

Dye Tracing Results from the Arbor Trails Sinkhole, Barton Springs Segment of the Edwards Aquifer, Austin, Texas



BSEACD Report of Investigations 2013-0501 May 2013

Barton Springs/Edwards Aquifer Conservation District 1124 Regal Row Austin, Texas

Disclaimer

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Cover. Phloxine B dye injection at Arbor Trails sinkhole. Dye was injected on February 3, 2012 at about 13:00. A mass of 16.27 lbs (7,382g) was mixed with water and then gravity injected via a hose using storm water from an adjacent pond. (see Figure 7).

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ABSTRACT

On January 24, 2012, a 4.5 inch rainfall filled a Storm Water Retention Pond (SWRP) located in the recharge zone of the Barton Springs segment of the Edwards Aquifer with about 10 feet of stormwater. Subsequently, a cover-collapse sinkhole developed within the floor of the SWRP, measuring about 30 ft in diameter and 12 ft deep. About 7 million gallons of stormwater drained into the aquifer through this opening.

To determine the path, velocity, and destination of stormwater entering the sinkhole, a dye trace was conducted. Phloxine B was injected into the sinkhole on February 3, 2012. The dye was detected at one well and arrived at Barton Springs in less than 4 days, corresponding to a minimum velocity of 1.3 mi/day. The successful dye trace confirmed conclusions of previously published reports by demonstrating that the sinkhole is well integrated into the aquifer system, and that groundwater in the study area is within the Sunset Valley Groundwater Basin. Phloxine B proved to be a very good, conservative tracer through the collapsed terra rosa material of the sinkhole.

INTRODUCTION

Sudden cover-collapse sinkhole (doline) development is uncommon in the karstic Cretaceous-age Edwards limestone of central Texas. On January 24, 2012, a 4.5 in rainfall filled a Storm Water Retention Pond (SWRP), located in the recharge zone of the Barton Springs segment of the Edwards Aquifer, with about 10 ft of stormwater. Subsequently, a sinkhole developed within the floor of the SWRP, measuring about 30 ft in diameter and 12 ft deep. About 7 million gallons of stormwater drained into the aquifer through this opening. The sinkhole is located on a commercial development property called Arbor Trails, and hereafter is referred to as the Arbor Trails Sinkhole (ATS). The property is located southwest of the intersection of William Cannon Dr. and MoPac (Loop 1) within the recharge zone of the Barton Springs segment of the Edwards Aquifer (**Figure 1**).



Figure 1. Location map of the study area. Indicated are the Brush Country well (BC well) and a USGS stream gage station on Williamson Creek.

The ATS is located near a groundwater basin divide (Cold Springs and Sunset Valley basins) defined by previous studies and dye tracing by Hauwert et al., 2004 (**Figure 2**). The purpose of the dye trace is to understand whether water that entered the ATS flowed north to Cold Springs, or northeast to Barton Springs. Understanding groundwater flow in the area is important as it contains relatively dense urban development with large highways and roads that could be potential sources of contaminants. Understanding the flow routes can help agencies notify existing groundwater users and to know which spring would be impacted in the event of a spill. Barton Springs is a major recreational destination for

the City of Austin and is habitat for the endangered Barton Springs salamander. The ATS provided an opportunity to trace groundwater flow and better delineate and define groundwater flow in the area.

The dye trace study was conducted by the Barton Springs/Edwards Aquifer Conservation District (District) and the City of Austin (CoA). District staff injected 16.3 lbs of Phloxine B dye into the ATS on February 3, 2012. The dye was detected at one well and Barton Springs within a few days. Results of the trace indicate rapid groundwater flow from the injection site to Barton Springs and confirms that the area is part of the Sunset Valley Groundwater basin as previously defined by Hauwert et al., 2004.

This report documents the dye trace study conducted at this feature. The reader is referred to Hunt et al., 2013, to learn more about the ATS and its mitigation.

Previous Work

Previous groundwater dye tracing studies that established major flow paths and also groundwater basins within the aquifer were published by Hauwert et al., 2004. The ATS is located near a groundwater divide between the Cold Springs and Sunset Valley basins. Whirlpool Cave is located 0.5 miles southwest of the ATS. In 1999 5 lbs of Eosine dye were traced from Whirlpool Cave to Upper and Main Barton Springs in 3-4 days. In 1997 10 lbs of Rhodamine WT (RWT) were injected into a monitor well located in the middle of Williamson Creek (BC well, **Figure 2**), which is located 0.5 miles north of the ATS. Dye arrived from the BC well at Cold Springs in less than 8 days (Hauwert et al., 2004). These two features, along with other traces and data, helped define the groundwater basins known as the Cold Springs and Sunset Valley Groundwater Basins (**Figure 2**).



Figure 2. Summary of previous dye tracing in the area and the delineation of groundwater basins. Note the Arbor Trails Sinkhole is located very close to the estimated groundwater divide between the Cold Springs and Sunset Valley basins. WC is whirlpool cave and BC is Brush Country Well.

Setting

The ATS is located within the recharge zone of the Barton Springs segment of the Edwards Aquifer (Figures 1 and 2). The 72-acre property was developed in accordance with City of Austin's Land Development Code and the State of Texas requirements (Chapter 213 Edwards Rules). Review of topographic contours from the City of Austin 2-ft contour maps dated 1981 prior to MoPac (Loop 1) reveals a very shallow and large (6 acre) depression centered on the SWRP (Figure 3). The contours are present but more subtle on the 10-ft contour USGS quadrangle map of the area. The area appears well drained with no ponded water features evident in the aerial photos, and hardwood trees are present. However, the subdued nature of the feature and the subsequent disturbance from the highway that bisected the eastern portion of the depression made detection of the feature in the field difficult.

As part of the site engineering studies, geotechnical cores and borings were conducted throughout the site. I the preliminary geotechnical studies, 6-m (20-ft) deep cores were collected near the ATS (B-8 and B-9; **Figure 3**). The core holes and borings extended to the same depth as the final SWRP excavation depth. Both cores returned rock quality designation (RQD) of very poor to incompetent rock. Both cores indicated lost fluids within the first 10 feet and solution channels and small voids (HBC/Terracon, 2005), consistent with epikarst.

The location of the SWRP for the Arbor Trails development is shown in **Figure 4.** The purpose of the SWRP is to capture storm runoff from impervious areas (buildings and parking lots) and then irrigate vegetative areas throughout the property with the stormwater. The SWRP consists of two water quality controls: a geomembrane-lined wet pond, inset within a compacted clay-lined retention pond. The wet pond has a forebay and main permanent pool area that are separated by a berm. The wet pond was constructed for aesthetics within the retention basin. The retention pond has its capture volume above the permanent pool elevation for the wet pond. The capture volume for the retention pond extends up 6 ft onto the slope areas of the basin. The retention pond is the actual permitted water-quality control structure for the surrounding shopping center. During a rain event, stormwater captured by the retention basin is held and then used to irrigate vegetated areas throughout the property within 72 hours.



Figure 3. Predevelopment topographic map. Basemap is USGS Oak Hill Quadrangle (10-ft contours in brown). Geologic information from HBC/Terracon (2004) and likely sourced from Small et al., 1996. Black lines are City of Austin 2-ft topographic contours dated 1981, prior to major highway construction (MoPac). Contours create a depression centered around the SWRP, shown as dashed lines.



Figure 4. Detailed site map with key elements of the stormwater retention pond (SWRP), sinkhole location, and 2012 geophysics and boreholes.

Hydrologic Conditions and Sinkhole Collapse

Prior to collapse of the ATS, central Texas had been experiencing a severe drought. Beginning in late January, rainfall and subsequent recharge brought the aquifer out of drought conditions. **Figure 5** illustrates the rainfall, runoff, and response of wells and springs to the recharge. On January 24, 2012 a 4.5 in rainfall event occurred in the area of the Arbor Trails development filling, the SWRP with about 10 ft of water. On January 25, 2012, maintenance crews noticed the pond was draining into a developing sinkhole (**Figure 6a**). The size of the sinkhole was about 30 ft in diameter and 12 ft deep. About 7 million gallons of storm water drained into the aquifer through this opening. It is possible the drought and desiccation of the clay liner in the pond contributed to the compromise of the SWRP and development of the sinkhole.

A significant increase in turbidity at Barton Springs is associated with the late January rainfall (and March rainfall; **Figure 5**). These types of increases are relatively common in this karst system. District staff observed the runoff and recharge into swallets (Brodie Cave) within nearby tributaries of Slaughter

Creek from the same rainfall event that triggered the collapse of the ATS. It was noted that the stormwater entering those features was very turbid. Accordingly, the jump in turbidity cannot be solely attributed to the failure of the SWRP.

After the collapse, the sinkhole was further characterized by ACI Consulting (Austin, TX) through excavation, surface geophysics, and borehole drilling. These studies are discussed in Hunt et al. (2013). The ATS was excavated to a total depth of 21 feet. Most of the geologic material in the sinkhole consisted of friable, highly altered (weathered) clayey limestone and terra rosa, an iron-rich clay soil. Very little competent bedrock was encountered in the excavations. Solution fractures in the ATS were observed to have a NNE strike. Steep (~30 degree) west-dipping limestone beds in the ATS and along strike behind the northern retaining wall, were observed (**Figure 6**). The highly altered, fractured, and dipping nature of the rocks along strike supports the presence of the inferred mapped fault zones (**Figure 3**).



Figure 5: Hydrograph showing rainfall, streamflow, and Barton Springs flow with conductivity and turbidity. Time of sinkhole collapse and dye injection indicated.



Figure 6. Photographs of sinkhole, all photos facing north. A) photo taken the day the sinkhole was observed (credit Heather Beatty, TCEQ). B) Photo taken two days after collapse and prior to excavation. Note the limestone beds are dipping to the west. C) Photo showing solutioned fracture in bedrock overlain by terra rosa and clay liner.

DYE TRACING METHODS

Groundwater dye tracing involves the introduction of non-toxic, organic dyes into the subsurface via injection points, such as caves, sinkholes, and wells, and analyzing charcoal receptors and water samples taken from discharge points, such as wells and springs. Alexander and Quinlan (1992) and Alley (1999) discuss the methodology of groundwater tracing with dyes.

Groundwater Tracers (Phloxine B)

Phloxine B dye used in this study was selected because it is nontoxic, inexpensive, widely tested and used, and easily detected by its fluorescence. The dye has been evaluated to be suitable for this and other studies due to its physical characteristics, safety for drinking water supplies, and aquatic habitats, and low background concentrations (Smart, 1984; Field et al., 1995).

Phloxine B has been used extensively in the San Antonio segment of the Edwards Aquifer (Johnson et al., 2012), but it has not been used in the Barton Springs segment. **Table 1** lists the molecular weight and emission wavelength of Phloxine B. The amount that was injected was consistent with previous injections (Hauwert et al., 2004) for the given location, distance, and hydrologic conditions. In addition, few public water supply systems are located along the expected flow paths, so that visible concentrations were less of a concern.

Table 1. Chemical Characteristics of Dyes

Common Name	Color Index Generic Name	Molecular Weight	CAS Number	Emission Wavelength (nm)
Phloxine B	Acid Red 92	829.63	18472-87-2	541

from Johnson et al., (2012)

Injection

A mass of 16.3 lbs (7,382 grams) of Phloxine B Dye was injected on February 3, 2012, at about 13:00. The dye was in powder form and was mixed with water at the ATS site. The dye solution was mixed with water from the adjacent storm water pond and gravity injected into the sinkhole with a hose and PVC pipe that was placed in the bottom of the sinkhole where the dye solution infiltrated. About 5,000 gallons of water was pumped from the adjacent storm water pond to flush the dye into the feature (**Figure 7**).



Figure 7. Phloxine B dye injection at the Arbor Trails Sinkhole. Dye was injected on February 3, 2012, at about 13:00. A mass of 16.27 lbs (7,382g) was mixed with water and then gravity injected via a hose using storm water from an adjacent pond.

Sampling

Samples were collected by the District and CoA during the course of this study. Staff who injected the dye were not involved in sample collection. Sampling supplies were provided by the respective labs, and sampling procedures outlined by Ozark Underground Labs (OUL) were followed (Aley, 1999; Hauwert et al., 2004). Field control samples were carried by staff collecting samples.

Spring sampling locations were monitored by the City of Austin and included Barton Springs (Main, Eliza, Upper, and Old Mill spring outlets) and Cold Springs (**Figure 2**). From 2/3/12 to 3/5/12 ten wells were monitored by the BSEACD weekly for the presence or absence of dyes in groundwater using charcoal samples (**Table 3**). No background charcoal samples were in place prior to injection.

Barton Springs sites were monitored from 2/2/12 to 3/13/12 with charcoal receptors. No background receptors were in place prior to injection. However, grab samples taken on 2/2/12 were non-detect for Phloxine B. After injection of the dye, charcoal receptors were collected approximately daily beginning 2/7/12. Grab samples were taken when receptors were changed. In addition, water samples were taken from an ISCO 3700 Automatic Compact Sampler at 4- to 8-hour intervals at Upper Barton Springs from 2/7/12 to 2/25/12. Charcoal and grab samples from Cold Springs were collected weekly between 2/3/12 and 3/13/12. No background receptors were in place at Cold Springs prior to injection, but water samples collected on 2/3/12 were non-detect for Phloxine B.

Laboratories

Receptors and grab samples from springs were analyzed at the Edwards Aquifer Authority (EAA), and replicate samples were analyzed at OUL in Missouri. Detection limits are provided in **Table 2**. Below is a brief narrative of each laboratory's methods.

	Water Detection Limit (ug/L or ppb)	Charcoal Detection Limit (ug/L or ppb)
EAA	0.044	0.044
OUL	0.004	0.004

Table 2. Reported Detection Limits for Phloxine B

Edwards Aquifer Authority

For analyses at the EAA, dye was extracted from charcoal receptors prior to analysis by eluting the charcoal (desorbing the dye) for one hour in a solution containing 95% of a 70% solution of 2-propanol in water and 5% sodium hydroxide. Phloxine B in vials and eluents from charcoal were analyzed in the laboratory with a Perkin Elmer LS-50B Luminescence Spectrometer using synchronous scan and right-angle sampling geometry. The scan spanned 401 to 650 nm at 0.5-nm intervals (covering Eosine, Uranine, and Phloxine B), with a difference between excitation and emission wavelengths (delta lambda) of 15 nm and emission and excitation slits set at 6 nm (see Narrative **Appendix 1**).

Results of the analysis are recorded in intensity units and converted to concentrations by comparison with known standards. Three standards were prepared for each of the three dyes detected in the tracer tests. Dye solutions were prepared on the basis of mass and diluted with deionized water filtered

through a 0.2-micron filter to produce dye concentrations in the range that were expected in the water samples (see Narrative **Appendix 1**).

Detection limits for each dye were calculated from background fluorescence of naturally occurring fluorophores and instrument noise, following the method of Alexander (2005). The method defines limits of detection (LOD) and quantitation (LOQ) as three and ten times the fit standard error of background fluorescence, respectively. Water samples were selected that contained dyes at concentrations just above background fluorescence to calculate LOD and LOQ, and fit standard error was calculated using peak-fitting software (see Narrative **Appendix 1**).

Ozark Underground Labs

OUL does not routinely analyze for Phloxine B dye. However, the lab did the analyses and followed procedures established for the analyses of other dyes (such as Pyranine). OUL elutes charcoal in a mixture of 5% aqua ammonia and 95% isopropyl alcohol solution and sufficient potassium hydroxide flakes to saturate the solution for most dyes. The isopropyl alcohol solution is 70% alcohol and 30% water. The aqua ammonia solution is 29% ammonia. The potassium hydroxide is added until a super-saturated layer is visible in the bottom of the container. Fifteen ml of the eluting solution is poured over washed charcoal in a disposable sample beaker. The sample beaker is capped, allowed to stand for 60 minutes, and then the liquid is carefully poured off the charcoal into a new disposable beaker which has been appropriately labeled with the laboratory identification number (Aley, 2008).

OUL analyzes water and eluent samples on one of two Shimadzu spectrofluorophotometers: model RF-5000U or RF-5301. The RF-5301 is the primary instrument used; the RF-5000U is primarily used as a back-up instrument except for tracing studies which were begun using this instrument. Approximately 3 ml of the eluent is withdrawn from the sample container using a disposable polyethylene pipette, placed in a transparent, disposable rectangular polystyrene cuvette designed for fluorometric analysis, and then inserted into the RF-5000U or the RF-5301. Positive detections will have peak emission wavelengths in the range from about 573 to 578 nm.

A sample of the dye was shipped to OUL. To calculate detection limits OUL normally uses a sizeable collection of data. However, this data set did not exist for Phloxine B. However, the fluorescence peaks for Phloxine B are about 4 times larger per ppb of dye concentration than are the peaks for Pyranine. The detection limit in elutants is 0.015 ppb for Pyranine, so the estimated detection limit for Phloxine B is about 25% of that or 0.004 ppb. (Tom Alley, personal communication, 8/20/12).

Quality Control

Field control samples were carried by staff collecting samples. Eight field control samples were analyzed by the EAA and were non-detect for Phloxine B.

Split samples were taken from each site and sent for analyses to the EAA and OUL labs. Laboratory quality control procedures included dye standards, duplicate and replicate samples, distilled water blanks, and rinsate samples described in Johnson et al. (2012).

RESULTS

Lab results from the EAA and OUL are presented in **Appendix 1 and 2**, respectively. Results of the dye trace are summarized in **Table 3**. Breakthrough curves for three sites are shown in **Figures 8**. Interpreted flow paths are presented in **Figure 9**.

Table	3:	Sites	monitored	and	results
		0.000			

Site ID	Site Name	Туре	Ddlat	Ddlong	Linear Distance from Injection (miles)	First Dye Arrival (days)	Pumping Well	Comment
Positive								
183A	Upper Barton	Spring	30.263563	-97.774216	4.9	< 4	n/a	OUL 2/2-2/7; both labs after 2/7
42914B	Main Barton	Spring	30.263683	-97.770821	5.1	< 4	n/a	Both labs 2/2-2/7 and after
5850207	Ashbaugh	Domestic (Irrigation only) Well	30.217596	-97.822845	1.0	< 7	yes	OUL 2/6-2/10; both labs 2/10- 2/16
Tentative								
42921B	Eliza	Spring	30.264278	-97.770172	5.1	< 8 T	n/a	possible EAA detection 2/9-2/11
5850230	Picard	Domestic Well	30.226685	-97.809219	1.9	< 7 T	yes	possible EAA detection 2/6-2/10
58501GR	Randalls	Monitor Well	30.223333	-97.835281	0.4	< 3 T	no	possible EAA detection 2/3-2/6
58502B	6200 Brodie	Domestic Well	30.221865	-97.826498	0.8	< 3 T	yes	possible EAA detection 2/3-2/6
Non- Detects								
42916C	Cold Spring	Spring	30.279593	-97.780434	5.4	ND	n/a	
58502SC	Schaffer	Abandoned well	30.221682	-97.828135	0.7	ND	no	
42922B	Old Mill	Spring	30.26354	-97.768066	5.2	ND	n/a	
5850235	Holiday Inn	Monitor Well	30.234873	-97.814096	1.8	ND	no	
5850212	Sunset MW	Monitor Well	30.225475	-97.806183	2.0	ND	no	
5850222	Besse	Domestic Well	30.217216	-97.818794	1.3	ND	yes	
58502JR	Jenkins	Domestic Well	30.217044	-97.817631	1.4	ND	yes	
5850128	Whirlpool	Monitor Well	30.215555	-97.847221	0.5	ND	no	

ND = Non-detect; T = tentative



Figure 8. Phloxine B breakthrough graphs from the study. Both labs repeatedly detected Phloxine B at these three sites in charcoal samples. Additionally OUL detected dye in water samples from the three sites. A) Ashbaugh well, the only well monitoring site with both labs returning positive results; B) Upper Barton Springs contained the highest concentrations of dye from both labs; and C) Main Barton Springs consistently had positive results from both labs. Note that "ND" indicates a non-detect and "ns" indicates no sample.



Figure 9. Map of results from the Arbor Trails Sinkhole dye trace. Pink circles indicate positive detections (very high confidence, both labs) of Phloxine B. White circles are wells with tentative detections (single detections from EAA lab), and solid black circles are locations with non-detects (both labs). Dashed pink line represents estimated flow route and is coincident with the "Sunset Valley Flow Route" defined by Hauwert et al., 2004. Small gray circles are existing water-supply wells. Light gray potentiometric lines are from February 2002 high flow conditions.

DISCUSSION

Although no background charcoal samples were in place prior to injection, grab samples analyzed the day before, and the day of, the injection were non-detect. In addition, Phloxine B has never been utilized as a fluorescent dye in the Barton Springs segment of the Edwards Aquifer. Accordingly, background concentrations were not a major concern for this study.

The first arrival of the Phloxine B dye was not well defined by sampling at Barton Springs. Charcoal receptors were placed at Upper and Main springs from 2/3-2/7, and both had a positive dye detection. Although we report a 4 day minimum travel time, OUL labs interpreted the first arrival at Barton Springs within 2 days (Tom Alley, personal communication).

Duplicate samples from the EAA and OUL were generally in agreement. Both labs repeatedly detected Phloxine B at the Ashbaugh well, Upper Barton Springs, and Main Barton Springs. However, there were detections reported by OUL that were not reported by the EAA. This is particularly true for water samples. The lower detection limit for the OUL lab (one order of magnitude lower) offers one explanation of the differences in results.

However, the EAA lab indicated dye at four additional sites not reported by OUL, but only from one sample at each site. Both labs re-evaluated their respective samples and did not change their reported results (**Appendix 3**). For the purposes of this study, those sites are listed as tentative detections (**Table 3**).

CONCLUSIONS

- Results of this study were similar to other dye trace studies in this area by Hauwert et al., 2004.
- Rapid travel time (1.3 mi/day at a minimum) was documented from the ATS to Barton Springs.
- Groundwater flow from the William Cannon and MoPac area was within the Sunset Valley Groundwater Basin as delineated by Hauwert et al., 2004.
- Subtle karst features near fault zones, expressed as closed surface depressions, can be very well integrated into the conduit flow system.
- Phloxine B was a very good conservative tracer through the collapsed terra rosa material in the ATS.

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Appendices

- Appendix 1: Dye Trace Results EAA
- **Appendix 2: Dye Trace Results OUL**
- **Appendix 3: Correspondence on confirmation of results**

Appendices 1: Dye Trace Results EAA

Arbor Trails Sinkhole Results

Narrative

Edwards Aquifer Authority (EAA) analyzed 201 samples submitted by Barton Springs Edwards Aquifer Conservation District (BSEACD) from the Arbor Trails Sinkhole project. Although vials from autosamplers and grab samples required no preparation before analysis, dye must be extracted from charcoal receptors prior to analysis by eluting the charcoal (desorbing the dye) for one hour in a solution containing 95% of a 70% solution of 2-propanol in water and 5% sodium hydroxide. The eluent was then decanted into a labeled glass vial and stored in darkness until analyzed.

Uranine, Phloxine B, and Eosin in vials and eluents from charcoal were analyzed in the laboratory with a Perkin Elmer LS-50B Luminescence Spectrometer using synchronous scan and right-angle sampling geometry. The scan spanned 401 to 650 nm at 0.5-nm intervals, with a difference between excitation and emission wavelengths (delta lambda) of 15 nm and emission and excitation slits set at 6 nm.

Dye Standards

Results of the analysis are recorded in intensity units and converted to concentrations by comparison with known standards. Three standards were prepared for each of the three dyes detected in the tracer tests. Dye solutions were prepared on the basis of mass and diluted with deionized water filtered through a 0.2-micron filter to produce dye concentrations in the range that was expected in the water samples. To convert intensity to concentration, a power regression was calculated between intensity units and standard concentrations. For example, Figure 1 shows power regression of Uranine concentrations versus amplitude.



Figure 1. Power Regression for Uranine

Detection Limits

Detection and quantitation limits for each dye were calculated from background fluorescence of naturally occurring fluorophores and instrument noise, following the method of Alexander (2005). The method defines limits of detection (LOD) and quantitation (LOQ) as three and 10 times the fit standard error of background fluorescence, respectively. Water samples were selected that contained dyes at concentrations just above background fluorescence to calculate LOD and LOQ, and fit standard error was calculated using peak-fitting software. For example, Figure 2 shows original intensities, separated dye peaks, and calculated LODs and LOQs for each dye. Using regression equations yields the limits of detection and quantitation for each dye in Table 1.



Figure 2. Example of Peak Used for LOD

Table 1. Limits of Detection and	Quantitation for the Dyes
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Dye	Sample	Fit Standard Error	Limit of Detection (µg/L)	Limit of Quantitation (µg/L)
Uranine (charcoal)	Upper Barton 2/11/2012 1:05:00 PM	0.54	0.0061	0.020
Eosin (charcoal)	42916B 2/16/2012 2:14:00 PM	0.77	0.068	0.23
Phloxine B (charcoal)	Upper Barton 2/11/2012 1:05:00 PM	0.54	0.044	0.15
Phloxine B (water)	Upper Barton 2/19/2012 9:00:00 AM	0.54	0.044	0.15

Control Samples

One control sample (February 1, 2012; sample 100) of charcoal contained detectable concentrations of Uranine and Phloxine B because it was processed differently than the other charcoal samples. A contaminated pipettor was used to transfer eluent into a vial for analysis to avoid introducing suspended particles of charcoal into the vial. The normal procedure is to pour eluent from the desorption cup into a vial. When the analyst observed dye in the results, he prepared a new sample from the remaining charcoal and poured eluent into a vial for analysis. The second sample contained no detectable dyes. Consequently, none of the sample results were compromised.

References

Alexander, S.C. 2005, *Spectral deconvolution and quantification of natural organic material and fluorescent tracer dyes.* In: Sinkholes and the engineering and environmental impacts of karst: Proceedings of the 10th Multidisciplinary Conference, September 24–28, San Antonio: ASCE Geotechnical Special Publication No. 144, p. 441–448.

Results for Arbor Trails Sinkhole

Sample No.	Sample	Site Name	Sample Name	Set Date	Collected	Center	Height	FWHM	Peak Area	Dye	Concentration (µg/L)
154	Water	6200 Brodie	58-50-2		2/3/2012 2:10 PM						ND
160	Water	6200 Brodie	58-50-2		2/6/2012 1:02 PM						ND
194	Charcoal	6200 Brodie	58-50-2	2/3/2012 2:10 PM	2/6/2012 1:02 PM	493.2	9.1	31.4	310	Uranine	0.76
194	Charcoal	6200 Brodie	58-50-2	2/3/2012 2:10 PM	2/6/2012 1:02 PM	555.1	0.88	27.9	38.7	Phloxine B	1.4
204	Water	6200 Brodie	58-50-2		2/7/2012						ND
164	Water	6200 Brodie	58-50-2		2/10/2012 2:55 PM						ND
114	Charcoal	6200 Brodie	58-50-2	2/10/2012 2:55 PM	2/10/2012 2:55 PM						ND
124	Charcoal	6200 Brodie	58-50-2	2/16/2012 11:55 AM	2/16/2012 11:55 AM						ND
170	Water	6200 Brodie	58-50-2		2/16/2012 11:55 AM						ND
123	Charcoal	6200 Brodie	58-50-2	2/10/2012 2:45 PM	2/16/2012 12:05 PM						ND
198	Charcoal	6200 Brodie	58-50-2	2/16/2012 11:55 AM	2/23/2012 1:45 PM						ND
214	Charcoal	6200 Brodie	58-50-2	2/23/2012 1:45 PM	3/5/2012 1:30 PM						ND
203	Water	Ashbaugh	58-50-207		2/23/2012 1:35 PM						ND
213	Water	Ashbaugh	58-50-207		3/5/2012 1:10 PM						ND
155	Water	Ashbaugh	58-50-207		2/3/2012 2:17 PM						ND
107	Charcoal	Ashbaugh	58-50-207	2/6/2012 12:53 PM	2/6/2012 12:53 PM						ND
159	Water	Ashbaugh	58-50-207		2/6/2012 12:53 PM						ND
163	Water	Ashbaugh	58-50-207		2/10/2012 2:30 PM						ND
113	Charcoal	Ashbaugh	58-50-207	2/10/2012 2:30 PM	2/10/2012 2:30 PM	546.2	4.9	21.7	126	Phloxine B	4.8
169	Water	Ashbaugh	58-50-207		2/16/2012 11:35 AM						ND
122	Charcoal	Ashbaugh	58-50-207	2/16/2012 11:35 AM	2/16/2012 11:35 AM	546.5	6.3	21.5	191	Phloxine B	7.5
122	Charcoal	Ashbaugh	58-50-207	2/16/2012 11:35 AM	2/16/2012 11:35 AM	496.4	5.6	45.0	268	Uranine	0.67
197	Charcoal	Ashbaugh	58-50-207	2/16/2012 11:35 AM	2/23/2012 1:35 PM						ND
212	Charcoal	Ashbaugh	58-50-207	2/23/2012 1:35 PM	3/5/2012 1:10 PM	546.5	5.4	22.8	174	Phloxine B	6.8
212	Charcoal	Ashbaugh	58-50-207	2/23/2012 1:35 PM	3/5/2012 1:10 PM	546.7	5.7	20.9	177	Phloxine B	6.9
152	Water	Besse	58-50-222		2/3/2012 1:09 PM						ND
158	Water	Besse	58-50-222		2/6/2012 12:44 PM						ND
202	Water	Besse	58-50-222		2/10/2012						ND
211	Water	Besse	58-50-222		2/10/2012						ND
162	Water	Besse	58-50-222		2/10/2012 2:25 PM						ND
112	Charcoal	Besse	58-50-222	2/10/2012 2:25 PM	2/10/2012 2:25 PM						ND
168	Water	Besse	58-50-222		2/16/2012 11:30 AM						ND
121	Charcoal	Besse	58-50-222	2/16/2012 11:30 AM	2/16/2012 11:30 AM						ND
196	Charcoal	Besse	58-50-222	2/16/2012 11:30 AM	2/23/2012 12:55 PM						ND
210	Charcoal	Besse	58-50-222	2/23/2012 12:55 PM	3/5/2012 1 PM						ND
286	Water	Cold Spring	42916		2/3/2012 5:30 PM						ND
192	Water	Cold Spring	42916		2/10/2012 3:45 PM						ND

Sample No.	Sample	Site Name	Sample Name	Set Date	Collected	Center	Height	FWHM	Peak Area	Dye	Concentration (µg/L)
142	Charcoal	Cold Spring	42916C	2/3/2012 5:35 PM	2/10/2012 3:50 PM	523.7	185	20.1	4085	Eosin	46.1
193	Water	Cold Spring	42916		2/16/2012 2:12 PM						ND
129	Charcoal	Cold Spring	42916B	2/10/2012 3:47 PM	2/16/2012 2:14 PM	523.8	206	19.9	4512	Eosin	50.2
281	Charcoal	Cold Spring	42916	2/16/2012 2:12 PM	3/13/2012 1:25 PM						ND
276	Water	Cold Spring	42916		3/13/2012 1:35 PM						ND
219	Charcoal	Control	Control	3/5/2012	3/5/2012						ND
100	Charcoal	Control	Control	2/1/2012 5 PM	2/1/2012 5 PM						ND
100	Charcoal	Control	Control	2/1/2012 5 PM	2/1/2012 5 PM	549.1	0.98	23.7	33.5	Phloxine B	1.2
100	Charcoal	Control	Control	2/1/2012 5 PM	2/1/2012 5 PM	492.1	9.6	30.7	324	Uranine	0.79
102	Charcoal	Control	Control	2/3/2012	2/3/2012						ND
101	Charcoal	Control	Control	2/3/2012	2/3/2012						ND
110	Charcoal	Control	Control	2/6/2012	2/6/2012						ND
120	Charcoal	Control	Control	2/10/2012	2/10/2012						ND
127	Charcoal	Control	Control	2/16/2012	2/16/2012						ND
128	Charcoal	Control	Control	2/16/2012	2/16/2012						ND
287	Water	Eliza	42921		2/2/2012 1:45 PM						ND
139	Charcoal	Eliza	42921A	2/2/2012 1:45 PM	2/7/2012 4:45 PM						ND
185	Water	Eliza	42921		2/7/2012 4:50 PM						ND
144	Charcoal	Eliza	42921A	2/7/2012 4:45 PM	2/9/2012 2:15 PM						ND
190	Water	Eliza	42921		2/9/2012 2:20 PM						ND
173	Water	Eliza	42921		2/10/2012 4:40 PM						ND
148	Charcoal	Eliza	42921B	2/9/2012 2:17 PM	2/10/2012 4:42 PM						ND
131	Charcoal	Eliza	42921A	2/10/2012 4:40 PM	2/11/2012 9:45 AM						ND
176	Water	Eliza	42921		2/11/2012 9:45 AM						ND
149	Charcoal	Eliza	42921C	2/9/2012 2:20 PM	2/11/2012 9:50 AM	548.1	5.0	18.9	101	Phloxine B	3.9
181	Water	Eliza	42921		2/16/2012 3:15 PM						ND
134	Charcoal	Eliza	42921A	2/11/2012 9:45 AM	2/16/2012 3:15 PM						ND
270	Water	Eliza	42921		2/28/2012 3:20 PM						ND
275	Charcoal	Eliza	42921	2/16/2012 3:17 PM	2/28/2012 3:22 PM						ND
278	Water	Eliza	42921		3/13/2012 2:10 PM						ND
283	Charcoal	Eliza	42921	2/28/2012 3:20 PM	3/13/2012 2:10 PM						ND
106	Charcoal	Holiday Inn	58-50-235	2/3/2012 1:57 PM	2/6/2012 1:57 PM						ND
117	Charcoal	Holiday Inn	58-50-235	2/6/2012 1:57 PM	2/16/2012 12:50 PM						ND
153	Water	Jenkins	58-50-2JR		2/3/2012 1:15 PM						ND
104	Charcoal	Jenkins	58-50-2JR	2/6/2012 12:37 PM	2/6/2012 12:37 PM						ND
104	Charcoal	Jenkins	58-50-2JR	2/6/2012 12:37 PM	2/6/2012 12:37 PM						ND
157	Water	Jenkins	58-50-2JR		2/6/2012 12:37 PM						ND
201	Water	Jenkins	58-50-2JR		2/7/2012						ND
207	Water	Jenkins	58-50-2JR		2/10/2012						ND

Sample No.	Sample	Site Name	Sample Name	Set Date	Collected	Center	Height	FWHM	Peak Area	Dye	Concentration (µg/L)
166	Water	Jenkins	58-50-2JR		2/10/2012 2:10 PM						ND
111	Charcoal	Jenkins	58-50-2JR	2/6/2012 12:37 PM	2/12/2012 2:10 PM						ND
126	Charcoal	Jenkins	58-50-2JR	2/16/2012 11:20 AM	2/16/2012 11:20 AM						ND
167	Water	Jenkins	58-50-2JR		2/16/2012 11:20 AM						ND
195	Charcoal	Jenkins	58-50-2JR	2/16/2012 11:20 AM	2/23/2012 12:35 PM						ND
206	Charcoal	Jenkins	58-50-2JR	2/23/2012 12:35 PM	3/5/2012 12:50 PM						ND
145	Charcoal	Main Barton	42914A	2/7/2012 5 PM	2/9/2010 2:35 PM						ND
188	Water	Main Barton	42914		2/9/2010 2:35 PM						ND
288	Water	Main Barton	42914		2/2/2012 2 PM						ND
140	Charcoal	Main Barton	42914A	2/2/2012 2 PM	2/7/2012 5 PM	547.3	9.9	22.1	191	Phloxine B	7.5
186	Water	Main Barton	42914		2/7/2012 5 PM						ND
174	Water	Main Barton	42914		2/10/2012 4:55 PM						ND
150	Charcoal	Main Barton	42914B	2/9/2012 2:37 PM	2/10/2012 4:57 PM	547.7	11.9	18.9	260	Phloxine B	10.3
179	Water	Main Barton	42914		2/11/2012 2:05 PM						ND
132	Charcoal	Main Barton	42914A	2/10/2012 4:55 PM	2/11/2012 2:05 PM	548.1	14.8	19.4	308	Phloxine B	12.2
182	Water	Main Barton	42914		2/16/2012 3:30 PM						ND
137	Charcoal	Main Barton	42914A	2/11/2012 2:05 PM	2/16/2012 3:30 PM						ND
269	Water	Main Barton	42914		2/28/2012 3:35 PM						ND
273	Charcoal	Main Barton	42914	2/16/2012 3:32 PM	2/28/2012 3:37 PM	547.7	39.3	19.4	858	Phloxine B	35.3
277	Water	Main Barton	42914		3/13/2012 2:30 PM						ND
285	Charcoal	Main Barton	42914	2/28/2012 3:35 PM	3/13/2012 2:30 PM						ND
290	Water	Old Mill	42922		2/2/2012 2:30 PM						ND
141	Charcoal	Old Mill	42922B	2/2/2012 2:32 PM	2/7/2012 5:27 PM						ND
187	Water	Old Mill	42922		2/7/2012 5:30 PM						ND
146	Charcoal	Old Mill	42922A	2/7/2012 5:25 PM	2/9/2012 3 PM						ND
191	Water	Old Mill	42922		2/9/2012 3 PM						ND
151	Charcoal	Old Mill	42922A	2/9/2012 3 PM	2/10/2012 5:15 PM						ND
175	Water	Old Mill	42922		2/10/2012 5:15 PM						ND
133	Charcoal	Old Mill	42922A	2/10/2012 5:15 PM	2/11/2012 1:30 PM						ND
178	Water	Old Mill	42922		2/11/2012 1:30 PM						ND
183	Water	Old Mill	42922		2/16/2012 3:50 PM						ND
136	Charcoal	Old Mill	42922B	2/11/2012 1:32 PM	2/16/2012 3:52 PM						ND
271	Water	Old Mill	42922		2/28/2012 4 PM						ND
272	Charcoal	Old Mill	42922	2/16/2012 3:52 PM	2/28/2012 4:02 PM						ND
272	Charcoal	Old Mill	42922	2/16/2012 3:52 PM	2/28/2012 4:02 PM						ND
280	Water	Old Mill	42922		3/13/2012 3:15 PM						ND
284	Charcoal	Old Mill	42922	2/28/2012 4 PM	3/13/2012 3:15 PM						ND
218	Water	Picard	58-50-230		3/5/2012 2:10 PM						ND
156	Water	Picard	58-50-230		2/3/2012 4:34 PM						ND

Sample No.	Sample	Site Name	Sample Name	Set Date	Collected	Center	Height	FWHM	Peak Area	Dye	Concentration (µg/L)
161	Water	Picard	58-50-230		2/6/2012 1:16 PM						ND
161	Water	Picard	58-50-230		2/6/2012 1:16 PM						ND
109	Charcoal	Picard	58-50-230	2/6/2012 1:16 PM	2/6/2012 1:16 PM	554.1	0.79	47.2	40.9	Phloxine B	1.5
205	Water	Picard	58-50-230		2/9/2012						ND
165	Water	Picard	58-50-230		2/10/2012 3:05 PM						ND
165	Water	Picard	58-50-230		2/10/2012 3:05 PM						ND
115	Charcoal	Picard	58-50-230	2/10/2012 3:05 PM	2/10/2012 3:05 PM						ND
125	Charcoal	Picard	58-50-230	2/16/2012 12:20 PM	2/16/2012 12:20 PM						ND
171	Water	Picard	58-50-230		2/16/2012 12:20 PM						ND
200	Charcoal	Picard	58-50-230	2/16/2012 12:20 PM	2/23/2012 2:20 PM						ND
217	Charcoal	Picard	58-50-230	2/23/2012 2:20 PM	3/5/2012 2:10 PM						ND
103	Charcoal	Randalls	58-50-1GR	2/3/2012 10:50 AM	2/6/2012 2:14 PM	553.7	1.6	33.0	94.0	Phloxine B	3.6
103	Charcoal	Randalls	58-50-1GR	2/3/2012 10:50 AM	2/6/2012 2:14 PM	493.2	13.8	34.8	542	Uranine	1.3
118	Charcoal	Randalls	58-50-1GR	2/6/2012 2:14 PM	2/16/2012 1:05 PM						ND
208	Charcoal	Randalls	58-50-1GR	2/16/2012 1:05 PM	3/5/2012 11:45 AM						ND
215	Water	Schaffer	58-50-2		2/9/2012						ND
199	Charcoal	Schaffer	58-50-2	2/16/2012 12:05 PM	2/23/2012 2 PM						ND
216	Charcoal	Schaffer	58-50-2	2/23/2012 2 PM	3/5/2012 1:40 PM						ND
105	Charcoal	Sunset MW	58-50-212	2/3/2012 1:40 PM	2/6/2012 1:34 PM						ND
116	Charcoal	Sunset MW	58-50-212	2/6/2012 1:34 PM	2/16/2012 12:35 PM						ND
289	Water	Upper Barton	183		2/2/2012 1:30 PM						ND
220	Water	Upper Barton	183		2/7/2012 9 AM						ND
138	Charcoal	Upper Barton	183A	2/2/2012 1:20 PM	2/7/2012 4:20 PM						ND
184	Water	Upper Barton	183		2/7/2012 4:20 PM						ND
221	Water	Upper Barton	183		2/7/2012 5 PM						ND
222	Water	Upper Barton	183		2/8/2012 1 AM						ND
223	Water	Upper Barton	183		2/8/2012 5 PM						ND
224	Water	Upper Barton	183		2/9/2012 1 AM						ND
225	Water	Upper Barton	183		2/9/2012 9 AM						ND
143	Charcoal	Upper Barton	183A	2/7/2012 4:20 PM	2/9/2012 2 PM	547.5	57.4	19.5	1246	Phloxine B	51.9
189	Water	Upper Barton	183		2/9/2012 2 PM						ND
226	Water	Upper Barton	183		2/9/2012 5 PM						ND
227	Water	Upper Barton	183		2/10/2012 1 AM						ND
228	Water	Upper Barton	183		2/10/2012 9 AM						ND
147	Charcoal	Upper Barton	183A	2/9/2012 2 PM	2/10/2012 4:25 PM	545.0	4.6	18.9	104	Phloxine B	4.0
147	Charcoal	Upper Barton	183A	2/9/2012 2 PM	2/10/2012 4:25 PM	545.9	5.6	19.6	119	Phloxine B	4.6
172	Water	Upper Barton	183		2/10/2012 4:25 PM						ND
229	Water	Upper Barton	183		2/10/2012 5 PM						ND
229	Water	Upper Barton	183		2/10/2012 5 PM						ND

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Sample No.	Sample	Site Name	Sample Name	Set Date	Collected	Center	Height	FWHM	Peak Area	Dye	Concentration (µg/L)
230	Water	Upper Barton	183		2/11/2012 1 AM						ND
231	Water	Upper Barton	183		2/11/2012 9 AM						ND
130	Charcoal	Upper Barton	183A	2/10/2012 4:25 PM	2/11/2012 1:05 PM	547.3	4.7	17.7	46.8	Phloxine B	1.8
177	Water	Upper Barton	183		2/11/2012 1:05 PM						ND
130	Charcoal	Upper Barton	183A	2/10/2012 4:25 PM	2/11/2012 1:05 PM	546.5	5.5	20.6	145	Phloxine B	5.6
130	Charcoal	Upper Barton	183A	2/10/2012 4:25 PM	2/11/2012 1:05 PM	495.8	6.6	45.6	386	Uranine	0.93
232	Water	Upper Barton	183		2/11/2012 5 PM						ND
233	Water	Upper Barton	183		2/12/2012 1 AM						ND
234	Water	Upper Barton	183		2/12/2012 9 AM						ND
235	Water	Upper Barton	183		2/12/2012 5 PM						ND
236	Water	Upper Barton	183		2/13/2012 1 AM						ND
237	Water	Upper Barton	183		2/13/2012 9 AM						ND
238	Water	Upper Barton	183		2/13/2012 5 PM						ND
239	Water	Upper Barton	183		2/14/2012 1 AM						ND
240	Water	Upper Barton	183		2/14/2012 9 AM						ND
241	Water	Upper Barton	183		2/14/2012 5 PM						ND
242	Water	Upper Barton	183		2/15/2012 1 AM						ND
243	Water	Upper Barton	183		2/15/2012 9 AM						ND
180	Water	Upper Barton	183		2/16/2012 2:55 PM						ND
135	Charcoal	Upper Barton	183A	2/11/2012 1:05 PM	2/16/2012 2:55 PM	547.5	65.6	19.6	1444	Phloxine B	60.4
244	Water	Upper Barton	183		2/17/2012 5 PM						ND
245	Water	Upper Barton	183		2/18/2012 1 AM						ND
246	Water	Upper Barton	183		2/18/2012 9 AM						ND
247	Water	Upper Barton	183		2/18/2012 5 PM	533.0	1.8	32.5	92.3	Phloxine B	3.5
247	Water	Upper Barton	183		2/18/2012 5 PM	533.7	1.6	32.8	74.7	Phloxine B	2.8
248	Water	Upper Barton	183		2/19/2012 1 AM	536.3	5.2	20.4	125	Phloxine B	4.8
249	Water	Upper Barton	183		2/19/2012 9 AM	535.8	2.5	20.9	85.3	Phloxine B	3.3
250	Water	Upper Barton	183		2/19/2012 5 PM	535.2	2.1	21.8	59.7	Phloxine B	2.3
251	Water	Upper Barton	183		2/20/2012 1 AM	535.0	2.5	25.4	96.0	Phloxine B	3.7
252	Water	Upper Barton	183		2/20/2012 9 AM	535.3	2.2	-1	95.4	Phloxine B	3.7
253	Water	Upper Barton	183		2/20/2012 5 PM	535.8	2.8	26.4	204	Phloxine B	8.0
254	Water	Upper Barton	183		2/21/2012 1 AM	535.5	2.9	21.0	90.8	Phloxine B	3.5
255	Water	Upper Barton	183		2/21/2012 9 AM	532.8	2.3	32.3	94.7	Phloxine B	3.6
256	Water	Upper Barton	183		2/21/2012 5 PM	534.5	2.0	-1	87.4	Phloxine B	3.3
257	Water	Upper Barton	183		2/22/2012 1 AM	535.9	2.7	21.6	80.6	Phloxine B	3.1
258	Water	Upper Barton	183		2/22/2012 9 AM						ND
259	Water	Upper Barton	183		2/22/2012 5 PM	536.1	2.3	24.0	92.9	Phloxine B	3.6
260	Water	Upper Barton	183		2/23/2012 1 AM	538.5	1.8	17.4	36.4	Phloxine B	1.4
261	Water	Upper Barton	183		2/23/2012 9 AM	534.8	2.1	26.2	82.8	Phloxine B	3.2

Sample No.	Sample	Site Name	Sample Name	Set Date	Collected	Center	Height	FWHM	Peak Area	Dye	Concentration (µg/L)
262	Water	Upper Barton	183		2/23/2012 5 PM	535.0	2.5	33.0	222	Phloxine B	8.7
263	Water	Upper Barton	183		2/24/2012 1 AM						ND
264	Water	Upper Barton	183		2/24/2012 9 AM	536.6	1.7	23.3	4.3	Phloxine B	0.15J
265	Water	Upper Barton	183		2/24/2012 5 PM	533.4	1.6	32.1	1.3	Phloxine B	0.043J
266	Water	Upper Barton	183		2/25/2012 1 AM	535.1	1.9	24.8	88.6	Phloxine B	3.4
267	Water	Upper Barton	183		2/25/2012 9 AM	534.8	2.0	27.1	85.1	Phloxine B	3.2
268	Water	Upper Barton	183		2/28/2012 2:45 PM						ND
274	Charcoal	Upper Barton	183	2/16/2012 2:17 PM	2/28/2012 2:50 PM	548.5	1708	20.0	42,000	Phloxine B	1962
279	Water	Upper Barton	183		3/13/2012 2:55 PM						ND
282	Charcoal	Upper Barton	183	2/28/2012 2:45 PM	3/13/2012 2:55 PM	546.4	11.3	18.1	201	Phloxine B	7.9
282	Water	Upper Barton	183		3/13/2012 2:55 PM	546.5	11.3	17.6	313	Phloxine B	12.5
119	Charcoal	Whirlpool	58-50-128	2/6/2012 2:45 PM	2/16/2012 1:20 PM						ND
209	Charcoal	Whirlpool	58-50-128	2/16/2012 1:20 PM	3/5/2012 12:20 PM						ND

ND indicates not detected at the following limits of detection:

Uranine (charcoal) 0.0061 μg/L Eosin (charcoal) 0.068 μg/L

Phloxine B (charcoal) 0.044 µg/L Phloxine B (water) 0.044 µg/L

J indicates detection between limit of detection and limit of quantitation.

FWHM indicates full width at half maximum.

Appendices 2: Dye Trace Results OUL

Ozark UNDERGROUND LABORATORY 1572 Aley Lane • Protem, MO 65733 • (417) 785-4289 • fax (417) 785-4290 • contact@ozarkundergroundlab.com

Certificate of Analysis

Date of certificate: March 8. 2012 Client: BSEACD Project name: Arbor Trails Sinkhole, Austin, TX Project contacts: Brian Smith (brians@bseacd.org) Brian Hunt (Brianh@bseacd.org) Mailing address: 1124 RegalRow Austin, Texas 78748 Samples collected by: BSEACD/COA Date samples shipped: February 22, 2012 Date samples rec'd at OUL: February 24, 2012 Date analyzed by OUL: March 1, 2 and 5, 2012 Included with certificate of analysis: Table of results and copies of sample collection data sheets

Results for charcoal samplers analyzed for the presence of pyranine and phloxine B dyes.

Peak wavelengths are reported in nanometers (nm); dye concentrations are reported in parts per billion (ppb).

OUL	Station Name	Date/Time	Date/Time	Pyranine	e Results	Phloxine l	B Results
Number		Placed	Collected	Peak nm	Conc. ppb	Peak nm	Conc. ppb
V5656P	58-50-2 6200 Brodie	2/3/2012 1410	2/6/2012 1302	ND		ND	
V5657P	58-50-2 6200 Brodie	2/6/2012 1302	2/10/2012 1455	ND		ND	
V5658P	58-50-2 6200 Brodie	2/10/2012 1455	2/16/2012 1155	ND		ND	
V5659P	58-50-207 Ashbaugh	2/3/2012 1417	2/6/2012 1253	ND		ND	
V5660P	Laboratory control charcoal	blank					
V5661P	58-50-207 Ashbaugh	2/6/2012 1253	2/10/2012 1430	ND		573.6 **	0.799
V5662P	58-50-207 Ashbaugh	2/10/2012 1430	2/16/2012 1135	ND		575.9	25.9
V5663P	58-50-222 Besse	2/3/2012 1309	2/6/2012 1244	ND		ND	
V5664P	58-50-222 Besse	2/6/2012 1244	2/10/2012 1425	ND		ND	
V5665P	58-50-222 Besse	2/10/2012 1425	2/16/2012 1130	ND		ND	
V5666P	42916A Cold Spring	2/10/2012 1545	2/16/2012 1412	ND		ND	
V5667P	42916A Cold Spring	2/3/2012 1730	2/10/2012 1545	ND		ND	
V5668P	42921B Eliza	2/11/2012 0947	2/16/2012 1517	501.6 **	29.4	ND	
V5669P	58-50-235 Holiday Inn	2/3/2012 1357	2/6/2012 1357	ND		ND	
V5670P	58-50-235 Holiday Inn	2/6/2012 1357	2/16/2012 1250	ND		ND	
V5671P	58-50-2JR Jenkins	2/3/2012 1315	2/6/2012 1237	ND		ND	
V5672P	58-50-2JR Jenkins	2/6/2012 1237	2/12/2012 1410	ND		ND	
V5673P	58-50-2JR Jenkins	2/10/2012 1410	2/16/2012 1120	ND		ND	
V5674P	42914B Main Barton	2/10/2012 1657	2/11/2012 1407	502.4	8.39	576.6	3.77
V5675P	42914B Main Barton	2/11/2012 1407	2/16/2012 1532	500.6 **	31.9	576.0	18.1
V5676P	42914B Main Barton	2/2/2012 1402	2/7/2012 1702	ND		573.4 **	5.75
V5677P	42914B Main Barton	2/7/2012 1702	2/9/2012 1437	ND		575.6	9.58
V5678P	42914B Main Barton	2/9/2012 1435	2/10/2012 1655	ND		575.6	7.60
V5679P	42922B Old Mill	2/10/2012 1717	2/11/2012 1332	499.6 **	3.98	ND	
V5680P	Laboratory control charcoal	blank					
V5681P	42922A Old Mill	2/11/2012 1330	2/16/2012 1550	501.8 **	20.0	ND	
V5682P	42922A Old Mill	2/2/2012 1430	2/7/2012 1725	ND		ND	
V5683P	42922B Old Mill	2/7/2012 1727	2/9/2012 1502	ND		ND	
V5684P	42922C Old Mill	2/7/2012 1730	2/16/2012 1555	499.2 **	14.7	ND	

f:\docs\coa\BSEACD_ArborTrails_01.xls

OUL	Station Name	Date/Time	Date/Time	Pyranine	Results	Phloxine l	B Results
Number		Placed	Collected	Peak nm	Conc. ppb	Peak nm	Conc. ppb
V5685P	42922B Old Mill	2/9/2012 1502	2/10/2012 1717	ND		ND	
V5686P	58-50-230 Picard	2/3/2012 1634	2/6/2012 1316	ND		ND	
V5687P	58-50-230 Picard	2/6/2012 1316	2/10/2012 1505	ND		ND	
V5688P	58-50-230 Picard	2/10/2012 1505	2/16/2012 1220	ND		ND	
V5689P	58-50-1GR Randalls	2/3/2012 1050	2/6/2012 1414	ND		ND	
V5690P	58-50-1GR Randalls	2/6/2012 1414	2/16/2012 1305	ND		ND	
V5691P	58-50-2 Schaffer	2/3/2012 1542	2/10/2012 1445	ND		ND	
V5692P	58-50-2 Schaffer	2/10/2012 1445	2/16/2012 1205	ND		ND	
V5693P	58-50-212 Sunset MW	2/3/2012 1340	2/6/2012 1334	ND		ND	
V5694P	58-50-212 Sunset MW	2/6/2012 1334	2/16/2012 1235	ND		ND	
V5695P	183B Upper Barton	2/10/2012 1627	2/11/2012 1307	ND		576.4	7.36
V5696P	183B Upper Barton	2/11/2012 1307	2/16/2012 1457	ND		576.0	45.1
V5697P	183B Upper Barton	2/2/2012 1322	2/7/2012 1622	ND		576.4	34.5
V5698P	183C Upper Barton	2/7/2012 1625	2/16/2012 1500	ND		576.0	637
V5699P	183B Upper Barton	2/9/2012 1402	2/10/2012 1627	ND		576.0	18.0
V5700P	Laboratory control charcos	al blank					
V5701P	58-50-128 Whirlpool	2/3/2012 1442	2/6/2012 1445	ND		ND	
V5702P	58-50-128 Whirlpool	2/6/2012 1445	2/16/2012 1320	ND		ND	

Note: Dye concentrations are based upon standards used at the OUL. The standard concentrations are based upon the as sold weight of the dye that the OUL uses. If the client is not using OUL dyes, the client should provide the OUL with a sample of the dye to compare to the OUL dyes.

Footnotes:

ND = No dye detected

** = A fluorescence peak is present that does not meet all the criteria for this dye. However, it has been calculated as a positive dye result.

Thomas J. Aley, PHG and RG

Thomas I. Alley

			SAMPLE COLLECTION DA	TA SHEET for FLUC	DRESCENCE ANAL	YSIS		
Project	Arbor Trails Sinkh	nole, Austin Texas		Week No:	1-3	_Samples Collected By:	BSEACD/CO/	~
Samples Shipped By-		Brian Hunt, BSEACD				Samples Received By:	C. aler	J na,
Date Samples Shippe	:þ¢	2/22/2012	Date& Time Samples Received:	2/24/12/	315			1
Bill to:	BSEACD, 1124 Re	egal Row, Austin Texas 78	3748	Send Results to:	Brianh@bseacd.org (sai	me mailing address as billi	ng)	i
Analyze for:	Phloxine B and	Pyranine for all sample	ss; see BSEACD comments for add	litional				
	se only	Please indicate statio	ns where dve was visible in the field	for field technician use -	use black ink only	our use outy	BSEACD Comn	lents
# Char rec'd	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED Date & Time	COLLECTED Date & Time	# Water /Rec'd	Analyze/Holc	Additional Dye
-	V50,56	58-50-2	6200 Brodie	2/3/2012 14:10	2/6/12 13:02)	A	
	V5657	58-50-2	6200 Brodie	2/6/12 13:02	2/10/12 14:55		A	
	V5658	58-50-2	6200 Brodie	2/10/12 14:55	2/16/12 11:55		٩	
	V5059	58-50-207	Ashbaugh	2/3/2012 14:17	2/6/12 12:53		A	
	V Slub	58-50-207	Ashbaugh	2/6/12 12:53	2/10/12 14:30		A	
_	VSUB	58-50-207	Ashbaugh	2/10/12 14:30	2/16/12 11:35		A	
	V5663	58-50-222	Besse	2/3/2012 13:09	2/6/12 12:44		A	
	VSG64	58-50-222	Besse	2/6/12 12:44	2/10/12 14:25		A	
	VSIGES	58-50-222	Besse	2/10/12 14:25	2/16/12 11:30		A	
-	VSbbb	42916A	Cold Spring	2/10/12 15:45	2/16/12 1412		A	
_	VSbbJ	42916A	Cold Spring	2/3/12 1730	2/10/12 1545		A	Eos, Fl, RWT, SRB
	NSULB	42921B	Eliza	2/11/12 9:47	2/16/12 1517		A	
BSE	VSbbg	58-50-235	Holiday Inn	2/3/2012 13:57	2/6/12 13:57		A	
	VSUJO	58-50-235	Holiday Inn	2/6/12 13:57	2/16/12 12:50		A	
Rer	V5671	58-50-2JR	Jenkins	2/3/2012 13:15	2/6/12 12:37		A	
	VSUAR	58-50-2JR	Jenkins	2/6/12 12:37	2/12/12 14:10		A	
	V5673	58-50-2JR	Jenkins	2/10/12 14:10	2/16/12 11:20		۷	
estic	V5674	42914B	Main Barton	2/10/12 16:57	2/11/12 1407		A	
	VS675	42914B	Main Barton	2/11/12 1407	2/16/12 1532		A	
ns 2	NS676	42914B	Main Barton	2/2/12 1402	2/7/12 1702		A	Eos, Fl, RWT, SRB
013-	LLASA	42914B	Main Barton	2/7/12 1702	2/9/12 1437	~	A	Eos, FI, RWT, SRB
0501		V5660	- out charead by	lant.	thom t	cr listed on Se	parate (20C. Lefour
OUL Project No. 1/1	51 Date Analyze	ad: 3/1 4 3/2/1	Analyzed By: LG + WC	lart	and	21/2/2/12	by we	(סיר
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OZARK UNDERGROUND LABORATORY, INC. 1572 Aley Lane Protem, MO 65733 (417) 785-4289 fax (417) 785-4290 email: contact@ozarkundergroundiab.com

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			SAMPLE COLLECTION D	ATA SHEET for FLU	JORESCENCE ANAL	ysis			
Project	Arbor Trails Sinkh	hole, Austin Texas		Week No:	1-3	Samples Collected By	: BSEACD/COA	. 1	
Samples Shipped By:		Brian Hunt, BSEACD		•	١	Samples Received By:	C. ale	-/out	
Date Samples Shipped	d:	2/22/2012	Date& Time Samples Received	2//2//2 :	1315		Ì		
Bill to:	BSEACD, 1124 Re	egal Row, Austin Texas 78	748	Send Results to:	Brianh@bseacd.org (s	ame mailing address as bill	ling)	3	
Analyze for:	Phloxine B and	Pyranine for all sample	s; see BSEACD comments for a	dditional					
00T 1136	e only	Please indicate station	is where dye was visible in the fic	eldfør field technician use	use black ink only	OUL use only	BSEACD Comme	ents	
# Char rec'd	LAB NUMBER	STATION NUMBER	STATION NAME	PLACED Date & Time	COLLECTED Date & Time	# Water /Rec'd	Analvze/Hold	Additional Dve	2
		1-4 Numbers				Ð			27 -
	V54078	42914A	Main Barton	2/9/10 1435	2/10/12 1655	_	A		-7
_	V5679	429228	Old Mill	2/10/12 17:17	2/11/12 1332		A		-Ę
	V5681	42922A	Old Mill	2/11/12 1330	2/16/12 1550		A		? †
	VSUB2	42922A	Old Mill	2/2/12 1430	2/7/12 1725		A	Eos, Fl, RWT, SRB	ъł
	V5683	42922B	Old Mill	2/7/12 1727	2/9/12 1502		A	Eos, Fl, RWT, SRB	fy
	VSLABY	42922C	Old Mill	2/7/12 1730	2/16/12 1555		A		101
	V5085	42922B	Old Mill	2/9/12 1502	2/10/12 1717		A		M
	V5686	58-50-230	Picard	2/3/2012 16:34	2/6/12 13:16		A		
_	VSLB7	58-50-230	Picard	2/6/12 13:16	2/10/12 15:05		A		
	VSLBB	58-50-230	Picard	2/10/12 15:05	2/16/12 12:20		A		
	VSLEA	58-50-1GR	Randalls	2/3/2012 10:50	2/6/12 14:14		A		
	N5690	58-50-1GR	Randalls	2/6/12 14:14	2/16/12 13:05		A		21
	N5691	58-50-2	Schaffer	2/3/2012 15:42	2/10/12 14:45		A		-9
	VS692	58-50-2	Schaffer	2/10/12 14:45	2/16/12 12:05		A		?-{
	V5693	58-50-212	Sunset MW	2/3/2012 13:40	2/6/12 13:34		A		
•	V5694	58-50-212	Sunset MW	2/6/12 13:34	2/16/12 12:35		A		P-
	V5695	183B	Upper Barton	2/10/12 16:27	2/11/12 1307		A		ff
	VS696	183B	Upper Barton	2/11/12 1307	2/16/12 1457		A		rf.
	LP02V	183B	Upper Barton	2/2/12 1322	2/7/12 1622		A		ou
	V569B	183C	Upper Barton	2/7/12 1625	2/16/12 1500		A		n
_	15699	1838	Upper Barton	2/9/12 1402	2/10/12 1627	<i>></i>	A		
) V568	10-011 Charcoal	blank, V!	5700-0UL Chai	ceal blank.			
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Project	Arbor Trails Sinkh	ole, Austin Texas		Week No:	1 - 3	Samples Collected By:	BSEACD/COA	
Samples Shipped By:		Brian Hunt, BSEACD		-		Samples Received By:	C. aler	Jour
Date Samples Shipped		2/22/2012 1)ate& Time Samples Received:	2/24/12	1315		_	
Bill to:	BSEACD, 1124 Rei	gal Row, Austin Texas 787	48	Send Results to:	Brianh@bseacd.org (san	ne mailing address as billi	ng)	
Analyze for:	Phloxine B and 1	Pyranine for all samples;	see BSEACD comments for ad	lditional				
osn TNO	ouly	Please indicate stations	where dye was visible in the fie	lafor field technician use	use black ink only	OUL use only	BSEACD Commen	\$
# Char rec'd	LAB NUMBER C) NO XF 001	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED Date & Time	COLLECTED Date & Time	# Water /Rec'd	Analyze/Hold	Additional Dye
	VETOI	58-50-128	Whirlpool	2/3/2012 14:42	2/6/12 14:45		A	
	V5702	58-50-128	Whirlpool	2/6/12 14:45	2/16/12 13:20)	A	
0	H	58-50-2	6200 Brodie	2/3/2012 14:10		_	т	
0	Н	58-50-2	6200 Brodie	2/6/12 13:02		-	I	
0	Ŧ	58-50-2	6200 Brodie	2/10/12 14:55		_	Т	
a	t	58-50-2	6200 Brodie	2/16/12 11:55		•	т	
0	H	58-50-207	Ashbaugh	2/3/2012 14:17			T	
٩	±	58-50-207	Ashbaugh	2/6/12 12:53			т	
0	Ŧ	58-50-207	Ashbaugh	2/10/12 14:30			т	
0	H H	58-50-207	Ashbaugh	2/16/12 11:35	-	_	т	
0	н	58-50-222	Besse	2/3/2012 13:09		•	т	
C	H	58-50-222	Besse	2/6/12 12:44		_	т	
0	H	58-50-222	Besse	2/10/12 14:25			т	
	+	58-50-222	Besse	2/16/12 11:30			τ	
_	Н	42916C	Cold Spring	2/10/12 15:50	2/16/12 1417	۲	т	
	+	429168	Cold Spring	2/3/12 1732	2/10/12 1547	۲	r	
С	t	42916	Cold Spring	2/10/12 1545			т	
ۍ د	H	42916	Cold Spring	2/16/12 1412			r	
	H	42921B	Eliza	2/10/12 16:42	2/11/12 0947	æ	т	
	Ŧ	429218	Eliza	2/2/12 1347	2/7/12 1647		т	
	Ħ	42921B	Eliza	2/7/12 1647	2/9/12 1417	Ş	т	
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いて 3 of 5

Project	Arbor Trails Sinkn	iole, Austin Texas		Week No:	1 - 3	Samples Collected By:	BSEACD/COA	
Samples Shipped By:		Brian Hunt, BSEACD				Samples Received By:	C. aler 10	DUL
Date Samples Shipped		2/22/2012	Date& Time Samples Received	2/24/12	1315		~	
Bill to:	BSEACD, 1124 Re	gal Row, Austin Texas 78	748	Send Results to:	Brianh@bseacd.org (sar	ne mailing address as billi	(Bu	
Analyze for:	Phloxine B and I	Pyranine for all samples	; see BSEACD comments for ac	lditional				
OUL use	shoo .	<u>Please indicate station</u>	s where dye was visible in the fie	ldfor field technician us	e - use black ink only	Appendition of the second seco	BSEACD Commer	lts
# Char rec'd	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED Date & Time	COLLECTED Date & Time	# Water /Rec'd	Analyze/Hold	Additional Dye
	Ŧ	42921A	Eliza	2/9/12 1415	2/10/12 1640	B	т	
	И	42921C	Eliza	2/9/12 1420	2/16/12 1520	-7	т	
0	÷±	42921	Eliza	2/10/12 1640			т	
0	H	42921	Eliza	2/11/12 0945			т	
0	Ŧ	42921	Eliza	2/16/12 1515			т	
0	+	42921	Eliza	2/7/12 1650			т	
0	H	42921	Eliza	2/9/12 1420			т	
0	H H	58-50-2JR	Jenkins	2/3/2012 13:15			т	
Q	H	58-50-2JR	Jenkins	2/6/12 12:37			т	
σ	Ŧ	58-50-2JR	Jenkins	2/10/12 14:10			т	
б	H	58-50-2JR	Jenkins	2/16/12 11:20			т	
	+	42914C	Main Barton	2/2/12 1405	2/7/12 1705	B	т	
Ø	ŧ	42914	Main Barton	2/10/12 1655			Ŧ	
Q	Ŧ	42914	Main Barton	2/11/12 1405			т	
0	Ŧ	42914	Main Barton	2/16/12 1530			т	
0	Ħ	42914	Main Barton	2/7/12 1700			Ξ	
0	H	42914	Main Barton	2/9/10 1435			т	
0	Ħ	42922	Old Mill	2/10/12 1715		.—	т	
0	±	42922	NiM PIO	2/11/12 1330			r	
0	Ŧ	42922	liim pio	2/16/12 1550			т	
Ø	Ħ	42922	Old Mill	2/7/12 1730			τ	
This sheet filled out by	oUL staff? Yes	(No) Charts for same	oles on this page proofed by C		Ð	Nater listed on	Separat (DC .TERUL
OUL Project No.	Date Analyze		Analyzed By:		1			

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Time Samples Received: Juily Samples Received By: Juily Stant Results to: Branh@bseacd org (same mailing address as billing) SEACD comments for additional Branh@bseacd org (same mailing address as billing) SEACD comments for additional OUL use only BSEACD comments STATION NAME PLACED OUL use only BSEACD comments STATION NAME PLACED OUL use only BSEACD comments STATION NAME PLACED OUL use only BSEACD comments Old Mill 2/9/12 15:00 H H Pleard 2/9/12 15:05 H H Upper Barton 2/1/12 15:05 H H Upper Barton 2/1/12 15:05 H H Upper Barton 2/1/12 16:20 H H Upper Barton 2/9/12 14:50 H H Upper Barton 2/9/12 14:50 H H		
Time Samples Received:	Brian Hunt, BSEACD	
Send Results to: Search Cong (same mailing address as billing) SEACD comments for additional Defended Defended Gle was visible in the fieldfor field cechnician use - use black ink out OUL use only BSEACD comments STATION NAME PLACED OUL use only BSEACD comments STATION NAME PLACED COLLECTED # Water /Rec'd Analyze/Hold Old Mill 2/9/12 13:00 Date & Time # Water /Rec'd Analyze/Hold Pleard 2/9/12 13:16 PLACED PLACED H Pleard 2/9/12 13:16 PLACED H H Pleard 2/6/12 13:16 PLACED H H Upper Barton 2/1/12 13:05 2/7/12 16:25 P H Upper Barton 2/1/12 13:05 2/9/12 14:02 H H Upper Barton 2/1/1/12 13:05 2/9/12 14:02 H H Upper Barton 2/1/1/12 13:05 2/9/12 14:02 H H Upper Barton 2/1/1/12 15:05 P H H </td <td>2/22/2012 D</td>	2/22/2012 D	
SEACD comments for additional dre vars visible in the fieldfor field technician use - use black ink ouly OUL use only BSEACD comments STATION NAME PLACED # Water /Rec'd Additional STATION NAME PLACED COLLECTED # Water /Rec'd Additional STATION NAME PLACED COLLECTED # Water /Rec'd Additional STATION NAME PLACED # Water /Rec'd Additional Old Mill 2/9/121500 OLL use only Plant Pleard 2/9/121625 O O Direard 2/9/121625 O Upper Barton 2/1/121625 O O Upper Barton 2/1/121625 <td col<="" td=""><td>1124 Regal Row, Austin Texas 78748</td></td>	<td>1124 Regal Row, Austin Texas 78748</td>	1124 Regal Row, Austin Texas 78748
Indecense visible in the field refider field rechnician use - use black ink only OUL use only BEACD Comments STATION NAME PLACED COLLECTED # Water/Rec ⁱ Analyze/Hold Open STATION NAME Date & Time Date & Time Mater/Rec ⁱ Analyze/Hold Open STATION NAME Date & Time Date & Time # Water/Rec ⁱ Analyze/Hold Open Old Mill 2/9/12 15:05 OPC Image Image Image Image Pleard 2/3/2012 16:34 OPC Image Image Image Image Pleard 2/3/2012 15:05 OPC Image Image Image Image Pleard 2/16/12 13:20 2/17/12 1625 2/1/12 1625 Image Image Image Upper Barton 2/10/12 1622 2/9/12 1602 2/9/12 1602 Image Image Image Upper Barton 2/11/12 1625 2/9/12 1602 2/9/12 1602 Image Image Image Upper Barton 2/11/12 1625 2/9/12 1602 2/9/12 1602 Image Image Image Upper Barton 2/11/12 1625 2/9/12 1602 2/9/12 1602 Image Image Image Upper Barton 2/11/12 1655	e B and Pyranine for all samples; see	
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Upper Barton 2/9/12 1400 H	183	
	183	

1572 Aley Lane Protem, MO 65733 (417) 785-4289 fax (417) 785-4290 email: contact@ozarkundergroundlab.com **OZARK UNDERGROUND LABORATORY, INC.**

DWake listed an Separate COC. LG/OUL

This sheet filled out by OUL staff? Yes (Not Charts for samples on this page proofed by OUL: Rout Project Not Date Analyzed: Analyzed By:

	OZETK	alfaquation DUND ORY 1572 Aley	Lane • Protem, M	10 65733 •	(417) 7 85	4289 • fax	1) 1997 (712) - 785	4290 • cont	act@ozarku	ndergroundla	.com
			Certif	icate of An	ıalysis						
Date of certi	ificate: March 8. 2012					Samples co	llected by:	BSEACD/CO	AC		
Client: BSE	ACD					Date sampl	es shipped:	February 22,	2012		
Project nam	e: Arbor Trails Sinkhole, Au	ustin, TX				Date sampl	les rec'd at (DUL: Febru	ary 24, 201:	2	
Project cont	acts: Brian Smith (brians	(abseacd.org)				Date analy:	zed by OUI	.: March I a	nd 2, 2012		
	Brian Hunt (brianh	1@bseacd.org)				COA inclu	des: Table o	of results, cop	ies of sampl	e collection	
Mailing add	ress: 1124 Regal Row					data she	eets				
	Austin, Texas 787	748									
Results for v	vater samples analyzed fo	or the presence of	Aluorescein, eosine	, rhodamine	WT (RWT) and sulfor	hodamine F	t (SRB) dyes.			
Peak waveler	ngths are reported in nanor	neters (nm); dye co	oncentrations are rel	ported in parts	s per billion	(ppb).					
OUL	Station Number	Date/Time	Date/Time	Fluoresce	in Results	Eosine	Results	RWT R	tesults	SRB Re	sults
Number	and Name	Placed	Collected	Peak nm	Conc. ppb	Peak nm	Conc. ppb	Peak nm	Conc. ppb	Peak nm	Conc. ppb
V5667	42916A Cold Spring	2/3/12 1730	2/10/12 1545	ΠN		542.3	47.3	ND		ND	
V5676	42914B Main Barton	2/2/12 1402	2/7/12 1702	QZ		544.6 *	0.661	ND		ND	
V5677	42914B Main Barton	2/7/12 1702	2/9/12 1437	QN		ND		ND		ND	
V5682	42922A Old Mill	2/2/12 1430	2/7/12 1725	QN		543.6	0.399	ND		ND	
V5683	42922B Old Mill	2/7/12 1727	2/9/12 1502	ΩN		QN		ND		ND	
Note: Dye o	oncentrations are based up	on standards used	at the OUL. The sta	indard concer	ntrations are	based upon	the as sold	veight of the			
dye that the (OI II dves	OUL uses. If the client is r	not using OUL dye	s, the client should I	provide the O	UL with a s	ample of the	dye to com	pare to the			
Footnotes:											

* = A fluorescence peak is present that does not meet all the criteria for a positive dye result. However, it has been calculated as though it was ND = No dye detected

Thomas J. Aley, PHG and RG the tracer dye.

1 love I. Al

f:\docs\coa\BSEACD_ArborTrails_02.xls

		1572 Aley Lane Pro	OZARK UNDF item, MO 65733 (417) 785-4 SAMPLE COLLECTION D	ERGROUND LABOR 4289 fax (417) 785-4; 0ATA SHEET for FLU	ATORY, INC. 290 email: contact@ ORESCENCE ANAL ⁷	ozarkundergroundlab YSIS	com	
Project	Arbor Trails Sinkh	iole, Austin Texas		Week No:	1 - 3	_Samples Collected By:	BSEACD/CO/	-1
Samples Shipped By:		Brian Hunt, BSEACD		-		Samples Received By:	C. aler 1	DMC
Date Samples Shipped.		2/22/2012	_Date& Time Samples Received	1/24/12	1315			
Bill to:	BSEACD, 1124 Re	gal Row, Austin Texas 7	.8748	Send Results to:	Brianh@bseacd.org (sar	me mailing address as billi	ng)	
Analyze for:	Phloxine B and	Pyranine for all samp	es; see BSEACD comments for at	dditional				
OUL use	only	Please indicate stati	ons where dve was visible in the fie	eldfor field technician use	- use black ink only	OUL use only	BSEACD Comm	ents
# Char rec'd	LAB	STATION	STATION NAME	PLACED	COLLECTED	# Water /Rec'd		Additional
	NUMBER	NUMBER 1-4 Numbers		Date & Time	Date & Time	X	Analyze/Hold	Dye
	V5656	58-50-2	6200 Brodie	2/3/2012 14:10	2/6/12 13:02		A	
	V5657	58-50-2	6200 Brodie	2/6/12 13:02	2/10/12 14:55		A	
	V5658	58-50-2	6200 Brodie	2/10/12 14:55	2/16/12 11:55		∢	
	V5659	58-50-207	Ashbaugh	2/3/2012 14:17	2/6/12 12:53		A	
	VStolol	58-50-207	Ashbaugh	2/6/12 12:53	2/10/12 14:30		A	
	V5662	58-50-207	Ashbaugh	2/10/12 14:30	2/16/12 11:35		A	
	V5663	58-50-222	Besse	2/3/2012 13:09	2/6/12 12:44		A	
	VSWH	58-50-222	Besse	2/6/12 12:44	2/10/12 14:25		٨	
	VSUUS	58-50-222	Besse	2/10/12 14:25	2/16/12 11:30		A	
	VSlobe	42916A	Cold Spring	2/10/12 15:45	2/16/12 1412		A	
	VSbbr	42916A	Cold Spring	2/3/12 1730	2/10/12 1545		A	Eos, FI, RWT, SRB
	VSbbB	42921B	Eliza	2/11/12 9:47	2/16/12 1517		A	
-	VSbbg	58-50-235	Holiday Inn	2/3/2012 13:57	2/6/12 13:57		A	
-	VSUJO	58-50-235	Holiday Inn	2/6/12 13:57	2/16/12 12:50		A	
	VSGT	58-50-2JR	Jenkins	2/3/2012 13:15	2/6/12 12:37		A	
	VS672	58-50-2JR	Jenkins	2/6/12 12:37	2/12/12 14:10		A	
	V5673	58-50-2JR	Jenkins	2/10/12 14:10	2/16/12 11:20		A	
	V5674	42914B	Main Barton	2/10/12 16:57	2/11/12 1407		A	
	V5675	429148	Main Barton	2/11/12 1407	2/16/12 1532		A	
-	NS1076	42914B	Main Barton	2/2/12 1402	2/7/12 1702		A	Eos, FI, RWT, SRB
	VENTT	42914B	Main Barton	2/7/12 1702	2/9/12 1437	>	A	Eos, Fl, RWT, SRB
This sheet filled out hv	OUIL staff? Vec	V5660	2-OUL Charboal &	blank. 111. Es	4 Wat	cr listed on Se	paratc (DC. Lefour
OUL Project No. 115	Date Analyze	13/143/2/	PAnalyzed By: LG & WC	- Jarl	and	M3/2/12	by wel	al
				1 of 5 0 u	un geg	d proved by	1 RS	

BSEACD Report of Investigations 2013-0501 Appendix 2: Page 9

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Manuality: Terr Information: Samples Record By: Comment Size: 0.5 simples Nation: 202401.13 Just Size:	.oject	Arbor Trails Sinkt	hole, Austin Texas		Week No:	1 - 3	Samples Collected By:	: BSEACD/COA		
Bits: Sign: 1111 flag: file, functif "constrained and the file file file file file file file fil	umples Shipped By: Ate Samules Shinned	÷	Brian Hunt, BSEACD	Datas: Timo Samulas Dacaivod	cilturi c	2121	Samples Received By:	C. Ob.	Jour	
Instruction: Theorem Provide family amples your MSRACD community Contraction Oct. work Rest of default amples your MSRACD community 0.01 working Process indicate station when the rest of default and the default and and and the default and the default and the default and	Il to:	BSEACD, 1124 Re	gal Row, Austin Texas 78.	748	Send Results to:	Brianh@bseacd.org (si	ame mailing address as bill	ling)		
OUL are only a Char rector Present inflator and more directly in the direct field in the direct and in a statute contract mean in a statute contrect mean in a statute contract mean in a statute con	nalyze for:	Phloxine B and	Pyranine for all samples	i; see BSEACD comments for a	dditional					r
# Charterd Lus STATION NAME PL-CED COLLECTED I Water factor Andreation Andreation NUNBER NUNBER NUNBER NUNBER PAIN	OUL us	e only	<u>Please indicate station</u>	s where dye was visible in the fu	eldfor field technician <u>us</u> e	- use black ink only	OUL use only	BSEACD Comme	ents	
I V54.76 439.14 Win Barton 27/10.135 21/11.21332 21/11.21332 7 A A I V56.77 429.23.8 0d Mili 2/11.12133 2/11.12132 2/11.12132 A B A B A B A B A B A B A B A B A B B A B	# Char rec'd	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED Date & Time	COLLECTED Date & Time	# Water /Rec'd	Analyze/Hold	Additional Dye	-
I V5075 49236 OdeMil 210121330 210112330 210111230	•	V54078	42914A	Main Barton	2/9/10 1435	2/10/12 1655		A		-
I V5aB1 4392.4 Ote Mill 21/12/1360 I A Exercises I V5aB1 4392.2 Ote Mill 22/12.1360 2/1/12/136 A Exercises I V5aB3 4292.2 Ote Mill 2/1/12/136 2/1/12/136 A Exercises I V5aB3 4292.2 Ote Mill 2/1/12/136 2/1/12/136 A Exercises I V5aB1 5850-230 Pleared 2/1/0/11/164 2/1/12/136 A Exercises I V5aB1 5850-230 Pleared 2/10/12/164 2/10/12/166 A A I V5aB1 5850-230 Pleared 2/10/12/164 2/10/12/166 A A I V5aB1 5850-230 Pleared 2/10/12/166 A A A I V5aB1 5850-230 Pleared 2/10/12/166 A A A I V5aB1 5850-230 Pleared 2/10/12/165 A A	_	VSerg	429228	Old Mill	2/10/12 17:17	2/11/12 1332		A		5
V5682 4292.4 Old Mill 2/2/12 1630 2/7/12 1735 2/7/7/2 1735 2/7/12		V5681	42922A	Old Mill	2/11/12 1330	2/16/12 1550		A		· · · ·
I V5683 42928 Oth Mill 27/12.1730 21/6/12 1555 20/12 1500 A Ecs, Fi, NWT, Stell I V568H 628-02.320 Od Mill 27/12 1500 21/6/12 1555 21/0/12 1500 A Ecs, Fi, NWT, Stell I V568L 58-02.320 Pleard 2/9/12 1505 21/0/12 1505 21/0/12 1505 A A A I V568L 58-50.230 Pleard 2/9/12 1505 21/0/12 1505 A A A A I V568L 58-50.230 Pleard 2/9/12 1505 2/10/12 1413 A A A I V568H 58-50.230 Pleard 2/9/12 1414 2/10/12 1413 A A I V569H 58-50.16R Randils 2/9/12 1413 2/10/12 1413 A A I V569H 58-50.13 Senter 2/9/12 1413 2/10/12 1413 A A I V569H 58-50.13 Senter 2/9/12 13130 2/6/12 1313 2/		V5682	42922A	Old Mill	2/2/12 1430	2/7/12 1725		A	Eos, Fl, RWT, SRB	r · · · ·
V568H 42920C Old Mill 27/12.1730 27/10.121555 216/12.1555 216/12.1515 216/12.1515 216/12.1515 216/12.1515 216/12.1515 216/12.1515 216/12.1515 216/12.1515 216/12.1515 216/12.1515 216/12.1515 216/12.1515 216/12.1515 216/12.1515 216/12.1215 216/12.		V5683	429228	liim bio	2/7/12 1727	2/9/12 1502		A	Eos, FI, RWT, SRB	, v
I V5,055 42228 Old Mill 29/12 1502 2/10/12 1505 A A I V5,08L 58-50.230 Picard 2/3/2012 16:34 2/6/12 13:16 2/10/12 1505 A A I V5,08H 58-50.230 Picard 2/6/12 13:16 2/10/12 1505 2/6/12 13:16 2/10/12 16:05 A A I V5,08H 58-50.16R Randalis 2/3/2012 10:50 2/6/12 14:14 2/16/12 13:15 A A I V5,04H 58-50.16R Randalis 2/3/2012 10:50 2/6/12 14:14 2/16/12 13:15 A A I V5,04H 58-50.2 Schaffer 2/3/012 15:42 2/3/0/12 16:35 2/3/0/12 16:35 2/3/0/12 16:35 2/3/0/12 16:35 A A V V5,04H 58-50.21 Sumeet MW 2/3/2/12 14:14 2/3/0/12 16:35 2/3/0/12 16:35 2/3/0/12 16:35 A A A V V5,04H 58-50.21 Sumeet MW 2/3/0/12 16:37 2/3/0/12 16:30 2/6/12 13:34 A	_	VSLABH	42922C	Old Mill	2/7/12 1730	2/16/12 1555		A		-
I V368L 58-0-230 Prand 2/3/7013.16:3 2/6/12.13:16 A A I V568T 58-0-230 Prand 2/6/12.13:16 2/6/12.13:16 A A I V568T 58-0-230 Prand 2/6/12.13:16 2/10/12.15:05 2/10/12.15:05 2/10/12.15:05 A A I V569D 58-50-16r Randalis 2/6/12.14:14 2/16/12.12:05 A A I V560D 58-50-16r Randalis 2/6/12.14:14 2/16/12.12:05 A A I V560D 58-50-13 Schaffer 2/3/2012.15:05 2/16/12.12:05 A A I V560D 58-50-13 Schaffer 2/3/2012.15:42 2/16/12.12:05 A A I V560D 58-50-13 Schaffer 2/3/2012.15:42 2/16/12.12:05 A A I V560P 58-50-13 Sumethow 2/3/2012.15:43 2/16/12.12:05 A A V560P 188 Upper Bar		V5,85	42922B	Old Mill	2/9/12 1502	2/10/12 1717		A		- v
V5&7 58-50-230 Pitard 2/6/12 13:16 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 2/10/12 15:05 A	_	V5686	58-50-230	Picard	2/3/2012 16:34	2/6/12 13:16		A		· · · · · ·
V5428 58-50-30 Piard 2/10/1215/05 2/16/1213:05 2/16/1213:05 A I V5429 58-50-16R Randalls 2/3/20121050 2/6/1214:14 A A I V5429 58-50-16R Randalls 2/3/20121050 2/6/1214:14 2/16/1213:05 A A I V5429 58-50-2 Schaffer 2/3/201213:42 2/16/1214:55 A A I V5401 58-50-2 Schaffer 2/3/201213:43 2/16/1214:55 A A I V5603 58-50-2 Schaffer 2/3/201213:43 2/16/1214:55 A A V V5603 58-50-2 Schaffer 2/3/201213:43 2/16/1213:45 A A V5603 58-50-2 Sumet MW 2/3/201213:45 2/11/121307 A A A V56041 58-50-212 Sumet MW 2/3/201216:27 2/11/121307 A A A V56042 1838 Upper Barton 2/10/1216:27 <t< td=""><td></td><td>VSUBT</td><td>58-50-230</td><td>Picard</td><td>2/6/12 13:16</td><td>2/10/12 15:05</td><td></td><td>٩</td><td></td><td></td></t<>		VSUBT	58-50-230	Picard	2/6/12 13:16	2/10/12 15:05		٩		
I V569 58-50-1GR Randals 2/3/2012 10:50 2/6/12 14:14 2/16/12 13:05 A I V5691 58-50-1GR Randals 2/6/12 14:14 2/16/12 13:05 A A I V5691 58-50-1 Santfer 2/3/2012 15:42 2/16/12 13:05 A A I V5691 58-50-2 Schaffer 2/3/2012 15:42 2/16/12 12:05 A A I V5691 58-50-2 Sumet MW 2/3/2012 15:42 2/16/12 12:05 A A I V5691 58-50-212 Sumet MW 2/3/2012 16:27 2/11/12 13:05 A A I V5691 1838 Upper Barton 2/11/12 13:07 2/11/12 13:07 A A I V5691 1838 Upper Barton 2/11/12 13:07 2/11/12 13:07 A A I V5691 1838 Upper Barton 2/11/12 13:07 2/11/12 13:07 A A I V5691 1838 Upper Barton 2	_	V56BB	58-50-230	Picard	2/10/12 15:05	2/16/12 12:20		A		
I V56/90 58-50-16R Randalls 2/6/12 14:14 2/16/12 13:05 A A I V56/91 58-50-2 Schaffer 2/3/2012 15:42 2/10/12 14:45 2/16/12 13:05 A A I V56/93 58-50-212 Schaffer 2/3/2012 15:42 2/16/12 12:05 A A I V56/93 58-50-212 Sunset MW 2/3/2012 13:40 2/6/12 13:05 A A I V56/94 58-50-212 Sunset MW 2/3/2012 13:40 2/6/12 13:05 A A I V56/94 58-50-212 Sunset MW 2/3/12 13:07 2/11/12 13:07 A A I V56/94 1838 Upper Barton 2/11/12 13:07 2/16/12 14:57 A A I V56/94 1838 Upper Barton 2/11/12 16:07 2/16/12 14:57 A A A I V56/94 1838 Upper Barton 2/11/12 16:27 2/16/12 14:57 A A A I V5	-	VSUBA	58-50-1GR	Randalls	2/3/2012 10:50	2/6/12 14:14		A		
I N50 (I 58-50-2 Schaffer 2/3/2012 15:42 2/10/12 14:45 2/10/12 14:45 2/10/12 14:45 2/10/12 14:45 A A A A A A A A B A B B Construct 2/3/2012 13:40 2/16/12 12:05 A A A A A A A B B D V50 (J S8-50-212 Summet MW 2/3/2012 13:30 2/16/12 12:05 A A A A A B D V50 (J S8-50-212 Summet MW 2/3/2012 13:34 2/16/12 13:35 2/16/12 13:35 A B D D A D A D<	_	N5690	58-50-1GR	Randalls	2/6/12 14:14	2/16/12 13:05		A		
V5693 58-50-2 Schaffer 2/10/12 14:45 2/16/12 12:05 A V5693 58-50-212 Sunset MW 2/3/2012 13:40 2/6/12 13:34 A A V5694 58-50-212 Sunset MW 2/3/2012 13:34 2/5/12 13:34 A A V5694 58-50-212 Sunset MW 2/3/12 16:27 2/11/12 1307 A A V5694 1838 Upper Barton 2/11/12 1307 2/16/12 1457 A A V5697 1838 Upper Barton 2/11/12 1307 2/16/12 1457 A A V5699 1835 Upper Barton 2/11/12 1307 2/16/12 1457 A A V5699 1835 Upper Barton 2/11/12 1307 2/16/12 1457 A A V5699 1835 Upper Barton 2/11/12 1307 2/16/12 1452 A A V5699 1835 Upper Barton 2/1/12 1452 2/11/12 1657 A A V5699 1836 Upper Barton 2/1/12 1652 2/11/12	-	NS691	58-50-2	Schaffer	2/3/2012 15:42	2/10/12 14:45		A		
V5693 58-50-212 Sunset MW 2/3/2012 13:40 2/6/12 13:34 2/6/12 13:34 A V5694 58-50-212 Sunset MW 2/10/12 16:27 2/11/12 1307 A A V5695 1838 Upper Barton 2/11/12 1307 2/11/12 1307 2/11/12 1307 A A V5696 1838 Upper Barton 2/11/12 1307 2/11/12 1307 2/11/12 1457 A A V5697 1838 Upper Barton 2/11/12 1307 2/11/12 1622 A A A V5699 1838 Upper Barton 2/11/12 1625 2/17/12 1622 A A A V5699 1835 Upper Barton 2/1/12 1625 2/17/12 1622 A A A V5699 1835 Upper Barton 2/1/12 1622 A A A B V5699 1835 Upper Barton 2/1/12 1622 2/10/12 1627 A A B V5040001L 500 001L 2/10/12 1627 A B <t< td=""><td>-</td><td>VS692</td><td>58-50-2</td><td>Schaffer</td><td>2/10/12 14:45</td><td>2/16/12 12:05</td><td></td><td>A</td><td></td><td></td></t<>	-	VS692	58-50-2	Schaffer	2/10/12 14:45	2/16/12 12:05		A		
Í VSlo94 58-50-212 Sunset MW 2/6/12 13:34 2/16/12 13:35 A A Í VSlo94 1838 Upper Barton 2/10/12 16:27 2/11/12 1307 2/11/12 1307 A A Í VSlo94 1838 Upper Barton 2/11/12 1307 2/16/12 1457 A A Í VSlo94 1838 Upper Barton 2/11/12 1507 2/16/12 1457 A A Í VSlo98 1836 Upper Barton 2/11/12 1525 2/16/12 1500 A A Í VSlo99 1836 Upper Barton 2/9/12 1625 2/16/12 1500 A A Í VSlo99 1836 Upper Barton 2/9/12 1625 2/16/12 1500 A A Í VSlo99 1836 Upper Barton 2/9/12 1625 2/16/12 1500 A A Í VSlo91 1838 Upper Barton 2/9/12 1625 2/16/12 1500 A A Í VSlo90 1838 Upper Barton 2/9/12 1627 2/16/12 1627 A A Í Vel		V5693	58-50-212	Sunset MW	2/3/2012 13:40	2/6/12 13:34		A		
V5695 1838 Upper Barton 2/10/12 16:27 2/11/12 1307 A V5696 1838 Upper Barton 2/11/12 1307 2/11/12 1457 A V5696 1838 Upper Barton 2/11/12 1307 2/15/12 1457 A V5697 1838 Upper Barton 2/2/12 1322 2/7/12 1622 A A V5699 1836 Upper Barton 2/2/12 1505 A A A V5699 1838 Upper Barton 2/7/12 1625 2/10/12 1627 A A Sheet filled out by OUL staff? Yes No Charts for symples on this page proofed by OUL: Y Y A A Proiect No. //S/ Date Analyzed: Z/1.1 * S Analyzed By: MR / AUL MR / AUL MA K / Hsh d on Separate Coc ·LG/6M		V5694	58-50-212	Sunset MW	2/6/12 13:34	2/16/12 12:35		A		
V569 1838 Upper Barton 2/11/12 1307 2/16/12 1457 A 1 V5699 1835 Upper Barton 2/2/12 1322 2/7/12 1622 A 1 V5699 1835 Upper Barton 2/7/12 1625 2/16/12 1500 A 1 V5699 1835 Upper Barton 2/7/12 1625 2/16/12 1500 A 1 V5699 1838 Upper Barton 2/7/12 1625 2/16/12 1500 A 1 V5699 1838 Upper Barton 2/9/12 1402 2/16/12 1500 A 1 V5699 1838 Upper Barton 2/9/12 1402 2/16/12 1500 A 1 V5699 0ut by OUL staff? Yes No V5680 A A 1 V5693 0ut by OUL staff? Yes No V5100-0ut Ut by rowal blank. A A 1 No V5693 Makr< Itskd on Separate Coc		VSLOAS	183B	Upper Barton	2/10/12 16:27	2/11/12 1307		А		
V5697 1836 Upper Barton 2/2/12 1322 2/7/12 1622 A 1 V5698 183C Upper Barton 2/7/12 1625 2/16/12 1500 A 1 V5699 183B Upper Barton 2/9/12 1402 2/16/12 1500 A 1 V5699 183B Upper Barton 2/9/12 1402 2/10/12 1627 A 1 V5699 183B Upper Barton 2/9/12 1402 2/10/12 1627 A 1 V5699 0UL staff? Yes V5680 0UL Charcoal blank A 2 Protect No. //57 Date Analyzed: 3/1.2 *57 Analyzed By: MR/out. M5/0UL		V5696	1838	Upper Barton	2/11/12 1307	2/16/12 1457		A		. v
I V569B 183C Upper Barton 2/7/12 1625 2/16/12 1500 A I V5699 183B Upper Barton 2/9/12 1402 2/10/12 1627 A I V5680-OUL Charts for samples on this page proofed by OUL 2/9/12 1402 2/10/12 1627 A I V5680-OUL Charts for samples on this page proofed by OUL PAL V5700-OUL Darcoal	•	LPol2V	183B	Upper Barton	2/2/12 1322	2/7/12 1622		A		
V V5699 183B Upper Barton 2/9/12 1402 2/10/12 1627 V V sheet filled out by OUL staff? Yes V5680-OUL Chartes for symples on this page proofed by OUL: V5700-OUL V5700-OUL A Project No. 1/5/ Date Analyzed: 3/1.2 +5/ Analyzed By: MR/oUL: A		V5698	183C	Upper Barton	2/7/12 1625	2/16/12 1500		A		<u> </u>
V5680-DUL Charceal blank. V5700-OUL Charceal blank. sheet filled out by OUL staff? Yes No Charts for symples on this page proofed by OUL: P5 Project No. 1151 Date Analyzed: 311.2 +5 / Analyzed By: MR/aul	_	15699	183B	Upper Barton	2/9/12 1402	2/10/12 1627		A		
s sheet filled out by OUL staff? Yes (No) Charts for symples on this page proofed by OUL: (F) L Project No. 1/5/ Date Analyzed: 3/1.2 +5/ Analyzed By: MR/out) V568	0-046 Charceal	blank, Ve	1200-001 (hai	real blank.			_
	s sheet filled out b L Proiect No. //5	Y OUL staff? Yes	No Charts for same	ales on this page proofed by C Analvzed Bv: MR/out	Cオ : 100	M B	atr listed on	Separat	COC ILE POR	· _

BSEACD Report of Investigations 2013-0501 Appendix 2: Page 10 2 of 5 0 W

mples Shipped By:Brian Hunt, BSEACDte Samples Shipped: $2/22/2012$ Date Samples Shipped: $2/22/2012$ Daalyze for:BSEACD, 1124 Regal Row, Austin Texas 7874alyze for:Phloxine B and Pyranine for all samples; ialyze for:Phloxine B and Pyranine for all samples; i# Char rec'dLABSTATION# Char rec'dLABSTATION0UL use outyCrowroocul14 Numbers0H58-50-1280H58-50-20H58-50-20H58-50-2	ate& Time Samples Received: 48 see BSEACD comments for ad see BSEACD comments for ad where dve was visible in the fiel Whirlpool Whirlpool 6200 Brodie 6200 Brodie 6200 Brodie	$\frac{2/2 \frac{1}{2}}{1/2}$ Send Results to: ditional dfor field technician use -	1 375 Brianh@bseacd.org (san	Samples Received By:	C. aler	Jour
te Samples Shipped: $2/22/2012$ DaI to::BSEACD, 1124 Regal Row, Austin Texas 7874alyze for::Phloxine B and Pyranine for all samples: salyze for::Phloxine B and Pyranine for all samples: s $nUL use ouly$ Please indicate stations v# Char rec'dLABNUMBERNUMBERI vorted1-4 NumbersVorted1-4 NumbersVorted58-50-128VortedHS8-50-128PhoHS8-50-2PhoHS8-50-2	ate& Time Samples Received: 48 see BSEACD comments for add where dye was visible in the fiel STATION NAME Whirlpool Whirlpool 6200 Brodie 6200 Brodie 6200 Brodie	ンタイ/レー Send Results to: ditional dfor field technician use -	3.5 Brianh@bseacd.org (san			
I to:: BSEACD, 1124 Regal Row, Austin Texas 7874 alyze for:: Phloxine B and Pyranine for all samples: i alyze for:: Phloxine B and Pyranine for all samples: i # Char rec'd LAB STATION # Char rec'd LAB STATION # Char rec'd NUMBER 14 Numbers 0UL use outy Please indicate stations i # Char rec'd NUMBER 14 Numbers 0 H 58-50-128 0 H 58-50-2 0 H 58-50-2 0 H 58-50-2	48 see BSEACD comments for ad- where dye was visible in the fiel STATION NAME Whirlpool Whirlpool 6200 Brodie 6200 Brodie 6200 Brodie	Send Results to: ditional <i>dfor field technician use -</i>	Brianh@bseacd.org (san			
alyze for: Phloxine B and Pyranine for all samples; so only the please indicate stations is the charter of LAB STATION NUMBER NUMBER 1-4 Numbers in the second of the seco	see BSEACD comments for add where due was visible in the field STATION NAME Whirlpool 6200 Brodie 6200 Brodie 6200 Brodie	ditional dfor field technician use -		ne mailing address as billir	(BL	
OUL use onlyPlease indicate stations of the second of the se	where dye was visible in the fiel STATION NAME Whirlpool Whirlpool 6200 Brodie 6200 Brodie 6200 Brodie	dfor field technician use -				
# Char rec'd LAB STATION NUMBER NUMBER NUMBER NUMBER NUMBER 14 Numbers V V5700 58-50-128 V V5702 58-50-128 V H 58-50-128 V H 58-50-2 V H 58-50-2	STATION NAME Whirlpool Whirlpool 6200 Brodie 6200 Brodie		nse black ink only	OUL use only	BSEACD Commen	Its
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Whirlpool Whirlpool 6200 Brodie 6200 Brodie	PLACED Date & Time	COLLECTED Date & Time	# Water /Rec'd	Analyze/Hold	Additional Dye
I V5702 58-50-128 0 H 58-50-2 0 H 58-50-2 0 H 58-50-2	Whirlpool 6200 Brodie 6200 Brodie 6200 Brodie	2/3/2012 14:42	2/6/12 14:45	2-	A	
O H 58-50-2 O H 58-50-2 O H 58-50-2	6200 Brodie 6200 Brodie 6200 Brodie	2/6/12 14:45	2/16/12 13:20	7	A	
0 H 58-50-2 0 H 58-50-2	6200 Brodie 6200 Brodie	2/3/2012 14:10		ļ	н	
0 H 58-50-2	6200 Brodie	2/6/12 13:02		-	н	
		2/10/12 14:55			τ	
D H 58-50-2	6200 Brodie	2/16/12 11:55			Н	
O H 58-50-207	Ashbaugh	2/3/2012 14:17			т	
D H 58-50-207	Ashbaugh	2/6/12 12:53		ļ	н	
0 H 58-50-207	Ashbaugh	2/10/12 14:30			т	
O # 58-50-207	Ashbaugh	2/16/12 11:35			т	
0 H 58-50-222	Besse	2/3/2012 13:09			т	
0 H 58-50-222	Besse	2/6/12 12:44			т	
O H 58-50-222	Besse	2/10/12 14:25			т	
H 58-50-222	Besse	2/16/12 11:30			Ŧ	
1 H 42916C	Cold Spring	2/10/12 15:50	2/16/12 1417	E	H	
I I 429168	Cold Spring	2/3/12 1732	2/10/12 1547	۲	т	
O H 42916	Cold Spring	2/10/12 1545			н	
O H 42916	Cold Spring	2/16/12 1412			Ŧ	
H 42921B	Eliza	2/10/12 16:42	2/11/12 0947	æ	т	
 42921B	Eliza	2/2/12 1347	2/7/12 1647		Ŧ	
429218	Eliza	2/7/12 1647	2/9/12 1417	÷	н	

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BSEACD Report of Investigations 2013-0501 Appendix 2: Page 11

Project	Arbor Trails Sinkh	iole, Austin Texas		Week No:	1 - 3	Samples Collected By:	BSEACD/COA	
Samples Shipped By:		Brian Hunt, BSEACD		1		- Samples Received By:	C. aller 10	DUL
Date Samples Shipped	<u></u>	2/22/2012	Date& Time Samples Received	1 2/24/12 1;	315			
Bill to:	BSEACD, 1124 Rei	gal Row, Austin Texas 78	748	Send Results to:	Brianh@bseacd.org (sar	ne mailing address as billi	(Bu	
Analyze for:	Phloxine B and I	Pyranine for all sample	s; see BSEACD comments for a	dditional				
OUL use	only .	Please indicate station	s where dye was visible in the fie	eldfør field technician use	- use black ink only	OUL use only	BSEACD Commen	ts
# Char rec'd	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED Date & Time	COLLECTED Date & Time	# Water /Rec'd	Analyze/Hold	Additional Dye
-	t	42921A	Eliza	2/9/12 1415	2/10/12 1640	B	т	
	И	42921C	Eliza	2/9/12 1420	2/16/12 1520	7	т	
0	H.	42921	Eliza	2/10/12 1640		4	н	
0	Ŧ	42921	Eliza	2/11/12 0945			т	
0	H	42921	Eliza	2/16/12 1515			т	
9	t	42921	Eliza	2/7/12 1650			. т	
0	Ŧ	42921	Eliza	2/9/12 1420			Ξ	
0	H H	58-50-2JR	Jenkins	2/3/2012 13:15			т	
0	#	58-50-2JR	Jenkins	2/6/12 12:37			н	
Q	+	58-50-2JR	Jenkins	2/10/12 14:10			т	
б	Ŧ	58-50-2JR	Jenkins	2/16/12 11:20			т	
-	Ŧ	42914C	Main Barton	2/2/12 1405	2/7/12 1705	Ð	т	
O	ŧ	42914	Main Barton	2/10/12 1655			т	
φ	Ŧ	42914	Main Barton	2/11/12 1405			Т	
0	Ŧ	42914	Main Barton	2/16/12 1530			I	
0	±	42914	Main Barton	2/7/12 1700			т	
0	Ŧ	42914	Main Barton	2/9/10 1435			т	
0	#	42922	Old Mill	2/10/12 1715			H	
0	H H	42922	Old Mill	2/11/12 1330		-	т	
0	Ŧ	42922	Old Mill	2/16/12 1550			т	
ð	t	42922	Old Mill	2/7/12 1730			Ξ	
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BSEACD Report of Investigations 2013-0501 Appendix 2: Page 12

Project	Arbor Trails Sinkho	ole, Austin Texas	~	Veek No:	1 - 3	Samples Collected By:	BSEACD/COA	
Samples Shipped By:		Brian Hunt, BSEACD		-		Samples Received By:	C. aler 104	2
Date Samples Shipped:		2/22/2012	Date& Time Samples Received:	2/4/12	315			
Bill to:	BSEACD, 1124 Reg	al Row, Austin Texas 7	8748 S	send Results to:	Brianh@bseacd.org (sam	ie mailing address as billir	ng)	
Analyze for:	Phloxine B and P	yranine for all sampl	es; see BSEACD comments for addi	tional				
OUL use	only .	Please indicate statio	vis where dye was visible in the field	for field technician use	- use black ink only	Spio asin TAO	BSEACD Comment:	
# Char rec'd	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED Date & Time	COLLECTED Date & Time	# Water /Rec'd	Anaiyze/Hold	Additional Dye
0	Ŧ	42922	Old Mill	2/9/12 1500			H	
0	Ŧ	58-50-230	Picard	2/3/2012 16:34		1	н	
٩	H	58-50-230	Picard	2/6/12 13:16		-	н	
0	Ŧ	58-50-230	Picard	2/10/12 15:05			н	
0	Ŧ	58-50-230	Picard	2/16/12 12:20			т	
	-+	183C	Upper Barton	2/2/12 1325	2/7/12 1625	0 89	н	
_	+	183B	Upper Barton	2/7/12 1622	2/9/12 1402	0 N	Т	
3	±	183	Upper Barton	2/10/12 1625			Т	
0	T	183	Upper Barton	2/11/12 1305			т	
0	T	183	Upper Barton	2/16/12 1455			т	
0	Ŧ	183	Upper Barton	2/7/12 1620		-	т	
0	Н	183	Upper Barton	2/9/12 1400			т	

& Wake listed an Separate COC - LG POUL

This sheet filled out by OUL staff? Yes $(N_{OUL}, Charts for samples on this page proofed by OUL: <math>\mathcal{R}$ Analyzed By: Date Analyzed: OUL Project No.

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Certificate of Analysis

Brian Hunt (brianh@bseacd.org) Project contacts: Brian Smith (brians@bseacd.org) Project name: Arbor Trails Sinkhole. Austin. TX Austin, Texas 78748 Date of certificate: March 19, 2012 Mailing address: 1124 Regal Row Client: BSEACD

Date samples rec'd at OUL: February 24, 2012 and archived COA includes: Table of results, copies of sample collection Date analyzed by OUL: March 16 and 19, 2012 Date samples shipped: February 22, 2012 Date of analysis request: March 14, 2012 Samples collected by: BSEACD/COA data sheets

Results for charcoal and water samples analyzed for the presence of pyranine and phloxine B dyes.

I CAN WAVUL		וכובוס לוווון), עצר בסווכבווחמו					-	
OUL	Station Number	Medium	Date/Time	Date/Time	Pyranine	Results	Phloxine	B Results
Number	and Name		Placed	Collected	Peak nm	Conc. ppb	Peak nm	Conc. ppb
V6108P	42921B Eliza	charcoal	2/10/12 1642	2/11/12 0947	501.8	11.7	ND	
V6109P	42921B Eliza	charcoal	2/2/12 1347	2/7/12 1647	DN		ND	
V6110P	42921B Eliza	charcoal	2/7/12 1647	2/9/12 1417	ND		ND	
V6111P	42921A Eliza	charcoal	2/9/12 1415	2/10/12 1640	ND		ND	
V6112P	42921C Eliza	charcoal	2/9/12 1420	2/16/12 1520	500.4 **	15.4	ND	
V6113	58-50-207 Ashbaugh	water		2/6/12 1253	Analysis no	t requested	ND	
V6114	58-50-207 Ashbaugh	water		2/10/12 1430	Analysis no	t requested	554.2	0.039
V6115	58-50-207 Ashbaugh	water		2/16/12 1135	Analysis no	t requested	554.8	0.077
V6116	42921 Eliza	water		2/10/12 1640	Analysis no	t requested	ND	
V6117	42921 Eliza	water		2/11/12 0945	Analysis no	t requested	ND	
V6118	42921 Eliza	water		2/16/12 1515	Analysis no	t requested	DN	
V6119	42921 Eliza	water		2/7/12 1650	Analysis no	t requested	ND	
V6120	Laboratory control water l	blank						
V6121	42921 Eliza	water		2/9/12 1420	Analysis no	t requested	ND	
V6122	42914 Main Barton	water		2/10/12 1655	Analysis no	t requested	554.4	0.033
V6123	42914 Main Barton	water		2/11/12 1405	Analysis no	t requested	553.2	0.032

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0110	Station Number	Medium	Date: Time	Date/Time	Pyranine Results	Phloxine	3 Results
Number	and Name		Placed	Collected	Peak nm Conc. ppb	Peak nm	Conc. ppb
4210V	42914 Main Barton	water		2 16 12 1530	Analysis not requested	552.0	0.040
V6125	42914 Main Barton	water		2 7-12 1700	Analysis not requested	555.4	0.039
V6120	42914 Main Barton	water		2-9-12-1435	Analysis not requested	555.6	0.040
V6127	183 Upper Barton	water		2:9:12 1625	Analysis not requested	554.8	0.471
V6128	183 Upper Barton	water		2/11/12 1305	Analysis not requested	554.8	0.430
V6129	183 Upper Barton	water		2/16/12 1455	Analysis not requested	554.8	0.628
V6130	183 Upper Barton	water		2/7/12 1620	Analysis not requested	555.0	0.279
V6131	183 Upper Barton	water		2/9/12 1400	Analysis not requested	555.2	0.390

Note: Dye concentrations are based upon standards used at the OUL. The standard concentrations are based upon the as sold weight of the

dye that the OUL uses. If the client is not using OUL dyes, the client should provide the OUL with a sample of the dye to compare to the OUL dyes.

Footnotes:

ND = No dye detected

** = A fluorescence peak is present that does not meet all the criteria for this dye. However, it has been calculated as a positive dye result.

Thomas J. Aley, PHG and RG

1 Home J. Hey

1572 Aley Lane Protem, MO 65733 (417) 785-4289 fax (417) 785-4290 email: contact@ozarkundergroundlab.com SAMPLE COLTECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project	Arbor Trails Sinkhole, Austin Texas	Week No:	1-3 Samples Collected By: <u>BSEACD/COA</u>
Samples Shipped By:	Brian Hunt, BSEACD	ne d 2/24/1	2- 1 Walpin Ungest Samples Received By: (40 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Date Samples Shipped	: 2/22/2012 Date& Time Sam	les Received: 3/14/12 &	800
Bill to:	BSEACD, 1124 Regal Row, Austin Texas 78748	Send Results to:	Brianh@bseacd.org (same mailing address as billing)
Analyze for:	Phloxine B and Pyranine where indicated		

OUL ace on) Tense infract anticant sating antication within an intermediation and antication andotener andoteneer antication and antintreation and antication and	OUL use only Please indicate stations where dre was visible in the field # Char rec'd LAB STATION # Char rec'd LAB STATION Ørayroad 58-50-207 Ashbaugh Ø 429218 Eliza Ø 429214 Eliza Ø 42921 Eliza Ø 42921 Eliza Ø 42921 Ashbaugh <	the fieldfor field technician use - us PLACED Date & Time 2/6/12 12:53 2/10/12 14:30 2/10/12 14:30 2/10/12 16:42 2/10/12 16:42 2/10/12 16:42 2/10/12 16:47 2/9/12 1415 2/9/12 1415 2/9/12 1420 2/9/12 1420	e black ink only. COLLECTED Date & Time 2/11/12 0947 2/7/12 1647 2/9/12 1647 2/10/12 1640 2/16/12 1520	0UL use only # Water /Rec ⁱ d 	BSEACD Comme Analyze/Hold A	nts Additional Dye
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OZARK UNDERGROUND LABORATORY, INC. 1572 Aley Lane Protem, MO 65733 (417) 785-4289 fax (417) 785-4290 email: contact@ozarkundergroundlab.com SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

74 Kul	コラーロ						Inal	d1				
D	ろえ				nts		Additic	Dye				
BSEACD/COA	AC DC.		ing)		BSEACD Comme			Analyze/Hold		A	A	A
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Week No:	1-11/Late & mi	314120	Send Results to:		for field technician use - 1		PLACED	Date & Time		2/6/12 12:53	2/10/12 14:30	2/16/12 11:35
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ole, Austin Texas	Brian Hunt, BSEACD	2/22/2012	al Row, Austin Texas 78	yranine where indicat	Please indicate station		STATION	NUMBER	1-4 Numbers	58-50-207	58-50-207	58-50-207
Arbor Trails Sinkho			BSEACD, 1124 Reg	Phloxine B and P	only	GUL	LAB	NUMBER	Water	VIEITS	71014	VIBIIS
Project	Samples Shipped By:	Date Samples Shipped:	Bill to:	Analyze for:	OUL use		# Char rec'd			0	0	0

# Char rec'd	LAB NUMBER	STATION NUMBER	STATION NAME	PLACED Date & Time	COLLECTED Date & Time	# Water /Rec'd	Analyze/Hold	Additional Dye
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0	V6118	42921	Eliza	2/16/12 1515			A	
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0	V6125	42914	Main Barton	2/7/12 1700			A	
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1572 Aley Lane Protem, MO 65733 (417) 785-4289 fax (417) 785-4290 email: contact@ozarkundergroundlab.com SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS **OZARK UNDERGROUND LABORATORY, INC.**

This sheet filled out by OUL staff? Yes (No) Charts for samples on this page proofed by OUL CL phlotuin B OUL Project No. 1151 Date Analyzed: 3 19:12 Analyzed By: M. P. O. W. C.

2 of 2 (U)

Appendix 3: Correspondence on confirmation of results

Brian Hunt

From:	Julie Stearman [jstearman@ozarkundergroundlab.com] on behalf of talev@ozarkundergroundlab.com
Sent:	Tuesday, May 15, 2012 9:52 AM
То:	Brian Hunt
Subject:	RE: Confirmation of Results

Hi Brian:

At your request I re-examined the analysis graphs for the following three samples. I also had our lab do a reanalyzed of the three samples. The re-analysis showed the following:

V5656P. This is Station 6. 58-50-2 6200 Brodie. This was a charcoal sampler elutant. There is a fluorescence peak in this sample at 521.2 nm. The results confirmed the initial analysis.

V5687P. This is Station 11. 58-50-230 Picard. This was a charcoal sampler elutant. There were no fluorescence peaks in this sample. The results confirmed the initial analysis.

V5689P. This is Station 12. 58-50-1GR Randalls. This was a charcoal sampler elutant. There was a fluorescence peak in this sample at 519.3 nm. The results confirmed the initial analysis.

Under the protocol we are using for phloxine dye positive detections will have peak emission wavelengths in the range from about 573 to 578 nm. The fluorescence peaks at Stations 6 and 12 were far outside of this range. The peaks were also well outside the range for pyranine dye.

Based upon both our initial and our re-analysis results there was no detectable phloxine dye or pyranine dye in any of these three samples.

Best regards,

Tom Aley

From: Brian Hunt [mailto:brianh@bseacd.org] Sent: Thursday, May 10, 2012 5:46 PM To: Julie Stearman Cc: Brian Hunt Subject: RE: Invoice

Hi Julie,

For our recent study we had some duplicate charcoal and water samples analyzed by the Edwards Aquifer Authority. For the most part there is good agreement in the all results, but there are three samples that I wonder if you could look at your analyses to reconfirm the results. These include three different wells where your results indicate a non-detect, while the EAA indicates a detection of Phloxine B. They only detected the dye once in each of these wells corresponding to the samples I listed below.

The samples are: V5656P, V5687P, and V5689P.

Thank you!

Cheers, Brian

Brian B. Hunt Senior Hydrogeologist Barton Springs/Edwards Aquifer Conservation District 1124 Regal Row Austin, Texas 78748 (512) 282-8441 office (512) 282-7016 fax brianh@bseacd.org

Here's all the legal stuff:

"This message is intended only for the named recipient. If you are not the intended recipient, you are notified that disclosing, copying, distributing or taking any action in reliance on the contents of this information is strictly prohibited, and you are hereby instructed to notify the Sender by reply email and then immediately delete this email message."

From: Julie Stearman [mailto:jstearman@ozarkundergroundlab.com] Sent: Tuesday, March 20, 2012 10:56 AM To: Brian Hunt Subject: Invoice

Hello Brian, Please see the attached invoice; let me know if you have any questions.

Thank you, Julie Stearman

Brian Hunt

From: Sent: To: Subject: Steven Johnson [sjohnson@edwardsaquifer.org] Friday, May 11, 2012 3:37 PM Brian Hunt RE: dye trace results

Brian, the yellow line is the combination of the two peaks in the sample that are shown in red. The green line is the original spectrograph. The peaks around 500 are Uranine as in 194 and 103 or background optical properties of water as in 109 and 115.

Steve Johnson Hydrogeologist Supervisor-Aquifer Science Team

Edwards Aquifer Authority 1615 N. St. Mary's Street San Antonio, TX 78215 210/222-2204 mailto:sjohnson@edwardsaquifer.org



From: Brian Hunt [mailto:brianh@bseacd.org]Sent: Friday, May 11, 2012 3:04 PMTo: Steven JohnsonSubject: RE: dye trace results

Steve, the yellow line is the sample and the two red lines are for the standard and blank?

Thanks again!

b

Brian B. Hunt Senior Hydrogeologist Barton Springs/Edwards Aquifer Conservation District 1124 Regal Row Austin, Texas 78748 (512) 282-8441 office (512) 282-7016 fax brianh@bseacd.org

Here's all the legal stuff:

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From: Steven Johnson [mailto:sjohnson@edwardsaquifer.org] Sent: Friday, May 11, 2012 10:08 AM To: Brian Hunt Subject: RE: dye trace results

Brian, here are the three sample results:



sample #194 (6200 Brodie, charcoal 2/3-2/6) Phloxine B shows up around 550 nm. In this case, it's a very low concentration, but I think it's there.



#103 (Randalls, charcoal 2/3-2/6) Same results as above



#109 (Picard, charcoal 2/6-2/10) This one has the lowest concentration. Phloxine B is more easily recognized than Uranine and Eosin because it appears where the background interference is low. I have the dates as 2/3-2/6/10.



For comparison, here's sample #115 from Picard with no detectable Phloxine B so you can see the contrast in the 550 nm area.

I would call the other samples tentative detections at least because they were in only one sample from the site and because the peak shape is somewhat subjective.

Steve Johnson

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From: Brian Hunt [mailto:brianh@bseacd.org]
Sent: Thursday, May 10, 2012 5:59 PM
To: Steven Johnson
Cc: Brian Smith
Subject: dye trace results

Hi Steve,

We some of the dye trace samples to OUL labs as duplicates. For the most part there is good agreement in the results where they overlap. However, there are 3 sites that you all detect Phloxine B and OUL did not. I wanted to see if perhaps you wouldn't mind looking at the results of those 3 sites again—if possible.

The three samples include: EAA sample #194 (6200 Brodie, charcoal 2/3-2/6); #103 (Randalls, charcoal 2/3-2/6); and #109 (Picard, charcoal 2/6-2/10).

I suspect those sites would have been on the flow path, and since they were only detected once, and by only 1 lab, I am trying to confirm or deny. I've asked OUL to review those three samples too.

Thanks! Cheers, Brian