

REPORT

MANATEE SPRINGS DYE TRACE LEVY COUNTY, FLORIDA JUNE -SEPTEMBER, 2009



Prepared for

Florida Department of Environmental Protection
Ground Water Protection Section
Bureau of Watershed Management
2600 Blair Stone Road, MS 3575
Tallahassee FL 32399-2400

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URS Corporation Southern
1625 Summit Lake Drive – Suite 200
Tallahassee, Florida 32317
850.574.3197
12805625.00000

PROFESSIONAL SEAL

In accordance with Chapter 492, Florida Statutes this report dated December 4, 2009 and titled *Manatee Springs Dye Trace Levy County, Florida June -September, 2009* has been reviewed and approved by the undersigned licensed Florida Professional Geologist.

URS has conducted this investigation in accordance with the agreed upon Scope of Services, in a manner consistent with sound geologic practices and that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar circumstances. Information provided to URS by client representatives has been accepted in good faith and is assumed to be accurate.

Signed: _____

Wm H. Colona III

William H. Colona III, P.G.
Licensed Professional Geologist
State of Florida No. 1107



Date: _____

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The Manatee Springs dye trace was conducted to assess the potential of a hydraulic connection between a karst drainage feature, identified herein as the Chiefland Sink, and Manatee Springs (including its cave system), and municipal and private water wells located near and downgradient of Chiefland Sink. As originally scoped, the project included a second dye trace (Fanning Springs dye trace) with a planned dye release location at a sink, identified herein as the Lancaster Sink. However, due to project-related time constraints caused by flooding and sustained high water levels in the Suwannee River that caused flow reversal in both Fanning Springs and Manatee Springs, and dye trace design considerations specifically related to these conditions, the second trace was postponed. URS recommends that the Fanning Springs dye trace be conducted to complete the study as originally scoped, when water level conditions are favorable and funding is available.

Prior to beginning the Manatee Springs dye trace, background sampling was conducted, which indicated the presence of fluorescein in charcoal samplers positioned at one location, Manatee Springs Blue Water Tunnel, at concentrations ranging from 0.643 parts per billion (ppb) to 1.72 ppb. The source(s) of these low concentrations of fluorescein is unknown; however, urbanization within the karstic study area suggest its origin may plausibly be described as “anthropogenic background.”

On August 3, 2009 (Day 0), 25 pounds of rhodamine WT dye was released into the Chiefland Sink. The dye release was immediately followed by flushing approximately 89,000 gallons of chase water in the sink. Stormwater that entered the Chiefland Sink as a result of rainfall that fell the next day delivered a considerable amount of additional water into the sink. During the next 40 days (August 4 through September 13, 2009), charcoal samplers and water samples were collected at scheduled intervals at three springs, two cave tunnels, three river locations, five public water wells, and one private water well in the study area. A total of 243 charcoal samplers and water samples were collected, of which 76 were analyzed. There were 24 dye-positive charcoal samplers, and one dye-positive water sample.

The first detection of rhodamine WT dye occurred between Days 4 and 8 at the Manatee Springs, Manatee Springs Main Tunnel, and Manatee Springs Blue Water Tunnel sampling stations. The dye reached its highest detected concentrations at the Manatee Springs Main Tunnel and Blue Water Tunnel locations between Days 8 and 12, and at the Manatee Springs sampling station between Days 12 and 16. A water sample collected on Day 12 at Manatee Springs tested positive for dye. Laboratory analyses indicated dye was still present at the Manatee Springs and the Main Tunnel sampling stations, over the Days 32 to 40 time interval. The final detection of dye in the Blue Water Tunnel was in the charcoal sampler positioned during the Days 21 to 25 time interval.

The detection of rhodamine WT dye at Manatee Springs and its cave system indicates a direct hydrologic connection between the Chiefland Sink and the Manatee Springs Cave System. Given that the distance between Chiefland Sink and Manatee Springs is 7.26 miles, the estimated range of groundwater flow velocity between the sink and the cave/spring system is approximately 9,600 feet per day (four-day travel time) to 4,800 feet per day (eight-day travel time) under the conditions present during this dye trace. These flow rates indicate that, in addition to matrix-bound flow, conduit flow must be considered when developing an understanding of the hydrogeologic framework of the area. No dye was detected in any of the six water wells monitored during the study, including the five public supply wells.

URS Corporation Southern (URS) was contracted by the Florida Department of Environmental Protection (FDEP) under the WM-946 contract to perform a qualitative dye trace to identify potential hydrogeologic connections between Chiefland Sink and Manatee Springs in Levy County, and between a sink near Lancaster Correctional Institution and Fanning Springs in Gilchrist and Levy Counties. URS was supported by its team member Karst Environmental Services, Inc. (KES). A map of the study area is presented as **Figure 1**. An aerial photograph of the study area is presented as **Figure 2**.

1.1 OBJECTIVE AND SCOPE

The objective of this study was to identify potential hydraulic connections between Chiefland Sink and Manatee Springs through the use of a qualitative dye trace. As originally scoped, this study included a dye tracer test at Fanning Springs; however, this component of the study was postponed for reasons discussed in the following sections.

Secondary goals of this study included determining if any hydraulic connections existed between Chiefland Sink and selected public and private water supply wells, determining the approximate arrival time of the dye at the spring and wells, the relative strength of dyes present, and durations of the dye.

The scope of this qualitative dye trace study included the following elements:

1. Dye trace design, planning and logistics: coordination and scheduling of personnel; identification of dye introduction and sampling locations/stations; development of sampling schedules; obtaining site and well access permissions (where needed); securing FDEP approvals; notification of the Levy County and Gilchrist County Health Departments, Suwannee River Water Management District (SRWMD), the City of Chiefland, and other public agencies.
2. Establishment of dye sampling stations and conducting background sampling and analysis.
3. Introduction of dye into the groundwater at Chiefland Sink.
4. Dye sampler collection and replacement and water sample collection during the study period, along with sampler handling and preparation and shipment to the analytical laboratory.
5. Laboratory analyses of dye samplers and water samples.
6. Data management and reporting.

Photographs taken over the course of the study, which document site conditions, are presented in **Appendix A**.

1.2 WEATHER CONDITIONS

The Fanning Springs and Manatee Springs dye trace study was originally scheduled to begin in April 2009. However, severe flooding and a corresponding rise in the Suwannee River water level began in late March and peaked in mid-April 2009, with high water level conditions continuing into May 2009. Record-breaking floodwaters moved down the Suwannee River during this time period. Two major tributaries of the Suwannee River, the Withlacoochee and the Alapaha, set new flood records in April 2009. The Withlacoochee River at Pinetta, Florida reached a new record height on midnight of April 7, 2009. The United States Geological Survey (USGS) measured the peak height at 41.34 feet, the highest measurement in 77 years of records.

The previous record for the river's height was set during the 1948 flood, when the river reached a height of 38.64 feet.

The rise of the Suwannee River was so significant that a flow reversal was observed at both Fanning Springs and Manatee Springs. That is, rather than the springs discharging water into the river, the increase in hydraulic head caused by the increase in the river level caused spring flow to reverse, and water from the Suwannee River flowed or “back siphoned” into the springs, charging the aquifer with river water. Flow reversal was documented by KES staff on April 3 and April 10, 2009 and appeared generally to reach equilibrium in early May 2009. At noon on May 4, 2009, Mark Long (KES) made a brief dive at Fanning Springs and made the following field observation:

“The spring is outflowing, barely. There was no improvement in visibility at the vents. I had about 3 ft visibility with a powerful light. The spring right now appears to be discharging river water.”

After about one month the river stage had dropped and spring discharge was observed to be “clear,” suggesting that the majority of surface water that entered the groundwater system during the flow reversal had been discharged. A graph depicting the level of the river as measured at the USGS 02323566 Manatee Springs river gauge located near Chiefland, Florida is presented as **Figure 3**.

1.3 SCOPE REDUCTION

While weather and site conditions allowed for the Manatee Springs dye trace to proceed, special consideration was given to dye possibly affecting the public supply well that supplies the Lancaster Correctional Institution. A recommendation was developed that called for releasing a relatively small amount (about 1 to 2 pounds) of eosine dye into the Lancaster Sink and monitoring the Lancaster Correctional supply well, to be followed by a release of fluorescein dye. Eosine is generally not considered to be visible under field conditions at relatively high concentrations (e.g., about 13,000 ppb), but can readily be detected through the use of scanning spectrofluorophotometric methodologies. It was believed that the amount recommended for release would allow for detection through laboratory analysis without the undesired result of being visible in a public water supply well. Flooding delayed the start of the project by about two months; and it was determined there would not be sufficient time to conduct the small eosine trace and the subsequent fluorescein trace within the contracting period. Therefore, the Fanning Springs dye trace was postponed.

1.4 PERSONNEL AND ACKNOWLEDGEMENTS

This study was designed, organized and supervised by Peter L. Butt (KES) and Bill Colona (URS). Dye release was conducted by Peter Butt, Mark Long, Bill Colona, Georgia Shemitz and Matt Hubner. Charcoal sampler and water sample collection was conducted by Peter Butt, Mark Long and other KES staff. This report was prepared by Peter Butt and Bill Colona.

URS and KES would like to acknowledge and thank the following individuals and organizations for their support and contributions to the success of this study:

- City Manager Grady Hartzog, Water Facilities Manager Shane Keene and staff; City of Chiefland Public Works Department
- Ron Sherman, Florida Department of Transportation
- Sally Lieb, Park Manager, Bryon Maxwell, Asst. Manager, and the staff of Manatee Springs State Park
- Steve Davenport, Assistant Manager, and the staff of Fanning Springs State Park
- Staff of the FDEP Division of Recreation and Parks, Bureau of Parks, District 2
- Michael Poucher, National Speleological Society, Cave Diving Section, current survey effort coordinator (Manatee Springs Cave maps and survey data)
- Todd Kincaid, H2H (cave survey data support)
- Cave survey and documentation efforts by various individuals and members of the National Speleological Society-Cave Diving Section, National Association for Cave Diving and Global Underwater Explorers over the four past decades
- Gerald Roberts, Warden, and Rick Landrum, Maintenance Supervisor; Lancaster Correctional Institution
- Richard Tummond, Levy County Water Department
- Rick Tisdale, Springside Subdivision water system
- Bobby and Angela Barnhill, Barnhill Landscaping, Chiefland
- Nancy Nieman, Otter Springs Park
- Suwannee River Water Management District
- Tom Greenhalgh and the Florida Geologic Survey
- John Davis, PG, FDEP, Northeast District Office

The study area is located in northwestern Levy County and southwestern Gilchrist County, and includes the cities of Chiefland and Fanning Springs, and Manatee Springs and Fanning Springs State Parks. The Suwannee River forms the western boundary of the study area. All springs in this study area discharge into the Suwannee River.

The Chiefland Sink is located on the northwest corner of the intersection of NE 4th Avenue and NE 4th Street in the City of Chiefland, just west of Alternate U.S. Highway 27. Manatee Springs is located approximately 7.25 miles west of Chiefland, and within Manatee Springs State Park. Lancaster Sink is located approximately 2.75 miles west of the City of Trenton, north of the Lancaster Correctional Institution. Fanning Springs is located on the south side of the City of Fanning Springs and south of the U.S. Highway 19 bridge, within Fanning Springs State Park.

2.1 GEOMORPHOLOGY

The study area is located in northwestern Levy County and southwestern Gilchrist County near the town of Chiefland, Florida on the Chiefland Limestone Plain. Levy County lies near the northern edge of the Midpeninsular Zone of Florida. This zone spans the Florida peninsula from the lower edge of the topographically higher Northern Highlands southward to approximately the Caloosahatchee River. The Mid-peninsular zone is partitioned into a series of geomorphic subzones. These subzones are differentiated based on elevation. Two of these subzones, the Central Highlands and the Gulf Coastal Lowlands, occur within Levy County. A map showing the geomorphic features and surficial geology of Levy County is presented as **Figure 4**.

The Gulf Coastal Lowlands geomorphic province parallels the present Gulf Coast of Florida from Ft. Myers northward, then westward around the Big Bend to the Alabama state line. In the vicinity of Levy County, the Gulf Coastal Lowlands extend distances of between 15 and 30 miles inland from the Gulf of Mexico shoreline, terminating at the western edge of the Brooksville Ridge. The Gulf Coastal Lowlands in Levy County are characterized by broad, flat, marine erosional plains, underlain by Eocene limestones, and blanketed by thin Pleistocene sands. Elevations within this province vary from 0 feet mean sea level (MSL) at the Gulf shoreline, to about 60 feet MSL near the Brooksville Ridge. Several geomorphic subdivisions, based on topography, divide the Gulf Coastal Lowlands zone in Levy County. These include the Waccasassa Flats, the Limestone Shelf and Hammocks, the Chiefland Limestone Plain, the Suwannee River Valley Lowlands, and the Coastal Marsh Belt.

The flat, karstic limestone shelf in northwestern Levy County associated with the Pleistocene-age Wicomico Terrace is named the Chiefland Limestone Plain. This plain extends from Gilchrist County southward into Levy County. The terrain is generally flat to rolling, characterized by a veneer of well-drained Pleistocene sands, generally less than 30 feet thick, overlying the solutioned Eocene limestones. Elevations range from 25 feet MSL at the southern edge of the plain, to nearly 50 feet MSL at the Levy-Gilchrist County line.

2.2 GEOLOGY

The oldest rock commonly penetrated by water wells in Levy County is marine limestone of the Eocene age Avon Park Formation. Undifferentiated Pleistocene to Holocene age surficial sands, clayey sands, and alluvium are the youngest sediments present. The Avon Park Formation and the younger overlying limestone units are important freshwater aquifers.

Marine limestones of the Ocala Group unconformably overlie the Avon Park Formation under all of Levy County except along the crest of the Ocala Platform, where the younger limestones erosional pinch out against the Avon Park Formation. The Ocala Group is comprised of three formations; in ascending order, they are the Inglis Formation, the Williston Formation, and the Crystal River Formation. The thickness of the Ocala Group sediments under Levy County averages about 100 feet. The depth to the irregular and highly solutioned top of the Ocala Group is generally less than 50 feet. In western Levy County, and offshore of the modern coast, a thin blanket of sand covers the limestone; and exposures in the form of limestone boulders and pinnacles are common. The permeable and cavernous nature of the Ocala Group limestones makes them important freshwater-bearing units of the Floridan aquifer system. Many drinking water wells in Levy County withdraw water from the upper units of this group.

Undifferentiated Pleistocene age marine quartz sands and clayey sands form a thin veneer over all of Levy County. In the western part of the county and on the Chiefland Limestone Plain, these sands are generally less than 20 feet thick and directly overlie the Ocala Group limestone.

A geologic cross section through the study area is presented as **Figure 5**.

2.3 WATER RESOURCES

Three main rivers flow through Levy County and discharge to the Gulf of Mexico. These are the Suwannee River in the northwestern part of the county, the Waccasassa River in the central part, and the Withlacoochee River in the southern part. Numerous small streams and creeks transect the coastal limestone shelf and feed into these rivers or discharge directly into the Gulf of Mexico. The Chiefland Limestone Plain is drained by networks of underground caverns that are fed by numerous sinkholes and solution pipes that extend to land surface. Freshwater springs are common in the area. Four large springs and numerous smaller ones are scattered throughout the county. The four largest springs are: Manatee Spring, Fanning Springs, Blue Spring and Wekiva Spring. Manatee Springs, near Chiefland, and Fanning Springs, near the town of Fanning Springs, discharge to the Suwannee River and are the focus of this study. Manatee Springs and Fanning Springs are both Magnitude 1 springs with discharge rates greater than 100 cubic feet per second (cfs) per day. The SRWMD reports average discharge rates of 178 cfs for Manatee Springs and 113 cfs for Fanning Springs.

The surficial aquifer system is the uppermost freshwater aquifer in Levy County. Where present, this non-artesian aquifer is contained within the interbedded sands and clays of the Alachua Formation and the overlying marine terrace sands in east-central Levy County. In western Levy County, the surficial aquifer system is thin or absent, occurring only in locally thick Pleistocene sands immediately overlying the Ocala Group limestone. Published data indicate the surficial sands are less than 20 feet thick in the study area and the surficial aquifer is not thought to be present.

The Floridan aquifer is the only aquifer present throughout the entire study area. The aquifer is composed of fractured and cavernous limestones of the Ocala and Avon Park Formations. The Floridan aquifer system is the water source for Manatee Springs and Fanning Springs, as well as the major source of drinking water in North-Central Florida. Floridan aquifer formations are approximately 1,200 feet thick in the study area. The Floridan aquifer is unconfined in the study area. The May, 2005 potentiometric surface map of the Floridan aquifer (**Figure 6**) indicates the direction of groundwater flow in the study area is west, towards the Suwannee River.

3.1 DESCRIPTION OF FEATURES WITHIN THE STUDY

As depicted on **Figure 1**, the study area consists of the Fanning Springs springshed and the Manatee Springs springshed. While the Fanning Springs dye trace was not performed, features within the Fanning Springs study area are identified on **Figure 7**, because some background work was conducted. Features within the Manatee Springs study area are presented on **Figure 8**, and are described in the following sections.

3.1.1 Suwannee River

The Suwannee River represents the general western boundary for this study, and receives the discharge of all springs monitored. This river is the boundary between Levy and Gilchrist Counties on the east and Dixie County on its west. The bridge for State Highways 19/98 crosses the river at the northern end of the study area at Fanning Springs, and is the last bridge on the river before it enters the Gulf of Mexico. The river can be accessed by numerous public landings. The landings chosen as sampling points for this study were the Hart Ramp, Clay Landing and Usher Landing.

The Suwannee River is the dominant hydrologic feature in the study area, directly affecting groundwater levels and spring discharge as it rises or falls due to inputs occurring in its upstream drainage, which extends all the way to the Okefenokee Swamp in Georgia. The river level and discharge within the study area are also affected by ocean tides.

3.1.2 Manatee Springs and Cave System

Manatee Springs is one of Florida's 27 first-magnitude springs. It has the distinction of being the last first-magnitude spring on the Suwannee River. It is also the last known spring on the Suwannee River. A diagram of the Manatee Springs Cave System, presented as **Figure 9**, indicates that the cave system has over 5 miles of currently explored passage. The relatively high water velocity, extensive passage length, and dark cave walls have challenged explorers for over four decades. An overlay of the Manatee Springs Cave System onto an aerial photograph is presented as **Figure 10**.

The average depth of the Manatee Springs Cave System is around 85 feet. There is a point 920 feet upstream of Friedman Sink that gets slightly shallower than 30 feet deep. There are some points in the main tunnel and side tunnels where the depths, as determined by a depth gauge worn by a diver exceed just over 100 feet with normal water levels. Under normal conditions, depths within the cave system are not known to exceed 110 feet.

Water depths presented in the following descriptions are approximate, and represent the depths usually encountered by divers during normal water level conditions in these locations. The variations in the levels of the water table and the Suwannee River affect depth gauge readings. There are also minor variations between the individual depth gauges used. Use of the terms "right" and "left" here are referenced to an observer facing upstream and into the cave passages.

The cave system has four known entrances; one spring and three sinks (or karst windows). The first entrance is that of the spring pool, and it is also where all cave waters discharge. The second entrance is in a large sink named Catfish Hotel, located 467 feet upstream from the

spring. The third entrance, Sue Sink, is 1,204 feet upstream from the spring. The fourth and final entrance is Friedman Sink, located 2,179 feet upstream from the spring.

Entering the Manatee Springs pool a diver finds a limestone cliff that descends to an approximately 25-foot depth. From here the cavern bottom slopes down to a depth of around 50 feet, where high-velocity outflow is encountered due to reduction in size of the entrance. The opening here is approximately 12 feet wide and 4 feet high. Just past the entrance the cavern enlarges to approximately 30 feet wide and 12 feet high. After a penetration of 50 feet the cave starts to descend and all natural light is lost.

Approximately halfway to Catfish Hotel, there is an obscure entrance (about 2 feet high) to a side tunnel on the right (south) side of the cave that is known as the Snack Bar Tunnel. This tunnel is between 400 and 500 feet long. It is characterized by moderate flow, low visibility, a very silty floor and several restrictions. The tunnel ends in a small room with at least two different sources of water issuing from small vents in the floor. This tunnel was named following a survey that indicated that it is very nearly under the park's concession stand "snack bar."

Catfish Hotel is a large sinkhole that is typically covered with duckweed year round. It has a relatively large, open, water basin and is a popular spot used for open-water scuba diving classes. The cavern is located under a limestone cliff on the north side of the sink. Descending to 50 feet in depth from the surface, the cavern begins and drops to approximately 95 feet maximum depth on its south side, connecting to the spring 467 feet downstream. The north side of the cavern opens to the upstream passage and quickly drops to 90 feet deep. The tunnel here is nearly 40 feet wide and has a sand floor.

Between Catfish Hotel and Sue Sink are two small side tunnels on the north side of the main passage. The first is roughly 300 feet from Catfish Hotel and is known as the Cold Tunnel. It continues for approximately 60 feet, and then ends. The second tunnel is approximately 500 feet upstream from Catfish Hotel and is too small to enter. There is a slight outflow emanating from this small tunnel; and, based on visible observations, its water is believed to be of a different quality or origin than that in the main passage.

Sue Sink is less than half the size of Catfish Hotel and is used as an emergency exit only, as divers are not allowed to enter or normally exit there. It is located within an organized camping area in the park. The surface of this sink is completely covered with water lettuce. Beneath the surface, the bottom falls away into a vertical chasm that actually has two entrances that enter the main passage. At approximately 75 feet deep the diver passes over the top of the permanent line that runs through the cave. Upstream from this section the cave takes on a rounder shape with some cross sections as large as 50 feet wide and 30 feet high. The main passage continues on to Friedman Sink.

Between Sue Sink and Friedman Sink, there is a passage on the right (south) side of the main tunnel named the Sewer Tunnel. Its entrance is 204 feet downstream from Friedman Sink. This unusual name is attributed to the presence of large, suspended particulates routinely observed in the water by divers. This causes the visibility to be reduced beyond what is normally encountered in the main tunnel.

About 100 feet upstream into the Sewer Tunnel, it branches into two passages. The tunnel bearing straight ahead is called the Chalkley Bypass. This tunnel continues for another 300 feet

and reconnects into the main tunnel upstream of Friedman Sink. It is characterized by an eroded white clay floor.

At the intersection, the second tunnel branches to the south and continues as the Sewer Tunnel for thousands of feet. This passage is characterized by low visibility, high outflow, and some restrictions. Located 400 feet into this tunnel is one of the monitoring wells/instrument stations placed in the center of the cave passage by the Florida Geological Survey (FGS).

This tunnel continues to wind and twist but generally takes a southerly direction. After approximately 3,000 feet of distance (from Friedman Sink) the tunnel makes several branches and becomes much smaller. Some of the tunnels require a special side-mount diving configuration. Eventually, some of these tunnels reconnect. The size of the tunnel increases and the flow velocity increases. The Sewer Tunnel continues to a point where it enters the Manatee Springs Cave System's main tunnel at a point 6,200 feet upstream from Friedman Sink (main tunnel distance). When this passage off the main tunnel at 6,200 feet was originally discovered and explored, it was named the Siphon Tunnel. Only later, after the original exploration, was the connection with the Sewer Tunnel discovered.

The final known entrance into the Manatee Springs Cave System is Friedman Sink. It is a small sink. The surface pool can vary in size from 40 feet by 50 feet to as small as 4 feet by 8 feet. The size of the pool is dependent on the height of the Suwannee River and the hydrostatic head of the cave. The entrance to the cave is through a small, 3-foot diameter chimney. At around 20 feet deep, the chimney opens into a room with an irregular ceiling and the floor at a depth of 55 feet.

Continuing upstream of Friedman Sink, the next significant side tunnel is located 750 feet upstream and is known as the Milk Tunnel. The passage is located on the right (south) side of the main tunnel. This tunnel is generally smaller in size than the Sewer Tunnel and has high flow and low visibility. Two hundred feet into the Milk Tunnel is located probably the most difficult major restriction for divers to negotiate in the entire Manatee Springs Cave. Past this major restriction the tunnel enlarges somewhat and continues for a distance of over 3,500 feet from Friedman Sink. Surveying efforts have strongly suggested that there may be a connection into the Sewer Tunnel somewhere near the end of this tunnel. The plotted survey maps of the tunnels show them to be in close proximity to each other.

Upstream from the Milk Tunnel junction the diver generally finds the best visibility in the Manatee Springs Cave System's main tunnel. The main passage in this area is quite picturesque and has many ups and downs with a white sand and rock-covered floor. Parts of the passage in this area could be called rooms.

At a distance of 2,400 feet upstream of Friedman Sink, a small side tunnel intersects the main tunnel on the left (east) side. This passage has the clearest water of any tunnel in the Manatee Springs Cave System and is known as the Blue Water Tunnel. The walls of this tunnel are generally cream colored as opposed to the black walls in the rest of the cave system. After going a short distance east, the tunnel makes a turn and continues for over 4,000 feet. The current survey shows the passage trending in a north/northeast direction.

A second FGS monitoring well/instrument station was installed in the Blue Water Tunnel about 50 feet upstream from the intersection with the main cave passage.

A third and final FGS monitoring well/instrument station was installed in the main passage about 50 feet upstream from the intersection with the Blue Water Tunnel.

Upstream from the Blue Water Tunnel, the main passage becomes slightly smaller in size. There are two pits that drop the main passage floor by 15 feet. The first is at a penetration of 4,800 feet and the other is at 5,300 feet. The next significant change occurs at an approximate distance of 6,200 feet. At this point, there is an intersection of three tunnels with the main passage. The tunnel trending east from the main passage is called the Snow Tunnel. This tunnel continues to a distance of 7,665 feet from Friedman Sink and ends at a hill, with water spilling over and around, making it impossible to penetrate further.

The tunnel on the right (west) side of the main passage is the previously mentioned Siphon Tunnel that ultimately exits downstream from Friedman Sink via the Sewer Tunnel.

The third tunnel is known as the Spring Tunnel and it branches in a south/southeast direction. This tunnel leads to the most distant parts of the Manatee Springs Cave System. There are several side tunnels in this part of the cave system; and the maximum distance of current exploration is approximately 9,600 feet upstream from Friedman Sink.

3.1.3 Clay Landing Vent

This small spring vent is located on the bottom of the Suwannee River about 50 feet out from the bank upstream of Clay Landing, and is about 17 feet deep (during normal river levels). It has a circular opening of slightly larger than 1 foot in diameter. Clear water discharges from this vent. The vent is often choked with debris.

3.1.4 Chiefland Sink

The Chiefland Sink is a natural karst drainage feature located on the northwest corner of the intersection of Northeast 4th Avenue and Southeast 4th Street within the Chiefland city limits. The property is owned by the Florida Department of Transportation (FDOT) and is fenced and gated. Access is strictly controlled by FDOT. Two stormwater culverts that drain the surrounding area, including portions of Alternate Highway 27 and U.S. Highway 19, empty into the sink.

The sink is a small open canyon running from west to east along the south side of the property. The walls of the sink consist of exposed bedrock. The culverts empty into the west side, which has also been dressed with concrete. Stormwater drains down into the bottom of the sink, about 15 feet below the surrounding land surface, and to the extreme eastern end, where it goes underground. This is the deepest point of the sink, and the conduit passage below the water level was observed to be choked with rubble and boulders. There is no possibility of further entry by a diver due to those conditions. The water level here probably represents the top of the water table, when observed under dry conditions.

There is an area of dry sinks and subsiding ground adjacent to and northeast of the water-filled east end of the sink canyon. Some of this subsidence appears to be relatively recent, based on the condition of tree roots. During the dye introduction for this project, chase water discharged into the sink at a rate of approximately 250 gallons per minute (GPM) did not affect the water level here. However, stormwater from rainfall the next day quickly raised the water level over 6 feet, which then quickly dropped when stormwater inputs ended. These observations suggest that this area is very hydrogeologically dynamic.

3.1.5 Willow Sink

Willow Sink is located about 2 miles west of Chiefland, in the northwest corner of the intersection of NW 100th Street and NW 70th Avenue. The east side of the sink depression runs adjacent to the west side of NW 70th Avenue; and the water-filled portion can be seen from the road shoulder. This feature is on private property, and access is not allowed by the owner. It is shown as a named feature on the Manatee Springs USGS 7.5-minute quadrangle map. This map also indicates the presence of three other sink/water features to the east and north of Willow Sink.

While direct access was not granted by the property owner, Willow Sink has been routinely observed from the property boundary to have clear blue waters; and levels appear to fluctuate along with changes in the river levels. Based on these observations, and its position and proximity to the Manatee Springs Cave and the Chiefland Sink, it is possible that this feature is part of the local conduit flow path.

Key planning elements for this study included collaborating with FGS during the selection of appropriate dye introduction and sampling points, selection of dyes and quantities to be used, methods for dye recovery and analyses, and observation and anticipation of weather and water conditions. Logistical concerns included scheduling of staff; background sampling; dye release; and the collection, preservation and shipping of samples. Procedures generally followed those as outlined in the 1999 “Groundwater Tracing Handbook” and 2003 “Procedures and Criteria - Analysis of Fluorescein, Eosine, Rhodamine WT, Sulforhodamine B, and Pyranine Dyes in Water and Charcoal Samplers” by Thomas J. Aley. A summary of dye introduction and sample station information is presented in **Table 1**.

4.1 DYE SELECTION

The dye selected for the Manatee Springs dye trace was rhodamine WT. Rhodamine WT, also called Fluorescent Red, has a color index name of Acid Red 388, and is introduced in liquid form. This dye is economical and is used routinely throughout the United States for water tracing studies. Rhodamine WT ultimately dissipates and deteriorates in the natural environment.

The dye for this study was supplied by Ozark Underground Laboratory (OUL) of Protem, Missouri. This afforded a benefit in that OUL performed all of the sample analyses for this study. For this study, the rhodamine WT was supplied as a 20% solution.

4.2 WEATHER AND WATER CONDITIONS

As previously discussed, uncommonly high water levels were observed in the Suwannee River from late March through mid-May 2009. These high water levels were accompanied by spring flow reversal conditions (the springs receive river water rather than discharge groundwater) at both Fanning Springs and Manatee Springs. The dye release conditions considered desirable for the success of this dye trace included falling river hydrographs and the potential for at least some inflow into the sink selected for dye release. Conditions that were considered suitable to begin background sampling and dye release returned in June 2009.

4.3 OPERATIONAL APPROVALS

Two permit applications and a sampling and analysis plan (SAP) were submitted to FDEP as part of this dye tracer study. A brief description of these submittals is provided below.

Research and Collection Permit - On April 7, 2009, Research and Collection Permit #04070921 was issued by Daniel Pearson (FDEP) to Peter Butt (KES). This permit authorized dye trace studies at Manatee and Fanning Springs State Parks. A copy of the application and approval letter is provided in **Appendix B**.

Operational Plan - In correspondence dated May 4, 2009, from John Davis, PG (FDEP) to Peter Butt (KES) a determination was issued that no FDEP permit is required for the project Operational Plan under the Ground Water Monitoring provisions of Chapter 62-520, Florida Administrative Code (FAC), nor the Underground Injection Control provisions of Chapter 62-528, FAC. A copy of the application and approval letter is provided in **Appendix C**.

Sampling and Analysis Plan - On July 27, 2009 the project SAP was submitted to Rick Hicks, PG (FDEP) and Tom Greenhalgh of the FGS. E-mail correspondence from FDEP (Rick Hicks) dated July 28 and July 29, 2009 provided confirmation that the SAP was modified to proceed with the Manatee Springs dye trace and to postpone the Fanning Springs dye trace. A copy of the SAP and e-mail correspondence from FDEP dated July 28 and July 29, 2009 is provided in **Appendix D**.

4.4 SAMPLING PROCEDURES

Charcoal packets and water sample vials were used to sample for the presence or absence of dye. Charcoal packets, containing activated carbon, were used to accumulate dye at a sampling station through the sampling interval. Analysis of the charcoal packet indicated the presence or absence of dye during that sampling interval. The packets are especially useful for performing initial qualitative traces, if the dye is present in very small concentrations, and to monitor sites with a low sampling frequency.

Charcoal packets supplied by OUL are envelopes of fiberglass window screen about 2 inches by 4 inches in size, filled with 4.25 grams of Barneby and Sutcliffe activated coconut shell carbon, size 6 to 12 mesh. The packets are heat-sealed.

At spring sites, bricks or similar weights with a large loop of stiff wire were used to secure the charcoal packets. These allowed for maximum exposure of the packet to the water flow. These samplers were either lowered into position underwater with a length of cord, or placed directly by wading or snorkeling. Efforts taken to conceal the samplers from disturbance or vandalism were successful; very few were disturbed during the study, although two were destroyed by animals.

At water well sampling stations, water was routed through a specialized PVC packet holder that facilitated packet change-out. Water flow through the holder was controlled with a gate valve, and one-way valves that prevented backflow were used as appropriate on any public water supply. The packet holders were connected upstream of any chlorinators. Water flowed through these holders only when the pump was in operation.

Whirlpak[®] bags were used to isolate, transport, and store charcoal packets. Each Whirlpak[®] bag was labeled with the sampling station number. The sampling station number, location, date, and time for each sample were recorded on the Sample Collection Data Sheet. Samples were isolated from sunlight in the field to prevent photodegradation of the dye.

Water samples were collected simultaneously in plastic vials supplied by OUL with each charcoal packet change-out. Analysis of the water samples yielded the concentration of dye in that water, at that location, at that point in time.

As this was a qualitative trace, analysis of the charcoal packets took priority; the water samples collected provided a backup for the charcoal packets.

A suitable number of background samples were collected at each sampling station to show conditions prior to any release of dye. These were available as needed for analysis.

Background samples from Manatee Springs and Cave, Fanning Springs, and selected wells were analyzed prior to dye release, and confirmed the absence of any dye that might bias sampling results. None of the other background sampler packets were analyzed because the results of any

dye-positive stations were preceded by dye-negative sampler packets collected after the dyes were released. These dye-negative samplers functioned as de facto background samples.

All samples were shipped to OUL via Federal Express, with a Sample Collection Data Sheet, which was signed and returned by OUL staff, providing a chain of custody from KES to OUL.

4.5 SAMPLING FREQUENCY AND DURATION

Background sampling was initiated on June 19, 2009. Sampling intervals were typically conducted in rounds of at least one week, but varied based on the type of sampling station (e.g. river, spring or water well).

After the dye release on August 3, 2009 (Day 0), charcoal dye samplers and water samples were collected at varying intervals at three springs, two cave tunnels, three river locations, five public water wells, and one private water well in the study area. Intervals used for most sites were once every four days during the first two weeks, once every five days during the third week, and then weekly. Monitoring continued for a period of 40 days after the dye release on September 13, 2009, when the last charcoal samplers and water samples were collected.

4.6 SAMPLING LOCATIONS

Manatee Springs, which is located within Manatee Springs State Park, is located approximately 7.26 miles due west of the Chiefland Sink. The two Manatee Springs Cave conduit sampling sites are about 6.62 miles from the Chiefland Sink. The public supply wells and the private well are located in the region between the Chiefland Sink and Manatee Springs. Sampling station setups are described below. A summary of sample tracking information for charcoal samplers is presented as **Table 2**, and for water samples as **Table 3**.

As previously noted, sampling stations were established, and some background samples were collected as part of the proposed Fanning Springs dye trace. Information on these stations is presented in **Tables 1, 2 and 3**.

4.6.1 Manatee Springs and Cave

Station No. 31 - Manatee Springs Main: A wire mesh packet holder was placed along the side of the spring pool above (upstream) of the vent. It was tethered with a cord to a post on the bank, and later tethered to various cypress knees as the water level dropped so as to be as effectively placed as possible.

Station No. 31B - Manatee Springs Main Backup: This station functioned as a backup and quality control station for Station 31. The packet holder was placed on the run bottom and tethered with a cord attached to the upstream end of the boardwalk overlook.

Station No. 32 - Manatee Springs Main Tunnel: The packets were attached at the end of a weighted line and lowered into an FGS/SRWMD cave observation and instrumentation well (Well #8). These packets were set at a depth that placed them in the direct flow of the cave passage. No water sample collection was possible here.

Station No. 33 - Manatee Springs Blue Water Tunnel: The packets were attached at the end of a weighted line and lowered into an FGS/SRWMD cave observation and instrumentation well

(Well #7). These packets were set at a depth that placed them in the direct flow of the cave passage. No water sample collection was possible here.

Station No. 34 - Clay Landing Vent: The packet holder was placed at arm's length into the spring vent located on the bottom of the Suwannee River, at a depth of about 17 feet.

4.6.2 Manatee Springs Area Wells

Station No. 41A - Manatee Springs State Park Public Supply Well #2: This well was selected as the primary sampling well of the two park supply wells, and kept in continuous use during the project. Packets were placed in a flow-through packet holder with the appropriate connections and fittings. A water system meter was monitored.

Station No. 42 - Levy County Public Supply Well: Packets were placed in a flow-through packet holder with the appropriate connections and fittings. A water system meter was monitored. This county public supply well serves a nearby golf course and surrounding residences.

Station No. 43N - Springside Public Supply Well North: Packets were placed in a flow-through packet holder with the appropriate connections and fittings. A water system meter was monitored. This public supply well is operated by, and serves, the Springside Subdivision.

Station No. 44 - Barnhill Landscape Well: Packets were placed in a flow-through packet holder with the appropriate connections and fittings. This private well is located about 1,450 feet southeast of Willow Sink.

Station No. 45 - Chiefland Public Supply Well South: Packets were placed in a flow-through packet holder with the appropriate connections and fittings. A water system meter was monitored. Monitoring was alternated weekly (switched Mondays) with the Chiefland Public Supply Well North.

Station No. 46 - Chiefland Public Supply Well North: Packets were placed in a flow-through packet holder with the appropriate connections and fittings. A water system meter was monitored. Monitoring was alternated weekly (switched Mondays) with the Chiefland Public Supply Well South.

4.6.3 Suwannee River

Station No. 51 - Hart Ramp: The packet holder was placed on the river bottom and tethered with a cord attached to a floating dock. This was the most upstream sampler location. Analysis of samples collected at this location was contingent on the results of other sites.

Station No. 52 - Clay Landing: The packets were held on a wire loop attached to the post of a dock. This sampler location was just upstream of the Manatee Springs Run to the Suwannee River. Analysis of samples collected at this location was contingent on the results of other sites.

Station No. 53 - Usher Landing: The sampler holder was placed on the river bottom and tethered to a large snag upstream of the boat ramp. This sampler location was just downstream of the Manatee Springs Run to the Suwannee River. Analysis of samples collected at this location was contingent on the results of other sites.

4.7 BACKGROUND SAMPLING

Prior to beginning the dye trace, background sampling was conducted between June 19 and August 2, 2009 to confirm baseline conditions. Background analyses indicated the presence of fluorescein in the elute from charcoal samplers positioned at one location, Manatee Springs Blue Water Tunnel. Concentrations were observed ranging from 0.643 parts per billion (ppb) to 1.72 ppb. The source of the fluorescein is unknown; however, urbanization within the karstic study area suggests its origin may plausibly be described as “anthropogenic background.” A summary of dye-positive analytical results for the study is presented as **Table 4**.

4.8 DYE RELEASE

On August 3, 2009 (Day Zero) 25 pounds of liquid rhodamine WT dye was released into the Chiefland Sink. A source for chase water had been established by running a 3-inch fire hose line from a nearby city fire hydrant equipped with a flow meter. Prior to the dye release, the line was tested with about 700 gallons flushed into the sink.

The dye release was immediately followed by flushing approximately 89,000 gallons of chase water into Chiefland Sink. The chase water was discharged over a period of six consecutive hours at an approximate rate of 250 gallons per minute (GPM). There were no visible signs of a rise in the water level at the bottom of the sink at a chase water discharge rate of 250 GPM. However, stormwater discharge from rainfall the next day quickly raised the water level over 6 feet, which then quickly dropped when stormwater inputs ended.

The dye introduction was conducted by placing the weighted end of a 1-inch hose into the flooded bottom of the sink, and using a large funnel at the upper end to receive the dye. Flush water was turned on at 08:59 hours immediately prior to the dye release. The pre-measured rhodamine WT liquid was poured via the one-inch hose into the dye introduction point located in the base of the sink beginning at 08:59 hours. Approximately 20 gallons of water was used to chase residual dye from the dye container, funnel and hose used for dye introduction. Dye release and equipment flushing was completed by 09:06 hours. Dye was visible on the water surface for a relatively short period of time, with all visible traces of the dye gone by 09:15 hours. The absence of any visible signs of the dye in the standing water at the bottom of the sink indicated that the dye had been successfully flushed underground with the incoming chase water.

At the dye release site, all containers, bags, personal protective equipment and other dye-contaminated materials were collected and sealed in trash bags for proper disposal or cleaning. A bleach spray was used to further eliminate any dye contamination on equipment and surfaces; and all personnel involved had no contact with any sampling sites, devices, or samplers until they had fully bathed, changed clothing, and otherwise removed all traces of any residual dye, or otherwise left the area study area entirely.

4.9 SAMPLE INVENTORY

A total of 243 samples were collected and logged during this study. Of this total, 150 were charcoal sampler packets and 93 were water samples.

A total of 61 charcoal samplers were analyzed. Eleven of these were background samples. Of these 61 samplers, a total of 24 tested positive for rhodamine WT. Four samplers from one site also tested positive for fluorescein, which was from a source other than this dye trace.

A total of 15 water samples were analyzed. All of these were samples where the associated charcoal samplers had tested positive for dye. Of these 15 samples, only one tested positive for rhodamine WT.

Five charcoal samplers and two water samples were submitted for analyses for quality control purposes.

A summary of sample tracking information for charcoal samplers is presented as **Table 2**, and for water samples as **Table 3**. The information documents the exact placement and collection times for each specific sampler and sample.

4.9.1 Duplicate Samples

Duplicate samples were collected from selected sites, and stored in case of shipping losses or to be analyzed in the case of ambiguous results. The analysis of duplicate samples was not required as part of the study.

4.10 RATIONALE FOR SELECTING SAMPLES FOR ANALYSIS

This study was an initial qualitative dye trace designed to help identify potential connections between the dye release site and springs, caves, and water wells located along what was determined to be a likely travel path of the dye. With dye travel rates unknown, this meant planning for a large number of samples. However, there were budget limitations governing the number of samples that could be analyzed within the scope of this study.

Therefore, strategies were designed to allow for a maximum return of information from the finite number of laboratory analyses that could be performed, without jeopardizing the study's goals. These strategies included the measures described below to provide economy while maintaining effectiveness.

Except for a few initial background sample analyses, background samples were held pending analyses of post-dye release samples. Typically, stations with positive dye results had pre-arrival samples analyzed so as to function as de facto background samples.

Samples from stations on the Suwannee River (Stations 51, 52 and 53) were held pending any negative results at the springs; the positive results at Manatee Springs ultimately made analyses of all river samples unnecessary for the purposes of this qualitative trace.

This study is the first fully documented dye trace performed between Chiefland Sink and Manatee Springs. As this was an initial qualitative dye trace, sampling periods were designed to measure a potential rapid arrival time of the dye.

5.1 RESULTS OF SCANNING SPECTROFLUOROPHOTOMETER ANALYSIS

Sixty-one (61) charcoal samplers and 15 water samples from selected sampling stations were analyzed. **Table 4** provides a summary of the results of analysis from dye-positive stations. The numbered days in **Table 4** are sequential from the day of dye introduction, Day 0.

Dye-positive sample stations are depicted on **Figure 11**. A graph depicting the detected concentrations of rhodamine WT over time is presented as **Figure 12**. The Certificates of Analysis from OUL listing the results of these analyses, including fluorescence magnitude graphs, are presented in **Appendix E**.

5.1.1 Background Sampling

With the exception of Station 33, the Manatee Springs Blue Water Tunnel, no dye was detected in any of the background samples analyzed. At Station 33, low concentrations of fluorescein were detected prior to and after the release of rhodamine WT at the Chiefland Sink. With the exception of the Day 21 charcoal sampler, whenever rhodamine WT was detected at Station 33, the fluorescein, if present, was not detected.

5.1.2 Manatee Springs and Cave

Station No. 31 - Manatee Springs Main: No dye was detected in analyzed samplers collected through August 7 (Day 4). Rhodamine WT was initially detected at a concentration of 14.4 ppb in the August 7-11 (Days 4-8) packet. During the next six sampling intervals, from Day 8 through Day 40 (August 12 through September 13), the rhodamine WT concentration increased, with the highest concentration of 175 ppb being detected in the Days 12-16 packet, with concentrations dropping after that. The final sampler analyzed was from the Days 32-40 interval, and had a concentration of 30.3 ppb.

One sampler was also taken from this station and submitted for analyses as a quality control sample. That QC sample, from the Days 16-21 interval, had a concentration of 107 ppb; its counterpart from the same interval had a concentration of 71.8 ppb.

Thirteen water samples collected at this station, including one taken prior to dye release, were analyzed. Of the samples collected and analyzed between Days 4 and 26, only one, taken on Day 12, showed a detection for rhodamine WT at 0.418 ppb. All other analyses were non-detect.

Station No. 31B - Manatee Springs Main Backup: One sampler was analyzed from this site for comparative purposes with Site 31. Rhodamine WT was detected at a concentration of 11.1 ppb in the August 7-11 (Days 4-8) packet.

Station No. 32 - Manatee Springs Main Tunnel: No dye was detected in analyzed samplers collected through August 7 (Day 4). Rhodamine WT was initially detected at a concentration of 27.5 ppb in the August 7-11 (Days 4-8) packet. During the next six sampling intervals, from Day 8 through Day 40 (August 12 through September 13), the rhodamine WT concentration increased, with the highest concentration of 268 ppb being detected in the Days 8-12 packet,

with concentrations dropping after that. The final sampler analyzed was from the Days 32-40 interval, and had a concentration of 37 ppb.

Two samplers were also taken from this station and submitted for analyses as quality control samples. The Days 12-16 interval QC sample had a concentration of 216 ppb; its counterpart from the same interval had a concentration of 222 ppb. The Days 32-40 interval QC sampler had a concentration of 40.3 ppb; its counterpart from the same interval had a concentration of 37 ppb.

No water samples were collected at this site.

Station No. 33 - Manatee Springs Blue Water Tunnel: No dye was detected in analyzed samplers collected through August 7 (Day 4). Rhodamine WT was initially detected at a concentration of 5.03 ppb in the August 7-11 (Days 4-8) packet. During the next four sampling intervals, from Day 8 through Day 40 (August 12 through September 13), the rhodamine WT concentration increased, with the highest concentration of 47.6 ppb being detected in the Days 8-12 packet, with concentrations dropping after that. The final sampler analyzed with a positive detection for rhodamine WT was from the Days 21-25 interval, and had a concentration of 9.01 ppb.

During the Days 16-21 sampling interval, a detection of 0.503 ppb for fluorescein was also recorded, similar to the fluorescein detections in the background samplers for this station.

One sampler was also taken from this station and submitted for analyses as a quality control sample. That QC sample, from the Days 8-12 interval, had a concentration of 43.7 ppb; its counterpart from the same interval had a concentration of 47.6 ppb.

No water samples were collected at this site.

Station No. 34 - Clay Landing Vent: No dye was detected in the two samplers analyzed for this site, from the Days 16-25 and Days 25-32 sampling intervals.

5.1.3 Manatee Springs Area Wells

Station No. 41A - Manatee Springs State Park Public Supply Well #2: No dye was detected in the three samplers analyzed for this site, from the Days 8-12, Days 21-25 and Days 32-40 sampling intervals.

Station No. 42 - Levy County Public Supply Well: No dye was detected in the three samplers analyzed for this site, from the Days 8-12, Days 16-21 and Days 25-32 sampling intervals, and in the QC sample also from Days 25-32.

Station No. 43N - Springside Public Supply Well North: No dye was detected in the three samplers analyzed for this site, from the Days 8-12, Days 21-25 and Days 32-40 sampling intervals.

Station No. 44 - Barnhill Landscape Well: No dye was detected in the two samplers analyzed for this site, from the Days 8-12 and Days 16-21 sampling intervals.

Station No. 45 - Chiefland Public Supply Well South: No dye was detected in the two samplers analyzed for this site, from the Days 8-12 and Days 21-25 sampling intervals.

Station No. 46 - Chiefland Public Supply Well North: No dye was detected in the four samplers analyzed for this site, from the Days 0-2, Days 2-4, Days 4-8 and Days 16-21 sampling intervals.

5.1.4 Suwannee River Sites

Station No. 51 - Hart Ramp: All samplers were held pending any anomalous positive results found in downstream stations. As no anomalous results were seen, no samplers from this station were analyzed.

Station No. 52 - Clay Landing: No dye was detected in the one sampler analyzed for this site, from the Days 16-21 sampling interval.

Station No. 53 - Usher Landing: All samples were held pending any negative results in all upstream stations. As dye was detected at, and discharged by, Manatee Springs, no samplers from this station were analyzed.

5.1.5 Fanning Springs Area Springs and Wells

Background sampling was conducted at Fanning Springs area stations at the same time as that conducted in the Manatee Springs area. However, as the dye release in the Fanning Spring area was postponed, sampling frequency at those sites was reduced or eliminated. Only one sampler from Fanning Springs was analyzed during the period after the release of dye at the Chiefland Sink for due diligence purposes.

Station No. 11 - Fanning Springs Main: One sample was analyzed for this site for quality control/due diligence purposes; no dye was detected in the Days 18-26 sampling interval.

6.1 CONCLUSIONS

The following conclusions are made, based on a review of the analytical results for samplers and samples collected under the conditions present during the June through September 2009 dye tracer study:

- A direct hydrologic connection exists between Chiefland Sink and the Manatee Springs and Cave System. The observed rate of groundwater flow was between 9,600 feet per day, based on a four-day travel time and 4,800 feet per day, based on an eight-day travel time. These rates of flow are indicative of conduit flow rather than a matrix flow regime.
- Rhodamine WT was detected in both carbon samplers and water samples, providing an additional level of dye confirmation.
- Dye was not detected at any of the public or private supply wells monitored during this study.
- Laboratory analyses for samplers and samples collected during the background sampling and dye trace identified low fluorescence magnitude peaks that are consistent with an instrument response for fluorescein. These detections were made in samples collected at the Blue Water Tunnel sampling station of the Manatee Springs Cave System. The origin of these responses is unknown, but is likely anthropogenic background.

6.2 RECOMMENDATIONS

- Complete the original scope of work for this study; perform the Lancaster Sink to Fanning Springs dye trace as soon as funding is available and site conditions are appropriate.
- Continued exploration and mapping of the Manatee Springs Cave System to provide supporting lines of evidence on the approximate location(s) of potential conduits and zones of low permeability. This could include the use of geophysical survey methods such as ground penetrating radar, electrical resistivity imaging, microgravity, and multichannel analysis of surface waves to support previous geophysical studies conducted for the FGS at Manatee Springs State Park. Based on a conversation with Lynn Yuhr (Technos), who conducted the previous geophysical study for the FGS, candidate north-south transects might generally follow the path of County Road 345 (e.g. NW 70th Avenue), NW 100th Avenue and NW 110th Avenue.
- Resume monitoring operations at the existing Manatee Springs Cave Main Tunnel and Blue Water Tunnel observation wells.

For the purposes of city planning, stormwater management, and emergency response, develop an understanding of the existing stormwater sewer collection system and sources of direct and indirect input that ultimately discharges into Chiefland Sink.

TABLES

TABLE 1: FANNING-MANATEE SPRINGS DYE TRACE 2009
DYE INTRODUCTION & SAMPLING SITES; LOCATIONS and DISTANCES.

INTRO/SAMPLING STATION NAME:	Station Number	GPS Coordinates*		Approximate Distance from: Chiefland Swallet	Approximate Distance from: Lancaster Sink	Elevation	FOM +/-
		DECIMAL	MINUTES				
INTRO/SAMPLING STATION NAME:	Station Number	LATITUDE	LONGITUDE				
Lancaster Sink	1	N 29° 36' 78.4"	W 82° 51' 8.43"	9.06		51.7	14.6
Chiefland Swallet	2	N 29° 28' 9.26"	W 82° 51' 3.86"		9.06	27.7	16
FANNING SPRING STATIONS							
Fanning Spring Main	11	N 29° 35' 25.7"	W 82° 56' 1.23"	8.7			
Fanning Spring Backup	11B	N 29° 35' 26.8"	W 82° 56' 1.26"		4.83		46.5
Little Fanning Spring	12	N 29° 35' 18.7"	W 82° 56' 1.07"		4.83		22.3
Fanning North Springs	13	N 29° 35' 30.0"	W 82° 56' 1.79"		4.83		43.3
Bell Spring	14	N 29° 35' 8.38"	W 82° 56' 4.76"		4.78	9.6	11.7
Otter Spring	15	N 29° 38' 6.81"	W 82° 56' 5.42"		5.19		
Little Otter Spring/GIL 94972	16	N 29° 38' 18.1"	W 82° 57' 5.07"		5.9		
FANNING WELL SAMPLING STATIONS							
Lancaster CI Well #1	21	N 29° 36' 5.38"	W 82° 51' 9.31"		15.90 feet	Reported Well Depth (In Feet) 300	Well Diameter (Inches) 12
Lancaster CI Well #2	22	N 29° 36' 5.38"	W 82° 51' 9.46"		15.15 feet	120	6
Lancaster CI Well Aq East		N 29° 36' 5.44"	W 82° 51' 5.07"		23.00 feet		8
Lancaster CI Well Aq West		N 29° 36' 5.93"	W 82° 52' 1.97"		22.00 feet		8
Fanning Springs Municipal Well West		N 29° 34' 0.36"	W 82° 54' 4.83"	6.65	4.12		
Fanning Springs Municipal Well East		N 29° 34' 0.28"	W 82° 54' 4.66"	6.64	4.12		
Dennis Well	23	N 29° 35' 3.97"	W 82° 53' 1.84"		2.09	90	4
Howell Well						75	50
Hilltop Dairy?							4
Alliance Dairy?							
MANATEE SPRING & CAVE STATIONS							
Manatee Spring Main	31	N 29° 29' 3.80"	W 82° 58' 6.11"	7.26	10.9	Bank Side Position Head	28.8
Manatee Spring Backup	31B						
Clay Landing Vent	34	N 29° 31' 1.46"	W 82° 58' 2.02"	7.29	9.1		13
Manatee Spring Main Tunnel (#8)	32	N 29° 29' 1.01"	W 82° 57' 9.98"	6.62		Reported Well Depth (In Feet) 81	Well Diameter (Inches) 4
Manatee Spring Blue Water Tunnel (#7)	33	N 29° 29' 1.09"	W 82° 57' 9.88"	6.63		87	4
Manatee Spring Sewer Tunnel (#6)		N 29° 29' 1.73"	W 82° 58' 4.11"	7.05		80	70
MANATEE WELL SAMPLING STATIONS							
Manatee Spring SP Public Supply Well #2	41A	N 29° 29' 3.74"	W 82° 58' 3.10"	6.96		80	55
Manatee Spring SP Public Supply Well #1	41B	N 29° 29' 3.94"	W 82° 58' 3.23"	6.96			4
Levy County Public Supply Well	42	N 29° 29' 3.60"	W 82° 58' 4.00"	5.05		110	63
Springside Public Supply Well North	43N	N 29° 29' 5.99"	W 82° 57' 8.26"	6.5		96 or 89	70
Springside Public Supply Well South	43S	N 29° 29' 5.76"	W 82° 57' 8.22"	6.5		96 or 89	70
Barnhill Landscape	44	N 29° 28' 4.42"	W 82° 53' 1.81"	1.88		68	69?
Chiefland Public Supply Well South	45	N 29° 29' 2.13"	W 82° 51' 8.89"	3.180 feet		120	4
Chiefland Public Supply Well North	46	N 29° 29' 2.76"	W 82° 51' 9.11"	3.500 feet		120	
RIVER CONTROL STATIONS							
Hart Ramp (Upper)*	51	N 29° 40' 4.69"	W 82° 57' 2.83"	12.28	6.03		
Clay Landing (Middle)	52	N 29° 31' 0.95"	W 82° 58' 2.21"	7.29			12.9
Usher Landing (Lower)	53	N 29° 28' 9.17"	W 82° 58' 9.42"	7.58	11.57		13.4

*From hand-held GPS positions taken during this study. WGS 84 Map Datum. Distances are estimated from these positions.

** Estimated from TopoQuads or Google Earth.

TABLE 2: Fanning-Manatee Dye Trace 2009 Charcoal Sampler Station Tracking Record

Station Number: 11												
Station Name: FANNING SPRING MAIN												
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	RESULTS (ppb)		Dates:		OUL
Date:	Time:	Date:	Time:	In:	Out:	(days)		Rhod WT	Fluor.	Shipped:	Analyzed:	Lab #
6/19/2009	15:39	6/26/2009	18:32			7		ND	ND	7/9/2009	7/15/2009	T1333
6/26/2009	18:32	7/7/2009	11:49			12		ND	ND	7/9/2009	7/15/2009	T1335
7/7/2009	11:49	7/24/2009	11:52			17						
7/24/2009	11:52	8/21/2009	16:31		18	28						
8/21/2009	16:31	8/30/2009	16:37	18	26	9		ND	ND	9/3/2009	9/10/2009	T2183
8/30/2009	16:37	9/5/2009	18:06	26	32	5						
9/5/2009	18:06			32								
# BG Samples Collected:		3										
# BG Samples Shipped:		2										
# BG Samples Analyzed:		2										
# Samples Collected:		6										
# Samples Shipped:		3										
# Samples Analyzed:		3										
# Samples RWT pos:		0										
# Samples FL pos:		0										

TABLE 2: Fanning-Manatee Dye Trace 2009 Charcoal Sampler Station Tracking Record

Station Number:		11B													
Station Name:		FANNING SPRING MAIN BACKUP													
PLACED:		COLLECTED:		Day Number:		Duration		Dupe		RESULTS (ppb)		Dates:		Notes:	
Date:	Time:	Date:	Time:	In:	Out:	(days)				Rhod WT	Fluor.	Shipped:	Analyzed:	OUL	Lab #
6/19/2009	15:43	6/26/2009	18:40			7									
6/26/2009	18:40	7/7/2009	11:52			12									
7/7/2009	11:52	7/24/2009	11:57			17									
7/24/2009	11:57	8/21/2009	16:38		18	28									
8/21/2009	16:38	8/30/2009	16:45	18	26	9									
8/30/2009	16:45	9/5/2009	18:12	26	32	5									
9/5/2009	18:12			32											
# BG Samples Collected:															
# BG Samples Shipped:															
# BG Samples Analyzed:															
# Samples Collected:															
# Samples Shipped:															
# Samples Analyzed:															
# Samples RWT pos:															
# Samples FL pos:															

TABLE 2: Fanning-Manatee Dye Trace 2009 Charcoal Sampler Station Tracking Record

Station Number:		13										
Station Name:		FANNING NORTH SPRINGS										
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	RESULTS (ppb)		Dates:		Notes:
Date:	Time:	Date:	Time:	In:	Out:	(days)		Rhod WT	Fluor.	Shipped:	Analyzed:	
6/19/2009	16:03	6/26/2009	18:59			7						7/7 was above water level 7/24 was out of vent 8/21 was out of vent
6/26/2009	18:59	7/7/2009	12:06			12						
7/7/2009	12:06	7/24/2009	12:01			17						
7/24/2009	12:01	8/21/2009	16:45		18	28						
8/21/2009	16:45	8/30/2009	16:55	18	26	9						
8/30/2009	16:55	9/5/2009	17:48	26	32	5						
9/5/2009	17:48			32								
# BG Samples Collected:												
# BG Samples Shipped:												
# BG Samples Analyzed:												
# Samples Collected:												
# Samples Shipped:												
# Samples Analyzed:												
# Samples RWT pos:												
# Samples FL pos:												

TABLE 2: Fanning-Manatee Dye Trace 2009 Charcoal Sampler Station Tracking Record

Station Number: 32		MANATEE SPRING MAIN TUNNEL													
Station Name:															
PLACED:		COLLECTED:		Day Number:		Duration		Dupe		RESULTS (ppb)		Dates:		OUL	
Date:	Time:	Date:	Time:	In:	Out:	(days)				Rhod WT	Fluor.	Shipped:	Analyzed:	Lab #	
6/26/2009	17:22	7/7/2009	15:20			12				ND	ND	7/9/2009	7/13/2009	T1338	
7/7/2009	15:20	7/16/2009	14:40			9				ND	ND	7/20/2009	7/22/2009	T1458	
7/16/2009	14:40	8/2/2009	15:35			17									
8/2/2009	15:35	8/7/2009	16:57	-1	4	4				ND	ND	8/24/2009	8/27/2009	T2013	
8/7/2009	16:57	8/11/2009	17:04	4	8	4				27.5	ND	8/24/2009	8/27/2009	T2014	
8/11/2009	17:04	8/15/2009	16:50	8	12	4				268	ND	8/17/2009	8/19/2009	T1954	
8/15/2009	16:50	8/19/2009	15:00	12	16	4		X		222	ND	8/24/2009	8/27/2009	T2015	
8/19/2009	15:00	8/24/2009	17:03	16	21	5				120	ND	9/3/2009	9/10/2009	T2174	
8/24/2009	17:03	8/29/2009	18:00	21	25	5				96.8	ND	9/3/2009	9/10/2009	T2175	
8/29/2009	18:00	9/5/2009	19:02	25	32	6				57.9	ND	9/14/2009	9/16/2009	T2307	
9/5/2009	19:02	9/13/2009	15:34	32	40	8		X		37	ND	9/14/2009	9/16/2009	T2308	
9/13/2009	15:34			40											
# BG Samples Collected:		3													
# BG Samples Shipped:		2													
# BG Samples Analyzed:		2													
# Samples Collected:		8													
# Samples Shipped:		8													
# Samples Analyzed:		8													
# Samples RWT pos:		7													
# Samples FL pos:		0													

TABLE 2: Fanning-Manatee Dye Trace 2009 Charcoal Sampler Station Tracking Record

Station Number: 33		MANATEE SPRING BLUE WATER TUNNEL												
Station Name:		PLACED:		COLLECTED:		Day Number:		Duration	Dupe	RESULTS (ppb)		Dates:		OUL
Date:	Time:	Date:	Time:	In:	Out:			(days)		Rhod WT	Fluor.	Shipped:	Analyzed:	Lab #
6/26/2009	17:09	7/7/2009	15:17					12		ND	1.72	7/9/2009	7/13/2009	T1339
7/7/2009	15:17	7/16/2009	14:36					9		ND	0.996	7/20/2009	7/22/2009	T1459
7/16/2009	14:36	8/2/2009	15:25					17						
8/2/2009	15:25	8/7/2009	17:01	-1	4			4		ND	0.643	8/24/2009	8/27/2009	T2016
8/7/2009	17:01	8/11/2009	16:56	4	8			4		5.03	ND	8/24/2009	8/27/2009	T2017
8/11/2009	16:56	8/15/2009	16:46	8	12			4	X	47.6	ND	8/17/2009	8/19/2009	T1955
8/15/2009	16:46	8/19/2009	14:52	12	16			4		19.1	ND	8/24/2009	8/27/2009	T2018
8/19/2009	14:52	8/24/2009	16:57	16	21			5		24.8	0.503	9/3/2009	9/10/2009	T2176
8/24/2009	16:57	8/29/2009	17:50	21	25			5		9.01	ND	9/3/2009	9/10/2009	T2177
8/29/2009	17:50	9/5/2009	18:56	25	32			6		ND	ND	9/14/2009	9/16/2009	T2309
9/5/2009	18:56	9/13/2009	15:28	32	40			8		ND	ND	9/14/2009	9/16/2009	T2310
9/13/2009	15:28			40										
# BG Samples Collected:		3												
# BG Samples Shipped:		2												
# BG Samples Analyzed:		2												
# Samples Collected:		8												
# Samples Shipped:		8												
# Samples Analyzed:		8												
# Samples RWT pos:		5												
# Samples FL pos:		4												

TABLE 2: Fanning-Manatee Dye Trace 2009 Charcoal Sampler Station Tracking Record

Station Number:		42											
Station Name:		LEVY COUNTY PUBLIC SUPPLY WELL											
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	RESULTS (ppb)		Dates:		OUL	Meter Reading
Date:	Time:	Date:	Time:	In:	Out:	(days)		Rhod WT	Fluor.	Shipped:	Analyzed:	Lab #	
6/29/2009	11:15	7/7/2009	14:49			9							50370400
7/7/2009	14:49	8/2/2009	16:18			26							50532600
8/2/2009	16:18	8/7/2009	17:58	-1	4	4							51108200
8/7/2009	17:58	8/11/2009	16:12	4	8	4							51234800
8/11/2009	16:12	8/15/2009	16:05	8	12	4		ND	ND	8/17/2009	8/19/2009	T1957	51362000
8/15/2009	16:05	8/19/2020	13:35	12	16	4							51456600
8/19/2020	13:35	8/24/2009	15:43	16	21	5		ND	ND	9/3/2009	9/10/2009	T2179	51537400
8/24/2009	15:43	8/29/2009	16:45	21	25	5							51636600
8/29/2009	16:45	9/5/2009	16:00	25	32	6	X	ND	ND	9/14/2009	9/16/2009	T2312	51731600
9/5/2009	16:00	9/13/2009	15:00	32	40	8							51847200
9/13/2009	15:00			40									52055300
# BG Samples Collected:		2											
# BG Samples Shipped:		0											
# BG Samples Analyzed:		0											
# Samples Collected:		8											
# Samples Shipped:		3											
# Samples Analyzed:		3											
# Samples RWT pos:		0											
# Samples FL pos:		0											

TABLE 2: Fanning-Manatee Dye Trace 2009 Charcoal Sampler Station Tracking Record

Station Number:		43N															
Station Name:		SPRINGSIDE PUBLIC SUPPLY WELL NORTH															
PLACED:		COLLECTED:		Day Number:		Duration (days)		Dupe		RESULTS (ppb)		Dates:		OUL		Meter Reading	
Date:	Time:	Date:	Time:	In:	Out:					Rhod WT	Fluor.	Shipped:	Analyzed:	Lab #			
6/29/2009	17:05	7/7/2009	15:01			9				ND	ND	7/20/2009	7/22/2009	T1461		92392400	
7/7/2009	15:01	8/2/2009	15:45			26										92593500	
8/2/2009	15:45	8/7/2009	17:45	-1	4	4										93284400	
8/7/2009	17:45	8/11/2009	16:24	4	8	4										93519100	
8/11/2009	16:24	8/15/2009	17:38	8	12	4				ND	ND	8/17/2009	8/19/2009	T1958		93633800	
8/15/2009	17:38	8/19/2020	14:20	12	16	4										93725100	
8/19/2020	14:20	8/24/2009	16:20	16	21	5				ND	ND	9/14/2009	9/16/2009	T2315		93857600	
8/24/2009	16:20	8/29/2009	17:20	21	25	5										94068900	
8/29/2009	17:20	9/5/2009	15:17	25	32	6										94387700	
9/5/2009	15:17	9/13/2009	13:38	32	40	8				ND	ND	9/14/2009	9/16/2009	T2316		94664000	
9/13/2009	13:38			40													
# BG Samples Collected:		2															
# BG Samples Shipped:		1															
# BG Samples Analyzed:		1															
# Samples Collected:		8															
# Samples Shipped:		3															
# Samples Analyzed:		3															
# Samples RWT pos:		0															
# Samples FL pos:		0															

TABLE 2: Fanning-Manatee Dye Trace 2009 Charcoal Sampler Station Tracking Record

Station Number: 46		CHIEFLAND PUBLIC SUPPLY WELL NORTH										
Station Name:												
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	RESULTS (ppb)		Dates:		OUL Lab #
Date:	Time:	Date:	Time:	In:	Out:	(days)		Rhod WT	Fluor.	Shipped:	Analyzed:	
7/9/2009												
8/3/2009	16:08	8/5/2009	11:38	0	2	2		ND	ND	8/24/2009	8/27/2009	T2019
8/5/2009	11:38	8/7/2009	14:18	2	4	2		ND	ND	8/24/2009	8/27/2009	T2020
8/7/2009	14:18	8/11/2009	14:13	4	8	4		ND	ND	8/24/2009	8/27/2009	T2021
Switched to South Well												
8/17/2009	13:21	8/19/2009	12:59	14	16	2						
8/19/2009	12:59	8/24/2009	15:25	16	21	5		ND	ND	9/3/2009	9/10/2009	T2182
8/24/2009	15:25	9/5/2009	16:48	21	32	11						
9/5/2009	16:48	9/13/2009	14:21	32	40	8						
9/13/2009	14:21			40								
# BG Samples Collected:		0										
# BG Samples Shipped:		0										
# BG Samples Analyzed:		0										
# Samples Collected:		7										
# Samples Shipped:		4										
# Samples Analyzed:		4										
# Samples RWT pos:		0										
# Samples FL pos:		0										

TABLE 2: Fanning-Manatee Dye Trace 2009 Charcoal Sampler Station Tracking Record

QUALITY CONTROL DUPLICATES

Sample ID#	Station Number	PLACED:		COLLECTED:		Day Number:		Duration (days)		RESULTS (ppb)		Dates:		OUL Lab #	Notes:
		Date:	Time:	Date:	Time:	In:	Out:			Rhod WT	Fluor.	Shipped:	Analyzed:		
D-1	33	8/11/2009	16:56	8/15/2009	16:46	8	12	4		43.7	ND	8/17/2009	8/19/2009	T1962	Manatee Blue Water Tunnel
D-2	32	8/15/2009	16:50	8/19/2009	15:00	12	16	4		216	ND	8/24/2009	8/27/2009	T2023	Manatee Main Tunnel
D-3	31	-	-	8/11/2009	17:24	-	8	-		ND	ND	8/24/2009	8/27/2009	T2030	Manatee Spring Main-water
D-4	31	8/19/2009	15:18	8/24/2009	17:19	16	21	5		107	ND	9/3/2009	9/10/2009	T2184	Manatee Spring Main
D-5	31	-	-	8/22/2009	17:30	-	19	-		ND	ND	9/3/2009	9/10/2009	T2192	Manatee Spring Main-water
D-6	32	9/5/2009	19:02	9/13/2009	15:34	32	40	8		40.3	ND	9/14/2009	9/16/2009	T2319	Manatee Main Tunnel
D-7	42	8/29/2009	16:45	9/5/2009	16:00	25	32	6		ND	ND	9/14/2009	9/16/2009	T2321	Levy County PSW

Samples Collected:

Samples Shipped:

Samples Analyzed:

Samples RWT pos:

Samples FL pos:

TABLE 3: Fanning-Manatee Dye Trace 2009 Water Sample Sample Tracking Record

Station Number:		31							
Station Name:		MANATEE SPRING MAIN							
COLLECTED:		Day	RESULTS		Dates:		OUL	Notes:	
Date:	Time:	Number:	Rhod WT	Fluor.	Shipped:	Analyzed:	Lab #		
8/2/2009	14:50		ND	ND	8/24/2009	8/27/2009	T2029		
8/7/2009	17:17	4	ND	ND	8/24/2009	8/27/2009	T2028		
8/11/2009	17:24	8	ND	ND	8/24/2009	8/27/2009	T2027	QC dupe analysed	
8/15/2009	17:07	12	0.418	ND	8/24/2009	8/27/2009	T2026		
8/19/2009	15:18	16	ND	ND	8/24/2009	8/27/2009	T2025		
8/20/2009	18:34	17	ND	ND	8/24/2009	8/27/2009	T2024		
8/21/2009	20:34	18	ND	ND	9/3/2009	9/10/2009	T2185		
8/22/2009	17:30	19	ND	ND	9/3/2009	9/10/2009	T2186	QC dupe analysed	
8/23/2009	20:58	20	ND	ND	9/3/2009	9/10/2009	T2187		
8/24/2009	17:19	21	ND	ND	9/3/2009	9/10/2009	T2188		
8/28/2009	22:15	24	ND	ND	9/3/2009	9/10/2009	T2189		
8/29/2009	18:15	25	ND	ND	9/3/2009	9/10/2009	T2190		
8/30/2009	13:40	26	ND	ND	9/3/2009	9/10/2009	T2191		
9/1/2009	22:05	28							
9/2/2009	19:17	29							
9/4/2009	18:15	31							
9/5/2009	19:17	32							
9/13/2009	15:52	40							

TABLE 3: Fanning-Manatee Dye Trace 2009 Water Sample Sample Tracking Record

Station Number:		34									
Station Name:		CLAY LANDING VENT									
COLLECTED:		Day	RESULTS		Dates:		OUL		Notes:		
Date:	Time:	Number:	Rhod WT	Fluor.	Shipped:	Analyzed:	Lab #				
8/21/2009	12:24	16									
8/29/2009	15:13	25									
9/5/2009	14:00	32									

TABLE 3: Fanning-Manatee Dye Trace 2009 Water Sample Sample Tracking Record

Station Number: 41A

Station Name: MANATEE SPRINGS STATE PARK PUBLIC SUPPLY WELL #2

COLLECTED:		Day	RESULTS		Dates:		OUL	Meter Reading
Date:	Time:	Number:	Rhod WT	Fluor.	Shipped:	Analyzed:	Lab #	
8/2/2009	15:15							3715700
8/7/2009	16:47	4						3736600
8/11/2009	16:44	8						3759100
8/15/2009	16:22	12						3777300
8/19/2009	14:37	16						3791220
8/24/2009	16:48	21						3813400
8/29/2009	17:34	25						3822800
9/5/2009	18:45	32						3844900
9/13/2009	15:18	40						3882700

Station Number: 42
Station Name: LEVY COUNTY PUBLIC SUPPLY WELL

[illegible]

Station Number: 43N
Station Name: SPRINGSIDE PUBLIC SUPPLY WELL NORTH

[illegible]

44

Station Name:

BARNHILL LANDSCAPE

[illegible]

Station Number: 45
Station Name: CHIEFLAND PUBLIC SUPPLY WELL SOUTH

[illegible]

46

Station Name:

CHIEFLAND PUBLIC SUPPLY WELL NORTH

[illegible]

Station Number: 51
Station Name: HART RAMP

[illegible]

TABLE 3: Fanning-Manatee Dye Trace 2009 Water Sample Sample Tracking Record

Station Number: 52

Station Name: CLAY LANDING

[illegible]

Station Number: 53
Station Name: USHER LANDING

[illegible]

FIGURES

FIGURE 1
Map of Study Area

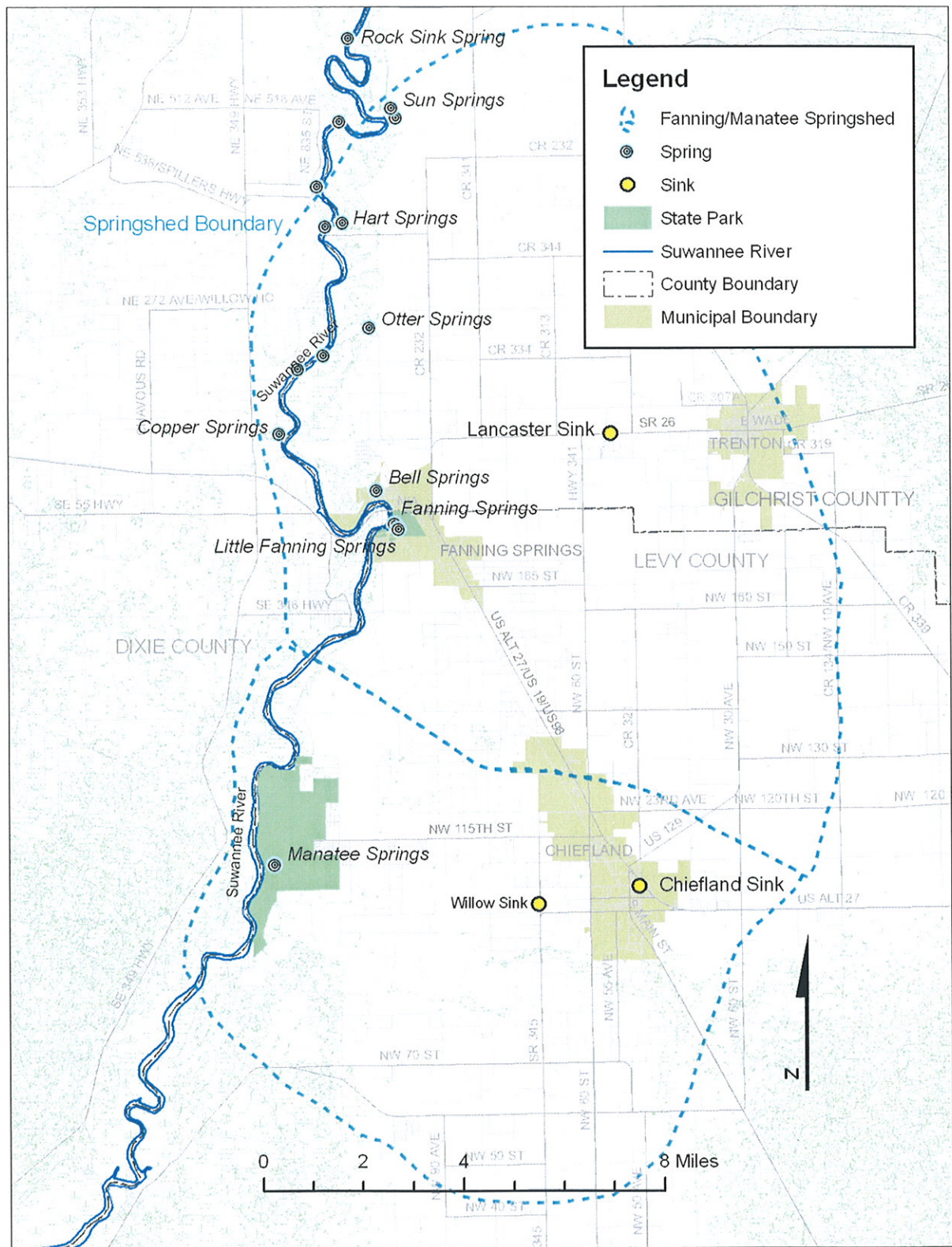


FIGURE 2
Aerial of Study Area

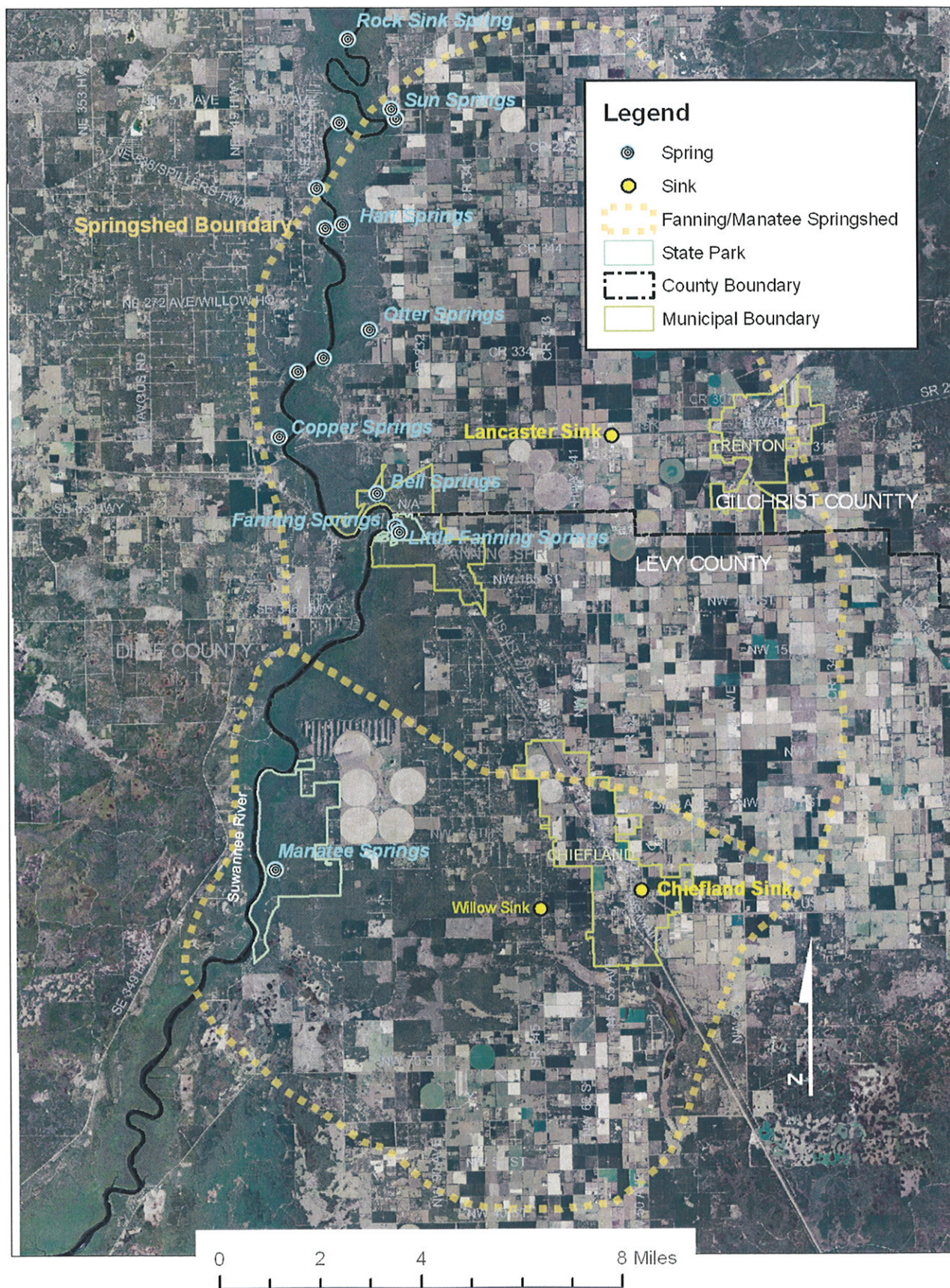
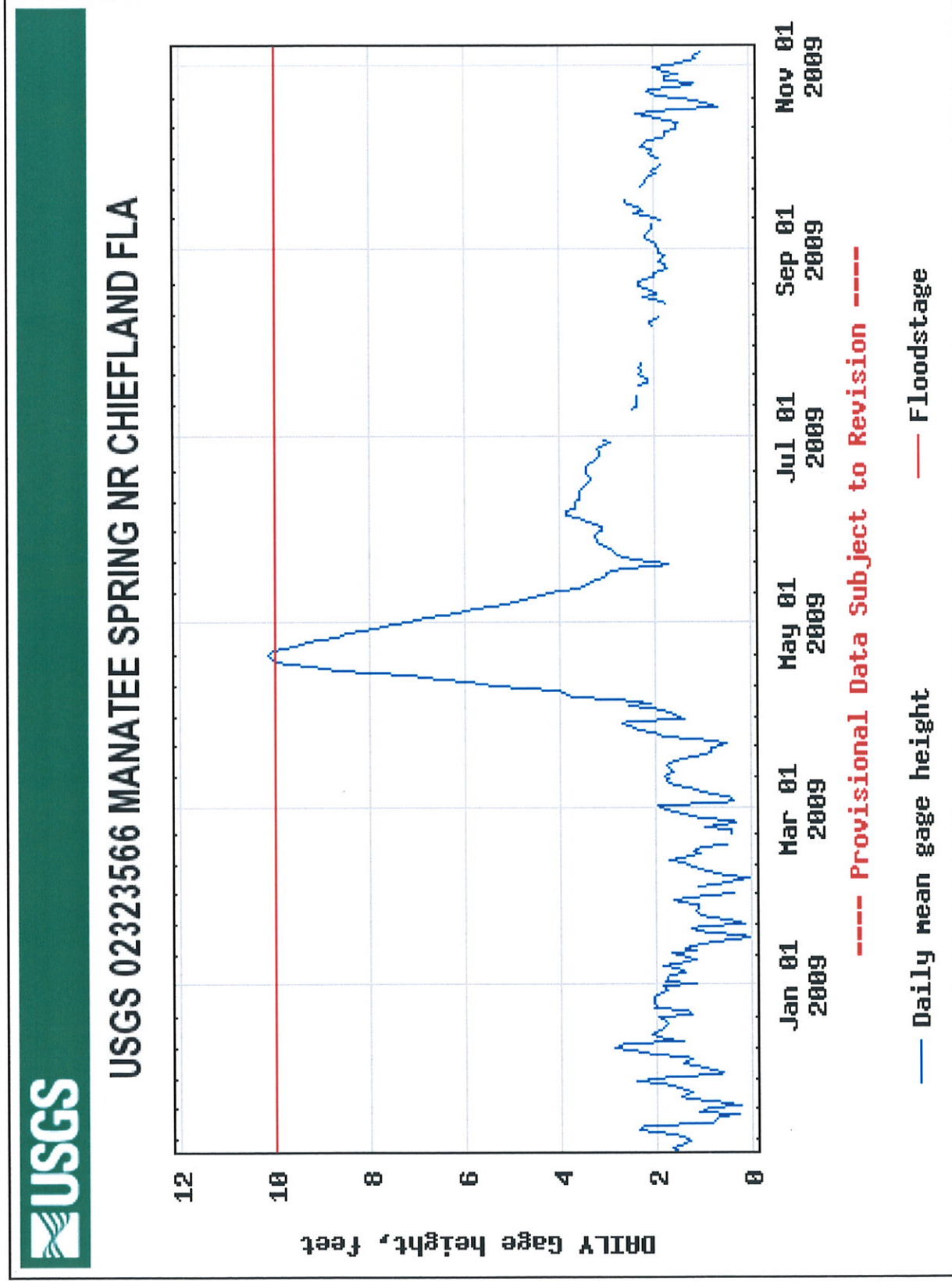


FIGURE 3



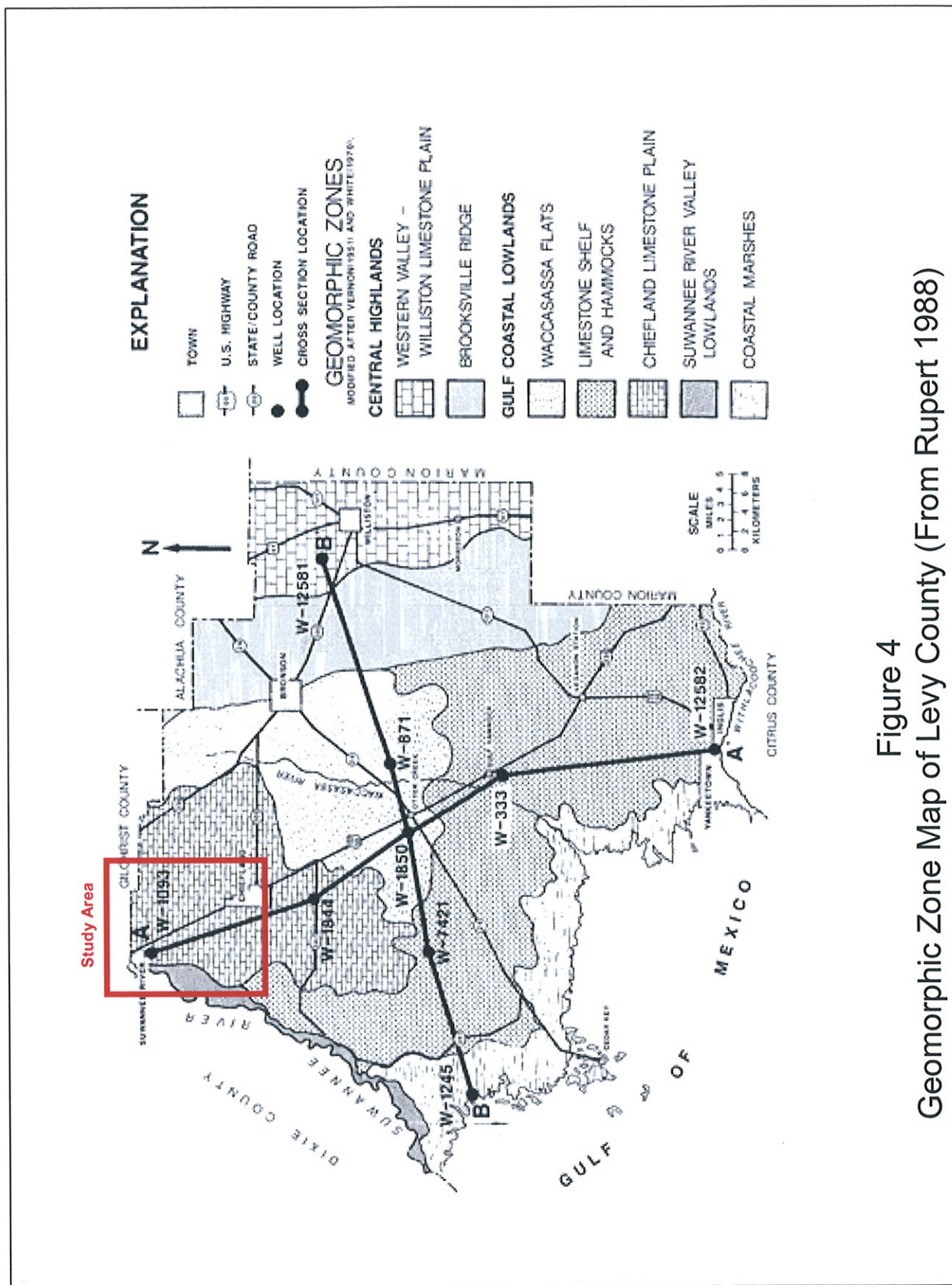


Figure 4
Geomorphic Zone Map of Levy County (From Rupert 1988)

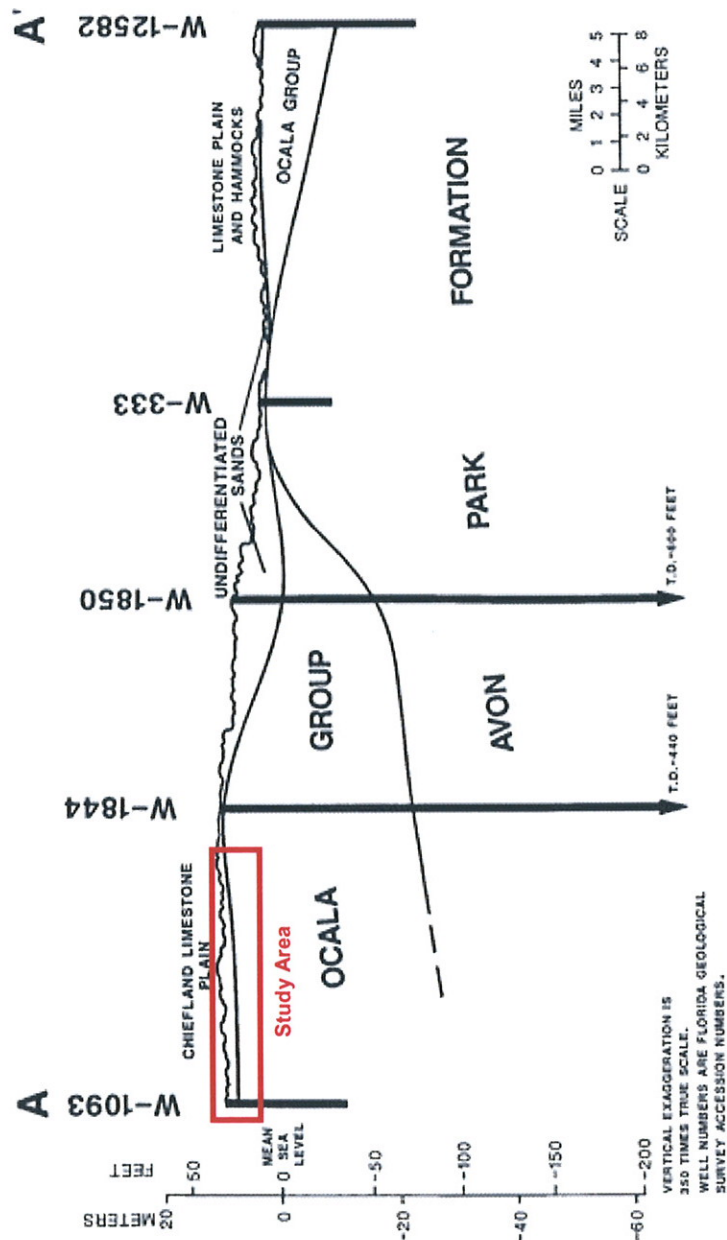


Figure 5
Geologic Cross Section Through Study Area (from Rupert 1988)

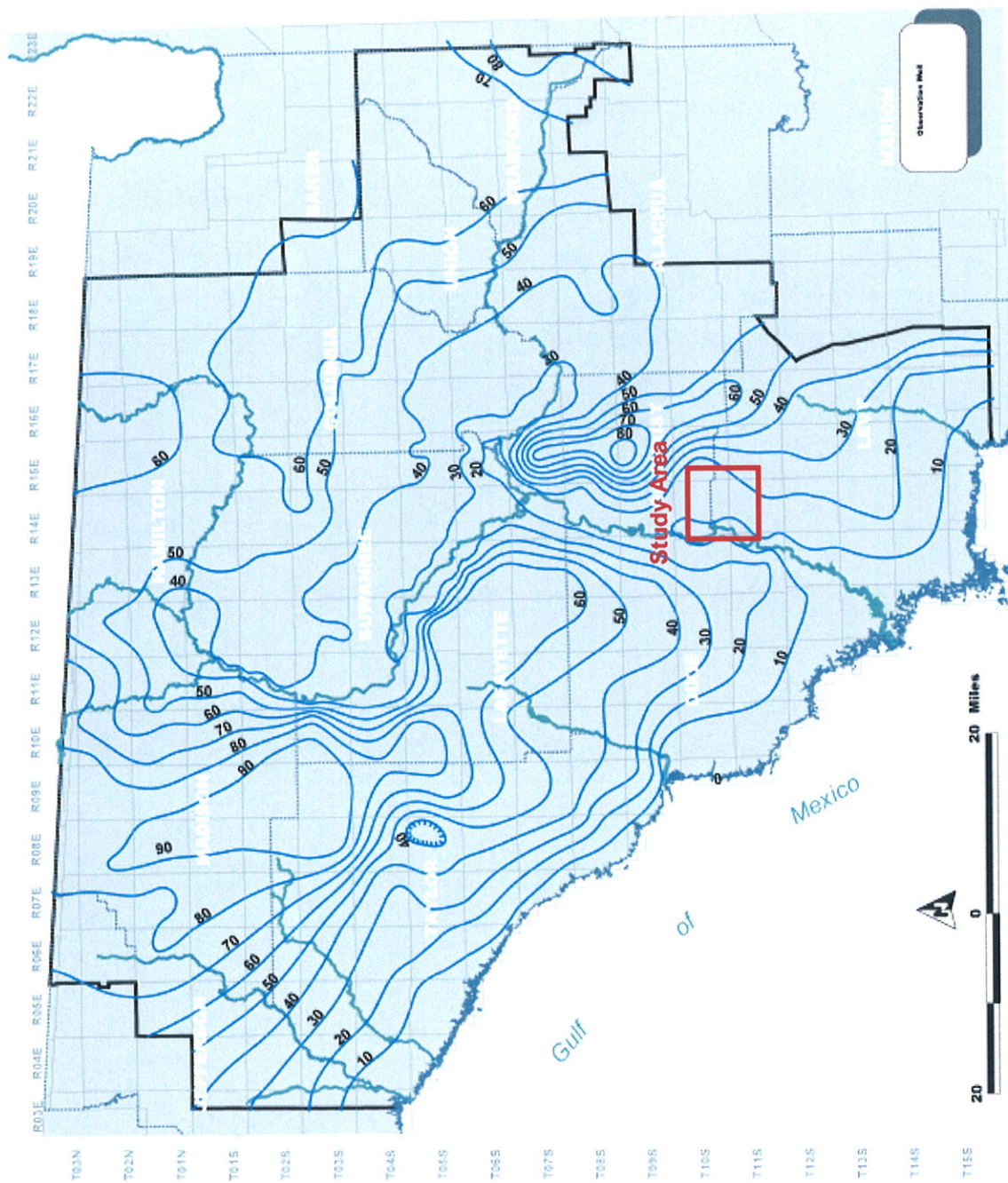


Figure 6.
Potentiometric Surface of the Upper Floridan Aquifer
in the Suwannee River Water Management District, May 2005 (SRWMD, 2005)

FIGURE 7
Fanning Springs Study Area

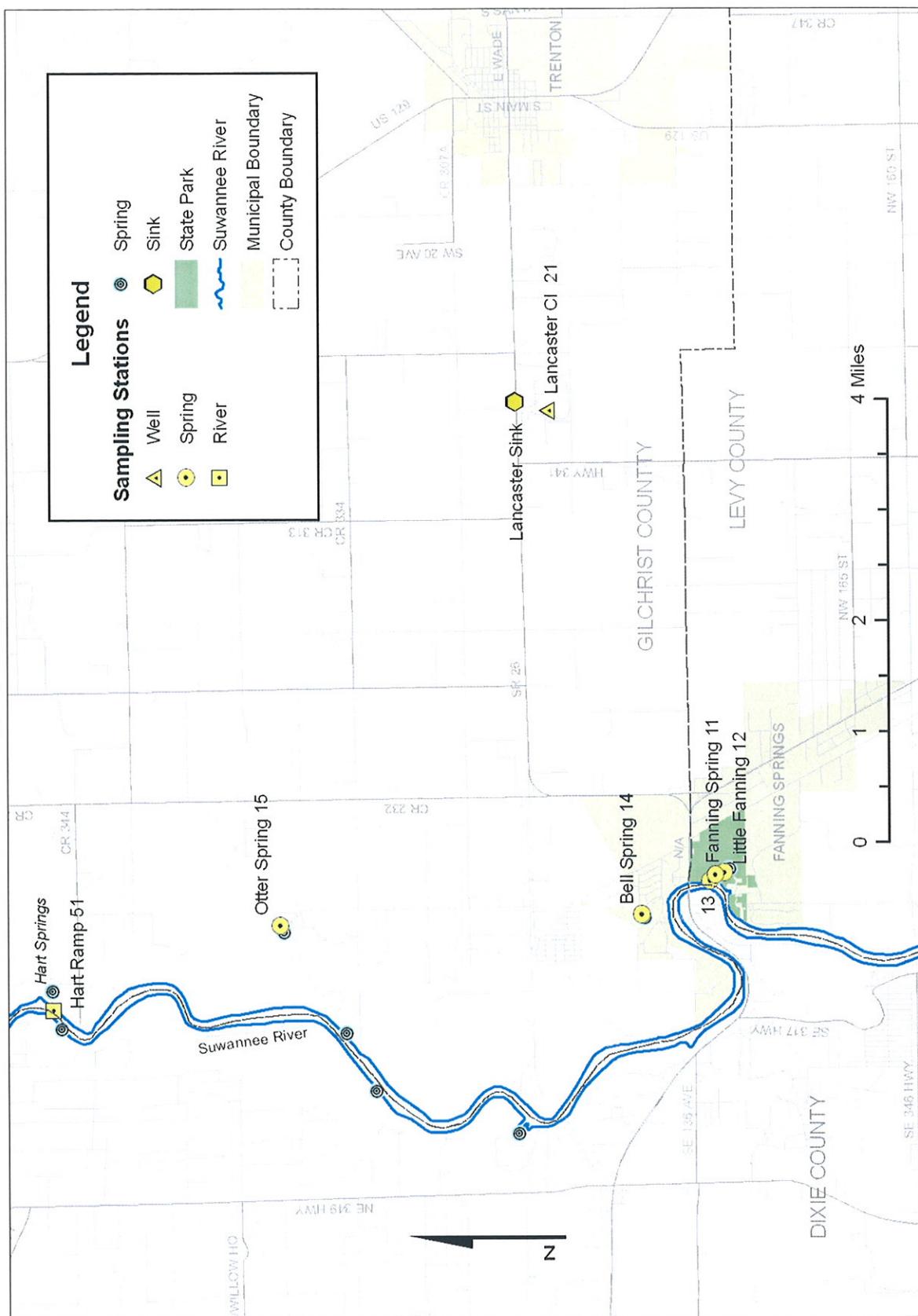


FIGURE 8
Manatee Springs Study Area

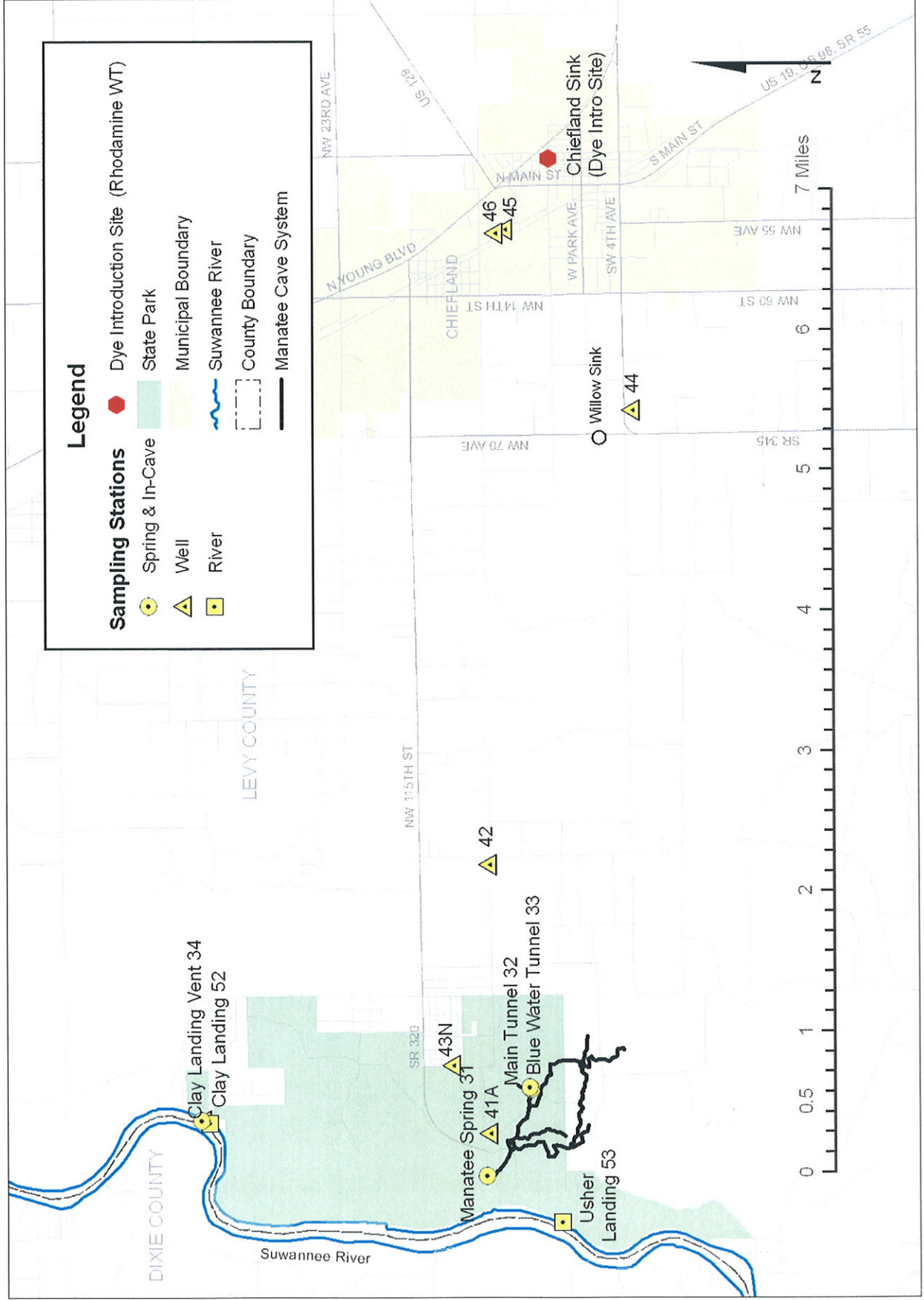


FIGURE 9

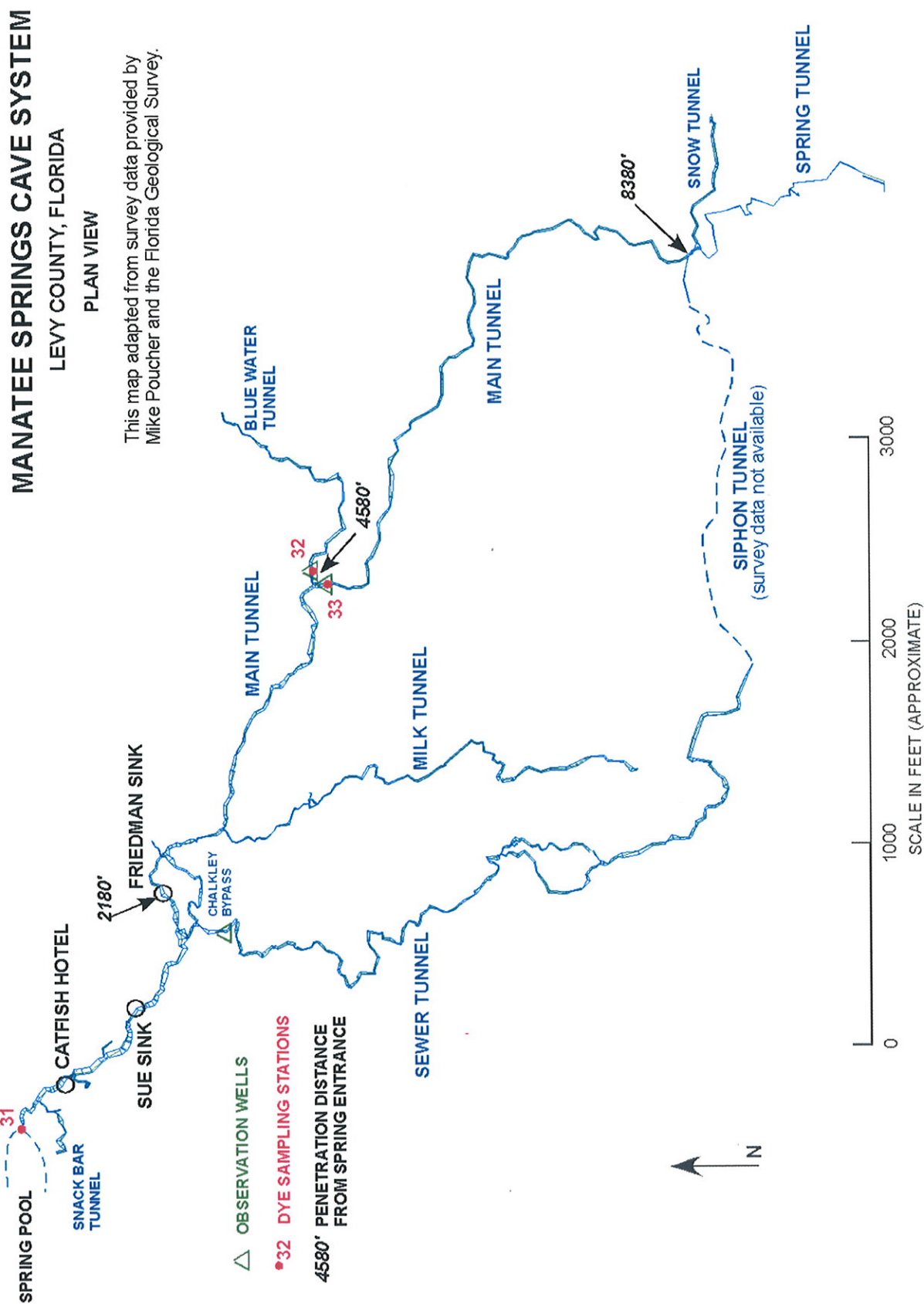


FIGURE 10

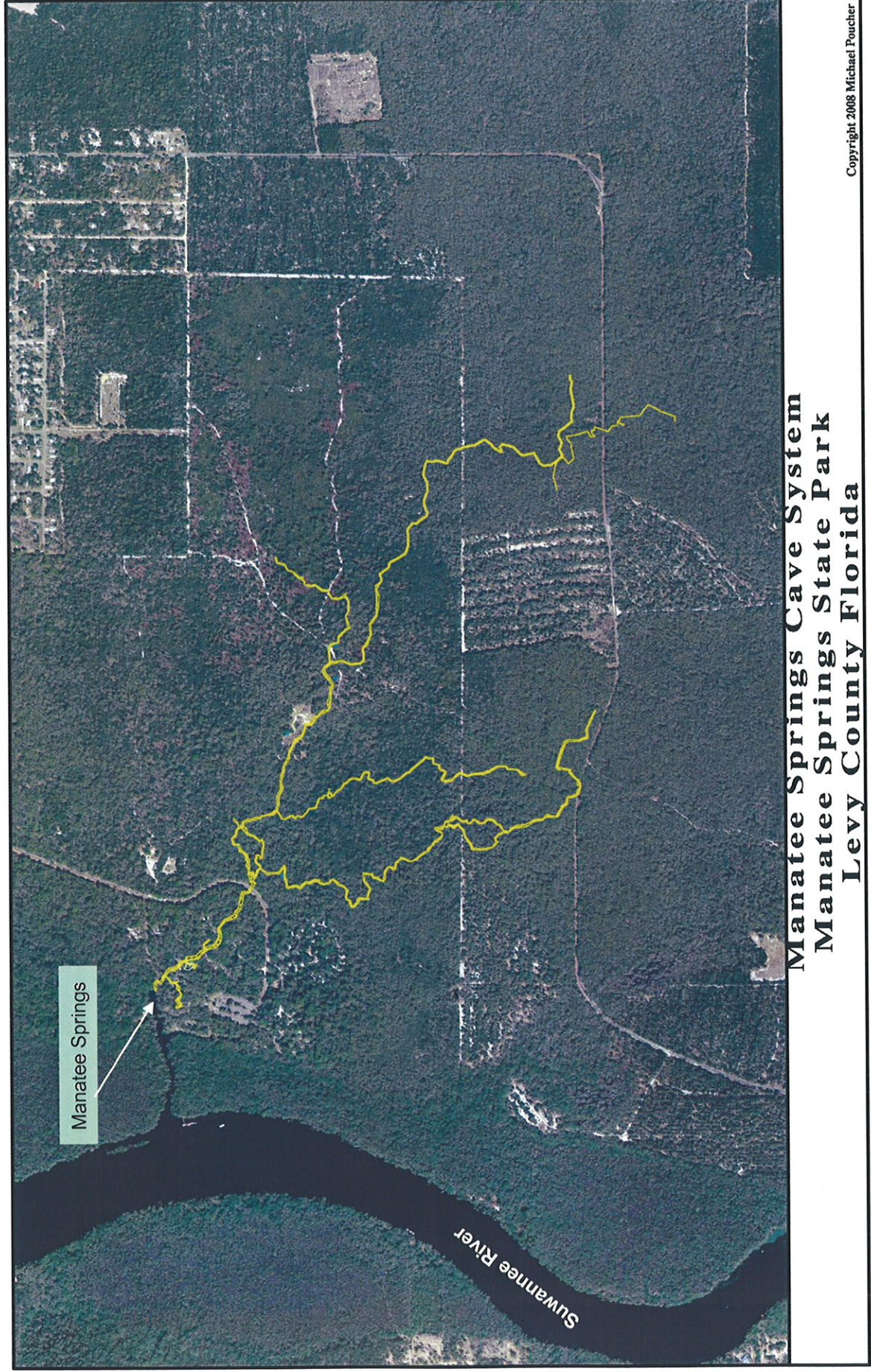


FIGURE 11

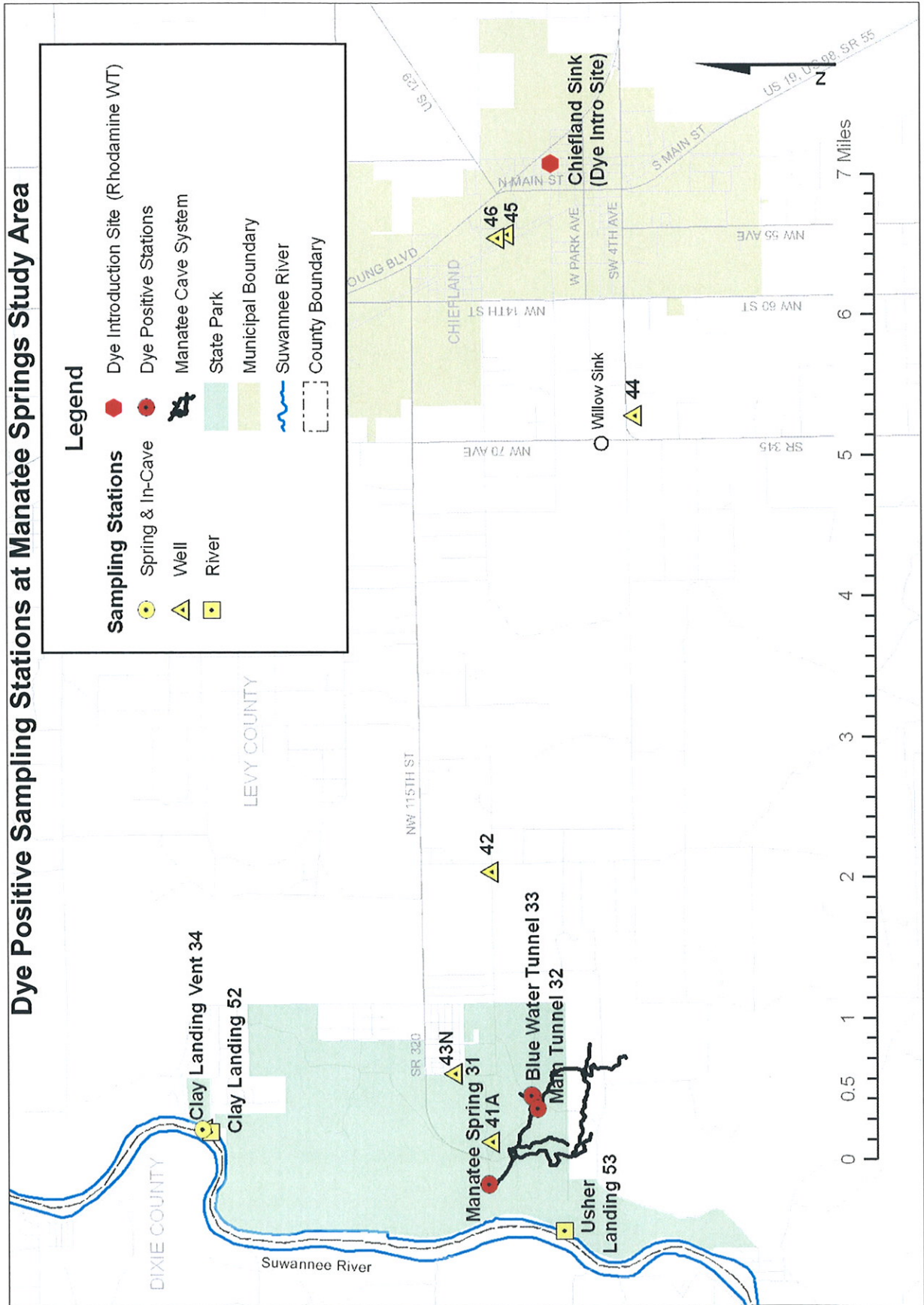
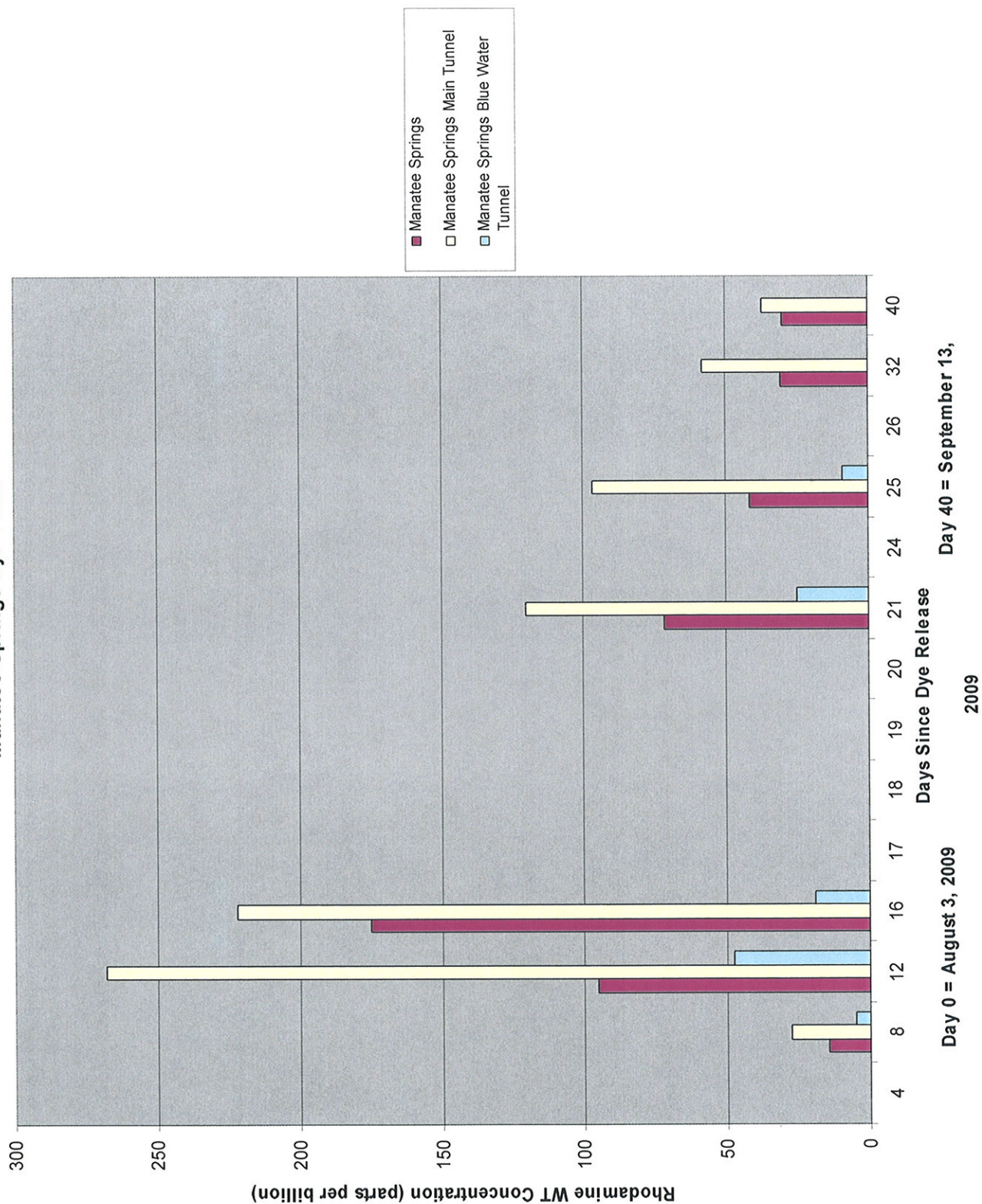


Figure 12
Rhodamine WT Concentrations With Time
Manatee Springs Dye Trace



APPENDIX A

Client Name:

Florida Department of Environmental
Protection - Ground Water Protection
Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.

12805625

Photo No.

1

Date:

8/30/09

Direction Photo Taken:

North

Description:

Manatee Springs. Spring
basin under normal
conditions.


Photo No.

2

Date:

5/3/09

Direction Photo Taken:

NA

Description:

Manatee Springs. Spring
basin inundated with river
water during Suwannee
River flooding, March
through May of 2009.



Client Name: Florida Department of Environmental Protection - Ground Water Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.

3

Date:

5/3/09

Direction Photo Taken:

NA

Description:

Manatee Springs.
Spring basin is inundated with river water during Suwannee River flooding, March through May of 2009.



Photo No.

4

Date:

5/3/09

Direction Photo Taken:

Southwest

Description:

Fanning Springs. Spring basin is inundated with river water during Suwannee River flooding, March through May of 2009.



Client Name: Florida Department of Environmental Protection - Ground Water Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.

5

Date:

2/12/09

Direction Photo Taken:

East

Description:

Lancaster Sink. The drainage swale is located on the north side of SR-26 opposite of Lancaster Correctional Institute. Note the concrete structure on the right (south) slope where a drainage pipe passes under SR 26.



Photo No.

6

Date:

4/7/09

Direction Photo Taken:

Southeast

Description:

Chiefland Sink. This view shows the area of sinking ground around the actual swallet.





PHOTOGRAPHIC LOG

Client Name: Florida Department of
Environmental Protection - Ground Water
Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.
7

Date:
4/7/09

Direction Photo Taken:

Southwest

Description:

Chiefland Sink. This view shows a storm water culvert on the right side of the photo that discharges into the sink.



Photo No.
8

Date:
3/31/09

Direction Photo Taken:

Northwest

Description:

Chiefland Sink. Storm water discharging from the two culverts on the west side.





PHOTOGRAPHIC LOG

Client Name: Florida Department of Environmental Protection - Ground Water Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.
9

Date:
3/31/09

Direction Photo Taken:

NA

Description:

Chiefland Sink. Storm water from the two culverts flowing into the sink canyon to the swallet.



Photo No.
10

Date:
8/3/09

Direction Photo Taken:

Southeast

Description:

Chiefland Sink. This view from the west shows the canyon as it descends to the swallet and the top of ground water visible at its east end during dry conditions.

NOTE: This is a LARGE portrait photo; image view here is cropped.





PHOTOGRAPHIC LOG

Client Name: Florida Department of Environmental Protection - Ground Water Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.
11

Date:
8/3/09

Direction Photo Taken:

NA

Description:

Chiefland Sink dye release. Twenty-five pounds of Rhodamine WT dye are being introduced into the swallet.



Photo No.
12

Date:
8/3/09

Direction Photo Taken:

NA

Description:

Chiefland Sink dye release. Rhodamine WT dye is being introduced into groundwater.





PHOTOGRAPHIC LOG

Client Name: Florida Department of Environmental Protection - Ground Water Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.
13

Date:
8/3/09

Direction Photo Taken:

NA

Description:

Chiefland Sink dye release. Chase water being applied to released dye at the deepest end of the swallet.



Photo No.
14

Date:
8/3/09

Direction Photo Taken:

NA

Description:

Chiefland Sink dye release. Close-up of chase water being applied to released dye at the deepest end of the swallet.





PHOTOGRAPHIC LOG

Client Name: Florida Department of Environmental Protection - Ground Water Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.
15

Date:
8/4/09

Direction Photo Taken:

Northwest

Description:

Chiefland Sink. High water level conditions in the sink below the culvert discharge on the afternoon of August 4, 2009 caused by rainfall the day after the dye release.



Photo No.
16

Date:
8/30/09

Direction Photo Taken:

NA

Description:

Manatee Spring. The Station 31 charcoal sampler holder was placed to the right of the KES sampler collector.





PHOTOGRAPHIC LOG

Client Name: Florida Department of
Environmental Protection - Ground Water
Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.
17

Date:
8/30/09

Direction Photo Taken:

NA

Description:

Manatee Springs Cave
Main Tunnel monitor
well, Station 32.



Photo No.
18

Date:
8/30/09

Direction Photo Taken:

NA

Description:

Manatee Spring Cave
Blue Water Tunnel
monitor well, Station 33.





PHOTOGRAPHIC LOG

Client Name: Florida Department of Environmental Protection - Ground Water Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.
19

Date:
8/30/09

Direction Photo Taken:

NA

Description:

In-cave sampler holder array for Stations 32 and 33.



Photo No.
20

Date:
8/30/09

Direction Photo Taken:

NA

Description:

Chiefland Public Supply Well South. The charcoal sampler holder in place on Station 45.





PHOTOGRAPHIC LOG

Client Name: Florida Department of Environmental Protection - Ground Water Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.
21

Date:
8/30/09

Direction Photo Taken:

NA

Description:

Chiefland Public Supply Well North. The charcoal sampler holder in place on Station 46.



Photo No.
22

Date:
8/30/09

Direction Photo Taken:

NA

Description:

Barnhill Landscape well. The charcoal sampler holder in place on Station 44.





PHOTOGRAPHIC LOG

Client Name: Florida Department of Environmental Protection - Ground Water Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.
23

Date:
6/26/09

Direction Photo Taken:

NA

Description:

Levy County public supply well. The charcoal sampler holder in place on Station 42.



Photo No.
24

Date:
6/26/09

Direction Photo Taken:

NA

Description:

Sunnyside Subdivision public supply well. The charcoal sampler holder in place on Station 43N.





PHOTOGRAPHIC LOG

Client Name: Florida Department of Environmental Protection - Ground Water Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.
25

Date:
8/29/09

Direction Photo Taken:

NA

Description:

Manatee Springs State Park public supply well, Station 41A. The charcoal sampler holder is in place near the end of the hose.



Photo No.
26

Date:
4/3/09

Direction Photo Taken:

East

Description:

Lancaster Sink. Dry portion of drainage swale on the north side of SR-26 opposite of Lancaster Correctional Institute.





PHOTOGRAPHIC LOG

Client Name: Florida Department of Environmental Protection - Ground Water Protection Section

Site Location: Manatee Springs Area
Chiefland, Manatee County, Florida

Project No.
12805625

Photo No.
27

Date:
4/3/09

Direction Photo Taken:

West

Description:

Lancaster Sink. Wet portion of drainage swale on the north side of SR-26 opposite of Lancaster Correctional Institute. Standing water still present from a recent rainfall.



Photo No.
28

Date:
2/12/09

Direction Photo Taken:

NA

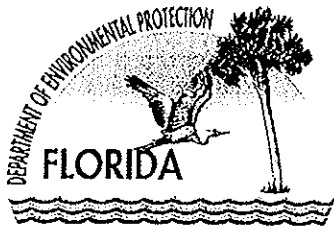
Description:

Lancaster Sink.

Small karst features located east of the concrete drainage pipe structure in the drainage swale on the north side of SR-26 opposite of Lancaster Correctional Institute.



APPENDIX B



Florida Department of Environmental Protection

Bureau of Parks District 2
4801 Camp Ranch Road
Gainesville, Florida 32641-9299

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

April 7, 2009

Pete Butt
5779 NE CR 340
High Springs, FL 32643

Dear Mr. Butt,

Enclosed is Research & Collecting Permit #04070921 authorizing your dye trace studies at Manatee and Fanning Springs State Parks. This permit must be attached to your original application and carried with you at all times while conducting research in the park.

Please communicate with the Park Manager, Sally Lieb, before your visits. For your convenience, her phone number is listed on the permit.

Recently, Florida State Parks have become popular research sites. Although the parks are eager to accommodate your project, please note that Park Staff may not always be available to physically assist you during your study.

In exchange for the privilege of working in our parks, please continue to submit to us any field reports and species lists, including incidental observations of other flora or fauna, following your study period. As always, we appreciate your previous work and thank you for providing your valuable research to the Florida Park Service.

If you have any questions, or if I can be of further assistance, please call me at (352) 955-2135.

Sincerely,

Daniel W. Pearson
Environmental Specialist II

DWP/dwp
Enclosure

cc: Park Manager, District Files

Florida Department of Environmental Protection
Division of Recreation and Parks

Permit Number:
04070921

RESEARCH/COLLECTING PERMIT

This Permit Must Be Carried At All Times While Researching/Collecting

Primary Holder:

Bull, Pete

Karst Env. Services, URS Corp. H2H Assoc., & FDEP

Issue: 4/7/2009

Expiration: 12/31/2009

Additional Permittees:

Long, Mark

5779 NE County Road 340

High Springs, FL 32643

Morris, Tom

(386) 454-3556 kes@atlantic.net

Shemitz, Georgia

Long, Annette

Hubner, Matt

Colona, Bill

Smith, Mark

Hatchel, Lyle

Dickey, Rufus

Ciaravella, Phil

Greenhalgh, Tom

McClean, James

Mast, Jake

Walrath, Alexandra

Spall, Melinda

Cerame, Caitlin

Thomas, Eric

Carroll, John

Bobrycki, Jim

Copeland, Rick

Means, Harley

Paul, Dave

Kromhout, Clint

Maddox, Gary

Wade, Edgar

Kincaid, Todd

To Research/ Collect:

Dye Trace studies at Fanning Springs State Park and Manatee Springs State Park as detailed in permit application. Work is being performed for Florida Department of Environmental Protection.

in the Following Parks:

Fanning Springs State Park

Manatee Springs State Park

Standard Conditions:

1. Contact the Park Manager and Biologist (if listed below) in advance of project start (2 weeks notice when possible), for coordination and arrangements. Due to the increasing popularity of research within state parks and their other duties and responsibilities, the park staff may not be available to physically assist with project activities but will provide guidance and direction.

Fanning (352) 493-6738 Park Manager: Sally Lieb

.....Manatee.....(352) 493-6738Park Manager:.....Sally Lieb

2. Check in upon arrival at and departure from the park. Collected material is subject to inspection.
3. Collect only materials as stated above, in the quantities and manner indicated in the attached application form.
4. Any other applicable state and federal permits are the responsibility of the permittee.
5. Collected objects may not be sold, bartered, or traded.
6. Collect no state or federally listed, or rare endemic species or forms, unless otherwise stated in permit.
7. Research shall be conducted in such a manner as not to attract attention or cause damage to the environment.
8. Remove all flagging and project markings upon project completion.
9. The permit is non-transferable. At least one named collector (above) must be present.
10. The permittee and research associates will not be subject to park day-fees.

Florida Department of Environmental Protection
Division of Recreation and Parks

Permit Number:
04070921

RESEARCH/COLLECTING PERMIT

This Permit Must Be Carried At All Times While Researching/Collecting

11. The permit is revocable.
12. The permit may be renewed upon written request. Consideration for renewal will be contingent up on submission of an interim progress report.
13. A final report, including species lists, museum voucher numbers, incidental observations, and any research reports concerning project data shall be submitted to the district biologist and the parks within one month of permit expiration. The report is the responsibility of the primary permit holder. Failure to submit a report may result in denial of future research requests.

Special Conditions and Restrictions:

- 1 All divers must possess current certification and dive within their certification limits.

Approved:


Donald V. Forgione

Chief, Bureau of Parks District 2
Division of Recreation and Parks
District 2 Administration
4801 Camp Ranch Road
Gainesville, FL 32641-9299

Phone: (352) 955-2135
Suncom: 625-2135
FAX: (352) 955-2139

cc: District Biologist, Park Manager(s), Park Biologist(s)

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Recreation and Parks (DRP)

APPLICATION FOR RESEARCH/COLLECTING PERMIT

(Please Print or Type)

Applicant's Name Peter L. Butt, Karst Environmental Services, Inc.

Date of Application 4/6/09

Applicant's Signature 

Occupation Project Manager

Affiliation Karst Environmental Services, Inc. (KES), URS Corporation and H2H Assoc., LLC performing services for the FL Dept. of Environmental Protection

Address 5779 NE County Road 340 High Springs, FL 32643

Phones (386) 454-3556 (386) 454-2147 (386) 454-3541 kes@atlantic.net
Business Home FAX Email

Additional Persons to be Authorized Under Permit:

Name	<u>Mark Long, Tom Morris, Georgia Shemitz</u>	Affiliation	<u>KES Staff</u>
Name	<u>Annette Long, Matt Hubner</u>	Affiliation	<u>KES Staff</u>
Name	<u>Bill Colona (URS contact), Mark Smith,</u>	Affiliation	<u>URS Staff</u>
Name	<u>Lyle Hatchet, Rufus Dickey, Phil Ciaravella</u>	Affiliation	<u>URS Staff</u>
Name	<u>Tom Greenhalgh, James McClean, Jake Mast</u>	Affiliation	<u>FDEP Staff</u>
Name	<u>Alexandra Walrath, Melinda Spall, Caitlin Cerame</u>	Affiliation	<u>FDEP Staff</u>
Name	<u>Eric Thomas, John Carroll, Jim Bobrycki</u>	Affiliation	<u>FDEP Staff</u>
Name	<u>Rick Copeland, Harley Means, Dave Paul</u>	Affiliation	<u>FDEP Staff</u>
Name	<u>Clint Kromhout, Gary Maddox, Edgar Wade</u>	Affiliation	<u>FDEP Staff</u>
Name	<u>Todd Kincaid (H2H contact)</u>	Affiliation	<u>H2H Staff</u>

*Other staff and volunteers may also be participating; all KES staff or volunteers will have a copy of any required permits with them. KES will submit any additional names as appropriate for revisions to the permit. State park staff will also be participating in this study.

Do you have a federal or other state agency permit for the proposed activity? Yes No* if Yes, please attach a copy.

* FDEP Northeast District (typically John Davis) will be informed of the dye trace, and we will obtain approval prior to any dye release (as with past dye traces). This is also an FDEP authorized and funded project.

Have you previously had a DRP research/collecting permit? Yes No if Yes, give permit number. 02250622

List parks to be included in permit.

Fanning Springs and Manatee Springs State Parks are the primary sites.

Why is a state park/preserve proposed for this project?

These state lands contain specific sites that are critical to the successful outcome of a dye trace that is being authorized and funded by the Florida Department of Environmental Protection. This is a geographic and site

specific project to determine/define a segment of the groundwater flow system of southwest Gilchrist and northwest Levy Counties.

Describe/propose benefits to state park/preserve.

The goal of this qualitative dye trace is to determine the hydrogeologic connections of selected drainage/sinking points in Gilchrist and Levy Counties with Fanning and Manatee Springs, and other selected springs. Selected public and private water supply wells will also be monitored for dye during the study. The study will also provide information on travel times between the sinks and springs. This study will provide the State of Florida and others with information needed to enhance the protection of surface and ground waters flowing to Fanning and Manatee Springs.

Project Start Date: 4/1/09 (planning/prep underway) **Project End Date:** 12/31/09 We will contact you for any renewals or extensions as needed/appropriate; specific weather and water conditions may be needed for dye release and monitoring, and this may cause delays.

Describe research/collecting needs and objectives (attach additional page if necessary). Append a copy of a research proposal if available.

Charcoal samplers would be placed/collected and water samples collected from spring pools and runs, and monitor wells at Manatee and Fanning Springs, and analyzed to determine the presence/absence of dye. Park public supply wells will also be monitored by the use of flow-through sampler holders tied into the system at the well sampling bib location.

Species/samples to be collected/studied (if taking is necessary, specify numbers requested and justify need for sample size).

No animals or plants will be collected. Water samples will typically be collected in vials of less than 250 ml in volume. The only other sampling will be with the use of charcoal packets attached to anchors, holders or well sample holders (equipped with no-return valves on any well used for public supply).

Methodology (describe collecting/trapping/marketing methods)

Background conditions will be checked with charcoal sampler packets and water samples. After release of the dye, packets and water samples will be collected at scheduled intervals as are appropriate for the duration of the study. The duration of the project is anticipated to be at least 16 weeks. Charcoal samplers will be changed out at least weekly, and some daily water sampling may be performed at manatee and Fanning Spring. Sampling visits will be unobtrusive, and will not interfere with any park activities. Due to the extensive sample station network/circuit that is being planned, it would be helpful if the samplers had before- and after-hours access privileges to the parks. Sample analysis will be performed at a spectrofluorophotometer-equipped lab.

Proposed disposition of collected specimens n/a

Return to: District 2 Administration, 4801 SE 17th Street, Gainesville, FL 32641-9299.
Phone (352) 955-2135 FAX (352) 955-2139

OFFICE USE ONLY:

Date Application Received 4/6/09 **30 Day Review Due** _____

Biologist Recommendation: Approved X Denied _____

Issue Date 4/7/09 **Permit No.** 04070921

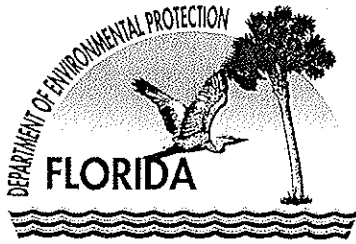
Biologist Reviewer
DWP

Notification Method: mailed / phoned / FAXed / e-mailed

FPS-R009 rev. 02/95

2/04

APPENDIX C



Florida Department of Environmental Protection

Northeast District
7825 Baymeadows Way, Suite B200
Jacksonville, Florida 32256-7590
Phone: 904/807-3300 ♦ Fax: 904/448-4366

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

May 4, 2009

Sent via email: kes@atlantic.net

Mr. Peter L. Butt, V.P.
Karst Environmental Services, Inc.
3779 N.E. County Road 340
High Springs, Florida 32643

Dear Pete,

Re: **Fanning & Manatee Springs Area Tracer Study**
Permit Determination
Gilchrist & Levy Counties - Ground Water/UIC

CPS PLAN APPROVAL

Information on a proposed tracer study, with tentative release date of May 2009, was received by email on April 20, 2009. Your submittal details the introduction of sodium fluorescein and/or rhodamine WT at the Lancaster and Chiefland Sinks, with primary sample recovery at Manatee and Fanning Springs.

Given the chosen dyes and manner of use, it does not appear that your investigation presents a threat to the environment or public health. Therefore, no DEP permit will be required under the Ground Water Monitoring provisions of Chapter 62-520, Florida Administrative Code (F.A.C.), nor the Underground Injection Control provisions of Chapter 62-528, F.A.C.

Thank you for informing me of these tracer studies, and as always, please feel free to contact me at (904) 807-3313, or by email at john.davis@dep.state.fl.us, if you should have any questions.

Sincerely,

John J. Davis, P.G.
Potable Water/Ground Water Supervisor
FDEP Northeast District - Jacksonville

JJD:jd

Karst Environmental Services, Inc.

5779 NE County Road 340 High Springs, Florida 32643
(386) 454-3556 (386) 454-3541 FAX kes@atlantic.net

John Davis, P.G.
FDEP NE District Office
7825 Baymeadows Way
Suite B-200
Jacksonville, FL 32256-7590

April 20, 2009

Dear Mr. Davis,

The Florida Department of Environmental Protection (FDEP) has authorized and contracted with URS Corporation (URS) and its subcontractor Karst Environmental Services, Inc. (KES) to conduct a qualitative dye trace in the northwest portion of Levy County and the southwest portion of Gilchrist County. The dye trace will focus on Fanning and Manatee Springs and selected drainage sink points. I can be contacted for operational questions or information, and Bill Colona, URS Senior Project Geologist, can be contacted regarding any FDEP contract details, if needed (contact numbers below). Our primary point of contact with the FDEP for this project is Rick Hicks.

The purpose of this qualitative dye trace is to identify connections from a drainage sink located directly across from the Lancaster Correctional Institution to Fanning Springs, and from a drainage sink located on the east side of the City of Chiefland and Manatee Springs. Additional springs and selected wells will also be monitored. This study is contingent on weather and flood conditions in the area. We are currently monitoring the flood conditions on the Suwannee River, and we will be conducting the background testing in preparation for the trace as soon as it is practicable.

We plan to begin the trace in late April or early May and complete as much as possible by June, with monitoring continuing after that date as needed. An Operational Plan for the dye study is attached; any additional changes will be forwarded to you, if necessary.

The tracer dyes that we plan to use are sodium fluorescein, (also called Uranine C or Acid Yellow 73) and rhodamine WT. (MSDS sheets are attached). These dyes are non-toxic, and are not persistent in the environment. These dyes are used routinely around the United States for water tracing studies. Fluorescein is in a powder that will be made into a solution prior to release. Rhodamine WT is in liquid form. These dyes will appear bright green and red when present in sufficient concentration in the water, about 140 parts per billion. We will purchase the dye from Ozark Underground Lab (OUL), Protom, Missouri. OUL is a long recognized quality source of tracer dyes.

The present plan is to release fluorescein dye into a drainage sink along the north side of Highway 26, across from the Lancaster Correctional Institution, on the FDOT right-of-way. We do not anticipate using more than 50 pounds of fluorescein. We will chase the dye using water

hauled in by tanker, or use the natural flow if we can time the release to coincide with a rainfall event. Dilution should quickly lower the dye concentration to the 10 ppb threshold. (Ozark Underground Lab estimates that the "general public" under "field conditions" will visually detect concentrations of fluorescein at about 140 ppb (parts per billion) in water.)

We also plan to release rhodamine WT dye into a FDOT owned sink on the eastern side of the City of Chiefland. We do not anticipate using more than 50 pounds of rhodamine WT. We will chase the dye using water from a nearby municipal hydrant and/or use the natural flow if we can time the release to coincide with a rainfall event. Dilution should quickly lower the dye concentration to the 10 ppb threshold.

The dye release and sampling locations are shown on the attached map. The focus for sampling will be within the Fanning Springs and Manatee Springs and its cave passage observation wells. We will also sample at selected wells as needed. Charcoal sampler packets and water samples will be collected, and shipped to Ozark Underground Laboratory in Missouri for analyses. We have worked with OUL extensively in the past, due to their expertise and ability to achieve extremely low detection limits (parts per trillion) with both charcoal and water samples, using a scanning spectrofluorophotometer for analysis.

I will be contacting the directors of the Levy and Gilchrist County Environmental Health Directors, and the Chiefland water utility staff, and discussing our plans with them as our preparations continue. They will be notified prior to the actual dye release. I will also provide them and any other interested party with an information sheet that will explain what is being done and by whom, that there is no danger, and contact numbers for those of us performing the trace. We have prepared a "Notice to Well Owners" that we will distribute as needed and will encourage calls both to provide information to residents, and to obtain any useful data or sampling opportunities that may result from local observations. I will also keep Jon Dinges at the Suwannee River Water Management District informed of our plans. All pertinent local agencies will be given at least a 48-hour notice prior to tracer release.

Lists of wells in the two portions of the study area generated from the SRWMD database are included as separate Excel spreadsheets. I have also included a copy of our FDEP Division of Recreation and Parks Research/Collecting Permit for this study.

We hope that the information enclosed is sufficient. Please let me know if you need more information regarding this dye trace. I can be reached at 386-454-3556, 386-454-2147 and 352-339-3380. Bill Colona of URS can be reached at 850-574-3197 or 850-402-6422.

Sincerely,



Peter L. Butt
Vice President,
Karst Environmental Services, Inc.

Attachments:

Operational Plan

Maps of study area

Notice to local well owners.

MSDS sheets for fluorescein and rhodamine WT.

FDEP-DRP research permit.

Sent as separate file:

Lists (in Excel) of wells/owners within the study area (from SRWMD database).

Cc. Jon Dinges, Suwannee River Water Management District

Director, Levy County Health Department

Director, Gilchrist County Health Department

Karst Environmental Services, Inc.

5779 NE County Road High Springs, Florida 32643
(386) 454-3556 (386) 454-3541 FAX kes@atlantic.net

DYE TRACE: Fanning and Manatee Springs, Spring, 2009

OPERATIONAL PLAN (4/1/09)

The Florida Department of Environmental Protection (FDEP) has authorized the URS Corporation (URS) and its associated team to conduct a dye trace in the southwest Gilchrist and northwest Levy Counties, Florida. The goal and objective of this qualitative dye trace is to determine any underground hydrogeologic connections between selected natural sink features and Fanning and Manatee Springs, other selected springs and selected wells. The URS team includes Karst Environmental Services, Inc. (KES) and Ozark Underground Laboratory (OUL) of Protom, Missouri. KES will be conducting most of the fieldwork for this project, and OUL will be providing dyes, sampling supplies and sample analyses.

The dye sampling locations include Fanning Spring, Little Fanning Spring Manatee Spring, Bell Spring, Otter Springs, and other springs along the Suwannee River. In addition, locations along the Suwannee River will be monitored. Selected wells in the area will be monitored, including public supply, irrigation and private residential wells.

A research permit has been obtained from the Division of Recreation and Parks, and the FDOT has approved access to the dye release sites. The FDEP Northeast office will be provided with the usual information it needs regarding the plan and implementation of this dye trace, and appropriate updates. The SRWMD, Levy and Gilchrist County Health Departments, and the City of Chiefland water department staff will be kept informed as to the details and scheduling of this project.

General Methods and Logistics

The release of tracer dyes is planned for April, as long as weather conditions allow an effective dye trace. Dye will be introduced into a sink north of the entrance to the Lancaster Correctional Institution along Highway 26 west of Trenton, and into a sink within the Chiefland city limits. If no natural flow of water is present during the release, the release sites will be pre-wetted, and then chase water will be used to flush the dye into the ground. Use of a water tanker is anticipated at the Lancaster site, and a hydrant hookup will be used at the Chiefland site.

The quantity of dye selected for release will be determined in large part by the results of background testing and existing aquifer conditions. We plan to release up to 50 pounds of fluorescein dye at the Lancaster Sink and up to 50 pounds of rhodamine WT at the Chiefland Sink. Chase water dilution should quickly lower the dye concentration to the 10 ppb threshold.

Charcoal packets will be in place at the moment of dye release. The charcoal packets will be collected/reset and water samples will be collected at predetermined intervals. Sampling for the dye may continue through August and beyond as needed.

KES staff will collect and replace samplers and collect water samples. Some FDEP-DRP staff or volunteers may collect water samples. Sample data will be organized by station name and number and be recorded on Sample Collection Data Sheets. The Sample Collection Data Sheets will indicate site, sample/packet identifying number, time placed/collected, any visual observations of dye, and sampling personnel. Sample tracking spreadsheets will also track every sample collected, held, shipped and analyzed by site, and include the results. All analyses documents from OUL will also be placed in a database.

Sample Analysis

During routine sampling, charcoal sampler packets will be placed and retrieved and water samples will be collected. These charcoal sampler packets and vials will be provided by OUL. Samples will be sent to the OUL lab for analysis on a spectrofluorophotometer operated under a synchronous scan mode.

Quality Control

Prior to the actual introduction of the dyes, charcoal sampler packets will be placed, collected and analyzed for background information. This will identify any natural fluorescence or man-made interference, and provide guidance for selecting the type and amount of dye to be used.

During the release of the dyes, those personnel handling the dyes will not be allowed to have contact with any sampling devices, sampling locations and sample handling areas, at least until they have bathed, donned different clothing and footwear, waited a minimum period of time, etc, before again participating in any study operations.

All charcoal samplers, water sample vials, and Whirlpak bags will be obtained from OUL. Only black "Sharpie" markers will be used for labeling bags and vials. Collected samples will be kept in the dark, and as cool as possible in the field. Samples will be refrigerated as soon as possible, and shipped with a plastic "blue ice" block. Samples will be shipped via Federal Express or Next Day UPS to OUL.

Tracer Dye

Of the dyes selected for this trace, fluorescein (uranine or Acid Yellow 73) is in a powder that will be made into a solution prior to release. Rhodamine WT is in liquid form. These dyes will appear bright green or red when present in sufficient concentration in the water, about 140 parts per billion. These dyes are used routinely around the United States for water tracing studies. Once released, the dyes will quickly reach non-toxic concentrations and move harmlessly with the flowing water. These dyes will eventually dissipate and deteriorate in the natural environment.

Dye Detection Materials and Procedures

Collection of the dye will be through the use of charcoal sampler packets and with water grab samples. The exact time that each sample was placed and collected will be recorded, and all samples will be placed in coolers and kept from light as they are transported to the project headquarters. All sample data will be recorded on a Sample Collection Data Sheet with sample number, site, time placed/collected, any visual observations of dye, and sampling personnel. Collection dates and times will also be recorded on the sample bag or vial.

Charcoal sampler packets will be used to indicate the cumulative presence of dye over selected time intervals. The charcoal samplers are small envelopes of plastic window screen

filled with activated charcoal. These bags will be attached to fixed mounting points within the flow of water at the sampling locations. Samplers at each site will be changed out at designated intervals during the study. When collected, samplers will be placed in a pre-labeled sealable Whirlpak plastic bag, and kept from light until it can be delivered to the project headquarters.

Water samples will indicate the actual concentration of dye in the water at the moment of sampling. Grab samples of water will be taken in OUL vials either by hand while moving into the flow, or directly from plumbing connected to wells. It will be uncapped, filled with sample, capped and stored.

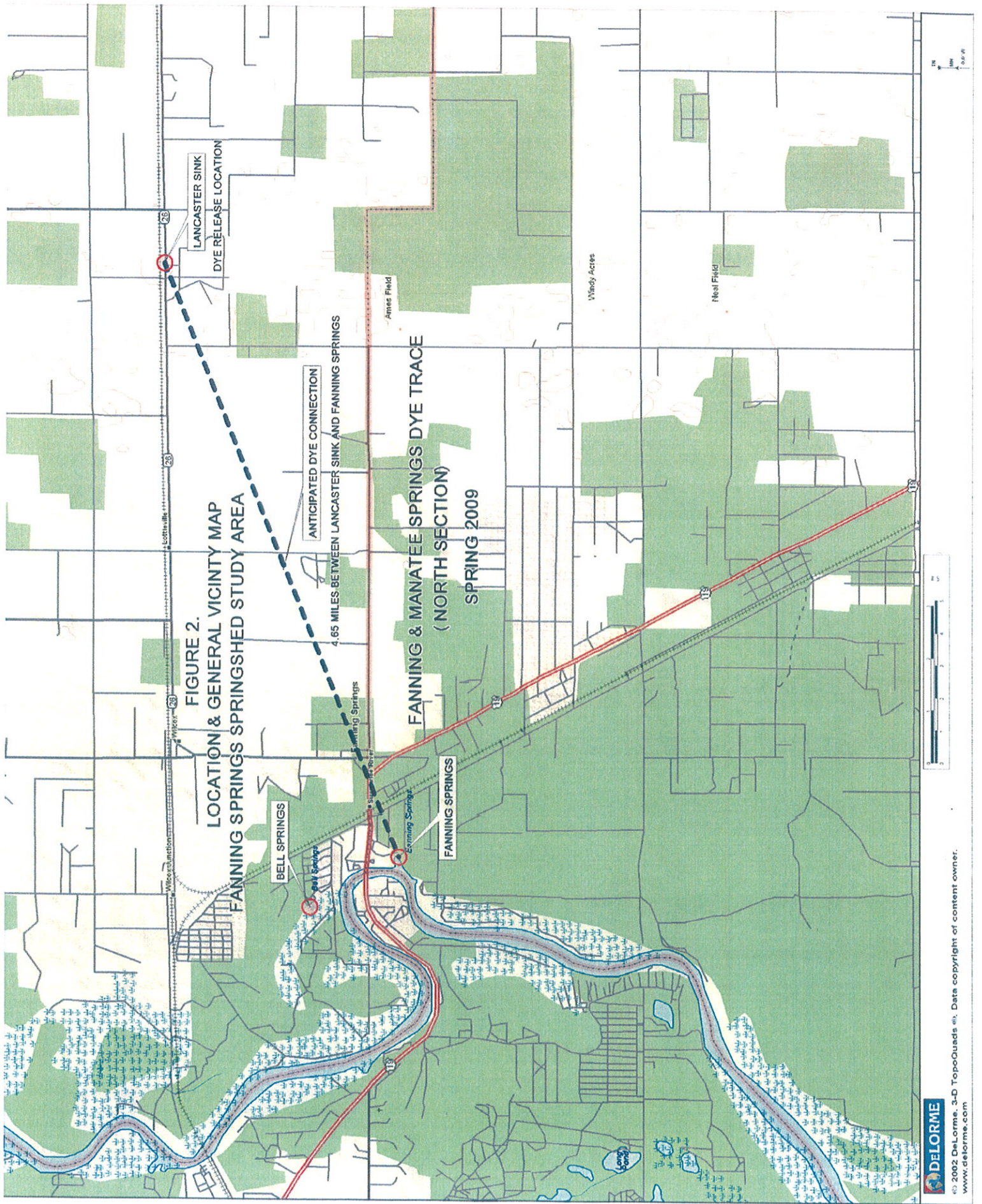
Sampling Sites

The following sites have been selected for monitoring during this tracer study. Two sampling intervals will be used for background readings. Current plan is to have a maximum of 20 sampling stations and 3 river control stations. Actual stations used may vary from the list below.

1. Fanning Spring (at least 3 stations);
Including Fanning, Little Fanning Springs and the run.
Sampling intervals of 2-3 days will be used initially, and then daily upon the arrival of an appropriate precipitation event. FDEP-DRP volunteers may collect water samples if needed.
2. Manatee Spring (at least 2 stations);
Including Manatee Main Spring and Bluewater Tunnel monitor well.
Sampling intervals of 2-3 days will be used initially, and then daily upon the arrival of an appropriate precipitation event. FDEP-DRP volunteers may collect water samples if needed.
3. Other Springs (at least 3 stations);
Including Bell Spring, Otter Spring, Little Otter Spring (GIL 94972).
Sampling intervals of 4-6 days will be used for the duration of the study.
4. Wells (at least 8 stations);
Including available public supply, state park supply, irrigation and residential wells.
Sampling intervals of 4-6 days will be used for the duration of the study.
6. River control stations; selected intervals along the Suwannee River (at least 3 stations);
Include upstream, downstream and intermediate sampling stations.
Sampling intervals of approximately 4-6 days will be used for the duration of the study.

Contacts

For additional information regarding the operations of this dye trace, please contact Pete Butt at (386) 454-3556 or (386) 454-2147. Email: kes@atlantic.net.



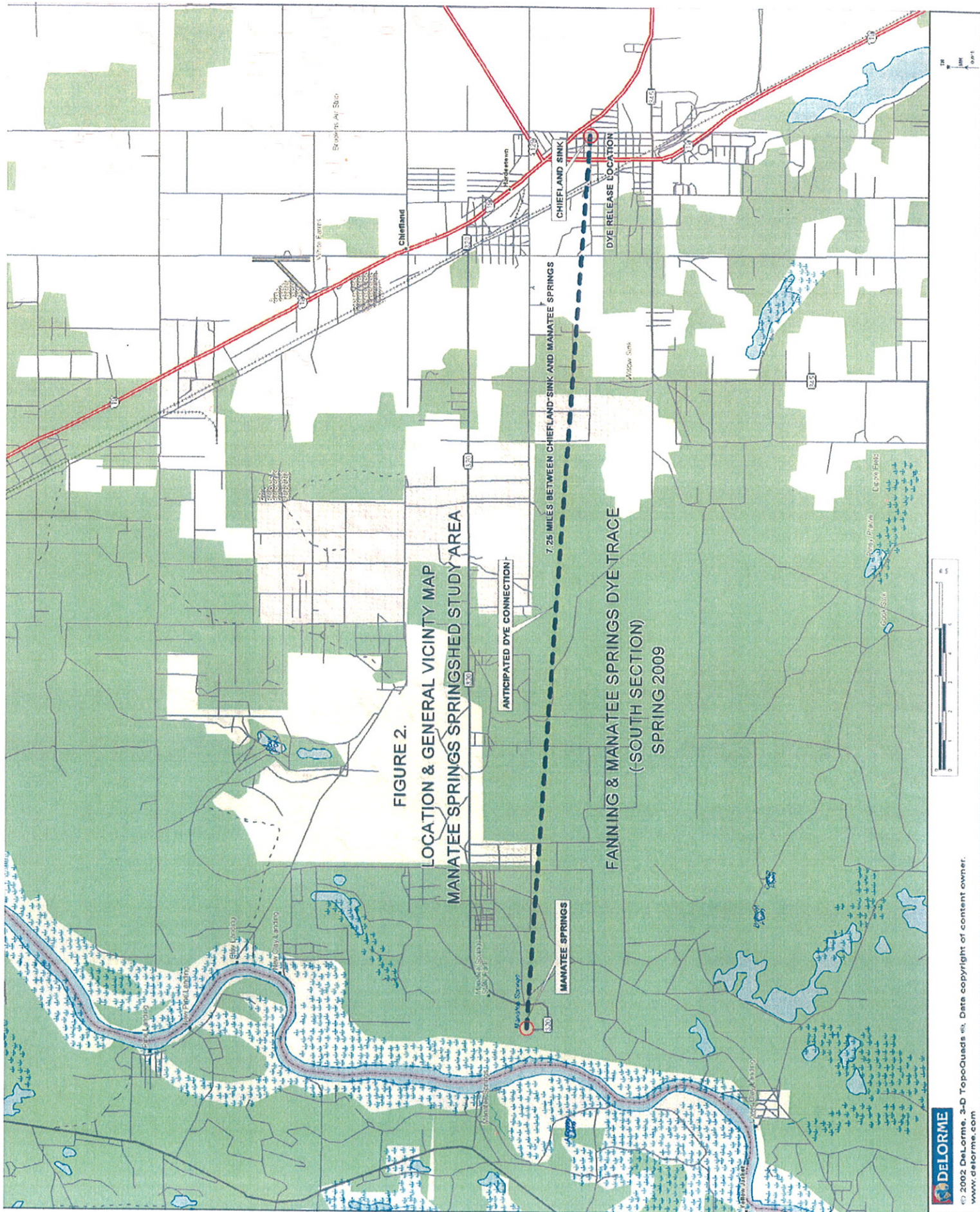


FIGURE 2.
LOCATION & GENERAL VICINTY MAP
MANATEE SPRINGS SPRINGSHED STUDY AREA

FANNING & MANATEE SPRINGS DYE TRACE
(SOUTH SECTION)
SPRING 2009

NOTICE TO WELL OWNERS:

**ATTENTION NW LEVY AND SW GILCHRIST COUNTY WELL OWNERS
IN THE AREAS BETWEEN
CHIEFLAND AND MANATEE SPRINGS
AND LANCASTER CORRECTIONAL AND FANNING SPRINGS**

**FANNING & MANATEE SPRINGS AREA DYE TRACE,
APRIL, 2009**

**Conducted by: URS CORPORATION & KARST ENVIRONMENTAL SERVICES, INC.
For the: FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION**

During the months of April through July of 2009, URS Corp. and Karst Environmental Services, Inc. will be conducting a dye trace authorized by the Florida Department of Environmental Protection (FDEP) in the Fanning and Manatee Springs springshed areas in Levy and Gilchrist Counties. The results of this study will provide the FDEP and others with important data regarding groundwater movement and connections of surface drainage features with Fanning and Manatee Springs.

We will release dye into two natural drainage features during April or May of 2009. These features include a drainage depression directly north of the entrance to the Lancaster Correctional Institution, and a drainage sink north of Fourth Avenue on the east side of the City of Chiefland. Fanning and Manatee Springs and their springshed areas will be monitored for about at least a twelve-week period to see if and when the dyes arrive. The tracer dyes that are being used for this project are fluorescein (yellowish-green in color) in the Lancaster to Fanning Spring area, and rhodamine WT (reddish in color) in the Chiefland to Manatee Spring area. Both are non-toxic tracer dyes that are used routinely across the United States for these types of tracer studies. The dyes will be diluted when released, and these substances break down naturally in the environment. Once diluted in the environment, these dyes are harmless, and present absolutely no danger to users of local well water.

It is unlikely that the dye would be visible to the naked eye, should it pass near a well. If you wish to participate in this tracer study, simply run the tap a bit, fill a clear drinking glass and shine a flashlight through it in a darkened room. Avoid taps that may be downstream of any chlorinating device, if present. If the dye is present, a yellowish-green or reddish tint may be visible. If you make such an observation, please note the time, save a sample in your refrigerator, and call the numbers listed below. We will send a technician out to retrieve a water sample and check it for the tracer.

The information collected during this tracer study will assist the FDEP and others with a primary goal of protecting the water quality in this area. All data collected during this study will ultimately be available as public information.

CONTACTS

For further information regarding this dye trace, or if you have any observations of water color changes during this tracer study, please contact Pete Butt anytime at Karst Environmental Services, Inc., (386) 454-3556 or 454-2147, or cell phone at (352) 339-3380. Email: kes@atlantic.net.

Material Safety Data Sheet

15174 URANINE C

CHEMCENTRAL/Dyes & Pigments
13395 Huron River Drive
Romulus, MI 48174

REVISION DATE: 01/20/2003
CHEMTREC: 800-424-9300
EMERGENCY: 734-941-8235

SECTION I - IDENTIFICATION

TRADE NAME: 15174 URANINE C
CHEMICAL NAME: Acid Yellow 73
CHEMICAL FAMILY: Xanthene
CAS NUMBER: 518-47-8

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENT	PERCENT	CAS NUMBER	PEL
None as per 29CFR part 1910.1200 or Sara Title III			

HMIS HAZARD RATINGS (if applicable):

HEALTH: 1
FIRE: 0
REACTIVITY: 0

SECTION III - PHYSICAL DATA

APPEARANCE: Orange powder, no characteristic odor.
BOILING POINT: N/A
MELTING POINT: N/A
FREEZING POINT: N/A
VAPOR PRESSURE: N/A
VAPOR DENSITY (AIR=1): N/A
SPECIFIC GRAVITY: Approximately 1
pH: N/A
SOLUBILITY IN WATER: Moderate
VOLATILITY: N/A

SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT: N/A
EXTINGUISHING MEDIA: Water fog, CO2, or Dry chemical.
FIRE FIGHT PROCEDURES: ... Fire fighters should be equipped with self contained breathing apparatus and turnout gear.
UNUSUAL FIRE HAZARD: Adequate ventilation and clean up must be maintained to minimize dust accumulation. May form explosive dust/air mixture.

Material Safety Data Sheet

15174 URANINE C

SECTION V - REACTIVITY DATA

STABILITY: Stable
CONDITIONS TO AVOID: N/A
HAZARDOUS POLYMERIZATION: Does not occur
POLYMERIZATION TO AVOID: N/A
INCOMPATIBILITY: Avoid contact with strong oxidizing agents
DECOMPOSITION: Carbon monoxide, Carbon dioxide, and oxides of Nitrogen and Sulfur.

SECTION VI - HEALTH DATA

THRESHOLD LIMIT VALUE:.. Not Established
OVER EXPOSURE EFFECTS: Contact with eyes may result in severe irritation. Contact with skin may result in irritation. Ingestion may result in gastric disturbances. Inhalation of dust may irritate respiratory tract.

SECTION VII FIRST AID

FIRST AID PROCEDURES: Flush eyes with flowing water at least 15 minutes. If irritation develops, consult a physician. Wash affected skin areas thoroughly with soap and water. If irritation develops, consult a physician. Remove and launder contaminated clothing before reuse.

If swallowed, dilute with water and induce vomiting. Get immediate medical attention. If inhaled, move to fresh air. Aid in breathing, if necessary, and get medical attention.

****NEVER GIVE FLUIDS OR INDUCE VOMITING IF PATIENT IS UNCONSCIOUS OR HAS CONVULSIONS.****

SECTION VIII EMPLOYEE PROTECTION

RESPIRATORY PROTECTION: NIOSH/OSHA approved dust respirator as necessary.
PROTECTIVE GLOVES: To prevent skin contact.
EYE PROTECTION: Goggles.
ADDITIONAL MEASURES: Eye wash fountains should be easily accessible.
HANDLING AND STORAGE: ... Keep away from excessive heat and moisture. Keep containers closed.
VENTILATION: Local exhaust to control dusts.

SECTION IX - SPILL AND DISPOSAL DATA

SPILL: Spills should be contained and placed in suitable containers.
WASTE DISPOSAL: Do not discharge into sewers or waterways. Dispose of in accordance with local regulations.

Material Safety Data Sheet

15174 URANINE C

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: INK MATERIAL
HAZARD CLASS AND LABEL: MFR LABEL ONLY
UN NUMBER: N/A
REPORTABLE QUANTITY: N/A

SECTION XI - ADDITIONAL INFORMATION

FOOT NOTES: This information is furnished without warranty, representation, or license of any kind, except that it is accurate to the best of CHEMCENTRAL Corporation's knowledge or obtained from sources believed by CHEMCENTRAL Corporation to be accurate.

The CHEMCENTRAL Corporation does not assume any legal responsibility for use or reliance upon same. Customers are encouraged to conduct their own tests. Before using any product, read its label.

Material Safety Data Sheet

16972 Rhodamine WT 20%

CHEMCENTRAL/Dyes & Pigments
13395 Huron River Drive
Romulus, MI 48174

REVISION DATE:03/19/2003
CHEMTREC:800-424-9300
EMERGENCY:734-941-8235

SECTION I - IDENTIFICATION

TRADE NAME: 16972 Rhodamine WT 20%
CHEMICAL NAME: Acid Red 388
CHEMICAL FAMILY: Xanthene

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENT	PERCENT	CAS NUMBER	PEL
Trimellitic Acid	2.6%	528-44-9	Not Established
Dye Compound			
Sodium Chloride			
Water			
None as per 29CFR part 1910.1200 or Sara Title III			

This Product is not reportable for
SARA 313

TSCA: In Compliance

All components of this product
are included on the TSCA
Inventory and the DSL.

HMIS HAZARD RATINGS (if applicable):

HEALTH: 2
FIRE 1
REACTIVITY 1

SECTION III - PHYSICAL DATA

APPEARANCE: Dark red liquid, no odor
BOILING POINT: 100C
MELTING POINT: N/A
FREEZING POINT: Not evaluated
VAPOR PRESSURE: Not evaluated
VAPOR DENSITY (AIR=1): N/A
SPECIFIC GRAVITY: 1.13
pH: 10.5-10.8
SOLUBILITY IN WATER: Soluble

Material Safety Data Sheet

16972 Rhodamine WT 20%

VOLATILITY: N/A

SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT: N/A

EXTINGUISHING MEDIA: Water fog, CO2, or Dry chemical.

FIRE FIGHT PROCEDURES: ... Fire fighters should be equipped with self contained breathing apparatus and turnout gear.

UNUSUAL FIRE HAZARD: Adequate ventilation and clean up must be maintained to minimize fume accumulation.

SECTION V - REACTIVITY DATA

STABILITY: Stable

CONDITIONS TO AVOID: N/A

HAZARDOUS POLYMERIZATION: Does not occur

POLYMERIZATION TO AVOID: N/A

INCOMPATIBILITY: Unknown

DECOMPOSITION: Carbon monoxide, Carbon dioxide, and oxides of Nitrogen.

SECTION VI - HEALTH DATA

THRESHOLD LIMIT VALUE:.. Not established

OVER EXPOSURE EFFECTS:.. Contact with eyes may result in severe irritation. Contact with skin may result in irritation. Ingestion may result in gastric disturbances. Inhalation of dust may irritate respiratory tract.

SECTION VII FIRST AID

FIRST AID PROCEDURES: Flush eyes with flowing water at least 15 minutes. If irritation develops, consult a physician. Wash affected skin areas thoroughly with soap and water. If irritation develops, consult a physician. Remove and launder contaminated clothing before reuse.

If swallowed, dilute with water and induce vomiting. Get immediate medical attention. If inhaled, move to fresh air. Aid in breathing, if necessary, and get medical attention.

****NEVER GIVE FLUIDS OR INDUCE VOMITING IF PATIENT IS UNCONSCIOUS OR HAS CONVULSIONS.****

SECTION VIII EMPLOYEE PROTECTION

RESPIRATORY PROTECTION: NIOSH/OSHA approved respirator as necessary.

PROTECTIVE GLOVES: To prevent skin contact.

EYE PROTECTION: Goggles.

Material Safety Data Sheet

16972 Rhodamine WT 20%

ADDITIONAL MEASURES: Eye wash fountains should be easily accessible.

HANDLING AND STORAGE: ... Keep away from excessive heat and moisture. Keep containers closed.

VENTILATION: Local exhaust to control fumes.

SECTION IX - SPILL AND DISPOSAL DATA

SPILL: Spills should be contained and placed in suitable containers.

WASTE DISPOSAL: Do not discharge into sewers or waterways. Dispose of in accordance with local regulations.

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: INK MATERIAL

HAZARD CLASS AND LABEL: L - MFR, PROTECT FROM FREEZING

UN NUMBER: N/A

REPORTABLE QUANTITY: N/A

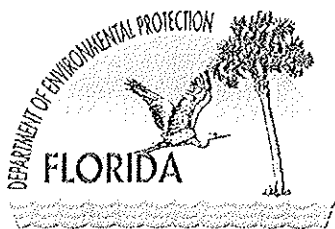
SECTION XI - ADDITIONAL INFORMATION

FOOT NOTES:

This information is furnished without warranty, representation, or license of any kind, except that it is accurate to the best of CHEMCENTRAL Corporation's knowledge or obtained from sources believed by CHEMCENTRAL Corporation to be accurate.

The CHEMCENTRAL Corporation does not assume any legal responsibility for use or reliance upon same. Customers are encouraged to conduct their own tests. Before using any product, read its label.

N/A = Not Applicable



Florida Department of Environmental Protection

Bureau of Parks District 2
4801 Camp Ranch Road
Gainesville, Florida 32641-9299

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

April 7, 2009

Pete Butt
5779 NE CR 340
High Springs, FL 32643

Dear Mr. Butt,

Enclosed is Research & Collecting Permit #04070921 authorizing your dye trace studies at Manatee and Fanning Springs State Parks. This permit must be attached to your original application and carried with you at all times while conducting research in the park.

Please communicate with the Park Manager, Sally Lieb, before your visits. For your convenience, her phone number is listed on the permit.

Recently, Florida State Parks have become popular research sites. Although the parks are eager to accommodate your project, please note that Park Staff may not always be available to physically assist you during your study.

In exchange for the privilege of working in our parks, please continue to submit to us any field reports and species lists, including incidental observations of other flora or fauna, following your study period. As always, we appreciate your previous work and thank you for providing your valuable research to the Florida Park Service.

If you have any questions, or if I can be of further assistance, please call me at (352) 955-2135.

Sincerely,

Daniel W. Pearson
Environmental Specialist II

DWP/dwp
Enclosure

cc: Park Manager, District Files

Florida Department of Environmental Protection
Division of Recreation and Parks
RESEARCH/COLLECTING PERMIT

Permit Number:
04070921

This Permit Must Be Carried At All Times While Researching/Collecting

Primary Holder:

Butt, Pete

Karst Env. Services, URS Corp. H2H Assoc., & FDEP

Issue: 4/7/2009

Expiration: 12/31/2009

Additional Permittees:

5779 NE County Road 340

Long, Mark

High Springs, FL 32643

Morris, Tom

(386) 454-3556 kes@atlantic.net

Shemiltz, Georgia

Long, Annette

Hubner, Matt

Colona, Bill

Smith, Mark

Hatchel, Lyle

Dickey, Rufus

Ciaravella, Phil

Greenhalgh, Tom

McClean, James

Mast, Jake

Walrath, Alexandra

Spall, Melinda

Cerame, Caitlin

Thomas, Eric

Carroll, John

Bobrycki, Jim

Copeland, Rick

Means, Harley

Paul, Dave

Kromhout, Clint

Maddox, Gary

Wade, Edgar

Kincaid, Todd

To Research/ Collect:

Dye Trace studies at Fanning Springs State Park and Manatee Springs State Park as detailed in permit application. Work is being performed for Florida Department of Environmental Protection

In the Following Parks:

Fanning Springs State Park

Manatee Springs State Park

Standard Conditions:

1. Contact the Park Manager and Biologist (if listed below) in advance of project start (2 weeks notice when possible), for coordination and arrangements. Due to the increasing popularity of research within state parks and their other duties and responsibilities, the park staff may not be available to physically assist with project activities but will provide guidance and direction.

Fanning (352) 493-6738 Park Manager: Sally Lieb

Manatee (352) 493-6738 Park Manager: Sally Lieb

2. Check in upon arrival at and departure from the park. Collected material is subject to inspection.
3. Collect only materials as stated above, in the quantities and manner indicated in the attached application form.
4. Any other applicable state and federal permits are the responsibility of the permittee.
5. Collected objects may not be sold, bartered, or traded.
6. Collect no state or federally listed, or rare endemic species or forms, unless otherwise stated in permit.
7. Research shall be conducted in such a manner as not to attract attention or cause damage to the environment.
8. Remove all flagging and project markings upon project completion.
9. The permit is non-transferable. At least one named collector (above) must be present.
10. The permittee and research associates will not be subject to park day-fees.

Florida Department of Environmental Protection
Division of Recreation and Parks

Permit Number:
04070921

RESEARCH/COLLECTING PERMIT

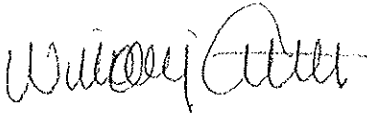
This Permit Must Be Carried At All Times While Researching/Collecting

11. The permit is revocable.
12. The permit may be renewed upon written request. Consideration for renewal will be contingent up on submission of an interim progress report.
13. A final report, including species lists, museum voucher numbers, incidental observations, and any research reports concerning project data shall be submitted to the district biologist and the parks within one month of permit expiration. The report is the responsibility of the primary permit holder. Failure to submit a report may result in denial of future research requests.

Special Conditions and Restrictions:

- 1 All divers must possess current certification and dive within their certification limits.

Approved:



 Donald V. Forgione

Chief, Bureau of Parks District 2
Division of Recreation and Parks
District 2 Administration
4801 Camp Ranch Road
Gainesville, FL 32641-9299

Phone: (352) 955-2135
Suncom: 625-2135
FAX: (352) 955-2139

cc: District Biologist, Park Manager(s), Park Biologist(s)

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Recreation and Parks (DRP)

APPLICATION FOR RESEARCH/COLLECTING PERMIT

(Please Print or Type)

Applicant's Name Peter L. Butt, Karst Environmental Services, Inc. Date of Application 4/6/09

Applicant's Signature  Occupation Project Manager

Affiliation Karst Environmental Services, Inc. (KES), URS Corporation and H2H Assoc., LLC performing services for the FL Dept. of Environmental Protection

Address 5779 NE County Road 340 High Springs, FL 32643

Phones (386) 454-3556 (386) 454-2147 (386) 454-3541 kes@atlantic.net
Business Home FAX Email

Additional Persons to be Authorized Under Permit:

Name	<u>Mark Long, Tom Morris, Georgia Shemitz</u>	Affiliation	<u>KES Staff</u>
Name	<u>Annette Long, Matt Hubner</u>	Affiliation	<u>KES Staff</u>
Name	<u>Bill Colona (URS contact), Mark Smith,</u>	Affiliation	<u>URS Staff</u>
Name	<u>Lyle Hatchet, Rufus Dickey, Phil Ciaravella</u>	Affiliation	<u>URS Staff</u>
Name	<u>Tom Greenhalgh, James McClean, Jake Mast</u>	Affiliation	<u>FDEP Staff</u>
Name	<u>Alexandra Walrath, Melinda Spall, Caitlin Cerame</u>	Affiliation	<u>FDEP Staff</u>
Name	<u>Eric Thomas, John Carroll, Jim Bobrycki</u>	Affiliation	<u>FDEP Staff</u>
Name	<u>Rick Copeland, Harley Means, Dave Paul</u>	Affiliation	<u>FDEP Staff</u>
Name	<u>Clint Kromhout, Gary Maddox, Edgar Wade</u>	Affiliation	<u>FDEP Staff</u>
Name	<u>Todd Kincaid (H2H contact)</u>	Affiliation	<u>H2H Staff</u>

*Other staff and volunteers may also be participating; all KES staff or volunteers will have a copy of any required permits with them. KES will submit any additional names as appropriate for revisions to the permit. State park staff will also be participating in this study.

Do you have a federal or other state agency permit for the proposed activity? Yes No* if Yes, please attach a copy.

* FDEP Northeast District (typically John Davis) will be informed of the dye trace, and we will obtain approval prior to any dye release (as with past dye traces). This is also an FDEP authorized and funded project.

Have you previously had a DRP research/collecting permit? Yes No if Yes, give permit number. 02250622

List parks to be included in permit.

Fanning Springs and Manatee Springs State Parks are the primary sites.

Why is a state park/preserve proposed for this project?

These state lands contain specific sites that are critical to the successful outcome of a dye trace that is being authorized and funded by the Florida Department of Environmental Protection. This is a geographic and site

specific project to determine/define a segment of the groundwater flow system of southwest Gilchrist and northwest Levy Counties.

Describe/propose benefits to state park/preserve.

The goal of this qualitative dye trace is to determine the hydrogeologic connections of selected drainage/sinking points in Gilchrist and Levy Counties with Fanning and Manatee Springs, and other selected springs. Selected public and private water supply wells will also be monitored for dye during the study. The study will also provide information on travel times between the sinks and springs. This study will provide the State of Florida and others with information needed to enhance the protection of surface and ground waters flowing to Fanning and Manatee Springs.

Project Start Date: 4/1/09 (planning/prep underway) **Project End Date:** 12/31/09 We will contact you for any renewals or extensions as needed/appropriate; specific weather and water conditions may be needed for dye release and monitoring, and this may cause delays.

Describe research/collecting needs and objectives (attach additional page if necessary). Append a copy of a research proposal if available.

Charcoal samplers would be placed/collected and water samples collected from spring pools and runs, and monitor wells at Manatee and Fanning Springs, and analyzed to determine the presence/absence of dye. Park public supply wells will also be monitored by the use of flow-through sampler holders tied into the system at the well sampling bib location.

Species/samples to be collected/studied (if taking is necessary, specify numbers requested and justify need for sample size).

No animals or plants will be collected. Water samples will typically be collected in vials of less than 250 ml in volume. The only other sampling will be with the use of charcoal packets attached to anchors, holders or well sample holders (equipped with no-return valves on any well used for public supply).

Methodology (describe collecting/trapping/marketing methods)

Background conditions will be checked with charcoal sampler packets and water samples. After release of the dye, packets and water samples will be collected at scheduled intervals as are appropriate for the duration of the study. The duration of the project is anticipated to be at least 16 weeks. Charcoal samplers will be changed out at least weekly, and some daily water sampling may be performed at manatee and Fanning Spring. Sampling visits will be unobtrusive, and will not interfere with any park activities. Due to the extensive sample station network/circuit that is being planned, it would be helpful if the samplers had before- and after-hours access privileges to the parks. Sample analysis will be performed at a spectrofluorophotometer-equipped lab.

Proposed disposition of collected specimens n/a

Return to: District 2 Administration, 4801 SE 17th Street, Gainesville, FL 32641-9299.
Phone (352) 955-2135 FAX (352) 955-2139

OFFICE USE ONLY:

Date Application Received 4/6/09 **30 Day Review Due** _____

Biologist Recommendation: Approved X Denied _____

Issue Date 4/7/09 **Permit No.** 04070921

Biologist Reviewer
DWP

Notification Method: mailed / phoned / FAXed / e-mailed

FPS-R009 rev. 02/95

2/04

APPENDIX D

Sampling and Analysis Plan

DYE TRACE: FANNING and MANATEE SPRINGS, 2009 DEP Contract #WM946

1.1 Introduction

1.1.1. PROJECT DESCRIPTION:

URS Corporation (URS) and Karst Environmental Services, Inc. (KES) will perform a qualitative dye trace for the Florida Department of Environmental Protection (FDEP) in order to determine the possible underground hydrogeologic connection of Fanning Springs with a natural drainage feature near Lancaster Correctional Institution in Gilchrist County, and Manatee Springs with a natural sink used to drain storm water runoff in Chiefland in Levy County. Selected wells in the study area will also be sampled.

Work will be conducted under contract with the Florida Department of Environmental Protection; Contract Number WM946.

1.1.2. PROJECT SCOPE AND PURPOSE:

This qualitative dye trace is designed to identify connections of selected drainage features and wells with Fanning and Manatee Springs.

The primary dye release sites will be at two locations: a roadside drainage sink feature north of Lancaster Correctional Institution entrance and Highway 26 in Gilchrist County, and at a sink used for urban street drainage on FDOT property on the NW corner of NE 4th Avenue and NE 4th Street, on the east side of the City of Chiefland in Levy County. See Table 1, and Maps 1 and 2.

The dye recovery/sampling locations will include the main springs at Fanning and Manatee Springs State Parks, Little Fanning Springs, Bell Springs, Manatee Spring Cave observation wells, and selected municipal, park and private wells. Three control stations along the Suwannee River will also be used.

The estimated time frame of this project includes two weeks of background sampling for any residual dyes and background interferences, one to two days for dye introduction, at least six weeks of dye sampling, and report preparation. This project is scheduled for completion during 2009.

1.1.3. PROJECT ORGANIZATION:

This study will be designed and managed by KES Project Manager/Senior Technician Peter Butt and URS Senior Project Geologist William H. Colona. Additional project staff are listed in Table 2; Contact Information. Scheduling of volunteers for charcoal packet retrieval and water sampling will be organized by KES staff. All volunteers will have appropriate credentials and be listed on research/collection permits with the State of Florida prior to conducting any sampling activities.

Peter Butt will be overall project manager, and will be involved in all aspects of the study; planning and design, property access, purchasing, background sampling management, dye release, sampling management, sample processing, cataloging and shipping, and report preparation.

William Colona of URS will provide operational oversight and review of results and conclusions of the study. He and URS staff will assist with report preparation and provide report certification.

Mark Long, Georgia Shemitz, Matt Hubner and Tom Morris are KES field technicians, with duties for this study to include; establishing sampling stations, background sampling, assistance with dye release, and sampling activities at wells and springs.

Ozark Underground Laboratory (OUL) of Protem, Missouri will perform analyses of samplers, and provide dye and sampling supplies.

1.2. Data Quality Objectives (DQO)

1.2.1. DATA USE:

This qualitative data will be used to determine underground hydrogeologic connections between two drainage sink points and Fanning and Manatee Springs and selected wells in Gilchrist and Levy Counties, Florida. As this is an initial trace for these sites, the primary data will be categorized as qualitative, with simple Yes (connected)/No (not connected) data being sought. However, sampling frequencies and the method of analysis used may provide additional basic information regarding time of travel and relative concentration information.

1.2.2. DATABASES/DATA REPOSITORIES:

1.2.2.1. Data will be maintained in spreadsheet form to be provided to the FDEP upon request. Data will be presented as part of the final report, and remain on file at KES' corporate office for five (5) years.

1.2.2.2. Data will be entered into spreadsheets from final reports received from Ozark Underground Laboratory. These will be verified for accuracy by KES staff, prior to report preparation and completion including, but not limited to, the procedures outlined in Section 4.2 of this document. Appropriate data qualifiers will be added to all analysis results, in accordance with Chapter 62-160 F. A. C. (Appendix A). Copies of all Certificates of Analyses, individual sample scan printouts, sample collection data sheets and discrepancy sheets (if any) will be included in the final report. KES will maintain a comprehensive Dye Trace Station Sampler/Water Sample Tracking Record.

1.2.2.3. All shipments of charcoal packets and water samples are accompanied by shipment-specific sample collection data sheets. Copies of all sample collection data sheets will be made, filed, and incoming data from the Certificates of Analyses will be referenced against these documents. Results are emailed to KES from the

lab as soon as they are available, reviewed, and direct contact with the lab is made to discuss discrepancies if any are apparent.

Additionally, in-house quality control procedures at the laboratory are presented in Appendix B "Procedures And Criteria - Analysis Of Fluorescein, Eosine, Rhodamine WT, Sulforhodamine B, And Pyranine Dyes In Water And Charcoal Samplers", dated August 22, 2003, by Thomas Aley, PHG 179, President, Ozark Underground Laboratory, Inc., Protem, Missouri.

1.2.3. EXPECTED DATA QUALITY:

1.2.3.1. For this study, two tracer dyes will be used: Fluorescein (C.I. Acid yellow 73, Color Index Number 45350) and Rhodamine WT (Acid Red 388; there is no assigned Color Index Number for this dye). Analyses will be to detect the presence or absence of dye; positive results may range from parts per million to parts per trillion, depending on the sample matrix. Detection levels and emission wavelength ranges are listed in the attached OUL "Procedures and Criteria" document.

1.2.3.2. Not applicable.

1.2.3.3. Not applicable.

1.2.3.4. The Sampling Plan includes the collection of two rounds of background sampling and a minimum of six weeks of sampling at sampling locations. The background sampling will provide critical guidance for dye selection and quantity, and will serve to quantify any dye that may be present prior to our dye release or identify any natural interferences that may be present. The actual qualitative sampling will be used to identify connections between the sinks and the sampling locations. Sampling locations can be found in Table 1 and on Maps 1 and 2. The data is categorized as qualitative as the primary goal is to determine connections by Yes (connected)/No (not connected) data. Any useful time-of-travel and concentration data will also be noted.

1.2.3.5.

Duplicate charcoal samplers will be collected at all locations. At least one charcoal sample duplicate will be selected and analyzed per sampling shipment batch. If a shipment is in excess of 20 samplers, a second duplicate will be selected and analyzed. All extra samplers will be retained for analyses as needed. Should any sampler analysis yield a result that the lab considers ambiguous or otherwise questionable, the duplicate will be analyzed.

For samplers that test positive for dye, the corresponding water samples will also be analyzed. For every 20 water samples analyzed, at least one replicate sample will be analyzed.

Laboratory quality control procedures, use of lab blanks, quantification and preparation of standards for spectrofluorophotometers, etc., are detailed in the attached OUL "Procedures and Criteria" document.

As analyses are being performed to find specific compounds that have been purposefully released, lab QA/QC procedures address identifying the presence of those compounds from sources other than tracer samples. These procedures are explained in 1.3.2, below. Should a QA/QC failure be detected at the laboratory, all analyses are stopped, and the problem is identified, isolated and resolved before resuming analyses.

1.2.4. TEST METHODS:

The selected method and instruments to analyze both charcoal packets and water samples for the presence of tracer dye is by synchronous scan protocols on a Shimadzu RF-5000U or RF-5301 spectrofluorophotometer. Descriptions of the instruments and related procedures are detailed in the attached OUL "Procedures and Criteria" document.

1.3. Data Quality Indicators (DQI)

1.3.1. QUANTITATIVE DQIs:

Detection limits and criteria for the determination of a positive dye recovery by OUL in both water samples and charcoal packets for selected dyes is presented in the attached OUL "Procedures and Criteria" document. These criteria include the presence, wavelength and shape of the fluorescence peak, and the peak intensity relative to the detection limit and any background fluorescence, specific to each dye and sample type. Also, positive water samples require that associated charcoal samplers show positive for the target dye.

1.3.2. QUALITY CONTROL MEASURES:

Duplicate charcoal samplers will be collected at all locations. At least one charcoal sample duplicate will be selected and analyzed per sampling shipment batch. If a shipment is in excess of 20 samplers, a second duplicate will be selected and analyzed. All extra samplers will be retained for analyses as needed. Should any sampler analysis yield a result that the lab considers ambiguous or otherwise questionable, the duplicate will be analyzed.

For samplers that test positive for dye, the corresponding water samples will also be analyzed. For every 20 water samples analyzed, at least one replicate sample will be analyzed.

At the laboratory, blank samples are run as every 20th sample, using the same matrix of the prior (charcoal or water) sample.

The lab also tests 1% of the actual materials used for sampling and analyses, including vials, whirl-pak bags, cuvettes, pipettes, etc. All materials are discarded after a single use.

For laboratory quality control, the OUL "Procedures and Criteria" (Appendix B) document states that:

“Laboratory blanks are run for every sample where the last two digits of the laboratory numbers are 00, 20, 40, 60, or 80. A charcoal packet is placed in a pumping well sampler and at least 25 gallons of unchlorinated water is passed through the sampler at a rate of about 2.5 gallons per minute. The sampler is then subjected to the same analytical protocol as all other samplers.

System functioning tests of the analytical instruments are conducted in accordance with the manufacturer's recommendations.

All materials used in sampling and analysis work are routinely analyzed for the presence of any compounds which might create fluorescence peaks in or near the acceptable wavelength ranges for any of the tracer dyes. This testing typically includes approximately 1% of materials used.”

Should any QA/QC sampling and analyses indicate a potential error, anomaly or discrepancy, it will be duly recorded, and affected sample results qualified or rejected as appropriate. Qualifiers will be applied in a manner consistent with Appendix A.

1.4. Field Activities

1.4.1. SAMPLING DESIGN:

The location for release of dye in the Fanning Springs area is a depression between the north side of Highway 26 and the Nature Coast State Trail, directly across from the entrance of the Lancaster Correctional Facility. The location for Manatee Springs dye release will be at a drainage sink within a fenced and gated FDOT site along 4th Avenue in the eastern side of the City of Chiefland. Both dye release sites are controlled by the Florida Department of Transportation, and access permission has been obtained for both sites for the purposes of this project. The dyes to be used will be fluorescein and rhodamine WT; the actual location selection and amount to be used will be based on background sampling and prevailing conditions.

At least four locations and two wells within the Fanning Springs area will be sampled for the presence or absence of the released dye. At least three locations and four wells within the Manatee Springs area will be sampled for the presence or absence of the released dye. See Table 1 and Maps 1 and 2.

After the release of the dyes, all sampling sites will be sampled at least once per week. This level of sampling will provide the coverage needed to determine connections, if any, between the dye input locations and sampling points. Additional and/or more frequent sampling may be performed as a result of increased precipitation or if any visual detection of dye is made.

1.4.2. SAMPLING/TEST LOCATIONS:

The study area lies in northeast Levy and southwest Gilchrist Counties, within the generally accepted springshed boundaries for each spring.

Selected wells in the study area will also be sampled; these will be selected based on well depth and use, and access will be contingent on owner permission.

See Table 1 and Maps 1 and 2. Charcoal packet retrieval/placement and water sampling will be conducted at one-week intervals at each site.

1.4.3. SAMPLE COLLECTION METHODS:

The procedures listed below will be followed for this dye trace. They are based on the procedures described in Appendix B, in the sections titled "Placement of Samplers" and "Collection and Replacement of Samplers". As KES uses sampling materials (charcoal packets, Whirlpak bags, vials) provided by OUL, the particulars for these items is detailed in those Appendix B sections.

As stated in Appendix B, placement of samplers requires adjustment to field conditions. Should an un-anticipated sampling situation be encountered, KES would defer to Appendix B for guidance, and consult with staff at OUL if needed. Any additional methods or significant variations used would be documented in the "Methods" section of the report.

Charcoal packets placed in surface water sites will be secured to a wire loop and anchor assembly, and tethered to the surface by a nylon cord, to be recovered by hand or a boat hook. Samplers will be positioned for maximum exposure to the water flow, and with consideration for their protection from curious persons or vandals, and animals. Back-up samplers will be placed as needed.

Wells (with active water systems) will be sampled using PVC flow-through charcoal packet holders, with internal diameters of either 1.5 or 2 inches, and with PVC, nylon or brass end fittings. Garden hose or tubing will be used for connections and discharge lines. These holders will be attached to the water system as close as possible to the well, and upstream of any chlorinators. Water from the system will be adjusted by a gate valve to flow continuously through the packet holder at a rate of 0.25 to 1 gallon per minute. In chlorinated systems, the sampler will be installed so as to isolate it from any chlorine contact; this typically means that the sampler will only receive water when the pump is operating. Charcoal packets will be collected weekly. An anti-backflow device will be used between the holder and the water system on any public water supply. All packet holders will be cleaned in a bleach solution prior to use, in order to eliminate any potential for dye contamination.

Charcoal packets will also be lowered into selected monitoring wells for sampling purposes; these are wells that have been drilled directly into Manatee Spring Cave passages and allow access to the flowing conduit. (These locations have been well visited underground by KES divers.) A weight will be added below the charcoal packet to insure that it stay in the conduit flow. The weight will not affect water quality.

Where convenient, the collected samplers will be briefly rinsed in the water being sampled. This is typically not necessary with well samples. The packets are shaken to remove excess water. Collected samplers are kept in the dark to minimize algal growth

on the charcoal prior to analysis work. Samplers will be placed in "blue ice" or ice upon collection. New charcoal samplers are routinely placed when used charcoal packets are collected. The last set of samplers placed at a stream or spring is commonly not collected.

Water samples will be collected as grab samples with the lab-supplied vials. The vials supplied for use from the lab are 50 ml research grade polypropylene copolymer Perfector Scientific vials. In submerged waters, collection will be made while the diver is moving forward into undisturbed water. In flowing surface waters, collection will be in a downstream to upstream direction to avoid any contamination (disturbed sediments, detritus, etc.) from the collector's passage. Water samples will be placed into darkness and refrigerated as they are collected.

Upon collection charcoal packets will be placed into a Whirl-Pak bag. All bags, packets, and vials will be labeled on the outside using a permanent type ink black felt-tipped "Sharpie" pen. (Only pens that have black ink are to be used, as colored inks may contain fluorescent dyes. No labels are to be inserted inside the sample bags.) Labels will include site name, number, dates and times placed and recovered (charcoal), date and time collected (water) and sampler. Sample Collection Data Sheets will be completed as samples are collected. An OUL/KES Sample Collection Data Sheet is included as Figure 1, and a KES Sampler Tracking Workbook is included as Figure 2.

Collected samples will be stored in darkness. Samples will be stored at the KES office until they are processed for shipping to lab, where they will be stored until analyzed. Samplers are shipped refrigerated with "blue ice"-type cold pack or equivalent. Samplers are not shipped packed in ice since this can create a potential for cross contamination when the ice melts.

While it is optimal to send samples to the lab within the same week as collected, and be analyzed as soon as practicable, there is no specific protocol for length of holding time for dye samples. As it is normally unnecessary and uneconomical to analyze all of the samples collected, and that the analysis of many samples is contingent on the results of others, samples may be stored as needed during the duration of the dye trace at the KES office or at the lab. The primary condition for storage is darkness and refrigeration, with both of these conditions satisfied by any suitable, dedicated refrigerator.

1.4.4. EQUIPMENT:

Charcoal packets will be placed in lab-supplied Whirl-Pak bags immediately upon collection. Plastic vials and caps also supplied by the lab will be used for collecting water samples.

1.4.5. NON-STANDARD OR ALTERNATE FIELD METHODS:

Not applicable.

1.5. Laboratory Activities

1.5.1. NON-STANDARD LABORATORY METHODS:

1.5.1.1 New or Alternative Methods:

A method for analysis of Fluorescein, Rhodamine WT, and Eosine dye has not been reviewed by DEP. Detailed methods and procedures used in this study for detection of the above dye tracers are provided in Appendix B. This document is provided by the laboratory that performs the analyses.

2. DOCUMENTATION AND RECORD KEEPING

2.1 Documentation

2.1.1 Field

Documentation for field activities will be consistent with the Department's SOPs.

2.1.2 Laboratory

Records of all laboratory activities shall be maintained such that marginal dye detections can be evaluated by a third party.

2.2 Record Keeping

The field and laboratory records for this project will be linked so that information on the project can be easily and quickly retrieved. This shall be maintained in an electronic format to be determined by Karst Environmental Services, Inc. All project records shall be made available to the Department upon request.

3. REPORTING REQUIREMENTS

3.1 Format

All laboratory and field data must be collected on standard forms used consistently throughout the project. Hard copies of field data as well as electronic copies of all field and laboratory data shall be made available to the Department upon request.

3.2 Report Contents

In addition to laboratory reports, the Department may request some or all of the following field and laboratory information and any documentation records generated per Section 2 above.

3.2.1 Field and Site Information

- Site Location Information: Site and/or facility latitude and longitude measured in degrees-minutes-seconds or degrees-decimal minutes.
- Collector name – name of individual who collected the locational data
- Collector affiliation – collector's agency or entity affiliation
- Type of site – to include well, spring run, spring boil, etc. as applicable

3.2.2 Field Activities

- Collection method – method or mechanism used to derive the measurements

- Sample identification number
- Results of any field measurements
- Calibration activities including date(s) and time(s) of initial and calibration checks for any field testing equipment
- Results of all calibration checks including acceptance
- Date and time of sample collection
- Meteorological information, as applicable
- Purging and sampling equipment
- Number and results of field quality control samples
- Purge beginning and ending times and volume purged, if applicable
- Preservation method, if applicable

3.2.3 Laboratory Related Data

- Laboratory name, address, and phone number
- Client name and/or site name
- Client or field identification number for each sample
- Date and time of sample collection
- Sample matrix (e.g. groundwater, soil, flowing water, etc.)
- Sample type (e.g. environmental sample, field blank, matrix spike, equipment blank)
- Type of chemical and/or physical sample preservative and if intact at sample receipt/analysis
- Sample analysis method
- Sample preparation method, if applicable
- Date of sample preparation, if applicable
- Date of sample analysis
- Analyte name
- Result units
- Method detection limit(s)
- Practical quantitation limit(s)
- Dilution factor, if applicable
- Replicate sample reference
- Matrix and laboratory control spike concentration level, recovery, duplicate recovery, precision, recovery limits, and precision limits, if applicable
- The analytical result for each analysis (including replicates, blanks, matrix spikes, etc.) with applicable data qualifier, as specific in Appendix A. Note – non-detected analytes shall be indicated by the method detection limit value, followed by the code “U.”

4. QUALITY CONTROL REQUIREMENTS

4.1 Quantitative Data Quality Indicators and Comparison Checking:

All quality control measures shall be assessed against acceptance criteria and corrective actions taken if any criterion is not met. Data that are associated with an unacceptable QC measure must be appropriately qualified (see Appendix A). All QC reviews, assessments, and corrective actions shall be documented.

4.2 Data Usability Assessment, Validation, and Verification Requirements

An assessment of sampling results for the final deliverable must be conducted to ensure that project data quality objectives are met and to correct errors not readily apparent from the initial laboratory results.

- Recalculate at least 5% of all manual calculations for accuracy. This includes field data such as purging volume.
- Verify at least 5% of all data points that were manually entered, including comparison of hard-copy field sheets against electronic data files.
- Verify that dates and times are consistent with sampling chronology.
- Verify that sample preservation was intact upon receipt by the laboratory, as applicable. Qualify any failures.
- Verify that all analyses were performed within allowable holding time, as applicable. Qualify any failures with a “Q” qualifier code.
- Verify that all QC elements are available and reported for all analytes, test, and batches.
- Verify that all comments in the final data report are appropriate to the analysis and that each result associated with a QC failure has an appropriate explanatory comment.
- Verify that results between analytes run by two different methods are comparable, if appropriate.

Karst Environmental Services, Inc.

5779 NE County Road 340 High Springs, Florida 32643
(386) 454-3556 2nd line 386-454-4322 1-800-453-3556
(386) 454-3541 FAX kes@atlantic.net

DYE TRACE: Fanning-Manatee Springs Area, Levy and Gilchrist Counties, Florida Summer, 2009

Sampling and Analysis Plan; Table 2

PERSONNEL NAMES AND CONTACT NUMBERS

Karst Environmental Services, Inc.

Pete Butt (Primary operational contact)

386-454-3556

386-454-2147 Home

352-339-3380 Cell

Georgia Shemitz

Cell: 352-283-2022

kes@atlantic.net

Mark Long

Home: 352-490-8930

Cell: 352-949-1005

Annette Cell: 352-213-2167

Matt Hubner

3520318-0097 Cell

Tom Morris

Home: 352-373-0741

URS

Bill Colona (Primary URS contact)

850-402-6422

850-574-3197

william_colona@urscorp.com

Additional URS Staff:

Mark Smith

Lyle Hatchet

Rufus Dickey

Phil Ciaravella

Eric Mann

Florida Park Service

352-493-6072

Sally Lieb, Park Manager

352-493-6737

Brian Maxwell

352-493-6074

Steve Davenport, Assistant Manager

352-463-4036

Bureau of Parks District 2

Research Permits

Dan Pearson

352-955-2135

FDOT

Ron Sherman

352-493-6868 Office

352-535-7651 Cell

Lancaster Correctional Institution

Gerald "Buddy" Roberts - Warden

352-463-4100

Rick Landrum – Maint Supervisor

352-463-4250

landrum.rick@mail.dc.state.fl.us

Levy County Water Dept.

Dick Tummond

352-486-5598

Hazie Cannon

352-221-5152

dtummond@circuit8.org

City of Chiefland

Shane Keene – Water Utilities

352-493-6789

shane@chieflandfla.com

Jackie Bennet

352-284-4119 cell

Laura, Anita, Candy – City Hall
Grady Hartzog - City Manager
352-493-6711
Teal Pomeroy - Mayor
352-535-5763 cell

Springside Subdivision
Twofold Water Engineering
Rick Tisdale
352-745-1022
Todd Hubbard
twofold@gmail.com

RESIDENTIAL/PRIVATE WELLS

Barn hill Landscape
6850 NW 100 St, Chiefland
Bobby Barnhill
352-493-0947 home
352-949-5127 cell

Eugene Dennis
6850 NW 180th Street
352-463-0168

Carly Howell/ Jeremy
7890 NW 180th Street
352-578-4076

City of Fanning Springs
Doyle Fireson- Water Dept.
352-542-4024
352-498-5520
Cheryl Nicola – mayor
352-463-2855 X-203
Paul Chase – Councilman
352-463-7552
Silver Oaks- Bob Kerr

Suwannee River Springs Association
Al Barrett – president
352-463-0866

Levy County Health Dept.
Anthony Dennis - ALDOH
anthony_dennis@doh.state.fl.us
Cindy Sheffield
352-486-5300 x-5301
cynthia_sheffield@doh.state.fl.us

Gilchrist County Health Dept.
Wesley Asbell
352-463-3120
wesley_asbell@doh.state.fl.us

Ozark Underground Lab
Tom and Cathy Aley
Julie (receptionist)
417-785-4289

FDEP
John Davis
904-807-3313

SRWMD
Jon Dinges
800-226-1066

FDEP Staff
(Listed on FDEP Parks Research Permit)
Tom Greenhalgh
James McClean
Jake Mast
Alexandra Walrath
Melinda Spall
Caitlin Cerame
Eric Thomas
John Carroll
Jim Bobrycki
Rick Copeland
Harley Means
Dave Paul
Clint Kromhout
Gary Maddox
Edgar Wade

1572 Alev Lane Protom, MO 65733 (417) 785-4289 fax (417) 785-4290 email: oul@tri-lakes.net

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: _____
 Week No: _____
 Samples Collected By: _____
 Samples Collected By: _____

Samples Shipped By: _____
Samples Received By: _____

Date Samples Shipped: ____/____/____ Date Samples Received: ____/____/____
Return Cooler? Yes ____ No ____

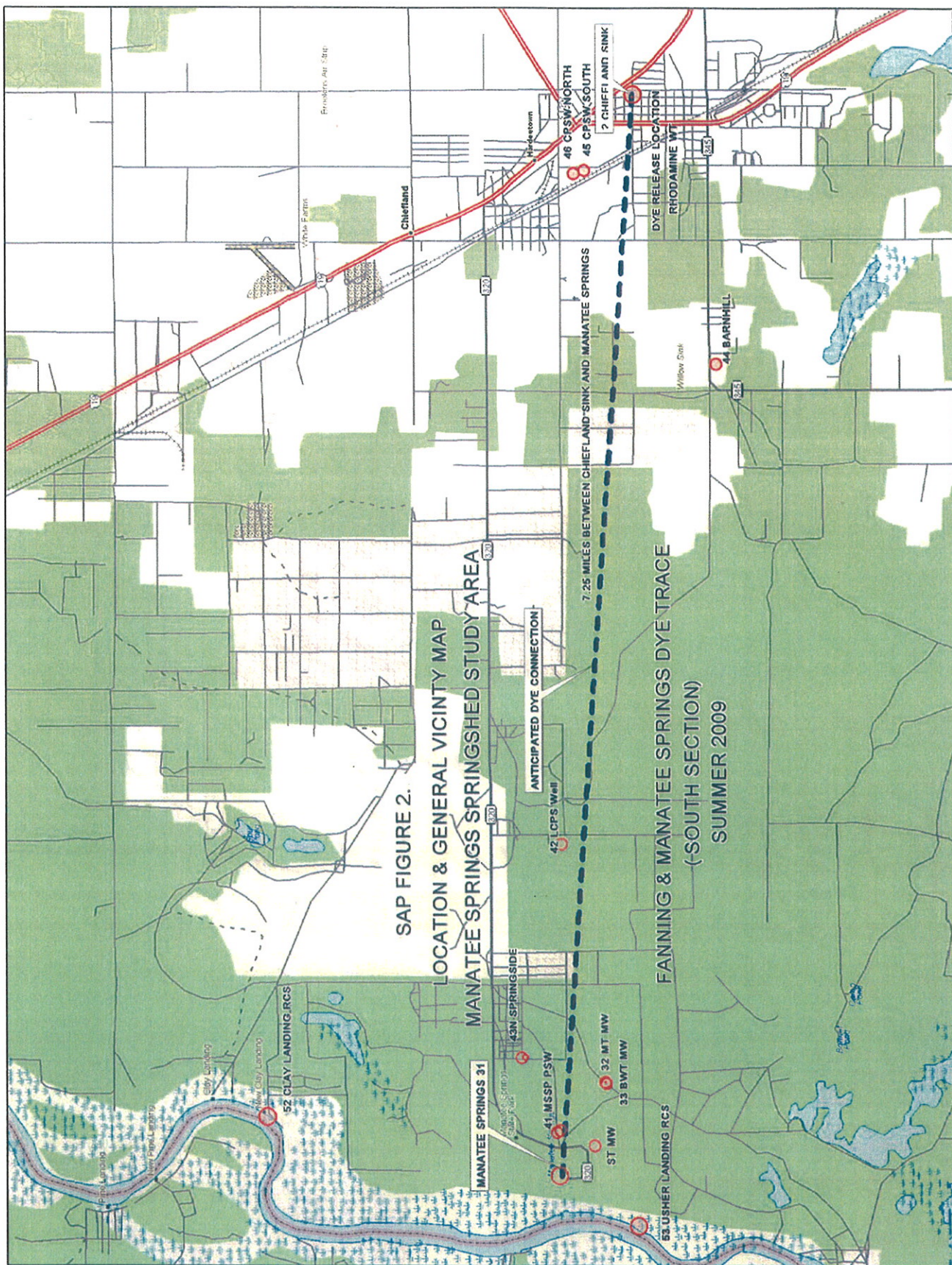
Bill to: _____
Send Results to: _____

Analyze for: Fluorescein Eosine Rhodamine WT Other Ship cooler to: n/a

[illegible]

COMMENTS:

This sheet filled out by OUL staff? Yes No X Charts for samples on this page proofed by OUL: _____



SAP FIGURE 2.

LOCATION & GENERAL VICINTY MAP
MANATEE SPRINGS SPRINGSHEDED STUDY AREA

FANNING & MANATEE SPRINGS DYE TRACE
(-SOUTH SECTION)
SUMMER 2009

APPENDIX A

Data Qualifiers (From Chapter 62-160 F. A. C.)

The following codes shall be used by laboratories when reporting data values that either meet the specified description outlined below or do not meet the quality control criteria of the laboratory:

SYMBOL	MEANING
A	Value reported is the arithmetic mean (average) of two or more determinations. This code shall be used if the results of two or more discrete and separate samples are averaged. These samples shall have been processed and analyzed (e.g., laboratory replicate samples, field duplicates, etc.) independently. Do not use this code if the data are the result of replicate analysis on the same sample aliquot, extract or digestate. Under most conditions, replicate values shall be reported as individual analyses.
B	Results based upon colony counts outside the acceptable range. This code applies to microbiological tests and specifically to membrane filter colony counts. The code is to be used if the colony count is generated from a plate in which the total number of coliform colonies is outside the method indicated ideal range. This code is not to be used if a 100 mL sample has been filtered and the colony count is less than the lower value of the ideal range.
F	When reporting species: F indicates the female sex.
H	Value based on field kit determination; results may not be accurate. This code shall be used if a field screening test (i.e., field gas chromatograph data, immunoassay, vendor-supplied field kit, etc.) was used to generate the value and the field kit or method has not been recognized by the Department as equivalent to laboratory methods.
I	The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.
J	Estimated value; value may not be accurate. This code shall be used in the following instances: 1. Surrogate recovery limits have been exceeded; 2. No known quality control criteria exist for the component; 3. The reported value failed to meet the established quality control criteria for either precision or accuracy; 4. The sample matrix interfered with the ability to make any accurate determination; or 5. The data are questionable because of improper laboratory or field protocols (e.g., composite sample was collected instead of a grab sample).

Note: a "J" value shall be accompanied by justification for its use.

	A "J" value shall not be used if another code applies (e.g., K, L, M, T, V, Y, I).
K	Off-scale low. Actual value is known to be less than the value given. This code shall be used if: 1. The value is less than the lowest calibration standard and the calibration curve is known to be non-linear; or 2. The value is known to be less than the reported value based on sample size, dilution or some other variable. This code shall not be used to report values that are less than the laboratory practical quantitation limit or laboratory method detection limit.
L	Off-scale high. Actual value is known to be greater than value given. To be used when the concentration of the analyte is above the acceptable level for quantitation (exceeds the linear range or highest calibration standard) <u>and</u> the calibration curve is known to exhibit a negative deflection.
M	When reporting chemical analyses: presence of material is verified but not quantified; the actual value is less than the value given. The reported value shall be the laboratory practical quantitation limit. This code shall be used if the level is too low to permit accurate quantification, but the estimated concentration is greater than the method detection limit. If the value is less than the method detection limit use "T" below.
N	Presumptive evidence of presence of material. This qualifier shall be used if: 1. The component has been tentatively identified based on mass spectral library search; <u>or</u> 2. There is an indication that the analyte is present, but quality control requirements for confirmation were not met (i.e., presence of analyte was not confirmed by alternative procedures).
O	Sampled, but analysis lost or not performed.
Q	Sample held beyond the accepted holding time. This code shall be used if the value is derived from a sample that was prepared or analyzed after the approved holding time restrictions for sample preparation or analysis.
T	Value reported is less than the laboratory method detection limit. The value is reported for informational purposes, only and shall not be used in statistical analysis.
U	Indicates that the compound was analyzed for but not detected. This symbol shall be used to indicate that the specified component was not detected. The value associated with the qualifier shall be the laboratory method detection limit. Unless requested by the client, less than the method detection limit values shall not be reported (see "T" above).
V	Indicates that the analyte was detected in both the sample and the associated method blank. Note: the value in the blank shall not be subtracted from associated samples.

SYMBOL	MEANING
Y	The laboratory analysis was from an improperly preserved sample. The data may not be accurate.
Z	Too many colonies were present (TNTC); the numeric value represents the filtration volume.
?	Data are rejected and should not be used. Some or all of the quality control data for the analyte were outside criteria, and the presence or absence of the analyte cannot be determined from the data.
*	Not reported due to interference.

The following codes deal with certain aspects of field activities. The codes shall be used if the laboratory has knowledge of the specific sampling event. The codes shall be added by the organization collecting samples if they apply:

D	Measurement was made in the field (i.e., in situ). This applies to any value (except pH, specific conductance, dissolved oxygen, temperature, total residual chlorine, transparency, or salinity) that was obtained under field conditions using approved analytical methods. If the parameter code specifies a field measurement (e.g., "Field pH"), this code is not required.
E	Indicates that extra samples were taken at composite stations.
R	Significant rain in the past 48 hours. (Significant rain typically involves rain in excess of ½ inch within the past 48 hours.) This code shall be used when the rainfall might contribute to a lower than normal value.
!	Data deviates from historically established concentration ranges.

APPENDIX B

**PROCEDURES AND CRITERIA
ANALYSIS OF FLUORESCCEIN, EOSINE, RHODAMINE WT,
SULFORHODAMINE B, AND PYRANINE
DYES IN WATER AND CHARCOAL SAMPLERS**

August 22, 2003

**Thomas Aley, PHG 179
President
Ozark Underground Laboratory, Inc.**

PROCEDURES

Introduction

This document describes standard procedures and criteria currently in use at the Ozark Underground Laboratory as of the date shown on the title page. Some samples may be subjected to different procedures and criteria because of unique conditions; such non-standard procedures and criteria are identified in reports for those samples. Standard procedures and criteria change as knowledge and experience increases and as equipment is improved or up-graded. A summary of changes in standard procedures and criteria is maintained by the Ozark Underground Laboratory.

Dye Nomenclature

Fluorescein is C.I. Acid yellow 73, Color Index Number 45350. Rhodamine WT is Acid Red 388; there is no assigned Color Index Number for this dye. Eosine (sometimes called eosin) is Acid Red 87, Color Index Number 45380. Sulforhodamine B is C.I. Acid Red 52, Color Index Number 45100. Pyranine is Solvent Green 7 (also called D&C Green 8), Color Index Number 59040.

Description of the Samplers

The charcoal samplers are packets of fiberglass screening partially filled with approximately 4.25 grams of activated coconut charcoal. The charcoal used by the Ozark Underground Laboratory is Barnebey and Sutcliffe coconut shell carbon, 6 to 12 mesh, catalog type AC.

The most commonly used samplers are about 4 inches long by two inches wide. A cigar-shaped sampler is made for use in very small diameter wells (such as 1 inch diameter wells); this is a special order item and should be specifically requested when it is needed. All of the samplers are closed by heat sealing.

Placement of Samplers

Samplers (also called charcoal packets) are placed so as to be exposed to as much water as possible. In springs and streams they are typically attached to a rock or other anchor in a riffle area. Attachment of the packets often uses plastic tie wires. In swifter water galvanized wire (such as electric fence wire) is often used. Other types of anchoring wire can be used. Electrical wire with plastic insulation is also good. Packets are attached so that they extend outward from the anchor rather than being flat against it. Two or more separately anchored packets are typically used for sampling springs and streams. The use of fewer packets is discouraged except when the spring or stream is so small that there is not appropriate space for placing multiple packets.

When pumping wells are being sampled, the samplers are placed in sample holders made of PVC pipe fittings. Brass hose fittings are installed at the end of the sample holders so that the sample holders can be installed on outside hose bibs and water which has run through the samplers can be directed to waste through a connected garden hose. The samplers can be unscrewed in the middle so that charcoal packets can be

changed. The middle portions of the samplers consists of 1.5 inch diameter pipe and pipe fittings.

Charcoal packets can also be lowered into monitoring wells for sampling purposes. In general, if the well is screened, samplers should be placed approximately in the middle of the screened interval. Some sort of weight should be added near the charcoal packet to insure that it will not float. The weight should be of such a nature that it will not affect water quality. One common approach is to anchor the packets with a plastic cable tie to the top of a dedicated weighted disposable bailer. We typically run nylon cord from the top of the well to the charcoal packet and its weight. Nylon fishing line should not be used since it can be readily cut by a sharp projection in the well.

In some cases, especially with narrow wells and appreciable well depths, the weighted disposable bailers sink very slowly or may even fail to sink because of friction and floating of the anchoring cord. In such cases a stainless steel weight may be added to the top of the disposable bailer. We have had good success with two to three ounce segments of stainless steel pipe which have an outside diameter of 1.315 inches and an inside diameter of 1.049 inches; such pipe weighs about 1.7 pounds per linear foot. The weight of the stainless steel is approximately 497 pounds per cubic foot. The pipe segments can be attached over the anchoring cord at the top of the bailer. All weights should be cleaned prior to use; the cleaning approach should comply with decontamination procedures in use at the project site.

Placement of samplers requires adjustment to field conditions. The above placement comments are intended as guidance, not firm requirements.

Rinsing of Charcoal Packets Prior to Sampling

Charcoal packets routinely contain some fine powder which washes off rapidly when they are placed in water. Since such material could remain in monitoring wells, charcoal packets to be placed in such wells are triple rinsed with distilled, demineralized, or reagent water known to be free of tracer dyes. This rinsing is typically done by soaking. With this approach, approximately 25 packets are placed in one gallon of water and soaked for at least 10 minutes. The packets are then removed from the water and excess water is shaken off the packets. The packets are then placed in a second gallon of water and again soaked for at least 10 minutes. After this soaking they are removed from the water and excess water is shaken off the packets. The packets are then placed in a third gallon of water and the procedure is again repeated. Rinsed packets are placed in plastic bags and are placed at sampling stations within three days. Packets can also be rinsed in jets of water for about one minute; this requires more water and is typically difficult to do in the field with water known to be free of tracer dyes.

Collection and Replacement of Samplers

Samplers are routinely collected and replaced from each of the sampling stations. The frequency of sampler collection and replacement is determined by the nature of the study. Collections at one week intervals are common, but shorter or longer collection frequencies are acceptable and sometimes more appropriate. Shorter sampling frequencies are often used in the early phases of a study to better characterize time of

travel. As an illustration, we often collect and change charcoal packets 1, 2, 4, and 7 days after dye injection. Subsequent sampling is then weekly.

Where convenient, the collected samplers should be briefly rinsed in the water being sampled. This is typically not necessary with well samples. The packets are shaken to remove excess water. Next, the packet (or packets) are placed in a plastic bag (Whirl-Pak bags are ideal). The bag is labeled on the outside with a permanent type felt marker pen. Use only pens that have black ink; colored inks may contain fluorescent dyes. The notations include station name or number and the date and time of collection. Labels are not inserted inside the sample bags.

For most projects the Ozark Underground Laboratory supplies the Whirl-Pak bags. Prior to use, 1% of the new bags are randomly selected. Each bag is soaked in the standard eluting solution and then analyzed for the presence of any of the tracer dyes being used.

Collected samplers are kept in the dark to minimize algal growth on the charcoal prior to analysis work. We prefer (and in some studies require) that samples be placed on "blue ice" or ice upon collection and that they be shipped refrigerated with "blue ice" by overnight express. Do not ship samplers packed in ice since this can create a potential for cross contamination when the ice melts. Our experience indicates that it is not essential for samplers to be maintained under refrigeration, yet maintaining them under refrigeration clearly minimizes some potential problems. A product known as "green ice" should not be used for maintaining the samples in a refrigerated condition since this product contains a dye which could contaminate samples if the "green ice" container were to break or leak.

New charcoal samplers are routinely placed when used charcoal packets are collected. The last set of samplers placed at a stream or spring is commonly not collected.

Water samples are often collected. They should be collected in either glass or plastic; the Ozark Underground Laboratory routinely uses 50 ml research grade polypropylene copolymer Perfector Scientific vials (Catalog Number 2650) for such water samples. The vials should be placed in the dark and refrigerated immediately after collection. They should be refrigerated until shipment. For most projects the Ozark Underground Laboratory supplies the vials. Prior to use, 1% of the new vials are randomly selected. Each vial is soaked in the standard eluting solution and then analyzed for the presence of any of the tracer dyes being used.

When water or charcoal samplers are collected for shipment to the Ozark Underground Laboratory they should be shipped promptly. We receive good overnight and second day air service from both UPS and Fed Ex; Airborne Service is excessively slow, and the Postal Service does not provide next day service to us.

Each shipment of charcoal samplers or water samples must be accompanied by a sample tracking sheet. These sheets (which bear the title "Samples for Fluorescence Analysis") are provided by the Ozark Underground Laboratory and summarize placement and collection data. These sheets can be augmented by a client's chain of custody forms or any other relevant documentation. 1 is one of our blank sample forms.

Receipt of Samplers

Samplers shipped to the Ozark Underground Laboratory are refrigerated upon receipt. Prior to cleaning and analysis, samplers are assigned a laboratory identification number. All samples are logged in upon receipt and are recorded in a bound journal.

It sometimes occurs that there are discrepancies between the chain-of-custody sheets and the actual samples received. When this occurs, a "Discrepancy Sheet" form is completed and sent to the shipper of the sample for resolution. A copy of this form is included on Page 7 of Appendix B. The purpose of the form is to help resolve discrepancies, even when they may be minor.

Cleaning of Samplers

Samplers are cleaned by spraying them with jets of clean water. At the Laboratory we use unchlorinated water for the cleansing to minimize dye deterioration. Effective cleansing cannot generally be accomplished simply by washing in a conventional laboratory sink even if the sink is equipped with a spray unit.

The duration of packet washing depends upon the condition of the sampler. Very clean samplers may require less than a minute of washing; dirtier samplers may require several minutes of washing.

After washing, the packets are shaken to remove excess water. Next, the packets are cut open and the charcoal is emptied into a new disposable plastic beaker. The beaker has been pre-labeled with the laboratory identification number. The charcoal is now ready for elution. The emptied fiberglass screen packet is discarded. At stations where two or more charcoal packets are collected, one is selected for analysis and the other is frozen and retained until the end of the study. In some studies the analysis protocol stipulates that a fixed percentage (often 5%) of the samples should be duplicates; in these cases the second charcoal packet is separately analyzed. Note that these are duplicate samples, not replicate samples since each packet is, of necessity, placed in a somewhat different location and is therefore exposed to somewhat different conditions.

Cleaning of Glassware

Most of our work uses disposable plastic containers. A small amount of glassware is occasionally used for preparation of standards. It is dedicated to this use. In the event that any glassware does come in contact with tracer dyes it will be carefully cleaned before re-use. To do this cleaning, containers are rinsed several times in clean water. Glassware which may be contaminated with dyes is washed with detergent, and then again rinsed. Next, the glassware is soaked for one hour or more in a bleach and water solution. Upon removal from this soaking, the glassware is rinsed again and allowed to air dry.

OZARK UNDERGROUND LABORATORY, INC.

1572 Aley Lane Protom, MO 65733 (417) 785-4289 fax (417) 785-4290 email: oul@tri-lakes.net

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: _____ Week _____ No: _____ Samples _____ Collected _____

By: _____

Samples _____ Shipped _____ By: _____ Received _____

Date Samples Shipped: ____/____/____ Date Samples Received: ____/____/____

Return Cooler? Yes _____ No _____

Bill to: _____ Send Results to: _____

Analyze for:	Eosine	Rhodamine WT	Other	Ship cooler to:
Fluorescein				

[illegible]

COMMENTS:

This sheet filled out by OUL staff? Yes

Charts for samples on this page proofed by OUL: [

Page _____ of _____

OZARK UNDERGROUND LABORATORY, INC.

[illegible]

Elution of the Charcoal

There are various eluting solutions which can be used for the recovery of tracer dyes. The solutions typically include an alcohol, some water, and a strong basic solution such as aqueous ammonia.

The standard elution solution now used at the Ozark Underground Laboratory is a mixture of 5% aqua ammonia and 95% isopropyl alcohol solution and sufficient potassium hydroxide flakes to saturate the solution. The isopropyl alcohol 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. This super-saturated layer is not used for elution. Preparation of eluting solutions uses dedicated glassware which is never used in contact with dyes or dye solutions.

The eluting solution we use will elute fluorescein, eosine, rhodamine WT, sulforhodamine B, and pyranine dyes. It is also suitable for separating fluorescein peaks from peaks of some naturally present materials found in some samplers.

Fifteen ml of the eluting solution is poured over the washed charcoal in a disposable sample beaker. The sample beaker is capped. The sample is allowed to stand for 60 minutes. After this time, the liquid is carefully poured off the charcoal into a new disposable beaker which has been appropriately labeled with the laboratory identification number. A few grains of charcoal may inadvertently pass into the second beaker; no attempt is made to remove these from the second sample beaker. After the pouring, a small amount of the elutant will remain in the initial sample beaker. After the transfer of the elutant to the second sample beaker, the contents of the first sample beaker (the eluted charcoal) are discarded.

Analysis on the Shimadzu RF-5000U or RF-5301

The Laboratory uses two Shimadzu spectrofluorophotometers. One is a model RF-5000U, and the other is a model RF-5301. Both of these instruments are capable of synchronous scanning. 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. The OUL also owns a Shimadzu RF-540 spectrofluorometer which is occasionally used for special purposes.

A sample of the elutant is withdrawn from the sample container using a disposable polyethylene pipette. Approximately 3 ml of the elutant is then placed in disposable rectangular polystyrene cuvette. The cuvette has a maximum capacity of 3.5 ml. The cuvette is designed for fluorometric analysis; all four sides and the bottom are clear. The spectral range of the cuvettes is 340 to 800 nm. The pipettes and cuvettes are discarded after one use.

The cuvette is then placed in the RF-5000U or the RF-5301. Both instruments are controlled by a programmable computer. Each instrument is capable of conducting substantial data analysis.

Our instruments are operated and maintained in accordance with the manufacturer's recommendations. On-site installation of the instruments and a training session on the use of spectrofluorophotometers was provided by Delta Instrument Company.

Our typical analysis of an elutant sample where fluorescein, eosine, rhodamine WT, or sulforhodamine B dyes may be present includes synchronous scanning of excitation and emission spectra with a 17 nm separation between excitation and emission wavelengths. For these dyes, the excitation scan is from 443 to 613 nm; the emission scan is from 460 to 630 nm. The emission fluorescence from the scan is plotted on a graph. The typical scan speed setting is "very fast" on the RF-5000U; it is "fast" on the RF-5301. The typical sensitivity setting used on both instruments is "high."

Our typical analysis of an elutant sample where pyranine dye may be present includes a synchronous scanning of excitation and emission spectra with a 35 nm separation between excitation and emission wavelengths. For this dye, the excitation scan is from 360 to 600 nm; the emission scan is from 395 to 635 nm. The emission fluorescence from the scan is plotted on a graph. The typical scan speed setting is "very fast" on the RF-5000U; it is "fast" on the RF-5301. The typical sensitivity setting on both instruments is "high."

Excitation and emission slit width settings vary between the two instruments. The widths vary with the dyes for which we are sampling and for the matrix in which the dyes may be present. Excitation and emission slit width settings are summarized in Table 1.

Table 1. Excitation and emission slit width settings routinely used for dye analysis.
Units are nanometers (nm)

Parameter	RF5000U	RF5301
Excitation slit for Eos, Fl, RWT, and SRB in elutant	5	3
Emission slit for Eos, Fl, RWT, and SRB in elutant	3	1.5
Excitation slit for Eos, Fl, RWT, and SRB in water	5	5
Emission slit for Eos, Fl, RWT, and SRB in water	10	3
Excitation slit for Pyranine in elutant	5	5
Emission slit for Pyranine in elutant	3	3
Excitation slit for Pyranine in pH adjusted water	5	5
Emission slit for Pyranine in pH adjusted water	3	3

Eos = Eosine. Fl = Fluorescein. RWT = Rhodamine WT. SRB = Sulforhodamine B.

A plot of the synchronous scan for each sample is produced by the instrument; the plot shows emission fluorescence only. It is photocopied as a part of the final record. The synchronous scans are subjected to computer peak picks; peaks are picked to the nearest 0.1 nm. All samples run on the RF-5000U and RF-5301 are stored on disk and printed on normal typing paper with a laser printer; sample information is printed on the chart.

Quantification

We calculate the magnitude of fluorescence peaks for fluorescein, eosine, rhodamine WT, sulforhodamine B, and pyranine dyes. Dye quantities are expressed in

microgram per liter (parts per billion; ppb). On the RF-5000U and RF-5301 the dye concentrations are calculated by separating fluorescence peaks due to dyes from background fluorescence on the charts, and then calculating the area within the fluorescence peak. This area is proportional to areas obtained from standard solutions.

Where there are multiple fluorescence peaks it is sometimes necessary to calculate dye concentrations based upon the height of the fluorescence peak rather than the area. The heights of the peaks are also proportional to dye concentrations.

We run dye concentration standards each day the machine is used. Ten separate standards are used; the standard or standards appropriate for the analysis work being conducted are selected. All standards are based upon the as-sold weights of the dyes. The standards are as follows:

- 1) 10 ppb fluorescein and 100 ppb rhodamine WT in well water from the Jefferson City-Cotter Formation
- 2) 10 ppb eosine in well water from the Jefferson City-Cotter Formation
- 3) 100 ppb sulforhodamine B in well water from the Jefferson City-Cotter Formation.
- 4) 10 ppb pyranine in well water from the Jefferson City-Cotter Formation. A sample of the standard is placed for at least two hours in a high ammonia atmosphere to adjust the pH to a value of 9.5 or greater.
- 5) 10 ppb fluorescein and 100 ppb rhodamine WT in elutant.
- 6) 10 ppb eosine in elutant.
- 7) 100 ppb sulforhodamine B in elutant.
- 8) 10 ppb pyranine in elutant.

Preparation of Standards

Dye standards are prepared as follows:

Step 1. A small sample of the as-sold dye is placed in a pre-weighed sample vial and the vial is again weighed to determine the weight of the dye. We attempt to use a sample weighing between 1 and 5 grams. This sample is then diluted with well water to make a 1% dye solution by weight (based upon the as-sold weight of the dye). The resulting dye solution is allowed to sit for at least four hours to insure that all dye is fully dissolved.

Step 2. One part of each dye solution from Step 1 is placed in a mixing container with 99 parts of well water. Separate mixtures are made for fluorescein, rhodamine WT, eosine, sulforhodamine B, and pyranine. The resulting solutions contain 100 mg/l dye (100 parts per million dye). The typical prepared volume of this mixture is appropriate for the sample bottles being used; we commonly prepare about 50 ml. of the Step 2 solutions. The dye solution from Step 1 that is used in making the Step 2 solution is withdrawn with a digital Finnpiptette which is capable of measuring volumes between 0.200 and 1.000 ml at intervals of 0.005 ml. The calibration certificate with this instrument indicates that the accuracy (in percent) is as follows:

At 0.200 ml, 0.90%

At 0.300 ml, 0.28%

At 1.000 ml, 0.30%

The Step 2 solution is called the long term standard. Ozark Underground Laboratory experience indicates that Step 2 solutions, if kept refrigerated, will not deteriorate appreciably over periods of less than a year. Furthermore, these Step 2 solutions may last substantially longer than one year.

Step 3. A series of intermediate-term dye solutions are made. Approximately 45 ml. of each intermediate-term dye solution is made. All volume measurements of less than 5 ml are made with a digital Finn timer. (see description in Step 2). All other volume measurements are made with Rheinland Kohn Geprüfte Sicherheit 50 ml. capacity pump dispenser which will pump within plus or minus 1% of the set value. The following solutions are made; all concentrations are based on the as-sold weight of the dyes:

- 1) A solution containing 1 ppm fluorescein dye and 10 ppm rhodamine WT dye.
- 2) A solution containing 1 ppm eosine.
- 3) A solution containing 10 ppm sulforhodamine B dye.
- 4) A solution containing 1 ppm pyranine.

Step 4. A series of eight short-term dye standards are made from solutions in Step 3. These standards were identified earlier in this section. In the experience of the Ozark Underground Laboratory these standards have a useful shelf life in excess of one week. However, in practice, they are kept under refrigeration and new standards are made weekly.

Dilution of Samples

Samples with peaks that have arbitrary fluorescence unit values of 500 or more are diluted a hundred fold to ensure accurate quantification.

Some water samples have high turbidity or color which interferes with accurate detection and measurement of dye concentrations. It is often possible to dilute these samples and then measure the dye concentration in the diluted sample.

The typical dilution is 100 fold. One part of the test sample is combined with 99 parts of water (if the test sample is water) or with 99 parts of the standard elutant (if the test sample is elutant). Typically, 0.300 ml of the test solution is combined with 29.700 ml of water (or elutant as appropriate) to yield a new test solution. All volume measurements of less than 5 ml are made with a digital Finn timer, which is capable of measuring volumes between 0.200 and 1.000 ml at intervals of 0.005 ml. The calibration certificate with this instrument indicates that the accuracy (in percent) is as follows:

At 0.200 ml, 0.90%

At 0.300 ml, 0.28%

At 1.000 ml, 0.30%

All other volume measurements are made with Rheinland Kohn Geprüfte Sicherheit 50 ml. capacity pump dispenser which will pump within plus or minus 1% of the set value.

Quality Control

Laboratory blanks are run for every sample where the last two digits of the laboratory numbers are 00, 20, 40, 60, or 80. A charcoal packet is placed in a pumping

well sampler and at least 25 gallons of unchlorinated water is passed through the sampler at a rate of about 2.5 gallons per minute. The sampler is then subjected to the same analytical protocol as all other samplers.

System functioning tests of the analytical instruments are conducted in accordance with the manufacturer's recommendations.

All materials used in sampling and analysis work are routinely analyzed for the presence of any compounds which might create fluorescence peaks in or near the acceptable wavelength ranges for any of the tracer dyes. This testing typically includes approximately 1% of materials used.

Reports

Reports are provided in accordance with the needs of the client. At a minimum we provide copies of the analysis graphs and a listing of stations and samples where dye was detected. The reports indicate dye concentrations.

Work at the Ozark Underground Laboratory is directed by Mr. Thomas Aley. Mr. Aley has 36 years of professional experience in hydrology and hydrogeology. He is certified as a Professional Hydrogeologist (Certificate #179) by the American Institute of Hydrology. Mr. Aley has 34 years of professional experience in groundwater tracing with fluorescent tracing agents.

CRITERIA FOR DETERMINATION OF POSITIVE DYE RECOVERIES

Normal Emission Ranges and Detection Limits

The OUL has established normal emission fluorescence wavelength ranges for each of the five dyes. The normal acceptable range equals mean values plus and minus two standard deviations. These values are derived from actual groundwater tracing studies conducted by the OUL.

The detection limits are based upon concentrations of dye necessary to produce emission fluorescence peaks where the signal to noise ratio is 3. The detection limits are realistic for most field studies since they are based upon results from actual field samples rather than being based upon values from spiked samples in a matrix of reagent water or the elutants from unused activated carbon samplers. In some cases detection limits may be smaller than reported if the water being sampled has very little fluorescent material in it. In some cases detection limits may be greater than reported; this most commonly occurs if the sample is turbid due to suspended material or a coloring agent such as tannic compounds. Turbid samples are typically centrifuged or, if this is not effective, diluted prior to analysis.

Table 2 provides normal emission wavelength ranges and detection limits for the five dyes when analyzed on the OUL's RF-5000U spectrofluorophotometer. Table 3 provides similar data for the OUL's RF-5301. As indicated earlier in Table 1, the analytical protocols used on the two instruments are somewhat different, especially in regard to the widths of excitation and emission slit settings.

Table 2. RF-5000U Spectrofluorophotometer. Normal emission wavelength ranges and detection limits for fluorescein, eosine, rhodamine WT, sulforhodamine B, and pyranine dyes in water and elutant samples. Detection limits are based upon the as-sold weight of the dye mixtures normally used by the OUL.

Dye and Matrix	Normal Acceptable Emission Wavelength Range (nm)	Detection Limit (ppb)
Eosine in Elutant	533.0 to 539.6	0.035
Eosine in Water	529.6 to 538.4	0.008
Fluorescein in Elutant	510.7 to 515.0	0.010
Fluorescein in Water	505.6 to 510.5	0.0005
Pyranine in Elutant	500.4 to 504.6	0.055
Pyranine in Water*	501.2 to 505.2	0.030
Rhodamine WT in Elutant	561.7 to 568.9	0.275
Rhodamine WT in Water	569.4 to 574.8	0.050
Sulforhodamine B in Elutant	567.5 to 577.5	0.150
Sulforhodamine B in Water	576.2 to 579.7	0.040

* pH adjusted water with pH of 9.5 or greater.

Note: The protocols for the analysis of pyranine dye are substantially different than those for the other dyes. As a result, there is less potential interference between pyranine and fluorescein than might otherwise be indicated by the emission wavelength values shown in the table.

Table 3. RF-5301 Spectrofluorophotometer. Normal emission wavelength ranges and detection limits for fluorescein, eosine, rhodamine WT, sulforhodamine B, and pyranine dyes in water and elutant samples. Detection limits are based upon the as-sold weight of the dye mixtures normally used by the OUL.

Dye and Matrix	Normal Acceptable Emission Wavelength Range (nm)	Detection Limit (ppb)
Eosine in Elutant	535.2 to 541.8	0.050
Eosine in Water	532.1 to 540.9	0.015
Fluorescein in Elutant	513.6 to 517.9	0.025
Fluorescein in Water	506.9 to 509.9	0.002
Pyranine in Elutant	502.1 to 508.1	0.015
Pyranine in Water*	504.1 to 510.1	0.010
Rhodamine WT in Elutant	566.6 to 573.8	0.170
Rhodamine WT in Water	572.0 to 576.3	0.015
Sulforhodamine B in Elutant	570.8 to 580.8	0.080
Sulforhodamine B in Water	579.7 to 583.2	0.008

* pH adjusted water with pH of 9.5 or greater.

Note: The protocols for the analysis of pyranine dye are substantially different than those for the other dyes. As a result, there is less potential interference between pyranine and fluorescein than might otherwise be indicated by the emission wavelength values shown in the table.

Criteria for Determining Positive Dye Recoveries

The following sections identify normal criteria used by the OUL for determining positive dye recoveries. Beginning January 1, 2001, the primary analytical instrument in use at the OUL was the RF-5301; the RF-5000U was the principal backup instrument. Studies which were in progress prior to January 1, 2001 continued to have samples analyzed on the RF-5000U.

Except for pyranine dye, the analytical protocol used for the RF-5301 provides for the use of narrower excitation and/or emission slit settings than the RF-5000U protocol. This enhances our ability to discriminate between dyes and other fluorescent compounds. The protocol which is possible with the RF-5301 (as contrasted with the RF-5000U) also provides for a better balance in the sizes of the fluorescence peaks associated with an equal concentration of all of the dyes.

Normal Criteria Used by the Ozark Underground Laboratory for Determining Positive Eosine Dye Recoveries in Elutants from Charcoal Samplers.

There is generally little or no detectable fluorescence background in the general range of eosine dye encountered in most groundwater tracing studies. The following four criteria are used to identify fluorescence peaks which are deemed to be eosine dye.

Criterion 1. There must be at least one fluorescence peak at the station in question in the range of 535.2 to 541.8 nm for samples analyzed by the RF-5301. The range must be 533.0 to 539.6 nm for samples analyzed by the RF-5000U.

Criterion 2. The dye concentration associated with the fluorescence peak must be at least 3 times the detection limit. For the RF-5301, the eosine detection limit in elutant samples is 0.050 ppb, thus this dye concentration limit equals 0.150 ppb. For the RF-5000U the eosine detection limit in elutant samples is 0.035 ppb, thus this dye concentration limit equals 0.105 ppb.

Criterion 3. The dye concentration must be at least 10 times greater than any other concentration reflective of background at the sampling station in question.

Criterion 4. The shape of the fluorescence peak must be typical of eosine. Much background fluorescence yields low, broad, and asymmetrical fluorescence peaks rather than the more narrow and symmetrical fluorescence peaks typical of eosine. In addition, there must be no other factors which suggest that the fluorescence peak may not be eosine dye from our groundwater tracing work.

Normal Criteria Used by the Ozark Underground Laboratory for Determining Positive Eosine Dye Recoveries in Water Samples.

There is generally little or no detectable fluorescence background in the general range of eosine dye encountered in most groundwater tracing studies. The following three criteria are used to identify fluorescence peaks which are deemed to be eosine dye.

Criterion 1. The associated charcoal samplers for the station should also contain eosine dye in accordance with the criteria listed above. These criteria may be waived if no charcoal sampler exists.

Criterion 2. There must be no factors which suggest that the fluorescence peak may not be eosine dye from our groundwater tracing work. For samples analyzed on the RF-5301, the fluorescence peak should generally be in the range of 532.1 to 540.9 nm. For samples analyzed on the RF-5000U, the fluorescence peak should generally be in the range of 529.6 to 538.4 nm.

Criterion 3. The dye concentration associated with the fluorescence peak must be at least three times the detection limit. Our eosine detection limit in water samples analyzed on the RF-5301 is 0.015 ppb, thus this dye concentration limit equals 0.045 ppb. For samples analyzed on the 5000U the detection limit is 0.008 ppb, thus this dye concentration limit equals 0.024 ppb.

Normal Criteria Used by the Ozark Underground Laboratory for Determining Positive Fluorescein Dye Recoveries in Elutants from Charcoal Samplers.

There is often some fluorescence background in the range of fluorescein dye present at some of the stations used in groundwater tracing studies. We routinely conduct background sampling prior to the introduction of any tracer dyes to characterize this background fluorescence and to identify the existence of any tracer dyes which may be present in the area. The fact that a fluorescence peak is identified in our analytical results is not proof that it is fluorescein dye or that it is fluorescein dye from the trace of concern. The following 4 criteria are used to identify fluorescence peaks which are deemed to be fluorescein dye recoveries from our tracing work.

Criterion 1. There must be at least one fluorescence peak at the station in question in the range of 513.6 to 517.9 nm for samples analyzed by the RF-5301. The range must be 510.7 to 515.0 for samples analyzed by the RF-5000U.

Criterion 2. The dye concentration associated with the fluorescence peak must be at least 3 times the detection limit. For the RF-5301, the fluorescein detection limit in elutant samples is 0.025 ppb, thus this dye concentration limit equals 0.075 ppb. For the RF-5000U, the fluorescein detection limit in elutant samples is 0.010 ppb, thus this dye concentration limit equals 0.030 ppb.

Criterion 3. The dye concentration must be at least 10 times greater than any other concentration reflective of background at the sampling station in question.

Criterion 4. The shape of the fluorescence peak must be typical of fluorescein. Much background fluorescence yields low, broad, and asymmetrical fluorescence peaks rather than the more narrow and symmetrical fluorescence peaks typical of fluorescein. In addition, there must be no other factors which suggest that the fluorescence peak may not be fluorescein dye from our groundwater tracing work.

Normal Criteria Used by the Ozark Underground Laboratory for Determining Positive Fluorescein Dye Recoveries in Water Samples.

There is commonly some fluorescence background in the general range of fluorescein dye at some sampling stations used in groundwater tracing studies. The following criteria are used to identify fluorescence peaks which are deemed to be fluorescein dye in water.

Criterion 1. The associated charcoal samplers for the station should also contain fluorescein dye in accordance with the criteria listed above. These criteria may be waived if no charcoal sampler exists.

Criterion 2. There must be no factors which suggest that the fluorescence peak may not be fluorescein dye from our groundwater tracing work. For samples analyzed on the RF-5301, the fluorescence peak should generally be in the range of 506.9 to 509.9 nm. For samples analyzed on the RF-5000U, the fluorescence peak should generally be in the range of 505.6 to 510.5 nm.

Criterion 3. The dye concentration associated with the fluorescence peak must be at least three times the detection limit. Our fluorescein detection limit in water samples analyzed on the RF-5301 is 0.002 ppb, thus this dye concentration limit equals 0.006 ppb. For the RF-5000U the detection limit is 0.0005 ppb, thus this dye concentration limit equals 0.0015 ppb.

Normal Criteria Used by the Ozark Underground Laboratory for Determining Positive Rhodamine WT Dye Recoveries in Elutants from Charcoal Samplers.

There is generally little or no detectable fluorescence background in the general range of Rhodamine WT dye encountered in most groundwater tracing studies. The following four criteria are used to identify fluorescence peaks which are deemed to be Rhodamine WT.

Criterion 1. For samples analyzed on the RF-5301, there must be at least one fluorescence peak at the station in question in the range of 566.6 to 573.8 nm. For samples analyzed on the RF-5000U, there must be at least one fluorescence peak at the station in question in the range of 561.7 to 568.9 nm.

Criterion 2. The dye concentration associated with the Rhodamine WT peak must be at least 3 times the detection limit. For the RF-5301, the detection limit in elutant samples is 0.170 ppb, thus this dye concentration limit equals 0.510 ppb. For the RF-5000U, the detection limit in elutant samples is 0.275 ppb, thus this dye concentration limit equals 0.825 ppb.

Criterion 3. The dye concentration must be at least 10 times greater than any other concentration reflective of background at the sampling station in question.

Criterion 4. The shape of the fluorescence peak must be typical of Rhodamine WT. In addition, there must be no other factors which suggest that the fluorescence peak may not be dye from the groundwater tracing work under investigation.

Normal Criteria Used by the Ozark Underground Laboratory for Determining Positive Rhodamine WT Dye Recoveries in Water Samples.

The following criteria are used to identify fluorescence peaks which are deemed to be Rhodamine WT dye in water.

Criterion 1. The associated charcoal samplers for the station should also contain Rhodamine WT dye in accordance with the criteria listed above. These criteria may be waived if no charcoal sampler exists.

Criterion 2. There must be no factors which suggest that the fluorescence peak may not be Rhodamine WT dye from the tracing work under investigation. For samples analyzed with the RF-5301, the fluorescence peak should generally be in the range of 572.0 to 576.3 nm. For samples analyzed with the RF-5000U, the fluorescence peak should generally be in the range of 569.4 to 574.8 nm.

Criterion 3. The dye concentration associated with the fluorescence peak must be at least three times the detection limit. Our Rhodamine WT detection limit in water samples analyzed on the RF-5301 is 0.015 ppb, thus this dye concentration limit is 0.045 ppb. For samples analyzed on the RF-5000U the detection limit is 0.050 ppb, thus this dye concentration limit equals 0.150 ppb.

Normal Criteria Used by the Ozark Underground Laboratory for Determining Positive Sulforhodamine B Dye Recoveries in Elutants from Charcoal Samplers.

There is generally little or no detectable fluorescence background in the general range of sulforhodamine B dye encountered in most groundwater tracing studies. The following four criteria are used to identify fluorescence peaks which are deemed to be sulforhodamine B.

Criterion 1. For samples analyzed on the RF-5000U, there must be at least one fluorescence peak at the station in question in the range of 567.5 to 577.5 nm. The acceptable range for samples analyzed on the RF-5301 is 570.8 to 580.8 nm.

Criterion 2. The dye concentration associated with the sulforhodamine B peak must be at least 3 times the detection limit. For the RF-5000U, the detection limit in elutant samples is 0.150 ppb, thus this dye concentration limit equals 0.450 ppb. For the RF-5301, the detection limit in elutant samples is 0.080 ppb, thus this dye concentration limit equals 0.240 ppb.

Criterion 3. The dye concentration must be at least 10 times greater than any other concentration reflective of background at the sampling station in question.

Criterion 4. The shape of the fluorescence peak must be typical of sulforhodamine B. In addition, there must be no other factors which suggest that the fluorescence peak may not be dye from the groundwater tracing work under investigation.

Normal Criteria Used by the Ozark Underground Laboratory for Determining Positive Sulforhodamine B dye Recoveries in Water Samples.

The following criteria are used to identify fluorescence peaks which are deemed to be sulforhodamine B dye in water.

Criterion 1. The associated charcoal samplers for the station should also contain sulforhodamine B dye in accordance with the criteria listed earlier. These criteria may be waived if no charcoal sampler exists.

Criterion 2. There must be no factors which suggest that the fluorescence peak may not be sulforhodamine B dye from the tracing work under investigation. For samples analyzed with the RF-5000U, the fluorescence peak should generally be in the range of 576.2 to 579.7 nm. For samples analyzed with the RF-5301, the fluorescence peak should generally be in the range of 579.7 to 583.2 nm.

Criterion 3. The dye concentration associated with the fluorescence peak must be at least three times the detection limit. For samples analyzed on the RF-5301 the detection limit in water is 0.008 ppb, thus this dye concentration limit equals 0.024 ppb. For samples analyzed on the RF-5000U the detection limit in water samples is 0.040 ppb, thus this dye concentration limit equals 0.120 ppb.

Normal Criteria Used by the Ozark Underground Laboratory for Determining Positive Pyranine Dye Recoveries in Elutants from Charcoal Samplers.

It must be remembered that the analysis protocol for pyranine dye is different than the protocol for the other four dyes discussed in this document. If the other dyes are present in a sample analyzed for pyranine dye their emission fluorescence peaks (if any) will be appreciably different than the values presented above. Because of this, there is very little analytical interference between fluorescein and pyranine dyes when both are present in a sample.

There is often some detectable fluorescence background encountered in the general range of pyranine dye in groundwater tracing studies. The following four criteria are used to identify fluorescence peaks which are deemed to be pyranine.

Criterion 1. For samples analyzed on the RF-5000U, there must be at least one fluorescence peak at the station in question in the range of 500.4 to 504.6 nm. The acceptable range for samples analyzed on the RF-5301 is 502.1 to 508.1 nm.

Criterion 2. The dye concentration associated with the pyranine dye peak must be at least 3 times the detection limit. For the RF-5000U, the detection limit in elutant samples is 0.055 ppb, thus this dye concentration limit equals 0.165 ppb. For the RF-5301, the detection limit in elutant samples is 0.015 ppb, thus this dye concentration limit equals 0.045 ppb.

Criterion 3. The dye concentration must be at least 10 times greater than any other concentration reflective of background at the sampling station in question.

Criterion 4. The shape of the fluorescence peak must be typical of pyranine dye. In addition, there must be no other factors which suggest that the fluorescence peak may not be dye from the groundwater tracing work under investigation.

Normal Criteria Used by the Ozark Underground Laboratory for Determining Positive Pyranine Dye Recoveries in Water Samples.

It must be remembered that the analysis protocol for pyranine dye is different than the protocol for the other four dyes discussed in this document. If the other dyes are present in a sample analyzed for pyranine dye their emission fluorescence peaks (if any) will be appreciably different than the values presented above. Because of this, there is very little analytical interference between fluorescein and pyranine dyes when both are present in a sample.

The fluorescence of pyranine decreases below a pH of about 9.5. Prior to analysis water samples are placed in a high ammonia atmosphere for at least two hours. A pyranine dye in water standard is placed in the same atmosphere as the samples. Prior to analysis samples are tested to insure that their pH is 9.5 or greater. If pyranine dye concentrations in a sample are so great as to require dilution for quantification of the dye concentration the diluting water used is OUL reagent water which has been pH adjusted in a high ammonia atmosphere.

The following criteria are used to identify fluorescence peaks which are deemed to be pyranine dye in water.

Criterion 1. The associated charcoal samplers for the station should also contain pyranine dye in accordance with the criteria listed earlier. These criteria may be waived if no charcoal sampler exists.

Criterion 2. There must be no factors which suggest that the fluorescence peak may not be pyranine dye from the tracing work under investigation. For samples analyzed with the RF-5000U, the fluorescence peak should generally be in the range of 501.2 to 505.2 nm. For samples analyzed with the RF-5301, the fluorescence peak should generally be in the range of 504.1 to 510.1 nm.

Criterion 3. The dye concentration associated with the fluorescence peak must be at least three times the detection limit. For samples analyzed on the RF-5301 the detection limit in water is 0.010 ppb, thus this dye concentration limit equals 0.030 ppb. For samples analyzed on the RF-5000U the detection limit in water samples is 0.030 ppb, thus this dye concentration limit equals 0.090 ppb.



"Hicks, Richard W."
<Richard.W.Hicks@dep.state.fl.us>
07/28/2009 04:06 PM

To "Greenhalgh, Tom" <Tom.Greenhalgh@dep.state.fl.us>,
<William_Colona@URSCorp.com>, <kes@atlantic.net>
cc "Holland, Kathryn" <Kathryn.Holland@dep.state.fl.us>

bcc

Subject Lancaster Correction Institute Well, Nitrate Concentrations

History: This message has been replied to.

Based on the elevated nitrate concentrations in the LCI well water (see attached), I think that the chance of our turning their water green might be pretty high and not worth the risk. Proceed with Manatee and we will regroup on the Fanning trace. (Thanks, Kathryn). Thanks..Rick

The Department of Environmental Protection values your feedback as a customer. DEP Secretary Michael W. Sole is committed to continuously assessing and improving the level and quality of services provided to you. Please take a few minutes to comment on the quality of service you received. Simply click on [this link to the DEP Customer Survey](#) . Thank you in advance for completing the survey.

From: Holland, Kathryn
Sent: Tuesday, July 28, 2009 3:53 PM
To: Hicks, Richard W.
Subject: RE:

From: Hicks, Richard W.
Sent: Tuesday, July 28, 2009 3:46 PM
To: Holland, Kathryn
Subject: RE:

detected nitrate concentrations

From: Holland, Kathryn
Sent: Tuesday, July 28, 2009 3:30 PM
To: Hicks, Richard W.
Subject:
I'm in the PWS database...what did you want me to look up at LCI?

Kathryn Holland
Department of Environmental Protection
Florida Springs Initiative
Phone: (850) 245-8235



PWS_LCI_RH.xls

PWS ID	OFFICE	MAILING PWS TY	POP	PWS ST	SUB H	INSP MIT GROUP	CONTAM	CONTAM SM TY	RESULT	UOM	MCL	SAMPLE QA TIMESTAMP	USER/MAL LOC	EP	LAB	METHOD	ANALYSIS DATE	MDL	RCL	SM#	CL RESID REMARKS TEST
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE D	2.65 MG/L		10-4999	1/5/1984	5/7/1984 0:00 PWS	AAA	E12700	UNK	3/19/1994				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE D	1.48 MG/L		10-4999	1/8/1987	7/20/1987 0:00 PWS	AAA	E82016	UNK	1/8/1987				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE D	1.73 MG/L		10-4999	8/20/1988	11/20/1988 0:00 PWS	AAA	E82016	UNK	8/20/1988				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE D	0.73 MG/L		10-4999	3/29/1991	6/7/1991 0:00 PWS	AAA	E82031	UNK	4/20/1991				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE D	0 MG/L		10-4999	3/29/1991	6/7/1991 0:00 PWS	AAA	E82031	UNK	2/28/1991				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE D	1.78 MG/L		10-4999	4/20/1993	5/12/1993 0:00 PWS	AAA	E82031	UNK	4/21/1993				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	1.793 MG/L		10-4999	8/10/1993	12/30/1993 0:00 PWS	AAA	E82031	UNK	2/11/1993				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	1.73 MG/L		10-4999	8/10/1993	12/30/1993 0:00 PWS	AAA	E82031	UNK	2/11/1993				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	1.28 MG/L		10-4999	12/21/1995	3/22/1995 0:00 PWS	AAA	E82031	UNK	1/27/1996				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	1.34 MG/L		10-4999	2/7/1996	3/22/1996 0:00 PWS	AAA	E82031	UNK	2/8/1996				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	1.43 MG/L		10-4999	8/19/1997	10/21/1997 0:00 PWS	AAA	E82031	UNK	8/20/1997				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	2 MG/L		10-4999	12/7/1998	1/15/1999 0:00 PWS	AAA	E84129	UNK	12/21/1998				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	1.9 MG/L		10-4999	8/20/1998	12/23/1998 0:00 PWS	AAA	E84129	UNK	8/24/1999				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	1.9 MG/L		10-4999	8/20/1998	12/23/1998 0:00 PWS	AAA	E84129	UNK	8/24/1999				
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	1.56 MG/L		10-4999	5/16/2001	10/23/2001 13:44 CARRIER	AAA	E82335	UNK	5/24/2001	0.02			
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	1.9 MG/L		10-4999	8/22/2002	10/10/2002 0:00 JORDAN	AAA	E82335	UNK	8/23/2002	0.05			
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	1.7 MG/L		10-4999	5/13/2003	6/30/2003 0:00 NEUMAN	AAA	E82620	UNK	5/14/2003	0.05			
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	2.3 MG/L		10-4999	7/17/2004	8/10/2004 0:00 BENTLEY	AAA	E92920	UNK	7/22/2004	0.075			
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	2.3 MG/L		10-4999	7/17/2004	8/10/2004 0:00 BENTLEY	AAA	E92920	UNK	7/22/2004	0.075			
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	2.2 MG/L		10-4999	6/21/2006	8/16/2006 0:00 OTTO	ENTRY	E82018	UNK	6/21/2006	0.0228			
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	2.11 MG/L		10-4999	7/17/2007	8/17/2007 0:00 MONTOMY	ENTRY	E82018	UNK	7/19/2007	0.05			
2210647	NED	LANCAST C	1175 A	N		SMT	INOR	1040 NITRATE N	2.43 MG/L		10-4999	7/15/2008	8/11/2008 0:00 MONTOMY	POE	E82018	UNK	7/16/2008	0.05			



"Hicks, Richard W."
<Richard.W.Hicks@dep.state.fl.us>
07/29/2009 03:50 PM

To <kes@atlantic.net>
cc "Greenhalgh, Tom" <Tom.Greenhalgh@dep.state.fl.us>,
<William_Colona@URSCorp.com>
bcc
Subject RE: Lancaster Correction Institute Well, Nitrate Concentrations

Thanks, Pete. Good luck with the release in Chiefland. Unfortunately, I won't be able to come. Let's take our time with Fanning...Rick

-----Original Message-----

From: kes@atlantic.net [mailto:kes@atlantic.net]
Sent: Wednesday, July 29, 2009 2:21 PM
To: Hicks, Richard W.
Cc: Greenhalgh, Tom; William_Colona@URSCorp.com
Subject: Re: Lancaster Correction Institute Well, Nitrate Concentrations

Rick,

Thanks for forwarding this water quality data for the Lancaster well. I agree; it does show reason for concern. Perhaps we should then seriously consider performing a trace with a small amount of eosine dye (as suggested by Tom Aley) instead, with an eye to reviewing those results to determine if use of this sink is appropriate for a future trace using the needed amount of fluorescein dye. We would then know if we would be comfortable using that sink, or if an alternate sink location would be needed.

Regarding the Chiefland sink to Manatee Springs trace, we are getting ready to release dye on Monday AM (8/3/09). I have booked the hydrant meter for chase water, cleared things with FDOT for site access, will have completed all background sampling, will have fresh samplers in place, and am currently in the process of notifying the appropriate persons/agencies (John Davis at FDEP, SRWMD, local DOH, municipals, etc.) The rhodamine WT dye has also been delivered. We plan to be on site at the sink by about 08:00 on Monday, so all who want to see the release are invited to be on site. We'll probably release the dye sometime after 09:00, when any traffic on 4th Street quiets down.

I'll be around the office for the rest of the week getting prepped for Monday, so please feel free to call to discuss things.

Later,

Pete Butt
KES
386-454-3556
386-454-2147
352-339-3380 cell

Quoting "Hicks, Richard W." <Richard.W.Hicks@dep.state.fl.us>:

> Based on the elevated nitrate concentrations in the LCI well water
> (see attached), I think that the chance of our turning their water

> green might be pretty high and not worth the risk. Proceed with
> Manatee and we will regroup on the Fanning trace. (Thanks, Kathryn).
> Thanks..Rick

>

>

>

> From: Holland, Kathryn

> Sent: Tuesday, July 28, 2009 3:53 PM

> To: Hicks, Richard W.

> Subject: RE:

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> From: Hicks, Richard W.

> Sent: Tuesday, July 28, 2009 3:46 PM

> To: Holland, Kathryn

> Subject: RE:

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>

> detected nitrate concentrations

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>

> From: Holland, Kathryn

> Sent: Tuesday, July 28, 2009 3:30 PM

> To: Hicks, Richard W.

> Subject:

>

> I'm in the PWS database...what did you want me to look up at LCI?

>

>

>

> Kathryn Holland

>

> Department of Environmental Protection

>

> Florida Springs Initiative

>

> Phone: (850) 245-8235

>

>

>

> The Department of Environmental

>

> Protection values your feedback as a customer. DEP Secretary Michael

> W. Sole is committed to continuously assessing and

>

> improving the level and quality of services provided to you. Please

> take a few minutes to comment on the quality of

>

> service you received. Copy the url below to a web browser to complete

> the DEP

>
> survey:
> <http://survey.dep.state.fl.us/?refemail=Richard.W.Hicks@dep.state.fl.us>
> Thank you in advance for completing the survey.
>

This message was sent using IMP, the Internet Messaging Program.

APPENDIX E

OUL

Ozark Underground Laboratory, Inc.

1572 Alely Lane, Protem, MO 65733 Phone 417-785-4289 Fax 417-785-4290 OUL@tri-lakes.net

Certificate of Analysis

Date of certificate: July 15, 2009

Client: Pete Butt, Karst Environmental Services, Inc.
(kes@atlantic.net)
Bill Colona, URS Corp.
(William Colona@URSCorp.com)

Project: Fanning-Manatee Dye Trace, A & B (Background)
Samples collected by: Peter Butt, Tom Morris, Mark Long
Date samples shipped: July 9, 2009
Date samples received at OUL: July 13, 2009
Date analyzed by OUL: July 15, 2009
Included with certificate of analysis:

Table of results, copies of sample collection data sheets and graphs

Results for charcoal samplers analyzed for the presence of fluorescein and rhodamine WT (RWT) dyes.

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

OUL Number	Station Number	Station Name	Date/Time		Fluorescein Results		RWT Results	
			Placed	Collected	Peak nm	Conc. ppb	Peak nm	Conc. ppb
T1333	11	Fanning Spring Main	6/19/09 1539	6/26/09 1832	ND		ND	
T1334	31	Manatee Spring Main	6/19/09 1802	6/26/09 1738	ND		ND	
T1335	11	Fanning Spring Main	6/26/09 1832	7/7/09 1149	ND		ND	
T1336	12	Little Fanning Spring	6/26/09 1850	7/7/09 1158	ND		ND	
T1337	31	Manatee Spring Main	6/26/09 1738	7/7/09 1546	ND		ND	
T1338	32	Manatee Spring Main Tunnel	6/26/09 1722	7/7/09 1502	ND		ND	
T1339	33	Manatee Spring Blue Water Tunnel	6/26/09 1709	7/7/09 1517	515.1	1.72	ND	
T1340	Laboratory control charcoal blank							

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

Thomas J. Alely, PHG and RG

1572 Aley Lane Proteom, MO 65733 (417) 785-4289 fax (417) 785-4290 email: oul@tri-lakes.net

1572 Aley Lane Protom, MO 65733 (417) 785-4289 fax (417) 785-4290 email: oul@tri-lakes.net

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Samples Shipped By: KES via FedEx

Samples Shipped By: KES via FedEx

Date Samples Shipped: 7 / 9 / 09 Date Samples Received: 7 / 13 / 09 Time Samples Received: 13:45 Return Cooler? Yes ☐ No ☒

Bill to: Karst Environmental Services, Inc.
Send Results to: Karst Environmental Services, Inc.

Analyze for: Fluorescein X Engine Rhodamine WT X Other	Ship cooler to: <u>n/a</u>
--	----------------------------

[illegible][illegible]

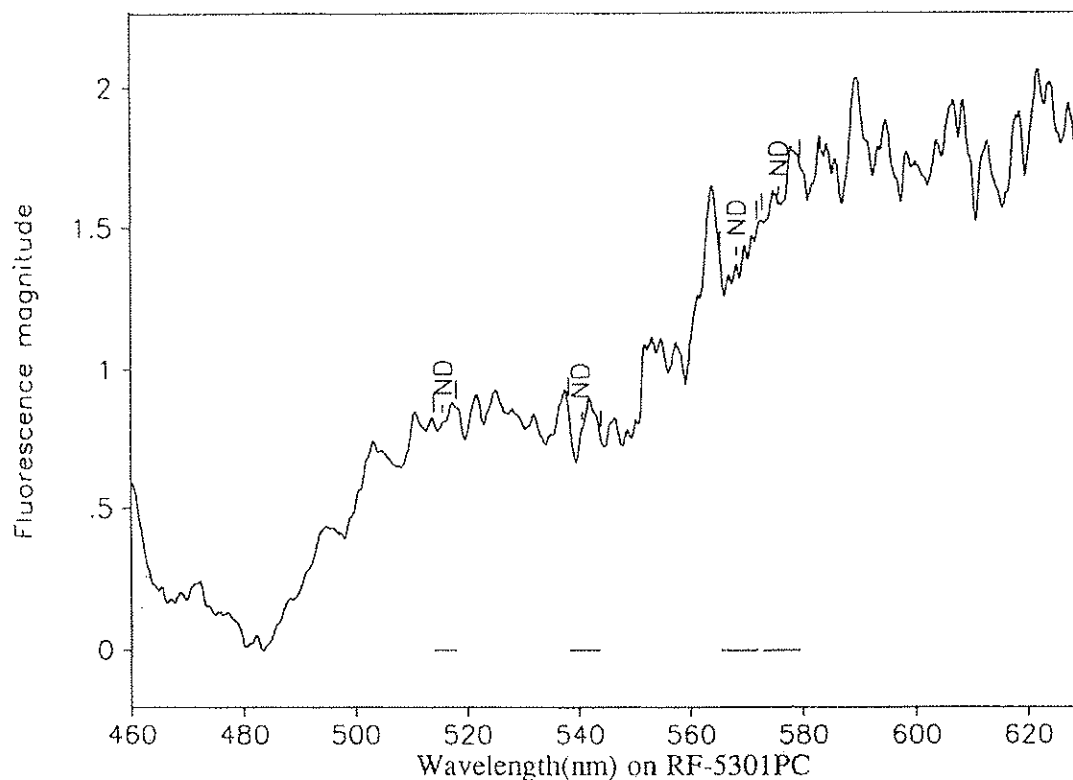
COMMENTS: Please analyze all samples. These samples are initial background samples for this project.

Out Project 956 Analyzed 7/15/09 by WA Loul

This sheet filled out by OUL staff? Yes No X Charts for samples on this page proofed by OUL: No X

Observations for Dec. 22/23

Ozark Underground Laboratory



Station 11: Fanning Spring Main

OUL number: T1333

Matrix: Elutant

Placed: 06/19/09 1539

Analyzed: 07/15/09

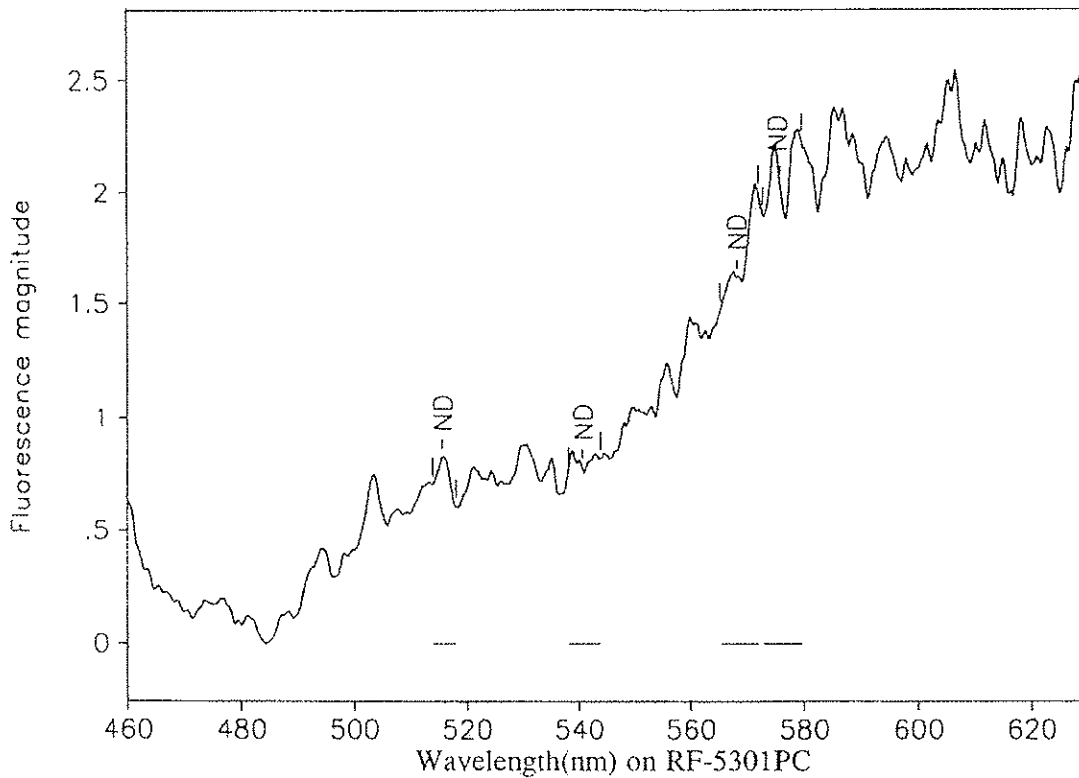
Collected: 06/26/09 1832

Peaks within the normal range of tracer dyes:

Peak nm	Left X	Right X	Height	Area	H/A	Conc.
515.6	514.0	518.1	0.00	0.00	0.00	ND
540.6	538.1	543.9	0.00	0.00	0.00	ND
568.3	565.4	572.0	0.00	0.00	0.00	ND
575.8	572.8	579.6	0.00	0.00	0.00	ND

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T1334

Matrix: Elutant

Placed: 06/19/09 1802

Analyzed: 07/15/09

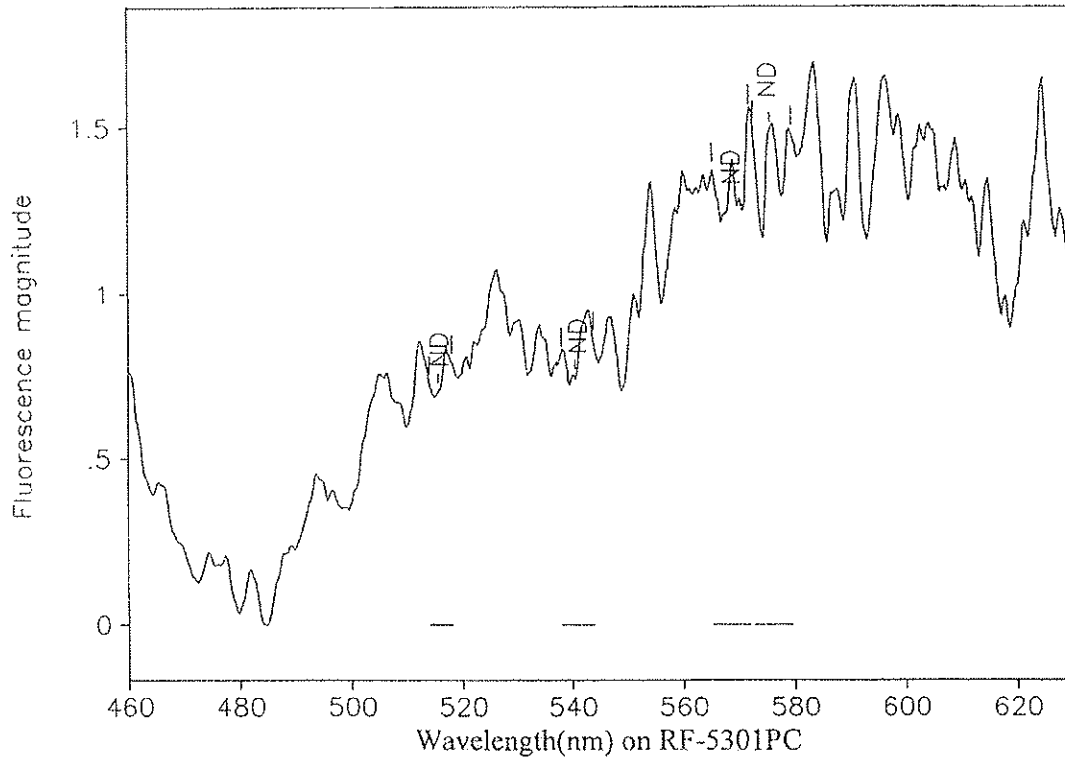
Collected: 06/26/09 1738

Peaks within the normal range of tracer dyes:

Peak nm	Left X	Right X	Height	Area	H/A	Conc.
515.6	514.0	518.1	0.00	0.00	0.00	ND
540.6	538.1	543.9	0.00	0.00	0.00	ND
568.3	565.4	572.0	0.00	0.00	0.00	ND
575.8	572.8	579.6	0.00	0.00	0.00	ND

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 11: Fanning Spring Main

OUL number: T1335

Matrix: Elutant

Placed: 06/26/09 1832

Analyzed: 07/15/09

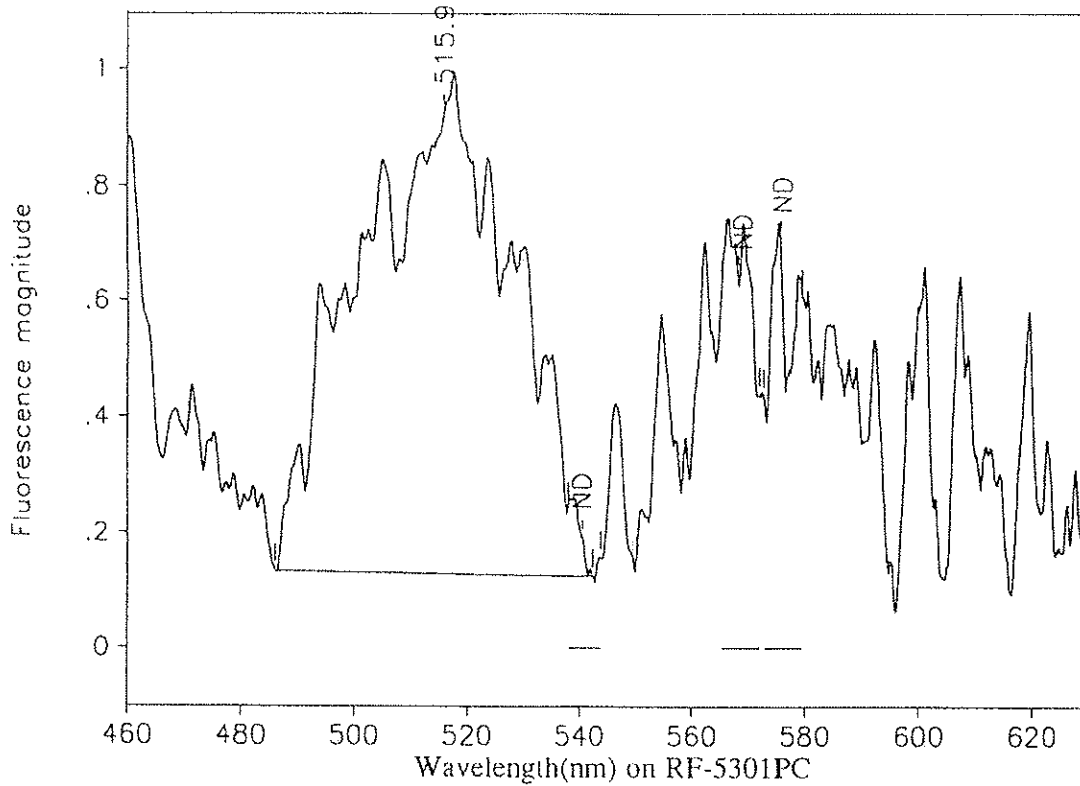
Collected: 07/07/09 1149

Peaks within the normal range of tracer dyes:

Peak nm	Left X	Right X	Height	Area	H/A	Conc.
515.6	514.0	518.1	0.00	0.00	0.00	ND
540.6	538.1	543.9	0.00	0.00	0.00	ND
568.3	565.4	572.0	0.00	0.00	0.00	ND
575.8	572.8	579.6	0.00	0.00	0.00	ND

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 12: Little Fanning Spring
 OUL number: T1336
 Matrix: Elutant
 Placed: 06/26/09 1850

Analyzed: 07/15/09

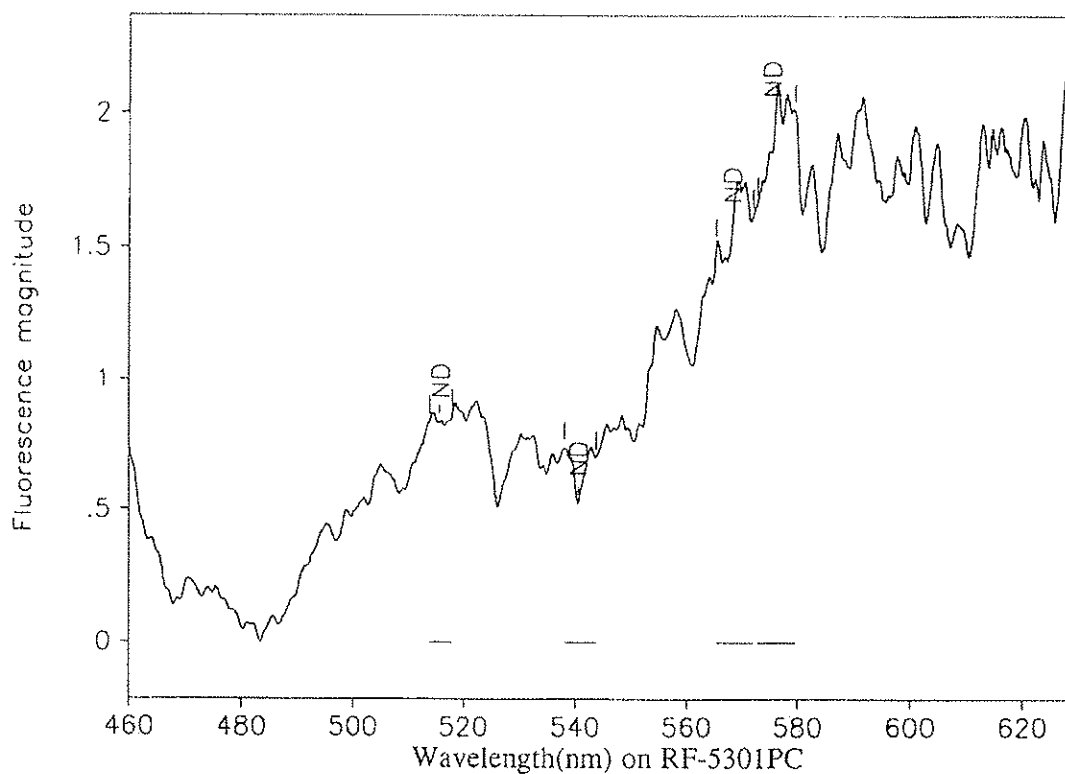
Collected: 07/07/09 1158

Peaks within the normal range of tracer dyes:

Peak nm	Left X	Right X	Height	Area	H/A	Conc.
515.9	486.0	542.4	0.80	26.96	0.03	0.953 ND
540.6	538.1	543.9	0.00	0.00	0.00	ND
568.3	565.4	572.0	0.00	0.00	0.00	ND
575.8	572.8	579.6	0.00	0.00	0.00	ND

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T1337

Matrix: Elutant

Placed: 06/26/09 1738

Analyzed: 07/15/09

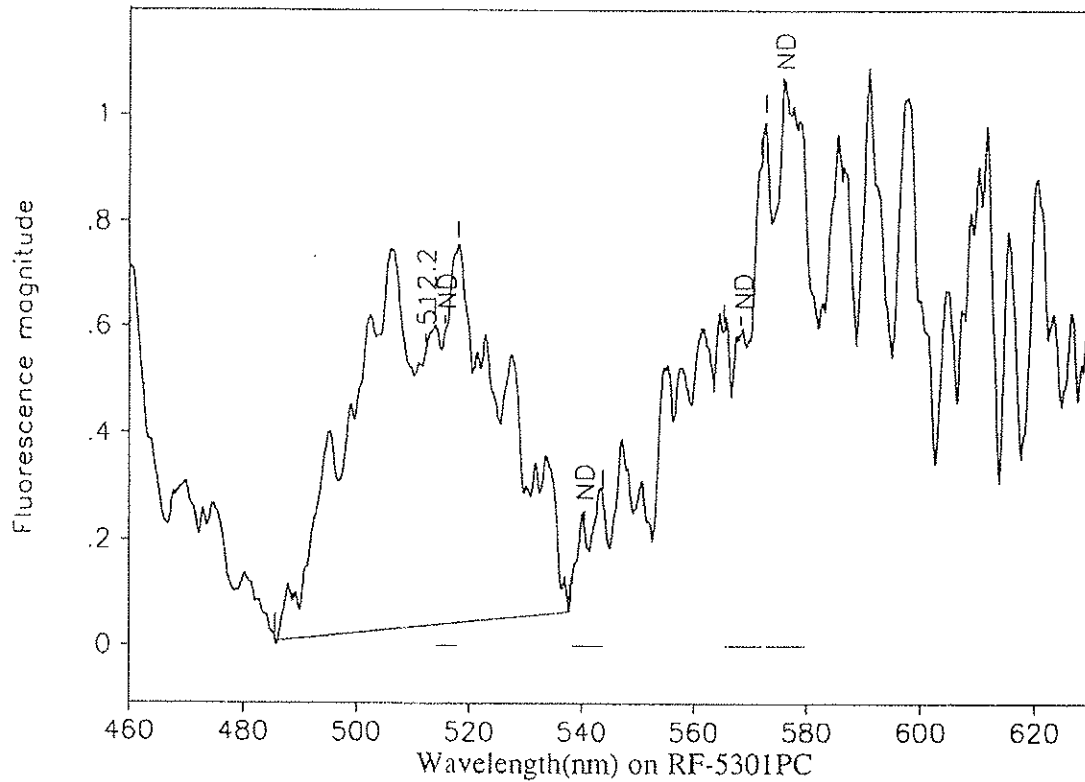
Collected: 07/07/09 1546

Peaks within the normal range of tracer dyes:

Peak nm	Left X	Right X	Height	Area	H/A	Conc.
515.6	514.0	518.1	0.00	0.00	0.00	ND
540.6	538.1	543.9	0.00	0.00	0.00	ND
568.3	565.4	572.0	0.00	0.00	0.00	ND
575.8	572.8	579.6	0.00	0.00	0.00	ND

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 32: Manatee Spring Main Tunnel

OUL number: T1338

Matrix: Elutant

Placed: 06/26/09 1722

Analyzed: 07/15/09

Collected: 07/07/09 1502

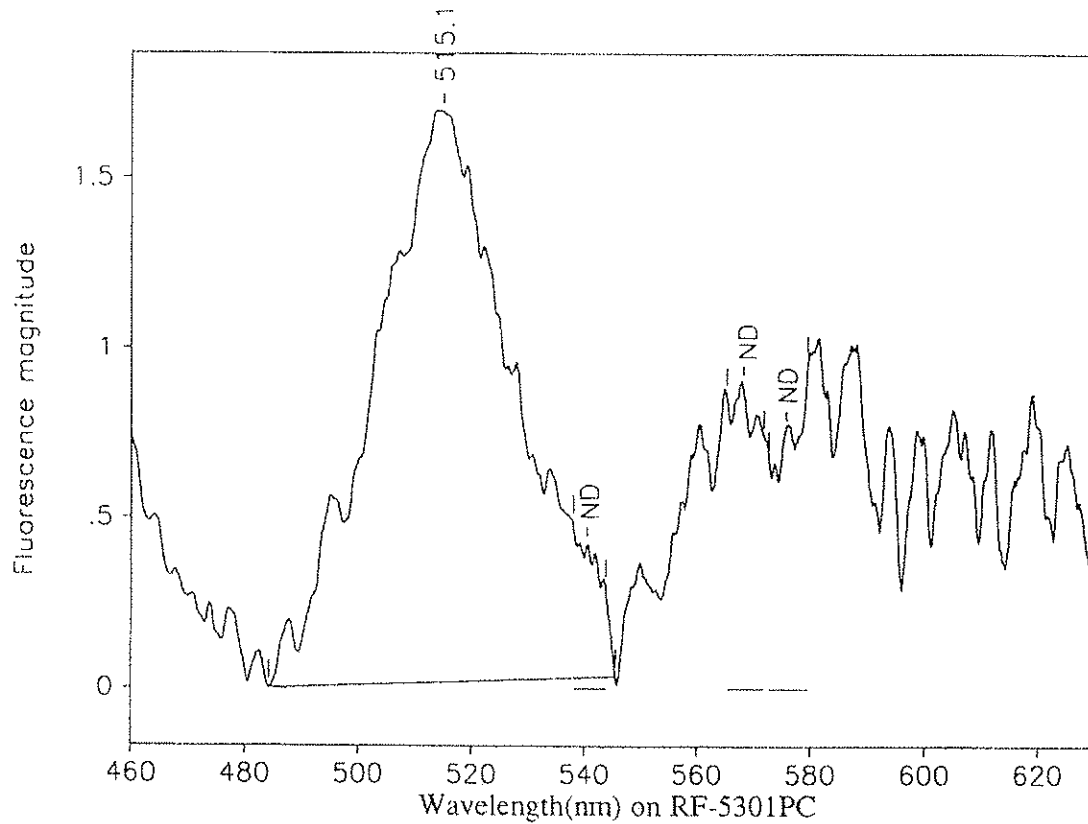
Peaks within the normal range of tracer dyes:

Peak nm	Left X	Right X	Height	Area	H/A	Conc.
515.6	514.0	518.1	0.00	0.00	0.00	ND
540.6	538.1	543.9	0.00	0.00	0.00	ND
568.3	565.4	572.0	0.00	0.00	0.00	ND
575.8	572.8	579.6	0.00	0.00	0.00	ND

Peaks close to the normal range of tracer dyes:

512.2	485.6	537.8	0.52	20.51	0.03	0.725 ND
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Ozark Underground Laboratory



Station 33: Manatee Spring Blue Water Tunnel

OUL number: T1339

Analyzed: 07/15/09

Matrix: Elutant

Placed: 06/26/09 1709

Collected: 07/07/09 1517

Peaks within the normal range of tracer dyes:

Peak nm	Left X	Right X	Height	Area	H/A	Conc.
515.1	484.2	545.6	1.67	48.75	0.03	1.72
540.6	538.1	543.9	0.00	0.00	0.00	ND
568.3	565.4	572.0	0.00	0.00	0.00	ND
575.8	572.8	579.6	0.00	0.00	0.00	ND

Peaks close to the normal range of tracer dyes:

OUL

Ozark Underground Laboratory, Inc.

1572 Aley Lane, Protem, MO 65733 Phone 417-785-4289 Fax 417-785-4290 OUL@tri-lakes.net

Certificate of Analysis

Date of certificate: July 29, 2009

Client: Pete Butt, Karst Environmental Services, Inc.
(kes@atlantic.net)

Bill Colona, URS Corp.

(William Colona@URSCorp.com)

Project: Fanning-Manatee Dye Trace, B&C (Background)

Samples collected by: Peter Butt, Mark Long

Date samples shipped: July 20, 2009

Date samples received at OUL: July 21, 2009

Date analyzed by OUL: July 22, 2009

Included with certificate of analysis:

Table of results, discrepancy sheet,

copy of corrected chain of custody,

copy of sample collection data sheet and graphs

Results for charcoal samplers analyzed for the presence of fluorescein and rhodamine WT (RWT) dyes.

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

OUL Number	Station Number	Station Name	Date/Time		Collected	Fluorescein Results		RWT Results	
			Placed			Peak nm	Conc. ppb	Peak nm	Conc. ppb
T1457	31B	Manatee Spring Main BackUp	7/7/09 1619		7/16/09 1508	ND		ND	
T1458	32	Manatee Spring Main Tunnel	7/7/09 1520		7/16/09 1440	ND		ND	
T1459	33	Manatee Spring Blue Water Tunnel	7/7/09 1517		7/16/09 1436	515.7	0.996	ND	
T1460	Laboratory control charcoal blank								
T1461	43N	Springside Public Supply Well North	6/29/09 1705		7/7/09 1501	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

Thomas J. Aley, PHG and RG

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Fanning-Manatee Dye Trace Week No: B & C (Background) Samples Collected By: Peter Butt/Mark Long

Samples Shipped By: KES via FedEx

Date Samples Shipped:	7 / 20 / 09	Date Samples Received:	7 / 20 / 09	Time Samples Received:	15:15
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Bill to: Karst Environmental Services, Inc. Send Results to: Karst Environmental Services

Analyze for:	Fluorescein	X	Eosine	Rhodamine	WT	X	Other
Ship cooler to:							

bioRxiv preprint doi: <https://doi.org/10.1101/2017.03.11.128113>; this version posted March 11, 2017. The copyright holder for this preprint (which was not certified by peer review) is the author/funder, who has granted bioRxiv a license to display the preprint in perpetuity. It is made available under aCC-BY-NC-ND 4.0 International license.

OUL	Please indicate stations where dye was visible in the field

USE ONLY

for field technician use - use black ink only

# CHAR DESC	LAB NUMBER	STATION NUMBER	STATION NAME	PLACED
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KEY	NUMBER	NUMBER	DATE	T
		14 Numbers		

1	T11/Est	31B	Manatee Spring Main Backfill	7/7/00	16
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1	11431	210	manage spring main backup	117107	51
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1	TI458	32	Manatee Spring Main Tunnel	7/7/09	1
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33	Manatee Spring Blue Water Tunnel	7/7/09	13
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1	42N	Springside Public Supply Well North	6/20/00	13
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1	43IN	1510	springside public supply well NO101	01/23/03
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Figure 1: A schematic diagram of a 1D lattice chain. The chain consists of a series of sites (represented by small circles) connected by horizontal bonds. A vertical line passes through the center of the chain, representing a symmetry axis. The chain is divided into two halves by this axis. The left half is labeled 'Left' and the right half is labeled 'Right'. The chain is also labeled '1D Lattice Chain' at the bottom.

[illegible]

Fall 2001 - 1. Klausur ist best!

1700- CAL CHARLES DIXON. LO/ALL

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COMMENTS: Please analyze all samples. These samples are additional background samples for this project.

Our Project #956 Analyzed 7/22/09 by Lisa Geyer-Halpern

☐ This sheet filled out by OUL staff? Yes No X Charts for samples on this page proofed by OUL: CA

Page 10 of 10

1572 Aley Lane Protom, MO 65733 (417) 785-4289 fax (417) 785-4290 email: ouf@tri-lakes.net

1572 Aley Lane Protom, MO 65733 (417) 785-4289 fax (417) 785-4290 email: ouf@tri-lakes.net

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Fanning-Manatee Dye Trace Week No: B & C (Background) Samples Collected By: Peter Butti/Mark Long

Samples Shipped By: KES via FedEx Samples Received By: _____

Date Samples Shipped: 7 / 20 / 09

Bill to: Karst Environmental Services, Inc. Send Results to: Karst Environmental Services

Analyze for:	Fluorescein	Eosine	Rhodamine WT	Other
Ship cooler to:				

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for field technician use - use black ink only

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19/19/19	1919
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21/21/21	2121
22/22/22	2222
23/23/23	2323
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31B	Manatee Spring Main BackUp	7/7/09	16
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37	Manatee Spring Main Tunnel	7/7/00
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11/109	variance spring water tunnel	26
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33	Manatee Spring Blue Water Tunnel	7/7/09	12
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43N	Springside Public Supply Well North	6/29/09	17
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John L. Dwyer

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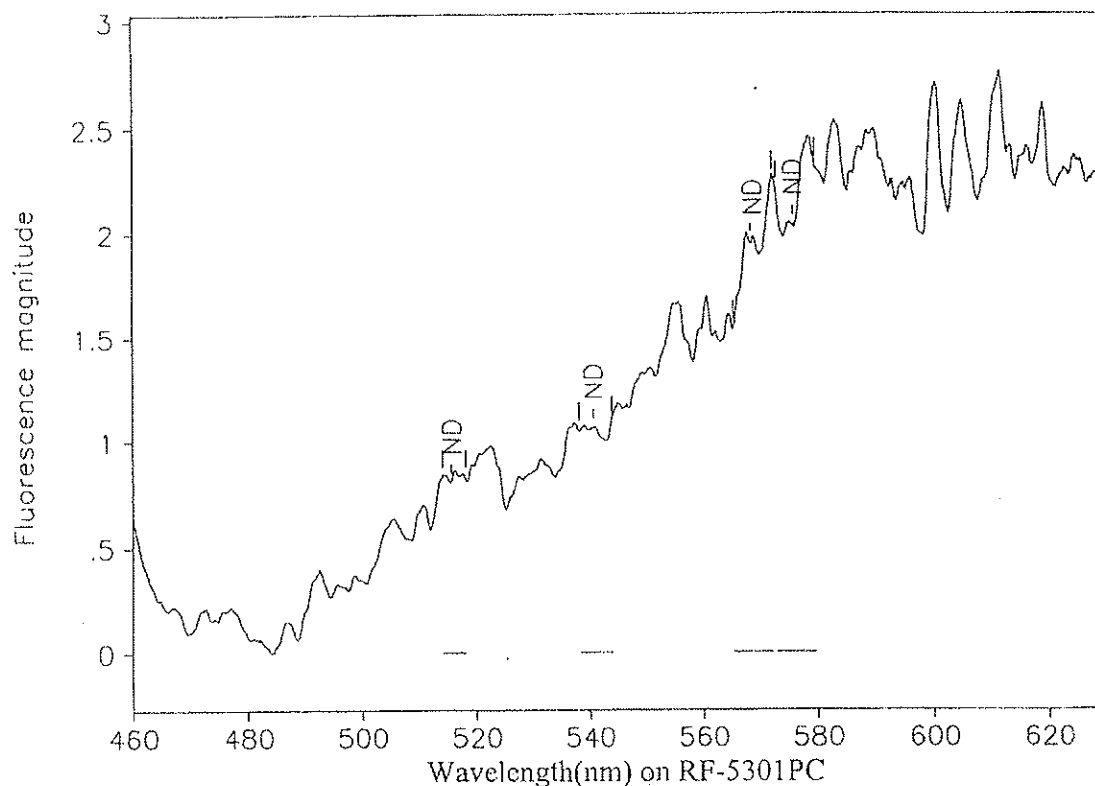
COMMENTS: Please analyze all samples. These samples are additional background samples for this project.

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Ozark Underground Laboratory



Station 31B: Manatee Spring Main BackUp

OUL number: T1457

Matrix: Elutant

Placed: 07/07/09 1619

Analyzed: 07/22/09

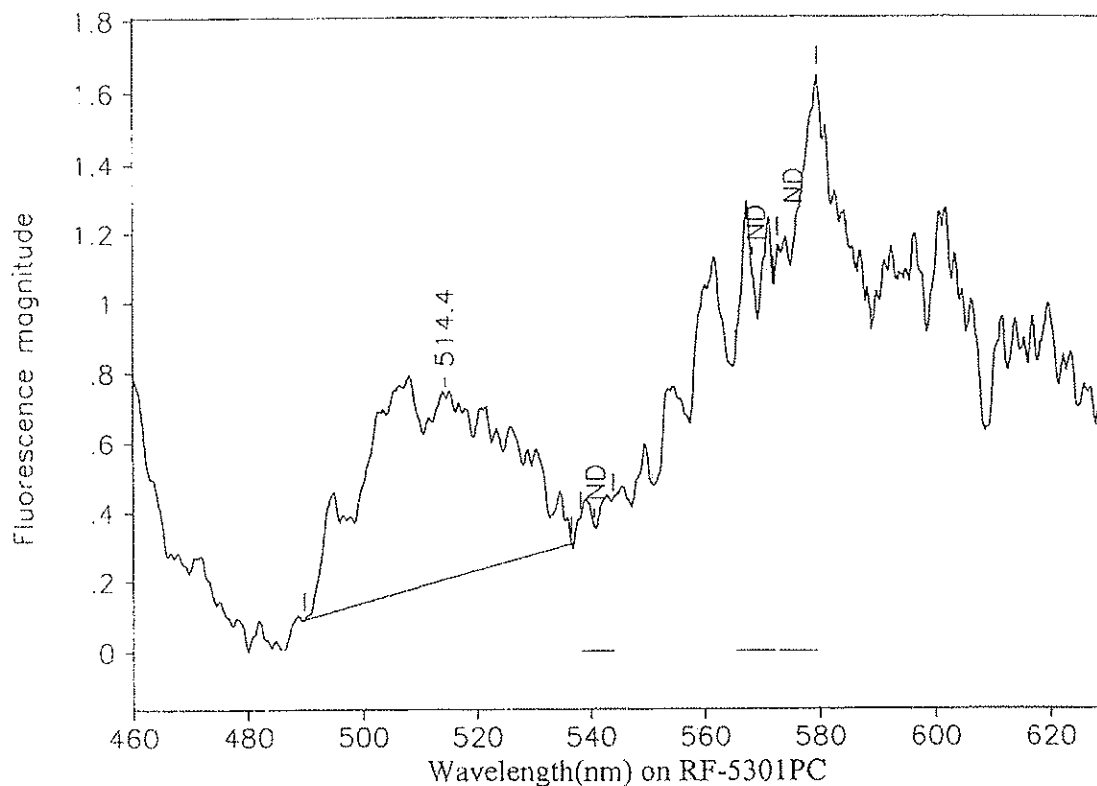
Collected: 07/16/09 1508

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 32: Manatee Spring Main Tunnel

OUL number: T1458

Matrix: Elutant

Placed: 07/07/09 1520

Analyzed: 07/22/09

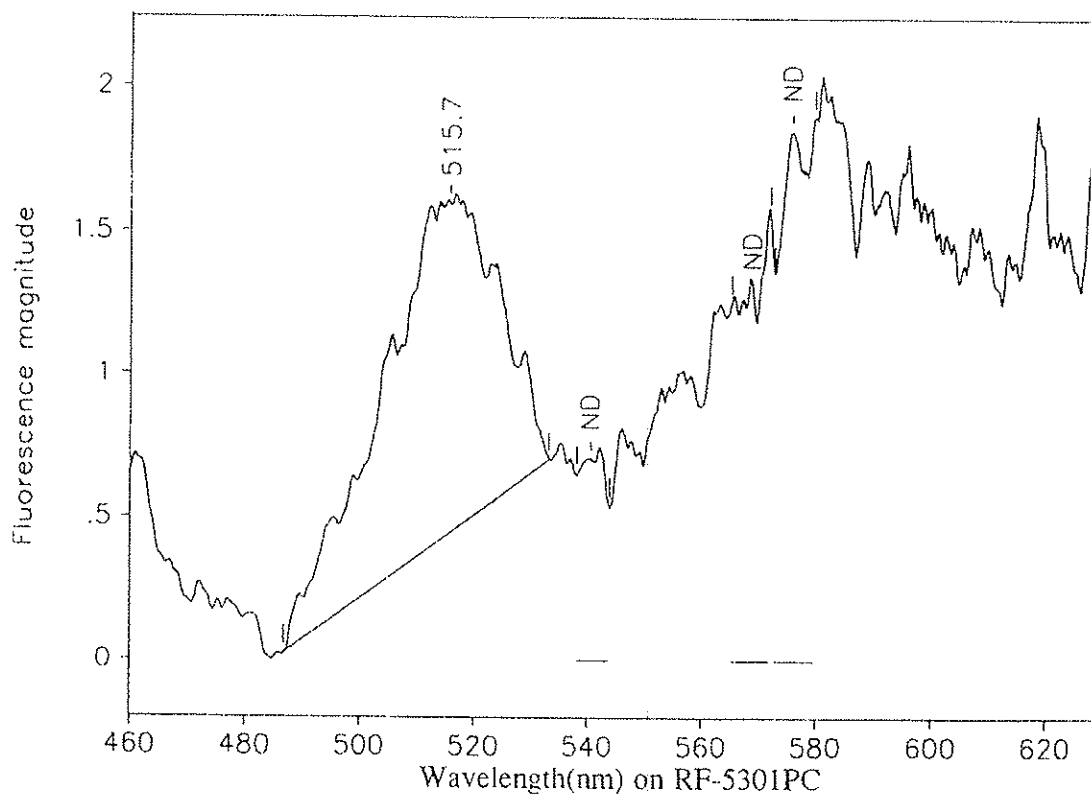
Collected: 07/16/09 1440

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|-------|------|----------------------|
| 514.4 | 489.8 | 536.6 | 0.53 | 16.80 | 0.03 | 0.591 ✓ 0 |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 33: Manatee Spring Blue Water Tunnel

OUL number: T1459

Matrix: Elutant

Placed: 07/07/09 1517

Analyzed: 07/22/09

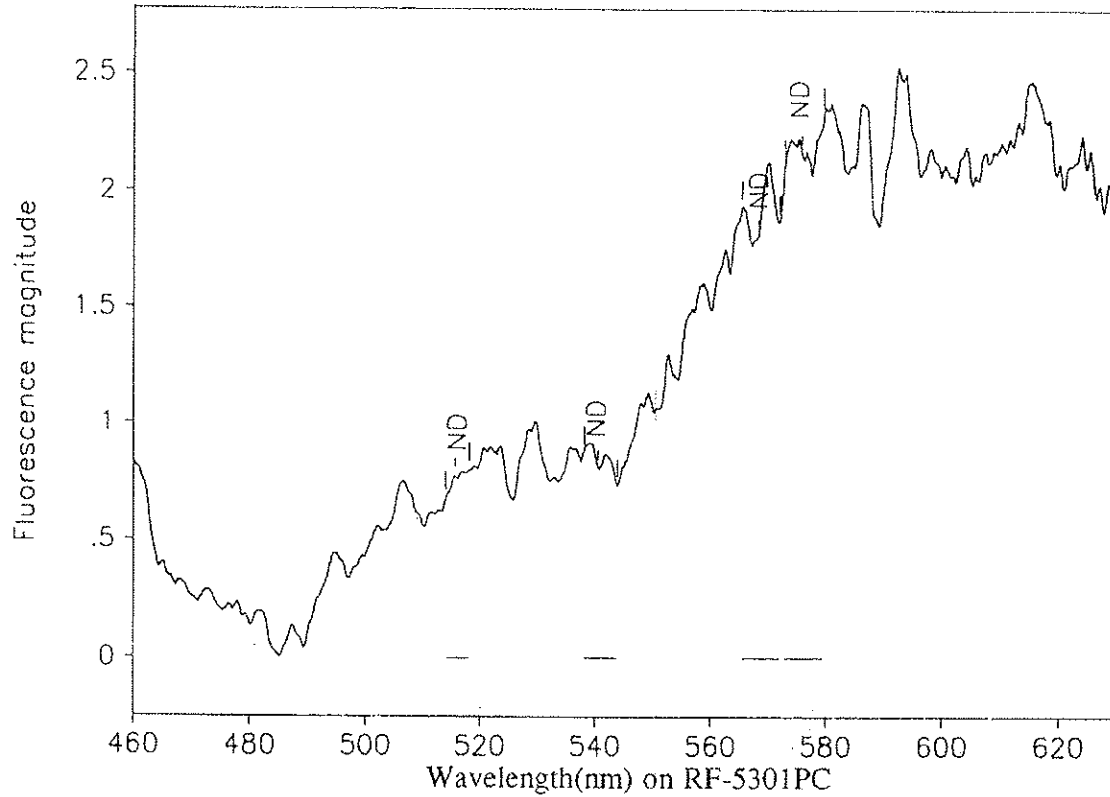
Collected: 07/16/09 1436

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|-------|------|-------|
| 515.7 | 486.8 | 533.2 | 1.15 | 28.30 | 0.04 | 0.996 |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 43N: Springside Public Supply Well North

OUL number: T1461

Analyzed: 07/22/09

Matrix: Elutant

Placed: 06/29/09 1705

Collected: 07/07/09 1501

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

OUL

Ozark Underground Laboratory, Inc.

1572 Aley Lane, Protom, MO 65733 Phone 417-785-4289 Fax 417-785-4290 OUL@tri-lakes.net

Certificate of Analysis

Date of certificate: August 21, 2009

Client: Pete Butt, Karst Environmental Services, Inc.
(kes@atlantic.net)

Bill Colona, URS Corp.

(William Colona@URSCorp.com)

Project: Fanning-Manatee Dye Trace, Week 1-2 (Shipment 1)

Samples collected by: Peter Butt, Mark Long

Date samples shipped: August 17, 2009

Date samples received at OUL: August 18, 2009

Date analyzed by OUL: August 19, 2009

Included with certificate of analysis:

Table of results, copy of sample collection data sheet
and graphs

Results for charcoal samplers analyzed for the presence of fluorescein and rhodamine WT (RWT) dyes.

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

| OUL
Number | Station
Number | Station
Name | Date/Time | | Fluorescein Results | | RWT Results | |
|---------------|-----------------------------------|---|--------------|--------------|---------------------|-----------|-------------|-----------|
| | | | Placed | Collected | Peak nm | Conc. ppb | Peak nm | Conc. ppb |
| T1953 | 31 | Manatee Spring Main | 8/11/09 1724 | 8/15/09 1707 | ND | | 568.1 | 95.3 |
| T1954 | 32 | Manatee Spring Main Tunnel | 8/11/09 1704 | 8/15/09 1650 | ND | | 568.3 | 268 |
| T1955 | 33 | Manatee Spring Blue Water Tunnel | 8/11/09 1656 | 8/15/09 1646 | ND | | 568.2 | 47.6 |
| T1956 | 41A | Manatee Spring SP Public Supply Well #2 | 8/11/09 1644 | 8/15/09 1622 | ND | | ND | |
| T1957 | 42 | Levy County Public Supply Well | 8/11/09 1612 | 8/15/09 1605 | ND | | ND | |
| T1958 | 43N | Springside Public Supply Well North | 8/11/09 1624 | 8/15/09 1738 | ND | | ND | |
| T1959 | 44 | Barnhill Landscape Well | 8/11/09 1434 | 8/15/09 1532 | ND | | ND | |
| T1960 | Laboratory control charcoal blank | | | | | | | |
| T1961 | 45 | Chiefland Public Supply Well South | 8/11/09 1457 | 8/15/09 1545 | ND | | ND | |
| T1962 | D1 | QC Duplicate | 8/11/09 NT | 8/15/09 NT | ND | | 568.5 | 43.7 |

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

NT = No time given

Thomas J. Aley, PHG and RG

1572 Aley Lane Protem, MO 65733 (417) 785-4289 fax (417) 785-4290 email: oul@tri-lakes.net

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Fanning-Manatee Dye Trace Week/No: 1-2 (Shipment 1) Samples Collected By: Peter Butt/Mark Long
 Samples Shipped By: KES via FedEx 8/17/09 Samples Received By: Kobler Scott Gil
 Date Samples Shipped: 8 / 17 / 09 Date Samples Received: 8/18/09 Time Samples Received: 13:30 Return Cooler? Yes No X
 Bill to: Karst Environmental Services, Inc. Send Results to: Karst Environmental Services, Inc.
 Analyze for: Fluorescein X Eosine Rhodamine WT X Other Ship cooler to: n/a

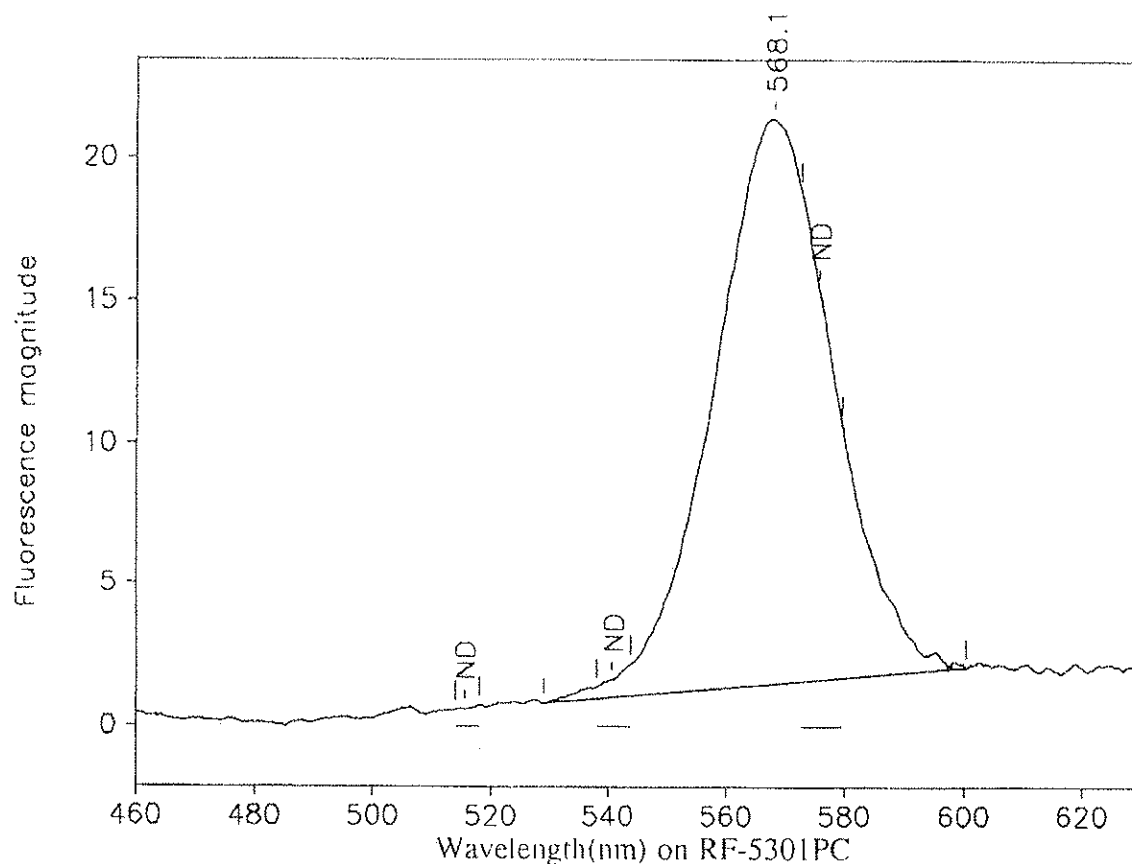
[illegible]

COMMENTS: Please analyze all samples.

COMMENTS: Please analyze all samples.

This sheet filled out by OUL staff? Yes ☒ No ☐ Charts for samples on this page proofed by OUL: ☒ ☐

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T1953

Matrix: Elutant

Placed: 08/11/09 1724

Analyzed: 08/19/09

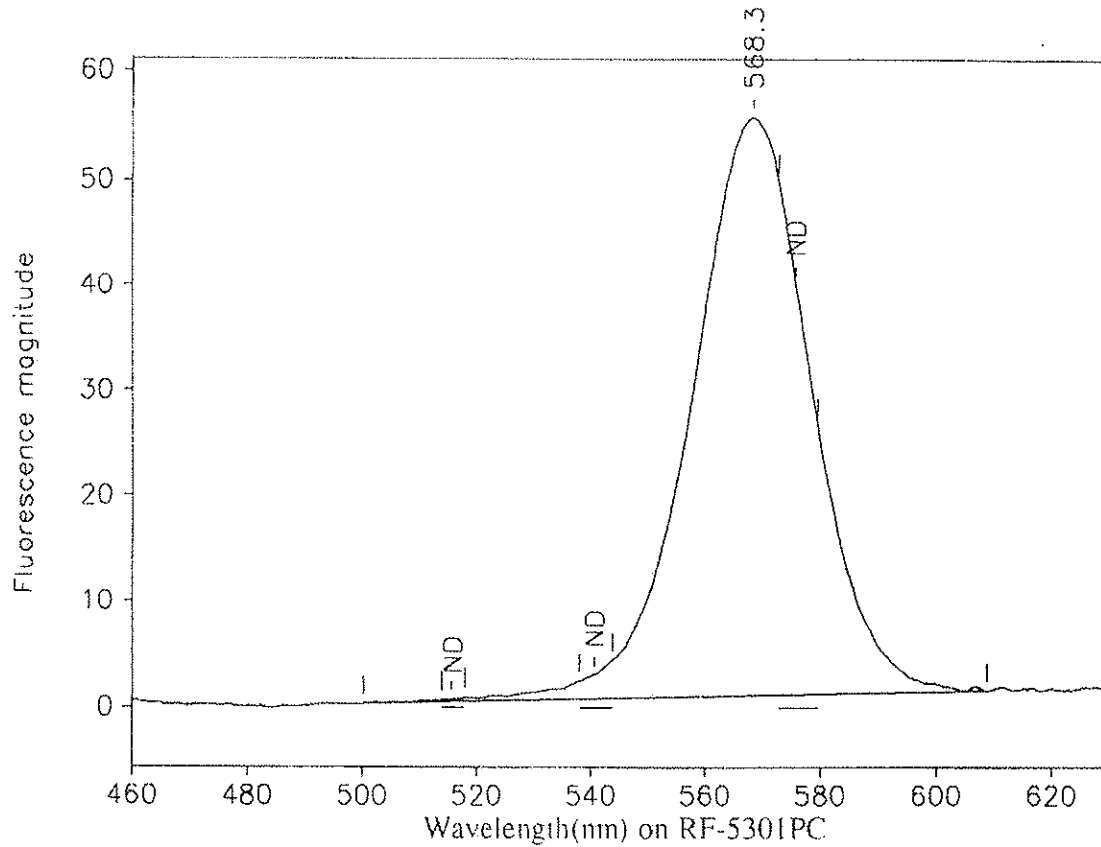
Collected: 08/15/09 1707

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|--------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.1 | 529.0 | 600.4 | 19.89 | 468.88 | 0.04 | 95.3 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 32: Manatee Spring Main Tunnel

OUL number: T1954

Matrix: Elutant

Placed: 08/11/09 1704

Analyzed: 08/19/09

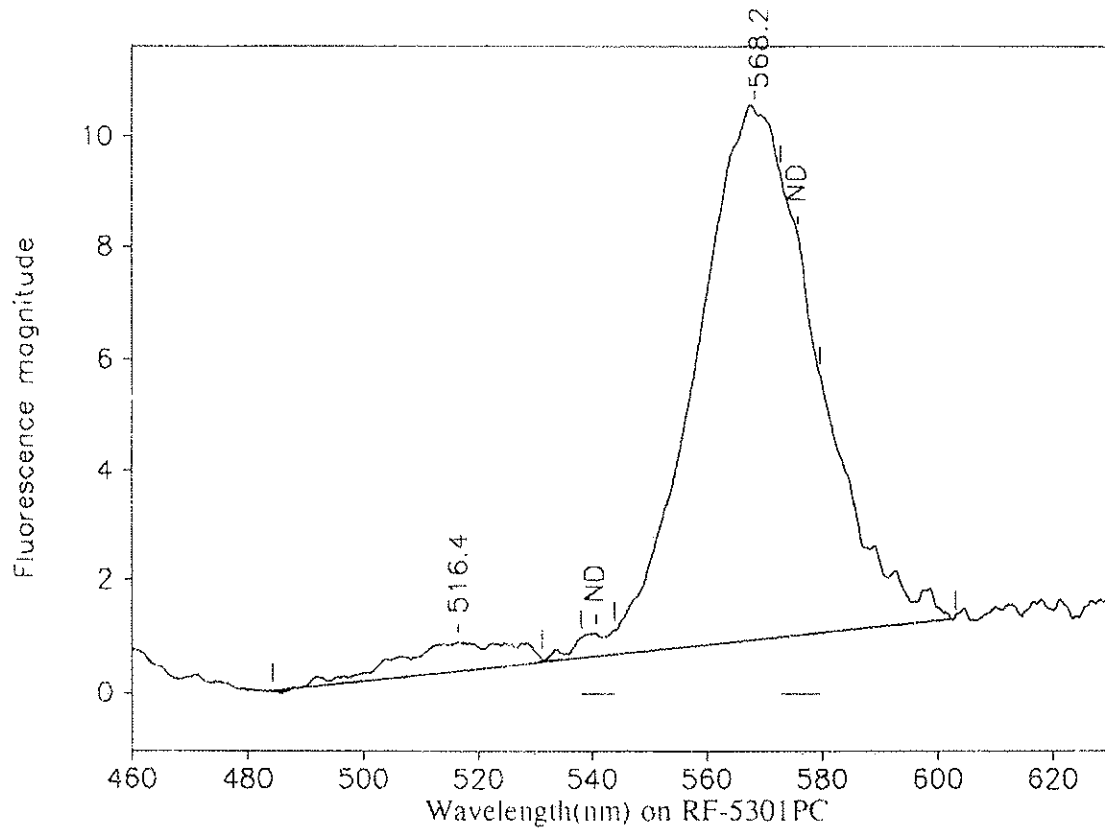
Collected: 08/15/09 1650

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|----------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 500.2 | 608.8 | 54.65 | 1,317.76 | 0.04 | 268 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 33: Manatee Spring Blue Water Tunnel

OUL number: T1955

Analyzed: 08/19/09

Matrix: Elutant

Placed: 08/11/09 1656

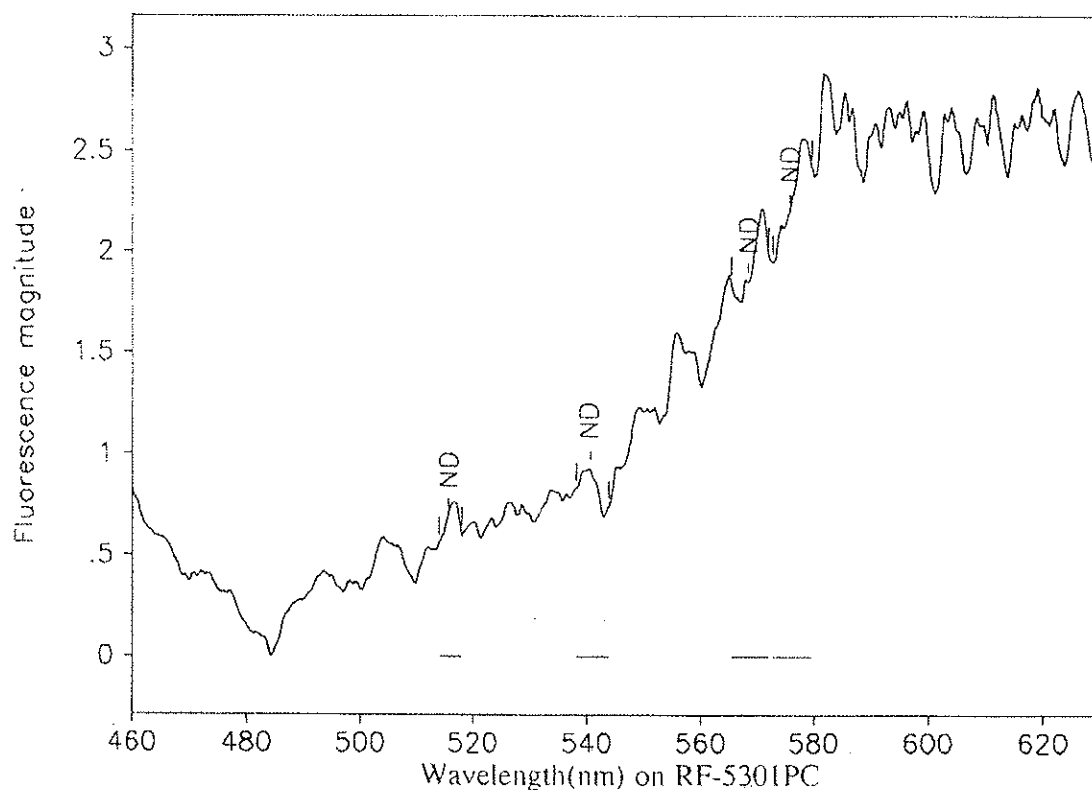
Collected: 08/15/09 1646

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|--------|------|---------------------|
| 516.4 | 484.2 | 531.1 | 0.51 | 12.61 | 0.04 | 0.408 ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.2 | 531.1 | 603.0 | 9.56 | 234.23 | 0.04 | 47.6 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 41A: Manatee Spring SP Public Supply Well #2

OUL number: T1956

Analyzed: 08/19/09

Matrix: Elutant

Placed: 08/11/09 1644

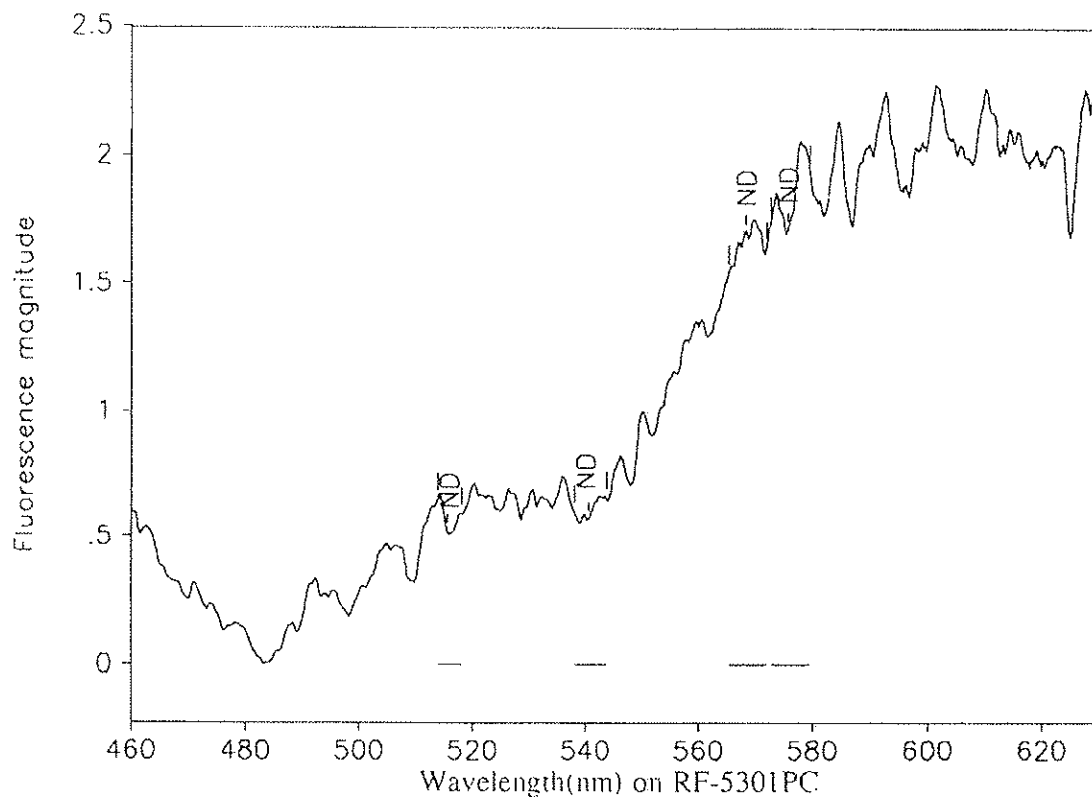
Collected: 08/15/09 1622

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 42: Levy County Public Supply Well

OUL number: T1957

Matrix: Elutant

Placed: 08/11/09 1612

Analyzed: 08/19/09

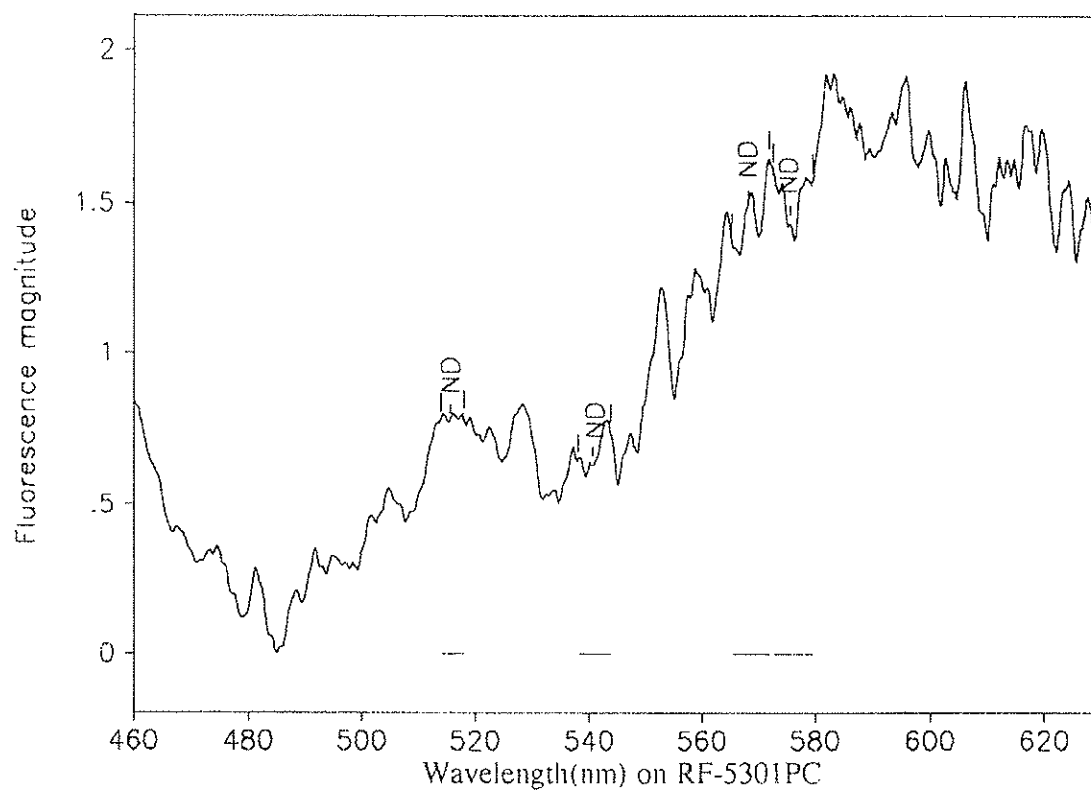
Collected: 08/15/09 1605

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 43N: Springside Public Supply Well North

OUL number: T1958

Analyzed: 08/19/09

Matrix: Elutant

Placed: 08/11/09 1624

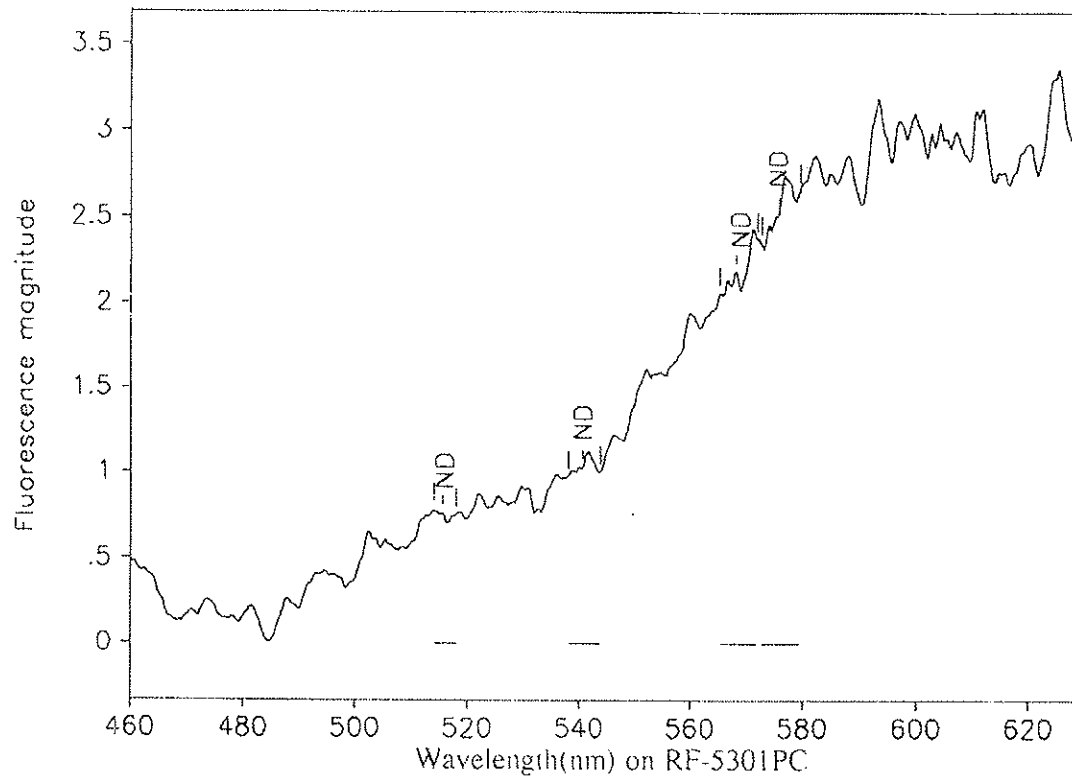
Collected: 08/15/09 1738

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 44: Barnhill Landscape Well

OUL number: T1959

Matrix: Elutant

Placed: 08/11/09 1434

Analyzed: 08/19/09

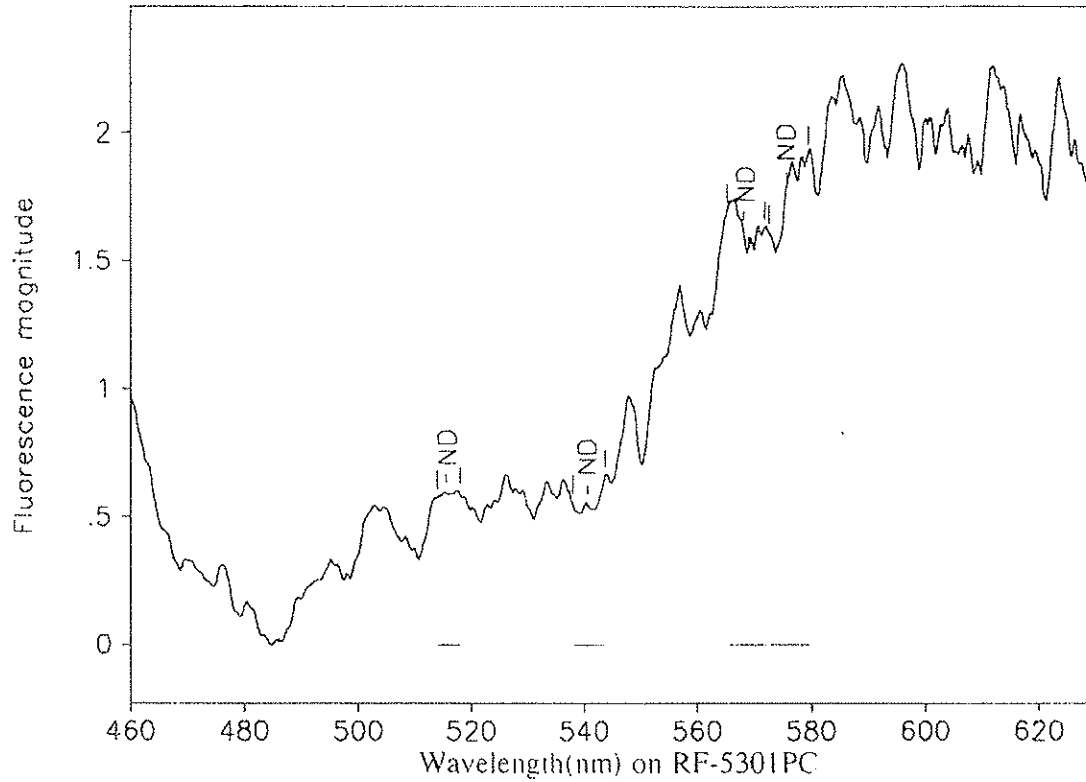
Collected: 08/15/09 1532

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 45: Chiefland Public Supply Well South

OUL number: T1961

Analyzed: 08/19/09

Matrix: Elutant

Placed: 08/11/09 1457

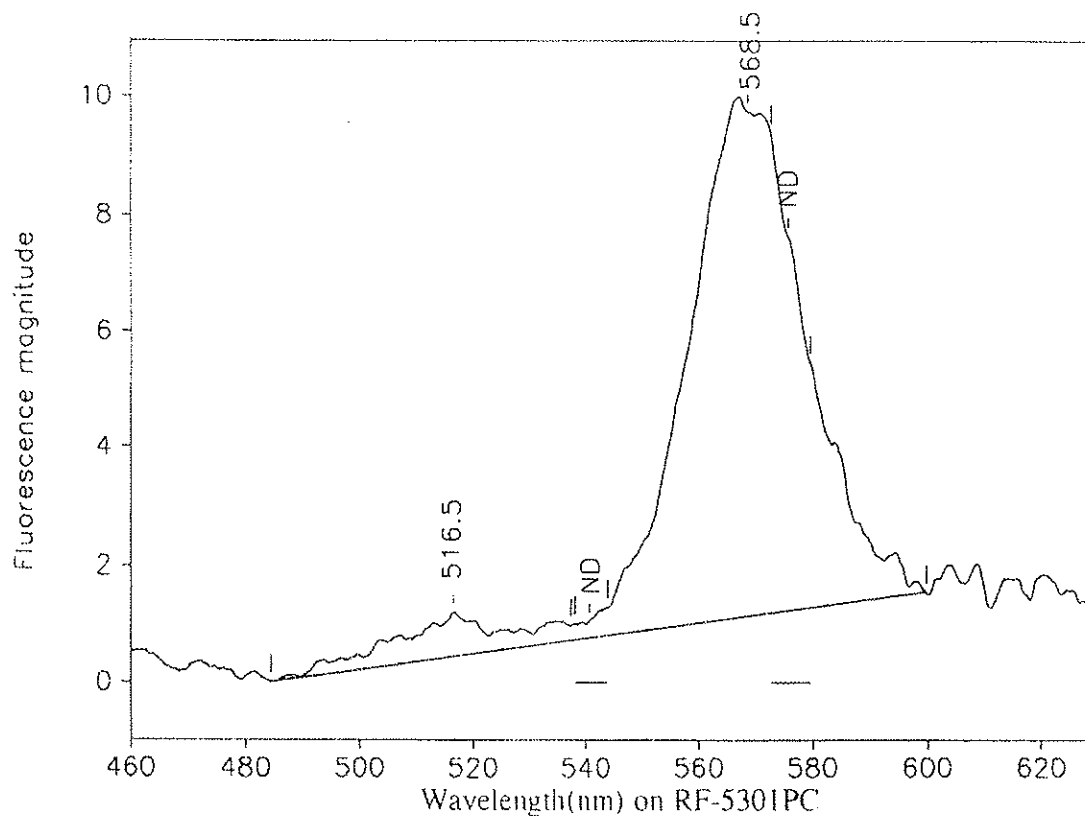
Collected: 08/15/09 1545

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station D1: QC Duplicate
 OUL number: T1962
 Matrix: Elutant
 Placed: 08/11/09

Analyzed: 08/19/09

Collected: 08/15/09

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|--------|------|---------------------|
| 516.5 | 484.4 | 537.3 | 0.77 | 17.76 | 0.04 | 0.574 ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.5 | 537.3 | 599.8 | 8.60 | 215.09 | 0.04 | 43.7 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

1572 Aley Lane, Protem, MO 65733 Phone 417-785-4289 Fax 417-785-4290 OUL@tri-lakes.net

Samples collected by: Peter Butt, Mark Long

Peak wavelengths are reported in nanometers (nm); dye concentrations are reported in parts per billion (ppb). All results for charcoal unless otherwise indicated.

| OUL Number | Station Number | Station Name | Date/Time Placed | Date/Time Collected | Fluorescein Results | | RWT Results | |
|------------|----------------|----------------------------------|------------------|---------------------|---------------------|-----------|-------------|-------------|
| | | | | | Peak nm | Conc. ppb | Peak nm | Conc. ppb |
| T2024 | 31 | Manatee Spring Main | water | 8/20/09 1834 | ND | | ND | |
| T2025 | 31 | Manatee Spring Main | water | 8/19/09 1518 | ND | | ND | |
| T2026 | 31 | Manatee Spring Main | water | 8/15/09 1707 | ND | | 575.4 * | 0.418 |
| T2027 | 31 | Manatee Spring Main | water | 8/11/09 1724 | ND | | ND | |
| T2028 | 31 | Manatee Spring Main | water | 8/7/09 1717 | ND | | ND | |
| T2029 | 31 | Manatee Spring Main (Background) | water | 8/2/09 1450 | ND | | ND | |
| T2030 | D3 | QC Duplicate | water | NDT | ND | | ND | |
| | | | | | | | | Page 2 of 2 |

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

NDT = No date or time given

NT = No time given

* = 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 were the tracer dye.

Thomas J. Aley, PHG and RG

OZARK UNDERGROUND LABORATORY, INC.

1572 Aley Lane Protem, MO 65733 (417) 785-4289 fax (417) 785-4290 email: oul@tri-lakes.net

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Fanning-Manatee Dye Trace Weigh No: 1-3 (Shipment 2) Samples Collected By: Peter Butt/Mark Long
 Samples Shipped By: KES via FedEx Samples Received By: C. Aley / oul
 Date Samples Shipped: 8 / 24 / 09 Date Samples Received: 8 / 25 / 09 Time Samples Received: 12:15 Return Cooler? Yes No X
 Bill to: Karst Environmental Services, Inc. Send Results to: Karst Environmental Services, Inc.
 Analyze for: Fluorescein X Eosine WT Rhodamine WT X Other n/a Ship cooler to: n/a

| # CHAR REC'D | LAB NUMBER | STATION NUMBER | STATION NAME | PLACED | | COLLECTED | | OUL use only |
|--------------|------------|----------------|------------------------------------|---------|-------|-----------|-------|--------------|
| | | | | DATE | TIME | DATE | TIME | |
| | T2009 | 31 | Manatee Spring Main | 8/2/09 | 14:50 | 8/7/09 | 17:17 | 0 |
| | T2010 | 31 | Manatee Spring Main | 8/7/09 | 17:17 | 8/11/09 | 17:24 | 0 |
| | T2011 | 31 | Manatee Spring Main | 8/15/09 | 17:07 | 8/19/09 | 15:18 | 0 |
| | T2012 | 31B | Manatee Spring Main Backup | 8/7/09 | 17:30 | 8/11/09 | 17:39 | 0 |
| | T2013 | 32 | Manatee Spring Main Tunnel | 8/2/09 | 15:35 | 8/7/09 | 16:57 | 0 |
| | T2014 | 32 | Manatee Spring Main Tunnel | 8/7/09 | 16:57 | 8/11/09 | 17:04 | 0 |
| | T2015 | 32 | Manatee Spring Main Tunnel | 8/15/09 | 16:50 | 8/19/09 | 15:00 | 0 |
| | T2016 | 33 | Manatee Spring Blue Water Tunnel | 8/2/09 | 15:25 | 8/7/09 | 17:01 | 0 |
| | T2017 | 33 | Manatee Spring Blue Water Tunnel | 8/7/09 | 17:01 | 8/11/09 | 16:56 | 0 |
| | T2018 | 33 | Manatee Spring Blue Water Tunnel | 8/15/09 | 16:46 | 8/19/09 | 14:52 | 0 |
| | T2019 | 46 | Chiefland Public Supply Well North | 8/3/09 | 16:08 | 8/5/09 | 11:38 | 0 |
| | T2021 | 46 | Chiefland Public Supply Well North | 8/5/09 | 11:38 | 8/7/09 | 14:18 | 0 |
| | T2022 | 46 | Chiefland Public Supply Well North | 8/7/09 | 14:18 | 8/11/09 | 14:13 | 0 |
| | T2023 | D2 | QC Duplicate | 8/15/09 | | 8/19/09 | | 0 |
| | | | T2020 - oul charcoal blank | | | | | |

COMMENTS: Please analyze all samples.

OUL Project 456 Analyzed 8/27/09 by oul
 This sheet filled out by OUL staff? Yes No X Charts for samples on this page proofed by OUL: oul

1572 Aley Lane Protem, MO 65733 (417) 785-4289 fax (417) 785-4290 email: out@tri-lakes.net

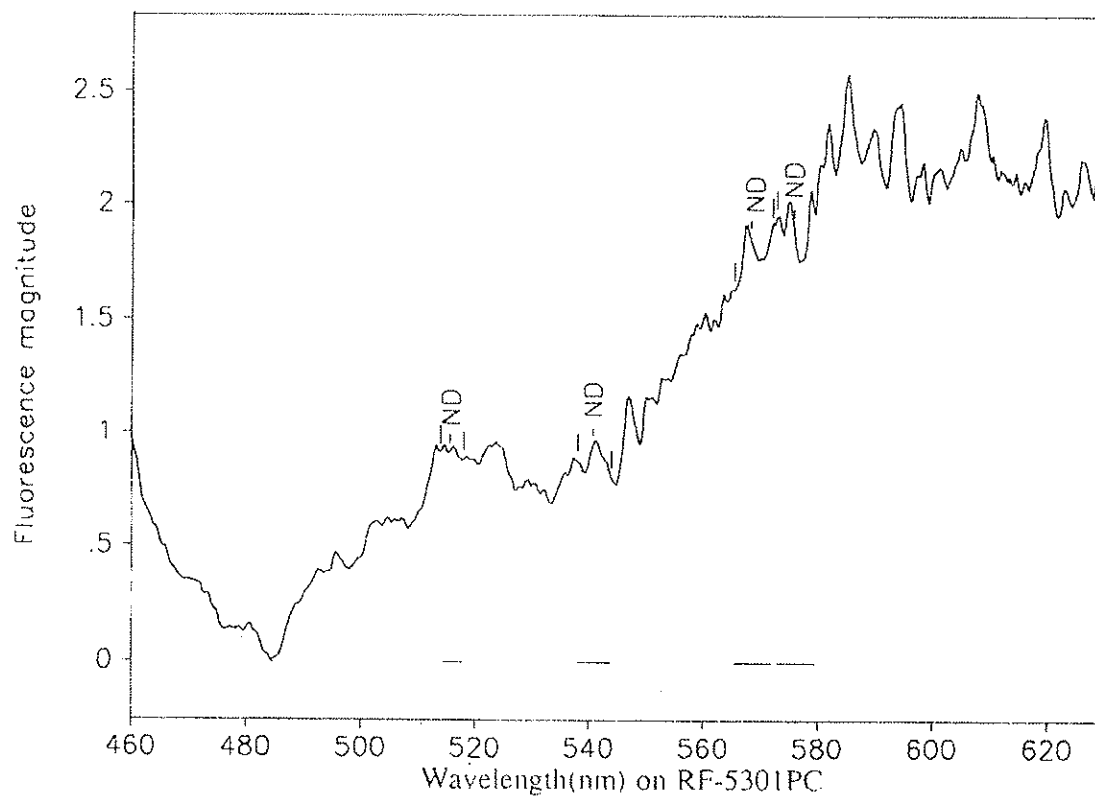
Project: Fanning-Manatee Dye Trace Week No: 1-3 (Shipment 2) Water Samples Collected By: Peter Butt/Mark Long
 Samples Shipped By: KES via FedEx Samples Received By: C. Olay / oall
 Date Samples Shipped: 8 / 24 / 09 Date Samples Received: 8 / 25 / 09 Time Samples Received: 12: 15 Return Cooler? Yes No X
 Bill to: Karst Environmental Services, Inc. Send Results to: Karst Environmental Services, Inc.
 Analyze for: Fluorescein X Eosine Rhodamine WT X Other Ship cooler to: n/a

[illegible]

| |
|---------------------------------------|
| COMMENTS: Please analyze all samples. |
|---------------------------------------|

| This sheet filled out by OUL staff? Yes | No | X | Charts for samples on this page proofed by OUL: <u>2</u> |
|---|----|---|--|
| | | | |

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2009

Matrix: Elutant

Placed: 08/02/09 1450

Analyzed: 08/26/09

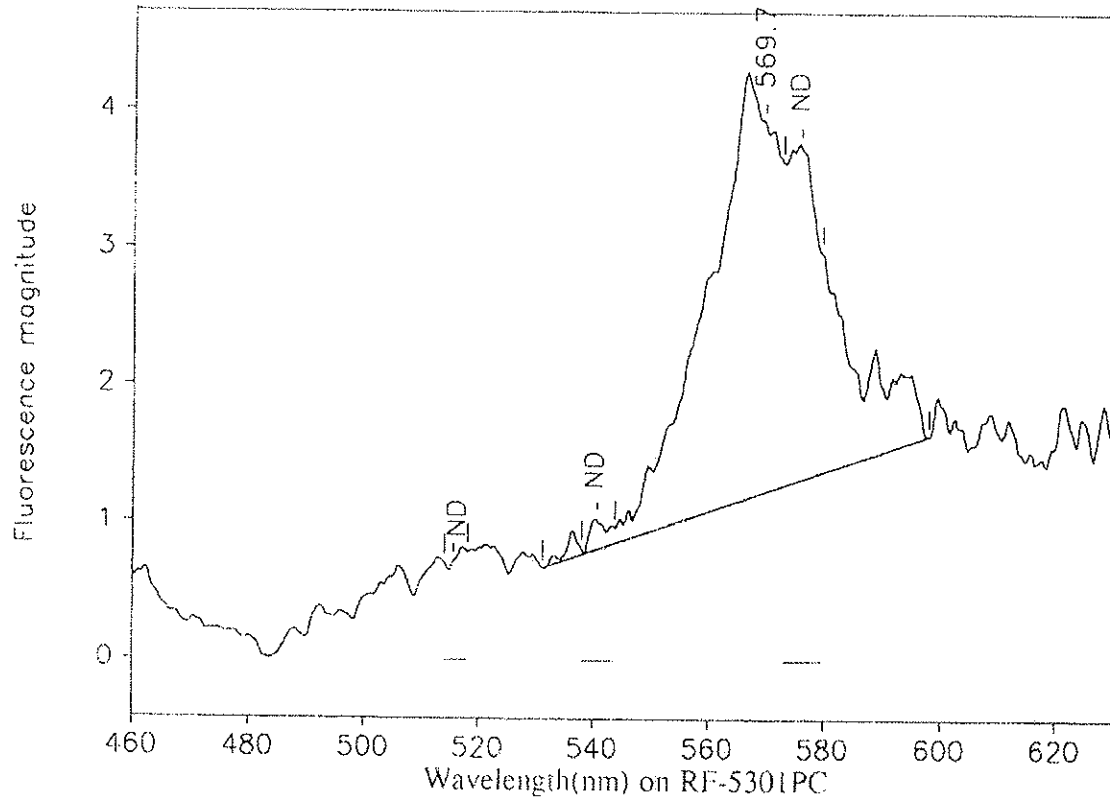
Collected: 08/07/09 1717

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2010

Matrix: Elutant

Placed: 08/07/09 1717

Analyzed: 08/26/09

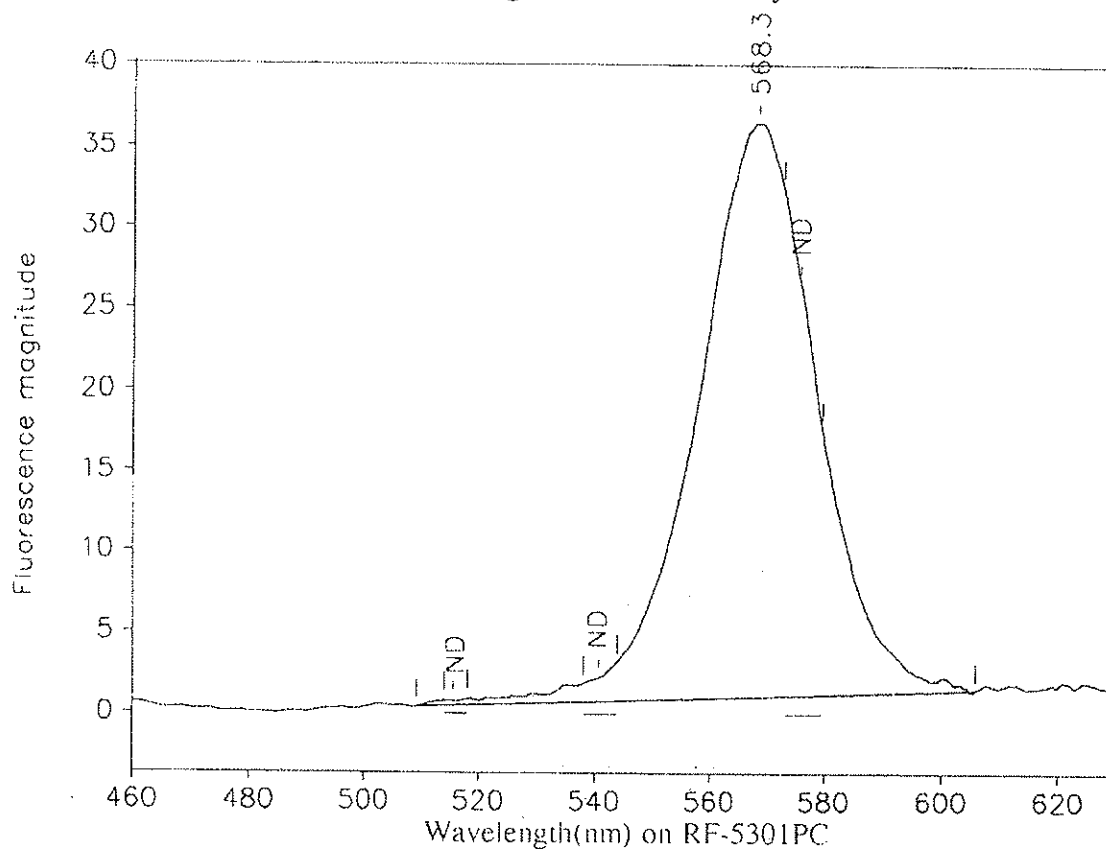
Collected: 08/11/09 1724

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|-------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 569.7 | 531.2 | 598.0 | 2.70 | 70.83 | 0.04 | 14.4 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main
 OUL number: T2011
 Matrix: Elutant
 Placed: 08/15/09 1707

Analyzed: 08/26/09

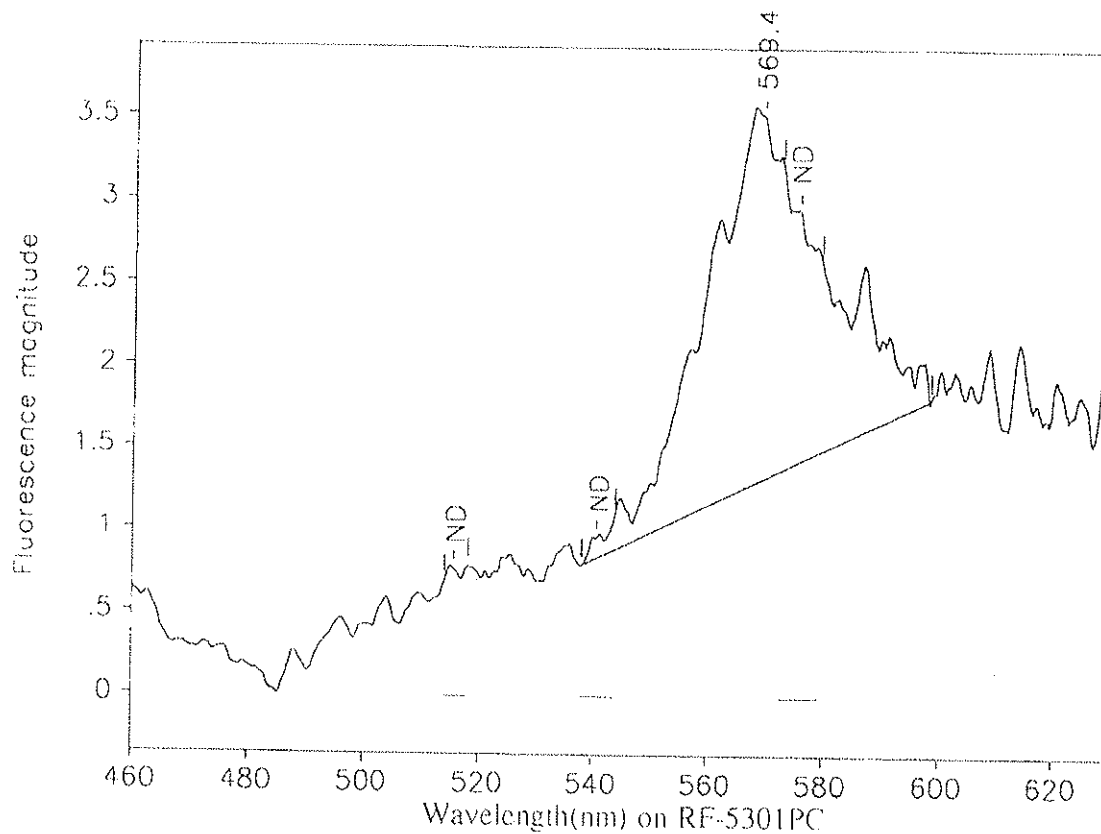
Collected: 08/19/09 1518

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|--------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 509.2 | 605.8 | 35.44 | 863.46 | 0.04 | 175 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31B: Manatee Spring Main BackUp

OUL number: T2012

Matrix: Elutant

Placed: 08/07/09 1730

Analyzed: 08/26/09

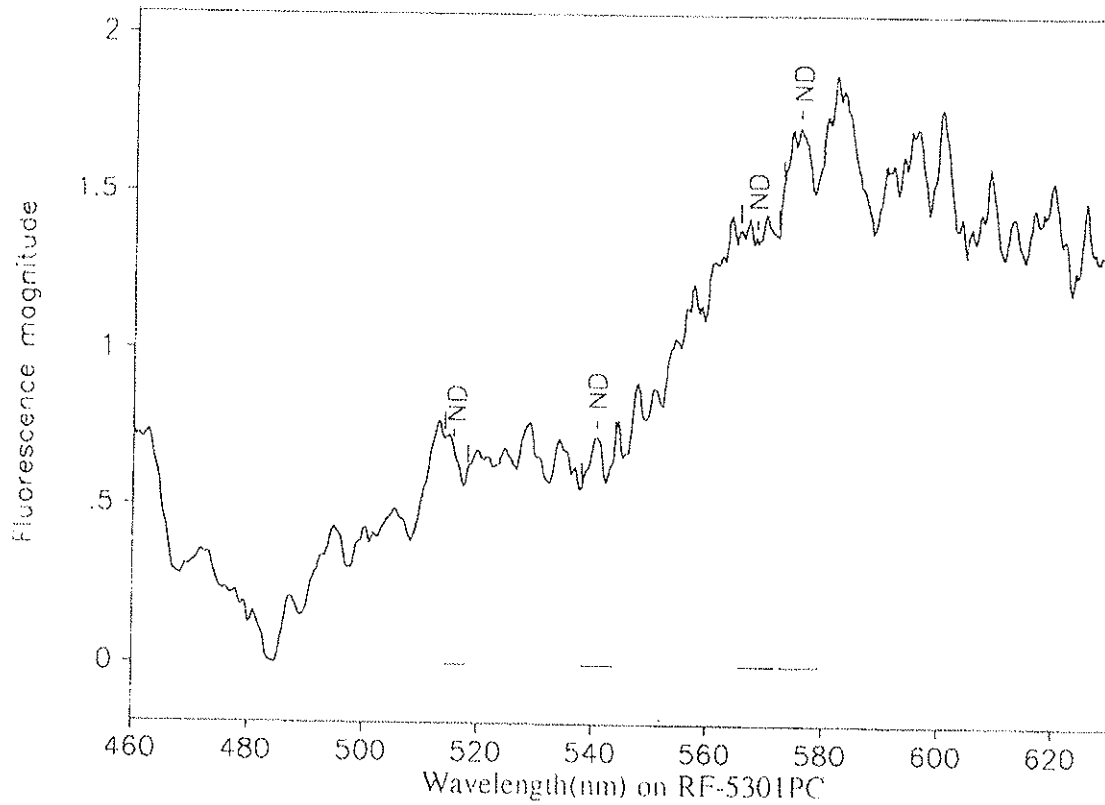
Collected: 08/11/09 1739

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|-------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 569.4 | 538.0 | 598.6 | 2.20 | 54.60 | 0.04 | 11.1 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 32: Manatee Spring Main Tunnel

OUL number: T2013

Matrix: Elutant

Placed: 08/02/09 1535

Analyzed: 08/26/09

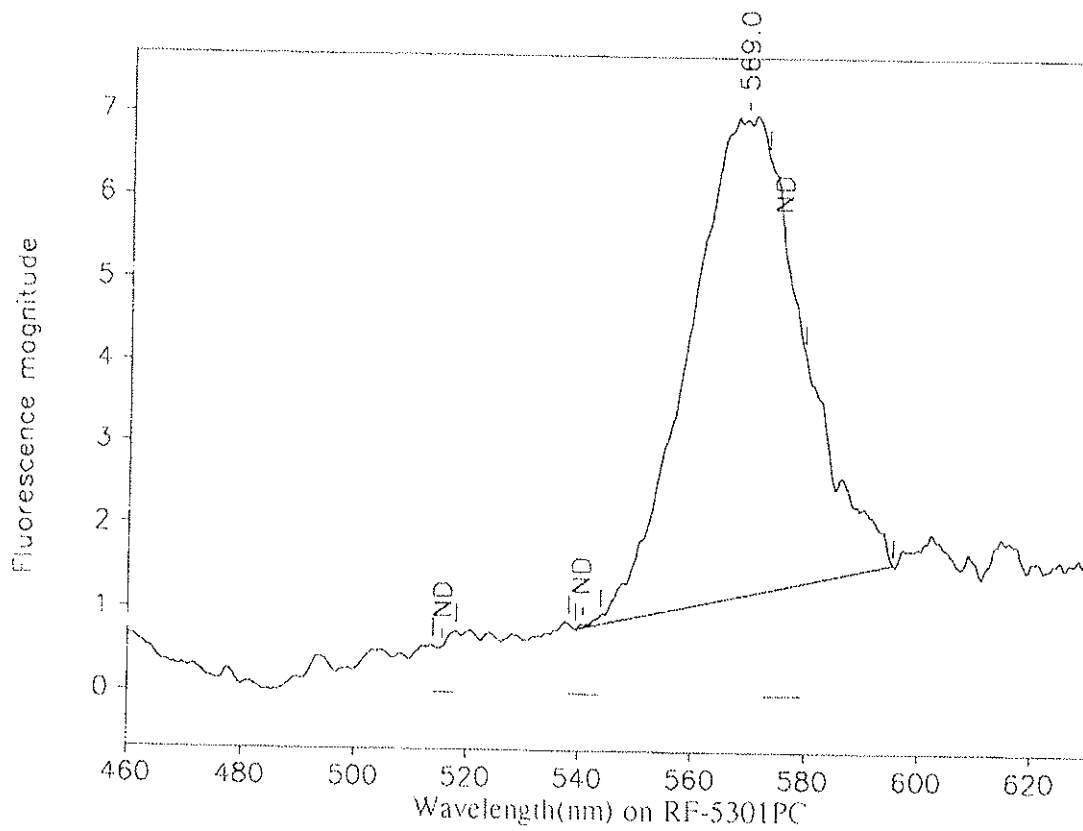
Collected: 08/07/09 1657

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 32: Manatee Spring Main Tunnel

OUL number: T2014

Matrix: Elutant

Placed: 08/07/09 1657

Analyzed: 08/26/09

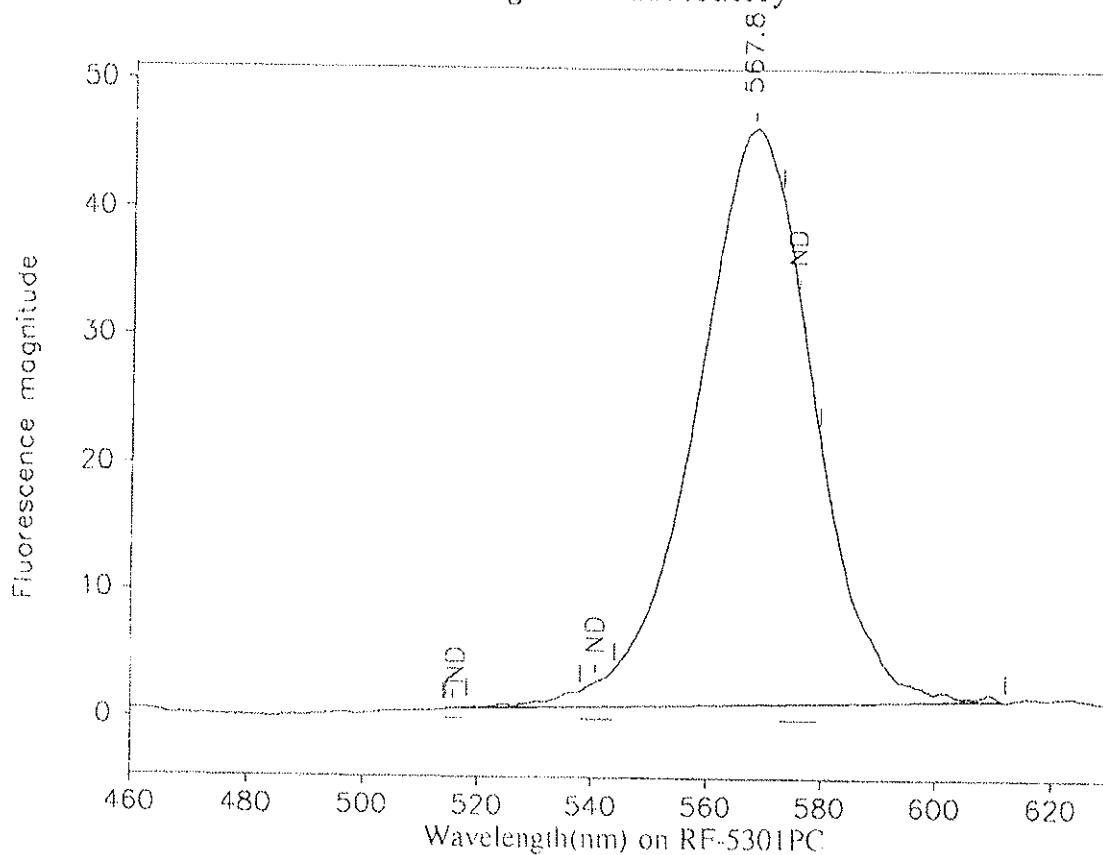
Collected: 08/11/09 1704

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|--------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 569.0 | 539.4 | 595.6 | 5.77 | 135.54 | 0.04 | 27.5 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 32: Manatee Spring Main Tunnel

OUL number: T2015

Matrix: Elutant

Placed: 08/15/09 1650

Analyzed: 08/26/09

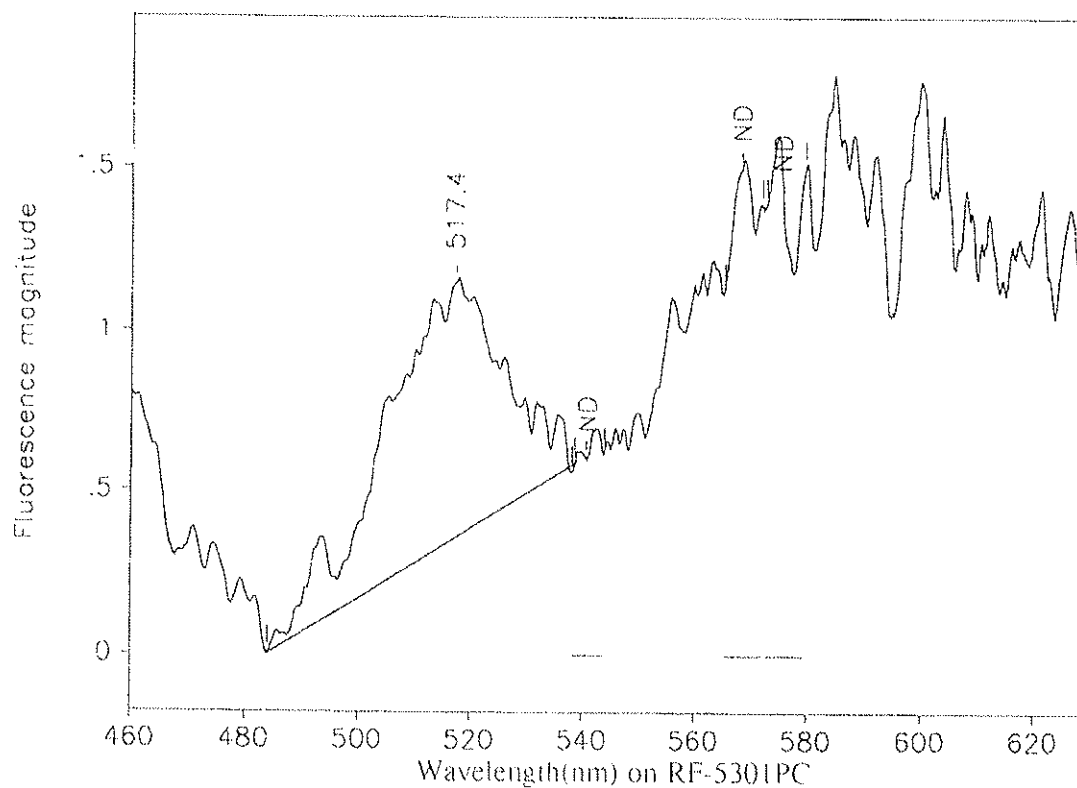
Collected: 08/19/09 1500

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|----------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 567.8 | 514.4 | 612.0 | 45.24 | 1,093.66 | 0.04 | 222 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 33: Manatee Spring Blue Water Tunnel

OUL number: T2016

Analyzed: 08/26/09

Matrix: Elutant

Placed: 08/02/09 1525

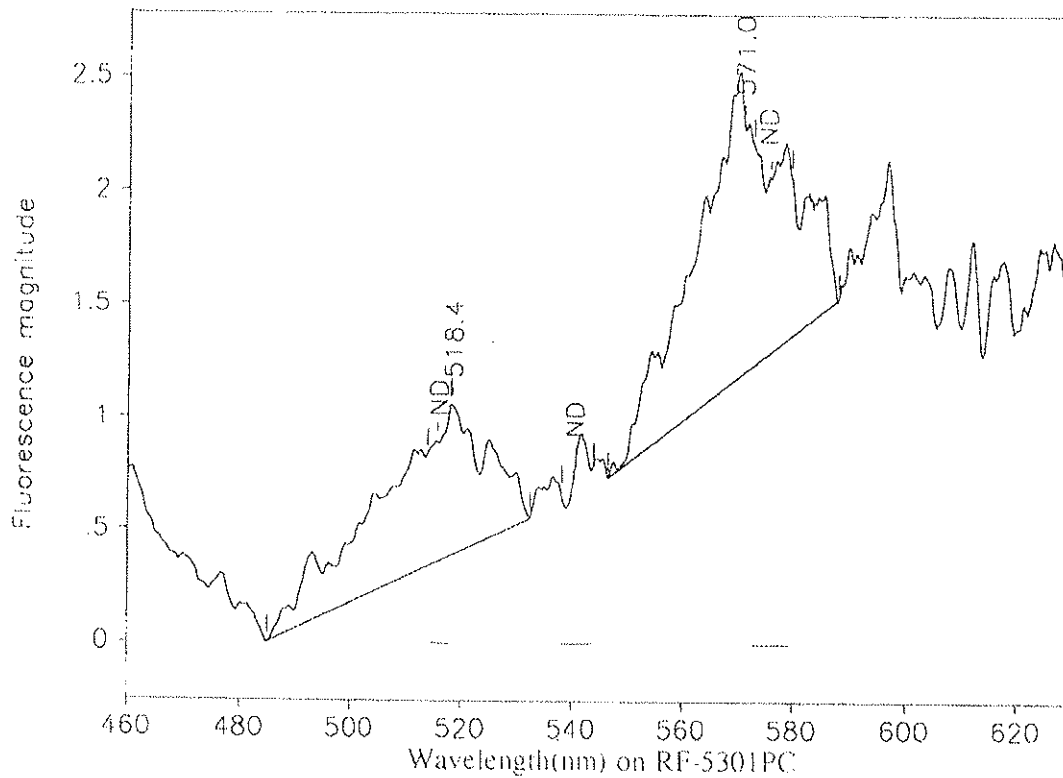
Collected: 08/07/09 1701

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|-------|------|---------|
| 517.4 | 484.0 | 538.6 | 0.79 | 19.90 | 0.04 | 0.643 * |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 33: Manatee Spring Blue Water Tunnel

OUL number: T2017

Analyzed: 08/26/09

Matrix: Elutant

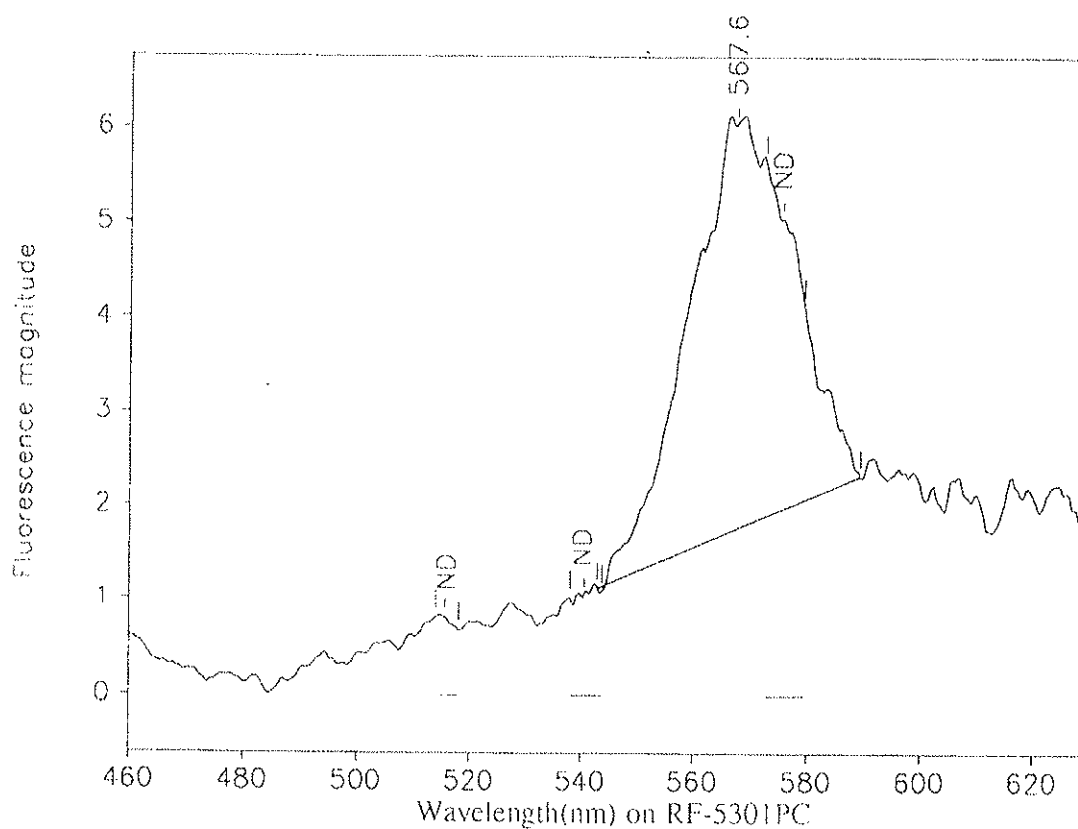
Placed: 08/07/09 1701

Collected: 08/11/09 1656

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---|--------|---------|--------|-------|------|---------------------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 571.0 | 546.4 | 588.0 | 1.10 | 24.77 | 0.04 | 5.03 * |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |
| Peaks close to the normal range of tracer dyes: | | | | | | |
| 518.4 | 485.0 | 532.4 | 0.67 | 15.66 | 0.04 | 0.506 ND |

Ozark Underground Laboratory



Station 33: Manatee Spring Blue Water Tunnel

OUL number: T2018

Analyzed: 08/26/09

Matrix: Elutant

Placed: 08/15/09 1646

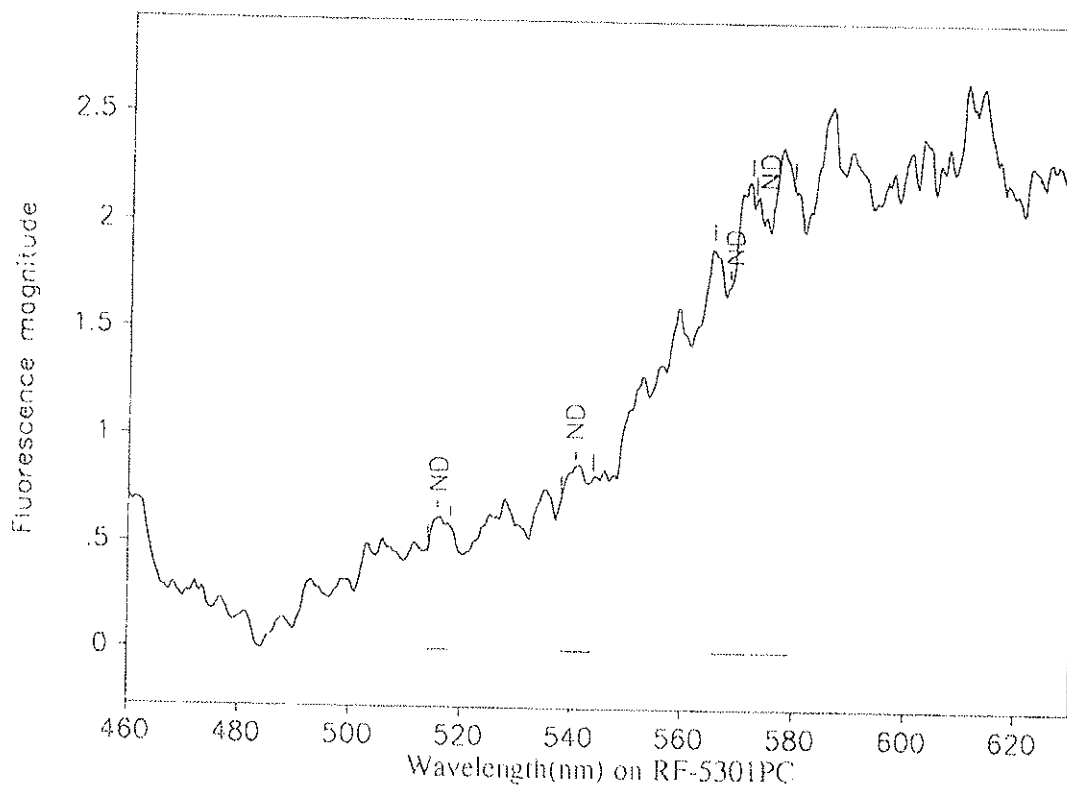
Collected: 08/19/09 1452

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|-------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 567.6 | 543.0 | 589.4 | 4.28 | 93.90 | 0.05 | 19.1 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 46: Chiefland Public Supply Well North

OUL number: T2019

Analyzed: 08/26/09

Matrix: Elutant

Placed: 08/03/09 1608

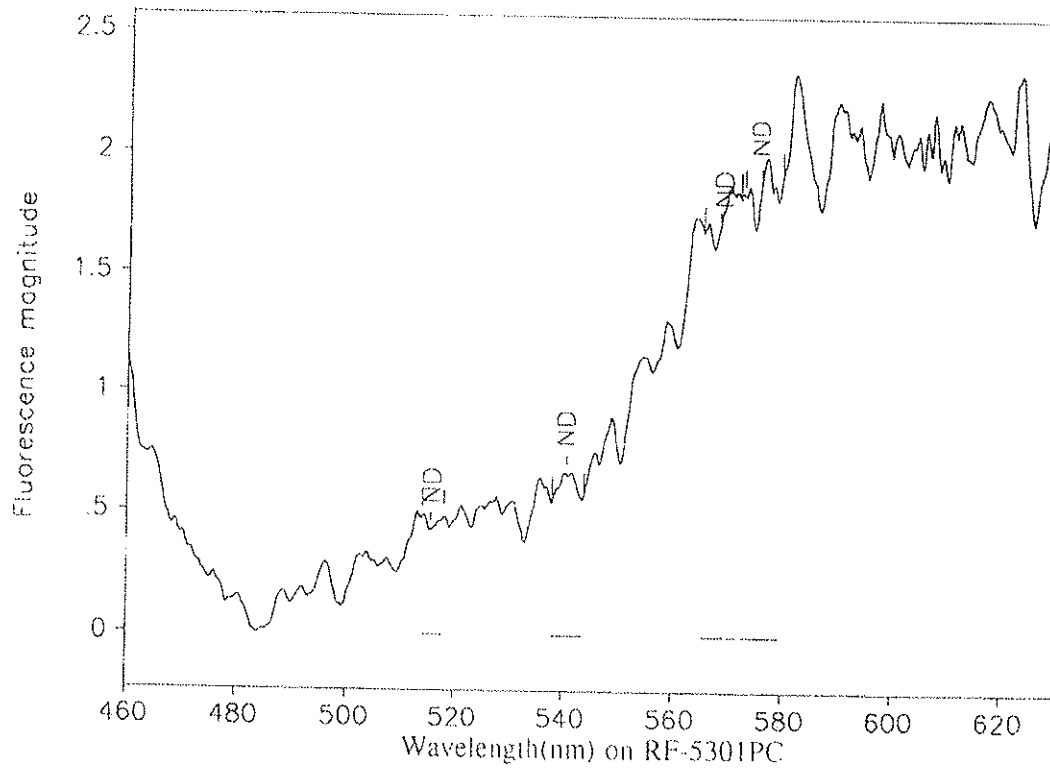
Collected: 08/05/09 1138

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 46: Chiefland Public Supply Well North

OUL number: T2021

Analyzed: 08/26/09

Matrix: Elutant

Placed: 08/05/09 1138

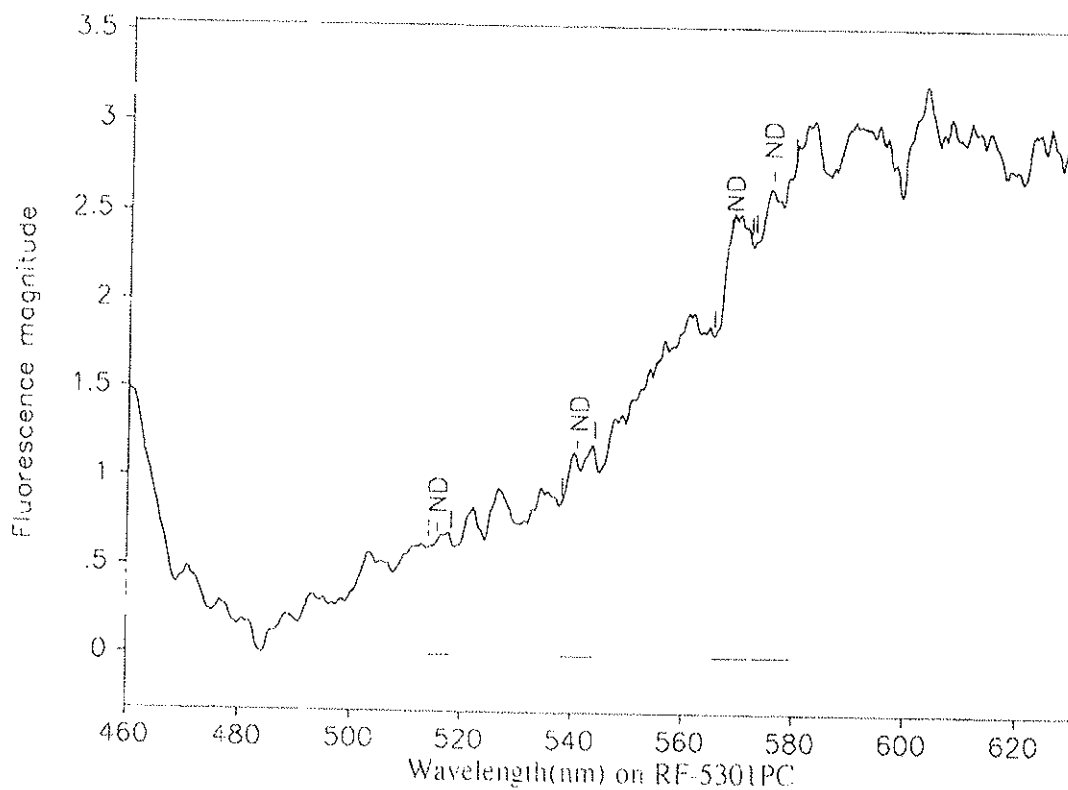
Collected: 08/07/09 1418

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 46: Chiefland Public Supply Well North

OUL number: T2022

Matrix: Elutant

Placed: 08/07/09 1418

Analyzed: 08/26/09

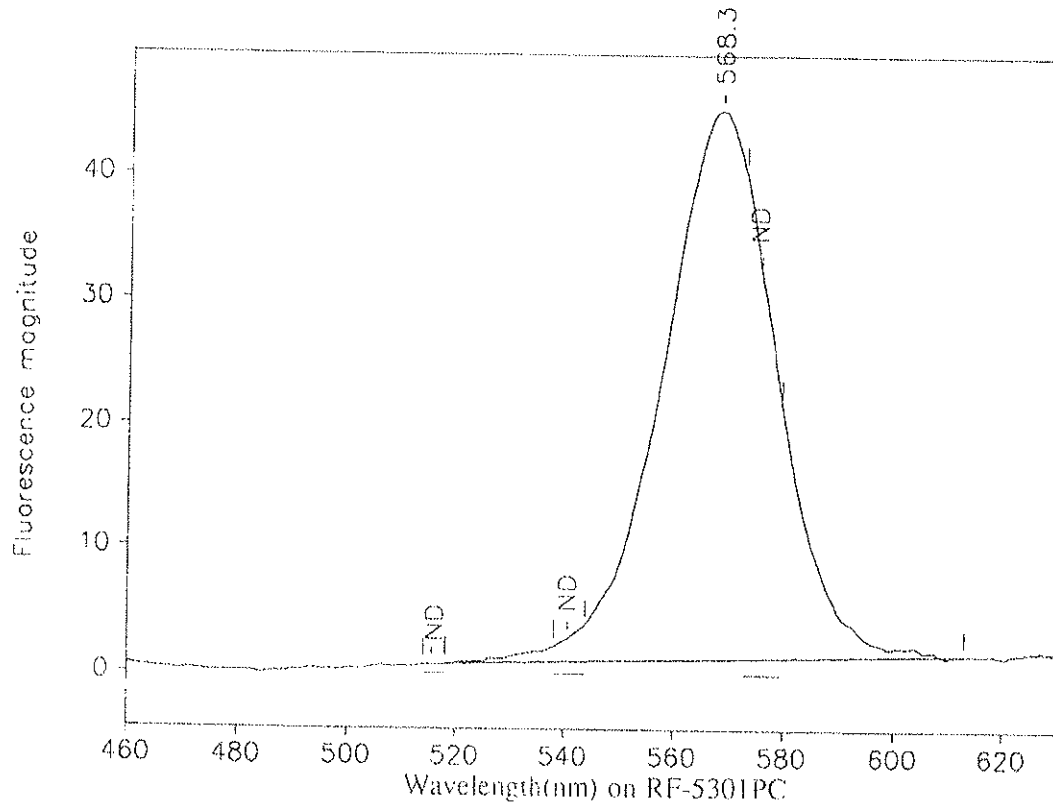
Collected: 08/11/09 1413

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station D2: QC Duplicate

OUL number: T2023

Matrix: Elutant

Placed: 08/15/09

Analyzed: 08/26/09

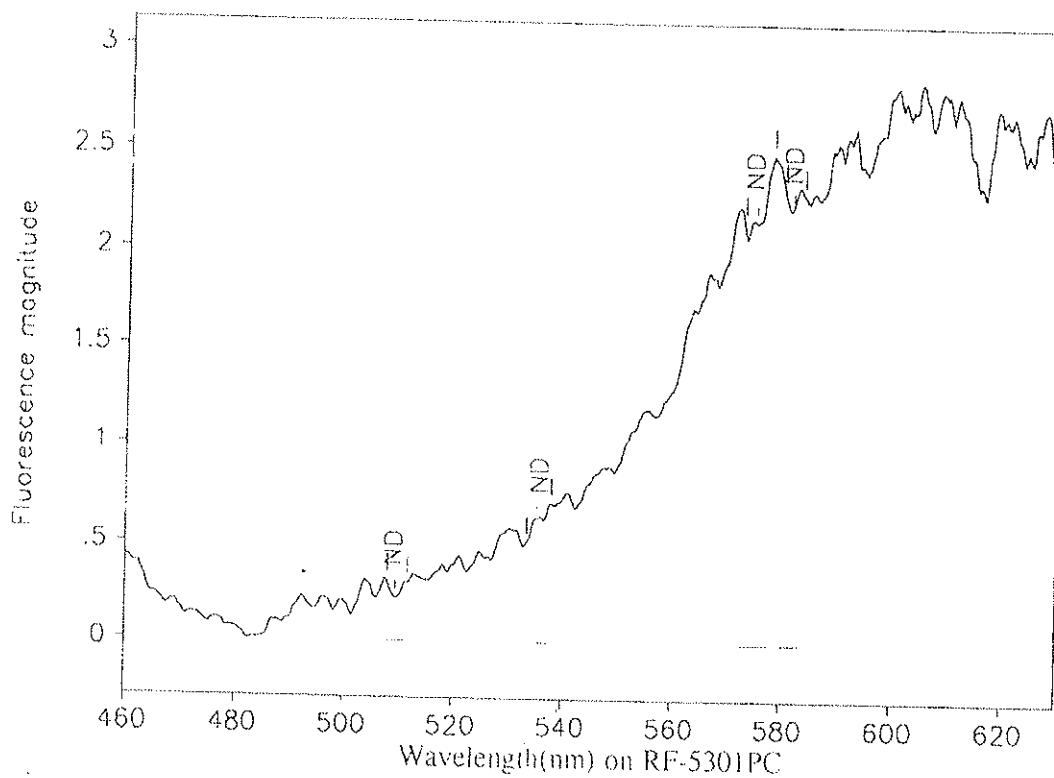
Collected: 08/19/09

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|----------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 518.2 | 613.0 | 44.09 | 1,065.19 | 0.04 | 216 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Mam

OUL number: T2024

Matrix: Water

Collected: 08/20/09 1834

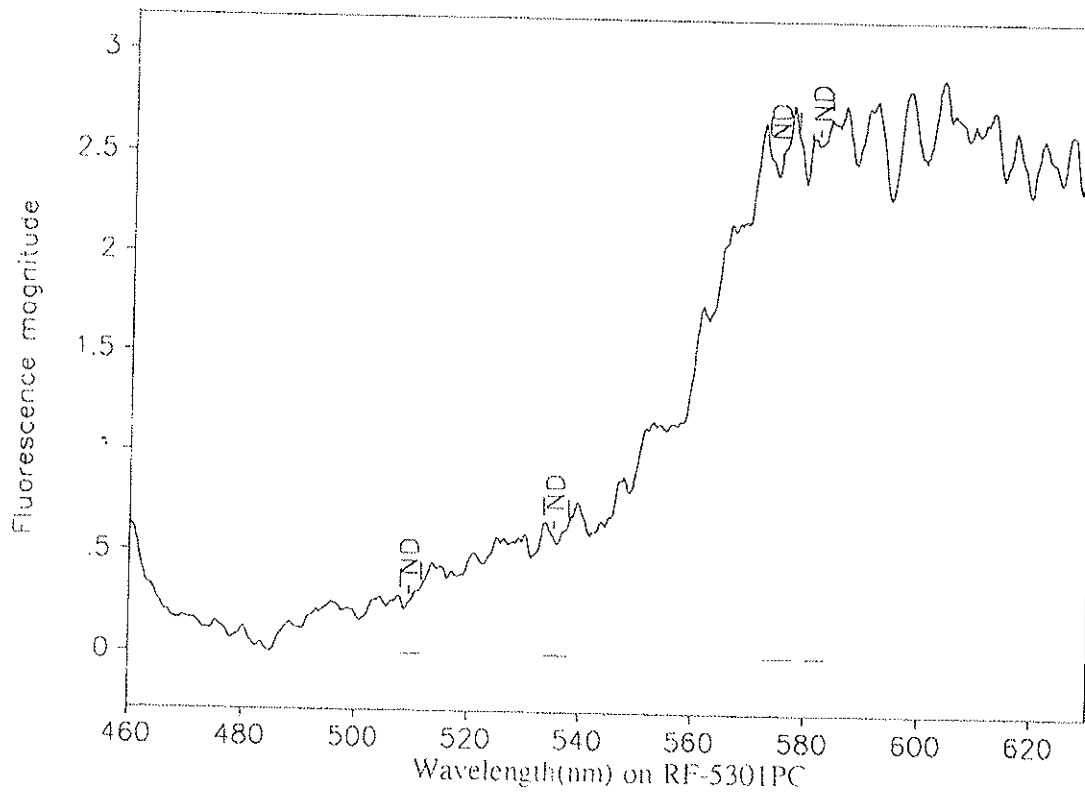
Analyzed: 08/27/09

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.4 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2025

Matrix: Water

Collected: 08/19/09 1518

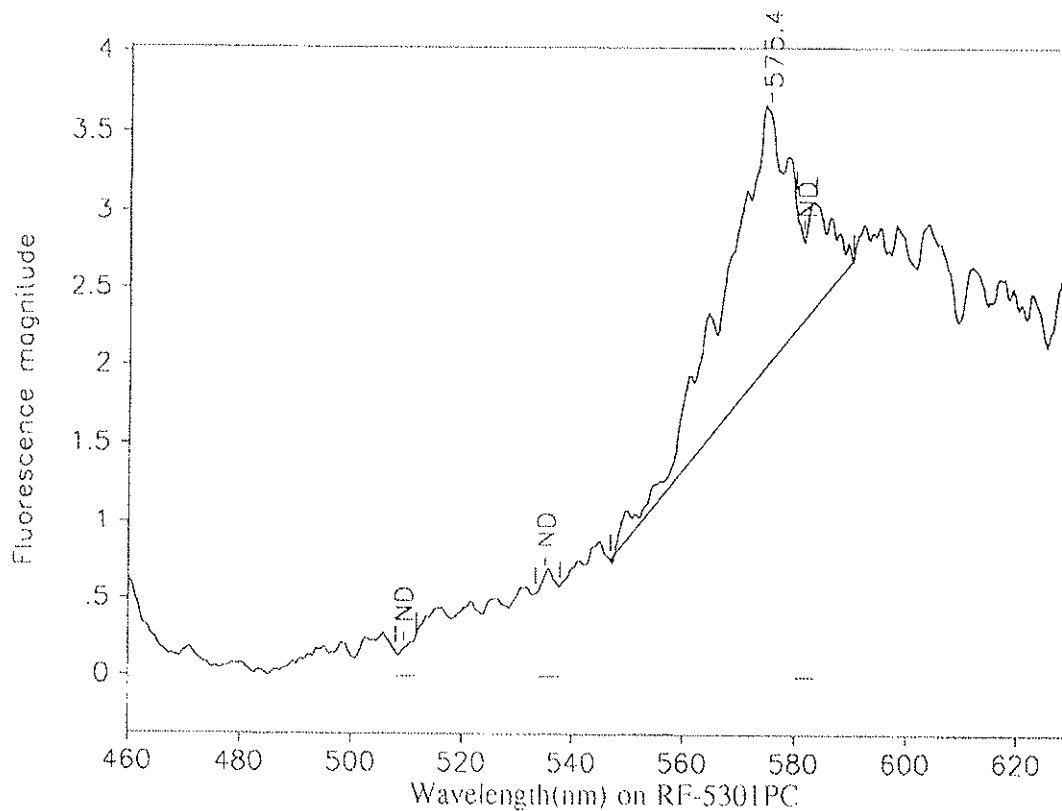
Analyzed: 08/27/09

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.4 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2026

Matrix: Water

Collected: 08/15/09 1707

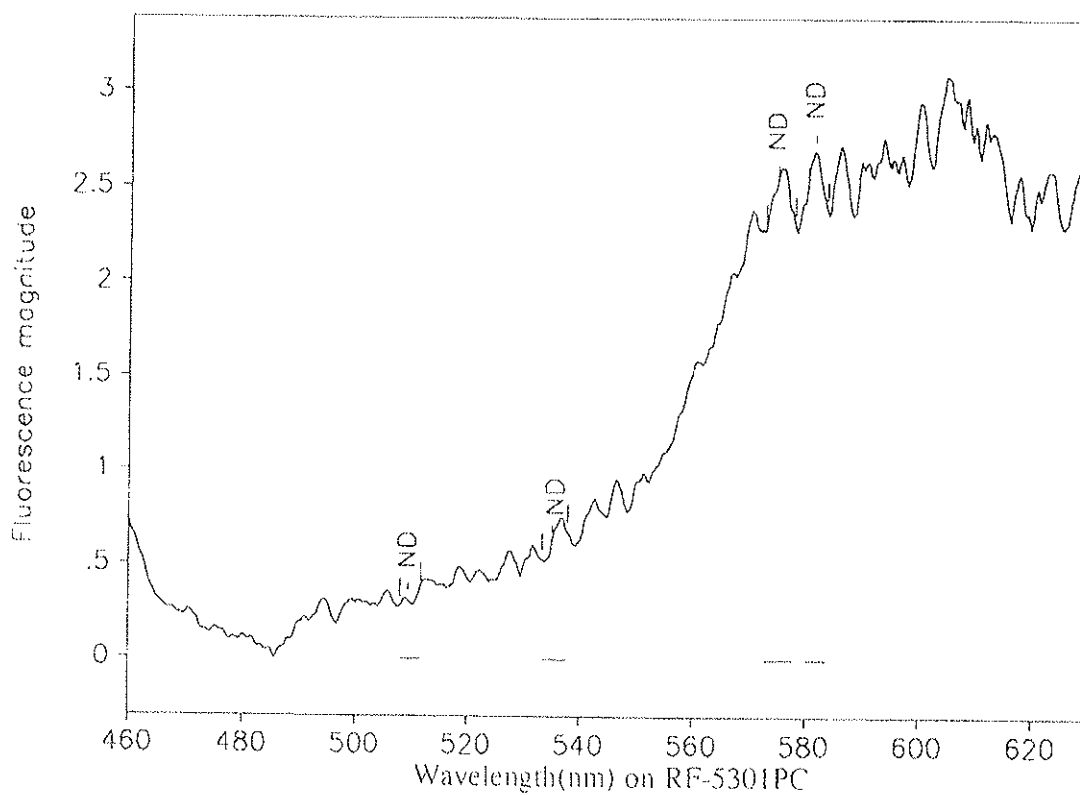
Analyzed: 08/27/09

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|-------|------|---------|
| 509.4 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 575.4 | 547.0 | 590.4 | 1.62 | 26.05 | 0.06 | 0.418 * |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2027

Analyzed: 08/27/09

Matrix: Water

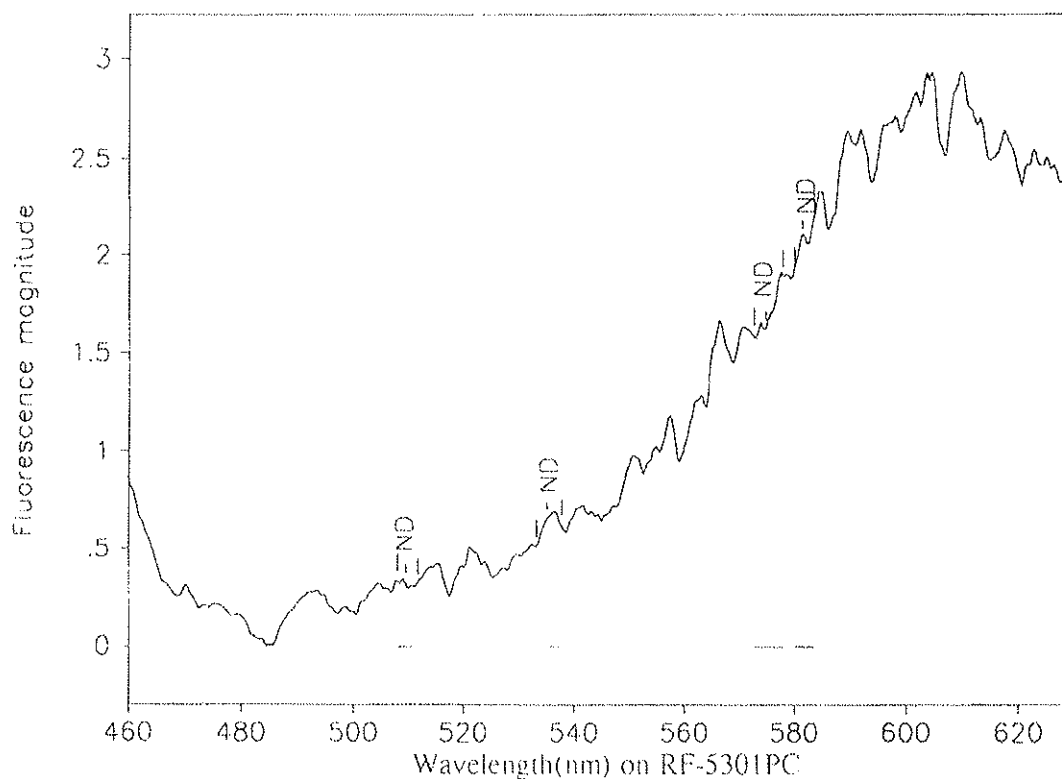
Collected: 08/11/09 1724

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.4 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2028

Analyzed: 08/27/09

Matrix: Water

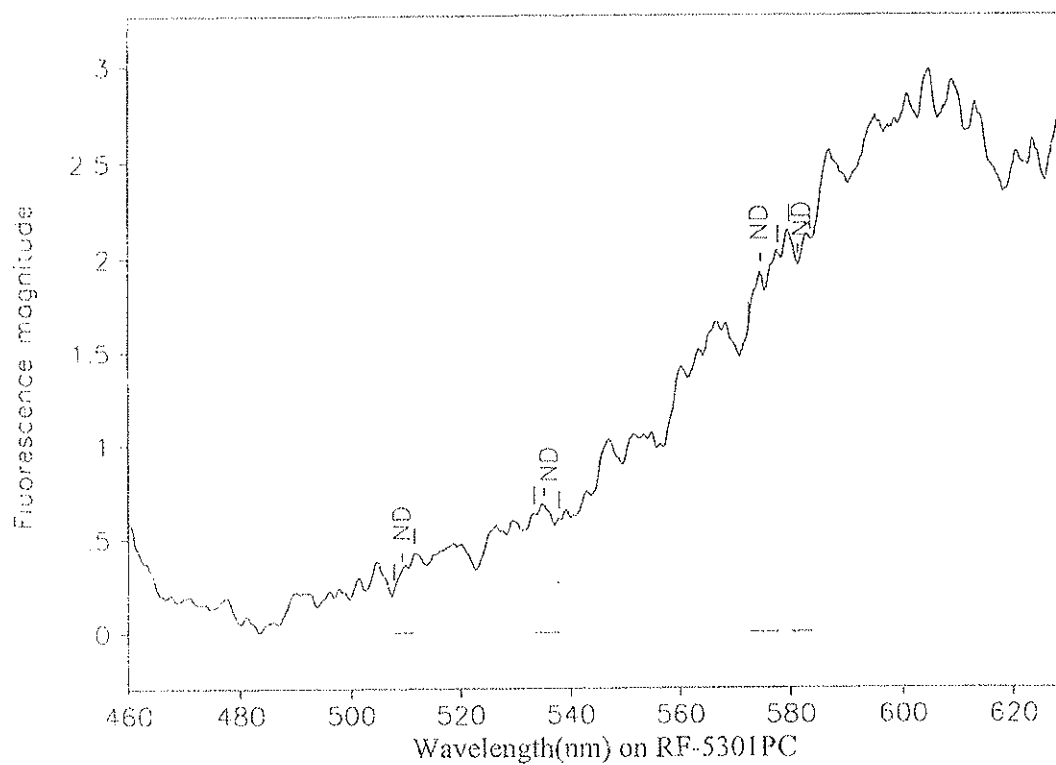
Collected: 08/07/09 1717

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.4 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main (Background)

OUL number: T2029

Analyzed: 08/27/09

Matrix: Water

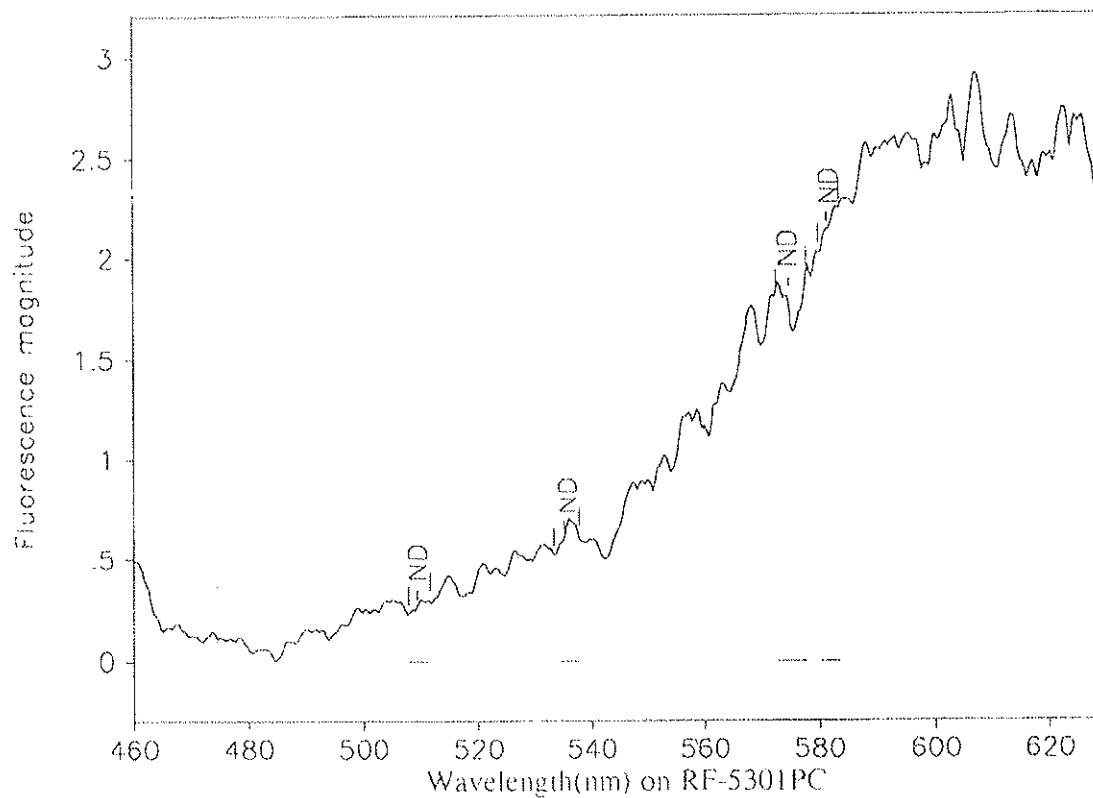
Collected: 08/02/09 1450

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.4 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station D3: QC Duplicate

OUL number: T2030

Matrix: Water

Collected:

Analyzed: 08/27/09

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.4 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory, Inc.

1572 Alev Lane, Protem, MO 65733 Phone 417-785-4289 Fax 417-785-4290 OUL@tri-lakes.net

Certificate of Analysis

Date of certificate: September 11, 2009

Date samples shipped: September 3, 2009

Client: Pete Butt, Karst Environmental Services, Inc.

Date samples received at OUL: September 4, 2009

(kes@atlantic.net)

Date analyzed by OUL: September 10, 2009

Bill Colona, URS Corp.

Included with certificate of analysis:

(William.Colona@URS Corp.com)

Table of results, copy of sample collection data sheets and graphs

Project: Fanning-Manatee Dye Trace, Week 3-4 (Shipment 3)

Samples collected by: Peter Butt, Mark Long

Results for charcoal and water samplers analyzed for the presence of fluorescein and rhodamine WT (RWT) dyes.

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

All results are for charcoal unless otherwise indicated.

| OUL Number | Station Number | Station Name | Date/Time Placed | Date/Time Collected | Fluorescein Results | | RWT Results | |
|------------|-----------------------------------|------------------------------------|------------------|---------------------|---------------------|-----------|-------------|-----------|
| | | | | | Peak nm | Conc. ppb | Peak nm | Conc. ppb |
| T2172 | 31 | Manatee Spring Main | 8/19/09 1518 | 8/24/09 1719 | ND | | 568.3 | 71.8 |
| T2173 | 31 | Manatee Spring Main | 8/24/09 1719 | 8/29/09 1815 | ND | | 567.6 | 41.8 |
| T2174 | 32 | Manatee Spring Main Tunnel | 8/19/09 1500 | 8/24/09 1703 | ND | | 568.1 | 120 |
| T2175 | 32 | Manatee Spring Main Tunnel | 8/24/09 1703 | 8/29/09 1800 | ND | | 568.4 | 96.8 |
| T2176 | 33 | Manatee Spring Blue Water Tunnel | 8/19/09 1452 | 8/24/09 1657 | 517.2 * | 0.503 | 568.1 | 24.8 |
| T2177 | 33 | Manatee Spring Blue Water Tunnel | 8/24/09 1657 | 8/29/09 1750 | ND | | 570.5 * | 9.01 |
| T2178 | 34 | Clay Landing Vent | 8/21/09 1224 | 8/29/09 1513 | ND | | ND | |
| T2179 | 42 | Levy County Public Supply Well | 8/19/09 1335 | 8/24/09 1543 | ND | | ND | |
| T2180 | Laboratory control charcoal blank | | | | | | | |
| T2181 | 45 | Chiefland Public Supply Well South | 8/24/09 1505 | 8/29/09 1622 | ND | | ND | |
| T2182 | 46 | Chiefland Public Supply Well North | 8/19/09 1259 | 8/24/09 1525 | ND | | ND | |
| T2183 | 11 | Fanning Spring Main | 8/21/09 1631 | 8/30/09 1637 | ND | | ND | |
| T2184 | D4 | QC Duplicate | 8/19/09 NT | 8/24/09 NT | ND | | 568.2 | 107 |
| T2185 | 31 | Manatee Spring Main | Water | 8/21/09 2034 | ND | | ND | |
| T2186 | 31 | Manatee Spring Main | Water | 8/22/09 1730 | ND | | ND | |
| T2187 | 31 | Manatee Spring Main | Water | 8/23/09 2058 | ND | | ND | |
| T2188 | 31 | Manatee Spring Main | Water | 8/24/09 1719 | ND | | ND | |

| OUL Number | Station Number | Station Name | Date/Time Placed | Date/Time Collected | Fluorescein Results | | RWT Results | |
|------------|----------------|---------------------|------------------|---------------------|---------------------|-----------|-------------|-------------|
| | | | | | Peak nm | Conc. ppb | Peak nm | Conc. ppb |
| T2189 | 31 | Manatee Spring Main | Water | 8/28/09 2215 | ND | | ND | |
| T2190 | 31 | Manatee Spring Main | Water | 8/29/09 1815 | ND | | ND | |
| T2191 | 31 | Manatee Spring Main | Water | 8/30/09 1340 | ND | | ND | |
| T2192 | D5 | QC Duplicate | Water | NDT | ND | | ND | |
| | | | | | | | | Page 2 of 2 |

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

NDT = No date or time given

NT = No time given

* = 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 were the tracer dye.

Thomas J. Aley, PHG and RG

1572 Aley Lane Proteom, MO 65733 (417) 785-4289 fax (417) 785-4290 email: out@tri-takes.net

Project: Fanning-Manatee Dye Trace Week No: 3-4 (Shipment 3) Samples Collected By: Peter Butt/Mark Long
 Samples Shipped By: KES via FedEx Samples Received By: C. Allen / P. McC
 Date Samples Shipped: 9/3/09 Date Samples Received: 9/14/09 Time Samples Received: 12:30 Return Cooler? Yes No X
 Bill to: Karst Environmental Services, Inc. Send Results to: Karst Environmental Services, Inc.
 Analyze for: Fluorescein ☒ Eosine ☐ Rhodamine WT ☒ Other ☐ Ship cooler to: n/a

| OUL
use only | | Please indicate stations where dye was visible in the field
for field technician use - use black ink only | | | | | | | | | | OUL
use only |
|-----------------|---------------|--|------------------------------------|---------|-------|-----------|-------|---------------------|--|--|--|-----------------|
| # CHAR
REC'D | LAB
NUMBER | STATION
NUMBER
1-4 Numbers | STATION NAME | PLACED | | COLLECTED | | #
WATER
REC'D | | | | |
| | | | | DATE | TIME | DATE | TIME | | | | | |
| 1 | T2172 | 31 | Manatee Spring Main | 8/19/09 | 15:18 | 8/24/09 | 17:19 | 0 | | | | |
| 1 | T2173 | 31 | Manatee Spring Main | 8/24/09 | 17:19 | 8/29/09 | 18:15 | 0 | | | | |
| 1 | T2174 | 32 | Manatee Spring Main Tunnel | 8/19/09 | 15:00 | 8/24/09 | 17:03 | 0 | | | | |
| 1 | T2175 | 32 | Manatee Spring Main Tunnel | 8/24/09 | 17:03 | 8/29/09 | 18:00 | 0 | | | | |
| 1 | T2176 | 33 | Manatee Spring Blue Water Tunnel | 8/19/09 | 14:52 | 8/24/09 | 16:57 | 0 | | | | |
| 1 | T2177 | 33 | Manatee Spring Blue Water Tunnel | 8/24/09 | 16:57 | 8/29/09 | 17:50 | 0 | | | | |
| 1 | T2178 | 34 | Clay Landing Vent | 8/21/09 | 12:24 | 8/29/09 | 15:13 | 0 | | | | |
| 1 | T2179 | 42 | Levy County Public Supply Well | 8/19/09 | 13:35 | 8/24/09 | 15:43 | 0 | | | | |
| 1 | T2181 | 45 | Chiefland Public Supply Well South | 8/24/09 | 15:05 | 8/29/09 | 16:22 | 0 | | | | |
| 1 | T2182 | 46 | Chiefland Public Supply Well North | 8/19/09 | 12:59 | 8/24/09 | 15:25 | 0 | | | | |
| 1 | T2183 | 11 | Fanning Spring main | 8/21/09 | 16:31 | 8/30/09 | 16:37 | 0 | | | | |
| 1 | T2184 | D4 | QC Duplicate | 8/19/09 | | 8/24/09 | | 0 | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

T2180 - OUL Charcoal Blank

COMMENTS: Please analyze all samples.

COPIES - I WOULD ANALYZE ALL SAMPLES.

Out Project 456 9/10/09 4 x WP

| | | |
|---|-----------|--|
| <p>Is this sheet filled out by OUL staff? Yes</p> | <p>No</p> | <p>Charts for samples on this page proofed by OUL:</p> |
| <p>Is this sheet filled out by OUL staff? Yes</p> | <p>No</p> | <p>Charts for samples on this page proofed by OUL:</p> |

1572 Aley Lane Proteom, MO 65733 (417) 785-4289 fax (417) 785-4290 email: cul@tri-lakes.net

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Fanning-Manatee Dye Trace Week No: 3-4 (Shipment 3) Water Samples Collected By: Peter Butt/Mark Long

Samples Shipped By: KES via FedEx Samples Received By: C. Alley / *oull*

Date Samples Shipped: 9 / 3 / 09 Date Samples Received: 9 / 4 / 09 Time Samples Received: 13:30 Return Cooler? Yes No X

Bill to: Karst Environmental Services, Inc. Send Results to: Karst Environmental Services, Inc.

Analyze for: Fluorescein X Eosine Rhodamine WT X Other Ship cooler to: n/a

[illegible]

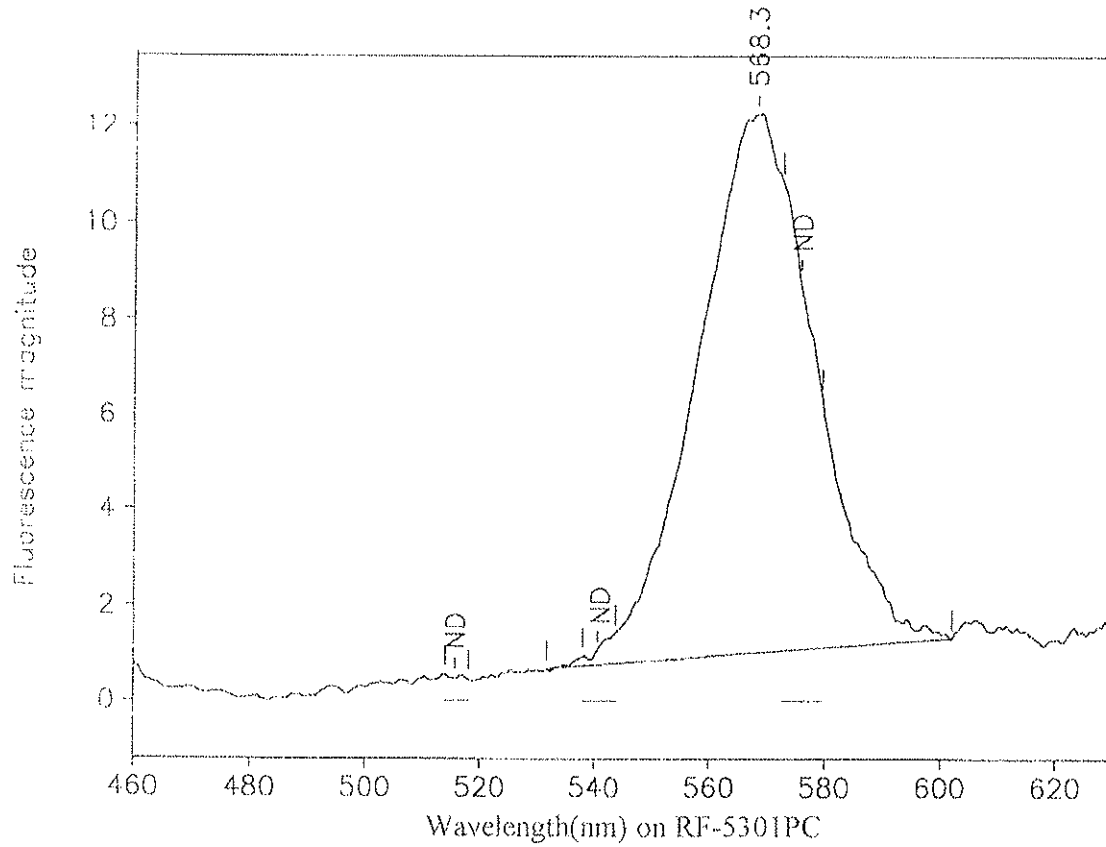
COMMENTS: Please analyze all samples.

This sheet filled out by OUL staff? Yes No X Charts for samples on this page proofed by OUL: OK

OUL Project # 954 Analyzed 9/10/09 by LG-jmc Page 2 of 2 OUL

FishBase forms doc, Rev. 8/99

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2172

Analyzed: 09/10/09

Matrix: Elutant

Placed: 08/19/09 1518

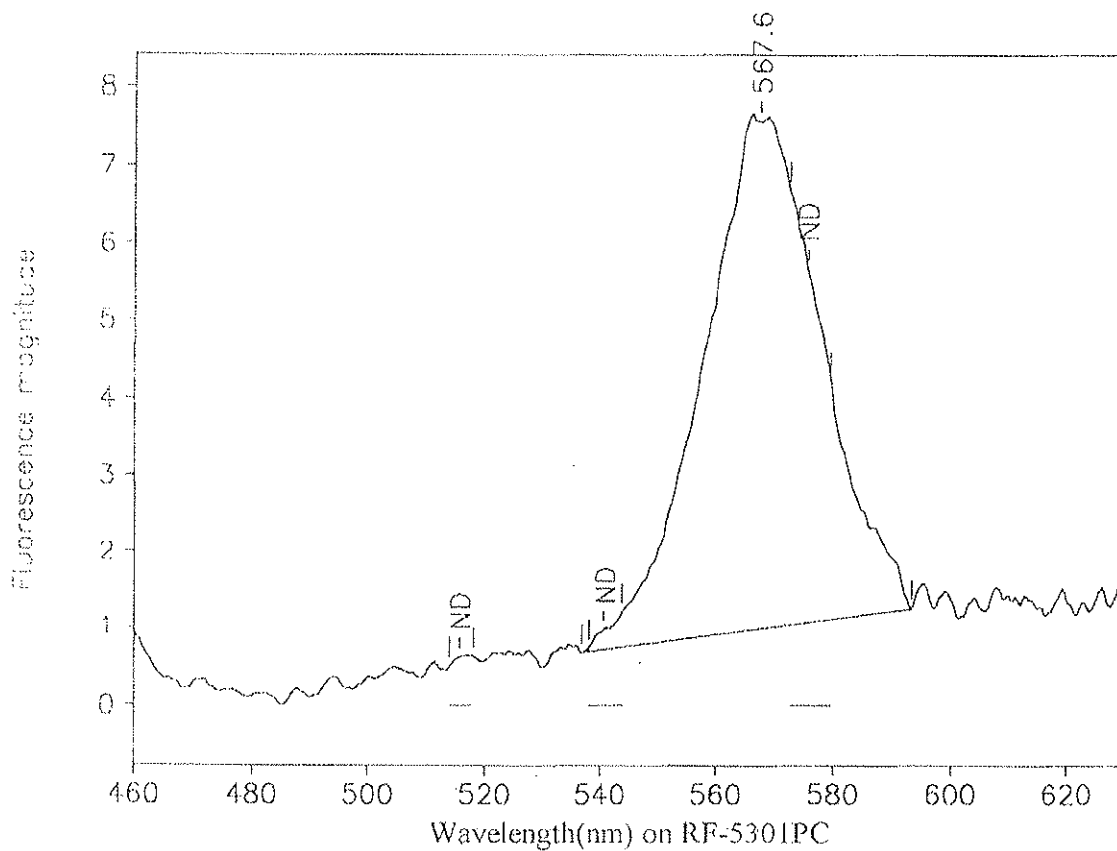
Collected: 08/24/09 1719

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|--------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 531.8 | 602.2 | 11.23 | 269.52 | 0.04 | 71.8 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2173

Analyzed: 09/10/09

Matrix: Elutant

Placed: 08/24/09 1719

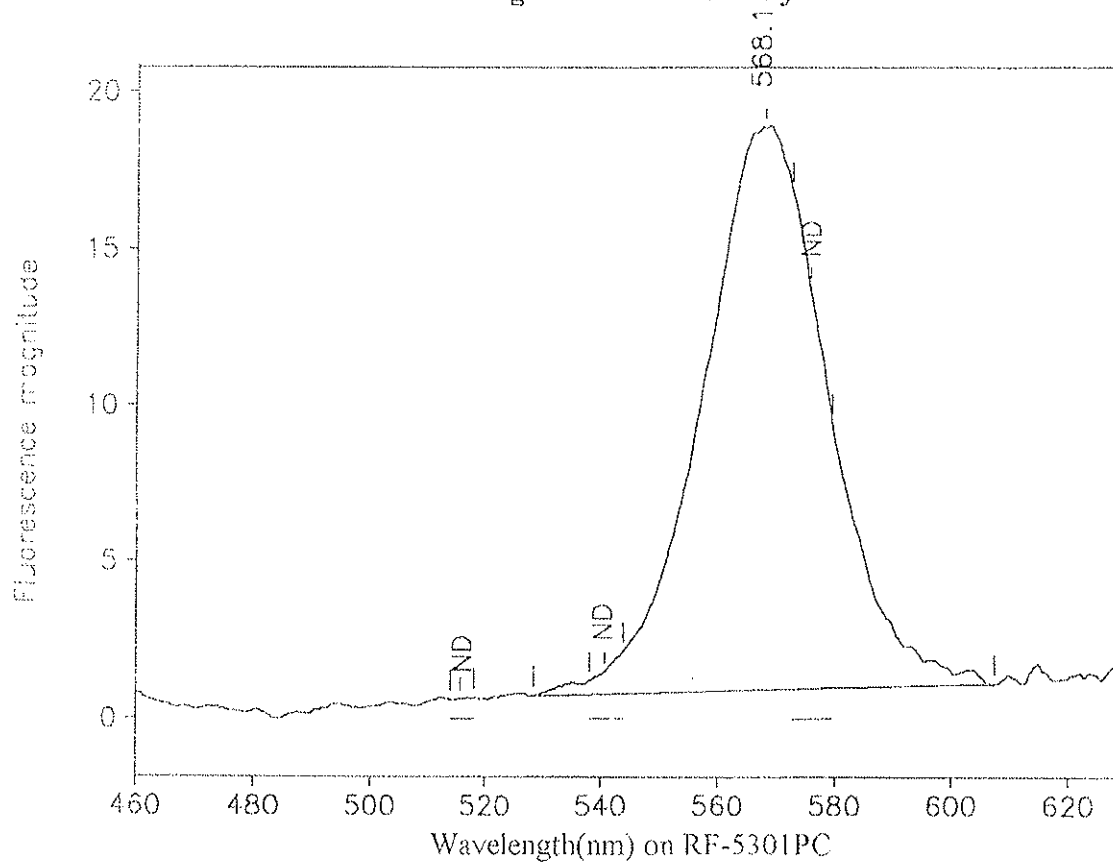
Collected: 08/29/09 1815

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | I/A | Conc. |
|---------|--------|---------|--------|--------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 567.6 | 536.8 | 593.4 | 6.58 | 157.18 | 0.04 | 41.8 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 32: Manatee Spring Main Tunnel

OUL number: T2174

Analyzed: 09/10/09

Matrix: Elutant

Placed: 08/19/09 1500

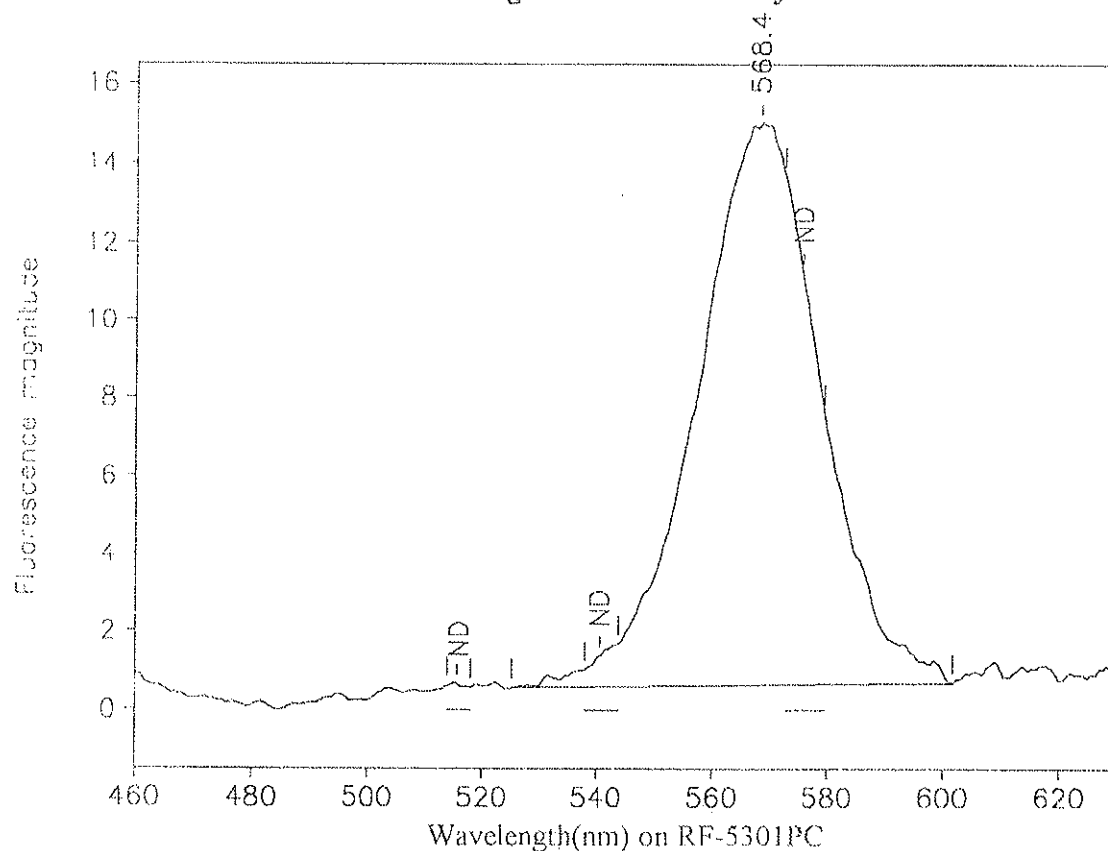
Collected: 08/24/09 1703

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|--------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.1 | 528.4 | 607.4 | 17.94 | 450.40 | 0.04 | 120 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 32: Manatee Spring Main Tunnel

OUL number: T2175

Analyzed: 09/10/09

Matrix: Elutant

Placed: 08/24/09 1703

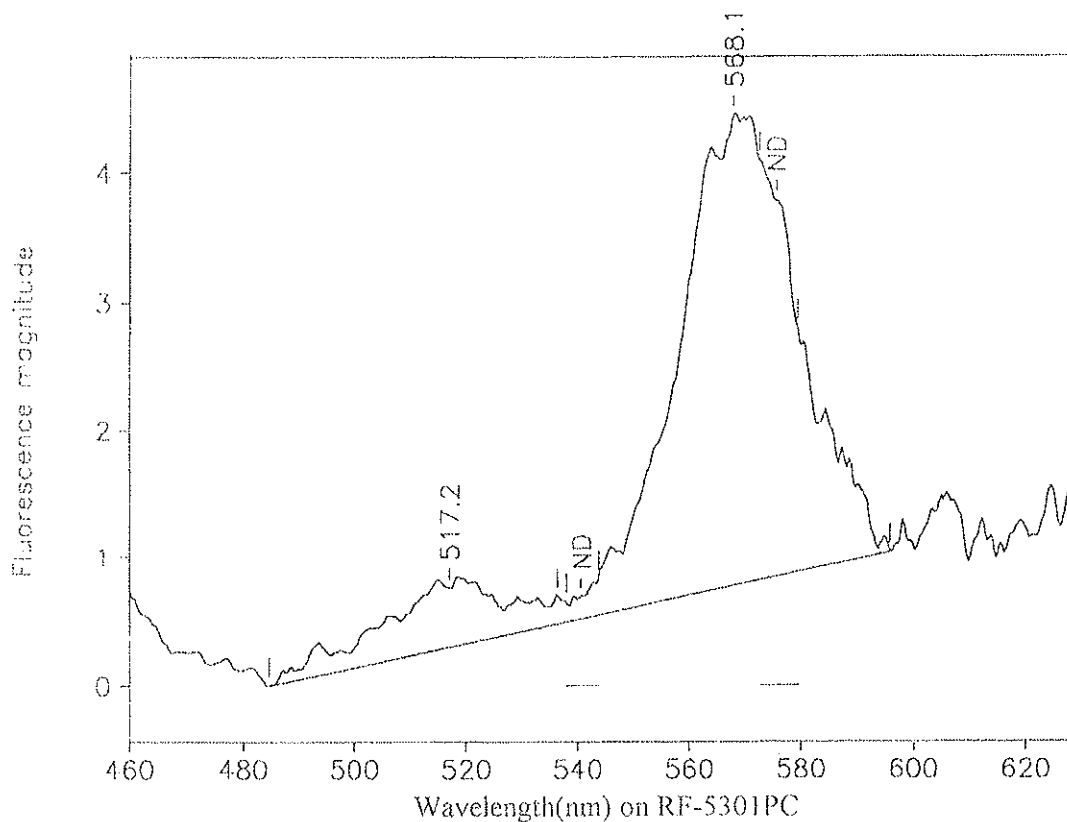
Collected: 08/29/09 1800

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|--------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.4 | 525.2 | 601.8 | 14.37 | 363.57 | 0.04 | 96.8 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 33: Manatee Spring Blue Water Tunnel

OUL number: T2176

Analyzed: 09/10/09

Matrix: Elutant

Placed: 08/19/09 1452

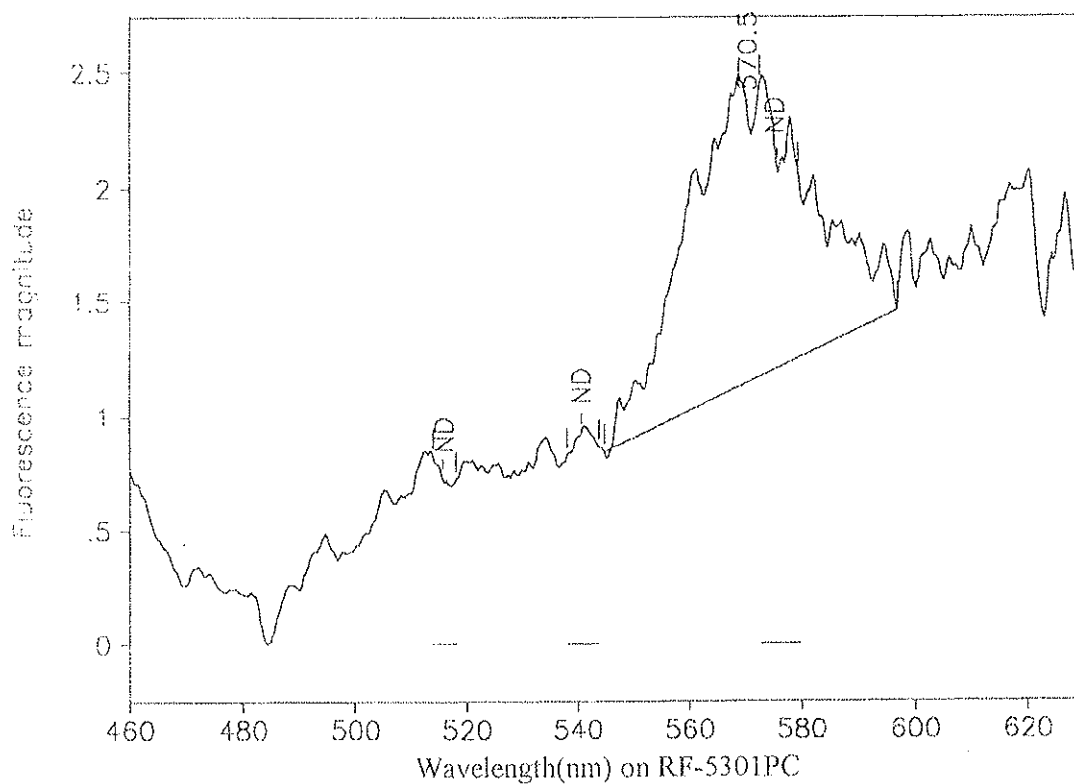
Collected: 08/24/09 1657

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. | * |
|---------|--------|---------|--------|-------|------|-------|---|
| 517.2 | 484.6 | 536.5 | 0.46 | 14.02 | 0.03 | 0.503 | * |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND | |
| 568.1 | 536.5 | 596.0 | 3.67 | 93.11 | 0.04 | 24.8 | |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND | |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 33: Manatee Spring Blue Water Tunnel

OUL number: T2177

Analyzed: 09/10/09

Matrix: Elutant

Placed: 08/24/09 1657

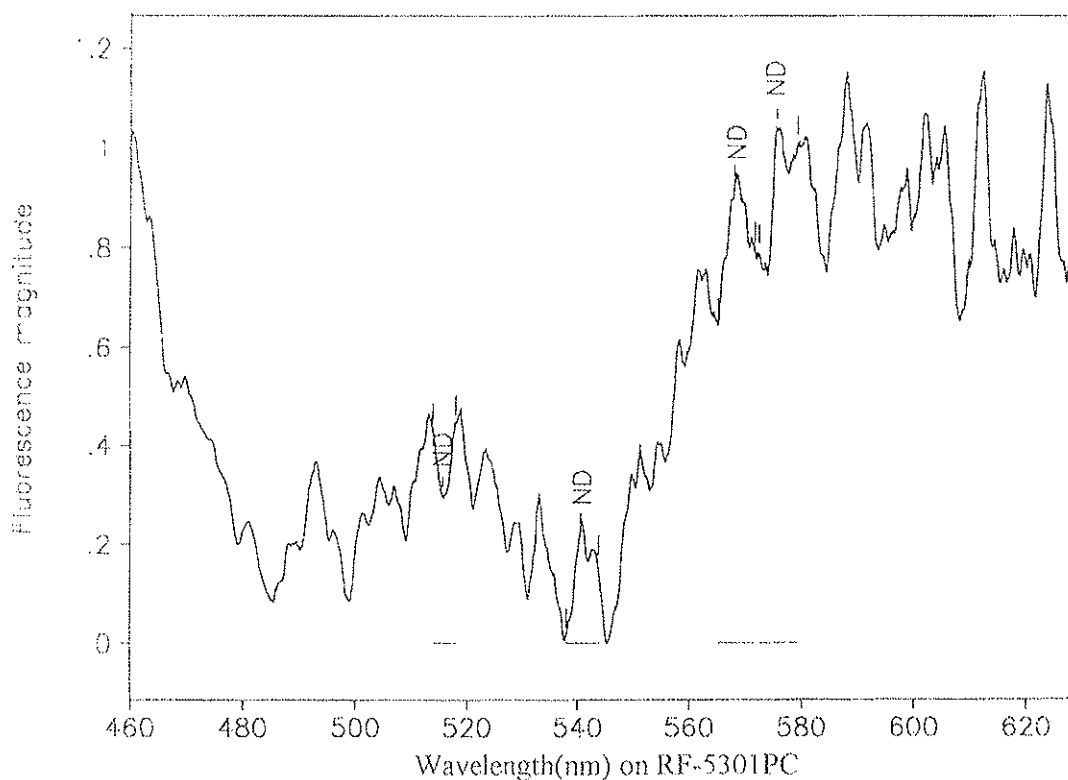
Collected: 08/29/09 1750

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|-------|------|--------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 570.5 | 544.8 | 597.0 | 1.15 | 33.82 | 0.03 | 9.01 * |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 34: Clay Landing Vent

OUL number: T2178

Matrix: Elutant

Placed: 08/21/09 1224

Analyzed: 09/10/09

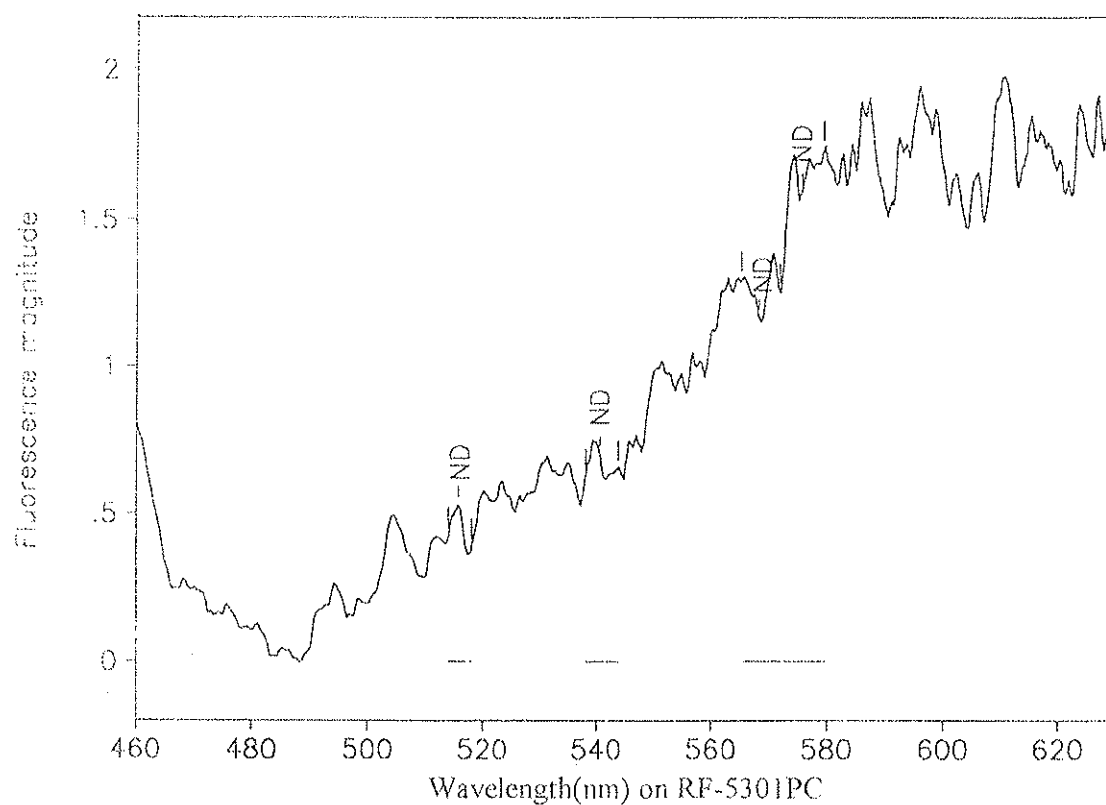
Collected: 08/29/09 1513

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 42: Levy County Public Supply Well

OUL number: T2179

Analyzed: 09/10/09

Matrix: Elutant

Placed: 08/19/09 1335

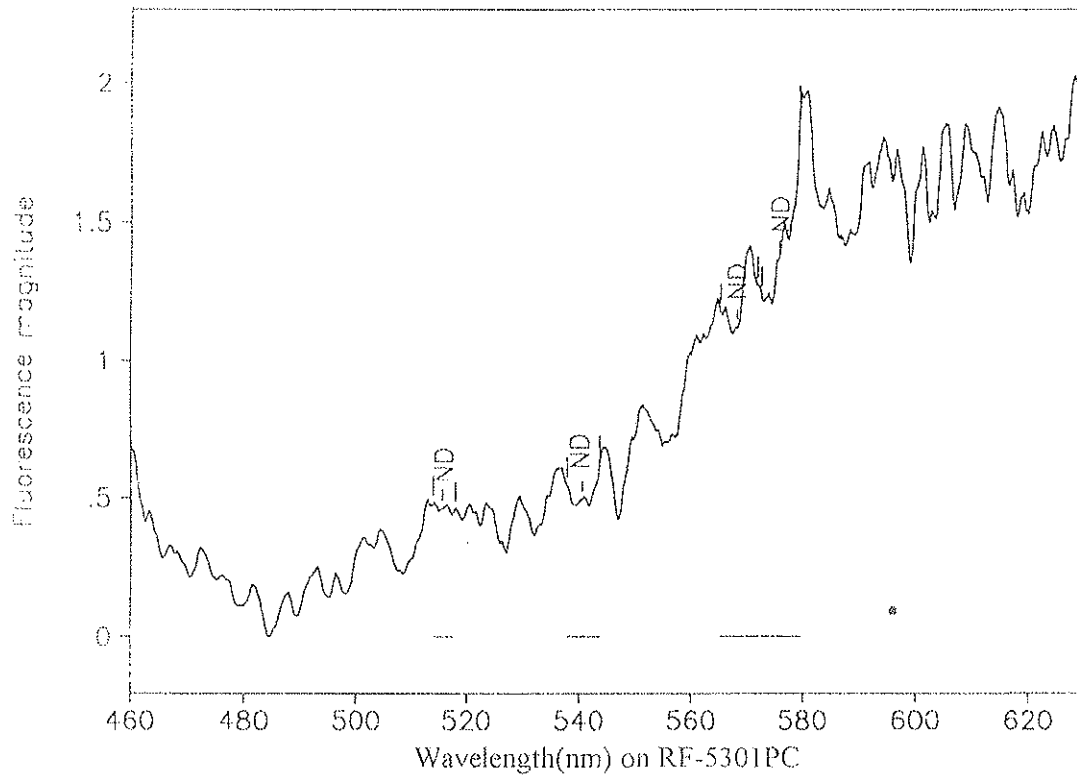
Collected: 08/24/09 1543

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 45: Chiefland Public Supply Well South

OUL number: T2181

Analyzed: 09/10/09

Matrix: Elutant

Placed: 08/24/09 1505

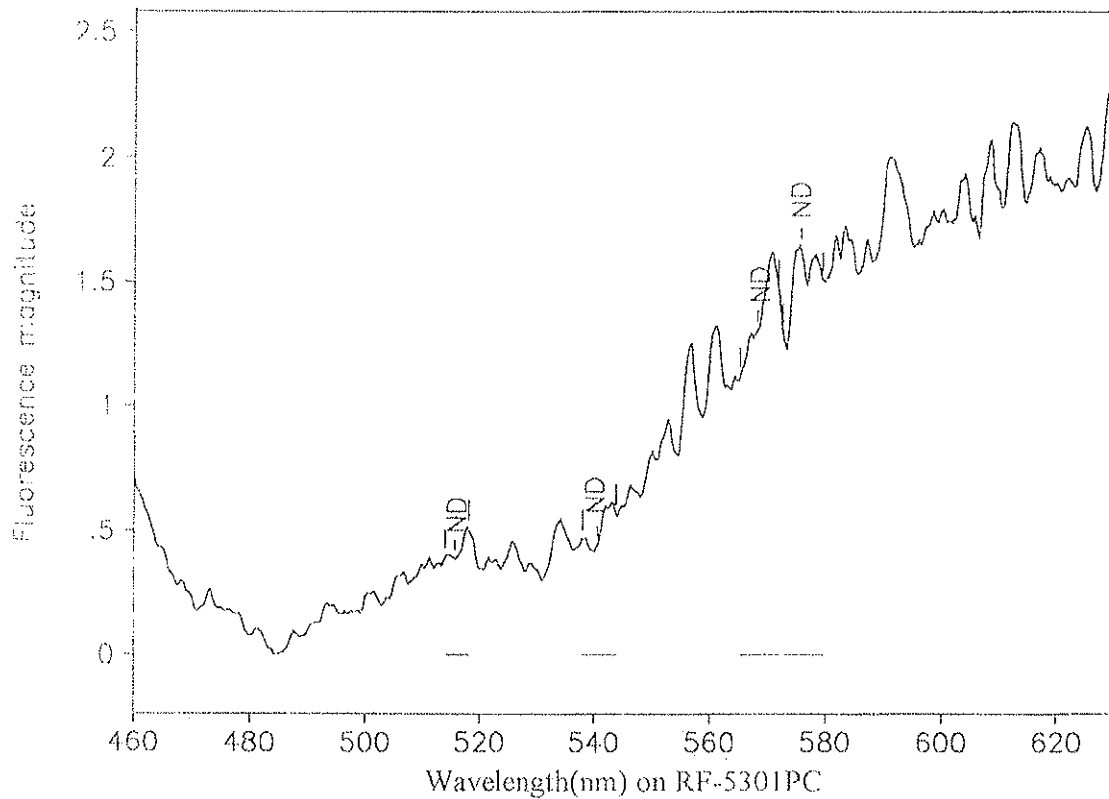
Collected: 08/29/09 1622

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 46: Chiefland Public Supply Well North

OUL number: T2182

Analyzed: 09/10/09

Matrix: Elutant

Placed: 08/19/09 1259

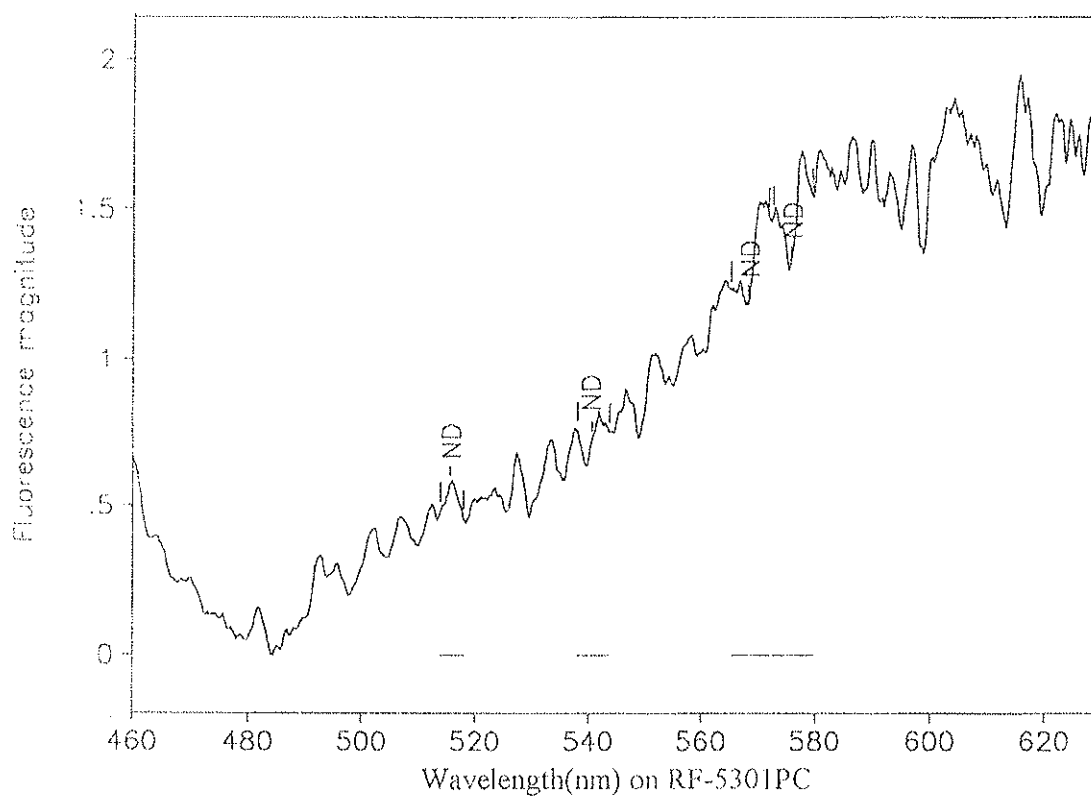
Collected: 08/24/09 1525

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 11: Fanning Spring Main

OUL number: T2183

Analyzed: 09/10/09

Matrix: Elutant

Placed: 08/21/09 1631

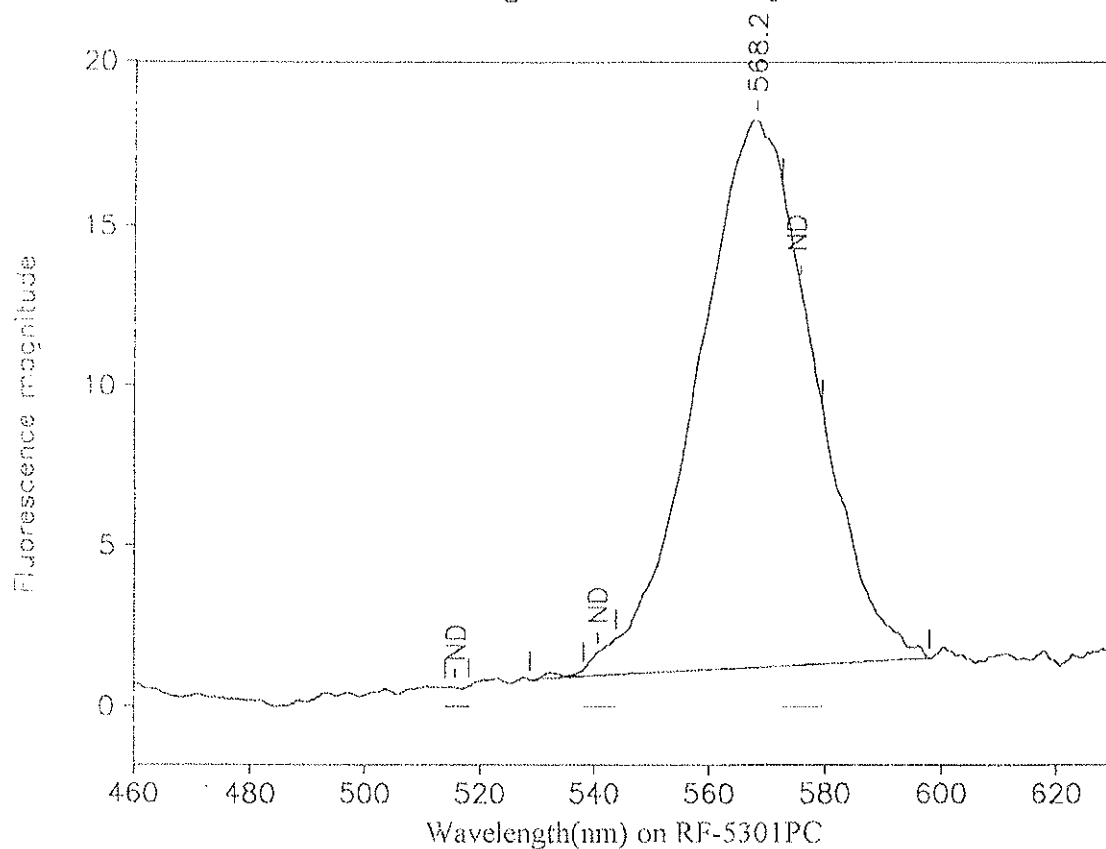
Collected: 08/30/09 1637

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station D4: QC Duplicate

OUL number: T2184

Matrix: Elutant

Placed: 08/19/09

Analyzed: 09/10/09

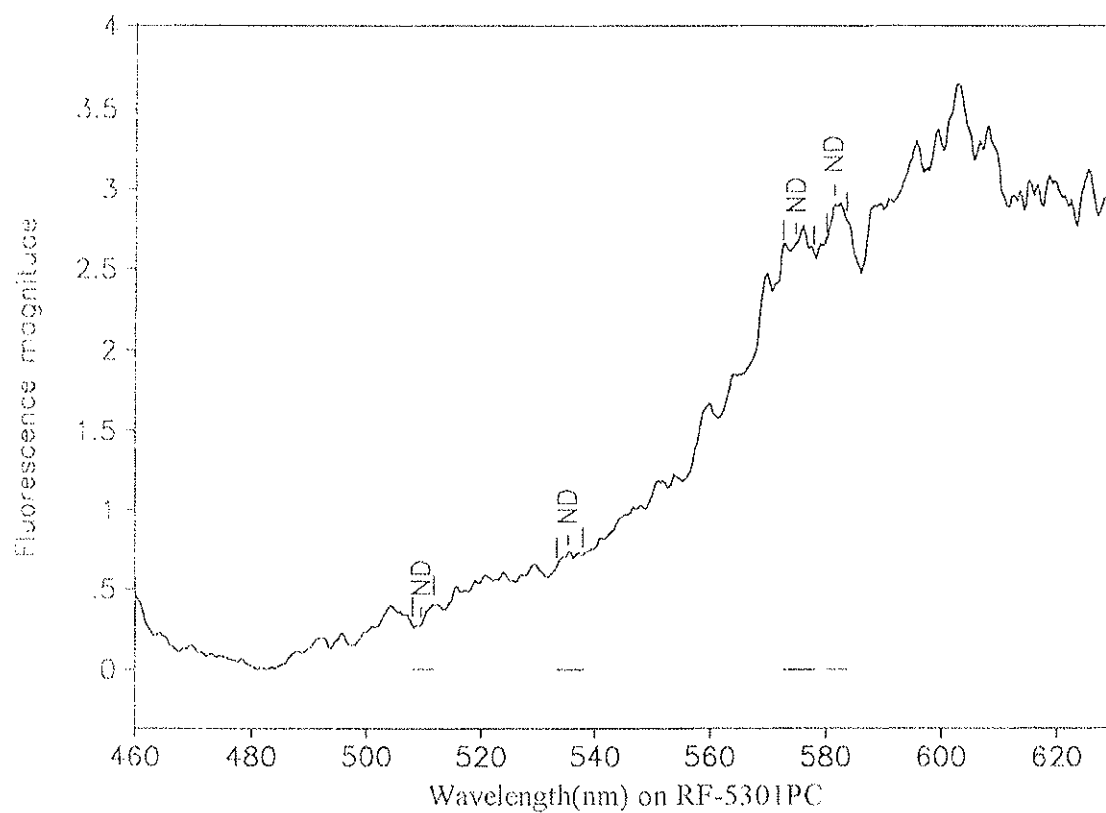
Collected: 08/24/09

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|--------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.2 | 528.8 | 598.0 | 16.99 | 402.36 | 0.04 | 107 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2185

Analyzed: 09/10/09

Matrix: Water

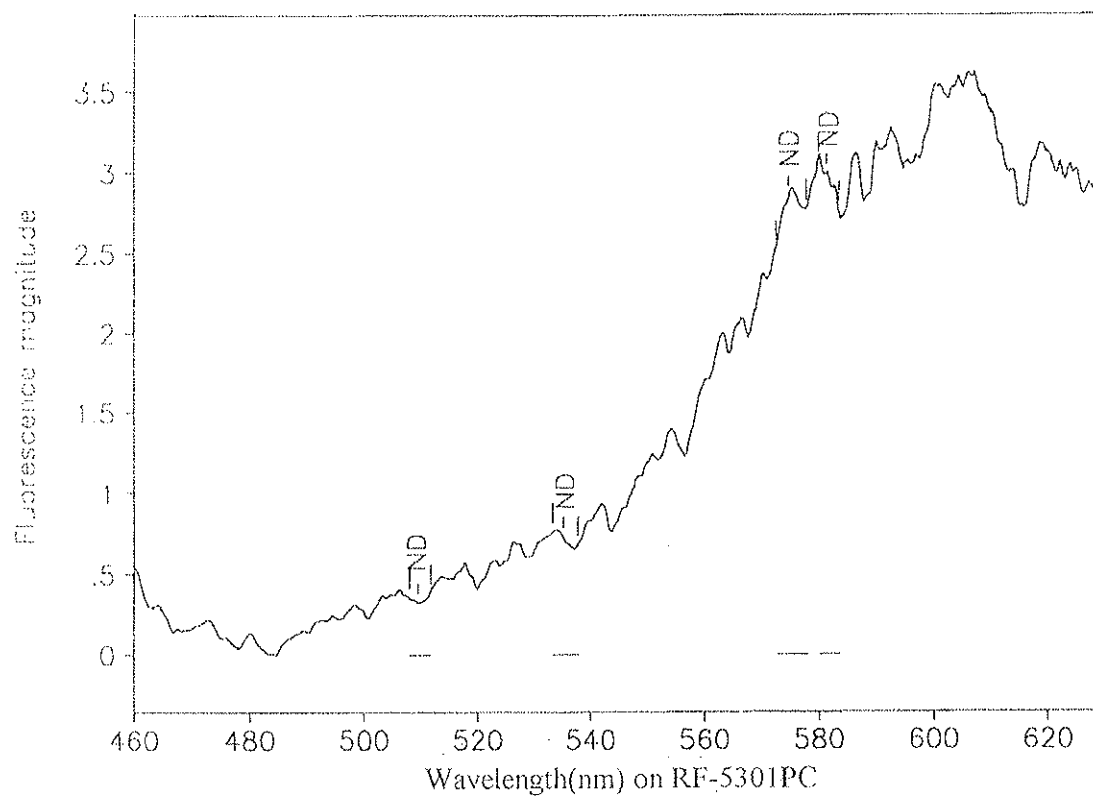
Collected: 08/21/09 2034

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.5 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2186

Analyzed: 09/10/09

Matrix: Water

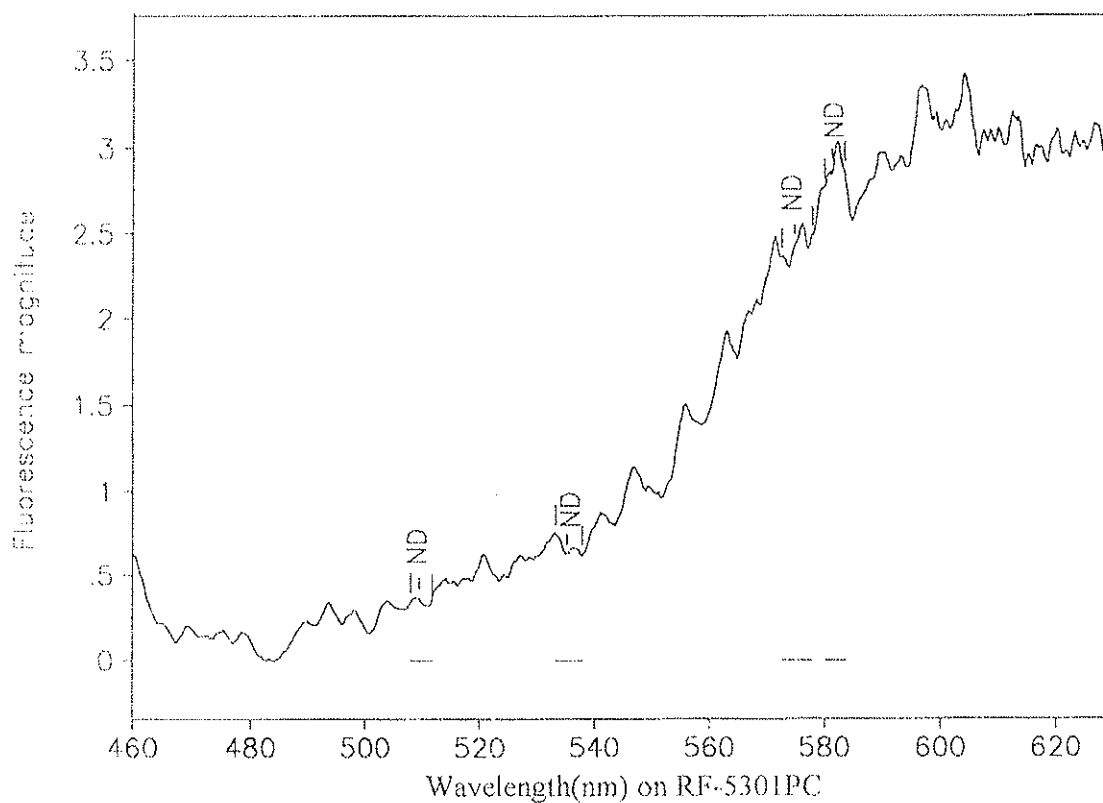
Collected: 08/22/09 1730

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.5 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2187

Analyzed: 09/10/09

Matrix: Water

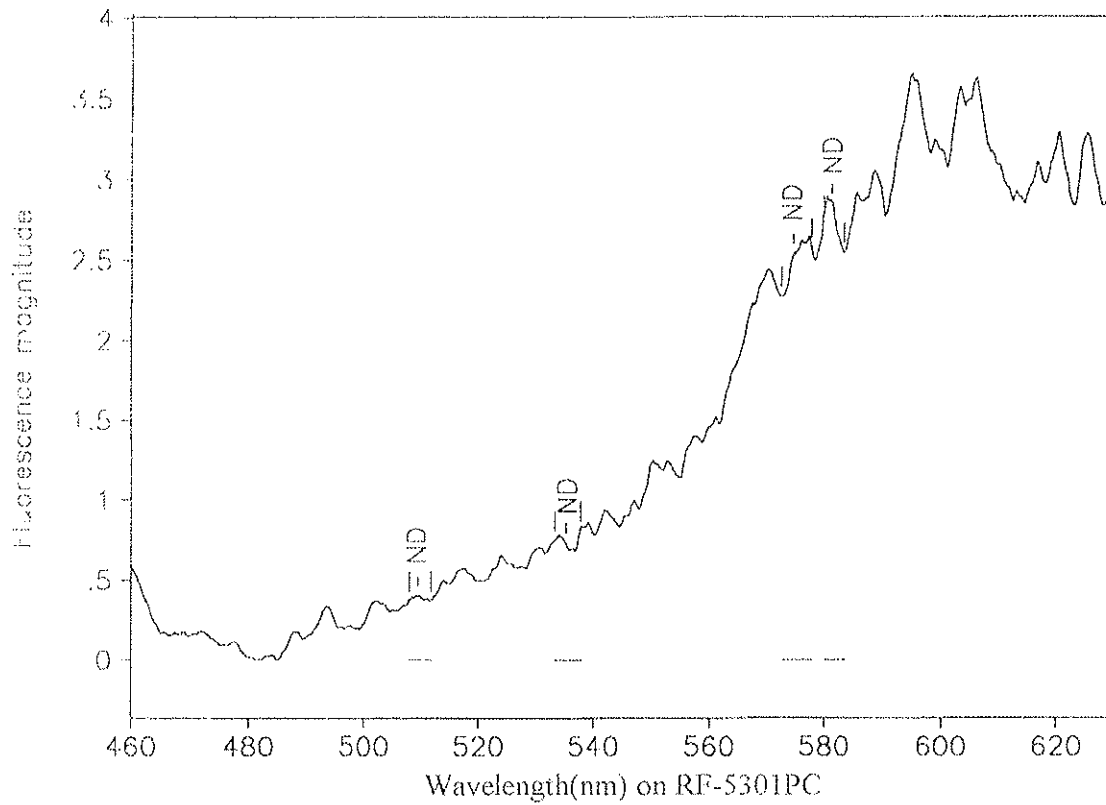
Collected: 08/23/09 2058

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.5 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2188

Analyzed: 09/10/09

Matrix: Water

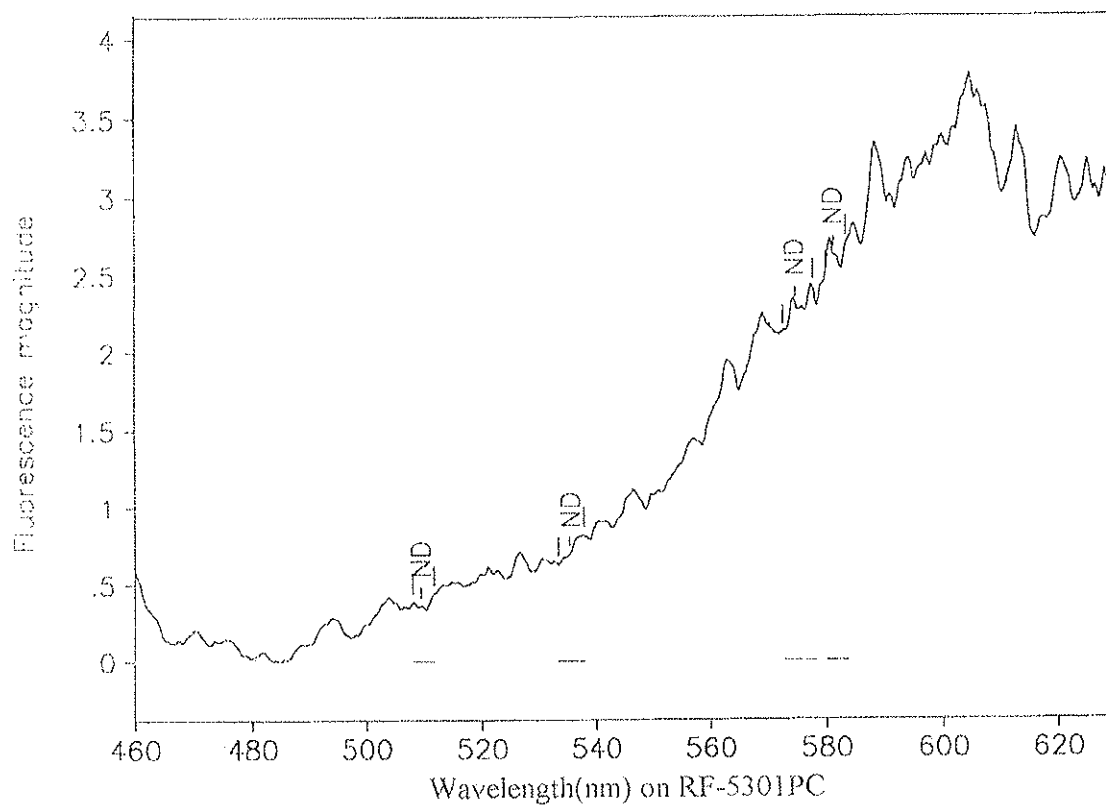
Collected: 08/24/09 1719

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.5 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2189

Analyzed: 09/10/09

Matrix: Water

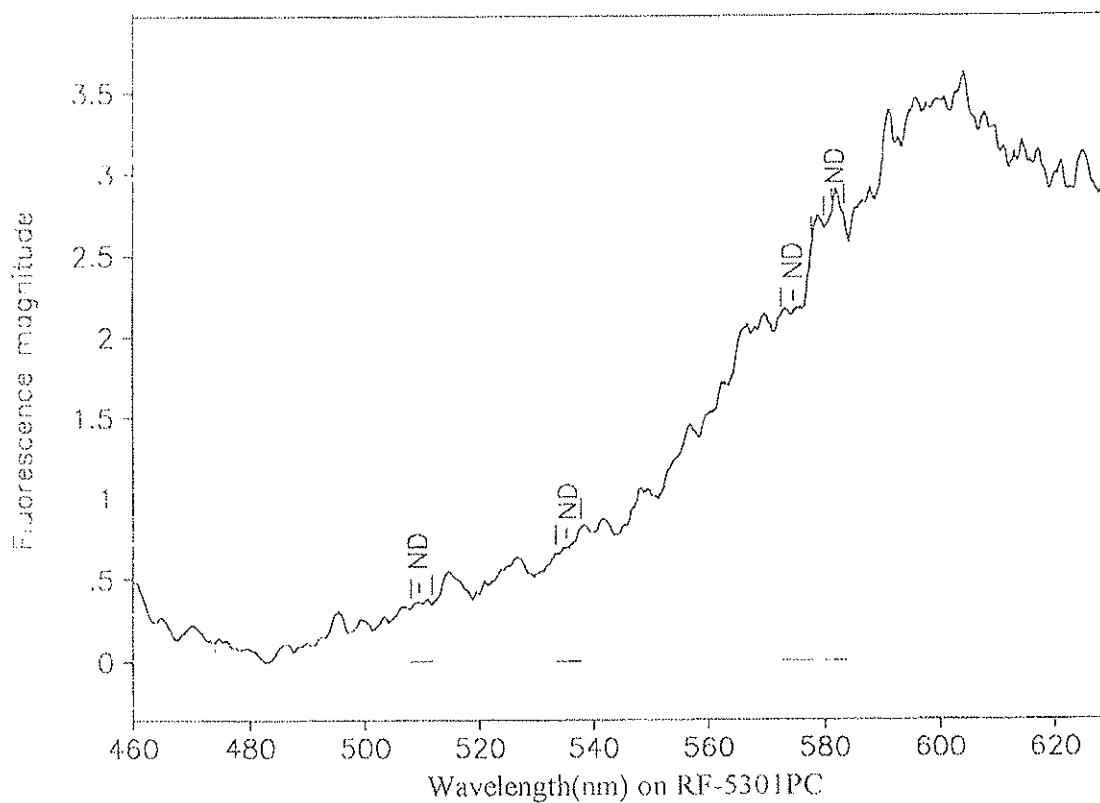
Collected: 08/28/09 2215

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.5 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2190

Analyzed: 09/10/09

Matrix: Water

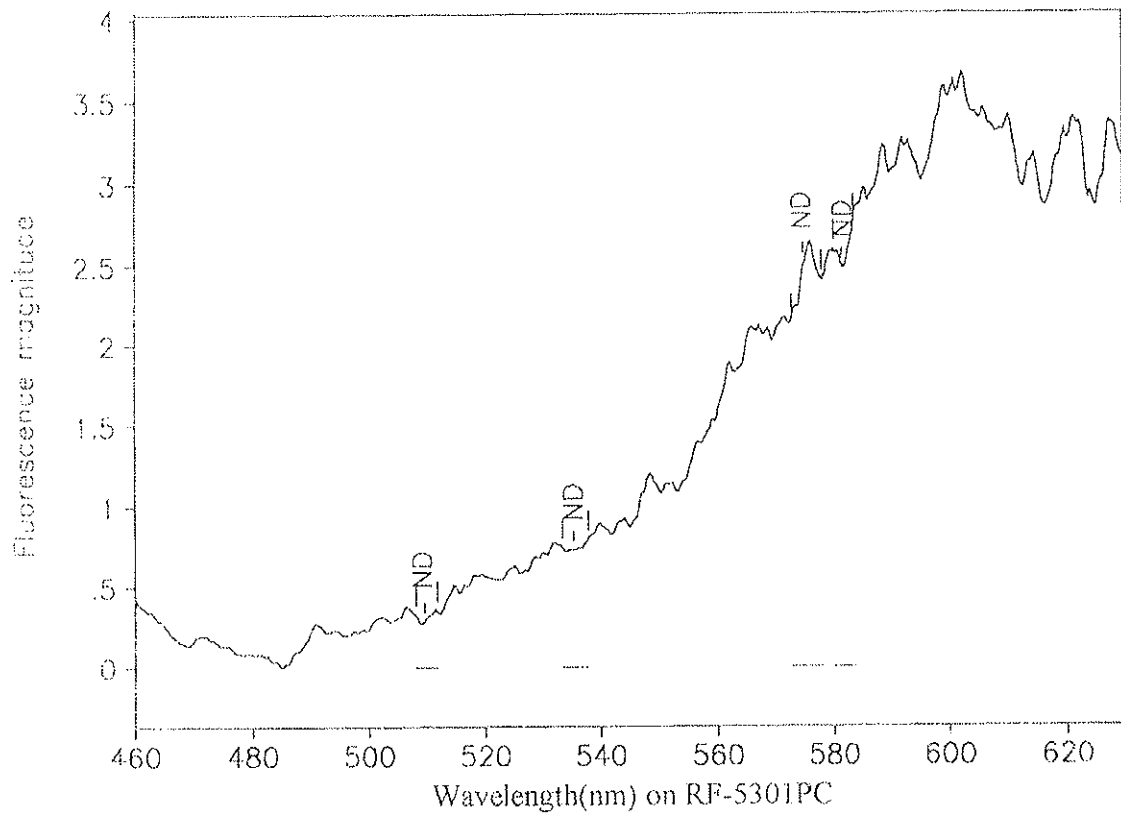
Collected: 08/29/09 1815

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.5 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2191

Analyzed: 09/10/09

Matrix: Water

Collected: 08/30/09 1340

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 509.5 | 508.0 | 511.7 | 0.00 | 0.00 | 0.00 | ND |
| 535.2 | 533.4 | 537.9 | 0.00 | 0.00 | 0.00 | ND |
| 574.9 | 572.7 | 578.0 | 0.00 | 0.00 | 0.00 | ND |
| 581.5 | 580.1 | 583.7 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

| Number | Number | Name | Placed | Collected | Peak nm | Conc. ppb | Peak nm | Conc. ppb |
|--------|--------|-----------------------------------|------------|------------|---------|-----------|---------|-------------|
| T2319 | D6 | QC Duplicate | 9/5/09 NT | 9/13/09 NT | ND | | 569.3 | 40.3 |
| T2320 | | Laboratory control charcoal blank | | | | | | |
| T2321 | D7 | QC Duplicate | 8/29/09 NT | 9/5/09 NT | ND | | ND | |
| | | | | | | | | Page 2 of 2 |

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
NT = No time given

Thomas J. Aley, PHG and RG

OZARK UNDERGROUND LABORATORY, INC.

1572 Aley Lane Protom, MO 65733 (417) 785-4289 fax (417) 785-4290 email: oul@tri-lakes.net

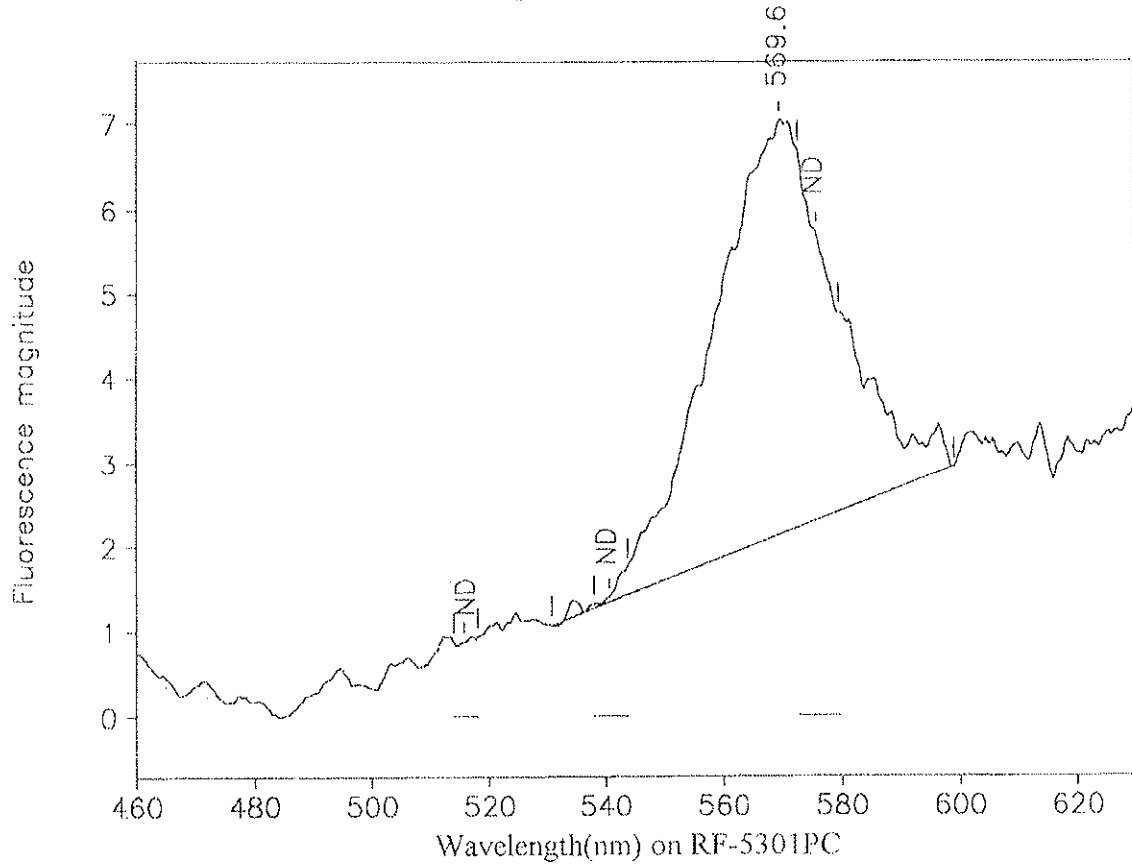
SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Fanning-Manatee Dye Tracc Week No: 4-6 (Shipment 4) Samples Collected By: Peter Butt/Mark Long
 Samples Shipped By: KES via FedEx Samples Received By: Monica Redinger OUL Return Cooler? Yes No X
 Date Samples Shipped: 9 / 14 / 09 Date Samples Received: 9 / 15 / 09 Time Samples Received: 14:00
 Bill to: Karst Environmental Services, Inc. Send Results to: Karst Environmental Services, Inc.
 Analyze for: Fluorescein X Eosine X Rhodamine WT X Other n/a Ship cooler to: n/a

| # CHAR
REC'D | LAB
NUMBER | STATION
NUMBER
1-4 Numbers | STATION NAME | | PLACED | | COLLECTED | | #
WATER
REC'D | OUL
use only |
|-----------------|---------------|----------------------------------|--|------|---------|-------|-----------|-------|---------------------|-----------------|
| | | | DATE | TIME | DATE | TIME | DATE | TIME | | |
| 1 | T2305 | 31 | Manatee Spring Main | | 8/29/09 | 18:15 | 9/5/09 | 19:17 | 0 | |
| 1 | T2306 | 31 | Manatee Spring Main | | 9/5/09 | 19:17 | 9/13/09 | 15:52 | 0 | |
| 1 | T2307 | 32 | Manatee Spring Main Tunnel | | 8/29/09 | 18:00 | 9/5/09 | 19:02 | 0 | |
| 1 | T2308 | 32 | Manatee Spring Main Tunnel | | 9/5/09 | 19:02 | 9/13/09 | 15:34 | 0 | |
| 1 | T2309 | 33 | Manatee Spring Blue Water Tunnel | | 8/29/09 | 17:50 | 9/5/09 | 18:56 | 0 | |
| 1 | T2310 | 33 | Manatee Spring Blue Water Tunnel | | 9/5/09 | 18:56 | 9/13/09 | 15:28 | 0 | |
| 1 | T2311 | 34 | Clay Landing Vent | | 8/29/09 | 15:13 | 9/5/09 | 14:00 | 0 | |
| 1 | T2312 | 42 | Levy County Public Supply Well | | 8/29/09 | 16:45 | 9/5/09 | 16:00 | 0 | |
| 1 | T2313 | 41A | Manatee Springs State Park Public Supply Well #2 | | 8/24/09 | 16:48 | 8/29/09 | 17:37 | 0 | |
| 1 | T2314 | 41A | Manatee Springs State Park Public Supply Well #2 | | 9/5/09 | 17:37 | 9/13/09 | 15:18 | 0 | |
| 1 | T2315 | 43N | Springside Public Supply Well North | | 8/24/09 | 16:20 | 8/29/09 | 17:20 | 0 | |
| 1 | T2316 | 43N | Springside Public Supply Well North | | 9/5/09 | 15:17 | 9/13/09 | 13:38 | 0 | |
| 1 | T2317 | 44 | Barnhill Landscape Well | | 8/19/09 | 12:40 | 8/24/09 | 14:35 | 0 | |
| 1 | T2318 | 52 | Clay Landing | | 8/19/09 | 12:15 | 8/24/09 | 14:05 | 0 | |
| 1 | T2319 | D6 | QC Duplicate | | 9/5/09 | | 9/13/09 | | 0 | |
| 1 | T2321 | D7 | QC Duplicate | | 8/29/09 | | 9/5/09 | | 0 | |

COMMENTS: Please analyze all samples. OUL Proves 95.6 Analyzed 9/16/09 by me/oul
 This sheet filled out by OUL staff? Yes No Charts for samples on this page proofed by OUL: OK
T2320 - OUL Character Blank. Rid Page 1 of 1 by oul

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2305

Matrix: Elutant

Placed: 08/29/09 1815

Analyzed: 09/16/09

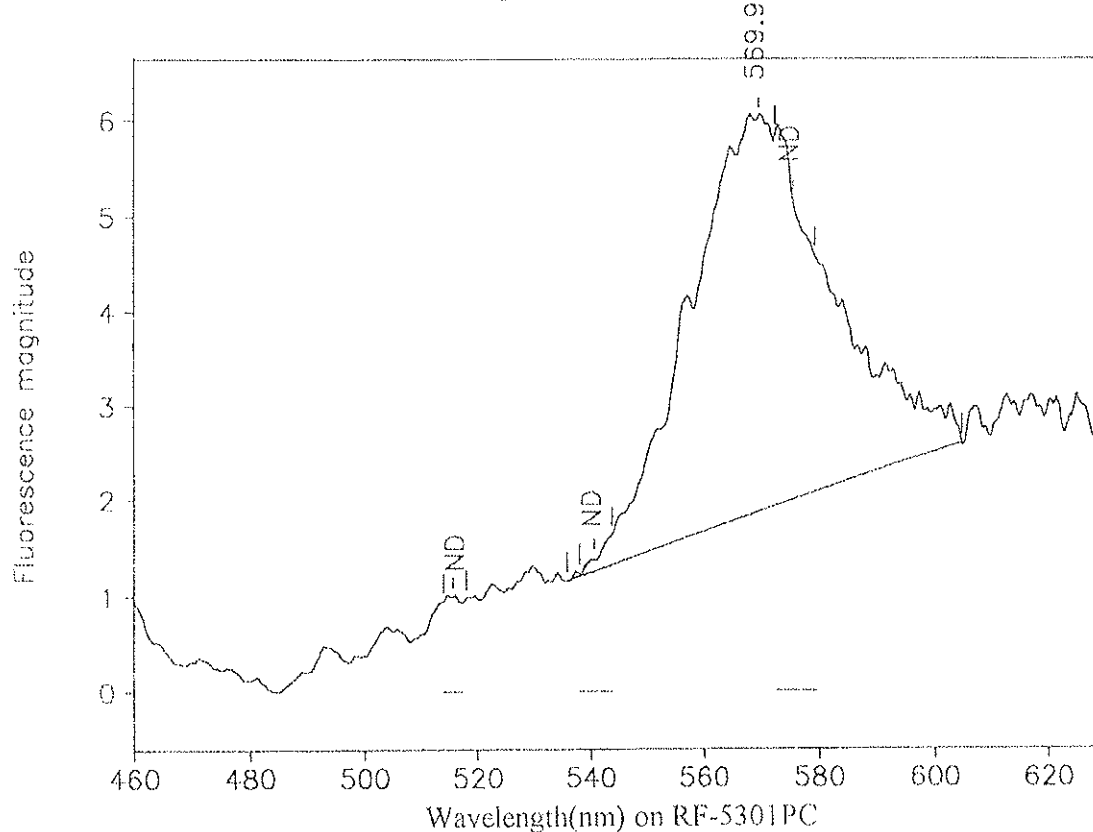
Collected: 09/05/09 1917

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|--------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 569.6 | 530.8 | 599.2 | 4.89 | 121.11 | 0.04 | 30.4 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 31: Manatee Spring Main

OUL number: T2306

Matrix: Elutant

Placed: 09/05/09 1917

Analyzed: 09/16/09

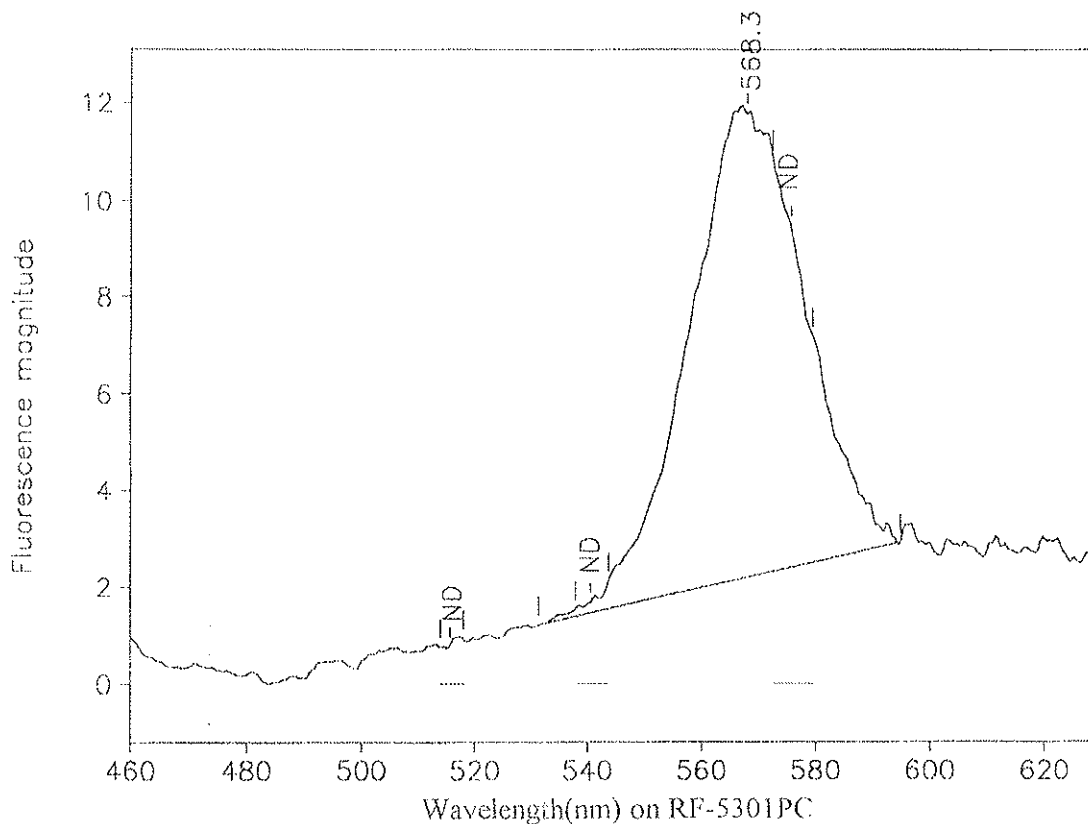
Collected: 09/13/09 1552

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc |
|---------|--------|---------|--------|--------|------|------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 569.9 | 535.8 | 605.0 | 4.16 | 120.92 | 0.03 | 30.3 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 32: Manatee Spring Main Tunnel

OUL number: T2307

Analyzed: 09/16/09

Matrix: Elutant

Placed: 08/29/09 1800

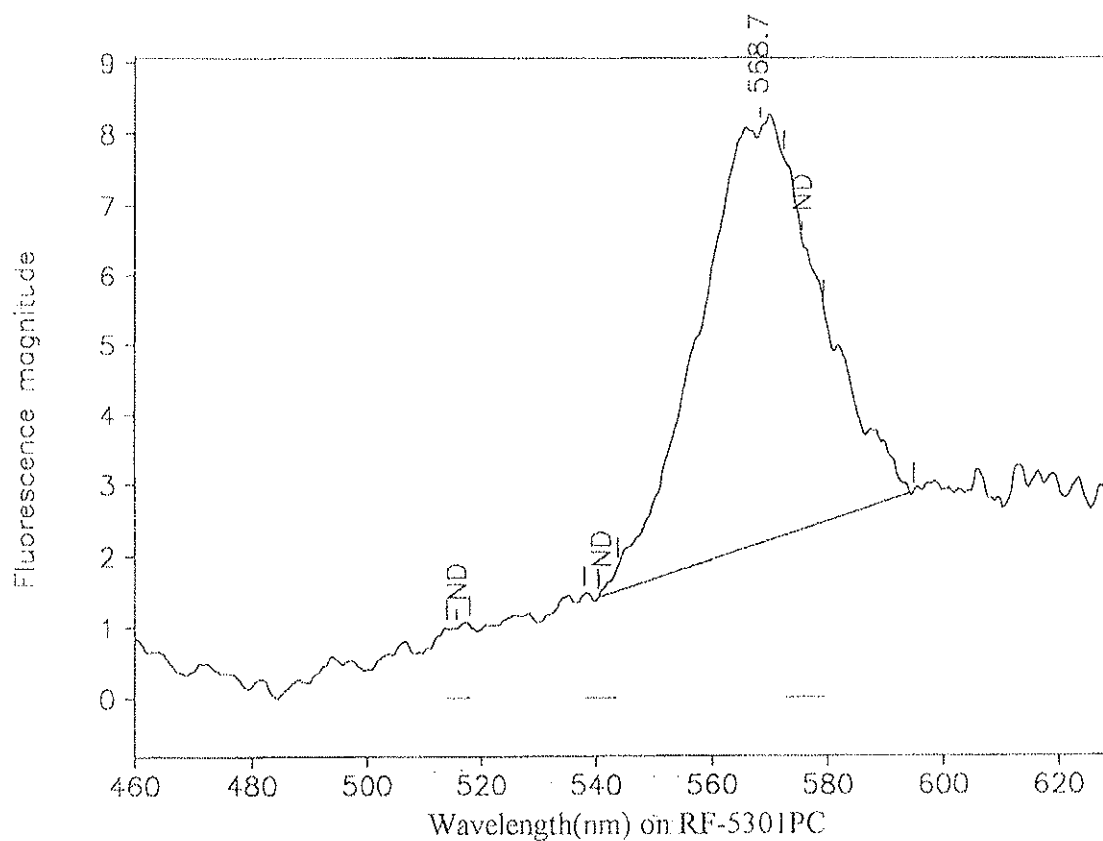
Collected: 09/05/09 1902

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | I/A | Conc. |
|---------|--------|---------|--------|--------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 531.4 | 595.0 | 9.59 | 230.64 | 0.04 | 57.9 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 32: Manatee Spring Main Tunnel

OUL number: T2308

Matrix: Elutant

Placed: 09/05/09 1902

Analyzed: 09/16/09

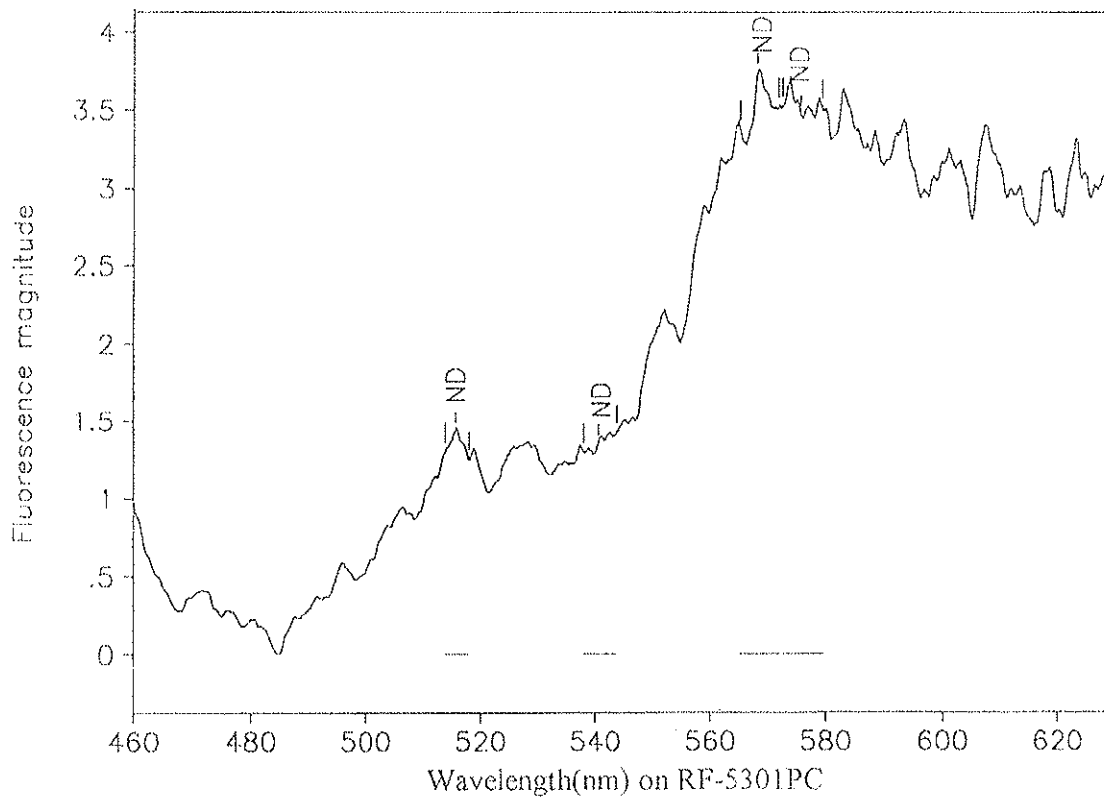
Collected: 09/13/09 1534

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|--------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.7 | 540.4 | 595.0 | 5.91 | 147.39 | 0.04 | 37.0 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 33: Manatee Spring Blue Water Tunnel

OUL number: T2309

Analyzed: 09/16/09

Matrix: Elutant

Placed: 08/29/09 1750

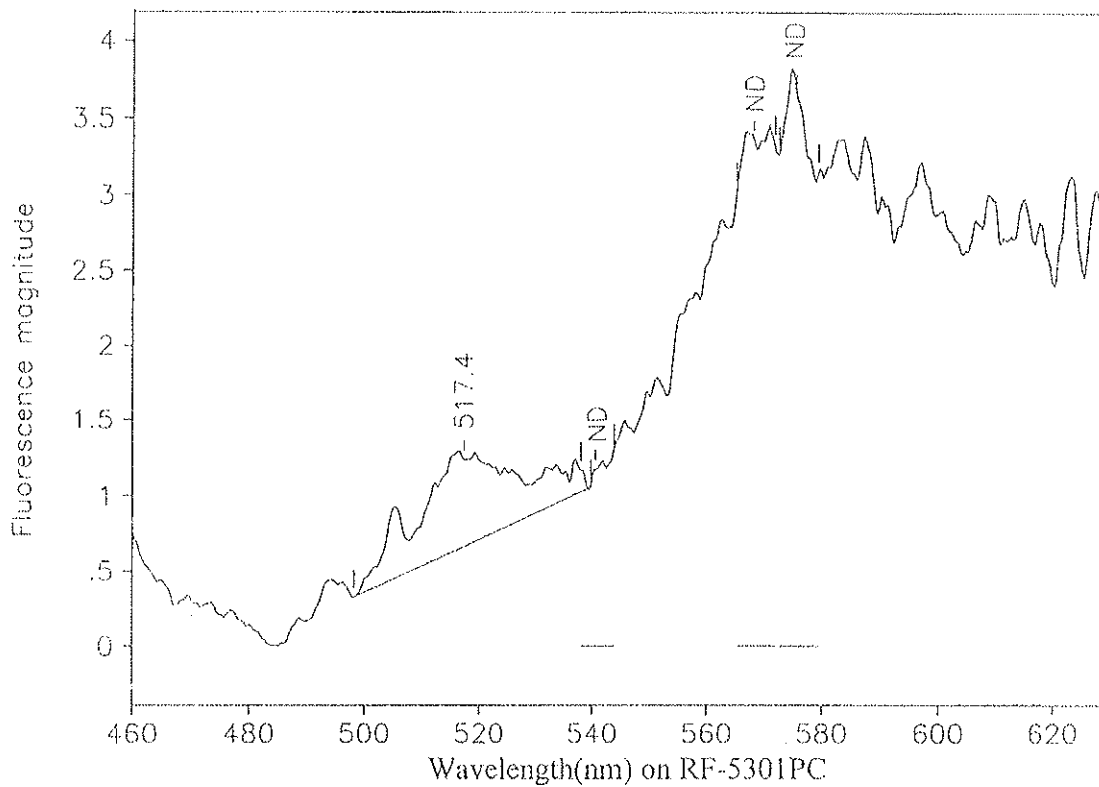
Collected: 09/05/09 1856

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 33: Manatee Spring Blue Water Tunnel

OUL number: T2310

Analyzed: 09/16/09

Matrix: Elutant

Placed: 09/05/09 1856

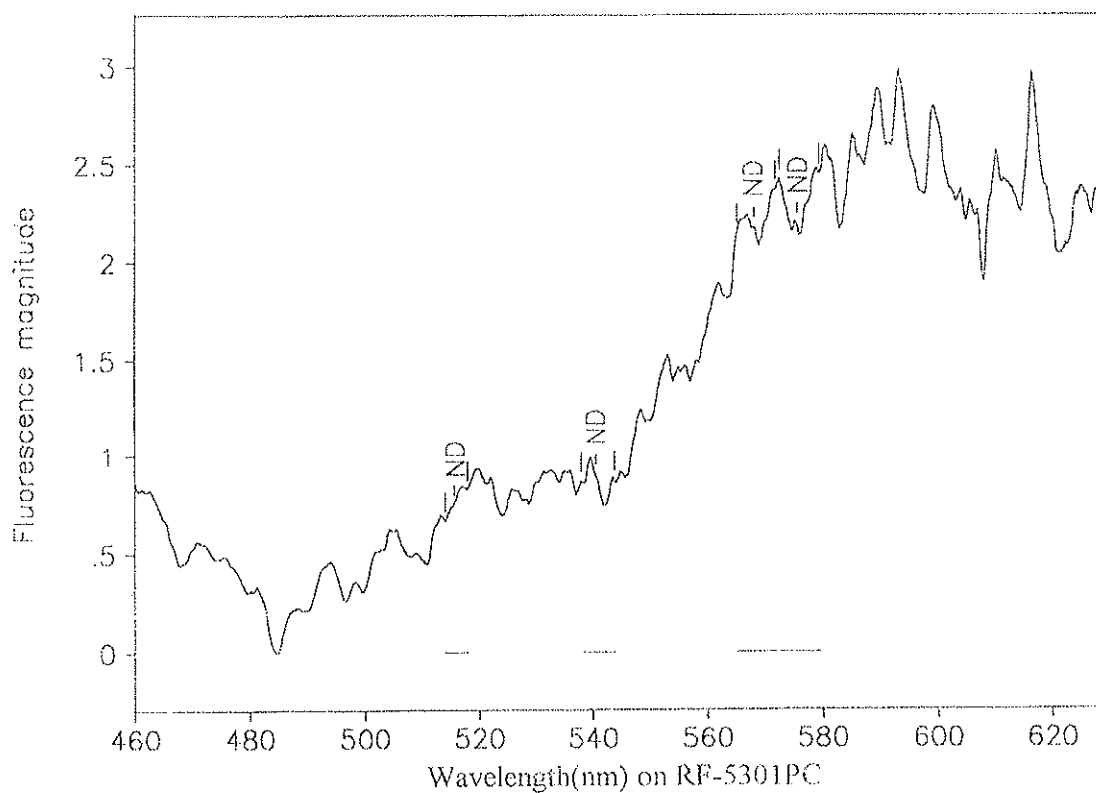
Collected: 09/13/09 1528

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|-------|------|-----------|
| 517.4 | 498.2 | 539.8 | 0.57 | 13.03 | 0.04 | 0.445 (✓) |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 34: Clay Landing Vent

OUL number: T2311

Matrix: Elutant

Placed: 08/29/09 1513

Analyzed: 09/16/09

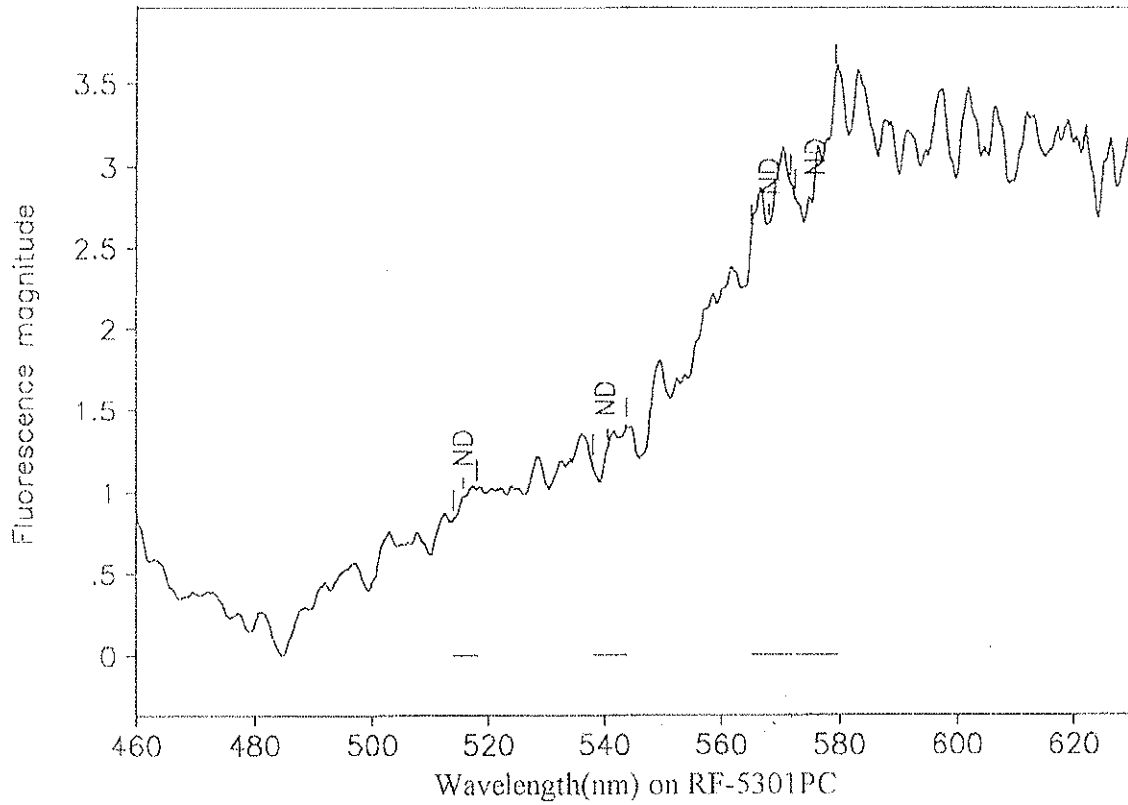
Collected: 09/05/09 1400

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 42: Levy County Public Supply Well

OUL number: T2312

Matrix: Elutant

Placed: 08/29/09 1645

Analyzed: 09/16/09

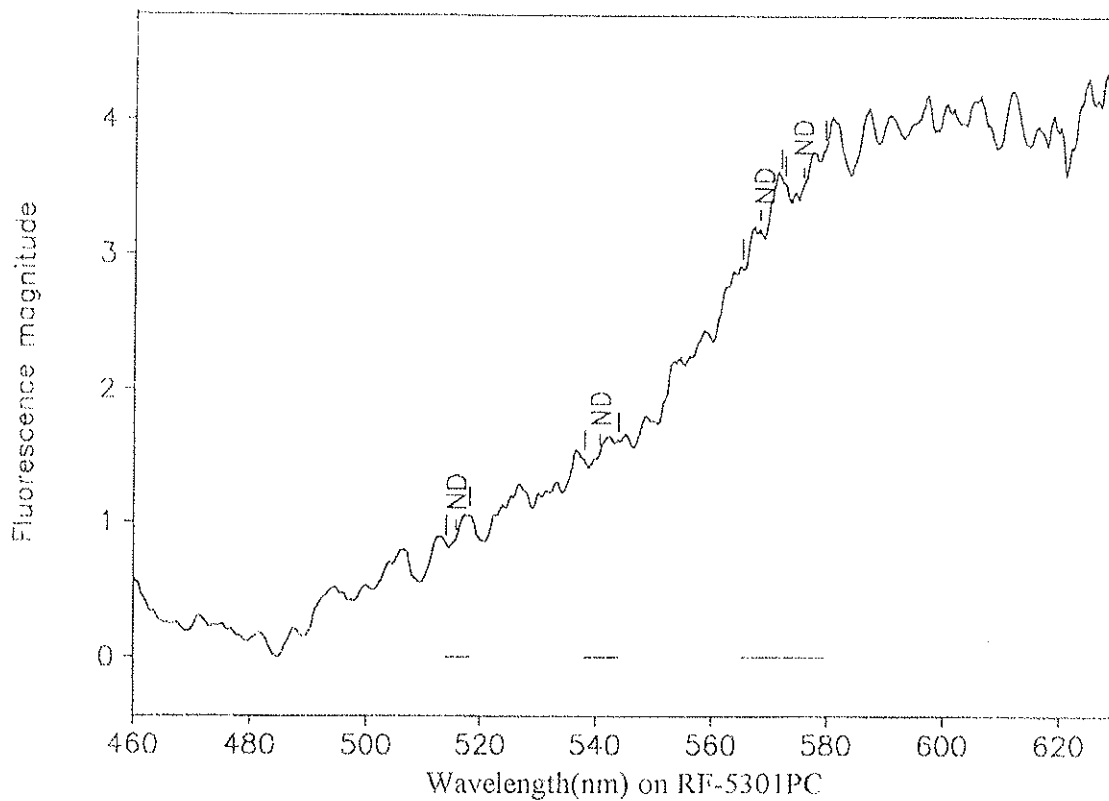
Collected: 09/05/09 1600

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 41A: Manatee Spring SP Public Supply Well #2

OUL number: T2313

Analyzed: 09/16/09

Matrix: Elutant

Placed: 08/24/09 1648

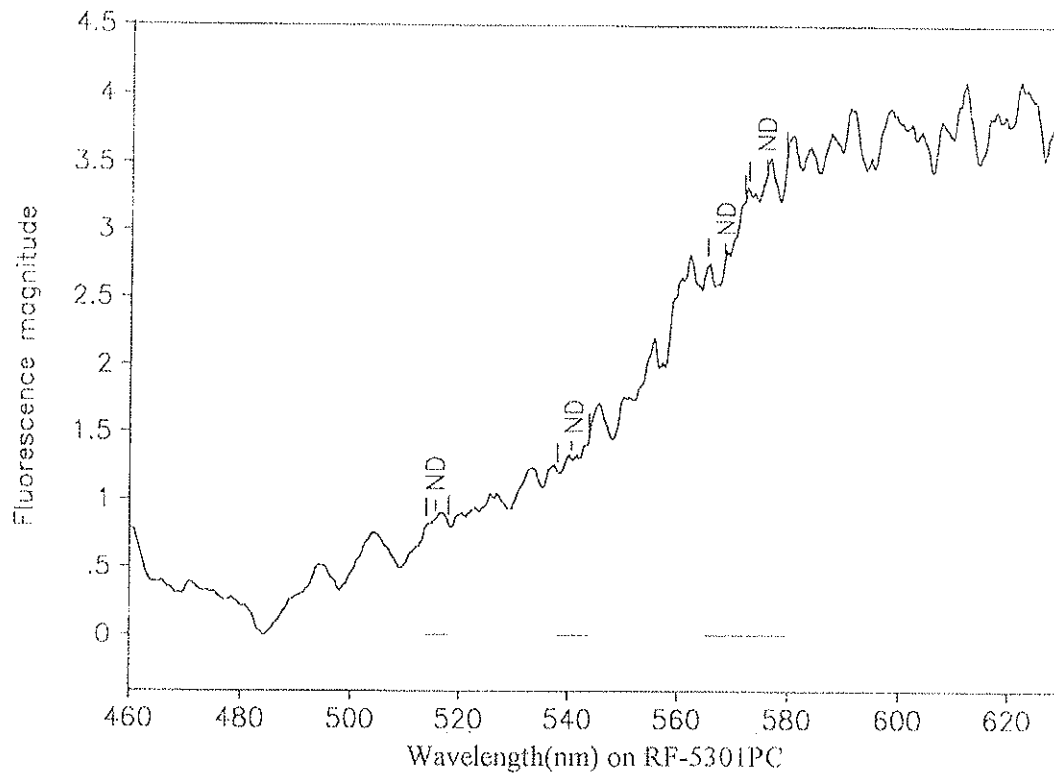
Collected: 08/29/09 1737

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 41A: Manatee Spring SP Public Supply Well #2

OUL number: T2314

Analyzed: 09/16/09

Matrix: Elutant

Placed: 09/05/09 1737

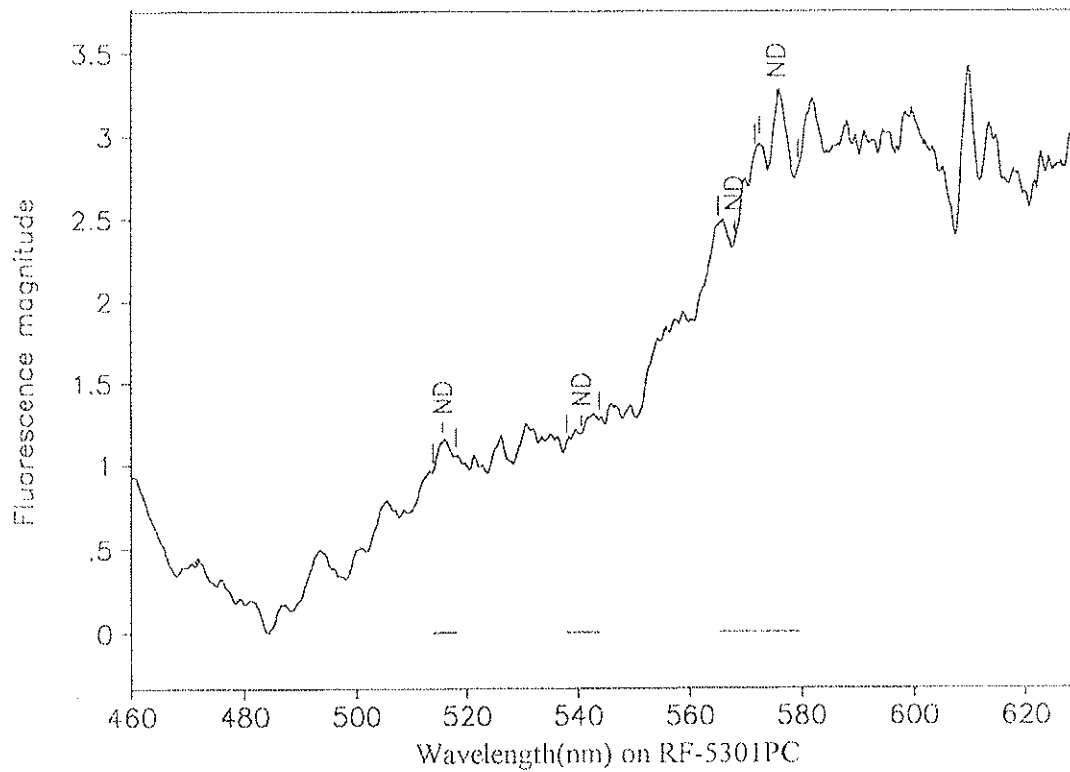
Collected: 09/13/09 1518

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 43N: Springside Public Supply Well North

OUL number: T2315

Analyzed: 09/16/09

Matrix: Elutant

Placed: 08/24/09 1620

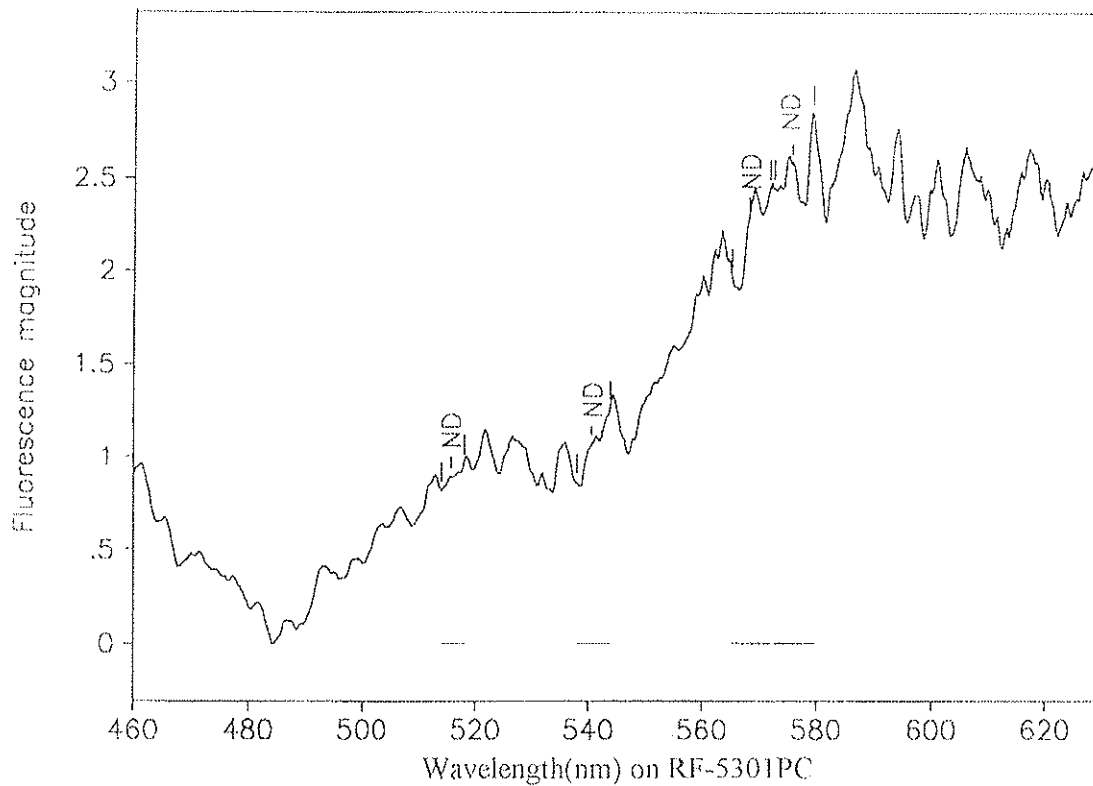
Collected: 08/29/09 1720

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 43N: Springside Public Supply Well North

OUL number: T2316

Analyzed: 09/16/09

Matrix: Elutant

Placed: 09/05/09 1517

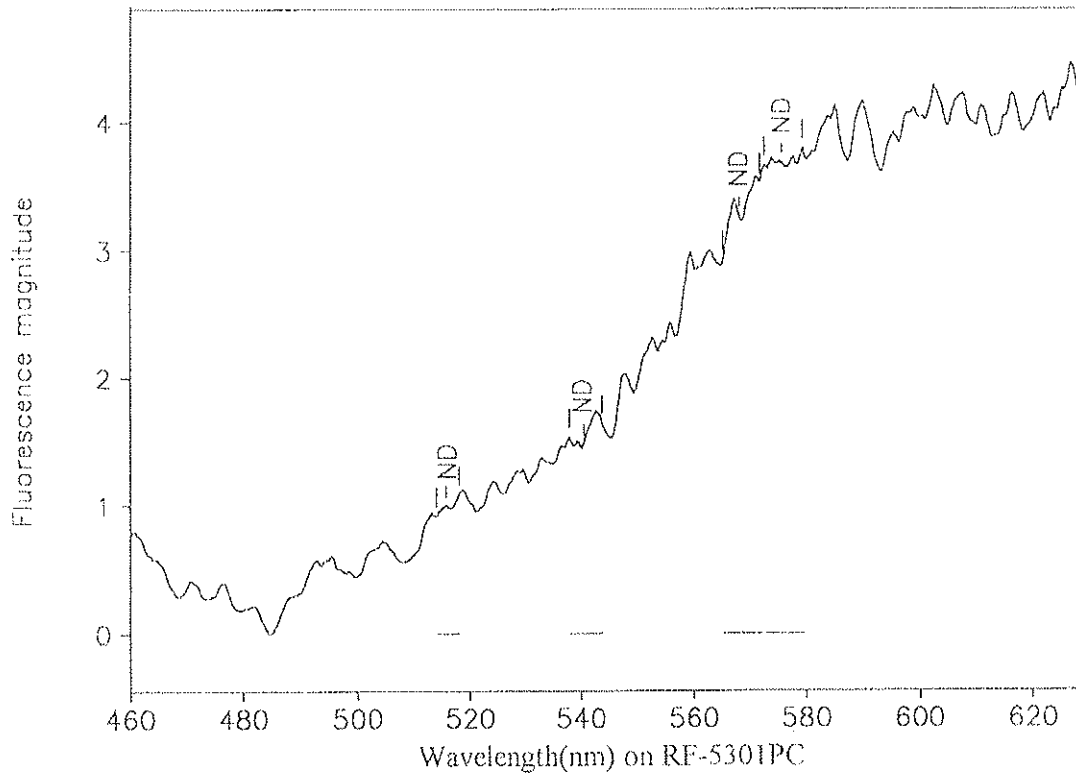
Collected: 09/13/09 1338

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 44: Barnhill Landscape Well

OUL number: T2317

Analyzed: 09/16/09

Matrix: Elutant

Placed: 08/19/09 1240

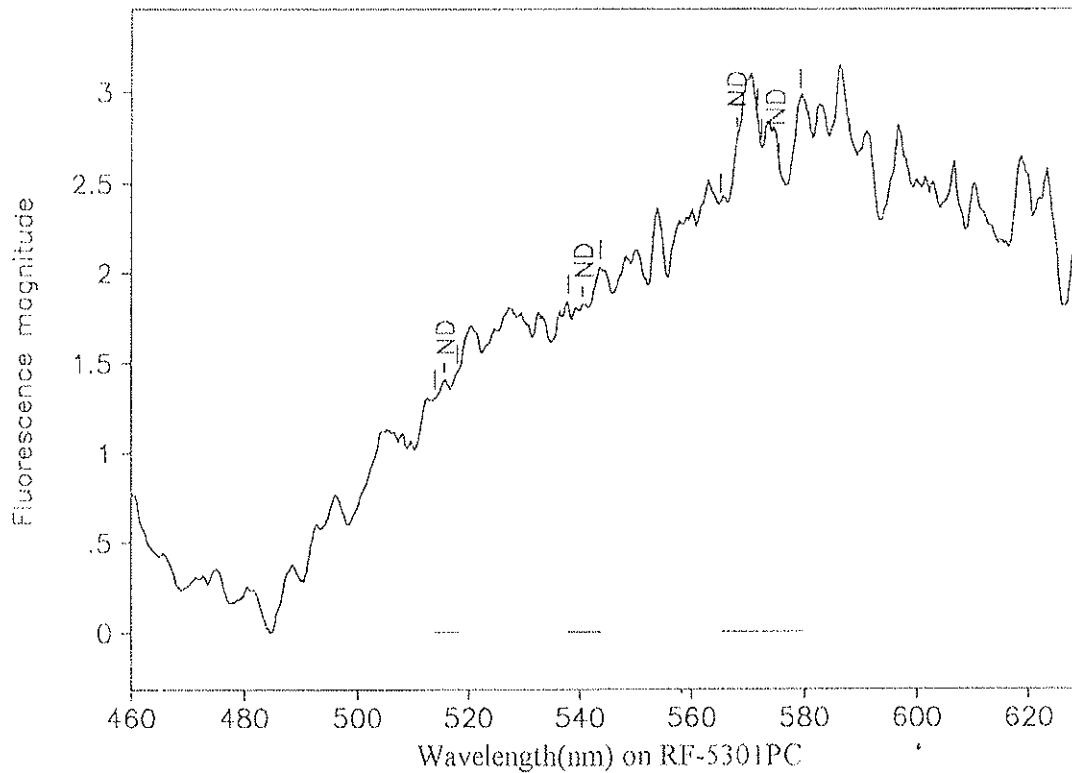
Collected: 08/24/09 1435

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station 52: Clay Landing

OUL number: T2318

Matrix: Elutant

Placed: 08/19/09 1215

Analyzed: 09/16/09

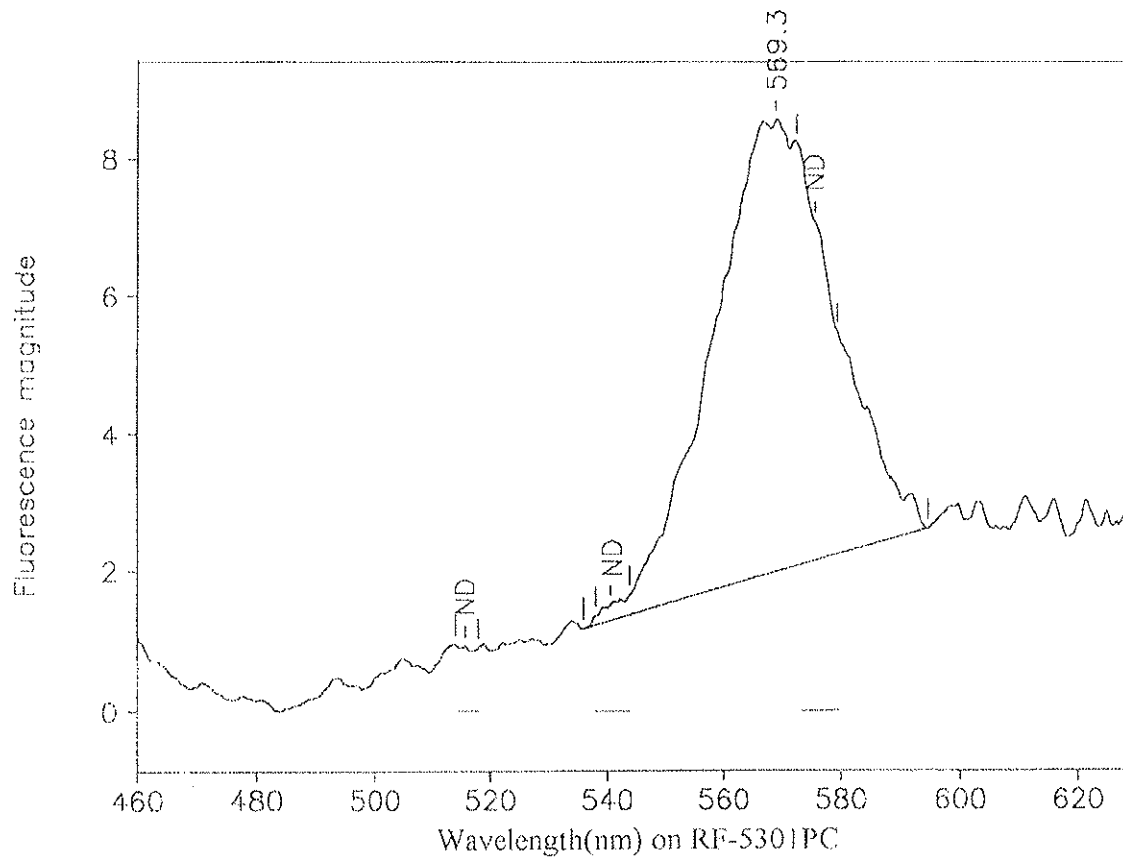
Collected: 08/24/09 1405

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station D6: QC Duplicate

OUL number: T2319

Matrix: Elutant

Placed: 09/05/09

Analyzed: 09/16/09

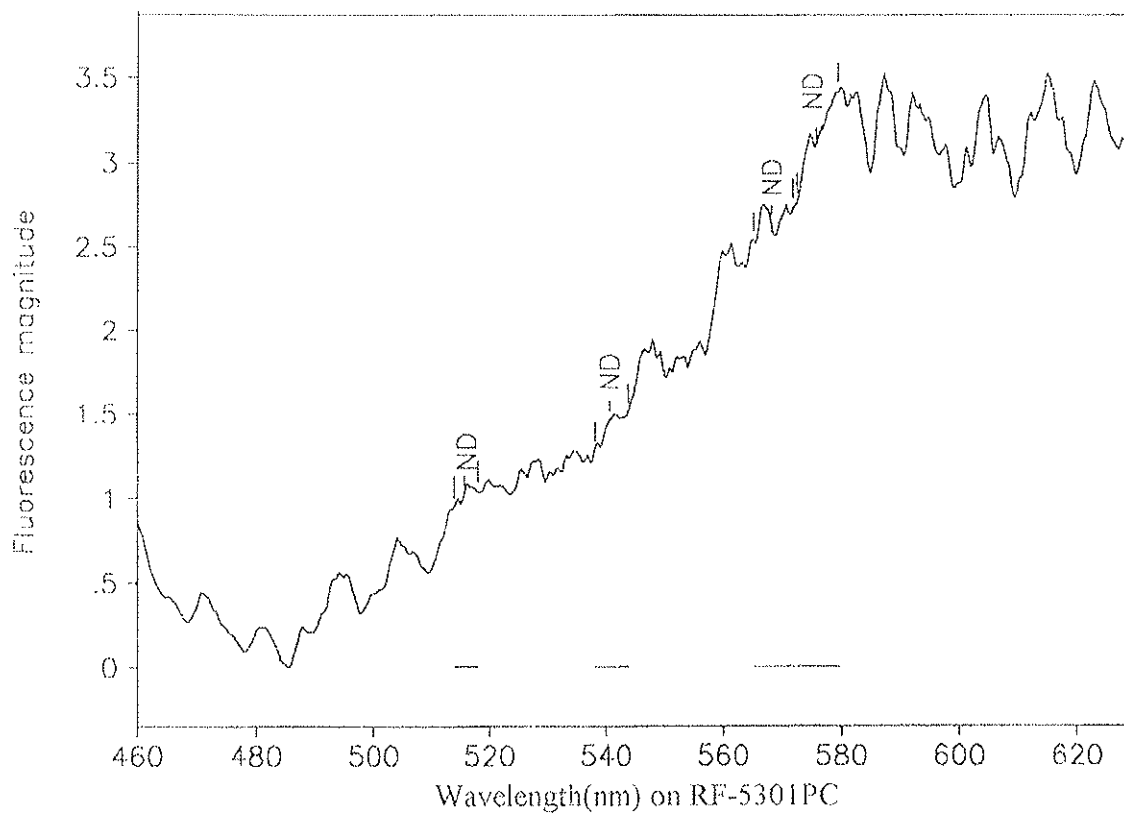
Collected: 09/13/09

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|--------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 569.3 | 536.0 | 594.8 | 6.58 | 160.70 | 0.04 | 40.3 |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes:

Ozark Underground Laboratory



Station D7: QC Duplicate

OUL number: T2321

Matrix: Elutant

Placed: 08/29/09

Analyzed: 09/16/09

Collected: 09/05/09

Peaks within the normal range of tracer dyes:

| Peak nm | Left X | Right X | Height | Area | H/A | Conc. |
|---------|--------|---------|--------|------|------|-------|
| 515.6 | 514.0 | 518.1 | 0.00 | 0.00 | 0.00 | ND |
| 540.6 | 538.1 | 543.9 | 0.00 | 0.00 | 0.00 | ND |
| 568.3 | 565.4 | 572.0 | 0.00 | 0.00 | 0.00 | ND |
| 575.8 | 572.8 | 579.6 | 0.00 | 0.00 | 0.00 | ND |

Peaks close to the normal range of tracer dyes: