

Water Quality Monitoring Program

Second revised version placed in the Public Document Repository on September 30, 2009

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D. Wayne Loveday

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9.30.2009

Date



The 7 Elements of a Proper MOM Program KUB's Water Quality Monitoring Program

1. Utility Specific

Knoxville Utilities Board developed this Water Quality Monitoring Program to help improve the quality of waterways in our service area. It will be used to assess the impact of Unpermitted Discharges and to help protect the environment and public health in the Knoxville area.

2. Purposeful

This program will help identify Unpermitted Discharges that may impact the quality of nearby waterways and help mitigate sources that contribute to water quality issues. Information from this program will be used to investigate and help minimize the possibility of any Unpermitted Discharges from affecting the nearby environment or public health.

3. Goal-Oriented

KUB will evaluate information provided by the program and use it over time to determine and eliminate sources of Unpermitted Discharges impacting water quality. Improved water quality is the ultimate goal. Identifying potential sewer problems needing corrective action and elimination of the environmental impacts associated with overflows are the immediate goals.

4. Performance Measures

KUB will assess water quality data on a routine basis. Identified sampling points will be monitored over time to determine if water quality criteria are being met. Any areas not meeting these standards will be evaluated more closely to identify needed action.

5. Periodically Evaluated

KUB will review the Water Quality Monitoring Program annually and amend it as necessary. Reviewers will include individuals involved in sampling, analysis and data evaluation, as well as personnel key to identifying and correcting issues that impact water quality.

6. Available in Writing

Hard copies and electronic versions of this program or any revisions to it will be distributed to any employee involved with the program. This document will also be maintained in the Public Document Repository on the KUB website.

7. Implemented by Trained Personnel

All KUB personnel or any contractor personnel involved in this program will be trained in the program requirements before implementation. Training will include an overview of the program's purpose and goals and an outline of activities related to the individual components of the program. Personnel involved in specific activities will receive additional training on the requirements related to sampling, analysis and reporting.

Training will be conducted annually after the first year or whenever the Water Quality Monitoring Program is revised.

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Water Quality Monitoring Program

I. Scope

Knoxville Utilities Board (KUB) will maintain a Water Quality Monitoring Program to help improve the water quality of streams in our service area. This program is designed to identify Unpermitted Discharges that impact water quality. The discharges may originate at sewer pipe creek crossings or sewer locations near waterways. It will help locate and eliminate sources of those types of discharges. The program will also be used to assess the potential impact of any such discharges on the environment and public health.

II. Summary

The Water Quality Monitoring Program includes three important closely related components generate information KUB can use to improve the quality of area streams.

The **Routine Water Quality Monitoring Component** includes 24 selected sampling locations in the sewer basins of eight area creeks. Those creeks are Loves, Williams, Baker, Goose, First, Second, Third, and Fourth creeks. The sites are regularly sampled for specific water quality parameters during wet and dry conditions. The results are evaluated for potential investigation should the results exceed assessment criteria.

The **Investigative Water Quality Monitoring Component** identifies water quality problems that are a result of discharges from the wastewater collection and transmission system (WCTS) or any wastewater treatment plant (WWTP). In addition to using the data obtained from the Routine Component or other available resources, it includes whole stream investigations. The investigations involve walking surveys of the stream to gather information about the surrounding environment along with gathering samples of the stream. KUB evaluates results that exceed assessment criteria to determine the need for further investigation. Further investigation will include location and identification of the source.

The **Spill Impact Water Quality Monitoring Component** assesses any potential impacts to the environment and public health in the event of an Unpermitted Discharge during a dry weather event. KUB collects samples to determine impacts and the need for additional clean up or corrective action. This component supports the efforts of the Sewer Overflow Response Plan (SORP).

III. Program Management

The KUB Water Quality Assurance Laboratory will manage all the activities associated with this program. This program will be implemented within 60 days of EPA final approval. Individuals within this group will perform or coordinate all sampling and analysis as specified in this document. Protocols for sampling and testing will be maintained in accordance with the Laboratory Quality Assurance Plan. KUB will allow split or duplicate samples to be taken by EPA, TDEC, or their authorized representatives. In addition, EPA and TDEC have the right to take any additional samples that they may deem necessary.

In accordance with the KUB Safety Department, the following PPE should be worn during these field activities.

- Routine Creek Sampling: Steel toed safety boots, safety glasses, nitrile gloves
- Investigative Sampling: Steel-toed safety boots or waders, safety glasses, nitrile glasses as necessary
- Spill Impact Response: Steel toed safety boots, safety glasses, nitrile gloves, Safety vest, and hardhat.

Analysis procedures will be those approved for use in 40 CFR Part 136 for ambient water testing. Water quality data will be maintained in the Laboratory Information Management System (LIMS). Any additional information related to water quality investigations or source tracking will be maintained in a separate information management system that can be referenced and used to track corrective actions by laboratory personnel or the Collection System Improvement (CSI) team.

All water quality data obtained through this program will be reported on a quarterly basis according to the requirements of Section XIX of the Consent Decree. This report will include the following:

- Actions taken under the Water Quality Monitoring Program during the previous calendar quarter, including dates and times of all sampling
- A summary of all sampling results during the previous calendar quarter
- Actions including, but not limited to, data collection, which are scheduled for the next calendar quarter.

IV. Monitoring Areas

Several area creeks travel through the geographical area of Knox County and nearby counties. Eight of those creeks are located in the main service area of the KUB WCTS. They are Loves, Williams, Baker, Goose, First, Second, Third, and Fourth creeks. Those creeks will be the focus of water quality monitoring efforts in the routine, investigative, and spill impact program components. Monitoring of other small tributaries or waterways will be included if impacted by sanitary sewer overflows (SSOs) or other water quality concerns arise. The map provided in Appendix A shows the relative locations of each stream in relation to the KUB sewer basins. All monitoring locations will be mapped

through the use of the Knoxville-Knox County-KUB Geographical Information System (KGIS).

V. Routine Water Quality Monitoring Component

1. Monitoring Locations

The purpose of the Routine Water Quality Monitoring Component is to detect Unpermitted Discharges originating at or in proximity to stream crossings or other remote sewer locations. The eight area creeks, noted previously, traverse the main service area of the KUB WCTS. They will be sampled each month during both dry and (when applicable) wet weather conditions to monitor water quality on a consistent and regular basis. Three monitoring points along each stream have been identified as routine sampling sites, depending on drainage configuration, length of the stream, surrounding properties, and nearby sewer crossings. Table 1 shows these sampling locations by mile from the mouth of the creek. The mile numbers are approximate but are used as a Site Number for easy reference. The KGIS coordinates given in Table 2 are used to track and map the actual locations.

The site maps produced by KGIS and used for reference by KUB sampling personnel are included in Appendices B through AF. The aerial maps show the sampling locations relative to sewer crossings and surrounding structures or properties. The basin maps provide a broader view of the whole sewer basin and current monitoring points. KGIS is used to maintain these documents and other maps with more detail as needed.

Table 1.
Sample Locations by Creek Mile or Site Number

<i>Creek Name</i>	<i>Creek Mile #</i>	<i>Creek Mile #</i>	<i>Creek Mile #</i>
First Creek	1.74	2.57	6.33
Second Creek	0.30	1.54	5.76
Third Creek	0.87	2.08E	4.80W
Fourth Creek	1.75	2.79	3.29
Baker Creek	0.36	0.53	1.45
Goose Creek	0.40	1.19E	1.80E
Loves Creek	0.85	1.89	3.45
Williams Creek	0.89	1.70	2.02

Table 2.
Sample Locations by KGIS Coordinates

Creek Name	Creek Mile #	Longitude	Latitude
First Creek	1.74	-83:54:48.22	35:58:47.10
	2.57	-83:54:55.70	35:59:18.85
	6.33	-83:55:34.11	36:1:20.01
Second Creek	0.30	-83:55:25.31	35:57:30.09
	1.54	-83:55:49.21	35:58:28.04
	5.76	-83:58:26.25	36:0:35.33
Third Creek	0.87	-83:56:28.28	35:57:10.63
	2.08E	-83:57:14.50	35:57:53.34
	4.80W	-83:59:30.63	35:58:5.48
Fourth Creek	1.75	-83:59:56.70	35:55:32.66
	2.79	-84:0:26.43	35:56:9.13
	3.29	-84:0:4.15	35:56:29.72
Baker Creek	0.36	-83:53:21.43	35:57:27.17
	0.53	-83:53:22.45	35:57:20.03
	1.45	-83:53:47.99	35:56:43.42
Goose Creek	0.40	-83:55:7.24	35:56:31.14
	1.19E	-83:54:55.44	35:56:7.03
	1.80E	-83:54:37.44	35:55:41.02
Loves Creek	0.85	-83:50:19.29	36:0:30.63
	1.89	-83:51:16.58	36:0:55.79
	3.45	-83:52:10.62	36:1:59.25
Williams Creek	0.89	-83:52:55.34	35:58:12.48
	1.70	-83:53:14.34	35:58:50.46
	2.02	-83:53:21.82	35:59:6.62

2. Sampling

Monitoring will be performed over time during dry and wet weather periods to gather data under both conditions. Twenty-four samples will be collected and examined each month. If possible, efforts will be made to sample under dry conditions that are preceded by four or more days of no rainfall. Efforts will also be made to sample under wet conditions that occur during an inch or more of rainfall or as soon thereafter as practical. That approach will help KUB more easily separate the water quality impacts related to runoff and capacity from those related to dry weather SSOs and leaking sewer crossings.

Testing will include field measurements for water temperature, dissolved oxygen, and pH during sample collection. The KUB Water Quality Assurance Lab will conduct fecal coliform and *E. coli* bacteria analysis on creek water samples within the holding time per requirements in 40 CFR Part 136. Field documentation will be maintained for the following:

- Sample location

- Sample date and time
- Sampler's name
- Any field test data performed on the sample
- Weather conditions and any observations made.

3. Assessment

KUB will verify all results and associated quality assurance practices for accuracy and record results into the LIMS. Results will be assessed against the Water Quality Criteria Standards included in the latest version of the Tennessee Department of Environment and Conservation (TDEC) Rules on General Water Quality, specifically Section 1200-4-3-.03(4)(f). If the bacteriological counts exceed the current Water Quality Standard for recreational waters, KUB will review field information for unusual conditions in the stream. Locations found to exceed the criteria more than once during the quarter will be categorized as under "investigation" and undergo further examination in accordance with the protocol outlined in the Investigative Water Quality Monitoring Component. That component will determine what corrective actions, if any, are needed to eliminate the source of the pollution.

VI. Investigative Water Quality Monitoring Component

1. General Information

The goal of this component is to determine whether the WCTS and/or any WWTP is a source of pollution identified through the routine water quality monitoring component, spill component, or other valid means of identifying water quality concerns. KUB developed an investigative monitoring component that will help fulfill this purpose and determine whether the pollution is related to sewer or non-sewer related sources.

Each creek included in the Routine Monitoring Component will be included in the study. Other tributaries located within the KUB collection system boundaries will also be considered if concerns are identified.

This component will begin after final approval and implementation of the Water Quality Monitoring Program. The overall timeframe of this component will work in conjunction with the timeframe of activities associated with the Continuing Sewer System Assessment Program (CSSAP).

2. Methodology

This component is addressed through dry and wet weather stream investigations with a follow-up "location of source release" monitoring plan if a water quality standard violation is discovered. There are two elements to the Investigative Monitoring Component: (a) Dry Weather Investigative Monitoring and (b) Wet Weather Investigative Monitoring. In either case, areas identified to have water quality concerns will be thoroughly investigated to determine the source of the

impact. Figures 1 and 2 outline the steps associated with each of the elements, which are described in more detail in the following sections.

2.1 Dry Weather Investigations

For dry weather investigations, sampling will be initiated in three ways: (1) findings from the routine monitoring component during dry weather, (2) subsequent Dry Weather Investigative Monitoring, which is described below, or (3) other valid means of identifying areas of water quality concern, such as Spill Impact Monitoring. The purpose of dry weather investigations is to detect chronic line leaks.

2.1.1 Dry Weather Investigative Monitoring

Any water quality monitoring results determined to exceed the Water Quality Criteria Standards included in the latest version of the Tennessee Department of Environment and Conservation (TDEC) Rules on General Water Quality, specifically Section 1200-4-3-.03(4)(f) more than twice in a calendar quarter will be investigated. Investigation will include a review of nearby watershed characteristics and all existing water quality characterization data for the area in question. A dry weather walking survey will be performed for the portion of the stream under assessment to help identify existing and potential pollutant sources within the area and to collect additional samples.

Field Investigation

Before the field walking survey, the sampling team will review all relevant data concerning the condition of the area under investigation. This review will familiarize the team with the known issues in the nearby area and provide helpful background information concerning what to expect as the segment is walked.

During the dry weather walking survey, field personnel will document the condition of the stream that is sampled, including observations such as land use characteristics, cursory wildlife activity, notable point source and non-point source pollutant sources, etc. Photographs will also be taken of all potential site-specific point and non-point pollutant sources. These photographs will be linked to observations in a project database based on KGIS mapping location.

Water quality monitoring/sampling will be performed following these guidelines:

- Beginning just downstream from the monitoring location known to violate the water quality standard initially and continuing upstream above the nearest sanitary sewer crossing
- At a minimum at least one mile upstream
- At a minimum, four samples per mile.

Water quality monitoring/sampling will include the following parameters at each location meeting the above guidelines:

- Dissolved oxygen (DO)
- pH
- Temperature
- Silt level (noted on a scale of 1-3)¹
- Fecal coliform (FC).

Additional water quality sampling data may also be collected at various locations under investigation if further source identification is necessary. The additional sampling may include the following:

- PCR (Polymerase Chain Reaction) – This analysis will be performed for some locations when additional information is needed to identify the origin of high bacteria concentrations identified during the investigations
- Other source identification methodologies.

2.1.2 Assessment

All results and associated quality assurance practices will be verified for accuracy and reported to the LIMS. If the fecal coliform counts exceed 1000 cfu/100 ml, the site will be investigated further by the methodology described in Section 2.3 Location of Source Release.

Documentation will be maintained in hard copy and in an information management system for all activities (investigation maps, field notes, sampling notes, sample chain of custody forms, sample analysis forms, sample dilution calculation sheets, etc.) for review and reference.

2.2 Wet Weather Investigations

As with the dry weather monitoring, these investigations will be initiated in one of three ways; (1) findings from the Routine Monitoring component during wet weather, (2) subsequent Wet Weather Investigative Monitoring, which is described below, or (3) other valid means of

¹ This is an investigator-dependent observation. It is used purely to approximate the silt level in each sample collected and is recorded to provide an idea of the siltation present when the sample is collected for correlation with bacteria concentrations.

identifying areas of water quality concern. The purpose of wet weather investigations is to detect capacity problems.

2.2.1 Wet Weather Investigative Monitoring

Investigations will be performed on monitoring locations found to violate water quality standards during wet weather situations. For the wet weather investigations, sampling will be conducted under specific rainfall conditions if at all possible and based on stream-segment specific assessments. Two rainfall events will be monitored for any area under evaluation.

Field Investigation

Before any wet weather investigation is performed, the sampling team will evaluate all relevant data on the condition of the area possibly compiled during the Dry Weather Investigations. A wet weather investigation map will be created for use by field personnel. The map will identify all relevant information, including sampling points, any nearby areas of concern within the collection system, and any other known potential pollutant source, etc. Additionally, detailed note sheets will be developed for both sampling sites and for potential pollutant source sites.

Field personnel will monitor various predictive rainfall models and will make a go/no-go decision whether the event is sufficient to meet necessary rainfall intensity/totals criteria. Preliminary criteria will be an event predicted to include 1-inch or greater rainfall within a 24-hour period. If the event is determined to meet criteria, samplers will be mobilized for the investigations. If the total rainfall of the event does not meet criteria, the event data will still be used for investigation.

Samplers will be assigned nearby monitoring locations based on potential source locations related to either known SSOs or other potential sources identified during the Dry Weather Investigations. Additionally, an individual will monitor weather conditions during each rainfall event to keep all investigators apprised of weather conditions during the events.

The identified points within each watershed will be visited at various periods during the rainfall event. The first visit will be made as the event begins or as soon thereafter as practical. That will allow investigators to collect early water quality samples from the sampling locations and will also give investigators the opportunity to evaluate the condition of all potential source locations prior to rainfall impacts.

The second key sample collection will be made around the peak flow of the stream. This will be determined by in-stream stage observations or by weather monitoring personnel. Finally, two more samples will be collected in the latter portion of the event when SSOs are more likely to occur.

During each sampling event, samples will be collected at designated sampling locations and all potential source sites will be visited. Detailed notes for both sampling sites and observation sites will be maintained for each visit. As indicated previously, a minimum of four fecal samples will be collected from each location to be investigated during the wet weather event.

Water quality monitoring/sampling will include the following parameters at each location:

- Dissolved oxygen (DO)
- pH
- Temperature
- Silt level (noted on a scale of 1-3)¹
- Fecal coliform (FC).

Additional water quality sampling data may also be collected at various locations under investigation if further source identification is necessary. The additional sampling may include the following:

- PCR (Polymerase Chain Reaction) – This analysis will be performed for some locations when additional information is needed to identify high bacteria concentrations found during the investigations
- Other source identification methodologies.

2.2.2 Assessment

All results and associated quality assurance practices will be verified for accuracy and reported to the LIMS. If the fecal coliform counts exceed 1000 cfu/100 ml, the site will be investigated further by the methodology described in Section 2.3 Location of Source Release.

All activities, investigation maps, field notes, sampling notes, sample chain of custody forms, sample analysis forms, sample dilution calculation sheets, etc. will be maintained in hard copy and in an information management system for review and reference.

2.3 Location of Source Release

The Location of Source Release examination is the next step when a fecal coliform investigative monitoring result exceeds 1000 cfu/100 ml during Dry or Wet Weather Investigative Monitoring. The task will address site-specific water quality issues by initiating a more detailed level of investigation for any stream segment in question.

As Figures 1 and 2 indicate, the Location of Source Release task will include additional sampling and field investigations to identify the source the contamination. At this point, *E. coli* will be added to the suite of samples for this procedure. The first step will be to develop a map identifying the location of the Water Quality Standards (WQS) violation along with all known potential sources upstream of the location. Additionally, the map will identify the next point sampled upstream that is not in violation of the WQS.

If the segment upstream of the WQS violation is short enough, investigators may skip to the next step. Otherwise, additional locations upstream of the WQS violation will be monitored so that the segment, which includes the source of the WQS violation, may be further isolated. Additional samples will be collected at the point in violation and the additional points within the segment. This will allow investigators to further reduce the length of segment where the source is located.

Next, investigators will perform a field and data investigation of the segment in violation to identify the source of impact. If the source can be identified, investigators will determine if the source is the KUB WCTS or a WWTP. If the source is the WCTS or a WWTP, the appropriate department will be notified for further action or repair. Once the corrective action is complete, the investigative team will re-sample the segment in question to ensure the water quality concern has been addressed. If the resample is not in violation of the WQS, the issue will be closed and results reported.

If the resample remains in violation of the WQS, additional sampling will be performed to further characterize the source of the WQS violation. This step will include additional microbial source tracking (MST) techniques, including but not limited to Polymerase Chain Reaction (PCR) testing. Those tests will indicate whether the source is human or non-human related. If the source is non-human, the results will be reported and the site-specific investigation will be closed.

If a human source is identified, investigators will notify the appropriate KUB department to request television and/or smoke testing for the sewer segments along the reach of the stream. Once again, if the source is located and identified to be a KUB source, the appropriate department will be notified for repair. Once the repair is completed, the resample process will be initiated once again to confirm corrective action.

If the source is found not to be from the WCTS or a WWTP, the investigative process for that site will be deemed complete. The results will be logged and reported and the appropriate agency will be notified for further source investigation. The agencies could include the City of Knoxville, the Knox County Public Health Department, the Knox County Phase 2 MS4 program, and the local TDEC office.

Figure 1

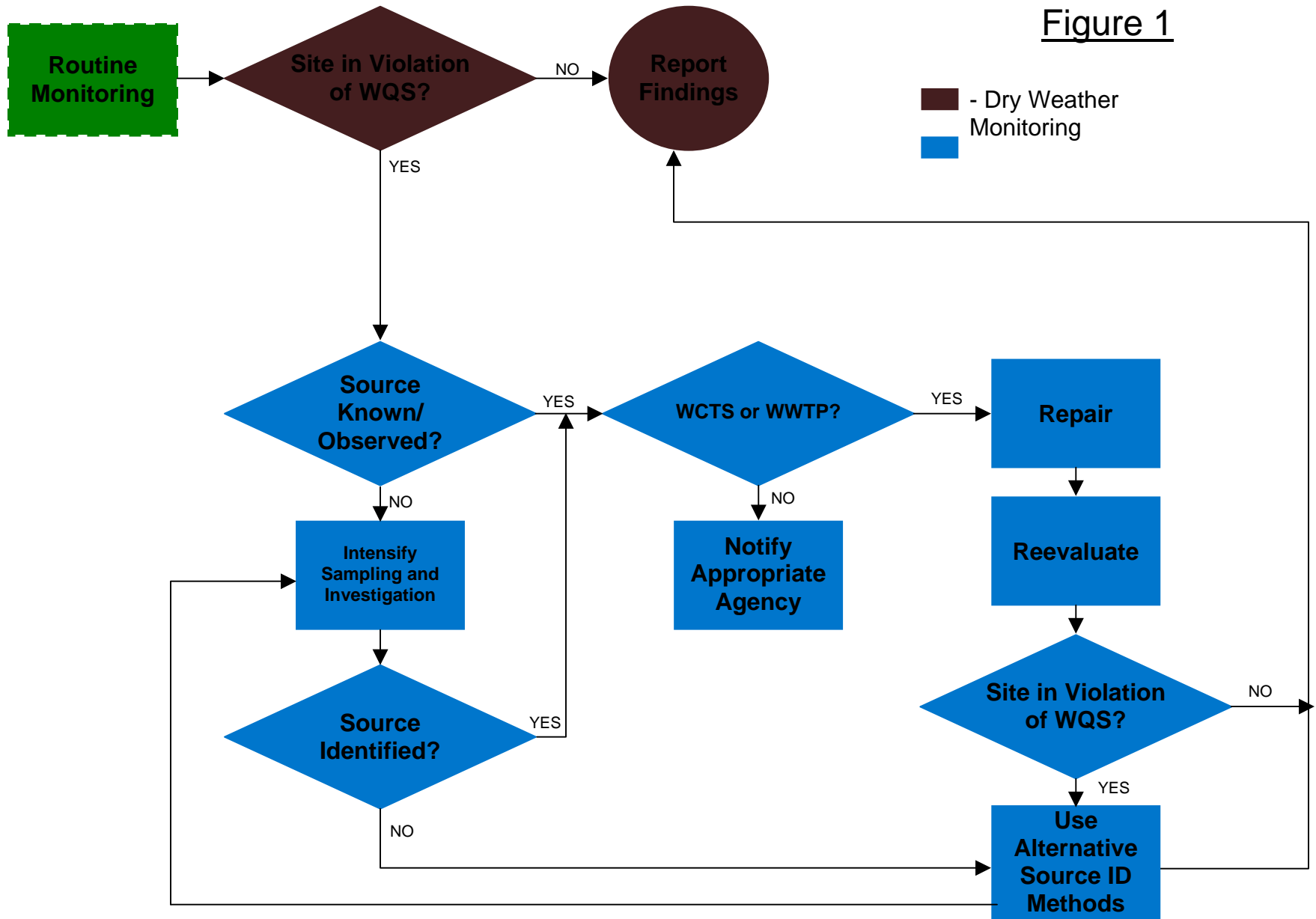
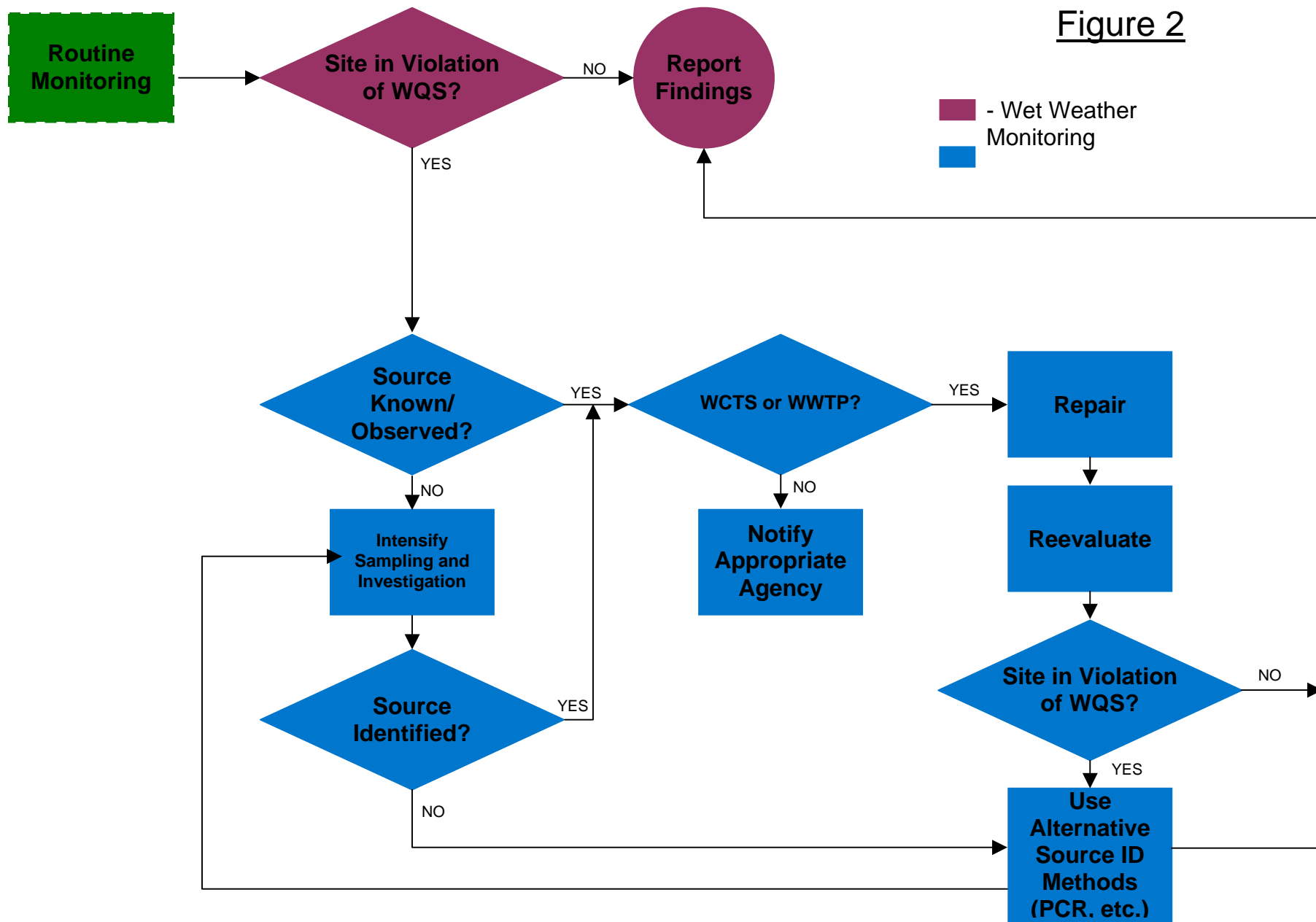


Figure 2



VII. Spill Impact Water Quality Monitoring Component

1.0 General Information

This component of the Water Quality Monitoring Program is used to assess any impacts from Unpermitted Discharges on the environment and public health. It will be limited primarily to dry weather events where material from a SSO could reach the waters of the state. Dry weather monitoring is required whenever the impacted areas include streams, creeks, storm waters or obvious paths to those waterways that could impact public safety. Monitoring may be performed during wet weather conditions after serious consideration of site assessment and public safety concerns.

Spill Impact Monitoring is performed in conjunction with the activities outlined in the SORP after the impacted area has been identified. If containment of an SSO is feasible, sampling may not be necessary at all. All sampling and analysis will be performed by the KUB Water Quality Assurance Laboratory and results maintained for retrieval if necessary.

2.0 Methodology

The SORP requires that the First Responder to an SSO identify the impacted area. In doing so, the Responder assesses the environmental concerns and potential hazards to public health in the surrounding area. Factors considered in determining the appropriate action are nearby waterways, stormwater infrastructure, private property, public safety and public accessibility. The decision and action protocol associated with Spill Impact Monitoring is outlined in Figure 3.

First Responders will make every effort to contain the spill to prevent any impacts. If the material cannot be contained adequately and has the potential to contaminate nearby waterways during dry weather conditions, the Responder must notify Water Quality Assurance Lab personnel to request Spill Impact Sampling. During wet weather conditions, the Responder must notify Water Quality Assurance Lab personnel for further guidance on sampling if the material cannot be contained adequately, has the potential to contaminate nearby waterways, or create a hazard to public safety during wet weather conditions that would not be communicated under current SORP posting requirements.

Water Quality Assurance Lab personnel will use the KGIS mapping system and information provided by the First Responder to assess the situation. They will also determine if any Significant Industrial Users (SIUs) of the WCTS are upstream of the SSO. That will determine the monitoring requirements. The maps included in appendices AG-AN

provide an example of how all SIUs can be identified in relation to the overflow location.

If no industries are upstream, sampling personnel will collect samples for fecal coliform and *E. coli*, and test the waterway for pH, water temperature, and dissolved oxygen upstream and downstream of the spill. The exact sampling locations will be based on the flow of the stream, the size of the waterway and nearby public access areas. If industries are upstream of the spill, samples will also be collected for all Priority Pollutants known to be present in the wastewater of those SIUs. Regulated Industrial Priority Pollutants are identified in Tables II and III of Appendix D in 40 C.F.R. Part 122.

Monitoring will be performed and results reported as soon as possible. The results will be used to assess the initial spill impact for posting and reference purposes.

Underground Construction Department personnel will perform the necessary cleanup procedures as described in the SORP and will notify Water Quality Assurance Lab personnel after cleanup is complete. Sampling personnel will return to the area after remediation and collect samples again both upstream and downstream of the SSO location.

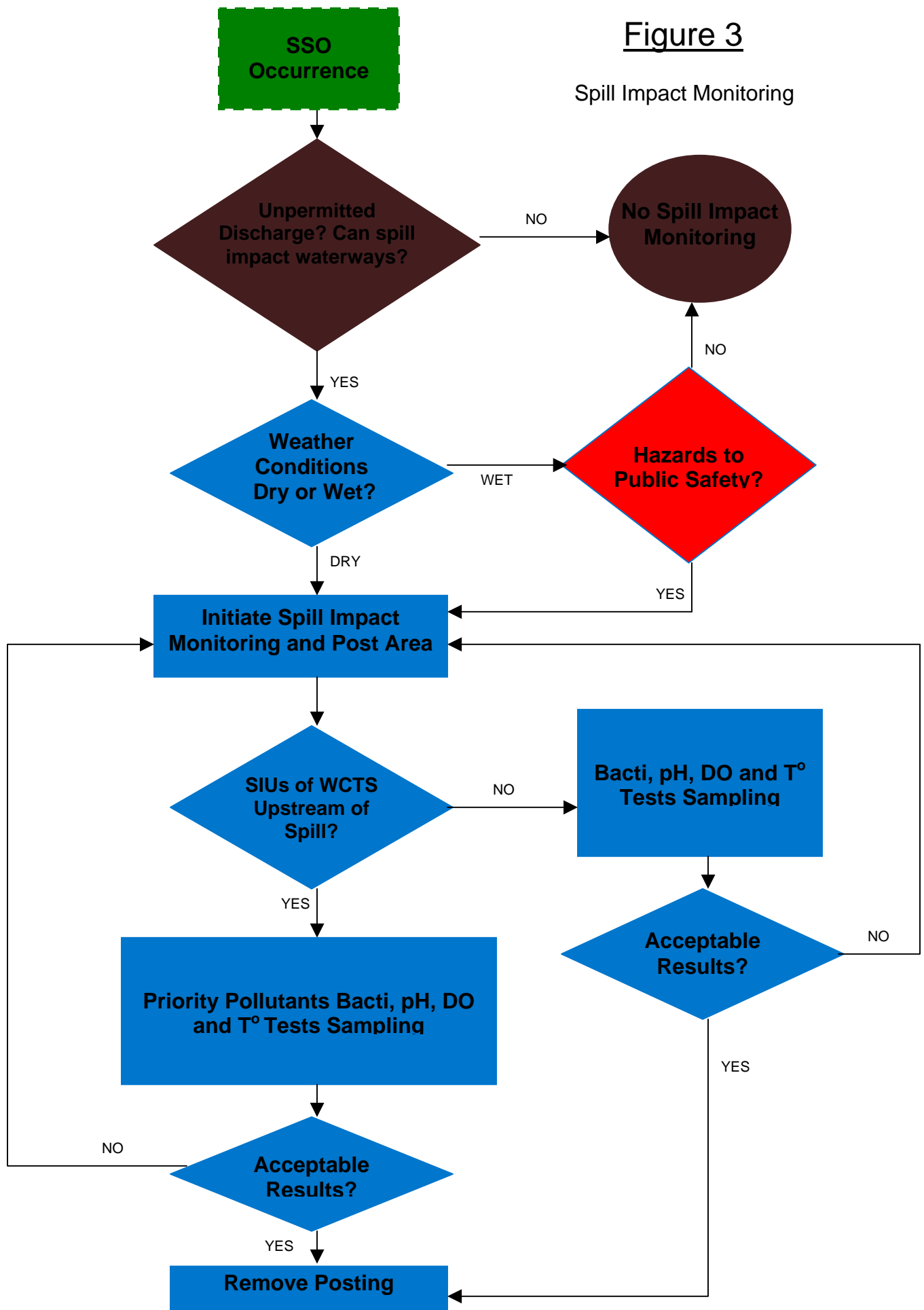
If pollutant levels downstream are lower or equal to those obtained upstream, no further sampling or analysis will be necessary.

If pollutant levels downstream are higher than those obtained upstream, repeat sampling will be performed and area notification maintained.

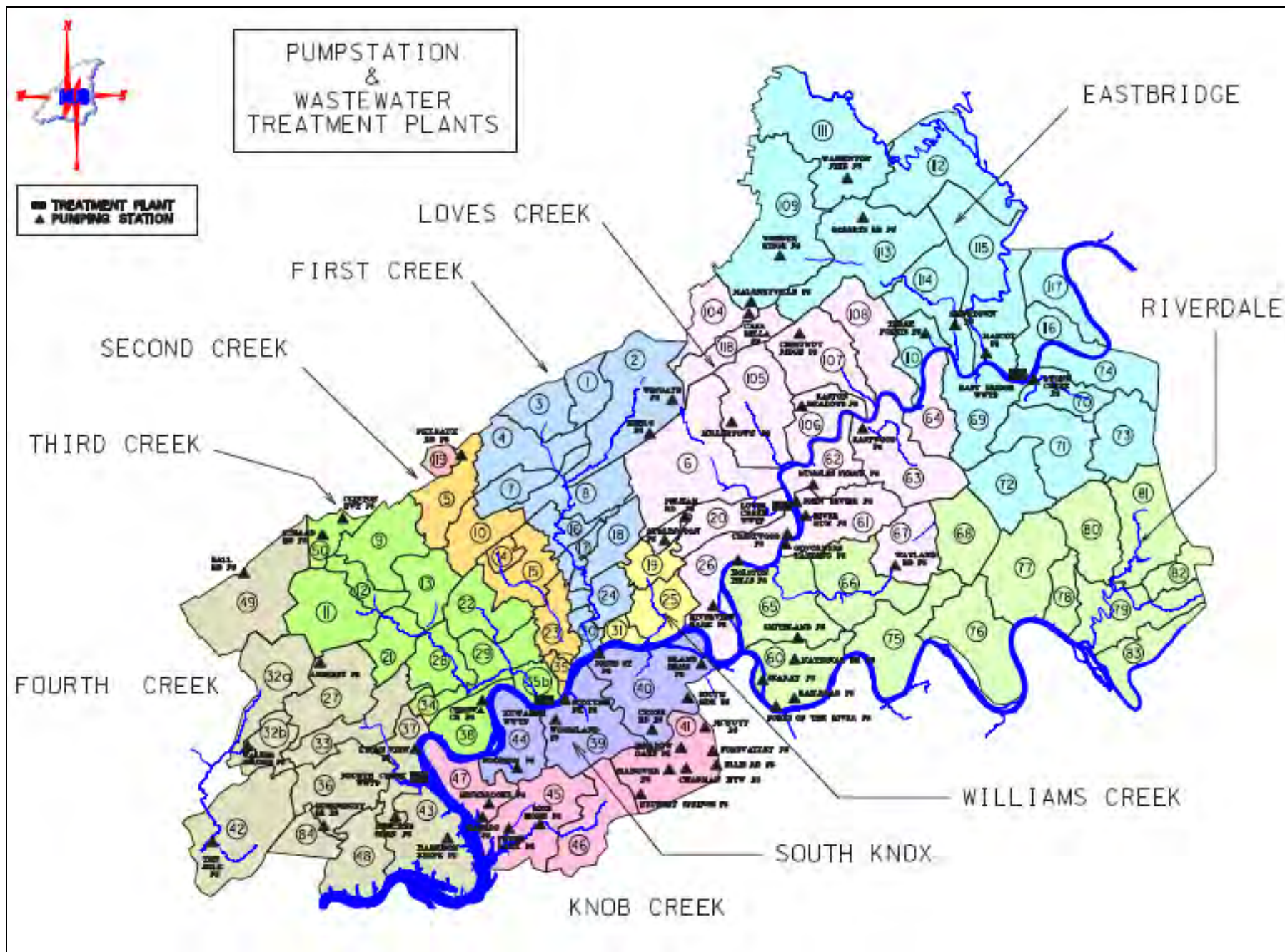
If bacteriological counts downstream continue to be higher than those obtained upstream after repeat sampling, the site will be evaluated according to protocol in the Investigative Water Quality Component of this monitoring program.

Figure 3

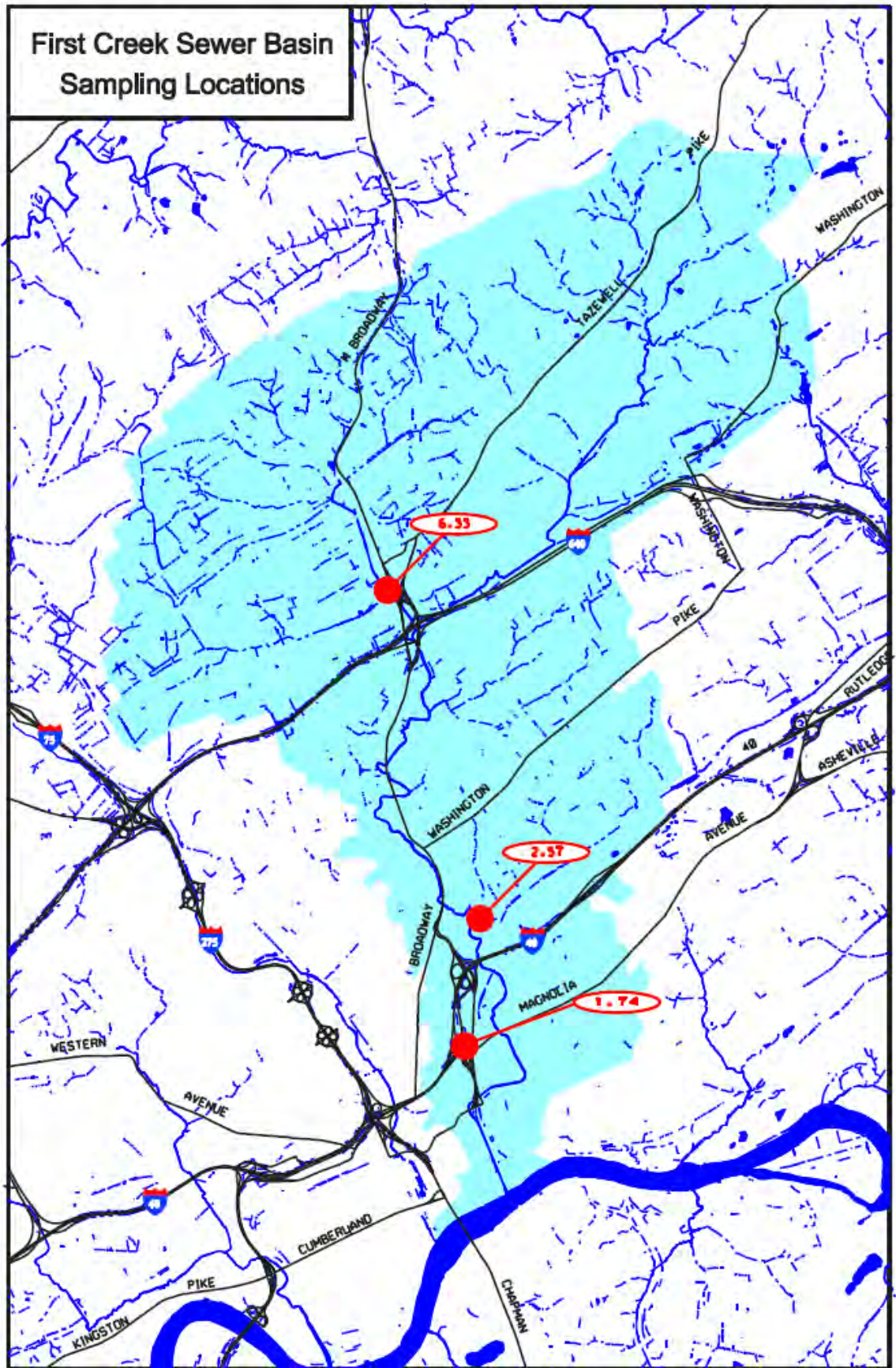
Spill Impact Monitoring



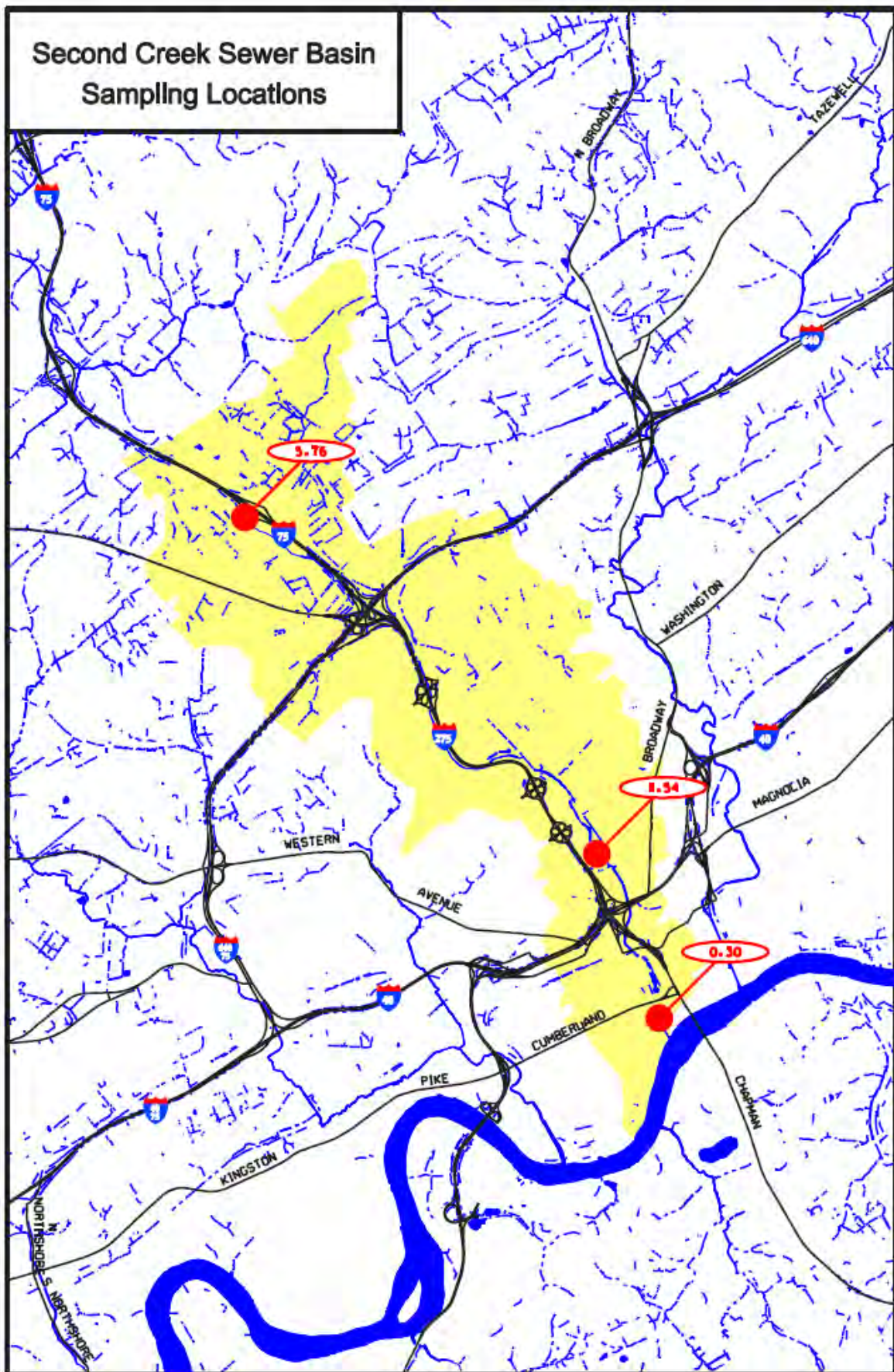
Appendices



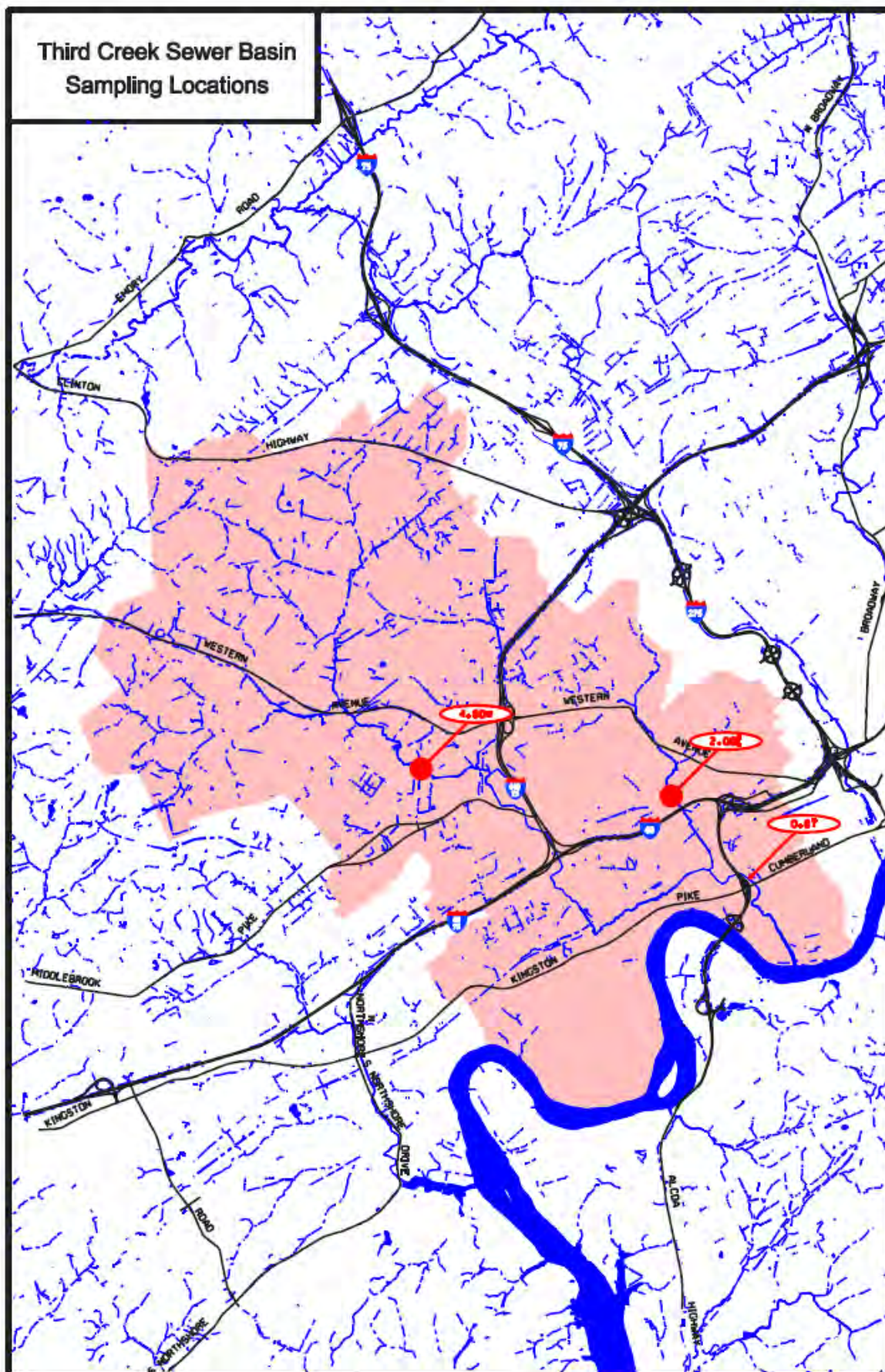
Appendix A
KUB Sewer Basin Map



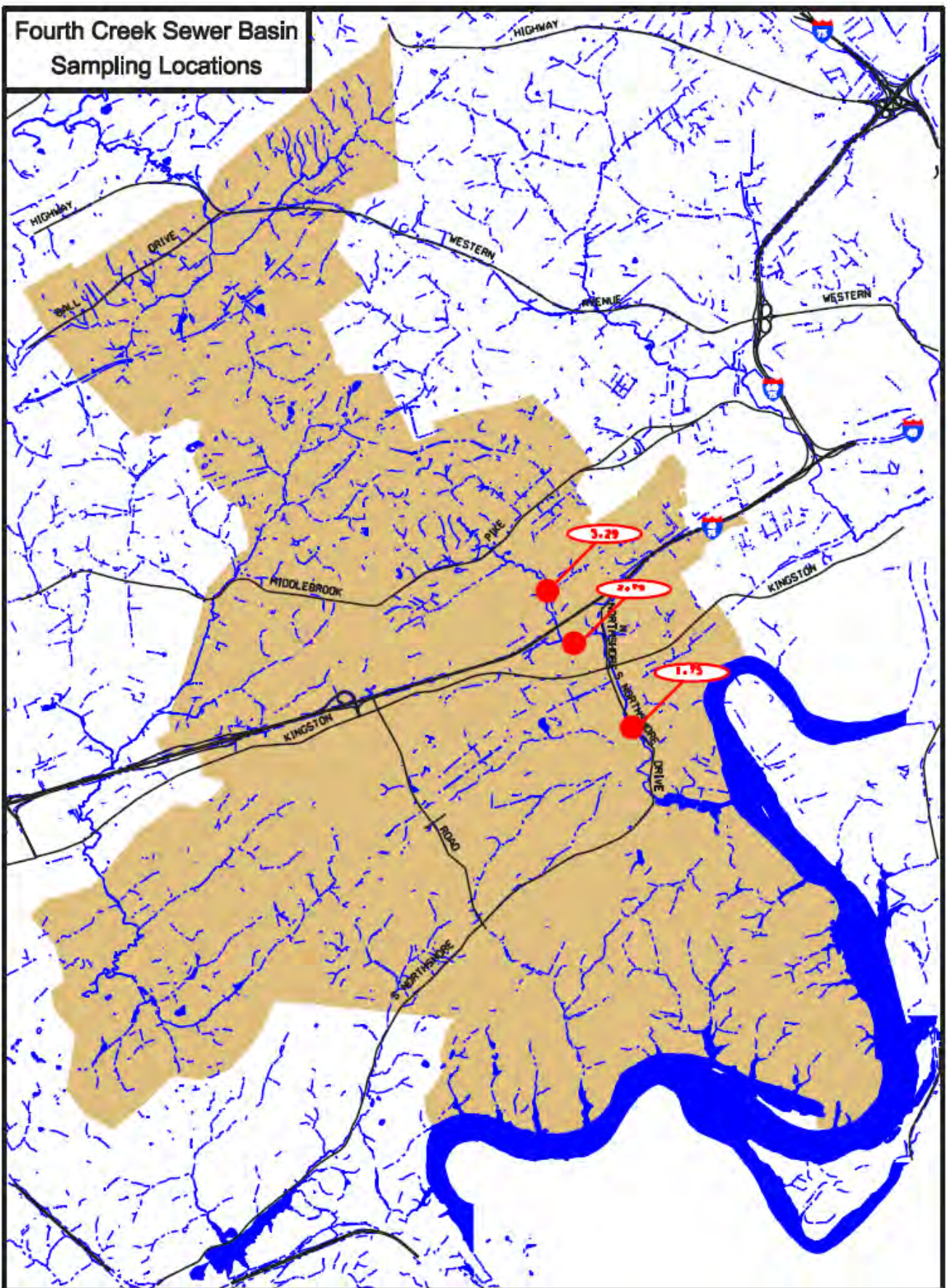
Appendix B
First Creek Basin Map



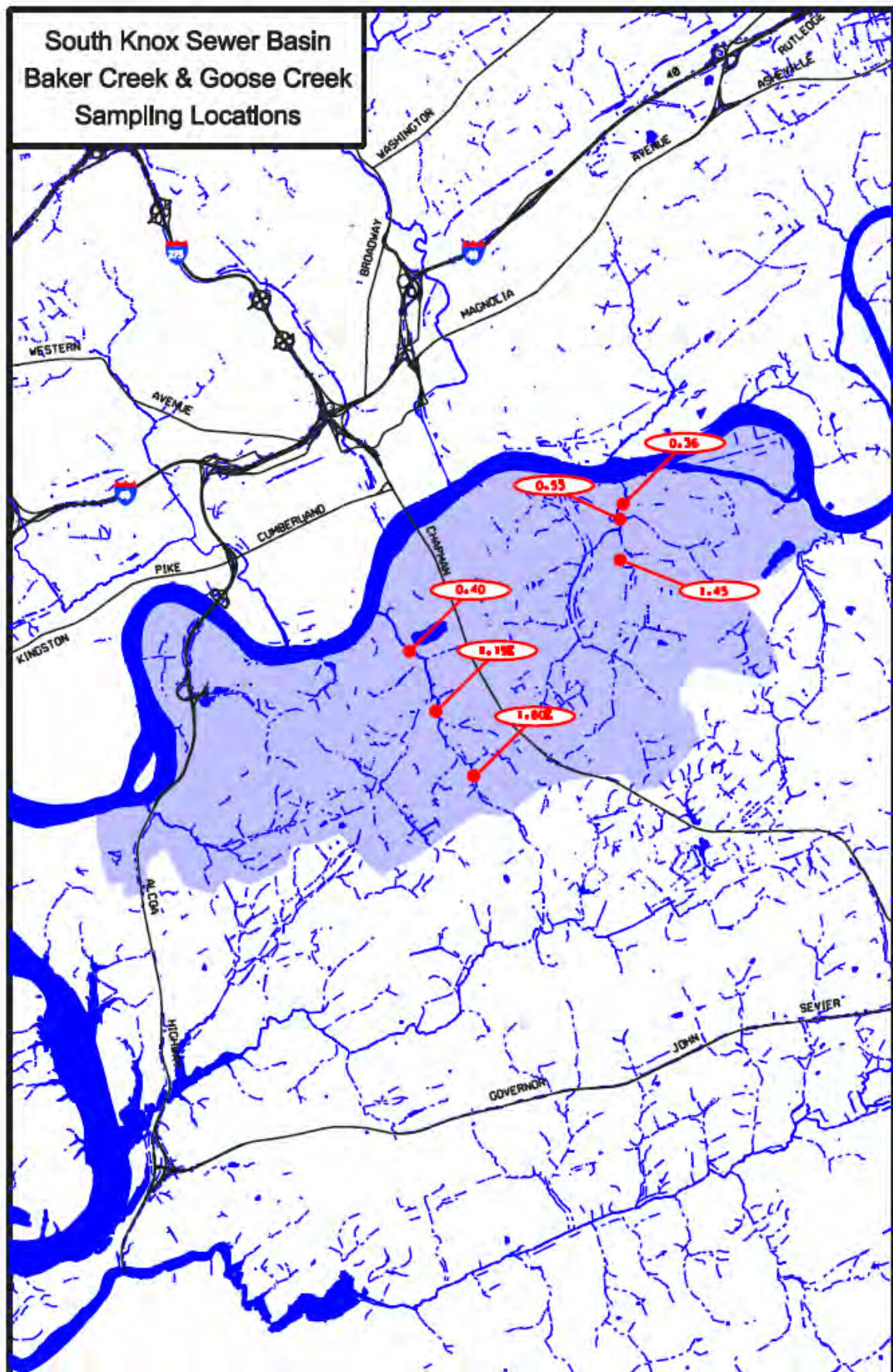
Appendix C
Second Creek Basin Map



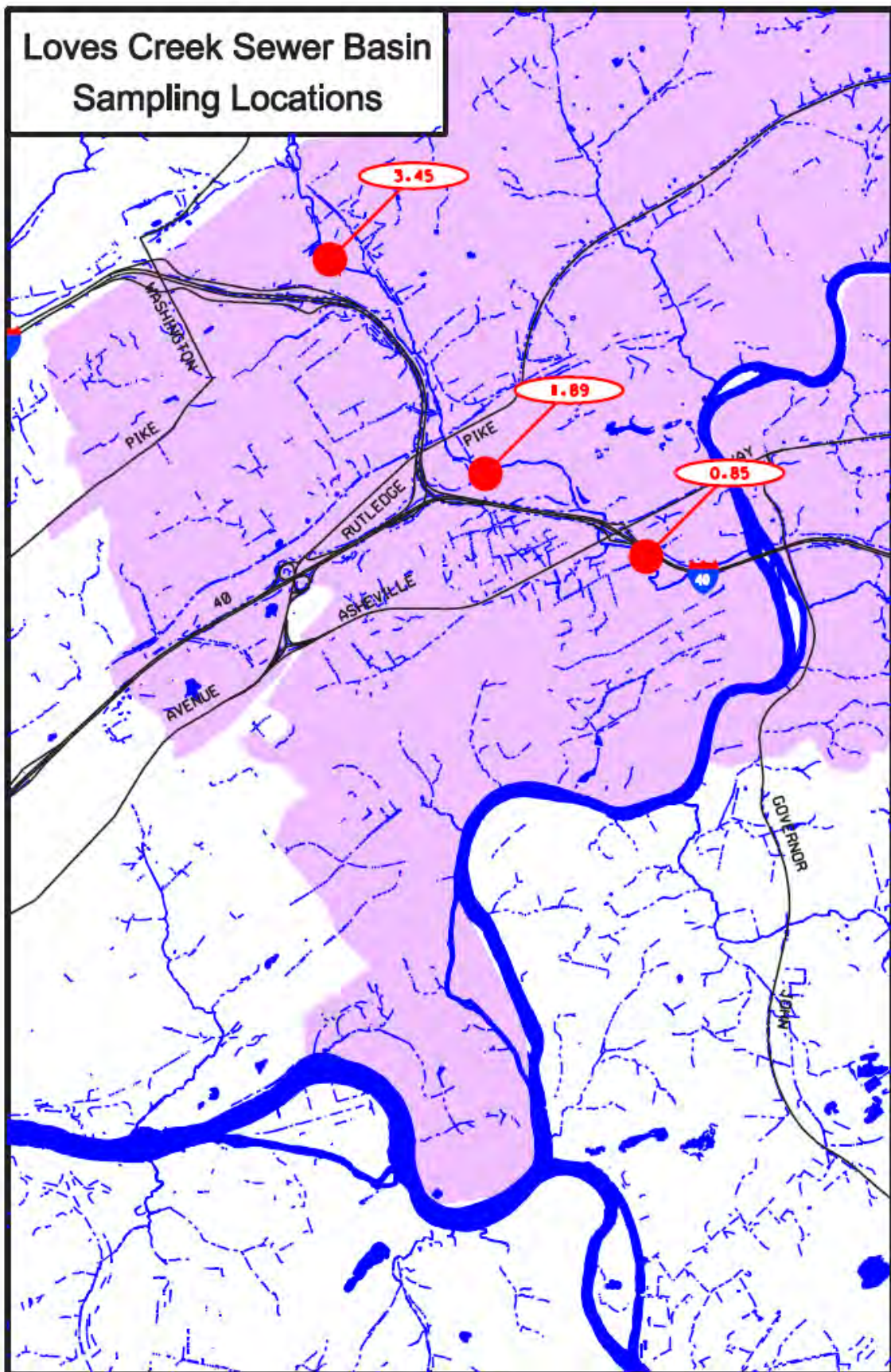
Appendix D
Third Creek Basin Map



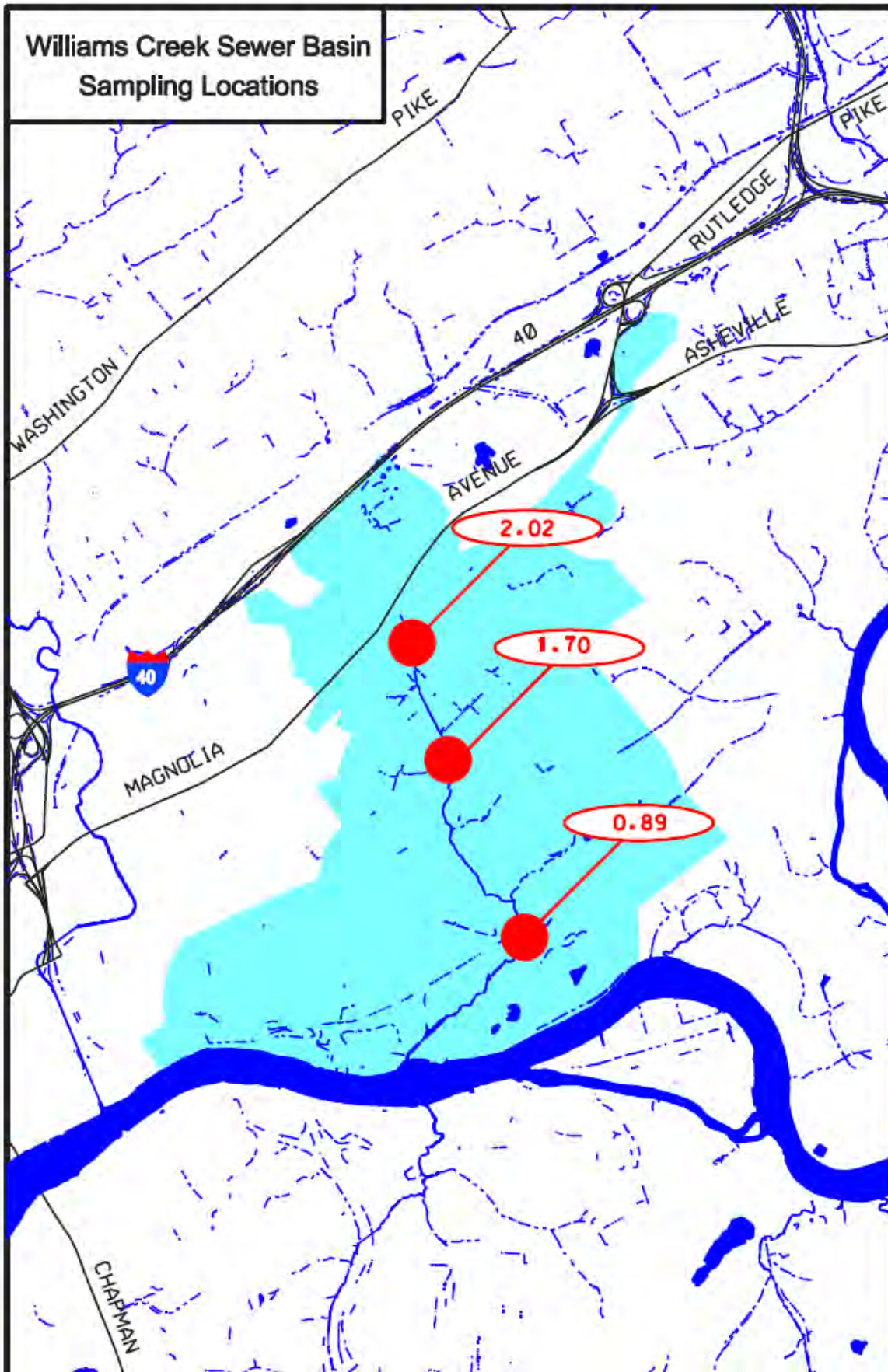
Appendix E
Fourth Creek Basin Map



Appendix F
South Knox Sewer Basin Map



Appendix G
Loves Creek Basin Map



Appendix H
Williams Creek Basin Map



Appendix I
First Creek Sampling Site 1.74



Appendix J
First Creek Sampling Site 2.57



Appendix K
First Creek Sampling Site 6.33



Appendix L
Second Creek Sampling Site 0.30



Appendix M
Second Creek Sampling Site 1.54



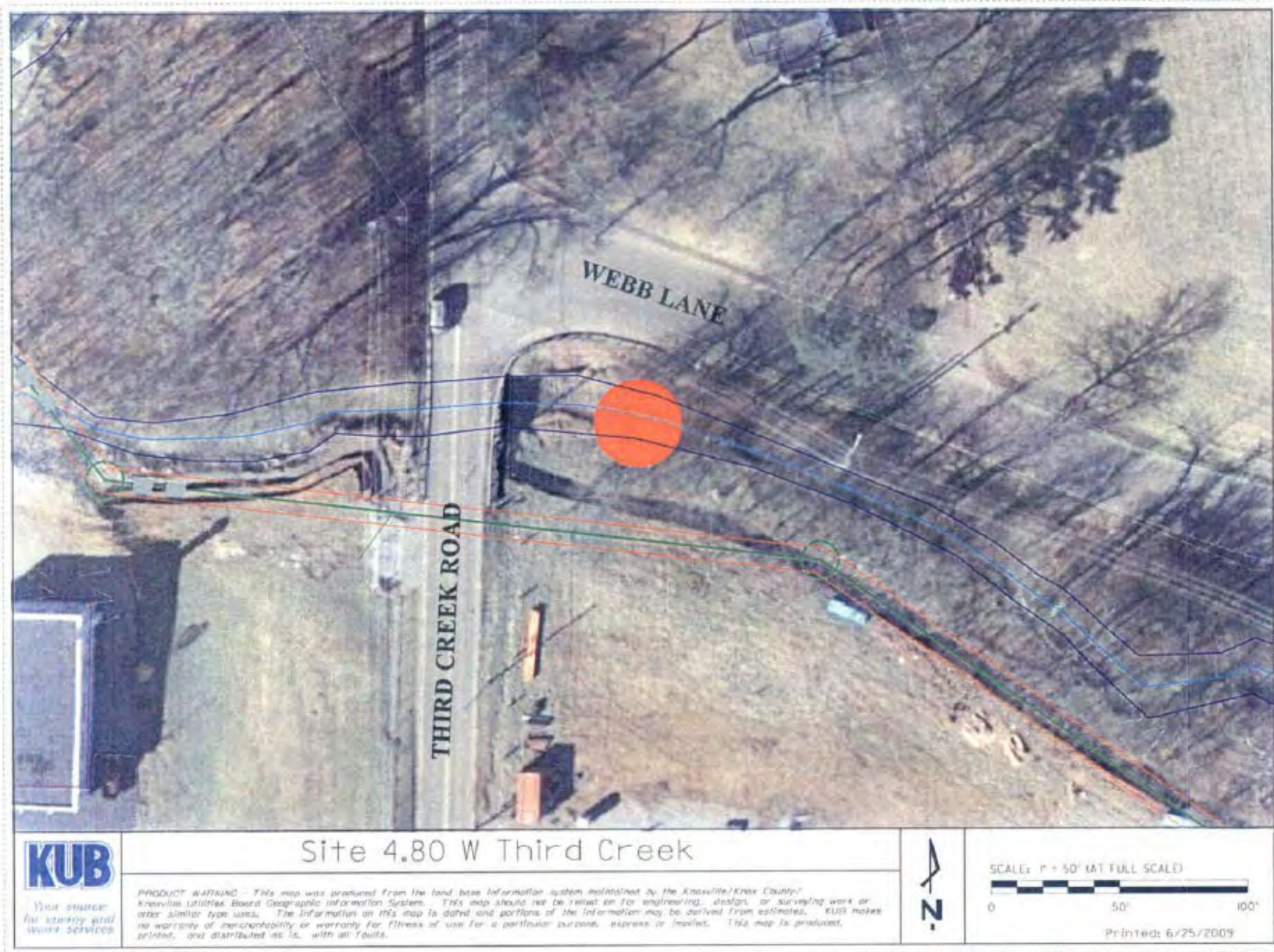
Appendix N
Second Creek Sampling Site 5.76



Appendix O
Third Creek Sampling Site 0.87



Appendix P
Third Creek Sampling Site 2.08E



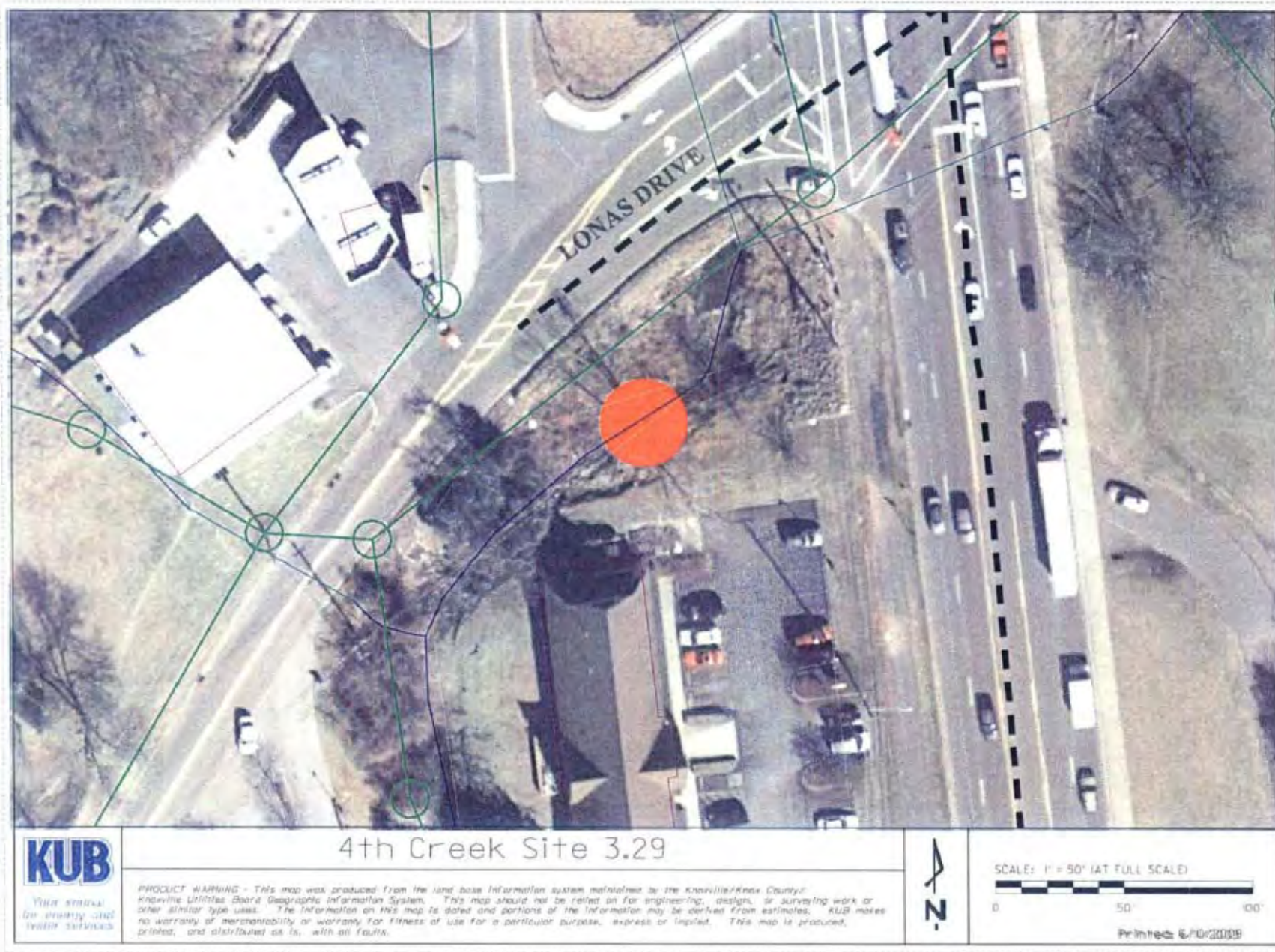
Appendix Q
Third Creek Sampling Site 4.80W



Appendix R
Fourth Creek Sampling Site 1.75



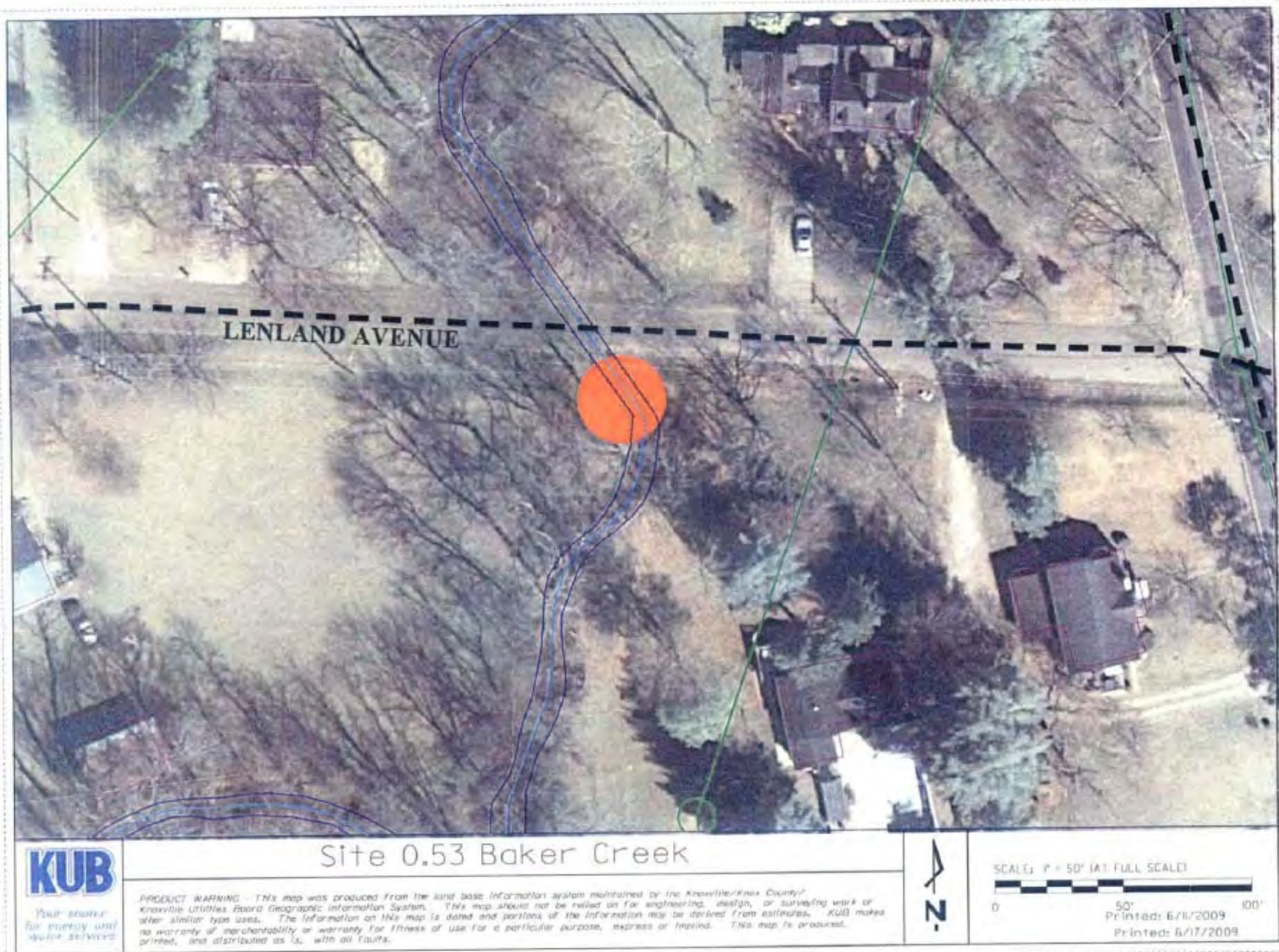
Appendix S
Fourth Creek Sampling Site 2.79



Appendix T
Fourth Creek Sampling Site 3.29



Appendix U
Baker Creek Sampling Site 0.36



Appendix V
Baker Creek Sampling Site 0.53



Appendix W
Baker Creek Sampling Site 1.45



Appendix X
Goose Creek Sampling Site 0.40



Appendix Y
Goose Creek Sampling Site 1.19E



Appendix Z
Goose Creek Sampling Site 1.80E



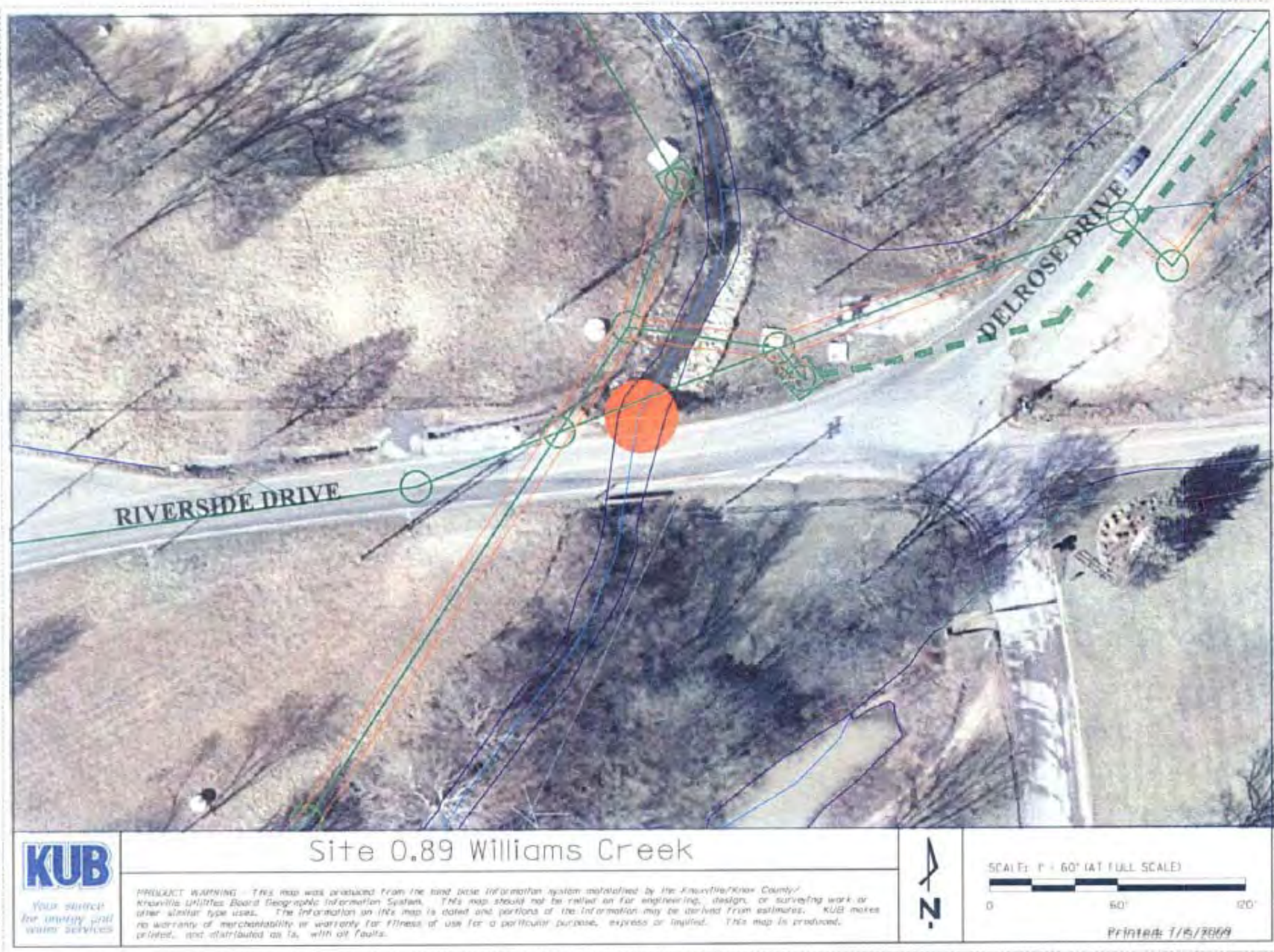
Appendix AA
Loves Creek Sampling Site 0.85



Appendix AB
Loves Creek Sampling Site 1.89



Appendix AC
Loves Creek Sampling Site 3.45



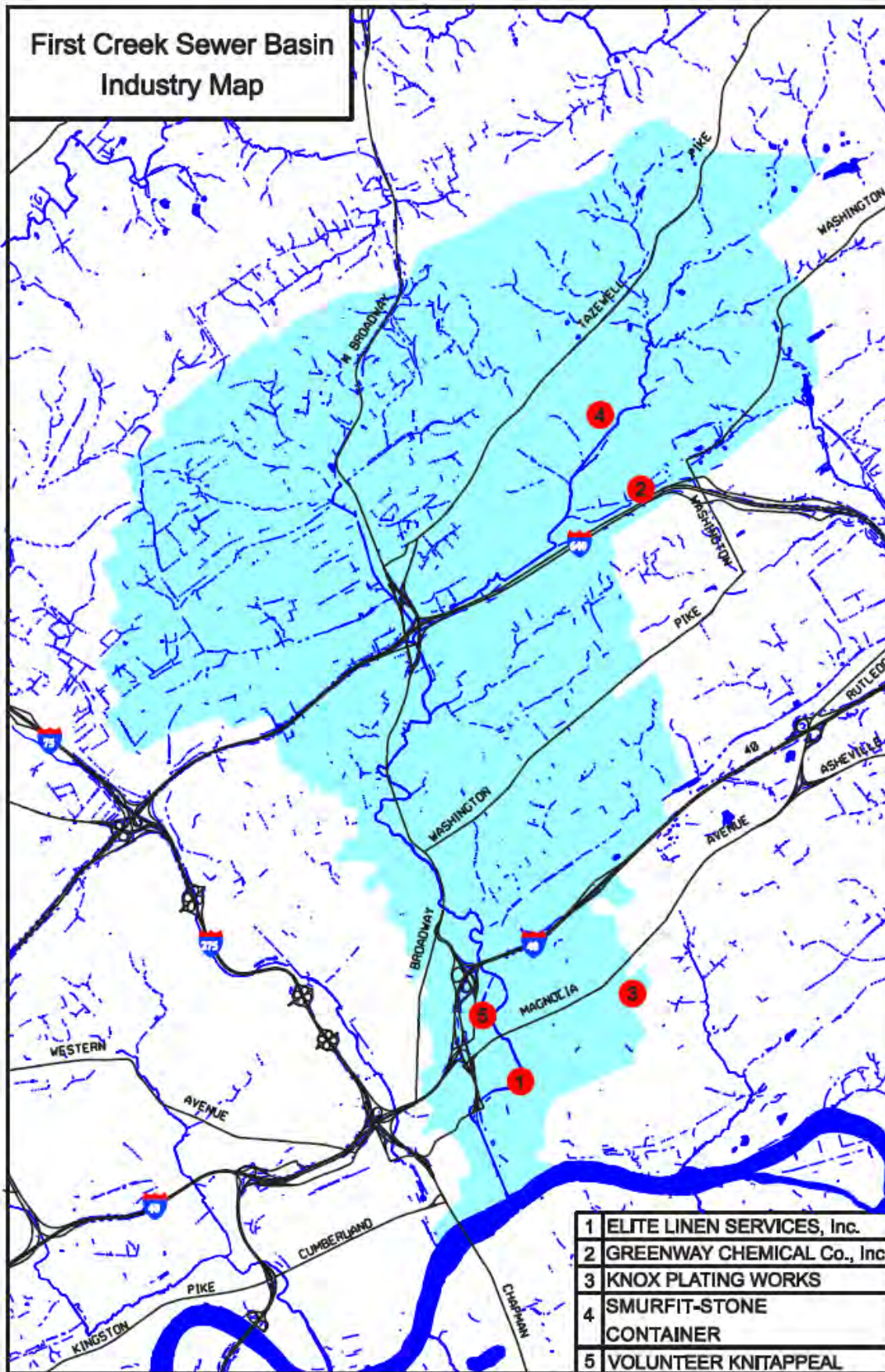
Appendix AD
Williams Creek Sampling Site 0.89



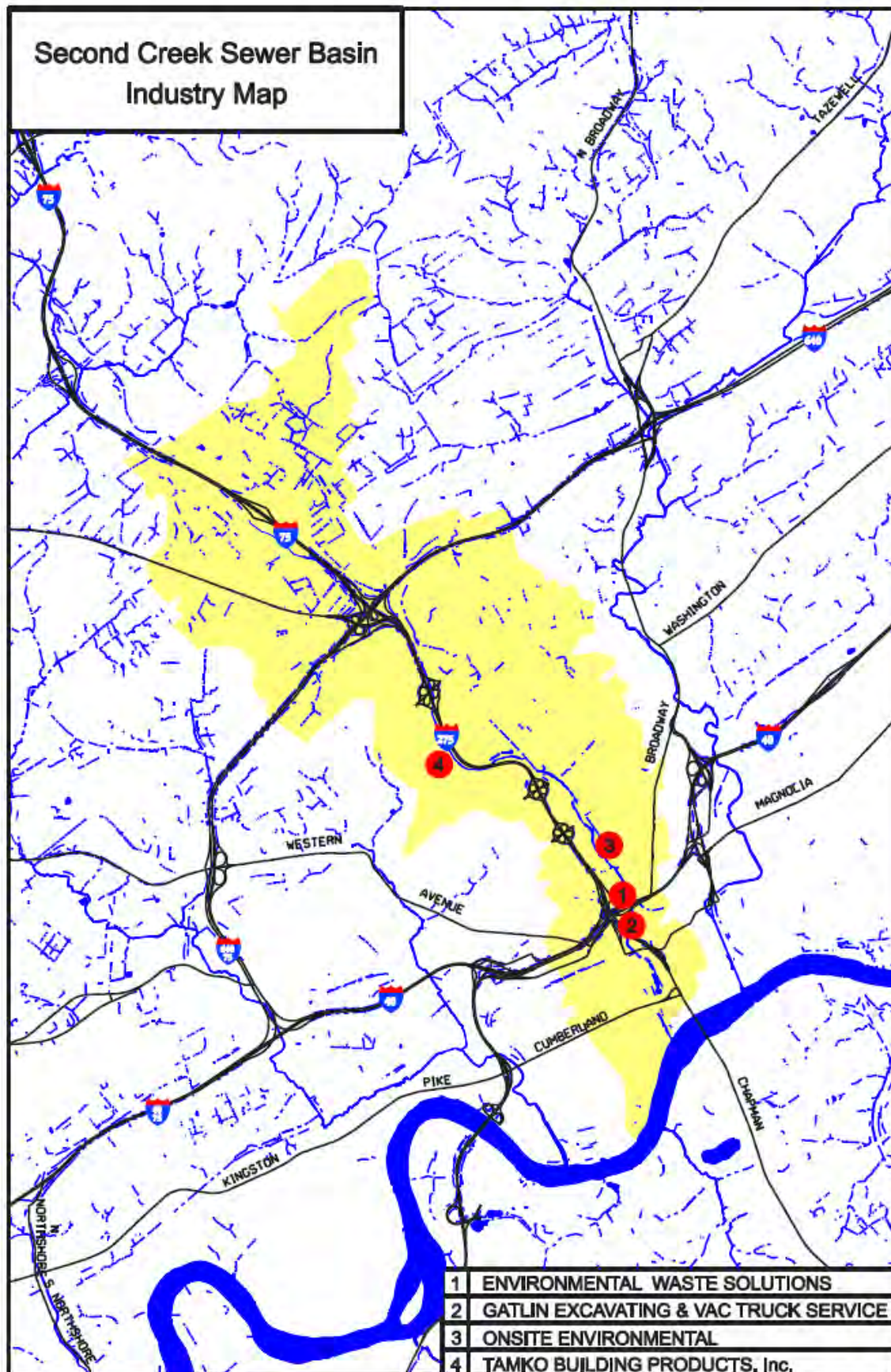
Appendix AE
Williams Creek Sampling Site 1.12



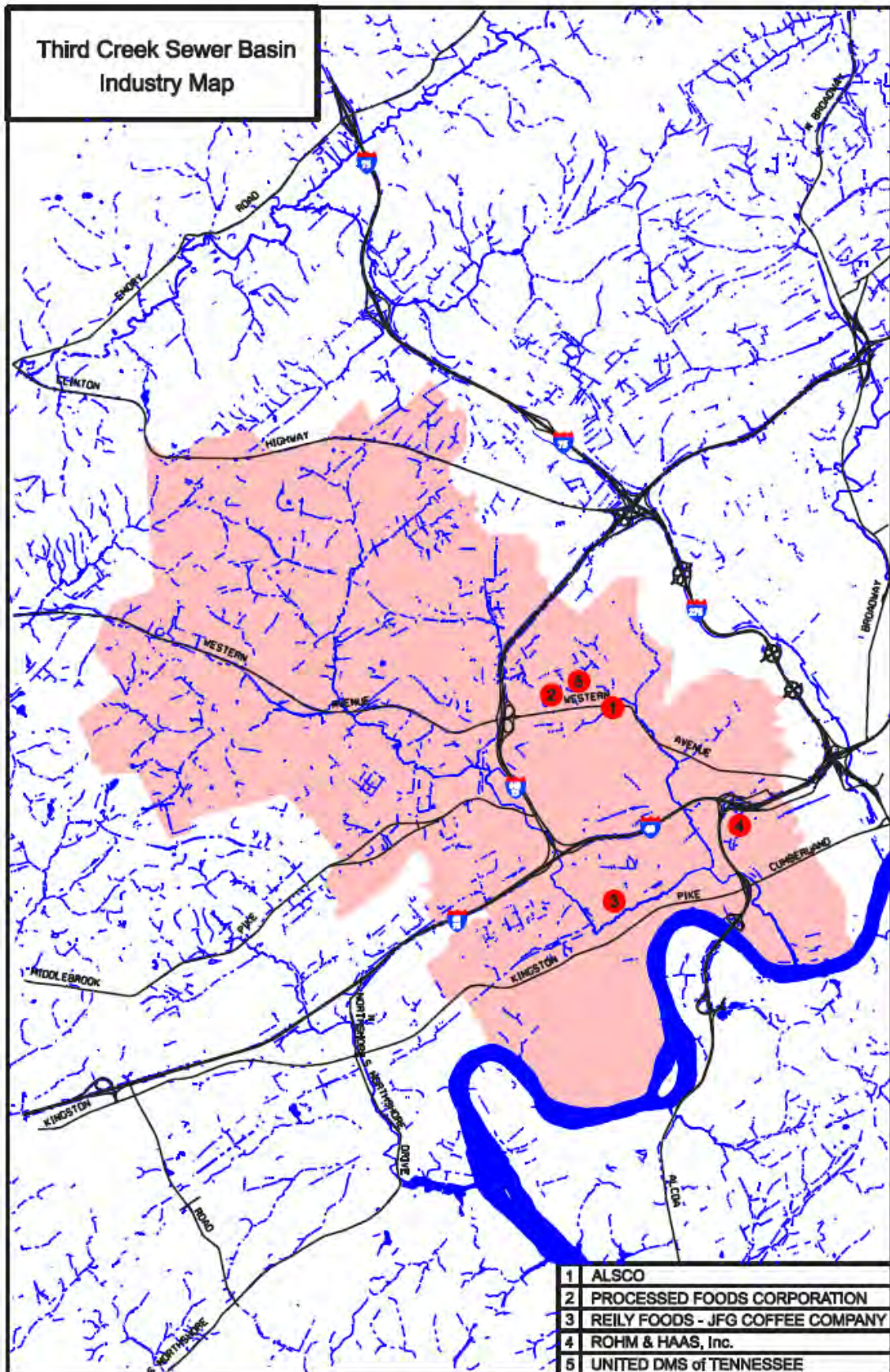
Appendix AF
Williams Creek Sampling Site 2.02



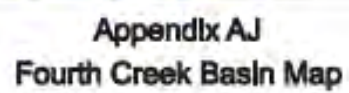
Appendix AG
First Creek Basin Map

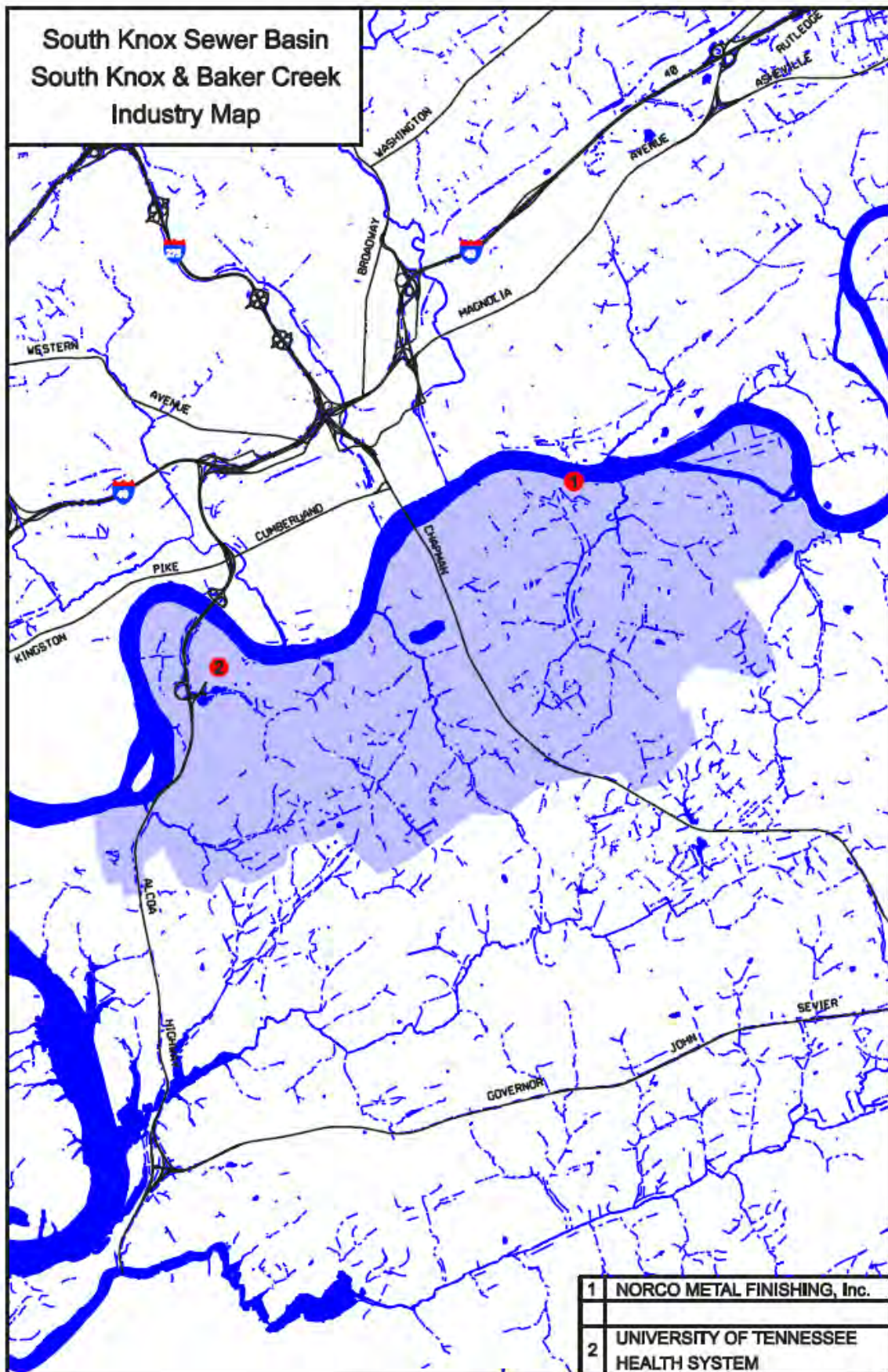


Appendix AH
Second Creek Basin Map

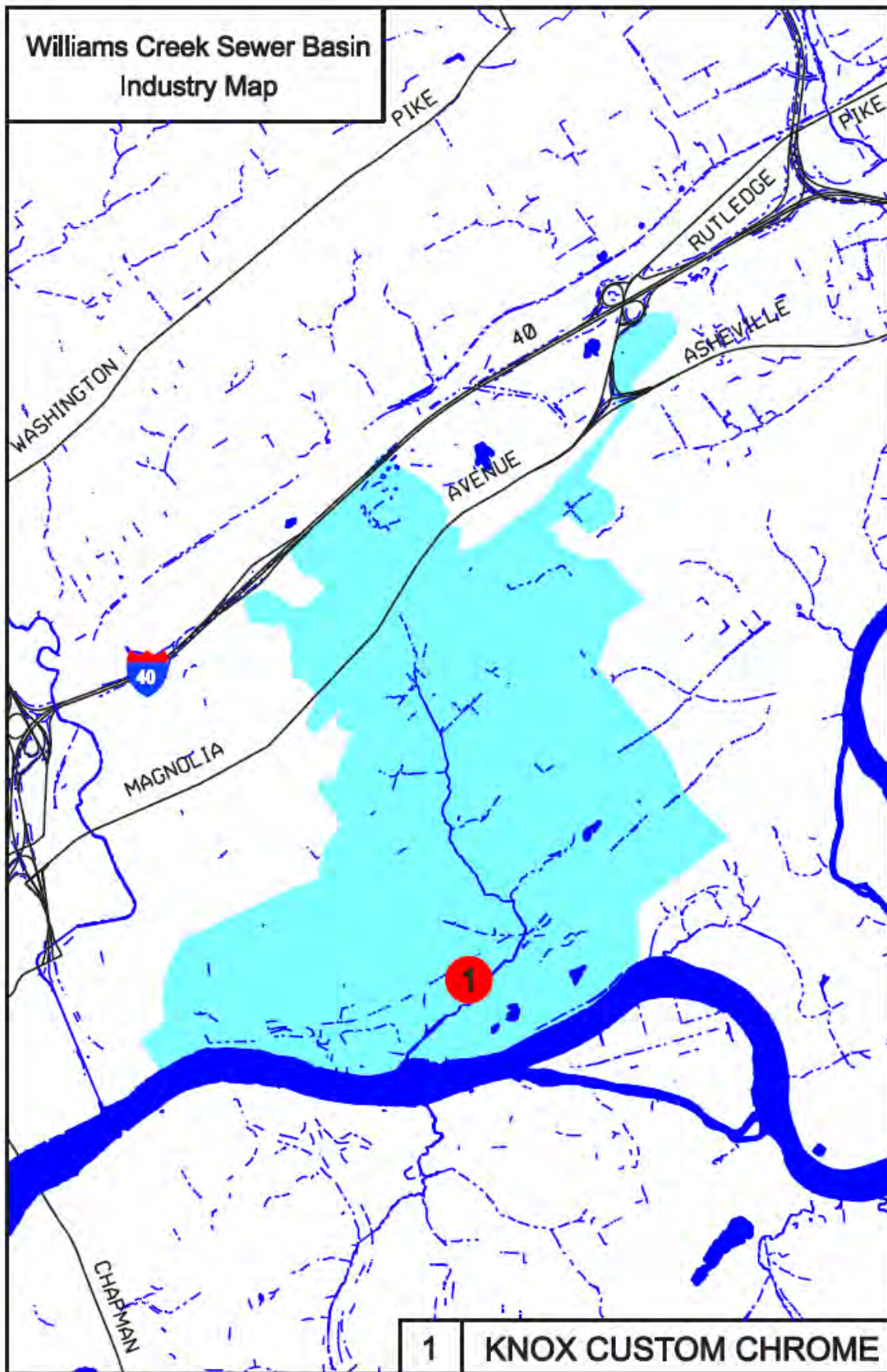


Appendix A1
Third Creek Basin Map

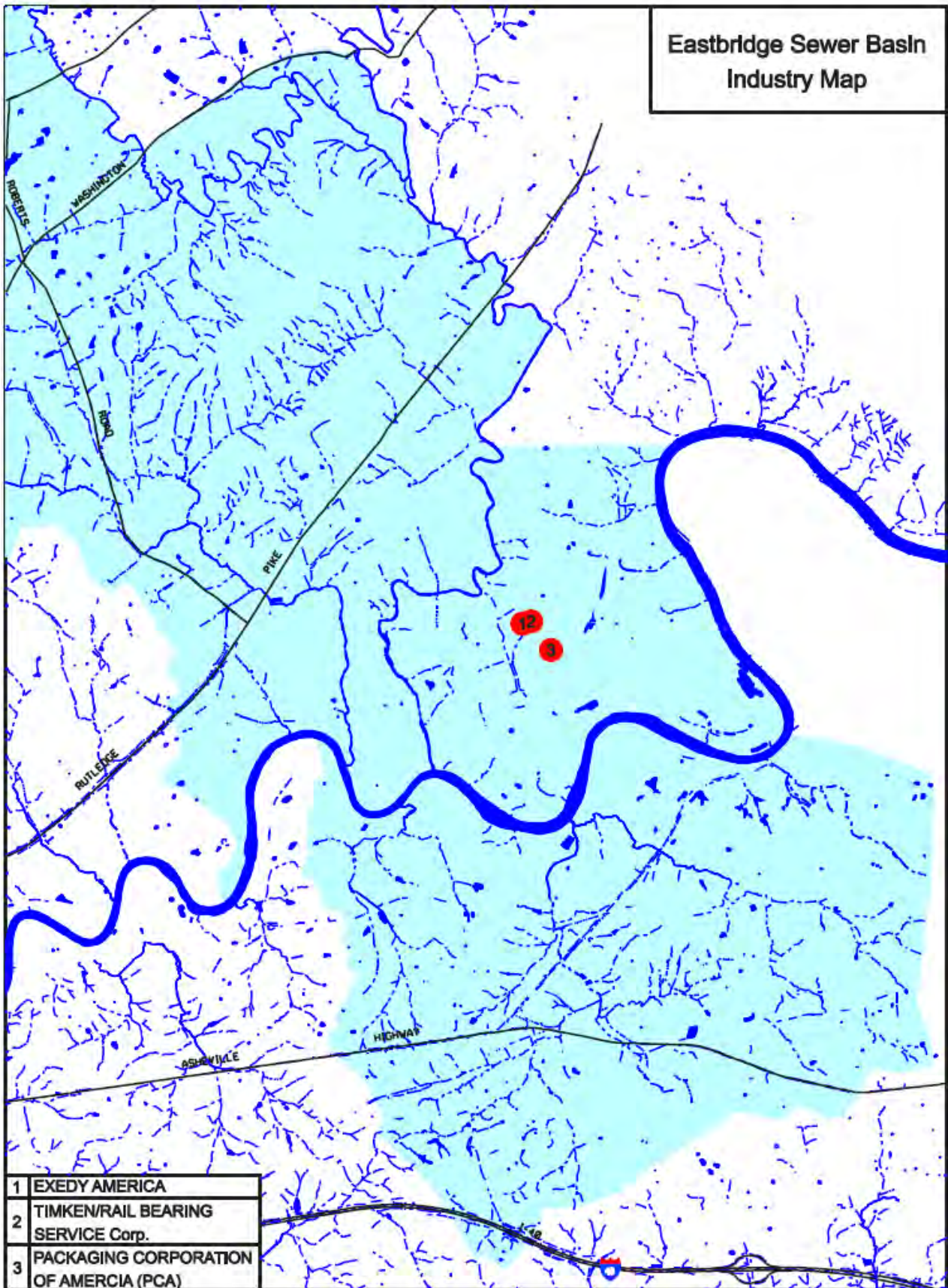




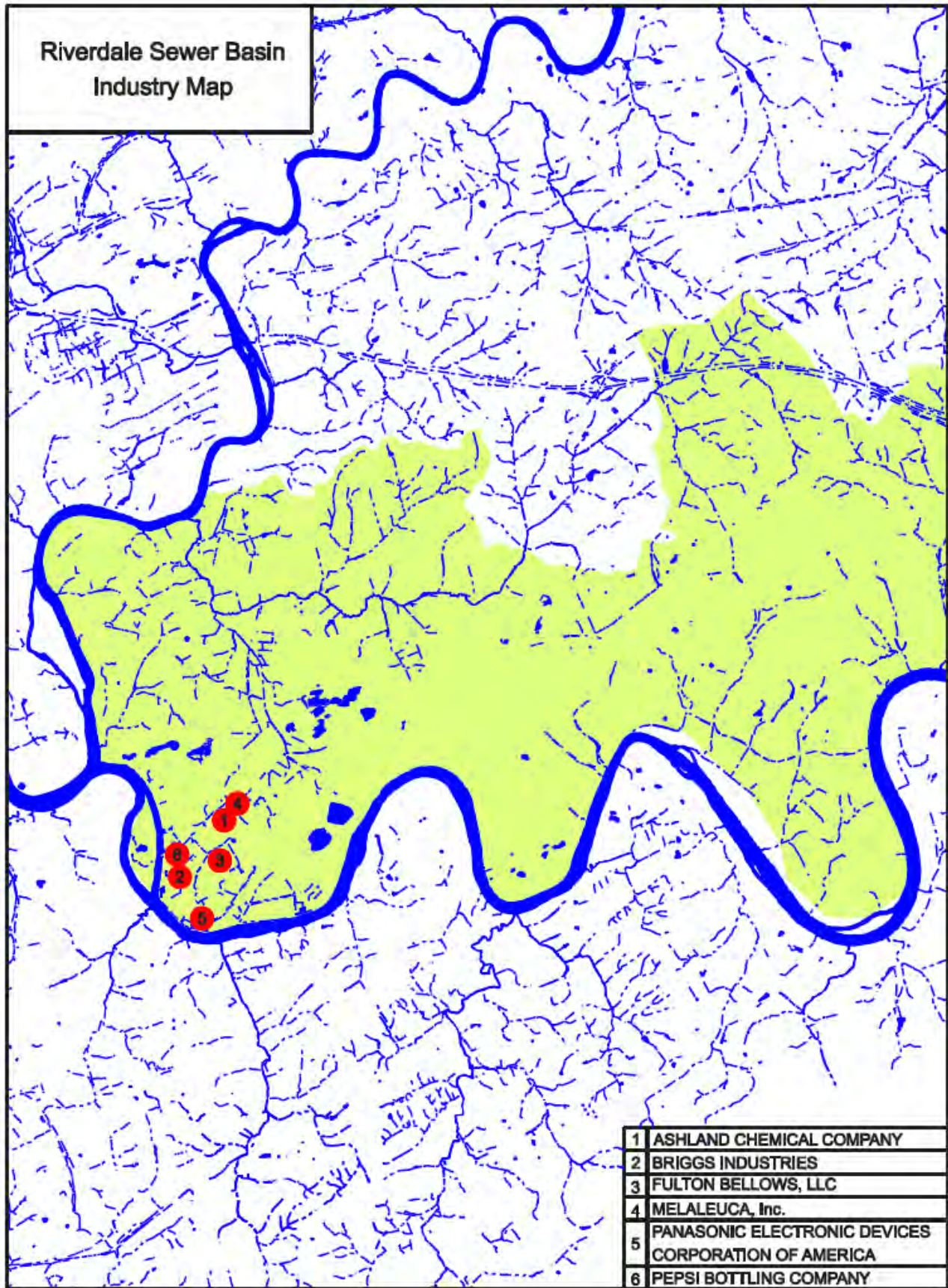
Appendix AK
South Knox Sewer Basin Map



Appendix AL
Williams Creek Basin Map



Appendix AM
Eastbridge Basin Map



Appendix AN
Riverdale Sewer Basin