Harmony Spring 2008 Dye Trace

May 6, 2008 to June 13, 2008

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Trace Name: Harmony Spring 2008
Trace Purpose: The sinkhole traced from lies near a springshed divide and was traced from in an effort to better delineate the boundary between three separate springsheds.
County: Fillmore
Cooperators: City of Harmony Fire Department, Earth Systems Class - Fillmore Central High School, Kwik Trip of Harmony

Introduction

A dye trace was conducted in an area in the City of Harmony, Minnesota from May 6, 2008 to June 13, 2008 (Figure 1). Numerous dye traces have been completed in this area in the past and this effort was made in order to better delineate the Buggywhip, Hart, and the Big Spring springsheds in this area due to the close proximity of numerous State of Minnesota designated trout streams. Achieving a better understanding of the connection of these sinkholes receiving surface water flow and their connectivity to springs that provide a cold water source for the designated trout streams in the area was the goal of this trace.

Dye tracing entails using fluorescent dyes to track groundwater flow directions and travel times. The dye is poured into a sinkhole or sinking stream; from there, it flows through the karst conduit system until it re-emerges at a spring or springs. For this project, the dye used was Uranine. Both direct water samples and passive dye detectors were used and all the samples were analyzed at the University of Minnesota Geology Department using a Shimadzu scanning spectrofluorophotometer. The trace was designed and executed by Jeff Green and Andrew Peters of MNDNR Waters with help from the City of Harmony Fire Department (which provided water for the trace) and the Earth Systems Class from Fillmore Central High School (Darrin Ellsworth, teacher). E. Calvin Alexander, Jr., Andrew Luhmann, and Scott Alexander of the University of Minnesota Geology Department performed the sample analysis and interpretation.
Results

Prior to dye injection, dye receptors had been placed at all the sampling points to determine background levels of dyes. The dye trace began on May 6, 2008. Table 1 summarizes the dye input information.

<table>
<thead>
<tr>
<th>Dye Input Point</th>
<th>Dye (type, quantity)</th>
<th>Time</th>
<th>Water Input (Est.)</th>
<th>Dye Detection Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinkhole 23:D6526</td>
<td>Uranine C, 881 grams</td>
<td>1649 hrs.</td>
<td>1,500 Gallons</td>
<td>Spring 23:A0237</td>
</tr>
</tbody>
</table>

Table 1: Dye Inputs, Harmony Spring 2008 Dye Trace

Direct water samples were collected and charcoal dye detectors were in place at all sampling locations from the start of the trace until mid-June of 2008. The dye was detected at levels high enough for positive identification. The dye, Uranine C, was detected in the water sample from spring 23:A0237 no more than 23 hours later. This translates to a groundwater flow rate of no greater than approximately 1.8-miles per day. This is consistent with previous traces in this geologic setting (Ordovician Galena limestone).

The dye input point and its known connection from this dye trace in addition to previously completed traces are shown in Figure 2. Through this trace, we have further delineated the springsheds feeding springs 23:A0237, 23:A0358 & 23:A0479. This new trace has expanded the known boundaries of that springshed.
Appendix 1

Figures
Appendix 2

Dye Input

Dye Input Points:

Input Point #1:
Sinkhole D6526:
Minnesota Karst Feature Database Number - MN23:D6526
UTM: 579,853 E, 4,823,346 N
Township, Range, Section: SE ¾ of the SE ¾ of Section 10, T101N, R10W
Elevation: ~1330 feet

At 1649 CDT on 6 May 2008, approximately 881 grams of Uranine dye solution was introduced into an open swallow hole in D6526 with approximately 1,500 gallons of water.
Harmony Dyke Thru
6 May 2008
Background Water samples at
Buggship, Hart, Queen, Cheer
Big Spring, Big Spring East
Background bugs @ these sites

Kuro Trik sinkhole 575853/1823346
Uranite & Chromium 082207-C
554.2 g m + 051807-C
Chromite ch 326.62 gm
554.2
326.6
880.8 gm
Water @ 1643
Dye @ 1649
Water @ 1651
Dye into swallow hole on W side
of sink, ponding, drainage
then this hole, low east side
sink approx 1500 gal water
Appendix 3

Dye Receptors
### Harmony Spring 2008 Dye Trace: May 6, 2008 to June 13, 2008

**Dye Receptor Locations:**

<table>
<thead>
<tr>
<th>Dye Receptor #1:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Spring</td>
<td>Minnesota Karst Feature Database Number - MN23:A0024</td>
</tr>
<tr>
<td>UTM:</td>
<td>576,647 E, 4,824,238 N</td>
</tr>
<tr>
<td>Notes:</td>
<td>Receptor located 10 feet upstream of confluence with Quarry Overflow near steel debris</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dye Receptor #2:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Spring East</td>
<td>Minnesota Karst Feature Database Number - MN23:A0237</td>
</tr>
<tr>
<td>UTM:</td>
<td>577,080 E, 4,823,582 N</td>
</tr>
<tr>
<td>Notes:</td>
<td>Receptor located in riffle just downstream of main spring discharge point</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dye Receptor #3:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hart Spring</td>
<td>Minnesota Karst Feature Database Number - MN23:A0358</td>
</tr>
<tr>
<td>UTM:</td>
<td>577,803 E, 4,826,382 N</td>
</tr>
<tr>
<td>Notes:</td>
<td>Receptor located on south side of road on the west bank of the stream just south of bridge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dye Receptor #4:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Buggy Whip</td>
<td>Minnesota Karst Feature Database Number - MN23:A0479</td>
</tr>
<tr>
<td>UTM:</td>
<td>561,549 E, 4,825,118 N</td>
</tr>
<tr>
<td>Notes:</td>
<td>Receptor located in the culvert discharge on the east side of road</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dye Receptor #5:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarry Overflow</td>
<td>Minnesota Karst Feature Database Number - MN23:X???</td>
</tr>
<tr>
<td>UTM:</td>
<td>576,581 E, 4,824,208 N</td>
</tr>
<tr>
<td>Notes:</td>
<td>Receptor located 10 feet upstream from confluence with Big Spring flow</td>
</tr>
</tbody>
</table>
Appendix 4

Summary of Analytical Results
### Harmony Spring 2008 Dye Trace: Summary of Analytical Results of Carbon Samples

<table>
<thead>
<tr>
<th>Sampling Location</th>
<th>4/9/08 to 5/6/08</th>
<th>5/6/08 to 5/14/08</th>
<th>5/14/08 to 5/22/08</th>
<th>5/22/08 to 6/13/08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Spring</td>
<td>None</td>
<td>Uranine</td>
<td>Uranine</td>
<td>-</td>
</tr>
<tr>
<td>Quarry Overflow</td>
<td>-</td>
<td>Uranine</td>
<td>None</td>
<td>Uranine</td>
</tr>
<tr>
<td>Buggy Whip</td>
<td>-</td>
<td>None</td>
<td>None</td>
<td>-</td>
</tr>
<tr>
<td>Hart Spring</td>
<td>-</td>
<td>-</td>
<td>None</td>
<td>-</td>
</tr>
<tr>
<td>Big Spring East</td>
<td>-</td>
<td>-</td>
<td>Uranine</td>
<td>-</td>
</tr>
</tbody>
</table>

### Harmony Spring 2008 Dye Trace: Summary of Analytical Results of Water Samples

<table>
<thead>
<tr>
<th>Sampling Location</th>
<th>5/6/08</th>
<th>5/7/08</th>
<th>5/8/08</th>
<th>5/9/08</th>
<th>5/14/08</th>
<th>5/22/08</th>
<th>6/13/08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Spring</td>
<td>-</td>
<td>Uranine</td>
<td>Uranine</td>
<td>Uranine</td>
<td>None</td>
<td>None</td>
<td>-</td>
</tr>
<tr>
<td>Quarry Overflow</td>
<td>None</td>
<td>Uranine</td>
<td>Uranine</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Buggy Whip</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>None</td>
</tr>
<tr>
<td>Hart Spring</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>-</td>
<td>-</td>
<td>None</td>
</tr>
<tr>
<td>Big Spring East</td>
<td>None</td>
<td>Uranine</td>
<td>Uranine</td>
<td>Uranine</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
Appendix 5

Scanning Spectrofluorophotometer Results

The following analytical results were completed by project participants associated with the Geology & Geophysics Department at the University of Minnesota. Analysis of the samples was completed by Andrew J. Luhmann and Scott C. Alexander. Interpretation of the analytical results was completed by Jeffrey A. Green, Andrew J. Peters, Andrew J. Luhmann, E. Calvin Alexander, Jr. and Scott C. Alexander.

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Archived file source: Andrew Peters – D:/Documents/Final Trace Reports/Harmony Spring 2008/HarmonySpringTrace All Curves
Sampling Spectrometers/Analyzers Results - Shimadzu RF-5000 and Peak V4.0
Harmony Spring, 9 May 2008 at 14:47

Harmony Spring, Carbon, Big Spring (13), b080514 1533, Out/050522 147

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