CADDO PARISH REGIONAL WATER/ UTILITY DISTRICT
MASTER PLAN
FINAL REPORT

Phase VI - Economic Evaluation of Alternatives for Toldeo Bend, Caddo Lake, and the Red River, Caddo Parish, Shreveport, Louisiana

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Project No. 149677
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Phase VI Economic Evaluation of Alternatives for Toledo Bend, Caddo Lake, and the Red River

1.0 Phase VI Introduction

1.1 General Overview

As discussed in previous phases, the purpose of this Regional Water/Utility District Master Plan (Master Plan) is to provide Caddo and Bossier Parish officials with a comprehensive planning document. The Plan is composed of different phases, five of which have previously been completed by Shaw Environmental & Infrastructure, Inc. (a CB&I Company) and are listed below.

- Phase I - Identify and Define Existing Water Resources
- Phase II - Identify and Evaluate Existing Water Supply Infrastructure
- Phase III - Development and Evaluation of Future Growth Scenarios
- Phase IV - Feasibility Watershed Analysis
- Phase V – Public Participation

As the next phase of the Master Plan, Phase VI – Economic Evaluation of Alternatives for Toledo Bend, Caddo Lake, and the Red River will examine and determine water supply options in Caddo and Bossier Parishes. Phase VI efforts will evaluate the feasibility of each of the water supply options by looking at the available supply and infrastructure required to transport water to customers.

1.2 Phase VI Scope

Phase VI efforts concentrated on providing a set of alternatives for review and comparison for Toledo Bend Reservoir, Caddo Lake, and the Red River as long-term water sources. To support these comparisons, Shaw developed five water supply strategies, considering the timing and locations of the projected need within the service area and potential sources of water supply. For each water supply strategy, a conceptual regional water distribution system was developed.

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Economic considerations such as new growth revenue, impact fees, rate increases, or taxing ability/incentives are discussed as options to fund water supply development options. Funding support from federal, state, and local levels was also reviewed considering cost sharing and partnering perspectives.

The five options considered included:

- Option 1 is serving all customers from Toledo Bend Reservoir
- Option 2 is serving all customers from the Red River
- Option 3 is serving northern Caddo and Bossier Parishes (District 1) from the Red River, central Caddo and Bossier Parishes (District 2) from Caddo Lake, and the southern portions of the parishes (District 3) from Toledo Bend Reservoir
- Option 4 is serving the central and northern portions of the parishes (Districts 1 and 2) from Caddo Lake and the southern portion of the parishes (District 3) from Toledo Bend Reservoir
- Option 5 is serving the central and northern portions of the parishes (Districts 1 and 2) from the existing treatment plants at Blanchard and Vivian and serving the southern portion of the parishes (District 3) from the Red River

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2.0 Population and Water Demands

2.1 Population and Water Demands by District

For the purposes of system development, the potential customers were divided into three districts:

- *District 1* consists of the northern portions of Caddo and Bossier Parishes and includes the cities of Plain Dealing and Hosston. There are 8 water supply systems in District 1. By 2035 this portion of the system is expected to serve a little less than 10,000 people.
- *District 2* includes suburban areas near Shreveport and Bossier City, Barksdale Air Force Base, and areas around Caddo Lake. There are 29 water supply systems in the district. By 2035 this portion of the system could serve almost 90,000 people.
- *District 3* consists of the southern portions of Bossier and Caddo Parishes. There are 24 water systems in the District. This area is expected to have about 19,500 people by 2035.

The proposed district boundaries are shown on Figure 2-1.

Population and water demands are important elements in the analysis of water systems. Population and water demand data for each customer by planning year were developed in Phase III of this study. For customers in Bossier Parish, a per capita usage of 140 gallons per capita per day (gpcd) was assumed. For customers in Caddo Parish, a per capita usage of 190 gpcd was assumed. The populations and water demands by planning year by district are summarized in Table 2-1 2-1. Tables 2-2, 2-3 and 2-4 show the demands by individual system. The average day and maximum day demands for each district were used to size treatment plants, delivery capacity and storage needs when developing conceptual designs for the regional system. For option 5, some customers in District 2 will be served by District 1.

Shreveport, Bossier City, and Blanchard Water System were not included in the water demand projections for District 2. It is assumed that these entities will continue to supply their own demands. In option 5, Blanchard Water System was included since it includes expanding the Blanchard water treatment plant, increasing 2035 maximum day demands by approximately 5.6 MGD.

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Table 2-1 Water Demand Summary

Average Day Water Demands (MGD)					
District	2015	2020	2025	2030	2035
1	1.20	1.28	1.37	1.45	1.54
2	10.66	11.42	12.17	12.94	13.74
3	2.84	3.00	3.16	3.31	3.46
Total	14.7	15.7	16.7	17.7	18.74
Maximum Day Water Demands (MGD)					
District	2015	2020	2025	2030	2035
1	2.40	2.57	2.73	2.90	3.07
2	21.32	22.84	24.35	25.88	27.49
3	5.67	6.01	6.32	6.62	6.92
Total	29.39	31.42	33.4	35.4	37.48

2.2 Current Water Sources

Bossier and Caddo Parish residents utilize both groundwater and surface water for their current water supply. Groundwater sources include the Red River Alluvial aquifer, the Upland Terrace aquifer, the Sparta aquifer, and the Carrizo-Wilcox aquifer. Surface water sources include the Red River, Caddo Lake, and Cross Lake. Detailed information on the existing water systems and their sources is provided in the Phase II report of the Caddo Parish Regional Water/Utility District Master Plan.

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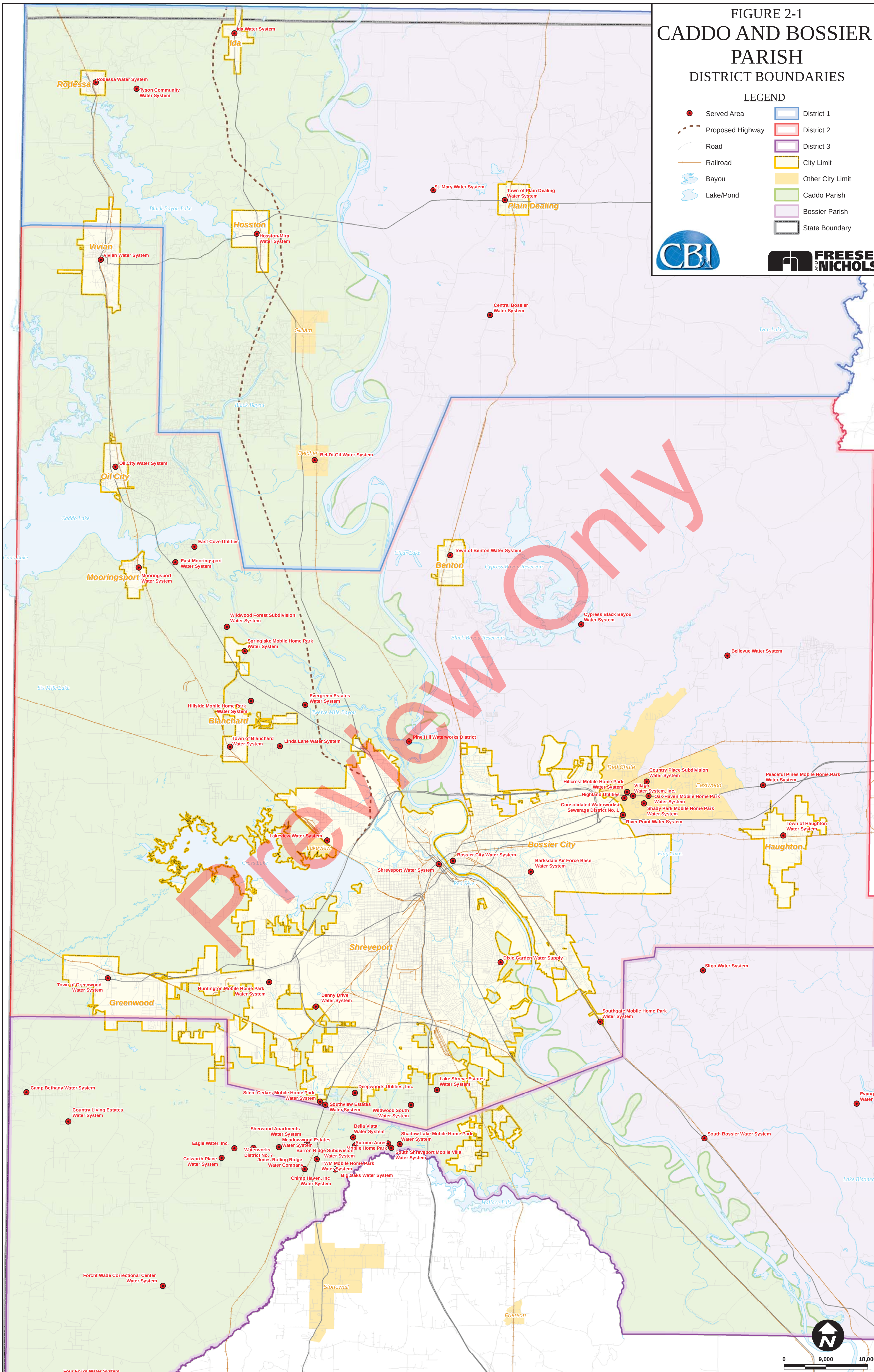

FIGURE 2-1
CADDO AND BOSSIER PARISH
DISTRICT BOUNDARIES

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Table 2-2 Population and Water Demand Projections for District 1

	Population					Average Day (MGD)					Peak Day (MGD)				
Water System Name	2015	2020	2025	2030	2035	2015	2020	2025	2030	2035	2015	2020	2025	2030	2035
Bossier Parish															
Plain Dealing Water System, Town of	3,041	3,301	3,567	3,846	4,145	0.43	0.46	0.50	0.54	0.58	0.85	0.92	1.00	1.08	1.16
Central Bossier Water System	1,008	1,094	1,182	1,275	1,374	0.14	0.15	0.17	0.18	0.19	0.28	0.31	0.33	0.36	0.38
St Mary Water System	361	392	424	457	492	0.05	0.05	0.06	0.06	0.07	0.10	0.11	0.12	0.13	0.14
Bossier Total	*4,410*	*4,787*	*5,173*	*5,578*	*6,011*	*0.62*	*0.67*	*0.72*	*0.78*	*0.84*	*1.23*	*1.34*	*1.45*	*1.56*	*1.68*
Caddo Parish															
Bel-Di-Gil Water System*	1,202	1,268	1,328	1,384	1,437	0.23	0.24	0.25	0.26	0.27	0.46	0.48	0.50	0.53	0.55
Ida Water System	427	450	472	491	510	0.08	0.09	0.09	0.09	0.10	0.16	0.17	0.18	0.19	0.19
Rodessa Water System	389	410	429	447	465	0.07	0.08	0.08	0.08	0.09	0.15	0.16	0.16	0.17	0.18
Tyson Community Water System	191	202	211	220	228	0.04	0.04	0.04	0.04	0.04	0.07	0.08	0.08	0.08	0.09
Hosston Mira Water System	854	900	943	983	1,021	0.16	0.17	0.18	0.19	0.19	0.32	0.34	0.36	0.37	0.39
Caddo Total	*3,063*	*3,230*	*3,383*	*3,525*	*3,661*	*0.58*	*0.61*	*0.64*	*0.67*	*0.70*	*1.16*	*1.23*	*1.29*	*1.34*	*1.39*
System Total	7,473	8,017	8,556	9,103	9,672	1.20	1.28	1.37	1.45	1.54	2.40	2.57	2.73	2.90	3.07

* Bel-Di-Gil is located in District 1 but is served from District 2 in Options 2 and 3.

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Table 2-3 Population and Water Demand Projections for District 2

	Population					Average Day (MGD)					Peak Day (MGD)				
Water System Name	2015	2020	2025	2030	2035	2015	2020	2025	2030	2035	2015	2020	2025	2030	2035
Bossier Parish															
Village Water System	11,494	12,476	13,481	14,537	15,668	1.61	1.75	1.89	2.04	2.19	3.22	3.49	3.77	4.07	4.39
Benton Water System, Town of	6,374	6,919	7,476	8,062	8,689	0.89	0.97	1.05	1.13	1.22	1.78	1.94	2.09	2.26	2.43
Haughton Water System, Town of	4,929	5,350	5,781	6,235	6,720	0.69	0.75	0.81	0.87	0.94	1.38	1.50	1.62	1.75	1.88
Cypress Black Bayou Water System	4,850	5,265	5,689	6,135	6,612	0.68	0.74	0.80	0.86	0.93	1.36	1.47	1.59	1.72	1.85
Consolidated Wwks Distr No. 1 of Bossier	3,284	3,564	3,852	4,154	4,477	0.46	0.50	0.54	0.58	0.63	0.92	1.00	1.08	1.16	1.25
Bellevue Water System	1,231	1,337	1,444	1,558	1,679	0.17	0.19	0.20	0.22	0.24	0.34	0.37	0.40	0.44	0.47
Country Place Subd Water System	1,314	1,426	1,541	1,661	1,791	0.18	0.20	0.22	0.23	0.25	0.37	0.40	0.43	0.47	0.50
J & N Mobile Home Park	161	175	189	204	219	0.02	0.02	0.03	0.03	0.03	0.05	0.05	0.05	0.06	0.06
Southgate MHP Water System	194	210	227	245	264	0.03	0.03	0.03	0.03	0.04	0.05	0.06	0.06	0.07	0.07
Bodcau Water Works	174	189	204	220	237	0.02	0.03	0.03	0.03	0.03	0.05	0.05	0.06	0.06	0.07
Hillcrest MHP Water System	131	143	154	166	179	0.02	0.02	0.02	0.02	0.03	0.04	0.04	0.04	0.05	0.05
Peaceful Pines MHP Water System	148	160	173	187	201	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.06
Oak Haven MHP Water System	95	103	112	120	130	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04
River Point Water System	49	53	58	62	67	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Shady Park MHP Water System	82	89	96	104	112	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03
Barksdale AFB Water System	14,230	15,446	16,691	17,999	19,399	1.99	2.16	2.34	2.52	2.72	3.98	4.32	4.67	5.04	5.43
Bossier Total	*48,740*	*52,905*	*57,168*	*61,649*	*66,444*	*6.82*	*7.41*	*8.00*	*8.63*	*9.30*	*13.65*	*14.81*	*16.01*	*17.26*	*18.60*

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Table 2-3 Continued

	Population					Average Day (MGD)					Peak Day (MGD)				
Water System Name	2015	2020	2025	2030	2035	2015	2020	2025	2030	2035	2015	2020	2025	2030	2035
Caddo Parish															
Dixie Garden Water Supply	634	669	700	730	758	0.12	0.13	0.13	0.14	0.14	0.24	0.25	0.27	0.28	0.29
Deepwoods Utilities, Inc.	698	736	771	803	834	0.13	0.14	0.15	0.15	0.16	0.27	0.28	0.29	0.31	0.32
Greenwood, Town of	5,231	5,327	5,397	5,444	5,481	0.99	1.01	1.03	1.03	1.04	1.99	2.02	2.05	2.07	2.08
Pinehill Waterworks District	4,698	4,955	5,192	5,409	5,617	0.89	0.94	0.99	1.03	1.07	1.79	1.88	1.97	2.06	2.13
Vivian Water System	4,698	4,955	5,192	5,409	5,617	0.89	0.94	0.99	1.03	1.07	1.79	1.88	1.97	2.06	2.13
Oil City Water Works	2,389	2,520	2,640	2,750	2,856	0.45	0.48	0.50	0.52	0.54	0.91	0.96	1.00	1.05	1.09
Huntington Mobile Home Park Water System	309	326	341	356	369	0.06	0.06	0.06	0.07	0.07	0.12	0.12	0.13	0.14	0.14
Linda Lane Water System	150	158	165	172	179	0.03	0.03	0.03	0.03	0.03	0.06	0.06	0.06	0.07	0.07
Denny Drive Water System	51	54	56	59	61	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
Evergreen Estates Water System	172	181	190	198	206	0.03	0.03	0.04	0.04	0.04	0.07	0.07	0.07	0.08	0.08
Hillside MHP Water System	344	363	380	396	411	0.07	0.07	0.07	0.08	0.08	0.13	0.14	0.14	0.15	0.16
Wildwood Forest Subdivision Water System	475	501	524	546	567	0.09	0.10	0.10	0.10	0.11	0.18	0.19	0.20	0.21	0.22
Springlake MHP Water System	392	413	433	451	468	0.07	0.08	0.08	0.09	0.09	0.15	0.16	0.16	0.17	0.18
Caddo Total	*20,241*	*21,158*	*21,981*	*22,723*	*23,424*	*3.85*	*4.02*	*4.18*	*4.32*	*4.45*	*7.69*	*8.04*	*8.35*	*8.63*	*8.90*
System Total	68,981	74,063	79,149	84,372	89,868	10.67	11.43	12.18	12.95	13.75	21.34	22.85	24.36	25.90	27.51

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Table 2-4 Population and Water Demand Projections for District 3

	Population					Average Day (MGD)					Peak Day (MGD)				
Water System Name	2015	2020	2025	2030	2035	2015	2020	2025	2030	2035	2015	2020	2025	2030	2035
Bossier Parish															
Evangeline Oaks Water System	213	232	250	270	291	0.03	0.03	0.04	0.04	0.04	0.06	0.06	0.07	0.08	0.08
Sligo Water System Incorporated	1,809	1,964	2,122	2,289	2,467	0.25	0.27	0.30	0.32	0.35	0.51	0.55	0.59	0.64	0.69
South Bossier Water System	1,333	1,447	1,564	1,686	1,818	0.19	0.20	0.22	0.24	0.25	0.37	0.41	0.44	0.47	0.51
Bossier Total	*3,355*	*3,643*	*3,936*	*4,245*	*4,576*	*0.47*	*0.51*	*0.55*	*0.59*	*0.64*	*0.94*	*1.02*	*1.10*	*1.19*	*1.28*
Caddo Parish															
Southview Estates Water System	209	212	215	217	219	0.04	0.04	0.04	0.04	0.04	0.08	0.08	0.08	0.08	0.08
Twm Mobile Home Community Water System	150	158	165	172	179	0.03	0.03	0.03	0.03	0.03	0.06	0.06	0.06	0.07	0.07
Bella Vista MHP Water System	350	370	387	403	419	0.07	0.07	0.07	0.08	0.08	0.13	0.14	0.15	0.15	0.16
Eagle Water, Inc.	1,580	1,666	1,746	1,819	1,889	0.30	0.32	0.33	0.35	0.36	0.60	0.63	0.66	0.69	0.72
Autumn Acres MHP Water System	96	101	106	110	114	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04	0.04
Barron Ridge Subdivision Water System	143	151	158	165	171	0.03	0.03	0.03	0.03	0.03	0.05	0.06	0.06	0.06	0.06
Big Oaks Water System	99	104	109	114	118	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04	0.04
Colworth Place Water Supply	127	134	141	147	152	0.02	0.03	0.03	0.03	0.03	0.05	0.05	0.05	0.06	0.06
Forcht Wade Correctional Center	595	627	657	684	711	0.11	0.12	0.12	0.13	0.14	0.23	0.24	0.25	0.26	0.27
Waterworks District #7	7,368	7,772	8,143	8,483	8,809	1.40	1.48	1.55	1.61	1.67	2.80	2.95	3.09	3.22	3.35

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Table 2-4 Continued

	Population					Average Day (MGD)					Peak Day (MGD)				
Water System Name	2015	2020	2025	2030	2035	2015	2020	2025	2030	2035	2015	2020	2025	2030	2035
Meadowwood Estates Water System	153	161	169	176	183	0.03	0.03	0.03	0.03	0.03	0.06	0.06	0.06	0.07	0.07
Country Living Estates Water System	26	26	26	27	27	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Jones Rolling Ridge Water Company	124	131	137	143	149	0.02	0.02	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.06
Lake Shreve Estates Water System	80	84	88	92	95	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04
Meadowwood Estates Water System	153	161	169	176	183	0.03	0.03	0.03	0.03	0.03	0.06	0.06	0.06	0.07	0.07
Shadow Lake MHP Water System	96	101	106	110	114	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04	0.04
Sherwood Apts. W. Sys.	53	56	59	61	63	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
Silent Cedars MHP Water System	67	69	70	70	71	0.01	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.03
South Shreveport Mobile Villa	53	56	59	61	63	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
Wildwood South Water System	452	477	500	521	541	0.09	0.09	0.10	0.10	0.10	0.17	0.18	0.19	0.20	0.21
Four Forks Water System	501	529	554	577	599	0.10	0.10	0.11	0.11	0.11	0.19	0.20	0.21	0.22	0.23
Caddo Total	*12,475*	*13,146*	*13,764*	*14,328*	*14,869*	*2.37*	*2.50*	*2.62*	*2.72*	*2.83*	*4.74*	*5.00*	*5.23*	*5.44*	*5.65*
System Total	15,830	16,789	17,700	18,573	19,445	2.84	3.01	3.17	3.32	3.47	5.68	6.02	6.33	6.63	6.93

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3.0 Proposed Water Supply Sources

This section briefly describes the three new water supply sources that could be used as new sources of supply in Caddo and Bossier Parishes. More detailed information can be found in Section 5.3 of the Phase I report and Sections 5, 6 and 9 of the Phase IV report. Supplemental information for Caddo Lake developed in this phase of the study is presented below and in Appendix B.

3.1 Toledo Bend Reservoir

With over 4 million acre-feet of storage, Toledo Bend Reservoir is one of the largest reservoirs in the United States. The reservoir is located on the border of Texas and Louisiana. Louisiana's share of the yield of Toledo Bend is at least 715 MGD. The major issue associated with this supply is the distance from the source to Caddo and Bossier Parishes. Use of water from this source would require a contract with the Sabine River Authority of Louisiana.

3.2 Red River

The estimated available supply from the Red River is 224 MGD. Currently, the City of Bossier City is the only user of water from this source. The projected 2035 average use for Bossier City is 12.8 MGD and the maximum day use is 25.6 MGD. Additional reliable supplies should be available for Caddo and Bossier Parish.

3.3 Caddo Lake

3.3.1 Description

Caddo Lake is located along the Texas-Louisiana border in Marion and Harrison Counties, Texas and Caddo Parish Louisiana. The drainage area of the watershed is 2,744 square miles, most of which is located in northeast Texas. Major upstream reservoirs include Lake O' The Pines, Johnson Creek (Wilkes) Reservoir, Ellison Reservoir, Welsh Reservoir, Lake Bob Sandlin, Lake Cypress Springs, and Lake Monticello, all located in Texas.

In 1998, the U.S. Geological Survey conducted a bathymetric survey of Caddo Lake. This survey found that at elevation 167.58 feet the reservoir had 85,100 acre-feet of storage and a surface area of 18,700 acres. Extrapolating this value to the normal pool elevation of 168.5 feet, currently the reservoir has approximately 104,000 acre-feet of storage. This value is somewhat less than the 129,000 acre-feet of storage reported in the Phase I report. The 129,000 acre-feet of storage reflects conditions in Caddo Lake prior to 1969, the first published reference found in this study. At least some of the reduction in volume is the result of sediment collection in the reservoir since the initial survey. Other differences are the result of different methods of calculating reservoir storage.

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3.3.2 Available Supplies

Table 3-1 is a summary of yield of Caddo Lake verses minimum storage in the reservoir. These yields were determined using a modified version of the Texas Commission on Environmental Quality's Cypress Basin Water Availability Model (WAM). This model assumes full development of existing upstream water supplies in the Texas portion of the Caddo Lake watershed. (It is assumed that water supply development upstream of Caddo Lake in Louisiana is not significant). More detailed information on the model may be found in Appendix B. The maximum yield of 108.8 MGD (average day) is the firm yield of the reservoir, which is the maximum reliable supply that can be obtained from the source without a shortage. Note that at this yield the minimum storage in the reservoir is close to zero. Also note that if only the top 1.5 feet of storage is used, the reservoir has no yield. The current use from the reservoir is assumed to be about 3.0 MGD, which is equivalent to the yield of about 1.6 feet of storage in the lake. An average annual diversion of about 17.4 MGD[1] is the maximum development from the reservoir proposed in this study (2.1 MGD of existing demand plus 15.3 MGD of new demand). Full use of this supply would require about 1.9 feet of storage in the reservoir.

Table 3-1 Caddo Lake Yield Summary

Minimum Storage (ac-ft)	Minimum Elevation (ft)	Feet Below Conservation (ft)	Yield [a] (MGD)
69	156.3	12.2	108.8
20,000	162.6	5.9	83.9
40,015	164.6	3.9	57.9
60,016	166.3	2.2	29.1
66,363	166.6	1.9	17.4[b]
72,187	166.9	1.6	3.0[c]
73,050	167.0	1.5	0.0

a Average day demand
b Maximum use from Caddo Lake proposed in this study
c Current estimated use from Caddo Lake

The use of water from Caddo Lake is governed by the Red River Compact, which gives Texas and Louisiana equal shares of the storage in the reservoir. This implies that Louisiana should have access to at least half of the yield of the lake. This assumption is complicated by the use of water upstream of Caddo Lake in Texas, at least some of which can be counted as use of Caddo Lake supplies under the terms of the Compact. For this study it has been assumed that the maximum available supply for Louisiana is half of the firm yield of the lake, or approximately

1 Demands from reservoirs are typically expressed in terms of average day demands. Capacities for water treatment and delivery are typically expressed in terms of peak day demands. In this area, peak demands are about 2 times the average day demands.

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54.4 MGD. Therefore the available supply exceeds the maximum expected 2035 use proposed in this study (17.4 MGD average day demand).

The Caddo Lake Compact is a proposed agreement that further refines the potential use of water from Caddo Lake. However, since this document has never been ratified by either state, it has not been considered for this study.

Caddo Lake is operated and maintained by the U.S. Army Corps of Engineers. However, unlike other federal projects, use of water from storage does not require a contract with the Corps.

3.3.3 Environmental Issues

In 1993, Caddo Lake was designated as a Ramsar Wetland of International Importance. The Ramsar Convention on Wetlands is an “intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources”. The Ramsar Convention was founded in 1971 and the United States has been a “contracting party” to the treaty since 1977, which is administrated through the U.S. Fish and Wildlife Service. Figure 3-1 shows the boundaries of the current Ramsar wetlands designation. The designation area is a mixture of public and private lands in the upper reaches of Caddo Lake. All but a small part of the designation area is in Texas.

The high profile of the Caddo Lake wetlands is a significant consideration when assessing Caddo Lake for water supply. In 2001, the City of Marshall, which owns a water right for diversion from Big Cypress Bayou upstream Caddo Lake, made an application to the Texas Commission on Environmental Quality (TCEQ) to change the purpose of use for part of the city’s water right from municipal use to industrial use. The City planned to sell the water to a power plant and possibly to others. The change of use did not involve a change in diversion location or the authorized quantity of water granted in the water right. However, it would increase the amount of water diverted from Big Cypress Bayou, since the authorized quantity of water exceeded the expected needs of the City of Marshall. Previously, TCEQ’s standard practice was to grant changes in use without notice or opportunity of a hearing. The City of Uncertain and others (primarily environmental groups) successfully challenged this practice, blocking the proposed amendment. This lawsuit has led to a change in TCEQ’s practice when considering changes in type of use. The City was ultimately granted their water right amendment, but the planned sale to the power plant did not materialize. Based on this experience, it is quite possible that a significant increase in water supply taken directly from Caddo Lake could also face court challenges.

Preview Only

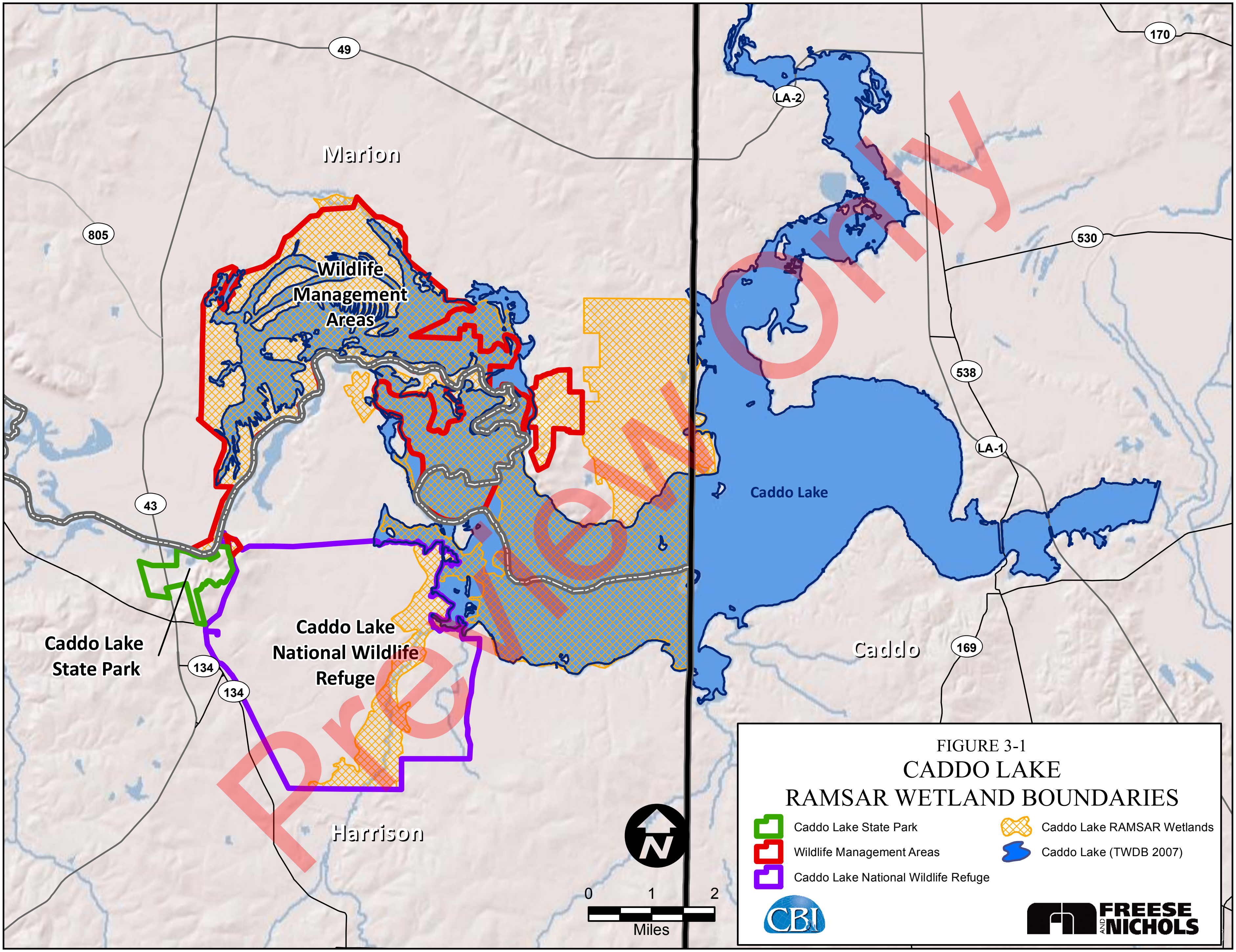

FIGURE 3-1
CADDO LAKE
RAMSAR WETLAND BOUNDARIES

Preview Only

The wetlands surrounding Caddo Lake are dependent on inundation caused by the rise and fall of lake levels. Increasing the frequency of reservoir drawdown could have a negative impact on these wetlands. Historically, Caddo Lake has been at or above the normal pool elevation of 168.5 feet about 77% of the time. The minimum storage in the available historical records was 166.37 feet on October 1, 2011. The modeled storage in the reservoir at current demand levels of 3.0 MGD is similar, with storage at conservation 77% of the time and a minimum elevation of 166.9 feet. At the maximum demand level considered in this study (17.4 MGD average day, 34.8 MGD peak day), the reservoir would be at conservation 74% of the time with a minimum elevation of 166.6 feet. Additional information on modeling can be found in Appendix B.

Another environmental issue that potentially affects water supply is giant salvinia, an invasive species. Giant salvinia is an aquatic floating fern native to Brazil first observed in Caddo Lake in 2006. Salvinia mats can double in size in one to two weeks. From a water supply standpoint, giant salvinia can be problematic because it can clog intake structures. Giant salvinia is currently being controlled by herbicides and bio-control using weevils.

Preview Only

4.0 Alternatives Evaluation

In order to compare potential for supplying Caddo and Bossier Parishes from Toledo Bend Reservoir, the Red River or Caddo Lake, Shaw developed five water supply strategies:

- Option 1 is serving all customers from Toledo Bend Reservoir
- Option 2 is serving all customers from the Red River
- Option 3 is serving District 1 from the Red River, District 2 from Caddo Lake, and District 3 from Toledo Bend Reservoir
- Option 4 is serving Districts 1 and 2 from Caddo Lake and District 3 from Toledo Bend Reservoir
- Option 5 is serving Districts 1 and 2 from the existing Blanchard and Vivian water treatment plants and serving District 3 from the Red River

For each water supply strategy, a conceptual regional water distribution system was developed. The locations of all facilities are tentative and subject to change in the future.

4.1 Conceptual Design Criteria

The conceptual designs include the following assumptions:

- Storage and pumping were sized to allow pressures to range from 150 psi at the discharge of the pump station to 20 psi or higher at delivery.
- Water lines were aligned with major roads where possible.
- Water lines will be hung from existing bridges for major river and lake crossings. If other means are needed to cross these features, costs of the system could increase.
- Pumping and storage were sized to meet maximum day demands.
- Customers will not have an air gap or individual ground storage tank associated with the connection to the system.
- Water treatment plants will use conventional treatment. Advanced treatment such as microfiltration or RO treatment may be required but were not considered in the cost estimates.

Preview Only

In Options 2, 3 and 4 the Bel-Di-Gil water system, which is located in District 1, is supplied from District 2. This system is relatively close to the proposed treatment plant location in Option 2. A different plant location further south may make this configuration less desirable. In Options 3 and 4 this configuration was retained for consistency. Supplying Bel-Di-Gil from District 1 would be about the same cost as shown here.

4.2 Option 1 - Toledo Bend

4.2.1 Facilities

Option 1 is serving all the districts from Toledo Bend Reservoir. The proposed facilities and water line alignments are presented in Figure 4-1. Option 1 consists of network of 315 miles of pipe ranging in size from 4- to 54-inches, 6 pump stations, 6 ground storage tanks, and 1 water treatment plant. Option 1 pumps water to serve all the districts from Toledo Bend.

For the conceptual design, a 25-mile 54-inch pipeline delivers raw water to the treatment plant from an intake and pump station located about halfway down the reservoir. This location was selected to allow pumping from the reservoir even when the reservoir has been drawn down. A site selection study will be needed prior to selection of the actual pump station site.

Option 1 requires a 37 MGD water treatment plant. This water treatment plant treats water for customers in all three districts. For the conceptual design the treatment plant has been located near the City of Logansport. Treated water from the water treatment plant will be conveyed to Caddo and Bossier Parishes via a 19-mile 54-inch treated water line.

4.2.2 Phasing Options

Option 1 could be phased from south to north with District 3 receiving service first, followed by District 2 and District 1. Extensive infrastructure is required to transport water from Toledo Bend Reservoir to customers. The first customers of the system would be bearing much of the cost of the transmission system, which would be a financial challenge when phasing the system.

4.2.3 Risks

Several risks have been identified associated with this option. This option:

- Requires pumping water a very long distance to reach customers. Therefore this option has the highest capital costs and the highest electricity costs.

- This option does not have any redundancy. In the event of a line break between Toledo Bend Reservoir and District 3 or a problem at the water treatment plant, all customers would be out of water.

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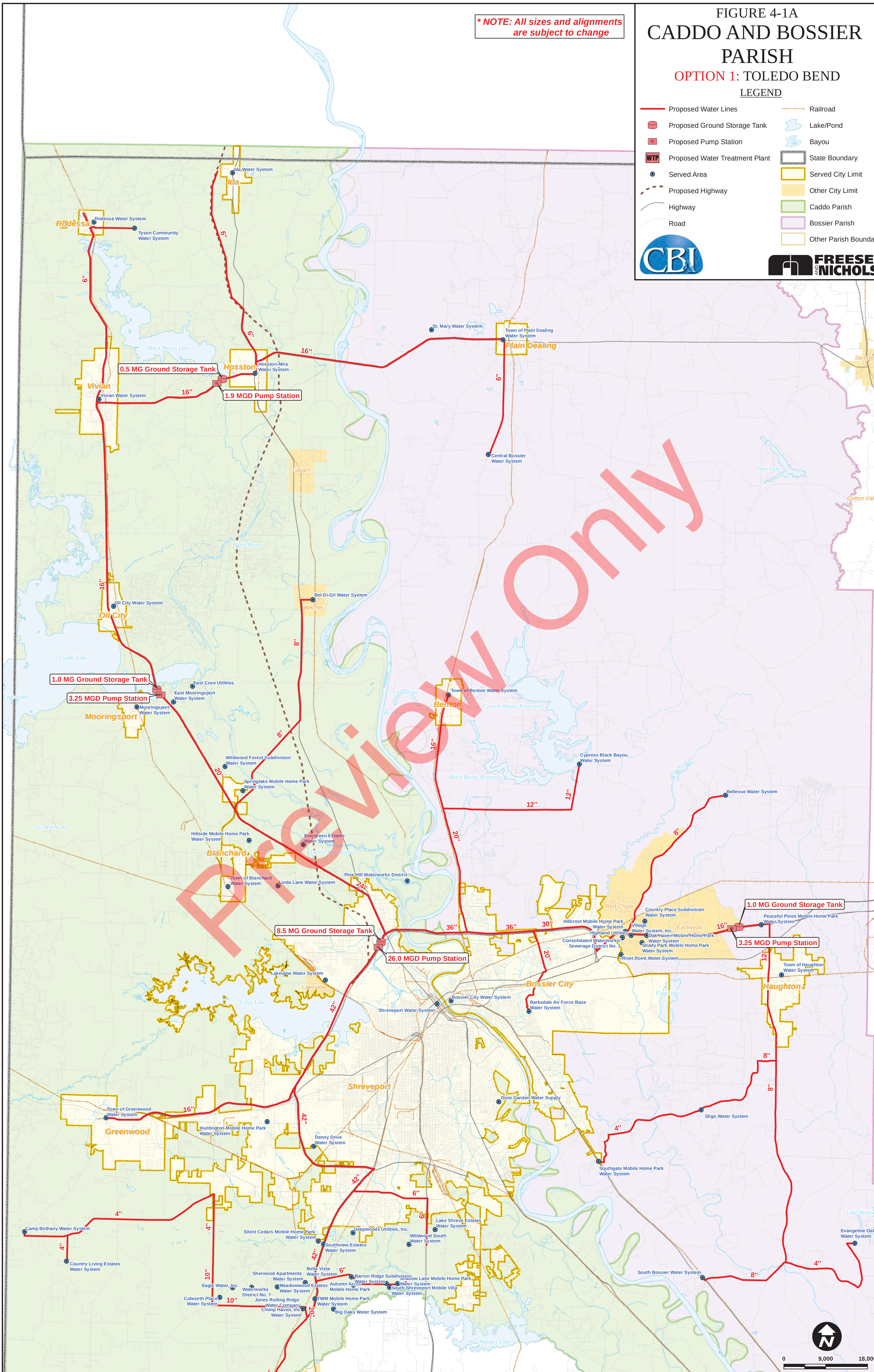
FIGURE 4-1A
CADDO AND BOSSIER PARISH
OPTION 1: TOLEDO BEND
LEGEND
Proposed Water Lines
Proposed Ground Storage Tank
Proposed Pump Station
Proposed Water Treatment Plant
Served Area
Proposed Highway
Highway
Road
Railroad
Lake/Pond
Bayou
State Boundary
Served City Limit
Other City Limit
Caddo Parish
Bossier Parish
Other Parish Boundary
CBI
FREESE AND NICHOLS
* NOTE: All sizes and alignments are subject to change
Preview Only
0.5 MG Ground Storage Tank
1.9 MGD Pump Station
1.0 MG Ground Storage Tank
3.25 MGD Pump Station
8.5 MG Ground Storage Tank
26.0 MGD Pump Station
1.0 MG Ground Storage Tank
3.25 MGD Pump Station
Rodessa
Rodessa Water System
Tyson Community Water System
Ida
Ida Water System
Vivian
Vivian Water System
Hosston
Hosston-Mira Water System
Plain Dealing
Town of Plain Dealing Water System
St. Mary Water System
Central Bossier Water System
Oil City
Oil City Water System
Belcher
Bel-Di-Gil Water System
Gilliam
Mooringsport
Mooringsport Water System
East Mooringsport Water System
East Cove Utilities
Benton
Town of Benton Water System
Cypress Black Bayou Water System
Bellevue Water System
Wildwood Forest Subdivision Water System
Springlake Mobile Home Park Water System
Hillside Mobile Home Park Water System
Blanchard
Town of Blanchard Water System
Evergreen Estates Water System
Linda Lane Water System
Pine Hill Waterworks District
Lakeview Water System
Shreveport Water System
Bossier City Water System
Bossier City
Barksdale Air Force Base Water System
Hillcrest Mobile Home Park Water System
Highland Utilities
Village Water System, Inc.
Oak Haven Mobile Home Park Water System
Shady Park Mobile Home Park Water System
Consolidated Waterworks/Sewerage District No. 1
River Point Water System
Country Place Subdivision Water System
Peaceful Pines Mobile Home Park Water System
Eastwood
Red Chute
Town of Haughton Water System
Haughton
Shreveport
Dixie Garden Water Supply
Sligo Water System
Southgate Mobile Home Park Water System
Greenwood
Town of Greenwood Water System
Huntington Mobile Home Park Water System
Denny Drive Water System
Camp Bethany Water System
Country Living Estates Water System
Silent Cedars Mobile Home Park Water System
Deepwoods Utilities, Inc.
Southview Estates Water System
Lake Shreve Estates Water System
Wildwood South Water System
Evangeline Oaks Water System
South Bossier Water System
Bella Vista Water System
Sherwood Apartments Water System
Eagle Water, Inc.
Waterworks District No. 7
Meadowwood Estates Water System
Barron Ridge Subdivision Water System
Autumn Acres Mobile Home Park
Shallow Lake Mobile Home Park Water System
South Shreveport Mobile Villa Water System
Colworth Place Water System
Jones Rolling Ridge Water Company
Chimp Haven, Inc. Water System
TWM Mobile Home Park Water System
Big Oaks Water System
Stonewall
Caddo Lake
Black Bayou Lake
Cross Lake
Six Mile Lake
Clear Lake
Cypress Bayou Reservoir
Black Bayou Reservoir
Flag Lake
Wallace Lake
Ivan Lake
Sarepta
Cotton Valley
6"
8"
10"
12"
16"
20"
24"
30"
36"
42"
48"
4"
0
9,000
18,000
SCALE IN FEET
N

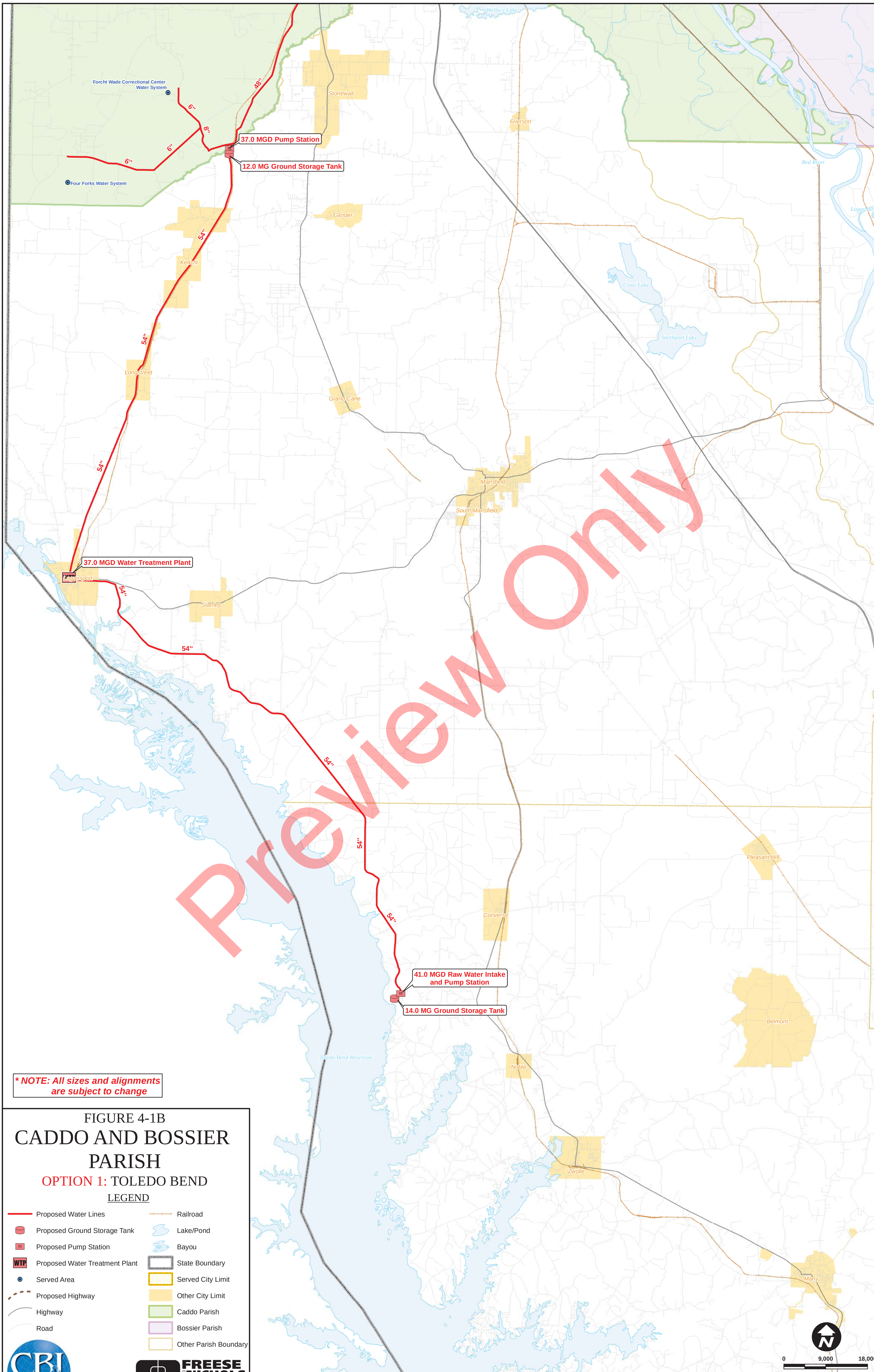

FIGURE 4-1B

CADDO AND BOSSIER PARISH

OPTION 1: TOLEDO BEND

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4.3 Option 2 - Red River

4.3.1 Facilities

Option 2 has water treatment plants on the Red River serving each district individually. The proposed facilities and water line alignments are presented on Figure 4-2. Option 2 consists of a network of almost 250 miles of pipe ranging in size from 4- to 36-inches, 5 pump stations, 5 ground storage tanks, and 3 water treatment plants. The District 1 water treatment plant has a capacity of 2.5 MGD, the District 2 plant has a capacity of 27.5 MGD, and the District 3 plant has a capacity of 7.0 MGD. Each water treatment plant will have a new river intake structure and pump station.

An alternative configuration of Option 2 would have customers on the south side of Shreveport supplied by the District 3 water treatment plant. This could eliminate the need for some of the water lines through the City of Shreveport.

4.3.2 Phasing Options

Option 2 can be phased by district since each district has its own treatment plant. District 3 has the greatest number of customers close to the water treatment plant. This option will allow customers to begin paying for service with the least amount of infrastructure. District 2 also has a large number of customers east of Barksdale Air Force Base. Water lines should initially be phased to reach as many customers as possible.

4.3.3 Risks

Option 2 is the least risky of the options considered since it has individual treatment plants for each district. The treatment plants are located close to customers so there are fewer opportunities for line breaks.

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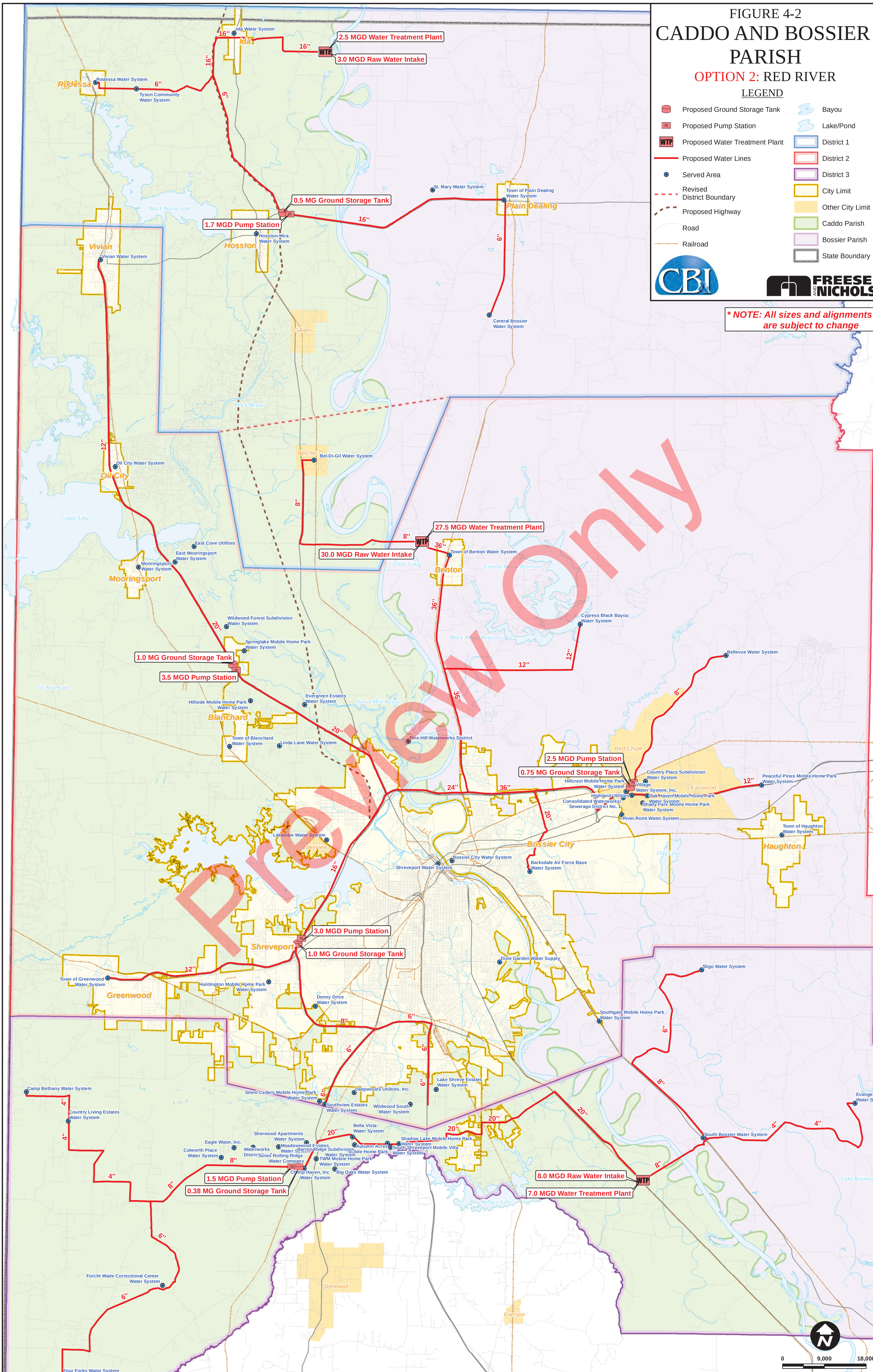

FIGURE 4-2
CADDO AND BOSSIER PARISH
OPTION 2: RED RIVER
LEGEND
Proposed Ground Storage Tank
Proposed Pump Station
Proposed Water Treatment Plant
Proposed Water Lines
Served Area
Revised District Boundary
Proposed Highway
Road
Railroad
Bayou
Lake/Pond
District 1
District 2
District 3
City Limit
Other City Limit
Caddo Parish
Bossier Parish
State Boundary
CBI
FREESE AND NICHOLS
* NOTE: All sizes and alignments are subject to change
2.5 MGD Water Treatment Plant
3.0 MGD Raw Water Intake
0.5 MG Ground Storage Tank
1.7 MGD Pump Station
27.5 MGD Water Treatment Plant
30.0 MGD Raw Water Intake
1.0 MG Ground Storage Tank
3.5 MGD Pump Station
2.5 MGD Pump Station
0.75 MG Ground Storage Tank
3.0 MGD Pump Station
1.0 MG Ground Storage Tank
1.5 MGD Pump Station
0.38 MG Ground Storage Tank
8.0 MGD Raw Water Intake
7.0 MGD Water Treatment Plant
Ida
Rodessa
Vivian
Hosston
Plain Dealing
Gilliam
Belcher
Oil City
Mooringsport
Benton
Blanchard
Red Chute
Eastwood
Haughton
Bossier City
Shreveport
Greenwood
Lakeview
Stonewall
Frierson
Ida Water System
Rodessa Water System
Tyson Community Water System
St. Mary Water System
Town of Plain Dealing Water System
Hosston-Mira Water System
Vivian Water System
Central Bossier Water System
Bel-Di-Gil Water System
Oil City Water System
East Cove Utilities
East Mooringsport Water System
Mooringsport Water System
Town of Benton Water System
Cypress Black Bayou Water System
Wildwood Forest Subdivision Water System
Springlake Mobile Home Park Water System
Bellevue Water System
Hillside Mobile Home Park Water System
Evergreen Estates Water System
Town of Blanchard Water System
Linda Lane Water System
Pine Hill Waterworks District
Country Place Subdivision Water System
Hillcrest Mobile Home Park Water System
Village Water System, Inc.
Peaceful Pines Mobile Home Park Water System
Highland Utilities
Oak Haven Mobile Home Park Water System
Shady Park Mobile Home Park Water System
Consolidated Waterworks/ Sewerage District No. 1
River Point Water System
Town of Haughton Water System
Lakeview Water System
Bossier City Water System
Shreveport Water System
Barksdale Air Force Base Water System
Dixie Garden Water Supply
Sligo Water System
Town of Greenwood Water System
Huntington Mobile Home Park Water System
Denny Drive Water System
Southgate Mobile Home Park Water System
Camp Bethany Water System
Country Living Estates Water System
Silent Cedars Mobile Home Park Water System
Deepwoods Utilities, Inc.
Southview Estates Water System
Wildwood South Water System
Lake Shreve Estates Water System
Evangeline Water System
Bella Vista Water System
Sherwood Apartments Water System
Eagle Water, Inc.
Colworth Place Water System
Waterworks District
Meadowwood Estates Water System
Jones Rolling Ridge Water Company
Autumn Acres Mobile Home Park
Shadow Lake Mobile Home Park Water System
South Shreveport Mobile Village Water System
TWM Mobile Home Park Water System
Camp Haven, Inc Water System
Big Oaks Water System
South Bossier Water System
Forcht Wade Correctional Center Water System
Four Forks Water System
Black Bayou Lake
Caddo Lake
Black Bayou
Clear Lake
Cypress Bayou Reservoir
Black Bayou Reservoir
Six Mile Lake
Twelve Mile Bayou
Cross Lake
Red River
Flag Lake
Wallace Lake
Lake Bistineau
0 9,000 18,000
SCALE IN FEET

4.4 Option 3 - Red River, Caddo Lake, and Toledo Bend

4.4.1 Facilities

Option 3 is serving District 1 from the Red River, District 2 from Caddo Lake, and District 3 from Toledo Bend Reservoir. The proposed facilities and water line alignments for Option 3 are presented on Figure 4-3. Option 3 consists of a network 350 miles of pipe ranging in size from 4- to 36-inches, 7 pump stations, 7 ground storage tanks, and 3 water treatment plants. The first water treatment plant is a 2.5 MGD plant on the Red River that serves District 1, and the second is a 27.5 MGD plant on Caddo Lake that serves District 2, and the third is 7.0 MGD plant near Toledo Bend that serves District 3. The treatment plant near Toledo Bend will have raw water pumped to the treatment plant from the raw water intake further south via a 25-mile 24-inch pipeline. Another 19-mile 24-inch pipeline will pump treated water to District 3.

In addition to the intake structure and pump station at Toledo Bend Reservoir, Option 3 requires a new lake intake and pump station on Caddo Lake providing raw water to the District 2 treatment plant. A river intake and settling basin would be required for the District 3 plant.

Like Option 2, an alternative to the current configuration would be to serve customers on the south side of Shreveport in District 2 from District 3. However, since this would involve increasing the capacity of the transmission system from Toledo Bend Reservoir, this alternative may not be as feasible in Option 3 as it would be in Option 2.

4.4.2 Phasing Options

Option 3 can be phased by district since each district has its own treatment plant. District 2 provides the greatest number of customers close to the water treatment plant. This option will allow customers to begin paying for service with the least amount of infrastructure constructed. District 2 also has a large number of customers east of Barksdale Air Force base. Expanding infrastructure to customers allows for return on investment.

4.4.3 Risks

Several risks have been identified with this option. In Option 3:

- Providing water to District 3 requires transporting water a long distance from Toledo Bend Reservoir. If there is a line break between Toledo Bend and District 3 all customers would be without water.

- Increasing supplies from Caddo Lake will initiate extensive scrutiny of the project because of environmental concerns. A likely vehicle for this scrutiny would be the federal permitting process required to build the pump station at Caddo Lake, although there may also be opportunities if a state permit is required.

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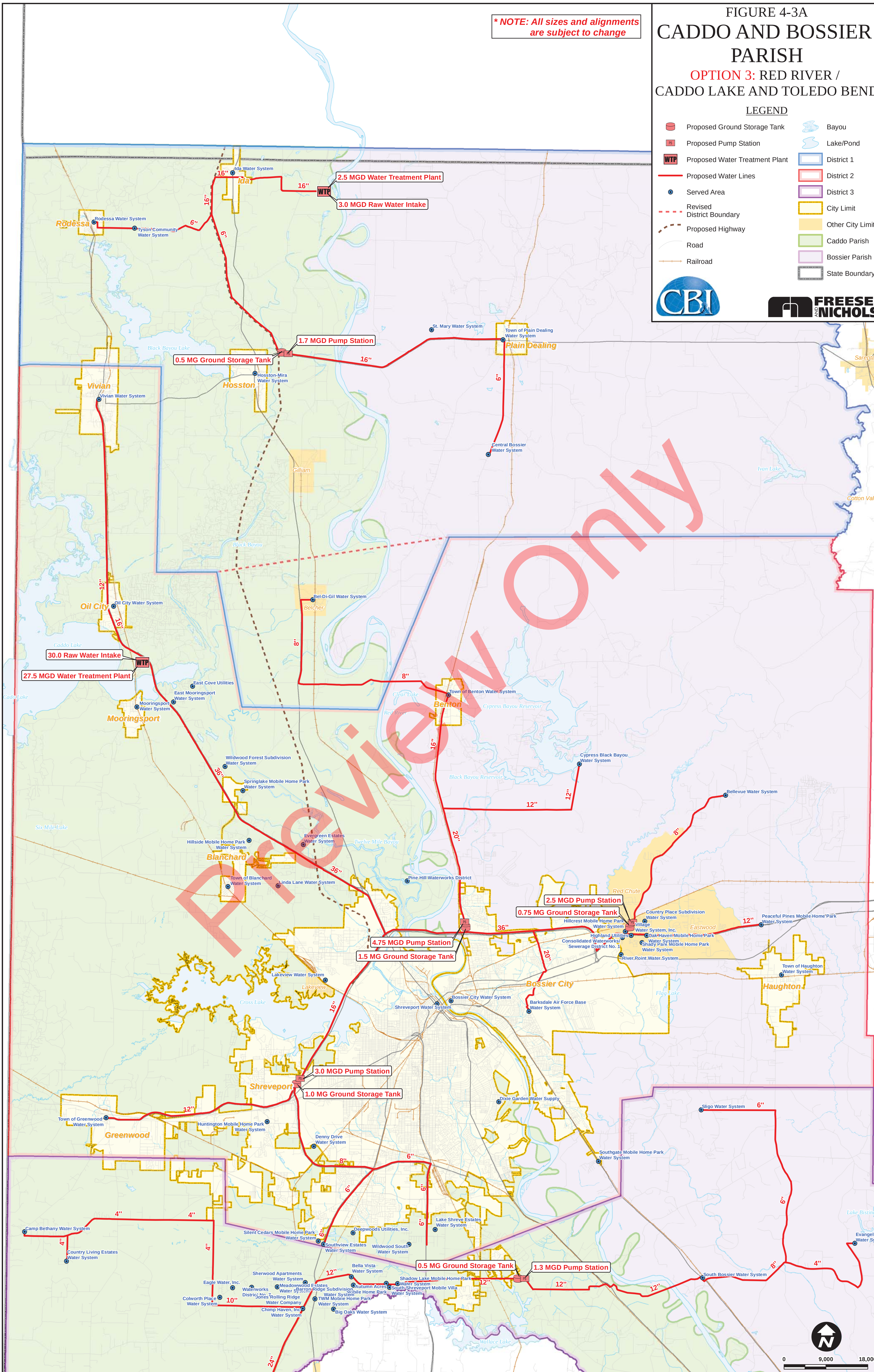

FIGURE 4-3A
CADDO AND BOSSIER PARISH
OPTION 3: RED RIVER / CADDO LAKE AND TOLEDO BEND
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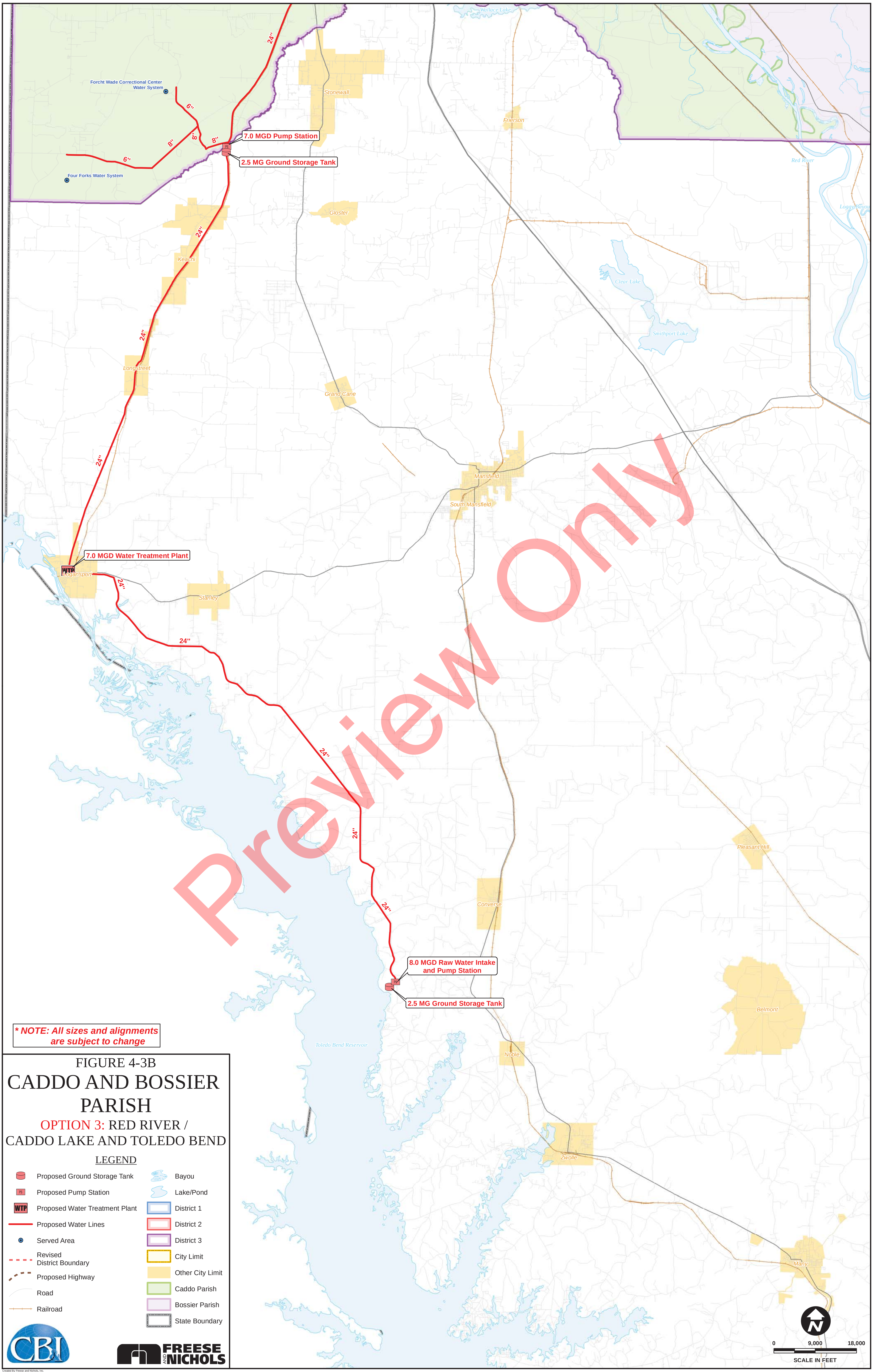

FIGURE 4-3B
CADDO AND BOSSIER PARISH
OPTION 3: RED RIVER / CADDO LAKE AND TOLEDO BEND

4.5 Option 4 - Caddo Lake and Toledo Bend

4.5.1 Facilities

Option 4 is serving districts 1 and 2 from Caddo Lake and serving district 3 from Toledo Bend Reservoir. This option consists of a network of 307 miles of pipe ranging in size from 4- to 36-inches, 7 pump stations, 7 ground storage tanks, and 2 water treatment plants. Option 4 has a 30 MGD water treatment plant on Caddo Lake to serve Districts 1 and 2, and a 7 MGD water treatment plant near Toledo Bend Reservoir to serve District 3. The District 3 treatment plant will have raw water pumped to the treatment plant from the raw water intake further south via a 25-mile 24-inch pipeline. Treated water from the plant will be pumped to District 3 via a 19-mile 24-inch pipeline.

Like Option 3, Option 4 requires an intake structure and pump station at Toledo Bend Reservoir, and a new lake intake and pump station on Caddo Lake.

Like Option 3, an alternative to the current configuration would be to serve customers on the south side of Shreveport in District 2 from District 3. However, the additional capacity of the transmission system from Toledo Bend Reservoir could negate any benefits of avoiding water lines in an urban area.

4.5.2 Phasing Options

Option 4 could be phased to serve Districts 1 and 2 first since they require the least amount of infrastructure to reach customers. It would be less beneficial to phase the District 3 system because of the excess capacity needed to bring water from Toledo Bend Reservoir.

4.5.3 Risks

The risks in Option 4 are identical to Option 3. In Option 4:

- Providing water to District 3 requires transporting water a long distance from Toledo Bend Reservoir. If there is a line break between Toledo Bend and district 3 there all customers would be without water.
- Increasing supplies from Caddo Lake may initiate extensive scrutiny of the project because of environmental concerns. A likely vehicle for this scrutiny would be the federal permitting process required to build the pump station at Caddo Lake, although there may also be opportunities if a state permit is required. Additional costs may be associated with addressing environmental concerns.

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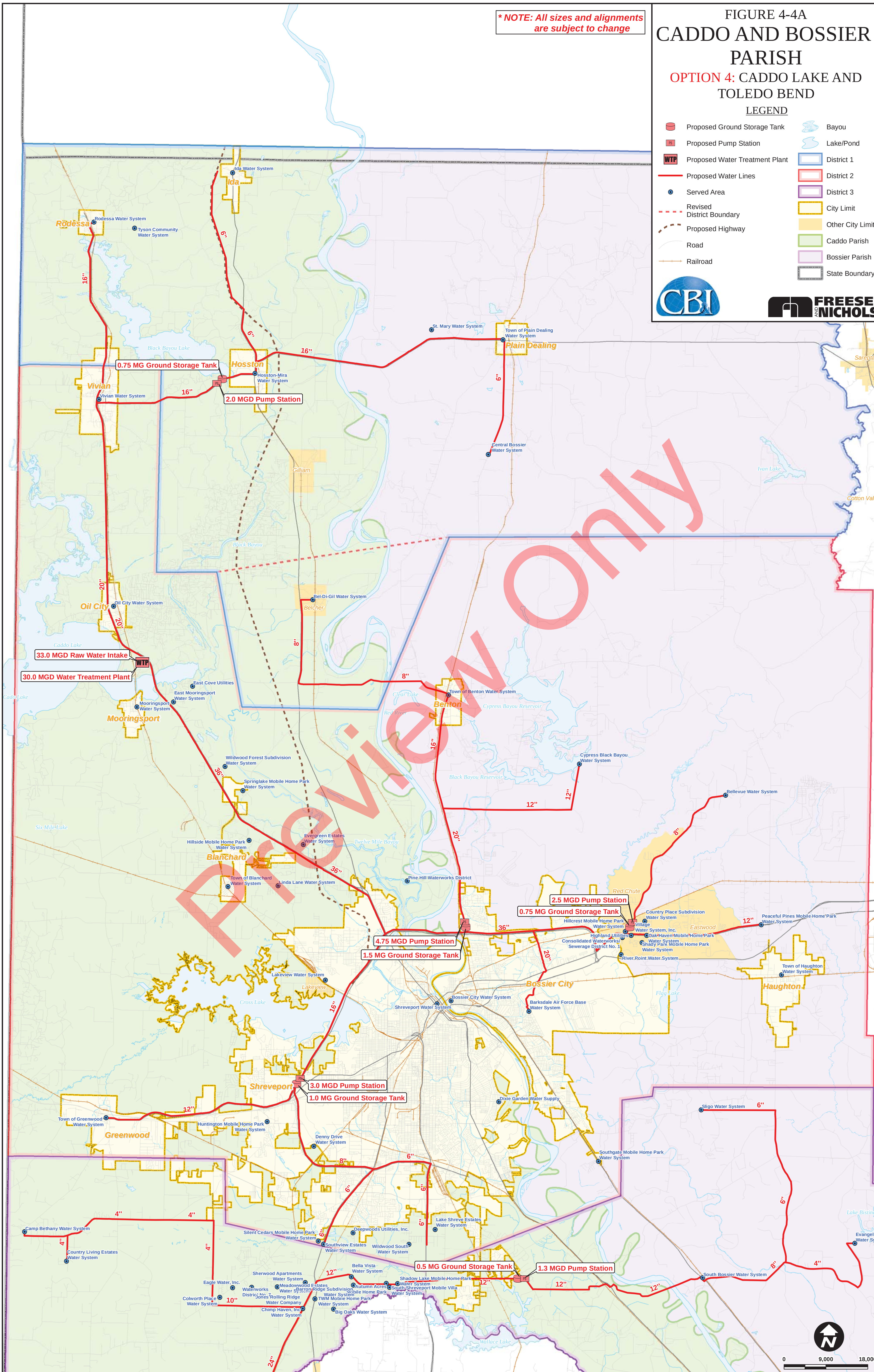

FIGURE 4-4A
CADDO AND BOSSIER PARISH
OPTION 4: CADDO LAKE AND TOLEDO BEND
LEGEND
Proposed Ground Storage Tank
Proposed Pump Station
Proposed Water Treatment Plant
Proposed Water Lines
Served Area
Revised District Boundary
Proposed Highway
Road
Railroad
Bayou
Lake/Pond
District 1
District 2
District 3
City Limit
Other City Limit
Caddo Parish
Bossier Parish
State Boundary
* NOTE: All sizes and alignments are subject to change
0.75 MG Ground Storage Tank
2.0 MGD Pump Station
33.0 MGD Raw Water Intake
30.0 MGD Water Treatment Plant
2.5 MGD Pump Station
0.75 MG Ground Storage Tank
4.75 MGD Pump Station
1.5 MG Ground Storage Tank
3.0 MGD Pump Station
1.0 MG Ground Storage Tank
0.5 MG Ground Storage Tank
1.3 MGD Pump Station
Rodessa
Ida
Hosston
Vivian
Plain Dealing
Oil City
Mooringsport
Benton
Blanchard
Shreveport
Bossier City
Greenwood
Haughton
Ida Water System
Rodessa Water System
Tyson Community Water System
St. Mary Water System
Town of Plain Dealing Water System
Hosston-Mira Water System
Vivian Water System
Central Bossier Water System
Bel-Di-Gil Water System
Oil City Water System
East Cove Utilities
East Mooringsport Water System
Mooringsport Water System
Town of Benton Water System
Wildwood Forest Subdivision Water System
Springlake Mobile Home Park Water System
Cypress Black Bayou Water System
Bellevue Water System
Hillside Mobile Home Park Water System
Evergreen Estates Water System
Town of Blanchard Water System
Linda Lane Water System
Pine Hill Waterworks District
Country Place Subdivision Water System
Peaceful Pines Mobile Home Park Water System
Hillcrest Mobile Home Park Water System
Village Water System, Inc.
Highland Utilities
Oak Haven Mobile Home Park Water System
Consolidated Waterworks/Sewerage District No. 1
Shady Park Mobile Home Park Water System
River Point Water System
Town of Haughton Water System
Lakeview Water System
Bossier City Water System
Shreveport Water System
Barksdale Air Force Base Water System
Dixie Garden Water Supply
Town of Greenwood Water System
Huntington Mobile Home Park Water System
Denny Drive Water System
Sligo Water System
Southgate Mobile Home Park Water System
Camp Bethany Water System
Country Living Estates Water System
Lake Shreve Estates Water System
Deepwoods Utilities, Inc.
Silent Cedars Mobile Home Park Water System
Southview Estates Water System
Wildwood South Water System
Evangeline Water System
Bella Vista Water System
Sherwood Apartments Water System
Shadow Lake Mobile Home Park
South Bossier Water System
Eagle Water, Inc.
Waterworks District No. 7
Meadowwood Estates Water System
Barron Ridge Subdivision Water System
Autumn Acres Mobile Home Park
South Shreveport Mobile Villa Water System
Colworth Place Water System
Jones Rolling Ridge Water Company
TWM Mobile Home Park Water System
Chimp Haven, Inc. Water System
Big Oaks Water System
Caddo Lake
Cross Lake
Black Bayou Lake
Cypress Bayou Reservoir
Black Bayou Reservoir
Twelve Mile Bayou
Red Chute
Eastwood
Gilliam
Belcher
Sarepta
Cotton Valley
Stonewall
Preview Only
SCALE IN FEET
0 9,000 18,000

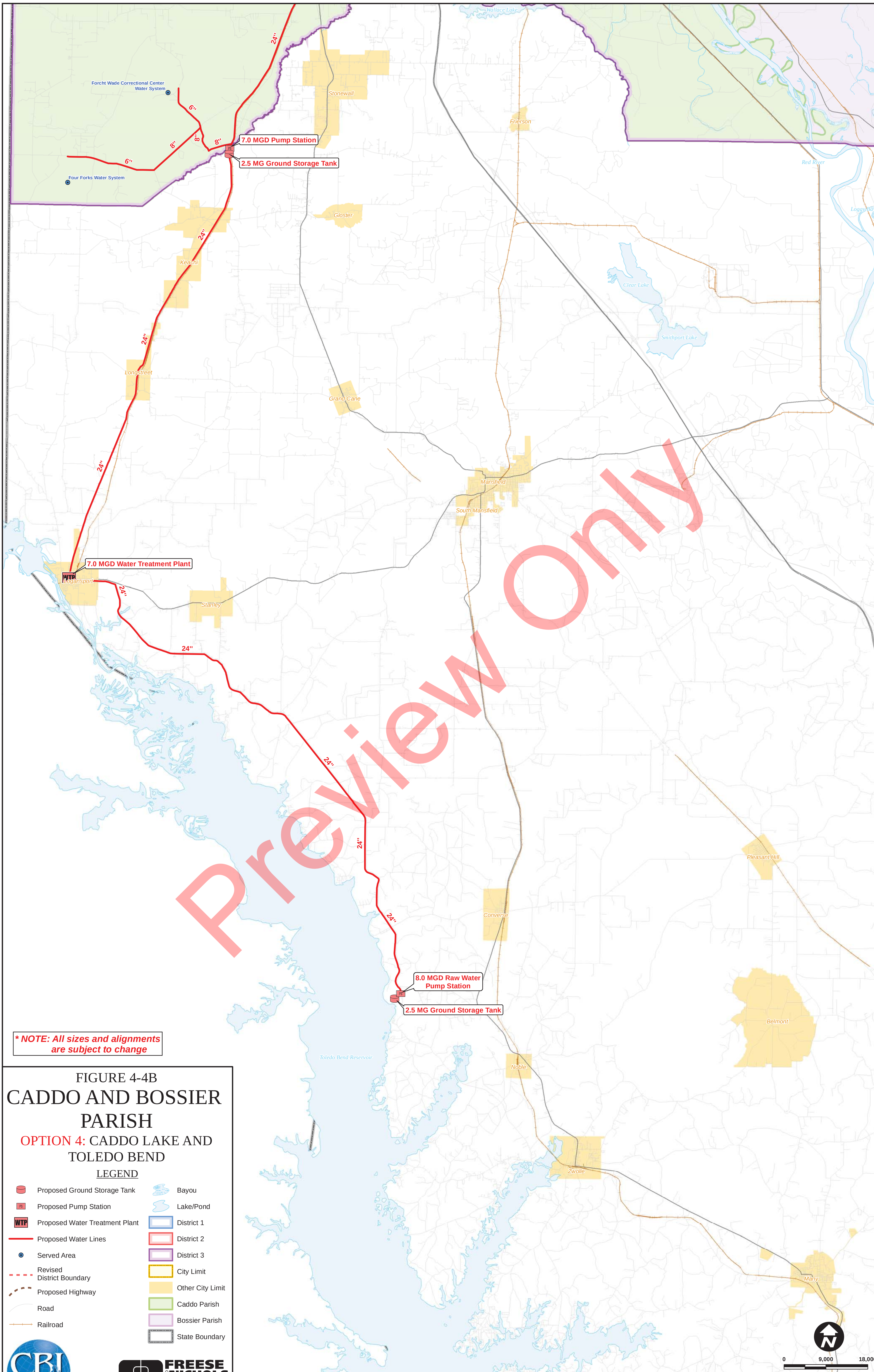

FIGURE 4-4B
CADDO AND BOSSIER PARISH
OPTION 4: CADDO LAKE AND TOLEDO BEND

Preview Only

4.6 Option 5 - Vivian, Blanchard, and Red River

4.6.1 Facilities

Option 5 uses the existing Vivian and Blanchard water treatment plants to serve District 1 and District 2 and a new treatment plant on the Red River to serve District 3. The proposed facilities and water line alignments are presented on Figure 4-5. Option 5 consists of a network of almost 220 miles of pipe ranging in size from 4- to 36-inches, 4 pump stations, 4 ground storage tanks, 2 existing water treatment plants, and 1 new water treatment plant. The Vivian water treatment plant will be expanded to 3.5 MGD and the Blanchard water treatment plant will be expanded to 28.5 MGD, and the new District 3 plant has a capacity of 10 MGD. For costing purposes, it was assumed that all three water treatment plants will have a new intake structures and pump stations. Although Blanchard and Vivian already have intakes, they may not have sufficient capacities to supply the additional water.

Unlike scenarios 1-4, this scenario considers future supplies for the Blanchard system. Costs for facilities are somewhat higher than other scenarios because of the additional treatment and pipeline capacity.

4.6.2 Phasing Options

Option 5 can be phased by district since each district has its own treatment plant. Starting with the existing Vivian or Blanchard water treatment plant will allow customers to be served immediately with a small amount of infrastructure. Phasing should attempt to maximize the number of potential customers as each portion of the system is constructed.

4.6.3 Risks

From a treatment perspective, Option 5 has low risk since it has individual treatment plants for each district. The condition of the Blanchard and Vivian treatment plants is unknown which could increase the costs. The treatment plants are located close to customers so there are fewer opportunities for line breaks. However, as with other options supplied from Caddo Lake, there is significant risk that environmental concerns may delay or increase costs associated with the project.

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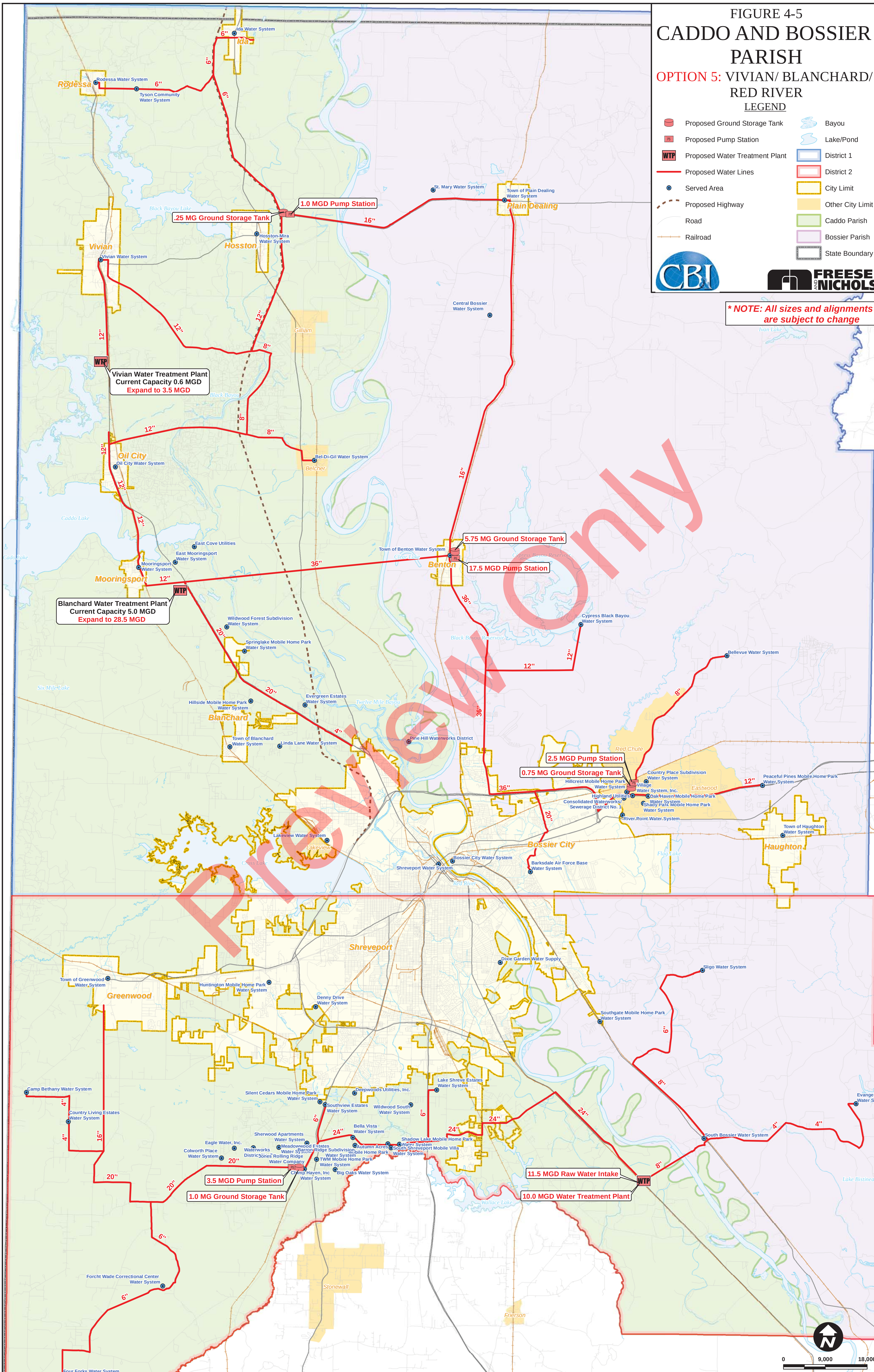

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5.0 Cost Estimates

5.1 General

Cost estimates were developed for each of the options. The cost estimates include costs for the facilities and water lines associated with the regional system. The costs do not include right-of-way costs for the regional system or the cost of running electricity to the regional facilities. Most pipelines are routed along existing roadway right-of-ways. The cost estimates also do not include costs such as storage tanks, meters or other infrastructure associated with connecting the local water providers to the regional system. The costs are in 2013 dollars and include an allowance for engineering, surveying, and contingencies. Unit costs are based on a recent study to standardize cost estimating procedures for regional water planning in Texas.

Table 5-1 provides a summary of the capital cost by district for each alternative. The detailed cost for each option by district is provided in Appendix A.

Table 5-1 Summary of Capital Cost Estimates

<table>
<tr><th></th><th>Option 1</th><th>Option 2</th><th>Option 3</th><th>Option 4</th><th>Option 5[(1)]</th></tr>
<tr><td>District 1</td><td>$18,958,200</td><td>$22,618,800</td><td>$22,618,800</td><td>$18,174,400</td><td rowspan="2">$214,207,500</td></tr>
<tr><td>District 2</td><td>$100,381,100</td><td>$188,319,100</td><td>$193,190,900</td><td>$206,397,600</td></tr>
<tr><td>District 3</td><td>$311,834,900</td><td>$53,206,600</td><td>$101,883,600</td><td>$100,154,200</td><td>$81,699,200</td></tr>
<tr><td>Total</td><td>$431,174,200</td><td>$264,144,500</td><td>$317,693,300</td><td>$324,726,200</td><td>$295,906,700</td></tr>
</table>

(1) In Option 5, Districts 1 and 2 and combined.

Annual costs are discussed in Section 6, the financial analysis.

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6.0 Financial Analysis

6.1 Introduction

The financial analysis provides a general overview of the financial feasibility of developing a new regional public water supply system. This overview considers the operating costs of the new water system, debt repayment on the capital investment and potential sources of income. This analysis also compares the local water rates of the potential customers of the regional provider to potential water rates for the new water system.

There are several different ways the water supply system could be structured for the financial viability of the water supply system. Some considerations in developing the structure of the regional system include:

- Provides wholesale water only;
- Provides retail water only;
- Provides a combination of wholesale water sales and retail sales;
- Has taxing authority within its service area;
- Has authority to impose other fees, such as impact fees to offset capital improvements associated with growth

The regional water supply system could be structured as a wholesale water provider that provides treated water to a specified delivery point to each wholesale customer. This is generally how the five water supply strategies were developed. This provides a clear demarcation of the service area and infrastructure responsibilities. The wholesale customer typically would be billed a minimum annual fee for water service plus a usage amount. If the regional system choses, there may be different customer classes that could reflect the level of commitment to using the water provider. For example, entities that agree to be wholly served by the new water system at the time of formation could be "member" customers and receive slightly lower water rates. Customers that request service at a later time or located outside the basic service area may be charged different rates.

If the water supply system provided retail water to the customers, then the existing water distribution systems would also fall under the responsibilities of the regional provider. There would be a capital cost in obtaining these systems and additional operation and maintenance costs to maintain them. This scenario was not considered in the financial analysis.

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Based on the size and types of potential customers, it is likely the regional water provider may provide both wholesale and retail services. This analysis did not identify which customer would be wholesale and which would be retail. Those most likely to receive retail services would be the systems serving mobile home parks and other small water supply systems.

How the regional water provider system is structured will impact the ability and methods to generate revenues. If the system is created as a political subdivision with taxing authority, then some revenue can be generated through taxes to offset rates. If there are large industries or other large users within the taxing district of the water provider, this can greatly offset the financial impacts to residential and smaller water users. If the taxing area is predominantly residential, then there would be less financial benefits to the residential customers. This is because the revenue would be mostly coming from residential customers, just from two different sources: taxes and rates.

There is also the possibility of generating revenue through other fees. Impact fees are one method of collecting income fees to accommodate growth. Within the service area of the proposed regional water system, there is relatively little growth over the next 25 years. There may be other fee mechanisms that could be incorporated in the structure for the system, such as connection fees or system buy-in fee. These fees were not specifically considered in this analysis.

6.2 Financial Analysis

For this financial analysis the capital and annual costs for the five strategies were reviewed and summarized in Table 6-1.

Table 6-1 Capital and Annual Costs for Options 1 – 5

	Option 1	Option 2	Option3	Option 4	Option 5
Total Capital Cost	$431,174,000	$264,145,000	$317,693,000	$324,726,000	$295,907,000
Total Annual Costs	$44,633,000	$25,963,000	$31,325,000	$31,908,000	$29,451,000
Cost per Acre-Foot	$2,125	$1,236	$1,491	$1,519	$1,269
Cost per 1,000 Gal	$6.52	$3.79	$4.58	$4.66	$3.90

Option 1 has the highest capital and annual costs, followed by Option 4, Option 3, and Option 5. Option 2 has the lowest capital and annual costs of the five options. On a cost basis, Option 2 is the preferred strategy. However, if treatment costs for Red River water are significantly higher than estimated here, the annual costs for Option 2 may be more similar to Options 3 and 4. Option 5 has somewhat higher capital costs than Option 2, but the unit costs are similar because of the larger volume of water supplied in Option 5.

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To determine the financial feasibility of the regional water system, the financial analysis was conducted for Option 2. This option, with the lowest costs, provides a reference point for developing potential rates. The other options would require higher revenues. Option 2 also allows easy phasing of the regional system since each district is distinctly served by its own infrastructure.

The annual costs by district for Option 2 are shown in Table 6-2. For this analysis, it was assumed that the water system to serve District 2 would be implemented first (by 2020 timeframe). District 3 would be added by 2025 and District 1 would be added by 2030. All three districts would be served by 2035. District 2 is the largest district proposed to be served by the new regional provider. Within the service area of this district, approximately 20 percent of the demand is associated with Barksdale AFB.

Table 6-2 Annual Costs by District for Option 2

Option 2: Red River	District 1	District 2	District 3
ANNUAL COSTS			
Debt Service (5.5% for 25 years)	$1,686,000	$14,039,000	$3,967,000
Operation & Maintenance	$131,000	$676,000	$203,000
Electricity - Transmission	$56,837	$346,937	$65,871
Treatment ($0.70/kgal)	$394,000	$3,513,000	$885,000
Total Annual Costs	**$2,267,837**	**$18,574,937**	**$5,120,871**

The costs shown in Table 6-2 are planning level costs using percentages of capital costs to estimate operations and maintenance and expected cost levels for treatment based on similar systems. The actual costs may differ. To estimate the expenses over time for the new regional water system, a more detailed assessment of expenses was conducted. A small inflation rate was included for salaries and electricity. Based on these assumptions, the expected expenses for the regional water system are shown in Table 6-3.

Table 6-3 Estimate of Annual Expenses (2020 – 2035)

Option 2: Red River	2020	2025	2030	2035
ANNUAL COSTS				
Debt Repayment	$14,039,000	$15,725,000	$19,692,000	$19,692,000
Operations	$4,986,239	$6,637,869	$7,992,956	$8,419,714
Total Annual Costs	**$19,025,239**	**$22,362,869**	**$27,684,956**	**$28,111,714**

As previously discussed, the infrastructure developed for this study assumed a wholesale water provider scenario. There are no costs associated with retail water service. Under this scenario, water rates would be developed for the wholesale customer. However, to better understand the impact to the retail customer, a retail customer type rate was developed. This rate includes a base

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service fee and a volume fee, and was developed for a single family residence. No other fees were included. These costs would be in addition to the revenues the wholesale water customer would need to operate the distribution system.

Two rate scenarios were considered: 1) 100 percent of the operating revenues and debt repayment are obtained through rates, and 2) 50 percent of the debt is forgiven through grants or paid through taxes. Based on these assumptions, the estimated rate impacts are shown in Table 6-4.

Table 6-4 Example of Impacts to Monthly Rates for Residential Customers

Option 2: Red River	Service charge	Volume charge	Total for 10,000 gallons
Residential Customer			
1. 100% Revenue through Rates	$15	$3.25	$47.50
2. 50% Grant for Debt Repayment	$15	$1.75	$32.50

This analysis shows that for 100 percent repayment of debt through rates, the potential impact to a typical residential customer would be $47.50 to its monthly water bill. This would be in addition to the revenues needed for the retail water provider. If the regional water system was able to secure grants or implement taxes for 50 percent of the capital improvements, the potential impacts to residential customers would be $32.50, a decrease of $15 per connection per month. If there are large industries within the service area, the potential revenues from taxes could be greater resulting in a potential lower impact to residential rates. The actual impacts to the residential customer will depend on the customer types and rate structures established by the retail provider. It is likely that the wholesale water rates will be structured differently. The retail structure provides a monthly service fee for each connection. The wholesale water structure may also include a monthly service fee and/or may include a minimum take or pay amount. It is important that there is sufficient revenue to cover the fixed costs of the new regional water system.

6.3 Existing Rates of Retail Water Providers

To better understand the impacts to existing rates, a survey of the retail residential customer rates was conducted for the water supply systems within the proposed services area. Some water providers do not have retail water rates, such as Barksdale AFB and the mobile home parks. The mobile home parks typically include a fee for water in the space rental.

Since each retail water provider sets its own rates, the structure of the rates will differ. For comparison purposes, the monthly water bill for a residential customer was calculated for 10,000

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gallons of water. The minimum, maximum and median water rates are shown in Table 6-5 for water providers in each district. For comparative purposes, Table 6-6 shows the rates for Bossier City and Shreveport.

Table 6-5 Water Rates for Existing Water Providers
(Residential Monthly Water Bill for 10,000 Gallons)

Existing Providers	Median	Maximum	Minimum
Residential Customer			
District 1*	$29.00	$29.00	$29.00
District 2	$40.50	$63.00	$38.00
District 3	$40.50	$65.00	$40.50

* At this time rates available for only one customer, so median, maximum and minimum are the same.

Table 6-6 Water Rates for Bossier City and Shreveport

Major Cities	Cost (10,000 Gallons)
Bossier City	$38.84
Shreveport	$31.25

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7.0 Funding

7.1 Potential Sources of Funding

This section presents several options for federal funding for the regional water district. Other sources of funding may be available as well.

7.1.1 Public Works and Economic Adjustment Assistance Programs

The Economic Development Administration (EDA) oversees the Public Works and Economic Adjustment Assistance Programs. This grant can be used to plan, design and construct public works projects recommended in the Economic Development Strategy Plan that bring jobs to economically distressed areas. This EDA program provides 50 to 80 percent of the cost of the project, depending on the applicant's economic situation. EDA typically provides $1 to $1.5 million in funding per project. This amount could be used to purchase of a piece of equipment.

To qualify as economically disadvantaged, a community or Census tract within a community must have a median per capita income less than 80 percent of that of the U.S. or have an unemployment rate greater than the U.S. unemployment rate plus one percent. Neither Caddo Parish nor Bossier Parish as a whole meets the EDA criteria to be considered economically disadvantaged. However, the following rural communities within the proposed service area qualify as economically disadvantaged: Benton, Eastwood, Hosston, Ida, Mooringsport, Oil City, Plain Dealing, Rodessa, and Vivian. Table 7-1 is a comparison of area communities to the EDA criteria.

EDA has established a quarterly award schedule for this program. The FY 2014 deadlines for this program have not been announced. At this time, no funding is currently available due to the Congressional sequestration. However, EDA is accepting, reviewing and approving applications with the anticipation of having funds to award in the near future.

If the proposed project will bring new jobs to the area, then this grant may be an option for the Northwest Louisiana area. The next step would be to look at the local Economic Development Strategy Plan(s). Typically, the local economic development corporation prepares this plan. The project must be consistent with the plan in order to pursue the funding.

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Table 7-1 Comparison of Per Capita Income and Employment Rate to EDA Criteria

Area	Per Capita Income	Unemployment Rate
United States	$27,915	8.7%
EDA Threshold*	**$22,332**	**9.7%**
Belcher	$29,153	8.5%
Benton	*$19,978*	*10.2%*
Blanchard	$25,935	3.9%
Eastwood	$25,040	*13.7%*
Greenwood	$27,974	4.5%
Haughton	$22,474	7.5%
Hosston	*$16,748*	5.9%
Ida	*$18,450*	*13.9%*
Mooringsport	*$14,716*	*12.6%*
Oil City	*$15,293*	*12.9%*
Plain Dealing	*$14,303*	*19.8%*
Red Chute	$29,503	4.3%
Rodessa	*$10,382*	*12.5%*
Vivian	*$20,501*	*14.3%*

Text in *orange italic* indicates economic distress criteria met.

7.1.2 Drinking Water Revolving Loan Fund (DWRLF)

The Louisiana Department of Health and Hospitals (LDHH) Office of Public Health (OPH) manages the Drinking Water Revolving Loan Fund (DWRLF). The DWRLF receives funding from the Environmental Protection Agency (EPA). The DWRLF provides loans at below market interest rates for planning, designing, and constructing public drinking water systems. (Planning and designing tasks must be associated with a construction project.)

The typical repayment period is 20 years for most applicants. Principal repayment must begin at least one year after construction is complete or two years after construction begins, whichever comes first. The loan provides allowances for disadvantaged communities, including longer loan terms, lower interest rates and principal forgiveness. The Secretary of LDHH determines which systems qualify as disadvantaged.

The program includes funding provided by the Federal government. The fund requires that the project include the following elements: NEPA review and Davis-Bacon Act wage rates.

In order for a project to be eligible for DWSRF funding, the applicant must first submit the DWRLF application and also submit a Notice of Intent to Apply for Funding to the Louisiana Water and Wastewater Joint Funding Committee. The process continues with engineering

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contracts, a System Improvement Plan (SIP) with Environmental Impacts, a business plan, plans and specifications, bidding and contract awards, and loan documents. Applications are accepted at all times. Awards are based on availability of funding and the project's readiness to proceed.

7.1.3 Water and Waste Disposal Direct Loans and Grants

The U.S. Department of Agriculture – Rural Development manages the Water and Waste Disposal Direct Loans and Grants program. This program is available to communities having populations less than 10,000 who are unable to secure financing elsewhere. Eligible applicants must meet economic criteria established by the USDA. Funds can be used for construction, land acquisition, engineering, equipment, and other necessary costs.

The program includes loans and grants. The maximum term for a loan is 40 years. Grant opportunities are determined based on the applicant's financial needs. Applications are accepted anytime and are awarded as funding is available.

7.2 Summary of Potential Opportunities

Table 7-2 summarizes the potential federal funding opportunities that might be applicable.

Table 7-2 Summary of Funding Opportunities

Fund	Agency	Application Deadline	Notes
Public Works and Economic Adjustment Assistance Programs, grant	Economic Development Administration	Quarterly	Only available to economically distressed areas. Project must support new, permanent jobs. Funding depends on Congressional appropriations.
Drinking Water Revolving Loan Fund (DWRLF), loan	Louisiana Department of Health and Hospitals (LDHH) Office of Public Health (OPH)	Anytime	LDHH has a defined process to apply for these funds. Economically disadvantaged communities given special consideration.
Water and Waste Disposal Direct Loans and Grants	U.S. Department of Agriculture – Rural Development	Anytime	Only available to communities with population less than 10,000 and meeting certain economic criteria.

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8.0 Summary and Recommendations

8.1 Summary

Phase VI of the Caddo Parish Regional Water/Utility District Master Plan is an economic evaluation of five alternatives for providing water to Caddo and Bossier Parishes. For the purposes of this study, the area was divided into three districts shown in. District 1 consists of the northern portions of Caddo and Bossier Parishes and includes the cities of Plain Dealing and Hosston. District 2 includes Shreveport/Bossier City metropolitan area as well as areas around Caddo Lake. District 3 consists of the southern portions of Bossier and Caddo Parishes and includes Waterworks District #7, Eagle Water Inc., Sligo Water System, South Bossier Water System and several other utilities.

Five options were examined in this study:

- *Option 1 – Toledo Bend.* This option assumes that the entire regional system is served from a single water treatment plant located near Toledo Bend Reservoir. This option has the highest capital and annual costs. This option also has the highest risk, since the entire system would be served from a single water treatment plant. Phased implementation of this project would be less desirable than other options, because much of the system capacity will need to be built in the initial phases of the project.

- *Option 2 – Red River.* Option 2 assumes that each district would have its own water treatment plant taking water from the Red River. This option has the lowest capital and annual costs of the five options. However, annual costs may be underestimated if treatment costs are significantly higher than estimated in this study. This option has the lowest risk because it involves the least transmission facilities and each district has its own treatment plant. This option would also be most amenable for phased implementation, since customers are located relatively near the proposed treatment plants.

- *Option 3 – Red River, Caddo Lake and Toledo Bend.* This option examines using all three proposed sources of water. The Red River would supply water to District 1, Caddo Lake would supply District 2 and Toledo Bend Reservoir would supply District 3. This option has the second lowest capital and annual costs of the five alternatives. District 3 supplies would be at a higher risk than the other districts because of the length of the pipeline from Toledo Bend. This option also has significant environmental concerns because of the increased diversions from Caddo Lake. The District 1 and 3 systems would be amenable for phased implementation because of the proximity of customers to

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the treatment facilities. Phasing of the District 3 system would be less desirable because of the long pipeline needed to deliver water from Toledo Bend.

- *Option 4 – Caddo Lake and Toledo Bend.* This option supplies water from Caddo Lake to Districts 1 and 2 and from Toledo Bend Reservoir for District 3. This option has the second highest capital costs and annual costs. However, the costs are relatively close to Option 3. Like Option 3, District 3 supplies would be at a higher risk than the other districts. This option also has the highest diversion from Caddo Lake, increasing the risk that environmental concerns may inhibit implementation of the project. The District 1 and 3 systems would be amenable for phased implementation because of the proximity of customers to the treatment facilities. Phasing of the District 3 system would be less desirable because of the long pipeline needed to deliver water from Toledo Bend Reservoir.

- *Option 5 – Vivian, Blanchard, and Red River.* Option 5 recommends expanding the Blanchard and Vivian water treatment plants and building a new treatment plant on the Red River. This option provides redundancy by having multiple treatment plants. The condition of the Vivian and Blanchard water treatment plants is unknown and could increase the cost estimates. This option would also be most amenable for phased implementation, since customers are located relatively near the proposed treatment plants.

Table 8-1 is a summary of the five options.

As an alternative to the current boundaries of the districts, it might be beneficial to include customers on the south side of Shreveport in District 3. This could avoid some of the water lines through urban areas. This alternative would probably be most beneficial is Option 2 is chosen as the final configuration. The alternative does not apply for Option 1. The increased capacity of the Toledo Bend system in Options 3 and 4 may eliminate the cost benefit of reducing the length of water lines in urban areas. Option 5 has revised boundaries that remove most of the lines through urban areas.

If the system will be financed through rates, individual customers could see cost increases between $32.50 and $47.50 per month. This cost increase could be reduced if the system is financed through a taxing authority and a significant portion of that tax revenue would be from industries or other entities that do not directly impact rate payers.

8.2 Recommendations

Of the alternatives examined, Option 2 is the most desirable based on cost, risk and environmental issues. However, it may be beneficial to examine potential treatment costs of Red

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River water prior to implementation. Significantly higher treatment costs could change annual costs. Option 5 may be preferable to Option 2 because it makes better use of existing infrastructure and may be more consistent with actual developments in the area. It has similar unit costs for water provided when compared to Option 2. However, there is some risk that environmental issues associated with increased supplies from Caddo Lake may delay the project, increase costs, or even make the project infeasible.

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Table 8-1 Summary of System Options

Option	Facilities	Costs	Risks	Benefits
Option 1 – Toledo Bend	350 miles of pipe 6 pump stations 6 ground storage tanks 1 37 MGD water treatment plant	Capital – $431 million Annual – $45 million $6.25 per 1,000 gallons	Single treatment plant and long transmission from Toledo Bend puts all customers at risk.	Plentiful supply with little environmental impact.
Option 2 – Red River	250 miles of pipe 5 pump stations 5 ground storage tanks 2.5, 27.5 and 7.0 MGD water treatment plants	Capital – $264 million Annual – $26 million $3.79 per 1,000 gallons	Potentially higher treatment costs than estimated.	Most amenable to phasing because customers located relatively close to treatment. Least cost.
Option 3 – Red River, Caddo Lake and Toledo Bend	350 miles of pipe 7 pump stations 7 ground storage tanks 2.5, 27.5 and 7.0 MGD water treatment plants	Capital – $318 million Annual – $31 million $4.58 per 1,000 gallons	District 3 customers at risk because of long transmission from Toledo Bend. High level of environmental concerns associated with Caddo Lake.	District 2 and 3 systems amenable to phasing because customers located close to treatment.
Option 4 – Caddo Lake and Toledo Bend	307 miles of pipe 7 pump stations 7 ground storage tanks 30.0 and 7.0 MGD water treatment plants	Capital – $325 million Annual – $32 million $4.66 per 1,000 gallons	District 3 customers at risk because of long transmission from Toledo Bend. High level of environmental concerns associated with Caddo Lake.	District 2 and 3 systems amenable to phasing because customers located close to treatment.
Option 5 – Vivian/Blanchard and Red River	220 miles of pipe 4 pump stations 4 ground storage tanks 3.5, 28.5, and 10.0 MGD water treatment plants	Capital – $295 million Annual – $30 million $3.90 per 1,000 gallons	Unknown condition of Blanchard and Vivian treatment plants. High level of environmental concerns associated with Caddo Lake.	Multiple treatment plants close to customers to provide reliability.

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9.0 References

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FIGURES

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APPENDICES

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APPENDIX A

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Appendix A
Cost by Option and District

Option 1: Toledo Bend

District 1

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" Pipe	140,156	LF	$18	$2,522,800
2	16" Pipe	108,584	LF	$57	$6,189,300
3	1.9 MGD Pump Station	1	EA	$1,251,000	$1,251,000
4	0.5 MG GST	1	EA	$400,000	$400,000
5	1.0 MG GST	1	EA	$678,000	$678,000
6	3.25 MGD Pump Station	1	EA	$1,723,060	$1,723,100
7	Red River Crossing	1	LS	$973,600	$973,600
		SUBTOTAL:			$13,737,800
		CONTINGENCY		20%	2,747,600
		SUBTOTAL:			16,485,400
		ENG/SURVEY		15%	2,472,800
		SUBTOTAL:			18,958,200

District 2

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	4" Pipe	68,671	LF	$12	$824,000
2	6" Pipe	30,157	LF	$18	$542,800
3	8" Pipe	208,020	LF	$28	$5,824,600
5	12" Pipe	77,368	LF	$35	$2,707,900
6	16" Pipe	166,043	LF	$57	$9,464,400
7	20" Pipe	115,460	LF	$80	$9,236,800
8	24" Pipe	49,840	LF	$102	$5,083,700
9	30" Pipe	29,168	LF	$136	$3,966,800
10	36" Pipe	36,986	LF	$169	$6,250,700
11	42" Pipe	86,852	LF	$203	$17,630,900
12	8.5 MG GST	1	EA	$3,293,750	$3,293,800
13	26 MGD Pump Station	1	EA	$4,342,432	$4,342,400
14	1.0 MG GST	1	EA	$678,000	$678,000
15	3.25 MGD Pump Station	1	EA	$1,723,061	$1,723,100
16	Red River Crossing	1	LS	$1,170,000	$1,170,000
		SUBTOTAL:			$72,739,900
		CONTINGENCY		20%	14,548,000
		SUBTOTAL:			87,287,900
		ENG/SURVEY		15%	13,093,200
		SUBTOTAL:			100,381,100

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District 3

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	4" Pipe	75,672	LF	$12	$908,100
2	6" Pipe	72,820	LF	$18	$1,310,800
3	8" Pipe	12,373	LF	$28	$346,500
4	10" Pipe	16,748	LF	$31	$519,200
5	20" Pipe	18,490	LF	$80	$1,479,200
6	42" Pipe	34,402	LF	$203	$6,983,600
7	48" Pipe	45,733	LF	$237	$10,838,800
8	54" Pipe	269,176	LF	$271	$72,946,700
9	37 MGD Pump Station	1	EA	$5,334,858	$5,334,900
10	14 MG GST	1	EA	$5,842,000	$5,842,000
11	12 MG GST	1	EA	$4,848,750	$4,848,800
12	41 MGD Pump Station	1	EA	$5,695,740	$5,695,700
13	41 MGD Intake	1	EA	$2,472,400	$2,472,400
14	37 MGD WTP	1	EA	$106,440,554	$106,440,600
		SUBTOTAL:			$225,967,300
		CONTINGENCY		20%	45,193,500
		SUBTOTAL:			271,160,800
		ENG/SURVEY		15%	40,674,100
		SUBTOTAL:			311,834,900
PROJECT TOTAL					**$431,174,200**

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Option 2: Red River

District 1

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" Pipe	102,007	LF	$18	$1,836,100
2	16" Pipe	97,689	LF	$57	$5,568,200
3	3 MGD Intake	1	EA	$758,300	$758,300
4	2.5 MGD WTP	1	EA	$5,725,000	$5,725,000
5	0.5 MG GST	1	EA	$400,000	$400,000
6	1.7 MGD Pump Station	1	EA	$1,129,216	$1,129,200
7	Red River Crossing	1	LS	$973,600	$973,600
					-
		SUBTOTAL:			$16,390,400
		CONTINGENCY		20%	3,278,100
		SUBTOTAL:			19,668,500
		ENG/SURVEY		15%	2,950,300
		SUBTOTAL:			22,618,800

District 2

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" Pipe	57,443	LF	$18	$1,034,000
2	8" Pipe	135,397	LF	$28	$3,791,100
3	12" Pipe	179,909	LF	$35	$6,296,800
4	16" Pipe	43,801	LF	$57	$2,496,700
5	20" Pipe	133,943	LF	$80	$10,715,400
6	24" Pipe	20,625	LF	$102	$2,103,700
7	30" Pipe	29,168	LF	$136	$3,966,800
8	36" Pipe	84,439	LF	$169	$14,270,200
9	30 MGD Intake	1	EA	$2,199,800	$2,199,800
10	27.5 MGD WTP	1	EA	$81,627,036	$81,627,000
11	3.5 MGD Pump Station	1	EA	$1,755,389	$1,755,400
12	1.0 MG GST	1	EA	$678,000	$678,000
13	0.75 MG GST	1	EA	$539,000	$539,000
14	2.5 MGD Pump Station	1	EA	$1,624,462	$1,624,500
15	3.0 MGD Pump Station	1	EA	$1,690,733	$1,690,700
16	1.0 MG GST	1	EA	$678,000	$678,000
17	Red River Crossing	1	LS	$996,000	$996,000
					-
		SUBTOTAL:			$136,463,100
		CONTINGENCY		20%	27,292,600
		SUBTOTAL:			163,755,700
		ENG/SURVEY		15%	24,563,400
		SUBTOTAL:			188,319,100

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District 3

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	4" Pipe	117,962	LF	$12	$1,415,500
2	6" Pipe	108,377	LF	$18	$1,950,800
3	8" Pipe	87,239	LF	$28	$2,442,700
4	20" Pipe	105,035	LF	$80	$8,402,800
5	1.5 MGD Pump Station	1	EA	$983,067	$983,100
6	0.38 MGD GST	1	EA	$333,438	$333,400
7	8 MGD Intake	1	EA	$1,126,600	$1,126,600
8	7.0 MGD WTP	1	EA	$21,490,000	$21,490,000
9	Red River Crossing	1	LS	$410,600	$410,600
					-
		SUBTOTAL:			$38,555,500
		CONTINGENCY		20%	7,711,100
		SUBTOTAL:			46,266,600
		ENG/SURVEY		15%	6,940,000
		SUBTOTAL:			53,206,600
PROJECT TOTAL					**$264,144,500**

Preview Only

Option 3: Red River, Caddo Lake, Toledo Bend

District 1

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" Pipe	102,007	LF	$18	$1,836,100
2	16" Pipe	97,689	LF	$57	$5,568,200
3	3 MGD Intake	1	EA	$758,300	$758,300
4	2.5 MGD WTP	1	EA	$5,725,000	$5,725,000
5	0.5 MG GST	1	EA	$400,000	$400,000
6	1.7 MGD Pump Station	1	EA	$1,129,216	$1,129,200
7	Red River Crossing	1	LS	$973,600	$973,600
		SUBTOTAL:			$16,390,400
		CONTINGENCY		20%	3,278,100
		SUBTOTAL:			19,668,500
		ENG/SURVEY		15%	2,950,300
		SUBTOTAL:			22,618,800

District 2

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" Pipe	57,443	LF	$18	$1,034,000
2	8" Pipe	143,170	LF	$28	$4,008,800
3	12" Pipe	179,909	LF	$35	$6,296,800
4	16" Pipe	90,797	LF	$57	$5,175,400
5	20" Pipe	54,758	LF	$80	$4,380,600
6	30" Pipe	29,168	LF	$136	$3,966,800
7	36" Pipe	129,481	LF	$169	$21,882,200
8	27.5 MGD WTP	1	EA	$81,627,036	$81,627,000
9	30 MGD Intake	1	EA	$2,199,800	$2,199,800
10	4.75 MGD Pump Station	1	EA	$2,201,700	$2,201,700
11	1.5 MG GST	1	EA	$939,000	$939,000
12	2.5 MGD Pump Station	1	EA	$1,624,462	$1,624,500
13	0.75 MG GST	1	EA	$539,000	$539,000
14	3.0 MGD Pump Station	1	EA	$1,981,753	$1,981,800
15	1.0 MG GST	1	EA	$678,000	$678,000
16	Red River Crossing	1	LS	$1,458,000	$1,458,000
		SUBTOTAL:			$139,993,400
		CONTINGENCY		20%	27,998,700
		SUBTOTAL:			167,992,100
		ENG/SURVEY		15%	25,198,800
		SUBTOTAL:			193,190,900

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District 3

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	4" Pipe	103,199	LF	$12	$1,238,400
2	6" Pipe	91,116	LF	$18	$1,640,100
3	8" Pipe	51,785	LF	$28	$1,450,000
4	10" Pipe	15,139	LF	$31	$469,300
5	12" Pipe	107,737	LF	$35	$3,770,800
6	20" Pipe	15,216	LF	$80	$1,217,300
7	24" Pipe	316,226	LF	$102	$32,255,000
8	0.5 MG GST	1	EA	$400,000	$400,000
9	1.3 MGD Pump Station	1	EA	$853,157	$853,200
10	7.0 MGD Pump Station	1	EA	$2,363,958	$2,364,000
11	8.0 MGD Pump Station	1	EA	$2,416,043	$2,416,000
12	2.5 MG GST	2	EA	$1,300,000	$2,600,000
13	8 MGD Intake	1	EA	$1,080,500	$1,080,500
14	7.0 MGD WTP	1	EA	$21,490,000	$21,490,000
14	Red River Crossing	1	LS	$584,100	$584,100
		SUBTOTAL:			$73,828,700
		CONTINGENCY		20%	14,765,700
		SUBTOTAL:			88,594,400
		ENG/SURVEY		15%	13,289,200
		SUBTOTAL:			101,883,600
PROJECT TOTAL					**$317,693,300**

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Option 4: Caddo Lake and Toledo Bend

District 1

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" Pipe	79,672	LF	$18	$1,434,100
2	16" Pipe	156,266	LF	$57	$8,907,100
3	0.75 MG GST	1	EA	$539,000	$539,000
4	2.0 MGD Pump Station	1	EA	$1,315,962	$1,316,000
5	Red River Crossing	1	LS	$973,600	$973,600
					-
		SUBTOTAL:			$13,169,800
		CONTINGENCY		20%	2,634,000
		SUBTOTAL:			15,803,800
		ENG/SURVEY		15%	2,370,600
		SUBTOTAL:			18,174,400

District 2

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6" Pipe	57,443	LF	$18	$1,034,000
2	8" Pipe	143,170	LF	$28	$4,008,800
3	12" Pipe	127,441	LF	$35	$4,460,400
4	16" Pipe	72,748	LF	$57	$4,146,700
5	20" Pipe	123,910	LF	$80	$9,912,800
6	30" Pipe	29,168	LF	$136	$3,966,800
7	36" Pipe	129,481	LF	$169	$21,882,200
8	30 MGD WTP	1	EA	$87,141,151	$87,141,200
9	33 MGD Intake	1	EA	$2,335,400	$2,335,400
10	4.75 MGD Pump Station	1	EA	$2,201,706	$2,201,700
11	1.5 MG GST	1	EA	$939,000	$939,000
12	2.5 MGD Pump Station	1	EA	$1,624,462	$1,624,500
13	0.75 MG GST	1	EA	$539,000	$539,000
14	3.0 MGD Pump Station	1	EA	$1,981,753	$1,981,800
15	1.0 MG GST	1	EA	$678,000	$678,000
16	0.5 MG GST	1	EA	$400,000	$400,000
17	1.3 MGD Pump Station	1	EA	$853,157	$853,200
18	Red River Crossing	1	LS	$1,458,000	$1,458,000
					-
		SUBTOTAL:			$149,563,500
		CONTINGENCY		20%	29,912,700
		SUBTOTAL:			179,476,200
		ENG/SURVEY		15%	26,921,400
		SUBTOTAL:			206,397,600

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District 3

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	4" Pipe	103,199	LF	$12	$1,238,400
2	6" Pipe	91,116	LF	$18	$1,640,100
3	8" Pipe	51,785	LF	$28	$1,450,000
4	10" Pipe	15,139	LF	$31	$469,300
5	12" Pipe	107,737	LF	$35	$3,770,800
6	20" Pipe	15,216	LF	$80	$1,217,300
7	24" Pipe	316,226	LF	$102	$32,255,000
8	7.0 MGD Pump Station	1	EA	$2,363,958	$2,364,000
9	8.0 MGD Pump Station	1	EA	$2,416,043	$2,416,000
10	2.5 MG GST	2	EA	$1,300,000	$2,600,000
11	7.0 MGD WTP	1	EA	$21,490,000	$21,490,000
12	8 MGD Intake	1	EA	$1,080,500	$1,080,500
12	Red River Crossing	1	LS	$584,100	$584,100
					-
		SUBTOTAL:			$72,575,500
		CONTINGENCY		20%	14,515,100
		SUBTOTAL:			87,090,600
		ENG/SURVEY		15%	13,063,600
		SUBTOTAL:			100,154,200
PROJECT TOTAL					**$324,726,200**

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Option 5: Vivian/Blanchard and Red River

District 1/2

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	4" Pipe	9,458	LF	$12	$113,500
2	6" Pipe	91,043	LF	$18	$1,638,800
3	8" Pipe	92,856	LF	$28	$2,600,000
4	12" Pipe	262,723	LF	$31	$8,144,400
5	16" Pipe	150,293	LF	$35	$5,260,300
6	20" Pipe	73,909	LF	$80	$5,912,800
7	30" Pipe	29,168	LF	$136	$3,966,800
8	36" Pipe	139,789	LF	$169	$23,624,400
9	Expand Vivian WTP 2.9 MGD	1	EA	$6,641,000	$6,641,000
10	Expand Blanchard WTP 28.5 MGD	1	EA	$83,005,565	$83,005,600
11	3.3 MGD Raw Water Intake	1	EA	$780,000	$780,000
12	33 MGD Raw Water Intake	1	EA	$2,845,000	$2,845,000
13	17.5 MGD Pump Station	1	EA	$3,577,307	$3,577,300
14	5.75 MG GST	1	EA	$2,225,000	$2,225,000
15	1.0 MGD Pump Station	1	EA	$790,589	$790,600
16	0.25 MG GST	1	EA	$266,875	$266,900
17	2.5 MGD Pump Station	1	EA	$1,624,139	$1,624,100
18	0.75 MG GST	1	EA	$539,000	$539,000
19	Red River Crossings	1	LS	$1,667,300	$1,667,300
		SUBTOTAL:			$155,222,800
		CONTINGENCY		20%	31,044,600
		SUBTOTAL:			186,267,400
		ENG/SURVEY		15%	27,940,100
		SUBTOTAL:			214,207,500

District 3

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	4" Pipe	90,618	LF	$12	$1,087,400
2	6" Pipe	132,546	LF	$18	$2,385,800
3	8" Pipe	45,668	LF	$28	$1,278,700
4	16" Pipe	36,112	LF	$57	$2,058,400
5	20" Pipe	68,915	LF	$80	$5,513,200
6	24" Pipe	105,035	LF	$102	$10,713,600
7	10 MGD WTP	1	EA	$32,000,000	$32,000,000
8	11.5 MGD Intake	1	EA	$1,320,000	$1,320,000
9	3.5 MGD Pump Station	1	EA	$1,756,552	$1,756,600
10	1.0 MG GST	1	EA	$678,000	$678,000
17	Red River Crossing	1	LS	$410,600	$410,600
					-
		SUBTOTAL:			$59,202,300
		CONTINGENCY		20%	11,840,500
		SUBTOTAL:			71,042,800
		ENG/SURVEY		15%	10,656,400
		SUBTOTAL:			81,699,200

PROJECT TOTAL	**$295,906,700**

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APPENDIX B

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TO: Jay LeBlanc, File

FROM: Jon S. Albright

SUBJECT: Yield of Caddo Lake

DATE: August 22, 2013

PROJECT: SWI13150

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1.0 SUMMARY

Table 1 is a summary of the yield of Caddo Lake determined using a modified version of the Texas Commission on Environmental Quality's Cypress Basin Water Availability Model (WAM). This model assumes full development of existing upstream water supplies in the Texas portion of the Caddo Lake watershed. (It is assumed that water supply development upstream of Caddo Lake in Louisiana is not significant). According to the Red River Compact, the State of Louisiana can use half of the storage in Caddo Lake for water supply. Assuming that this means that Louisiana has access to half of the firm yield, the maximum supply from the lake for use in Louisiana would be 61,000 acre-feet per year, or approximately 54.4 MGD. In 2011, according to the Louisiana Department of Transportation, about 3,350 acre-feet or 2.99 MGD was used from Caddo Lake.

Table 1: Yield Summary

Minimum Storage (ac-ft)	Minimum Elevation (ft)	Feet Below Conservation (ft)	Yield (ac-ft/yr)	Yield (MGD)
69	156.3	12.2	122,000	108.8
20,000	162.6	5.9	94,000	83.9
40,015	164.6	3.9	64,900	57.9
60,016	166.3	2.2	32,600	29.1
66,363	166.6	1.9	19,500	17.4
72,187	166.9	1.6	3,350	3.0
73,050	167.0	1.5	0	0.0

Portions of upper Caddo Lake have been designated as a Ramsar Wetland, a designation reserved for "wetlands of international importance"[1]. The lake also has problems with giant salvinia, an evasive species than can clog water intakes. The environmental sensitivity of the lake may make development of additional water supplies from this source difficult.

2.0 CADDO LAKE AND WATERSHED

Caddo Lake is located along the Texas-Louisiana border in Marion and Harrison Counties, Texas and Caddo Parish Louisiana. Currently the reservoir has approximately 104,000 acre-feet of storage at conservation elevation of 168.5 feet. Major tributaries include Big Cypress Bayou, Little Cypress Bayou, Black Cypress Bayou and Harrison Bayou. The drainage area of the watershed is 2,744 square miles[2], most of which is located in northeast Texas. Major upstream reservoirs include Lake O' The Pines, Johnson Creek (Wilkes) Reservoir, Ellison Reservoir, Welsh Reservoir, Lake Bob Sandlin, Lake Cypress Springs, and Lake Monticello, all located in Texas.

Caddo Lake, along with Black Bayou, Bistineau, Cross and Wallace Lakes, was originally formed by the "Great Raft", a natural log jam on the Red River. After the removal of the log jam in the 1830s, storage in Caddo Lake was maintained to enhance river navigation by a series of low-water dams beginning in 1914[3]. The current dam structure was completed in 1971[4].

In 1993, Caddo Lake was designated as a Ramsar Wetland of International Importance. The Ramsar Convention on Wetlands is an "intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources[5]". The Ramsar Convention was founded in 1971 and the United States has been a "contracting party" to the treaty since 1977, administrated through the U.S. Fish and Wildlife Service. The designation area is a mixture of public and private lands in the upper reaches of Caddo Lake. All but a small part of the designation area is in Texas.

In 2001, the City of Marshall, which is located upstream of Caddo Lake, made an application to the Texas Commission on Environmental Quality (TCEQ) to change the purpose of use for part of their water right from Big Cypress Bayou from municipal use to industrial use. The City planned to sell the water to a power plant and

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[1] Caddo Lake Institute, "Caddo Lake: the 13th Ramsar Wetland Site", available on-line at http://www.caddolakeinstitute.us/ramsar.html

[2] United States Geological Survey: USGS 07346310 (COE) Caddo Lake at Dam near Mooringsport, LA, http://waterdata.usgs.gov/la/nwis/nwisman/?site_no=07346310&agency_cd=USGS

[3] Great Raft Invasives Program: Caddo Lake, http://www.invasiveswatch.org/site/Lakes/Caddo.aspx

[4] U.S. Army Corps of Engineers New Orleans District: Caddo Lake Water Control Plan, September 1982.

[5] The Ramsar Convention on Wetlands, available on-line at http://www.ramsar.org/

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possibly to others. The change of use did not involve a change in diversion location or the authorized quantity of water granted in the water right. However, it would increase the amount of water diverted from Big Cypress Bayou, since the authorized quantity of water exceeded the expected needs of the City of Marshall. Previously, TCEQ's standard practice was to grant changes in use without notice or opportunity of a hearing. The City of Uncertain and others (primarily environmental groups) successfully challenged this practice based on public welfare concerns associated with impacts on Caddo Lake. This lawsuit has led to a change in TCEQ's practice when considering changes in type of use[6]. The City was ultimately granted their water right amendment, but the planned sale to the power plant did not materialize.

Invasive species have become an issue in Caddo Lake. From a water supply standpoint, giant salvinia can be problematic because it can clog intake structures. Giant salvinia is an aquatic floating fern native to Brazil first observed in Caddo Lake in 2006. Salvinia mats can double in size in one to two weeks. The plant is being controlled by herbicides and bio-control using weevils[7].

Water quality of Caddo Lake has been addressed in Section 8.3.1.2 of the Phase I report.

3.0 WATER SUPPLY

Water supply from Caddo Lake is governed by the Red River Compact. The lake is in Reach III Subbasin 3, which is covered in Article VI Section 6.03. According to this section:

- Texas has full use of flows above the Marshall, Lake O' the Pines (LOTP), and Black Cypress damsites. The Marshall and Black Cypress sites have not been built and are not currently part of the Texas water plan. However, this use is restricted to the full operation of the existing Lake Cypress Springs (Franklin County), Lake Bob Sandlin (Titus County), Ellison Creek Reservoir, Wilkes Reservoir (Johnson Creek), LOTP, other diversions and impoundments at the time of the signing of the Compact (1979), and the proposed Marshall and Black Cypress projects. Lake Monticello and Welsh Reservoir (Swauano Creek) were built in 1973 and 1975, respectively[8], and would presumably be considered part of existing impoundments.

- Any diversions by Texas of the inflow to Caddo Lake below the Marshall, LOTP and Black Cypress damsites, as well as other dam sites in existence at the date of the signing of the Compact will be subtracted from

[6] Supreme Court of Texas: City of Marshall v. City of Uncertain, available on-line at http://caselaw.findlaw.com/tx-supreme-court/1268857.html
[7] The Four Worst Invasive Aquatic Species currently in Lakes of the Great Raft, available on-line at http://www.invasiveswatch.org/site/Invasives/InvasivesInfo.aspx
[8] Freese and Nichols, Inc.: Report 126 Update, prepared for the Texas Water Development Board, 2007.

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Texas' share of the water in Caddo Lake. The "share of water in Caddo Lake" is not explicitly defined. Table 2 is a list of Texas water rights in the reach below the three damsites. Currently there are 22,192 acre-feet per year of permitted diversions and 2,502 acre-feet of authorized storage in the Texas portion of this reach.

- Texas and Louisiana split the storage in Caddo 50/50. This includes any future increase in storage.

The implication of these provisions is that each state gets half of the yield of Caddo Lake. However, this is complicated by the significant number of diversions authorized by the State of Texas in the reach below the Marshall, LOTP and Black Cypress damsites. At least some of these water rights would have access to water originating above the two proposed reservoirs (Marshall and Black Cypress), and the total use by the State of Texas will be less than allowed by the Compact in the foreseeable future. Because of this uncertainty, for the purposes of this study it is assumed that the State of Louisiana has the ability to use at least half of the firm yield of the entire storage in Caddo Lake. This amount should be more than adequate to meet future demands proposed in this study.

The Caddo Lake Compact is a proposed agreement that further refines the potential use of water from Caddo Lake. However, since this document has never been ratified by either state, it has not been considered for this study.

According to the Phase I and Phase II reports, Caddo Lake is currently used by the Blanchard Water System, Mooringsport Water System, the Towns of Greenwood and Vivian, and a few other public water supply systems. Water from the lake is also used for once-through cooling at the Southwestern Electric Power Company's Lieberman Power Plant[9] at Mooringsport. Section 7 of the Phase IV report shows historical water use varying from 94.54 MGD to 2.16 MGD. Most of the variation in water use appears to be associated with the power plant. Actual water use of more than 94 MGD seems unlikely for this source. It is possible that what has been reported in some cases is the diversion associated with the power plant, most of which is returned to Caddo Lake. The actual consumptive use, which is usually defined as the increased evaporation associated with heating the water in the lake, would be much less than the diverted amount. For the purposes of this memorandum, it is assumed

[9] Southwestern Electric Power Company, letter to Ronald L. Ellis of TCEQ regarding Consideration of Cypress Basin for Environmental Flow Rulemaking, December 10, 2010, available on-line at http://www.caddolakeinstitute.us/docs/flows/11.16.10_meeting/AEP_SWEPCO_Comments.pdf

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Table 2: Texas Water Rights below Lake O' The Pines and Proposed Marshall and Black Cypress Damsites

Water Right Number	Owner	Diversion Amount[a] (ac-ft/yr)	Use Type	Priority Date	Reservoir Name	Authorized Capacity (ac-ft)	Stream Name	County
CA 4618	James H Morris	93	Irr	2/21/1979		42	Jims Crk	Marion
CA 4617	Linden Club Lake Inc		Rec	2/7/1972			Jims Crk	Cass
P 4005/A 4349	Longhorn Army Ammunition Plant	1,281	Mun, Ind[b]	4/18/1983		8	Big Cypress & Caddo Lk	Harrison
P 4005/A 4349	US Department Of The Interior		Rec, Other					
P 5302/A 5302	Ross William Rotzler et Ux		Rec	7/10/1990			Unnamed Trib of Holly Crk	Harrison
P 5112/A 5112	Fern Lake Hunting & Fishing Club Inc		Rec	11/25/1986		277	Picnitt Crk	Harrison
CA 4616	Allen-Ware Inc		Rec	8/11/1969	Shadowood Lake	1,325	Unnamed Trib of Deboldin Crk	Harrison
CA 4615	Marshall Lakeside Country Club	10	Irr	12/15/1975		54[c]	Deboldin Crk	Harrison
CA 4614	City Of Marshall	7,558	Mun	4/18/1947			Cypress Crk	Harrison
		8,442	Mun	11/27/1956				
CA 4613	Fair Oil LC	165	Min	2/24/1969			Cypress Crk	Harrison
CA 4612	David R Key	47	Irr	3/23/1955			Ltl Cypress Crk	Marion
CA 4611	T & P Lake Inc et Al	955	Ind	7/1/1943	Holmes Lake	744	Grays Crk	Harrison
P 4254/A 4573	Snider Industries Inc	25	Ind	6/4/1985	Sue Belle Lake	42[c]	Unnamed Trib of Grays Crk	Harrison
CA 4600	Jarvis L Smoak	63	Irr	6/30/1966			Black Cypress	Marion
P 4198/A 4525	Jimmy & Jerry Moore	203	Irr	12/18/1984			Black Cypress	Marion
CA 4596	David R Key Estate	80	Irr	3/19/1957			Cypress Crk	Marion
CA 4595	Jefferson Water & Sewer Dist	2,000	Mun	2/18/1963			Cypress Crk	Marion
CA 4594	Billie J Ellis et Ux	1,080	Irr	1/3/1955			Cypress Crk	Marion
CA 4594	Rancho Guadalupe Inc		Irr	1/3/1955			Cypress Crk	Marion
CA 4592	David R & E M Key	97	Irr	9/30/1969			Cypress Crk	Marion
CA 4593	George D Grogan	85	Irr	5/31/1962		100	Cypress Crk	Marion
CA 4591	H Zeke Grogan	8	Irr	4/30/1967		6	Cypress Crk	Marion

Use Type	Total Diversions (ac-ft/yr)	Total Storage (ac-ft)
Mun	19,281	8
Ind	980	744
Irr	1,766	148
Min	165	0
Rec	0	1,602
Total	*22,192*	*2,502*

Notes

a Diversions limited to consumptive amount
b Total consumptive amount from Cypress WAM
c Water right states that storage amount is exempt so not explicitly authorized in water right

CA Certificate of Adjudication
P Permit
A Application

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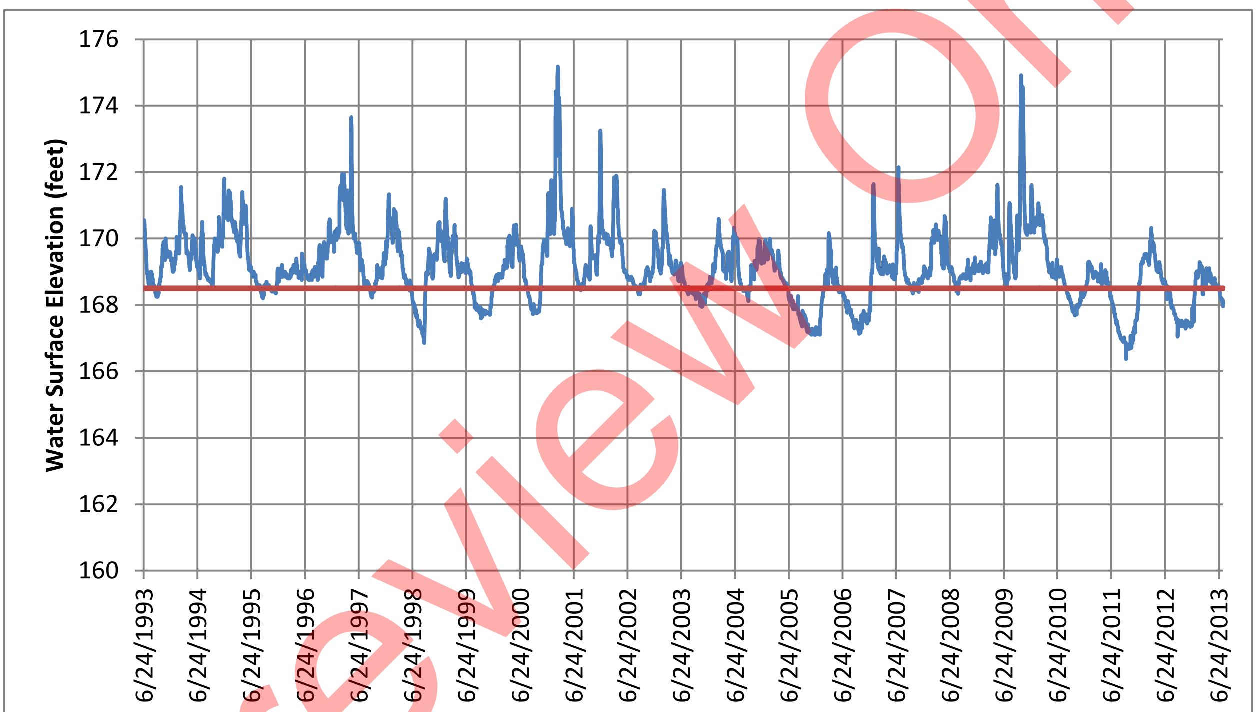
that the 2011 water use of 2.99 MGD (about 3,350 acre-feet) is a reasonable estimate of current water use from the lake.

Figure 2 shows the historical elevation of Caddo Lake from June 24, 1993 through July 23, 2013 as reported by the U.S. Army Corps of Engineers[10]. During this time, the minimum elevation of Caddo Lake was 166.37 feet on October 1, 2011, which is 2.13 feet below the normal pool elevation of 168.5 feet. The red line in Figure 2 is the normal pool elevation. Note that the elevation of Caddo Lake was greater than the normal pool elevation about 77% of the time during this period.

Figure 2: Historical Elevation of Caddo Lake from the U.S. Army Corps of Engineers



In 1998, the U.S. Geological Survey conducted a bathymetric survey of Caddo Lake. This survey found that at elevation 167.58 feet the reservoir had 85,100 acre-feet of storage and a surface area of 18,700 acres11. Extrapolating this value to the normal pool elevation of 168.5 feet, currently the reservoir has approximately 104,000 acre-feet of storage. This value is somewhat less than the 129,000 acre-feet of storage reported in the Phase I report. The 129,000 acre-feet of storage reflects conditions in Caddo Lake prior to 1969, the first

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[10] U.S. Army Corps of Engineers Fort Worth District, historical hydrologic data, available on-line at http://www.swf-wc.usace.army.mil/cgi-bin/rcshtml.pl

[11] Ensminger, Paul A: Bathymetric Survey and Chemical-Related Properties of Caddo Lake, Louisiana and Texas, August and September 1998, prepared for the United States Geological Survey.

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published reference found in this study[12]. At least some of the reduction in volume is the result of sediment collection in the reservoir since the initial survey. Other differences are the result of different methods of calculating reservoir storage.

4.0 MODEL

This study uses a modified version of the TCEQ's Water Availability Model for the Cypress Basin (Cypress WAM). Water availability models have been developed by TCEQ for all river basins in Texas and are used for a variety of water rights and planning activities. WAMs are comprehensive basin-wide models that include all water rights in a basin. The models are an application of the Water Rights Analysis Package (WRAP) developed by Dr. Ralph Wurbs of Texas A&M University. WRAP is a computer model specifically designed to model water rights using the prior appropriation doctrine that is the basis of Texas water law. In this model, water is distributed based on the priority of the water rights in the basin. The Cypress WAM uses historical monthly hydrology from 1948 to 1998.

Although not specifically authorized by a Texas water right, the Cypress WAM includes Caddo Lake as the most downstream point in the model. Caddo Lake is given the most junior priority date in the model, so all Texas water rights have priority over diversions and storage from Caddo Lake.

The Cypress WAM was modified by Freese and Nichols to model current conditions in the Cypress Basin. The most significant modifications include:

- Updates to the code modeling the Cypress Basin Operating Agreement using new features of the WRAP model that were not available when TCEQ developed the models. The Operating Agreement governs the division of water among water users above Lake O' the Pines.
- Use of the most recent volumetric surveys of the major reservoirs in the model, including Caddo Lake
- Use of Caddo Lake storage to back up the Lone Star Ammunition Plant water right

The Cypress WAM should give a conservative estimate of the yield of Caddo Lake based on the current level of development in the basin. The model assumes that all upstream Texas water rights are diverting at their full authorized amounts. Historically, use from the basin has been much less. The model also assumes that the storage in Caddo Lake is never greater than 104,000 acre-feet, the storage at the normal pool elevation of 168.5

[12] Lockwood, Andrews and Newman: Projected Water Needs for Marshall and Harrison County, Texas, as Related to Avaialbe Water Supplies; Especially that from Added Storage in Caddo Lake, Texas-Louisiana, prepared for the Economic Development Administration and the City of Marshall, 1969.

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feet. As shown in Figure 2 the lake tends to remain above conservation much of the time, potentially increasing the available supply from the lake. On the other hand, the model does not include the proposed Marshall or Black Cypress reservoirs included in the Red River Compact. These reservoirs do not have a Texas water right and have not been included in the state water plan. It is unlikely that these projects will ever be built, so excluding these reservoirs is a reasonable assumption.

Table 3 shows the yield of Caddo Lake associated with various drawdown levels. (This table is a repeat of Table 1 found at the beginning of this memorandum.) The first entry in the table, which has a minimum storage that is essentially zero, is the *firm yield* of the lake. The firm yield of 122,000 acre-feet per year is the maximum reliable supply from the lake. Figure 3 shows the storage trace associated with the firm yield simulation. Note that at this demand level the lake would be drawn down significantly. However, the lake would also be full about 60% of the time. This graph shows that there is a significant amount of inflow into the lake in most years – enough to frequently fill the reservoir even if it is drawn down significantly.

Table 3: Yield Summary

Minimum Storage (ac-ft)	Minimum Elevation (ft)	Feet Below Conservation (ft)	Yield (ac-ft/yr)	Yield (MGD)
69	156.3	12.2	122,000	108.8
20,000	162.6	5.9	94,000	83.9
40,015	164.6	3.9	64,900	57.9
60,016	166.3	2.2	32,600	29.1
66,363	166.6	1.9	19,500	17.4
72,187	166.9	1.6	3,350	3.0
73,050	167.0	1.5	0	0.0

The current use from the reservoir is assumed to be about 3.0 MGD (3,350 acre-feet per year), which is equivalent to the yield of about 1.6 feet of storage in the lake. A diversion of about 17.4 MGD (19,500 acre-feet per year) is the maximum development from the reservoir proposed in this study. Full use of this supply would require about 1.9 feet of storage in the reservoir.

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Figure 3: Caddo Lake Storage Trace – Firm Yield Operation (122,000 ac-ft/yr)

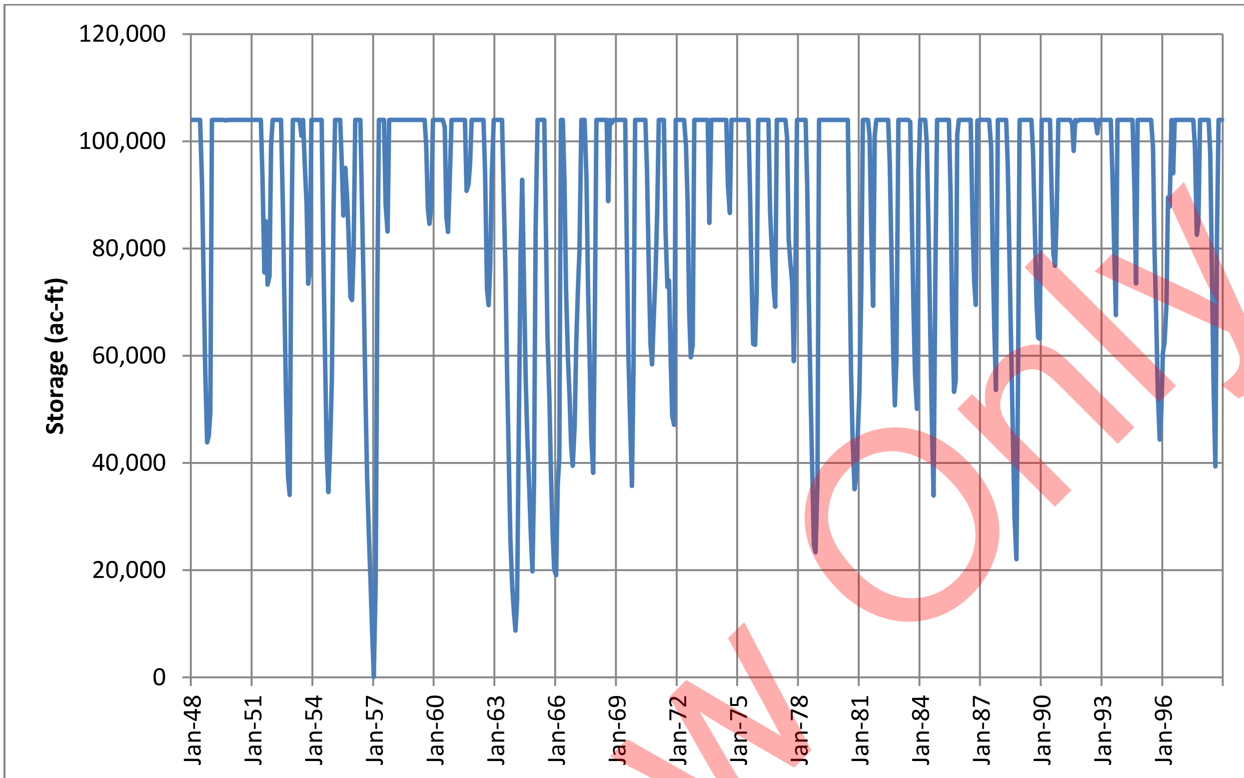

Figure 4 compares the historical elevation frequency to modeled elevations using current demands (approximately 3.0 MGD) and the maximum projected demand in this study (17.4 MGD). Historically, Caddo Lake has been at or above the normal pool elevation of 168.5 feet about 77% of the time. The minimum storage in the available historical records was 166.37 feet on October 1, 2011. The modeled elevation at 3.0 MGD is similar, with the reservoir at conservation 77% of the time and a minimum elevation of 166.9 feet. At the maximum demand level considered in this study (17.4 MGD), the reservoir would be at conservation 74% of the time with a minimum elevation of 166.6 feet. Although there would be some impact on reservoir elevations, the impact would be modest.

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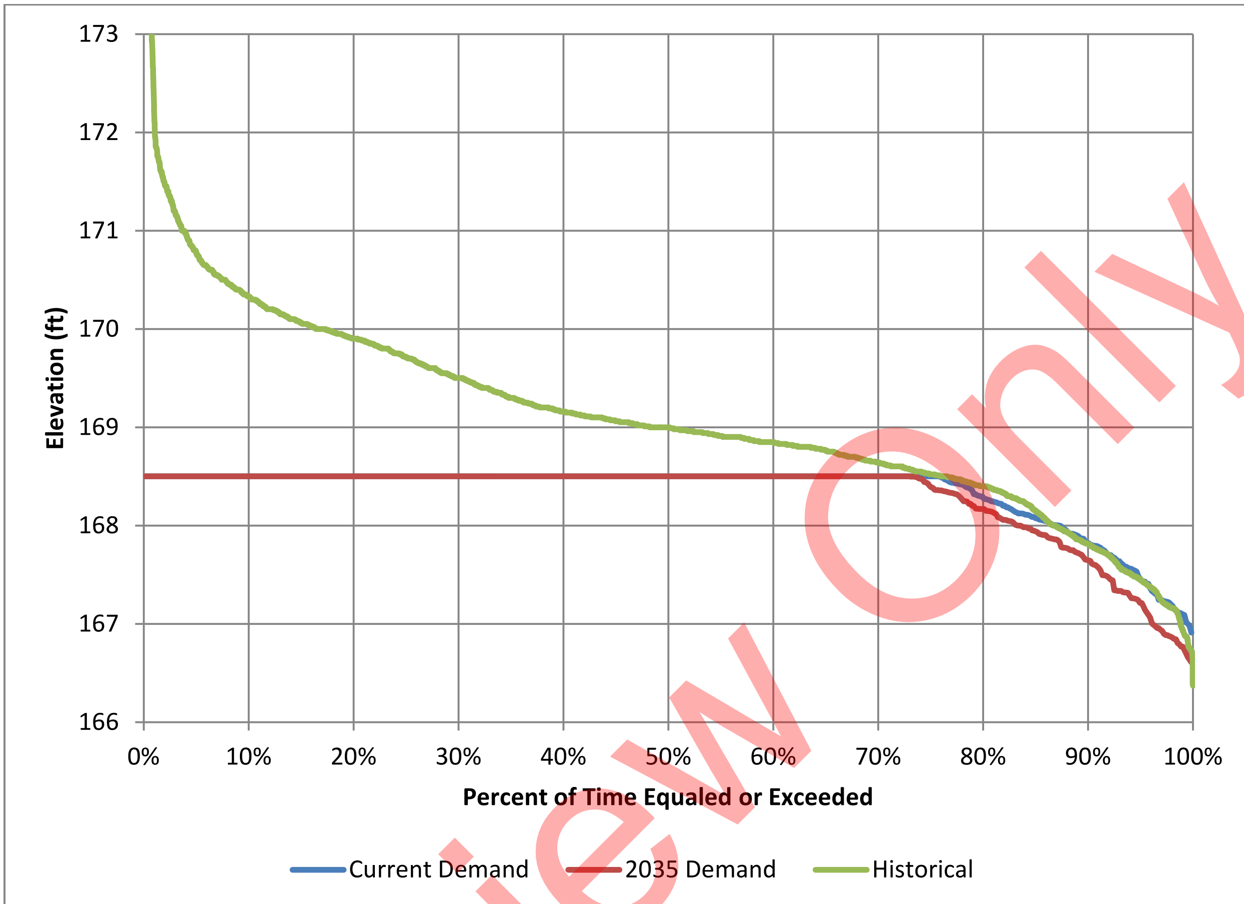
Figure 4: Comparison of Historical and Modeled Elevation Frequency for Caddo Lake



5.0 CONCLUSIONS

Under the Red River Compact, Louisiana's share of the yield in Caddo Lake should be at least 54.0 MGD. There should be sufficient supplies from Caddo Lake to meet demands in Bossier and Caddo Parish.

Currently Caddo Lake has problems with giant salvinia, a fast growing invasive species. This plant can clog water intakes.

Much of the Texas portion of Caddo Lake has been declared a "wetland of international importance." As a result, there are significant environmental issues associated with taking additional water from Caddo Lake. It could be challenging to obtain a federal permit for construction of a new intake.

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