

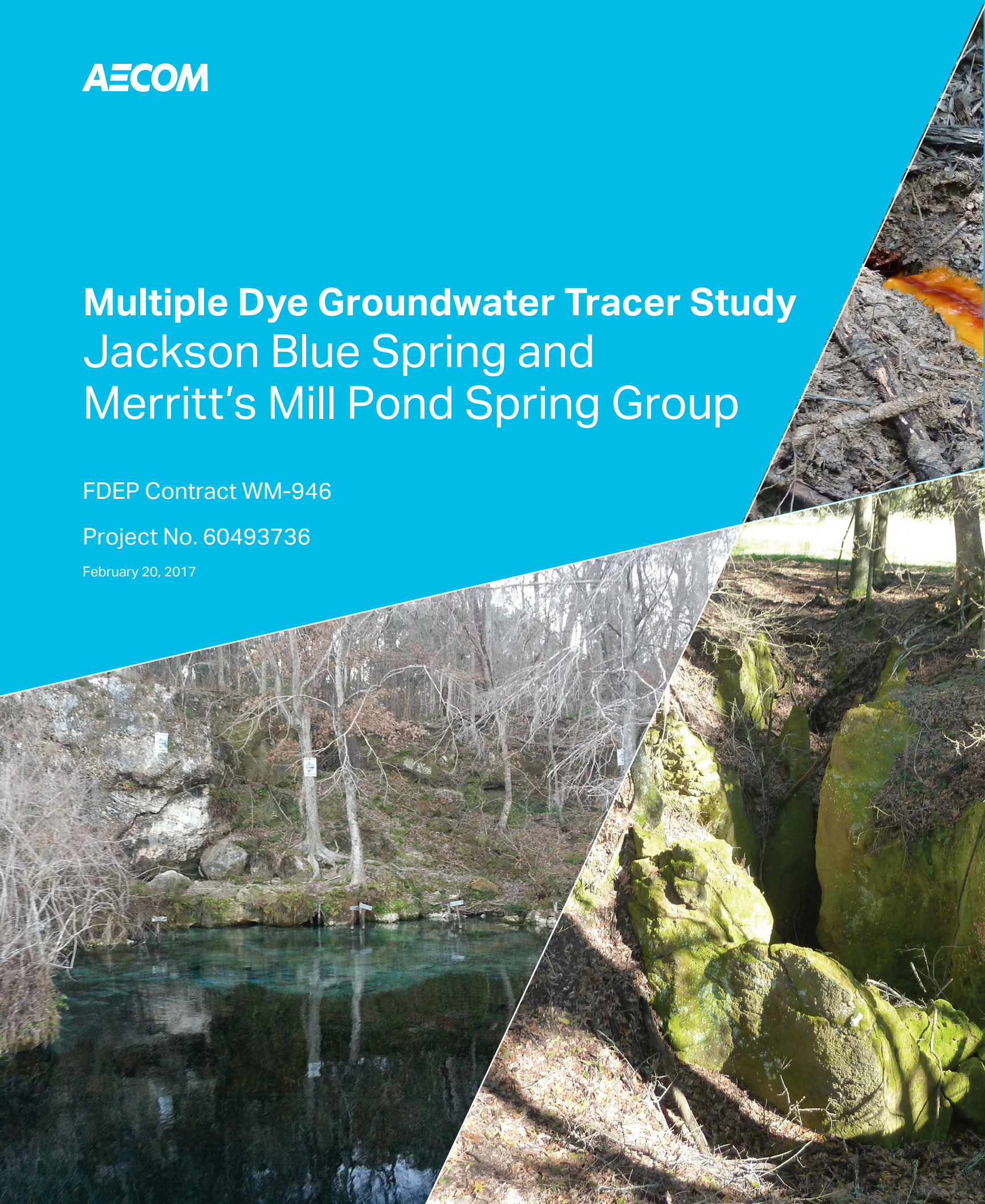


Multiple Dye Groundwater Tracer Study Jackson Blue Spring and Merritt's Mill Pond Spring Group

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1. Background

Nutrient impairment of the Merritt's Mill Pond Springs Group (MMPSG), which includes Jackson Blue Spring and at least seven other named springs, has been recognized, and the Florida Department of Environmental Protection (FDEP) and the Northwest Florida Water Management District (NFWFMD) are interested in better understanding groundwater flow within the springs capture zone so that future efforts to help mitigate nutrient transport can be recommended.

The MMPSG is located in Jackson County, approximately 4 miles east of Marianna, Florida. Jackson Blue Spring forms the headwaters of the approximately 270-acre Merritt's Mill Pond. Prior to 1860, Jackson Blue Spring represented the upper portion of a free-flowing spring run known as Spring Creek. Construction of a dam with an associated weir control structure in the 1920s expanded the limits of Merritt's Mill Pond to its current extent at U.S. Highway 90. Merritt's Mill Pond now forms the headwaters of Spring Creek which flows into the Chipola River and has been designated as an Outstanding Florida Water. FDEP has assigned a unique waterbody identification (WBID) number for Jackson Blue Spring (WBID 180Z) and for Merritt's Mill Pond and the springs that discharge into it (WBID 180A).

An overlay of the MMPSG spring basin capture zone over a roadmap background and an aerial photograph are presented as **Figure 1** and **Figure 2**, respectively.

To help refine an improved understanding of groundwater nutrient flow pathways within the MMPSG capture zone, FDEP issued AECOM Task Assignment 15 with two associated Change Orders to implement a multi-dye groundwater tracer study within the approximate southern half of the MMPSG spring basin, i.e., the study area. The goal of the dye trace study was to help assess potential hydrogeologic connections between three candidate dye introduction points located within the central and southern portions of the MMPSG capture zone. The concurrent introduction of three dyes with a project duration of six weeks was scoped for the study. Based on a review of analytical results from the sampling conducted during the initial six-week post dye release period, FDEP authorized three additional bi-weekly sampling events (one event every two weeks) with analysis that extended the post dye release sampler collection period to just over 12 weeks (86 days).

2. Regulatory and Public Notice

An Operational Plan (OP) was prepared for the use of interested agencies as part of this dye tracer study. The OP presented the two primary dye trace objectives:

- Identification of dominant groundwater pathways and travel times between three specific locations and a group of seven spring vents or vent clusters that comprise the MMPSG.
- Identification of potential sources of groundwater nutrient contamination that appear to be directly connected to the MMPSG discharge vents.

AECOM met with NFWFMD staff several times at the NFWFMD office located in Midway, Florida. With support from NFWFMD, AECOM prepared a public information flier that explained in language easily understood by the general public the nature of the dye tracer study and who to contact with questions. Prior to providing the flier, a draft flier was reviewed and approved by both FDEP and the NFWFMD.

Several weeks in advance of the tracer dye introduction and again 48 hours prior to dye introduction, Jackson County Health Department and the NFWFMD were notified. This notification was provided so that these agencies would be prepared should they receive calls from members of the general public in the unlikely event that dye was observed in water or wells/systems. Awareness of the dye trace activities by these parties would help manage potential public concern, and allow for project staff to be directed to such dye observation sites to collect samples. No calls from the public were received during the study.

3. Merritt's Mill Pond Spring Group, Explored Cave Systems and Discharge

The MMPSPG comprises Jackson Blue Spring, the main spring of the group, and seven other named springs: Shangri-La, Twin Caves, Hole-in-the-Wall, Heidi Hole, Gator Hole, Indian Washtub, and Lamar's Landing. The study area, which roughly approximates the southwestern portion of the Merritt's Mill Pond spring basin capture zone, is depicted on **Figure 3**. An aerial image identifying the seven spring vents monitored for this study, which includes overlays of explored cave passages for Jackson Blue Springs, Twin Caves, Hole-in-the-Wall, and Gator Hole is presented as **Figure 4**. A photographic log that provides selected photographs depicting field activities is presented in **Appendix A**.

3.1 Jackson Blue Spring

Located at the extreme northern and upstream end of Merritt's Mill Pond is the headspring, Jackson Blue Spring (**Appendix A, Photos 1 and 2**). It is referred to as "Jackson Blue Spring" to differentiate it from the many other Blue Springs found in Florida. The WBID for this spring is 180Z. This spring lies within property owned by the State of Florida, and is operated as a public park by Jackson County. This spring and its extensive cave system are very popular with cave divers.

The spring lies within a pool that makes up a public swimming area. Jackson Blue Spring's vent is a wide, elongated opening about 36 feet across, with floor to ceiling heights that vary from under 1.5 to over 10 feet. The depth of this vent ranges between 8 and 20 feet deep. The rock that comprises the ceiling of this vent is solid and self-supported, with the floor beneath largely composed of boulders and rubble. Inside the vent, the cavern is a complex structure of breakdown boulders, bedding planes, and side passages, with many areas of large dimension.

The most extensive known cave system located on Merritt's Mill Pond is found at Jackson Blue Springs. Over 30,000 feet of passages have been explored and surveyed, with a maximum penetration distance from the entrance of 10,000 feet. A maximum depth of 102 feet has been reached, with most of the cave passage lying between 70 and 100 feet in depth. Many passage cross sections are large, easily accommodating cave dive teams using propulsion vehicles. The cave network extends northeast from the spring and Merritt's Mill Pond.

At distances between approximately 2,000 to 2,500 feet and again at approximately 6,000 feet back along the main passage, several adjacent sinkholes connect into the cave system, as evidenced by debris and rubble present in the conduit, which fell in from land surface during a collapse event (Sorensen, 2016).

3.2 Shangri-La Spring

Shangri-La Spring is located on the right bank (west side) at the northern end of the Merritt's Mill Pond, about 900 feet downstream of Jackson Blue Spring (**Appendix A, Photos 3 through 5**). This spring also lies within property owned by the State of Florida and is operated as a public park by Jackson County. The primary spring vent and

entrance to the cavern discharges at the base of a limestone bluff and appears to account for most, if not all, of the water discharging here. Several very small flows can be observed along the bank. About 30 feet in front of the main spring vent, there is a large vertical fissure in the rock bottom that also discharges water. This fissure narrows to a discrete vent at about 18 feet in depth. This spring is also frequented by divers.

The entrance to the spring is just beneath the bank below the bluff, at about 7 to 10 feet of depth. This spring opens into a cavern room that has numerous passages extending out and connecting upwards to the dry cave passages that honeycomb the base of the rocky bluff. At the back of this room, the cave continues as a low, restrictive passage to depths below 25 feet. About 850 feet of cave passage has been explored and surveyed, with a maximum penetration distance from the entrance of 600 feet. A maximum depth of 40 feet has been reached. The cavern and cave extend northwest from the spring and Merritt's Mill Pond (Sorensen, 2016).

3.3 Indian Washtub Spring

Indian Washtub Spring is located off the right bank (north) near the northern end of Merritt's Mill Pond, about 1,800 feet downstream of Jackson Blue Spring (**Photo 6**). This spring is a depression in the bottom opening downward into a large vertical fissure in the rock bottom. Groundwater discharges from various vents along the fissure's bottom. The vertical fissure opens into a narrow fissure at about 10 feet in depth that is the entrance to the cave. Access into the cave and the passage beyond is extremely difficult, and it is not typically visited by cave divers.

About 500 feet of cave passage has been explored and surveyed, with a maximum penetration distance from the entrance of less than 600 feet. A maximum depth of 95 feet has been reached (Sorensen, 2016). A map of the cave network was not available at the time this report was completed.

3.4 Twin Caves

Twin Caves Spring is located to the east of the main channel in the upstream end and eastern side of Merritt's Mill Pond, about 2,000 feet downstream of Jackson Blue Spring (**Appendix A, Photos 7 and 8**). This spring has a vertical basin that has two openings into the cavern. As this is a popular cave diving location, a diver support platform has been built in the pond just east of the cave entrances.

The two entrances to the cavern are located on the north side of the vertical depression on the pond bottom, just inside of the "no wake zone" boundaries. The western and larger of the two entrances lies in 14 to 20 feet of water. The entrances open into a large cavern room, near the back of which is a pair of large vertical fissures that continue down to the main conduit of the cave.

These vertical fissures drop in depth from 30 to 45 feet down to the main cave passage. The main passage then continues in a southerly direction for about 1,000 feet to where the first major passage bifurcation occurs. The cave passages continue to bifurcate with distance, becoming smaller and siltier. Over 5,500 feet of cave passage has been explored and surveyed, with a maximum penetration distance from the

entrance of over 2,200 feet. A maximum depth of 108 feet has been reached in passage extending south. (Sorensen 2016).

3.5 Hole-In-The-Wall Cave

Hole-In-The-Wall Cave is located along the south bank of Merritt's Mill Pond, about 5,700 feet downstream of Jackson Blue Spring (**Appendix A, Photos 9 and 10**). The entrance to this submerged spring is beneath a rocky bluff. As this is a popular cave diving location, a diver support platform has been built in the pond in front of the site.

The entrance to the cave slopes down from the spring opening, heading north, narrowing and then opening to a large vertical shaft at about 50 feet deep. At the bottom of the shaft, a large cave passage is intersected, opening to the upstream and downstream main trunks of an extensive cave system.

The cave continues upstream for 4,500 feet in a northerly direction. The downstream portion of the cave reaches 6,000 feet in a southerly direction. About 29,000 total feet of cave passage has been explored and surveyed, with a maximum penetration distance from the entrance of 6,000 feet. A maximum depth of 108 feet has been reached (Sorensen, 2016).

3.6 Hidey Hole Spring

Hidey Hole Spring is located just out from a private dock on the left bank and east side of Merritt's Mill Pond, about 8,200 feet downstream of Jackson Blue Spring (**Appendix A, Photos 11 and 12**). This small submerged spring discharges at the bottom of a round vertical shaft on the rocky pond bottom.

The entrance to the spring is about 15 feet deep on the west side of the vertical shaft, where the bottom slopes to the west into a small room. At the bottom of this room at about 23 feet deep, discharge can be observed at a restriction. The low and narrow restriction is typically blocked by a heavy sediment accumulation along its bottom. Access is extremely difficult, but the cave then opens into a fairly extensive reach of passage. With such a difficult access and the extreme silt conditions here, it is not typically visited by cave divers.

The cave continues for 900 feet in a northeasterly direction. Approximately 1,300 total feet of cave passage has been explored and surveyed, with a maximum penetration distance from the entrance of 900 feet. A maximum depth of 35 feet has been reached (Sorensen, 2016).

3.7 Gator Hole Spring

Gator Hole Spring is located on the left bank and east side of Merritt's Mill Pond, about 9,700 feet downstream of Jackson Blue Spring (**Appendix A, Photos 13 and 14**). The entrance to this submerged spring is beneath a rocky bluff.

This spring discharge is a complex network of both water-filled and air-filled cave passages. The network of shallow passages here is several hundred feet long, and has

both a large, submerged opening along the shore of the pond and an opening to dry land back inside the cave.

The apparent spring discharge flows from a conduit intersecting the water-filled and air-filled passage network on the south side, about 150 feet into the cave from the pond side entrance. This conduit, which produces the spring flow here, begins at a depth of about 15 feet, and continues deeper as the main explored cave passage.

The cave continues for 1,000 feet in a southerly direction. About 1,300 total feet of cave passage has been explored and surveyed, with a maximum penetration distance from the entrance of 1,000 feet. A maximum depth of 55 feet has been reached (Sorensen, 2016).

3.8 MMPSG Discharge Measurements

In June 2007, the NFWFMD contracted with Karst Environmental Services (KES) to collect discharge measurements at the exit conduits of six springs that were observed to be discharging at that time (Lamar's Landing was not flowing) and found that Jackson Blue Spring had by far the largest discharge of the eight springs. Jackson Blue Spring contributed approximately 69% of the total flow of Merritt's Mill Pond (as measured at the pond outfall), the seven minor springs contributed 14%, and the remaining 17% was from other unmeasured sources. The estimated discharge measurements collected by KES are shown in **Table 1**.

Table 1: MMPSG Spring Discharge Measurements - 2007

Spring	Date	CFS	GPM	MGD
Gator Hole	7/20/2007	0.93	417	0.601
Hidey Hole	7/20/2007	0.16	72	0.103
Hole-In-The-Wall	7/17/2007	1.28	575	0.827
Jackson Blue	7/16/2007	39.8	17,540	25.258
Shangri-La	7/18 and 7/20/2007	3.87	1,737	2.501
Twin Caves	7/19/2007	1.6	718	1.034

CFS = cubic feet per second GPM = gallons per minute MGD = millions of gallons per day

The discharge at Shangri-La Spring represents the combined discharge of the Main Vent (measured 7/18/2007) and the Fissure (measured July 20, 2007). Using historical data, the NFWFMD calculated that from 2006 to 2010, Jackson Blue Spring accounted for 70% of the pond outflow on average (Dodson, 2013).

3.9 Precipitation

Physical and chemical factors that affect the ability of a tracer dye to be detected during a study include but are not limited to the duration of the study, distance from a dye introduction point to a discharging spring, the potential for matrix interference caused by organic matter and/or anthropogenic sources, the likelihood of direct surface water introduction into the aquifer during the study (e.g., recharge well, swallet, sinkhole, rapid infiltration basin), system hydraulics, and others, which are considered during the design phase of the tracer study. Notwithstanding these factors, the effect of the

amount of precipitation that falls within a spring basin capture zone is of paramount importance. For example, the absence of positive dye detection at a sample station during a drier period does not necessarily confirm the absence of a groundwater pathway. Rather, it may simply be that a lower groundwater recharge rate to the aquifer system yielded lower groundwater flow rates and that dye might have been detected if:

- a) There was more precipitation, or
- b) The duration of the study was extended to compensate for slower travel times.

Conditions for conducting this groundwater trace were favorable with respect to the amount of precipitation within the MMPSPG spring shed capture zone. During May 2016, observed precipitation measurements ranged from approximately 3 inches to 5 inches (**Figure 5**). The dye introduction occurred on June 9, 2016, with water flowing into Pelt Swallet. The observed precipitation ranged from 4 inches to 7 inches in June 2016 (**Figure 6**), 4 inches to 6 inches in July (**Figure 7**), and 5 inches to 9 inches in August (**Figure 8**).

4. Geology and Hydrostratigraphy

4.1 Introduction

The near surface geology of the area is composed of Eocene to Holocene carbonate and siliciclastic sediments. Within this area, geologic processes include a combination of fluvio-deltaic and marine deposition, erosion, dolomitization, and dissolution of underlying carbonates. In addition, there is a transition zone between the primarily siliciclastic sediments of the Gulf Coastal Plain of the Mississippi Embayment to the west and the predominantly carbonate sediments of the Florida Platform within the Jackson County area. These factors can make identification of formations difficult (Green et al., 2002).

4.2 Structure

Several structural, sedimentological, and geomorphic variables are unique to the area and have affected the near surface expression and interpretation of the geology of the region. Two important structural features are recognized: the Chattahoochee Arch – a northeast/southwest-trending high that exposes Eocene and Oligocene carbonates, with younger strata thinning around the arch (Murray, 1961) and the Apalachicola Embayment/Gulf Trough – an elongated basin that widens southwestward, towards the Gulf of Mexico, and narrows to the northeast into Georgia (Schmidt, 1984). Gulf water moved through this strait from the middle Eocene through Oligocene, flowing across the eastern panhandle of Florida, through southern Georgia and to the Atlantic Ocean (Green et al., 2003). This structure crosses through the southeastern part of Jackson County, and noticeably influenced sedimentation patterns in the region.

4.3 Geomorphology

Florida lies entirely within the Coastal Plain Physiographic Province as defined by Fenneman (1938). The lay of the land in the state of Florida consists of east-west trending highlands and lowlands in the Panhandle portion of the state (Scott, 2005).

Jackson County lies within the Marianna Karst Plain physiographic unit of the Dougherty Karst Plain District geomorphic province. The Marianna Karst Plain is a region of low, rolling hills; sinks; and depressions that extends into Alabama (Cooke, 1939). This terraced lowland has resulted from fluvial deposition and erosion by rivers and streams and underlying karst activity (Scott, 2005). Several relict Neogene coastal terraces have been recognized in the study area (Healy, 1975). Surface topography has been incised by numerous streams, often creating a dendritic drainage pattern. Some streams emerge from steep-sided ravines, called "steepheads." These features, unique to western Florida, reflect the interaction between groundwater and thick, siliciclastics that sit atop impermeable clays (Green et al., 2003).

Elevations of the Marianna Karst Plain range from 60 feet to 150 feet above mean sea level. The Ocala and Marianna Limestones are at or near the surface within this area and often exhibit extensive karstification. Karst processes can result in sinkholes, springs, fractures, cavern development, and other dissolution features that can

dramatically influence topography. Numerous well-developed caverns occur throughout the Marianna Karst Plain. In general, these caverns are formed in the upper Ocala Limestone by dissolution along fracture or bedding planes, but may also develop within the Marianna Limestone. The most well-known caves are found within Florida Caverns State Park, located just north of Marianna in Jackson County (Green et al., 2003).

4.4 Stratigraphy

The Eocene to Miocene units exposed in Jackson County have been identified, correlated, and interpreted in many different ways in the published literature. Some investigators relied heavily on fossils to establish formations and correlate facies within this region, a practice that has led to some confusion regarding lithostratigraphy (Green et al., 2003). The stratigraphic nomenclature of previous usage, along with that of current usage is shown in **Appendix B**.

For the purposes of this report, the nomenclature of Green et al. (2003) is adopted for upper Eocene and younger stratigraphy. The lithostratigraphic units beneath Jackson County generally dip and thicken to the southwest and are described below in ascending order.

4.5 Ocala Limestone

The study area is underlain by the Upper Eocene Ocala Limestone, and in the northern portion of the map area, where erosion has cut through the overlying siliciclastics, or removed the Marianna Limestone, it often crops out along major streams and rivers. The Ocala Limestone, which is the oldest unit to crop out in Jackson County, consists of a moderately indurated, cream to white colored grainstone that is rich in the distinctive larger foraminifer *Asterocyclina* sp. This unique biofacies of the Ocala Limestone also contains abundant large and small benthic foraminifera, some planktonic foraminifera, byozoa, brachiopods, mollusks, arthropods, and echinoderms (Green et al., 2003). The Ocala Limestone is unconformably overlain by the Marianna Limestone throughout the study area.

4.6 Bumpnose Limestone Member

The Bumpnose Limestone Member (Moore, 1955) of the Ocala Limestone is a poorly to well indurated, cream to white, fossiliferous packstone, dominated by the larger foraminifer *Lepidocyclina* (*L. chaperi*), many of which have especially large and thick tests (1/2 inch to over 1 inch in diameter). In some areas, the unit consists of a wackestone to packstone "sand dollar" bed, with abundant debris of the echinoid *Clypeaster* (*C. rogersi*).

The top of the unit is well indurated, nodular, and glauconite-rich, and often contains preserved internal molds of the nautiloid *Aturia alabamensis* (Morton). The calcitic bivalves *Amusium ocalanum* (Dall), *Spondylus dumosa* (Morton), *Chlamys anatipes* (Morton), and *Lopha vicksburgensis* (Conrad) are commonly found in the Bumpnose Limestone member of the Ocala Limestone. The unit is transitional in nature, containing fauna with both Eocene and Oligocene affinities. Although a member of the Ocala

Limestone, which is otherwise entirely Eocene, it is probable that the Bumpnose Limestone Member in the type area is Early Oligocene (Green et al., 2003).

4.7 Marianna Limestone

The Lower Oligocene Marianna Limestone (Matson and Clapp, 1909) disconformably overlies the Ocala Limestone in the vicinity of the study area. It is at or near the surface in the study area and numerous exposures can be seen in and around the town of Marianna. The massive, chalky, Marianna Limestone is sometimes referred to as "chimney rock" because it was once sawed by hand into blocks for construction purposes. The Marianna Limestone is well-defined and easily recognized in the field, extending from the type area to the Mississippi River, with outliers in southern Georgia. It has not been recognized in the Florida peninsula, south of the Gulf Trough (Green et al., 2003). It is laterally equivalent to the lower portion of the Suwannee Limestone (Scott et al., 1991).

The Marianna Limestone is a fossiliferous, variably argillaceous limestone (Scott et al., 1991) that ranges in color from white to cream to light gray and is a soft, fine-grained, poorly indurated, glauconitic, fossiliferous wackestone rich in *Lepidocyclina*, *Nummulites*, bryozoans, calcitic bivalves, and rare echinoids. The bivalve *Pecten howei mariannensis* (Glawe) is especially common (Green et al., 2003).

In and around the town of Marianna, a grayish-yellow or light olive-green dolosilt occurs at the top of the Marianna Limestone, which has previously been identified by some workers as the Byram Formation of Alabama and Mississippi. However, based upon sedimentological and faunal similarities to the Marianna Limestone, Green et al. (2003) retained them in the Marianna Limestone as originally defined by Cooke and Mossom (1929) and Cooke (1945).

A massive sequence of light brown to tan dolostone occurs only a few miles south of the surface exposures around Marianna, and near the Apalachicola Embayment/Gulf Trough. This dolostone, however, is recognizable as dolomitized Marianna Limestone by its fine-grained texture and abundance of (moldic) *Lepidocyclina* sp and *Nummulites* sp. This dolomitic facies of the Marianna Limestone has abundant casts of echinoids *Schizaster armiger* (Clark), *Clypeaster* sp, and *Echinolampas* sp. Dolomitization evidently occurred shortly after deposition, as indicated by dolomitic rip-up clasts observed in several cores in the southeastern portion of Jackson County and molds of platy gypsum present within the dolostone in the American Lime and Dolomite Quarry (Green et al., 2003).

4.8 Missing Stratigraphic Units

Based upon the mapping by Green et al. (2003), the Bridgeboro Limestone, Suwannee Limestone, Chattahoochee Formation, and the Citronelle Formation are not present in the vicinity of the study area.

4.9 Alum Bluff Group

The Middle Miocene to Early Pliocene Alum Bluff Group (Scott, et al., 2001) occurs throughout much of the area. Lithologically, it ranges from clayey sands and gravels to stiff, greenish, micaceous clays with variable admixtures of silt, sand, and shell. In the vicinity of the study area, the Alum Bluff Group unconformably overlies either the Ocala Limestone or the Marianna Limestone (Green et al., 2003).

4.10 Undifferentiated Residuum

Green et al. (2003) identified and mapped residual sediments of various origins at or near land surface throughout much of Jackson County. Based upon the mapping by Green et al. (2003), "undifferentiated residuum lying on Oligocene Marianna Limestone and Suwannee Limestone" is present to the north, south, and east of the study area and it is possible that local deposits of this residuum are present within the study area.

This residuum generally consists of reddish brown sandy clays and clayey sands with inclusions of weathered, variably fossiliferous and silicified limestone boulders (Scott et al., 2001; Huddleston, 1993). These carbonate boulders and smaller weathered limestone "floats" that occur intermittently along roads, ditches, and fields are often silicified, making determination of their exact origin difficult. The majority of these carbonates are located at the general latitude and longitude where the parent rock (the Ocala Limestone, Marianna Limestone, or the Chattahoochee Formation) is intermittently exposed at land surface. Therefore, it is suggested that these boulders may represent remnant portions of the parent rock, depending on general location. Much of the matrix of this residuum is likely derived from weathered Alum Bluff Group and Citronelle Formation sediments (Green et al., 2003).

4.11 Hydrostratigraphy

Groundwater is plentiful in Jackson County, and large quantities of water are generally produced from wells that penetrate the bedrock. This water is normally uncontaminated but is "hard" because of the presence of dissolved bicarbonates. The Ocala Limestone, the most important source of groundwater, lies at or near the surface in most of the county (Moore, 1955). The Marianna Limestone is also an important source of groundwater in the central and southern part of the county. Most municipalities and industries obtain their water from middle Eocene formations (Moore, 1955) of the Claiborne Group, which are normally too deep for domestic users.

Most of the rocks that underlie the Southeastern Coastal Plain in the United States can be assigned either to the clastic Southeastern Coastal Plain aquifer system or to the carbonate Floridan aquifer system (Renken, 1996). The overwhelming majority of Tertiary and minor Cretaceous carbonate rocks in Alabama, Georgia, South Carolina, and Florida make up the Floridan aquifer system (Miller, 1986; Johnston and Bush, 1988). Low-permeability clastic beds that are interbedded with carbonate rock of Oligocene to Pliocene age form the upper confining unit of the Floridan aquifer system. This upper confining unit is, in turn, overlain by unconsolidated sand and gravel deposits of Pliocene to Holocene age. These uppermost deposits form a surficial aquifer that contains water under water table conditions (Renken, 1996).

4.12 Surficial Aquifer System

The surficial aquifer is recharged by rainfall and mostly contains water under unconfined conditions. Infiltrating rainfall percolates downward through the surficial aquifer, recharging permeable rock within the Floridan aquifer system or quickly discharging water to adjoining streams and rivers (Renken, 1996).

The surficial aquifer system is present within most of the Northwest Florida Water Management District (NFWFMD); however, it is thin to absent on part of the Chattahoochee Arch in Jackson County. The siliciclastic sediments composing the surficial aquifer system in the NFWFMD are part of the Citronelle Formation and are undifferentiated sediments of Pleistocene-Holocene age. These sediments are primarily quartz sands with varying percentages of clay. Where the clay content becomes great enough to inhibit the transmission of groundwater, localized impermeable beds may confine water, creating artesian conditions within the surficial aquifer system (Scott, 1992).

Based upon the mapping by Green et al. (2003), the Citronelle Formation is absent in the vicinity of the study area, and the surficial aquifer, if present, would consist of undifferentiated sediments of Pleistocene-Holocene age that are less than 20 feet thick.

4.13 Upper Confining Unit

This unit includes the rocks that lie between and collectively retard the exchange of water between the overlying surficial aquifer system and the underlying Floridan aquifer system. In Florida, the Upper Confining Unit is generally referred to as the intermediate aquifer system (IAS), the intermediate confining unit (ICU), or the IAS/ICU, depending on whether the system behaves predominantly as an aquifer system, a confining unit, or both. These units generally consist of fine-grained siliciclastic deposits intercalated with carbonate strata belonging to all or parts of the Oligocene and younger series. The aquifers within this system contain water under confined conditions. The top of the IAS/ICU coincides with the base of the surficial aquifer system, and on a local scale, with land surface. The base of the IAS/ICU is hydraulically separated to a significant degree from the top of the Floridan aquifer system (Copeland et al., 2009).

The IAS/ICU occurs over much of the NFWFMD, serving to effectively confine the underlying Floridan aquifer system. It is thin to absent over the Chattahoochee Arch in portions of Jackson County (Scott, 1992). In Jackson County, the IAS/ICU is the upper confining unit of the Floridan aquifer system and is composed of the sediments of the Alum Bluff Group. The Upper Confining Unit in the region is characteristically thin, generally less than 50 feet thick, and is often absent or breached by sinkholes (Bartel et al., 2011).

Based upon the mapping by Green et al. (2003), the Alum Bluff Group is absent and there is no IAS/ICU in the area, although the undifferentiated sediments of Pleistocene-Holocene age may act as a semiconfining unit as described by Torak et al. (1996).

4.14 Floridan Aquifer System

The Floridan aquifer system (FAS) in the Southeastern United States has been described by Miller (1986) as a thick sequence of Paleocene to Miocene-age carbonate rocks that combine to form a vertically continuous carbonate sequence that is more or less hydraulically connected. Recently, the definition of the FAS was expanded by Williams and Kuniansky (2015) to include hydraulically connected clastic aquifers in the updip part of the aquifer system, including the Gordon aquifer (Brooks et al., 1985), the Claiborne aquifer (McFadden and Perriello, 1983), and the Lisbon aquifer (Gillett et al., 2004).

In Miller (1986), the Floridan aquifer system was subdivided into two aquifers separated by a series of discontinuous lower-permeability units in the approximate middle part of the aquifer system. Under that system the FAS was divided into three broad units, namely the Upper Floridan aquifer, Middle Floridan confining unit, and Lower Floridan aquifer.

Subsequently, the base of the FAS was mapped and extended in depth and areal extent by Williams and Kuniansky (2015) to incorporate hydraulically connected aquifers of the Southeastern Coastal Plain aquifer system (SECPAS) that they considered equivalent to the Lower Floridan aquifer of the FAS. Because of the gradational nature of the carbonate-clastic sequence, some of the updip clastic aquifers of the SECPAS were included in the FAS, the SECPAS, or both. In the vicinity of Jackson County, the lower portions of the FAS transition to and are underlain by the SECPAS.

Based upon the interpretations and mapping by Williams and Kuniansky (2015), the FAS in the study area is limited to the Upper Floridan aquifer, though they also consider the Claiborne aquifer (or Pearl River aquifer) of the SECPAS an equivalent or extension of the FAS. This represents a transition from the FAS to the SECPAS; therefore, the FAS is limited to the Upper Floridan aquifer for the purposes of this report.

4.15 Upper Floridan Aquifer

In central Jackson County, the Upper Floridan aquifer is composed of an offlapping sequence of carbonate sediments consisting of the Ocala, Marianna, and Suwannee Limestones, and the Chattahoochee Formation. Where they are near the surface, such as in Jackson, Gadsden, northern Calhoun, and northern Liberty Counties, the limestones are semiconfined from above by undifferentiated overburden and terrace and undifferentiated (surficial) deposits (Torak et al., 1996). The semi-confined condition of the Floridan aquifer in this area allows for large amounts of local recharge (Bartel et al., 2011).

The capacity of the Upper Floridan aquifer to store and transmit large quantities of water is attributed to the fractured nature of the Ocala Limestone (Hayes, et al., 1983) and associated dissolution of limestone by groundwater circulating along bedding planes and fractures (Hicks et al., 1987). Permeability of the Upper Floridan aquifer is imparted by small interconnected conduits or solution openings (Torak et al., 1996). In Jackson County, water levels generally lie 10-60 feet below the ground surface. Springs are present in the lower portions of the county; some wells located in these low places

might flow (Moore, 1955). A potentiometric surface map of the Upper Floridan aquifer system constructed from measurements collected by the Florida Geological Survey (FGS) in May 2014 within the MMPSPG spring basin capture zone is presented as **Figure 9**.

The lower confining unit consists of the Lisbon Formation. The hard, well-cemented, and clayey nature of the limestone gives this unit a distinctly lower water-yielding capability when compared with the Upper Floridan aquifer, causing it to act as a nearly impermeable base to the Upper Floridan aquifer (Hayes et al., 1983). The Lisbon formation has generally been recognized as part of the SECPAS, though Williams and Kuniansky (2015) include it in their extension of the Lower Floridan aquifer of the FAS in some parts of the Florida Panhandle, southern Alabama, and western Georgia.

5. Fluorescent Dye Tracing Methods

5.1 Tracer Dyes

Three fluorescent tracer dyes were used in this study. These were rhodamine WT dye, fluorescein, and eosine. Rhodamine WT has a Color Index Name of Acid Red 388; it has no assigned Color Index Number. Fluorescein dye is also known as uranine; its Color Index Name is Acid Yellow 73; its Color Index Number is 45350. Eosine dye is also known as D&C Red 22 and as Eosine OJ; its Color Index Name is Acid Red 87; its Color Index Number is 45380. Both eosine and fluorescein have D&C numbers, meaning that they are sometimes used in the manufacture of drugs and cosmetics. The dye mixtures used for this study contained approximately 75% dye equivalent except for the rhodamine WT, which has about a 20% dye equivalent. Dye quantities and dye concentrations were based upon the as-sold weight of the dye mixtures. The chemical structures of the three dyes are shown below:

Dye	Color Index Name	Color Index Number	APPROXIMATE PERCENT DYE IN "AS SOLD" MIXTURES	
			O U L Mixtures	Market Range
Eosine	Acid Red 87	45380	75%	2 to 75%
Fluorescein	Acid Yellow 73	45350	75%	2 to 80%
Rhodamine WT	Acid Red 388	Not Assigned	20%	3 to 20%
Sulforhodamine B	Acid Red 52	45100	75%	3 to 75%
Pyranine	D&C Green 8	59040	77%	Unknown

Eosine

Fluorescein

Pyranine

Sulforhodamine B

Rhodamine WT

Source: Ozark Underground Laboratory; Groundwater Tracing Handbook, 2002

All three of the dyes are commonly used in groundwater tracing work and have a good track record in providing successful traces. They are environmentally safe (Smart, 1984; Field et al., 1995) and pose no risk to humans, livestock, or aquatic life in the concentrations used in groundwater tracing work under the direction of experienced professionals. The dyes are highly detectable with analytical instruments at very low concentrations, so tracing work is conducted with dye concentrations at detection sites that are orders of magnitude smaller than the visible threshold where the general public might see colored water. As reported in Aley (2002), the differences between the instrument detection limit for the dyes in water is over four orders of magnitude (10,000 times) smaller than the visible threshold for the general public for rhodamine WT. The difference is more than five orders of magnitude smaller (100,000 times) for fluorescein and six orders of magnitude smaller (1 million times) than the visible threshold for the general public for eosine. **Table 2** presents OUL instrument detection limits for three tracer dyes in water and activated carbon sampler elutants. The general public visible

detection limit in water is from Aley (2002). Units are parts per billion (micrograms per liter) and are based on the as-sold weight of the dye mixtures used in this study.

Table 2: Detection Limits for Tracer Dyes Used in this Study

Dye mixture and dye equivalent percentage	Visual by general public under field conditions (ppb)	Water. OUL analytical protocol (ppb)	Carbon sampler elutant. OUL analytical protocol (ppb)
Eosine 75%	13,500	0.015	0.050
Fluorescein 75%	140	0.002	0.025
Rhodamine WT 20%	2,500	0.015	0.170

ppb = parts per billion

Each of the dyes except rhodamine WT are provided as powders that are typically mixed with water prior to introduction. When mixed with water at a rate of one pound of dye to one gallon of water, the resulting mixture has a specific gravity of about 1.12. The rhodamine WT solution also has a specific gravity of about 1.12. Since these specific gravities are heavier than water, a dye solution poured into a well will sink through the water column and color most or all of it rapidly (depending in part upon the total depth of the water column). Each of the dyes are essentially infinitely soluble. Each of the three dyes has the important characteristic that it can be adsorbed onto activated carbon samplers and then desorbed (eluted) from these samplers in the laboratory. Each of the dyes has different properties and each performs somewhat differently in aquifers. Important differences among the dyes are discussed in the following subsections. The selection of which dye was used for each introduction gave due consideration to the differences in the properties and performance characteristics of the three dyes, as well as characteristics of the dye introduction points.

5.1.1 Rhodamine WT Dye

Rhodamine WT was developed by DuPont in cooperation with the United States Geological Survey (USGS) as a water tracing dye, which is the reason for the letters "WT" in the name. It has a low photodecomposition rate and is fairly readily adsorbed, retained, and then eluted from activated carbon. It is less strongly bound on the activated carbon than are fluorescein and eosine and, in some waters, can be desorbed from activated carbon by other compounds present in the water. This is not a problem in relatively clean waters such as those in the aquifer feeding the MMPSG. A limitation of rhodamine WT is that it is composed of two isomers, with the amount of each isomer being approximately equal. One of the isomers is less conservative than the other and, as a result, Sabatini and Austin (1991) found that the breakthrough curve for rhodamine WT dye through alluvial aquifer sands was non-linear and not of the normal sigmoidal shape. Basically, the rhodamine WT cumulative breakthrough curve leveled off after about half of the dye had passed through the column, and remained level for a number of pore volumes before again increasing. In karst aquifers where much of the flow is through preferential flow routes, the fact that rhodamine WT is composed of two isomers does not seem to appreciably retard part of the dye pulse. However, in more dispersive flow systems, it has been the experience of Ozark Underground Laboratories (OUL) that some of the rhodamine WT dye is retarded due to adsorption. When this occurs, OUL

has noted that the emission fluorescence peaks of the retarded dye are typically somewhat shorter than dye arrivals attributable to the more mobile isomer.

5.1.2 Fluorescein Dye

Fluorescein dye has the best performance characteristics in karst aquifers of any of the dyes. It has a greater fluorescence intensity than any of the other tracer dyes (Aley, 2002; Leibundgut et al., 2009). It adsorbs readily onto activated carbon samplers, is retained well on such samplers, and then is readily eluted (desorbed) in the laboratory for subsequent analysis. Fluorescein is less subject to sorption onto limestone than rhodamine WT (Smart and Laidlaw, 1977); these authors did not evaluate eosine dye. Behrens (1986) ranked resistance of the three dyes used in this study to adsorption as fluorescein > eosine > rhodamine WT. Aley (2002 and 2008) concurred with this ranking. A limitation for the use of fluorescein is a relatively high photodecomposition rate in sunlight. This was not an important consideration in this study since the dye was introduced into a sinkhole and chased with water to more rapidly enter the groundwater system, such that exposure to sunlight was greatly minimized. Sampling at the springs of the MMPSG was conducted at the mouth of the vents, and as a result there was negligible fluorescein loss to photodegradation. OUL experience is that photodegradation of fluorescein is minimal once the dye has been adsorbed onto activated carbon. Another potential limitation for fluorescein is its use in various household products and in vehicle coolant solutions. Background sampling prior to dye introduction demonstrated that fluorescein or compounds with similar fluorescence characteristics were not detectable at the selected sampling sites.

5.1.3 Eosine Dye

Eosine dye is sometimes called brominated fluorescein. As indicated by Behrens (1986) and Aley (2002 and 2008), the resistance of eosine to adsorption is second only to fluorescein and is better than rhodamine WT. Another advantage of eosine is that, while being readily detected using instrumentation, it is less visually detectable than the other three dyes.

A disadvantage of eosine dye is that, like fluorescein, it is subject to photodegradation. This was not a significant limitation for this study, as the dye was directly introduced into Pelt Swallet via the inflowing surface stream. Another limitation of eosine is that it is less readily adsorbed, retained, and then eluted (desorbed) in the laboratory than is fluorescein. OUL experience is that this limitation is most significant when concentrations of eosine in water are very small. In some long-term groundwater tracing studies conducted by OUL, some degradation of eosine has occurred, with a resulting decrease in the peak emission fluorescence wavelength of the resulting compound. It is likely that the degradation is due to the loss of bromide from the structure of eosine, and the resulting compound, while still fluorescent, has a shorter peak emission fluorescence wavelength than non-degraded eosine.

5.2 Dye Sampling

Sampling for the tracer dyes placed primary reliance upon activated carbon samplers and secondary reliance upon grab samples of water. The activated carbon samplers

adsorb and retain each of the tracer dyes used and then release them to an eluting solution in the laboratory. The carbon samplers are continuous and accumulating samplers. In general, an activated carbon sampler in place in flowing water for one week will accumulate and then release to the eluting solution a dye concentration at least one and often two orders of magnitude greater than the mean dye concentration in the passing water (Aley, 2016). Samplers in place for a shorter time accumulate less dye, and samplers in place for longer than one week will accumulate more dye. Samplers are typically changed at approximately one-week intervals so that fresh carbon is always in place and if samplers are lost, there is no excessively long data gap. Longer sampling periods were used near the end of this study to extend the duration of the sampling effort. It is the conclusion of OUL that this did not adversely impact the quality of the sampling effort, since the waters being sampled were of good quality.

5.2.1 Sample Collection Methods

Collection of charcoal samplers and water samples was performed at in-water sample stations at the selected MMPSPG vents. For each charcoal sampler change-out and water sample collected, AECOM and KES provided a pre-labeled station kit with fresh replacement charcoal packets, a Whirlpak bag, and 40 mL vial, each kept in a slide-closure plastic bag. Samples were collected in the field by AECOM and KES personnel and placed into laboratory-supplied plastic bags, with the date and time of collection recorded on each label with an indelible marker. The samples were then placed in insulated coolers and shipped under chain-of-custody protocol with Blue Ice® by overnight courier service to OUL for analysis. Upon arrival the samples were refrigerated at 4°C until analysis. Sample Collection Data Sheets for samples collected are provided in **Appendix C**.

5.2.2 Activated Carbon Samplers

The activated carbon samplers contained 4.25 grams of chemically active coconut shell carbon. The samplers were manufactured by OUL, and the activated carbon used was Calgon 207C coconut shell carbon, 6 to 12 mesh. Based upon manufacturer's data, each carbon sampler has over one acre of adsorbing surface area (Aley, 2002).

5.2.3 Spring Vent and Surface Water Charcoal Samplers

Underwater charcoal sampler holders consisted of a brick with holes or concrete lawn sprinkler "doughnuts" that were fitted with an arch of heavy copper wire. A site identification label was attached. A pair of charcoal samplers was attached to the upper part of the wire arch by large brass-plated safety pins, in a manner that would provide for optimum water flow through them. The sampler holder was then placed or lowered into the selected spring vent. Some holders had a line and float attached to them for easier relocation and recovery. Holders in deeper water that needed to be serviced from watercraft were fitted with a line and float with a wire loop that could be grabbed with a hook pole from the surface. When recovered from the water, the exposed charcoal packets were removed and secured, and the fresh packets were attached. The holders were then placed back into their original positions.

5.2.4 Water Sampling Method

A surface water grab sample collected from shore or a support boat was accomplished by the sampler first rinsing a 50-mL vial, collecting the sample directly into the flow from the spring vent, and then filling, capping, and securing the vial. In the deeper vents where water needed to be sampled at a discrete depth, staff operating from watercraft lowered a vertical VanDorn sampler to the desired depth and position at the vent, and then activated the messenger to allow for filling the device. The sampler was then raised to the surface and the water sample was poured into the pre-cleaned vial provided by OUL.

5.3 Analytical Methods

5.3.1 Sample Preparation

Activated carbon samplers were rinsed in strong jets of OUL reagent water to remove debris that might be present. The activated carbon was then placed into disposable beakers and eluted for one hour in an eluting solution consisting of 5% aqua ammonia, 95% isopropyl alcohol solution, and sufficient potassium hydroxide flakes to saturate the solution. The isopropyl alcohol solution is 70% alcohol and 30% water. The aqua ammonia solution is 29% ammonia. After the one-hour period, the eluting solution was poured into a vial in preparation for analysis. The analysis was performed using a Shimadzu RF-5301 spectrofluorophotometer operated under a synchronous scan protocol. Water samples were also analyzed on the same instrument. Prior to analysis, the pH of each water sample was adjusted to pH 9.0 or greater by placing uncapped vials of the water in a high ammonia environment for a period of at least 12 hours. This maximizes the fluorescence intensity of fluorescein dye that may be present.

5.3.2 Laboratory Instrumentation

Laboratory dye analysis was conducted with a Shimadzu RF 5301 spectrofluorophotometer operated under a synchronous scan protocol and printing out a graph of emission fluorescence. Using proprietary software, emission fluorescence peaks are separated from background fluorescence in much the same way that a storm pulse is separated from base flow for stream hydrographs. The program calculates the area within the fluorescence peak and calculates the dye concentration based upon daily standards. The analytical graphs are filed on a station-by-station basis. Sample information is compared with chain-of-custody sheets for accuracy. Preliminary results are added to a spreadsheet. At the end of a study, graphs are again reviewed for accuracy and consistency. Acceptable emission fluorescence peak wavelengths have been calculated for all three of the dyes used during this study. These values were based upon a selected suite of samples with a high level of confidence by OUL that the fluorescence peaks were due to the specific dyes used for this study. The acceptable wavelength range equals the mean value plus and minus 2 standard deviations. The distribution of values is skewed toward the shorter side of the wavelength range and it is common for low concentrations of dyes to have emission fluorescence peaks that are between 2 and 3 standard deviations shorter than the mean.

Acceptable wavelength ranges and detection limits for the dyes in water and carbon sampler elutants are shown in **Table 3**. Concentrations are based on the as-sold weights of the dye mixtures.

Table 3: Acceptable Wavelength Ranges and Detection Limits for Three Tracer Dyes

Dye Mixture	Normal Acceptable Emission Wavelength Range (nm)		Detection Limit (ppb)	
	Elutant	Water	Elutant	Water
Eosine	539.1 to 545.1	532.5 to 537.0	0.050	0.015
Fluorescein	514.1 to 519.2	505.9 to 509.7	0.025	0.002
Rhodamine WT	564.6 to 571.2	571.9 to 577.2	0.170	0.015

nm = nanometers

5.3.3 Positive Dye Detection Criteria and Data Qualifiers

OUL procedures establish a four-point criteria that must be met for positive dye detection. These are:

1. There must be at least one fluorescence peak at the station in question in the acceptable wavelength range for the appropriate dye and matrix.
2. The dye concentration must be at least 3 times the detection limit.
3. The dye concentration must be at least 10 times greater than any other concentration reflective of background at the station in question.
4. The shape of the fluorescence peak must be typical of the dye in question and there must be no other factors that suggest the fluorescence peak may not be dye from this groundwater tracing work.

Some samples do not fully meet the four criteria specified above for a positive dye result, yet the preponderance of the data indicates that the sample is in fact dye introduced during a study. An example would be a fluorescence peak slightly shorter than the acceptable wavelength range. Samples that do not fully meet the criteria are flagged with the data qualifier (**) if the preponderance of the data indicates that the sample is dye introduced during the study. This footnote is used only if at least one sample at the station fully met the positive dye detection criterion. If a sample is qualified with a single * it indicates that the preponderance of the data indicates that the sample is dye introduced during the study, but that no samples at the station fully met the positive dye detection criteria.

5.4 Laboratory Quality Control

Laboratory blanks were run for every sample where the last two digits of the laboratory numbers are 00, 20, 40, 60, or 80. A charcoal packet was 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 (gpm). The sampler was then subjected to the same analytical protocol as all other samplers. System functioning tests of the analytical instruments were conducted in accordance with the manufacturer's recommendations.

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

6. Dye Trace Design and Dye Selection

The decision as to which dye to use for each of the three traces and the quantity of each was based upon a consideration of the properties of the three dyes described in Section 5, the method of dye introduction, site-specific characteristics of each dye introduction location, distance to likely receiving springs, and estimated flow rates of the springs. Experience from similar traces was the primary consideration in selecting which dye was most appropriate for each dye introduction. Equal amounts of fluorescein and eosine mixtures (10 pounds each) were used, and the amount of rhodamine WT used (20 pounds) was twice the amount of the other two dyes. The use of more rhodamine WT dye mixture than the other mixtures was partly a reflection that the dye equivalent percentage in this mixture is only 20% while it is 75% in the fluorescein and eosine mixtures. Rhodamine WT was used for what was anticipated to be the most directly connected flow system to springs, and fluorescein was used for what was anticipated to be the least directly connected flow system.

6.1 Selection of Introduction Points and Dyes

A list of candidate dye introduction locations was assembled from well-known sink and swallet sites, cataloged caves, sinks cataloged on GIS data, anecdotal local knowledge, and field reconnaissance into the area. An experienced local cave diver, Edd Sorenson, owner of Cave Adventurers dive facility at Merritt's Mill Pond, provided valuable assistance to the study team with field reconnaissance and site access. The candidate dye introduction sites recommended to FDEP included individual examples of the various types of surface to groundwater introduction points that exist throughout Jackson County:

1. An isolated sink open to the groundwater surface (RD's Sink).
2. A pair of soil-plugged sinks receiving regular runoff from an active agricultural field (Strickland Sinks East and West).
3. A swallet (Pelt Swallet), which receives intermittent stream inflow based on the frequency and duration of precipitation.

The candidate dye introduction locations were approved by FDEP and are depicted on **Figure 1** and **Figure 2**.

6.2 RD'S Sink – Rhodamine WT

6.2.1 Background

RD's Sink is a natural sinkhole located on private property approximately 2.5 miles north-northwest of the MMPSG (**Appendix A, Photos 21 and 22**). It lies in a wooded cattle pasture about 100 feet south of Hartsfield Road, between Poplar Springs Road to the west, and Sylvania Plantation Road to the east.

RD's Sink is a typical natural vertical sink feature in the limestone not uncommon in this area. The surface expression of the sink at land surface is approximately 70 feet long and 20 feet wide. After dropping down approximately 15 feet the sink narrows to a low,

narrow opening (approximately 3 feet x 5 feet) in the rock, where it intersects the visible top of the groundwater table. Evidence of surface water stream or significant stormwater draining into this sink was not observed. The water is clear and a troglobitic crayfish was observed within the sink during this study. Previous to this study, a diver made an attempt to enter the cave here, and was able only to make about an 8-foot penetration in about 2 feet of depth. A live fish was observed at this location during that activity.

6.2.2 Dye Selection

Twenty pounds of rhodamine WT dye mixture containing approximately 20% dye equivalent was used for the RD's Sink introduction. Since this dye has a greater adsorption tendency than fluorescein or eosine, its use much closer to the MMPSG was reasonable. The choice of 20 pounds of this mixture for this introduction was based on previous OUL experience, the desire that waters of the MMPSG would not be visually colored, and the need not to reduce the detectability of the other two dyes at sampling points in the MMPSG.

6.3 Strickland Sink East – Fluorescein

6.3.1 Background

Strickland Sinks East and West are located on private agricultural property about 5.1 miles northwest of the MMPSG (**Appendix A, Photos 23 through 26**). They lie on the north edge of an irrigated crop field about 1,350 feet south of Fort Road (CR 69) and about 1,000 feet east of Sylvania Plantation Road, about 1.25 miles west of Two Egg, Florida. The deepest portions of these two sinks lie approximately 430 feet apart.

Strickland West Sink is a network of eroded soil and gulleys, about 200 by 300 feet in size, which drains into the woods along its north side. The field runoff drains into solution shafts in the limestone visible to a depth of at least 20 feet.

Strickland East Sink is also a network of eroded soil and gulleys, about 150 by 200 feet in size. Its runoff drains into a central area of limestone outcrops and solution shafts, about 12 feet below the surrounding land. This sink was selected due to its proximity to the center pivot water supply and property control issues.

6.3.2 Dye Selection

Ten pounds of fluorescein dye mixture containing approximately 75% dye equivalent was used for the Strickland Sink East introduction. Since this dye has the lowest tendency of the three dyes for adsorption onto soil, its use at this site that had a soil plug was reasonable. The choice of 10 pounds of this mixture for this introduction was based on previous OUL experience, the desire that waters of the MMPSG would not be visually colored, and the need not to reduce the detectability of the other two dyes at sampling points in the MMPSG.

6.4 Pelt Swallet – Eosine

6.4.1 Background

Pelt Swallet is located on private property approximately 2.6 miles southeast of the MMPSG (**Appendix A, Photos 15 through 20**). It lies in a wooded depression about 300 feet east of Poplar Springs Road and 3,200 feet north of State Highway 90. Pelt Swallet is fed by an intermittent stream of stormwater runoff that comes primarily from drainage and low areas on the west side of Poplar Springs Road, and is channeled through culverts under that road. The swallet opening is in aggregate represented by a series of small perforated openings located within the limestone outcrop at the base of the bluff that forms the north side of the depression.

6.4.2 Dye Selection

Ten pounds of eosine dye mixture containing about 75% dye equivalent was used for this introduction.

6.5 Selection of Dye Sampling Locations

The consideration and selection of sampling locations at the various sites for dye introduction and sampling were conducted during field reconnaissance via watercraft on Merritt's Mill Pond.

6.5.1 Spring Vents and Control Stations

The study team wanted to include as many of the named spring vents or vent groups as possible. Data collected by KES and others during previous studies included collecting GPS positions, mapping, sampling, photography, and discharge measurements where possible. Based on this level of familiarity by the project team, a list of seven candidate sampling stations was generated, targeting individual vents, or the most prominent vent within a discrete named vent group. From that list, seven MMPSG vents were selected for sampling, along with two surface water control stations.

6.5.2 Control Stations

To safeguard against the unlikely possibility that the dyes released might bypass the spring vent stations and emerge at unknown locations within Merritt's Mill Pond, two surface water control stations were established. The mid-pond station was placed on the pond bottom just downstream of the opening in the remains of the Old Mill Pond Dam. The end-pond control station was placed along the left bank below the current dam control structure. This is on the south side of US Highway 90 just off a boardwalk constructed as part of a public access canoe and kayak launch used for recreational purposes.

7. Field Activities

7.1 Background Sampling

Background sampling was conducted prior to the introduction of the tracer dyes. The background sampling was designed to identify the presence of fluorescent tracer dyes or other compounds with similar fluorescent characteristics that might have been present within the aquifer system and observed at the sampling stations.

A review of historical and recent dye tracing activities in the MMPSG area indicated that conducting a Pre-Background sampling phase for interference from prior traces was not needed. The Comprehensive Background Sampling activities commenced on May 18, 2016, with the establishment of sampling stations at seven MMPSG springs. Control stations were also established at Merritt's Mill Pond Mid-Pond and End Pond, and at Pelt Swallet, with samplers also placed that same day.

The first Comprehensive Background Sampling interval for the spring vents and control sites continued until May 26, 2016. Charcoal samplers for the second interval were then left in place until June 8, 2016, the day prior to the dye releases.

Laboratory reports confirmed no positive detections were made regarding the presence of fluorescent dyes or sources of natural or anthropogenic fluorescent interference during background sampling.

7.2 Dye Introduction

Three dye introductions were conducted on June 9, 2016. The field activities are described below.

7.2.1 RD's Sink – Rhodamine WT

In the early morning of June 9, 2016, AECOM and KES staff arrived at the RD's Sink location to perform the first of three dye releases planned for that day (**Appendix A, Photos 27 through 30**). The team laid out approximately 100 feet of collapsible 4-inch supply hose from the water tanker parking location on Hartsfield Road. Once the supply line was in place and connected to the tanker, a pre-flush to test the lines and wet the sinkhole began at 08:41 hours. Twenty pounds of rhodamine WT dye from 10, 2-pound containers supplied by OUL were poured directly into the sinkhole's waters via a funnel and weighted hose while chase water was flowing. The initial pour began at 08:42 hours, and by 08:55, each of the containers prepared for use had been emptied and rinsed. At 09:02, the initial tanker was emptied, and at 09:03, the dye release team was out of the sink. The dye release team secured the empty containers in the vehicle dedicated for dye transport, bagged release-related trash and contaminated items, changed clothes, and used a bleach spray as needed for decontamination.

The chase water effectively flushed the dye into the sinkhole, with only some dye stains left on the sinkhole walls. The chase water was continued until 14:34, with about 20,000 gallons from four tanker loads used for the chase operation. During the

installation of the funnel hose at the start of the trace, KES observed a troglobitic crayfish in the clear groundwater visible in the sink.

7.2.2 Strickland Sink East – Fluorescein

In the late morning of June 9, 2016, AECOM and KES staff, along with FDEP and NFWFMD personnel, arrived at Strickland Sink East, about 1.25 miles west of Two Egg, Florida (**Appendix A, Photos 31 through 36**). This location was the second of the three dye releases planned for that day.

During the previous day, the center pivot irrigation system that straddles the Strickland East Sink was plumbed with an adaptor that allowed for the use of 2.5-inch-diameter fire hose to discharge chase water. The wellhead of the irrigation system is approximately 1,300 feet from the entrance to Strickland Sink East and is referred to in NFWFMD records as both “Bishop Farms #1 Well” and the “Craig Bishop - Powell South Well.” Several rolls of collapsible hose were connected via an adaptor to the sediment drain trap connection, the hose was run into the sink, and the irrigation well was turned on and tested successfully. In addition to water supplied directly from the fire hose, the center pivot's drop-head sprinklers also added water to the sink.

The irrigation well (State ID AAN7393) was drilled to a total depth of 160 feet below land surface (bls) and constructed using 8-inch-diameter steel casing set at a depth of 90 feet bls. The Well Completion Report, NFWFMD Well Inventory Database System Site Schedule, and an irrigation system performance evaluation report dated May 10, 2016, prepared by the Northwest Florida Mobile Irrigation Lab for the center-pivot well and sprinkler, are provided in **Appendix D**.

Ten pounds of fluorescein dye supplied by OUL in a total of 10, 1-pound containers was mixed with chase water in a plastic garbage can and released into the sink via a weighted hose. The center pivot's pump was turned on at 10:19, with overhead arrival of water at the sink and the fire hose line active at 10:22. The dye introduction team began to mix the dye with water at 10:25 (**Appendix A, Photos 33, 34, 35, and 36**). The release of dye into the sink began at 10:28 and by 10:42 the mixing tub was empty. At 10:54, the equipment rinsing was completed. Again, the dye release team secured empty containers in the vehicle dedicated for dye transport, bagged release-related trash and contaminated items, changed clothes, and used a bleach spray as needed for decontamination.

The center pivot pump was operated until 13:25. The discharge from the 2.5-inch-diameter fire supply hose connected to the center pivot was estimated to be at least 150 gpm. It is therefore estimated that at least 27,000 gallons of water was used as chase water, with additional water added from the sprinkler heads that were overhead. When the pump was shut down and hose and adaptors removed, there was a dye-stained pool several feet deep still present in the sink.

7.2.3 Pelt Swallet – Eosine

In the very late morning of June 9, 2016, AECOM and KES staff, along with FDEP and NFWFMD personnel, arrived at Pelt Swallet to perform the third and final of the three dye releases planned for that day (**Appendix A, Photos 37 through 40**). Upon arrival, it

was evident that there was a constant flow of water in a small stream that was draining from a depression on the west side of Poplar Spring Road via a culvert under that road. The flow in the stream at the swallet was estimated to be about 30 gpm. This inflow provided the chase water for the dye. Ten pounds of eosine dye powder from 1-pound and 2-pound containers was carefully shaken into the creek flow just upstream of the opening into the swallet. A KES staff member began the initial pour of dye powder at 11:59 hours, and by 12:14, each of the containers had been emptied and rinsed. The dye release team secured the empty containers in the vehicle dedicated for dye transport, bagged release-related trash and contaminated items, changed clothes, and used a bleach spray as needed for decontamination.

7.3 Field Sampling

7.3.1 MMPSG In-Water Sampling

Charcoal packets were exchanged in the MMPSG vents and control stations on June 8, 2016, one day prior to the dye release. These stations were then sampled for approximately 12 weeks. Initially, four charcoal sampler exchanges occurred at 4-day and 3-day intervals until June 23, 2016, or at 14 days from the release of the dyes. Three seven-day sampling intervals followed by one eight-day interval continued until July 22, 2016. One 12-day sampling interval followed by two 15-day intervals continued until the final sampling visit on September 3, 2016.

7.4 Carbon Sampler and Water Analytical Summary

A total of 139 carbon sampler sets (as sampler pairs) were placed and collected during this study. A tabular summary of station-specific field sampling logs identifying samples collected at each station is provided in **Appendix E**. Of the 22 background sampler sets placed, none were analyzed. Of the remaining 117 sets, 70 sampler packets were analyzed. Of these, 30 were positive for rhodamine WT, 13 were positive for eosine, and none indicated positive detection for fluorescein. Rhodamine WT detections were observed at three springs. Eosine detections were observed at two other springs. A total of 110 water samples were collected, of which 37 were analyzed. Two springs yielded 10 positive water samples for rhodamine WT and one other spring had two in-water detections for eosine. Fluorescein was not detected in the water samples analyzed.

8. Dye Trace Results

Activated carbon samplers are continuous and accumulating samplers. The concentration of dye eluted from carbon samplers in the laboratory is a function of the concentration of dye in the water being tested and the length of time the sampler was exposed to that water. As activation sites on the carbon are occupied by tracer dyes or other compounds, the rate at which the carbon sampler can continue to adsorb dye or other materials decreases. However, the activated carbon in a sampler has over an acre of surface area, so this decrease in adsorbing surface area is minimal if: (1) carbon samplers are not exposed to large concentrations of dye or other materials that can adsorb onto the carbon, and (2) are not left in the water being tested for unduly long periods of time. The dye concentrations at sampling stations used in this study were not large and samplers were typically left for periods of one week or in a few cases longer. In the experience of OUL, these were not unduly long periods. Dye concentrations from carbon samplers can be added together as an indicator of the relative amount of dye detected at a particular sampling station.

Procedures for the three dye introductions have been discussed in previous sections of this report. The OUL laboratory analytical reports with sample collection data sheets are provided in **Appendix F**. A tabular summary showing dye analysis results from each charcoal and water samples analyzed for tracer dyes are found in **Appendix G**. Concentrations are based on the as-sold weight of the dye mixtures used.

8.1 Results of Rhodamine WT Dye Introduction at RD's Sink

Twenty pounds of rhodamine WT dye mixture containing approximately 20% dye equivalent and 80% diluent was introduced into this sinkhole on June 9, 2016 (Day 0) between 08:42 and 08:55 hours. The dye introduction was followed by the introduction of about 20,000 gallons of chase water; this water introduction ended at 14:34 hours on June 9, 2016.

Rhodamine WT from this dye introduction was detected at the sampling stations listed in **Table 4**. The straight line travel path for rhodamine WT is presented as **Figure 10**.

Table 4: Stations Where Rhodamine WT was Detected

Station Number	Station Name	First Detection In Carbon Samplers	First Detection In Water Samples
1A	Jackson Blue Spring	6/12 to 6/16/2016 Day 3 to Day 7	6/16/2016 (1) Day 7
1B	Jackson Blue Spring Back-up	6/12 to 6/16/2016 Day 3 to Day 7	6/16/2016 Day 7
2	Shangri-La Spring	6/16 to 6/19/2016 Day 7 to Day 10	6/19/2016 Day 10
4	Indian Washtub Spring	6/23 to 6/30/2016 Day 14 to Day 21	Not detected at 0.015 ppb or more.

(1) A fluorescence peak is present that does not meet the criteria for this dye. However, it has been calculated as a positive dye result because dye was present in the corresponding activated carbon sample.

8.1.1 Jackson Blue Spring

Station 1A is in the spring discharge vent and is the better of the two sampling stations for this spring. Station 1B is at the downstream boundary of the swimming area just off a floating dock, and dye concentrations in carbon samplers from this location averaged only 31% of the values from the spring discharge vent. The explanation for this is very slow water movement through the carbon samplers located near the swimming dock, which reduced the amount of dye adsorbed onto the carbon. In contrast, rhodamine WT concentrations in grab water samples collected at essentially the same time at both sampling stations were substantially larger at the back-up station than at the spring vent in three out of four pairs of samples. In the fourth pair of samples dye was detected in the water from the vent at 0.037 ppb but was not detectable (i.e., less than 0.015 ppb) at the dock.

Jackson Blue Spring has the largest flow rate of the three springs where rhodamine WT dye was detected. Based on flow rate measurements made for the NFWMD by Pete Butt, Tom Morris and Mark Long in July 2007 (KES, 2007) the flow rate of Jackson Blue Spring at that time was 39.08 cfs, and the flow rate at Shangri-La Spring was 3.87 cfs. The flow rate of Indian Washtub Spring was not measured, but it is a relatively small spring. Personal communication with Pete Butt (KES) who was the team leader of the July 2007 spring discharge measurement program estimated the flow as < 1 cfs.

Appendix H, Graph A shows mean daily rhodamine WT concentration from carbon samplers at the two Jackson Blue Spring sampling stations. The Jackson Blue Spring sampling station is the better site for monitoring this spring since it is at the spring vent. The dotted lines are mathematical extrapolations of dye concentrations subsequent to the sampling period. Similar graphs are prepared for other springs. For each graph the mean daily dye concentration value for a sampling period is plotted at the date that the carbon sampler was collected.

Appendix H, Graph B shows the accumulation with respect to time for rhodamine WT detected in carbon samplers at Station 1A (Jackson Blue Spring). **Table 5** shows approximate times for important dye discharge events at Station 1A (Jackson Blue Spring) based on the two graphs.

Table 5: Approximate Times for Important Dye Discharge Events at Station 1A Jackson Blue Spring

Event	Estimated Days After Dye Introduction
First arrival of rhodamine WT	Between Days 3 and 7. Approximately Day 5
Maximum dye concentration at spring	Between Days 10 and 14. Approximately Day 12
50% of detected dye mass passed through the spring	Approximately Day 23
Dye concentration at spring declined by an order of magnitude from peak concentration	Between Days 35 and 43. Approximately Day 43

8.1.2 Shangri-La Spring

Station 2 is Shangri-La Spring. It is located about 900 feet downstream of Jackson Blue Spring. Its flow rate, when measured in July 2007 was about 10% of the flow rate at Jackson Blue Spring (KES, 2007). **Table 6** shows approximate times for important dye discharge events at Shangri-La Spring.

Table 6: Approximate Times for Important Dye Discharge Events at Shangri-La Spring

Event	Estimated Days After Dye Introduction
First arrival of rhodamine WT	Between Days 7 and 10. Approximately Day 9.
Maximum dye concentration at spring	Between Days 10 and 14. Approximately Day 12.
50% of detected dye mass passed through the spring	Approximately Day 27.
Dye concentration at spring declined by an order of magnitude from peak concentration	Between Days 66 and 71. Approximately Day 69.
90% of detected dye mass passed through the spring	Approximately Day 69.

Appendix H, Graph C shows mean daily rhodamine WT concentrations from carbon samplers at Shangri-La Spring. The dotted line is a mathematical extrapolation of dye concentrations subsequent to the sampling period.

Appendix H, Graph D shows accumulation with respect to time for rhodamine WT in carbon samplers at Shangri-La Spring. **Table 6** is based on this graph and the dye accumulation graph for this station.

8.1.3 Indian Washtub Spring

A comparatively small amount of rhodamine WT was also detected in carbon samplers from Station 4 located at Indian Washtub Spring. Dye was not detected in water samples from this station. The reason for this is that dye concentrations in the water did not equal or exceed the detection limit for this dye in water (0.015 ppb). **Appendix H, Graph E** shows mean daily rhodamine WT concentrations from carbon samplers at Indian Washtub Spring. A graph was not prepared showing accumulation of the mass of rhodamine WT at this station due to a lack of sufficient data. **Table 7** shows approximate times for important dye arrival events at Indian Washtub Spring.

Table 7: Approximate Times for Important Dye Discharge Events at Indian Washtub Spring

Event	Estimated Days After Dye Introduction
First arrival of rhodamine WT	Between Days 14 and 21. Approximately Day 18.
Maximum dye concentration at spring	Between Days 21 and 28. Approximately Day 25.
50% of detected dye mass passed through the spring	Insufficient data to accurately estimate but probably on or before Day 35.
Dye concentration at spring declined by an order of magnitude from peak concentration	Between Days 56 and 86. Approximately Day 71.
90% of detected dye mass passed through the spring	Insufficient data to accurately estimate but probably on or before Day 86.

8.1.4 Rhodamine WT Findings

As previously noted, dye concentrations from carbon samplers can be added together as an indicator of the relative amount of dye detected at a particular sampling station. Using this approach the total dye concentration detected at Jackson Blue Station 1A (the spring vent) was 441.1 ppb. The charcoal sampler for the three-day period from June 16 to June 19, 2016, was not analyzed for this station. If the mean concentration per day for these three days was equal to the mean of the previous and subsequent sampling periods, then this would equal 59.4 ppb, for total rhodamine WT at Jackson Blue Spring of 500.5 ppb through the sampling period ending on September 3, 2016 (Day 86).

For comparison, the total of dye concentrations from carbon samplers at Shangri-La Spring for the same period was 372.1 ppb, which is 74% of the value from Jackson Blue Spring. Shangri-La Spring is about 900 feet downstream of Jackson Blue Spring, and the 74% value suggests that this spring is largely another discharge point for the same waters that discharge from Jackson Blue Spring. When flow rates of Shangri-La Spring and Jackson Blue Spring were measured in 2007 (KES, 2007), the flow of Jackson Blue Spring was about an order of magnitude (10X) greater than Shangri-La Spring. The flow rate difference and the total dye recovery percentages from carbon samplers indicate that about 7.5% of the detected dye from the RD's Sink trace discharged from Shangri-La Spring. While that value fits the limited data, a value of 10% or less through Shangri-La Spring is a more reasonable estimate (Second Peak).

The total dye concentration from carbon samplers at Indian Washtub Spring was 9.58 ppb. This is less than 2% of the value from Jackson Blue Spring. This spring is about 1,800 feet downstream of Jackson Blue Spring and its flow rate was apparently not measured in 2007. Given that the flow rate of Indian Washtub Spring is only a small fraction of the flow rate of Jackson Blue Spring, along with the small amount of rhodamine WT detected from carbon samplers, it is OUL's conclusion that Indian Washtub Spring discharged less than 1% of the rhodamine WT dye introduced at RD's Sink.

8.2 Results of Eosine Dye Introduction at Pelt Swallet

Ten pounds of eosine dye mixture containing approximately 75% dye equivalent and 25% diluent was introduced into this swallet on June 9, 2016 (Day 0) between 11:59 and 12:14 hours. The dye introduction was into the flow of a small stream that was flowing into and sinking in the swallet. The estimated flow rate of the stream was 30 gpm. At this flow rate a total of about 21,600 gallons of water entered this swallet on June 9, 2016, following dye introduction. Eosine from this dye introduction was detected at the sampling stations listed in **Table 8**. The straight-line travel path for eosine is presented in **Figure 11**.

Table 8: Stations Where Rhodamine WT was Detected

Station Number	Station Name	First Detection in Carbon Samplers	First Detection in Water Sample
3	Twin Caves Spring	6/19 to 6/23/2016 Day 10 to Day 14	6/30/2016 Day 21
5	Hole-In-The-Wall Spring	6/23 to 6/30/2016 Day 14 to 21	Not detected in samples

8.2.1 Twin Caves Spring

Twin Caves Spring is located about 2,000 feet downstream of Jackson Blue Spring. The flow rate of this spring was measured at 1.6 cfs in July 2007 (KES, 2007). For comparison, at about the same time, the flow rate of Jackson Blue Spring was 39.08 cfs.

Appendix H, Graph F shows the mean daily eosine concentrations from carbon samplers at Twin Caves Spring, and **Appendix H, Graph G** is a plot of the accumulation of eosine dye in carbon samplers from this spring. Based on these data, **Table 9** summarizes important dye discharge events at Twin Caves Spring.

Table 9: Approximate Times for Important Dye Discharge Events at Twin Caves Spring

Event	Estimated Days After Dye Introduction
First arrival of eosine dye	Between Days 10 and 14. Approximately Day 13.
Maximum dye concentration at spring	Between Days 14 and 21. Approximately Day 18.
50% of detected dye mass passed through the spring	Day 24.
Dye concentration at spring declined by an order of magnitude from peak concentration	Between Days 56 and 71. Approximately Day 58.
90% of detected dye mass passed through the spring	Day 41.

8.2.2 Hole-In-The-Wall Spring

Hole-In-The-Wall Spring is located about 5,700 feet downstream of Jackson Blue Spring. The flow rate of this spring was measured at 1.28 cfs in July 2007 (KES, 2007). For comparison, at about the same time, the flow rate of Twin Caves was 1.6 cfs. Eosine dye from the Pelt Swallet introduction was detected at both of these springs.

Appendix H, Graph H shows the mean daily eosine concentrations from carbon samplers at Hole-In-The-Wall Spring, and **Appendix H, Graph I** is a plot of the accumulation of eosine in carbon samplers from this spring. Based on these data, **Table 10** summarizes times for important dye discharge events at Hole-In-The-Wall Spring.

Table 10: Approximate Times for Important Dye Discharge Events at Hole-In-The-Wall Spring

Event	Estimated Days After Dye Introduction
First arrival of eosine	Between Days 14 and 21. Approximately Day 18.
Maximum dye concentration at spring	Between Days 35 and 43. Approximately Day 39.
50% of detected dye mass passed through the spring	Day 38.
Dye concentration at spring declined by an order of magnitude from peak concentration	Between Days 71 and 86. Approximately Day 79.
90% of detected dye mass passed through the spring	Day 56.

8.2.3 Eosine Findings

The total dye concentrations detected in charcoal samplers from Twin Cave and Hole-In-The-Wall Spring were 4.73 ppb and 3.66 ppb, respectively. The first arrival of dye at Twin Caves Spring was in the charcoal sampler in place for the period from June 19 to June 23, 2016 while at Hole-In-The-Wall Spring the first dye arrival was in the charcoal sampler in place from June 23 to June 30, 2016. The difference in the first dye arrival time is consistent with a longer travel distance from the dye introduction point to Hole-In-The-Wall Spring.

Adjusting to account for flow rate differences, the total mass of dye detected in charcoal samplers from Hole-In-The-Wall Spring was 62% of that detected at Twin Caves Spring. This is consistent with a longer travel distance from the dye introduction point to Hole-In-The-Wall Spring and to dye losses along the flow routes.

The spring vent for Hole-In-The-Wall is about 3,600 feet downstream of the spring vent for Twin Caves. However, portions of mapped cave passage for Twin Caves and Hole-In-The-Wall (**Figure 4**) lie within approximately 1,100 feet of each other. The dye tracing data and the proximity of the two cave systems strongly suggest that Hole-In-The-Wall and Twin Caves Springs are separate discharge points for the same karst groundwater system.

8.3 Results of Fluorescein Dye Introduction at Strickland Sink East

Ten pounds of fluorescein dye mixture containing approximately 75% dye equivalent and 25% diluent was introduced into this sinkhole on June 9, 2016 (Day 0) between 10:28 and 10:42 hours. The dye introduction was followed by the introduction of chase water at a rate of at least 150 gpm for a total of at least 27,000 gallons of water. The chase water introduction ended at 13:25 hours on June 9, 2016.

8.3.1 Irregular Fluorescence Peaks

Due to the shapes of fluorescence peaks, none of the samples from the sampling stations fully met the criteria for positive fluorescein dye detection. Irregular fluorescence peaks were present on the analysis graphs for Jackson Blue Spring (Station 1A) for the periods 7/22 to 8/4/2016; 8/4 to 8/19/2016; and 8/19 to 9/3/2016. These fluorescence peaks were within the acceptable wavelength range for fluorescein dye in carbon sampler elutants. At Shangri-La Spring there were also irregular fluorescence peaks in the analysis graphs for the same three sampling periods; there was a duplicate carbon sampler analyzed as well. All but one of these samples had emission fluorescence peaks in the acceptable wavelength range of fluorescein. Results from the rhodamine WT trace showed that Jackson Blue Spring and Shangri-La Spring are discharges from the same groundwater system.

It is possible that the fluorescence peaks at Jackson Blue Spring and Shangri-La Spring represent very small concentrations of weathered fluorescein dye from the Strickland Sink East dye introduction. If so, then the first detection of this dye at these two springs was during the period 7/22 to 8/4/2016 (Days 43 to 56 after dye introduction). These detections included the last sampling period, which was from 8/19 to 9/3/2016 (Days 71 to 86).

There are three possible explanations for the failure to clearly detect fluorescein dye from this trace:

- The dye introduction point may have contributed little or no water to the sampling locations.
- Travel time from the dye introduction point to a discharge point was longer than the duration of the sampling. The sampling lasted until September 3, 2016; this is almost three months from the time of dye introduction. This was sufficient time for dyes from the other two traces to arrive at receiving springs, yet in a karst groundwater system, travel times can vary widely from point to point. This dye introduction point accepted a large volume of water very rapidly and this suggests that it is reasonably well connected with at least some karst conduits.
- An insufficient amount of tracer dye was used. Fluorescein is the most mobile of the tracer dyes and has the lowest detection limit of the three dyes used. However, fluorescein was used for this dye introduction point because this was expected to be the most difficult of the designed traces. Given the fluorescence peaks in some samples from Jackson Blue and Shangri-La Springs, it is the opinion of OUL that this is the most likely explanation for the failure to clearly

detect fluorescein dye from this trace. If the trace is replicated, it is recommend that at least 25 pounds of fluorescein dye mixture with a dye equivalent of 75% be used for the replication.

8.4 Comparison of Total Amounts of Dye Discharged From Sampled Springs

Table 11 shows the sum of the dye concentrations in carbon samplers from the five springs where tracer dyes were detected. This table also shows the measured flow rates of these springs in July 2007 (KES, 2007). By multiplying the total mass by the measured flow rate for that spring, we derived a numerical factor that permits us to roughly compare the relative amounts of tracer dye discharged from each spring. To facilitate comparison between rhodamine WT and eosine results, we have divided the calculated rhodamine WT values by 2, since the amount of rhodamine WT introduced was twice as great as eosine.

The values in **Table 11** are merely an estimate, and the precision of the values is based on various assumptions. As an example, the calculations assume that each of the three dyes adsorb at equal rates onto the carbon and are equally eluted for analysis. In the experience of OUL, this is a generally reasonable assumption. The important point for understanding this aquifer is that the values in **Table 11** clearly demonstrate that the amount of dye discharged through individual springs varied widely. Furthermore, even after adjusting for the fact that twice as much rhodamine WT was used as either of the other two dyes, the amount of rhodamine WT dye detected at springs was over 800 times greater than the amount of eosine detected. In the case of fluorescein, assuming that the irregular fluorescence peaks actually represented weathered dye from the Strickland Sink East introduction, about 225 times more rhodamine WT than fluorescein was discharged from the springs during the study period. The difference in relative detection amounts is probably attributable to dye losses onto the soil and rock matrix through which the water flows and to dispersion of dyed water into the matrix of the karst aquifer.

Table 11: Relative Mass of Dyed Water from Each Spring Where Dye was Detected

Spring	Dye Detected	Total Carbon Sample Concentration (ppb)	Flow Rate of Spring, July 2007 (cfs)	Relative Mass of Dyed Water
Jackson Blue Spring (Station 1A)	Rhodamine WT	500.8	39.08	9,780.0
Shangri-La Spring	Rhodamine WT	372.1	3.87	720.0
Indian Washtub Spring	Rhodamine WT	9.58	1 estimated	4.8
Rhodamine WT Total				10,504.8
Twin Caves Spring	Eosine	4.729	1.6	7.6
Hole-In-The-Wall Spring	Eosine	3.661	1.28	4.7
Eosine Total				12.3

Spring	Dye Detected	Total Carbon Sample Concentration (ppb)	Flow Rate of Spring, July 2007 (cfs)	Relative Mass of Dyed Water
Jackson Blue Spring (Station 1A)	Fluorescein	1.100	39.08	43.0?
Shangri-La Spring	Fluorescein	0.944	3.87	3.7?
Fluorescein Total				46.7?

Notes: Values shown for fluorescein have a question mark because none of the samples from these stations fully met the criteria for positive fluorescein results. It is possible that the fluorescence peaks at Jackson Blue and Shangri-La Spring represent very small concentrations of weathered fluorescein dye.

Rhodamine WT Values are divided by 2 in the "Relative Mass of Dyed Water" column to adjust for the weight of the introduced dye.

8.5 Importance of Activated Carbon Samplers

Table 12 provides a comparison of detections of rhodamine WT in carbon samplers with detections in grab samples of water collected each time carbon samplers were retrieved. This table demonstrates that placing primary sampling reliance on carbon samplers and secondary reliance on grab samples of water is an effective strategy for tracing work associated with spring systems in Florida. Furthermore, had this study relied only on water samples, the study would not have been able to identify Indian Washtub Spring as a rhodamine WT detection site and sampling at the main vent for Jackson Blue Spring would not have yielded water samples that met the criteria for positive rhodamine WT dye detection.

Table 12: Comparison of Rhodamine WT Dye Detectors in Carbon Samplers with Grab Samples of Water

Parameter	Jackson Blue Spring	Jackson Blue Backup	Shangri-La Spring	Indian Washtub Spring	Total
Positive detections in carbon samplers	9	7	9	4	29
Positive detections in water samples	0	1	1	0	2
Fluorescence peak present in water sample but did not meet all criteria for positive dye detection	4	2	2	0	8
Mean concentration (ppb) in positive carbon samplers	49.0	15.3	41.3	2.40	
Mean concentration (ppb) in positive water samples*	0.030	0.073	0.028	<0.015	
Mean concentration in carbon samplers divided by mean concentration in water samples for same sampling period	1,758	472	1,782	160	

*Includes water samples that did not meet all criteria for a positive dye detection but which are determined by the OUL to be positive dye detections because rhodamine WT dye was detected in the associated carbon samplers. Non-detect samples are calculated as 0.015 ppb (the detection limit) for this dye in water.

Table13 provides a similar comparison of detections of eosine in carbon samplers with detections in grab samples of water. As contrasted with rhodamine WT, the lower concentrations of eosine at the springs largely accounts for the lower ratio between carbon sampler values and water values.

Table 13: Comparison of Eosine Dye Detections in Carbon Samplers with Grab Samples of Water

Parameter	Twin Caves Spring	Hole-In-The-Wall Spring	Total
Positive detections in carbon samplers	5	5	10
Fluorescent peak present in carbon sampler but did not meet all criteria for positive dye detection	2	1	3
Positive detections in water samples	1	0	1
Fluorescence peak present in water sample but did not meet all criteria for positive dye detection	1	0	1
Mean concentration (ppb) in positive carbon samplers	0.676	0.610	---
Mean concentration (ppb) in positive water samples*	0.018	<0.015	---
Mean concentration in carbon samplers divided by mean concentration in water samples for same sampling period.	44	47	---

*Includes water samples that did not meet all criteria for a positive dye detection but were determined by OUL to be positive dye detections because eosine dye was detected in the associated carbon samplers. Non-detect samples are calculated as 0.015 ppb (the detection limit) for this dye in water.

8.6 Groundwater Nutrient Flow Pathways

The rhodamine WT dye introduced at RD's Sink was only detected in Jackson Blue Springs, Shangri-La Spring, and Indian Wash Tub Spring, the latter two spring vents being located on the right bank (west side) of Merritt's Mill Pond. Eosine dye that was introduced at Pelt Swallet was not detected in Jackson Blue Spring; however, it was reported in charcoal samplers collected from Twin Caves Spring and Hole-in-the-Wall Spring, both of which are located on the left bank (east side) of Merritt's Mill Pond.

A review of **Figure 12** suggests that these findings are consistent with what may be expected based on the dye introduction locations, the potentiometric surface map of the Upper Floridan aquifer, and the known extent and orientation of the karst cave systems at Merritt's Mill Pond.

9. References

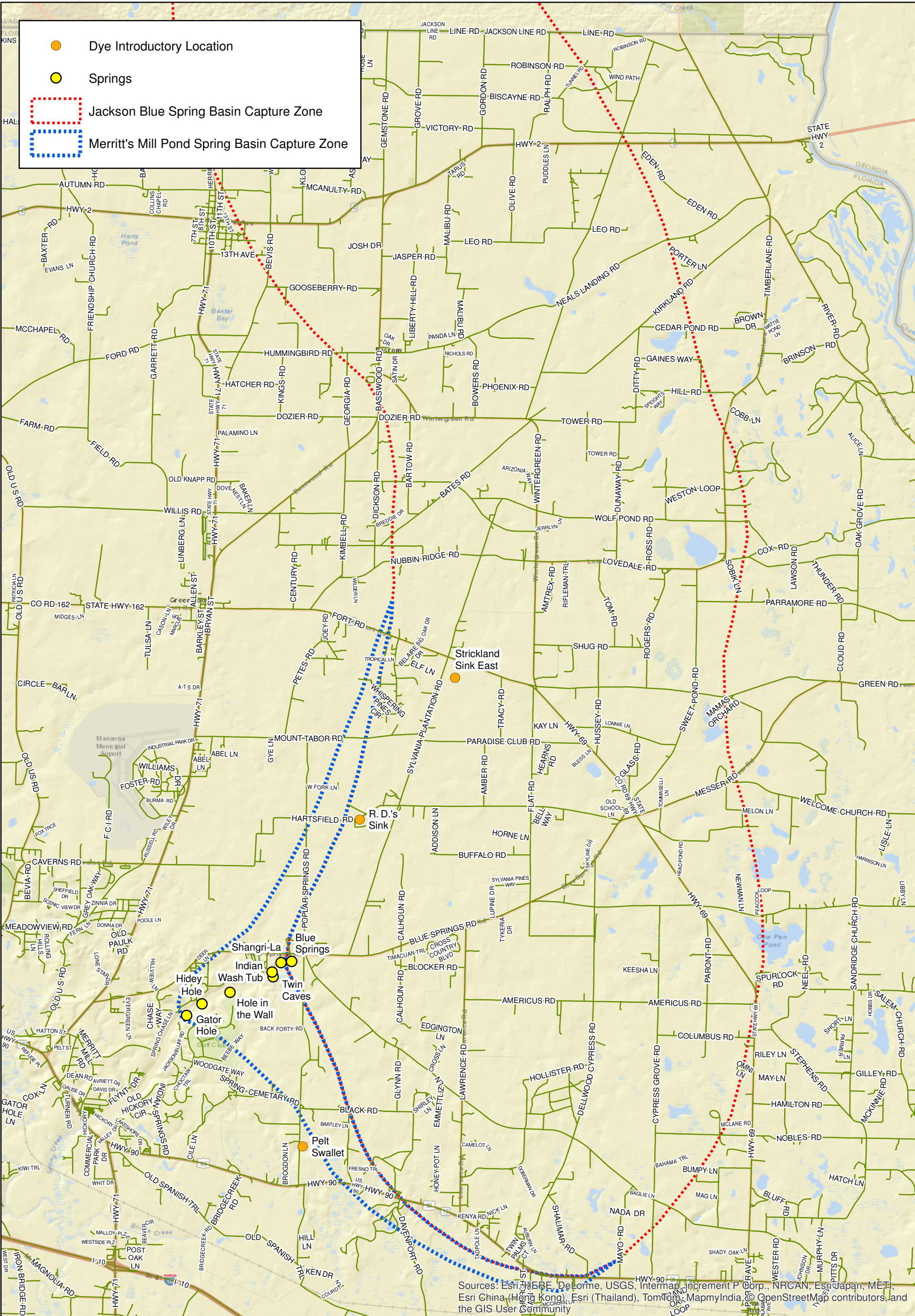
- Aley, Thomas. 2002. The Ozark Underground Laboratory's groundwater tracing handbook. 35p. Available online at www.ozarkundergroundlab.com
- Aley, Thomas. 2008. Chapter 15. Tracer Tests-Dyes. IN: Weight, Willis D. Hydrogeology Field Manual. McGraw-Hill Pp. 675-698.
- Aley, Thomas. 2016. Using activated carbon samplers to improve detection of fluorescent tracer dyes in groundwater remediation studies. Proceedings of Tenth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, May 2016 Palm Springs, CA. Expanded version available online at www.ozarkundergroundlab.com
- Bartel, R.L., Barrios, K., Pritzl, M., and Coates, K., 2011. Jackson Blue Spring Water Resources Assessment, Northwest Florida Water Management District Water Resources Assessment 11-01.
- Behrens, H. 1986. Water Tracer Chemistry: A Factor Determining Performance and Analytics of Tracers. Proc. 5th Intern'l Symp. on Water Tracing. Inst. of Geol. & Mineral Exploration. Athens, pp. 121-133.
- Brooks, R., Clarke, J.S., and Faye, R.E., 1985. Hydrogeology of the Gordon aquifer system of east-central Georgia: Georgia Geologic Survey Information Circular 75, 41 p.
- Butt, P.L., Long, M.H., and Morris, T.L., (KES) 2007. Discharge Measurement: Gator Hole Spring, Merritt's Mill Pond, Jackson County, Florida; July 20, 2007, Karst Environmental Services, Inc. 5779 NE County Road 340, High Springs, Florida 32643.
- Butt, P.L., Long, M.H., and Morris, T.L., (KES) 2007. Discharge Measurement: Heidi Hole Spring, Merritt's Mill Pond, Jackson County, Florida; July 20, 2007, Karst Environmental Services, Inc. 5779 NE County Road 340, High Springs, Florida 32643.
- Butt, P.L., Long, M.H., and Morris, T.L., (KES) 2007. Discharge Measurement: Hole-In-The-Wall Spring, Merritt's Mill Pond, Jackson County, Florida; July 17, 2007, Karst Environmental Services, Inc. 5779 NE County Road 340, High Springs, Florida 32643.
- Butt, P.L., Long, M.H., and Morris, T.L., (KES) 2007. Discharge Measurement: Jackson Blue Spring, Merritt's Mill Pond, Jackson County, Florida; July 16, 2007, Karst Environmental Services, Inc. 5779 NE County Road 340, High Springs, Florida 32643.
- Butt, P.L., Long, M.H., and Morris T.L., (KES) 2007. Discharge Measurement: Shangri-La Spring, Merritt's Mill Pond, Jackson County, Florida; July 18, 2007, Karst Environmental Services, Inc. 5779 NE County Road 340, High Springs, Florida 32643.

- Butt, P.L., Long, M.H., and Morris T.L., (KES) 2007. Discharge Measurement: Twin Caves Spring, Merritt's Mill Pond, Jackson County, Florida; July 19, 2007, Karst Environmental Services, Inc. 5779 NE County Road 340, High Springs, Florida 32643.
- Cooke, C.W., 1939. Scenery of Florida - Interpreted by a Geologist: Florida Geological Survey Bulletin 17, 118 p.
- Cooke, C.W., 1945, Geology of Florida: Florida Geological Survey, Bulletin 29, 339 p.
- Cooke, C.W., and Mossom, S., 1929, Geology of Florida: Florida Geological Survey 20th Annual Report, p. 29-227.
- Copeland, R., Upchurch, S.B., Scott, T.M., Kromhout, C., Arthur, J., Means, G., Rupert, F., and Bond, P., 2009. Hydrogeological Units of Florida; Florida Geological Survey Special Publication 28 (Revised).
- Dodson, James, 2013, Final Report, Nutrient TMDL for Jackson Blue Spring and Merritts Mill Pond (WBIDs 180Z and 180A), Florida Department of Environmental Protection, Ground Water Management Section.
- Fenneman, N.M., 1938. Physiography of Eastern United States: McGraw-Hill Book Company, Inc., New York, 714 p.
- Field, Malcolm S; Ronald G. Wilhelm; James F. Quinlan; and Thomas J. Aley. 1995. An Assessment of the Potential Adverse Properties of Fluorescent Tracer Dyes Used for Groundwater Tracing. Environmental Monitoring and Assessment, Vol. 38. Kluwer Academic Publishers, Pp. 75-96.
- Gillett, B., Raymond, D.E., and Moore, J.D., 2004. Hydrogeology and vulnerability to contamination of major aquifers in Alabama: Area 11: Geologic Survey of Alabama Circular 199E, 97 p.
- Green, R.C., Evans, W.L., Bryan, J.R., Paul, D.T. and Gaboardi, M.M., 2002, Surficial and bedrock geology of the western portion of the U.S.G.S. 1:100,000 scale Marianna, Quadrangle, Northwestern Florida: Florida Geological Survey Open-File Map Series 91, 2 sheets.
- Green, R.C., Evans, W.L. III, Bryan, J.R., and Paul, D.T., 2003. Surficial and Bedrock Geology of the Eastern Portion of the U.S.G.S. 1:100,000 Scale Marianna Quadrangle, Northwestern Florida: Florida Geological Survey Open-File Map Series 92.
- Hayes, L.R., Maslia, M.L., and Meeks, W.C., 1983. Hydrology and model evaluation of the principal artesian aquifer, Dougherty Plain, southwest Georgia: Georgia Geologic Survey Bulletin, 93 p.
- Healy, H.G., 1975, Terraces and shorelines of Florida: Florida Geological Survey Map Series 71. Scale: 1:1,900,800.
- Hicks, D.W., Gui, H.E., and Longworth, S.A., 1987. Hydrogeology, chemical quality, and availability of ground water in the Upper Floridan aquifer, Albany, Georgia: U.S. Geological Survey Water-Resources Investigations Report 87-4145, 52 p.

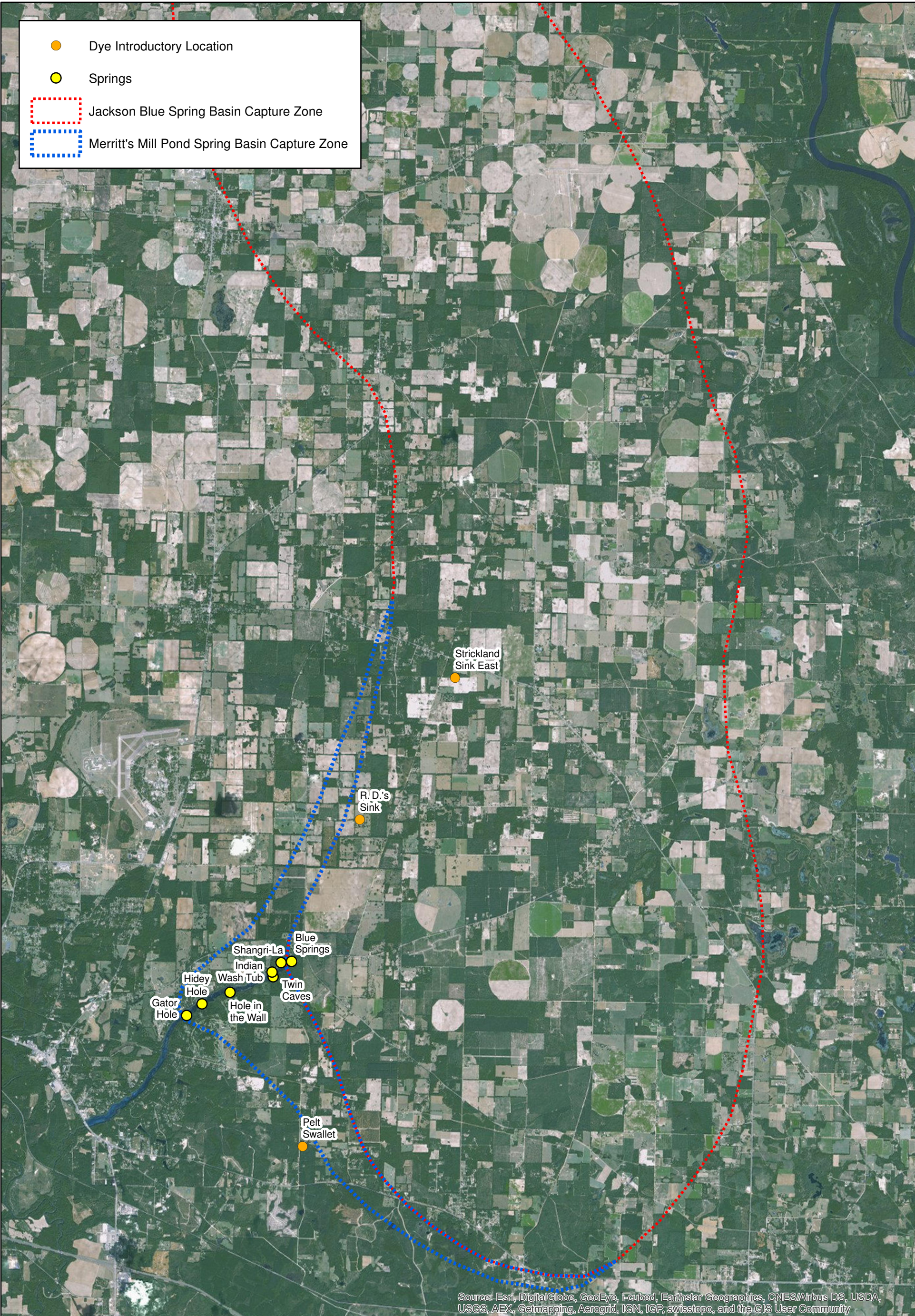
- Huddlestun, P.F., 1993. A revision of the lithostratigraphic units of the Coastal Plain of Georgia: the Oligocene, Georgia Geologic Survey Bulletin 105, 152 p.
- Johnston, R.H., and Bush, P.W., 1988. Summary of the hydrology of the Floridan aquifer system in Florida and in parts of Georgia, South Carolina, and Alabama: U.S. Geological Survey Professional Paper 1403-A, 24 p.
- Leibundgut, Christian; Piotr Maloszewski; and Christoph Kulls, 2009. Tracers In Hydrology. Wiley-Blackwell. 415 p.
- Matson, G.C., and Clapp, F.G., 1909. A preliminary report on the geology of Florida with special reference to the stratigraphy: Florida Geological Survey Second Annual Report, p. 21-1 73.
- McFadden, S.S., and Perriello, P.D., 1983. Hydrogeology of the Clayton and Claiborne aquifers in southwestern Georgia: Georgia Geologic Survey Information Circular IC-55, 59 p.
- Miller, J.A., 1986. Hydrogeologic framework of the Floridan aquifer system in Florida and parts of Georgia, Alabama and South Carolina: United States Geological Survey Professional Paper 1403-B, 91 p. plus maps.
- Moore, W.E., 1955. Geology of Jackson County: Florida Geological Survey Bulletin 37, 101 p.
- Murray, G.E., 1961. Geology of the Atlantic and Gulf Coastal Province of North America: Harper and Bros., New York, 692 p.
- Ozark Underground Laboratories, 2002. Ozark Underground Laboratory; Groundwater Tracing Handbook.
- Renken, R.A., 1996. Hydrogeology of the Southeastern Coastal Plain aquifer system in Mississippi, Alabama, Georgia, and South Carolina. Regional aquifer-system analysis - Southeastern Coastal Plain: U.S. Geological Survey professional paper 1410-B.
- Sabatini, David A. and T. Al Austin. 1991. Characteristics of Rhodamine WT and Fluorescein as Adsorbing Ground-Water Tracers. Ground Water, Vol. 29:3, pp. 341-349.
- Schmidt, W., 1984. Neogene stratigraphy and geologic history of the Apalachicola Embayment, Florida: Florida Geol. Survey Bull. 58, 146 p.
- Scott, T.M., Lloyd, J.M., and Maddox, G. (eds.). 1991, Florida's ground-water quality monitoring program, hydrogeological framework: Florida Geological Survey Special Publication 32, 97 p.
- Scott, T.M., 1992. A geological overview of Florida: Florida Geological Survey Open File Report No. 50, 78 p.
- Scott, T.M. (editor and compiler), Campbell, K.M., Rupert, F.R., Arthur, J.A., Green, R.C., Means, G.H., Missimer, T.M., Lloyd, J.M., and Duncan, J.G., 2001. Geologic map of Florida: Florida Geological Survey, Map Series 146, scale: 1:750,000.

- Scott, T.M., 2005. Revisions to the Geomorphology of Florida Focusing on the Eastern Panhandle and North-Central Florida in Southeastern Geological Society Field Trip Guidebook 44.
- Smart, Peter L. 1984. A Review of the Toxicity of Twelve Fluorescent Dyes Used for Water Tracing. National Speleological Society Bull., Vol. 46, pp. 21-33.
- Smart, P.L. and I.M.S. Laidlaw. 1977. An Evaluation of Some Fluorescent Dyes for Water Tracing. Water Resources Research, Vol. 13:1, pp. 15-33.
- Sorensen, Edd. Owner, Chief Dive Master, Cave Adventures Dive Shop. Personal communication on December 23, 2016.
- Torak, L.J., Davis, G.S., Strain, G.A., and Herndon, J.G., 1996. Geohydrology and evaluation of stream-aquifer relations in the Apalachicola-Chattahoochee-Flint River Basin, southeastern Alabama, northwestern Florida, and southwestern Georgia: U.S. Geological Survey Water-Supply Paper 2460, 95 p.
- Williams, L.J., and Kuniansky, E.L., 2015. Revised hydrogeologic framework of the Floridan aquifer system in Florida and parts of Georgia, Alabama, and South Carolina: U.S. Geological Survey Professional Paper 1807, 140 p., 23 pls., <http://dx.doi.org/10.3133/pp1807>.

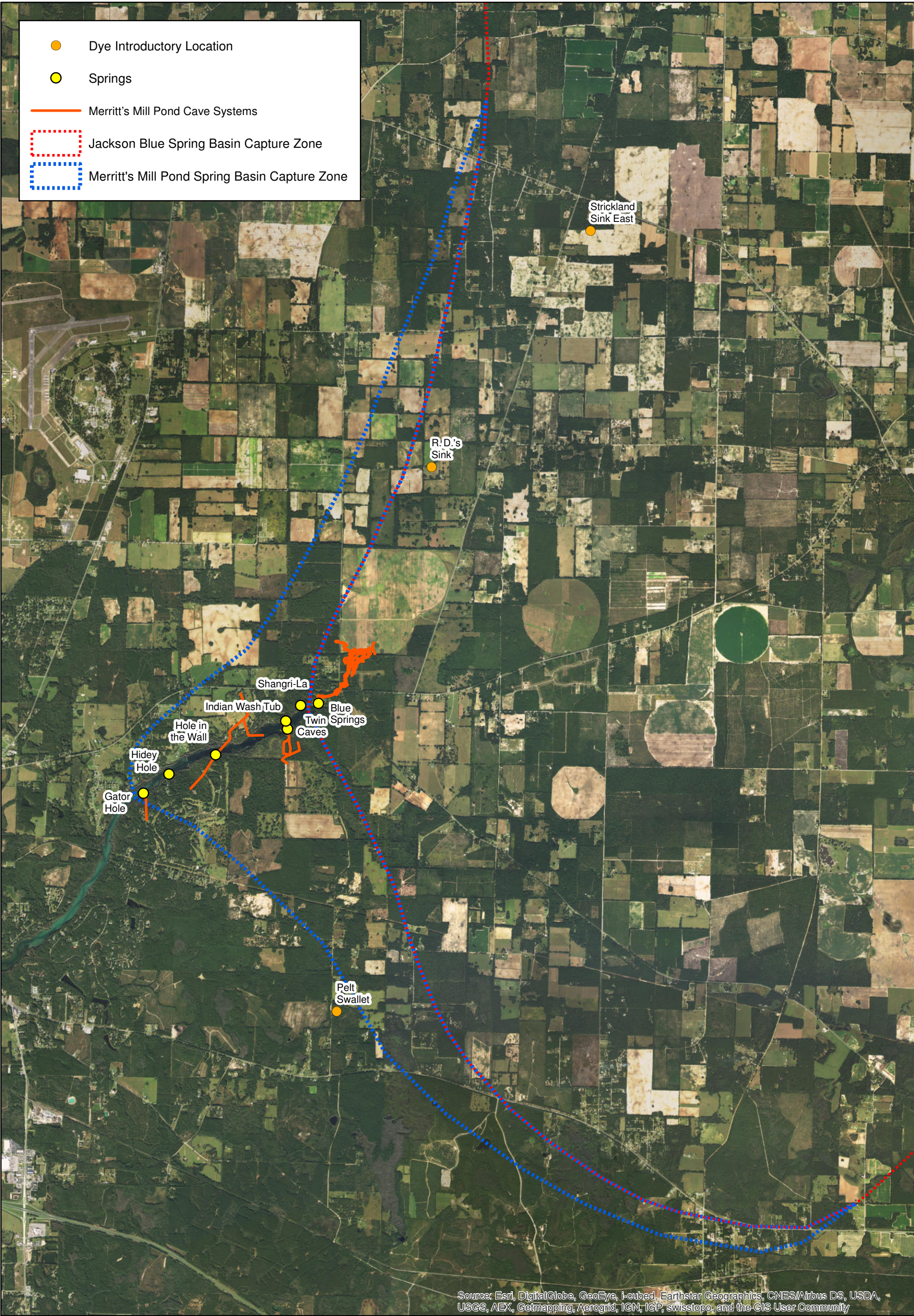
FIGURES



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Springs Vents

Jackson Blue Spring Basin Capture Zone

Merritt's Mill Pond Spring Basin Capture Zone

Cave System

Explored Cave System not Formally Mapped

The depiction of the cave systems for Gator Hole, Hole-in-the Wall and Twin Caves have been approximated based on constructed maps cited in the title frame of this figure.

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

AECOM

M. Clarisse - Tallahassee

Blue Springs Cave system provided by NFWFMD	
Gator Hole Cave Map Team: 1995	
Pauk Aughey	Carlenna Kyllonen
Tim Lewis	Allen Mosler
Beth Pascazi	Tom Stodd

Hole in the Wall Cave Map Team: 1978	
P. DeLoach	P.W. Smith
M. Evans	K. Sullivan
W. Fehring	D. Sweet
R. Gomez	W. Waiters
R. Goodman	J. Zumrick
	S. Exley

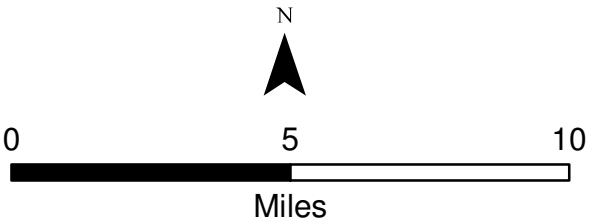
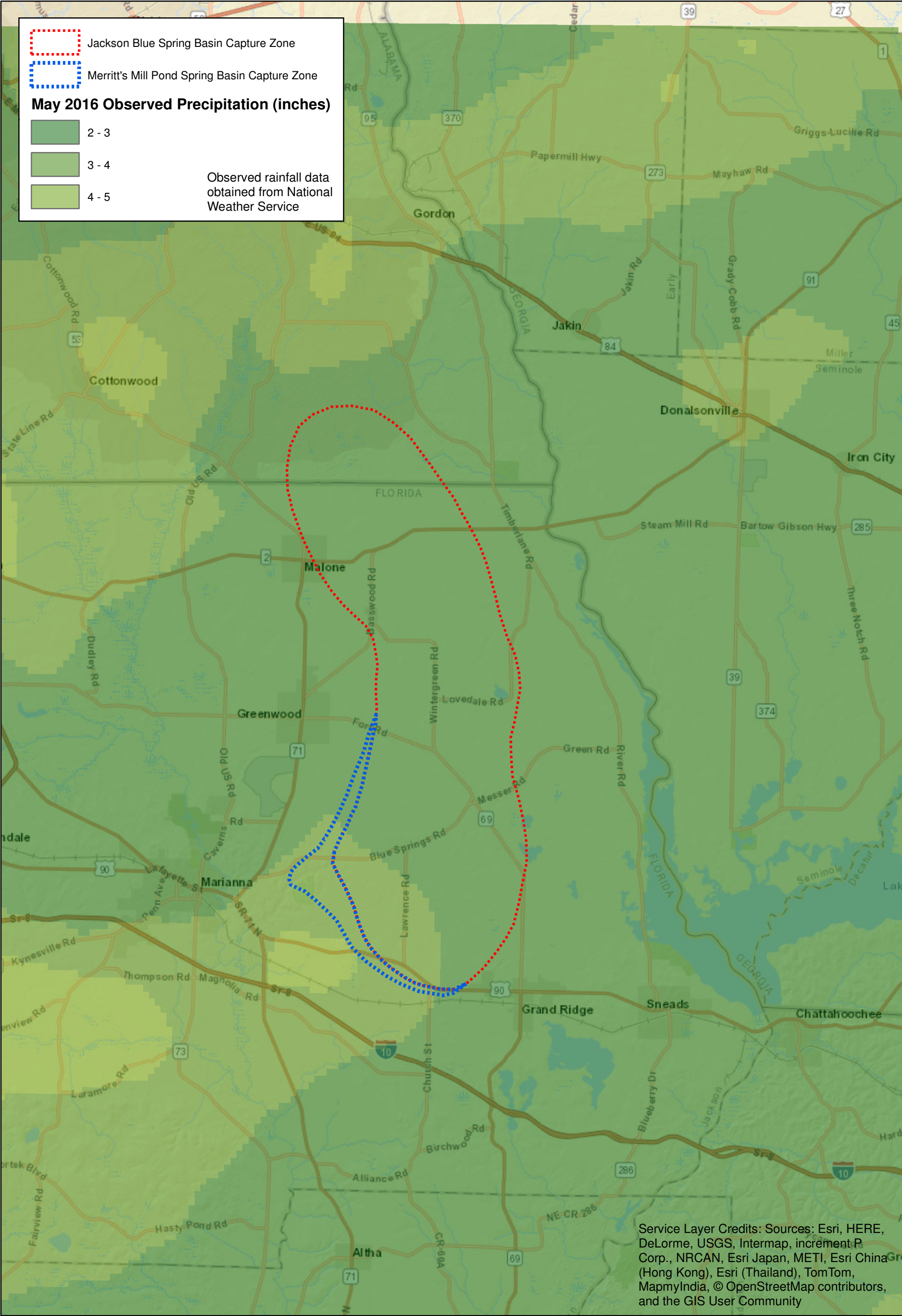
Twin Cave Map Team: 1994	
Keith Kinard	Gene Hellwig
Greg Knecht	Mike Guinn
Reg Hay	Wayne McKinnon
Kim Snow	Sid McCracken
Pat Watson	Alton Hall

N

01,2002,400

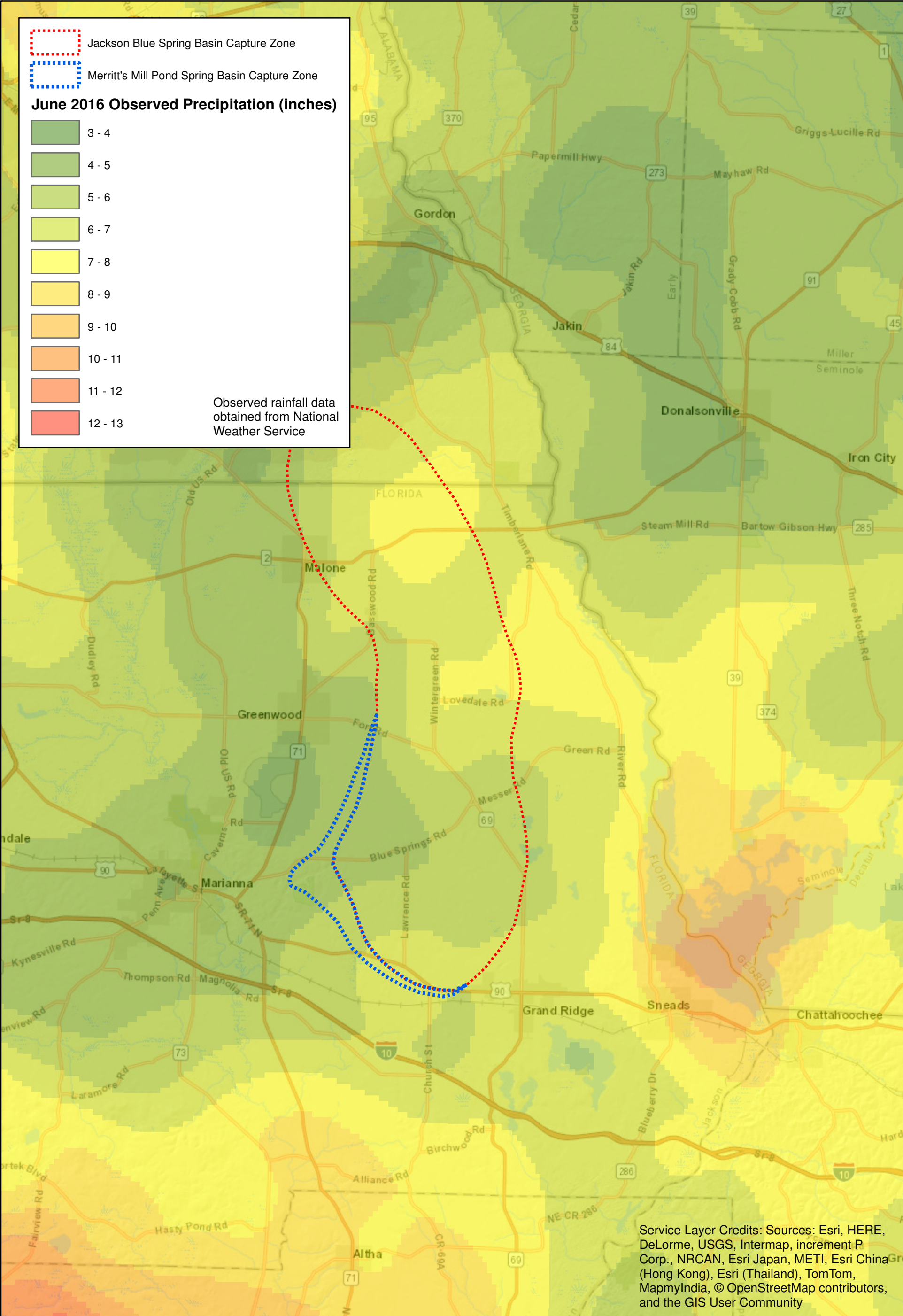
Feet

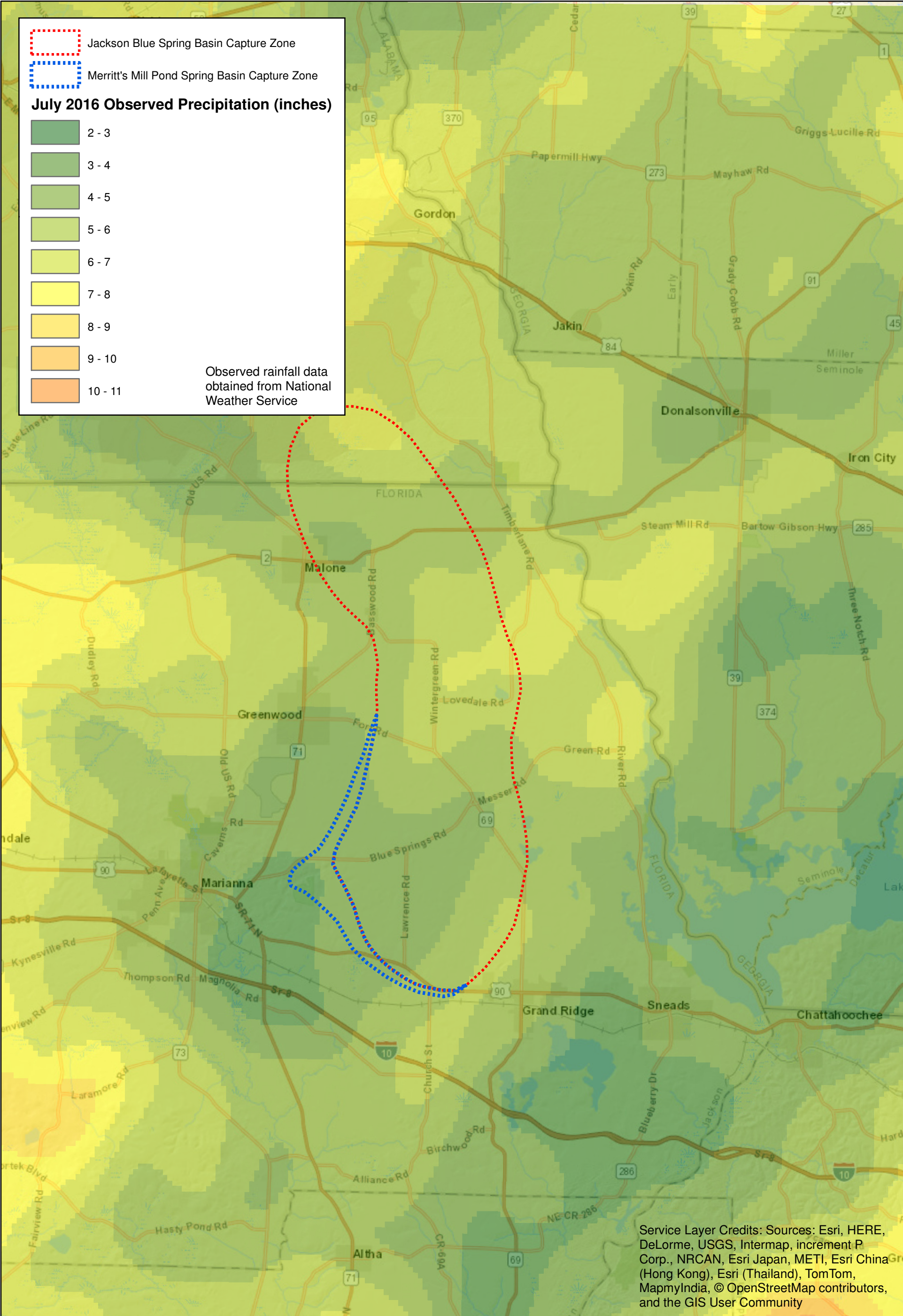
Figure 4
Jackson Blue Springs and
Merritt's Mill Pond Dye Tracer
Mapped Blue Spring Cave System

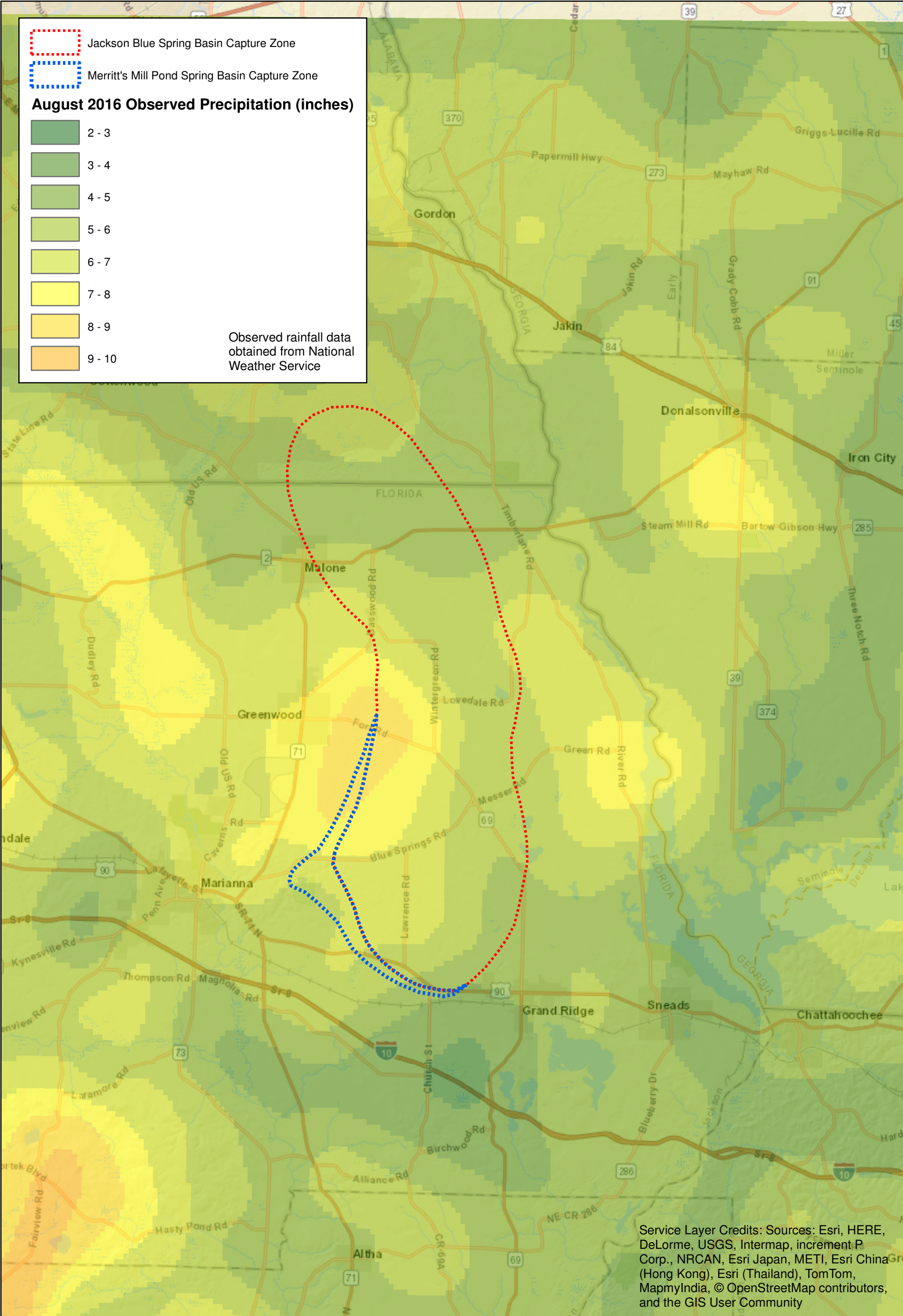


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M. Clarisse - Tallahassee

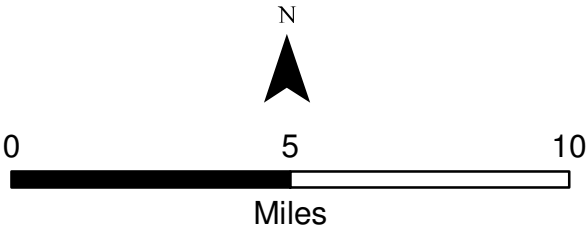
Figure 5
May 2016 Observed Precipitation
Jackson Blue Springs
and Merritt's Mill Pond
Dye Tracer
Jackson County, Florida





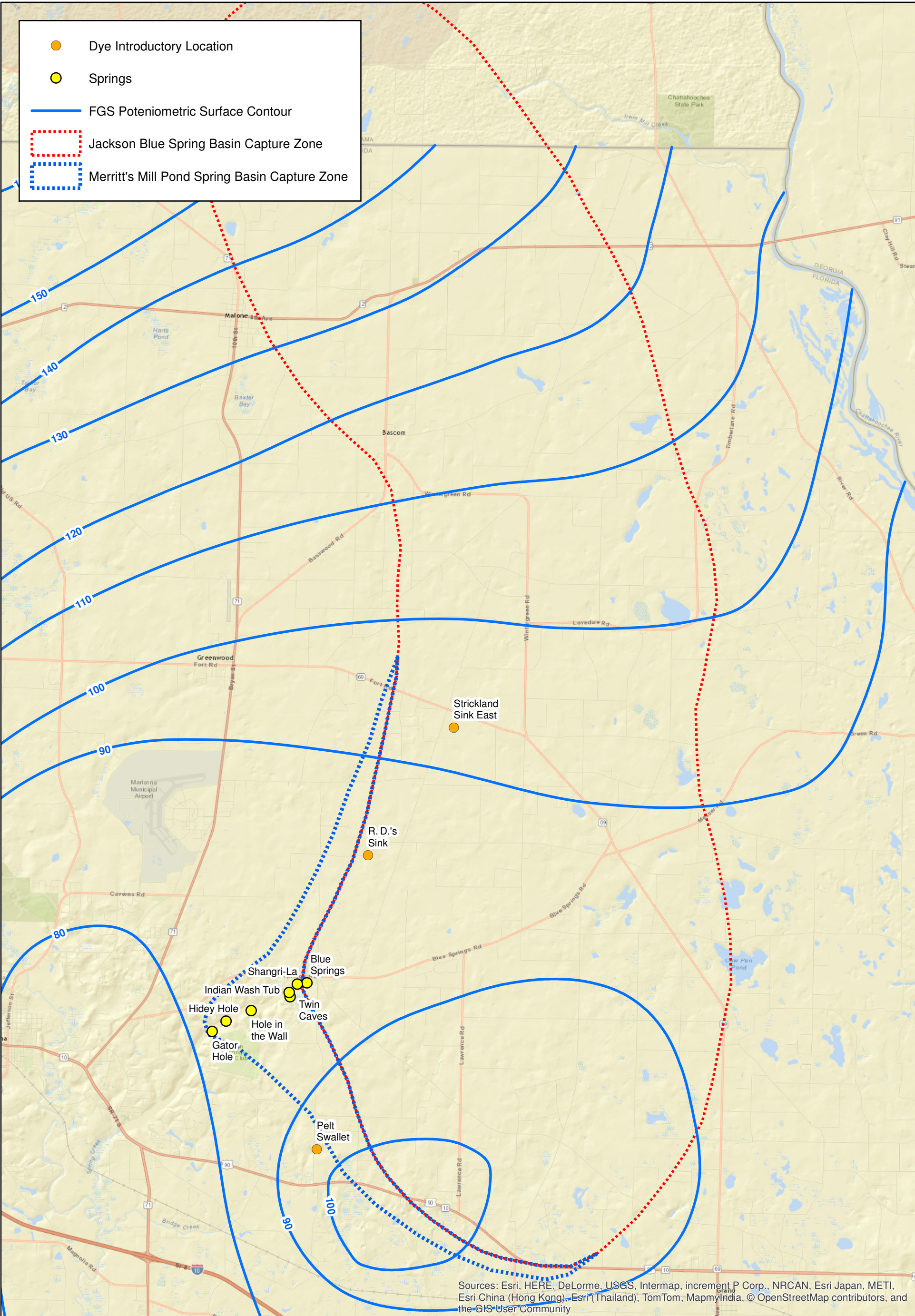


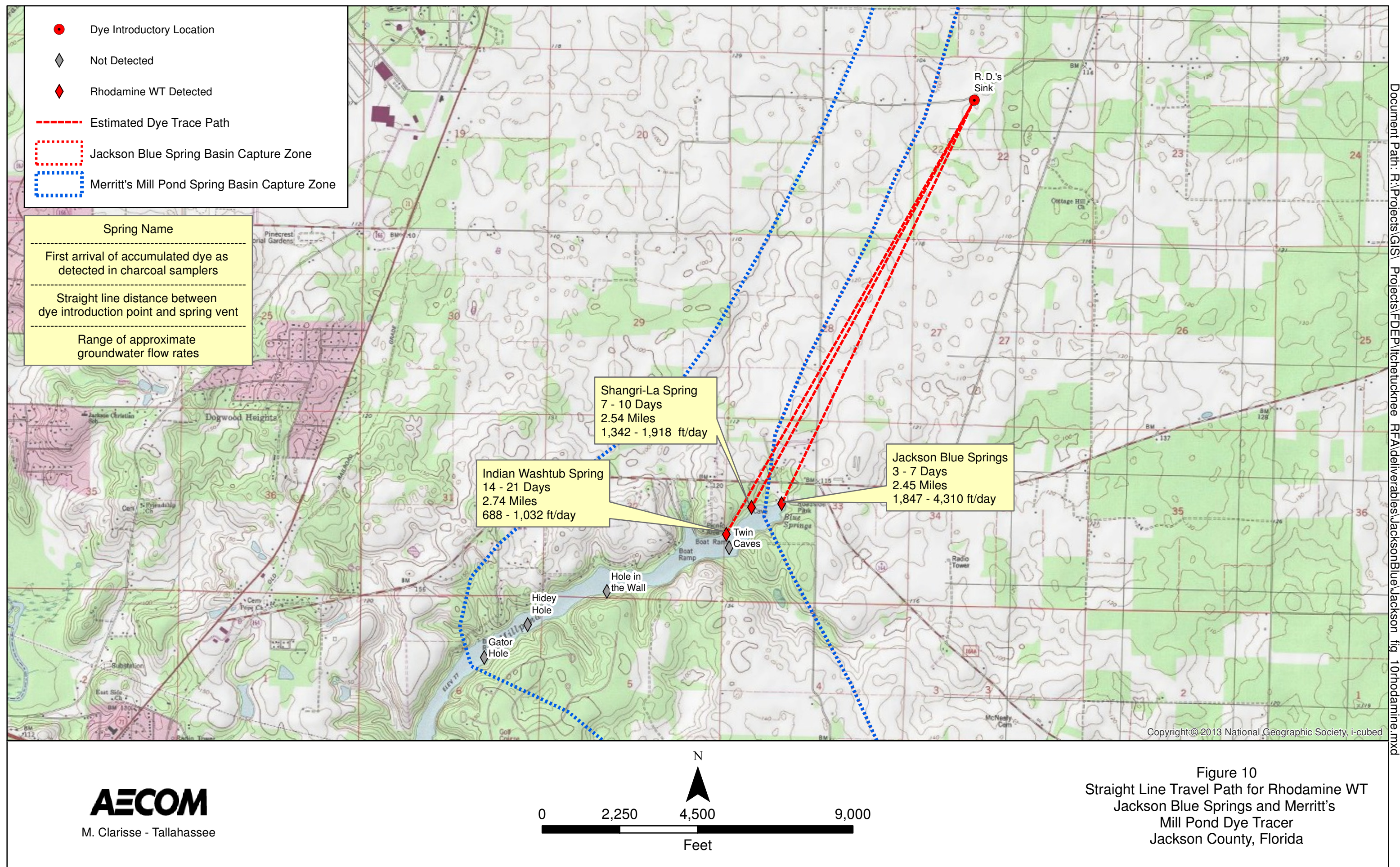
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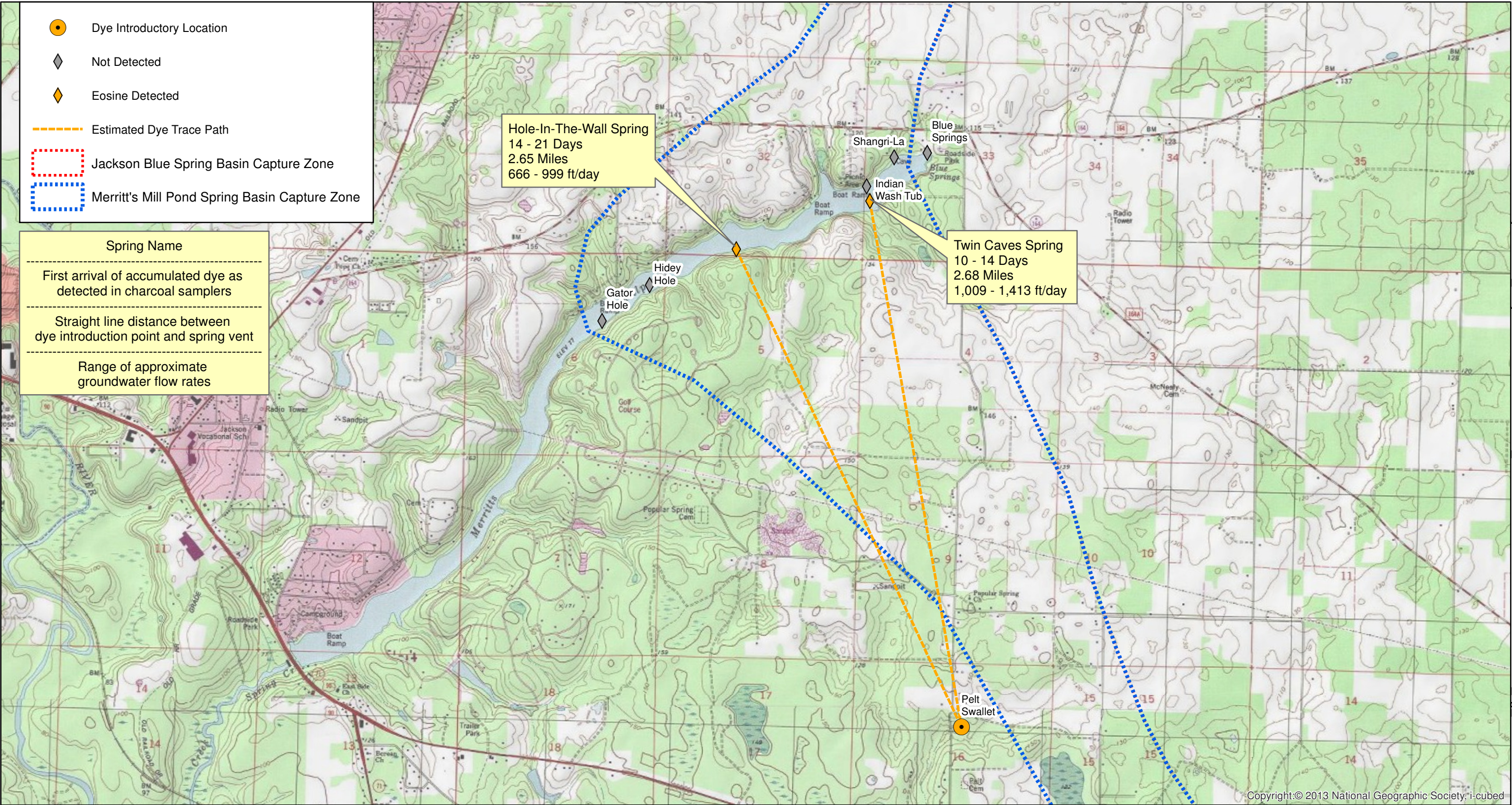


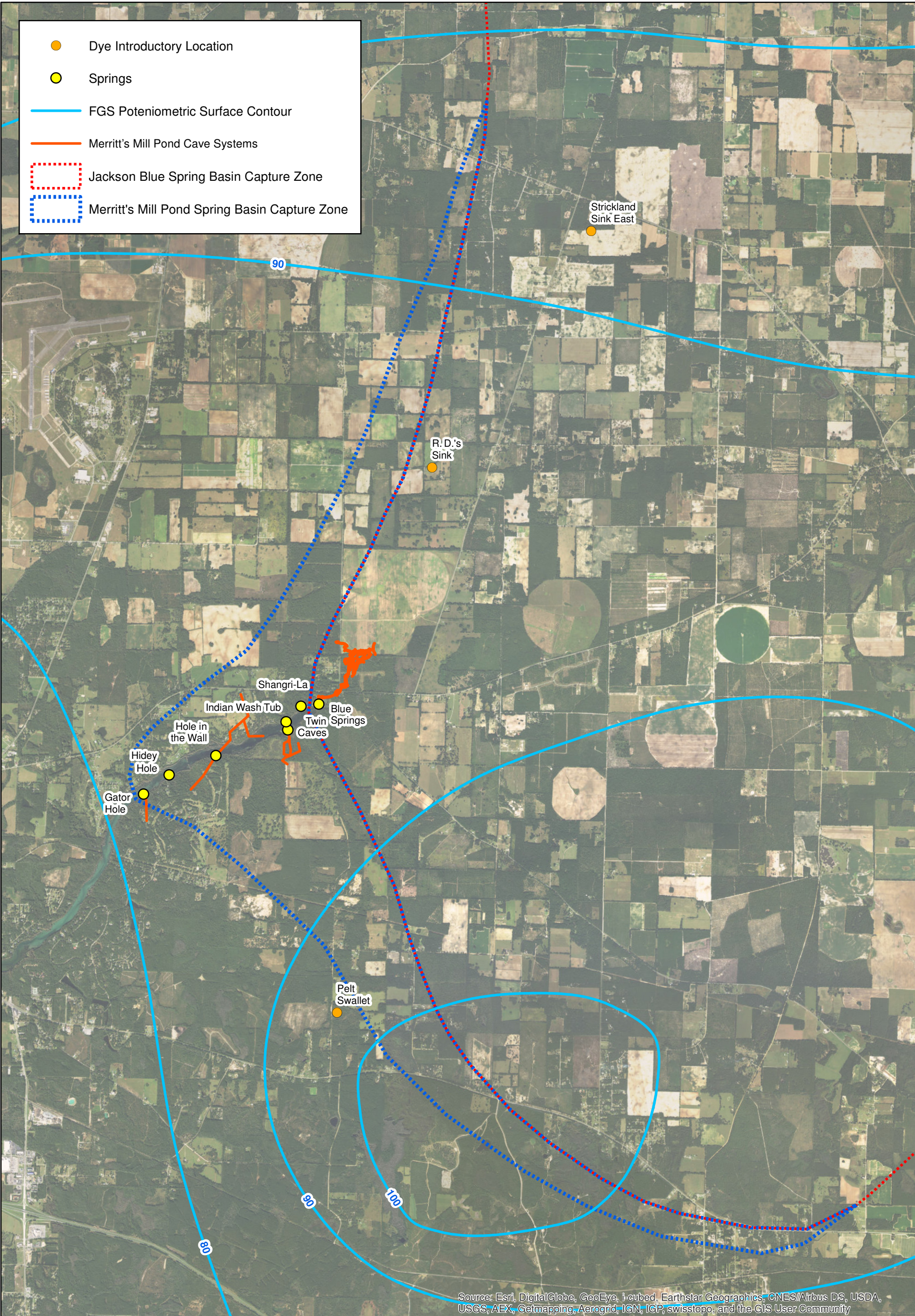
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M. Clarisse - Tallahassee

Figure 8
August 2016 Observed Precipitation
Jackson Blue Springs
and Merritt's Mill Pond
Dye Tracer
Jackson County, Florida









APPENDIX A
Photographic Log

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 1	Date: 07/16/2007		
Direction Photo Taken: North			
Description: Jackson Blue Spring with Jackson County recreational park in background. Photo courtesy of Karst Environmental Services.			

Photo No. 2	Date: 07/16/2007	
Direction Photo Taken: Southwest		
Description: View of discharge measurement grid from inside looking out; Jackson Blue Spring, Merritt's Mill Pond, Jackson County, Florida. Photo courtesy of Karst Environmental Services.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 3	Date: 1/29/16		
Direction Photo Taken: Northwest			
Description: Approaching Shangri-La Spring from Merritt's Mill Pond. Spring vent is at the base of the limestone bluff.			

Photo No. 4	Date: 1/29/16	
Direction Photo Taken: West		
Description: Main vent of Shangri-La Spring.		

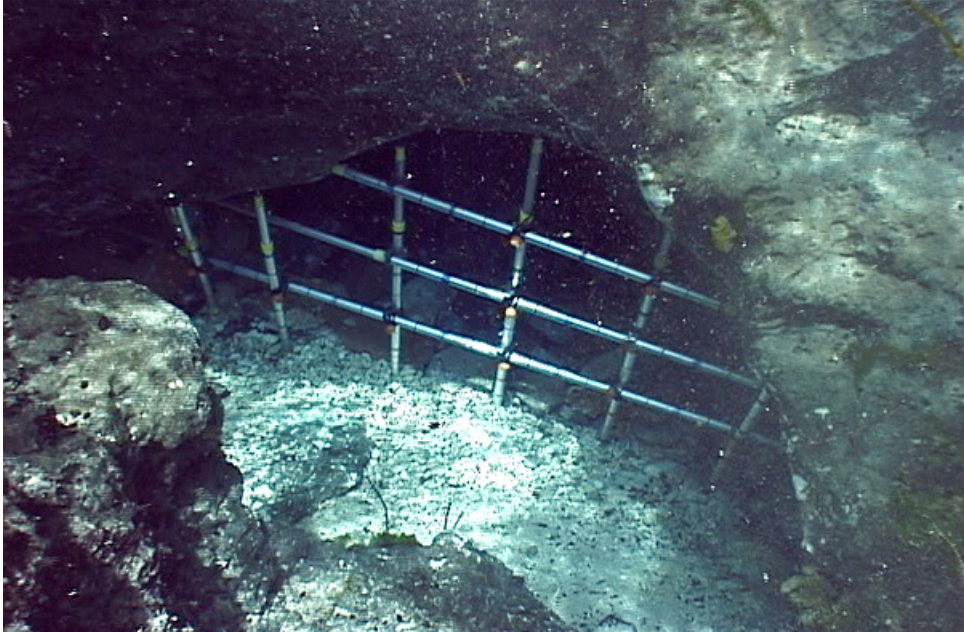
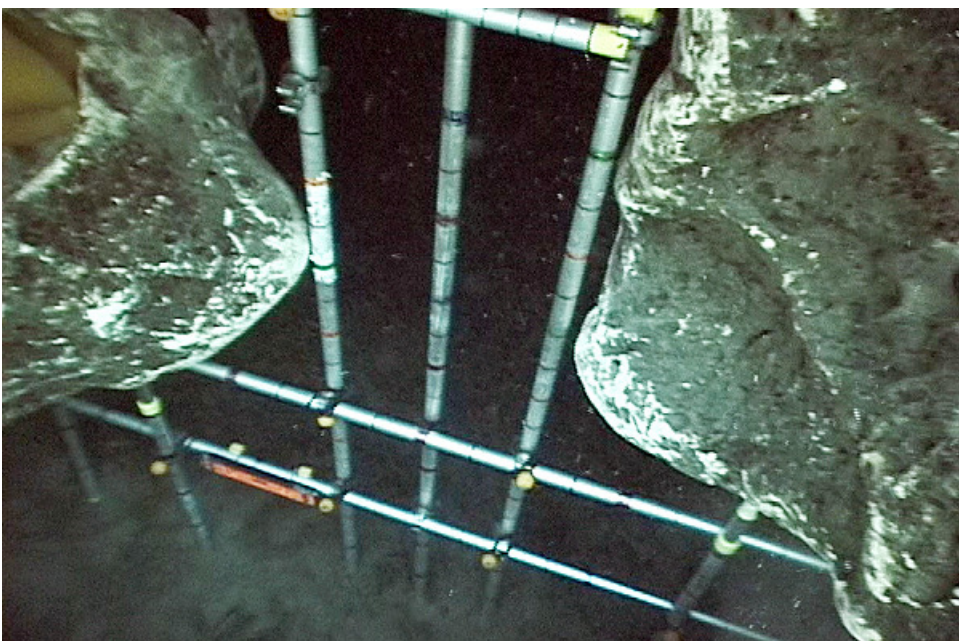
Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 5	Date: 7/18/2007		
Direction Photo Taken: N/A			
Description: View of grid in measurement cross-section; Shangri-La Spring main vent, Jackson County, Florida, July 18, 2007 measurement. Photo courtesy of Karst Environmental Services.			

Photo No. 6	Date: 1/29/16	
Direction Photo Taken: West		
Description: Private dock at Indian Wash Tub spring.		

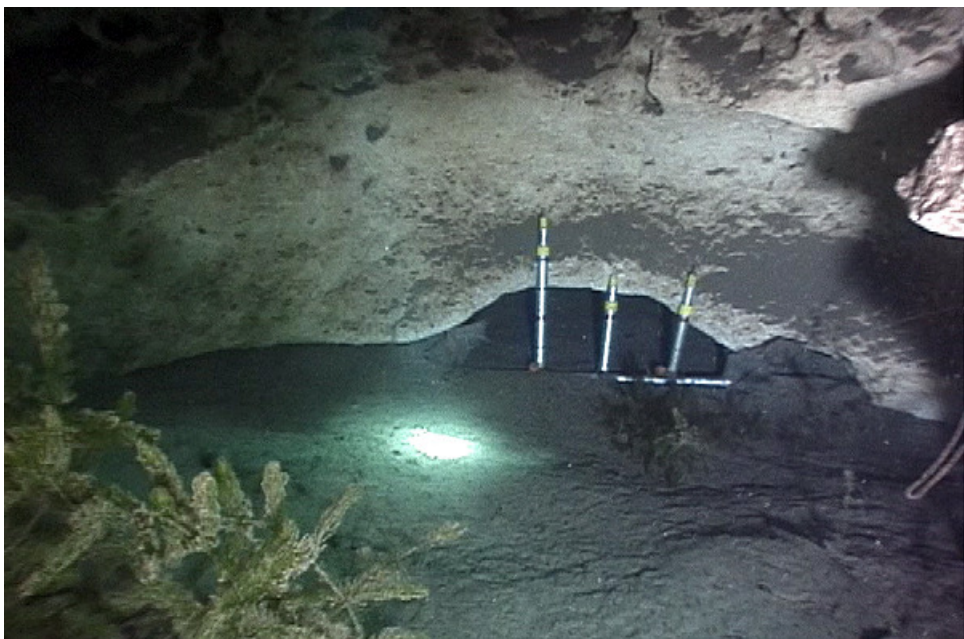
Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 7	Date: 1/29/16		
Direction Photo Taken: East			
Description: Diving Platform at Twin Caves			

Photo No. 8	Date: 7/19/16	
Direction Photo Taken: N/A		
Description: Discharge measurement cross-section; Twin Caves Spring, Jackson County, Florida, July 19, 2007. View of the measurement grid from the top looking down. Photo courtesy of Karst Environmental Services.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 9	Date: 1/29/16		
Direction Photo Taken: East			
Description: Hole-in-the-Wall Spring.			

Photo No. 10	Date: 7/7/2007	
Direction Photo Taken:		
Description: Hole-In-The-Wall Spring. View of the measurement cross-section at the restriction between the entrance cavern and the shaft to the lower sections of the cave.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 11	Date: 5/27/16		
Direction Photo Taken: East			
Description: Dock at Hidey Hole.			

Photo No. 12	Date: 7/20/2007	
Direction Photo Taken: N/A		
Description: Hidey Hole Spring. View of the measurement cross-section at the restriction at the bottom of the cavern. Photo courtesy of Karst Environmental Services.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 13	Date: 1/29/16		
Direction Photo Taken: East			
Description: Entrance to Gator Hole. The cave is air filled and water filled at the beginning then becomes fully water filled.			

Photo No. 14	Date: 7/20/2016	
Direction Photo Taken: N/A		
Description: View looking down hole at grid in measurement cross-section; Gator Hole Spring, Jackson County, Florida, July 20, 2007. Photo courtesy of Karst Environmental Services.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 15	Date: 5/17/16		
Direction Photo Taken: East			
Description: The basin area of Pelt Swallet. This area becomes completely water filled in times of greater precipitation.			

Photo No. 16	Date: 5/17/16	
Direction Photo Taken: Northeast		
Description: The dirt and rock outcrop bluff at Pelt Swallet where water drains directly into the Upper Floridan Aquifer. Water drains at various cracks and holes which are partially filled with debris in this photo.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 17	Date: 1/29/16		
Direction Photo Taken: West			
Description: Water flowing from west side of Poplar Spring Road through a pair of 48-inch culvert pipes into the Pelt Swallet basin area. Visual flow estimate was approximately 1.5 cubic feet per second (~970,000 gpd)			

Photo No. 18	Date: 1/29/16	
Direction Photo Taken: Northeast		
Description: Pelt Swallet with pooled water at point water drains into the Upper Floridan Aquifer.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 19	Date: 4/5/16		
Direction Photo Taken: East			
Description: View from Poplar Spring Road of Pelt Swallet with area completely full of water after rain event. Note water level is to the top of the road. Compare to Photo 17 which is taken standing in the basin area of Pelt Swallet looking west at Poplar Spring Road to better understand the volume of water draining into the swallet.			

Photo No. 20	Date: 4/5/16	
Direction Photo Taken: Northeast		
Description: Basin area of Pelt Swallet filled with water.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 21	Date: 2/1/16		
Direction Photo Taken: Northwest			
Description: Looking down the long-axis of RD's Sink			

Photo No. 22	Date: 2/1/16	
Direction Photo Taken: N/A		
Description: Base of RD's Sink. Note ponded water is actually the top of the Floridan Aquifer.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 23	Date: 4/18/16		
Direction Photo Taken: Northwest			
Description: Erosional drainage/gully in agricultural field which is a part of the Strickland East sinkhole feature.			

Photo No. 24	Date: 4/18/16	
Direction Photo Taken: Southeast		
Description: View from in the erosional gully which provides scale of sink feature.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 25	Date: 1/29/16		
Direction Photo Taken: N/A			
Description: Strickland East Sinkhole with pinnacled limestone rock at land surface.			

Photo No. 26	Date: 1/29/16	
Direction Photo Taken: Northeast		
Description: View of center pivot irrigation system that straddles Strickland East Sink.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 27	Date: 6/9/16		
Direction Photo Taken: West			
Description: Water tanker truck (5,000 gallons) with discharge hose used to provide chase water to RD's Sink dye release.			

Photo No. 28	Date: 6/9/16	
Direction Photo Taken: N/A		
Description: Chase water being introduced to RD's Sink. 20,000 gallons of chase water were used for this dye release.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 29	Date: 6/9/16		
Direction Photo Taken: Northwest			
Description: Preparing for release of rhodamine WT dye at RD's Sink.			

Photo No. 30	Date: 6/9/16	
Direction Photo Taken: Northwest		
Description: Introduction of rhodamine WT dye at RD's Sink.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 31	Date: 6/9/16		
Direction Photo Taken: Southwest			
Description: Center pivot wellhead that provides irrigation water to the agricultural field at Strickland East sink.			

Photo No. 32	Date: 6/9/16	
Direction Photo Taken: East		
Description: View from Strickland East sink with center pivot irrigation system in operational condition.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 33	Date: 6/9/16		
Direction Photo Taken: Northwest			
Description: Red chase water hose connected to the sediment drain trap hose barb at the end of the center pivot. Flow at the end of the hose was estimated to be at least 150 gallons per minute.			

Photo No. 34	Date: 6/9/16	
Direction Photo Taken: North		
Description: Mixing fluorescein dye in preparation for dye introduction. White Tyvek suits were used to help prevent splashed water from staining clothing.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 35	Date: 6/9/16		
Direction Photo Taken: North			
Description: Pouring fluorescein dye into sinkhole.			

Photo No. 36	Date: 6/9/16	
Direction Photo Taken: East		
Description: View after completion of dye introduction. Note that there are two pools of water. The pool in the foreground is where dye was introduced and is not colored due to chase water introduction. The pool in the background filled with water as the front pool filled and then both drained together.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 37	Date: 6/9/16		
Direction Photo Taken: Northeast			
Description: Pelt Swallet with pooled water draining into the upper Floridan Aquifer.			

Photo No. 38	Date: 6/9/16	
Direction Photo Taken: N/A		
Description: Pelt Swallet with pooled water draining into the upper Floridan Aquifer.		

Client Name: Florida Department of Environmental Protection		Site Location: Jackson Blue Spring and Merritt's Mill Pond, Marianna, Jackson County, Florida	Project No. 60393736
Photo No. 39	Date: 6/9/16		
Direction Photo Taken: N/A			
Description: Eosine dye being sprinkled into the water draining directly into the Upper Floridan Aquifer at Pelt Swallet. Flow into the swallet was estimated to be approximately 43,000 gallons per day at the time of the dye introduction.			

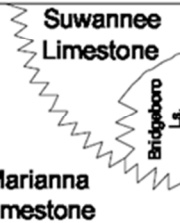
Photo No. 40	Date: 6/9/16	
Direction Photo Taken: N/A		
Description: Eosine dye being sprinkled into the water draining directly into the Upper Floridan Aquifer at Pelt Swallet. Flow into the swallet was estimated to be approximately 43,000 gallons per day at the time of the dye introduction.		

APPENDIX B

Geology

Appendix B

Historical Near-Surface Stratigraphic Nomenclature from Green et al., 2003

Cooke and Mossom, 1929		Cooke, 1945		Moore, 1955		Puri and Vernon, 1964		Cheetham, 1963; Huddlesun and Toulmin, 1965; Toulmin, 1977		Green, Evans, Bryan, and Paul, 2003		STUDY
Citronelle Formation		Citronelle Formation		Post-Miocene Deposits		High Level Alluvial and Deltaic Deposits				Citronelle Formation		EPOCH
Alum Bluff Group		Alum Bluff Group				Choctawhatchee Stage (?)				Alum Bluff Group (undifferentiated)		Pleist.
Chipola Formation		Chipola Formation				Chipola Formation						Miocene
Tampa Limestone		Tampa Limestone				Chattahoochee Fm.				Chattahoochee Fm.		
Vicksburg Group	Byram Marl	Suwannee Limestone		Suwannee Limestone		"Suwannee Limestone" (Duncan Church beds)				Oligocene		
	Glendon Limestone	Byram Limestone				"Byram" Fm.						
	Marianna Limestone	Marianna Limestone		Marianna Limestone		Marianna Limestone						Bumprnose Limestone
Ocala Limestone		Ocala Limestone		Ocala Group	Bumprnose Mbr., Crystal River Fm.	Ocala Group	(Bumprnose Member)	Crystal River Limestone		Ocala Limestone		Eocene
				Ocala Group	Crystal River Fm.	Ocala Group	Crystal River Fm.					
				Ocala Group		Ocala Group						

APPENDIX C

Sample Collection Data Sheet Summary

[illegible]

Jackson Blue Dye Trace 2016 Station Sampler Tracking Record														Page 1 of 1
Station Number:		1B												
Station Name:		Jackson Blue Spring Back-up												
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date	Notes:	
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:	
Comprehensive Background														
5/18/2016	10:45	5/26/2016	9:30	-21	-13									
5/26/2016	9:30	6/8/2016	15:34	-13	-1									
Dye Trace	6/9/16 = Day 0													
6/8/2016	15:34	6/12/2016	9:16	-1	3	4								
6/12/2016	9:22	6/16/2016	9:33	3	7	4		ND	ND	6.46	B5793	7/13/2016	7/21&22/16	
6/16/2016	9:33	6/19/2016	9:40	7	10	3								
6/19/2016	9:40	6/23/2016	9:07	10	14	4		ND	ND	23.3	B5802	7/13/2016	7/21&22/16	
6/23/2016	9:07	6/30/2016	9:10	14	21	7		ND	ND	28.7	B5810	7/13/2016	7/21&22/16	
6/30/2016	9:10	7/7/2016	9:12	21	28	7		ND	ND	18.5	B5818	7/13/2016	7/21&22/16	
7/7/2016	9:12	7/14/2016	9:02	28	35	7		ND	ND	12.1	B6896	8/2/2016	8/11/2016	
7/14/2016	9:02	7/22/2016	8:42	35	43	8		ND	ND	8.51	B7251	8/2/2016	8/25/2016	
7/22/2016	8:42	8/4/2016	8:46	43	56	13		ND	ND	9.27	B7657	9/6/2016	9/12/2016	
8/4/2016	8:46	8/19/2016	9:07	56	71	15						9/6/2016		
8/19/2016	9:07	9/3/2016	11:26	71	86	15						9/6/2016		
9/3/2016	11:26			86										
Sampling completed.														
# BG Sampler Sets Collected:		2												
# BG Sampler Sets Shipped:		0												
# BG Samplers Analyzed:		0												
# DT Sampler Sets Collected:		11												
# DT Sampler Sets Shipped:		9												
# DT Samplers Analyzed:		7												
Total # Sampler Sets Collected:		13												
Total # Sampler Sets Shipped:		9												
Total # Samplers Analyzed:		7												
# Samplers FL pos:		0												
# Samplers RWT pos:		7												
# Samplers EO pos:		0												

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Jackson Blue Dye Trace 2016 Station Sampler Tracking Record														Page 1 of 1
Station Number:		4												
Station Name:		Indian Washtub Spring												
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date	Notes:	
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:	
Comprehensive Background														
5/18/2016	11:19	5/26/2016	10:20	-21	-13									
5/26/2016	10:20	6/8/2016	15:52	-13	-1									
Dye Trace	6/9/16 = Day 0													
6/8/2016	15:52	6/12/2016	9:49	-1	3	4								
6/12/2016	9:49	6/16/2016	10:44	3	7	4		ND	ND	ND	B5796	7/13/2016	7/21&22/16	
6/16/2016	10:44	6/19/2016	10:18	7	10	3								
6/19/2016	10:18	6/23/2016	9:35	10	14	4		ND	ND	ND	B5805	7/13/2016	7/21&22/16	
6/23/2016	9:35	6/30/2016	9:44	14	21	7		ND	ND	1.57	B5813	7/13/2016	7/21&22/16	
6/30/2016	9:44	7/7/2016	9:52	21	28	7		ND	ND	3.62	B5822	7/13/2016	7/21&22/16	
7/7/2016	9:52	7/14/2016	9:30	28	35	7		ND	ND	2	B6899	8/2/2016	8/11/2016	
7/14/2016	9:30	7/22/2016	10:06	35	43	8							Missing	
7/14/2016	9:30	8/4/2016	10:45	35	56	21							Missing	
8/4/2016	10:45	9/3/2016	11:03	56	86	30		ND	ND	2.39	B7665	9/6/2016	9/12/2016	
9/3/2016	11:03			86										
Sampling completed.														
# BG Sampler Sets Collected:			2											
# BG Sampler Sets Shipped:			0											
# BG Samplers Analyzed:			0											
# DT Sampler Sets Collected:			8											
# DT Sampler Sets Shipped:			6											
# DT Samplers Analyzed:			6											
Total # Sampler Sets Collected:			10											
Total # Sampler Sets Shipped:			6											
Total # Samplers Analyzed:			6											
# Samplers FL pos:			0											
# Samplers RWT pos:			4											
# Samplers EO pos:			0											

Jackson Blue Dye Trace 2016 Station Sampler Tracking Record														Page 1 of 1
Station Number:		5												
Station Name:		Hole-In-The-Wall Spring												
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date	Notes:	
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:	
Comprehensive Background														
5/18/2016	11:45	5/26/2016	10:45	-21	-13									
5/26/2016	10:45	6/8/2016	16:17	-13	-1									
Dye Trace	6/9/16 = Day 0													
6/8/2016	16:17	6/12/2016	10:22	-1	3	4								
6/12/2016	10:22	6/16/2016	9:12	3	7	4		ND	ND	ND	B5797	7/13/2016	7/21&22/16	
6/16/2016	9:12	6/19/2016	10:38	7	10	3								
6/19/2016	10:38	6/23/2016	9:53	10	14	4		ND	ND	ND	B5806	7/13/2016	7/21&22/16	
6/23/2016	9:53	6/30/2016	10:07	14	21	7		ND	0.292	ND	B5814	7/13/2016	7/21&22/16	
6/30/2016	10:07	7/7/2016	10:09	21	28	7		ND	0.722	ND	B5823	7/13/2016	7/21&22/16	
7/7/2016	10:09	7/14/2016	10:25	28	35	7		ND	0.533	ND	B6901	8/2/2016	8/11/2016	
7/14/2016	10:25	7/22/2016	10:06	35	43	8		ND	1.020	ND	B7254	8/2/2016	8/25/2016	
7/22/2016	10:06	8/4/2016	9:35	43	56	13		ND	0.779	ND	B7659	9/6/2016	9/12/2016	
8/4/2016	9:35	8/19/2016	10:17	56	71	15		ND	0.315**	ND	B8244	9/6/2016	10/12/2016	
8/19/2016	10:17	9/3/2016	10:06	71	86	15		ND	ND	ND	B8249	9/6/2016	10/12/2016	
9/3/2016	10:06			86										
Sampling completed.														
# BG Sampler Sets Collected:		2												
# BG Sampler Sets Shipped:		0												
# BG Samplers Analyzed:		0												
# DT Sampler Sets Collected:		11												
# DT Sampler Sets Shipped:		9												
# DT Samplers Analyzed:		9												
Total # Sampler Sets Collected:		13												
Total # Sampler Sets Shipped:		9												
Total # Samplers Analyzed:		9												
# Samplers FL pos:		0												
# Samplers RWT pos:		0												
# Samplers EO pos:		6												

[illegible]

Jackson Blue Dye Trace 2016 Station Sampler Tracking Record														Page 1 of 1
Station Number:		7												
Station Name:		Gator Hole Spring												
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date	Notes:	
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:	
Comprehensive Background														
5/18/2016	12:31	5/26/2016	11:00	-21	-13									
5/26/2016	11:00	6/8/2016	16:37	-13	-1									
Dye Trace	6/9/16 = Day 0													
6/8/2016	16:37	6/12/2016	10:37	-1	3	4								
6/12/2016	10:37	6/16/2016	11:30	3	7	4		ND	ND	ND	B5799	7/13/2016	7/21&22/16	
6/16/2016	11:30	6/19/2016	11:06	7	10	3								
6/19/2016	11:06	6/23/2016	10:35	10	14	4		ND	ND	ND	B5808	7/13/2016	7/21&22/16	
6/23/2016	10:35	6/30/2016	10:40	14	21	7		ND	ND	ND	B5816	7/13/2016	7/21&22/16	
6/30/2016	10:40	7/7/2016	10:52	21	28	7		ND	ND	ND	B5825	7/13/2016	7/21&22/16	
7/7/2016	10:52	7/14/2016	10:08	28	35	7		ND	ND	ND	B6903	8/2/2016	8/11/2016	
7/14/2016	10:08	7/22/2016	10:50	35	43	8		ND	ND	ND	B7256	8/2/2016	8/25/2016	
7/22/2016	10:50	8/4/2016	10:04	43	56	13		ND	ND	ND	B7662	9/6/2016	9/12/2016	
8/4/2016	10:04	8/19/2016	10:40	56	71	15		ND	ND	ND	B8246	9/6/2016	10/12/2016	
8/19/2016	10:40	9/3/2016	9:39	71	86	15		ND	ND	ND	B8251	9/6/2016	10/12/2016	
9/3/2016	9:39			86										
Sampling completed.														
# BG Sampler Sets Collected:		2												
# BG Sampler Sets Shipped:		0												
# BG Samplers Analyzed:		0												
# DT Sampler Sets Collected:		11												
# DT Sampler Sets Shipped:		9												
# DT Samplers Analyzed:		9												
Total # Sampler Sets Collected:		13												
Total # Sampler Sets Shipped:		9												
Total # Samplers Analyzed:		5												
# Samplers FL pos:		0												
# Samplers RWT pos:		0												
# Samplers EO pos:		0												

[illegible]

[illegible]

Jackson Blue Dye Trace 2016 Station Sampler Tracking Record													Page 1 of 1
Station Number:		10											
Station Name:		Pelt Swallet Input Control											
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date	Notes:
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:
Comprehensive Background													
5/18/2016	16:19	5/26/2016	8:31	-21	-13								
5/26/2016	8:31	6/9/2016	11:50	-13	0								
Dye Trace		6/9/16 = Day 0											
6/9/2016	11:50	6/12/2016	8:17	0	3	4							
6/12/2016	8:17	6/16/2016	7:54	3	7	4							
6/16/2016	7:54	6/19/2016	8:05	7	10	3							
6/19/2016	8:05	6/23/2016	7:55	10	14	4							
6/23/2016	7:55	6/30/2016	7:58	14	21	7							
6/30/2016	7:58	7/7/2016	8:15	21	28	7							
7/7/2016	8:15	7/14/2016	8:00	28	35	7							
7/14/2016	8:00	7/22/2016	7:40	35	43	8							
7/22/2016	7:40	8/4/2016	7:40	43	56	13							
8/4/2016	7:40	8/19/2016	7:55	56	71	15							
8/19/2016	7:55	9/3/2016	8:18	71	86	15							
9/3/2016	8:18			86									
Sampling completed.													
# BG Sampler Sets Collected:		2											
# BG Sampler Sets Shipped:		0											
# BG Samplers Analyzed:		0											
# DT Sampler Sets Collected:		11											
# DT Sampler Sets Shipped:		0											
# DT Samplers Analyzed:		0											
Total # Sampler Sets Collected:		13											
Total # Sampler Sets Shipped:		0											
Total # Samplers Analyzed:		0											
# Samplers FL pos:		-											
# Samplers RWT pos:		-											
# Samplers EO pos:		-											

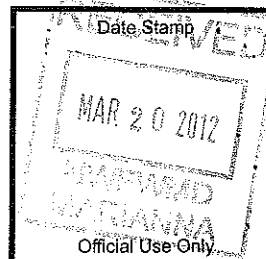
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APPENDIX D
Center Pivot Well Data



STATE OF FLORIDA WELL COMPLETION REPORT

- ☐ Southwest
☒ Northwest
☐ St. Johns River
☐ South Florida
☐ Suwannee River
☐ DEP
☐ Delegated Authority (If Applicable) _____
- PLEASE, FILL OUT ALL APPLICABLE FIELDS
(*Denotes Required Fields Where Applicable)



1. *Permit Number W2012-01406 *CUP/WUP Number _____ *DID Number _____ 62-524 Delineation No. _____

2. *Number of permitted wells constructed, repaired, or abandoned _____ *Number of permitted wells not constructed, repaired, or abandoned _____

3. *Owner's Name Craig Bishop Farm Inc 4. *Completion Date 1-27-12 5. Florida Unique ID _____

6. 6029 Fort Rd Homestead 17
*Well Location - Address, Road Name or Number, City, ZIP

7. *County JK *Section 1 Land Grant _____ *Township 5N *Range 9W

8. Latitude _____ Longitude _____

9. Data Obtained From: _____ GPS _____ Map _____ Survey _____ Datum: _____ NAD 27 _____ NAD 83 _____ WGS 84

10. *Type of Work: ☒ Construction _____ Repair _____ Modification _____ Abandonment

11. *Specify Intended Use(s) of Well(s):
☐ Domestic _____ ☐ Landscape Irrigation _____ ☒ Agricultural Irrigation _____ ☐ Site Investigation _____
☐ Bottled Water Supply _____ ☐ Recreation Area Irrigation _____ ☐ Livestock _____ ☐ Monitoring _____
☐ Public Water Supply (Limited Use/DOH) _____ ☐ Nursery Irrigation _____ ☐ Test _____
☐ Public Water Supply (Community or Non-Community/DEP) _____ ☐ Commercial/Industrial _____ ☐ Earth-Coupled Geothermal _____
☐ Golf Course Irrigation _____ ☐ HVAC Supply _____
☐ Class I Injection _____ ☐ HVAC Return _____
Class V Injection: _____ Recharge _____ Commercial/Industrial Disposal _____ Aquifer Storage and Recovery _____ Drainage
Remediation: _____ Recovery _____ Air Sparge _____ Other (Describe) _____
Other (Describe) _____

12. *Drill Method: _____ Auger _____ Cable Tool _____ Rotary ☒ Combination (Two or More Methods) _____ Jetted _____ Sonic _____
_____ Horizontal Drilling _____ Hydraulic Point (Direct Push) _____ Other _____

13. *Measured Static Water Level 39 ft. Measured Pumping Water Level _____ ft. After _____ Hours at _____ GPM

14. *Measuring Point (Describe) _____ Which is _____ ft. Above _____ Below Land Surface *Flowing: _____ Yes _____ No

15. *Casing Material: ☒ Black Steel _____ Galvanized _____ PVC _____ Stainless Steel _____ Not Cased _____ Other _____

16. *Total Well Depth 160 ft. Cased Depth 90 ft. *Open Hole: From 90 To 160 ft. *Screen: From _____ To _____ ft. Slot Size _____

17. *Abandonment: _____ Other (Explain) _____
From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____
From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____
From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____
From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____
From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____

18. *Surface Casing Diameter and Depth:
Dia _____ in. From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____
Dia _____ in. From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____

19. *Primary Casing Diameter and Depth:
Dia 8 in. From 90 ft. To 0 ft. No. of Bags 3 Seal Material (Check One): _____ Neat Cement ☒ Bentonite _____ Other _____
Dia _____ in. From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____
Dia _____ in. From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____
Dia _____ in. From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____
Dia _____ in. From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____

20. *Liner Casing Diameter and Depth:
Dia _____ in. From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____
Dia _____ in. From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____
Dia _____ in. From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____

21. *Telescope Casing Diameter and Depth:
Dia _____ in. From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____
Dia _____ in. From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____
Dia _____ in. From _____ ft. To _____ ft. No. of Bags _____ Seal Material (Check One): _____ Neat Cement _____ Bentonite _____ Other _____

22. Pump Type (If Known): _____ Centrifugal _____ Jet ☒ Submersible _____ Turbine _____
Horsepower 30 Pump Capacity (GPM) 600
Pump Depth _____ ft. Intake Depth _____ ft. _____ Laboratory Test _____ Field Test Kit _____

23. Chemical Analysis (When Required):
Iron _____ ppm Sulfate _____ ppm Chloride _____ ppm
24. Water Well Contractor: _____

*Contractor Name Danell *License Number 2157 E-mail Address _____

*Contractor's Signature [Signature] *Driller's Name (Print or Type) Brian Clark

(I certify that the information provided in this report is accurate and true.)



NWFWMD Well Inventory Database System

Site Schedule

Printed: April 28, 2016 01:25

Site Id **305118085053901**

Site Type **G**

NWF ID **12312**

Well Name **BISHOP FARMS #1**

State ID **AAN7393**

Owner **CRAIG BISHOP FARMS INC (CORA STRICKLAND)**

Contact Person

Phone

Street **6029 FORT ROAD**

City **GREENWOOD**

State **FL**

Zip

County **Jackson**

Latitude **305118.35**

Longitude **850539.64**

Datum **WGS84**

Loc Method **Global Positioning Satellite (GPS)**

Land Net **S02T05NR09W**

Loc Accuracy **0.3 < 3 meters**

Loc Source **NWFWMD**

Elevation **115.23**

Datum **NAVD88**

Method **LIDAR**

Accuracy **0.1 < 1 feet**

Source **NWFWMD**

Location Map

GW Region **Dougherty Karst Region**

Site Use **Withdrawal**

Water Use **Agricultural Irrigation**

Depth Of Well **160**

Depth Of Casing **90**

MP Distance From LSD

Diameter **8**

Construction Data Source **Driller**

Casing Material **Steel**

Finish **Open Hole**

Driller License Number **2157**

Date of Construction **27-JAN-12**

Construction Method **Combination**

Screen Length

Screened Intervals

Water Level Relative to MP

Measure Date

WL Source

WL Method

Hydrogeologic Units **Floridan Aquifer (Undiff)**

Lift **Submersible**

Power

Horsepower **30**

Pump Intake

Normal Yield

Spcap Discharge

Spcap Source

Spcap Discharge Method

Spcap Static Level **39**

Spcap Pumping Level

Spcap Drawdown

Hours Pumped

Spcap

Field Water Quality

Discharge

Temperature

pH

Specific Conductance

Chloride

Consumptive Use Permit

Construction Permit **W201201406**

FL Geological Survey #

Abandonment Permit

DEP Public Supply #

Project #'s

Geophysical Log #

Depth Logged

Available LOG Data

Visited By

Date Visited

Data Entered By **C_FREEMAN**

Date Entered **23-MAY-12**

Last Updated By **C_FREEMAN**

Last Updated **05-JUN-12**

Ambient Network



NORTHWEST FLORIDA MOBILE IRRIGATION LAB

4155 Hollis Dr., Marianna, FL 32448

Phone (850) 482-0388 FAX (850)526-2218

Craig Bishop Powell South

Application Chart

Date of Eval:
May 10, 2016

Percent Timer Setting	Hrs. Per Rev @ 54% Rotation	Avg. Inches per Rotation (Potential)	Avg. In. @ 5% Loss (Overcast)	Avg. In. @ 10% Loss (Sunny, Calm)	Avg. In. @ 15% Loss (Sunny, Windy)
100	5.64	0.11	0.11	0.10	0.09
95	5.94	0.12	0.11	0.11	0.10
90	6.27	0.12	0.12	0.11	0.10
85	6.64	0.13	0.12	0.12	0.11
80	7.05	0.14	0.13	0.12	0.12
75	7.52	0.15	0.14	0.13	0.13
70	8.06	0.16	0.15	0.14	0.13
65	8.68	0.17	0.16	0.15	0.15
60	9.41	0.18	0.18	0.17	0.16
55	10.26	0.20	0.19	0.18	0.17
50	11.29	0.22	0.21	0.20	0.19
45	12.54	0.25	0.23	0.22	0.21
40	14.11	0.28	0.26	0.25	0.24
35	16.12	0.32	0.30	0.29	0.27
30	18.81	0.37	0.35	0.33	0.31
25	22.57	0.44	0.42	0.40	0.38
20	28.22	0.55	0.53	0.50	0.47
15	37.62	0.74	0.70	0.67	0.63
10	56.43	1.11	1.05	1.00	0.94
5	112.86	2.22	2.11	2.00	1.89
1	564.31	11.09	10.53	9.98	9.43

Percentages of loss according to weather conditions is determined by current and actual conditions as measured by the Mobile Irrigation Lab in numerous irrigation system evaluations. However due to the unpredictability of the changing weather conditions, these losses are only a guide for your scheduling. Irrigation during the night time hours will be the most efficient.



NORTHWEST FLORIDA MOBILE IRRIGATION LAB

4155 Hollis Dr., Marianna, FL 32448

Phone (850) 482-0388 FAX (850) 526-2218

Reference: Powell South

May 10, 2016

Craig Bishop
6251 Stonefield Drive
Marianna, FL 32448

Dear Mr. Bishop,

Thank you for allowing the RC&D Mobile Irrigation Lab the opportunity to provide evaluation services for the above referenced irrigation system.

The Northwest Florida Resource Conservation & Development Council Mobile Irrigation Lab is now into the 12th year of operation and looks forward to serving you in the future. Our services are still FREE of any charge.

The Florida Department of Agriculture and Consumer Services, United States Department of Agriculture, National Resource Conservation Service, Northwest Florida Water Management District provide funding for the Mobile Irrigation Lab, with our services being FREE to the customer.

Many factors can influence the performance of the irrigation system. The MIL evaluation process is designed to test the overall ability of the system to evenly distribute water and measure the percentage of application loss. It is the desire of this MIL to represent the system in an unbiased report using USDA, Natural Resource Conservation Service (NRCS) guidelines as standards. Potential Water Savings (PWS) and Actual Water Savings (AWS) are calculated using Net Irrigation Requirements (NIR). Net Irrigation Requirements are defined as the amount of irrigation required to grow the crop, after consideration for estimated rainfall amounts. Crops on North Florida soils can be difficult to manage as significant rainfall or over applications of irrigation can quickly move nutrients below the root zone.

Thank you for your help in scheduling and assisting in the evaluation process. Should you have other systems that need testing or have questions or suggestions about our reporting format, please give us a call.

Mark Miles, NWF RCD

Craig Bishop

Powell South

Distribution Uniformity 74%

Distribution Uniformity without End Gun 69%

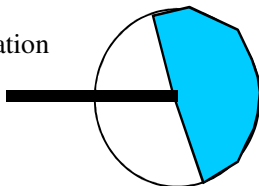
General Info	Date of Eval / Pre or Post /Pre DU%	May 10, 2016	Post	65
	MIL ID / Database ID	1137		
	System Brand / Nozzle Type / Crop	Zimmatic / Electric	Iwobs / 138	Cotton
	Wetted Length (ft) / Acres est. / Dist. to EG	1400	76	1314
	System Type / NIR	Center-pivot Low Pressure		9.46
	Timer Setting / Rotation	80%	54%	

System Output	MIL Flow Meter / System Flow Meter(GPM)	675	N / A
	System Pressure (psi) / Engine RPM	35	
	Total System Output (in) / Effective Irrigation	0.14	0.16
	Loss to Evaporation, Drift and Leaks	-0.02	-15.90%
	Application Efficiency	98%	

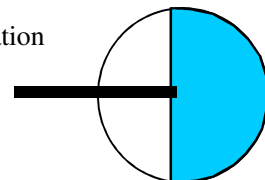
Operating Cost	41 KWH @ \$0.08	\$3.08	Estimated cost Per Hr
	Loss to Evaporation, Drift and Leaks	-\$0.49	-15.90%
	Loss to Displaced Water Dist DU 94%	\$0.60	19.63%
	Total \$ Losses /Hr	\$0.11	3.73%

Savings	Potential Water Savings (per season)	5.61mil gal / 17.23ac/ft
	Potential Reduced Pumping Hrs. (per season)	138.6
	Potential Savings (via reduced per season)	\$426
	Actual Water Savings (per season)	-2.28mil gal / -7.01ac/ft

Present End Gun Rotation



Recommended End Gun Rotation



Distribution Uniformity (DU%) measured here is expressed as the percent ratio of the average depth of the low quarter of the catches to the overall average: $DU = LQ/M$, where: LQ = average of the lowest 1/4 of the irrigation amounts: M = average of all irrigation amounts. Potential Water Savings, Reduced Pumping Hours, and Potential Savings are based on Suwannee River Mobile Irrigation Lab Standards, and USDA / NRCS Irrigation Standards for crop water use. Actual Water Savings are based on the Post DU%.

Recommendations: **Craig Bishop / Powell South / 5/10/2016**

The following recommendations will improve the Distribution Uniformity (DU) and Application Efficiency (AE) of this system. *The DU% is a score given after an MIL evaluation that indicates how evenly irrigation water is distributed across your field. The DU score is important because the lower the score the more uneven irrigation water is applied and this can effect your crops health and production. The Application Efficiency (AE) % expressed here is a measure of the amount of water pumped versus the amount of water that actually reaches the crop canopy. These losses occur through evaporation, drift and / or leaks. Any changes made to the irrigation system should be re-evaluated as it will change the Application Chart and uniformity pattern.*

- 1) The End Gun application represents a large percentage of the field. The Distribution Uniformity (DU) % reported here includes the End Gun application within the overall score.
- 2) As noted at the bottom of page three, the End Gun should be adjusted to the recommended rotation. This rotation change will likely correct the application rate and DU% could improve.
- 3) Page (4) is the customized Application Chart which is an irrigation management tool. The application amount indicated in the highlighted column is what you can expect after efficiency losses are considered and the hours per revolution at the chosen timer setting.
- 4) Because of obstructions in the field the pivot could not make a complete circle, however the Timer Chart enclosed here considers the partial circle (see rotation arc page 3).
- 5) The drain plug at Tower 1, 2,3,4,6 is leaking.
- 6) The 7th drop hose past Tower 6 is split.
- 7) The 20th nozzle past Tower 6 is clogged.
- 8) The pipe joint at Tower 7 is leaking.
- 9) The 6th and 7th nozzle past Tower 7 are wrapped around braces.
- 10) The 8th nozzle past Tower 7 is clogged.

APPENDIX E
Field Sampling Log Summary

Jackson Blue Dye Trace 2016 Station Sampler Tracking Record														Page 1 of 1
Station Number:		1A												
Station Name:		Jackson Blue Spring												
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date		Notes:
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:	
Comprehensive Background														
5/18/2016	10:19	5/26/2016	9:20	-21	-13									
5/26/2016	9:20	6/8/2016	15:22	-13	-1									
Dye Trace	6/9/16 = Day 0													
6/8/2016	15:22	6/12/2016	9:16	-1	3	4		ND	ND	ND	B6894	8/2/2016	8/11/2016	
6/12/2016	9:16	6/16/2016	9:39	3	7	4		ND	ND	32	B5792	7/13/2016	7/21&22/16	
6/16/2016	9:39	6/19/2016	9:30	7	10	3								
6/19/2016	9:30	6/23/2016	9:05	10	14	4		ND	ND	126	B5801	7/13/2016	7/21&22/16	
6/23/2016	9:05	6/30/2016	9:05	14	21	7		ND	ND	53	B5809	7/13/2016	7/21&22/16	
6/30/2016	9:05	7/7/2016	9:10	21	28	7		ND	ND	69.9	B5817	7/13/2016	7/21&22/16	
7/7/2016	9:10	7/14/2016	9:00	28	35	7		ND	ND	31.7	B6895	8/2/2016	8/11/2016	
7/14/2016	9:00	7/22/2016	8:40	35	43	8		ND	ND	24.40	B7250	8/2/2016	8/25/2016	
7/22/2016	8:40	8/4/2016	8:44	43	56	13		0.311*	ND	39.70	B7656	9/6/2016	9/12/2016	
8/4/2016	8:44	8/19/2016	9:05	56	71	15		0.461*	ND	40.00	B7663	9/6/2016	9/12/2016	
8/19/2016	9:05	9/3/2016	11:30	71	86	15		0.328*	ND	24.40	B7664	9/6/2016	9/12/2016	
9/3/2016	11:30			86										
Sampling completed.														
# BG Sampler Sets Collected:		2												
# BG Sampler Sets Shipped:		0												
# BG Samplers Analyzed:		0												
# DT Sampler Sets Collected:		11												
# DT Sampler Sets Shipped:		10												
# DT Samplers Analyzed:		10												
Total # Sampler Sets Collected:		13												
Total # Sampler Sets Shipped:		10												
Total # Samplers Analyzed:		10												
# Samplers FL pos:		0												
# Samplers RWT pos:		9												
# Samplers EO pos:		0												

Jackson Blue Dye Trace 2016 Station Sampler Tracking Record														Page 1 of 1
Station Number:		1B												
Station Name:		Jackson Blue Spring Back-up												
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date	Notes:	
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:	
Comprehensive Background														
5/18/2016	10:45	5/26/2016	9:30	-21	-13									
5/26/2016	9:30	6/8/2016	15:34	-13	-1									
Dye Trace	6/9/16 = Day 0													
6/8/2016	15:34	6/12/2016	9:16	-1	3	4								
6/12/2016	9:22	6/16/2016	9:33	3	7	4		ND	ND	6.46	B5793	7/13/2016	7/21&22/16	
6/16/2016	9:33	6/19/2016	9:40	7	10	3								
6/19/2016	9:40	6/23/2016	9:07	10	14	4		ND	ND	23.3	B5802	7/13/2016	7/21&22/16	
6/23/2016	9:07	6/30/2016	9:10	14	21	7		ND	ND	28.7	B5810	7/13/2016	7/21&22/16	
6/30/2016	9:10	7/7/2016	9:12	21	28	7		ND	ND	18.5	B5818	7/13/2016	7/21&22/16	
7/7/2016	9:12	7/14/2016	9:02	28	35	7		ND	ND	12.1	B6896	8/2/2016	8/11/2016	
7/14/2016	9:02	7/22/2016	8:42	35	43	8		ND	ND	8.51	B7251	8/2/2016	8/25/2016	
7/22/2016	8:42	8/4/2016	8:46	43	56	13		ND	ND	9.27	B7657	9/6/2016	9/12/2016	
8/4/2016	8:46	8/19/2016	9:07	56	71	15						9/6/2016		
8/19/2016	9:07	9/3/2016	11:26	71	86	15						9/6/2016		
9/3/2016	11:26			86										
Sampling completed.														
# BG Sampler Sets Collected:		2												
# BG Sampler Sets Shipped:		0												
# BG Samplers Analyzed:		0												
# DT Sampler Sets Collected:		11												
# DT Sampler Sets Shipped:		9												
# DT Samplers Analyzed:		7												
Total # Sampler Sets Collected:		13												
Total # Sampler Sets Shipped:		9												
Total # Samplers Analyzed:		7												
# Samplers FL pos:		0												
# Samplers RWT pos:		7												
# Samplers EO pos:		0												

Jackson Blue Dye Trace 2016 Station Sampler Tracking Record														Page 1 of 1
Station Number:		2												
Station Name:		Shangri-La Spring												
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date		Notes:
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:	
Comprehensive Background														
5/18/2016	11:07	5/26/2016	10:12	-21	-13									
5/26/2016	10:12	6/8/2016	15:44	-13	-1									
Dye Trace	6/9/16 = Day 0													
6/8/2016	15:44	6/12/2016	9:32	-1	3	4								
6/12/2016	9:32	6/16/2016	10:01	3	7	4		ND	ND	ND	B5794	7/13/2016	7/21&22/16	
6/16/2016	10:01	6/19/2016	9:42	7	10	3		ND	ND	12.1	B6904	8/2/2016	8/11/2016	
6/19/2016	9:42	6/23/2016	9:15	10	14	4		ND	ND	84.6	B5803	7/13/2016	7/21&22/16	
6/23/2016	9:15	6/30/2016	9:22	14	21	7		ND	ND	61.8	B5811	7/13/2016	7/21&22/16	
6/30/2016	9:22	7/7/2016	9:25	21	28	7		ND	ND	35.5	B5819	7/13/2016	7/21&22/16	
7/7/2016	9:25	7/14/2016	9:08	28	35	7		ND	ND	38	B6897	8/2/2016	8/11/2016	
7/14/2016	9:08	7/22/2016	9:09	35	43	8		ND	ND	10.6	B7252	8/2/2016	8/25/2016	
7/22/2016	9:09	8/4/2016	8:56	43	56	13		0.496*	ND	88.2	B7658	9/6/2016	9/12/2016	
7/22/2016	9:09	8/4/2016	8:56	43	56	13	X	0.365*	ND	73.2	B7658D	9/6/2016	10/12/2016	
8/4/2016	8:56	8/19/2016	9:22	56	71	15		0.272*	ND	37	B8242	9/6/2016	10/12/2016	
8/19/2016	9:22	9/3/2016	11:15	71	86	15		0.241*	ND	11.8	B8247	9/6/2016	10/12/2016	
9/3/2016	11:15			86										
Sampling completed.														
# BG Sampler Sets Collected:		2												
# BG Sampler Sets Shipped:		0												
# BG Samplers Analyzed:		0												
# DT Sampler Sets Collected:		11												
# DT Sampler Sets Shipped:		10												
# DT Samplers Analyzed:		11		(1 Dupe)										
Total # Sampler Sets Collected:		13												
Total # Sampler Sets Shipped:		10												
Total # Samplers Analyzed:		11												
# Samplers FL pos:		0												
# Samplers RWT pos:		10												
# Samplers EO pos:		0												

[illegible]

Jackson Blue Dye Trace 2016 Station Sampler Tracking Record														Page 1 of 1
Station Number:		4												
Station Name:		Indian Washtub Spring												
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date	Notes:	
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:	
Comprehensive Background														
5/18/2016	11:19	5/26/2016	10:20	-21	-13									
5/26/2016	10:20	6/8/2016	15:52	-13	-1									
Dye Trace	6/9/16 = Day 0													
6/8/2016	15:52	6/12/2016	9:49	-1	3	4								
6/12/2016	9:49	6/16/2016	10:44	3	7	4		ND	ND	ND	B5796	7/13/2016	7/21&22/16	
6/16/2016	10:44	6/19/2016	10:18	7	10	3								
6/19/2016	10:18	6/23/2016	9:35	10	14	4		ND	ND	ND	B5805	7/13/2016	7/21&22/16	
6/23/2016	9:35	6/30/2016	9:44	14	21	7		ND	ND	1.57	B5813	7/13/2016	7/21&22/16	
6/30/2016	9:44	7/7/2016	9:52	21	28	7		ND	ND	3.62	B5822	7/13/2016	7/21&22/16	
7/7/2016	9:52	7/14/2016	9:30	28	35	7		ND	ND	2	B6899	8/2/2016	8/11/2016	
7/14/2016	9:30	7/22/2016	10:06	35	43	8							Missing	
7/14/2016	9:30	8/4/2016	10:45	35	56	21							Missing	
8/4/2016	10:45	9/3/2016	11:03	56	86	30		ND	ND	2.39	B7665	9/6/2016	9/12/2016	
9/3/2016	11:03			86										
Sampling completed.														
# BG Sampler Sets Collected:			2											
# BG Sampler Sets Shipped:			0											
# BG Samplers Analyzed:			0											
# DT Sampler Sets Collected:			8											
# DT Sampler Sets Shipped:			6											
# DT Samplers Analyzed:			6											
Total # Sampler Sets Collected:			10											
Total # Sampler Sets Shipped:			6											
Total # Samplers Analyzed:			6											
# Samplers FL pos:				0										
# Samplers RWT pos:				4										
# Samplers EO pos:				0										

Jackson Blue Dye Trace 2016 Station Sampler Tracking Record														Page 1 of 1
Station Number:		5												
Station Name:		Hole-In-The-Wall Spring												
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date	Notes:	
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:	
Comprehensive Background														
5/18/2016	11:45	5/26/2016	10:45	-21	-13									
5/26/2016	10:45	6/8/2016	16:17	-13	-1									
Dye Trace	6/9/16 = Day 0													
6/8/2016	16:17	6/12/2016	10:22	-1	3	4								
6/12/2016	10:22	6/16/2016	9:12	3	7	4		ND	ND	ND	B5797	7/13/2016	7/21&22/16	
6/16/2016	9:12	6/19/2016	10:38	7	10	3								
6/19/2016	10:38	6/23/2016	9:53	10	14	4		ND	ND	ND	B5806	7/13/2016	7/21&22/16	
6/23/2016	9:53	6/30/2016	10:07	14	21	7		ND	0.292	ND	B5814	7/13/2016	7/21&22/16	
6/30/2016	10:07	7/7/2016	10:09	21	28	7		ND	0.722	ND	B5823	7/13/2016	7/21&22/16	
7/7/2016	10:09	7/14/2016	10:25	28	35	7		ND	0.533	ND	B6901	8/2/2016	8/11/2016	
7/14/2016	10:25	7/22/2016	10:06	35	43	8		ND	1.020	ND	B7254	8/2/2016	8/25/2016	
7/22/2016	10:06	8/4/2016	9:35	43	56	13		ND	0.779	ND	B7659	9/6/2016	9/12/2016	
8/4/2016	9:35	8/19/2016	10:17	56	71	15		ND	0.315**	ND	B8244	9/6/2016	10/12/2016	
8/19/2016	10:17	9/3/2016	10:06	71	86	15		ND	ND	ND	B8249	9/6/2016	10/12/2016	
9/3/2016	10:06			86										
Sampling completed.														
# BG Sampler Sets Collected:		2												
# BG Sampler Sets Shipped:		0												
# BG Samplers Analyzed:		0												
# DT Sampler Sets Collected:		11												
# DT Sampler Sets Shipped:		9												
# DT Samplers Analyzed:		9												
Total # Sampler Sets Collected:		13												
Total # Sampler Sets Shipped:		9												
Total # Samplers Analyzed:		9												
# Samplers FL pos:		0												
# Samplers RWT pos:		0												
# Samplers EO pos:		6												

[illegible]

Jackson Blue Dye Trace 2016 Station Sampler Tracking Record														Page 1 of 1
Station Number:		7												
Station Name:		Gator Hole Spring												
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date	Notes:	
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:	
Comprehensive Background														
5/18/2016	12:31	5/26/2016	11:00	-21	-13									
5/26/2016	11:00	6/8/2016	16:37	-13	-1									
Dye Trace	6/9/16 = Day 0													
6/8/2016	16:37	6/12/2016	10:37	-1	3	4								
6/12/2016	10:37	6/16/2016	11:30	3	7	4		ND	ND	ND	B5799	7/13/2016	7/21&22/16	
6/16/2016	11:30	6/19/2016	11:06	7	10	3								
6/19/2016	11:06	6/23/2016	10:35	10	14	4		ND	ND	ND	B5808	7/13/2016	7/21&22/16	
6/23/2016	10:35	6/30/2016	10:40	14	21	7		ND	ND	ND	B5816	7/13/2016	7/21&22/16	
6/30/2016	10:40	7/7/2016	10:52	21	28	7		ND	ND	ND	B5825	7/13/2016	7/21&22/16	
7/7/2016	10:52	7/14/2016	10:08	28	35	7		ND	ND	ND	B6903	8/2/2016	8/11/2016	
7/14/2016	10:08	7/22/2016	10:50	35	43	8		ND	ND	ND	B7256	8/2/2016	8/25/2016	
7/22/2016	10:50	8/4/2016	10:04	43	56	13		ND	ND	ND	B7662	9/6/2016	9/12/2016	
8/4/2016	10:04	8/19/2016	10:40	56	71	15		ND	ND	ND	B8246	9/6/2016	10/12/2016	
8/19/2016	10:40	9/3/2016	9:39	71	86	15		ND	ND	ND	B8251	9/6/2016	10/12/2016	
9/3/2016	9:39			86										
Sampling completed.														
# BG Sampler Sets Collected:		2												
# BG Sampler Sets Shipped:		0												
# BG Samplers Analyzed:		0												
# DT Sampler Sets Collected:		11												
# DT Sampler Sets Shipped:		9												
# DT Samplers Analyzed:		9												
Total # Sampler Sets Collected:		13												
Total # Sampler Sets Shipped:		9												
Total # Samplers Analyzed:		5												
# Samplers FL pos:		0												
# Samplers RWT pos:		0												
# Samplers EO pos:		0												

[illegible]

Jackson Blue Dye Trace 2016 Station Sampler Tracking Record													Page 1 of 1
Station Number:		9											
Station Name:		Merritt's Mill Pond End Pond Control											
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date	Notes:
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:
Comprehensive Background													
5/18/2016	15:49	5/26/2016	12:20	-21	-13								
5/26/2016	12:20	6/9/2016	7:37	-13	0								
Dye Trace		6/9/16 = Day 0											
6/9/2016	7:37	6/12/2016	8:28	0	3	4							
6/12/2016	8:28	6/16/2016	8:19	3	7	4							
6/16/2016	8:19	6/19/2016	8:25	7	10	3							
6/19/2016	8:25	6/23/2016	8:10	10	14	4							
6/23/2016	8:10	6/30/2016	8:17	14	21	7							
6/30/2016	8:17	7/7/2016	8:26	21	28	7							
7/7/2016	8:26	7/14/2016	8:12	28	35	7							
7/14/2016	8:12	7/22/2016	7:55	35	43	8							
7/22/2016	7:55	8/4/2016	7:53	43	56	13							
8/4/2016	7:53	8/19/2016	8:10	56	71	15							
8/19/2016	8:10	9/3/2016	8:32	71	86	15							
9/3/2016	8:32			86									
Sampling completed.													
# BG Sampler Sets Collected:		2											
# BG Sampler Sets Shipped:		0											
# BG Samplers Analyzed:		0											
# DT Sampler Sets Collected:		11											
# DT Sampler Sets Shipped:		0											
# DT Samplers Analyzed:		0											
Total # Sampler Sets Collected:		13											
Total # Sampler Sets Shipped:		0											
Total # Samplers Analyzed:		0											
# Samplers FL pos:		-											
# Samplers RWT pos:		-											
# Samplers EO pos:		-											

Jackson Blue Dye Trace 2016 Station Sampler Tracking Record													Page 1 of 1
Station Number:		10											
Station Name:		Pelt Swallet Input Control											
PLACED:		COLLECTED:		Day Number:		Duration	Dupe	ANALYSES RESULTS (ppb)			OUL	Date	Notes:
Date:	Time:	Date:	Time:	In:	Out:	(days)		Fluor.	Eosine	Rhod WT	Lab #	Shipped:	Analyzed:
Comprehensive Background													
5/18/2016	16:19	5/26/2016	8:31	-21	-13								
5/26/2016	8:31	6/9/2016	11:50	-13	0								
Dye Trace		6/9/16 = Day 0											
6/9/2016	11:50	6/12/2016	8:17	0	3	4							
6/12/2016	8:17	6/16/2016	7:54	3	7	4							
6/16/2016	7:54	6/19/2016	8:05	7	10	3							
6/19/2016	8:05	6/23/2016	7:55	10	14	4							
6/23/2016	7:55	6/30/2016	7:58	14	21	7							
6/30/2016	7:58	7/7/2016	8:15	21	28	7							
7/7/2016	8:15	7/14/2016	8:00	28	35	7							
7/14/2016	8:00	7/22/2016	7:40	35	43	8							
7/22/2016	7:40	8/4/2016	7:40	43	56	13							
8/4/2016	7:40	8/19/2016	7:55	56	71	15							
8/19/2016	7:55	9/3/2016	8:18	71	86	15							
9/3/2016	8:18			86									
Sampling completed.													
# BG Sampler Sets Collected:		2											
# BG Sampler Sets Shipped:		0											
# BG Samplers Analyzed:		0											
# DT Sampler Sets Collected:		11											
# DT Sampler Sets Shipped:		0											
# DT Samplers Analyzed:		0											
Total # Sampler Sets Collected:		13											
Total # Sampler Sets Shipped:		0											
Total # Samplers Analyzed:		0											
# Samplers FL pos:		-											
# Samplers RWT pos:		-											
# Samplers EO pos:		-											

[illegible]

APPENDIX F

Lab Data and Chain of Custody

Certificate of Analysis

Date of certificate: July 27, 2016

Client: AECOM

1625 Summit Lake Drive, Suite 200

Tallahassee, FL 32317

Project name / location: Jackson Blue Merritt's Mill Pond Dye Trace / Greenwood, Florida

Project number: URS Project Reference 60493736

Contact person: William.Colona@AECOM.com

Samples collected by: Bill Colona, J. Levy and T. Campbell

Date samples shipped: July 13, 2016

Date samples rec'd at OUL: July 14, 2016

Date analyzed by OUL: July 20 and 21, 2016

Included with certificate of analysis: Table of results,
copies of sample collection data sheets and
discrepancy sheet

Results for charcoal and water samples analyzed for the presence of fluorescein, eosine, 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 indicated otherwise.

OUL Number	Station Number	Station Name	Date/Time Placed	Date/Time Collected	Fluorescein		Eosine		RWT	
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)
B5792	1A	Jackson Blue Spring	6/12/16 0916	6/16/16 0939	ND		ND		569.0	32.0
B5801	1A	Jackson Blue Spring	6/19/16 0930	6/23/16 0905	ND		ND		568.6	126
B5809	1A	Jackson Blue Spring	6/23/16 0905	6/30/16 0905	ND		ND		568.2	53.0
B5817	1A	Jackson Blue Spring	6/30/16 0905	7/7/16 0910	ND		ND		568.6	69.9
B5793	1B	Jackson Blue Spring Back-up	6/12/16 0922	6/16/16 0933	ND		ND		568.4	6.46
B5802	1B	Jackson Blue Spring Back-up	6/19/16 0940	6/23/16 0907	ND		ND		568.6	23.3
B5810	1B	Jackson Blue Spring Back-up	6/23/16 0907	6/30/16 0910	ND		ND		568.2	28.7
B5818	1B	Jackson Blue Spring Back-up	6/30/16 0910	7/7/16 0912	ND		ND		569.0	18.5
B5794	2	Shangri-La Spring	6/12/16 0932	6/16/16 1001	ND		ND		ND	
B5803	2	Shangri-La Spring	6/19/16 0942	6/23/16 0915	ND		ND		568.6	84.6
B5811	2	Shangri-La Spring	6/23/16 0915	6/30/16 0922	ND		ND		568.6	61.8

OUL Number	Station Number	Station Name	Date/Time Placed	Date/Time Collected	Fluorescein		Eosine		RWT	
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)
B5819	2	Shangri-La Spring	6/30/16 0922	7/7/16 0925	ND		ND		568.8	35.5
B5795	3	Twin Caves Spring	6/9/16 1600	6/16/16 1024	ND		ND		ND	
B5804	3	Twin Caves Spring	6/19/16 1004	6/23/16 0925	ND		542.4	0.298	ND	
B5812	3	Twin Caves Spring	6/23/16 0925	6/30/16 0934	ND		542.0	1.72	ND	
B5821	3	Twin Caves Spring	6/30/16 0934	7/7/16 0943	ND		541.6	1.22	ND	
B5796	4	Indian Washtub Spring	6/12/16 0949	6/16/16 1044	ND		ND		ND	
B5805	4	Indian Washtub Spring	6/19/16 1018	6/23/16 0935	ND		ND		ND	
B5813	4	Indian Washtub Spring	6/23/16 0935	6/30/16 0944	ND		ND		567.8	1.57
B5822	4	Indian Washtub Spring	6/30/16 0944	7/7/16 0952	ND		ND		567.4	3.62
B5797	5	Hole-In-The-Wall Spring	6/12/16 1022	6/16/16 0912	ND		ND		ND	
B5806	5	Hole-In-The-Wall Spring	6/19/16 1038	6/23/16 0953	ND		ND		ND	
B5814	5	Hole-In-The-Wall Spring	6/23/16 0953	6/30/16 1007	ND		542.0	0.292	ND	
B5823	5	Hole-In-The-Wall Spring	6/30/16 1007	7/7/16 1009	ND		542.2	0.722	ND	
B5798	6	Hidey Hole Spring	6/12/16 1051	6/16/16 1117	ND		ND		ND	
B5807	6	Hidey Hole Spring	6/19/16 1120	6/23/16 1018	ND		ND		ND	
B5815	6	Hidey Hole Spring	6/23/16 1018	6/30/16 1028	ND		ND		ND	
B5824	6	Hidey Hole Spring	6/30/16 1028	7/7/16 1043	ND		ND		ND	
B5799	7	Gator Hole Spring	6/12/16 1037	6/16/16 1130	ND		ND		ND	
B5808	7	Gator Hole Spring	6/19/16 1106	6/23/16 1035	ND		ND		ND	
B5816	7	Gator Hole Spring	6/23/16 1035	6/30/16 1040	ND		ND		ND	
B5825	7	Gator Hole Spring	6/30/16 1040	7/7/16 1052	ND		ND		ND	
B6273	1A	Jackson Blue Spring	Water	6/16/16 0939	ND		ND		574.4 (1)	0.074
B6275	1A	Jackson Blue Spring	Water	6/23/16 0905	ND		ND		573.8 (1)	0.046
B6279	1A	Jackson Blue Spring	Water	6/30/16 0905	ND		ND		572.4 (1)	0.039
B6286	1A	Jackson Blue Spring	Water	7/7/16 0910	ND		ND		572.0 (1)	0.037
B6274	1B	Jackson Blue Spring Back-up	Water	6/16/16 0933	ND		ND		574.8	0.323
B6276	1B	Jackson Blue Spring Back-up	Water	6/23/16 0907	ND		ND		575.6 (1)	0.068
B6281	1B	Jackson Blue Spring Back-up	Water	6/30/16 0910	ND		ND		575.0 (1)	0.061
B6287	1B	Jackson Blue Spring Back-up	Water	7/7/16 0912	ND		ND		ND	
B6277	2	Shangri-La Spring	Water	6/23/16 0915	ND		ND		ND	

OUL Number	Station Number	Station Name	Date/Time Placed	Date/Time Collected	Fluorescein		Eosine		RWT	
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)
B6282	2	Shangri-La Spring	Water	6/30/16 0922	ND		ND		574.8 (1)	0.040
B6288	2	Shangri-La Spring	Water	7/7/16 0925	ND		ND		575.6 (1)	0.027
B6278	3	Twin Caves Spring	Water	6/23/16 0925	ND		ND		ND	
B6283	3	Twin Caves Spring	Water	6/30/16 0934	ND		536.8	0.035	ND	
B6289	3	Twin Caves Spring	Water	7/7/16 0943	ND		535.0 (1)	0.012	ND	
B6284	4	Indian Washtub Spring	Water	6/30/16 0944	ND		ND		ND	
B6290	4	Indian Washtub Spring	Water	7/7/16 0952	ND		ND		ND	
B6285	5	Hole-In-The-Wall Spring	Water	6/30/16 1007	ND		ND		ND	
B6291	5	Hole-In-The-Wall Spring	Water	7/7/16 1009	ND		ND		ND	
B5800	Laboratory control charcoal blank									
B5820	Laboratory control charcoal blank									
B6280	Laboratory control water 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.

Footnote: ND = No dye detected

(1) = A fluorescence peak is present that does not meet all the criteria for this dye. However, it has been calculated as a positive dye result because dye was present in the corresponding charcoal sample.

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: Jackson Blue Springs Dye Trace Week No: Week 1 Samples Collected By: B. Colona, J. Levy, T. Campbell
 Samples Shipped By: J. Levy Samples Received By: J. Sparks, OUL
 Date Samples Shipped: 07/13/2016 Date Samples Received: 7/14/16 Time Samples Received: 12:15 Return Cooler? Yes ☒ No ☐
 Bill to: N/A Send Results to: B. Colona AECOM Tallahassee
 Analyze for: Fluorescein ☒ Eosine ☒ Rhodamine WT ☒ Other _____ Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<u>Please indicate stations where dye was visible in the field</u> <u>for field technician use - use black ink only</u>							OUL use only
# CHAR REC'D	LAB NUMBER <i>char</i>	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D	
				DATE	TIME	DATE	TIME		
2	B5792	1A	Jackson Blue Spring	6/12/16	0916	6/16/16	0939	1	
2	B5793	1B	Jackson Blue Spring Back-up	6/12/16	0922	6/16/16	0933	1	
2	B5794	2	Shangri-La Spring	6/12/16	0932	6/16/16	1001	1	
2	B5795	3	Twin Caves Spring	6/9/16	1600 ⁸	6/16/16	1024	1	
2	B5796	4	Indian Washtub Spring	6/12/16	0949	6/16/16	1044	1	
2	B5797	5	Hole-In-The-Wall Spring	6/12/16	1022	6/16/16	0912	1	
2	B5798	6	Hidey Hole Spring	6/12/16	1051	6/16/16	1117	1	
2	B5799	7	Gator Hole Spring	6/12/16	1037	6/16/16	1130	1	

COMMENTS: See discrepancy Oul Charcoal Blank B5800 Oul Project 1499 Unanalyzed 7/20/16
 This sheet filled out by OUL staff? Yes ☐ No ☒ Charts for samples on this page proofed by OUL: MC by me/oul
 Page 1 of 4 (OUL) f:\shared\forms\coc.doc, Rev. 8/99

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: Jackson Blue Springs Dye Trace Week No: Week 2 Samples Collected By: B. Colona, J. Levy, T. Campbell
 Samples Shipped By: J. Levy Samples Received By: J. Stearns, OUL
 Date Samples Shipped: 07/13/2016 Date Samples Received: 7/14/16 Time Samples Received: 12:15 Return Cooler? Yes X No
 Bill to: N/A Send Results to: B. Colona AECOM Tallahassee
 Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<u>Please indicate stations where dye was visible in the field</u> <u>for field technician use - use black ink only</u>							OUL use only
# CHAR REC'D	LAB NUMBER <i>char</i>	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D	
				DATE	TIME	DATE	TIME		
2	B5801	1A	Jackson Blue Spring	6/19/16	0930	6/23/16	0905	1	
2	B5802	1B	Jackson Blue Spring Back-up	6/19/16	0940	6/23/16	0907	1	
2	B5803	2	Shangri-La Spring	6/19/16	0942	6/23/16	0915	1	
2	B5804	3	Twin Caves Spring	6/19/16	1004	6/23/16	0925	1	
2	B5805	4	Indian Washtub Spring	6/19/16	1018	6/23/16	0935 [Ⓢ]	1	
2	B5806	5	Hole-In-The-Wall Spring	6/19/16	1038	6/23/16	0953	1	
2	B5807	6	Hidey Hole Spring	6/19/16	1120	6/23/16	1018	1	
2	B5808	7	Gator Hole Spring	6/19/16	1106	6/23/16	1035	1	

COMMENTS: *See discrepancy sheet

Analyzed 7/20/16 by wellal

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

Page 2 of 4 (OUL)

OZARK UNDERGROUND LABORATORY, INC.

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 3 Samples Collected By: B. Colona, J. Levy, T. Campbell
 Samples Shipped By: J. Levy Samples Received By: J. Shearman, OUL
 Date Samples Shipped: 07/13/2016 Date Samples Received: 7/14/16 Time Samples Received: 12:15 Return Cooler? Yes ☒ No ☐
 Bill to: N/A Send Results to: B. Colona AECOM Tallahassee
 Analyze for: Fluorescein ☒ Eosine ☒ Rhodamine WT ☒ Other _____ Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<u>Please indicate stations where dye was visible in the field</u> for field technician use - use black ink only							OUL use only
# CHAR REC'D	LAB NUMBER <i>char</i>	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'T	
				DATE	TIME	DATE	TIME		
2	B5809	1A	Jackson Blue Spring	6/23/16	0905	6/30/16	0905	1	
2	B5810	1B	Jackson Blue Spring Back-up	6/23/16	0907	6/30/16	0910	1	
2	B5811	2	Shangri-La Spring	6/23/16	0915	6/30/16	0922	1	
2	B5812	3	Twin Caves Spring	6/23/16	0925	6/30/16	0934	1	
2	B5813	4	Indian Washtub Spring	6/23/16	0935 ⁽⁴⁾	6/30/16	0944	1	
2	B5814	5	Hole-In-The-Wall Spring	6/23/16	0953	6/30/16	1007	1	
2	B5815	6	Hidey Hole Spring	6/23/16	1018	6/30/16	1028	1	
2	B5816	7	Gator Hole Spring	6/23/16	1035	6/30/16	1040	1	

COMMENTS: *See discrepancy sheet

This sheet filled out by OUL staff? Yes ☐ No ☒

Analyzed 7/20/16 by me (OUL)

Charts for samples on this page proofed by OUL: NK

Page 1 of 4 (OUL)
3

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 4 Samples Collected By: J. Levy, T. Campbell

Samples Shipped By: J. Levy Samples Received By: J. Stearns, OUL

Date Samples Shipped: 07/13/2016 Date Samples Received: 7/14/2016 Time Samples Received: 12:15 Return Cooler? Yes ☒ No ☐

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: B. Colona AECOM Tallahassee

[illegible]

COMMENTS: Owl Charcoal Blank B3820 Analyzed 7/20/16 by WRE/OWL
This sheet filled out by OUL staff? Yes ☐ No ☒ Charts for samples on this page proofed by OUL: ML

Page 1 of 4 (over)

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

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Samples Shipped By: J. Levy Samples Received By: J. Stearns, D/L

Date Samples Shipped: 07/13/2016 Date Samples Received: 7/14/16 Time Samples Received: 12:15 Return Cooler? Yes ☒ No ☐

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: B. Colona AECOM Tallahassee

[illegible]

COMMENTS: (3) See discrepancy
This sheet filled out by OUL staff? Yes

Charts for samples on this page proofed by OUL: MK

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Samples Shipped By: J. Levy Samples Received By: A. Starkman, DILL

Date Samples Shipped: 07/13/2016 Date Samples Received: 7/14/16 Time Samples Received: 12:15 Return Cooler? Yes ☒ No ☐

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: B. Colona AECOM Tallahassee

CUI project #1499. Analyzed, 7/21/16, by Lisa Gilcrease/ou

COMMENTS: * See discrepancy sheet

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

Page 1 of 4 (OVL)

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Samples Shipped By: J. Levy Samples Received By: A. Spierman, OUL

Date Samples Shipped: 07/ 13 / 2016 Date Samples Received: 7 / 14 / 16 Time Samples Received: 12 : 15 Return Cooler? Yes ☒ No ☐

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: B. Colona AECOM Tallahassee

[illegible]

COMMENTS: See discrepancy sheet

This sheet filled out by OUL staff? Yes 0 No ✓ Charts for samples on this page proofed by OUL: NK

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

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Ship cooler to: B. Colona AECOM Tallahassee

[illegible]

This sheet filled out by OUL staff? Yes

X

Charts for samples on this page proofed by OUL: NK

Page 5 of 4 (over)

OZARK UNDERGROUND LABORATORY, INC.

[illegible]

Certificate of Analysis

Date of certificate: August 15, 2016

Client: AECOM

1625 Summit Lake Drive, Suite 200

Tallahassee, FL 32317

Project name / location: Jackson Blue Merritt's Mill Pond Dye Trace / Greenwood, Florida

Project number: URS Project Reference 60493736

Contact person: William.Colona@AECOM.com

Samples collected by: Bill Colona, J. Levy and T. Campbell

Date samples shipped: August 2, 2016

Date samples rec'd at OUL: August 3, 2016

Date analyzed by OUL: August 11, 2016

Included with certificate of analysis: Table of results,
copies of sample collection data sheets,
discrepancy sheet and e-mail from AECOM dated 8/2/16

Results for charcoal and water samples analyzed for the presence of fluorescein, eosine, 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 indicated otherwise.

OUL Number	Station Number	Station Name	Date/Time Placed	Date/Time Collected	Fluorescein		Eosine		RWT	
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)
B6904	2	Shangri-La Spring	6/16/16 1001	6/19/16 0942	ND		ND		569.0	12.1
B6897	2	Shangri-La Spring	7/7/16 0925	7/14/16 0908	ND		ND		568.2	38.0
B6905	3	Twin Caves Spring	6/16/16 1024	6/19/16 1004	ND		ND		ND	
B6905D	3	Twin Caves Spring	6/16/16 1024	6/19/16 1004	ND		ND		ND	
B6898	3	Twin Caves Spring	7/7/16 0943	7/14/16 0922	ND		541.2	0.854	ND	
B6906	3	Twin Caves Spring 2	6/12/16 NT	6/19/16 NT	ND		ND		ND	
B6906D	3	Twin Caves Spring 2	6/12/16 NT	6/19/16 NT	ND		ND		ND	
B6899	4	Indian Washtub Spring	7/7/16 0952	7/14/16 0930	ND		ND		567.6	2.00
B6901	5	Hole-In-The-Wall Spring	7/7/16 1009	7/14/16 1025	ND		541.6	0.533	ND	
B6902	6	Hidey Hole Spring	7/7/16 1043	7/14/16 0958	ND		ND		ND	
B6903	7	Gator Hole Spring	7/7/16 1052	7/14/16 1008	ND		ND		ND	

OUL Number	Station Number	Station Name	Date/Time Placed	Date/Time Collected	Fluorescein		Eosine		RWT	
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)
B6894	1A	Jackson Blue Spring	6/8/16 1522	6/12/16 0916	ND		ND		ND	
B6895	1A	Jackson Blue Spring	7/7/16 0910	7/14/16 0900	ND		ND		567.2	31.7
B6896	1B	Jackson Blue Spring Back-up	7/7/16 0912	7/14/16 0902	ND		ND		568.4	12.1
B6900	Laboratory control charcoal blank									
B6994	2	Shangri-La Spring	Water	6/19/16 0942	ND		ND		574.0	0.096
B6990	2	Shangri-La Spring	Water	7/14/16 0908	ND		ND		ND	
B6991	3	Twin Caves Spring	Water	7/14/16 0922	ND		ND		ND	
B6992	4	Indian Washtub Spring	Water	7/14/16 0930	ND		ND		ND	
B6993	5	Hole-In-The-Wall Spring	Water	7/14/16 1025	ND		ND		ND	
B6988	1A	Jackson Blue Spring	Water	7/14/16 0900	ND		ND		ND	
B6989	1B	Jackson Blue Spring Back-up	Water	7/14/16 0902	ND		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.

Footnote: ND = No dye detected NT = No time given

Thomas J. Aley, PHG and RG

Thomas Aley

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

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: T. Campbell, J. Levy Samples Received By: C. Shuman 

Date Samples Shipped: 08 / 02 / 16 Date Samples Received: 8 / 3 / 16 Time Samples Received: 13:15 Return Cooler? Yes ☒ No ☐

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: B. Colona AECOM Tallahassee

[illegible]

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

Q11 project # 1499. Analyzed 8/11/16 by Lisa Gilcrease Page 1 of 4 out

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: Jackson Blue Springs Dye Trace Week No: Week 5 Samples Collected By: J. Levy, T. Campbell
 Samples Shipped By: J. Levy, T. Campbell Samples Received By: ~~NA~~ C. Aley / oul
 Date Samples Shipped: 08 / 02 / 16 Date Samples Received: 8/3/16 Time Samples Received: 13:15 Return Cooler? Yes X No
 Bill to: N/A Send Results to: B. Colona AECOM Tallahassee
 Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

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		
2	B6895	1A	Jackson Blue Spring	7/7/16	0910	7/14/16	0900	1	
2	B6896	1B	Jackson Blue Spring Back-up	7/7/16	0912	7/14/16	0902	1	
2	B6897	2	Shangri-La Spring	7/7/16	0925	7/14/16	0908	1	
2	B6898	3	Twin Caves Spring	7/7/16	0943	7/14/16	0922	1	
2	B6899	4	Indian Washtub Spring	7/7/16	0952	7/14/16	0930	1	
2	B6901	5	Hole-In-The-Wall Spring	7/7/16	1009	7/14/16	1025	1	
2	B6902	6	Hidey Hole Spring	7/7/16	1043	7/14/16	0958	1	
2	B6903	7	Gator Hole Spring	7/7/16	1052	7/14/16	1008	1	

COMMENTS: B6900 = OUL charcoal blank

This sheet filled out by OUL staff? Yes No X Charts for samples on this page proofed by OUL: JC
 OUL project #1499. Analyzed 8/11/16 by Lisa Gilcrease/oul Page 1 of 2 of 4 oul

HOLDS

[illegible]

3 2 4 om

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

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

Project: Jackson Blue Springs Dye Trace **Week No:** Day 10 **Samples Collected By:** B. Colona, J. Levy

Samples Shipped By: T. Campbell, J. Levy Samples Received By: C. Blaz/ouL NTA

Date Samples Shipped: 08 / 02 / 16 Date Samples Received: 8 / 3 / 16 Time Samples Received: 13: 15 Return Cooler? Yes X No

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: B. Colona AECOM Tallahassee

[illegible]

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

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: Jackson Blue Springs Dye Trace Week No: Week 5 Samples Collected By: J. Levy, T. Campbell
 Samples Shipped By: J. Levy, T. Campbell Samples Received By: ### C. Aley 10/11/16
 Date Samples Shipped: 08 / 02 / 16 Date Samples Received: 8/31/16 Time Samples Received: 13:15 Return Cooler? Yes X No
 Bill to: N/A Send Results to: B. Colona AECOM Tallahassee
 Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

[illegible]**COMMENTS:**

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

To whom it may concern,

08/02/2016

Please run tests on the samples listed in the Chain of Custodies for "Day 3", "Day 10", and "Week 5," including all four carbon packets inside the Twin Caves samples for "Day 10."

Please wait to test "Week 6" samples until further notice.

Thank you,

AECOM Tallahassee

Certificate of Analysis

Date of certificate: August 29, 2016

Client: AECOM

1625 Summit Lake Drive, Suite 200

Tallahassee, FL 32317

Project name / location: Jackson Blue Merritt's Mill Pond Dye Trace / Greenwood, Florida

Project number: URS Project Reference 60493736

Contact person: William.Colona@AECOM.com

Samples collected by: Bill Colona, J. Levy

Date samples shipped: August 2, 2016

Date samples rec'd at OUL: August 3, 2016 and archived

Date of analysis request: August 24, 2016

Date analyzed by OUL: August 25, 2016

Included with certificate of analysis: Table of results,
copies of sample collection data sheets,
discrepancy sheet

Results for charcoal and water samples analyzed for the presence of fluorescein, eosine, 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 indicated otherwise.

OUL Number	Station Number	Station Name	Date/Time Placed	Date/Time Collected	Fluorescein		Eosine		RWT	
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)
B7250	1A	Jackson Blue Spring	7/14/16 0900	7/22/16 0840	ND		ND		567.4	24.4
B7251	1B	Jackson Blue Spring Back-up	7/14/16 0902	7/22/16 0842	ND		ND		568.2	8.51
B7252	2	Shangri-La Spring	7/14/16 0908	7/22/16 0909	ND		ND		567.2	10.6
B7253	3	Twin Caves Spring	7/14/16 0922	7/22/16 0920	ND		540.6	0.295	ND	
B7254	5	Hole-In-The-Wall Spring	7/14/16 1025	7/22/16 1006	ND		542.0	1.02	ND	
B7255	6	Hidey Hole Spring	7/14/16 0958	7/22/16 1045	ND		ND		ND	
B7256	7	Gator Hole Spring	7/14/16 1008	7/22/16 1050	ND		ND		ND	
B7259	1A	Jackson Blue Spring	Water	7/22/16 0840	ND		ND		ND	
B7260	Laboratory control water blank									
B7261	1B	Jackson Blue Spring Back-up	Water	7/22/16 0842	ND		ND		ND	
B7262	2	Shangri-La Spring	Water	7/22/16 0909	ND		ND		ND	

OUL Number	Station Number	Station Name	Date/Time Placed	Date/Time Collected	Fluorescein		Eosine		RWT	
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)
B7263	3	Twin Caves Spring	Water	7/22/16 0920	ND		ND		ND	
B7264	4	Indian Washtub Spring	Water	7/22/16 0924	ND		ND		ND	
B7265	5	Hole-In-The-Wall Spring	Water	7/22/16 1006	ND		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.

Footnote: ND = No dye detected

Thomas J. Aley, PHG and RG



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

OUL use only		<u>Please indicate stations where dye was visible in the field</u> for field technician use - use black ink only							OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER	STATION NAME	PLACED		COLLECTED		# WATER REC'D	
	Charcoal	1-4 Numbers		DATE	TIME	DATE	TIME		
2	B7250	1A	Jackson Blue Spring	7/14/16	0900	7/22/16	0840	1	
2	B7251	1B	Jackson Blue Spring Back-up	7/14/16	0902	7/22/16	0842	1	
2	B7252	2	Shangri-La Spring	7/14/16	0908	7/22/16	0909	1	
2	B7253	3	Twin Caves Spring	7/14/16	0922	7/22/16	0920	1	
0	—	4	Indian Washtub Spring – Sampler not found	7/14/16	0930	7/22/16	0924	1	
2	B7254	5	Hole-In-The-Wall Spring	7/14/16	1025	7/22/16	1006	1	
2	B7255	6	Hidey Hole Spring	7/14/16	0958	7/22/16	1045	1	
2	B7256	7	Gator Hole Spring	7/14/16	1008	7/22/16	1050	P	
			OUL project #1499. Analyzed, 8/25/16, by Lisa Gilcrease/OUL						
			(*) see discrepancy sheet						

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

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OZARK UNDERGROUND LABORATORY, INC.

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 6 Samples Collected By: B. Colona, J. Levy
 Samples Shipped By: T. Campbell, J. Levy Samples Received By: C. Alay / oul
 Date Samples Shipped: 08 / 02 / 16 Date Samples Received: 8 / 3 / 16 Time Samples Received: 13 : 15 Return Cooler? Yes ☒ No ☐
 Bill to: N/A Send Results to: B. Colona AECOM Tallahassee
 Analyze for: Fluorescein ☒ Eosine ☒ Rhodamine WT ☒ Other _____ Ship cooler to: B. Colona AECOM Tallahassee

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		
2	B7259	1A	Jackson Blue Spring	7/14/16	0900	7/22/16	0840	1	
2	B7261	1B	Jackson Blue Spring Back-up	7/14/16	0902	7/22/16	0842	1	
2	B7262	2	Shangri-La Spring	7/14/16	0908	7/22/16	0909	1	
2	B7263	3	Twin Caves Spring	7/14/16	0922	7/22/16	0920	1	
0	B7264	4	Indian Washtub Spring - Sampler not found	7/14/16	0930	7/22/16	0924	1	
2	B7265	5	Hole-In-The-Wall Spring	7/14/16	1025	7/22/16	1006	1	
2		6	Hidey Hole Spring	7/14/16	0958	7/22/16	1045	1	
2		7	Gator Hole Spring	7/14/16	1008	7/22/16	1050	1	
			B7260 - oul water blank						
			(*) see discrepancy sheet						

COMMENTS:

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

oul project # 1149. Analyzed 8/25/16 by
 Lisa Gilcrease/oul Page 1 of 3 of 4 oul

* Email received 8/24/16

Page 1 of 1

Date Rec'd by OUL: 8-3-16

Wk # 4 weeks

Day 3, 5, 6 & 10

[illegible]**Comments:**

(*) Email received from JS/oul noting Clients request to analyze week 16, "Hold", Samples. LG/oul



**Ozark
UNDERGROUND
LABORATORY**

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

Certificate of Analysis

Date of certificate: September 14, 2016

Client: AECOM

1625 Summit Lake Drive, Suite 200

Tallahassee, FL 32317

Project name / location: Jackson Blue Merritt's Mill Pond Dye Trace / Greenwood, Florida

Project number: URS Project Reference 60493736

Contact person: William.Colona@AECOM.com

Samples collected by: T. Campbell, J. Levy, B. Colona

Date samples shipped: September 6, 2016

Date samples rec'd at OUL: September 7, 2016

Date analyzed by OUL: September 12 and 14, 2016

Included with certificate of analysis: Table of results,
copies of sample collection data sheets, discrepancy
sheet and email from J. Levy dated September 6, 2016

Results for charcoal and water samples analyzed for the presence of fluorescein, eosine, 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		Eosine		RWT	
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)
B7656	1A	Jackson Blue Spring	7/22/16 0840	8/4/16 0844	514.6 *	0.311	ND		568.4	39.7
B7657	1B	Jackson Blue Spring Back-up	7/22/16 0842	8/4/16 0846	ND		ND		568.2	9.27
B7658	2	Shangri-La Spring	7/22/16 0909	8/4/16 0856	514.2 *	0.496	ND		568.3	88.2
B7659	5	Hole-In-The-Wall Spring	7/22/16 1006	8/4/16 0935	ND		542.0	0.779	ND	
B7660		Laboratory control charcoal blank								
B7661	6	Hidey Hole Spring	7/22/16 1045	8/4/16 0953	ND		ND		ND	
B7662	7	Gator Hole Spring	7/22/16 1050	8/4/16 1004	ND		ND		ND	
B7663	1A	Jackson Blue Spring	8/4/16 0844	8/19/16 0905	514.6 *	0.461	ND		568.3	40.0
B7664	1A	Jackson Blue Spring	8/19/16 0905	9/3/16 1130	515.0 *	0.328	ND		568.1	24.4
B7665	4	Indian Washtub Spring	8/4/16 1045	9/3/16 1103	ND		ND		566.6	2.39
B7715	1A	Jackson Blue Spring	water	8/4/16 0844	ND		ND		ND	
B7716	1B	Jackson Blue Spring Back-up	water	8/4/16 0846	ND		ND		ND	
B7717	2	Shangri-La Spring	water	8/4/16 0856	ND		ND		ND	
B7718	1A	Jackson Blue Spring	water	8/19/16 0905	ND		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.

Footnote: ND = No dye detected

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

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: Jackson Blue Springs Dye Trace Week No: Week 8 Samples Collected By: T. Campbell, J. Levy

Samples Shipped By: J. Levy Samples Received By: N/A N. Kelly / out

Date Samples Shipped: 09 / 06 / 16 Date Samples Received: 9 / 7 / 16 Time Samples Received: 13 : 00 Return Cooler? Yes ☒ No ☐

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: B. Colona AECOM Tallahassee

[illegible]

COMMENTS: Oil Charcoal Blank B 7660 OIL project # 1499 Analyzed 9/12/16 by Rebecca Co #10K
This sheet filled out by OUL staff? Yes No X Charts for samples on this page proofed by OUL: NC 10K

Page 1 of 3 /out

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

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: Jackson Blue Springs Dye Trace Week No: Week 10 Samples Collected By: T. Campbell, J. Levy, B. Colona

Samples Shipped By: J. Long Samples Received By: N/A N. Keith 1042

Date Samples Shipped: 09 / 06 / 16 Date Samples Received: 9 / 7 / 16 Time Samples Received: 13 : 00 Return Cooler? Yes ☐ No ☒

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: B. Colona AECOM Tallahassee

[illegible]

COMMENTS: OIL project # 1499 Analyzed 9/12/16 by Rebecca Scott/ken
This sheet filled out by OIL staff Yes

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

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: Jackson Blue Springs Dye Trace Week No: Week 12 Samples Collected By: J. Levy, B. Colona
 Samples Shipped By: J. Levy Samples Received By: N/A n. lath / oul
 Date Samples Shipped: 09 / 06 / 16 Date Samples Received: 9 / 7 / 16 Time Samples Received: 13 : 00 Return Cooler? Yes ☐ No ☐
 Bill to: N/A Send Results to: B. Colona AECOM Tallahassee
 Analyze for: Fluorescein ☒ Eosine ☒ Rhodamine WT ☒ Other _____ Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<i>Please indicate stations where dye was visible in the field</i> 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		
2	B7664	1A	Jackson Blue Spring	8/19/16	0905	9/03/16	1130	0	
2		1B	Jackson Blue Spring Back-up	8/19/16	0907	9/03/16	1126	0	
2		2	Shangri-La Spring	8/19/16	0922	9/03/16	1115	1	
2		3	Twin Caves Spring	8/19/16	0932	9/03/16	1056	0	
2	B7665	4	Indian Washtub Spring	8/04/16	1045	9/03/16	1103	0	
2		5	Hole-In-The-Wall Spring	8/19/16	1017	9/03/16	1006	0	
2		6	Hidey Hole Spring	8/19/16	1032	9/03/16	0954	0	
2		7	Gator Hole Spring	8/19/16	1040	9/03/16	0939	0	

COMMENTS: OUL project # 1499 Analyzed 9/12/16 by Rebecca Scott / oul

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

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

Project: Jackson Blue Springs Dye Trace Week No: Week 8 Samples Collected By: T. Campbell, J. Levy
 Samples Shipped By: J. Levy Samples Received By: N/A N. Galt / out
 Date Samples Shipped: 09 / 06 / 16 Date Samples Received: 9 / 7 / 16 Time Samples Received: 13 : 40 Return Cooler? Yes X No
 Bill to: N/A Send Results to: B. Colona AECOM Tallahassee
 Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

[illegible]

COMMENTS: Del Project 1499 Amalgized 9/14/16 by uhl/Del
This sheet filled out by OUL staff? Yes No Charts for samples on this page proofed by OUL: Ch
Page 1 of 3 (OUL)
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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Samples Collected By: T. Campbell, J. Levy, B. Colona

Samples Received By: N/A N. Keith 1041

Date Samples Received: 9 / 7 / 16

Time Samples Received: 13 : 00

Return Cooler? Yes ☐ No ☐

Bill to: N/A

Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____

Ship cooler to: B. Colona AECOM Tallahassee

[illegible]

COMMENTS: Analyzed 9/14/16 by MR/DEL

This sheet filled out by OUL staff Yes

No

Charts for samples on this page proofed by OUL:

Page 2 of 3 / over

Ozark Underground Laboratory, Inc.

DISCREPANCIES BETWEEN CHAIN-OF-CUSTODY SHEETS AND ACTUAL SAMPLES RECEIVED

Page 1 of 1

Company & Project Name: AECOM - Jackson Blue Springs

Date Rec'd by OUL: 9-7-16

Wk # 8-12[illegible]**Comments:**

Julie Stearman

From: Levy, Jack <Jack.Levy@aecom.com>
Sent: Tuesday, September 06, 2016 4:59 PM
To: jstearman@ozarkundergroundlab.com
Cc: Colona, William
Subject: Week 8, 10, and 12 Samples have been shipped

Ms. Stearman,

The samples from Week 8, 10, and 12 have been shipped. Please test:

- All six Week 8 Samples
- Jackson Blue (Station 1A) for Week 10 and Week 12
- Indian Washtub (Station 4) for Week 12

Please do not test the remaining samples until further notice.

Thank you.

Jack Levy
Environmental Business Unit Intern
Florida Environment Business Line
D 850-402-6423 C 954-881-9319
jack.levy@aecom.com

AECOM
1625 Summit Lake Dr #200, Tallahassee, FL 32317
T 850-574-3197
www.aecom.com

Certificate of Analysis

Date of certificate: October 14, 2016

Client: AECOM

1625 Summit Lake Drive, Suite 200

Tallahassee, FL 32317

Project name / location: Jackson Blue Merritt's Mill Pond Dye Trace / Greenwood, Florida

Project number: URS Project Reference 60493736

Contact person: William.Colona@AECOM.com

Samples collected by: T. Campbell, J. Levy, B. Colona

Date samples shipped: September 6, 2016

Date samples rec'd at OUL: September 7, 2016 and archived

Date of analysis request: October 11, 2016

Date analyzed by OUL: October 12 and 13, 2016

Included with certificate of analysis: Table of results,
copies of sample collection data sheets, discrepancy
sheet and email from J. Levy dated October 11, 2016

Results for charcoal and water samples analyzed for the presence of fluorescein, eosine, 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		Eosine		RWT	
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)
B7658D	2	Shangri-La Spring	7/22/16 0909	8/4/16 0856	514.4 *	0.365	ND		568	73.2
B8242	2	Shangri-La Spring	8/4/16 0856	8/19/16 0922	515.4 *	0.272	ND		567.2	37.0
B8243	3	Twin Caves Spring	8/4/16 1048	8/19/16 0932	ND		541.6 **	0.173	ND	
B8244	5	Hole-In-The-Wall Spring	8/4/16 0935	8/19/16 1017	ND		542.0 **	0.315	ND	
B8245	6	Hidey Hole Spring	8/4/16 0953	8/19/16 1032	ND		ND		ND	
B8246	7	Gator Hole Spring	8/4/16 1004	8/19/16 1040	ND		ND		ND	
B8247	2	Shangri-La Spring	8/19/16 0922	9/3/16 1115	513.6 *	0.241	ND		567.8	11.8
B8248	3	Twin Caves Spring	8/19/16 0932	9/3/16 1056	ND		542.4 **	0.169	ND	
B8249	5	Hole-In-The-Wall Spring	8/19/16 1017	9/3/16 1006	ND		ND		ND	
B8250	6	Hidey Hole Spring	8/19/16 1032	9/3/16 0954	ND		ND		ND	
B8251	7	Gator Hole Spring	8/19/16 1040	9/3/16 0939	ND		ND		ND	

OUL Number	Station Number	Station Name	Date/Time Placed	Date/Time Collected	Fluorescein		Eosine		RWT	
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)
B8292	2	Shangri-La Spring	Water	8/19/16 0922	ND		ND		ND	
B8293	2	Shangri-La Spring	Water	9/3/16 1115	ND		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.

Footnote: ND = No dye detected

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

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

Thomas J. Aley, PHG and RG



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

Dye Trace Week No: Week 8 Samples Collected By: T. Campbell

Samples Shipped By: J. Levy Samples Received By: N/A N. Keith /oul

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein ☒ Eosine ☒ Rhodamine WT ☒ Other ☐ Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<u>Please indicate stations where dye was visible in the field</u> 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	
2		1A	Jackson Blue Spring	7/22/16	0840	8/04/16	0844	1
2		1B	Jackson Blue Spring Back-up	7/22/16	0842	8/04/16	0846	1
2	B7658D	2	Shangri-La Spring (*)	7/22/16	0909	8/04/16	0856	1
2		5	Hole-In-The-Wall Spring	7/22/16	1006	8/04/16	0935	1
2		6	Hidey Hole Spring	7/22/16	1045	8/04/16	0953	1
2		7	Gator Hole Spring	7/22/16	1050	8/04/16	1004	1
0		3	Twin Caves Spring - nr			8/04/16	0908	1
			(*) See OUL discrepancy Sheet.					
			OUL project #1499 Analyzed 10/13/16 by MR/OUL					

COMMENTS:

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

Page 1 of 3 /out

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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

Dye Trace Week No: Week 10 Samples Collected By: T. Campbell

Samples Shipped By: J. Lony Samples Received By: N/A N. Keith 10/02

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: B. Colona AECOM Tallahassee

[illegible]

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

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Samples Shipped By: J. Levy Samples Received By: N/A N. Kelt 10/11

Samples Shipped By: J. Levy Samples Received By: N/A N. Kelt 10/11

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: B. Colona AECOM Tallahassee

[illegible]

COMMENTS:

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

Page 1 of 1

3 of 3 / out

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Samples Shipped By: J. Lony Samples Received By: N/A N. Keith 10/42

Date Samples Shipped: 09 / 06 / 16 Date Samples Received: 9 / 7 / 16 Time Samples Received: 13 : 00 Return Cooler? Yes ☐ No ☐

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: B. Colona AECOM Tallahassee

[illegible]**COMMENTS:**

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

Page 2 of 3 / ou

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Dye Trace Week No: Week 12 Samples Collected By: J Levy

Samples Shipped By: J. Levy Samples Received By: N/A n. lath / am

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: B. Colona AECOM Tallahassee

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

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

Page 1 of 3
3 of 3 / out

Ozark Underground Laboratory, Inc.

DISCREPANCIES BETWEEN CHAIN-OF-CUSTODY SHEETS AND ACTUAL SAMPLES RECEIVED						Page <u>1</u> of <u>1</u>
Company & Project Name: <u>AECOM - Jackson Blue Springs</u>				Date Rec'd by OUL: <u>9-7-16</u>		Wk # <u> </u>
Lab #	Sta #	Station Name	Date Pulled	Problem	Solution	
	3	Twin Caves Spring	8/04/16	Water vial only - not listed on Coc	Added to Coc by OUL Staff	
	3	Twin Caves Spring	8/19/16	Placed time on Sample is 0908. Placed time on Coc is 1048		
	5	Hole-In-The-Wall Spring	8/19/16	Placed time on Sample is 1048. Placed time on Coc is 0935		
10/12/16		Shangri-La Spring	8/4/16	No second packet for Shangri-La Spring (*) Packet found by OUL on 10/12. Analyzed 10/13 (*)	Email received 10/11/16 requesting 2nd chemical packet analyzed. - No packet was available to analyze as / MUR.	
Comments:						

Tom Aley

From: Levy, Jack <Jack.Levy@aecom.com>
Sent: Tuesday, October 11, 2016 11:13 AM
To: Julie Stearman; taley@ozarkundergroundlab.com
Cc: Colona, William
Subject: Testing Additional Samples - Jackson Blue

Ms. Stearman and Mr. Aley,

Please test the following stations from the Week 10 and 12 samples:

- Station 2 (Shangri-La)
- Station 3 (Twin Caves)
- Station 5 (Hole-In-The-Wall)
- Station 6 (Hidey Hole)
- Station 7 (Gator Hole)

Please also test the second charcoal packet from Week 8 for Station 2 (Shangri-La).

Thank you.

Jack Levy
Environmental Business Unit Intern
Florida Environment Business Line
D 850-402-6423 C 954-881-9319
jack.levy@aecom.com

AECOM
1625 Summit Lake Dr #200, Tallahassee, FL 32317
T 850-574-3197
www.aecom.com

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace **Week No:** BG Week 1 **Samples Collected By:** B. Colona, J. Levy

Samples Shipped By: N/A **Samples Received By:** N/A

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

Bill to: N/A **Send Results to:** N/A

Analyze for: Fluorescein ☒ Eosine ☒ Rhodamine WT ☒ Other ☐ **Ship cooler to:** N/A

[illegible]

COMMENTS: _____

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

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Samples Shipped By: N/A **Samples Received By:** N/A

Bill to: N/A **Send Results to:** N/A

Analyze for: Fluorescein ☒ Eosine ☒ Rhodamine WT ☒ Other ☐ **Ship cooler to:** N/A

[illegible]

COMMENTS:

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

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Bill to: N/A **Send Results to:** N/A

Analyze for: Fluorescein ☒ Eosine ☒ Rhodamine WT ☒ Other _____ **Ship cooler to:** _____ N/A

[illegible]

COMMENTS: _____

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Day 3 Samples Collected By: B. Colona, J. Levy
 Samples Shipped By: T. Campbell, J. Levy Samples Received By: N/A
 Date Samples Shipped: 08 / 02 / 16 Date Samples Received: / / Time Samples Received: : Return Cooler? Yes X No
 Bill to: N/A Send Results to: B. Colona AECOM Tallahassee
 Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

<i>OUL use only</i>		<u>Please indicate stations where dye was visible in the field</u> <i>for field technician use - use black ink only</i>							<i>OUL use only</i>
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D	
				DATE	TIME	DATE	TIME		
		1A	Jackson Blue Spring	6/8/16	1522	6/12/16	0916		

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

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Bill to: N/A **Send Results to:** N/A

Analyze for: Fluorescein ☒ Eosine ☒ Rhodamine WT ☒ Other ☐ **Ship cooler to:** N/A

[illegible]

COMMENTS: _____

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

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Day 10 Samples Collected By: B. Colona, J. Levy

Samples Shipped By: T. Campbell, J. Levy Samples Received By: N/A

Date Samples Shipped: 08 / 02 / 16 **Date Samples Received:** / / **Time Samples Received:** : **Return Cooler?** Yes X No

Bill to: N/A **Send Results to:** B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other **Ship cooler to: B. Colona AECOM Tallahassee**

[illegible]

COMMENTS:

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Samples Shipped By: N/A **Samples Received By:** N/A

Bill to: N/A **Send Results to:** N/A

Analyze for: Fluorescein ☒ Eosine ☒ Rhodamine WT ☒ Other ☐ **Ship cooler to:** N/A

[illegible]

COMMENTS:

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

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 1 Samples Collected By: B. Colona, J. Levy, T. Campbell

Samples Shipped By: J. Levy Samples Received By: _____

Date Samples Shipped: 07/ 13 / 2016 Date Samples Received: / / Time Samples Received: : Return Cooler? Yes X No

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<i>Please indicate stations where dye was visible in the field</i> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	6/12/16	0916	6/16/16	0939	
		1B	Jackson Blue Spring Back-up	6/12/16	0922	6/16/16	0933	
		2	Shangri-La Spring	6/12/16	0932	6/16/16	1001	
		3	Twin Caves Spring	6/9/16	1600	6/16/16	1024	
		4	Indian Washtub Spring	6/12/16	0949	6/16/16	1044	
		5	Hole-In-The-Wall Spring	6/12/16	1022	6/16/16	0912	
		6	Hidey Hole Spring	6/12/16	1051	6/16/16	1117	
		7	Gator Hole Spring	6/12/16	1037	6/16/16	1130	

COMMENTS: _____
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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Analyze for:	Fluorescein	X	Eosine	X	Rhodamine WT	X	Other	Ship cooler to:	N/A
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[illegible]

COMMENTS: _____

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 2 Samples Collected By: B. Colona, J. Levy, T. Campbell

Samples Shipped By: J. Levy Samples Received By: _____

Date Samples Shipped: 07/ 13 / 2016 Date Samples Received: / / Time Samples Received: : Return Cooler? Yes X No

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<u>Please indicate stations where dye was visible in the field</u> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	6/19/16	0930	6/23/16	0905	
		1B	Jackson Blue Spring Back-up	6/19/16	0940	6/23/16	0907	
		2	Shangri-La Spring	6/19/16	0942	6/23/16	0915	
		3	Twin Caves Spring	6/19/16	1004	6/23/16	0925	
		4	Indian Washtub Spring	6/19/16	1018	6/23/16	0935	
		5	Hole-In-The-Wall Spring	6/19/16	1038	6/23/16	0953	
		6	Hidey Hole Spring	6/19/16	1120	6/23/16	1018	
		7	Gator Hole Spring	6/19/16	1106	6/23/16	1035	

COMMENTS: _____

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace **Week No:** Week 3 **Samples Collected By:** J. Levy, T. Campbell

Samples Shipped By: N/A **Samples Received By:** N/A

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

Bill to: N/A **Send Results to:** N/A

Analyze for: Fluorescein ☒ Eosine ☒ Rhodamine WT ☒ Other ☐ **Ship cooler to:** N/A

[illegible]

COMMENTS: _____

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

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 3 Samples Collected By: B. Colona, J. Levy, T. Campbell

Samples Shipped By: J. Levy Samples Received By: _____

Date Samples Shipped: 07/ 13 / 2016 Date Samples Received: / / Time Samples Received: : Return Cooler? Yes X No

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<i>Please indicate stations where dye was visible in the field</i> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	6/23/16	0905	6/30/16	0905	
		1B	Jackson Blue Spring Back-up	6/23/16	0907	6/30/16	0910	
		2	Shangri-La Spring	6/23/16	0915	6/30/16	0922	
		3	Twin Caves Spring	6/23/16	0925	6/30/16	0934	
		4	Indian Washtub Spring	6/23/16	0935	6/30/16	0944	
		5	Hole-In-The-Wall Spring	6/23/16	0953	6/30/16	1007	
		6	Hidey Hole Spring	6/23/16	1018	6/30/16	1028	
		7	Gator Hole Spring	6/23/16	1035	6/30/16	1040	

COMMENTS: _____

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

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Bill to: N/A **Send Results to:** N/A

Analyze for: Fluorescein ☒ Eosine ☒ Rhodamine WT ☒ Other ☐ **Ship cooler to:** N/A

[illegible]

COMMENTS: _____

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

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 4 Samples Collected By: J. Levy, T. Campbell

Samples Shipped By: J. Levy Samples Received By: _____

Date Samples Shipped: 07/ 13 / 2016 Date Samples Received: / / Time Samples Received: : Return Cooler? Yes X No

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<i>Please indicate stations where dye was visible in the field</i> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	6/30/16	0905	7/7/16	0910	
		1B	Jackson Blue Spring Back-up	6/30/16	0910	7/7/16	0912	
		2	Shangri-La Spring	6/30/16	0922	7/7/16	0925	
		3	Twin Caves Spring	6/30/16	0934	7/7/16	0943	
		4	Indian Washtub Spring	6/30/16	0944	7/7/16	0952	
		5	Hole-In-The-Wall Spring	6/30/16	1007	7/7/16	1009	
		6	Hidey Hole Spring	6/30/16	1028	7/7/16	1043	
		7	Gator Hole Spring	6/30/16	1040	7/7/16	1052	

COMMENTS: _____

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

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 5 Samples Collected By: J. Levy, T. Campbell
 Samples Shipped By: N/A Samples Received By: N/A
 Date Samples Shipped: / / Date Samples Received: / / Time Samples Received: : Return Cooler? Yes No
 Bill to: N/A Send Results to: N/A
 Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: N/A

OUL use only		<u>Please indicate stations where dye was visible in the field</u> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	7/7/16	0910	7/14/16	0900	
		1B	Jackson Blue Spring Back-up	7/7/16	0912	7/14/16	0902	
		2	Shangri-La Spring	7/7/16	0925	7/14/16	0908	
		3	Twin Caves Spring	7/7/16	0943	7/14/16	0922	
		4	Indian Washtub Spring	7/7/16	0952	7/14/16	0930	
		5	Hole-In-The-Wall Spring	7/7/16	1009	7/14/16	1025	
		6	Hidey Hole Spring	7/7/16	1043	7/14/16	0958	
		7	Gator Hole Spring	7/7/16	1052	7/14/16	1008	
		8	MMP Mid Pond Control	7/7/16	1031	7/14/16	0953	
		9	MMP End Pond Control	7/7/16	0826	7/14/16	0812	
		10	Pelt Swallet Input Control	7/7/16	0815	7/14/16	0800	

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

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 5 Samples Collected By: J. Levy, T. Campbell
 Samples Shipped By: J. Levy, T. Campbell Samples Received By: N/A
 Date Samples Shipped: 08 / 02 / 16 Date Samples Received: / / Time Samples Received: : Return Cooler? Yes X No
 Bill to: N/A Send Results to: B. Colona AECOM Tallahassee
 Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<i>Please indicate stations where dye was visible in the field</i> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	7/7/16	0910	7/14/16	0900	
		1B	Jackson Blue Spring Back-up	7/7/16	0912	7/14/16	0902	
		2	Shangri-La Spring	7/7/16	0925	7/14/16	0908	
		3	Twin Caves Spring	7/7/16	0943	7/14/16	0922	
		4	Indian Washtub Spring	7/7/16	0952	7/14/16	0930	
		5	Hole-In-The-Wall Spring	7/7/16	1009	7/14/16	1025	
		6	Hidey Hole Spring	7/7/16	1043	7/14/16	0958	
		7	Gator Hole Spring	7/7/16	1052	7/14/16	1008	

COMMENTS: _____
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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 6 Samples Collected By: B. Colona, J. Levy
 Samples Shipped By: N/A Samples Received By: N/A
 Date Samples Shipped: ___/___/___ Date Samples Received: ___/___/___ Time Samples Received: ___:___ Return Cooler? Yes ___ No ___
 Bill to: N/A Send Results to: N/A
 Analyze for: Fluorescein X Eosine X Rhodamine WT X Other _____ Ship cooler to: N/A

OUL use only		<u>Please indicate stations where dye was visible in the field</u> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	7/14/16	0900	7/22/16	0840	
		1B	Jackson Blue Spring Back-up	7/14/16	0902	7/22/16	0842	
		2	Shangri-La Spring	7/14/16	0908	7/22/16	0909	
		3	Twin Caves Spring	7/14/16	0922	7/22/16	0920	
		4	Indian Washtub Spring – Sampler not found	7/14/16	0930	7/22/16	0924	
		5	Hole-In-The-Wall Spring	7/14/16	1025	7/22/16	1006	
		6	Hidey Hole Spring	7/14/16	0958	7/22/16	1045	
		7	Gator Hole Spring	7/14/16	1008	7/22/16	1050	
		8	MMP Mid Pond Control	7/14/16	0953	7/22/16	1038	
		9	MMP End Pond Control	7/14/16	0812	7/22/16	0755	
		10	Pelt Swallet Input Control	7/14/16	0800	7/22/16	0740	

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

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: Jackson Blue Springs Dye Trace Week No: Week 6 Samples Collected By: B. Colona, J. Levy
 Samples Shipped By: T. Campbell, J. Levy Samples Received By: N/A
 Date Samples Shipped: 08/02/16 Date Samples Received: / / Time Samples Received: : Return Cooler? Yes X No
 Bill to: N/A Send Results to: B. Colona AECOM Tallahassee
 Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<u>Please indicate stations where dye was visible in the field</u> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	7/14/16	0900	7/22/16	0840	
		1B	Jackson Blue Spring Back-up	7/14/16	0902	7/22/16	0842	
		2	Shangri-La Spring	7/14/16	0908	7/22/16	0909	
		3	Twin Caves Spring	7/14/16	0922	7/22/16	0920	
		4	Indian Washtub Spring – Sampler not found	7/14/16	0930	7/22/16	0924	
		5	Hole-In-The-Wall Spring	7/14/16	1025	7/22/16	1006	
		6	Hidey Hole Spring	7/14/16	0958	7/22/16	1045	
		7	Gator Hole Spring	7/14/16	1008	7/22/16	1050	

COMMENTS: _____
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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 8 Samples Collected By: T. Campbell, J. Levy
 Samples Shipped By: N/A Samples Received By: N/A
 Date Samples Shipped: 09 / 06 / 16 Date Samples Received: / / Time Samples Received: : Return Cooler? Yes X No
 Bill to: N/A Send Results to: B. Colona AECOM Tallahassee
 Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<u>Please indicate stations where dye was visible in the field</u> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	7/22/16	0840	8/04/16	0844	
		1B	Jackson Blue Spring Back-up	7/22/16	0842	8/04/16	0846	
		2	Shangri-La Spring	7/22/16	0909	8/04/16	0856	
		3	Twin Caves Spring – Sampler not recovered, only water sample	7/22/16	0920	8/04/16	0908	
		4	Indian Washtub Spring – Sampler not recovered, only water sample	7/14/16	0930	8/04/16	1045	
		5	Hole-In-The-Wall Spring	7/22/16	1006	8/04/16	0935	
		6	Hidey Hole Spring	7/22/16	1045	8/04/16	0953	
		7	Gator Hole Spring	7/22/16	1050	8/04/16	1004	
		8	MMP Mid Pond Control	7/22/16	1038	8/04/16	0944	
		9	MMP End Pond Control	7/22/16	0755	8/04/16	0753	
		10	Pelt Swallet Input Control	7/22/16	0740	8/04/16	0740	

COMMENTS: _____
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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 8 Samples Collected By: T. Campbell, J. Levy

Samples Shipped By: _____ Samples Received By: N/A

Date Samples Shipped: 09 / 06 / 16 Date Samples Received: / / Time Samples Received: : Return Cooler? Yes X No

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<u>Please indicate stations where dye was visible in the field</u> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	7/22/16	0840	8/04/16	0844	
		1B	Jackson Blue Spring Back-up	7/22/16	0842	8/04/16	0846	
		2	Shangri-La Spring	7/22/16	0909	8/04/16	0856	
		5	Hole-In-The-Wall Spring	7/22/16	1006	8/04/16	0935	
		6	Hidey Hole Spring	7/22/16	1045	8/04/16	0953	
		7	Gator Hole Spring	7/22/16	1050	8/04/16	1004	

COMMENTS: _____

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Bill to: N/A **Send Results to:** N/A

Analyze for: **Fluorescein** X **Eosine** X **Rhodamine WT** X **Other** _____ **Ship cooler to:** _____ N/A

[illegible]

COMMENTS: _____

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 10 Samples Collected By: T. Campbell, J. Levy, B. Colona

Samples Shipped By: _____ Samples Received By: N/A

Date Samples Shipped: 09 / 06 / 16 Date Samples Received: / / Time Samples Received: : Return Cooler? Yes No

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<u>Please indicate stations where dye was visible in the field</u> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	8/04/16	0844	8/19/16	0905	
		1B	Jackson Blue Spring Back-up	8/04/16	0846	8/19/16	0907	
		2	Shangri-La Spring	8/04/16	0856	8/19/16	0922	
		3	Twin Caves Spring	8/04/16	1048	8/19/16	0932	
		5	Hole-In-The-Wall Spring	8/04/16	0935	8/19/16	1017	
		6	Hidey Hole Spring	8/04/16	0953	8/19/16	1032	
		7	Gator Hole Spring	8/04/16	1004	8/19/16	1040	

COMMENTS: _____

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 12 Samples Collected By: J. Levy, B. Colona

Samples Shipped By: _____ Samples Received By: N/A

Date Samples Shipped: 09 / 06 / 16 Date Samples Received: / / Time Samples Received: : Return Cooler? Yes No

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<u>Please indicate stations where dye was visible in the field</u> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	8/19/16	0905	9/03/16	1130	
		1B	Jackson Blue Spring Back-up	8/19/16	0907	9/03/16	1126	
		2	Shangri-La Spring	8/19/16	0922	9/03/16	1115	
		3	Twin Caves Spring	8/19/16	0932	9/03/16	1056	
		4	Indian Washtub Spring	8/04/16	1045	9/03/16	1103	
		5	Hole-In-The-Wall Spring	8/19/16	1017	9/03/16	1006	
		6	Hidey Hole Spring	8/19/16	1032	9/03/16	0954	
		7	Gator Hole Spring	8/19/16	1040	9/03/16	0939	
		8	MMP Mid Pond Control	8/19/16	1024	9/03/16	0928	
		9	MMP End Pond Control	8/19/16	0810	9/03/16	0832	
		10	Pelt Swallet Input Control	8/19/16	0755	9/03/16	0818	

COMMENTS: _____

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SAMPLE COLLECTION DATA SHEET for FLUORESCENCE ANALYSIS

Project: Jackson Blue Springs Dye Trace Week No: Week 12 Samples Collected By: J. Levy, B. Colona

Samples Shipped By: _____ Samples Received By: N/A

Date Samples Shipped: 09 / 06 / 16 Date Samples Received: / / Time Samples Received: : Return Cooler? Yes No

Bill to: N/A Send Results to: B. Colona AECOM Tallahassee

Analyze for: Fluorescein X Eosine X Rhodamine WT X Other Ship cooler to: B. Colona AECOM Tallahassee

OUL use only		<u>Please indicate stations where dye was visible in the field</u> <i>for field technician use - use black ink only</i>						OUL use only
# CHAR REC'D	LAB NUMBER	STATION NUMBER 1-4 Numbers	STATION NAME	PLACED		COLLECTED		# WATER REC'D
				DATE	TIME	DATE	TIME	
		1A	Jackson Blue Spring	8/19/16	0905	9/03/16	1130	
		1B	Jackson Blue Spring Back-up	8/19/16	0907	9/03/16	1126	
		2	Shangri-La Spring	8/19/16	0922	9/03/16	1115	
		3	Twin Caves Spring	8/19/16	0932	9/03/16	1056	
		4	Indian Washtub Spring	8/04/16	1045	9/03/16	1103	
		5	Hole-In-The-Wall Spring	8/19/16	1017	9/03/16	1006	
		6	Hidey Hole Spring	8/19/16	1032	9/03/16	0954	
		7	Gator Hole Spring	8/19/16	1040	9/03/16	0939	

COMMENTS: _____

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APPENDIX G

Laboratory Analytical Results for Charcoal and Water Samples

Client: AECOM

1625 Summit Lake Drive, Suite 200

Tallahassee, FL 32317

Project name / location: Jackson Blue Merritt's Mill Pond Dye Trace / Greenwood, Florida

Project number: URS Project Reference 60493736

Contact person: William.Colona@AECOM.com

Results for charcoal samplers analyzed for the presence of fluorescein, eosine, 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 Placed	Date/Time Collected	Fluorescein		Eosine		Conc. per day	RWT		Conc. per day
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)		Peak (nm)	Conc (ppb)	
B6894	1A	Jackson Blue Spring	6/8/16 1522	6/12/16 0916	ND		ND			ND		
B5792	1A	Jackson Blue Spring	6/12/16 0916	6/16/16 0939	ND		ND			569.0	32.0	7.97
B5801	1A	Jackson Blue Spring	6/19/16 0930	6/23/16 0905	ND		ND			568.6	126	31.6
B5809	1A	Jackson Blue Spring	6/23/16 0905	6/30/16 0905	ND		ND			568.2	53.0	7.57
B5817	1A	Jackson Blue Spring	6/30/16 0905	7/7/16 0910	ND		ND			568.6	69.9	9.98
B6895	1A	Jackson Blue Spring	7/7/16 0910	7/14/16 0900	ND		ND			567.2	31.7	4.53
B7250	1A	Jackson Blue Spring	7/14/16 0900	7/22/16 0840	ND		ND			567.4	24.4	3.05
B7656	1A	Jackson Blue Spring	7/22/16 0840	8/4/16 0844	514.6 *	0.311	ND			568.4	39.7	3.05
B7663	1A	Jackson Blue Spring	8/4/16 0844	8/19/16 0905	514.6 *	0.461	ND			568.3	40.0	2.67
B7664	1A	Jackson Blue Spring	8/19/16 0905	9/3/16 1130	515.0 *	0.328	ND			568.1	24.4	1.62
B5793	1B	Jackson Blue Spring Back-up	6/12/16 0922	6/16/16 0933	ND		ND			568.4	6.46	1.61
B5802	1B	Jackson Blue Spring Back-up	6/19/16 0940	6/23/16 0907	ND		ND			568.6	23.3	5.84
B5810	1B	Jackson Blue Spring Back-up	6/23/16 0907	6/30/16 0910	ND		ND			568.2	28.7	4.10
B5818	1B	Jackson Blue Spring Back-up	6/30/16 0910	7/7/16 0912	ND		ND			569.0	18.5	2.64
B6896	1B	Jackson Blue Spring Back-up	7/7/16 0912	7/14/16 0902	ND		ND			568.4	12.1	1.73
B7251	1B	Jackson Blue Spring Back-up	7/14/16 0902	7/22/16 0842	ND		ND			568.2	8.51	1.07
B7657	1B	Jackson Blue Spring Back-up	7/22/16 0842	8/4/16 0846	ND		ND			568.2	9.27	0.713
B5794	2	Shangri-La Spring	6/12/16 0932	6/16/16 1001	ND		ND			ND		
B6904	2	Shangri-La Spring	6/16/16 1001	6/19/16 0942	ND		ND			569.0	12.1	4.03
B5803	2	Shangri-La Spring	6/19/16 0942	6/23/16 0915	ND		ND			568.6	84.6	21.3
B5811	2	Shangri-La Spring	6/23/16 0915	6/30/16 0922	ND		ND			568.6	61.8	8.82
B5819	2	Shangri-La Spring	6/30/16 0922	7/7/16 0925	ND		ND			568.8	35.5	5.08

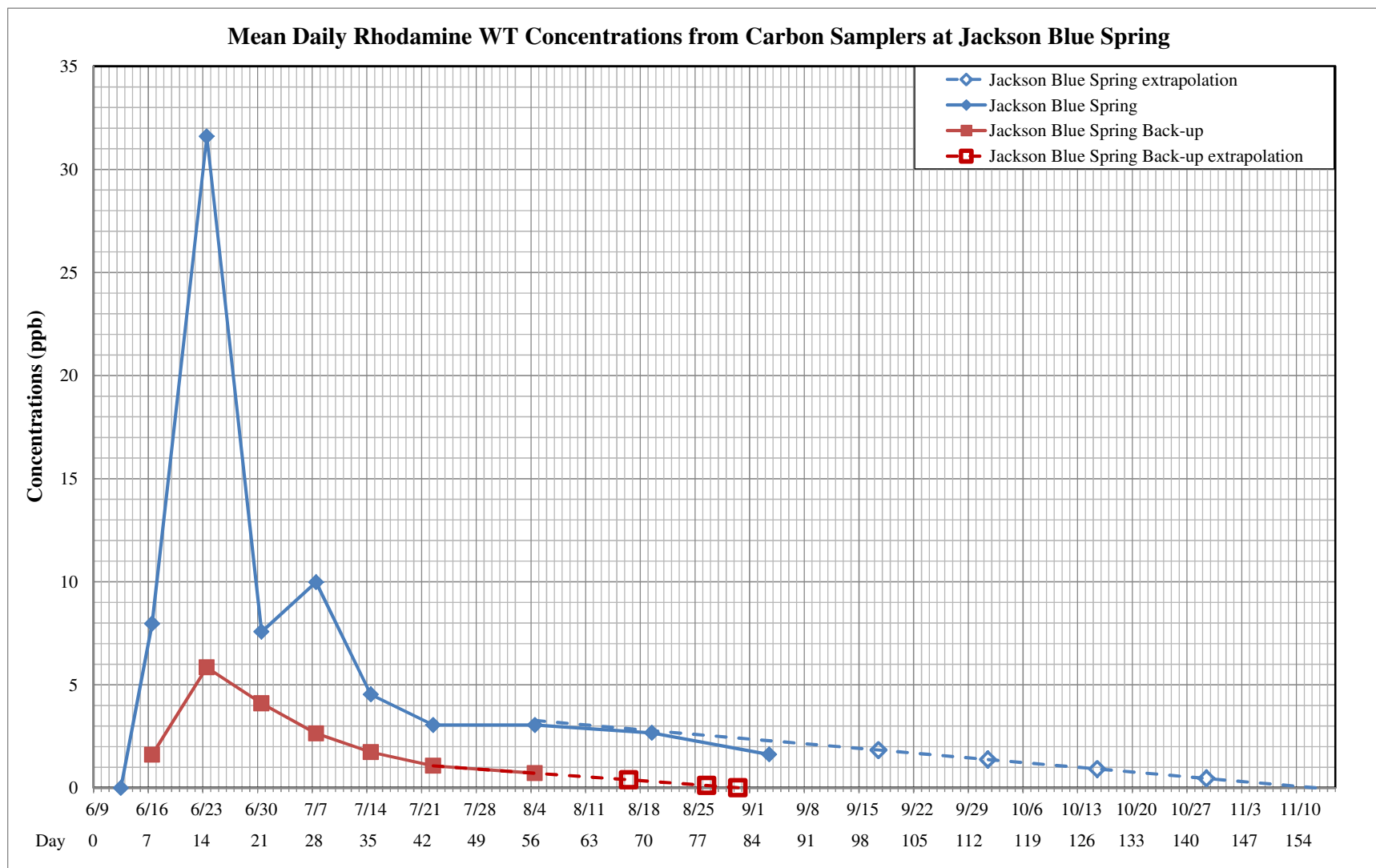
OUL Number	Station Number	Station Name	Date/Time Placed	Date/Time Collected	Fluorescein		Eosine		Conc. per day	RWT		Conc. per day
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)		Peak (nm)	Conc (ppb)	
B6897	2	Shangri-La Spring	7/7/16 0925	7/14/16 0908	ND		ND			568.2	38.0	5.43
B7252	2	Shangri-La Spring	7/14/16 0908	7/22/16 0909	ND		ND			567.2	10.6	1.33
B7658	2	Shangri-La Spring	7/22/16 0909	8/4/16 0856	514.2 *	0.496	ND			568.3	88.2	6.79
B7658D	2	Shangri-La Spring	7/22/16 0909	8/4/16 0856	514.4 *	0.365	ND			568.0	73.2	5.63
B8242	2	Shangri-La Spring	8/4/16 0856	8/19/16 0922	515.4 *	0.272	ND			567.2	37.0	2.46
B8247	2	Shangri-La Spring	8/19/16 0922	9/3/16 1115	513.6 *	0.241	ND			567.8	11.8	0.778
B5795	3	Twin Caves Spring	6/9/16 1600	6/16/16 1024	ND		ND			ND		
B6905	3	Twin Caves Spring	6/16/16 1024	6/19/16 1004	ND		ND			ND		
B6905D	3	Twin Caves Spring	6/16/16 1024	6/19/16 1004	ND		ND			ND		
B5804	3	Twin Caves Spring	6/19/16 1004	6/23/16 0925	ND		542.4	0.298	0.075	ND		
B5812	3	Twin Caves Spring	6/23/16 0925	6/30/16 0934	ND		542.0	1.72	0.245	ND		
B5821	3	Twin Caves Spring	6/30/16 0934	7/7/16 0943	ND		541.6	1.22	0.174	ND		
B6898	3	Twin Caves Spring	7/7/16 0943	7/14/16 0922	ND		541.2	0.854	0.122	ND		
B7253	3	Twin Caves Spring	7/14/16 0922	7/22/16 0920	ND		540.6	0.295	0.037	ND		
B8243	3	Twin Caves Spring	8/4/16 1048	8/19/16 0932	ND		541.6 **	0.173	0.012	ND		
B8248	3	Twin Caves Spring	8/19/16 0932	9/3/16 1056	ND		542.4 **	0.169	0.011	ND		
B6906	3	Twin Caves Spring 2	6/12/16 NT	6/19/16 NT	ND		ND			ND		
B6906D	3	Twin Caves Spring 2	6/12/16 NT	6/19/16 NT	ND		ND			ND		
B5796	4	Indian Washtub Spring	6/12/16 0949	6/16/16 1044	ND		ND			ND		
B5805	4	Indian Washtub Spring	6/19/16 1018	6/23/16 0935	ND		ND			ND		
B5813	4	Indian Washtub Spring	6/23/16 0935	6/30/16 0944	ND		ND			567.8	1.57	0.224
B5822	4	Indian Washtub Spring	6/30/16 0944	7/7/16 0952	ND		ND			567.4	3.62	0.517
B6899	4	Indian Washtub Spring	7/7/16 0952	7/14/16 0930	ND		ND			567.6	2.00	0.286
B7665	4	Indian Washtub Spring	8/4/16 1045	9/3/16 1103	ND		ND			566.6	2.39	0.080
B5797	5	Hole-In-The-Wall Spring	6/12/16 1022	6/16/16 0912	ND		ND			ND		
B5806	5	Hole-In-The-Wall Spring	6/19/16 1038	6/23/16 0953	ND		ND			ND		
B5814	5	Hole-In-The-Wall Spring	6/23/16 0953	6/30/16 1007	ND		542.0	0.292	0.042	ND		
B5823	5	Hole-In-The-Wall Spring	6/30/16 1007	7/7/16 1009	ND		542.2	0.722	0.103	ND		
B6901	5	Hole-In-The-Wall Spring	7/7/16 1009	7/14/16 1025	ND		541.6	0.533	0.076	ND		
B7254	5	Hole-In-The-Wall Spring	7/14/16 1025	7/22/16 1006	ND		542.0	1.02	0.128	ND		
B7659	5	Hole-In-The-Wall Spring	7/22/16 1006	8/4/16 0935	ND		542.0	0.779	0.060	ND		

OUL Number	Station Number	Station Name	Date/Time Placed	Date/Time Collected	Fluorescein		Eosine		Conc.	RWT		Conc.
					Peak (nm)	Conc (ppb)	Peak (nm)	Conc (ppb)	per day	Peak (nm)	Conc (ppb)	per day
B8244	5	Hole-In-The-Wall Spring	8/4/16 0935	8/19/16 1017	ND		542.0 **	0.315	0.021	ND		
B8249	5	Hole-In-The-Wall Spring	8/19/16 1017	9/3/16 1006	ND		ND			ND		
B5798	6	Hidey Hole Spring	6/12/16 1051	6/16/16 1117	ND		ND			ND		
B5807	6	Hidey Hole Spring	6/19/16 1120	6/23/16 1018	ND		ND			ND		
B5815	6	Hidey Hole Spring	6/23/16 1018	6/30/16 1028	ND		ND			ND		
B5824	6	Hidey Hole Spring	6/30/16 1028	7/7/16 1043	ND		ND			ND		
B6902	6	Hidey Hole Spring	7/7/16 1043	7/14/16 0958	ND		ND			ND		
B7255	6	Hidey Hole Spring	7/14/16 0958	7/22/16 1045	ND		ND			ND		
B7661	6	Hidey Hole Spring	7/22/16 1045	8/4/16 0953	ND		ND			ND		
B8245	6	Hidey Hole Spring	8/4/16 0953	8/19/16 1032	ND		ND			ND		
B8250	6	Hidey Hole Spring	8/19/16 1032	9/3/16 0954	ND		ND			ND		
B5799	7	Gator Hole Spring	6/12/16 1037	6/16/16 1130	ND		ND			ND		
B5808	7	Gator Hole Spring	6/19/16 1106	6/23/16 1035	ND		ND			ND		
B5816	7	Gator Hole Spring	6/23/16 1035	6/30/16 1040	ND		ND			ND		
B5825	7	Gator Hole Spring	6/30/16 1040	7/7/16 1052	ND		ND			ND		
B6903	7	Gator Hole Spring	7/7/16 1052	7/14/16 1008	ND		ND			ND		
B7256	7	Gator Hole Spring	7/14/16 1008	7/22/16 1050	ND		ND			ND		
B7662	7	Gator Hole Spring	7/22/16 1050	8/4/16 1004	ND		ND			ND		
B8246	7	Gator Hole Spring	8/4/16 1004	8/19/16 1040	ND		ND			ND		
B8251	7	Gator Hole Spring	8/19/16 1040	9/3/16 0939	ND		ND			ND		

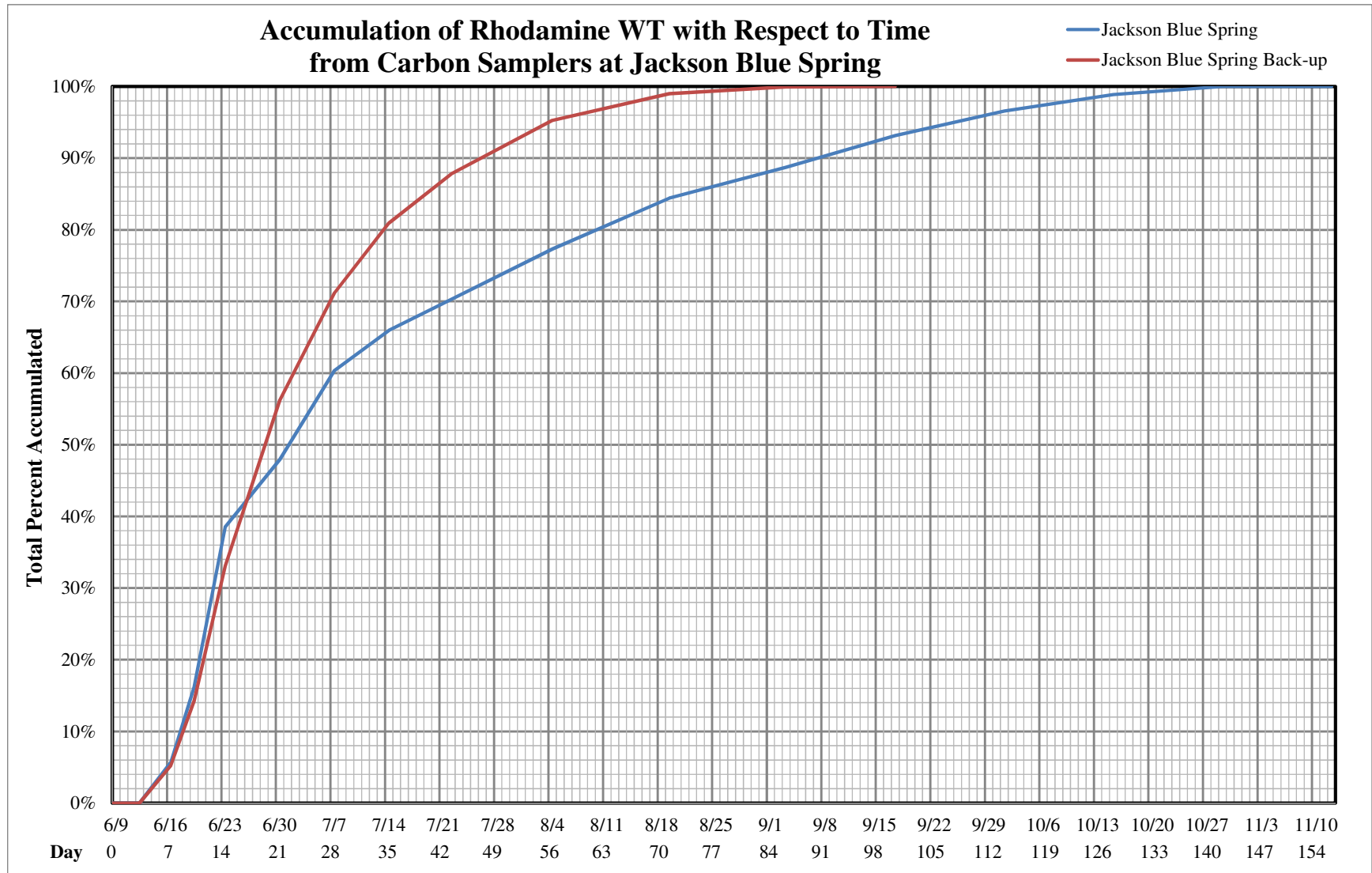
APPENDIX H

Graphs

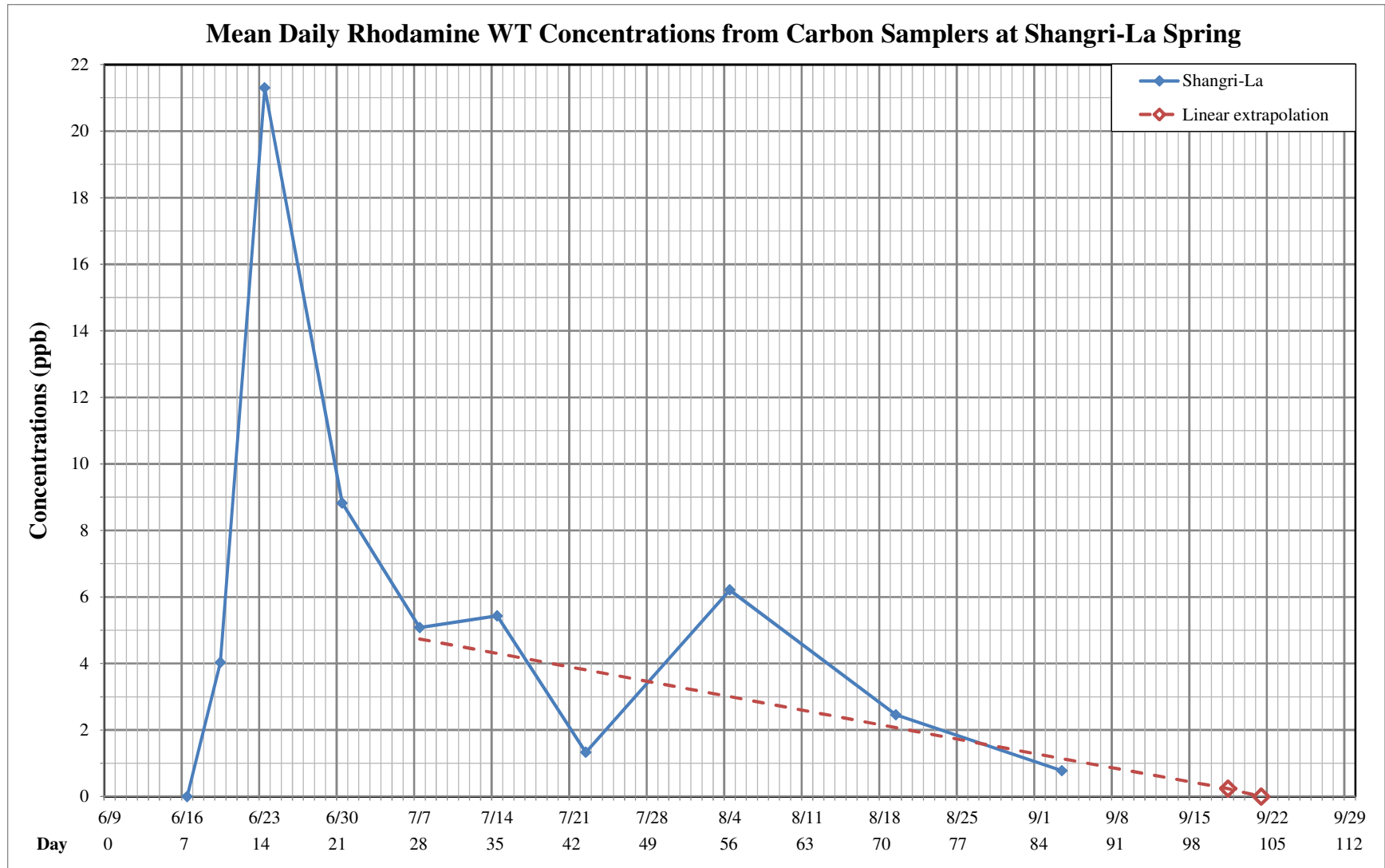
Graph A



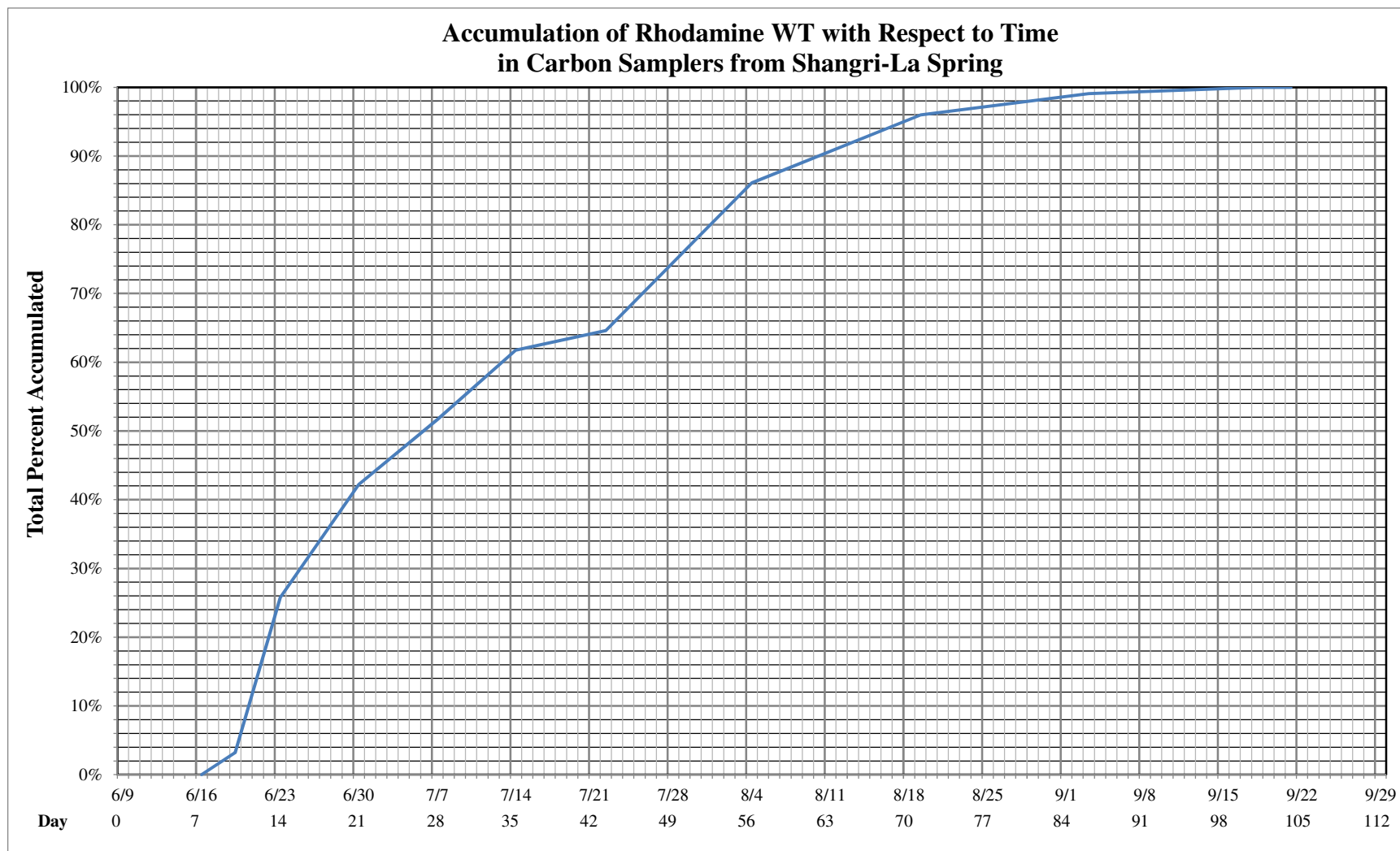
Graph B



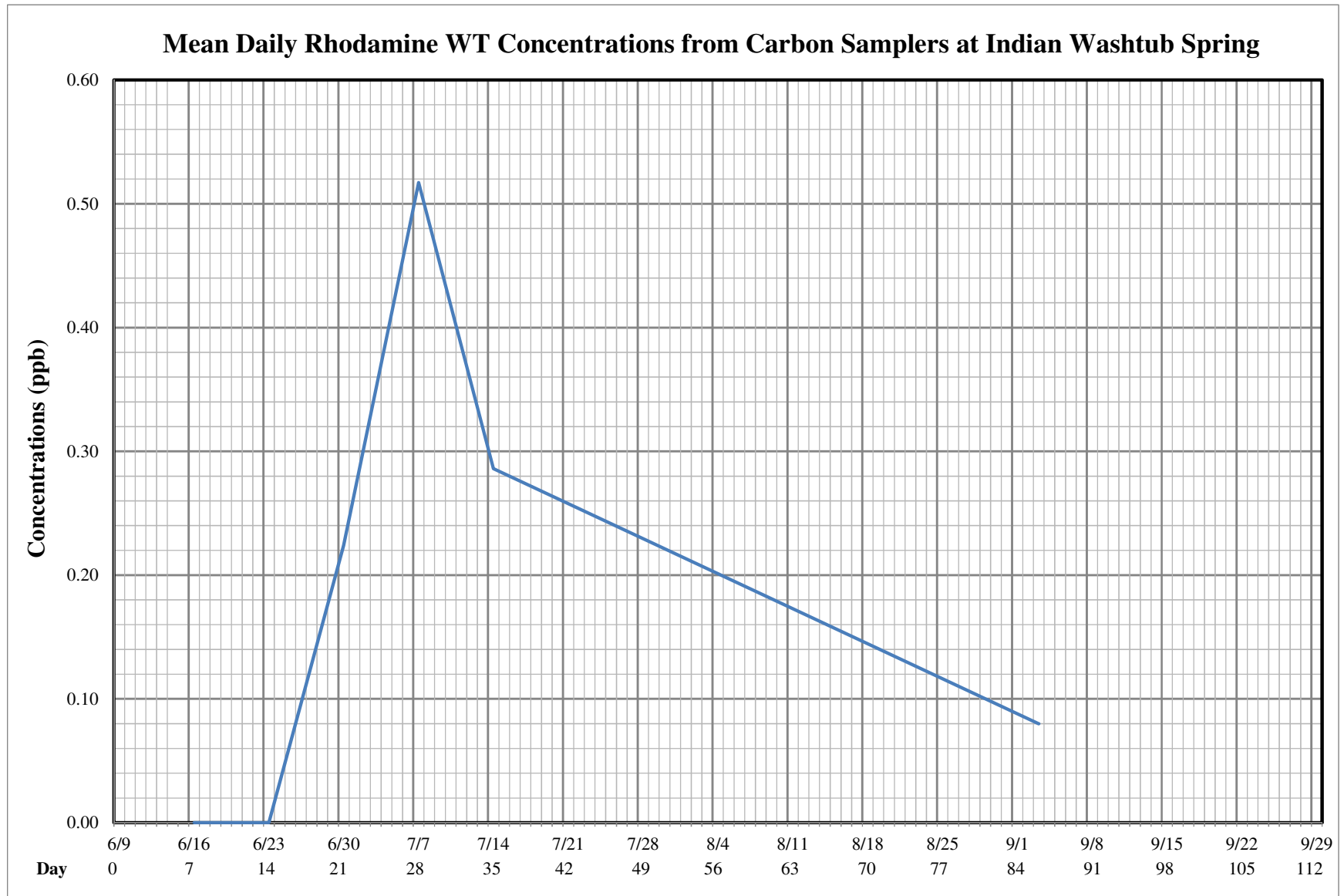
Graph C



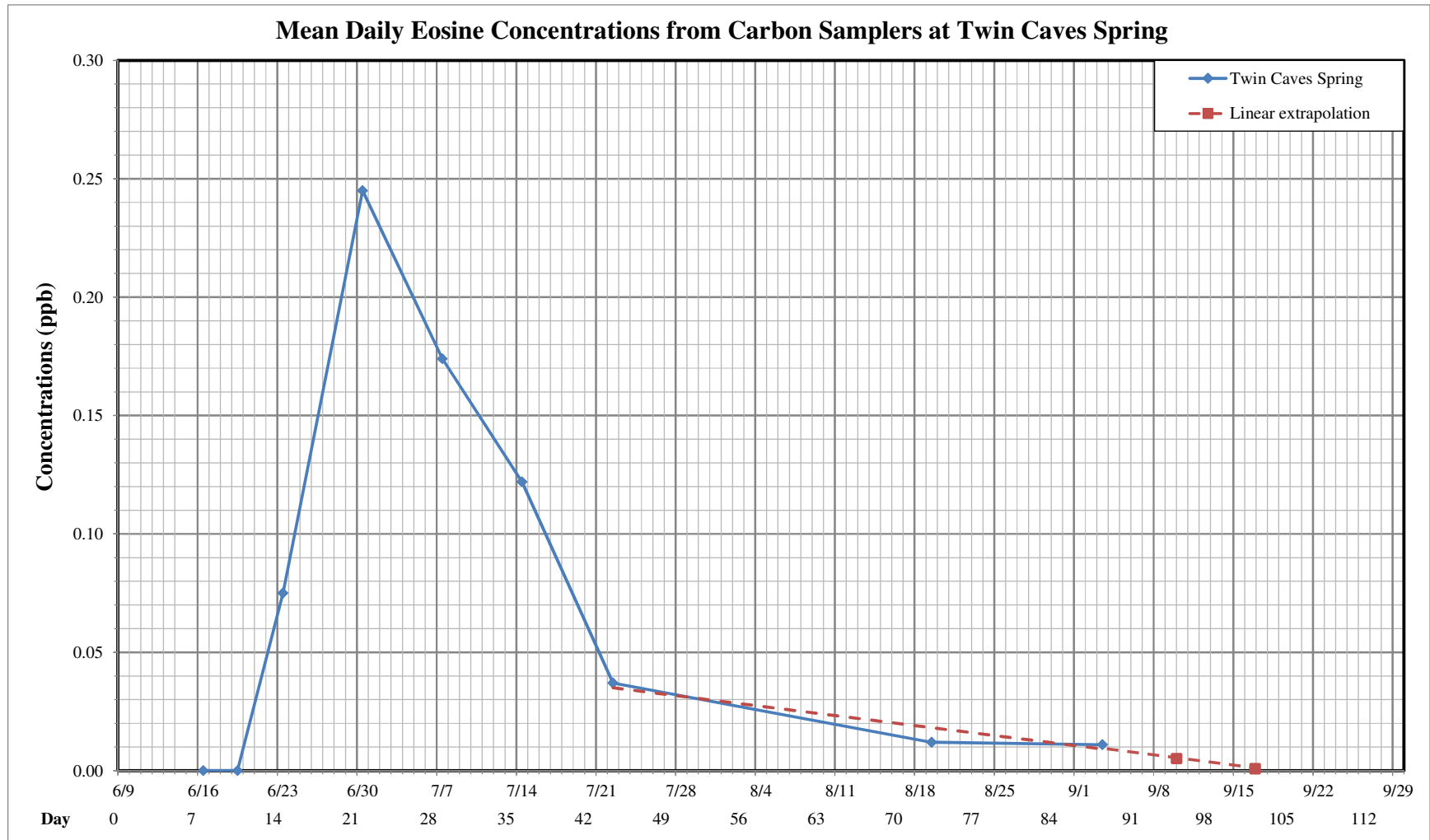
Graph D



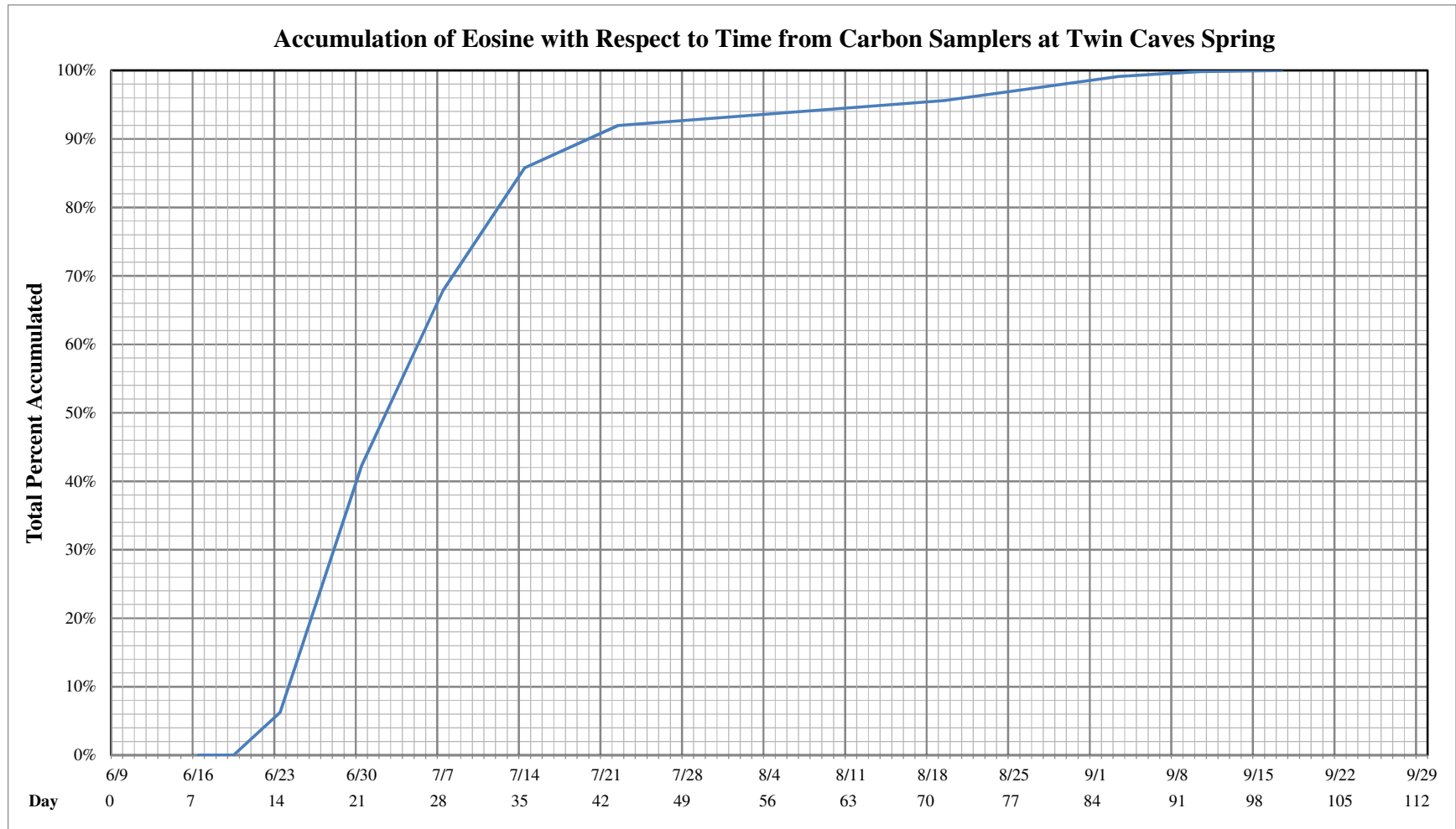
Graph E



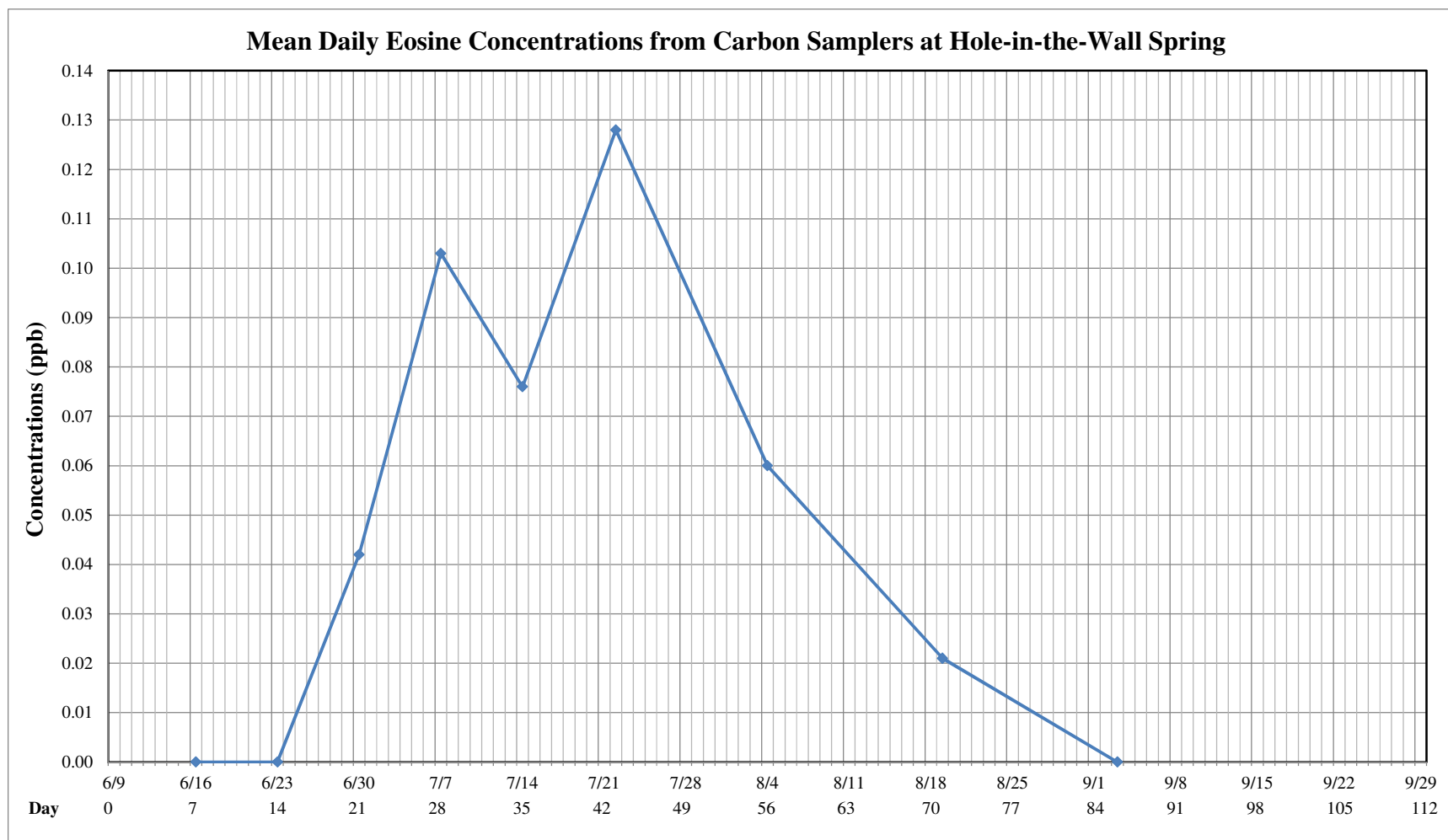
Graph F



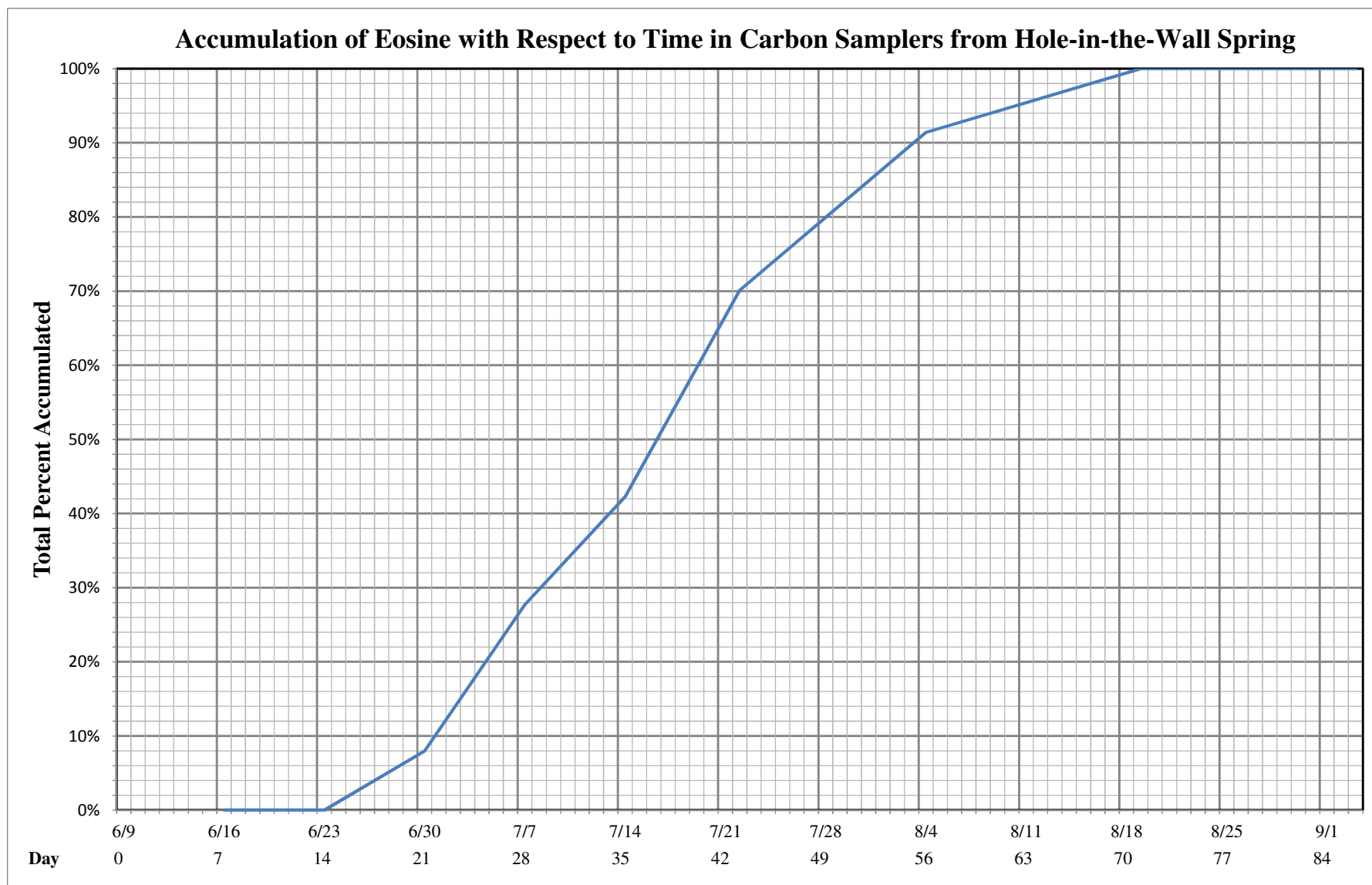
Graph G



Graph H



Graph I





About AECOM

AECOM is built to deliver a better world. We design, build, finance and operate infrastructure assets for governments, businesses and organizations in more than 150 countries. As a fully integrated firm, we connect knowledge and experience across our global network of experts to help clients solve their most complex challenges. From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our work is transformative, differentiated and vital. A Fortune 500 firm, AECOM had revenue of approximately \$17.4 billion during fiscal year 2016. See how we deliver what others can only imagine at aecom.com and [@AECOM](https://twitter.com/AECOM)

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