YEAR 1
JANUARY 2018 – DECEMBER 2018

REGIONAL WET WEATHER CHARACTERIZATION PROGRAM

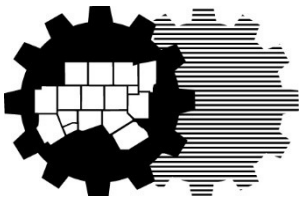
ANNUAL MONITORING REPORT FOR NORTH CENTRAL TEXAS

North Central Texas Council of Governments

Regional Wet Weather Characterization Program Annual Monitoring Report for North Central Texas

- Year 1 -

(January 2018 – December 2018)



Prepared by the
North Central Texas Council of Governments
Submitted to Texas Commission on Environmental Quality
March 1, 2019

The Regional Wet Weather Characterization Program Annual Monitoring Report was prepared by the North Central Texas Council of Governments (NCTCOG) on behalf of eight regional participants. The Annual Monitoring Report is submitted to the Texas Commission on Environmental Quality (TCEQ), either directly or by reference, along with each participant's annual report of their stormwater management programs to comply with the Regional Wet Weather Characterization Plan Proposal for the Fourth Term (2018 – 2022), approved by TCEQ on June 30, 2017. The Monitoring Report was submitted to TCEQ on March 1, 2019.

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BACKGROUND

Since 1996, a regional stormwater monitoring program has been ongoing in the North Central Texas region among the Phase 1 entities for compliance with Federal and State stormwater permit requirements. The Dallas-Fort Worth Regional Wet Weather Characterization Program (RWWCP) was first negotiated with the United States Environmental Protection Agency (USEPA) and incorporated into each entity's permit for the first term in 1996. The negotiated program reduced the number of sampling stations from the application phase of sampling but increased the number of samples per station to obtain better statistical representation. While several of the participants have changed through the years, the RWWCP has been a successful regional partnership, with eight participating entities currently undergoing chemical and bioassessment sampling during a Fourth Monitoring Term, 2018 – 2022.

FIRST MONITORING TERM

During the initial monitoring term (1996 - 2001), seven municipalities (Dallas, Fort Worth, Arlington, Irving, Garland, Plano, and Mesquite), and the Dallas and Fort Worth Districts of the Texas Department of Transportation (TxDOT), received joint approval from the U.S. Environmental Protection Agency (EPA) for a regional monitoring program. The program utilized the assistance of a shared consultant team and the U.S. Geological Survey (USGS), to sample and analyze stormwater runoff from 22 outfalls in primarily small watersheds of a single land use type. The participants worked through the North Central Texas Council of Governments (NCTCOG) to form a regional partnership and strategy to conduct wet-weather monitoring activities for the regional monitoring program. The sample collections served to characterize typical urban runoff from these limited land use types and were useful for estimating general pollutant loadings. However, they did little to evaluate impacts on actual receiving streams.

SECOND MONITORING TERM

In the second monitoring term (2006 - 2010), the Regional Wet Weather Characterization Program (RWWCP) was administered by the Texas Commission on Environmental Quality (TCEQ) and implemented through NCTCOG and a consultant team led by Atkins. Approval was obtained to utilize in-stream stations for the regional monitoring program to better assess the impact on receiving streams. The revised program was termed the Regional Wet Weather Characterization Program (RWWCP) and was added as an option in Part IV.A.3 of the Texas Pollutant Discharge Elimination System (TPDES) Municipal Separate Storm Sewer System (MS4) permits issued to the Phase I North Central Texas governmental entities. Since the RWWCP language existed outside of each permit, it allowed greater flexibility for making changes to the program.

During the second term, the North Texas Tollway Authority (NTTA) joined the regional program. All other participants remained the same, except TxDOT-Fort Worth District, who became a co-permittee with the cities of Fort Worth and Arlington and was no longer required to conduct wet weather monitoring. According to the original RWWCP protocol, municipal participants collected data from three sample sites in the watershed (typically upstream, midstream, and downstream) and the transportation agencies collected data from two sites (upstream and downstream only). Samples were collected quarterly from each site during a qualifying rainfall event and were analyzed for 18 parameters. The primary goal of the new in-stream monitoring program was to obtain baseline data on receiving streams in North Central Texas for use in determining long-term water quality trends.

Dallas and Fort Worth used their own staff to collect samples, while the consultant team assisted the remaining partners with field data collection, stormwater sample analysis, and technical assistance. As an added component, the City of Fort Worth selected the Representative Rapid Bioassessment Monitoring option (Part IV.A.2) in their permit, which allowed the sampling frequency to be reduced from four times a year per site, to once per year per site. In place of chemical sampling at all sampling

sites, Fort Worth conducted two bioassessments each year at a minimum of nine sites. These bioassessments were based on protocols developed by the EPA. A summarization of this bioassessment data was included along with the chemical data in the regional monitoring report for each year of the monitoring term.

THIRD MONITORING TERM

In the third monitoring term (2011-2015), the Cities of Arlington, Dallas, Fort Worth, Garland, Irving, Mesquite and Plano, together with the North Texas Tollway Authority (NTTA) and TxDOT-Dallas District agreed to continue their regional partnership and work cooperatively through NCTCOG to develop a revised RWWCP. This revised plan effectively monitored at least 50% of each entity's jurisdictional area by the end of the monitoring term. This extension of jurisdictional coverage allowed a reasonable assessment of each entity's jurisdictional watersheds while also achieving a balance among the various goals of obtaining valid scientific information, meeting permit compliance, and addressing what is practicable for each entity. The primary goal of the RWWCP during this permit term was to continue the assessment of urban impact on receiving stream water quality and to document any improvement presumably resulting from local best management practices (BMP) implementation. The data collected during the monitoring term built upon the set of regional data needed from each site for meaningful trend analysis. Since assessing the impact of urban runoff on receiving stream quality is a primary focus of this program, assessing the biological integrity of the streams was deemed fundamental in the third term. During the third term, 24 watersheds were chemically monitored and 12 watersheds were bio-assessed across the region, with substantial overlap between the two sampling approaches.

At the end of the sampling effort, a final summary report was prepared by Atkins to assess the sampling effort. The report found that more than half of the watersheds sampled had high bacteria exceedances, with an average number of nine exceedances in the studied watersheds. Stream degradation was noted by the consultant team in about half of the sampled watersheds based on the analyzed data. Additional monitoring was recommended at these sites. The final report also analyzed the specific characteristics of the monitored watersheds. This approach provided participants individual watershed information which could be used to implement BMPs and other monitoring practices in the future. Due to the data collected in the third permit term, many of the watersheds studied were classified as high priority for continued monitoring. Watersheds that were classified as a high priority were generally those with stream degradation, those with a high number of monitored parameter criteria exceedances, and those with existing Total Maximum Daily Loads (TMDLs).

As a result of the third monitoring term findings, several recommendations were made for modifying the RWWCP for the fourth term, including the following:

- Impaired Waterbodies Focus – Focused monitoring of impaired water bodies to assist with TMDL efforts underway in North Central Texas by the participants.
- Rapid Bio-Assessment Improvements – Continue to implement rapid bio-assessments and encourage additional participants to undertake rapid bio-assessments as part of the RWWCP. To allow for comparisons, parameters to record during the bio-assessment chemical monitoring activities should be expanded to include/match those of the wet weather monitoring.
- Revise Monitored Pollutants – During the third term, Carbaryl was chosen to replace Diazinon that was undetected in the second term. Carbaryl was not detected in any watershed during the third term, and therefore was recommended that it no longer needed to be monitored for the fourth term, but possible replacements could be dieldrin or atrazine.
- Revise Monitored Pollutants – Due to no recognized correlation between total coliforms and fresh water pathogens by TCEQ or EPA, it was recommended that total coliforms be removed from the list of monitoring parameters. It was also recommended to add ammonia nitrogen, nitrate nitrogen, and orthophosphate to the monitoring parameters for wet weather chemical monitoring. The additions of these nutrients would allow for better comparisons between bioassessment and wet

weather chemical monitoring results. Additionally, for the Duck Creek, Johnson Creek, and White Rock Creek (headwaters) subwatersheds, it was recommended that sampling of dissolved fractions of metals be included to determine the concentration of bioavailable metals.

REGIONAL WET WEATHER CHARACTERIZATION PROGRAM – CURRENT MONITORING TERM

This report documents the first year of the fourth monitoring term (2018 – 2022) involving revised approaches to both the chemical and bioassessment monitoring protocols. The North Central Texas Regional Wet Weather Characterization Plan Proposal for the Fourth Term, dated October 11, 2016, was approved by TCEQ on June 30, 2017. The approved Plan can be found in Appendix A. Upon agreement of the RWWCP participants, the resulting third monitoring term recommendations were incorporated in the approved fourth monitoring term proposal.

For the fourth term (2018-2022), the cities of Arlington, Dallas, Fort Worth, Garland, Irving, Mesquite, and Plano, and the NTTA (herein referred to as participants), agreed to continue their regional partnership and continue working through the NCTCOG to develop a revised regional monitoring program. As a result of TxDOT obtaining a statewide permit incorporating both the Dallas and Fort Worth Districts, their requirement to conduct wet weather monitoring was removed, and therefore they are not included in the current RWWCP fourth monitoring term.

The fourth term of the RWWCP began on January 1, 2018. Phase I stormwater permit information for each participant is included in Table 1. The permits defer to the approved RWWCP for sampling protocols and the final list of parameters to be tested.

Table 1: Permit Term Four RWWCP Participants

Permittee	TPDES Permit Number	Date Issued	Expiration Date
Arlington	WQ0004635000	04/26/2012	04/26/1017
Dallas	WQ0004396000	10/06/2011	10/06/2016
Fort Worth	WQ0004350000	03/08/2018	03/08/2023
Garland	WQ0004682000	06/17/2007	06/17/2017
Irving	WQ0004691000	08/06/2014	08/06/2019
Mesquite	WQ0004641000	05/24/2018	05/24/2023
Plano	WQ0004775000	12/02/2015	12/02/2020
North Texas Tollway Authority	WQ0004400000	08/15/2018	08/15/2023

The RWWCP participants selected Atkins (herein referred to as the consultants) as the lead contractor, and subconsultants Freese and Nichols, Inc. and Dougherty Sprague Environmental, Inc., to provide regional storm water monitoring services for the fourth term. The consultants will complete a variety of storm water monitoring compliance activities for the cities of Arlington, Garland, Irving, Mesquite, Plano, and NTTA, including storm water monitoring, bioassessments, and a Best Management Practices (BMP) Analysis and Evaluation Plan for all participating entities, including Dallas and Fort Worth. A Monitoring Program and Quality Assurance Project Plan for Wet Weather Equipment Deployment and Sampling Protocol (Appendix B), and Monitoring Program and Quality Assurance Project Plan for Bioassessments (Appendix C) have been documented and provided for the fourth term. For the duration of the fourth term, the cities of Dallas and Fort Worth will conduct their own collection of storm water samples and bioassessments. This report does include the results of their data collection efforts, Appendices F, H, and I.

The regional participants are using a sampling plan that will effectively monitor at least 50% of their jurisdictional area by the end of the monitoring term. As in the third monitoring term, in-stream watershed monitoring will be conducted at each location for a minimum of two years to provide greater statistical robustness of the data. The participants will maintain fixed sampling stations to the

extent practicable. This will enable the data to be examined for trends and show improvements or decline in water quality within the fixed sampling period.

Monitored subwatersheds were prioritized based on TMDLs and Clean Water Act Section 303(d) streams located within the watersheds that cover the jurisdictional area of the municipalities. Participants are monitoring these impaired waterbodies in order to assess the impacts of storm water on these impaired streams. Monitored subwatersheds were also prioritized to match those that have been historically monitored in previous terms, however some additional subwatersheds were added based on the TMDLs and impairments discussed above. Over the fourth monitoring term, 13 subwatersheds will be monitored chemically and 13 subwatersheds will be monitored biologically, according to the sampling schedule in Table 2.

Table 2: Regional Wet Weather Characterization Program Sampling Schedule

Jurisdiction Subwatershed	Number of Samples to be Collected[1]				
	2018	2019	2020	2021[2]	2022[2]
Arlington					
Johnson Creek	4C	4C			
Fish Creek – Mountain Creek Lake	4C	4C			
Rush Creek – Village Creek			8C	8C	
Dallas					
Floyd Branch – White Rock Creek	2B	2B	2B	2B	
Five Mile Creek – Trinity River		12C		12C	
Headwaters Five Mile Creek	2B	2B	2B	2B	
Headwaters Turtle Creek	12C		12C		
White Rock Creek – White Rock Lake	2B	2B	2B	2B	
City of Dallas – White Rock Creek		12C		12C	
Bachman Branch – Elm Fork Creek	2B	2B	2B	2B	
Turtle Creek – Trinity River	12C		12C		
Fort Worth					
Headwaters Sycamore Creek	2C/4B	4B	4B	4B	4B
Lake Como-Clear Fork Trinity River	4B	2C/4B	4B	4B	4B
Marine Creek-West Fork Trinity River	4B	2C/4B	4B	4B	4B
Mary's Creek	2C/4B	4B	4B	4B	4B
Sycamore Creek-West Fork Trinity River	4B	4B	2C/4B	4B	4B
Whites Branch-Big Fossil Creek	4B	4B	2C/4B	4B	4B
Garland					
Duck Creek	12C	12C			
Rowlett Creek – Lake Ray Hubbard	2B	2B	12C/2B	12C/2B	
Irving					
Delaware Creek – West Fork Trinity River	8C/2B	8C/2B			
Grapevine Creek – Elm Fork Trinity River			4C	4C	
Estelle Creek – Bear Creek			4C/2B	4C/2B	
Mesquite					
South Mesquite Creek	4C	4C	4C	4C	
North Mesquite Creek	4C	4C	4C	4C	
Plano					
Spring Creek	4C	4C			
Headwaters Rowlett Creek	2B	2B	4C	4C	
Brown Branch Rowlett Creek			4C/2B	4C/2B	
North Texas Tollway Authority					
Cotton Branch – Hackberry Creek	4C	4C	4C	4C	
Cotton Creek – Mountain Creek Lake	4C	4C	4C	4C	

[1] B-Signifies Bioassessment Samples; C-Signifies Chemical Samples

[2]The City of Fort Worth will conduct additional chemical sampling during 2021 and 2022 at watersheds selected after sampling 2020, and based on the chemical, physical, and biological assessment results done in 2018-2020.

Chemical Sampling

Most participants are performing chemical sampling on one subwatershed within their jurisdiction for two consecutive years and then moving to a second subwatershed for another two years. Exceptions include the cities of Dallas, Fort Worth, and Mesquite. Due to the size of their jurisdictional area, Dallas selected eight subwatersheds and Fort Worth selected six subwatersheds for chemical and/or biological monitoring that rotate. Mesquite has a unique situation where only two subwatersheds and the two creeks of those subwatersheds are almost wholly contained within the city limits. Mesquite has chosen to establish permanent in-stream monitoring stations in each of the two creeks and to sample them concurrently all four years. Figure 1 displays the monitored subwatersheds for the fourth term. Appendix A provides additional documentation of the chemical sampling occurring for Dallas, Fort Worth, and Mesquite.

For chemical monitoring, grab samples will be collected during the first flush (defined as the 30-minute period following a quantifiable rise in stream level) and analyzed for *E. coli*, oil and grease, and pH. An additional first flush sample and four subsequent samples collected at equal time intervals will be taken over the first two hours of the event and combined for a composite sample. Samples will be collected for no more than two hours, regardless of storm duration. Grab samples will be obtained either manually or through an automated collection device.

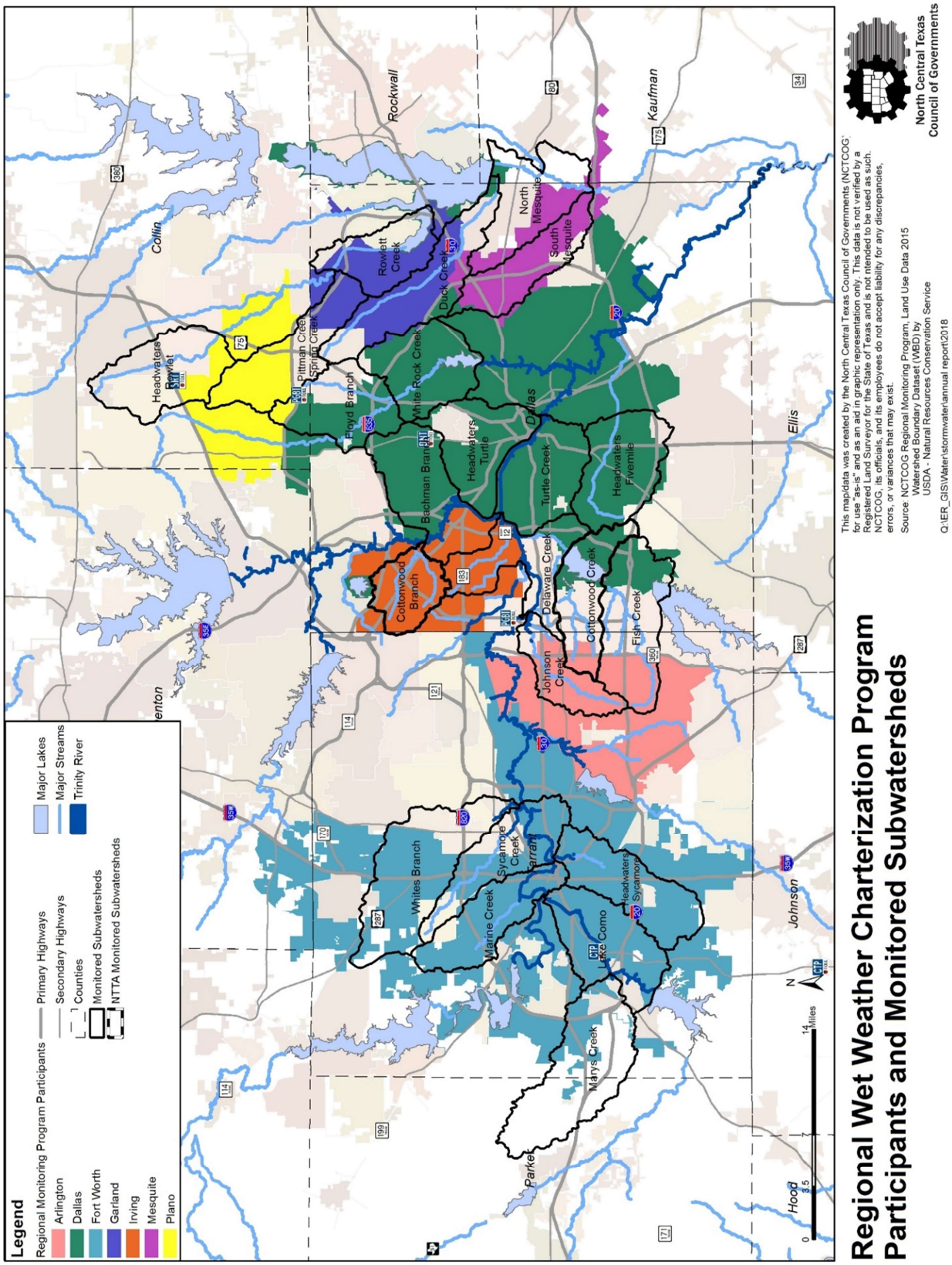
Sampling will be conducted only on qualifying events which are defined as satisfying the following requirements: 1) antecedent dry period of 72 hours minimum; 2) rainfall volume of 0.10 inch minimum; and, 3) a quantifiable increase in water surface elevation attributable to stormwater runoff. Rain gauges were deployed in each watershed to support the assessment of local wet weather conditions.

Chemical samples will be collected with automatic sampling equipment that will allow the collection of water through stainless steel strainer and flexible sampling tubing using a peristaltic pump. Samples will then be pumped into four, 1-gallon glass containers, located in a stormwater sampler shelter. The automatic samplers will also be equipped with bubbler flow modules that activate the samplers based on an increase in water surface elevation in the stream conveyance channel. Upon successful collection, the samples are preserved in ice and shipped immediately to the laboratory for analysis. Each sample is analyzed for 19 parameters which are listed in Table 3.

Table 3: RWWCP Fourth Monitoring Term Regional Parameter Set

Parameter	Method of Collection
Oil & Grease	Grab
pH	Grab
E. coli	Grab
Total Dissolved Solids (TDS)	Composite
Total Suspended Solids (TSS)	Composite
Biochemical Oxygen Demand (BOD5)	Composite
Chemical Oxygen Demand (COD)	Composite
Total Nitrogen	Composite
Dissolved Phosphorus	Composite
Total Phosphorus	Composite
Atrazine	Composite
Total Arsenic	Composite
Total Chromium	Composite
Total Copper	Composite
Total Lead	Composite
Total Zinc	Composite
Ammonia Nitrogen	Composite
Nitrate Nitrogen	Composite
Orthophosphate	Composite

Figure 1: RWWCP Fourth Monitoring Term – Monitored Subwatersheds



Bioassessments

In the fourth monitoring term, the cities of Dallas, Fort Worth, Garland, Irving, and Plano are conducting bioassessments; representing a substantial increase in the use of bioassessments as a component of the RWWCP. EPA and TCEQ have developed an array of methods and approaches that can be used in conducting bioassessments. As EPA states in their manual, *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish*, 2nd Ed. (1999), the protocols described are not "intended to be used as a rigid protocol without regional modifications. Instead, they provide options for agencies or groups that wish to implement rapid biological assessment and monitoring techniques."

The regional program participants that are implementing bioassessments will be performing bioassessments based upon EPA and TCEQ protocols. Specific protocols are detailed in manuals provided by each agency, but generally, program participants will be conducting bioassessments involving habitat assessment, a measurement of standard field physical conditions, and the collection and identification of macroinvertebrates and other biota. Habitat parameters will be compared to baseline standards for a reference site or reference conditions to determine the habitat's overall health.

OVERVIEW OF CHEMICAL AND BIOASSESSMENT PROTOCOLS

Regional Stormwater Monitoring and Bioassessment Protocols

The consultant team prepared the *Monitoring Program and Quality Assurance Project Plan for Wet Weather Equipment Deployment and Sampling Protocol: 2018–2021* and, *Monitoring Program And Quality Assurance Project Plan For Bioassessments: 2018–2021,* as the protocols for the RWWCP participants. These protocols were included as Appendix B and Appendix C, respectively. The protocol documents include detailed location information for the stormwater sampling and bioassessment sites for the cities of Arlington, Garland, Irving, Mesquite, Plano, and the NTTA.

All chemical sampling sites are equipped with automatic samplers (ISCO 6712, ISCO 730 Bubbler Module) that contain four 1-gallon glass sample containers. The sampler collects 0.5-gallon aliquots every 30 minutes after the initial sample for 120 minutes. Sample container one, or the grab sample container, contains one 1-gallon aliquot, sample containers two and three contain two 0.5-gallon aliquots, and sample container four contains one 0.5-gallon aliquot. All the upstream sampling sites include a tipping bucket rain gauge (ISCO 674) to verify rainfall amounts and antecedent dry periods. Graduated cylinder rain gauges are used at some of the other sites. In the event that the on-site rain gauge information is not applicable (e.g. malfunction or qualifying storm is only at the mid- or downstream stations), an online rain gauge is used to verify the rainfall amount and antecedent dry period. The consultants used TTI Laboratories and their subcontracted laboratories, Armstrong Forensic Laboratory, Inc. and ALS Laboratory, to analyze the samples. Appendix E includes the applicable laboratory certifications.

The cities of Dallas and Fort Worth conducted their sampling operations and have developed protocol documents to address the minor variances in their programs. Their respective protocols are described below.

City of Dallas Protocol

The City of Dallas uses the Regional Stormwater Monitoring and Bioassessment Protocols as their base protocols for stormwater sampling and bioassessment activities in accordance with Appendix B and Appendix C. The City of Dallas utilizes city personnel to operate their own equipment and to collect stormwater samples. City of Dallas staff also conducts bioassessment activities. The protocol

documents include maps of Dallas' 2012 through 2015 stormwater sampling and bioassessment sites. No changes have been made to this protocol for Year 1 activities.

The City of Dallas uses the ISCO 6712 model with ISCO 674 Rain Gauge and ISCO 750 Flow Meter for stormwater sample collection. The City of Dallas uses a program script designed to collect and analyze samples for parameters with short hold time from the three sampling stations in one rain event. Sampler equipment is programmed to activate at a 1/10-inch level rise recorded by the rain gauge within a two-hour period. At activation, the sampler collects two one-gallon samples (1st flush). Then after fifteen minutes, the sampler fills the remaining two one-gallon jars (composite) over an hour period in five equal aliquots. The City of Dallas used Pace Analytical Laboratories to carry out analyze the collected samples. Appendix E includes the laboratory certifications.

City of Fort Worth Protocol

The City of Fort Worth has developed a separate protocol, *City of Fort Worth RWWCP Monitoring Plan*, Appendix I, for conducting their stormwater sampling and bioassessment activities. The City of Fort Worth utilizes city personnel to operate their own equipment and to collect stormwater samples. City of Fort Worth staff also conduct bioassessment activities. The protocol document includes location information for Fort Worth's stormwater sampling and bioassessment sites. The City of Fort Worth has updated their protocol for the fourth monitoring term, 2018-2022. The updated City of Fort Worth protocol is included as Appendix I.

The City of Fort Worth has identified chemical sampling sites for years 2018-2020. Automatic water samplers (ISCO 3700 or other) are deployed at the site(s) to be monitored prior to the rain event. The samplers are programmed to initiate sampling at a 1.0-inch rise in receiving stream water level. Upon activation, the sampler collects a "first flush" grab sample and the first of four sub-samples for a time-weighted composite sample. Subsequent sub-samples are collected at 30-minute intervals. The City of Fort Worth Water Department Centralized Water and Wastewater Laboratory conducted analysis of most parameters and subcontracted analysis of the remaining parameters to AnaLab and Xenco Laboratories. Appendix E includes the laboratory certifications.

YEAR 1 CHEMICAL SAMPLING AND BIOASSESSMENT ACTIVITIES

Figure 2, RWWCP Fourth Monitoring Term, Year 1 (2018) Subwatersheds and Monitoring Sites, depicts the subwatersheds sampled in Year 1 (2018) as well as the location of the chemical sampling stations and bioassessment sites. Table 4 contains the corresponding list of Year 1 chemical monitoring and bioassessment sites that are part of the RWWCP, along with location information.

Figure 2: RWWCP Fourth Monitoring Term, Year 1 (2018) Subwatersheds and Monitoring Sites

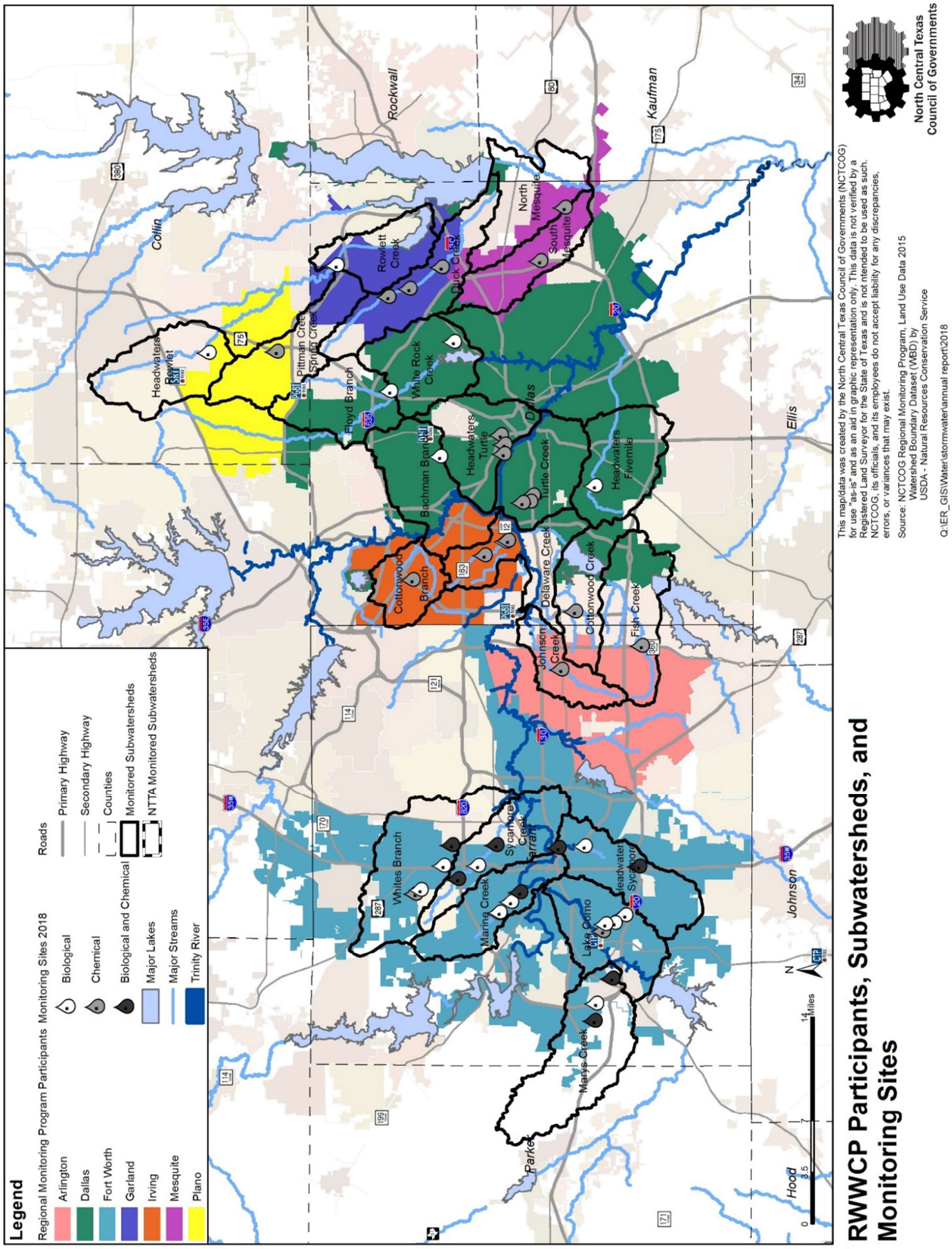


Table 4: RWWCP Year 1 (2018) Chemical Sampling and Bioassessment Site Locations

Jurisdiction Watershed	Station ID	Location	Latitude/Longitude	# of samples in 2018
Arlington				
Johnson Creek	AR1801	Johnson Creek at Six Flags	32.7588056/-97.0670278	3C
	AR1801A[2]	Johnson Creek at East Sanford Street	32.7428360/-97.087583	1C
Fish Creek – Mountain Creek Lake	AR1802	Fish Creek at SH 360	32.6623528/-97.0613889	4C
Dallas				
Turtle Creek – Trinity River	TCTR-100	3805 Pipestone Road at Mican Channel	32.768494/-96.884368	4C
	TCTR-200	3951 La Reunion Parkway at Mican Channel	32.771135/-96.891362	4C
	TCTR-300	4300 Singleton Boulevard at Mican Channel	32.778860/-96.892632	4C
Headwaters Turtle Creek	HTC-100	3505 Maple Avenue at Turtle Creek	32.799577/-96.813045	4C
	HTC-200	1201 Turtle Creek Boulevard at Turtle Creek	32.795850/-96.824203	4C
	HTC-300	2240 Irving Boulevard at Turtle Creek	32.796901/-96.8369522	4C
Bachman Branch – Elm Fork Trinity	bab-b	0.25 mile south of Midway Road and W. Northwest Hwy intersection at Banchman Branch	32.8604418/-96.8369522	2B
Floyd Branch – White Rock Creek	flo-a	Heading West on Forest Lane (towards US 75), turn Right onto gravel road underneath DART Rail	32.9090690/-96.7601368	2B
White Rock Creek – White Rock Lake	dix-a	Northeast of Peavy Road and E. Lake Highlands intersection at Dixon Branch	32.8446960/-96.7047586	2B
Headwaters Five Mile Creek	fiv-d	Westmoreland Road and Pentagon Pkwy intersection at Five Mile Creek	32.7064408/-96.8745138	2B
Fort Worth[3]				
Marine Creek – West Fork Trinity River	FWMAR1	3500 Macie, bridge crossing in Buck Sansom Park	32.8079/-97.3703	-
	FWMAR1	West of Angle Avenue in Buck Sansom Park	32.8069/-97.3691	2B
	FWMAR3	Saunders Park south of Mule Alley and downstream of JV1A	32.7862/-97.3460	2B
Lake Como - Clear Fork Trinity River	FWOVR1	NW of Granbury Rd and Trail Lake Dr	32.6820/-97.3738	2B
	FWOVR3	Overton Park West south of intersection with Bellaire	32.7017/-97.3839	2B
Sycamore Creek – West Fork Trinity River	FWLFC1	2200 block Cantrell Sansom	32.8478/-97.3297	2B
	FWLFC3	Dead end of Mesquite Rd. south of 3800 Long Ave.	32.8095/-97.2909	2B
White's Branch – Big Fossil Creek	FWBFC1	West of parallel to Pepperidge Lane	32.8854/-97.3421	2B
	FWBFC3	N. Beach St. north of Paula Ridge	32.8536/-96.2904	2B
Headwaters Sycamore Creek	FWSYC1	I-35W northbound frontage road beneath SE Loop IH-820 eastbound	32.6677/-97.3178	1C/2B

	FWSYC3	Dead end of Scott St. west of Beach St.	32.7475/-97.2949	1C/2B
Mary's Creek	FWMRY1	3900 Block Longvue (FM 2871)	32.7133/-97.4966	1C/2B
	FWMRY3	Winscott Road (Vickery Blvd.) in South Z Boaz Park	32.6954/-97.4477	1C/2B
Garland				
Duck Creek	GA1801	Duck Creek between Forest North and South	32.9090727/-96.6503388	4C
	GA1802	Duck Creek at Rick Oden Park/Briarwood Drive	32.888176/-96.641277	4C
	GA1803	Duck Creek under La Prada Bridge	32.8554635/-96.6168702	4C
Rowlett Creek – Lake Ray Hubbard	GARBA20189	Rowlett Creek bellow Atchison Topeka and Santa Fe Railroad bridge	32.960095/-96.612327	2B
Irving				
Delaware Creek – West Fork Trinity River	IR1801	Delaware Creek at Sowers Road	32.8175600/-96.9528400	4C
	IR1802	Delaware Creek at Oakdale	32.7938200/-96.9363500	4C
	IRRBA20189	Delaware Creek in Fritz Park	32.79590/-96.93770	2B
Mesquite				
South Mesquite Creek	MS1801	North of New Market Road	32.7572500/-96.6119444	4C
North Mesquite Creek	MS1802	North Mesquite Creek at Edward's Church	32.7321111/-96.55055000	4C
Plano				
Pittman Creek - Spring Creek	PL1801	Spring Creek at 16th Street	33.021317/-96712406	4C
Headwaters Rowlett Creek	PLRBA20189	Rowlett Creek at Sun Creek Park	33.08920/-96.70870	2B
North Texas Tollway Authority				
Cottonwood Branch – Hackberry Creek	NT1801	Unnamed Tributary at SH 161 N. of Gateway Drive	32.889808/-96.980065	4C
Cotton Creek – Mountain Creek Lake	NT1802	Cottonwood Creek at SH 161 S. of Dickey Road	32.728181/-97.019460	4C

Notes:
[1]B-Signifies bioassessment samples; C signifies chemical samples.
[2]Due to flooding in the region, AR1801 was moved to a new location and was renamed AR1801A.
[3]Table 4 includes the primary bioassessment sites for the City of Fort Worth for each watershed. The City of Fort Worth Sampling Protocol identifies an additional bioassessment site for each watershed that may be used as an alternative depending on local conditions at the time of sampling.

Chemical Sampling

All samples were successfully collected and analyzed in Year 1, January 2018 – December 2018 of the fourth term. Due to contracting delays, the consultant team did not collect any first quarter samples during the first quarter (January through March 2018). All first quarter samples for Year 1 collected by the consultant team were collected as make-up samples during quarters two through four.

In September 2018, heavy flooding inundated the sampling equipment at stations AR1801 (Arlington), AR1802 (Arlington), NT1802 (NTTA), MS1801 (Mesquite), and MS 1802 (Mesquite). The equipment located at AR1801 and NT1802 was lost to the flood waters and not recovered. The NT1802 equipment was later recovered. For all sites, the equipment was evaluated by the manufacturer and

was placed back in their original location, with the exception of AR1801. Replacement equipment was identified for AR1801 and a new location was chosen and named AR1801A.

In September 2018, the consultants and NCTCOG were informed that TTI Laboratories, the laboratory subcontracted by Atkins to analyze the chemical samples, had lost their accreditation (as of September 1, 2018) and could not apply for renewal of National Environmental Laboratory Accreditation Program (NELAP) accreditation until March 1, 2019. Atkins acquired quotes from several local laboratories and worked with TTI Laboratories to ensure that collected samples could be analyzed by a subcontracted NELAP laboratory. Samples collected in 2018 after the expiration of the TTI Laboratory accreditation were analyzed by TTI Laboratories sub-contracted laboratories, Armstrong Forensic Laboratory, Inc. and ALS Laboratory.

The sampling data and summary statistics for Year 1 of the monitoring term are included in Year 1 Regional Chemical Sampling Data. The complete raw sampling data and sample collection reports are provided in Appendix F and Appendix G, respectively.

Bioassessments

The Cities of Dallas, Fort Worth, Garland, Irving, and Plano conducted bioassessment activities in Year 1. All scheduled bioassessments were successfully conducted. An overview of each entity's bioassessment activities is provided below. For complete details, refer to bioassessment reports for Dallas (Appendix H), Fort Worth (Appendix I), and Garland, Irving, and Plano (Appendix D).

City of Dallas

The City of Dallas performs rapid bioassessment protocol (RBP) monitoring as a part of the RWWCP and conducts additional RBP monitoring beyond the regional program as part of their individual MS4 Permit Stormwater Management Program. The City uses the RBP as set forth in the TCEQ *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data (TCEQ, 2007, RG-416)*. The RBP monitoring evaluates the chemical, physical, and biological in-stream features that promote a healthy and diverse habitat; as such they provide a good assessment of overall watershed health. The RBP monitoring program involves performing an Aquatic Life Use (ALU) assessment through benthic macro-invertebrate collection, habitat assessment, and evaluating water quality samples.

Two sampling events were conducted in accordance with the index periods established by TCEQ for biological sampling:

- Spring Period (March 15th to June 30th): Targets spring's optimal conditions for biological community growth.
- Summer Period (July 1st to September 30th): Reflects impacts from typical summer low flows and higher water temperatures.

Under the RBP, each water body is given a composite score that is determined through evaluation of numbers and diversity of macro invertebrates, water quality parameters, stream habitat features and other metrics. A sample of each monitoring site's macro invertebrate community determines the sites' Aquatic Life Use (ALU) metric. Since 2005, the City of Dallas has used the Benthic Macro-invertebrate Index of Biotic Integrity (IBI) to test ALU. A sample from each monitoring site is tested according to the IBI. The City of Dallas' 2018 bioassessment report is included as Appendix H of this report. Note that the report contains data for all the sites monitored by Dallas in 2018.

City of Fort Worth

The City of Fort Worth performs rapid bioassessments on representative creeks within six subwatersheds twice per year as a part of the RWWCP monitoring program and to satisfy their storm water monitoring program requirements. Methods for bioassessments are based on protocols set forth in TCEQ, EPA, and Texas Parks and Wildlife guidance documents. A description of methodology may be found in the full bioassessment report in Appendix I. Regional rapid bioassessments included habitat assessment, chemical and physical water quality parameter evaluation, sample collection and analysis of benthic macroinvertebrate. Sampling was conducted during spring (May) and fall (October) 2018 on three sites on each creek.

Habitat assessments are based on USEPA guidelines for high gradient streams as outlined in *Rapid Bioassessment Protocol for Use in Streams and Wadeable Rivers*, second edition (EPA 841-B-99-002). Macroinvertebrate data were analyzed using methods for the TCEQ-based Texas Index of Biotic Integrity (IBI) for kick net samples. The metric calculation scores at a site for the IBI are compared to values in TCEQ guidelines and each site is assigned an aquatic life use rating. The values for the aquatic life use ratings found in the TCEQ guidelines were developed based on data collected from ecoregional reference sites. This method gives an individual value for each site without a direct comparison to a specific reference site, but to values from ecoregional reference sites. Individual sites may be compared to themselves year to year on a seasonal basis (spring to spring and fall to fall) to demonstrate community changes within each reach.

Garland, Irving, and Plano

Stream rapid bioassessments were conducted on Rowlett Creek in Garland, Delaware Creek in Irving, and Rowlett Creek Headwaters in Plano, in 2018. All three creeks were sampled once between June 18 and 20, 2018, during the “Index” period and another time between September 18 and 20, 2018, during the “Critical” period. The TCEQ (2012) recommends one sample be collected during the Index period and one during the Critical period when two samples are collected at the same site during the same year. The TCEQ (2012) also recommends samples be collected at least 1 month apart, when flows are relatively low, and not recently impacted by rainfall runoff. Benthic macroinvertebrate and fish communities were sampled and data compared with metrics from the TCEQ. Habitat, water chemistry, and flow were also measured in each trip.

The streams are in the Texas Blackland Prairie ecoregion (Ecoregion 32). Within an ecoregion, soils, climate, landforms, and vegetation are expected to be similar. Reference conditions for benthic macroinvertebrates and fish inhabiting wadeable streams in the Texas Blackland Prairie ecoregion are described by TCEQ. Evaluating benthic macroinvertebrates and fish communities with the TCEQ-established metrics to calculate aquatic life use may indicate whether the streams have been impacted by human activities. Appendix D contains the detailed bioassessment report for Garland, Irving, and Plano.

YEAR 1 REGIONAL MONITORING PROGRAM CHEMICAL SAMPLING DATA SUMMARY

Analytical results and field measurements from all storm events sampled during Year 1 (January-December 2018) are summarized for each parameter in Table 5. The table includes descriptive statistics of minimum, maximum, mean (average), median, and standard deviation. Note that for each of the chemical sampling sites, i.e. AR1801, there were four samples collected during the year (i.e. n=4). The arithmetic mean has been provided for all the parameters except for *E.coli*; the geometric mean was calculated for all bacteria samples. The raw (unmodified) data is provided in Appendix F.

The data includes cases where concentrations of some parameters for samples are below the detection limit (BDL) of the analytical equipment. When data for all samples collected during the year

for a given parameter at a sample site (dataset) contained values below the detection limit ("<"), values are reported as "BDL" in Table 5. In cases where datasets contained values both below and above the detection threshold, the value of one-half the detection limit was used in the statistical calculations.

The City of Fort Worth places emphasis on its bioassessment activities and collects one sample per year at each of its designated sampling sites. Therefore, summary statistics are not included in Table 5 for the City of Fort Worth (raw data is provided in Appendix F).

Table 5: Year 1, 2018 Stormwater Data Summary

PARAMETER / STATISTICS	ARLINGTON		GARLAND			IRVING		MESQUITE		NTTA		PLANO	DALLAS					
	AR1801*	AR1802	GA1801	GA1802	GA1803	IR1801	IR1802	MS1801	MS1802	NT1801	NT1802	PL1801	TCTR 100	TCTR 200	TCTR 300	HTC 100	HTC 200	HTC 300
TDS (mg/L)																		
Minimum	396	316	120	178	404	106	188	56	168	82	104	152	387	171	205	115	359	351
Maximum	714	512	400	496	704	176	252	488	420	192	628	356	996	320	617	275	487	424
Mean	557	417	267	311	575	148	220	285	285	157	320	252	642	236	353	169	411	376
Median	559	420	274	284	596	155	220	298	276	177	274	250	544	218	238	117	387	352
Std. Dev	161.20	80.16	115.99	134.02	136.64	32.78	30.81	181.65	105.90	50.66	228.55	90.10	316.18	76.17	228.94	91.80	67.29	41.86
TSS (mg/L)																		
Minimum	12.33	27.50	6.000	16.00	9.330	99	4.290	31.50	32.60	6	24.00	256.0	59	53	98	64.7	68	71
Maximum	26.67	242	316.0	285.0	86	298.0	184.0	358.5	330.0	498.0	383.0	399.0	224	144	370	146	134	120
Mean	18.93	105.94	116.55	100.83	38.97	226.00	73.14	151.75	118.68	197.13	130.53	312.75	169	96	219	111	90	92
Median	18.35	77.13	72.10	51.15	30.27	253.50	52.14	108.50	56.05	142.25	57.57	298.00	223	90	189	121	68	84
Std. Dev	7.05	97.22	141.19	125.12	36.14	88.82	81.71	148.61	141.32	220.94	169.12	69.03	94.98	45.76	138.46	41.64	38.11	25.38
BOD (mg/L)																		
Minimum	0.50	0.50	3.8	1.00	0.50	5.35	2.4	0.50	0.50	1.00	1.00	0.50	6.1	6.8	9.3	9.5	8.6	7.3
Maximum	10.47	6.21	10.25	8.35	7.37	17.34	16.59	5.64	6.77	15.37	16.38	12.1	8.6	13.6	23.2	16.5	67.4	16.5
Mean	3.89	3.86	6.91	5.71	3.71	13.31	7.89	3.36	3.64	8.05	9.45	6.63	7	10	14	13	59	11
Median	2.29	4.37	6.79	6.74	3.48	15.28	6.28	3.64	3.65	7.91	10.21	6.96	7.6	8.8	10.5	13.3	60.8	7.7
Std. Dev	4.59	2.74	3.48	3.32	2.82	5.41	6.32	2.20	2.76	6.06	6.42	4.78	1.26	3.49	7.70	3.50	9.11	5.20
COD (mg/L)																		
Minimum	6.19	19	19	16.5	7.50	24	6.10	7.50	7.50	7.50	7.50	24.7	52.9	53.6	77	47.6	49.4	45.5
Maximum	34.3	98.3	60.0	55.7	29.1	87.5	56.8	36.5	25	77.8	64.4	85.4	97.3	100	154	114	67.4	60.9
Mean	14.38	44.35	33.68	32.23	20.73	51.63	26.68	22.28	15.28	35.65	30.20	43.43	71	72	121	87	59	53
Median	8.52	30.05	27.85	28.35	23.15	47.50	21.90	22.55	14.31	28.65	24.45	31.80	63.1	61.6	131	100	60.8	51.6
Std. Dev	13.35	36.93	19.06	16.99	9.47	26.43	24.43	13.06	8.38	30.84	24.69	28.24	23.26	24.80	39.53	35.00	9.11	7.76

PARAMETER / STATISTICS	ARLINGTON		GARLAND			IRVING		MESQUITE		NTTA		PLANO	DALLAS					
	AR1801*	AR1802	GA1801	GA1802	GA1803	IR1801	IR1802	MS1801	MS1802	NT1801	NT1802	PL1801	TCTR 100	TCTR 200	TCTR 300	HTC 100	HTC 200	HTC 300
TOTAL NITROGEN (mg/L)																		
Minimum	1.10	0.50	0.66	0.78	2.30	0.94	1.50	0.55	0.70	1.10	1.39	1.09	1.2	2.1	1.9	2.3	2.6	1.7
Maximum	1.29	2.30	3.10	1.90	9.40	2.80	2.01	0.90	1.40	3.35	3.37	3.20	4.9	3.6	5.3	6.2	5.7	5.8
Mean	1.19	1.49	1.40	1.11	6.35	1.81	1.78	0.68	1.04	2.29	2.47	1.92	3	3	4	5	4	3
Median	1.18	1.59	0.91	0.88	6.85	1.75	1.80	0.63	1.04	2.35	2.55	1.70	1.7	2.2	4.5	6	2.8	2.1
Std. Dev	0.08	0.81	1.14	0.53	3.40	0.79	0.27	0.16	0.38	0.96	0.86	0.90	2.01	0.84	1.78	2.20	1.73	2.26
NITRATE N (mg/L)																		
Minimum	0.04	0.07	0.015	0.10	1.10	0.28	0.41	0.015	0.33	0.48	0.09	0.40	0.75	1.2	1.5	2.3	2.6	1.7
Maximum	0.59	0.50	2.46	1.09	8.23	0.60	0.86	0.20	0.72	1.15	1.00	0.93	4.9	3.6	5.3	6.2	5.7	5.8
Mean	0.35	0.34	0.67	0.36	4.51	0.43	0.56	0.10	0.52	0.86	0.50	0.61	2.1375	2.275	3.3	4.85	4.125	3.65
Median	0.38	0.39	0.11	0.13	4.35	0.42	0.48	0.09	0.52	0.90	0.45	0.55	1.45	2.15	3.2	5.45	4.1	3.55
Std. Dev	0.23	0.19	1.19	0.49	3.07	0.15	0.21	0.10	0.17	0.32	0.39	0.23	1.8821	0.9912	1.8833	1.7935	1.652	2.0535
AMMONIA N (mg/L)																		
Minimum	0.061	0.12	0.072	0.11	0.11	0.18	0.13	0.025	0.051	0.11	0.065	0.19	N/A	N/A	N/A	N/A	N/A	N/A
Maximum	0.58	1.09	1.33	0.40	0.81	1.00	0.49	0.63	0.18	1.64	0.62	0.95	N/A	N/A	N/A	N/A	N/A	N/A
Mean	0.27	0.59	0.55	0.24	0.34	0.49	0.32	0.28	0.12	0.58	0.28	0.46	N/A	N/A	N/A	N/A	N/A	N/A
Median	0.21	0.57	0.41	0.23	0.22	0.40	0.32	0.23	0.12	0.28	0.21	0.35	N/A	N/A	N/A	N/A	N/A	N/A
Std. Dev	0.22	0.41	0.56	0.14	0.32	0.36	0.18	0.25	0.06	0.72	0.24	0.35	N/A	N/A	N/A	N/A	N/A	N/A
ORTHOPHOSPHATE (mg/L)																		
Minimum	0.025	0.0025	0.025	0.025	0.78	0.13	0.16	0.05	0.025	0.02	0.025	0.025	N/A	N/A	N/A	N/A	N/A	N/A
Maximum	0.35	0.47	0.45	0.41	14.2	0.81	0.60	0.42	0.37	0.66	0.88	1.03	N/A	N/A	N/A	N/A	N/A	N/A
Mean	0.19	0.13	0.18	0.20	10.40	0.50	0.28	0.23	0.18	0.33	0.36	0.31	N/A	N/A	N/A	N/A	N/A	N/A
Median	0.20	0.03	0.13	0.19	13.30	0.53	0.18	0.22	0.17	0.32	0.27	0.09	N/A	N/A	N/A	N/A	N/A	N/A
Std. Dev	0.16	0.23	0.18	0.16	6.46	0.33	0.21	0.15	0.14	0.35	0.38	0.48	N/A	N/A	N/A	N/A	N/A	N/A
DISSOLVED PHOSPHORUS (mg/L)																		
Minimum	0.011	0.05	0.0025	0.010	0.512	0.046	0.010	0.015	0.015	0.037	0.044	0.022	0.120	0.051	0.074	0.150	0.120	0.086
Maximum	0.058	0.152	0.05	0.156	4.10	0.196	0.194	0.153	0.170	0.080	0.080	0.190	0.150	0.120	0.190	0.240	0.200	0.270
Mean	0.03	0.079	0.020	0.047	1.756	0.137	0.127	0.059	0.100	0.056	0.059	0.113	0.135	0.086	0.132	0.207	0.160	0.149

PARAMETER / STATISTICS	ARLINGTON		GARLAND			IRVING		MESQUITE		NTTA		PLANO	DALLAS					
	AR1801*	AR1802	GA1801	GA1802	GA1803	IR1801	IR1802	MS1801	MS1802	NT1801	NT1802	PL1801	TCTR 100	TCTR 200	TCTR 300	HTC 100	HTC 200	HTC 300
Median	0.02	0.058	0.015	0.012	1.205	0.154	0.153	0.034	0.107	0.054	0.055	0.120	0.135	0.086	0.132	0.230	0.160	0.091
Std. Dev	0.02	0.049	0.021	0.073	1.597	0.065	0.086	0.065	0.079	0.018	0.016	0.090	0.021	0.049	0.082	0.049	0.040	0.105
TOTAL PHOSPHORUS (mg/L)																		
Minimum	0.025	0.096	0.097	0.058	0.982	0.233	0.064	0.056	0.067	0.074	0.121	0.073	0.200	0.100	0.370	0.280	0.220	0.210
Maximum	0.172	3.72	0.470	0.688	4.20	0.563	0.371	0.223	0.301	0.331	0.282	0.438	0.300	0.260	0.500	0.470	0.330	0.270
Mean	0.11	1.09	0.23	0.22	3.23	0.38	0.23	0.11	0.19	0.22	0.19	0.29	0.237	0.173	0.423	0.390	0.287	0.247
Median	0.12	0.28	0.17	0.06	3.86	0.37	0.24	0.08	0.19	0.24	0.19	0.32	0.210	0.160	0.400	0.420	0.310	0.260
Std. Dev	0.07	1.76	0.17	0.31	1.51	0.17	0.13	0.08	0.10	0.11	0.07	0.16	0.055	0.081	0.068	0.098	0.059	0.032
ATRAZINE (µg/L)																		
Minimum	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	N/A	N/A	N/A	N/A	N/A	N/A
Maximum	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	N/A	N/A	N/A	N/A	N/A	N/A
Mean	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	N/A	N/A	N/A	N/A	N/A	N/A
Median	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	N/A	N/A	N/A	N/A	N/A	N/A
Std. Dev	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL ARSENIC (mg/L)																		
Minimum	0.001	0.00278	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059
Maximum	0.014	0.009	0.009	0.009	0.004	0.014	0.008	0.019	0.008	0.022	0.032	0.011	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059
Mean	0.005	0.005	0.005	0.004	0.003	0.005	0.004	0.007	0.005	0.007	0.013	0.005	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059
Median	0.003	0.004	0.005	0.003	0.003	0.003	0.002	0.004	0.005	0.003	0.010	0.004	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059
Std. Dev	0.006	0.003	0.004	0.004	0.001	0.006	0.003	0.008	0.003	0.010	0.013	0.004	0	0	0	0	0	0
TOTAL CHROMIUM (mg/L)*																		
Minimum	0.0005	0.002	0.002	0.002	0.0005	0.002	0.001	0.001	0.0005	0.002	0.002	0.0005	0.002	0.002	0.002	0.0059	0.0059	0.0059
Maximum	0.002	0.009	0.013	0.004	0.004	0.014	0.008	0.012	0.011	0.013	0.008	0.014	0.002	0.002	0.015	0.0059	0.0059	0.0059

PARAMETER / STATISTICS	ARLINGTON		GARLAND			IRVING		MESQUITE		NTTA		PLANO	DALLAS					
	AR1801*	AR1802	GA1801	GA1802	GA1803	IR1801	IR1802	MS1801	MS1802	NT1801	NT1802	PL1801	TCTR 100	TCTR 200	TCTR 300	HTC 100	HTC 200	HTC 300
Mean	0.001	0.004	0.006	0.003	0.002	0.008	0.003	0.004	0.004	0.007	0.006	0.007	0.002	0.002	0.0053	0.0059	0.059	0.059
Median	0.001	0.003	0.004	0.002	0.002	0.008	0.002	0.002	0.002	0.006	0.007	0.007	0.002	0.002	0.002	0.0059	0.059	0.059
Std. Dev	0.001	0.003	0.005	0.001	0.001	0.007	0.003	0.005	0.005	0.005	0.003	0.006	0	0	0.0065	0	0	0
TOTAL COPPER (mg/L)*																		
Minimum	0.00478	0.00434	0.00704	0.00702	0.007	0.00525	0.00339	0.00396	0.00291	0.001	0.00372	0.0146	0.0063	0.0063	0.0063	0.0063	0.063	0.063
Maximum	0.079	0.088	0.084	0.092	0.109	0.112	0.098	0.102	0.108	0.106	0.099	0.088	0.031	0.022	0.024	0.02	0.024	0.063
Mean	0.056	0.042	0.059	0.061	0.073	0.077	0.069	0.055	0.050	0.055	0.059	0.067	0.0174	0.0102	0.0147	0.0097	0.0107	0.063
Median	0.071	0.038	0.073	0.072	0.087	0.096	0.088	0.057	0.044	0.056	0.067	0.083	0.0162	0.0063	0.0142	0.0063	0.063	0.063
Std. Dev	0.035	0.042	0.036	0.040	0.045	0.049	0.044	0.041	0.054	0.056	0.041	0.035	0.013	0.0079	0.0097	0.0069	0.089	0
TOTAL LEAD (mg/L)																		
Minimum	0.002	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00555	0.0036	0.0036	0.0036	0.0036	0.012	0.036
Maximum	0.00425	0.012	0.013	0.00357	0.004	0.020	0.008	0.009	0.011	0.010	0.008	0.016	0.0036	0.0036	0.029	0.018	0.026	0.029
Mean	0.003	0.005	0.006	0.002	0.002	0.010	0.004	0.004	0.004	0.005	0.006	0.011	0.0036	0.0036	0.0118	0.0096	0.0173	0.0179
Median	0.003	0.003	0.005	0.003	0.002	0.009	0.003	0.003	0.002	0.004	0.007	0.012	0.0036	0.0036	0.0073	0.0083	0.0155	0.0195
Std. Dev	0.001	0.005	0.005	0.001	0.001	0.010	0.003	0.004	0.005	0.004	0.003	0.004	0	0	0.012	0.0072	0.0064	0.0112
TOTAL ZINC (mg/L)																		
Minimum	0.034	0.0238	0.0471	0.0409	0.0168	0.0254	0.0127	0.0237	0.0109	0.0105	0.0249	0.100	0.030	0.026	0.092	0.068	0.052	0.038
Maximum	0.087	0.177	0.156	0.105	0.110	0.224	0.115	0.088	0.104	0.186	0.172	0.155	0.044	0.087	0.160	0.130	0.130	0.076
Mean	0.068	0.079	0.092	0.065	0.076	0.140	0.073	0.062	0.057	0.099	0.105	0.129	0.037	0.060	0.131	0.097	0.083	0.054

PARAMETER / STATISTICS	ARLINGTON		GARLAND			IRVING		MESQUITE		NTTA		PLANO	DALLAS					
	AR1801*	AR1802	GA1801	GA1802	GA1803	IR1801	IR1802	MS1801	MS1802	NT1801	NT1802	PL1801	TCTR 100	TCTR 200	TCTR 300	HTC 100	HTC 200	HTC 300
Median	0.075	0.057	0.082	0.057	0.088	0.155	0.083	0.069	0.056	0.100	0.112	0.130	0.037	0.067	0.140	0.093	0.068	0.049
Std. Dev	0.023	0.069	0.046	0.028	0.041	0.093	0.043	0.031	0.044	0.073	0.061	0.026	0.007	0.031	0.035	0.031	0.041	0.020
OIL AND GREASE (mg/L)																		
Minimum	0.70	0.70	0.70	0.70	0.70	1.60	0.70	0.70	0.70	0.70	0.70	0.70	0.35	0.35	0.35	0.35	0.36	0.35
Maximum	7.92	2.60	9.20	1.00	3.20	8.50	2.40	1.70	2.80	8.33	9.10	4.40	3.5	0.36	0.36	4	3.6	10.2
Mean	2.83	1.33	3.03	0.78	1.33	4.25	1.38	1.03	1.30	3.13	3.83	2.68	1.1425	0.3575	0.3575	2.1275	1.17	2.8175
Median	1.35	1.00	1.10	0.70	0.70	3.45	1.20	0.85	0.85	1.75	2.75	2.80	0.36	0.36	0.36	2.08	0.36	0.36
Std. Dev	3.45	0.86	4.13	0.15	1.25	3.00	0.83	0.47	1.01	3.60	4.01	1.57	1.5717	0.005	0.005	2.0483	1.62	4.9217
pH (su)																		
Minimum	7.8	8.1	7.8	8.1	7.1	6.1	8.1	7.3	8.2	8.2	7.3	8.2	7.72	7.36	7.55	6.85	7.46	7.11
Maximum	8.5	9.1	8.2	8.6	8.4	8.8	8.5	8.2	8.3	9.1	8.2	9.0	9.96	7.89	8.31	8.01	8.01	7.76
Mean	8.2	8.6	8.1	8.4	7.7	7.9	8.3	7.9	8.2	8.6	7.8	8.5	8.54	7.63	7.92	7.55	7.80	7.52
Median	8.3	8.5	8.2	8.5	7.6	8.4	8.3	8.1	8.2	8.5	7.9	8.4	7.95	7.64	7.89	7.80	7.94	7.69
Std. Dev	0.3	0.4	0.2	0.2	0.6	1.2	0.2	0.4	0.0	0.4	0.5	0.4	1.23	0.27	0.38	0.62	0.30	0.36
***E. COLI* (col/100 mL)**																		
Minimum	12.00	10.00	32.00	18.00	20.00	0.50	28.00	25.00	10.00	10.00	0.50	50.00	2419.6	1011.2	517.2	139.6	104.6	2419.6
Maximum	3500	4100	900.0	1000	200.0	2500	14000	52.00	10000	3200	20000	5600	4839.2	2419.6	2419.6	64880	4611	14136
Mean	1090.5	1046.3	256.5	287.0	91.0	646.4	4182.0	41.8	3565.0	1440.0	5805.1	2512.5	3629.4	1959.2	1083.2	16904	2108.7	5348.7
Median	425.0	37.5	47.0	65.0	72.0	42.5	1350.0	45.0	2125.0	1275.0	1610.0	2200.0	3629.4	2203	697.9	1299.1	1859.7	2419.6

PARAMETER / STATISTICS	ARLINGTON		GARLAND			IRVING		MESQUITE		NTTA		PLANO	DALLAS					
	AR1801*	AR1802	GA1801	GA1802	GA1803	IR1801	IR1802	MS1801	MS1802	NT1801	NT1802	PL1801	TCTR 100	TCTR 200	TCTR 300	HTC 100	HTC 200	HTC 300
Std. Dev	1624.4	2035.9	429.1	477.3	86.1	1235.9	6611.5	12.3	4719.0	1653.1	9582.0	2816.1	1397	664.17	900.24	32001	191 7.4	585 8.2

* AR1801 and AR1801A results were combined for this summary.

SUBWATERSHED LAND USE ANALYSIS

The land use composition of watersheds can often have a significant impact on the pollutant loads generated in stormwater runoff. Various studies have associated certain types of pollutants with particular land use types and a similar correlation was found in the North Central Texas area during the first permit term's sampling effort (Alan Plummer & Associates, Inc. & Camp Dresser & McKee, 1994; Pitt, 2005; USEPA, 1983; UWRRC, ASCE, & WEF, 1992). Higher levels of metals, oil and grease, and total suspended solids were found in areas that were predominantly industrial whereas higher levels of nutrients, biochemical oxygen demand (BOD), pesticides and herbicides were associated with predominantly residential watersheds. Studies have also correlated pollutant runoff levels to the degree of impervious surface coverage and these have in turn been associated with various land use types (CWP, 2003). For example, heavy industrial areas are recognized for their expansive buildings surrounded by large parking lots and are on average 80% impervious. Residential areas customarily have lots that are only partially covered with dwellings, driveways and sidewalks, and the rest is usually grassy or wooded. Impervious estimates for these areas are usually in the range of 50-75%.

Land Use Classification and Composition for Subwatershed and Drainage Areas

This report provides land use classifications for each subwatershed containing the 2018 sampling sites. Land use classifications were determined for each subwatershed using the 2015 NCTCOG Regional Land Use data. NCTCOG's standard 42 land use categories were combined into the following six categories for the purpose of this analysis: commercial, industrial, open space, residential, roads, and water. Table 6 shows the land use classifications used for this analysis as well as the percentage of impervious cover typically related to each land use type.

Table 7 includes land use composition estimates of drainage areas for each of the chemical sampling sites. Land use category percentages were calculated based on the proportion of each land use type over the total area for that site's drainage area and expressed as a percent. Note that in most cases, the sampling sites are arranged as upper, middle, and lower sites within a subwatershed. However, the drainage area and associated land use percentages provided in Table 7 for the midstream and downstream sampling sites excludes the drainage area of the upstream site(s). The total drainage area and land use for the midstream and downstream sites may be calculated by adding in the area for the upstream site(s). While it may be expected that some portion of pollutant loading is cumulative as pollutants travel towards the midstream and downstream sites, it is also recognized that pollutant attenuation through degradation, settling, and dilution could also occur.

Table 8 provides detailed watershed descriptions of land use composition estimates for the subwatershed and site drainage area for each chemical sampling site. Figure 3 – Figure 15, depict the 2016 Watershed Boundary Dataset HUC12 subwatersheds, 2015 NCTCOG land use categories, sampling site drainage areas, 2018 sampling sites, airports, lakes, streams, Trinity River, and city and county boundaries.

Table 6: 2015 NCTCOG Regional Land Use Classifications

LAND USE CATEGORIES	MONITORING LAND USE CATEGORIES	% IMPERVIOUS COVER
Office	Commercial	70 - 90%
Commercial		
Educational		
Large Stadium		
Railroad		
Communication		
Transit		
Mixed Use		
Retail		
Hotel/Motel		
Institutional/Semi-Public		
Utilities		
Parking		
Airport	Road	90%
Primary Highways		
Secondary Highway		
Major Arteries		
Minos Arteries		
Connecting		
Private Roads		
Service Roads		
Access Ramps		
Driveways		
Trails		
Industrial	Industrial	80%
Parks/Recreation	Open	10 - 45%
Landfill		
Cemeteries		
Residential Acreage		
Ranchland		
Timberland		
Farmland		
Improved Acreage		
Flood Control		
Under Construction		
Vacant		
Group Quarters	Residential	50 - 75%
Single Family		
Multi-Family		
Mobile Homes		
Water	Water	N/A
Small Water Bodies		

Table 7: Land Use Composition Estimates for Chemical Sampling Drainage Areas

Subwatershed	Site ID	Location	Drainage Area Total (Acres)	Commercial (Acres/%)	Industrial (Acres/%)	Open Space (Acres/%)	Residential (Acres/%)	Water (Acres/%)	Roads (Acres/%)
Arlington									
Johnson Creek	AR1801A*	Johnson Creek at East Sanford Street	3539.0	1251.6/35.4	199.4/5.6	636.3/18.0	688.8/19.5	24.3/0.7	738.6/20.9
Fish Creek	AR1802	Fish Creek at SH 360	4929.6	900.6/18.3	71.9/1.5	1010.1/20.5	1655.6/33.6	5.6/0.1	1285.8/26.1
Dallas									
Turtle Creek	TCTR-100	3805 Pipestone Road at Mican Channel	569.7	47.6/8.4	127.7/22.4	281.0/49.3	45.3/8.0	1.7/0.3	66.4/11.7
	TCTR-200	3951 La Reunion Parkway at Mican Channel	232.1	7.4/3.2	152.0/65.5	25.1/10.8	0.0/0.0	0.0/0.0	47.6/20.5
	TCTR-300	4300 Singleton Boulevard at Mican Channel	980.7	182.1/18.6	358.8/36.6	275.1/28.1	48.2/4.9	13.3/1.4	103.2/10.5
Headwaters Turtle Creek	HTC-100	3505 Maple Avenue at Turtle Creek	3808.1	480.3/12.6	2.6/0.1	404.9/10.6	2468.6/64.8	22.4/0.6	446.9/11.7
	HCT-200	1201 Turtle Creek Boulevard at Turtle Creek	2700.0	682.8/25.3	59.6/2.2	207.1/7.7	964.3/35.7	48.8/1.8	737.4/27.3
	HCT-300	2240 Irving Boulevard at Turtle Creek	8620.1	3210.5/37.2	579.7/6.7	1018.1/11.8	1278.2/14.8	104.7/1.2	2428.9/28.2
Fort Worth									
Headwaters Sycamore Creek	FWSYC1	2200 Block Cantrell Sansom	12213.7	2593.0/21.2	577.4/4.7	3259.1/26.7	4150.6/34.0	20.6/0.2	1613/13.2
Mary's Creek	FWMRY1	3900 Block Longvue (FM 2871)	22908.0	180.4/0.8	43.7/0.2	19332.8/84.4	2184.1/9.5	156.0/0.7	1011/4.4
	FWMRY3	Winscott Road (Vickery Blvd.) in South Z Boaz Park	11675.2	1194.5/10.2	7.2/0.1	6143.2/52.6	2413.5/20.7	93.1/0.8	1823.7/15.6
Garland									
Duck Creek	GA1801	Duck Creek between Forest North and South	2434	489.1/20.1	104.8/4.3	215.1/8.8	1094.3/45.0	0/0	530.7/21.8
	GA1803	Duck Creek under La Prada Bridge	7112	1367.0/19.2	813.5/11.4	761.0/10.7	2706.2/38.1	6.1/0.1	1458.2/20.5
Irving									
Delaware Creek	IR1801	Delaware Creek at Sowers Road	2332	456.2/19.6	0/0	98.6/4.2	1273.6/54.6	0/0	503.6/21.6
	IR802	Delaware Creek at Oakdale	1496	305.7/20.4	0.1/0	249.8/16.7	636.5/42.5	0/0	303.9/20.3
Mesquite									

Subwatershed	Site ID	Location	Drainage Area Total (Acres)	Commercial (Acres/%)	Industrial (Acres/%)	Open Space (Acres/%)	Residential (Acres/%)	Water (Acres/%)	Roads (Acres/%)
South Mesquite Creek	MS1801	North of New Market Road	9965.1	2247.1/22.5	452.9/4.5	1614.5/16.2	3230.8/32.4	12.2/0.1	2407.6/24.2
North Mesquite Creek	MS1802	North Mesquite Creek at Edward's Church	6256.7	813.1/13.0	226.7/3.6	1898.9/30.3	2118.3/33.9	15.4/0.2	1184.3/18.9
Plano									
Pittman Creek - Spring Creek	PL1801	Spring Creek at 16th Street	5129.4	654.8/12.8	27.6/0.5	458.0/8.9	2713.0/52.9	4.4/0.1	1271.6/24.8
North Texas Tollway Authority									
Cottonwood Branch-Hackberry Creek	NT 1801	Unnamed Tributary at SH 161 N. of Gateway Dr.	134.7	89.6/66.5	0/0	19.7/14.6	0/0.0	0/0.0	25.4/18.9
Cottonwood Creek- Mountain Creek Lake	NT1802	Cottonwood Creek at SH 161 S. of Dickey Road	3440.1	466.7/13.6	484.8/14.1	669.5/19.5	1188.7/34.6	0/0.0	630.4/18.3

*AR1801 and AR1801A results were combined for this table.

Table 8: Detailed Subwatershed and Drainage Area Land Use Descriptions

Participant	Subwatershed Name	Subwatershed Land Use Description	Site Number	Drainage Area Land Use Description
Arlington	Johnson Creek	Located in Tarrant County and has a total area of 13577.8-acre. The land is predominantly residential (29.4%) and commercial (26.8%) and is composed by 19.8% of roads, which includes primary and secondary highways, major and minor arteries, connecting, private and service roads, access ramps, driveways, trails, and airports. 14% of this subwatershed is denominated as open space areas and 0.3% denominated as water bodies. Industrial areas are concentrated in the northeast region and consists of 9.7% of land use.	AR1801/AR1801A – East Sanford Street	The delineated drainage area coves 3539.0-acres and consists predominantly of 35.4% commercial property and 20.9% of roads. There are also several residential (19.5%) properties and open space (18.0%) near the sampling site. Industrial land use counts for 5.6% and is concentrated in the southeast direction of this delineated drainage site. An estimation of 0.7% is present in this drainage site.
	Fish Creek – Mountain Creek Lake	Located in southeast of Tarrant County and southwest of Dallas County and has a total area of 27531.6-acre. The land use is predominantly made up of open space (35.2%) and residential areas (28.7%). Roads cover up 20.1% of land use and includes the Tarrant Arlington Municipal, and part of Grand Prairie Municipal airports. Commercial (11.3%) and Industrial (2.2%) areas are spread out along the subwatershed, and water features counts for 2.5% of land use composition.	AR1802 – Fish Creek at SH 360	The delineated drainage site has a total area of 3763.5-acres and consists predominantly of residential (44.0%) and commercial (23.9%) properties and open space (26.8%). Arlington Municipal Airport is located inside of this drainage site and composes roads land use of 3.2%. Industrial (1.9%) land use can be observed west of Arlington Municipal Airport. Water bodies counts for 0.1% of this delineated drainage site.
Dallas	Turtle Creek – Trinity River	Located in west-central Dallas County, has a total area of 22443.5-acre. 31.3% of land use is denominated as residential. Commercial areas consist of 11.6% of land use and can be found all over this subwatershed. Open areas (27.6%) and water bodies (1.2%) are mainly concentrated around the border of Turtle Creek. Industrial land use consists of 11.6% and is concentrated in northwest region. Roads also counts for a large land use amount of 20.9%.	TCTR-100 – 3805 Pipestone Road at Mican Channel	The delineated drainage site has a total area of 569.7-acres and consists predominantly of open space (49.3%) and industrial area (22.4%). Commercial (8.4%) and residential (8.0%) are concentrated east of this drainage area. Land use estimates for roads is 11.7% and 0.3% for water bodies.
			TCTR-200 – 3951 La Reunion Parkway at Mican Channel	The delineated drainage site has a total area of 232.1-acres and consists of 65.5% of industrial area and 20.5% of roads. A small percentage of open space (10.8%) and commercial (3.2%) is found among industrial area. No water bodies are present in this drainage site.

Participant	Subwatershed Name	Subwatershed Land Use Description	Site Number	Drainage Area Land Use Description
			TCTR-300 – 4300 Singleton Blvd. at Mican Channel	The delineated drainage site has a total area of 980.7-acres and is primarily composed of industrial (36.6%) areas, open space (28.1%), and a cluster of commercial (18.6%) properties. Some residential properties can be observed south of the drainage area. Roads composes 10.5% of this drainage area and water bodies 1.4%.
	Headwaters Turtle Creek	Located in northwest Dallas County and it has a total area of 21887.6-acre. Residential (28.4%) and commercial (27.8%) land use areas are predominant in this subwatershed and are respectively located in the north and west direction. Roads acreage is also predominant in this subwatershed and contributes with 28.2% of land use composition, which includes most of Dallas Love Field airport. Open (11.2%) and industrial (3.5%) areas compose a smaller percentage of this subwatershed, as well as water bodies (0.9%). Trinity River surrounds the south and southwest sides of this subwatershed.	HTC-100 – 3505 Maple Avenue at Turtle Creek	The delineated drainage site has a total area of 3808.1-acres and is mainly composed of residential properties (64.8%). Commercial properties (12.6%) and open space (10.6%) are randomly distributed. Roads (11.7%) are present along residential and commercial areas. 0.1% of land use is classified as industrial and 0.6% as water bodies.
			HTC-200 – 1201 Turtle Creek Boulevard at Turtle Creek	This delineated drainage site has a total area of 2700.0-acres and is predominantly composed of commercial (25.3%) and residential (35.7%) properties. 27.3% of roads compose this drainage area. Most of the commercial properties are concentrated south of the drainage area, while residential properties are in the north. Industrial areas (2.2%) can be found around commercial areas. Open space contributes with 7.7% of the drainage area, and water bodies with 1.8%.
			HTC-300 – 2240 Irving Boulevard at Turtle Creek	This delineated drainage site has a total area of 8620.1-acres and is composed of 37.2% of residential properties and 28.2% of roads, which includes a significant part of the Dallas Love Field airport. Residential properties (14.8%) are concentrated north of this drainage area. Most of the open space (11.8%) and industrial areas (6.7%) are mixed among commercial properties. Water bodies composed 1.2% of the drainage area.

Participant	Subwatershed Name	Subwatershed Land Use Description	Site Number	Drainage Area Land Use Description
Fort Worth	Headwaters Sycamore Creek	Located in the southwest direction of Tarrant County. This 23679.1-acre subwatershed is predominately residential (42.8%) and commercial (28.6%). Open space (19.4%) also makes up a large part of the subwatershed and is dispersed throughout. Industrial areas (2.6%) are concentrated in the middle of this subwatershed. Roads make up 6.9% and water bodies 1.6% of this subwatershed.	FWSYC3 – Dead end of Scott St. west of Beach St.	This delineated drainage site has a total area of 12213.7-acres and has commercial (21.2%) and residential (34.0%) properties, as well as open space (26.7%) dispersed throughout. Industrial areas (4.7%) are randomly distributed west of this drainage site. Roads contribute with 13.2% of the drainage area, and water bodies with 0.2%.
	Mary's Creek	Located between northeast of Parker County and southwest of Tarrant County. The total area of this subwatershed is 35357.4-acre and 72.9% is classified as open space. Roads (7.9%) and commercial areas (4.3%) are mainly concentrated along the Tarrant County side, while residential areas (13.8%) along the Parker County. Industrial areas comprise a smaller percentage of 0.3%. This subwatershed contains 0.8% of water bodies that are distributed throughout open space areas.	FWMRY1 – 3900 Block Longvue (FM 2871)	This delineated drainage area covers 22908.0 acres and the predominant land use is open space (84.4%). Residential properties (9.5%) are mostly concentrated northwest of this drainage area. Commercial (0.8%) and industrial (0.2%) areas are located along roads (4.4%) and residential areas. Water bodies compose 0.7% of this drainage area and are randomly disperse in the open space areas.
			FWMRY3 – Winscott Road (Vickery Blvd.) in South Z Boaz Park	This delineated drainage area covers 11675.2 acres and the predominant land use is open space (52.6%). Residential properties (20.7%) are mostly concentrated northeast of this drainage area. Commercial (10.2%) areas are located along roads (15.6%). Only 0.1% of industrial areas compose this drainage area. Water bodies can be seen near open spaces and compose 0.8% of the drainage area.
Garland	Duck Creek	Located northeast of Dallas County and its total area is 27179.5-acre. This subwatershed is predominantly residential (34.8%) and open space (25.4%). Residential areas are dispersed throughout the land while open spaces are concentrated in the southeast tip of the subwatershed. Commercial areas (17.4%) and roads (17.2%) also make up a large part of this subwatershed. Industrial areas (4.6%) are located along commercial areas, and 0.6% of land use is classified as water bodies.	GA1801 – Duck Creek between Forest North and South	This delineated drainage site has a total area of 2434.0-acres. The predominant land use is residential properties (45.0%) and roads (21.8%). Commercial properties (20.1%) are centralized in this drainage site, and industrial areas (4.3%) can be found south among commercial properties. Open space composes 8.8% of the drainage area. No water bodies are present.
			GA1803 – Duck Creek under La Prada Bridge	This delineated drainage site has a total area of 7112.0-acres and is predominantly composed of residential properties (38.1%). Most of the commercial properties (19.2%) and industrial sites (11.4%) are concentrated northwest of this drainage area. Open areas (10.7%) are randomly

Participant	Subwatershed Name	Subwatershed Land Use Description	Site Number	Drainage Area Land Use Description
				dispersed. Roads compose 20.5% of land use, and only 0.1% of water bodies are present in this drainage area.
Irving	Delaware Creek – West Fork Trinity River	Located in west-central of Dallas County near Mountain Creek Lake, and it covers a total area of 21599.4-acre. Open space (32.4%) acreage is predominantly, followed by residential (26.8%) and commercial areas (17.9%). Roads acreage consists of 16.5% of this subwatershed, which includes part of Dallas NAS (Hensley/Millennium Dallas) airport. Part of Trinity River crosses Delaware Creek subwatershed, and it complements the water body percentage of 2.1%. Industrial areas consist of 4.3% of this subwatershed.	IR1801 – Delaware Creek at Sowers Road	The drainage area delineated for this site covers 2332.0-acres and is mainly composed of residential properties (54.6%). Commercial properties (19.6%) and a few open space (4.2%) are dispersed throughout. Roads composes 21.6% of the drainage site and no industrial or water bodies are present.
			IR1802 – Delaware Creek at Oakdale	The drainage area delineated for this site covers 1496.0 acres and is mainly composed of residential (42.5%) and commercial (20.4%) properties. Roads composes 20.3% of the drainage site and open space can be observed towards the center. No industrial or water bodies are present.
Mesquite	South Mesquite Creek	Located in eastern Dallas County, southwest of Lake Ray Hubbard. South Mesquite Creek covers a 17,840-acre area and the land use is predominantly made up of residential (30.5%) and open space (31.1%) areas which are dispersed across the entire watershed. The majority of commercial (17.1%) areas are located along roads (18.2%). The industrial sites (2.6%) are concentrated in the western part of the watershed. This watershed has 0.6% water features.	MS1801 – North of New Market Road	The drainage area delineated for this site covers 9965.1 acres and is mainly composed of residential (32.4%) and commercial (22.5%) properties. Roads also participate in a reasonable portion of the drainage area with 24.2% of the land use. Open space (16.2%) are centralized and becomes denser towards south of the drainage area. Clusters of industrial (4.5%) land use are located west of the drainage area. Only 0.1% of water compose the land use in this drainage area.
	North Mesquite Creek	Located between the far eastern edge of Dallas County and northwestern tip of Kaufman County. North Mesquite Creek Watershed covers a 21.862.5-acre area and consists mostly of open space (64.3%) and residential (20.9%) property. Residential property is primarily located on the western side of the subwatershed with a small section along the southern edge. Roads land use estimate for this subwatershed is 10.9%, including Mesquite Metro Airport. Industrial (1.5%) sites are mostly located in the central portion of this watershed. Most of the commercial (10.5%) areas are located throughout the watershed along roads and	MS1802 – North Mesquite Creek at Edward's Church	The drainage area delineated for this site covers 6256.7 acres and is mainly composed of residential properties (33.9%) and open space (30.3%). Commercial properties (13.0%) are spread over the drainage area. Clusters of industrial land use (3.6%) are concentrated towards the middle east of the drainage area. Roads compose 18.9% of land use and water bodies only 0.2%.

Participant	Subwatershed Name	Subwatershed Land Use Description	Site Number	Drainage Area Land Use Description
		residential areas. This subwatershed contains 1.3% of water features.		
Plano	Pittman Creek – Spring Creek	Located in the lower southwest side of Collin County and upper north east side of Dallas County and its total area is 23387.2-acre. This subwatershed is composed predominantly of residential (45.4%) and open space area (20.9%). There are clusters of commercial properties (18.1%) and industrial area is mainly concentrated towards the middle of this subwatershed. Water bodies consists of 0.2% of the subwatershed area.	PL1801 – Spring Creek at 16th Street	The drainage area delineated for this site covers a 5129.4-acre area and primarily consists of residential properties (52.9%) and roads (24.8%). Open space (8.9%) is scattered throughout the drainage area but is mostly located along Spring Creek and mixed in with the residential and commercial property. Clusters of commercial (12.8%) properties is dispersed in this drainage area. There is a very small section of industrial (0.5%) sites and water bodies (0.1%) present.
NTTA	Cottonwood Branch – Hackberry Creek	A 13,325-acre subwatershed located in northeast Dallas County. This subwatershed is composed predominately of roads acreage (39.0%) which is due to a large portion of the DFW International Airport residing in the western side of the subwatershed. Throughout the subwatershed, there are patches of open areas (22.7%) and clusters of commercial (23.1%) areas. Some of the residential (13.2%) areas are scattered along the southern edge of the watershed. The water bodies composition for this subwatershed is 1.2% and industrial land use is 0.7%.	NT1801 – Unnamed Tributary at SH 161 N. of Gateway Dr.	The delineated drainage area covers 134.7 acres. It is in the center of the Cottonwood Branch – Hackberry Creek subwatershed, and east of the Dallas/Fort Worth International airport. This drainage area is composed of 66.5% of commercial properties, 18.9% of roads, and 14.6% of open space. There are no areas designated as residential or industrial. No significant water bodies are present.
	Cottonwood Creek – Mountain Creek Lake	Located southwestern of Dallas County and southeastern of Tarrant County. This subwatershed has a total area of 18852.9-acres and is predominantly residential (24.2%) and open space (23.8%). Roads acreage contributes with 17.3% of land use composition, which includes Dallas NAS (Hensley/Millennium Dallas), and part of Grand Prairie Municipal airport. Commercial (13.1%) and industrial (8.5%) areas are dispersed throughout the subwatershed. Mountain Creek Lake is located inside of this subwatershed, and the water body percentage of 13.1%.	NT1802 – Cottonwood Creek at SH 161 S. of Dickey Road	The delineated drainage area covers 2996.4 acres and the predominant land use is residential properties (39.7%) and open space (22.3%). Industrial sites (16.2%) and open space areas are mainly concentrated on the east side of the drainage area near the chemical sampling site. Commercial properties (15.6%) are dispersed throughout the drainage area and roads compose only 6.2% of the land use. There is no area designated as water body.

Figure 3: Arlington, Johnson Creek Subwatershed, AR1801 and AR1801A

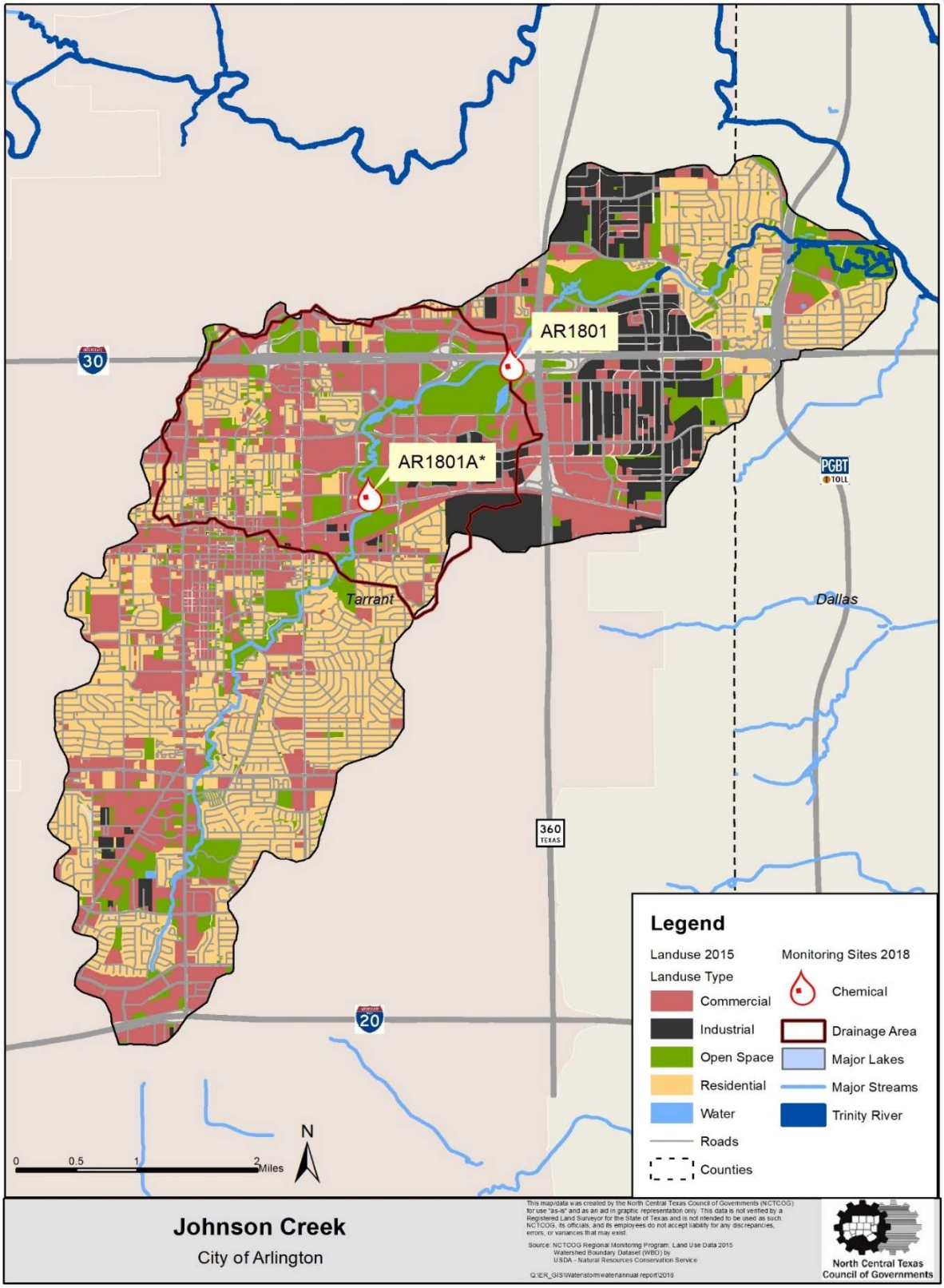


Figure 4: Arlington, Fish Creek – Mountain Creek Lake Subwatershed, AR1802

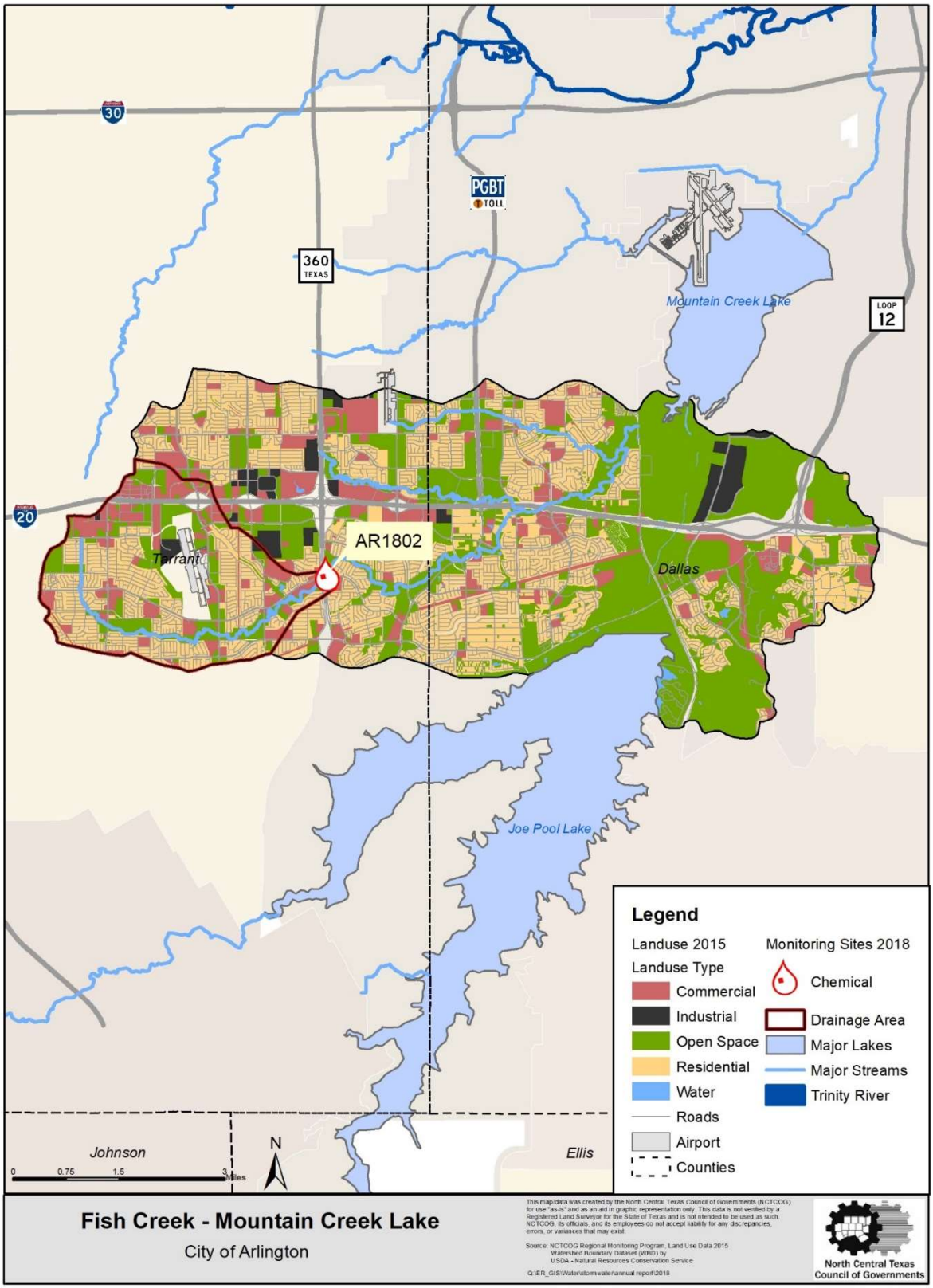


Figure 5: Dallas, Turtle Creek – Trinity River Subwatershed, TCTR-100, TCTR-200–3951, TCTR-300

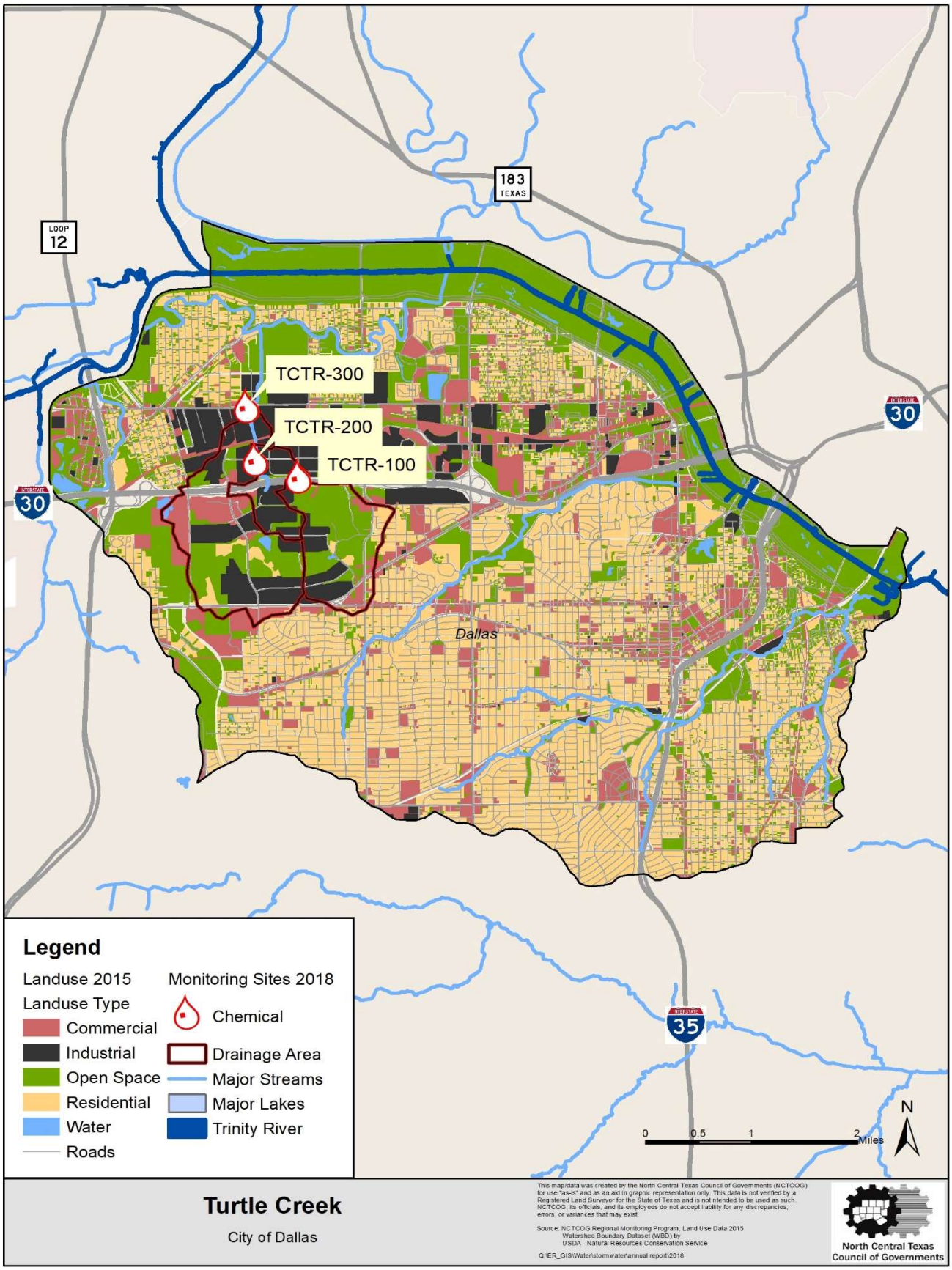


Figure 6: Dallas, Headwaters Turtle Creek Subwatershed, HTC-100, HTC-200–1201, HTC-300

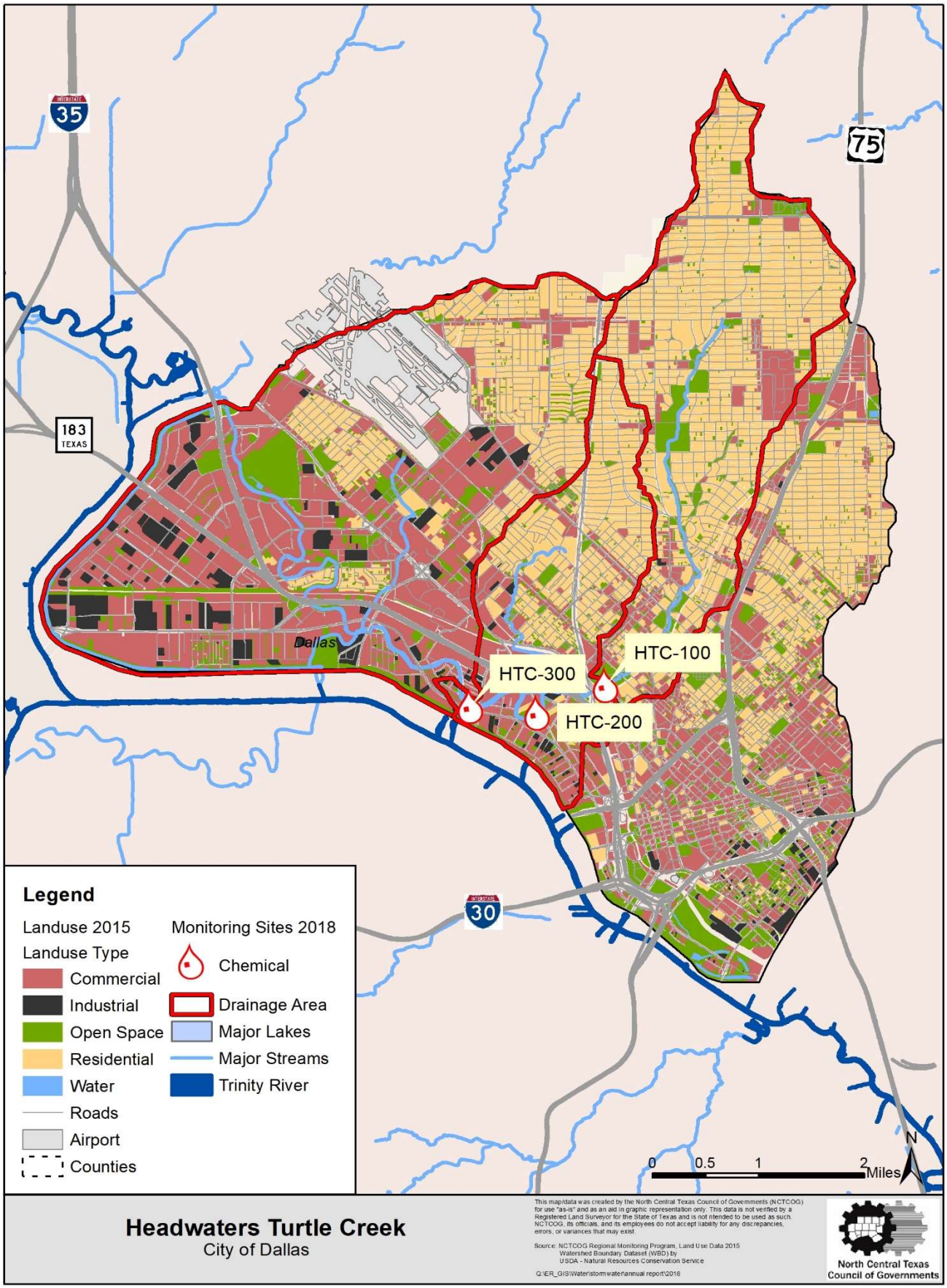


Figure 7: Fort Worth, Headwaters Sycamore Creek Subwatershed, FWSYC1, FWSYC3

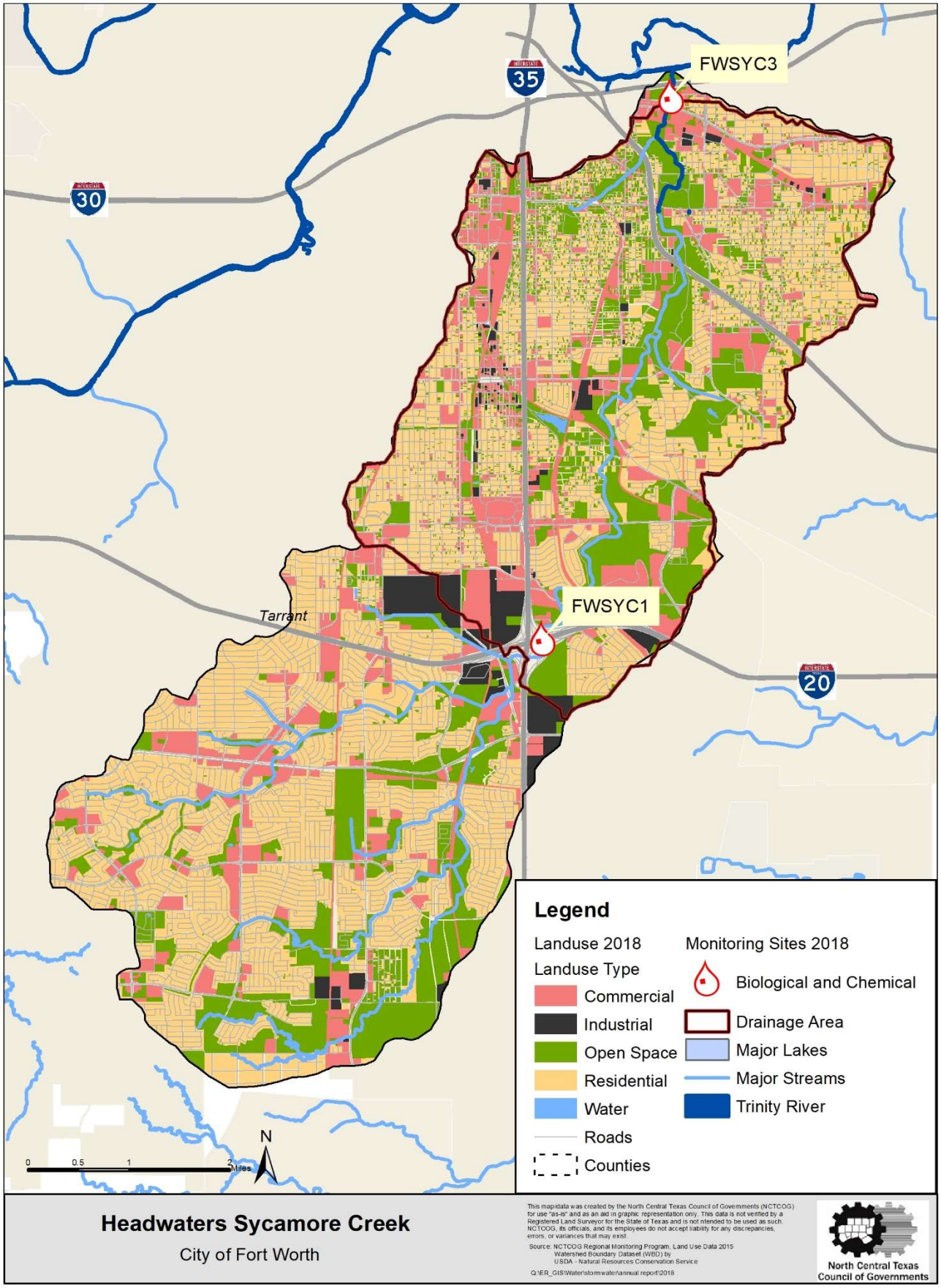


Figure 8: Fort Worth, Mary's Creek Subwatershed, FWMRY1, FWMRY3

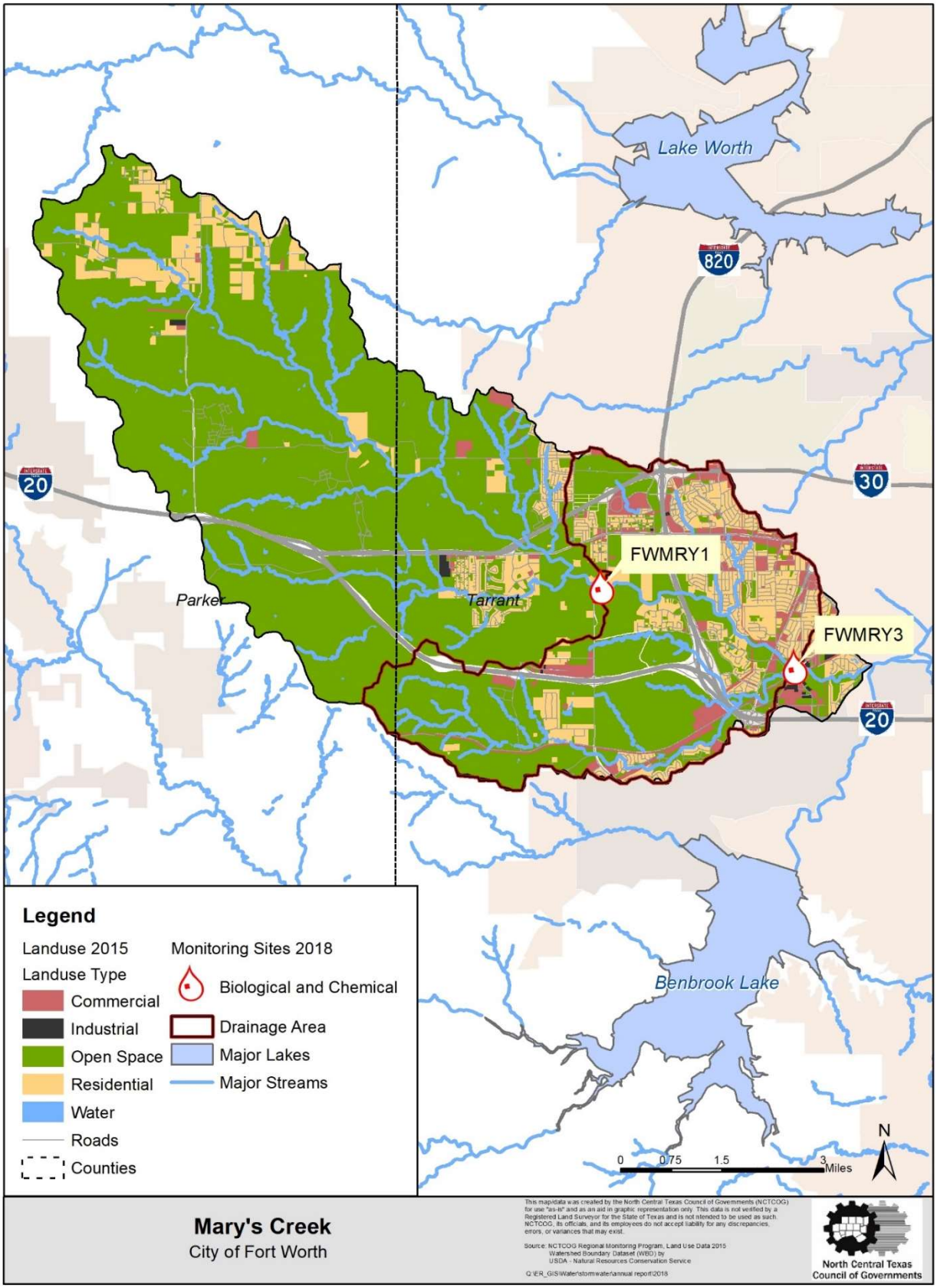


Figure 9: Garland, Duck Creek - GA1801; GA1802; GA1803 – Duck Creek under La Prada Bridge

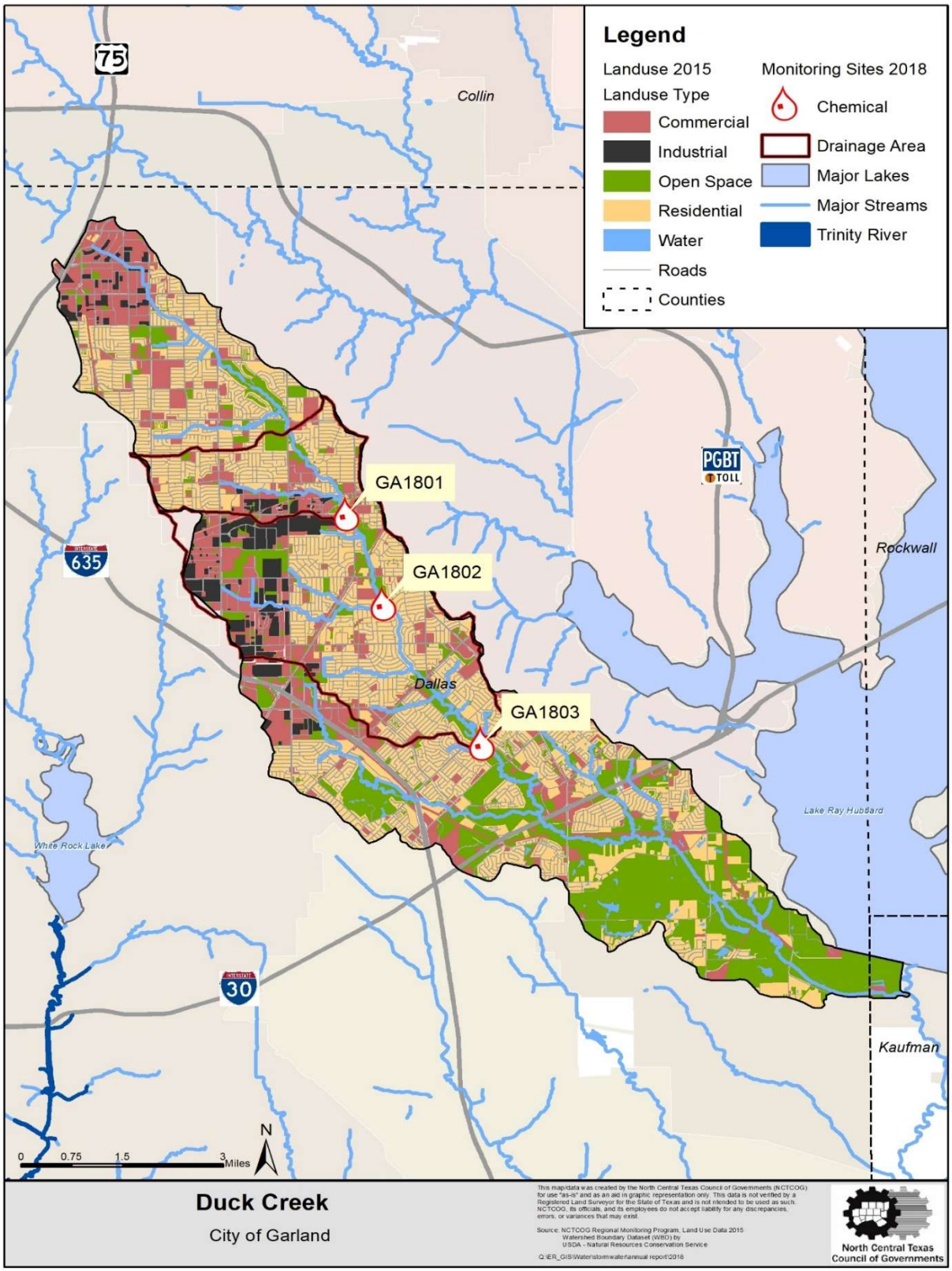


Figure 10: Irving, Delaware Creek – West Fork Trinity River Subwatershed, IR1801, IR1802

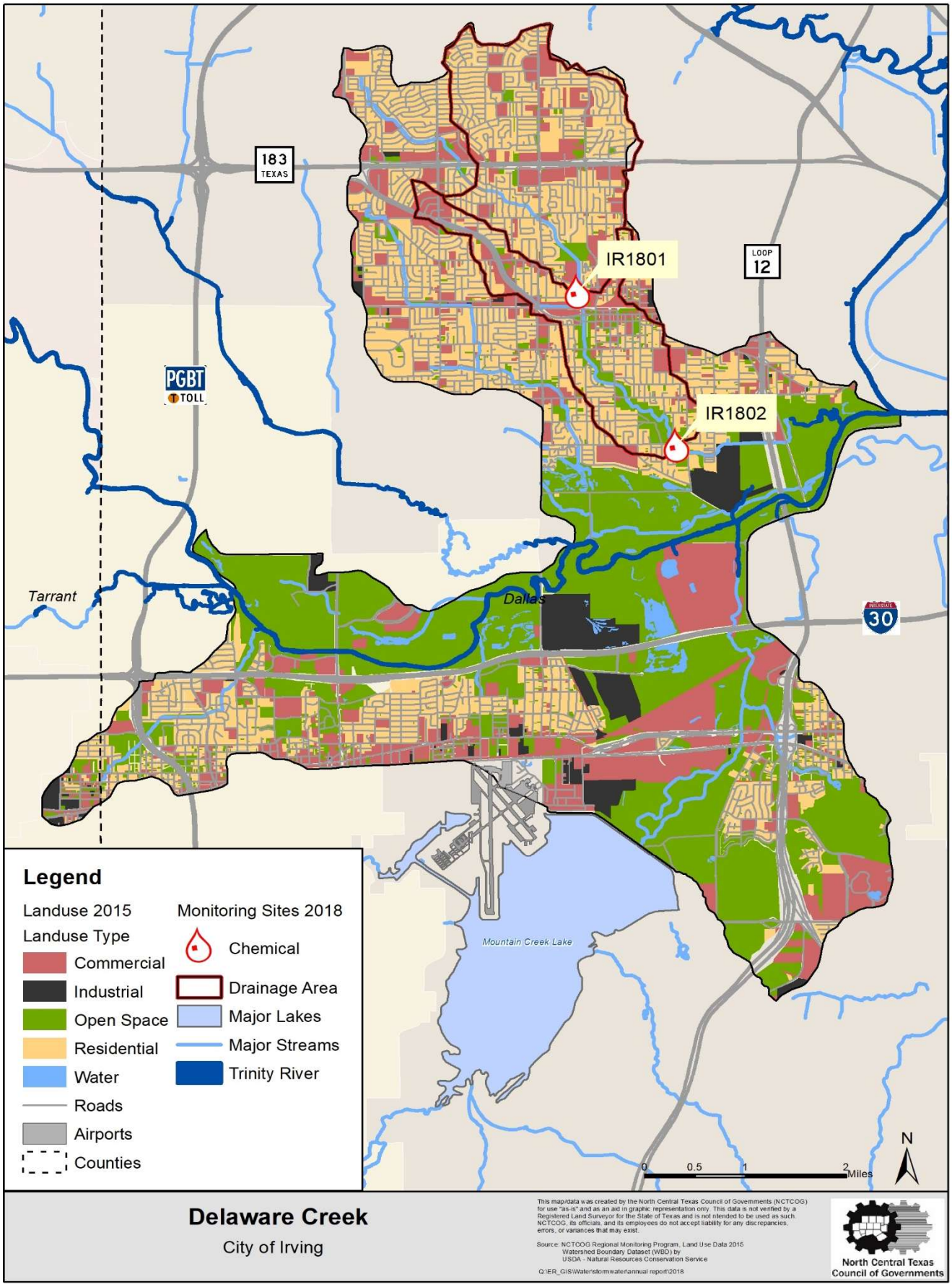

183
TEXAS
LOOP
12
IR1801
IR1802
PGBT
TOLL
Tarrant
Dallas
30
Mountain Creek Lake
N
0
0.5
1
2
Miles
Legend
Landuse 2015
Landuse Type
Commercial
Industrial
Open Space
Residential
Water
Roads
Airports
Counties
Monitoring Sites 2018
Chemical
Drainage Area
Major Lakes
Major Streams
Trinity River
Delaware Creek
City of Irving
This map/data was created by the North Central Texas Council of Governments (NCTCOG) for use "as-is" and as an aid in graphic representation only. This data is not verified by a Registered Land Surveyor for the State of Texas and is not intended to be used as such. NCTCOG, its officials, and its employees do not accept liability for any discrepancies, errors, or variances that may exist.
Source: NCTCOG Regional Monitoring Program, Land Use Data 2015
Watershed Boundary Dataset (WBD) by
USDA - Natural Resources Conservation Service
Q:\ER_GIS\Water\stormwater\annual report\2018
North Central Texas
Council of Governments

Figure 11: Mesquite, South Mesquite Creek Subwatershed, MS1801

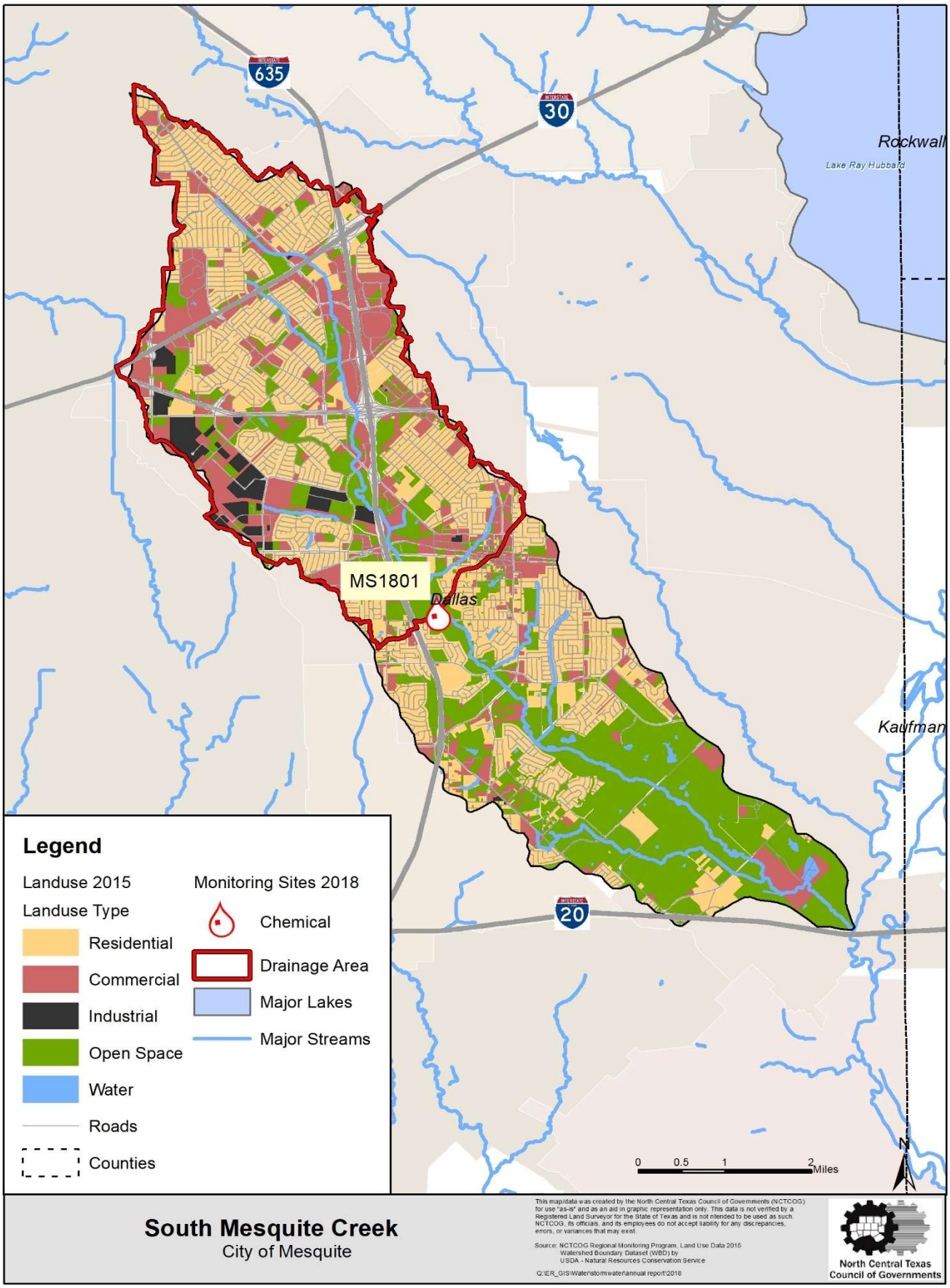


Figure 12: Mesquite, North Mesquite Creek Subwatershed, MS1802

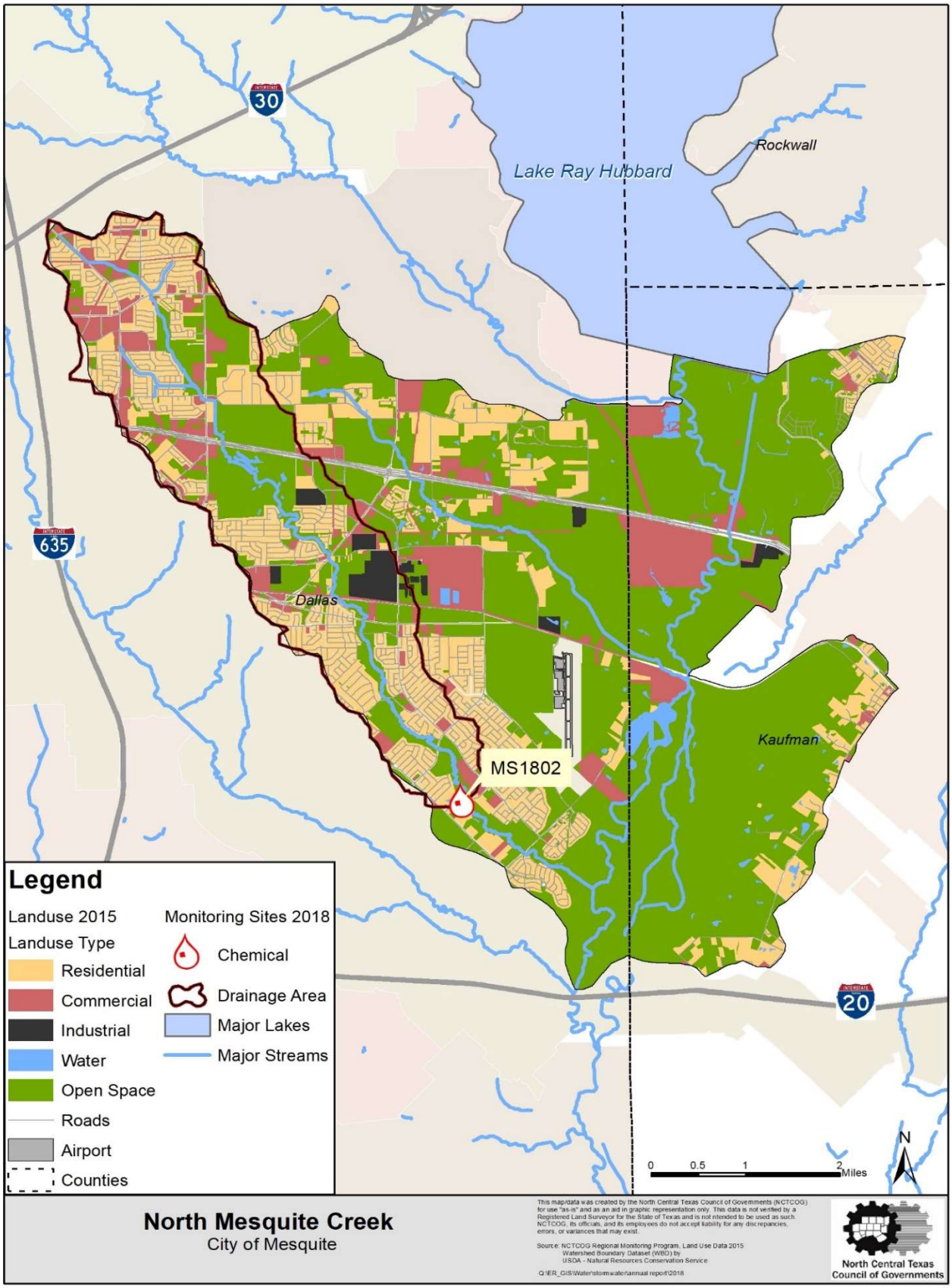


Figure 13: Plano, Pittman Creek – Spring Creek Subwatershed, PL1801

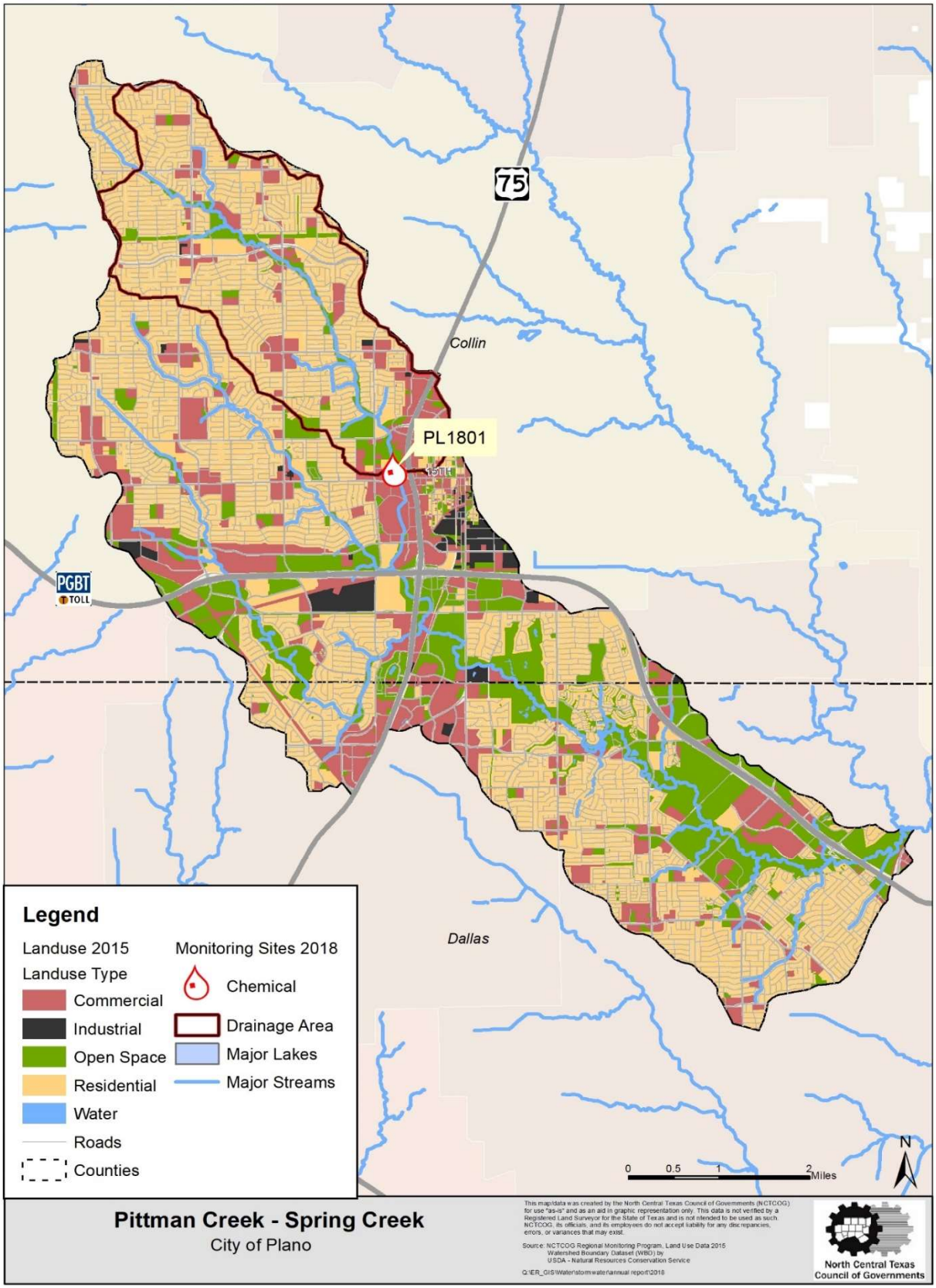


Figure 14: North Texas Tollway Authority, Cottonwood Branch – Hackberry Creek Subwatershed, NT1801

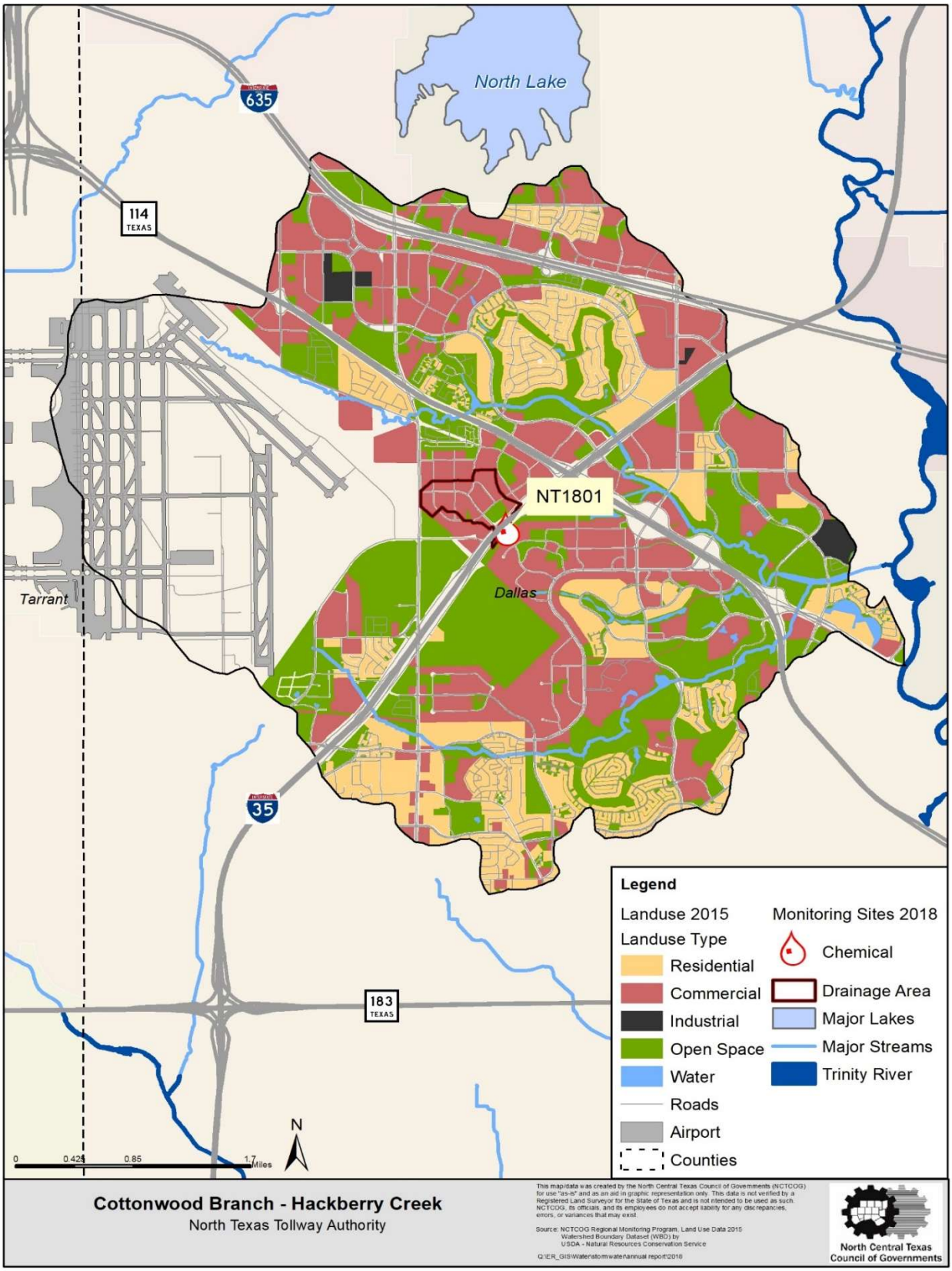
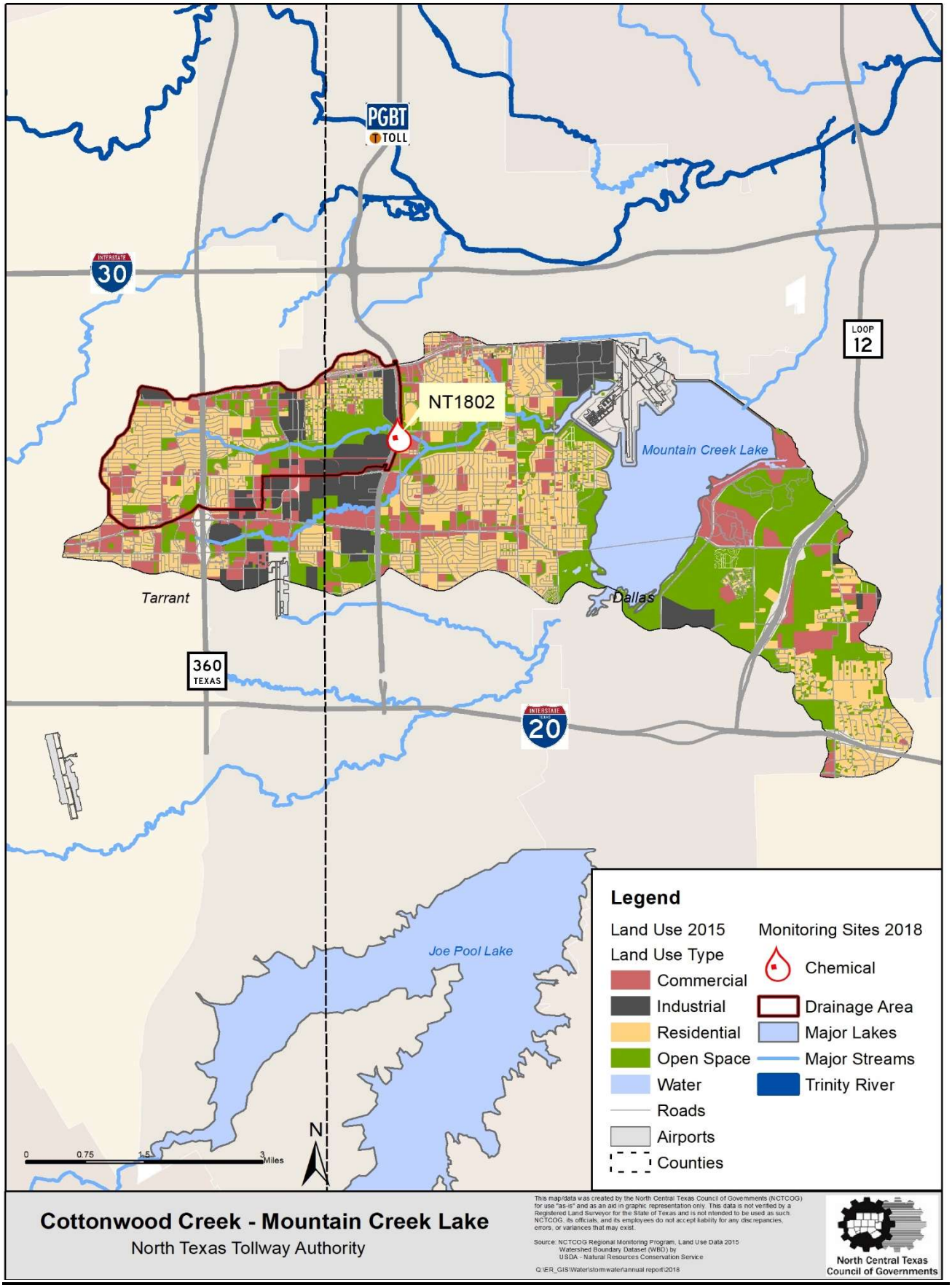


Figure 15: North Texas Tollway Authority, Cotton Creek – Mountain Creek Lake, NT1802



2018 STORM EVENTS AND MONTHLY RAINFALL

Table 9 includes each storm event by site, Rainfall Total, Peak 1-Hr Rate, Peak Depth and Antecedent Dry Period. The Rainfall Total is the total amount of rainfall measured for a qualifying storm event that is sampled. The Peak 1-Hr Rate is the highest amount of measurable rainfall during a 1-hour time frame. The Peak Depth is the highest measurable level the stream rose during the sampling event. The Antecedent Dry Period is the dry period prior to a storm event in which more than 0.10 inch of rain occurred. This information is normally collected from the ISCO equipment (rain gauge and bubbler module) and graphed using ISCO's proprietary Flowlink software. On-line internet rain gauges were used if the site rain gauge was not working. Sample collection reports are provided in Appendix G.

Table 9: Year 1 (2018) Storm Event Data

STORM EVENT DATE	SITE ID	RAINFALL TOTAL (in)	PEAK 1-HR RATE (in/hr)	PEAK DEPTH (ft)	ANTECEDENT DRY PERIOD (hrs)
1st QUARTER*					
6/4/2018	PL1801	1.00	0.89	1.5 (est.)	222
6/20/2018	AR1801	0.70	0.70	0.8	386
7/30/2018	GA1801	0.37	0.33	0.1 (est.)	418
	GA1803	0.37	0.33	0.6	418
	NT1802	0.24	0.20	1.0	471
8/9/2018	GA1802	0.12	0.10	1.2	239
	IR1801	0.10	0.09	0.6	234
	IR1802	0.10	0.09	0.1	234
	MS1801	0.22	0.22	2.3	238
10/31/2018	AR1802	1.03	0.31	3.5	156
	MS1802	0.16	0.16	1.8	151
11/8/2018	NT1801	0.10	0.08	1.5	119
2nd QUARTER					
5/25/2018	GA1801	0.11	0.11	0.6	120
	GA1802	0.11	0.11	0.5	120
	GA1803	0.11	0.11	0.9	120
	MS1801	0.55	0.55	2.3	120
	PL1801	0.21	0.21	1.1	120
6/4/2018	AR1801	0.3	0.3	1.5	356
	IR1801	0.76	0.76	1.4	356
	IR1802	0.76	0.76	1.2	356
	MS1802	2.31	1.82	5.6	233
	NT1801	0.30	0.28	1.7	355
	NT1802	0.30	0.28	1.1	355
8/10/2018	AR1802	0.34	0.22	0.7	263.5
3rd QUARTER					
7/6/2018	GA1803	0.62	0.62	0.8	772
7/9/2018	AR1801	0.4	0.4	1.7	480
	IR1801	1.27	1.18	1.5	846
	IR1802	1.27	1.18	1.5	846
	NT1802	0.24	0.24	1.9	764
7/12/2018	GA1801	1.32	0.93	3.3	919
7/30/2018	AR1802	0.28	0.22	0.4	419
	GA1802	0.37	0.33	1.1	418
	MS1801	0.41	0.34	2.8	418

STORM EVENT DATE	SITE ID	RAINFALL TOTAL (in)	PEAK 1-HR RATE (in/hr)	PEAK DEPTH (ft)	ANTECEDENT DRY PERIOD (hrs)
8/9/2018	NT1801	0.10	0.10	1.5	1499
	PL1801	0.10	0.05	0.5	651
8/10/2018	MS1802	0.34	0.28	1.1	263
4th QUARTER					
10/12/2018	GA1802	0.32	0.19	0.6	72
10/24/2018	AR1802	1.98	0.49	7.3	109.5
	GA1801	0.52	0.23	1.3	112
	GA1803	0.52	0.23	2.5	112
	IR1801	2.32	0.54	1.6	111
	MS1801	0.45	0.20	3.7	110
	MS1802	0.45	0.20	0.9	110
	NT1802	0.46	0.15	2.7	109
	PL1801	0.38	0.10	1.9	110
10/31/2018	IR1802	0.78	0.22	Unknown	157
	NT1801	0.34	0.16	1.8	157
11/8/2018	AR1801A	0.32	0.24	2.3	118.5

*All first quarter samples were collected during the second through fourth quarters.

MONTHLY RAINFALL DATA FOR JANUARY 2018 – DECEMBER 2018

The monthly rainfall totals for the 2018 sampling year were tracked using the Dallas/Fort Worth International Airport (DFW Airport Station) rain gauge and compared to long-term averages (National Oceanic and Atmospheric Administration, 2019). Figure 16 depicts monthly rainfall totals compared to the long-term monthly average rainfall at the DFW Airport Station. Figure 17 displays 2018 cumulative rainfall amounts versus the cumulative long-term monthly averages at the DFW Airport Station. The rainfall amounts during 2018 had several months far above the rainfall long-term averages (1974-2018), as much as 10 - 12 inches more, such as in February and October 2018. The remaining months had rainfall totals that were lower than the average rainfall for that month. In 2018, the DFW Airport Station cumulative monthly rainfall totals were not that different from the long-term cumulative rainfall averages from January thru August 2018. From August 2018 – December 2018, the DFW Airport Station cumulative monthly rainfall totals were up to 20 inches more (December 2018) than the long-term cumulative rainfall averages, as shown in Figure 17.

Figure 16: 2018 Monthly Rainfall Totals, Dallas/Fort Worth International Airport Rain Gauge
(Source: NOAA Climatic Data Center, 2019)

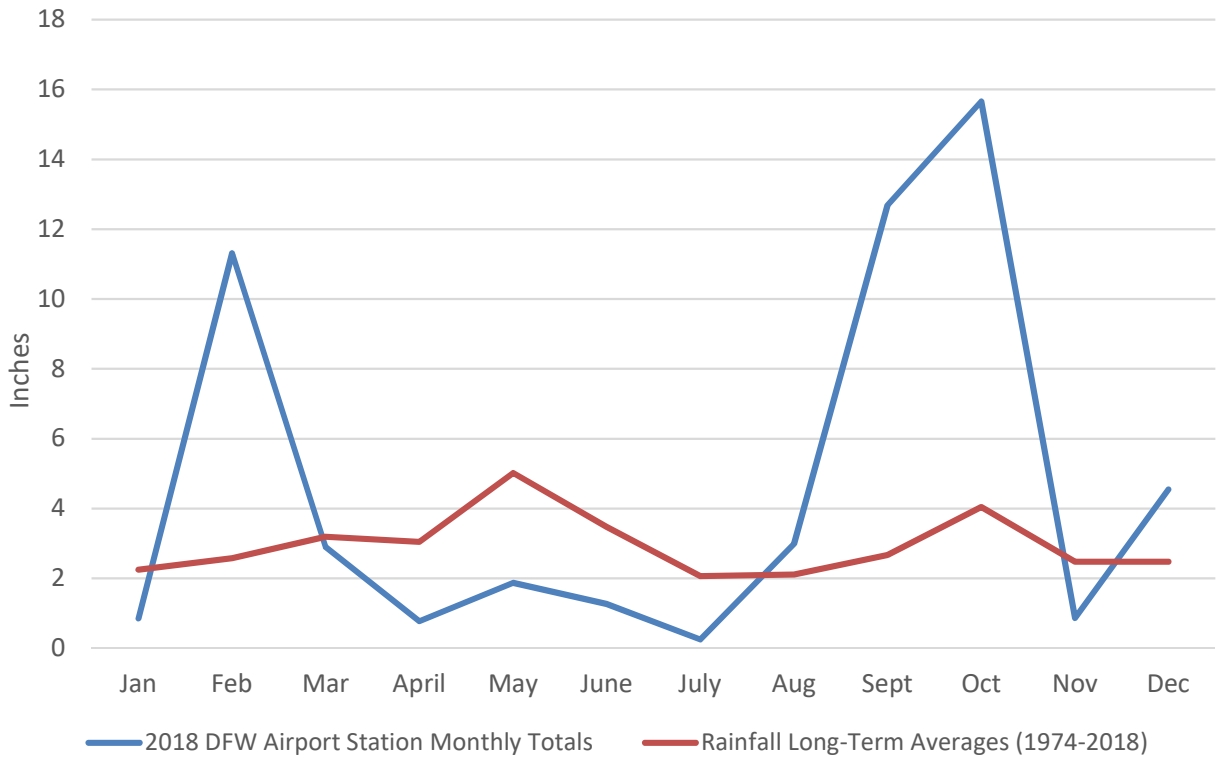
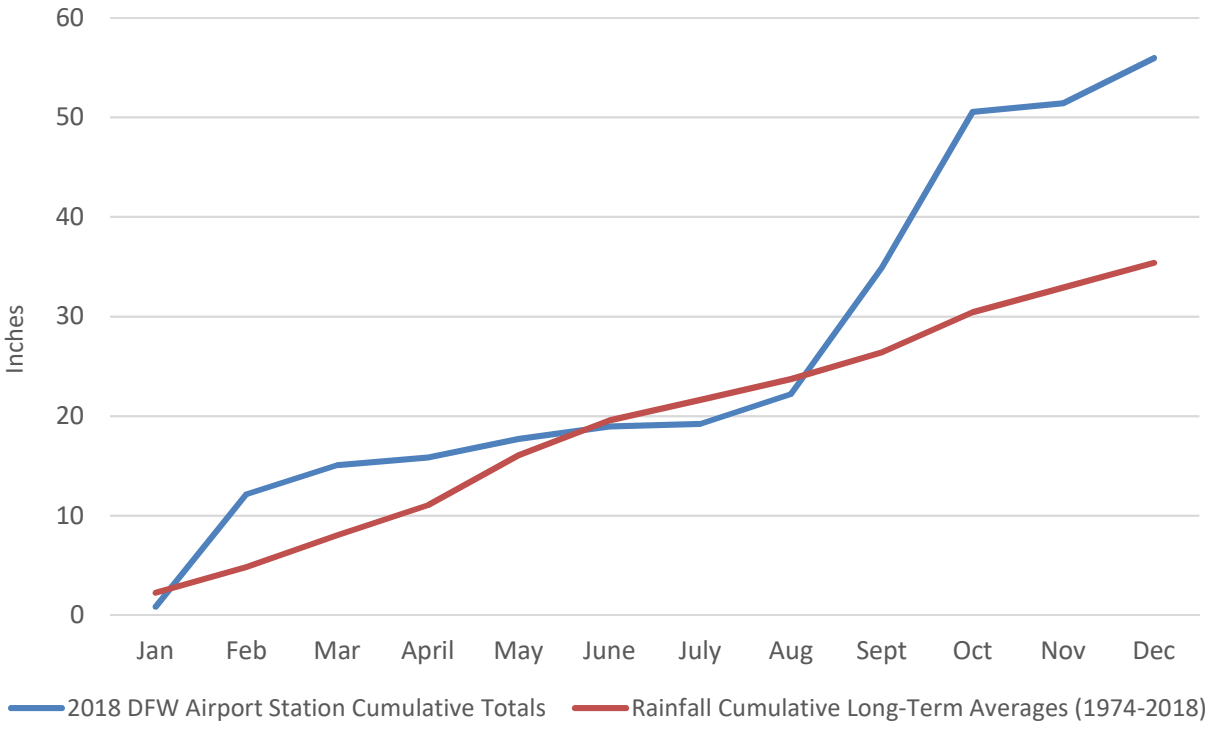


Figure 17: 2018 Cumulative Monthly Average Rainfall Totals, Dallas/Fort Worth International Airport Rain Gauge (Source: NOAA Climatic Data Center, 2019)



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APPENDICES

Appendix A: Regional Wet Weather Characterization Plan Proposal for the Fourth Term Submission and Letter of Approval from TCEQ

Appendix B: Monitoring Program and Quality Assurance Project Plan for Wet Weather Characterization Equipment Deployment and Sampling Protocol: 2018-2022

Appendix C: Monitoring Program and Quality Assurance Project Plan for: Bioassessments: 2018-2022

Appendix D: 2018 Stream Bioassessment: Rowlett Creek, City of Garland, Rowlett Creek Headwaters, City of Plano, and Delaware Creek, City of Irving

Appendix E: Lab Certifications and Accreditations

Appendix F: Raw Sampling Data

Appendix G: Sample Collection Reports

Appendix H: Dallas Bioassessment Report

Appendix I: Fort Worth Bioassessment Report