Lake Providence Watershed Council

An Interim Report to the Louisiana Legislature

April 2016

To the Distinguished Members of the La. House Committee on Natural Resources and Environment and Senate Committee on Environmental Quality of the Louisiana Legislature and the People of the Great State of Louisiana

April 2016

Dear Members:

We, the members of the Lake Providence Watershed Council, have completed this timely report in accordance with Senate Concurrent Resolution No. 115 of Regular Session 2015.

Specifically, the Lake Providence Watershed Council has assembled and prepared this document which is a plan of action for watershed management. It is the intent of this Council, interested stakeholders, and all those involved in the project to preserve, protect, and enhance the quality of Lake Providence located in East Carroll Parish - now and for generations to come.

The citizens of Louisiana deserve to have a restored and viable Lake Providence. The lake restoration and revitalization can be accomplished through engineering, education, enticement and, as well as, enforcement of existing and new regulations focused on best management practices.

The report offers background information, an executive summary, graphs, charts and maps, and recommendations for your review. We look forward to any further guidance or feedback as we press forward with managing the Lake Providence Watershed Resources Project.

We appreciate the support of the Louisiana Legislature as we move forward with this plan of action.

Sincerely yours,

The Members of the Lake Providence Watershed Council

Lake Providence Watershed Fact Sheet

Lake Providence Watershed:

- East Carroll Parish
- Total area: ~17,000 acres
- Cultivated area: ~11,000 acres (64%)
- Developed area: ~1,600 acres (14%)
- Forested/Other Use area: ~2,700 acres (12%)
- Open water: ~1,700 acres (10%)
- Average Annual Precipitation: ~57 inches

Lake Providence

- Owned by the State of Louisiana
- Oxbow/horseshoe lake – abandoned meander of the Mississippi River
- Area: ~1,380 acres (3,200 acres with associated wetlands)
- Shoreline (including the Chute): ~74,000 feet (14 miles)
- Developed shoreline: ~46,000 feet (9 miles)
- Pool stage: 90 feet above mean sea level (NGVD)
- Maximum depth: ~37 feet
- Average depth: ~12 feet
- Primary Outfall - Baxter Bayou Structure
- Secondary Outfall - Tensas Bayou spillway

Sources: LDWF, LDNR, LDOTD, NRCS

Members of the Lake Providence Watershed Council

(1) Kevin Wofford
Designee of the Commissioner of the Louisiana Department of Agriculture and Forestry
P.O. Box 631, 5825 Florida Blvd.
Baton Rouge, LA 70821-0631
Phone: (225) 925-3763/Email: kevin_w@ldaf.state.la.us

(2) Amanda Vincent
Designee of the Secretary of the Louisiana Department of Environmental Quality
P.O. Box 4301
Baton Rouge, LA 70821-4301
Phone: (225) 219-3188/Email: amanda.vincent@la.gov

(3) William Smith
Designee of the Secretary of the Louisiana Department of Health and Hospitals
1525 Fairfield Avenue, Room 569
Shreveport, LA 71101
Phone: (318) 676-7477/Email: william.j.smith@la.gov

(4) Thomas Van Biersel, Vice Chairman
Designee of the Secretary of the Louisiana Department of Natural Resources
P.O. Box 44487, 617 North Third Street
Baton Rouge, Louisiana 70804-4487
Phone: (225) 342-1813/Email: thomas.vanbiersel@la.gov

(5) Randy Myers, Chairman
Designee of the Secretary of the Louisiana Department of Wildlife & Fisheries
P.O. Box 98000, 2000 Quail Drive
Baton Rouge, LA 70898
Phone: (225) 765-2331/Email: rmyers@wlf.la.gov

(6) Francis Thompson
Senator – District 34
Box 68
Delhi, LA 71232
Phone: (318) 878-5650/Email: thompsof@legis.la.gov

(7) John F. "Andy" Anders
Representative – District 21
200 Advocate Row, Suite D
Vidalia, LA 71373
Phone: (318) 336-5865/Email: larep021@legis.la.gov

(8a) Donna Winters
Appointed by the Senator from Senate District 34
Lake Providence, LA 71254
Email: dbwd@yahoo.com

(8b) Mark Brown
Appointed by the Senator from Senate District 34
Lake Providence, LA 71254
Email: northend1961@gmail.com

(9a) Kenneth A. "Andy" Brister
Appointed by the representative from House District 21
Brister & Brister.
318 Morgan Street, PO Box 266
Lake Providence, LA 71254
Phone: (318) 559-5800/Email: andy@bristerlaw.com

(9b) Jim Lensing
Appointed by the representative from House District 21
Lensing, Lensing, Cunningham & Hager, Inc.
Lake Providence, LA 71254
Phone: (318) 669-5465/Email: jimlensing@gmail.com

(10a) S. Lee Denny
East Carroll Parish Police Juror - District 5
400 First St.
Lake Providence, LA 71254
Phone: (318) 559-2256/Email: leedenny@bellsouth.net

(10b) Francis Lensing
Appointed by East Carroll Parish Police Jury
Lensing, Lensing, Cunningham & Hager, Inc.
Lake Providence, LA 71254
Phone: (318) 559-2648/Email: francisllch@bayou.com

(11) Reynold S. Minsky
Appointed by the East Carroll Parish Sheriff
506 Island Point Drive
Lake Providence, LA 71254
Phone: (318) 559-1613/Email: minsky@bayou.com

(12) Teddy Schneider
Appointed by the town of Lake Providence
Lake Providence, LA 71254
Email: farm71254@gmail.com

Other Contributors to the Report

Gwendolyn Berthelot
Louisiana Department of Environmental Quality
Email: gwendolyn.bertholot@la.gov

Ryan Daniel
Louisiana Department of Wildlife & Fisheries
Email: rdaniel@wlf.la.gov

Tom Killeen
Louisiana Department of Environmental Quality
Email: tom.killeen@la.gov

Chris Knott
Louisiana Department of Transportation and Development
Email: chris.lnotts@la.gov

L. Riley Milner
Louisiana Geological Survey-Louisiana State University
Email: lmilne1@lsu.edu

Robert Paulsell
Louisiana Geological Survey-Louisiana State University
Email: rpaulsell@lsu.edu

John Posey
Louisiana Department of Environmental Quality
Email: john.posey@la.gov

William Finkbeiner
Louisiana Department of Wildlife & Fisheries
Email: wfinkbeiner@wlf.la.gov

EXECUTIVE SUMMARY

This report to the legislature has been prepared by the Lake Providence Watershed Council (LPWC) in response to Senate Concurrent Resolution No. 115 of the 2015 Louisiana Regular Session (SCR 115). SCR 115 established and mandated the LPWC to "*meet as often as necessary to deliberate and produce a report that will identify, review, and evaluate management strategies to facilitate the goal of improving the aquatic habitat of Lake Providence; to provide recommendations for the optimal management and protection of the resources within the Lake Providence watershed, including but not limited to the following: (1) The study of impacts and potential impacts to water quality, excess nutrient and sediment run-off management, shoreline modification management, watershed conservation measures, and innovative habitat restoration methodology. (2) Coordination of federal, state, and local efforts to improve and protect water quality; surface water resource management and protection policies; recommendations for the optimal management and protection of the natural resources in the Lake Providence watershed. (3) Recommended changes to current procedures and practices to make the management and protection of the natural resources in the Lake Providence watershed more efficient, comprehensive, and sustainable.*" The report is due no later than May 1, 2016.

Lake Providence is an abandoned meander of the Mississippi River located in East Carroll Parish. On-going alterations and development along this oxbow lake and within this oxbow lake's watershed have resulted in excessive sedimentation, and deterioration of the water quality, aquatic vegetation and fisheries.

This Lake Providence watershed management plan addresses the changes that came about from a thriving farming industry, as well as changes resulting from land development along the lake shore. Furthermore, the plan identifies potential changes that may occur in the future through land development within the watershed and addresses those as well. This is a living document that should be periodically updated to address changes in conditions and to take advantage of scientific discoveries.

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ACRONYMS

ac	Acre
BMP	Best Management Practice
CCPI	Cooperative Conservation Partnership Initiative
CPUE	Catch-per-unit-effort
CSP	Conservation Stewardship Program
CWA	Clean Water Act
DDE	Dichlorodiphenyldichloroethylene
DDD	Dichlorodiphenyldichloroethane
DDT	Dichlorodiphenyltrichloroethane
ECPJ	East Carroll Police Jury
EQIP	Environmental Quality Incentives Program
FEMA	Federal Emergency Management Agency
LDAF	Louisiana Department of Agriculture and Forestry
LDEQ	Louisiana Department of Environmental Quality
LDHH	Louisiana Department of Health and Hospitals
LDNR	Louisiana Department of Natural Resources
LDOTD	Louisiana Department of Transportation and Development
LDWF	Louisiana Department of Wildlife and Fisheries
LGS	Louisiana Geological Survey
LPWC	Lake Providence Watershed Council
MRBI	Mississippi River Basin Healthy Watersheds Initiative
MSL	Mean sea level
NAIP	National Agriculture Imagery Program
NAVD	North American Vertical Datum of 1988
NGVD	National Geodetic Vertical Datum of 1929
NRCS	Natural Resources Conservation Service
NTU	Nephelometric turbidity units
NPS	Nonpoint Source Program
SCR	Senate Concurrent Resolution
SCS	Soil Conservation Service
SWCD	Soil and Water Conservation Districts
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USDA	United States Department of Agriculture
WRDA	Water Resources Development Act
WRP	Wetland Reserve Program

1 Introduction

This report to the legislature has been prepared by the Lake Providence Watershed Council (LPWC) in response to Senate Concurrent Resolution No. 115 of the 2015 Louisiana Regular Session (SCR 115). SCR 115 created the LPWC and mandated that the LPWC

> *". . . produce a report that will identify, review, and evaluate management strategies to facilitate the goal of improving the aquatic habitat of Lake Providence; to provide recommendations for the optimal management and protection of the resources within the Lake Providence watershed, including but not limited to the following: (1) The study of impacts and potential impacts to water quality, excess nutrient and sediment run-off management, shoreline modification management, watershed conservation measures, and innovative habitat restoration methodology. (2) Coordination of federal, state, and local efforts to improve and protect water quality; surface water resource management and protection policies; recommendations for the optimal management and protection of the natural resources in the Lake Providence watershed. (3) Recommended changes to current procedures and practices to make the management and protection of the natural resources in the Lake Providence watershed more efficient, comprehensive, and sustainable."*

The report is to be submitted to the House Committee on Natural Resources and Environment and the Senate Committee on Environmental Quality no later than May 1, 2016.

Lake Providence is an abandoned meander of the Mississippi River located in East Carroll Parish (Figure 1). This bald cypress-lined picturesque waterbody is an economic asset to the town of Lake Providence, East Carroll Parish and northeastern Louisiana. It is a regional draw for sport fishermen, vacationers and boaters.

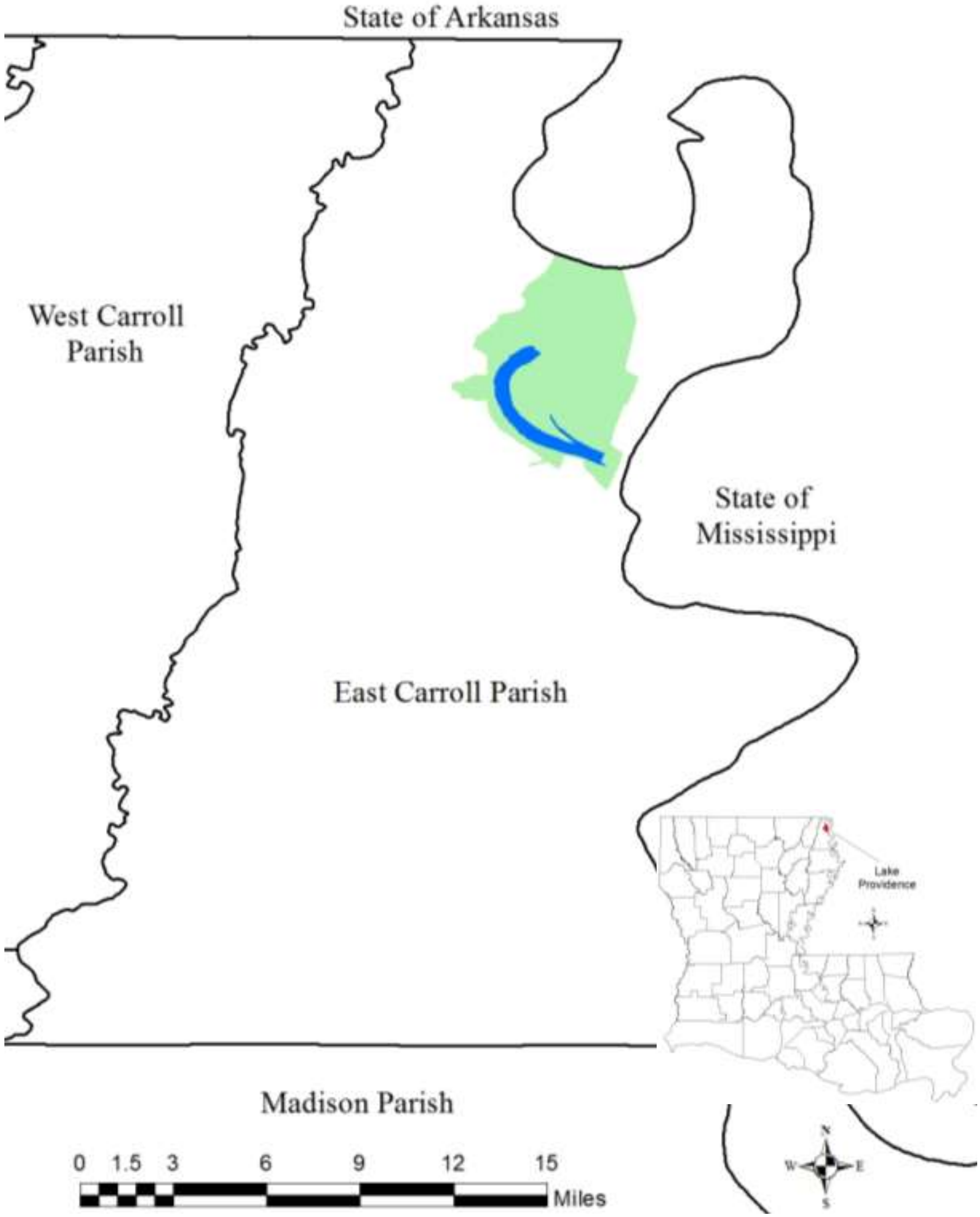

Figure 1: Lake Providence Watershed location map.

1.1 Public Access, Boat Launches and Parkland

There are two public boat launches on Lake Providence (Figure 2). The boat launch on the Chute is locally referred to as the 'Airport boat landing.' The pier at this location was not designed to be a fishing pier but instead used for handling of watercraft. The second public boat launch is located south of US Highway 65 on Tensas Bayou. It is locally referred to as 'Tensas boat landing.' Both public boat landings have parking, covered tables and benches for public use. Beyond the two public boat launches, there is no other public access or associated parkland on the shore of Lake Providence. A third privately owned boat launch is located at the Lakeview Inn Hotel (Figure 2).

2 Identification of Historical, Current and Future Watershed Issues/Concerns

Alterations along this oxbow lake, and past and on-going activities within this oxbow lake's watershed have resulted in deterioration of the water quality, aquatic vegetation and fisheries. The approximate extent of the Lake Providence watershed is shown on Figure 3.

Figure 2: Lake Providence public access.

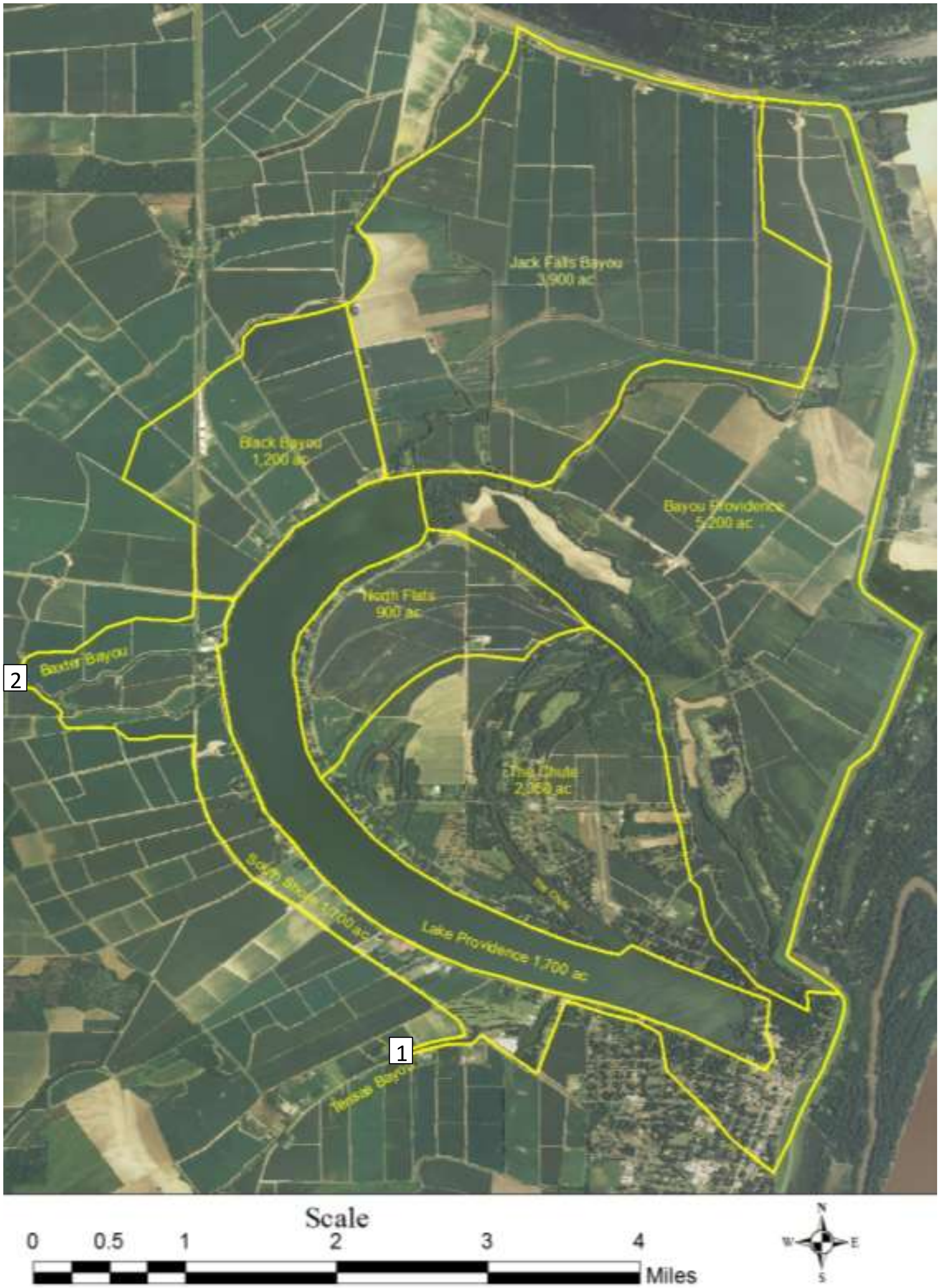

Figure 3: Lake Providence Watershed.
Notes: The yellow lines represent the sub-basin draining into Lake Providence. Box #1 locates the Tensas Bayou structure and box #2 the Baxter Bayou structure.

Primarily, water enters the lake from the north and east. Sub-basins are depicted on Figure 3 and the land use listed in Table 1. Lake Providence (including The Chute, which is the bay/channel located on the north side of the lake's south end – see Figure 3) represents approximately 10% of the watershed area. The two largest contributing sub-basins to the lake are Jack Falls Bayou (3,200 ac.) and Bayou Providence (5,200 ac.). The discharges of both of these sub-basins converge into the North Flats of the lake and are the primary contributors of sediment to the lake. The December 30, 2010 National Agriculture Imagery Program (NAIP) aerial imagery (Figure 4) distinctly shows the turbidity (discoloration) emanating from discharge of the sub-basin into the lake on that day. Based on a visual evaluation of the more recent 2013 NAIP imagery, approximately 64% (71% of the land area) of the watershed is used for agricultur, primarily crop. Surface drainage into the lake has been modified to enhance efficiency and to facilitate cultivation (Figures 5 and 6). Changes in agricultural and non-agricultural use from 2006 to present can be seen on the land cover plots presented in Appendix A. Cotton was the dominant crop in 2006, corn in 2007, and soybeans currently dominate the local industry.

The local topography (Figure 6) is relatively flat. In 1908, most of the watershed was too poorly drained to be farmed and the natural levees along the lakeshore limited flow into the lake (Worthen and Belden, 1908). In the mid-1940s, the primary water supply for the lake was reportedly underground seepage from the Mississippi River (Moore, 1950). Over the following 40 years, levee construction, laser leveling of fields and drainage canal construction changed the watershed's hydrology to what can be observed today, increased inward flow from surface runoff and limited outfall capability resulting in a lake behaving as a sediment trap.

TABLE 1: SUB-BASINS LAND USE

Sub-Basin	App. Area (ac)	Ag	Non-Ag	Open Water
Jack Falls Bayou	3,900	97%	3%	0%
Bayou Providence	5,200	69%	31%	0%
South Shore	1,700	59%	41%	0%
Black Bayou	1,200	92%	8%	0%
North Flats	900	78%	22%	0%
The Chute	2,350	28%	72%	0%
Lake Providence	1,700	0%	0%	100%
Total	16,950	64%	26%	10%

Figure 4: Suspended solids discharging into Lake Providence's North Flat on 12/30/2010.
Source: December 30, 2010 NAIP aerial imagery.

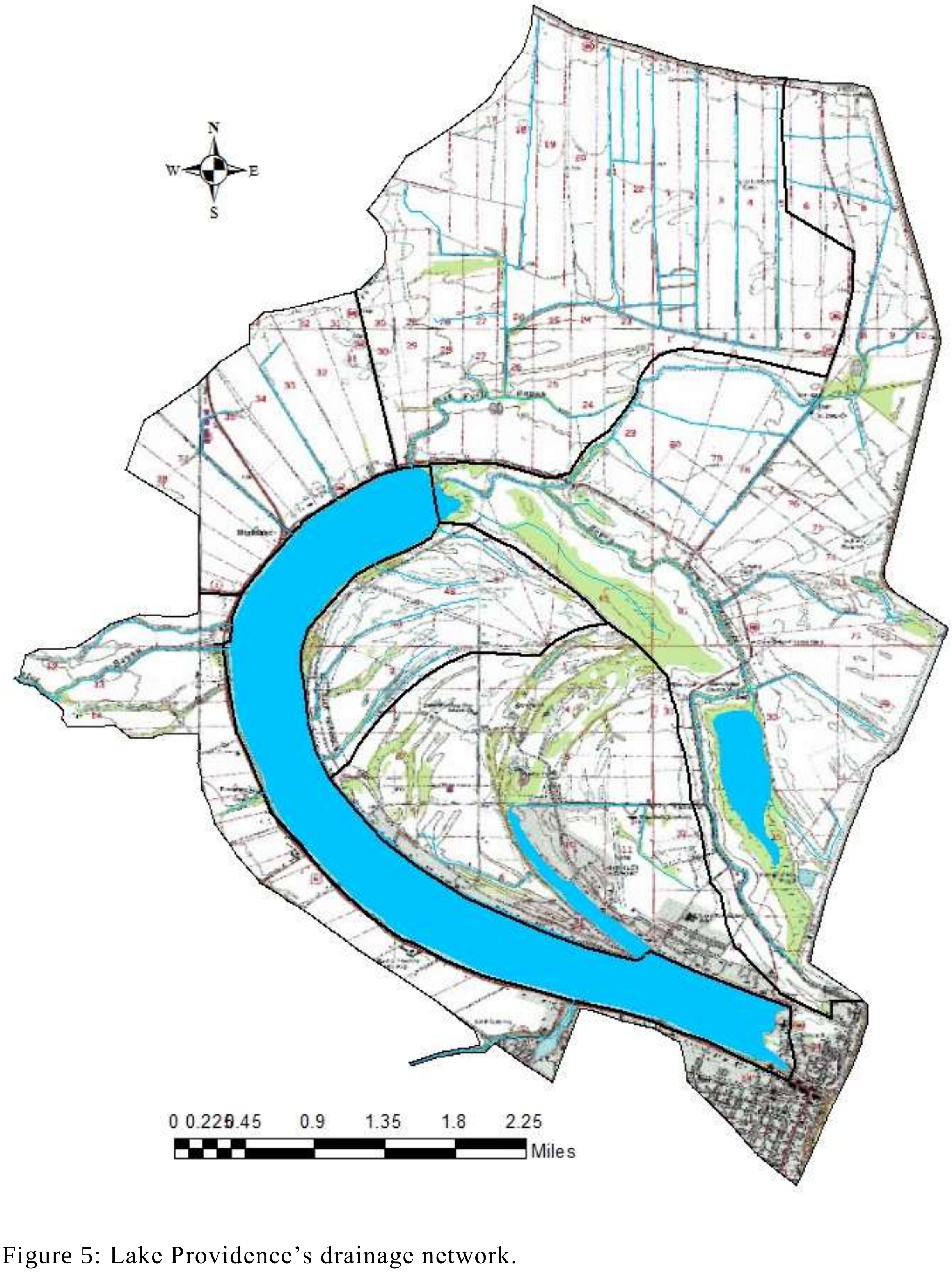

Figure 5: Lake Providence's drainage network.
Source: USGS 24K Quadrangle.

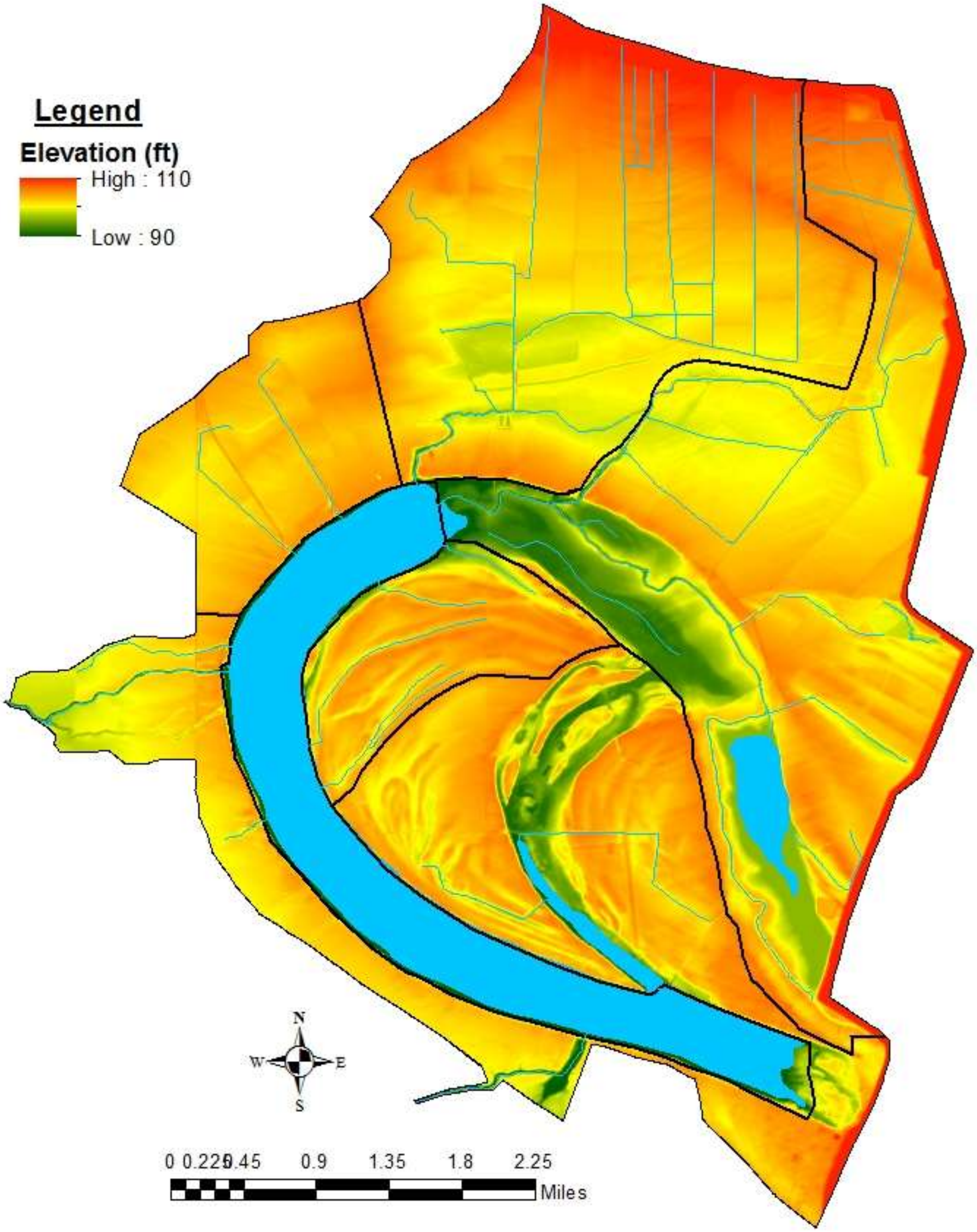

Figure 6: Lake Providence's topography.
Source: USGS 24K Quadrangle.

The lake has two outlets equipped with structures (Appendix B), Tensas Bayou (Figure 7) and Baxter Bayou (Figure 8). Anecdotal information by local stakeholders suggests that the structure on Baxter Bayou only allows water to flow out of the lake at high stage, otherwise reverse flow can occur at time of unevenly distributed precipitation. Prior to 1923, Baxter Bayou discharged into the lake. In 1923, Baxter Bayou was dredged to reverse the flow direction; it now flows toward Caney Bayou. The structure on Tensas Bayou is a weir that had been redesigned in 1975, but never replaced (Appendix B). Neither structure allows for lake level manipulation, both are in disrepair and both are being bypassed at higher flow. The U.S. Geological Survey (USGS) data collected at Baxter Bayou shows that during their one and a half year study, flow reversed direction (negative discharge) approximately eleven times (Figure 9).

2.1 Flooding

Water level data was collected by the USGS between 2/1/1985 and 9/30/1986 (Figure 10). The Louisiana Geological Survey at Louisiana State University (LGS) collected water level data between 12/15/15 and present (Figure 11). The lake's pool stage is 90 ft (NGVD 29) based on the weir height at the Baxter Bayou structure. The elevation of the Tensas Bayou weir is not known.

In September 2008, Hurricane Gustav and shortly thereafter Hurricane Ike caused heavy rainfall to occur throughout the Lake Providence Watershed (Figure 12). Anecdotal evidence suggests this was the worst flooding event in the watershed in 40 years (Appendix C). There was approximately 15 inches of rain in a 24 hour period. Many properties that border the lake were damaged as a result of the high water (Appendix C). At the time, several concerned citizens agreed that action needed to be taken. Mr. Reynold Minsky with the Fifth Louisiana Levee District contacted the US Army Corps of Engineers (USACE) for their support. The USACE made a study and suggested two different drainage plans that mainly involved the north end of Lake Providence Watershed (Figure 13). One plan was to divert the runoff to the west toward Bayou Macon. The other plan was to create a pumping station just north of town and pump the water over the Mississippi River levee. A couple of meetings followed, but due to lack of funding neither plan developed. Flooding was last experienced in March 2016 (Appendix D).

Figure 7: Tensas Bayou weir.
The Google Earth™ photograph (top) was taken on 11/15/12; the profile view (bottom) of the structure on 10/21/15

Figure 8: Baxter Bayou control structure.
Notes: The Google Earth™ photograph (top) was taken on 11/15/12; the profile view (bottom) of the structure on 10/21/15

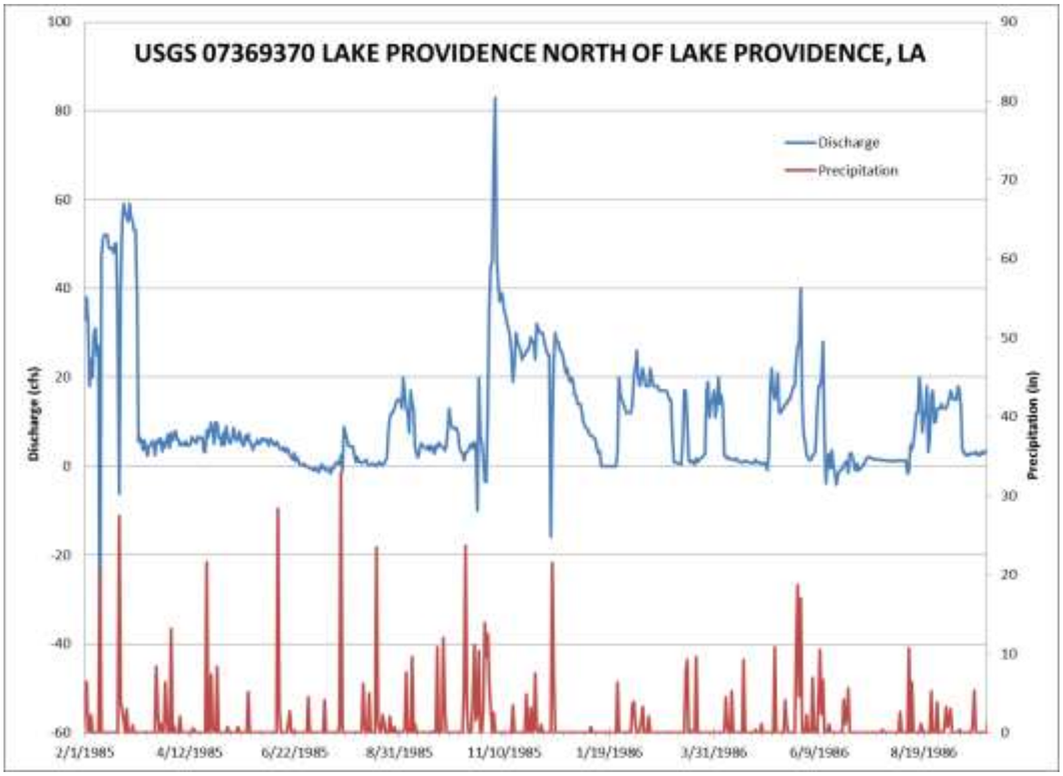

Figure 9: Lake Providence discharge at Baxter Bayou (1985-1986)
Source: USGS

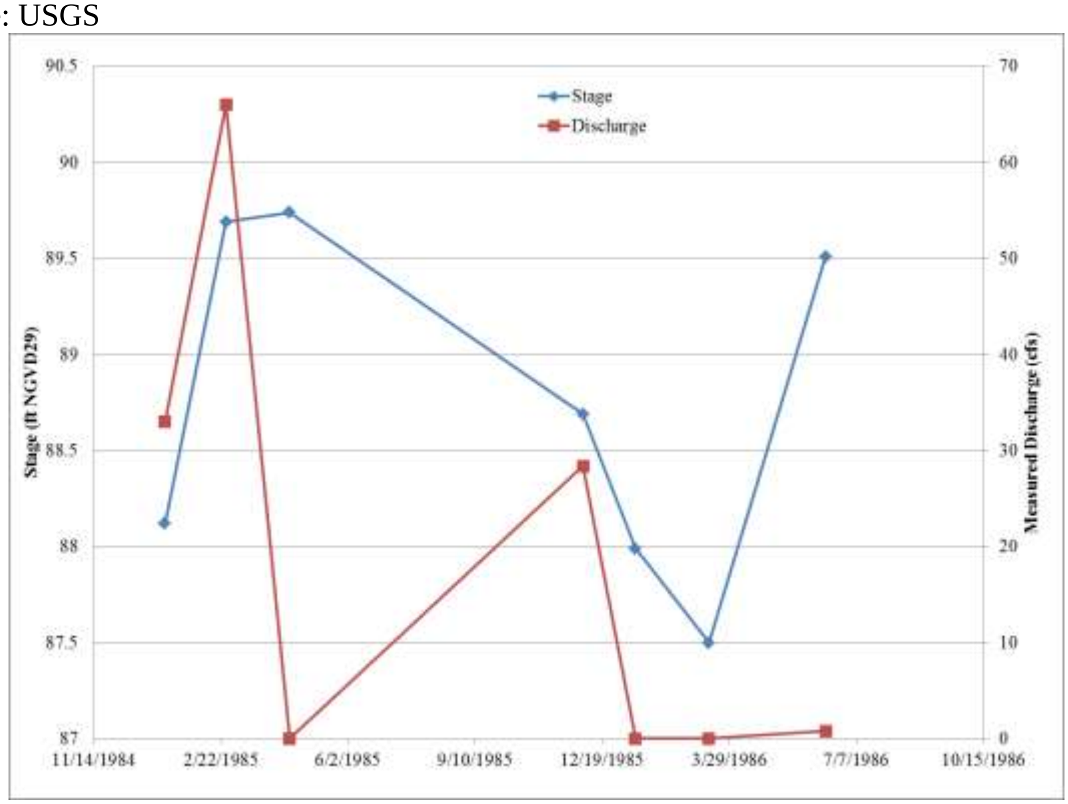

Figure 10: Lake Providence measured stage and discharge (1985-1986)
Source: Baxter Bayou USGS gage.

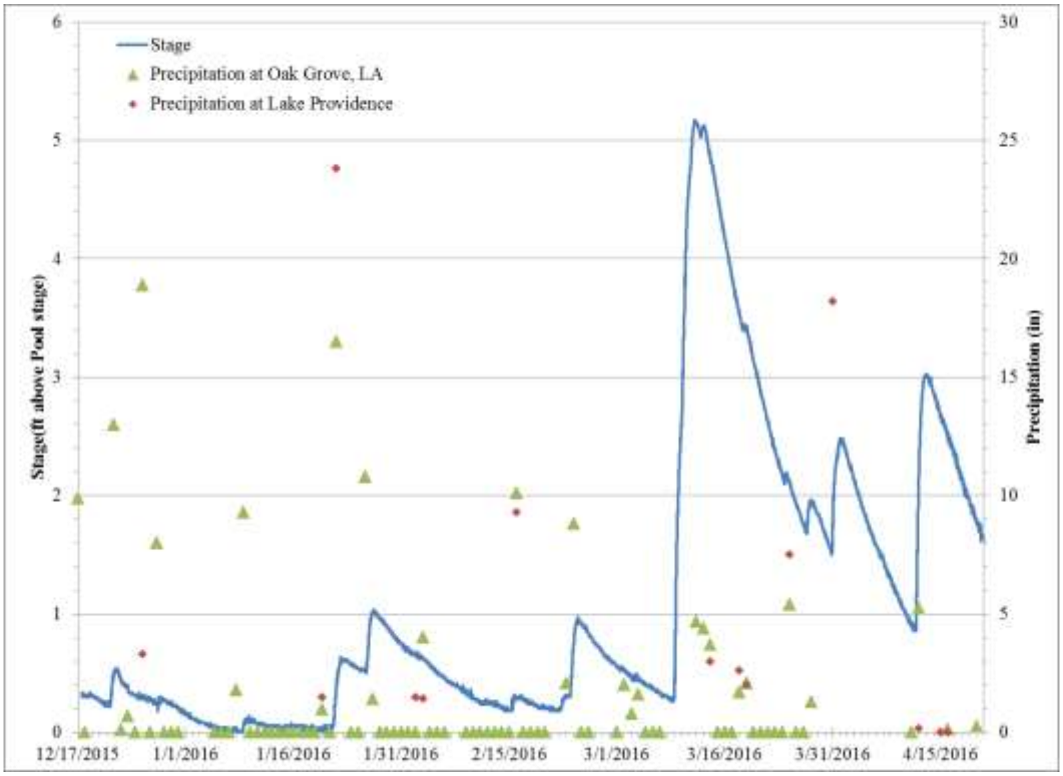

Figure 11: Lake Providence measured stage (2015-present)
Source: Lake Providence LGS gage.

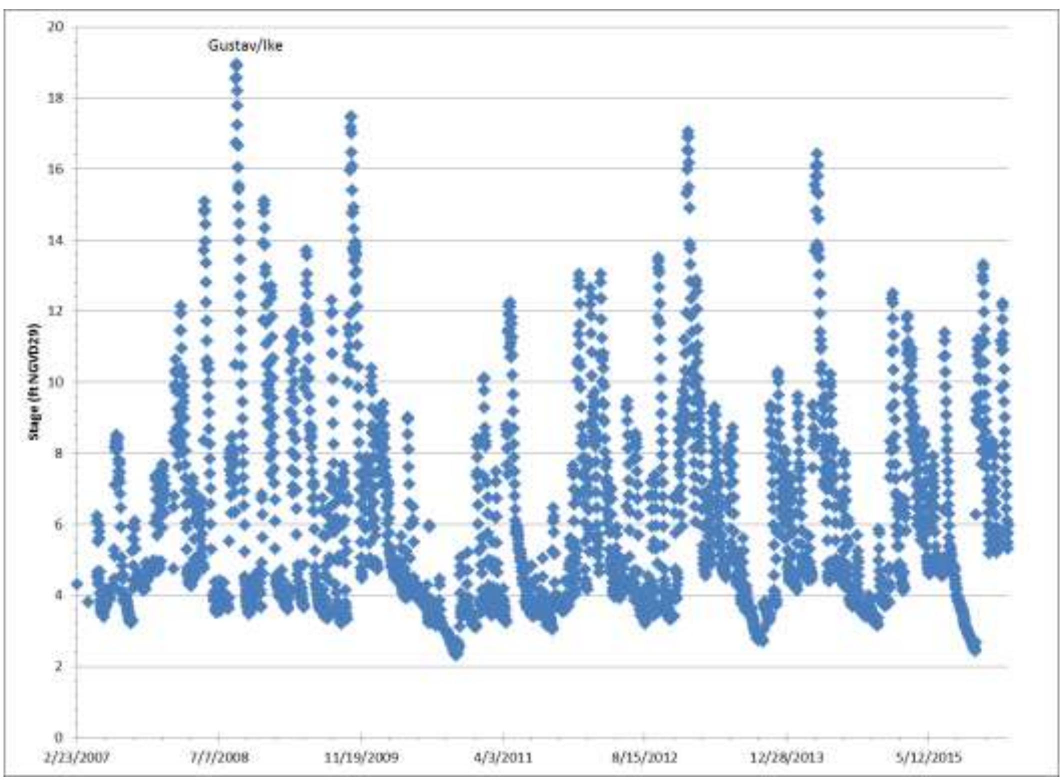

Figure 12: Tensas Bayou stage at Transylvania, LA (2007-present)
Source: USACE

Figure 13: Proposed drainage alternative submitted by USACE in 2009.
Source: USACE

The storm water that enters the north flat of the lake has been identified locally as the worst culprit (i.e. bringing in the most sediment - Figure 4). Local farmers have improved their drainage efficiency over the years and water now drains at a much faster speed. The north end of Lake Providence has had large deposits of silt over many years creating an average water depth of 2 to3 ft of which was 4 to 5 ft deep 30 years ago. If the same process continues, eventually the north flat will become choked with sediment and emerging vegetation.

In 2013, there was a 5-inch rain in early January. The lake turbidity was at an all-time high. Water clarity had not recovered until mid-June of that year. There were no water recreational sports and little fishing until June. The following year, a similar situation occurred and lasted until June 2014. Subsequent electrofishing efforts suggested little to no largemouth bass reproductive activity following the flood events. This is most likely attributable to increased turbidity and high water during the spawning period. In the early 2000's there was recreational fishing of white perch that flourished and today is almost non-existent.

The flood event in the spring of 2016 was documented by a Council member and local farmer with the use of a remote controlled helicopter drone equipped with a camera (Appendix E). The resulting photographs document the influx of sediments into the lake as a result of over 17 inches of rain falling over the watershed during the first two weeks of the month.

2.2 Lake Bathymetry

The maximum depth of the lake was reported to be 40 feet with an average depth of 17 feet in the late 1940s. In 2012, LDWF (2012) had estimated the maximum depth to be 37 ft and the average depth to be 12 ft. In a more recent bathymeric survey performed by LDWF in February 2016 (Figure 14), the lake, including the Chute, had a maximum (uncorrected) measured navigable depth of 37.2 ft and an average depth of 14.9 ft. The survey (Figure 15) shows the lake to be deeper in the outside portion of the abandonned meander between the Baxter Bayou and Tensas Bayou outlets, and shallowest in the north and south flats, and the Chute.

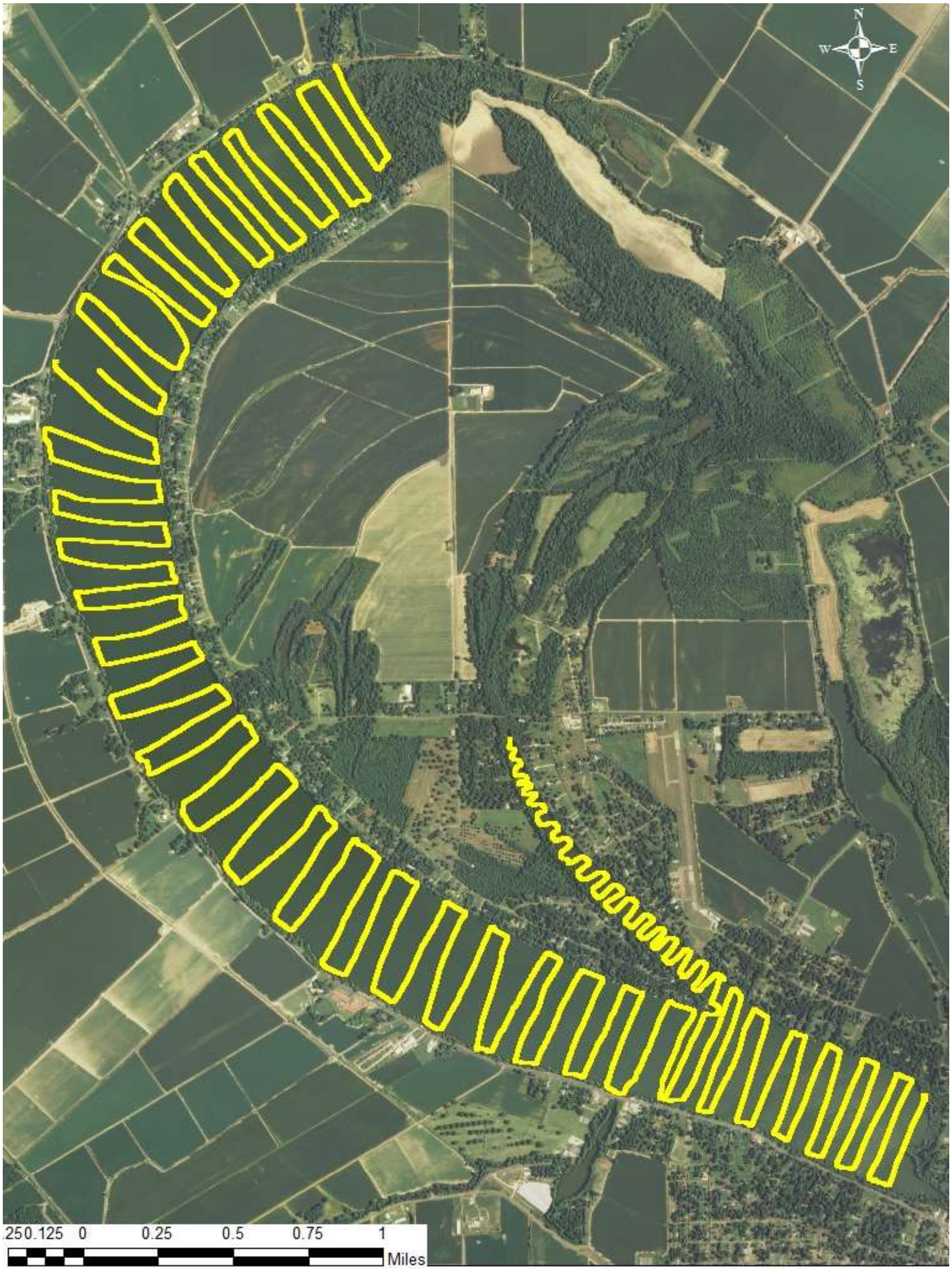

Figure 14: Lake Providence bathymetry survey.
Source: LDWF.

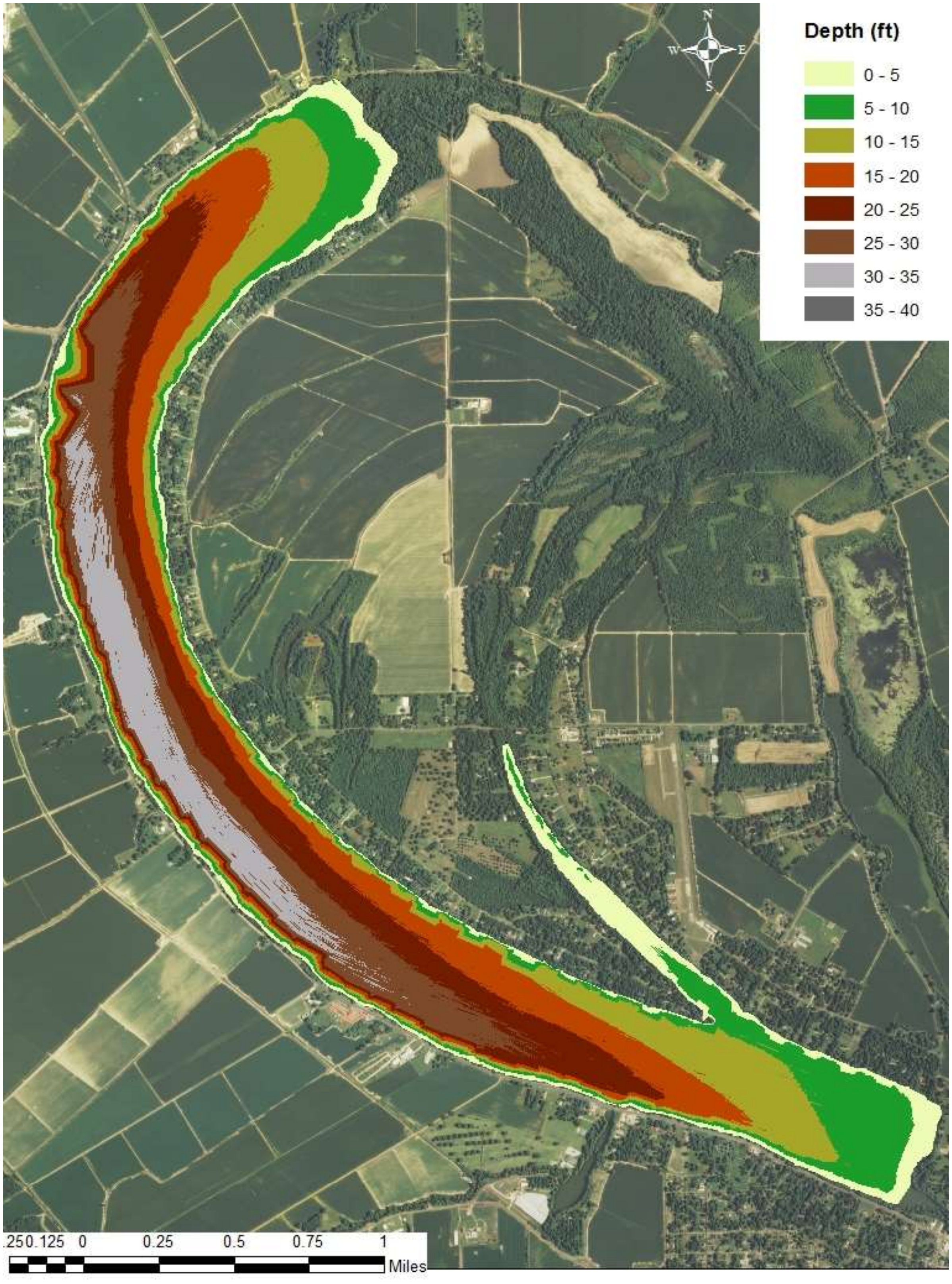

Figure 15: Lake Providence bathymetric chart (not corrected for water level).
Source: LDWF.

2.3 Water Quality

Water quality samples have been routinely collected by the Louisiana Department of Environmental Quality (LDEQ), the LDWF and the USGS since November 18, 1963. There are seven locations within the watershed where water quality and sediment samples were collected (Figure 16).

2.3.1 pH

The data collected by LDEQ and the USGS suggests that the pH of Lake Providence may be showing a slight increasing trend over the last 50 years (Figure 17). It is expected that the variability in pH values is driven by similar seasonal variability as is water temperature and nutrients concentration.

Figure 16: Lake Providence sampling and gaging locations

2.3.2 Dissolved Oxygen

The lake's Dissolved Oxygen (DO) concentration has been monitored by the USGS, LDEQ and LDWF since 1979. DO is vital for maintaining a thriving sport and commercial fisheries. The LDEQ's Fish and Wildlife Propagation standard for DO is 5 mg/L in freshwater. The data collected suggests that DO concentrations in Lake Providence have exhibited a small decline over the record period, although improvement can be observed during the 2005-2006 and 2013-2014 sampling events (Figure 18). This variability can be partially attributed to poor water clarity, resulting in less sunlight reaching deeper into the water column. Sunlight fosters the growth of aquatic vegetation, and, therefore, photosynthesis and oxygen production. It should be noted that surface DO in Lake Providence was meeting the Fish and Wildlife Propagation Use standard of 5 mg/L for DO during the last sampling year.

Without the presence of continuous water flow, Lake Providence is subject to annual stratification, a condition common to aquatic ecosystems. During the warm months of the year, stratification forms due to the effects of sunlight. The upper layer is warmer and less dense. The thickness of this upper layer is directly related to water clarity. In clear water, sunlight penetrates more deeply than in turbid water. Because sunlight is a requirement for oxygen production through photosynthesis, this upper layer is the region of highest dissolved oxygen. Water below the upper layer receives little sunlight, and, therefore, is colder and denser. This deeper layer has no source of oxygen, resulting in very low dissolved oxygen. Lake Providence stratifies annually, and develops a 5 to 6-foot epilimnion. Because average depth of Lake Providence is 12 feet, aquatic life that requires oxygen is limited to the relatively small portion of the waterbody during the warm months of the year.

2.3.3 Fecal Coliform

The limited fecal coliform data collected (Figure 19) shows that fecal coliform exceedances occur infrequently. LDEQ considers exceedance if over 400/100mL for primary contact recreation use in summer and if over 2,000/100mL year round for secondary contact recreation use.

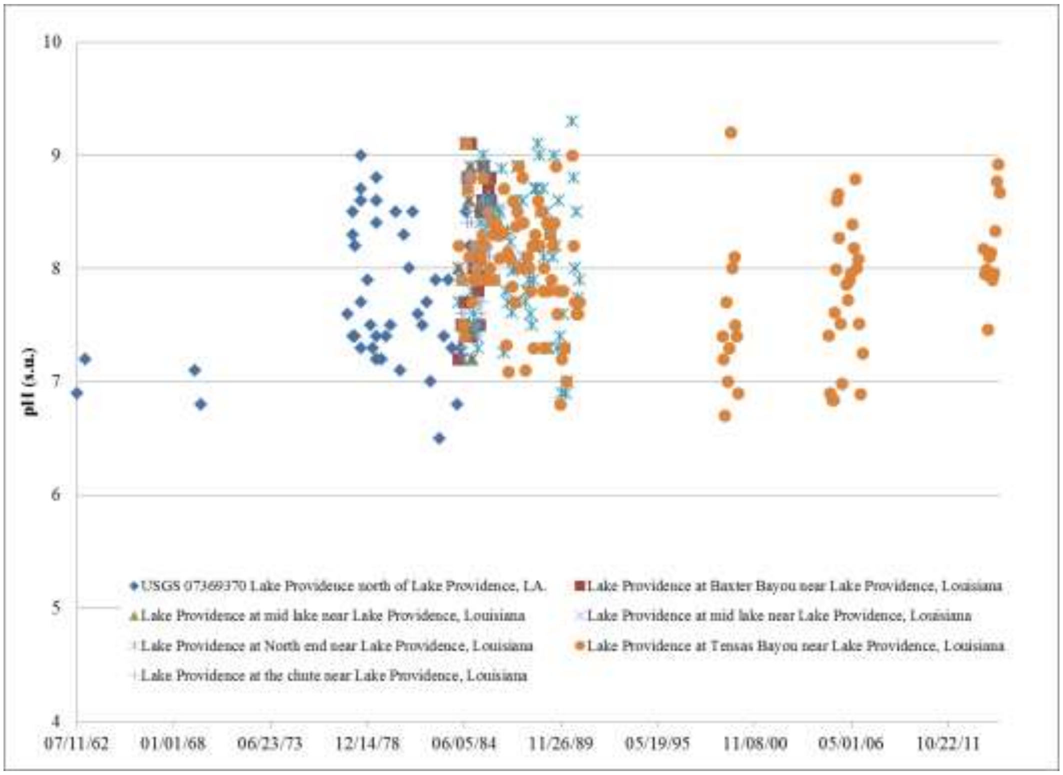

Figure 17: Lake Providence pH readings

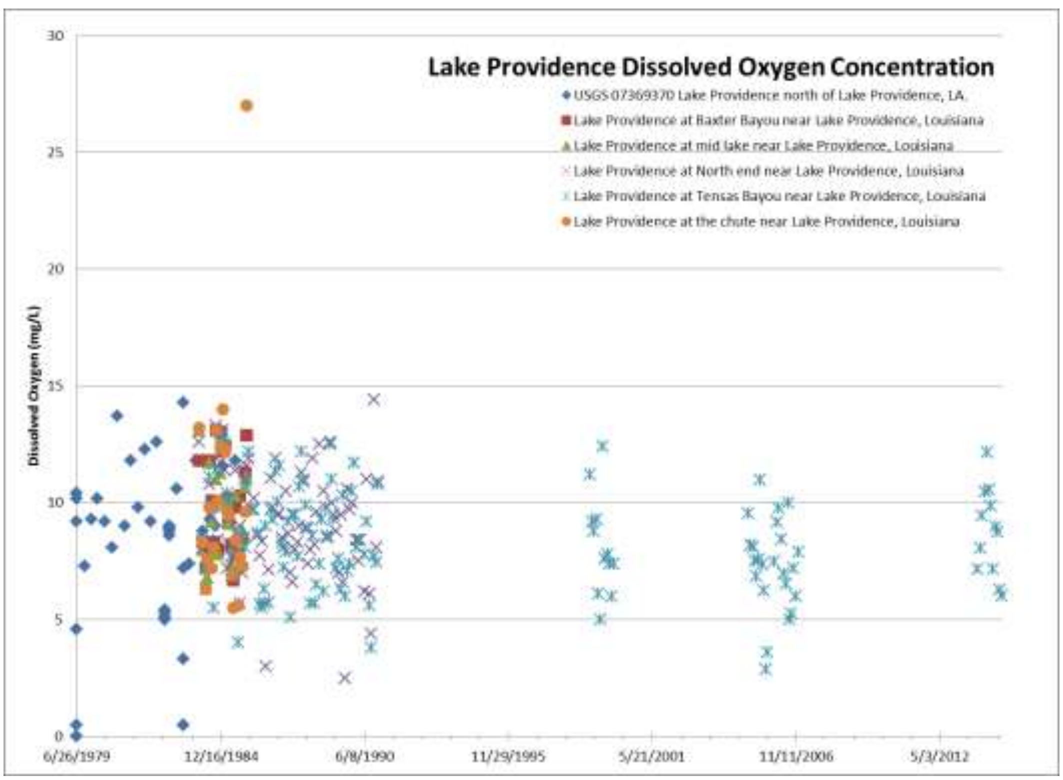

Figure 18: Lake Providence Dissolved Oxygen concentrations

2.3.4 Nutrients

Nitrogen and phosphorus concentrations have remained relatively consistent, but observed maximum concentrations seem to exhibit a slight overall decrease over time. Nitrate + Nitrite (as N) have consistently ranged between below detection limit and at/or slightly above 1.2 ppm as N (Figure 20). Organic nutrients [Total Kjeldahl Nitrogen (TKN)] have consistently ranged between below detection limit (0.1 ppm), and at or slightly above 2 ppm (Figure 21). Two samples collected by LDEQ on 2/14/1989 suggested organic nitrogen concentration > 4 ppm. Ammonia Nitrogen ranged between below detection limit (0.1 ppm) and 1.0 ppm (Figure 22). Total Nitrogen (calculated as Nitrate + Nitrite as N plus organic Nitrogen) ranged between below detection limit and 6.6 ppm N with an average of 1.1 ppm N (Figure 23). Total Phosphorus ranged between 0 and 0.8 mg/L (Figure 24).

2.3.5 Pesticides

Monitoring by the USGS and LDEQ for pesticides, including arsenic, Chlordane and Dichlorodiphenyltrichloroethane (DDT) has occurred in Lake Providence. In the early 1980s, Pesticides have been detected in Lake Providence water, sediments and fish tissues (Allen et al., 1988 and Niethammer et al, 1984). Due to the elevated concentration of pesticides, the consumption of fish from the lake was banned by Louisiana Department of Health and Hospitals (LDHH) between 1978 and 1982.

The use of the pesticide DDT within the watershed has been reported by the USGS and others. DDT, as well as its and its derivative/metabolite dichlorodiphenyldichloroethylene (DDE) and dichlorodiphenyldichloroethane (DDD), are known to bioaccumulate and are very persistent in the environment. The sale of DDT was banned in 1972 and DDT concentrations were detected in the lake's sediment and water in 1980. The highest DDT concentration measured by the USGS was at 110 µg/Kg in sediments (Figure 25) and at 0.02 µg/L in water (Figure 26). Chlordane concentration in the lake's sediment peaked in 1981 at 92 µg/Kg (Figure 27). Sales of Chlordane ended in 1988. During that same time period Chlordane was not reported above detection limit (0.1 ug/L) in lake water. Arsenic concentrations have been measured in lake water sporadically by the USGS and LDEQ since 1978. Although few if any pesticides sold in the US still contained Arsenic, the lake's water concentration are regularly above the USEPA 10 ug/L standard (Figure 28).

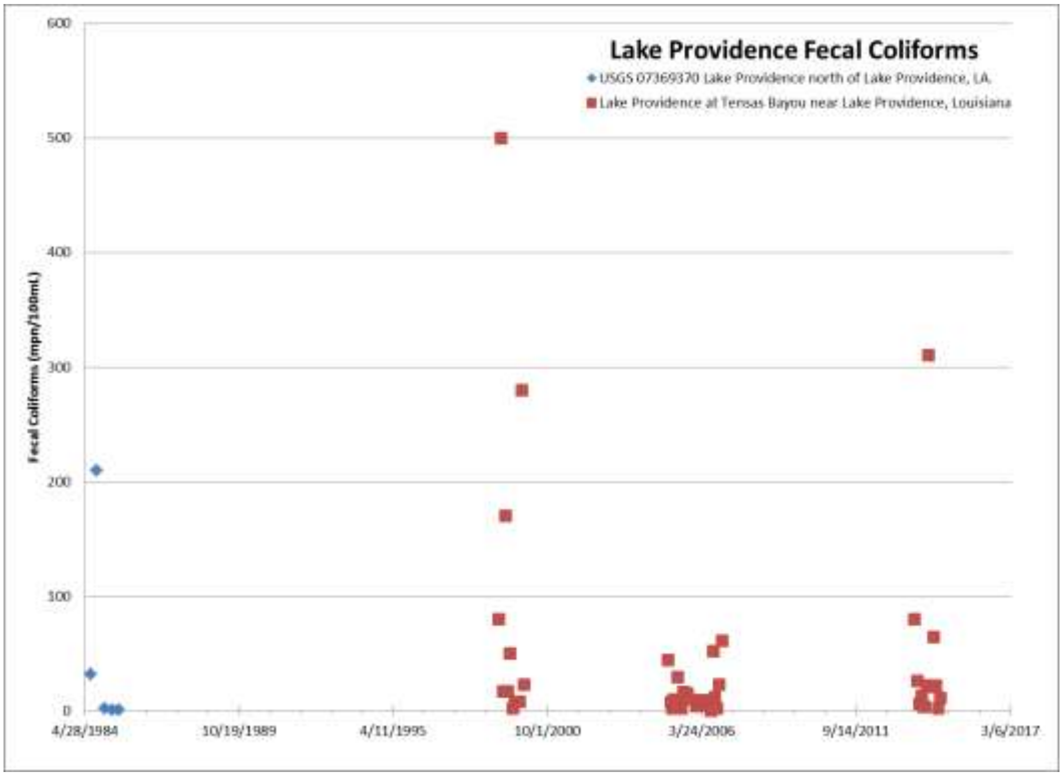

Figure 19: Lake Providence Fecal Coliform concentration

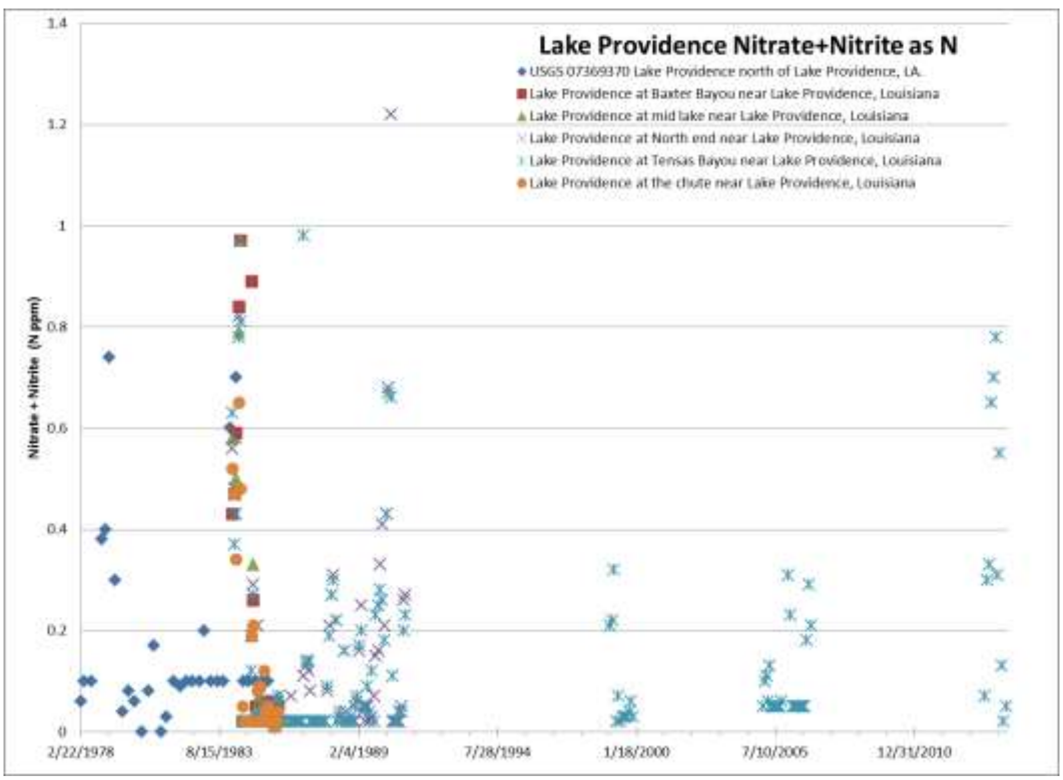

Figure 20: Lake Providence Nitrate + Nitrite concentrations

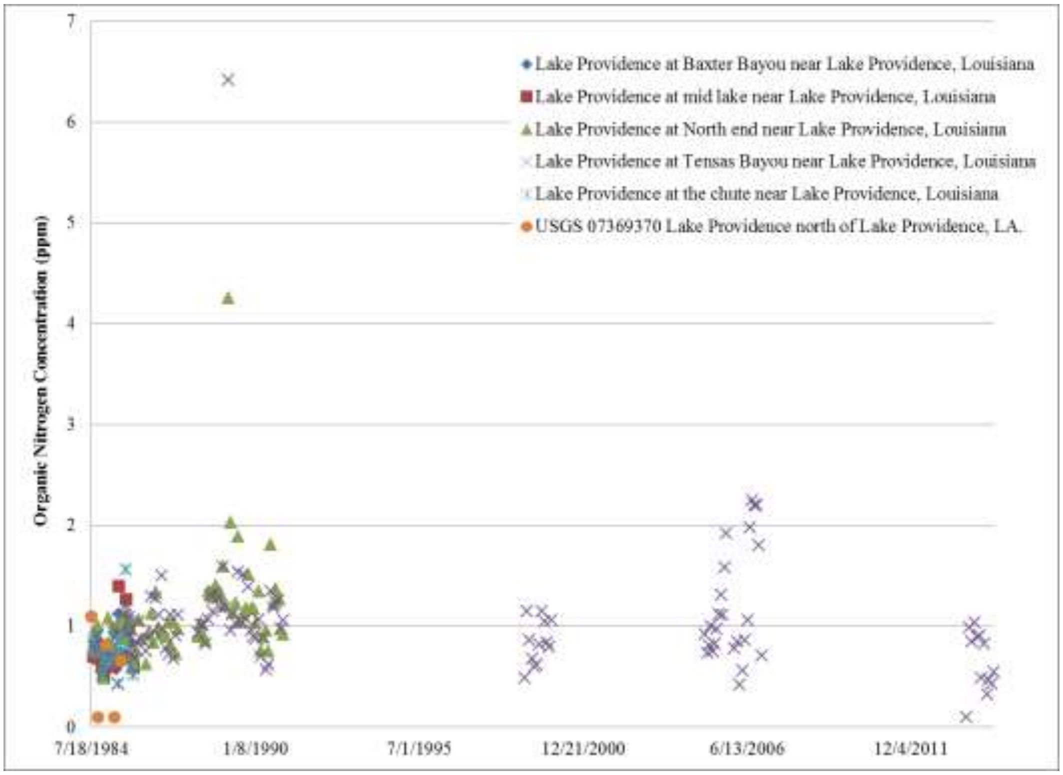

Figure 21: Lake Providence Organic Nitrogen (TKN) concentrations

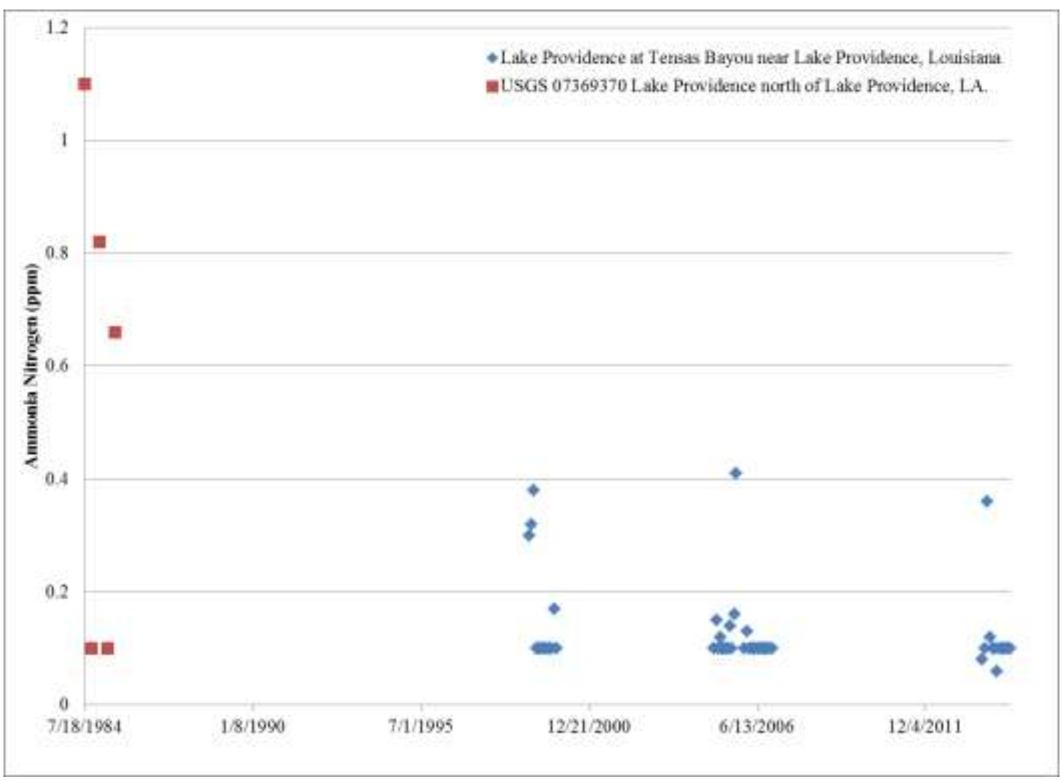

Figure 22: Lake Providence Ammonia Nitrogen concentrations

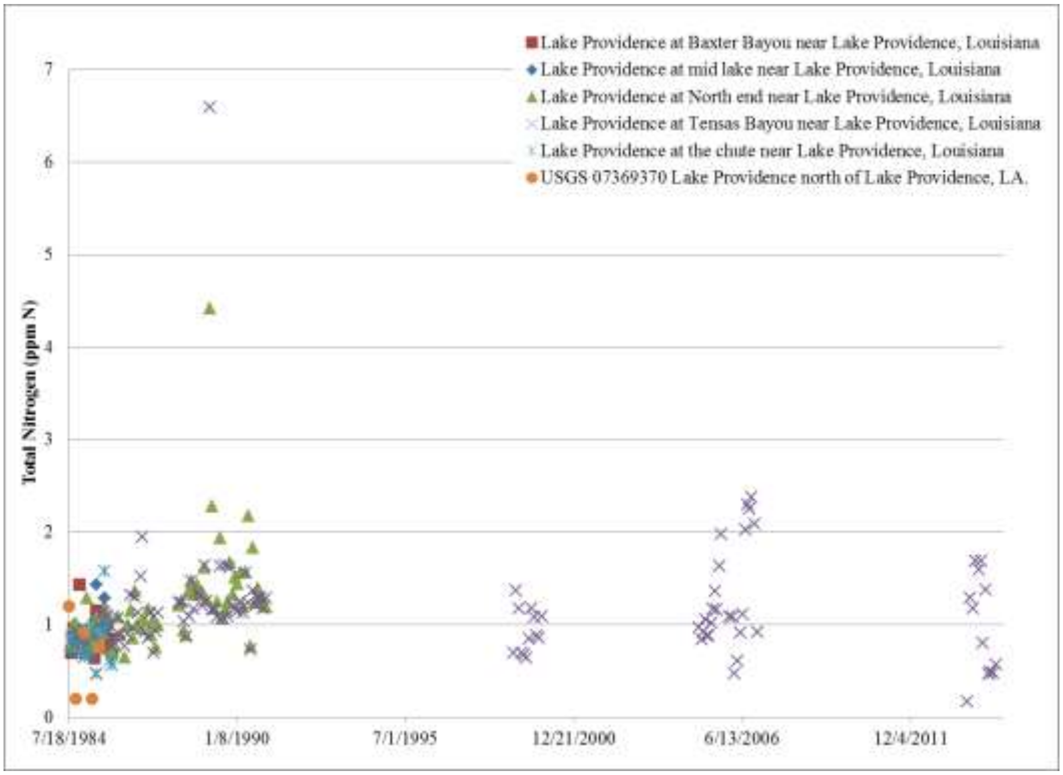

Figure 23: Lake Providence Total Nitrogen concentrations

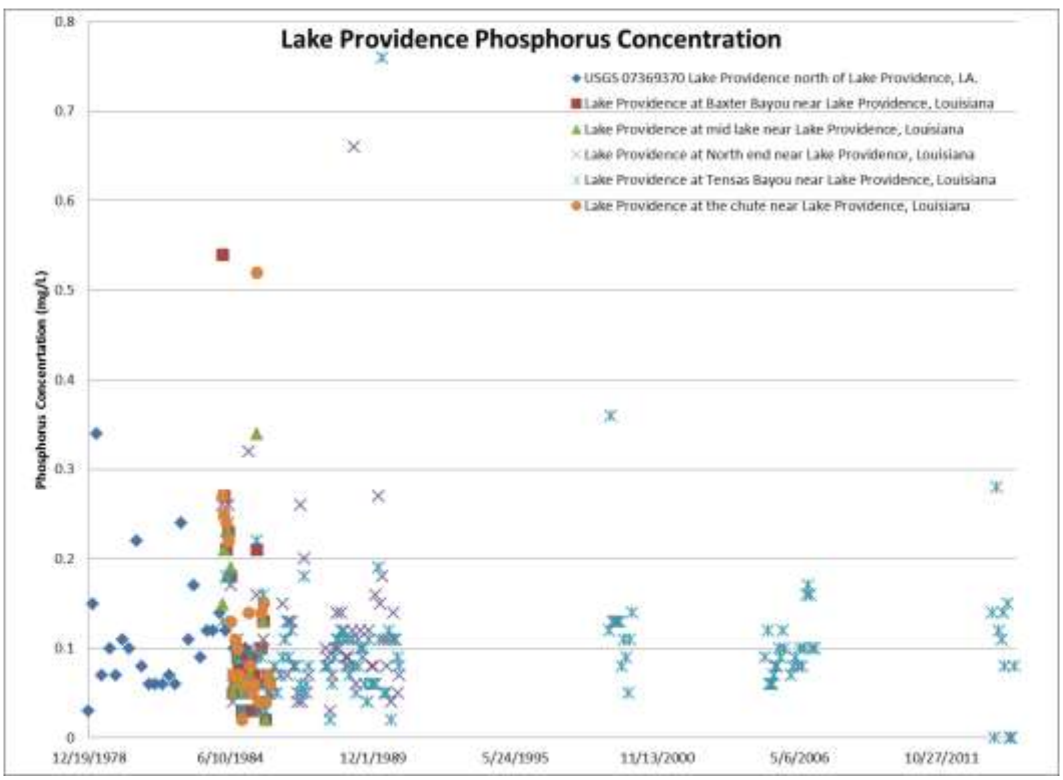

Figure 24: Lake Providence Total Phosphorus concentrations

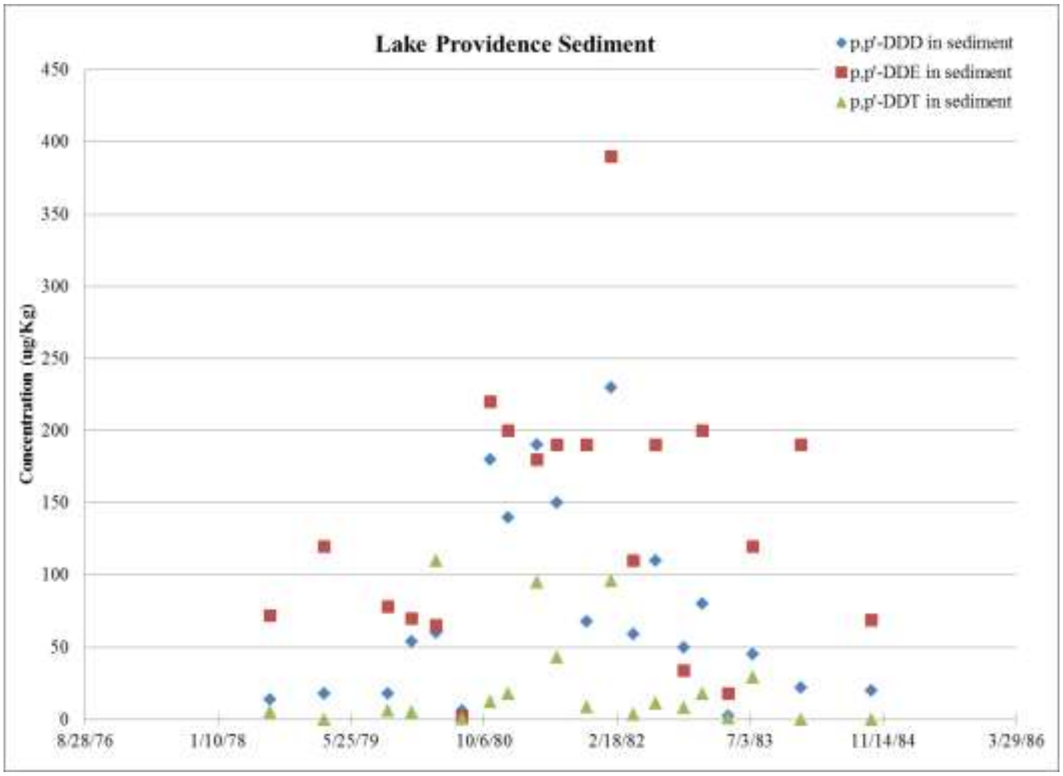

Figure 25: Lake Providence DDT/DDD/DDE concentrations in lake sediments

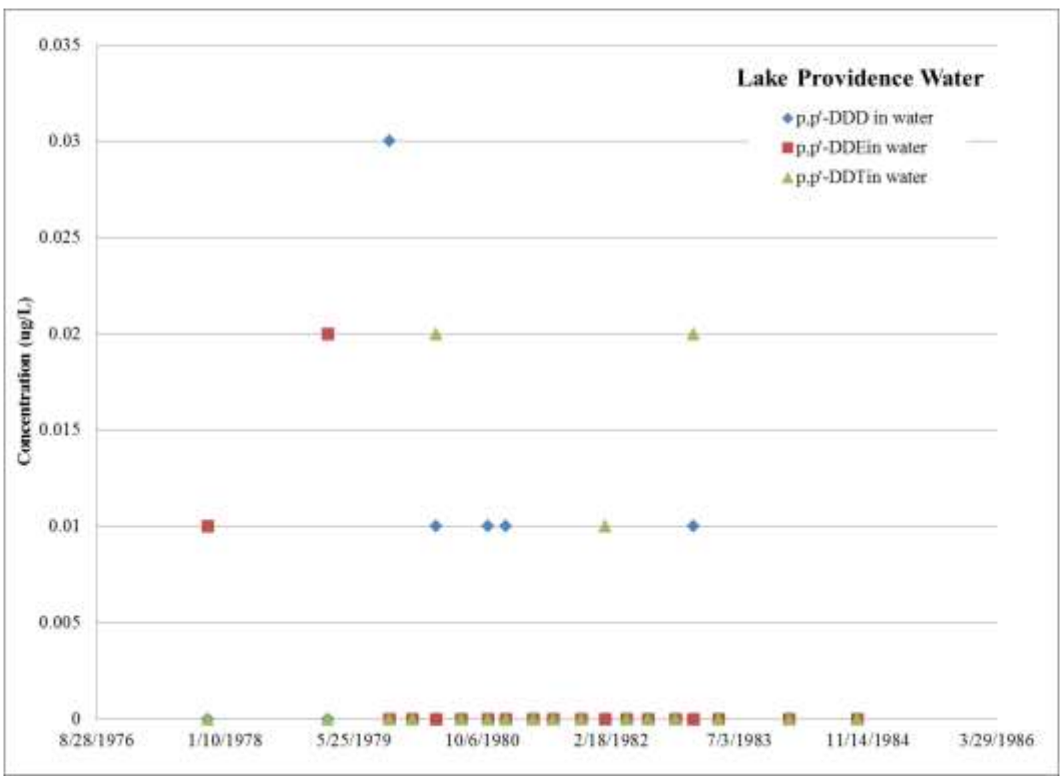

Figure 26: Lake Providence DDT/DDD/DDE concentrations in lake water

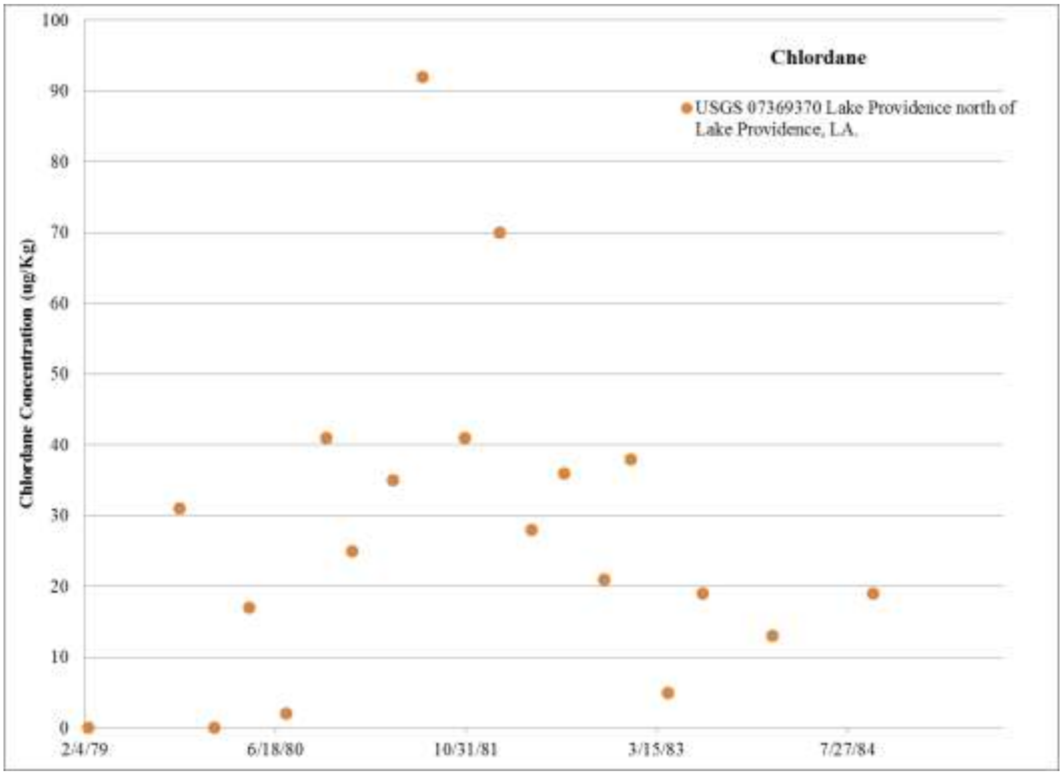

Figure 27: Lake Providence Chlordane concentrations in lake sediments

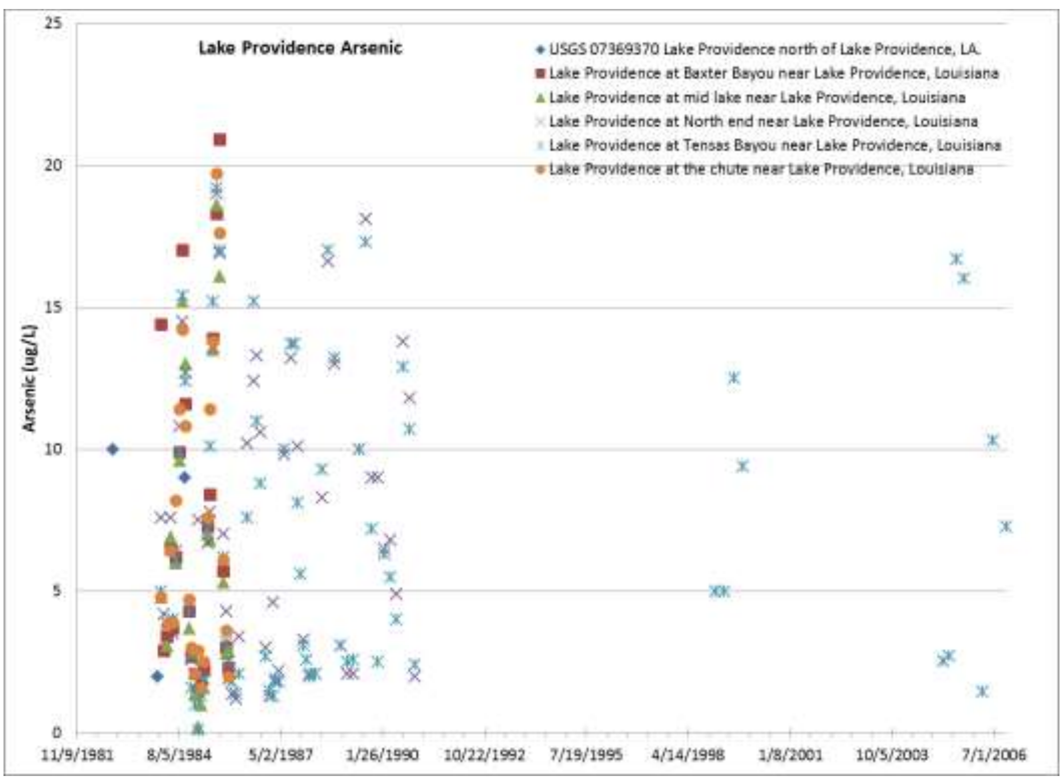

Figure 28: Lake Providence Arsenic concentrations

2.3.6. Turbidity

Although Total Suspended Solids (TSS) concentration does not account for all the sedimentation in a lake setting, it does account for the more mobile finer fraction of incoming sediments. Assuming that lake turbidity is caused primarily by the influx of sediment from the watershed and not re-suspension of in-situ lake sediment, recent Lake Providence data (Figure 29) suggests that inflow of sediments exhibit somewhat of a reduction from that observed during the 1980s. This may be the result of implementation of conservation methods (e.g. vegetative buffers, winter crop cover, etc.) by local farmers or an artifact of sampling (e.g. sample timing, frequency, etc.).

Turbidity data, a common surrogate analysis for sedimentation/siltation, is available for the past 40 years, and indicate that a reduction has occurred since the early 1980s (Figure 30). However, similarly to TSS this decrease may be an artifact of sampling (i.e. samples not taken during or directly after a storm) as well. The LDEQ turbidity standard for Lake Providence is 25 NTU. LDEQ conducted water quality sampling during 2013/2014 at the ambient water quality monitoring station (Site 0132) on the US Highway 65 bridge at Tensas Bayou. While two of the samples taken during this period exceeded the turbidity standard of 25 NTU, overall the turbidity is fully supporting its designated uses in Lake Providence in the Draft 2016 Integrated Report.

2.3.7 Total Dissolved Solids

Water quality was sampled for Total Dissolved Solids (TDS) by Moore (1951), the USGS and LDEQ (Figure 31). The TDS standard for Lake Providence is 150 ppm. During the LDEQ water quality sampling year of 2013/2014 at Lake Providence there were four exceedences of the TDS standard. The LDEQ is currently making a determination for Lake Providence for a Fish & Wildlife Propagation Use impairment due to TDS in the Draft 2016 Integrated Report.

2.3.8 Water Temperature

Although the record exhibit large seasonal variability, the data collected suggests that lake water temperature has remained relatively stable for the last 50 years (Figure 32).

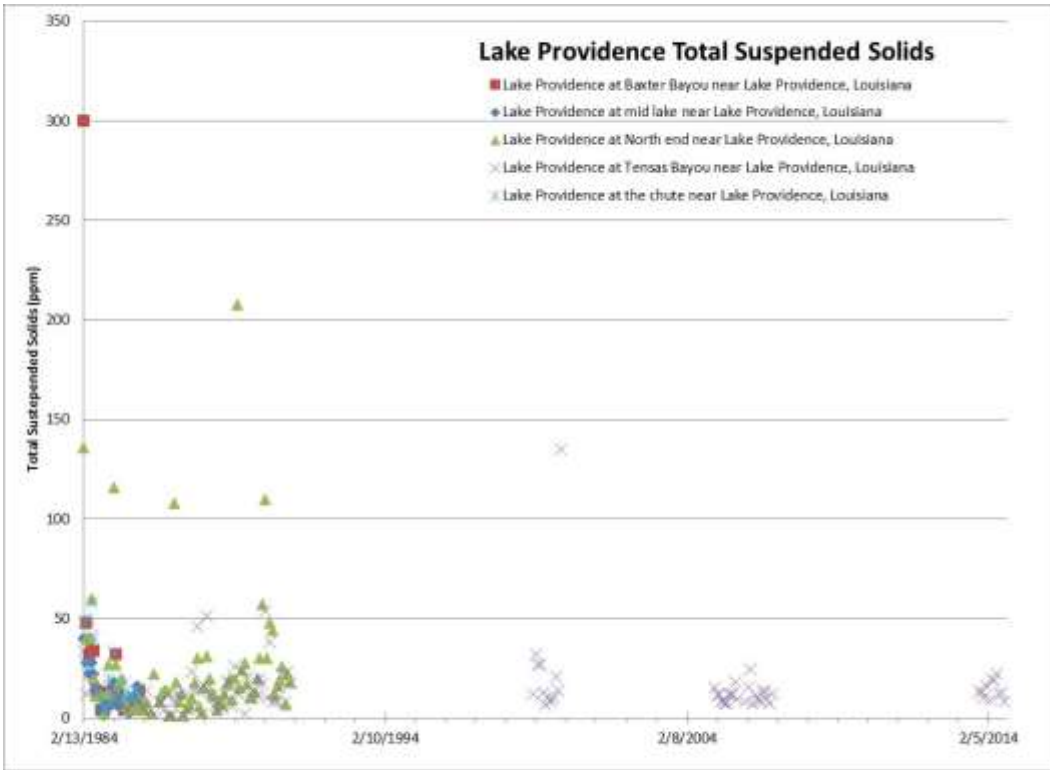

Figure 29: Lake Providence Total Suspended Solids concentrations

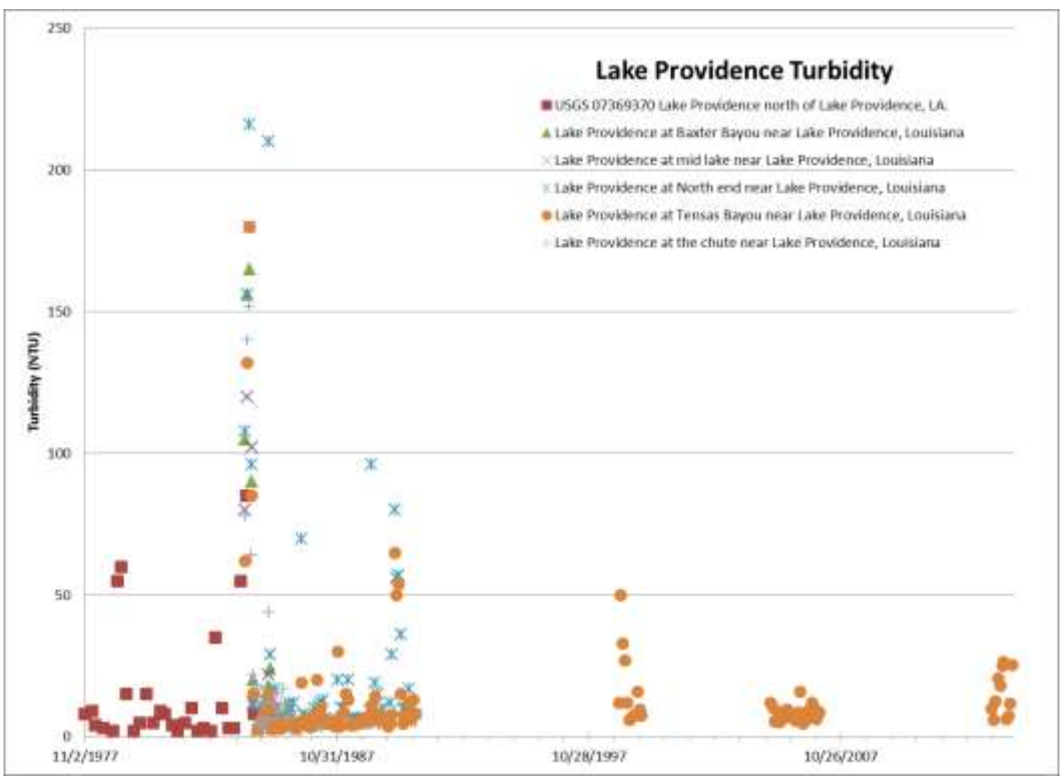

Figure 30: Lake Providence turbidity measurements

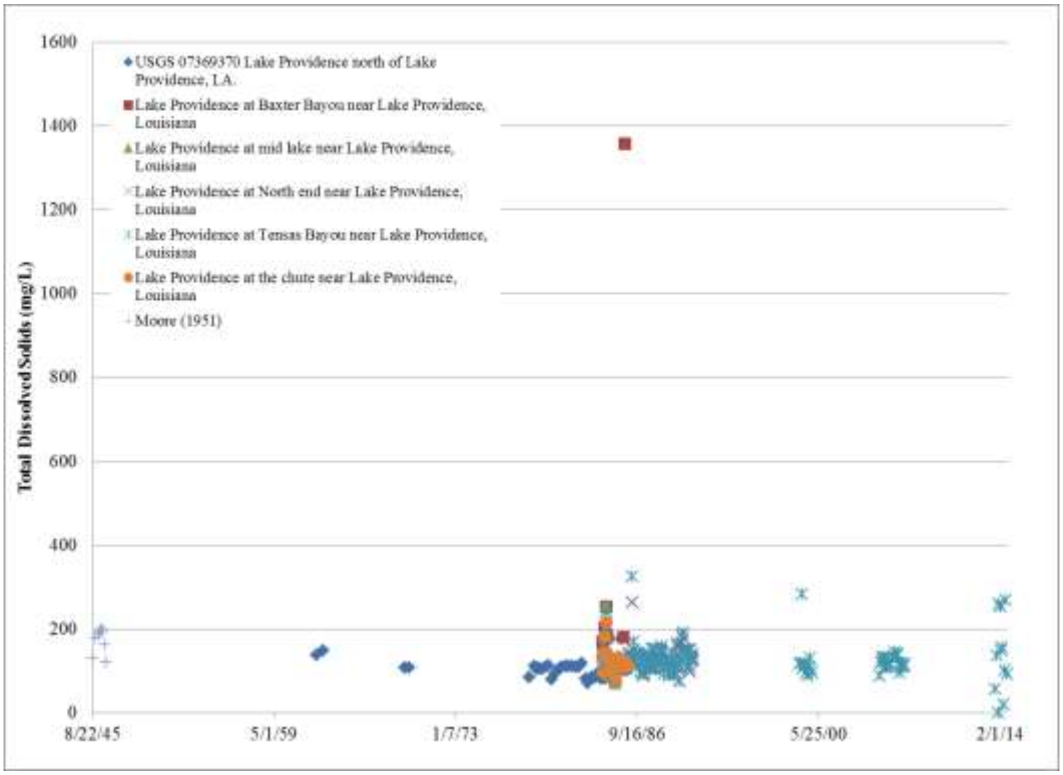

Figure 31: Lake Providence TDS measurements

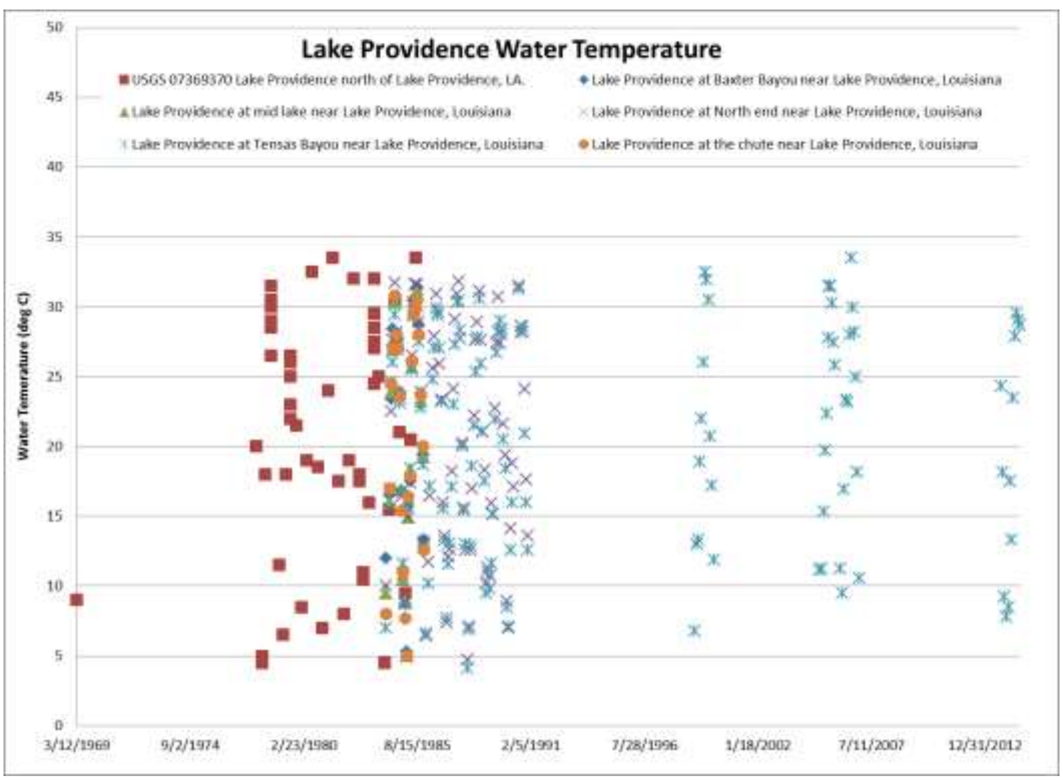

Figure 32: Lake Providence water temperature measurements

2.4 Fisheries

2.4.1 Non-native Fish

Efforts should be made to prevent the introduction of invasive Asian carps into the lake via migration over inundated control structures during flood events. Asian carp have already entered the lake from Tensas Bayou in recent years. The impact of these fish on native fish populations in Lake Providence is not yet known. There is also a danger to boaters and skiers from leaping fish. These fish will not reproduce within the lake and thus can be eradicated by preventing further introductions. Grass carp have also been observed in the lake, though their origin is unknown (illegal stocking or migration during flood events). Current impact of grass carp is believed to be minimal.

2.4.2 Declining Stock

Declining populations of crappie (Figure 33) and redear sunfish have been documented. A shift in the crappie population has also been documented. Black crappie comprised 94% of the crappie in a 2007 sample, but only comprised 32% in a 2014 sample. White crappies are typically more abundant in turbid waters, possibly indicating a response to increased turbidity. Redear sunfish rely heavily on crustaceans as food items, such as aquatic snails, grass shrimp and mussels. These food items are currently lacking in Lake Providence due to the low abundance of submerged aquatic vegetation (necessary for snails and grass shrimp) and increased turbidity, which may have impacted mussel populations. Largemouth bass, channel catfish, and bluegill populations have been steady. With the exception of smallmouth buffalo, rough fish species are not currently abundant in Lake Providence. It is unclear at this time whether there has been a real decline in these species.

2.5 Aquatic Habitat

2.5.1 Loss of Edge Habitat

There has been little net loss of edge or shoreline habitat in recent years in Lake Providence. Much of this type of habitat was lost during seawall construction and property clearing over 30

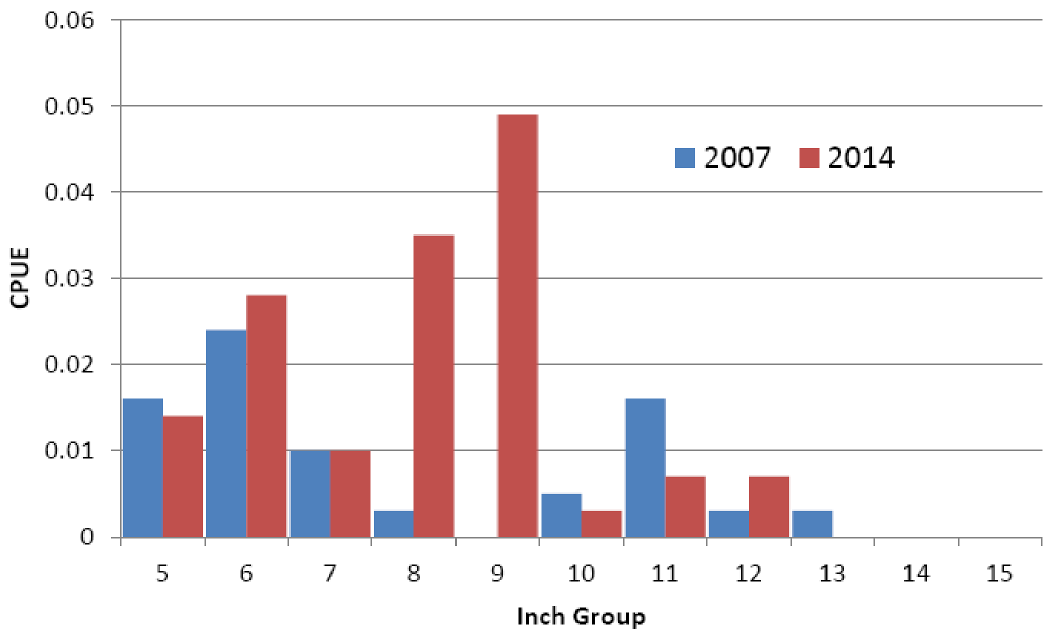

Figure 33: Lake Providence catch-per-unit-effort by length group for crappies. Source: LDWF.

years ago. Much of the shoreline is protected by cypress trees, which do provide valuable shallow cover for fish reduce shoreline erosion. Although it is unlikely that considerably more shoreline will be developed, property owners should be encouraged to maintain a natural shoreline when feasible to maintain shade canopy and provide cooler aquatic habitat for hatchlings and fingerlings. This can be accomplished by not removing shoreline vegetation and woody debris in the shallows adjacent to their property.

2.5.2 Loss of Submerged Aquatic Vegetation

Submerged aquatic vegetation is currently minimal in the lake. Coontail has been the only species observed in recent years and is widely scattered throughout the shallows, not providing desirable coverage for fisheries. Coverage of submerged vegetation has been adequate in the past, even requiring control by herbicide application in certain areas. Southern naiad and coontail have historically been the most common. Recent high water and associated turbidity during spring following major rain events, along with planktonic turbidity during the summer months has likely reduced the coverage of submerged species. Re-introductions of submerged aquatic vegetation at this time will likely have minimal effect on the overall coverage in the lake until turbidity issues are resolved. With improved water quality it is expected that aquatic vegetation will naturally come back.

2.5.3 Boat Wake

Elevated turbidity and sediment re-suspension, particularly on the north and south ends, can be associated with boat traffic and can result into minimized spawning habitat for nesting fish. Average depth of the flats is less than 5 feet and the loose sediments are easily stirred by boat traffic and wave action.

2.6 Land Use Development

2.6.1 Shoreline Development

The natural shoreline of any lake in Louisiana is usually a very gentle slope with vegetation at the water's edge and up the slope. This situation allows wave energy to be gradually dissipated both incoming and returning to the lake. As the developments around Lake Providence continue to increase, the value of the waterfront real estate has escalated. This has led to a situation where property owners, either in an effort to protect their structures or to increase their land area have constructed vertical bulkheads. These bulkheads are becoming more prevalent on the Lake Providence shoreline.

2.6.2 Bulkheads

Approximately 30% of Lake Providence's shore is lined bulkhead structures. These are primarily located at residences on the eastern inner portion of the oxbow lake. Although there is armoring along U.S. Highway 65 shoreline, most of this armoring consists of rip rap since that side of the lake is highly susceptible to erosion. There are several places all along the western side of the lake that are sloughing off next to the highway and need attention. The other 70% is unimproved or natural surroundings of cypress trees and stumps. Appendix E includes pictures depicting the current state of the lake's shoreline. The pictures were taken on 2/3/2016 after a minimal 0.30 in. of rainfall the day before and the lake is roughly 3-4" above pool stage.

As the length of vertical bulkhead shoreline increases, it creates an unintended erosional and turbidity problem. Vertical bulkheads are known to cause increased erosion of the lake bottom seaward of the bulkhead. Waves, especially breaking waves, impacting a vertical surface have a large portion of their energy directed downward to the mudline. This downward moving water erodes the bottom sediments as it retreats from the bulkhead. The eroded sediments increase the turbidity in Lake Providence while increasing the water depths seaward of the bulkheads.

2.6.3 Piers, Boathouses and Boatlifts

There are numerous piers, boathouses and boatlifts along the Lake Providence shoreline. These structures and the boat traffic associated with them create shade and disturbance which can limit aquatic plant growth and reduce fish habitat. In addition, construction and maintenance activities can cause the loss of shoreline vegetation and an increase in turbidity.

2.6.4 Sewerage Systems

Although there are numerous camps and residences along Lake Providence, these are primarily serviced by a public sewerage system. The Town of Lake Providence's community sewer system treated sewer from North Pond and Sewer Pond goes into the Mississippi River. According to LDHH's records for Individual Sewage Systems >95% of the houses on Lake Providence are serviced by the community sewage system. North of Baxter Bayou to the Point is serviced by Individual Sewage Systems. In addition, there are a few Individual Sewage Systems scattered around the Chute and possibly two or three more on Island Point Drive and Lakeside Drive due to elevation issues connecting to the community sewage system.

2.6.5 Drainage Systems

As indicated earlier in this report the local drainage pattern of Lake Providence has been modified over time for the purpose of more efficiently draining the local agricultural land. Figure 34 shows the manmade rectilinear pattern of channels draining the cultivated portion of the watershed. In addition, more recently a study prepared by the Federal Emergency Management Agency (FEMA) addressing repetitive flood damage experienced by the Town of Lake Providence as a result of tropical and other severe storm events made suggestions as to drainage improvement (FEMA, 2015). The draft environmental assessment concentrated with improving the conveyance of storm water toward Tensas Bayou and Lake Providence (Figure 35). The report did not recommend work on the bayou itself because "a more detailed study of the lake hydraulics would need to be completed before investigating the drainage regimes on the

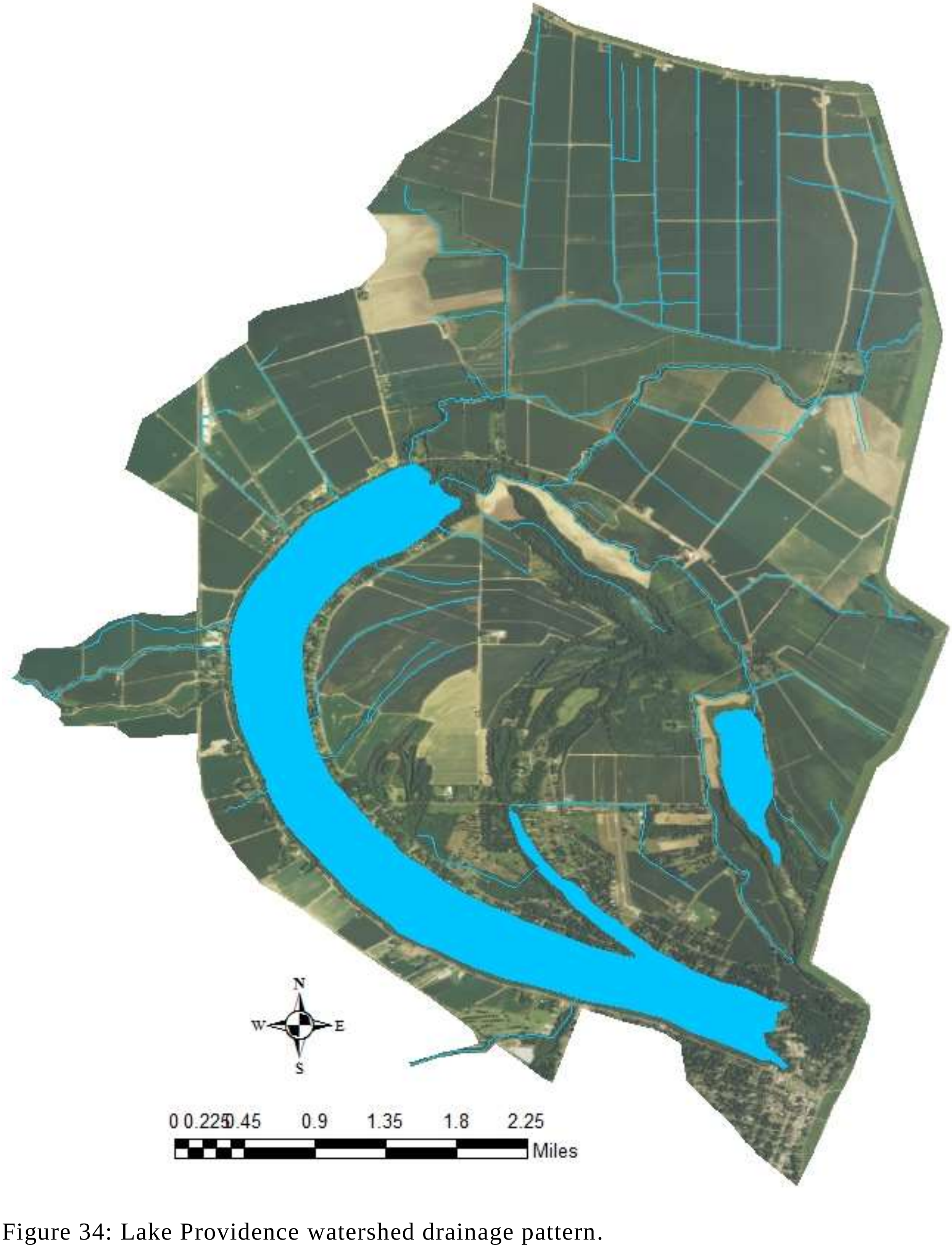

Figure 34: Lake Providence watershed drainage pattern.
Source: NRCS.

north side of the lake and possible causes of flooding there. Therefore, this alternative will not be further discussed in the environmental assessment."

2.7 Data Gap

2.7.1 Lake Level Monitoring

Water level (i.e. stage) monitoring of the lake began in December 2015. This data will be collected under an existing contract between the LDNR and the LGS until June 30, 2016. It is necessary for this data to be collected in order to evaluate the lake's response to rain/storm events, seasonal variability and begin to determine an appropriate lake level management schedule for the resource.

2.7.2 Lake Bathymetry

A bathymetric survey has been completed for Lake Providence by LDWF in February 2016. This information is essential in determining sedimentation patterns throughout the lake, identifying potential sources of sediment, and estimate the amount of sediment stored within the lake. A preliminary bathymetric chart was developed (Figure 15). However, the information needs to be corrected for changes in water levels during the survey and related to the lake's pool stage (90 ft.NGVD) as soon as surveying data can be secured for the weir and the lake gage.

2.7.3 Lake Sediment Physical and Chemical Properties

Excluding the lake sediment samples collected by the USGS between 1978 and 1984 for pesticides, no sediment from the lake has been collected and tested for geotechnical properties. The physical (e.g. grain size, etc.) and chemical properties of the sediments need to be characterized to determine the most appropriate mechanism(s), if any, of removal and disposal, and/or suitability for building aquatic habitat terraces.

2.7.4 Watershed Response to Storm Event

As the 2015 FEMA draft assessment indicates modifications to the control structure and drainage networks requires a scientific understanding of the hydrologic response of the watershed to storm event. Without this information it is difficult to develop a lake level management plan.

Seven (7) Project Sites
Drainage Improvements
FEMA Project Area
CDBG Project Area
DOTD L-25A Canal project area
DOTD project path to Hwy 3181

Figure 35: Proposed drainage improvements within and around the town of Lake Providence.
Source: FEMA, 2015.

2.7.5 Sedimentation and Nutrients Transport Study

Similarly to the need to evaluate storm event response within the watershed, the hydrologic response will directly impact the transport and loading of nutrients and sediments into the lake. This information is necessary to evaluate the potential for hydromodifications of the drainage network.

3 Management Strategies

3.1 Flooding

3.1.1 Lake Level Management

Flooding of Lake Providence continues to worsen due to improper drainage that currently exists. There are two drains on Lake Providence, namely Tensas Bayou and Baxter Bayou. Tensas Bayou is the main drain which allows roughly 70% of the water in Lake Providence to exit once the lake gets above the weir. The Tensas Bayou originates in Lake Providence as a ditch and becomes the Tensas River downstream, south of Tendal, LA. Due to lack of maintenance, Tensas Bayou has become overgrown and obstructed, therefore limiting the ability of Lake Providence to drain efficiently. Tensas Bayou is located on the lower end of the lake just west of the Town of Lake Providence (Figure 2). Baxter Bayou is located on the northwest side of the lake and it drains toward the Bayou Macon (Figure 2). The water that drains into Baxter will actually run backwards into the lake due to insufficient drainage below the weir. Baxter Bayou runs southwest across East Carroll Parish discharging into the Bayou Macon. Baxter Bayou's watershed cannot store excessive rainfall, causing it to flow backwards into the lake. It is not uncommon for Baxter Bayou to flow backwards multiple times in a given year. It is a rarity for Tensas Bayou to flow backwards, although it has been occurring more often in recent years.

There is an analysis containing history of flooding using the Tensas Bayou gage at Transylvania. The gage is located approximately nine miles downstream to the lake. Assuming the slope of 0.5 feet/mile, stages greater than 85.5 ft at Transylvania would result in a stage of 90.0 ft at Lake Providence. The Transylvania gage was established in 1961, since 1961 there have been only seven periods (three extended periods) where the stage at Transylvania exceeded 85.5 ft (Figure 12). In May 1991 the stage equaled or exceeded 85.5 ft for 11 days, in February 2007 for 9 days and in September 2008 for 4 days. In addition to these periods were Hurricane Katrina in August of 2005 and Hurricane Rita is September of 2005. Rita had extensive rainfall in the Lake Providence Watershed causing much flooding to real estate and agriculture.

3.1.1.1 Natural Cycle

Lake Providence is an inactive oxbow of the Mississippi River. Current lake levels are stabilized at 90'MSL with limited seasonal fluctuations. To improve the health of the lake, consideration should be given to manage water levels to the extent practical to mimic more natural seasonal fluctuations. Fluctuating water levels are dependent on the capacity of the control structures. Typical annual Mississippi River fluctuations are low water levels in the late summer and winter months (July–January), and high water levels in the spring and early summer months (February–June). In order to actively manage the lake's level it is recommended that both the Baxter and Tensas Bayous structure be rehabilitated or replaced. This recommendation is consistent with that proposed

3.1.1.2 Tropical Storm/Flooding Event

In order to increase the volume of water that Lake Providence can store during large rain events such as tropical storms and to actively manage the lake's level, it is recommended that both the Baxter and Tensas Bayous structure be upgraded or replaced, and regular maintenance made to Tensas Bayou. These recommendations are consistent with those proposed by the USACE after Hurricane Gustav (Figure 13).

3.1.1.3 Other Lake Level Management Issues

Lake level management can be a useful tool to improve water quality. Exposure of shallow water areas have the beneficial effect of hardening the lake substrate resulting in improvement in lake water quality from decreased turbidity, and improvement in fish habitat. Similarly, periods of low water level can be used by camp and home owners to perform shoreline maintenance on piers and bulkheads.

3.2 Water quality

3.2.1 Nutrient Run-off Management

According to the latest testing data, nutrient levels in Lake Providence are at very low levels and not considered a problem. However in the last decade corn has become a major crop grown in the watershed replacing cotton (Appendix A). Corn requires far more nitrogen fertilizer than cotton so continued monitoring will be required. Nutrient run-off will be contained if proper sediment run-off management can be achieved.

The NRCS' Mississippi River Basin Healthy Watersheds Initiative (MRBI) and Environmental Quality Incentives Program (EQIP) help producers in the watersheds to voluntarily implement conservation practices that avoid, control, and trap nutrient runoff; improve wildlife habitat; and maintain agricultural productivity. The LPWC will through its education and outreach program disseminate and promote the benefits of these programs. In addition, LDEQ's Nonpoint Source Program (NPS) has developed a Management Plan that includes types of best management practices (BMPs) that could be utilized to reduce NO_2/NO_3, Total Phosphorus and turbidity from agricultural activities such as crops and pastures. Appendix F includes a set of BMPs designed by USDA to reduce sediment, nutrients, pesticides, organic material and bacterial concerns in surface waters from croplands and a set of BMPs to reduce these pollutants from pasturelands.

3.2.2 Sediment Run-off Management

The lake's watershed consists of 11,000 acres of intensively tilled cropland (Appendix A). Sediment run-off from farmland is the main contributor to the turbidity problem in Lake Providence (Appendix E). Agriculture is the largest industry in East Carroll Parish, and the economic success of parish is determined by the success of the area's farmers, so this must be considered when attempting to manage run-off from surrounding farms.

The most effective sediment run-off management tool will be to encourage farmers in the watershed to plant and maintain cover crops immediately after harvest until just prior to planting crops in the spring. Appendix E shows pictures taken on March 9, 2016 following a torrential downpour overnight of six inches of rain. The Photograph E17 shows run-off from conventionally farmed cropland with no cover crops draining into the lake. The Photographs

E21 to E23 show run-off from the same rain event from a field planted to a wheat cover crop. Some farmers near the lake may have some reluctance to plant cover crops for the following reasons: cover crops can be expensive to plant; glyphosate resistant winter annual weeds and grasses are an increasing problem in the area and farmers have started applying pre-emergence herbicides in the fall to control this problem vegetation; and under certain conditions cover crops can harbor insects, snails and slugs that can destroy young crops planted into the stubble of the dead or dying cover crop.

There are several possible solutions to these issues. There are a few cost share programs administered by the NRCS, most commonly known as EQUIP and Conservation Stewardship Program (CSP) that offer farmers financial incentives to establish cover crops. However funding for these programs is normally insufficient to handle the demand. Some farmers are reluctant to go through the application process when the probability of getting funding is low. There is a targeted pool of funds currently available for farmers in the Lake Providence watershed that has encouraged many to begin the application process. Funds available total around $800,000 over a three-year period which will cover only a fraction of the acres necessary. Some glyphosate resistant weeds have been shown to be non-competitive in certain cover crop environments. Research is being done by many universities around the country to determine the best mixes of cover crops for controlling problem vegetation. Research has shown that cover crops contribute very favorably to overall soil health and productivity and keeping valuable and productive top soil in place. It is hoped that as more farmers are encouraged to try these crops that they will realize that the cost/benefit ratio favors their planting even without cost share assistance.

Other sediment run-off management tools include filter strips which are strips of vegetation allowed to grow on the upland side of field drainage ditches. The vegetation filters sediment out of storm or irrigation run-off just prior to entering the drainage ditch. Establishing grassy field borders is also a sediment run-off practice that can be effective. Farmers simply let the borders around fields grow naturally occurring or planted vegetation that filters run-off as it drains from the field. Both of these practices can be somewhat effective in reducing sediment run-off and are cheaper to establish than cover crops planted over an entire field. These are common practices used to help in the reduction of soil erosion around field drainage ditches and culverts.

In addition, the NRCS' MRBI help producers in the watersheds to voluntarily implement conservation practices that avoid, control, and trap nutrient runoff; improve wildlife habitat; and maintain agricultural productivity. The LPWC will through its education and outreach program disseminate and promote the benefits of these programs.

3.2.3 Private/Public Sanitary Effluent Management

LPWC recommends that an assessment of the private and public sanitary effluent systems within the watershed be effectuated to evaluate whether outdated systems need to be replaced by newer units or updated.

3.2.4 Storm Flow Management

The LPWC supports FEMA's recommended improvement to the drainage within the Town of Lake Providence. In addition, the LPWC has sought the expertise of the LDOTD to evaluate the conditions of the two control structures and is seeking funding to study the hydrology of the watershed. The LPWC recommends that ordinances as well as conservation and engineered solutions be evaluated. Sediment control and servitude ordinances should be evaluated, as well as drainage channel Operation and Maintenance Plan and hydromodification where applicable. Conservation measures through NRCS' MRBI, Wetland Reserve Program (WRP) and EQIP would help producers in the watersheds to voluntarily implement conservation practices that avoid, control, and trap nutrient runoff; improve wildlife habitat; and maintain agricultural productivity.

3.2.5 Shoreline Modification Management

Shoreline modifications are common along private shoreline, in the form of shoreline hardening and bulkheads. The vertical aspect of bulkheads causes erosion, turbidity and wave within the lake. Mitigation of wave energy from vertical bulkheads can be accomplished by multiple methods including the following treatments:

(1) placement of a debris fence (commonly referred to as Christmas tree fences), these are easy and relatively inexpensive to construct and can be very effective in removing wave energy from the shoreline (Figure 36). These structures could be built seaward of the bulkhead, approximately 10-15 yards in front to remove the wave energy from the

Figure 36: Examples of shoreline mitigation treatments

bulkhead. They also have the potential to create a fish habitat that currently does not exist. These fences have been used for many years by coastal parishes in their coastal restoration efforts. The debris fences allow water to filter through while eliminating the wave energy.

(2) placement of rip-rap in front of the vertical bulkhead to create a porous sloped surface. This would allow the wave to gently run up the slope while dissipating energy on the irregular surface. Prior to doing this, we suggest the property owner have their bulkhead evaluated by a Professional Engineer to insure that the material's placement will not have an adverse impact on their bulkhead or any adjacent structure.

Any shoreline treatment that mimics the lake's natural shoreline and prove edge habitat would be a huge advantage over vertical bulkheads. There are several methods to "harden" a shoreline while having it appear to be natural. This method uses gentle slopes and vegetation to dissipate wave energy.

The LPWC proposes to address shoreline modifications issues through three actions as follows:

(1) EDUCATE. The vast majority of Lake Providence property owners are not aware of the harmful effects that vertical bulkheads have on their lake's environment. LPWC proposes an educational outreach effort to make property owners aware of the current conditions. A handout illustrating the harmful effects would be created and copies provided at local government offices, fairs and other public events. Many property owners, once aware of the issue will take steps to mitigate the situation on their property.

(2) ENTICE. While many owners will undertake effort and expense to correct an issue once aware of the problem, others may choose not to mitigate or not be financially able to make the changes. LPWC suggests that an enticement or incentive program be created to assist property owners that wish to perform mitigation efforts, such as making equipment, labor or materials available at no or minimal charge.

(3) ENFORCE. Draft an ordinance for consideration by the East Carroll Police Jurors that prevents construction of vertical bulkheads, unless they include vertical bulkheads with a permanent mitigation measure, such as a debris fence or sloped rip-rap, included in the permit.

LPWC and ECPJ plan on addressing the matter of ownership of water bottoms with the State Land Office. It is likely that debris fences and rip-rap placed in front of the bulkheads may be constructed on State-owned water bottoms. Once those issues are resolved, the shoreline policy should be implemented.

3.2.6 Watershed Conservation Measures

The NRCS' MRBI, CSP and EQIP help producers in the watersheds to voluntarily implement conservation practices that avoid, control, and trap nutrient runoff; improve wildlife habitat; and maintain agricultural productivity. The LPWC will through its education and outreach program disseminate and promote the benefits of these programs.

3.2.7 Habitat Restoration

LDWF will conduct a qualitative assessment of the fisheries habitat in Lake Providence, identifying deficiencies and problems. Plans to address will be constructed. See also the Lake Providence Management Plans provided by LDWF (LDWF, 2013 and 2015).
http://www.wlf.louisiana.gov/fishing/waterbody-management-plans-inland

3.2.8 Fisheries Management

Current management strategies for all species will be re-evaluated. One particular issue of concern is the low abundance of crappie. If it is determined that current habitat and water quality conditions may be limiting natural reproduction, supplemental stocking may be investigated. The introduction of hybrid striped bass as an alternative recreational species should also become an option if anglers if it is determined that anglers would be in support. The current fisheries management strategies for Lake Providence may be found in the Management Plans.

3.2.9 Coordination of Federal, State, and Local Efforts to Improve and Protect Water Quality

LPWC through contacts with many of the local and regional stakeholders is currently seeking to assist coordinating many of the ongoing efforts to address the lake's water quality. LPWC will continue to seek ideas and help from Federal, State, and Local individuals interested in this effort. In addition, LPWC will through its education and outreach program disseminate and promote the benefits of these programs.

3.2.10 Surface Water Resource Management and Protection Policies

LPWC will assist the ECPJ, as well as the Lake Providence Commission to develop management tools and policies consistent with this effort.

3.2.11 Education and Outreach

Documents and presentations are continuously uploaded onto the Lake Providence webpage on the LDNR web site along with the Council's agendas and minutes, news articles, etc. The website is updated with a list of actions completed and in progress. Press releases are issued as actions are taken. E-Mails, flyers and talks at various nonprofit meetings are held to keep communities informed. Information generated by agencies or obtained to date has been placed on the LDNR website at the following URL:
http://dnr.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=1316.

4. Funding Strategies

4.1 Capital Outlay for Ecosystem Restoration

The East Carroll Police jury has made a request for funds ($100,000) for an hydrologic study in HB 2 of the Regular Legislative Session 2016. This project funding is critical in order to keep the project moving forward.

4.2 Statewide Flood Control Program

The LDOTD's Statewide Flood Control Program is "designed to help solve flood problems through an active, innovative approach. This Program uses state funds allocated each year by the Legislature to assist in the construction of flood control infrastructure. Eligible projects for consideration must reduce existing flood damages. Potential projects include measures to reduce or eliminate the incidence of flooding or damages." The program is designed to fund projects that do reduce existing flood damages, do not encourage additional development in flood-prone areas, do not increase upstream or downstream flooding. The program provides up to 90% of the project construction costs for projects that have a total construction cost of $100,000 or more.

http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Engineering/Public_Works/Flood_Control/Pages/Flood_Control.aspx)

4.3 Water Resources Development Act

Under Section 1135 of the 1986 Water Resources Development Act (WRDA), the USACE can enter in a cost share agreement with the East Carroll Police Jury to partially fund the restoration of Lake Providence (and associated bayous) degraded ecosystem. The funding would include a Feasibility Study (estimated at $600,000 - the first $100,000 100% federally funded then cost shared at 50%). The restoration project would have a maximum federal cost of $10,000,000 with a cost share of 75% federal and 25% non-federal.

4.4 Clean Water Act Section 319 Program

The LDEQ Nonpoint Source (NPS) Program is funded by USEPA's Clean Water Act (CWA) Section 319 Program funds. In a partnership between LDEQ and USDA-NRCS, both agencies are coming together in an effort for Lake Providence watershed protection and restoration through the USEPA CWA Section 319 Program and the USDA-NRCS Mississippi River Basin Initiative (MRBI), funded through the USDA Farm Bill.

LDEQ's ambient water quality monitoring network site for Lake Providence, subsegment 081101, showed elevated levels of total dissolved solids (TDS) for the sampling year 2014/2015. According to the Draft 2016 Integrated Report, Lake Providence, LDEQ subsegment 081101, is impaired for the fish and wildlife use with a suspected cause of impairment as total dissolved solids (TDS). Beginning the summer of 2016, the LDEQ Water Surveys Section will complete a waterbody survey and select approximately 8-10 locations within the lake to monitor. The LDEQ Nonpoint Source Section monitors in two phases: Phase One is a baseline assessment, to establish the current water quality conditions in the lake; and Phase Two is a long term assessment, which occurs during or after best management practices (BMPs) implementation by USDA-NRCS.

4.5 Other Funding Opportunities

NRCS through the EQIP program provides for channel landowners to reduce erosion. In addition, as part of its Mississippi River Basin Healthy Watersheds Initiative (MRBI)-Cooperative Conservation Partnership Initiative (CCPI), NRCS is accepting applications by landowners for Special Projects in Bayou Boeuf and Lower Bayou Macon Watersheds. The funding is there to "help producers implement conservation practices to avoid excess application of nutrients and water on fields; control the amount of nutrient and water runoff from fields into the watershed, and trap nutrients before they leave the field."

http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/home/?cid=stelprdb1048200

5 Recommendations

This plan takes a multifaceted approach to address issues within the watershed, including engineered, education, enticement and enforcement solutions. The plan draws from the expertise of many parish, state and federal agencies, including LDNR, LDWF, LDEQ, LDHH, LDAF, NRCS, as well as other local stakeholders.

6 References

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Louisiana Department of Wildlife and Fisheries (LDWF), 2015. Waterbody Management Plan Series. Lake Providence Part VI-B Waterbody Evaluation & Recommendations: LDWF, 29 p.

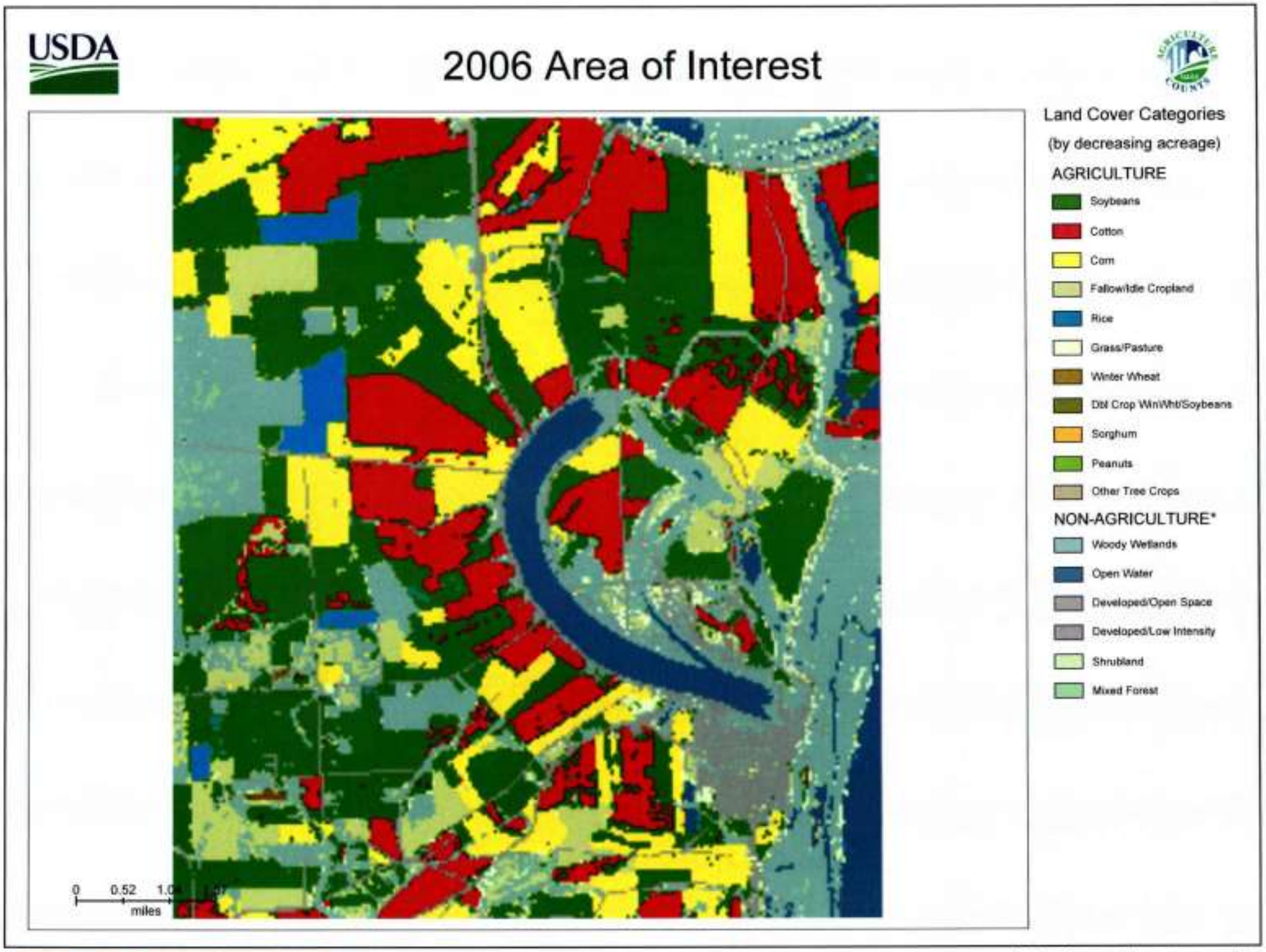
Moore W.G., 1950, Limnological studies of Louisiana lakes. 1. Lake Providence: Ecology, vol. 31(1), p. 86-99.

Worthen E.L. and Belden H.L., 1908, Soil Survey of East and West Carroll Parishes Louisiana: United States Department of Agriculture Bureau of Soils.

Appendix A

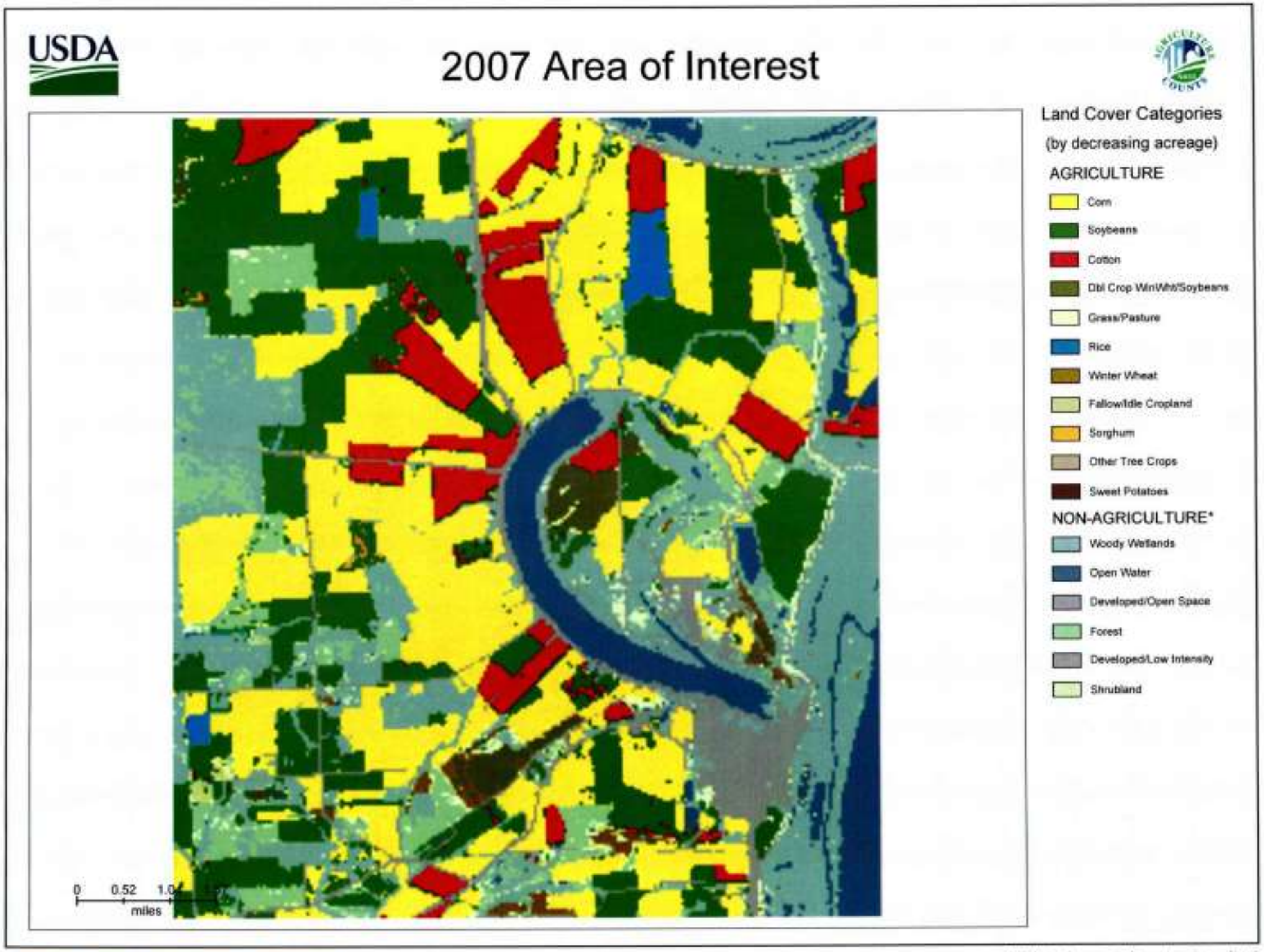
Land Cover Plots 2006-2015

(Source: NRCS)



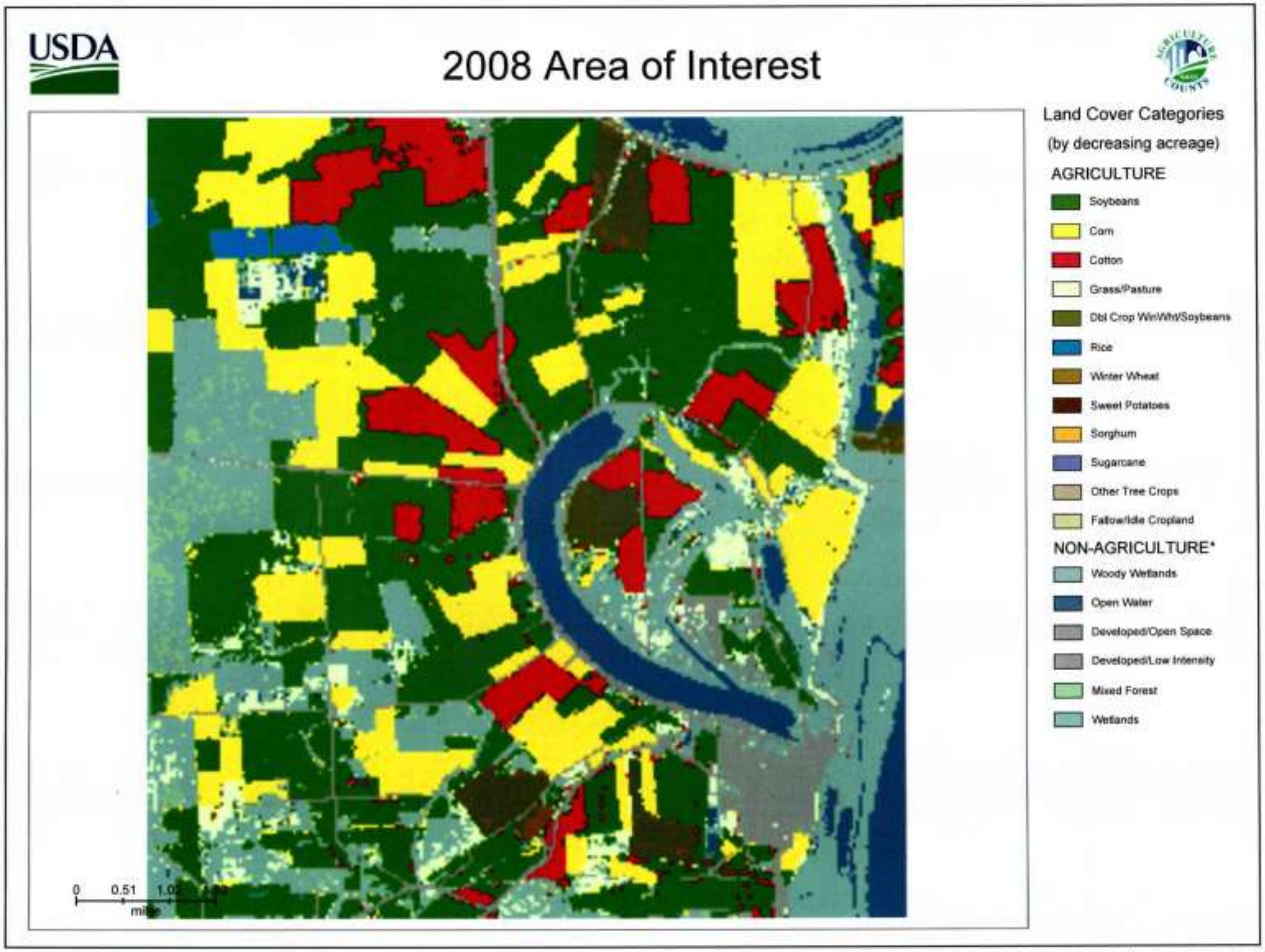
Produced by CropScape - http://nassgeodata.gmu.edu/CropScape

* Only top 6 non-agriculturecategories are listed



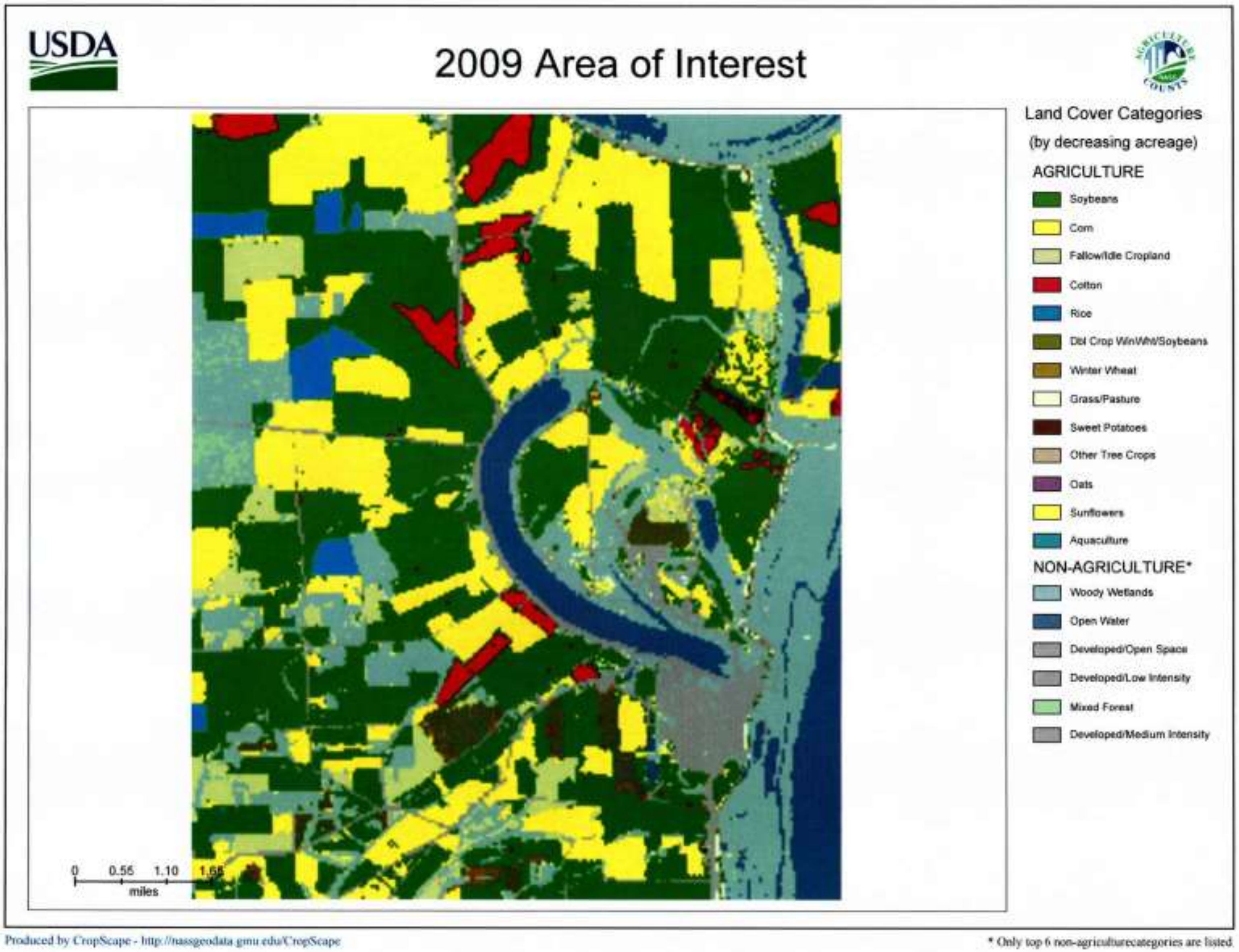
Produced by CropScape - http://nassgeodata.gmu.edu/CropScape

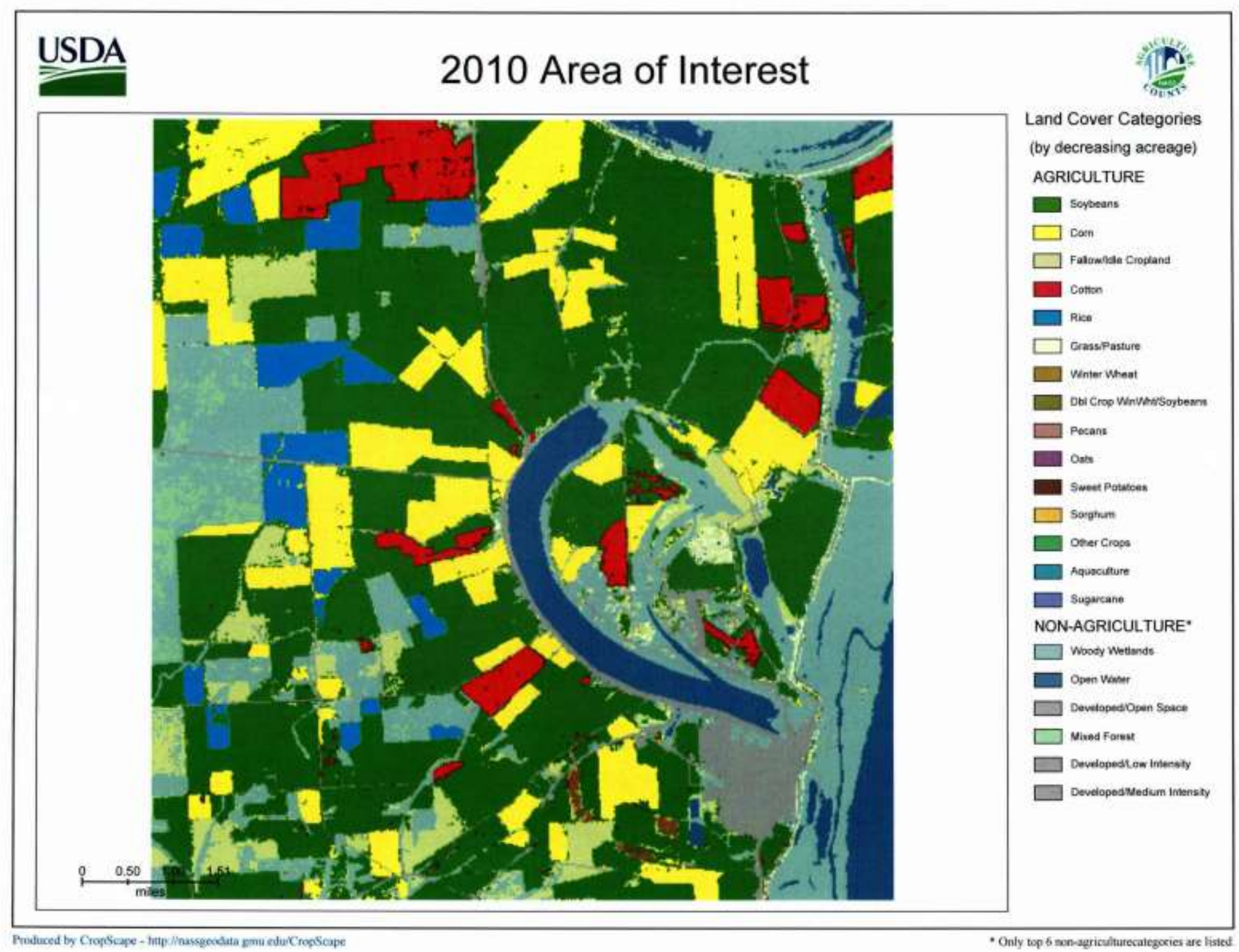
* Only top 6 non-agriculturecategories are listed

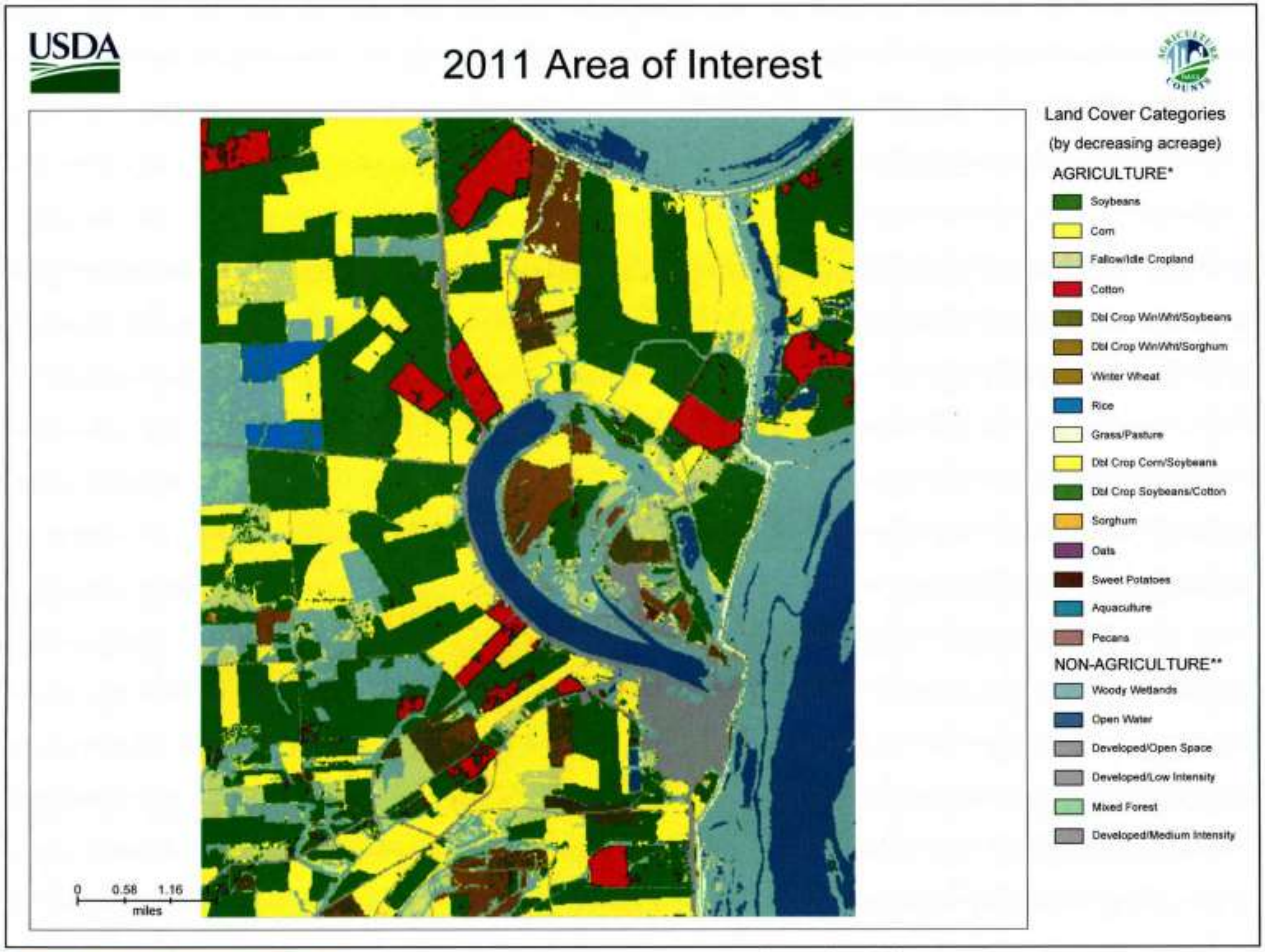


Produced by CropScape - http://nassgeodata.gmu.edu/CropScape

* Only top 6 non-agriculturecategories are listed.

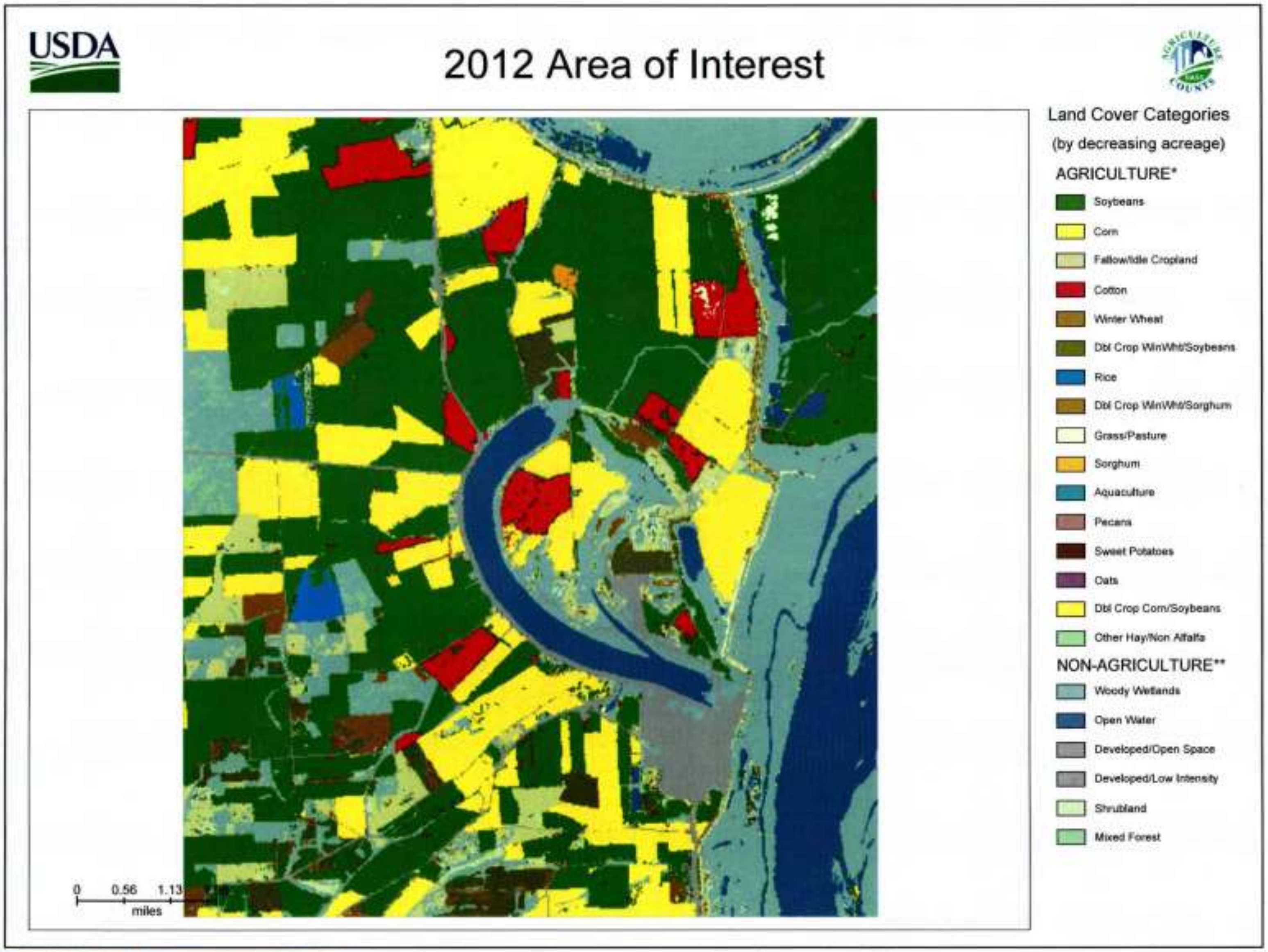

USDA
2009 Area of Interest
Land Cover Categories
(by decreasing acreage)
AGRICULTURE
Soybeans
Corn
Fallow/Idle Cropland
Cotton
Rice
Dbl Crop WinWht/Soybeans
Winter Wheat
Grass/Pasture
Sweet Potatoes
Other Tree Crops
Oats
Sunflowers
Aquaculture
NON-AGRICULTURE*
Woody Wetlands
Open Water
Developed/Open Space
Developed/Low Intensity
Mixed Forest
Developed/Medium Intensity
0 0.55 1.10 1.65
miles
Produced by CropScape - http://nassgeodata.gmu.edu/CropScape
* Only top 6 non-agriculturecategories are listed


USDA
2010 Area of Interest
Land Cover Categories
(by decreasing acreage)
AGRICULTURE
Soybeans
Corn
Fallow/Idle Cropland
Cotton
Rice
Grass/Pasture
Winter Wheat
Dbl Crop WinWht/Soybeans
Pecans
Oats
Sweet Potatoes
Sorghum
Other Crops
Aquaculture
Sugarcane
NON-AGRICULTURE*
Woody Wetlands
Open Water
Developed/Open Space
Mixed Forest
Developed/Low Intensity
Developed/Medium Intensity
0 0.50 1.51
miles
Produced by CropScape - http://nassgeodata.gmu.edu/CropScape
* Only top 6 non-agriculturecategories are listed.



Produced by CropScape - http://nassgeodata.gmu.edu/CropScape

culture categories are listed.



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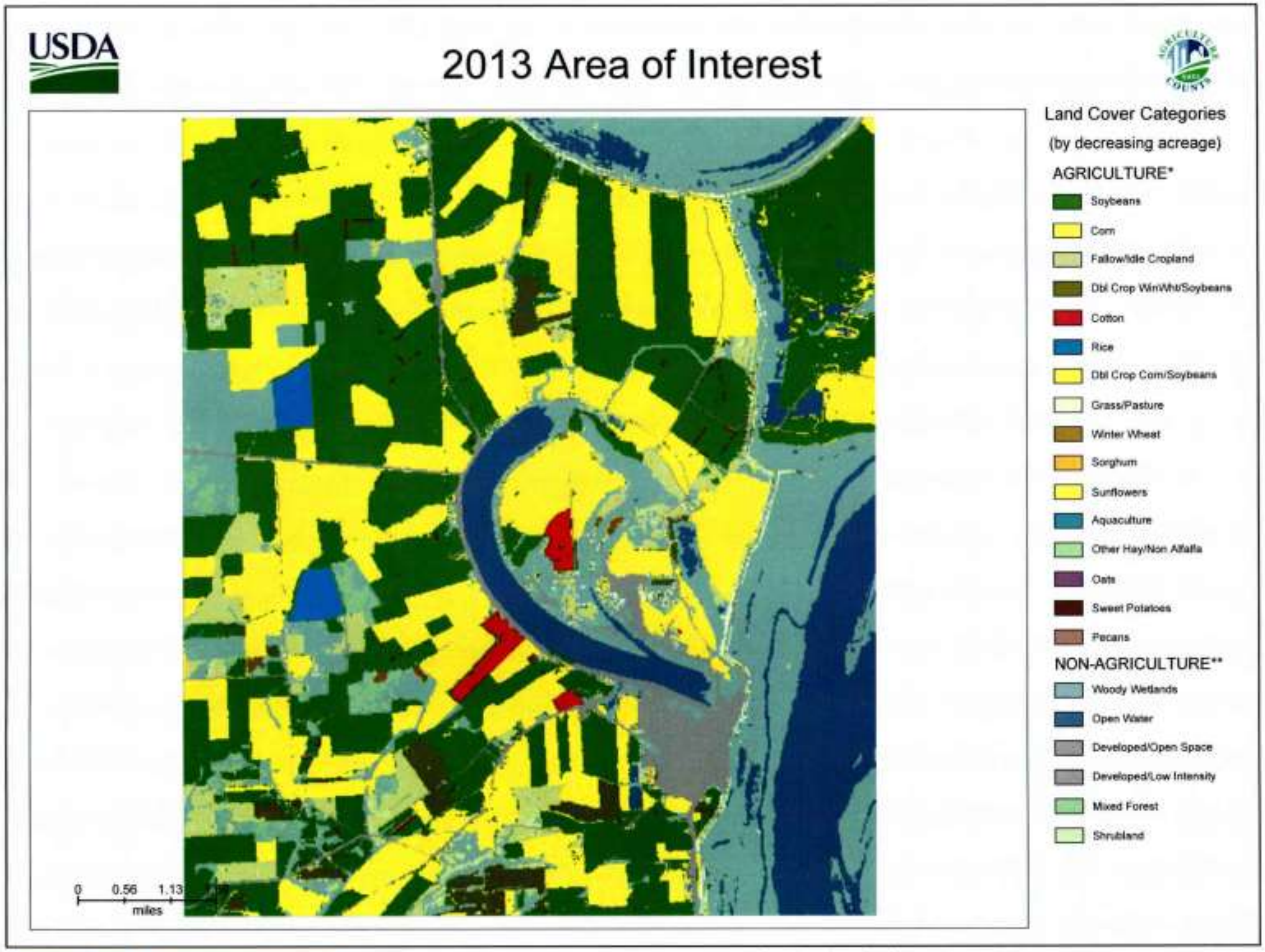
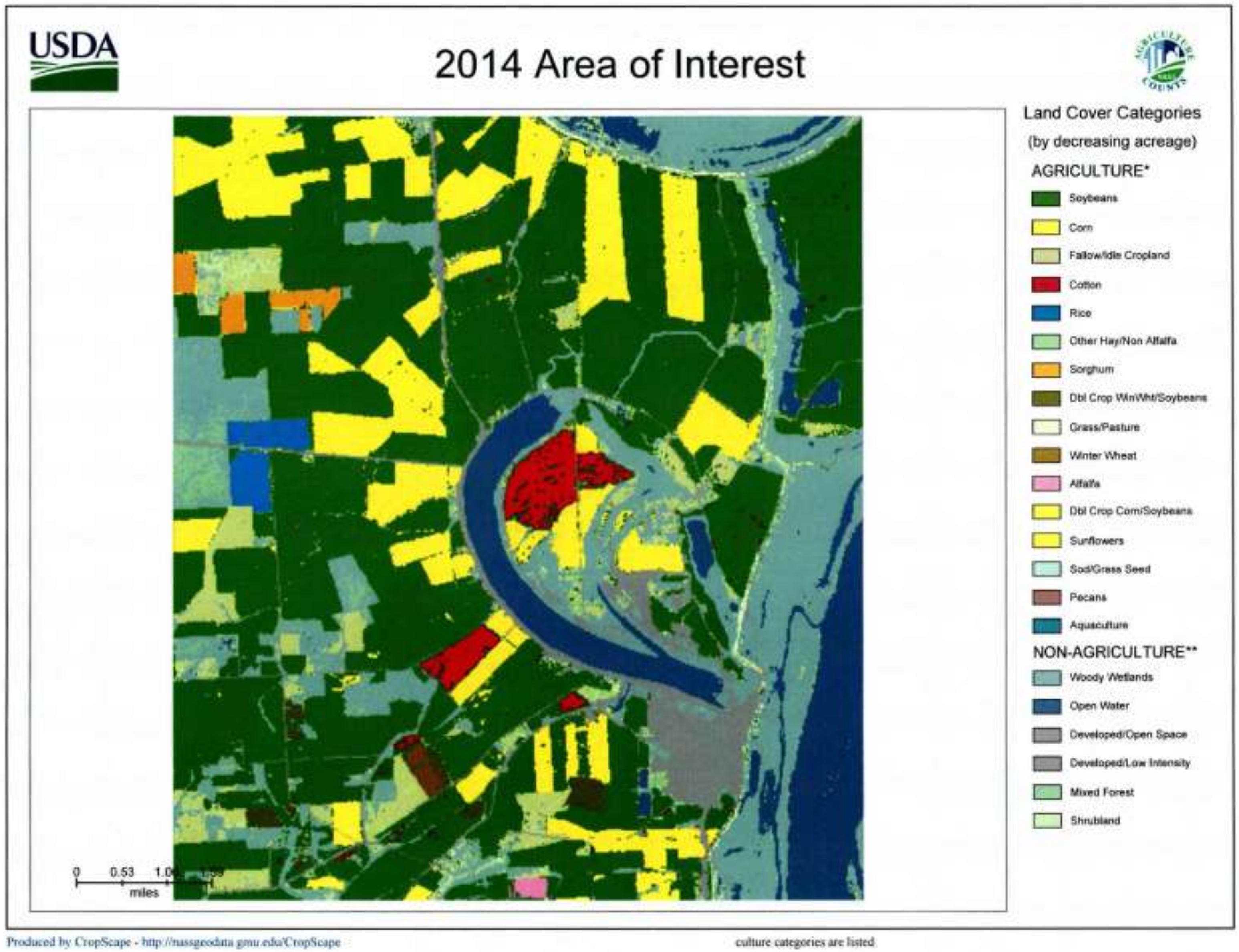
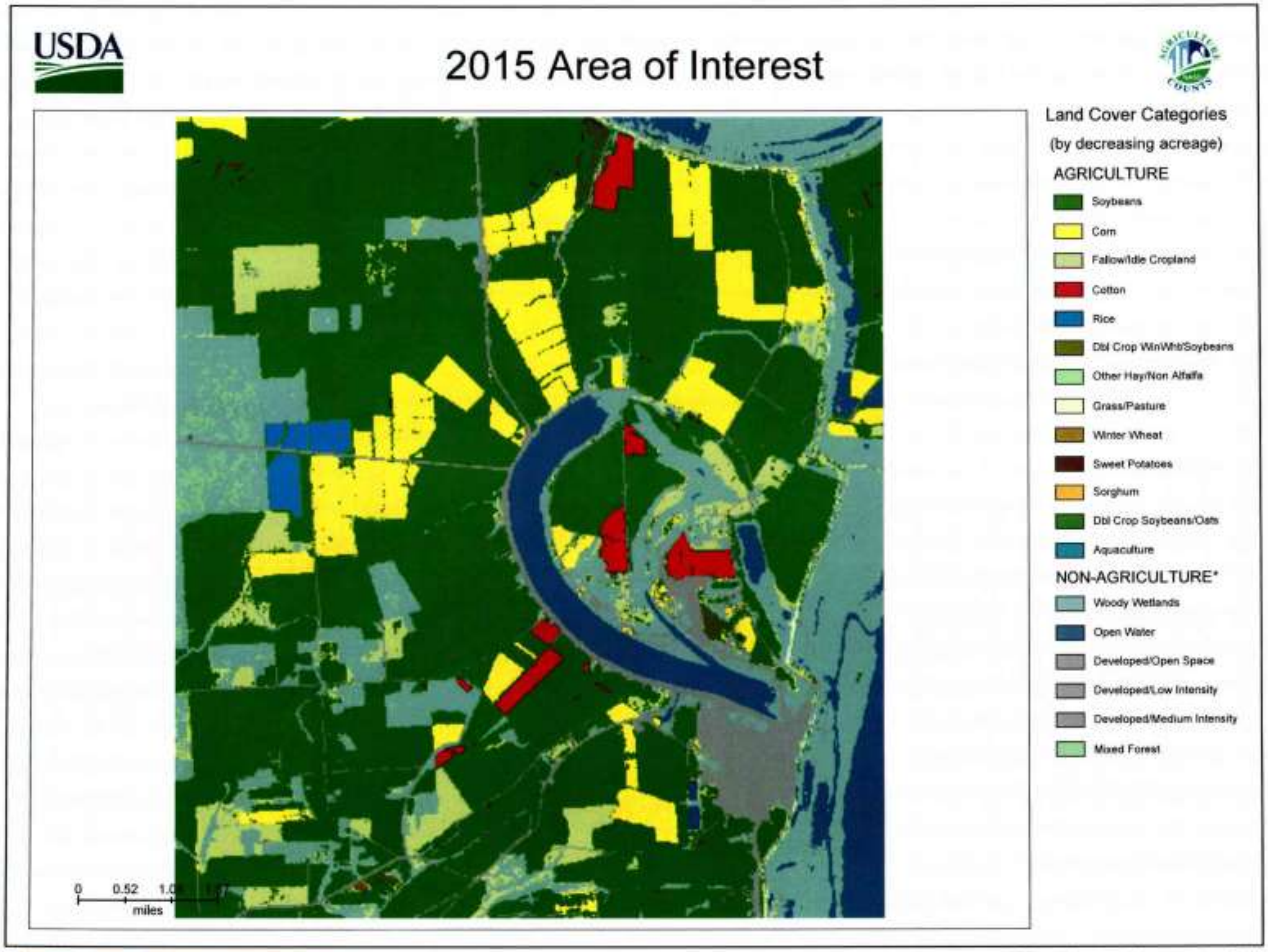


Produced by CropScape - http://nassgeodata.gmu.edu/CropScape

culture categories are listed


USDA
2014 Area of Interest
Land Cover Categories
(by decreasing acreage)
AGRICULTURE*
Soybeans
Corn
Fallow/Idle Cropland
Cotton
Rice
Other Hay/Non Alfalfa
Sorghum
Dbl Crop WinWht/Soybeans
Grass/Pasture
Winter Wheat
Alfalfa
Dbl Crop Corn/Soybeans
Sunflowers
Sod/Grass Seed
Pecans
Aquaculture
NON-AGRICULTURE**
Woody Wetlands
Open Water
Developed/Open Space
Developed/Low Intensity
Mixed Forest
Shrubland
0 0.53 1.0
miles
Produced by CropScape - http://nassgeodata.gmu.edu/CropScape
culture categories are listed.



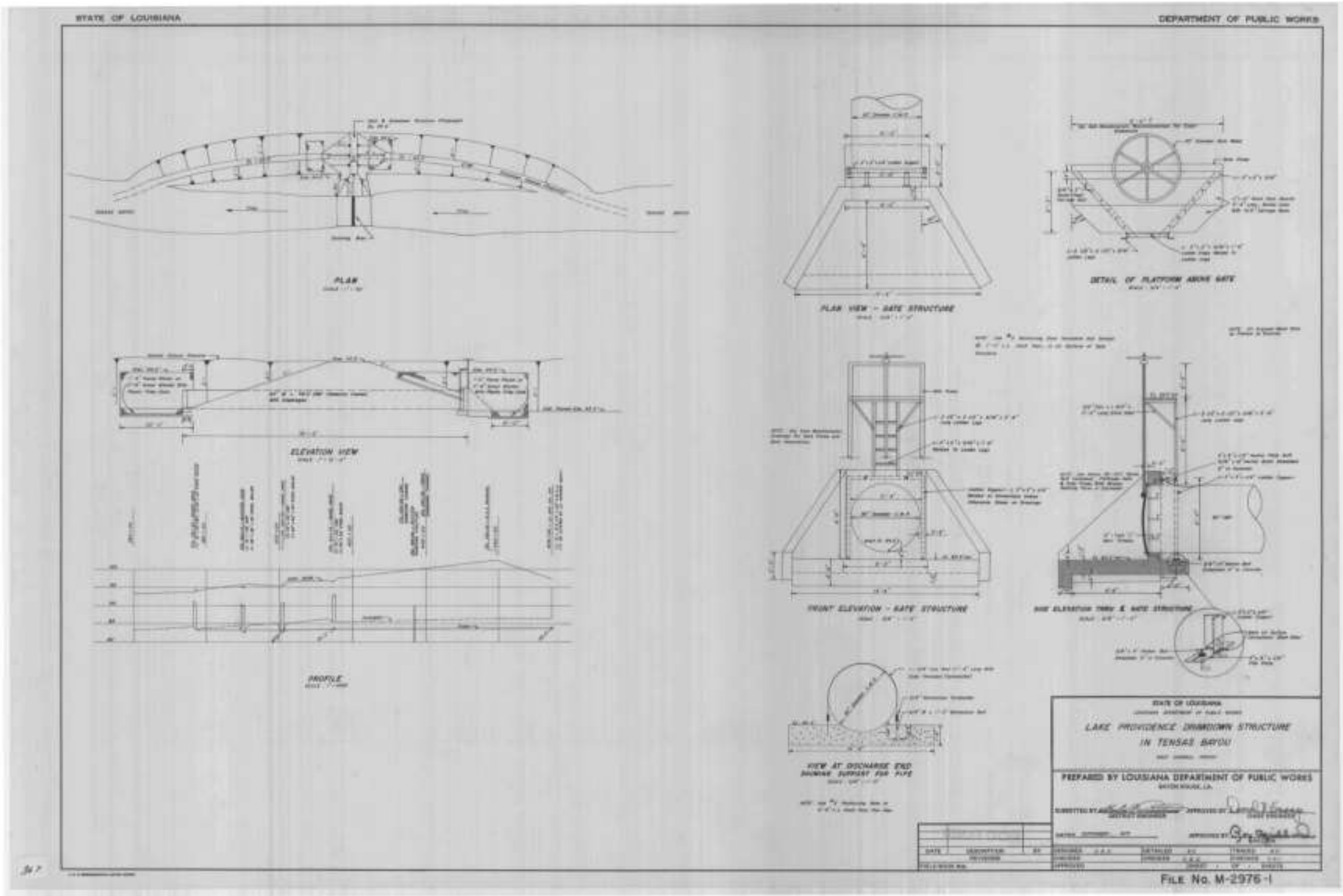
Produced by CropScape - http://nassgeodata.gmu.edu/CropScape

* Only top 6 non-agriculturecategories are listed

Appendix B

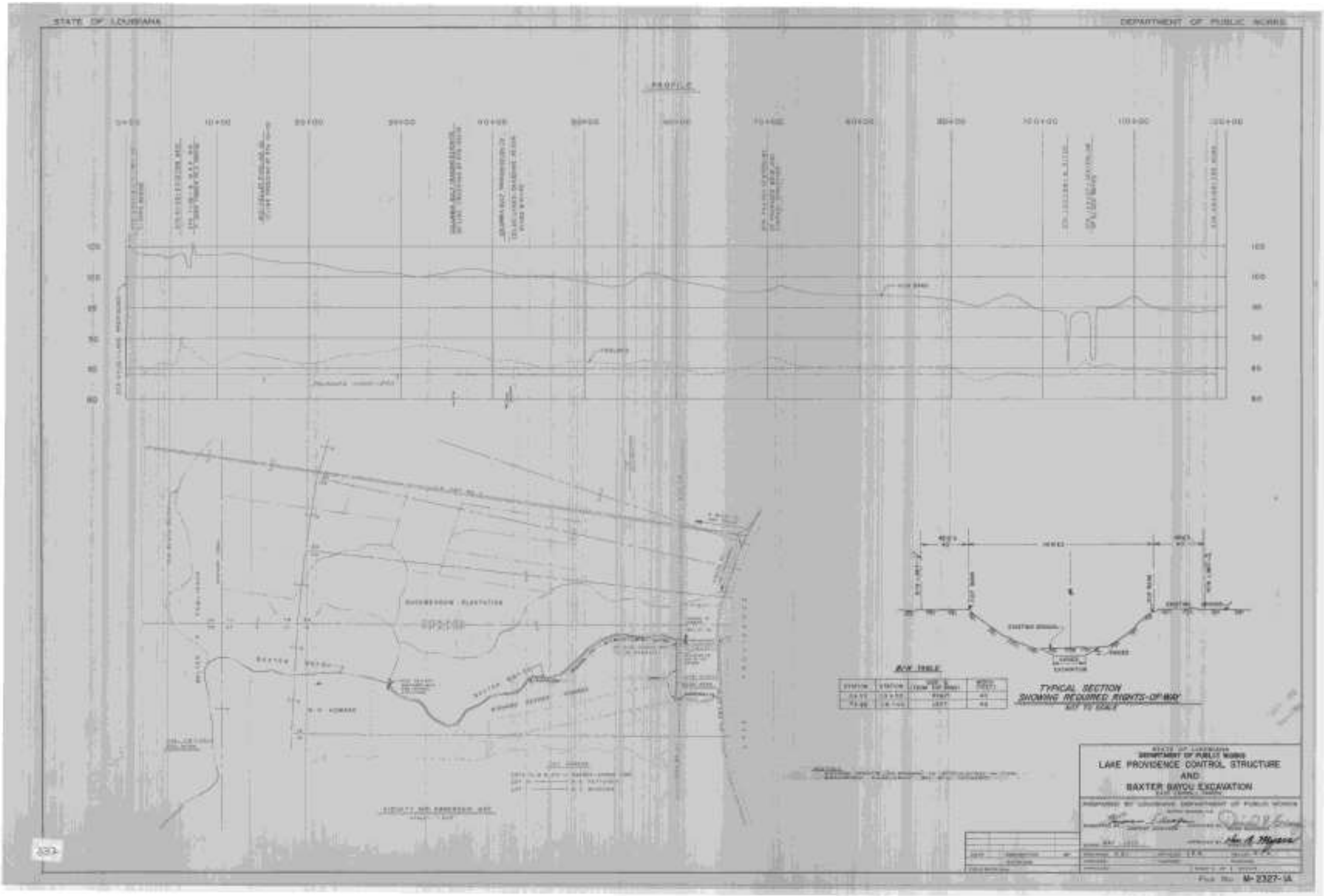
Lake Providence Control Structures Diagrams

(Source: LDOTD)

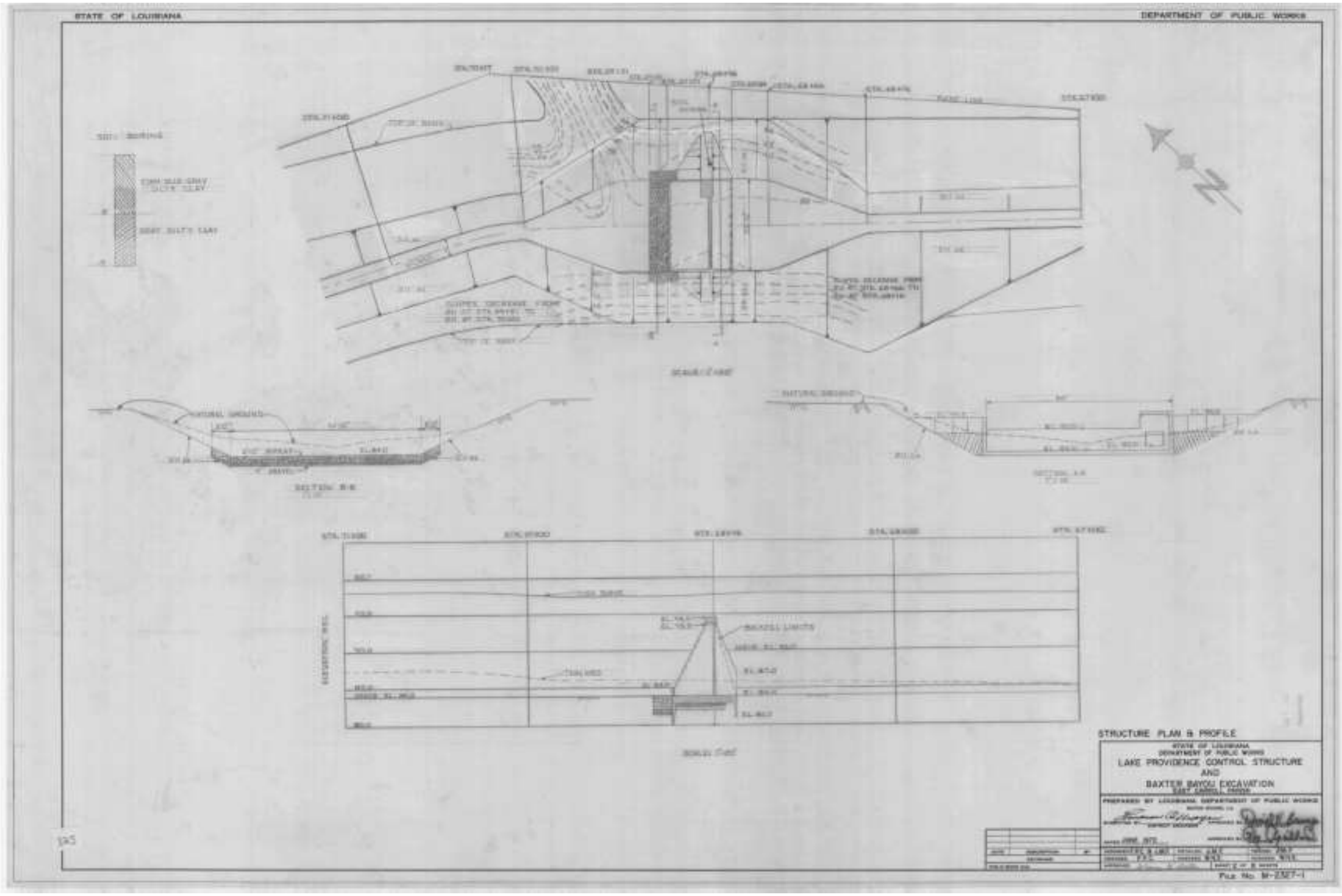


September 1975 proposed new Tensas Bayou structure (M-2976-1)

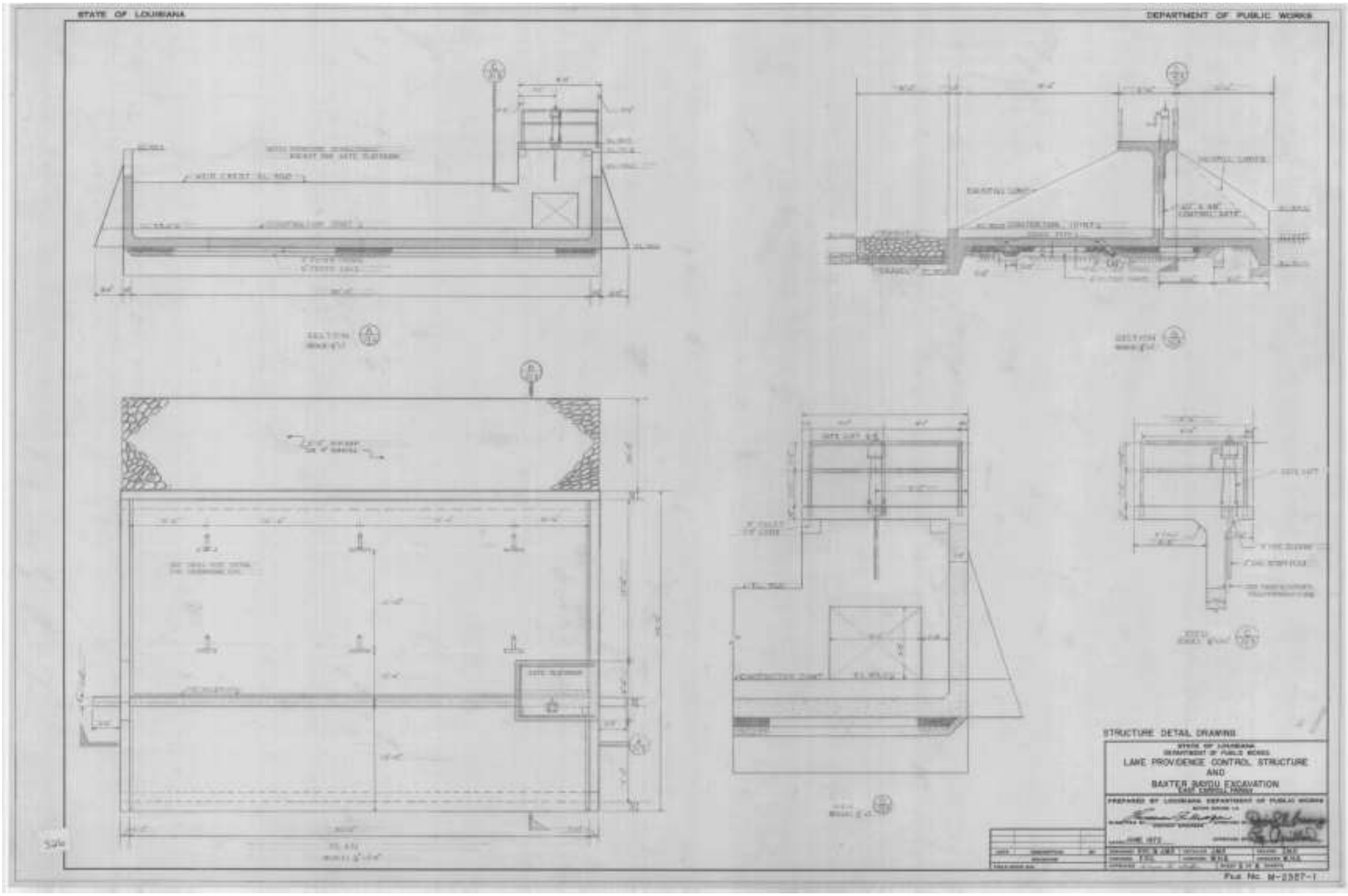
June 1972 plan (#1) for Baxter Bayou control Structure (M-2327-1)



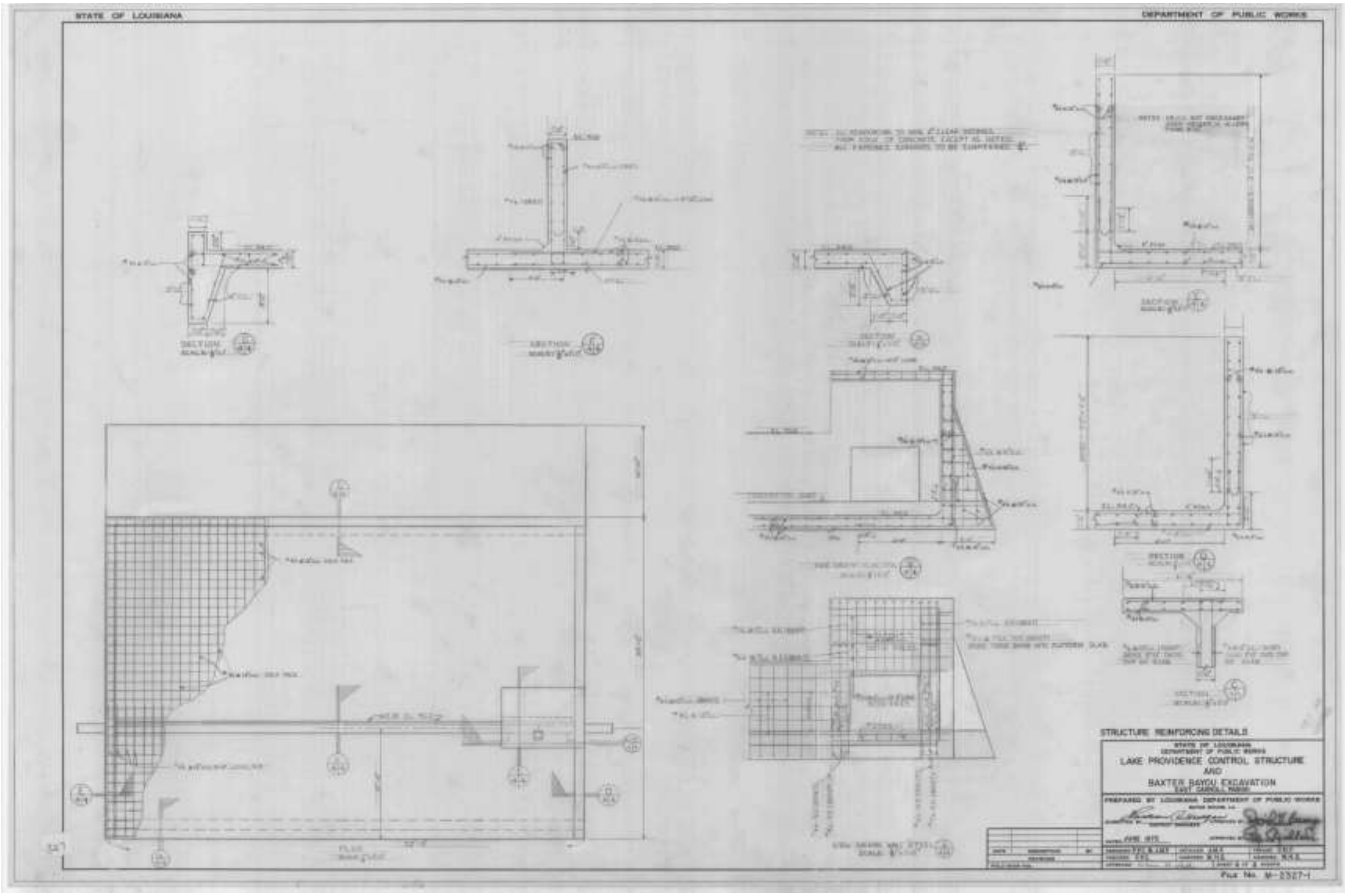
May 1972 plan for Baxter Bayou control Structure (M-2327-1A)



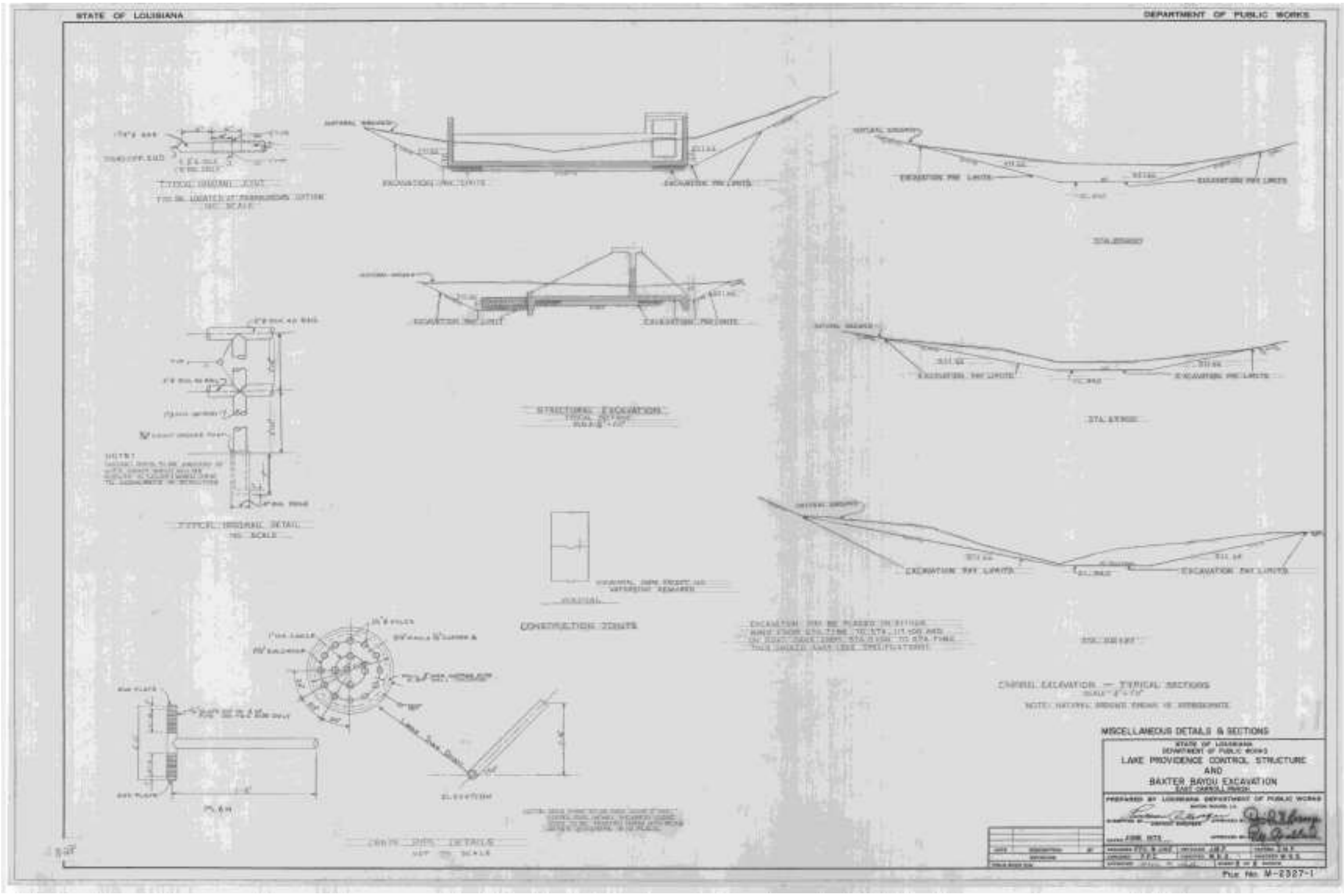
June 1972 plan (#2) for Baxter Bayou control Structure (M-2327-1)



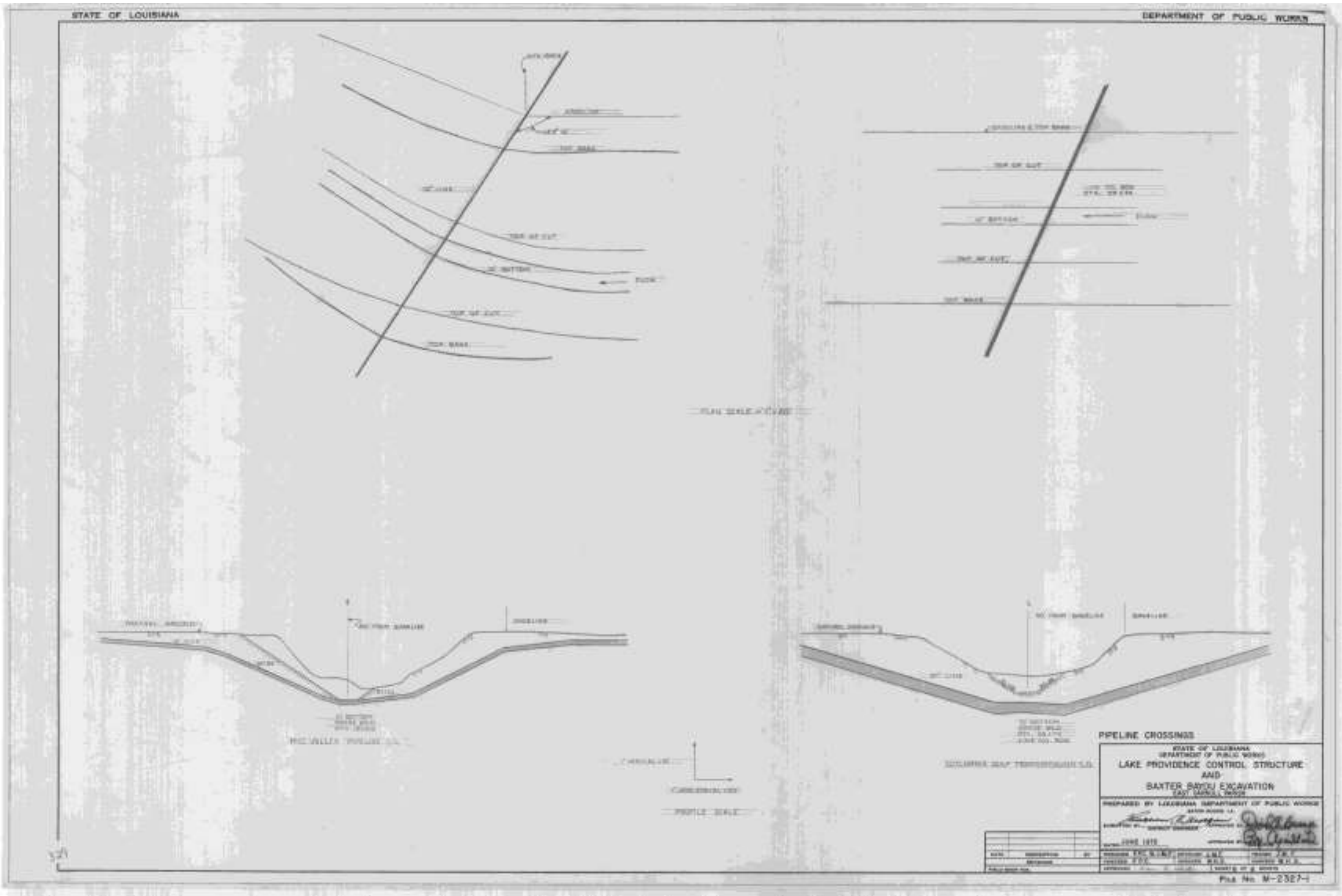
June 1972 plan (#3) for Baxter Bayou control Structure (M-2327-1)



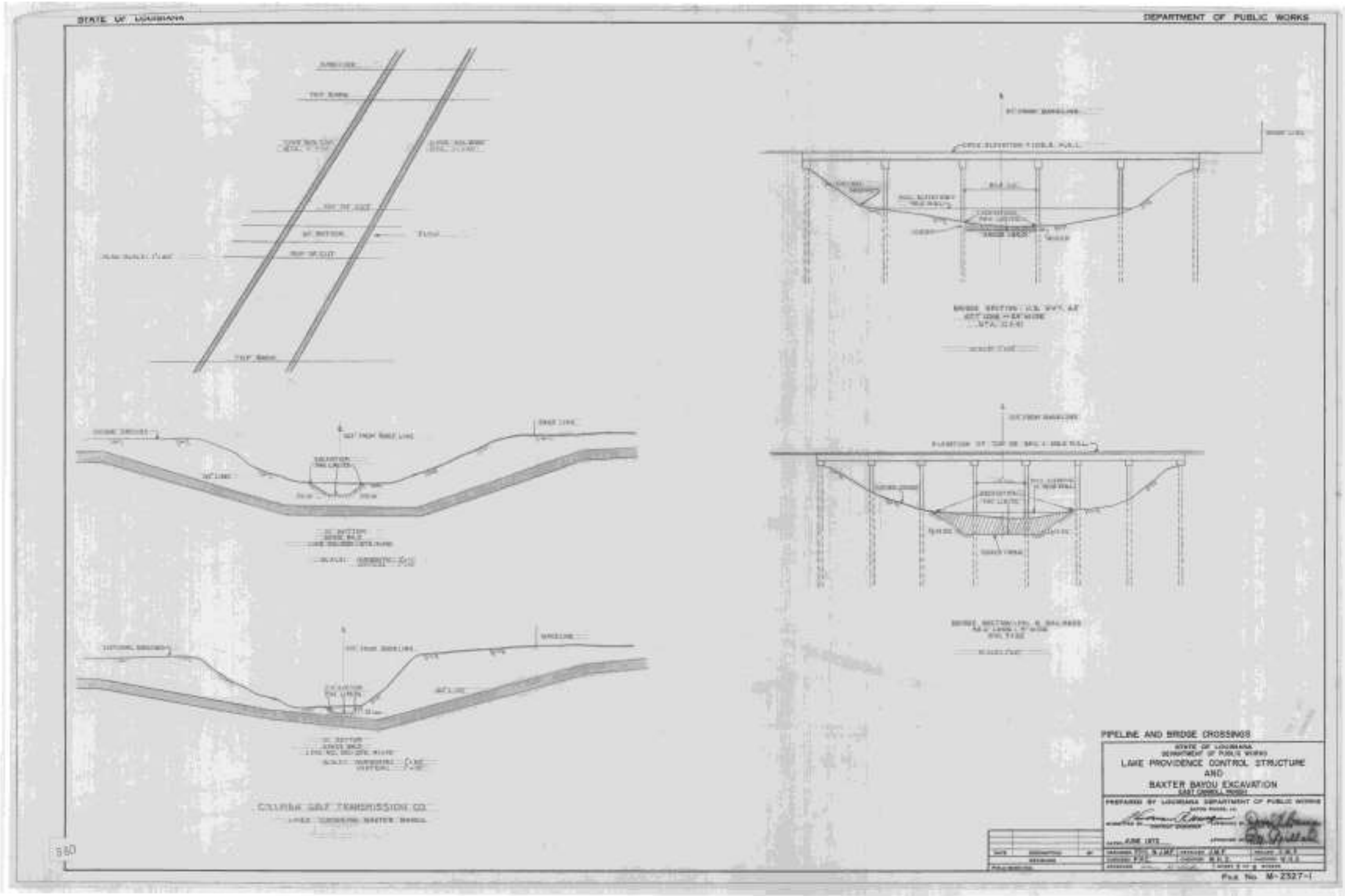
June 1972 plan (#4) for Baxter Bayou control Structure (M-2327-1)



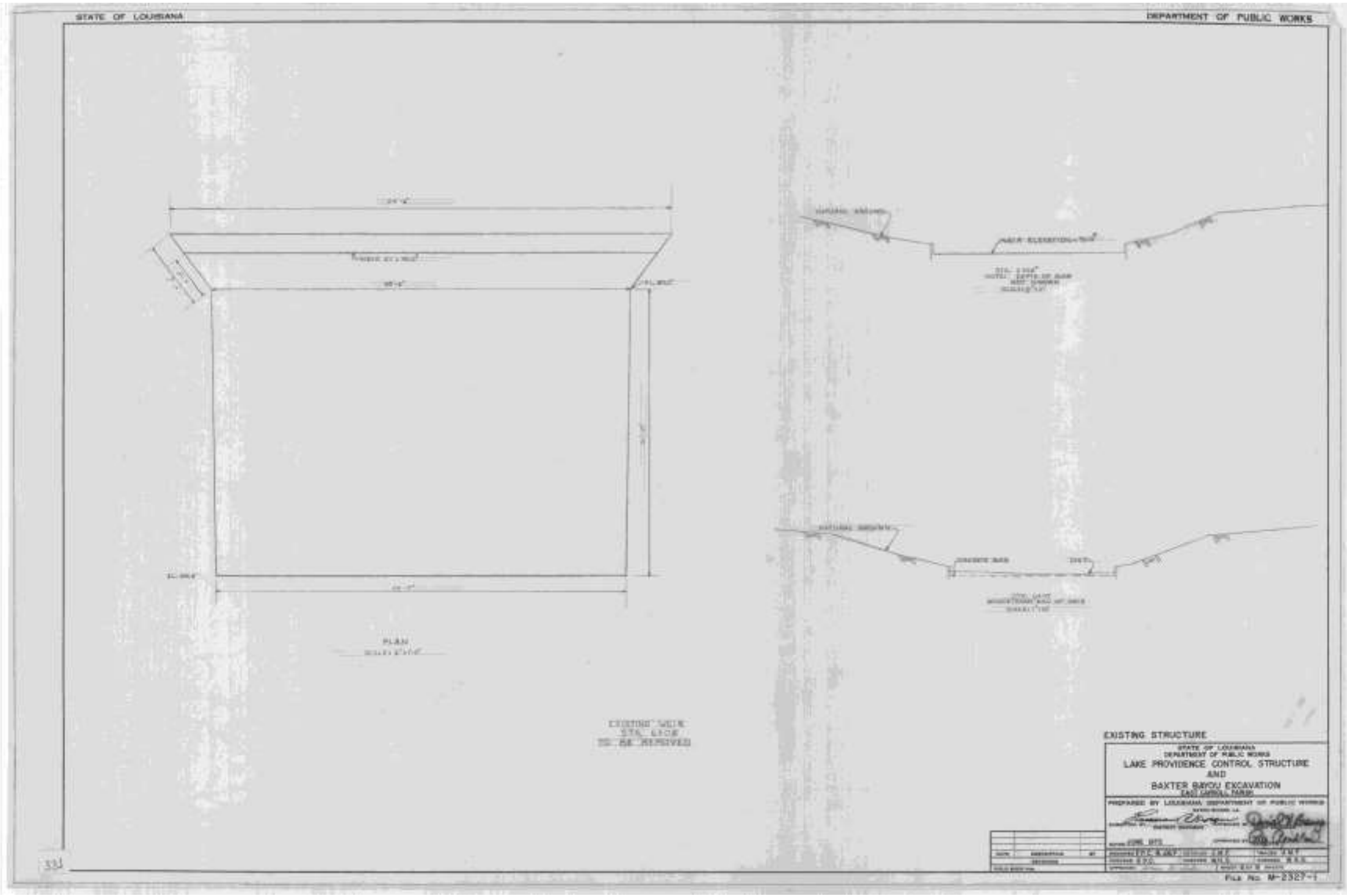
June 1972 plan (#5) for Baxter Bayou control Structure (M-2327-1)



June 1972 plan (#6) for Baxter Bayou control Structure (M-2327-1)



June 1972 plan (#7) for Baxter Bayou control Structure (M-2327-1)



June 1972 plan (#8) for Baxter Bayou control Structure (M-2327-1)

Appendix C

September 2008 Hurricane Gustav Flooding Damage Photographs

Photographs courtesy of Mr. Reynold Minsky

Photograph C1: Hurricane Gustav. Residence on Schneider Lane, Lake Providence, across the street from Lake Providence Byerley Airport

Photograph C2: Sept 2008 Hurricane Gustav. Airport boat landing on Schneider Lane, Lake Providence. The launch is totally submerged and covered tables for public are under water.

Photograph C3: Sept 2008 Hurricane Gustav. Residence on Schneider Lane, Lake Providence

Photograph C4: Sept 2008 Hurricane Gustav. Lake House on Island Point Drive, Lake Providence

Photograph C5: Sept 2008 Hurricane Gustav. Lake House on Island Point Drive, Lake Providence

Photograph C6: Sept 2008 Hurricane Gustav. Lake House on Island Point Drive, Lake Providence

Appendix D

March 2016 Flooding Damage Photographs

Photographs taken 3/12/2016 courtesy of Mr. Reynold Minsky

Photograph D1: Flooding at a residence on Island Point drive, Lake Providence

Photograph D2: Flooding at a residence on Island Point drive, Lake Providence

Photograph D3: Flooding at a residence on Island Point drive, Lake Providence

Photograph D4: Flooding at a residence on Riddle lane, Lake Providence

Photograph D5: Flooding at another residence on Island Point drive, Lake Providence

Photograph D6: Flooding at a residence on Island Point drive, Lake Providence

Photograph D7: Flooding at a residence on Island Point drive, Lake Providence

Photograph D8: Flooding at another residence on Island Point drive, Lake Providence

Photograph D9: Flooding at a residence on Island Point drive, Lake Providence

Photograph D10: Flooding at a residence on Island Point drive, Lake Providence

Photograph D11: Flooding at a residence on Schneider Lane, Lake Providence

Appendix E

March 2016 Flood Sediment Discharge Photographs

Photographs taken 3/9/2016 courtesy of Mr. Teddy Schneider

Figure E1: Photographs locator map

Photograph E1: Baxter Bayou outfall

Photograph E2: Baxter Bayou outfall. Note the sediment plume.

Photograph E3: Baxter Bayou outfall. Note water turbidity.

Photograph E4: Drainage ditch outfall south of Black Bayou

Photograph E5: Drainage ditch outfall south of Black Bayou

Photograph E6: Black Bayou outfall

Photograph E7: Jack Falls Bayou outfall

8

Photograph E8: Bayou Providence outfall

Photograph E9: Drainage ditch flowing into Bayou Providence

Photograph E10: Sediment flowing into the Chute (looking N-NW)

Photograph E11: Sediment flowing into the Chute (Looking N-NW)

Photograph E12: Sediment flowing into the Chute (Looking S-SE)

Photograph E13: Lake Providence (Looking N-NW)

Photograph E14: Lake Providence (Looking N-NW)

Photograph E15: Lake Providence (Looking W at an unnamed drainage ditch)

Photograph E16: Lake Providence (Looking W at an unnamed drainage ditch)

Photograph E17: Surface water runoff from tilled fields near the North Flat

Photograph E18: Rill erosion near the North Flat

Photograph E19: Eroded sediment from a tilled field flowing across Lakeside Drive

Photograph E20 : Sediment laden water flowing toward the North Flat

Photograph E21: Field with winter cover crop. Note water clarity.

Photograph E22: Field with winter cover crop. Note water clarity.

Photograph E23: Field with winter cover crop

Appendix F

Lake Providence Shoreline Photographs

Photographs courtesy of Mr. Jim Lensing

Photograph F1: Airport boat launch

Photograph F2: Tensas Bayou boat launch

Photograph F3: Piers and boathouses on east side of the lake

Photograph F4: Common boatlifts found throughout the lake

Photograph F5: Old swimming pier where the new LGS data gage has been installed

Photograph F6: View of the underside of the US Highway 65 bridge toward Tensas Bayou

Photograph F7: Pier located on Tensas Bayou

Photograph F8: Cypress tree shoreline on Tensas Bayou

Photograph F9: Pier located on Tensas Bayou

Photograph F10: Tensas Bayou

Photograph F11: Tensas Bayou which turns into Tensas River 9 miles south of this point

Photograph F12: Tensas Bayou which turns into Tensas River nine miles south of this point (same view of previous picture from the road)

Photograph F13: Weir located on Tensas Bayou

Photograph F14: Bulkhead across from airport landing on Chute

Photograph F15: Bulkhead located on inner east side of lake

Photograph F16: Bulkhead and riprap located on inner east side of lake

Photograph F17: Bulkhead located on inner east side of lake

Photograph F18: Riprap revetment located on inner east side of lake

Photograph F19: Bulkhead located on inner east side of lake

Photograph F20: Riprap revetment located on inner east side of lake

Photograph F21: Riprap revetment located along U.S. Highway 65 on western side of the lake

Photograph F22: Erosion located along U.S. Highway 65 (in order to give you a reference the truck pictured is driving down the highway)

Photograph F23: Riprap revetment along U.S. Highway 65

Photograph F24: Cypress tree shoreline on U.S. Highway 65 along western side of the lake

Photograph F25: Cypress tree shoreline on U.S. Highway 65 by cemetery

Photograph F26: Cypress tree shoreline along U.S. Highway 65 close to Grant's Canal showing high water marks on the trees.

Photograph F27: Baxter Bayou Bridge along U.S. Highway 65

Photograph F28: Drainage that comes into lake from the northern most point

Photograph F29: North Flat

Appendix G

Water Quality Best Management Practices

Cropland Best Management Practices (1)- Sediment Concerns in Surface Water

Favorable BMPs (2)	Effectiveness of Favorable BMPs	Crops(3)	Practices Which May Be Unfavorable (4)
Mulch Till	slight	1, 2, 4-6	Land clearing
No Till	moderate	1, 2, 4-6	
Ridge Till	slight-moderate	1,-3, 5, 6	Access roads
Contour farming	moderate	1,2,5,6	Clearing & snagging
Grassed waterway	slight-moderate	1-6	
Residue Mgt., Seasonal	slight	1-6	
Grade stab strut.	slight-moderate	1-6	
Cons. crop. rot.	slight-moderate	1-6	
Waste utilization	na	1-6	
Irrig.Water mgt. (5)	moderate	1-6	
Tailwater rec. (5)	slight	1-6	
Irrig. system (5)	na	1-6	
Struct. water cont.	slight	1-6	
Water & sed. basin	moderate-substantial	1,2,5,6	
Sediment basin	substantial	1,2,5,6	
Irrig. leveling (5)	slight	1-6	
Field border	slight-moderate	1, 2, 5, 6(6)	
Cover crop	slight-moderate	1-6	
Deep Tillage	slight-moderate	1-6	
Filter strips/buffers	substantial	1, 2, 4-6(6)	
Diversion	medium	1,2,5,6	

PROBLEM: Sediment in a water body can smother organisms, interfere with photosynthesis by reducing light penetration, and may fill in waterways, hindering navigation and increasing flooding. Sediment particles often carry nutrients, pesticides, and other organic compounds into water bodies. Sediments can be resuspended in a water column and act as an uncontrolled source of pollution.

PROCESSES: Soil movement in water.

CAUSES: Precipitation on unprotected soil, flowing runoff water, and irrigation water applied at erosive rates.

1. There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed.
2. This list is not ranked in an order, which would indicate preference in installation.
3. 1 = cotton, 2 = soybeans, 3 = sugarcane, 4 = rice, 5 = corn, 6 = truck crops.
4. An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed.
5. Irrigated fields.
6. Fields not artificially drained.

CROPLAND BEST MANAGEMENT PRACTICES (1) - Pesticide Concerns in Surface Water

Favorable BMPs (2)	Favorable BMPs for: Soluble P/Adsorbed P	Crops(3)	Practices Which May Be Unfavorable (4)
Pest management	Sub Substantial	1-6	Land clearing
Irrig.Water mgt. (5)	Slight Substantial	1-6	Surface drainage(6)
Tailwater rec. (5)	slight moderate	1-6	Subsurface drain (6)
Land leveling (5)	slight moderate	1-6	
Irrig. system (5)	slight substantial	1-6	
Struct. water cont.	na na	1-6	
Field border	slight moderate	1-6(9)	
Cover crop	slight moderate	1-6	
Deep Tillage	slight substantial	1-6	
Cons. crop. rot.	slight moderate	1-6	
Mulch till	mod substantial	1, 2, 4-6	
No till	mod substantial	1, 2, 4-6	
Ridge Till	mod substantial	1-6	
Crop residue, Seasonal	slight moderate	1-6	
Grade stab. struct.	na na	1-6	
Water & sed. basin	slight moderate	1,2,5,6	
Terrace	slight substantial	1,2,5,6	
Sediment basin	slight moderate	1,2,5,6	
Filter strip/buffers	slight substantial	1-6(9)	
Contour farming	slight moderate	1,2,5,6	
Strip-cropping	slight moderate	1,2,5,6	
Diversion	slight slight	1,2,5,6	
Channel vegetation	na na	1-6 (7)	
Grassed waterway	slight moderate	1-6 (7)	

PROBLEM: Pesticides by their nature are toxic substances. Many are highly toxic to fish, other aquatic fauna, and warm-blooded animals. Some persist in the aquatic environment for long periods of time so that even at very low level concentrations, they are a serious environmental concern in runoff water.

PROCESSES: Runoff of soluble pesticides in water and movement of pesticides combined with soil and organic matter from site.

CAUSES: Excess pesticide, applied pesticides with affinity for soil and organic matter, persistent pesticides, runoff water and interflow, excess irrigation water, improper pesticide application or irrigation timing, and improper mixing and handling of pesticides and pesticide containers.

1. There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effect on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed.
2. This list is not ranked in an order, which would indicate preference in installation.
3. 1 = cotton, 2 = soybeans, 3 = sugarcane, 4 = rice, 5 = corn, 6 = truck crops.
4. An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed.
5. Irrigated fields.
6. Where water table control or regulating water in drainage systems is not applied.
7. Chemical maintenance of vegetation may adversely affect the quality of runoff water.
8. Where drainage practices already exist.
9. Fields not artificially drained.

CROPLAND BEST MANAGEMENT PRACTICES (1) - Nutrient Concerns in Surface Water

Favorable BMPs (2)	Favorable BMPs for: Soluble N/Adsorbed N	Crops(3)	Practices Which May Be Unfavorable (4)
Nutrient Mgt.	substantial	1-6	Land clearing
Waste utilization	slight moderate	1-6	Surface drainage(6)
Irrig.Water mgt. (5)	Slight substantial	1-6	Subsurface drain (6)
Tailwater rec. (5)	slight moderate	1-6	
Land leveling (5)	slight moderate	1-6	
Irrig. system (5)	slight substantial	1-6	
Struct. water cont.	na na	1-6	
Field border	slight moderate	1-6(8)	
Cover crop	slight moderate	1-6	
Deep tillage	slight substantial	1-6	
Cons. crop. rot.	slight moderate	1-6	
Mulch till	slight moderate	1, 2, 4-6	
No till	slight slight	1, 2, 4-6	
Ridge till	slight slight	1-6	
Crop residue, Seasonal	slight slight	1-6	
Grade stab. struct.	na na	1-6	
Water & sed. basin	slight moderate	1,2,5,6	
Terrace	slight moderate	1,2,5,6	
Sediment basin	substantial	1,2,5,6	
Filter strips/buffers	substantial	1-6(8)	
Contour farming	slight substantial	1,2,5,6	
Strip-cropping	Slight substantial	1,2,5,6	
Diversion	na na	1,2,5,6	
Channel vegetation	na na	1-6 (7)	
Grassed waterway	slight moderate	1-6 (7)	

PROBLEM: Excess nitrogen and phosphorus in a water body causes excessive plant and alga growth, an imbalance of natural nutrient cycles, and a decline in the number of desirable fish species. High nitrate levels can be hazardous to warm-blooded animals under conditions that are favorable to reduction to nitrite.

PROCESSES: Runoff of soluble nitrogen and phosphorus in water and movement of nitrogen and phosphorus combined with soil and organic matter from site.

CAUSES: Excess amounts of surface-applied nitrogen and phosphorus, runoff water and interflow, improperly managed irrigation systems, and erosion of soil and organic wastes.

1. There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed.
2. This list is not ranked in an order, which would indicate preference in installation.
3. 1 = cotton, 2 = soybeans, 3 = sugarcane, 4 = rice, 5 = corn, 6 = truck crops.
4. An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed.
5. Irrigated fields.
6. Where water table control or regulating water in drainage systems is not applied.
7. Chemical maintenance of vegetation may adversely affect the quality of runoff water.
8. Fields not artificially drained.
9. Where drainage practices already exist.

CROPLAND BEST MANAGEMENT PRACTICES (1) - Minerals or Salinity Concerns in Surface Water

Favorable BMPs (2)	Effectiveness of Favorable BMPs	Crops(3)	Practices Which May Be Unfavorable (4)
Irrig.Water mgt. (5)	slight-moderate	1-6	Land clearing
Tailwater rec. (5)	slight	1-6	Surface drainage(6)
Water convey. (5)	slight	1-6	Subsurface drain (6)
Land leveling (5)	neutral	1-6	
Irrig. system (5)	slight-substantial	1-6	
Deep Tillage	slight-moderate	1-6	
Cons. crop. rot.	slight-moderate	1-6	
Waste utilization	slight-moderate	1-6	

PROBLEM: Excessive concentrations of salts/minerals in surface waters can render the waters unfit for human and animal consumption and impair the growth of plants. It can also reduce or restrict the water's value for industrial use, irrigation and for propagation of fish and wildlife. The toxic effect of certain chemicals can be enhanced in saline waters, and the saturation levels of dissolved oxygen decrease with increasing salinity. Excessive salts can adversely alter the permeability of soils. The U.S. Public Health Service has established the maximum allowable concentrations of chlorides and sulfates in water for human consumption at 250 mg/l each. Excessive salt intake can produce minor to serious effects.

PROCESSES: Natural processes and movement (surface runoff and interflow) of dissolved minerals and salts from soil and organic waste by irrigation or storm water.
CAUSES: High content of minerals and salt concentration in soil and underlying geology, excess irrigation water, high content of minerals and salt concentration in irrigation water, and over-application of waste with high salt content.

1. There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed.
2. This list is not ranked in an order, which would indicate preference in installation.
3. 1 = cotton, 2 = soybeans, 3 = sugarcane, 4 = rice, 5 = corn, 6 = truck crops.
4. An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed.
5. Irrigated fields.
6. Where water table control or regulating water in drainage systems is not applied.
7. Where drainage practices already exist.

CROPLAND BEST MANAGEMENT PRACTICES (1) - Organic Matter & Bacteria Concerns in Surface Water

Favorable BMPs (2)	Effectiveness of Favorable BMPs for: Oxy. Demand/Bacteria	Crops(3)	Practices Which May Be Unfavorable (4)
Waste utilization	Slight neutral	1-6	Land clearing
Struct. water cont.	na na	1-6	Surface drainage(6)
Field border	mod slight	1, 2, 5, 6(7)	Subsurface drain (6)
Filter strips/buffers	sub slight	1, 2, 5, 6(7)	
Terrace	mod moderate	1,2,5,6	
Contour farming	mod slight	1,2,5,6	
Strip-cropping	mod slight	1,2,5,6	
Water & sed. basin	mod slight	1,2,5,6	
Sediment basin sub	mod	1,2,5,6	
Diversion	neutral slight	1,2,5,6	
Irrig Water mgt. (5)	slight substantial	1-6	
Irrig. system (5)	slight slight	1-6	
Deep tillage	slight slight	1-6	

PROBLEM: Animal waste and crop debris are the major organic pollutants resulting from agricultural activities. They place an oxygen demand on receiving waters during decomposition, which can result in stress or the death of fish and other aquatic species. Certain bacteria can cause disease in humans such as infectious hepatitis, typhoid fever, dysentery, and other forms of diarrhea.

PROCESSES: Movement of organic waste, bacteria, and organic matter in soil from the site and excess irrigation water.

CAUSES: Over-application of waste or irrigation water, application of waste on unsuitable sites, improper timing of waste or irrigation application, and storm runoff.

1. There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed.
2. This list is not ranked in an order, which would indicate preference in installation.
3. 1 = cotton, 2 = soybeans, 3 = sugarcane, 4 = rice, 5 = corn, 6 = truck crops.
4. An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed.
5. Irrigated fields.
6. Where water table control or regulating water in drainage systems is not applied.
7. Fields not artificially drained.
8. Where drainage practices already exist.

BEST MANAGEMENT PRACTICES (1) - Sediment Concerns in Surface Water

Favorable BMPs (2)	Effectiveness of Favorable BMPs	Practices Which May Be Unfavorable (3)
Pasture & hayland planting	substantial	Land clearing
Irrigation water management (4)	substantial	
Critical area planting	substantial	
Use Exclusion (5)	na	
Fencing (6)	neutral	
Prescribed Grazing	substantial	
Mechanical Forage Harvest	moderate	
Irrigation water conveyance (4)	moderate	
Appropriate irrigation system (4)	moderate	
Filter strip/buffer	moderate	
Pond (6)	slight-substantial	
Well (6)	na	
Spring development (6)	slight	
Pipeline (6)	na	
Brush management	slight	

PROBLEM: Sediment in a water body can smother benthic organisms, interfere with photosynthesis by reducing light penetration, and may fill in waterways, hindering navigation and increasing flooding. Sediment particles often carry nutrients and pesticides and other organic compounds into water bodies. Sediments can be resuspended in a water column and act as an uncontrolled source of pollution.

PROCESS: Movement of sediment from site.

CAUSES: Concentration of livestock in or near watercourses leading to instability and overuse of vegetation.

1. There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed.
2. This list is not ranked in an order, which would indicate preference in installation.
3. An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed.
4. Irrigated fields.
5. To exclude livestock from streams.
6. To distribute grazing.

PASTURELAND BEST MANAGEMENT PRACTICES (1) - Nutrient Concerns in Surface Water

Favorable BMPs (2)	Effectiveness of Favorable BMPs for: Soluble N./ Adsorbed N.	Practices Which May Be Unfavorable (3)
Nutrient management	substantial	Subsurface drain (4)
Waste Utilization	substantial	Subsurface drain (4)
Irrigation water management (5)	substantial	
Pasture & hayland planting	substantial	
Use Exclusion (6)	neutral	
Pond	slight-moderate	
Buffers	slight-substantial	
Fencing (7)	neutral	
Well (7)	na	
Pipeline (7)	na	
Prescribed Grazing	moderate	
Forage harvest mgt.	slight-moderate	
Spring development	na	

PROBLEM: Excess nitrogen and phosphorus in a water body causes excessive plant and algae growth, an imbalance of natural nutrient cycles, and a decline in the number of desirable fish species. High nitrate levels can be hazardous to warm-blooded animals under conditions that are favorable to reduction to nitrite.

PROCESSES: Runoff of soluble nitrogen and phosphorus in water and movement of nitrogen and phosphorus combined with soil and organic matter from site.

CAUSES: Excess surface applied nitrogen and phosphorus, runoff water and interflow, erosion of soil and organic waste, cattle congregating in or near streams, and excess irrigation water application beyond root zone.

1. There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed.
2. This list is not ranked in an order, which would indicate preference in installation.
3. An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed.
4. Where water table control or regulating water in drainage systems is not applied.
5. Irrigated fields.
6. To exclude livestock from streams.
7. To distribute grazing.

PASTURELAND BEST MANAGEMENT PRACTICES (1) - Pesticide Concerns in Surface Water

Favorable BMPs (2)	Effectiveness of Favorable BMPs for: Soluble P./ Adsorbed P.	Practices Which May Be Unfavorable (3)
Pasture & hayland planting	substantial	Subsurface drain (4)
Irrigation water management (5)	substantial	Surface drainage (4)
Prescribed grazing	moderate	
Forage harvest management	slight-moderate	
Filter strips/buffers	moderate	
Pest Management	substantial	

PROBLEM: Pesticides by their nature are toxic substances. Many are highly toxic to fish, other aquatic fauna, and warm-blooded animals. Some persist in the aquatic environment for long periods of time so that even at very low concentrations, they are a serious environmental concern in runoff water.

PROCESSES: Runoff of soluble pesticides in water and movement of pesticides combined with soil and organic matter from site.

CAUSES: Excess pesticide, applied pesticides with affinity for soil and organic matter, persistent pesticides, runoff water and interflow, improper pesticide application and/or timing, improper mixing and handling of pesticides and pesticide containers, and excess irrigation water application beyond root zone.

1. There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed.
2. This list is not ranked in an order, which would indicate preference in installation.
3. An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed.
4. Where water table control or regulating water in drainage systems is not applied.
5. Irrigated fields.

PASTURELAND BEST MANAGEMENT PRACTICES (1) - Organic Matter & Bacteria Concerns in Surface Water

Favorable BMPs (2)	Effectiveness of Favorable BMPs for: Oxygen Demand/ Bacteria	Practices Which May Be Unfavorable (3)
Waste utilization	mod neutral	Surface drainage (4)
Pond	slight sl. worsening	Subsurface drain (4)
Nutrient management	Sub slight	
Use Exclusion (5)	slight-moderate	
Fencing (6)	neutral	
Filter strip/buffers	sub. slight	
Prescribed grazing	slight	
Forage harvest mgt.	slight	
Pasture and hayland planting	slight	
Well (6)	na	
Pipeline (6)	na	
Spring development (6)	na slight	
Irrigation water management (7)	slight substantial	

PROBLEM: Animal waste and plant debris is the major organic pollutant from pastureland. They place an oxygen demand on receiving waters during decomposition, which can result in stress or the death of fish and other aquatic species. Certain bacteria can cause disease in humans such as infectious hepatitis, typhoid fever, dysentery, and other forms of diarrhea.

PROCESS: Movement of organic waste, bacteria, and organic matter in soil and water from the site.

CAUSES: Over application of waste, application of waste on unsuitable sites, improper timing of waste application, storm runoff, and concentration of livestock in or near watercourses.

1. There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed.
2. This list is not ranked in an order, which would indicate preference in installation.
3. An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed.
4. Where water table control or regulating water in drainage systems is not applied.
5. To exclude livestock from streams.
6. To distribute grazing.
7. Irrigated fields.

PASTURELAND BEST MANAGEMENT PRACTICES (1) - Minerals or Salinity Concerns in Surface Water

Favorable BMPs (2)	Effectiveness of Favorable BMPs	Practices Which May Be Unfavorable (3)
Irrigation water management (4)	slight-moderate	Land clearing
Nutrient management	slight	Subsurface drain (5)
Irrigation water conveyance (4)	slight	Surface drainage (5)
Irrigation system (4)	neutral to moderate	
Forage harvest management	slight	
Prescribed grazing	slight-moderate	
Waste utilization	slight-moderate	

PROBLEM: Excessive concentrations of salts/minerals in surface waters can render the waters unfit for human and animal consumption and impair the growth of plants. It can also reduce or restrict the water's value for industrial use, irrigation and for propagation of fish and wildlife. The toxic effect of certain chemicals can be enhanced in saline waters. Excessive salts can adversely alter the permeability of soils. The U.S. Public Health Service has established the maximum allowable concentrations of chlorides and sulfates in water for human consumption at 250 mg/l each. Excessive salt intake can produce minor to serious effects.

PROCESSES: Natural processes, movement of organic waste, sheet flow from surface runoff and interflow from ground water as influenced by human activities.

CAUSES: High content of minerals and salt concentration in soil and underlying geology, over application of waste with high salinity content, movement of minerals and salinity in soil from the site by precipitation runoff and interflow (saline seeps), high content of minerals and salt concentration in irrigation water, and excess irrigation water.

1. There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed.
2. This list is not ranked in an order, which would indicate preference in installation.
3. An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed.
4. Irrigated fields.
5. Where water table control or regulating water in drainage systems is not applied.

PASTURELAND BEST MANAGEMENT PRACTICES (1) - Minerals or Salinity Concerns in Ground Water

Favorable BMPs (2)	Effectiveness of Favorable BMPs	Practices Which May Be Unfavorable (3)
Irrigation water management (4)	slight-substantial	Irr. field ditch (4)
Surface drainage	slight-moderate	Irr. canal/lateral (4)
Subsurface drain	slight-moderate	Soil salinity mgt
		Toxic salt reduction
Irrigation conveyance (4)	slight	
Irrigation system (4)	slight-moderate	
Nutrient management	slight	
Waste utilization	slight-moderate	
Prescribed grazing	slight	
Forage harvest mgt.	slight	
Pasture/hayland planting	slight	
Fencing	neutral	
Pond	na	
Spring development	na	
Pipeline	na	

PROBLEM: Excessive concentrations of salts/minerals can render ground water unfit for human and animal consumption. It can reduce or restrict the water's value for industrial and municipal use and irrigation. The toxic effect of certain chemicals can be enhanced in saline waters, and the saturation levels of dissolved oxygen decreases with increasing salinity. The U. S. Public Health Service has established the maximum allowable concentrations of chlorides and sulfates in water for human consumption at 250 mg/l each. Excessive salt intake can produce minor to serious effects.

PROCESSES: Natural processes and leaching of minerals or salt concentrations.

CAUSES: Naturally occurring, excess water moving downward from human activity of concentrating water or changing evapotranspiration, and irrigation water contains high concentration of dissolved solids.

1. There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed.
2. This list is not ranked in an order, which would indicate preference in installation.
3. An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed.
4. Irrigated fields.

Appendix H

Commodity Manual Best Management Practices

Beef Cattle Best Management Practices

http://www.lsuagcenter.com/NR/rdonlyres/55BE3063-E11C-483E-BF86-40DB68705270/87569/pub2884beefbmppubLOWRES.pdf

Agronomic Crops Best Management Practices

http://www.lsuagcenter.com/NR/rdonlyres/CB67F3CD-CE73-4C39-B6E4-52F772F970CF/84012/pub2807AgronomicCropsBMPLOWRES.pdf

Sugarcane Best Management Practices

http://www.lsuagcenter.com/NR/rdonlyres/27AA7189-F3AC-4FEA-A51D-E5D8E2B16505/82493/pub2833_SugarcaneBMP.pdf

Outreach efforts have been developed to address residential nonpoint source pollution. The La Yards and Neighborhoods Program was developed by the LSU AgCenter to encourage homeowners to create and maintain landscapes in ways that minimize environmental damage/impact through educational programs and outreach activities. This program can be offered to residents of the Lake Providence community. The program link as well as home source best management practice manuals are below:

http://www.lsuagcenter.com/NR/rdonlyres/BC916876-1D8F-4F4D-83FC-F86A1BE5DDF4/57407/Pages17.pdf

Home Source Best Management Practices

http://www.lsuagcenter.com/NR/rdonlyres/3A849060-4119-48B7-9771-A0DE16A6A623/39935/Pub2994NPSmanual2.pdf