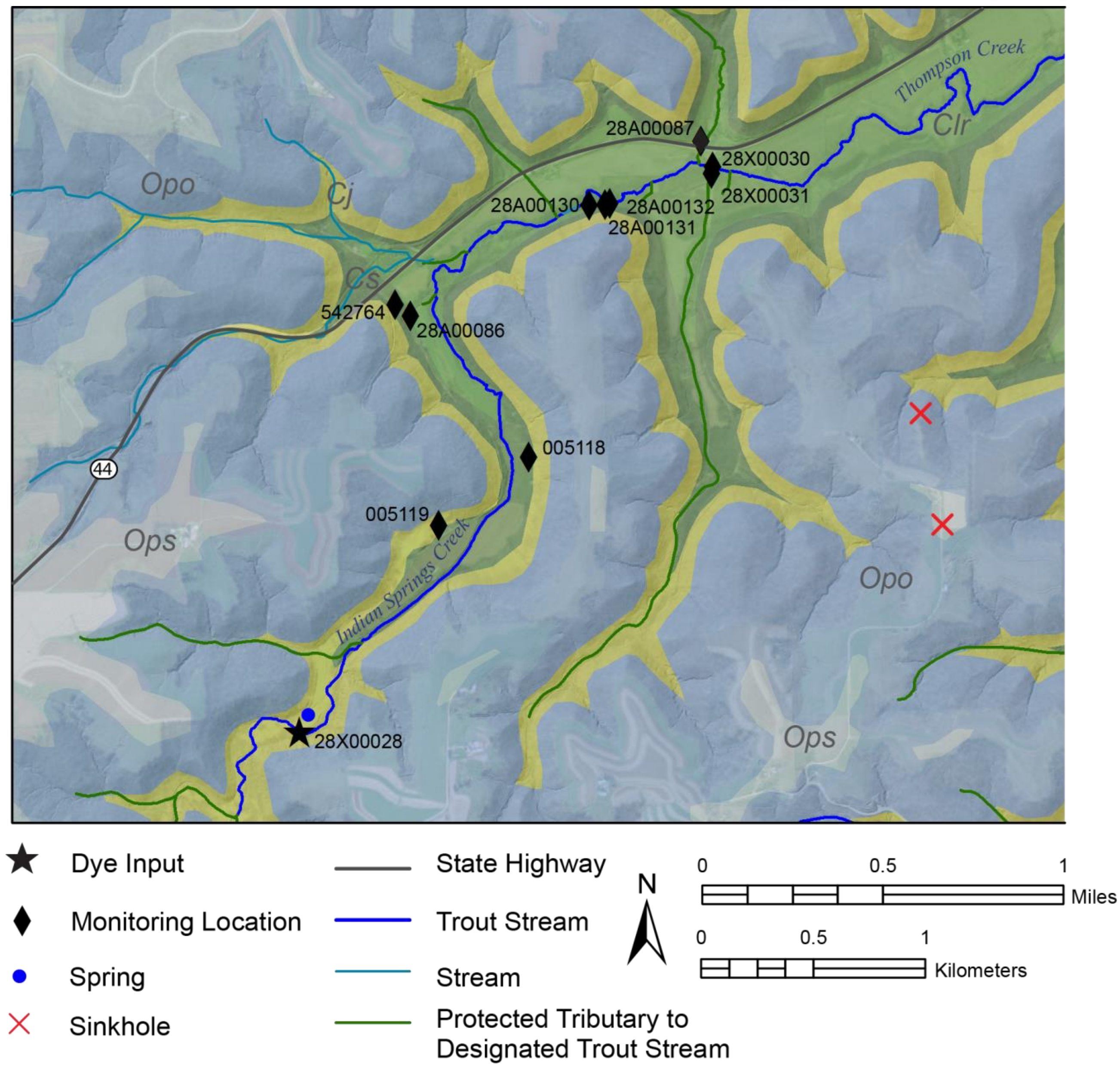

Figure 3. *Dye trace sampling points*

Formation/lower Oneota Formation contact (Runkel, 2010). After a three mile reach, the creek becomes Thompson Creek. When this trace was conducted, Indian Springs Creek was flowing along its entire run; this has not always been the case. During the set-up work for this trace, a property owner on the creek told us that when he moved to his home in the early 1990s, the creek was dry on his property. Thaddeus Surber observed the same conditions in June 1920 (Surber, 1920). Downstream from Indian Springs, the flow is augmented by flow from spring 28A0086, labeled as Dexter Spring by Thaddeus Surber, and 28A0087, which Surber named as Beeson Spring. Both of these springs were monitored during the trace; additional detectors were placed in the creek and one tributary (Figure 3). Three domestic wells were also monitored during the trace. The location of springs 28A0130, 28A0131, and 28A0132 were not known prior to the trace. A local landowner, Vern Yolton, alerted us to them after the trace began.

Methods

On 25 October 2010, 1.19 kg of Uranine HS dye solution was poured into the flow of Indian Springs Creek upstream of the reach where the St. Lawrence Formation is the first bedrock. The dye was poured into a riffle to promote mixing in the stream flow. Dye trace sample packets were placed in selected springs and one tributary stream that discharge to Indian Springs Creek. At the time of the dye pour, springs 28A0130 and 28A0131 were not being monitored since we did not know about their existence. Mr. Yolton, the owner of spring 28A0086 told us about these springs on 2 November 2010. The site was checked and the springs were located and a charcoal detector was placed in them. Spring 28A132 was not located until 18 November 2010; at that date it was added to the monitoring scheme. Table 1 contains the dye input information, the location information for the sample sites, and the dye detection summary.

Dye tracing entails using fluorescent dyes to track groundwater flow directions and travel times. The dye is poured into a sinking stream or sinkhole; from there it flows through a conduit system until it re-emerges at a spring. Passive samplers, charcoal detectors, summarized as carbon bug analysis in Table 1, were used to trace groundwater flow and were returned to the University of Minnesota Geology & Geophysics Department Hydrochemistry Laboratory for analysis. There, the charcoal detectors were opened, the charcoal was removed, and using an eluent solution of 70% isopropyl alcohol, 30% deionized water, and 10g/L NaOH, the fluorescent materials were then extracted for analysis. The eluent solution was then run through the Shimadzu RF5000U scanning spectrofluorometer to detect and record the spectra. Spectral components, including the background spectral components, were quantified using PeakFit software as described in Alexander (2005). Andrew Luhmann of the University of Minnesota Geology Department performed sample analysis. E. Calvin Alexander and Betty Wheeler interpreted and prepared the data table.

Results & Discussion

Dye was detected at spring 28A131 in the 2-18 November and 18 November-10 December charcoal packets. These results are show as red flow paths in Figure 4. This confirms that Indian Springs Creek is leaking into the St. Lawrence Formation. Springs A130 and A132 had slight quantities of dye but the levels were not conclusive. Because these springs were not monitored until several weeks after the dye pour, dye could have already passed through the system and our samplers caught only the end of the dye cloud in the groundwater system. These springs are all located within a 300 ft. reach of stream and emanate from the basal St. Lawrence or uppermost Lone Rock Formation. The dye detect in Thompson Creek (28X29) from 25 October to 2 November was from the dye pour into the creek. Subsequent positives were from dye discharging at A131 and flowing downstream. Dye was also detected in our samplers in Indian Springs/Thompson Creek (28X30 & 28X31). Those detects were from the initial dye pour or the dye discharging from A131 and are not shown on Figure 4.

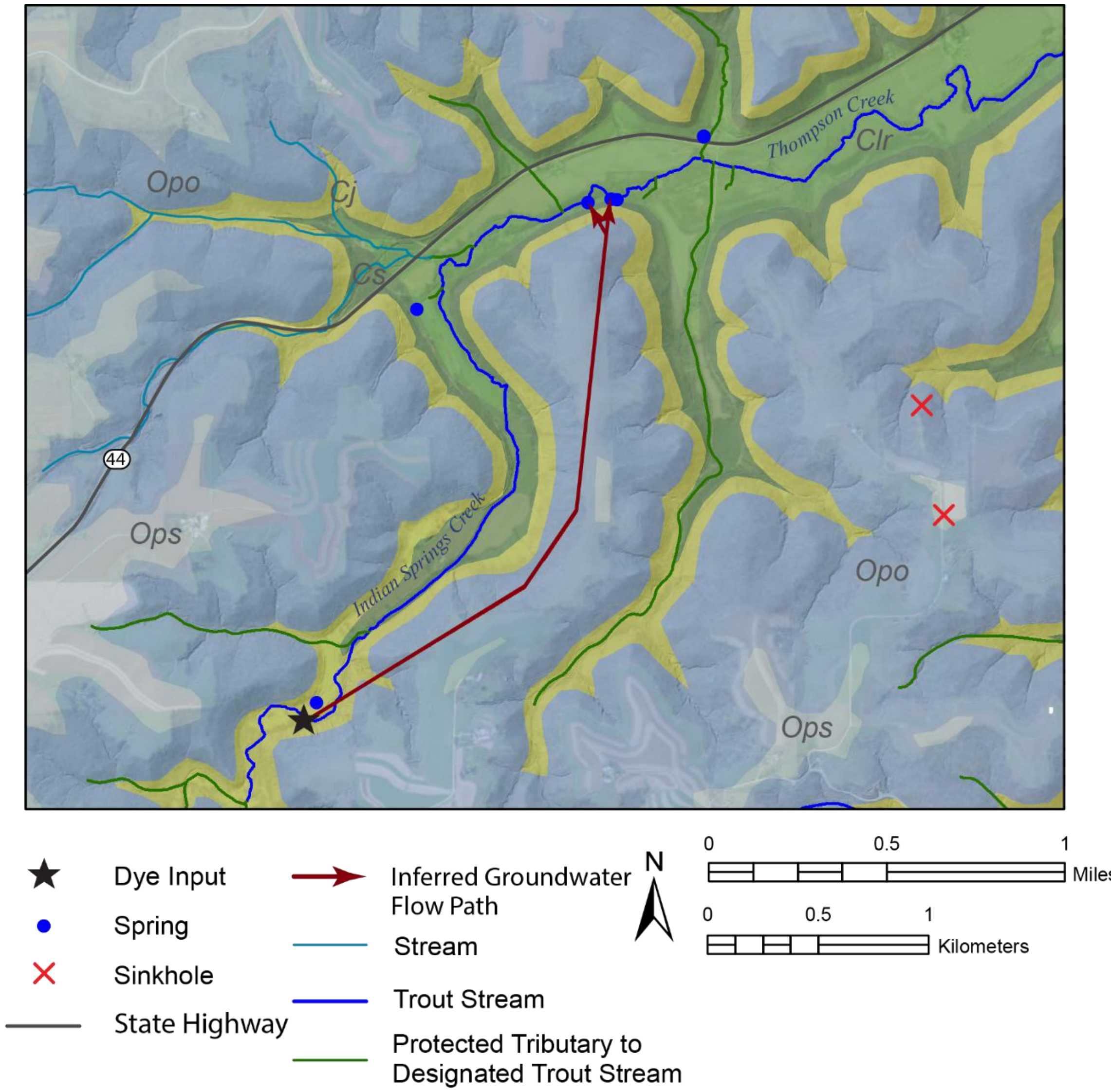

Figure 4. *Inferred Groundwater flow paths*

No dye was detected in any of the three domestic wells that were monitored.

This trace demonstrates that Indian Springs Creek is losing flow into the St. Lawrence Formation. This is occurring without the stream disappearing completely and is another example of streamflow recharging the St. Lawrence/Lone Rock Formations.

Acknowledgements
This work would not have been possible without the cooperation of the Klinski family (owners of Indian Springs and the upper stream reach), Vern Yolton, the Connif family, the Nutt family and Al Fruechte.

References

Alexander SC. 2005. Spectral deconvolution and quantification of natural organic material and fluorescent tracer dyes. In: Beck B, editor, Sinkholes and the Engineering and Environmental Impacts of Karst: Proceedings of the Tenth Multidisciplinary Conference, San Antonio, 24-28 September 2005, ASCE Geotechnical Special Publication 144, Amer. Soc. Civil Engineers, Reston, VA, p. 441-448.

Green JA, Runkel AC, Alexander EC Jr. 2012. Karst conduit flow in the Cambrian St. Lawrence confining unit, southeast Minnesota, USA: Carbonates and Evaporites. 27 (2): 167-172.

Lusardi BA, Adams RS, Hobbs HC. 2014. Surficial Geology, plate 3, Geologic Atlas of Houston County, Minnesota, Minnesota Geological Survey County Atlas C-33, 4 pls. scale 1:100,000.

Runkel AC, Steenberg JR, Tipping RG, Retzler AJ. 2013. Physical hydrogeology of the groundwater-surface water system of southeastern Minnesota and geologic controls on nitrate transport and stream baseflow concentrations: Minnesota Geological Survey report delivered to the Minnesota Pollution control agency, Contract number B50858 (PRJ07522).

Runkel, AC, personal communication, 6 November, 2010

Steenberg JR. 2014. Bedrock Geology, plate 2, Geologic Atlas of Houston County, Minnesota, Minnesota Geological Survey County Atlas C-33, 4 pls., scale 1:100,000.

Surber T. 1920. Streams of Southeastern Minnesota: Root River drainage basin, Lesser Streams of Winona and Houston Counties, Whitewater River Basin. Surveys and Investigations, Minnesota Game & Fish Department. Available on request from the DNR-EWR Groundwater Mapping Unit.

Indian Springs Creek 2010 Dye Trace -- 25 Oct 2010 (1 Trace)

Trace Input: Indian Springs Creek (MN28:X00028, 625,726 E / 4,840,032 N, NAD83, Zone 15)
Poured 1,199.01 grams Uranine HS (35 weight %) into riffle on Indian Springs Creek at 18:10. Dye input point is approximately 20 meters (66 feet) downstream of snowmobile trail crossing.

Field Personnel at Inputs and/or Sampling: Jeff Green.

Lab Personnel: Andrew J. Luhmann, Betty J. Wheeler, Dr. E. Calvin Alexander, Jr.

Carbon (Bug) Analysis Results

Field Name	KFD #	Site Type	UTMs NAD 83, Zone 15		7 Oct to 25 Oct 2010	Dye Input 25 Oct 2010	25 Oct to 2 Nov 2010	2 Nov to 18 Nov 2010	18 Nov to 10 Dec 2010
			Easting	Northing					
Beeson Spring (28A87)	**MN28:A00087**	spring	627,516	4,842,667	Uran * (5 σ) Eos * (4 σ)		Uran * (4 σ)	**nd**	Uran * (8 σ)
Thompson Creek under County Highway 20 bridge (28X29)	**MN28:X00029**	creek	629,928	4,843,487			**Uran (602 σ)** (26 Oct to 2 Nov 2010)	**Uran (102 σ)**	**Uran (30 σ)** Eos * (4 σ)
Spring (28A130)	**MN28:A00130**	spring	627,017	4,842,380				Uran * (8 σ)	Uran * (5 σ)
Spring (28A131)	**MN28:A00131**	spring	627,089	4,842,384				**Uran (114 σ)**	**Uran (94 σ)**
Spring (28A132)	**MN28:A00132**	spring	627,110	4,842,389					Uran * (19 σ)
Dexter Spring (28A86)	**MN28:A00086**	spring	626,218	4,841,888	Uran * (8 σ)		Uran * (5 σ)	Uran * (14 σ)	Uran * (9 σ)
Fruechte Well (bug in toilet tank)	**# 1000005118**	well water	626,747	4,841,257	**nd**		Uran * (3 σ) (25 Oct to 23 Nov 2010)		
Loomis Road Spring Tributary (28X31)	**MN28:X00031**	spring run	627,563	4,842,522			**Uran (11 σ)** (26 Oct to 2 Nov 2010)	**nd**	**lost** (iced in and not retrievable)
Thompson Creek under Loomis Road bridge (28X30)	**MN28:X00030**	creek	627,567	4,842,551			**Uran (85 σ)** (26 Oct to 2 Nov 2010) (diluted)	**lost**	**lost**
Yolton Well (bug in toilet tank)	**MN # 542764**	well water	626,152	4,841,938	**nd** (7 Oct to 26 Oct 2010)		**nd** (25 Oct to 10 Dec 2010)		
Nutt Well (bug in toilet tank)	**# 1000005119**	well water	626,345	4,840,953			**nd** (25 Oct to 24 Nov 2010)		

Uran indicates Uranine (fluorescein) dye detected
Eos * indicates Eosine from some other unknown source
Uran * indicates Uranine (fluorescein) from some other unknown source

nd indicates no dye detected
lost indicates bug was lost in the field
(yellow cell) indicates no bug was received by the lab