Work Plan Addendum

Sabine and Neches Rivers and Sabine Lake Bay Basin and Bay Area Stakeholder Committee

8 August 2011

Table of Contents

Table of Tables

Table of Figures

1. Introduction

This Addendum to the Sabine and Neches Rivers and Sabine Lake Bay Basin and Bay Area Stakeholder Committee (Sabine-Neches BBASC) Work Plan was prepared in response to the Texas Environmental Flows Science Advisory Committee (SAC)'s 24 June 2011 Draft Memorandum to the Texas Environmental Flows Advisory Group (EFAG), "Re: Review comments on Sabine and Neches Rivers and Sabine Lake Basin and Bay Area Stakeholders Committee Work Plan dated 7 December 2010" (SAC Memorandum). The Sabine-Neches BBASC appreciates the constructive comments provided in this draft review, which are intended to assist the EFAG in determining if the Sabine-Neches BBASC Work Plan is consistent with Senate Bill 3 (SB 3) requirements, and is pleased to provide herein the additional detail and specificity needed for the Work Plan to better serve as a useful framework for detailed planning and development of future monitoring studies and projects.

The Addendum further defines "what monitoring, special studies, or other information is required to fill data gaps and validate and refine the environmental flow analyses and environmental flow regime, as well as the environmental flow standards and achievement strategies" (SAC Memorandum/ Sabine-Neches Work Plan). Specifically, the Addendum lays out what parameters will be addressed within the disciplines of hydrology, water quality, biology, and geomorphology. Data gathered will supplement existing data and establish baselines where data is lacking. The Addendum adds survey schedules (see Table 6, pg. 15), allows for assessment of the effectiveness of the monitoring programs, surveys, and research studies, and ensures that state flow standards continue to protect a sound ecological environment. Estimates of cost and funding sources are included for parameters within each discipline.

The Sabine-Neches BBASC should provide oversight for Work Plan implementation. The competitive request for proposal (RFP) process described in the Work Plan (Section 5.2, pg. 12) should be developed and issued by the Sabine-Neches BBASC, with assistance from the Sabine-Neches BBEST and technical support from the Tri-Agencies. The Sabine-Neches BBASC will also be responsible for assigning prioritized ranks to the RFPs, because it is likely that funds will not be sufficient to study all proposed elements. The RFPs will be motivated by the objectives and strategies laid out in the Work Plan and this Addendum, and details of studies will be developed by the researchers in response to the RFPs based on

available funds, for example Texas Water Development Board (TWDB) Research and Planning Funds for Environmental Studies.

2. Adoption of Environmental Flow Standards for Surface Water

On 20 April 2011, the Texas Commission on Environmental Quality (TCEQ) adopted environmental flow standards for the Sabine and Neches Rivers, their associated tributaries, and Sabine Lake Bay.[1] By rule, these environmental flow standards are adequate to support a sound ecological environment, to the maximum extent reasonable considering other public interests and other relevant factors.[2] In the Standards, TCEQ found that the Sabine and Neches Rivers, their associated tributaries, Sabine Lake Bay, and the associated Sabine-Neches estuary are substantially sound ecological environments.[3] **Sound ecological environment** is defined in the Standards as "an ecological environment that: supports a healthy diversity of fish and other aquatic life; sustains a full complement of important species; provides for all major habitat types including rivers and streams, reservoirs, and estuaries; sustains key ecosystem processes; and maintains water quality adequate for aquatic life."[4]

3. Central Geo-Referenced Database

To make the data and literature pertaining to the Sabine and Neches Rivers and Sabine Lake Bay centralized and more universally accessible, the TCEQ-contracted literature review conducted by Stephen F. Austin State University (SFASU) for the Angelina and Neches River Basins and the literature gathered for the Sabine River Basin by the Sabine-Neches BBEST[5] should be added to the TCEQ-funded Texas Environmental Flows Information System (EFIS[6]) maintained by the University of Texas at Austin Center for Research in Water Resources (CRWR). A central geo-referenced database is an essential tool in future

[1] TEX. WATER CODE ANN. § 298 Subchapter C, http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=5&ti=30&pt=1&ch=298&sch=C&rl=Y, referenced 19 July 2011.
[2] Senate Bill 3, Section 11.1471(a)(1).
[3] TEX. WATER CODE ANN. § 298.260(a).
[4] TEX. WATER CODE ANN. § 298.255(3); this is the definition of "sound ecological environment" recommended by the Sabine-Neches BBASC in its Recommendations Report (Section 10.1 Recommendation 10, pg. 49), http://www.tceq.state.tx.us/assets/public/permitting/watersupply/water_rights/eflows/2010snbbasc_finalrecommendations.pdf, referenced 19 July 2011.
[5] Sabine-Neches BBEST Library, http://www.sratx.org/BBEST/library.html, referenced 21 July 2011.
[6] http://efis.crwr.utexas.edu/, referenced 19 July 2011.

efforts to determine and address data gaps and to validate and refine the environmental flow standards and achievement strategies.

4. Existing Data Summary

While the Sabine-Neches BBEST identified data gaps in its Recommendations Report, extensive U.S. Geological Survey (USGS) hydrology[7] and water quality data[8] are available, as well as biology sampling for programs such as the Texas Instream Flow Program (TIFP[9]) and the Toledo Bend Project Federal Energy Regulatory Commission (FERC) relicensing[10] and geomorphology studies conducted for the TIFP. Existing data is summarized below.

[7] USGS Water Data for Texas, http://waterdata.usgs.gov/tx/nwis, referenced 21 July 2011.
[8] Available via Texas Clean Rivers Program: Data, Forms, and Map Resources, http://www.tceq.texas.gov/waterquality/clean-rivers/data/crp-resources.html, referenced 21 July 2011.
[9] http://www.twdb.state.tx.us/instreamflows/, referenced 21 July 2011.
[10] http://www.tbpjo.org/PublicRelicensing/default.aspx, referenced 21 July 2011.

Table 1. Existing Data Summary

Location (USGS Gage ID)	TCEQ Segment (Station ID)	Hydrology	Water Quality	Biology	Geomorphology
Big Cow Creek (08029500)	0513 (10466)	USGS gage (1952-present)	Routine monthly, >10yrs, diel 10, 11	Fish 02, 03, Benthics 93, 94, 96, 02, 03	Phillips 08
Big Sandy Creek (08019500)	0514 (10468)	USGS gage (1939-present)	Routine monthly, >10yrs	Benthics 93, 94	
Sabine R. @ Gladewater (08020000)	0506 (10428)	USGS gage (1932-present)	Routine monthly, >10yrs		
Sabine R. @ Beckville (08022040)	0505 (13628)	USGS gage (1938-present)	Routine monthly, >10yrs	Karatayev 07 (US59)	
Sabine R. @ Ruliff (08030500)	0502 (10397)	USGS gage (1924-present)	Routine monthly, >10yrs	Karatayev 08, Randklev 09	Phillips 03, 07, 08, 09; Heitmuller 10
Village Creek (08041500)	0608 (10609)	USGS gage (1939-present)	Quarterly, >10yrs	Cooper 04	Phillips 08, 09
Angelina River@Alto (08036500)	0611 (10630)	USGS gage (1959-present)	Quarterly, >10yrs		
Neches R. @ Neches (08032000)	0604 (13627)	USGS gage (1939-present)	Quarterly, >10yrs		Phillips 08
Neches R. @ Rockland (08033500)	0604 (10585)	USGS gage (1912-present)	Quarterly, >10yrs		Phillips 08
Neches R. @ Evadale (08041000)	0602 (10580)	USGS gage (1921-present)	Quarterly, >10yrs	Cooper 04	Phillips 08, 09

5. Work Plan Approach

The SAC Work Plan Guidance[11] recommends an approach that utilizes measurements within the following four environmental flow disciplines, hydrology, water quality, biology, and geomorphology, to evaluate characteristics reflecting a sound ecological environment. Data from all four disciplines will be collected concurrently as applicable to provide a comprehensive interdisciplinary assessment within three categories: monitoring programs, surveys, and research studies. Table 2 (pg. 13) to Table 5 (pg. 15) present study matrices for each discipline subdivided by category.

5.1. Monitoring Programs

Long-term monitoring programs will provide an extensive dataset over an extended period for analysis of whether the environmental flow standards are adequate to support a sound ecological environment, to the maximum extent reasonable considering other public interests and other relevant factors.

5.1.1. Hydrology

Hydrology measurements at the environmental flow standards measurement points will utilize USGS gaging data. Although the USGS periodically verifies and adjusts rating curves, adjustments to the rating tables will be recommended on a periodic basis as needed. Please see Table 2. Hydrology Study Matrix (pg. 13) for details.

5.1.2. Water Quality

Routine water quality parameters will be collected at each site utilizing existing Texas Clean Rivers Program (TCRP[12]) monitoring and established TCEQ Surface Water Quality Monitoring (SWQM[13]) protocol to determine water quality. Current monitoring under TCRP will be sufficient to meet the objectives for this project. All monitoring will be conducted in accordance with an approved TCRP

[11] Report # SAC-2010-02, Considerations in the Development of an SB3 Work Plan for Adaptive Management, 20 August 2010, http://www.tceq.state.tx.us/assets/public/permitting/watersupply/water_rights/eflows/20100820sac_guidance_workplan.pdf, referenced 21 July 2011.
[12] http://www.tceq.texas.gov/waterquality/clean-rivers, referenced 21 July 2011.
[13] http://www.tceq.texas.gov/waterquality/monitoring/index.html, referenced 21 July 2011.

Quality Assurance Project Plan (QAPP[14]). The monitoring results will be submitted to TCEQ as routine monitoring for inclusion in the assessment to produce the *Texas Integrated Reported for Clean Water Act Sections 305(b) and 303(d)* (Integrated Report[15]). The parameters included are listed in Table 3. Water Quality Study Matrix (pg. 13).

5.2. Surveys

Focused surveys (short- or long-term) address data gaps identified by the Sabine-Neches BBEST in its Recommendations Report.

5.2.1. Hydrology

During periods of low flow (near environmental flow standards subsistence flows or lower), additional flow measurements may be collected as needed to verify flow values recorded by the USGS gages. The gages are most accurate for the middle of the rating curve and it is critical for this project to have accurate measurements during low flow events. Since low flows may not occur every year, this monitoring will not be regularly scheduled. Low flows will be measured in accordance with the TCEQ SWQM protocols and compared to the USGS gaged flows. Coordination with the USGS through the USGS Cooperative Water Program[16] provides for routine evaluation of gage rating curves and making any necessary adjustments on a four to six week visitation schedule.

5.2.2. Water Quality

Additional water quality monitoring will be conducted periodically during low flow conditions. The data collected during these TCRP Special Studies will be used to compare the water quality during low flows to other flow conditions. These measurements will include 24-hour dissolved oxygen (DO) and other field parameters for a one-week period. The procedures will follow TCEQ SWQM protocols and will be biased for flow data (BF-Biased Flow); these data will not be suitable for assessments for inclusion in the Integrated Report. The water

[14] See Quality Assurance Information for the Texas Clean Rivers Program, http://www.tceq.texas.gov/waterquality/clean-rivers/qa/index.html, referenced 21 July 2011.
[15] http://www.tceq.texas.gov/waterquality/assessment/10twqi/10twqi, referenced 21 July 2011.
[16] http://water.usgs.gov/coop/, referenced 21 July 2011.

quality parameters included for Special Studies for low flow monitoring are listed in Table 3. Water Quality Study Matrix (pg. 13).

5.2.3. Biology

Biological monitoring will be conducted to increase the baseline data set that characterizes the sound ecological environment for each site. Biological monitoring will include fishes, benthic macroinvertebrates, aquatic plants, and habitat assessment. The monitoring will be performed in adherence to the methodologies listed in the latest TCEQ SWQM protocols. Monitoring of mainstem measuring points will utilize the procedures specified for large rivers. One low flow survey will be conducted at each location on a five-year cycle and the monitoring will be conducted during the established critical period from July 1 to September 30. It is possible the low flows may occur outside of the critical period. The sampling periods will be adjusted for site- and collection-method-specific protocols to meet the objectives of the study. Reach lengths to be sampled in the large river sites will include at least one full meander of the stream channel whenever possible and will include at least two types of geomorphic channel units (e.g. riffles, pools, runs, glides). The minimum length for biological sampling in large rivers will be 500 meters and the maximum will be one kilometer. Modifications to meet the study objectives for this sampling will be addressed on a case by case basis. Final sampling specifications will be addressed in the TCRP QAPP prior to sampling.

Biological monitoring data collected during low flows will be submitted to TCEQ as biased for flow data (BF-Biased Flow) and will not be suitable for assessments for inclusion in the Integrated Report.

5.3. Research Studies

Short-term research studies also address data gaps identified by the Sabine-Neches BBEST in its Recommendations Report. Please see also Table 4. Biology Study Matrix (pg. 14).

5.3.1. Biology

The Sabine-Neches BBEST identified data gaps for biological data particularly mussels, riparian, and some fish communities and recommended research to establish baseline information.

Mussels The distribution and abundance of freshwater mussels of the family Unionidae in the Sabine and Neches River Basins are poorly understood. Natural factors and manmade disturbances affect the presence and survival of freshwater mussels. Natural factors include: drought-to-flood cycles; lack of suitable habitat; and competition and predation by other indigenous species. Manmade disturbances include: water pollution; environmental alterations; commercial harvesting; and competition from invasive species such as the Asian Clam (*Corbicula* sp.) and Zebra Mussels. Special studies through specific RFPs need to be undertaken in the Sabine and Neches River Basin watersheds to document and establish baseline distribution and life history information including host fish for glochidia (larval stage) life stages.

Riparian A Research Study similar to work done in the Lower Sabine River under the TIFP[17] should be conducted in the Lower Neches River in the first ten-year study cycle. Since the Big Thicket lines the Lower Neches River, it would be important to compare and/or contrast the two systems because large woody debris is a very important geomorphological and fish habitat parameter. Similar studies should be considered for the second ten-year study cycle for the Upper Sabine and Upper Neches River Basins.

Fish Communities The SAC biological overlay guidance[18] provided numerous references that address the complexity of describing flow regimes for aquatic organisms. First, habitat characteristics are strongly influenced by but not solely dependent on flow. Second, different life stages (adults, eggs, fry, and juveniles),

[17] McBroom, M. 2008. Developing a large woody debris budget for Southern rivers. Presented to The Texas Water Development Board, In Fulfillment of TWDB Contract No. 0604830632, August 31, 2010. http://www.twdb.state.tx.us/RWPG/rpgm_rpts/0604830632_WoodyDebris.pdf, referenced 1 August 2011.

[18] Report # SAC-2009-05, Essential Steps for Biological Overlays in Developing Senate Bill 3 Instream Flow Recommendations, 31 August 2009, http://www.tceq.texas.gov/assets/public/permitting/watersupply/water_rights/eflows/biologyoverlay.pdf, referenced 22 July 2011.

and habitat use (foraging, cover, and spawning) have different habitat-flow relationships. Work Plan surveys described in Section 5.2.3 will be directed toward documenting existing populations, their distribution in the Sabine and Neches River Basins, and establishing habitat features by direct measure of populations. Specific research studies will be required to describe the flow needs of target species that can't be determined with existing data. An existing effort by TPWD and Texas State University to assemble a database of habitat needs for fish species[19] may guide future studies. Additional research studies will be achieved through specific RFPs to address data gaps and supplement other efforts.

5.3.2. Geomorphology

Sabine and Neches River Basin areas with insufficient geomorphological data will be evaluated to delineate major geomorphic process zones and identify major geomorphic controls and transition zones. This geomorphological work has been developed for the Lower Sabine River[20] and needs to be developed for the Upper Sabine River and the Upper and Lower Neches River. The details of these studies should be developed by the researchers in response to Sabine-Neches BBASC RFPs.

[19] Texas Fish Habitat Survey, http://rsi-db.its.txstate.edu/fishhabitatsurvey/, referenced 22 July 2011.
[20] Phillips, J.D., Slattery M.C. 2007. Geomorphic Processes, Controls, and Transition Zones in the lower Sabine River. Austin: Texas Instream Flow Program, http://www.twdb.state.tx.us/RWPG/rpgm_rpts/0600010595_Sabine.pdf, referenced 21 July 2011; and Phillips, J.D. 2008. Geomorphic controls and transition zones in the lower Sabine River. Hydrological Processes 22, 2424-2437.

Table 2. Hydrology Study Matrix

Objectives - Continue to support USGS gages at locations with TCEQ flow standards criteria. Flow may be measured by other methods (doppler flow meters are currently used) as needed.		
Work Plan Approach	Monitoring Program	Survey
Parameter	USGS flow	Other methods as needed
Frequency	15 min continuous	As required by flow conditions
Existing Program	Yes	No
Approximate Cost	$16,000/year/gage	$1,200/measurement/site
Sponsor	USGS/Local Cooperator/Sabine Compact/TWDB	USGS/TCRP Partner/Tri-agencies

Table 3. Water Quality Study Matrix

Objectives - Continue existing monitoring programs. Additionally, use targeted in-situ monitoring to evaluate dissolved oxygen, pH, temperature, and specific conductivity at 15min intervals for up to seven days during low flow conditions.		
Work Plan Approach	Monitoring Program	Survey
SWQM Monitoring Category	Routine Monitoring	Special Study
Frequency	monthly or quarterly	2 events/year[21]
Existing Program	Yes	No
Approximate Cost	$1,500/site/event	$2,200/site/deployment
Sponsor	TCEQ/TCRP Partner	TCEQ/TCRP Partner
	Routine Monitoring Parameters	**Special Study Parameters**
	DO, pH, Temp., Specific Cond.	Biased Flow (BF), 15 min interval, 1 week period
	TP, NH4, TKN, SO4, Cl	DO, pH, Temp., Specific Cond.
	Bacteriological	
	Turbidity	

[21] September to August Fiscal Year (FY).

Table 4. Biology Study Matrix

Objectives - Collect biological community data over time to support future validation and/or refinement of environmental flow standards.				
Work Plan Approach	Surveys	Research Studies	Research Studies	Research Studies
Parameter	Fish/Ecoregion-specific IBI	Mussels	Riparian	Fish Lifecycle - main channel / oxbows / tributaries
	Benthic Macroinvertebrates/TCEQ Aquatic Life Use (ALU) metrics		Woody debris and riparian forest study	
	Physical Habitat/TCEQ habitat assessment as minimum			
Frequency	1/5 yrs; see Table 6			As determined by specific SN-BBASC RFPs
Upper Sabine Basin		2012 & 2013[22]		
Upper Neches Basin		2014 & 2015		
Lower Neches Basin		2016 & 2017	2016 & 2017	
Lower Sabine Basin		2018 & 2019		
Existing Program	No	No	No	No
Approximate Cost	$10,000	$50,000 per 2 yr period	$50,000 per 2 yr period	TBD
Sponsor	TCRP Partner/Tri-agencies (TCEQ, TWDB, TPWD)	Tri-agencies	Tri-agencies	Tri-agencies

[22] All study years are based on a September to August FY.

Table 5. Geomorphology Study Matrix

Objectives - Establish baseline information to delineate major geomorphic process zones and identify major geomorphic controls and transition zones.		
Work Plan Approach	Research Studies	Projected Dates
Parameter	geomorphic process zones, geomorphic controls, and transition zones	
Existing Program	No	
Approximate Costs		
Upper Sabine Basin	$40,000	2012 & 2013
Upper Neches Basin	$45,000	2014 & 2015
Lower Neches Basin	$35,000	2016 & 2017
Total	$110,000	
Sponsor	Tri-agencies	

Table 6. Surveys Schedule

Measurement Point	Year									
	2012*	2013	2014	2015	2016	2017*	2018	2019	2020	2021
Big Cow Creek nr Newton	X					X				
Village Creek nr Kountze	X					X				
Big Sandy Creek nr Big Sandy		X					X			
Angelina River nr Alto		X					X			
Sabine R. nr Gladewater			X					X		
Neches R. nr Neches			X					X		
Sabine R. nr Beckville				X					X	
Neches R. nr Rockland				X					X	
Sabine R. nr Ruliff					X					X
Neches R. at Evadale					X					X

* Senate Bill 1 State Water Plan[23] published.

6. Proposed Budget

The current programs as well as proposed additional studies to be developed through the Sabine-Neches BBASC RFP process will be dependent upon available funding. Any reductions in funds for these data collection efforts would require the Sabine-Neches BBASC to reassess and prioritize the Proposed Ten Year Budget Distribution (Table 7, below) based upon available funds.

[23] http://www.twdb.state.tx.us/wrpi/swp/swp.asp, referenced 21 July 2011.

Table 7. Proposed Ten Year Budget Distribution

Study	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTAL
Continous Flow (USGS Gauges)*	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	1,600,000
Flow (Survey)	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	120,000
WQ Monitoring*	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	1,200,000
WQ Survey	8,800	8,800	8,800	8,800	8,800	8,800	8,800	8,800	8,800	8,800	88,000
Biological Surveys	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	200,000
Biological Research Studies											
Mussels	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	250,000
Riparian					25,000	25,000					50,000
Fishes	TBD**	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Geomorphological Studies											
Upper Sabine	20,000	20,000									40,000
Upper Neches Basin			22,500	22,500							45,000
Lower Neches					17,500	17,500					35,000
Total	$365,800	$365,800	$368,300	$368,300	$363,300	$388,300	$388,800	$345,800	$345,800	$345,800	$3,628,000

* These programs are currently funded through TCRP (TCEQ and Planning Partners), USGS (and Local Cooperators including the Sabine Compact), TWDB (Research and Planning Funds for Environmental Studies), and TPWD.

** To Be Determined

7. Appendix

7.1. Environmental Flow Standards Measuring Points / Standards & Maps

7.1.1. Sabine Basin

The TCEQ-adopted environmental flow standards for the Sabine River Basin are presented in Table 8, below. The Sabine River Basin measurement points with flow standards are shown in Figure 1 through Figure 5.

Table 8. Sabine River and Tributaries - Final TCEQ Adopted E-Flow Standards

Season	Flow Status	**BSBS** Big Sandy Creek near Big Sandy, TX	**SRGW** Sabine River near Gladewater, TX	**SRBE** Sabine River near Beckville, TX	**n/a*** Big Cow Creek near Newton, TX	**SRRL** Sabine River near Ruliff, TX
Winter Jan-Feb-Mar	Subsistence	20 cfs	45 cfs	66 cfs	28 cfs	949 cfs
	Base	73 cfs	305 cfs	482 cfs	62 cfs	1,672 cfs
	Pulse	1 per season Trigger: 358 cfs Duration: 10 days Volume: 5,932 ac-ft	1 per season Trigger: 1,880 cfs Duration: 15 days Volume: 48,599 ac-ft	1 per season Trigger: 2,900 cfs Duration: 15 days Volume: 84,998 ac-ft	1 per season Trigger: 693 cfs Duration: 8 days Volume: 4,911 ac-ft	1 per season Trigger: 1,600 cfs Duration: 3 days Volume: 10,202 ac-ft
Spring Apr-May-Jun	Subsistence	9 cfs	22 cfs	28 cfs	20 cfs	436 cfs
	Base	33 cfs	131 cfs	255 cfs	42 cfs	1,329 cfs
	Pulse 1 per season	2 per season Trigger: 313 cfs Duration: 13 days Volume: 5,062 ac-ft	2 per season Trigger: 1,580 cfs Duration: 16 days Volume: 51,150 ac-ft	2 per season Trigger: 2,160 cfs Duration: 15 days Volume: 72,092 ac-ft	2 per season Trigger: 350 cfs Duration: 7 days Volume: 2,545 ac-ft	2 per season Trigger: 3,250 cfs Duration: 8 days Volume: 42,883 ac-ft
Summer Jul-Aug-Sep	Subsistence	8 cfs	14 cfs	22 cfs	20 cfs	396 cfs
	Base	15 cfs	37 cfs	56 cfs	31 cfs	737 cfs
	Pulse	1 per season Trigger: 50 cfs Duration: 6 days Volume: 671 ac-ft	1 per season Trigger: 168 cfs Duration: 7 days Volume: 2,752 ac-ft	1 per season Trigger: 285 cfs Duration: 6 days Volume: 5,436 ac-ft	1 per season Trigger: 109 cfs Duration: 5 days Volume: 873 ac-ft	1 per season Trigger: 3,380 cfs Duration: 11 days Volume: 54,321 ac-ft
Fall Oct-Nov-Dec	Subsistence	8 cfs	17 cfs	22 cfs	20 cfs	396 cfs
	Base	22 cfs	54 cfs	83 cfs	40 cfs	809 cfs
	Pulse 1 per season	2 per season Trigger: 130 cfs Duration: 9 days Volume: 2,189 ac-ft	2 per season Trigger: 380 cfs Duration: 11 days Volume: 1,098 ac-ft	2 per season Trigger: 628 cfs Duration: 9 days Volume: 7,245 ac-ft	2 per season Trigger: 322 cfs Duration: 7 days Volume: 2,232 ac-ft	2 per season Trigger: 2,020 cfs Duration: 5 days Volume: 17,662 ac-ft

*No control point is established within the WAM for this gage.
All designated flow rates shown in this table represent average daily values in units of cubic feet per second.

Figure 1. Big Sandy near Big Sandy, Texas (08019500)

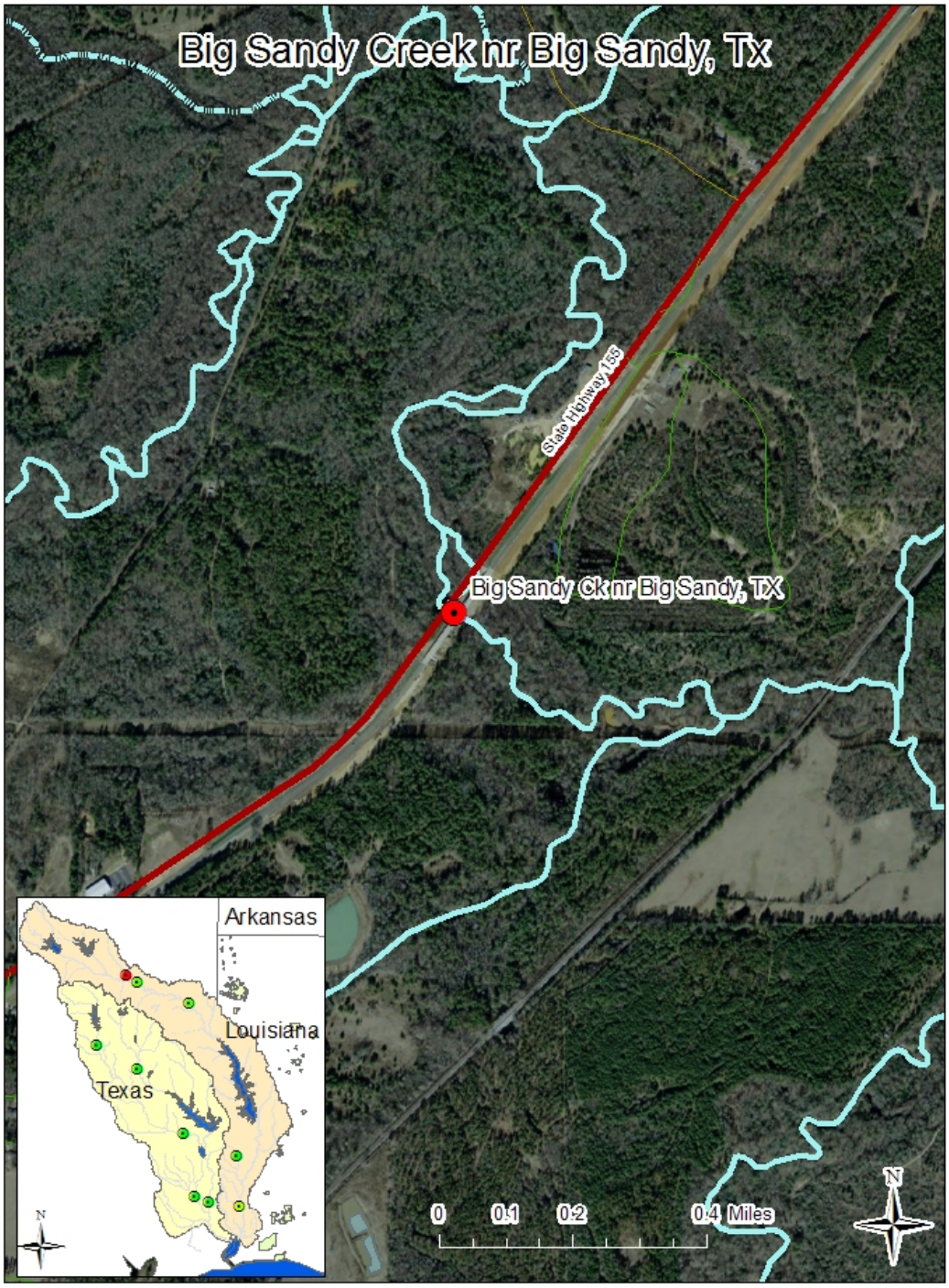

Figure 2. Sabine River near Gladewater, Texas (08020000)

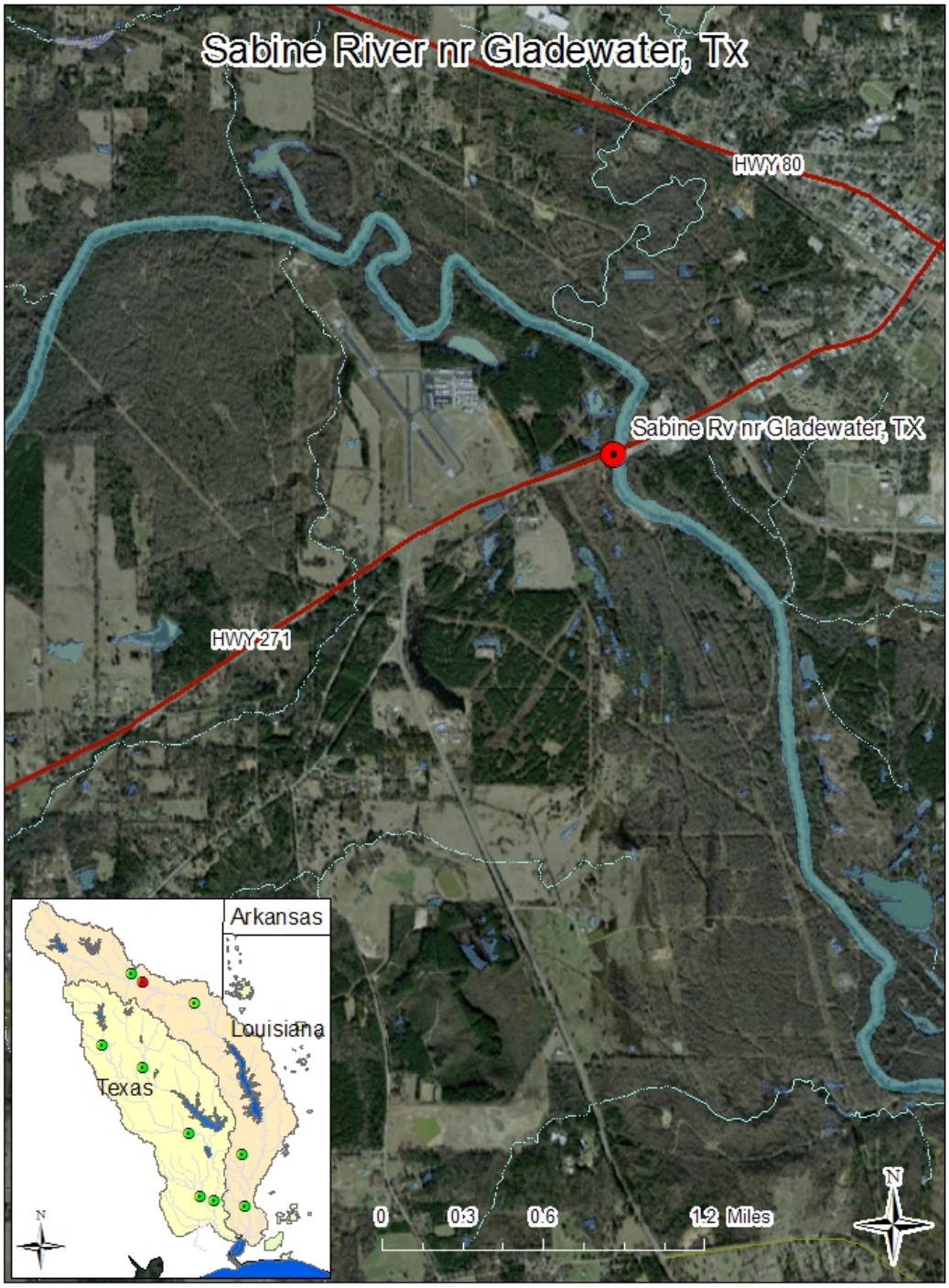

Figure 3. Sabine River near Beckville, Texas (08022040)

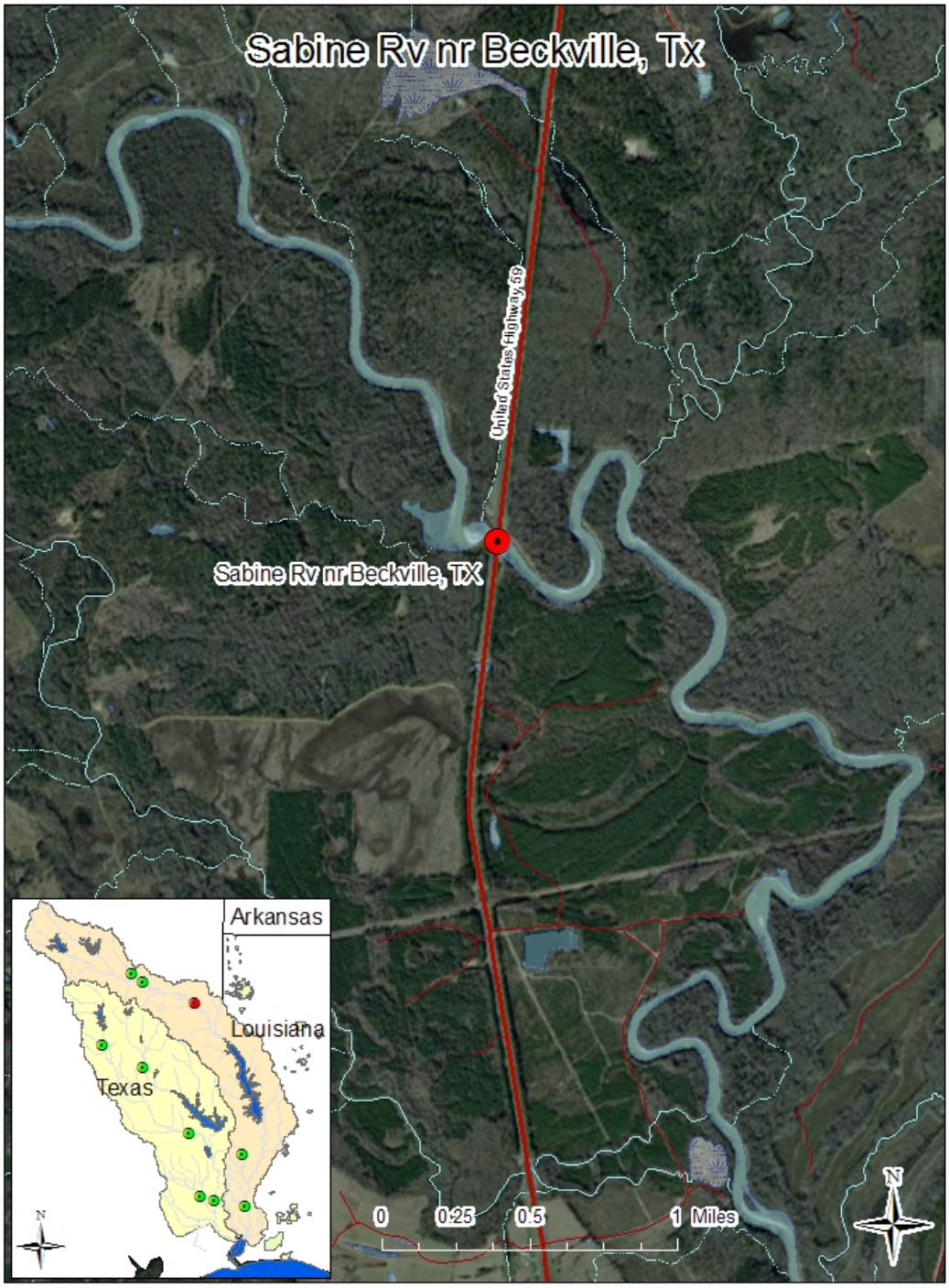

Figure 4. Big Cow Creek near Newton, Texas (08029500)

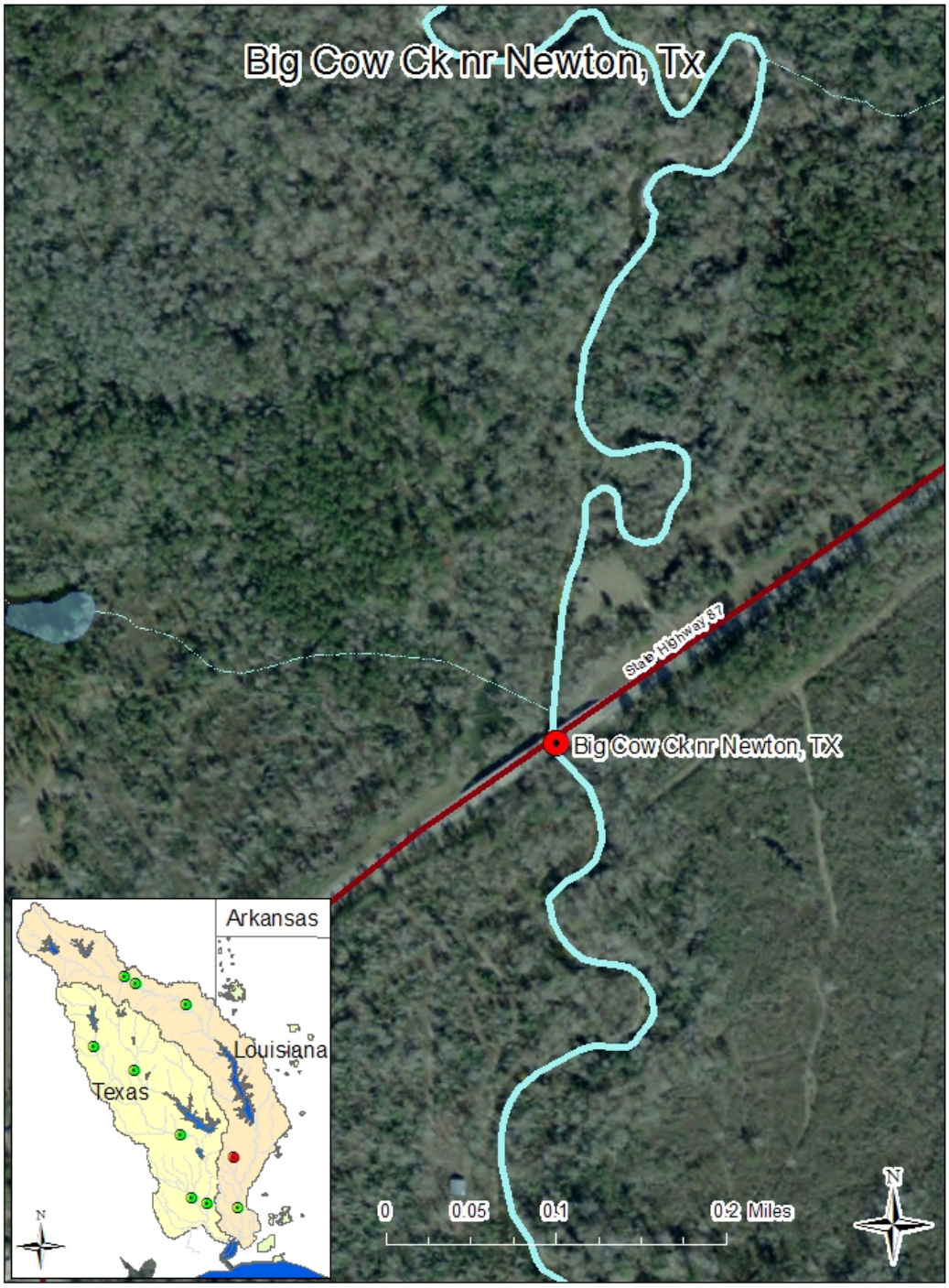

Figure 5. Sabine River near Ruliff, Texas (08030500)

7.1.2. Neches Basin

The TCEQ-adopted environmental flow standards for the Neches River Basin are presented in Table 9, below. The Neches River Basin measurement points with flow standards are shown in Figure 6 through Figure 10.

Table 9. Neches River and Tributaries - Final TCEQ Adopted E-flow Standards

Season	Flow Status	**NENE** Neches River near Neches, TX	**NERO** Neches River near Rockland	**ANAL** Angelina River near Alto, TX	**NEEV** Neches River near Evadale, TX	**VIKO** Village Creek near Kountze, TX
Winter Jan- Feb-Mar	Subsistence	51 cfs	67 cfs	55 cfs	228 cfs	83 cfs
	Base	196 cfs	603 cfs	277 cfs	1,925 cfs	264 cfs
	Pulse	1 per season Trigger: 833 cfs Duration: 10 days Volume: 19,104 ac-ft	1 per season Trigger: 3,080 cfs Duration: 14 days Volume: 82,195 ac-ft	1 per season Trigger: 1,620 cfs Duration: 13 days Volume: 37,114 ac-ft	1 per season Trigger: 2,020 cfs Duration: 6 days Volume: 20,920 ac-ft	1 per season Trigger: 2,010 cfs Duration: 13 days Volume: 36,927 ac-ft
Spring Apr-May-Jun	Subsistence	21 cfs	29 cfs	18 cfs	266 cfs	49 cfs
	Base	96 cfs	420 cfs	90 cfs	1,804 cfs	117 cfs
	Pulse 1 per season	2 per season Trigger: 820 cfs Duration: 12 days Volume: 20,405 ac-ft	2 per season Trigger: 1,720 cfs Duration: 12 days Volume: 39,935 ac-ft	2 per season Trigger: 1,100 cfs Duration: 14 days Volume: 24,117 ac-ft	2 per season Trigger: 3,830 cfs Duration: 12 days Volume: 68,784 ac-ft	2 per season Trigger: 1,380 cfs Duration: 13 days Volume: 23,093 ac-ft
Summer Jul- Aug- Sep	Subsistence	12 cfs	21 cfs	11 cfs	288 cfs	41 cfs
	Base	46 cfs	67 cfs	40 cfs	580 cfs	77 cfs
	Pulse	1 per season Trigger: 113 cfs Duration: 4 days Volume: 1,339 ac-ft	1 per season Trigger: 195 cfs Duration: 5 days Volume: 1,548 ac-ft	1 per season Trigger: 146 cfs Duration: 8 days Volume: 2,632 ac-ft	1 per season Trigger: 1,540 cfs Duration: 9 days Volume: 21,605 ac-ft	1 per season Trigger: 341 cfs Duration: 8 days Volume: 6,159 ac-ft
Fall Oct-Nov-Dec	Subsistence	13 cfs	21 cfs	16 cfs	228 cfs	41 cfs
	Base	80 cfs	90 cfs	52 cfs	512 cfs	98 cfs
	Pulse 1 per season	2 per season Trigger: 345 cfs Duration: 8 days Volume: 5,391 ac-ft	2 per season Trigger: 515 cfs Duration: 8 days Volume: 8,172 ac-ft	2 per season Trigger: 588 cfs Duration: 12 days Volume: 12,038 ac-ft	2 per season Trigger: 1,570 cfs Duration: 7 days Volume: 17,815 ac-ft	2 per season Trigger: 712 cfs Duration: 9 days Volume: 11,426 ac-ft

Figure 6. Neches River at Neches, Texas (08032000)

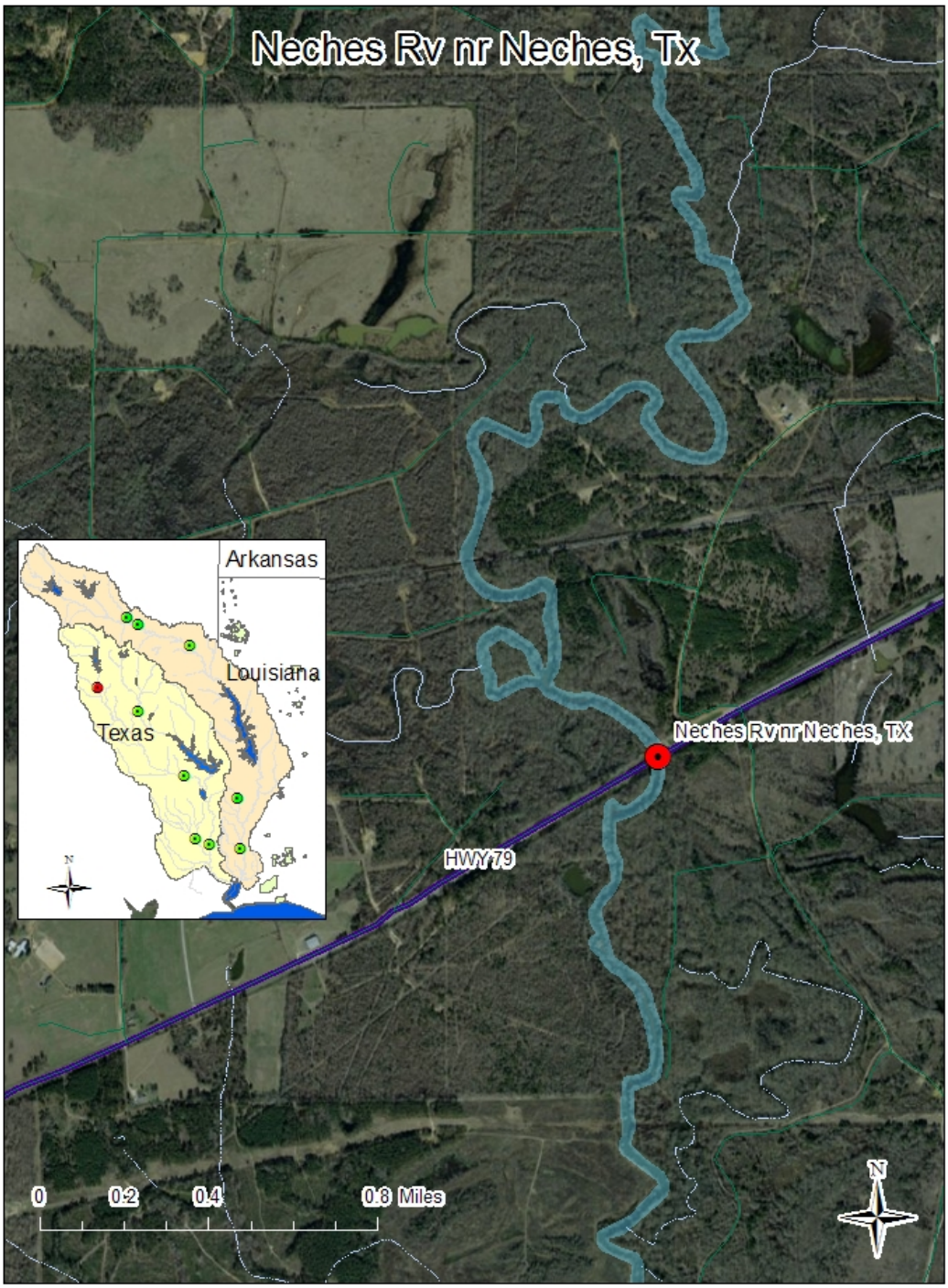

Figure 7. Neches River near Rockland, Texas (08033500)

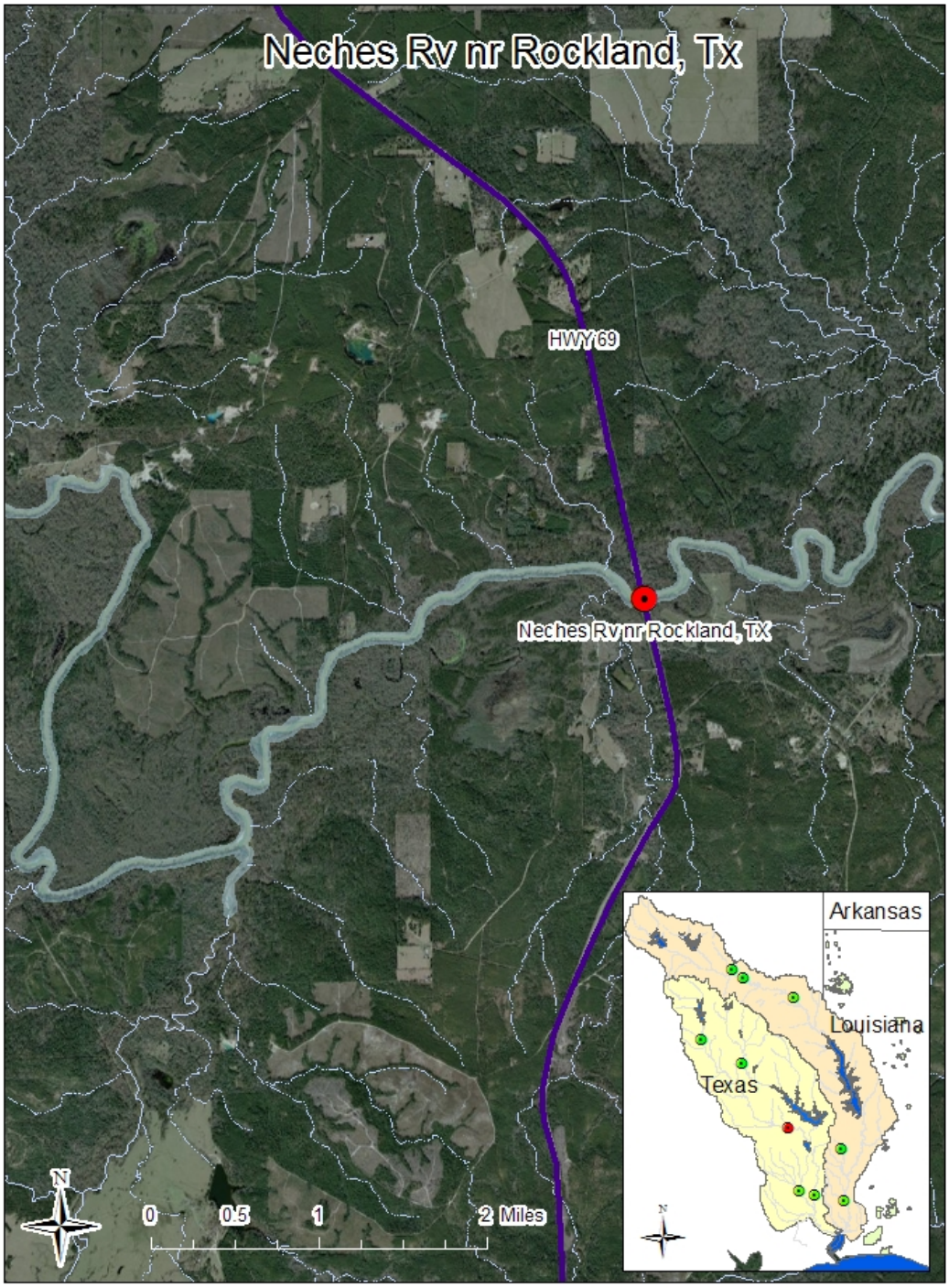

Figure 8. Angelina River near Alto, Texas (08036500)

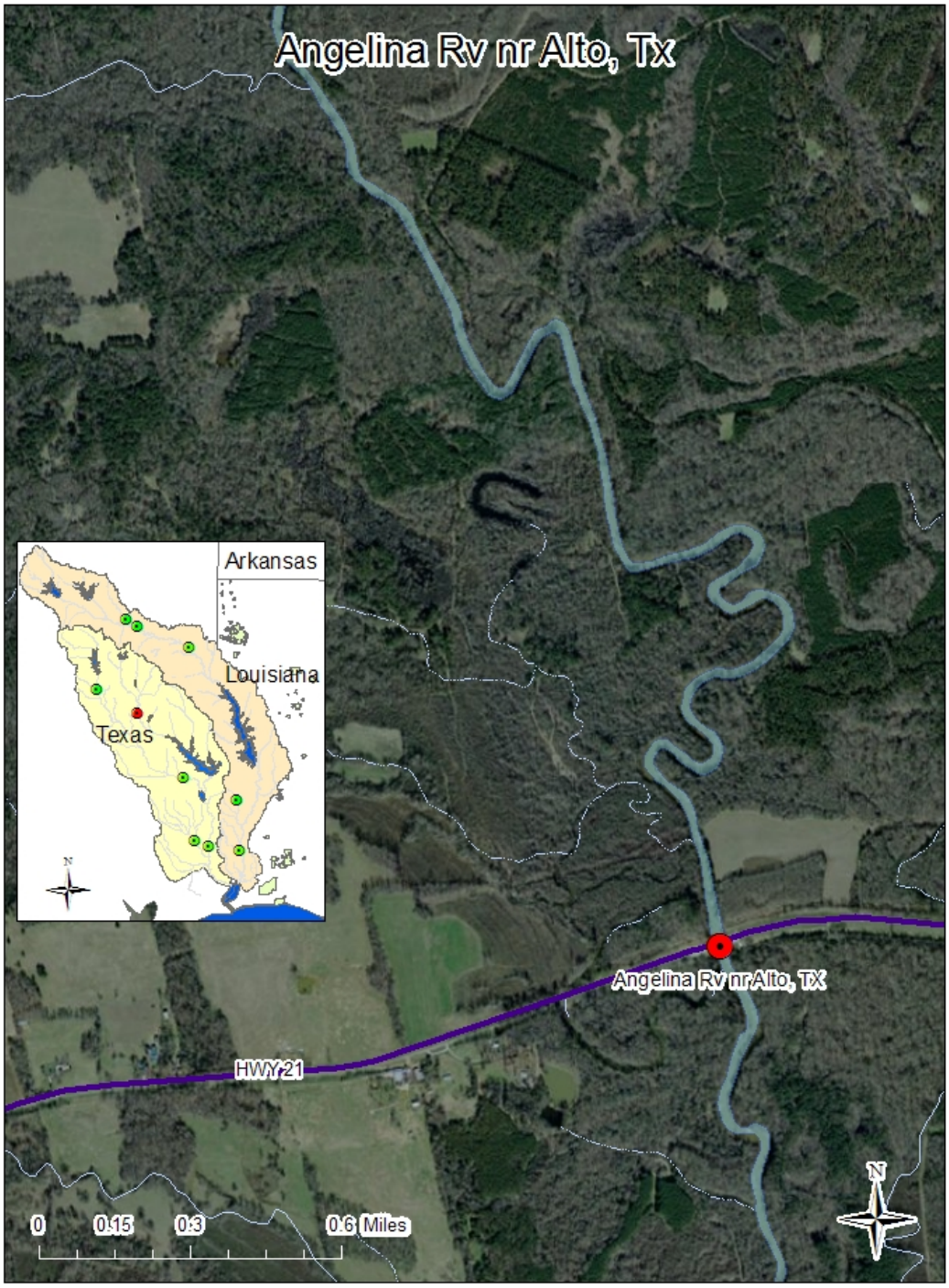

Figure 9. Neches River at Evadale, Texas (08041000)

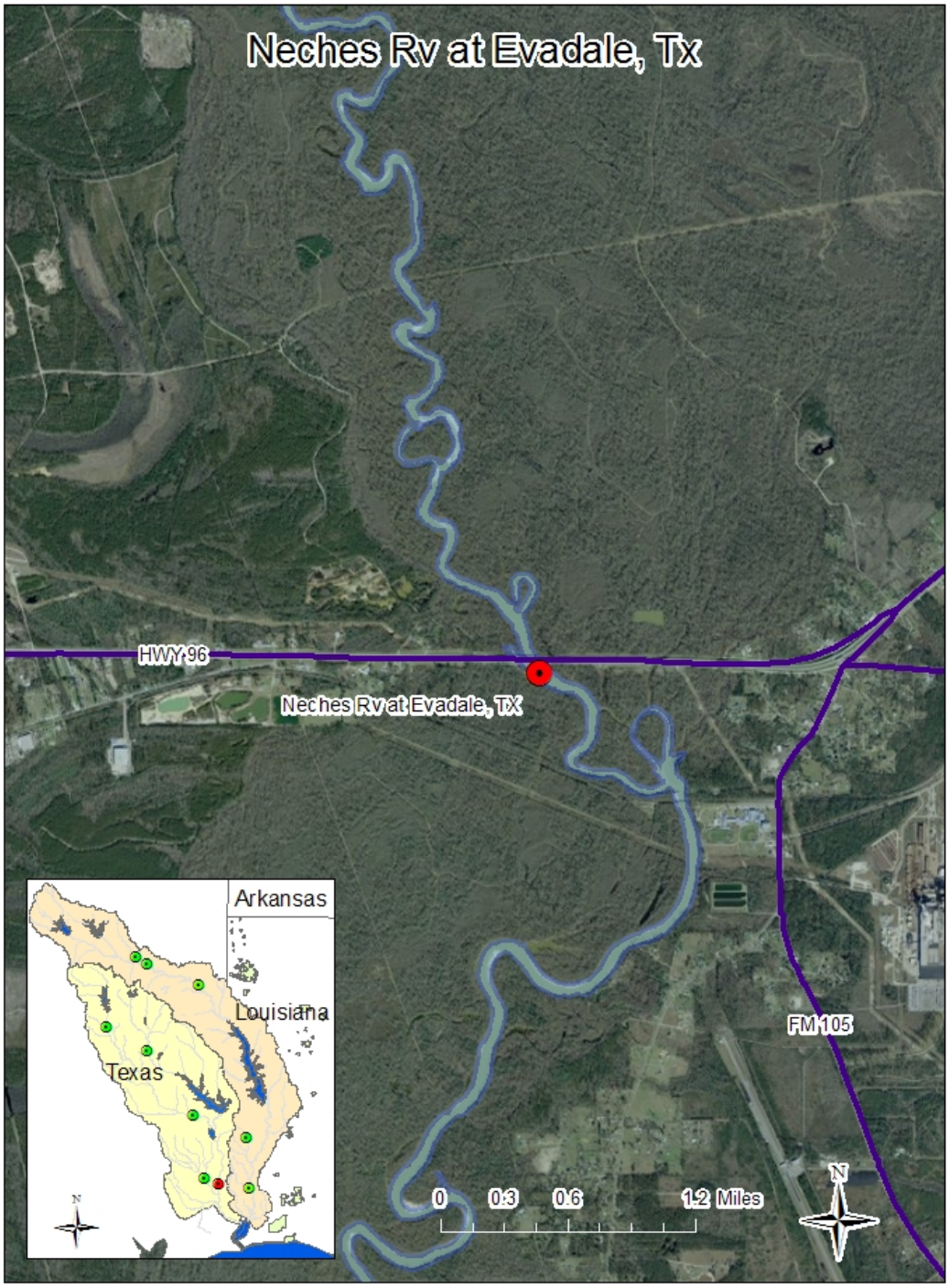

Figure 10. Village Creek near Kountze, Texas (08041500)