2012 Summary of Tracing for Four Points in and near the Balcones Canyonlands Sam Hamilton and Bull Creek Preserves

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Abstract

Follow up monitoring was conducted to determine the direction of groundwater migration, approximate flow velocities, and what springs are downgradient of the proposed Four Points Jollyville Transmission Main shaft in the vicinity of Four Points Drive and Riverplace Blvd.. In addition, a new trace was started in July to verify that groundwater flow paths have not been altered by construction of the Four Points shaft. Relatively wet conditions in 2012 keep springs and creeks flowing most of the year and allowed continuation of monitoring. New results show the dye injected in 2011 emerging from only Gaas Spring, just upstream of the Sam Hamilton Preserve, and being detected at two close downstream sites on the main stem of Bull Creek. Preliminary results from the 2012 injected show dye detection in two nearby downgradient monitoring wells, similar to 2011.

Background

Infrastructure related to Water Treatment Plant 4 is proposed near and below the Balcones Canyonlands Sam Hamilton west and Bull Creek Preserves. Greater understanding of groundwater in these areas will help provide data to protect significant resources within the preserve, particularly springs and the aquatic species associated with the springs. Groundwater tracing is a commonly used technique to achieve reliable understanding of groundwater movement in karst systems (Hauwert et al, 2004, Quinlan, 1990, Aley, 1999)

Followup monitoring for the 2011 trace and a single new trace was begun in 2012 at the Four Points shaft site adjacent to the Bull Creek Preserve. A previous tracing study using multiple dyes injected into boreholes located on uplands on the original Bull Creek plant site detected dyes in springs to the north, northwest and east of the site, essentially radiating from the topographic higher uplands. Results also indicate movement of water from the Edwards into the underlying Walnut formation as indicted by tracer detections in spring discharging from the Walnut (CoA, in preparation).

The Four Points shaft is located west of the intersection of River Place Blvd. and Four Points Rd. This area is geologically underlain by the Edwards, Walnut, and Glen Rose Formations. The Edwards commonly contains karst features, including caves, sinkholes, and solution enlarged fractures, ranging in size from millimeters to tens of feet. The karst openings allow rapid recharge of surface water and movement of groundwater from

recharge points to springs. Groundwater migration to springs can be primarily through solution-enlarged conduits in the subsurface. Analysis of outcrops and cores suggest that regional dip for the bedrock is approximately 1 degree or less to the north and northeast (CoA, unpublished data 2010). Limited water level data suggest that groundwater migrates generally in a northeast direction in the Four Points area although there is likely a groundwater divide in the general area of RM 620 separating water moving eastward toward Bull Creek and westward toward Lake Travis (unpublished data, 2010). Locally, shallow groundwater may migrate radially from topographic high ground, as indicated by tracing on the original Bull Creek Plant site (CoA, in preparation).

The Four Points shaft is potentially upgradient of several springs in the headwaters of Bull Creek to the north and east. The closest springs approximately 1,500-2,000 ft away discharge from the Edwards near the contact with the underlying Walnut Formation. Further downgradient, generally northeast, other springs discharge from the Walnut and Glen Rose Formations.

The proposed Four Points shaft will be 36 ft in diameter and over 200 feet deep. Excavation through the Edwards has the potential to intercept conduits carrying groundwater to springs. Mitigation strategies are proposed to minimize groundwater impacts and data from these tracer studies on how rapidly groundwater migrates and which springs could be impacted will assist in evaluating their success in protecting groundwater resources.

Methods

The study area includes undeveloped land for the Balcones Canyonlands Preserve managed by the City of Austin, Travis County and private preserves. In addition, springs and channels in private preserves in the Bull Creek headwaters in the Four Points area were monitored along with sites in the upper reaches of Panther Hollow and adjacent to the current Water Treatment Plant 4 site at RR 620 and Bullick Hollow Road.

For the Four Points trace, an existing monitoring well inside the proposed location of the shaft at the Four Points site was used as a point to introduce environmentally safe fluorescein dye to the water table. The well was completed with 11.5 ft of casing and as an open hole to a depth of 90 ft below ground surface or approximately 5 feet into the Walnut formation. The water table at the time of injection was approximately 81.2 ft below ground surface. Approximately 20 gallons of non-potable water from Lake Austin was used to wet the inside of the well casing to reduce attenuation of the dye. A peristaltic pump transferred three pounds of fluorescein dye mixed into five gallons of water from a carboy into the well. Approximately 250 gallons of non-potable water were used to flush the dye down the well and into the rock formation. An additional injection was conducted July 22, 2012 of two pounds of rhodamine WT dye with over 2,000 gallons of water (Photo 1). The dye was introduced into a permeable ring (a porous donut or “french drain”) constructed at the water table at the Edwards/Walnut contact.

Since the Four Points injection site is located on or very close to an apparent groundwater divide, monitoring attempted to cover all reasonable directions of groundwater migration

to the north, east, south, and west. However, access was not granted for two springs on a private preserve north of the site. Channel sites were monitored downstream of these springs.

Four Points monitoring locations include (Photo 2):

- Two monitoring wells adjacent to the proposed shaft location
- Three monitoring wells along Riverplace Blvd. south of Four Points Dr.
- Set of springs east of four points in the 3M private preserve
- Powerline Spring on the original Bull Creek plant site.
- Lanier Spring on the north side of Bull Creek in the BCP
- Ribelin Spring (on Tributary 8) in the Sam Hamilton Reserve east (managed by Travis County) on the east side of the original Bull Creek site.
- Two channel sites in Tributary 8 near the upper end of the Sam Hamilton east Reserve
- Channel of Bull Creek at the upstream and downstream of the original Bull Creek site.
- Channel of Bull Creek downstream of Lanier Spring.
- Bull Creek downstream of Pit Spring (approximately 2.2 miles NE)
- Three channel sites adjacent to the current water treatment plant site in unnamed tributaries to Lake Travis
- Two springs and one channel site near the head of Panther Hollow south of the injection site.
- Additionally, a spring and channel sites were added in November 2011 in a newly acquired tract (Gass property) along the main channel of Bull Creek between the existing Sam Hamilton Reserve west and a private preserve along Four Points Dr..

Frequency:

- Receptors were changed every two days for first week and then weekly. Frequency was reduce to every three to four weeks
- Periodic grab water samples were collected with charcoal receptors

Initial dye injection was on March 2, 2011 and the follow up injection was conducted July 22, 2012 and monitoring continues.

Monitoring used a combination of charcoal receptors and grab water samples. Several specific spring outlets and channel sites were monitored. Receptors will be secured using a combination of paper clips and string attached to roots or rocks and small rock bolts in the bedrock channel.

Overall climatic conditions include above average rainfall during most of 2012. Even with this rainfall, creek reaches and some springs dried up several times during the year. The creek hydrograph serves an indicator of general hydraulic conditions affecting groundwater movement over the monitoring period.

Water and charcoal samples were analyzed by the Ozark Underground Laboratory.

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Results

Four Points Trace

Dye injected in the Four Points well in 2011 was detected in multiple wells generally northeast of the injection point and a single spring (Photo 3). Dye was also detected in the main stem of Bull at two sites downstream of the spring. The 2012 trace has been detected in JT112 with an as yet unconfirmed hit in the closer JT128 well (Photo 4).

Following the 2011 trace, dye was first detected in JT112, approximately 140 ft ENE of the injection well, within 46 hours of injection. This equals a travel time equates to a velocity of approximately 3 ft/hr or 72.9 ft/d. This velocity is comparable to that determined from tracing on the original plant site in 2007 (COA in preparation). Dye was also detected in JT128 only 35 ft away from the injection well with first arrival between 46 and 97 hours following injection. These travel times equate to much slower velocities than to JT-112. First arrival velocities were found to be between 0.8 ft/hr (18.3 ft/d) or 0.4 ft/h (8.7 ft/d). Faster groundwater migration velocity to JT112, northeast of the injection well, than to JT128, north of the injection well, suggests a preferential direction of groundwater movement that may be based on regional dip of the geologic units. Access to the Gaas tract upstream of the Sam Hamilton west Reserve was granted in November 2011. Results indicate dye was already present although concentrations had not yet peaked. Assuming dye arrived at the start of monitoring at the spring, equivalent travel time would be about 13.9 ft/d.

By comparison, the 2012 trace was also detected first in JT112, this time between 50 and 76 hours after injection. This travel time equate to a velocity of between 2.8 ft/hr (67.3 ft/d) to 1.8 f/hr (44.2 ft/d). RWT was detected in the JT128 well between 7/22/12 and 7/23/12 followed by over 4 weeks with no further detection until another hit from between 8/29/12 and 9/13/12 (no samples after this date have been analyzed). The 7/22-23 hit is likely due to cross contamination as the receptor we placed immediately following the injection and there we no further hits in the well. However, the 8/29-9/13 hit is tentatively classified as a true hit as fluorescein concentrations also increased in the same sample. Fluorescein was used in the original 2011 trace and was also used to test for leaks in the water table permeable ring after the completion of contact grouting in January 2012. Analysis of additional samples may confirm the detection.

Additionally, dye was detected in wells JT113, 114, and 115, 2,000 ft, 3,000, ft and 4,000 ft respectively away from the injection well. First arrival of dye at these wells is unclear at this time because of inconsistent initial detection of dye. However, detecting dyes in randomly drilled wells as sampled here is unusual. Such consistent hits may be due to 1) strong preferred direction of groundwater movement along regional formation dip, 2) formation characteristics similar to porous media rather than conduit-dominated (Photo 10), 3) cross contamination from another monitoring site, or 4) dye from another source or a combination of these factors.

There have been unconfirmed hits of the fluorescein and eosine as well in some locations. Fluorescein was detected in a single sample from JT101A, a single sample from WTRS west of the WTP4 construction site, in 2 samples from WTST south of the WTP4 site,

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and a single sample from Bull downstream of Pit Spring. It is very unlikely that these detections are due to dye from the 4 Points injection. If dye had migrated over 3,800 ft to these sites near the WPT4 site, the dye would almost certainly be present for longer. For example, eosine is still being detected in RBS2 over five years after dye injections on the original plant site in 2007. Dye detections adjacent to the plant are most likely due to dye from other sources, stormwater runoff from roads and parking lots, or other environmental conditions producing fluorescence at a similar wavelength (Aley, 1999).

Eosine has been detected at a number of sites, some related to recent tracing, others to past tracing and some to unrelated activities. Detections at 3M, Panther Hollow, and two sites adjacent to WTP4 are considered unconfirmed because they have not been verified in follow-up samples. Additionally, eosine (used in other nearby traces) has been detected in a number of sites, including Pit Spring, Bull Creek downstream of Pit Spring, Bull Creek adjacent to the original plant site, Bull downstream of the Ribelin tributary and Ribelin Spring 2. The Bull Creek downstream of Pit Spring, Pit Spring, and Ribelin Spring detections are likely related to tracer studies conducted in 2010 and 2007. Eoscine downstream of the original plant site may be related to injections there in 2007 as well. Since the other detections, such as adjacent to the current WTP4 site, have not been consistently detected in follow-up samples they are likely due to other dye sources or environmental conditions. Dye traveling over 3,800 ft in this aquifer would likely be present in spring water for many weeks. These dyes are also used in many common products which could get into surface or groundwater.

Conclusions

Tracers at the Four Points shaft site have been detected in monitoring wells, a spring and Bull Creek downstream of the spring northeast of the injection well suggesting that regional dip may be a strong factor in groundwater migration direction. Detection of dye in many monitoring wells and observations of the Edwards/Walnut contact in the Four Points shaft suggests that the basal Edwards in this area has characteristics more like a porous media aquifer rather than a conduit-dominated aquifer. A follow up injection in July 2012 has been detected in one and possibly two monitoring wells near the shaft, following the same pattern as the 2011 trace. Additional monitoring is ongoing.

References

Aley, Thomas J., 1999, *The Ozark Underground Laboratory's Groundwater Tracing Handbook.* Ozark Underground Laboratory, Protem, Missouri 35 p.

CoA, in preparation, *Tracing on the Bull Creek Water Treatment Plant 4 Site*.

Hauwert, Nico, David Johns, Thomas Aley, and James Sansom, 2004, *Groundwater Tracing Study of the Barton Springs Segment of the Edwards Aquifer, Southern Travis and Northern Hays Counties, Texas*: Report by the Barton Springs/Edwards Aquifer Conservation District and City of Austin Watershed Protection and Development Review Department. 110 p. and appendices.

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Quinlan, James F., 1990, *Special Problems of Ground-Water Monitoring in Karst Terranes*: Ground Water and Vadose Zone Monitoring, ASTM STP 1053, D. M. Nielsen and A.I. Johnson, Editors, American Society for Testing and Materials, p. 275-304.

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Photo 1. Introducing dye into a standpipe leading to the permeable ring constructed at the Edwards/Walnut contact July 22, 2012. Dye was flushed with approximately 2,300 gallons of water.

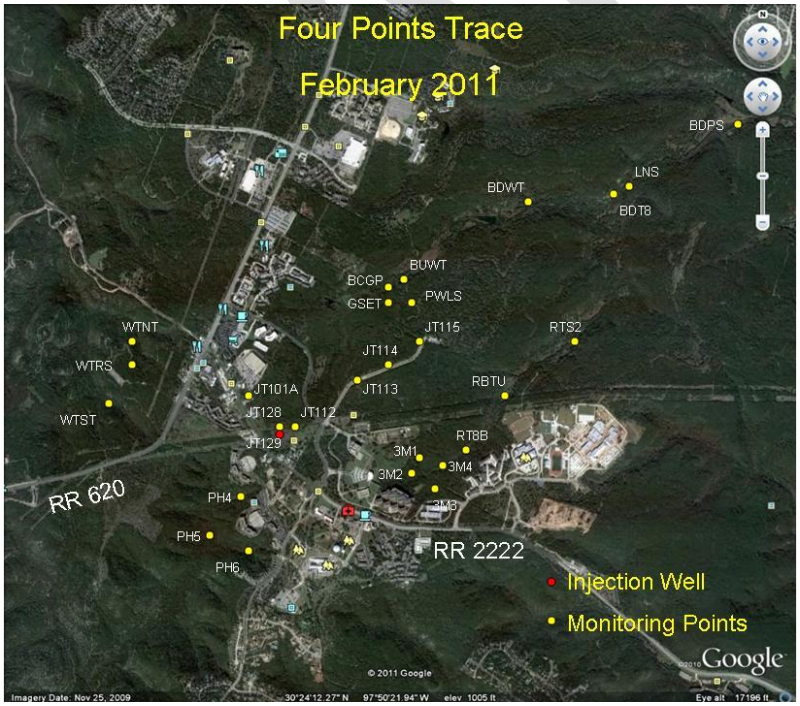

Photo 2. Aerial image of the Four Points area showing location of injection point and monitoring sites.

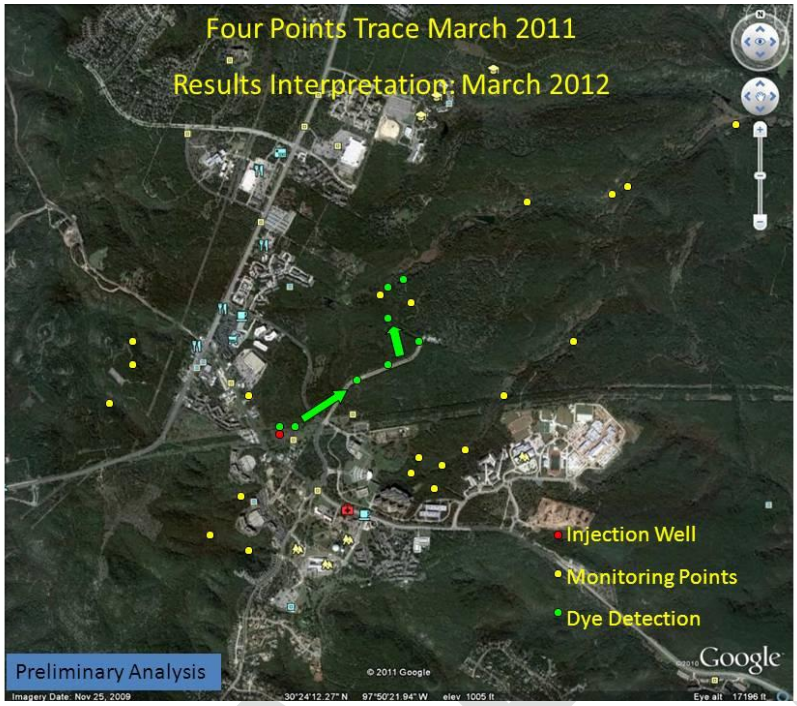

Photo 3. Aerial image of the Four Points area showing location of March 2011injection point, monitoring sites and preliminary interpretation of results.

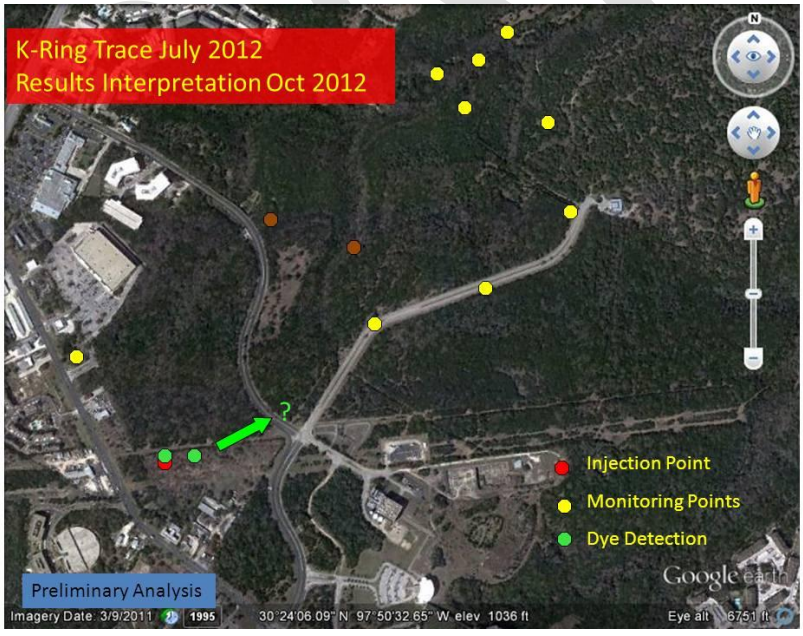

Photo 4. Aerial image of Four Points area showing injection point at current 4 Points shaft and confirmed detections in monitoring wells. The two brown points are springs where only temporary monitoring was possible.