

Report of a Dye Trace Investigation, Osmundson Quarry at Grand Meadow, MN, Sept. 1998
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In September of 1998, three student interns and I conducted a dye trace from a sinking stream just south of the quarry. Funding for the dye trace analysis was provided by Mower County. The quarry lies in Sec. 9 T103N R9W. The purpose of the trace was to further our understanding of the nature of groundwater flow in the Devonian Spillville formation which is the formation being extracted in the quarry. Groundwater was emanating from joints and conduits in the southeast corner of the west half of the quarry (Figure 1). This water flows into the quarry sump where it is pumped out into Bear Creek. Water was also discharging into the north part of the quarry. The discharge points in the southeast corner were labeled as springs and are shown in Figure 1. The flow was coming out of lateral joints that had wetted lengths of 30-90 ft. Figure 2 is a close-up photo of one of those joints. Figure 3 shows the conduit pattern in a rock found in the quarry. In place, these conduits are on the bottom of the rock. We theorized that the groundwater we were tracing was flowing through a similar set of conduits.

On 8 Sept. 1998 at 1410 we poured 100 gm. 35% Uranine C liquid into the stream sink 300 m. south of the quarry. The flow was estimated at 0.3 cfs. This was the terminal sinking point. At 1352 we poured 150 gm. of 20% solution Rhodamine WT into Bear Creek at Bridge #50521 immediately upstream of the quarry. The sampling points are shown in Figure 4. Samples were taken at 5-minute intervals @ F1, F2, F3, and F4. These sites were divided further in drips (D) where water was dripping from the lateral fractures and channels (C) where there was a concentrated flow from the quarry face. The biggest discharge appeared to be from F3C followed by F4C.

At 1734 green dye was visible at F3C. Within the next hour it was visible at F3D, F4C and F4D. At 2000 hours dye was visible in the sample bottles at F1 and F2. A dye recovery graph is shown in Figure 5. Scanned copies of a dye recovery curve from multiple sample sites and my original field notes are attached.

The Rhodamine WT was detected in minute quantities (1 ppb or less) in the seeps and sump in the north part of the quarry. This part of the trace was run to determine if the quarry dewatering was pulling water in from Bear Creek. Based on his trace, there is a minor connection.

This dye trace demonstrates that conduit flow is occurring in the Spillville Formation. Our conclusion is that the dye is flowing though the solution-enlarged lateral fractures. The travel time of 100+ meters/hour is consistent with other dye traces we have done in the Devonian limestone karst at LeRoy, MN.

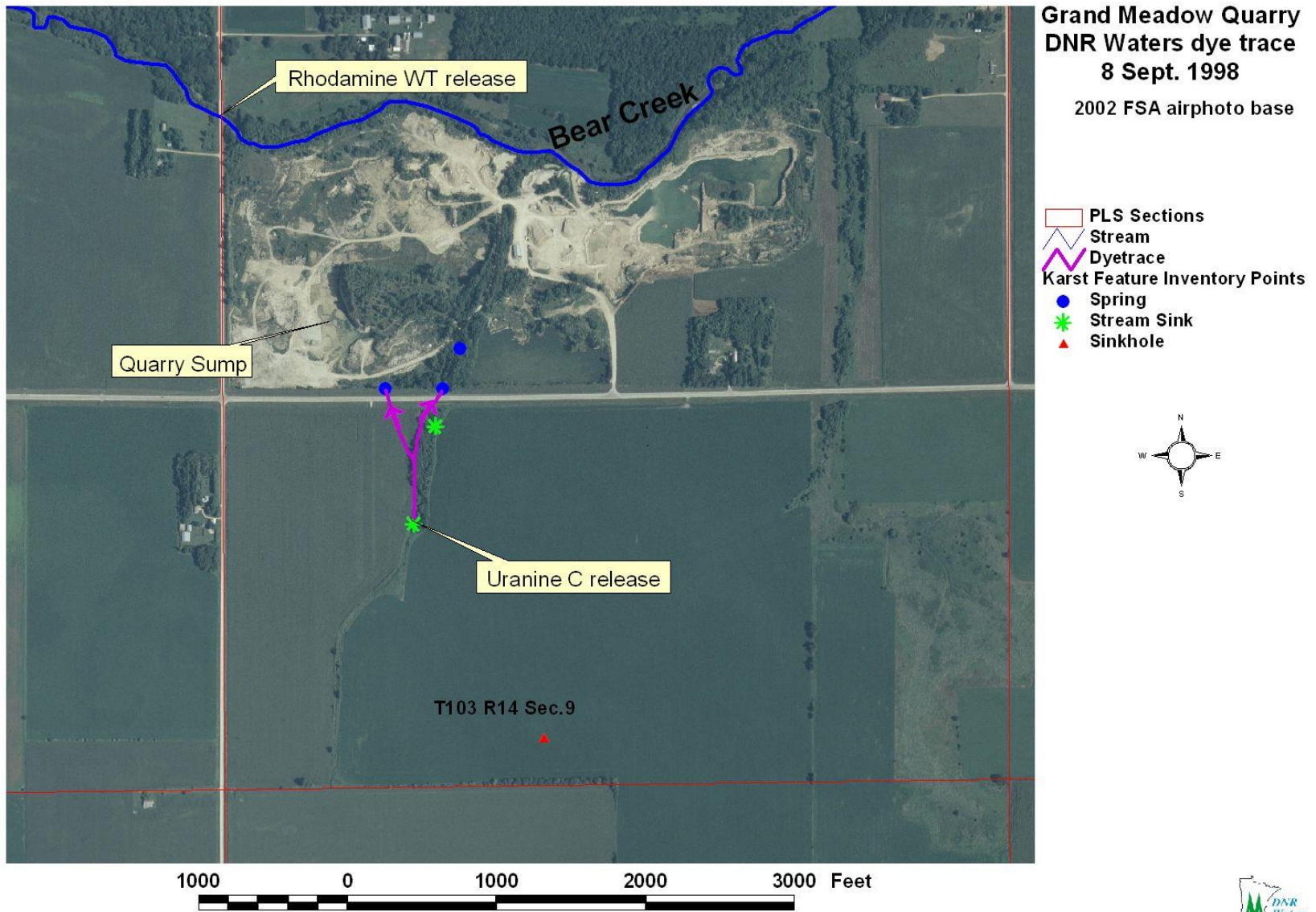


Figure 1. Dye Trace Location Map



Figure 2. Lateral fracture discharge



Figure 3. Solution conduits in the Spillville Limestone. Camera case in upper left for scale.

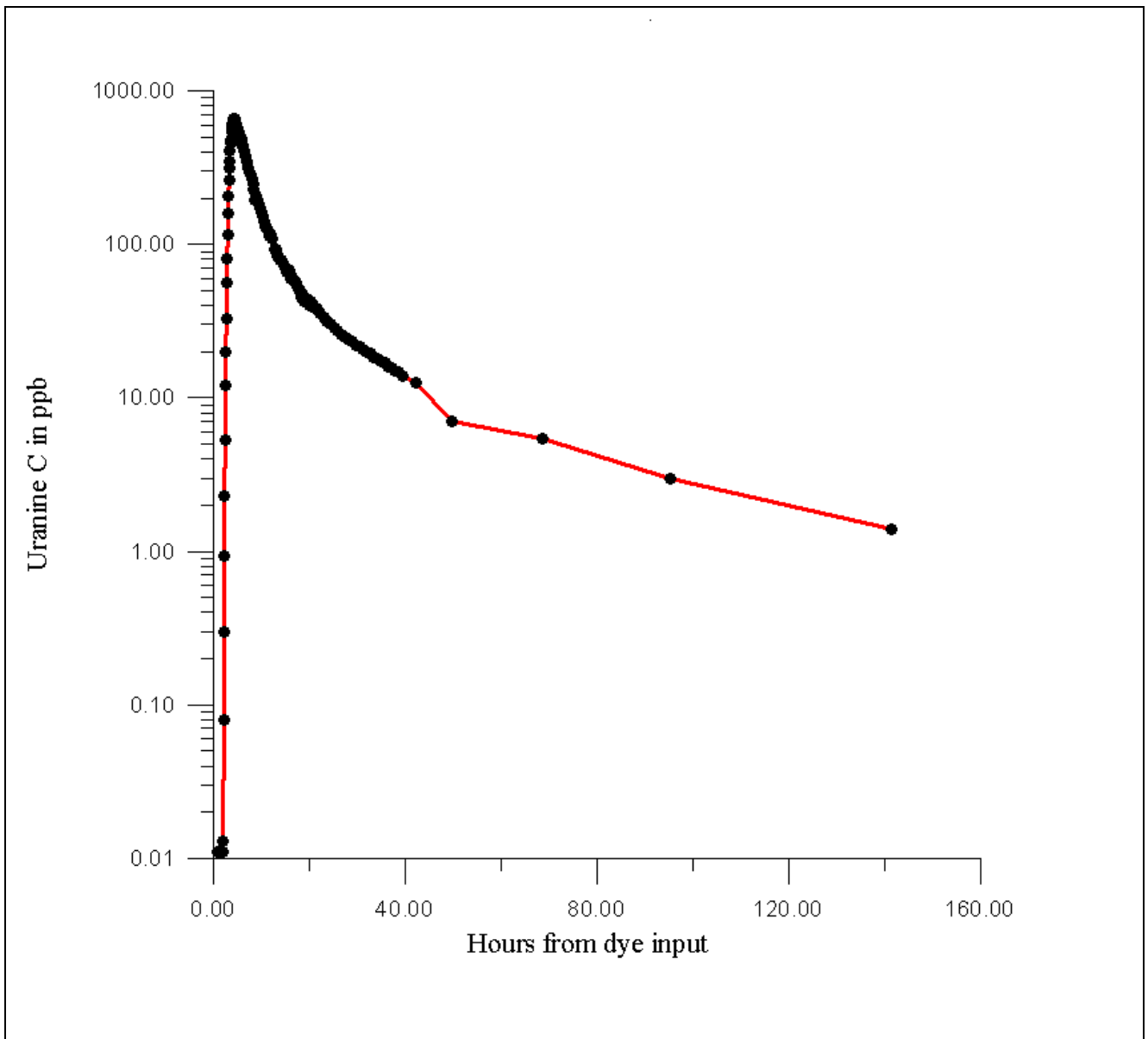
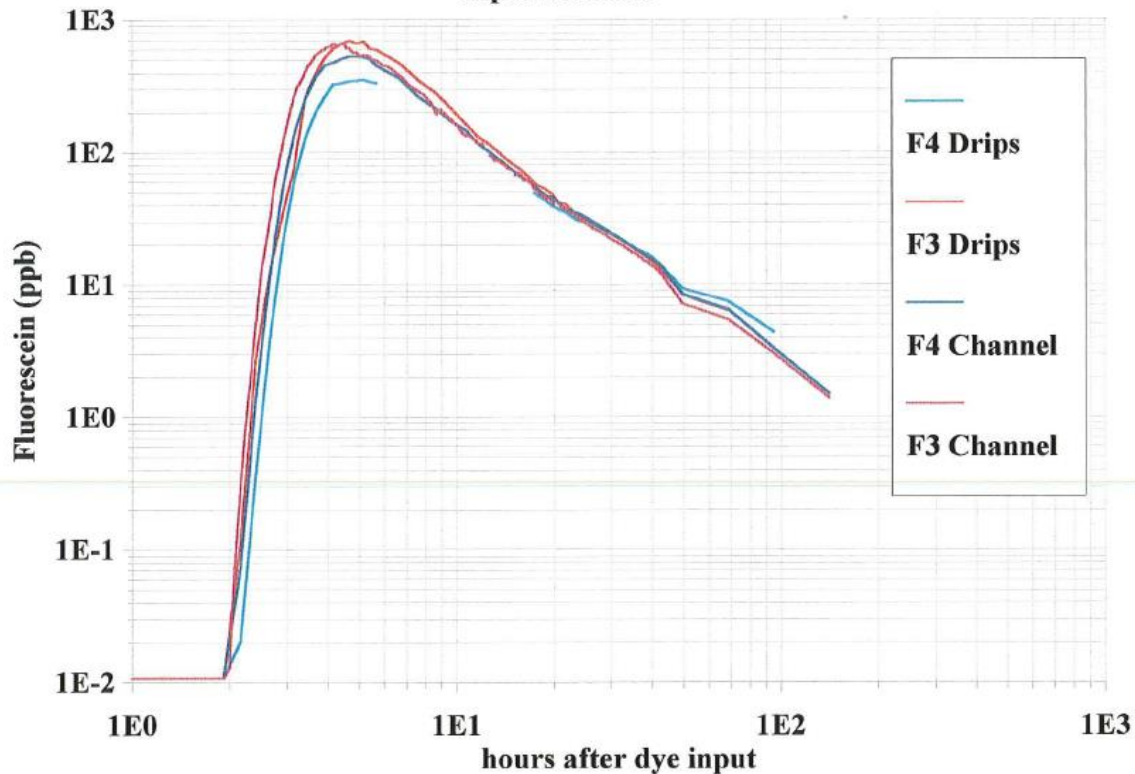


Figure 4. Dye recovery curve

Grand Meadow, Minnesota

September 1998



Grand Meadow - Osmondson's Quarry Traces,
Mower Co. 9-8-98. 5.6 S. Hwy. N.E. T.R.,
Clear, 70 mph light winds
Background logs, field mapping 9-3-98
Conditions have changed since 9-3; several
discharge points are now dry.
We exposed large conduit @ F3/F4.
T103NR9W sect 9

Uranium E 100 µgms liquid @ 1410 on the
dot in dis. stream south of quarry,
Flow est. @ 3 cfs, terminal sink

Rhwt @ Bear Creek bridge u.s. of
quarry (Bridge # 50521)
150 µm 20% solar @ 1352:45
Bugs @ A₁, A₂, A₃ & East Sump

5 minute sampling intervals @ F1, F1D,
F2, F3C, F3D, F4C, F4D began @ 1345

ISCO's @ F3C, F3D, F4C, F4D.

The most prominent discharge point by
an order of magnitude is F3C. Next
largest is F4C. Flow below F3C is
audible but not visible.

F3D, F3C
F2C, F2
F4C, F4D
F1 drips

Dis. stream @ 14.5°C @ 1240
Pond @ 22.2°C @ 1250
F1 @ 13.6°C @ 1515
F2 @ 13.6°C @ 1515
F3C @ 14.0°C @ 1130
F4C @ 14.0°C @ 1130

F4D
F3C
F4D1, F4C1, F4D2

F5C2 20.9°C 9-3-98
F5D2 21.5°C 9-3-98

1734:13 Dye visible @ F3C(2)
with next hour dye visible @ F3D,
F4C, F4D. Dye visible in bottles
of F2C, F2D, F2 by 2000 hrs, may
have been visible earlier.