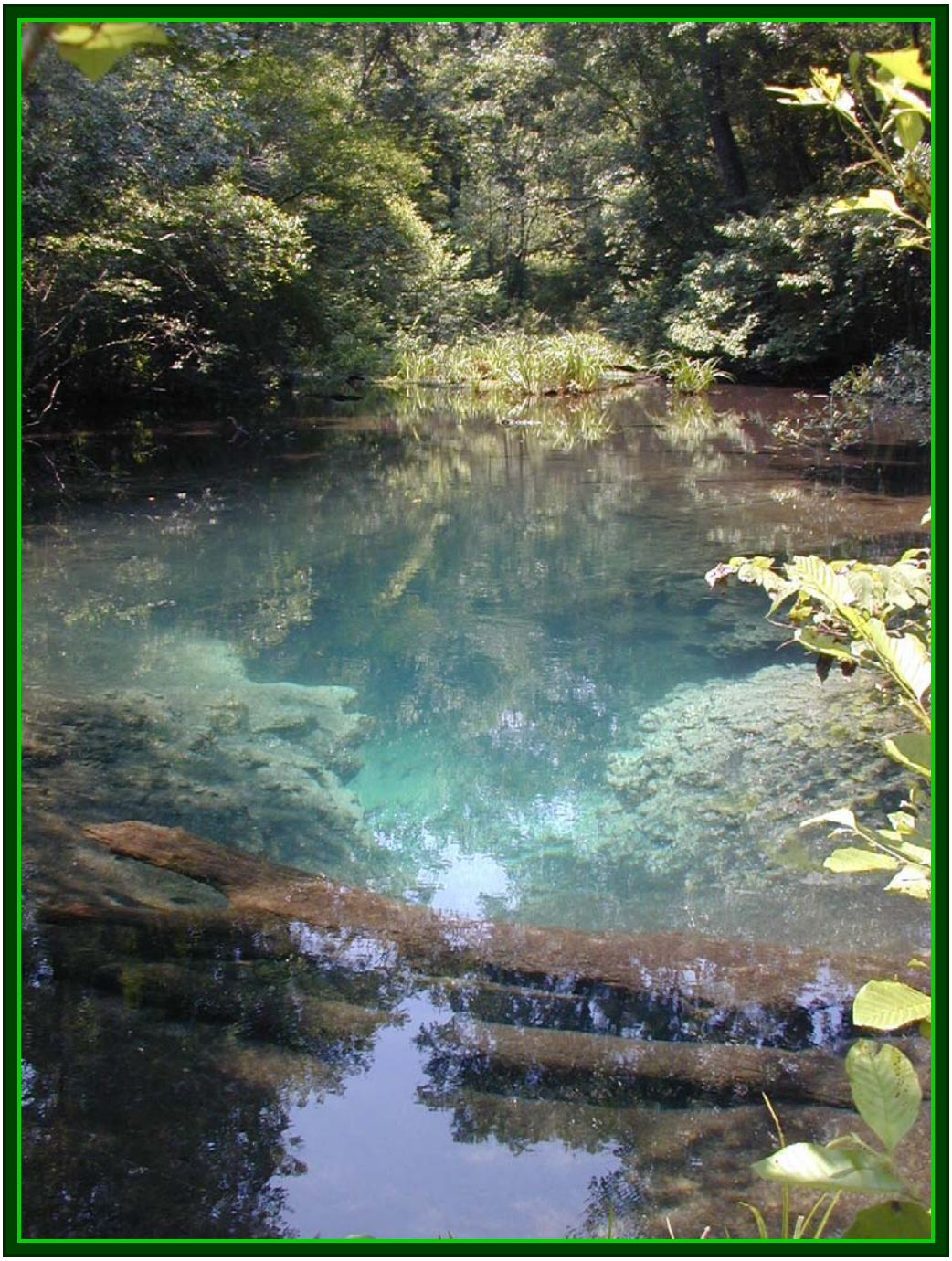
PRELIMINARY GROUND WATER BASIN DELINEATION FOR THE SPRING LAKE SPRING GROUP JACKSON COUNTY, FLORIDA



PREPARED BY:
NORTHWEST FLORIDA
WATER MANAGEMENT DISTRICT
JUNE 2003

PRELIMINARY GROUND WATER BASIN DELINEATION FOR THE SPRING LAKE SPRING GROUP JACKSON COUNTY, FLORIDA

Water Resources Special Report 03-02

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June 2003

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ACKNOWLEDGMENTS

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INTRODUCTION

This report serves as one of several project deliverables prepared by the Northwest Florida Water Management District under the FY02-03 Florida Springs Initiative.

The Spring Lake spring group is located in southwest Jackson County. At least eight Floridan Aquifer springs comprise the group, including Mill Pond, "the Crack", Coffin, Springboard, Double, Black Hole and Gadsen springs and Dry Creek Rise. Ground water discharging from these springs provides a significant source of water to Dry Creek, a tributary of the Chipola River. Due to the spring group's magnitude, it is beneficial to understand ground water sources and the extent of the ground water basin contributing to these springs.

A fluorescent dye tracer study was completed to gain a preliminary understanding of the ground water basin for the Spring Lake spring group. A necessary first step in delineating ground water basins is the development of an understanding of connections between points of recharge and points of discharge. Fluorescent tracer studies have proven effective in determining such connections in karst aquifer systems. Three traces were completed during the course of the study. Results allowed for an improved understanding of the relationship between the swallets and springs comprising the Spring Lake spring group. The knowledge gained of existing connections should aid any future efforts to identify ground water basins for the group.

STUDY AREA

The Spring Lake spring group is a complex of karst features lying along the lower reach of Dry Creek. The group lies within the Kynesville USGS 7.5 minute topographic quadrangle, approximately four miles south of Interstate 10 and just east of County Road 167 south. This area is within the Marianna Lowlands physiographic subdivision of the Dougherty Karst Plain. The karst aquifer underlying the area is developed in a sequence of southward dipping Oligocene aged and older carbonates. More detail on the geology and geomorphology of the area can be found in Moore (1955) and in a soon to be published geologic map prepared by the Florida Geological Survey.

Dry Creek drains much of southwest Jackson County, south of Interstate 10 and west of the Chipola River. At higher elevations the creek drains the thick, relatively sandy sediments of the Citronelle Formation. At lower elevations it drains Alum Bluff Group sediments. At the lowest elevations the creek drains Oligocene aged carbonates at the top of the Floridan Aquifer system. This is the area where Spring Lake is found. Under low flow conditions, Dry Creek is entirely diverted out of its channel and into springs of the Spring Lake spring group by Dry Creek swallet. Higher water levels allow a portion of Dry Creek to bypass its swallet and flow overland, reentering Dry Creek channel below Gadsen Spring.

METHODOLOGY

Field Reconnaissance

A thorough field reconnaissance was conducted to locate karst features pertinent to the study (Figure 1). Understanding the relative spatial proximity of these features was crucial when considering issues such as dye introduction and recovery. Eight springs, four swallets, a karst window and a sinking stream were visited and located with differential GPS. Numerous other sinkholes were visited, but were deemed not relevant to the study. Blue Sink is considered to be a karst window. Although water flow across the sink was not observed during the study, conversations with the landowner indicate that divers have previously observed water discharging from the south end of the feature and sinking at the north end.

Dye Recovery

The recovery of dye (Table 1) introduced into the ground water/surface water flow system was accomplished with activated charcoal dye detectors. These receptors function as an adsorptive media for passing dye. Detector locations (Figure 2) were established so that dye introduced into the flow system was recoverable from all known points of discharge. Because they are continually exposed to flowing water, acting as 24-hour water samplers, minor ambient dye concentrations passing in the water are detectable.

Table 1.—Fluorescent Dyes Used in Tracer Study.

Name	Chemical Name	Color Index Name	Manufacturer
Uranine*	Dipotassium Fluorescein	Acid Yellow 73	ChemCentral
Rhodamine WT	Trimellitic acid	Acid Red 833	Crompton and Knowles

* The preferred term fluorescein is used in this study.

Detectors were deployed at discrete locations using weighted stands and line to keep them in flowing water and to avoid detector loss. They were placed in spring runs and along the main stream channel so ground water discharging from unknown springs or in a diffuse nature to the stream bottom could be detected. Detectors were left exposed to the water for approximately seven days, after which they were collected and a new detector was secured in its place. An additional detector served as a field blank. As detectors were collected, it was frequently handled as a control against any unintentional transfer of dye to detectors. The detectors were then mailed to a laboratory to analyze for the presence of dye.

Detectors were deployed at the following locations:

1—Surface water overflow between Coffin swallet #2 and Springboard Spring run. The site was established as a confirmation that dye was not traveling overland during trace I and being recovered at location 2. This feature conveyed water for the entirety of the study period.

2—Springboard Spring run downgradient of Springboard Spring vent. The site was established to recover dye discharging from Springboard Spring.

3—Spring Lake upgradient of the confluence of the Springboard Spring run and Spring Lake. The site was established as a confirmation that dye was not discharging from Mill Pond Spring or the Crack.

4—Double Spring. The site was established to recover dye discharging from Double Spring.

5—Spring Lake upgradient of Black Hole Spring. The site was established to recover dye that may have been discharging to Spring Lake between Double Spring and Black Hole Spring.

6—Northerly flowing limb of the Black Hole Spring run. Black Hole Spring run bifurcates around a small island. For the duration of the study, water flowed out from Black Hole Spring to Spring Lake along both limbs of the bifurcated run. At no point did water flow in from Spring Lake and over Black Hole spring.

7—Easterly flowing limb of Black Hole Spring run.

8—Gadsen Spring run downgradient of Gadsen Spring vent. The site was established to recover dye discharging from Gadsen Spring.

9—Double Spring run downgradient of Double Spring vent. The site was established to confirm that dye discharging from Double Spring was traveling downgradient and sinking at Double Spring swallet.

10—Dry Creek downgradient of known springs in the group. The site was established to recover dye that may have been discharging from unknown locations.

11—Blue Sink. The site was established to recover dye discharging from the south end of the sink.

Analysis

Charcoal detectors collected from the field were shipped to and analyzed by Ewers Water Consultants, Inc. (EWC) in Richmond, Kentucky. Semi-quantitative analyses were performed utilizing synchronous scanning spectrofluorophotometry. In general, this

method is able to detect the presence of dye in concentrations in the parts per trillion range. The results contained in Appendix A use a '+/-' system to denote the presence or absence of dye. EWC defines 'Low Flow' as an indicator that the dye detector has not been subjected to sufficient water flow to remove the intrinsic fluorescence signature from the charcoal.

RESULTS

Background

A period of background data collection is necessary due to the potential existence of natural and anthropogenic sources of fluorescence in ground and surface waters. These background levels of fluorescence can be problematic if an existing substance fluoresces at a wavelength similar to that of a dye used in the investigation. Because of this, background data can greatly influence the type and quantity of dye used in a tracer study.

The interval March 12 through April 17, 2003 served as the background data collection period. Five exchanges, each representing approximately seven days of exposure, were completed. Monitoring sites 6, 7, 8, and 10 had background water quality characteristics with the potential to complicate the analyses. Each of these sites was established in black waters. Tannins, humics and other organic acids in these waters fluoresce at a wavelength and produce a fluorescence scan that could result in a reduced ability to identify the presence of small amounts of eosine. Due to the potential conflict, eosine was not used in this study.

All other locations and the field blanks showed no presence of substances fluorescing at wavelengths similar to that of the dyes used.

Dye Trace I

On April 18, 2003, two different dyes were introduced to the system through the two swallets at the terminus of Coffin Spring run. Three-quarters of a pound of a 20 percent solution of rhodamine wt (diluted to two liters) was injected through Coffin swallet #2 (Figure 4). Approximately 3 hours later, one-half pound of a 50 percent solution of fluorescein (diluted to two liters) was injected through Coffin swallet #1 (Figure 5). In each case, a weighted garden hose was extended approximately 15 feet below the surface to facilitate dye release into the throat of the swallet. The dye was released in stages with a manual flushing of the delivery hose following each stage of the release.

Visual detection of both fluorescein and rhodamine wt was observed at Springboard Spring the day of the injection. The first post-introduction detector exchange (April 23) provided positive recoveries for both dyes at Springboard Spring run (2), both Double Spring monitoring sites (4 and 9), both Black Hole Spring monitoring sites (6 and 7), Gadsen Spring (8), and surface water sites 5 and 10.

The second post-introduction exchange (April 30) showed the recovery of substances that fluoresce at wavelengths in the vicinity of fluorescein and rhodamine wt at both Springboard Spring (2) and at one of the Spring Lake sites (5). Although this cannot be considered a positive recovery, it should be noted that there were definitive recoveries of these dyes at these sites in the previous week's exchange. A similar recovery in the vicinity of fluorescein was made at Blue Sink (11) in this exchange and in the third post-introduction exchange (May 8). The EWC analyst noted that it more closely resembles a degraded form of rhodamine wt known as "DAR-WT". However, this would have to be confirmed with further analysis. No positive recoveries of rhodamine wt were reported at this location for any of the exchanges. All other locations showed no presence of dye for exchanges dated April 23, April 30, and May 8. The fourth post-introduction (May 14) exchange produced no dye recoveries at any of the monitoring locations.

Dye Trace II

On May 15, 2003, fluorescein was introduced to ground water through Dry Creek swallet (Figure 6). One pound of a 50 percent solution of fluorescein (diluted to two liters) was released in the spring run that descends from Dry Creek Rise approximately ten feet upgradient of the swallet. Upon release of the dye, it flowed down the spring run into the swallet. The discoloration of water in Dry Creek swallet subsided within 15 minutes following each stage of the release.

The first post-introduction exchange (May 21) revealed positive fluorescein recoveries at both Black Hole Spring sites (6 and 7), at Gadsen Spring (8) and on Dry Creek (10). A recovery was reported at Gadsen Spring with the second post-introduction exchange (May 28). No fluorescein was recovered at any of the other sites for the May 21 and May 28 exchanges. The third post-introduction exchange (June 4) produced no fluorescein recovery at any of the monitoring locations.

Dye Trace III

On June 6, 2003, fluorescein was introduced through Double Spring swallet (Figure 7). At the time of the introduction, a pronounced rotation was observed at the surface of the swallet. Of the one pound of a 50 percent solution (diluted to two liters) prepared, approximately three quarters was released. The dye was released in multiple stages from a position approximately 15 feet up the spring run leading to the swallet. The discoloration of the water was significantly diminished between stages. Within 2 hours after the final release, the discoloration of water in the swallet had completely dissipated.

The first post-introduction exchange (June 11), revealed positive recoveries of fluorescein at both Black Hole Spring sites (6 and 7), at Gadsen Spring (8) and on Dry Creek (10). The recovery of a substance fluorescing at a wavelength in the vicinity of eosine was noted at Double Spring East (9) for this exchange and the second post-introduction exchange (June 19). Because eosine was not used for this study, it is likely that the fluorescence originates from a natural or anthropogenic source. No fluorescein

was recovered at any of the monitoring locations June 19 and 25. The detector at Dry Creek (10) was missing at the time of the exchange on June 19 and 25.

CONCLUSIONS AND RECOMMENDATIONS

The results from the tracer study allow for a better understanding of the existing connections between the swallets and springs in the area of the Spring Lake spring group (Figure 3). With these connections established, some general remarks can be made about the ground water basin contributing water to these springs. However, qualifying statements must be made about several of the reported recoveries.

With the exception of the fluorescein recoveries at Gadsen Spring on May 21 and 28, all other recoveries were reported for only one week. In general, recovery of the dye in question at a given site in two successive exchanges improves the validity of a trace. However, considering the length of the exchange interval, the short trace distance, and the ground water velocity, it is reasonable to expect short transit times and therefore, single exchange recoveries. Two considerations would have likely resulted in the preferred two successive recoveries. First, the exchange interval could have been shortened to three days. Second, tracing a longer distance allows more lateral dispersion which may delay the dye transit through the system.

Although recovery of both fluorescein and rhodamine wt was reported at Double Spring (sites 4 and 9) for trace I, an explanation is warranted. At the time of trace I, the direction of flow from the spring was difficult to discern. The detector at site 4 was placed east of the spring, between the spring and Spring Lake in order to avoid vandalism and under the assumption that a portion of water discharging from the spring flowed into Spring Lake. Once water levels declined several weeks after the trace, it was observed that the Double Spring swallet siphons (at least occasionally) water from both Double Spring and Spring Lake. It is, therefore, possible that dyes recovered at sites 4 and 9 originated from Springboard Spring run.

During trace I dye flowed down Springboard Spring run and out into the main channel. Double Spring lies downgradient of the confluence of the run and the lake. It is possible that dye flowing down the lake was siphoned “up” the Double Spring run and into the swallet. A sketch of the cave network in this portion of the flow system composed by Mr. Wes Skiles of Karst Environmental Services confirms an underground connection between the Coffin Swallets and Double Spring, in addition to the overland flow component. Therefore, although dye recovery at sites 4 and 9 could have been influenced by surface transport, a portion of the dye recovered at site 9 would have undoubtedly been discharged through Double Spring.

It was noted in the EWC analytical report that tannins at Black Hole and Gadsen springs caused a slight interference with trace I dye recovery at these sites. However, due to the extensive background collected, the analysts at EWC felt comfortable interpreting the recoveries as those of fluorescein and rhodamine wt used for the trace.

These recoveries confirm a connection between the Coffin swallets and Black Hole and Gadsen springs. However, it is uncertain whether there is a direct connection or connection via Double Spring swallet only. Trace III showed a connection between the swallet and these two springs. In addition to this route, it is possible that an unknown direct connection also exists. Based on the sketch of the cave network mentioned above, it is suggested that, between the Coffin swallets and Double Spring, there exists a passage splaying off to the east. Further cave diving is necessary to confirm its existence. If it does exist, a release into this passage would be necessary to confirm connections to one or both of these springs.

The recoveries for trace II and III were much more definitive. Results from trace II show a ground water flow connection between Dry Creek swallet and Black Hole and Gadsen springs. As stated above, results from trace III show a connection between Double Spring swallet and Black Hole and Gadsen springs.

Flow connections established through this study show that Black Hole (Figure 8) and Gadsen (Figure 9) springs serve as the ultimate discharge points for much of the ground water flow and a portion of the surface flow in the area. Although no definitive ground water basins can be drawn, sources for a significant portion of the water discharging from these springs can be discerned. Ground water basins for Coffin Spring (Figure 10), Double Spring (Figure 11), and Dry Creek Rise can be included in that of Black Hole and Gadsen springs via the Double Spring and Dry Creek swallets. In addition, the entire surface basin for Dry Creek can be included in the Black Hole/Gadsen Spring basin via the Dry Creek swallet. Based on available cave and flow data, it may be that the ground water basin for Springboard Spring (Figure 12) is essentially the same as that of Coffin Spring. Additional work is needed to confirm this. It appears Mill Pond Spring (Figure 13) and the Crack (Figure 14) possess ground water basins that, to a large degree, are isolated from those of Black Hole and Gadsen Springs. However, during times when flow from the main channel enters the Double Spring run and sinks at the swallet, some portion of the water from these springs enters the Black Hole/Gadsen basin.

To better understand actual ground water basin boundaries, it is recommended that additional tracer introductions be focused further out from the spring group. It should be noted that finding introduction locations not connected to the group can as beneficial as traces recovered there. The area to the north of Spring Lake may be of interest when considering potential sources of contamination. Interstate 10 extends to the east-west across this area. Determining how much of the interstate lies within the ground water basin for these springs would be beneficial. Other point locations of potential contamination may be used as dye introduction locations in order to understand their connection with the spring group.

REFERENCES

Moore, W.E., “Geology of Jackson County, Florida”, Florida Geological Survey, Bulletin 37, 1955, 101 pp.

APPENDIX A

LOCATIONS OF KARST FEATURES PERTINENT TO STUDY

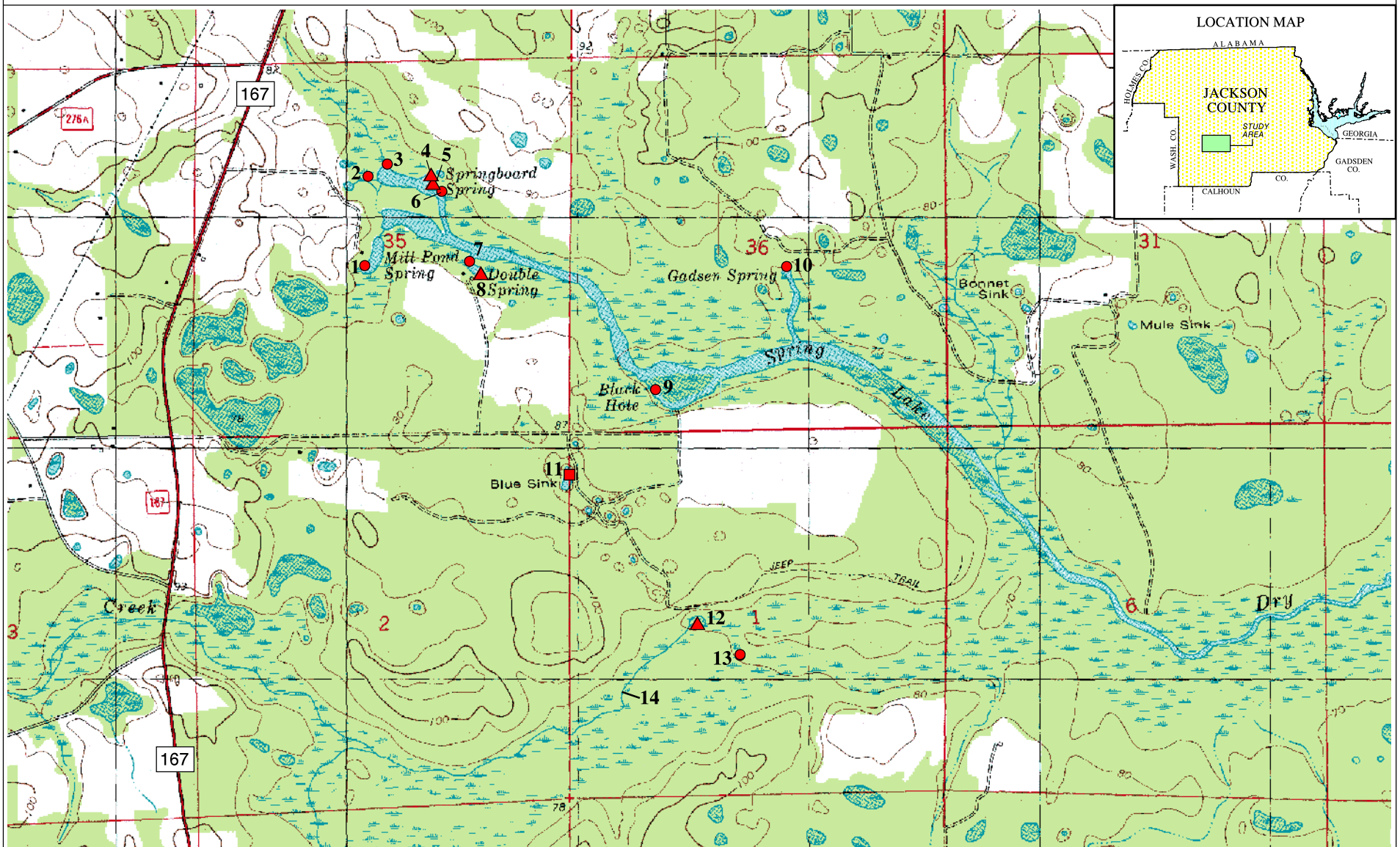
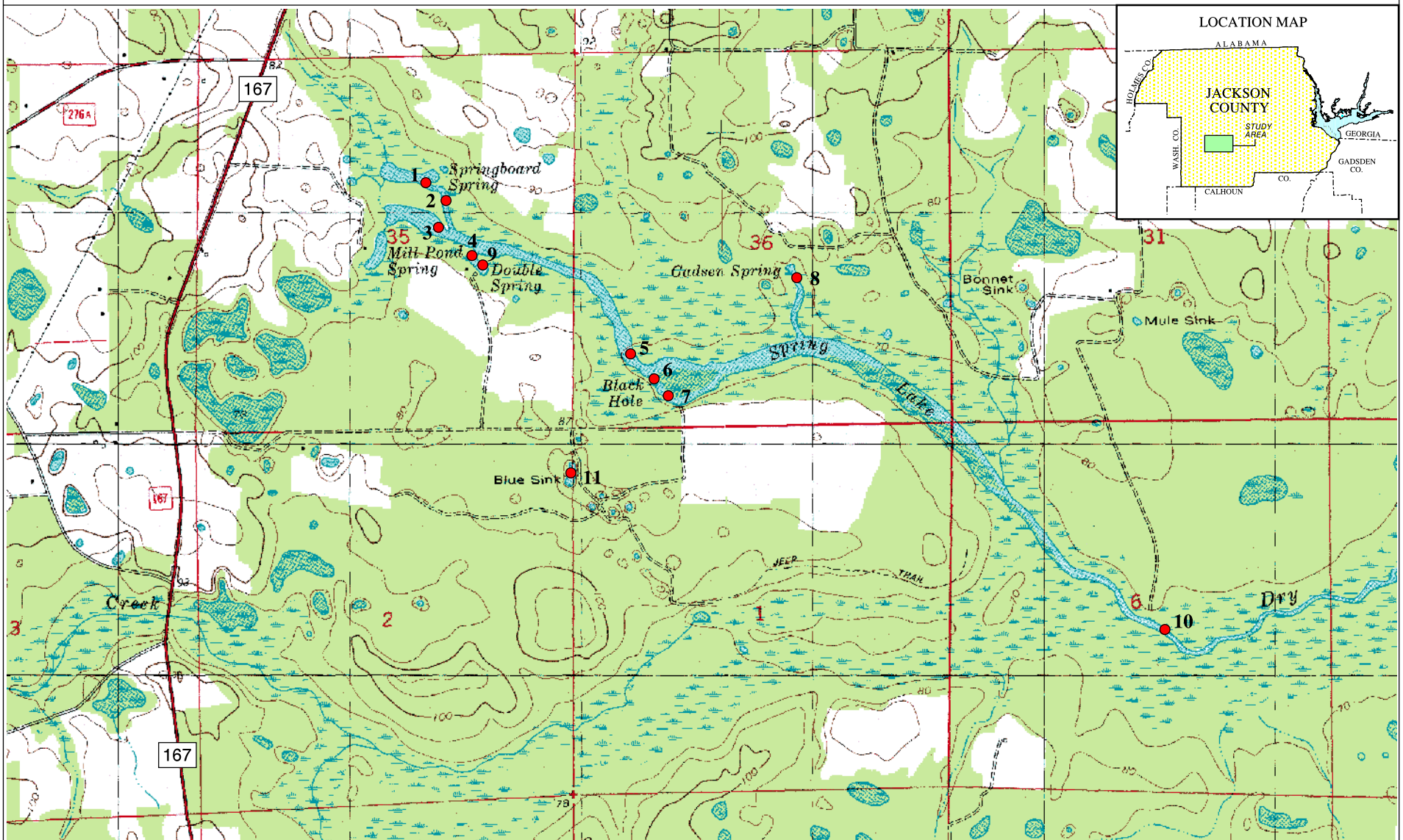


FIGURE 1

DYE MONITORING LOCATIONS



LEGEND

1 - COFFIN SWALLET #2 / SPRINGBOARD SPRING OVERFLOW
2 - SPRINGBOARD SPRING RUN
3 - SPRING LAKE ABOVE SPRINGBOARD SPRING
4 - DOUBLE SPRING NORTH
5 - SPRING LAKE ABOVE BLACK HOLE SPRING
6 - BLACK HOLE SPRING RUN NORTH
7 - BLACK HOLE SPRING RUN EAST
8 - GADSEN SPRING RUN
9 - DOUBLE SPRING EAST
10 - DRY CREEK
11 - BLUE SINK

SCALE

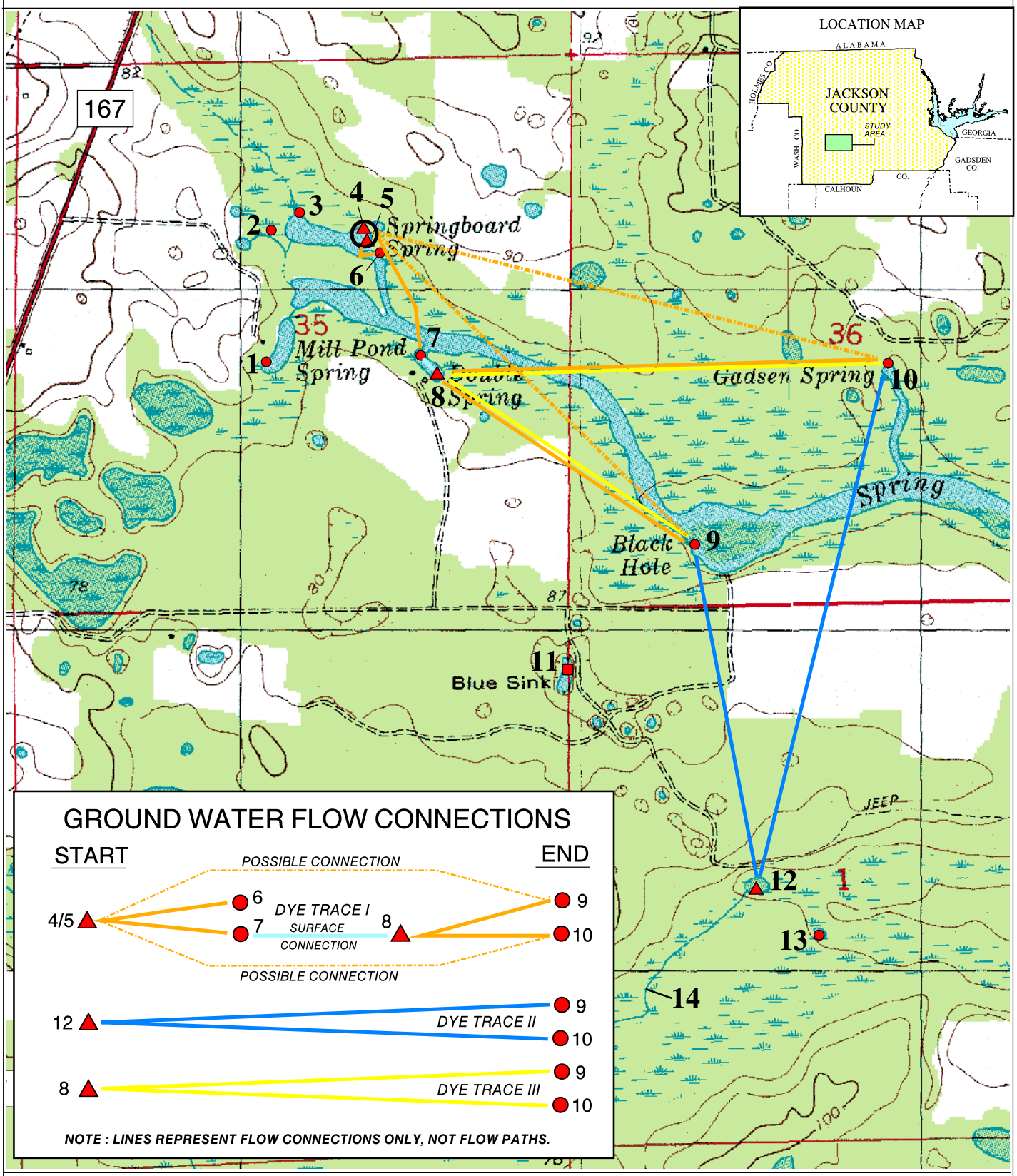
0 1/2 1 MILES

0 2000 4000 6000 FEET

N

FIGURE 2

RESULTS FROM TRACER STUDY: GROUND WATER FLOW CONNECTIONS



GROUND WATER FLOW CONNECTIONS

START

END

POSSIBLE CONNECTION

4/5 — 6 — DYE TRACE I — 9

4/5 — 7 — SURFACE CONNECTION — 8 — 10

POSSIBLE CONNECTION

12 — DYE TRACE II — 9, 10

8 — DYE TRACE III — 9, 10

NOTE : LINES REPRESENT FLOW CONNECTIONS ONLY, NOT FLOW PATHS.

LEGEND

- ● - SPRING
- ▲ - SWALLET / DYE INTRODUCTION LOCATION
- ■ - KARST WINDOW
- GROUND WATER FLOW CONNECTION
- POSSIBLE GROUND WATER FLOW CONNECTION

SCALE

0 — 1/4 — 1/2 MILES

0 — 1000 — 2000 — 3000 FEET

N

FIGURE 3

APPENDIX B

Figure 4. Coffin swallet #2. View from spring run looking east across swallet.

Figure 5. Coffin swallet #1. View looking north down the spring run toward the swallet. The swallet is largely covered with duckweed.

Figure 6. Dry Creek swallet. View looking south across swallet. Inflow from Dry Creek enters right of image. Inflow from Dry Creek Rise enters left of image.

Figure 7. Double Spring swallet. View looking southeast down the spring run toward the swallet.

Figure 8. Black Hole Spring. View looking south across spring pool.

Figure 9. Gadsen Spring. View looking north across spring pool.

Figure 10. Coffin Spring. View looking north across spring pool.

Figure 11. Double Spring. View looking west up the spring run towards the spring pool.

Figure 12. Springboard Spring. View from overflow channel looking east across spring pool.

Figure 13. Mill Pond Spring. View looking east across spring pool.

Figure 14. The Crack. View up the spring run looking northwest across spring pool.

APPENDIX C

BACKGROUND MONITORING
Date: 03/12/2003 - 04/17/2003

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	3/19/2003	-	-	-	-	
2	Springboard Spring Run	3/19/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	3/19/2003	-	-	-	-	
4	Double Spring North	3/19/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	3/19/2003	-	-	-	-	
6	Black Hole Spring Run North	3/19/2003	-	-	-	-	*
7	Black Hole Spring Run East	3/19/2003	-	-	-	-	*
8	Gadsen Spring Run	3/19/2003	-	-	-	-	*
FB	Field Blank	3/19/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	3/27/2003	-	-	-	-	
2	Springboard Spring Run	3/27/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	3/27/2003	-	-	-	-	
4	Double Spring North	3/27/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	3/27/2003	-	-	-	-	
6	Black Hole Spring Run North	3/27/2003	-	-	-	-	*
7	Black Hole Spring Run East	3/27/2003	-	-	-	-	*
8	Gadsen Spring Run	3/27/2003	-	-	-	-	*
9	Double Spring East	3/27/2003	-	-	-	-	
FB	Field Blank	3/27/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	4/3/2003	-	-	-	-	
2	Springboard Spring Run	4/3/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	4/3/2003	-	-	-	-	
4	Double Spring North	4/3/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	4/3/2003	-	-	-	-	
6	Black Hole Spring Run North	4/3/2003	-	-	-	-	*
7	Black Hole Spring Run East	4/3/2003	-	-	-	-	*
8	Gadsen Spring Run	4/3/2003	-	-	-	-	*
9	Double Spring East	4/3/2003	-	-	-	-	
FB	Field Blank	4/3/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Symbol	Definition
-	No Dye Present
+	Positive Fluorescence Signature
++	Strong Positive Fluorescence Signature
+++	Very Positive Fluorescence Signature
++++	Spectacularly Positive Fluorescence Signature, Analyzed Under Low Sensitivity
+++++	Dilution Required
?	Fluorescence is Not the Dye of Interest or Concentration too Low for Positive Identification
NS	Detector Not Sent

BACKGROUND MONITORING
Date: 03/12/2003 - 04/17/2003

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	4/10/2003	-	-	-	-	
2	Springboard Spring Run	4/10/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	4/10/2003	-	-	-	-	
4	Double Spring North	4/10/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	4/10/2003	-	-	-	-	
6	Black Hole Spring Run North	4/10/2003	-	-	-	-	*
7	Black Hole Spring Run East	4/10/2003	-	-	-	-	*
8	Gadsen Spring Run	4/10/2003	-	-	-	-	*
9	Double Spring East	4/10/2003	-	-	-	-	
10	Dry Creek	4/10/2003	-	-	-	-	*
FB	Field Blank	4/10/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	4/17/2003	-	-	-	-	
2	Springboard Spring Run	4/17/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	4/17/2003	-	-	-	-	
4	Double Spring North	4/17/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	4/17/2003	-	-	-	-	
6	Black Hole Spring Run North	4/17/2003	-	-	-	-	*
7	Black Hole Spring Run East	4/17/2003	-	-	-	-	*
8	Gadsen Spring Run	4/17/2003	-	-	-	-	*
9	Double Spring East	4/17/2003	-	-	-	-	
10	Dry Creek	4/17/2003	-	-	-	-	*
11	Blue Sink	4/17/2003	-	-	-	-	
FB	Field Blank	4/17/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Symbol	Definition
-	No Dye Present
+	Positive Fluorescence Signature
++	Strong Positive Fluorescence Signature
+++	Very Positive Fluorescence Signature
++++	Spectacularly Positive Fluorescence Signature, Analyzed Under Low Sensitivity
+++++	Dilution Required
?	Fluorescence is Not the Dye of Interest or Concentration too Low for Positive Identification
NS	Detector Not Sent

DYE INTRODUCTION I
Date: 04/18/2003 Location: Coffin Swallets #1 & #2

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	4/23/2003	-	-	-	-	
2	Springboard Spring Run	4/23/2003	+++++	-	+++++	-	
3	Spring Lake above Springboard Spring	4/23/2003	-	-	-	-	
4	Double Spring North	4/23/2003	++++	-	++++	-	
5	Spring Lake above Black Hole Spring	4/23/2003	++++	-	++++	-	
6	Black Hole Spring Run North	4/23/2003	+++#	-	++#	-	*
7	Black Hole Spring Run East	4/23/2003	+++#	-	++#	-	*
8	Gadsen Spring Run	4/23/2003	+++#	-	++#	-	*
9	Double Spring East	4/23/2003	++++	-	++++	-	
10	Dry Creek	4/23/2003	++++	-	++++	-	*
11	Blue Sink	4/23/2003	-	-	-	-	
FB	Field Blank	4/23/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Due to the broad background at these sights the dye peaks are shifted and not well defined.

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	4/30/2003	-	-	-	-	
2	Springboard Spring Run	4/30/2003	?	-	?	-	
3	Spring Lake above Springboard Spring	4/30/2003	-	-	-	-	
4	Double Spring North	4/30/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	4/30/2003	?	-	?	-	
6	Black Hole Spring Run North	4/30/2003	-	-	-	-	*
7	Black Hole Spring Run East	4/30/2003	-	-	-	-	*
8	Gadsen Spring Run	4/30/2003	-	-	-	-	*
9	Double Spring East	4/30/2003	-	-	-	-	
10	Dry Creek	4/30/2003	-	-	-	-	*
11	Blue Sink	4/30/2003	?	-	-	-	
FB	Field Blank	4/30/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

?'s indicate that the fluorescein is in the general visinity of this dye and
is shifted from the ideal peak wavelength or is near the detection limit

Symbol	Definition
-	No Dye Present
+	Positive Fluorescence Signature
++	Strong Positive Fluorescence Signature
+++	Very Positive Fluorescence Signature
++++	Spectacularly Positive Fluorescence Signature, Analyzed Under Low Sensitivity
+++++	Dilution Required
?	Fluorescence is Not the Dye of Interest or Concentration too Low for Positive Identification
NS	Detector Not Sent

DYE INTRODUCTION I
Date: 04/18/2003 Location: Coffin Swallets #1 & #2

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	5/8/2003	-	-	-	-	
2	Springboard Spring Run	5/8/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	5/8/2003	-	-	-	-	
4	Double Spring North	5/8/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	5/8/2003	-	-	-	-	
6	Black Hole Spring Run North	5/8/2003	-	-	-	-	*
7	Black Hole Spring Run East	5/8/2003	-	-	-	-	*
8	Gadsen Spring Run	5/8/2003	-	-	-	-	*
9	Double Spring East	5/8/2003	-	-	-	-	
10	Dry Creek	5/8/2003	-	-	-	-	*
11	Blue Sink	5/8/2003	?	-	-	-	
FB	Field Blank	5/8/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	5/14/2003	-	-	-	-	
2	Springboard Spring Run	5/14/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	5/14/2003	-	-	-	-	
4	Double Spring North	5/14/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	5/14/2003	-	-	-	-	
6	Black Hole Spring Run North	5/14/2003	-	-	-	-	*
7	Black Hole Spring Run East	5/14/2003	-	-	-	-	*
8	Gadsen Spring Run	5/14/2003	-	-	-	-	*
9	Double Spring East	5/14/2003	-	-	-	-	
10	Dry Creek	5/14/2003	-	-	-	-	*
11	Blue Sink	5/14/2003	-	-	-	-	
FB	Field Blank	5/14/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Symbol	Definition
-	No Dye Present
+	Positive Fluorescence Signature
++	Strong Positive Fluorescence Signature
+++	Very Positive Fluorescence Signature
++++	Spectacularly Positive Fluorescence Signature, Analyzed Under Low Sensitivity
+++++	Dilution Required
?	Fluorescence is Not the Dye of Interest or Concentration too Low for Positive Identification
NS	Detector Not Sent

DYE INTRODUCTION II
Date: 05/15/2003 Location: Dry Creek Swallet

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	5/21/2003	-	-	-	-	
2	Springboard Spring Run	5/21/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	5/21/2003	-	-	-	-	
4	Double Spring North	5/21/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	5/21/2003	-	-	-	-	
6	Black Hole Spring Run North	5/21/2003	++++	-	-	-	*
7	Black Hole Spring Run East	5/21/2003	++++	-	-	-	*
8	Gadsen Spring Run	5/21/2003	++++	-	-	-	*
9	Double Spring East	5/21/2003	-	-	-	-	
10	Dry Creek	5/21/2003	++++	-	-	-	*
11	Blue Sink	5/21/2003	-	-	-	-	
FB	Field Blank	5/21/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	5/28/2003	-	-	-	-	
2	Springboard Spring Run	5/28/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	5/28/2003	-	-	-	-	
4	Double Spring North	5/28/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	5/28/2003	-	-	-	-	
6	Black Hole Spring Run North	5/28/2003	-	-	-	-	*
7	Black Hole Spring Run East	5/28/2003	-	-	-	-	*
8	Gadsen Spring Run	5/28/2003	+++	-	-	-	*
9	Double Spring East	5/28/2003	-	-	-	-	
10	Dry Creek	5/28/2003	-	-	-	-	*
11	Blue Sink	5/28/2003	-	-	-	-	
FB	Field Blank	5/28/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Symbol	Definition
-	No Dye Present
+	Positive Fluorescence Signature
++	Strong Positive Fluorescence Signature
+++	Very Positive Fluorescence Signature
++++	Spectacularly Positive Fluorescence Signature, Analyzed Under Low Sensitivity
+++++	Dilution Required
?	Fluorescence is Not the Dye of Interest or Concentration too Low for Positive Identification
NS	Detector Not Sent

DYE INTRODUCTION II
Date: 05/15/2003 Location: Dry Creek Swallet

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	6/4/2003	NS	NS	NS	NS	
2	Springboard Spring Run	6/4/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	6/4/2003	NS	NS	NS	NS	
4	Double Spring North	6/4/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	6/4/2003	-	-	-	-	
6	Black Hole Spring Run North	6/4/2003	-	-	-	-	*
7	Black Hole Spring Run East	6/4/2003	-	-	-	-	*
8	Gadsen Spring Run	6/4/2003	-	-	-	-	*
9	Double Spring East	6/4/2003	-	-	-	-	
10	Dry Creek	6/4/2003	NS	NS	NS	NS	*
11	Blue Sink	6/4/2003	-	-	-	-	
FB	Field Blank	6/4/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Symbol	Definition
-	No Dye Present
+	Positive Fluorescence Signature
++	Strong Positive Fluorescence Signature
+++	Very Positive Fluorescence Signature
++++	Spectacularly Positive Fluorescence Signature, Analyzed Under Low Sensitivity
+++++	Dilution Required
?	Fluorescence is Not the Dye of Interest or Concentration too Low for Positive Identification
NS	Detector Not Sent

DYE INTRODUCTION III
Date: 06/06/2003 Location: Double Spring Swallet

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	6/11/2003	-	-	-	-	
2	Springboard Spring Run	6/11/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	6/11/2003	-	-	-	-	
4	Double Spring North	6/11/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	6/11/2003	-	-	-	-	
6	Black Hole Spring Run North	6/11/2003	++++	-	-	-	*
7	Black Hole Spring Run East	6/11/2003	++++	-	-	-	*
8	Gadsen Spring Run	6/11/2003	++++	-	-	-	*
9	Double Spring East	6/11/2003	-	?	-	-	
10	Dry Creek	6/11/2003	++++	-	-	-	*
11	Blue Sink	6/11/2003	-	-	-	-	
FB	Field Blank	6/11/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	6/19/2003	-	-	-	-	
2	Springboard Spring Run	6/19/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	6/19/2003	-	-	-	-	
4	Double Spring North	6/19/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	6/19/2003	-	-	-	-	
6	Black Hole Spring Run North	6/19/2003	-	-	-	-	*
7	Black Hole Spring Run East	6/19/2003	-	-	-	-	*
8	Gadsen Spring Run	6/19/2003	-	-	-	-	*
9	Double Spring East	6/19/2003	-	?	-	-	
10	Dry Creek	6/19/2003	NS	NS	NS	NS	
11	Blue Sink	6/19/2003	-	-	-	-	
FB	Field Blank	6/19/2003	-	-	-	+	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Symbol	Definition
-	No Dye Present
+	Positive Fluorescence Signature
++	Strong Positive Fluorescence Signature
+++	Very Positive Fluorescence Signature
++++	Spectacularly Positive Fluorescence Signature, Analyzed Under Low Sensitivity
+++++	Dilution Required
?	Fluorescence is Not the Dye of Interest or Concentration too Low for Positive Identification
NS	Detector Not Sent

DYE INTRODUCTION III
Date: 06/06/2003 Location: Double Spring Swallet

Site ID	Location	Date	Fluorescein	Eosine	Rhodamine WT	Low Flow	Comments
1	Coffin Swallet #2/Springboard Spring Overflow	6/25/2003	-	-	-	-	
2	Springboard Spring Run	6/25/2003	-	-	-	-	
3	Spring Lake above Springboard Spring	6/25/2003	-	-	-	-	
4	Double Spring North	6/25/2003	-	-	-	-	
5	Spring Lake above Black Hole Spring	6/25/2003	-	-	-	-	
6	Black Hole Spring Run North	6/25/2003	-	-	-	-	*
7	Black Hole Spring Run East	6/25/2003	-	-	-	-	*
8	Gadsen Spring Run	6/25/2003	-	-	-	-	*
9	Double Spring East	6/25/2003	-	-	-	-	
10	Dry Creek	6/25/2003	NS	NS	NS	NS	
11	Blue Sink	6/25/2003	-	-	-	-	
FB	Field Blank	6/25/2003	NS	NS	NS	NS	

* Very Dark coloration to the elutant. Large very broad peak across the entire dye scan.

Symbol	Definition
-	No Dye Present
+	Positive Fluorescence Signature
++	Strong Positive Fluorescence Signature
+++	Very Positive Fluorescence Signature
++++	Spectacularly Positive Fluorescence Signature, Analyzed Under Low Sensitivity
+++++	Dilution Required
?	Fluorescence is Not the Dye of Interest or Concentration too Low for Positive Identification
NS	Detector Not Sent