APPENDIX I: DESIGN REPORT FOR LOWER BOIS D'ARC CREEK RESERVOIR RAW WATER PIPELINE

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

Design Report for Lower Bois d'Arc Creek Reservoir Raw Water Pipeline (Project No. 317)

Prepared for:

North Texas Municipal Water District

Prepared by:

FREESE AND NICHOLS, INC.
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NTD13136

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INTRODUCTION

The North Texas Municipal Water District (NTMWD) will be constructing raw water transmission facilities as part of the Lower Bois d'Arc Creek Reservoir (LBCR) Project. These facilities include a raw water intake pump station at the proposed Lower Bois d'Arc Creek Reservoir, a terminal storage reservoir located near Leonard, Texas, and approximately 36 miles of 90-inch raw water pipeline. These raw water transmission projects will be part of an overall system of raw water storage and transmission facilities that will be included in the United States Army Corps of Engineers (USACE) 404 Permit required for the for the construction of LBCR.

By contract dated January 30, 2013, the NTMWD authorized Freese and Nichols, Inc. (FNI) to perform raw water transmission studies and to identify locations for various raw water facilities for Project No. 317 which is the LBCR Final Pipeline Alignment Study and referred to as the "The Project" in this report. Final design and construction will require a separate NTMWD Board Authorization in the future. The purpose of this Preliminary Design Report (PDR) is to summarize the raw water transmission studies, document the technical decisions that were made, and provide FNI's recommendation for the LBCR Raw Water Pipeline alignment. The LBCR Raw Water Pipeline alignment has been split into three design sections that are labeled as Section A, B and C. Section A begins at the proposed LBCR dam and continues south to State Highway (SH) 56. Section B spans from SH 56 to Farm to Market Road (FM) 68. Section C continues from FM 68 to the proposed North Water Treatment Plant (NWTP) site near Leonard, Texas.

This PDR is organized into three primary sections. These sections and their content are summarized below;

- Section 1.0 – Corridor Study – Section A North of 82: This section summarizes the corridor analysis performed for the portion of Section A affected by the decision to move the pump station to the LBCR Dam. This section directs the reader to the Appendices discussing the details of the corridor selection process.
- Section 2.0 – Pipeline Alignment: This section summarizes the overall alignment of the pipeline and directs the reader to the Appendices and a series of technical alignment selection memorandums discussing the details of the alignment selection process.
- Section 3.0 – Preliminary System Hydraulics and Pipe Diameters: This section discusses the

various hydraulic scenarios that were analyzed to determine pipe diameters, interconnections, and design flow rates. This section also discusses sending water from the North Water Treatment Plant near Leonard to Wylie.

1.0 CORRIDOR STUDY – SECTION A NORTH OF US 82

1.1 SECTION A – NORTH OF US 82

1.1.1 Introduction

The corridor for Section A, north of US Highway 82 (US 82), of the LBCR Raw Water Pipeline is defined as a 1,000 foot wide path following a possible pipeline centerline. Once the corridor is selected, the final alignment of the proposed pipeline will be selected from within the chosen corridor. This memo discusses the overall project constraints used to determine the recommended corridor. Selection of the preferred corridor was based on a "desktop" analysis of economic and non-economic factors for various route options. The recommended corridor, documented herein, is used to identify parcels needed for Right-of-Entry (ROE) and is used as a baseline for the first stages of field work and alignment development. The following general parameters were adopted to generate acceptable corridors:

1. Avoid or minimize environmental permitting potential.
2. Align beginning with the proposed Pump Station Site Options.
3. Align end with beginning of Section B.
4. Minimize pipeline length where it does not impact other parameters
5. Minimize impact to landowners along corridor.

This portion of Section A of the LBCR Pipeline is being rerouted due to a decision by the NTMWD to move the pump station site to a location at or near the proposed dam. The shift in the proposed pump station site is also why this Corridor Study is being included in the PDR. Moving the pump station site caused the original Corridor north of US 82 that had been documented and approved via the Technical Memorandum titled "LBCR Conceptual Raw Water Transmission Facilities Design: 404 Permitting Pipeline Route Study, Recommended Pipeline Routes" dated March 11, 2008 to be shifted. The corridors documented and approved via that same Technical Memorandum for south of US 82 on Section A and all of Sections B and C were not affected. The proposed dam will be located approximately 9 miles north-northwest of Honey Grove, Texas. With Section A now beginning at the dam, there are two feasible approaches for the corridor study. The first approach crosses the Honey

Grove Creek arm of the reservoir and the other would be to travel around that arm of the reservoir. The pipeline will begin by heading southeast around the main body of the reservoir. Generally speaking, the pipeline will then head southwest towards the connection point with Section B just east of the intersection of FM 867 and SH 56.

1.1.2 Corridor Alternatives

Five corridors were developed north of US 82 to access the pump station site. The five corridors selected are shown on **Figure 1**. Corridor A1 is shown in dark green, Corridor A2 is shown in red, Corridor A3A is shown in purple and Corridor A3 is shown in teal. Corridor B is shown in lime green. All five corridors share a similar path heading southeast around the main body of the reservoir until Corridor A1 begins heading south to join up with Corridor A2. Corridor A2 diverges from Corridor B and then heads southwest to cross the Honey Grove Creek arm of the reservoir. Corridor A2 continues heading southwest for approximately five miles where it converges with Corridor B just south of US 82. Corridor A3A continues heading south where Corridor A1 converges with Corridor A2. Corridor A3A then crosses the reservoir at a narrower point than Corridor A2. After crossing the reservoir Corridor A3A turns and heads southwest and converges with Corridor A3. Corridor A3 separates from Corridor A2 shortly after Corridor A2 crosses the reservoir. Corridor A3 then heads on a more south-southwesterly heading than Corridor A2 in order to by-pass a large swath of densely wooded areas with numerous creek crossings and several

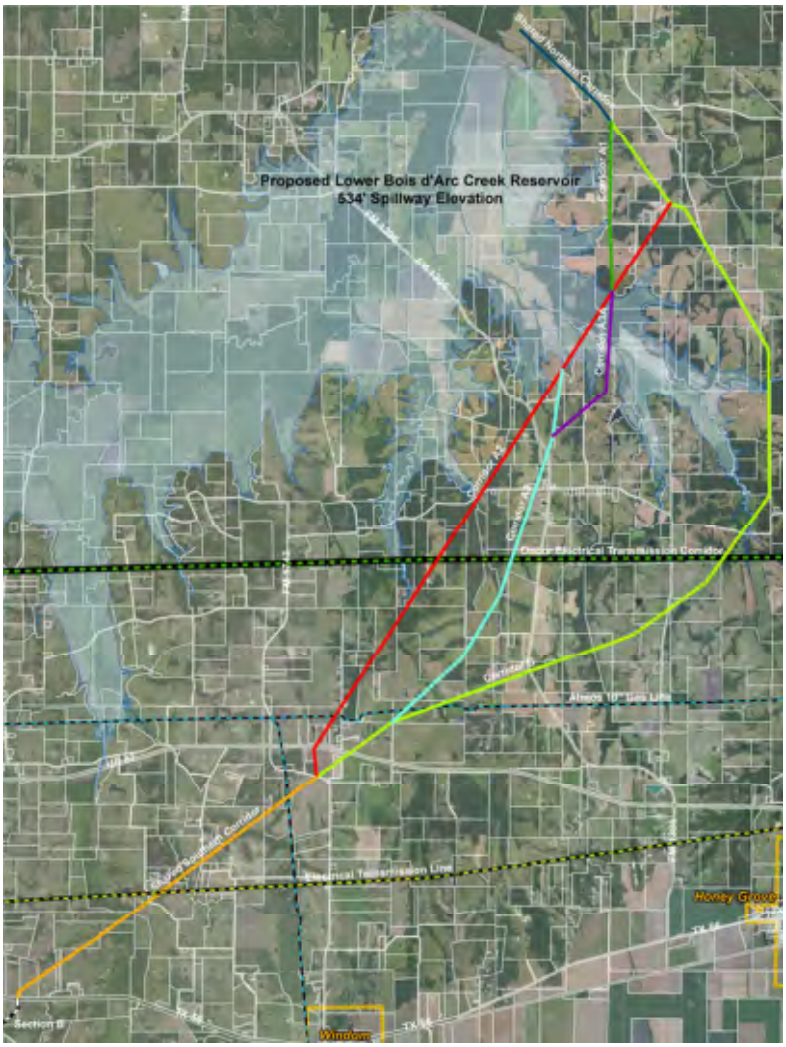


Figure 1 – Overall Segment A Corridor Map

potential environmentally sensitive areas. Corridor A2 then converges with Corridor B just south of the US 82. Corridor B begins by heading southeast around the main body and the Honey Grove Creek arm of the reservoir that the other corridors cut across. Once Corridor B clears the large arm of the reservoir, it heads due south for approximately two miles crossing a smaller finger of the reservoir. Corridor B then turns and begins heading southwest for approximately five miles where it converges with Corridor A2 just south of US 82. The final portion of Section A is approximately five miles long and heads southwest towards the connection point with Section B. The location shown for the pump station represents the approximate pump station site selected by the NTMWD on the service spillway.

1.1.3 Detailed Corridor Analysis

The shared beginning of these corridors has only minor issues and is partially contained in land that will be purchased for the reservoir and spillway. The corridor begins by heading southwest from the pump station site. The corridor travels through mostly open cultivated land before going through a densely wooded area. After coming out of the densely wooded area the terrain opens up to uncultivated land with a few abandoned structures. The corridor then crosses County Road (CR) 2725 and it is at this point where Corridors A1 and B diverge. Overall this portion of the corridor has no apparent environmentally sensitive areas, or major transportation and known utility crossings.

As Corridor A1 heads south it follows along the west side of CR 2725/2730 traveling through sparsely wooded open land. As it follows along CR 2725/2730 the corridor comes upon three houses with cultivated lands. Corridor A1 then crosses CR 2730 before traveling into a densely wooded area where it joins up with Corridor A2. Overall this possible corridor has no apparent environmentally sensitive areas that can be identified at this level of analysis. Corridor A1 cuts off about 2,000 feet of corridor as a shortcut to connect with Corridor A2.

As Corridor A2 heads southwest after separating from Corridor B it comes in close proximity (approximately 500') to a family cemetery. It is near this point where Corridor A2 encounters a densely wooded area. After clearing the wooded area the terrain opens back up to cultivated land. In this area Corridor A2 also crosses CR 2740 just before crossing the Honey Grove Creek arm of the reservoir. Corridor A2 has two possible methods of installation within this corridor to cross the reservoir. One option is to install this section of pipeline by open cut with a casing or tunnel liner plate, and the other option is an aerial crossing, which will be discussed in subsequent sections. This arm of the reservoir is

approximately 4,600 feet wide based on the spillway elevation of the reservoir which is at the 534 foot reservoir contour shown in **Figure 1**.

Both options include additional costs beyond the standard installation price per linear foot. These costs are shown in detail in **Tables 4 & 5**.

After the reservoir crossing, Corridor A2 continues to travel southwest and crosses CR 2745 and FM 1396. Immediately after crossing FM 1396, there are five abandoned structures in a wooded area that shows signs of being a potential forested wetland. The environmental analysis performed for the corridor study will be discussed later in **Section 1.1.4** "Environmental Analysis" of this report. The corridor continues through this wooded area passing through two small plots of cultivated land with houses on each. After this, the corridor heads into a large densely wooded area which Yoakum Creek is located. This area shows signs of potential environmental issues associated with the creek and wooded area. The terrain then briefly opens up into a small cultivated area. In this clearing the corridor also crosses an electrical transmission corridor before entering a sparsely wooded area around Ward Creek that has been flagged as a possible forested wetland. The corridor then crosses through a clearing of uncultivated land before it encounters another sparsely wooded area. As the corridor continues southwest out of the sparsely wooded area, the terrain once again opens up into a clearing. In this clearing the corridor crosses an Atmos 10" transmission gas line. As the corridor continues it passes in between two houses and a small stock tank. There is approximately 900 feet between the two houses. The corridor then crosses US 82 and converges with Corridor B just after crossing FM 1743.

For the portion of the corridor crossing the reservoir, the buried option has inherent maintenance and design concerns. The maintenance issue associated with a long submerged crossing like this is access to the pipe to perform repairs and maintenance throughout the life of the pipeline. With access being the biggest maintenance concern, FNI has provided a conceptual profile view of the reservoir crossing showing a blow-off valve to drain this section of pipe. Along with a manway for access, this would allow for maintenance and repairs on the pipe to be performed from the inside. Also, the annular space between the liner plate and pipe would be grouted for increased stiffness and protection. The constructability issues with this method are that the blow-off valve would be over 40 feet deep and there would be about 1,200 feet of pipe that would be buried deeper than 20 feet. The profile is shown in **Figure 2**.

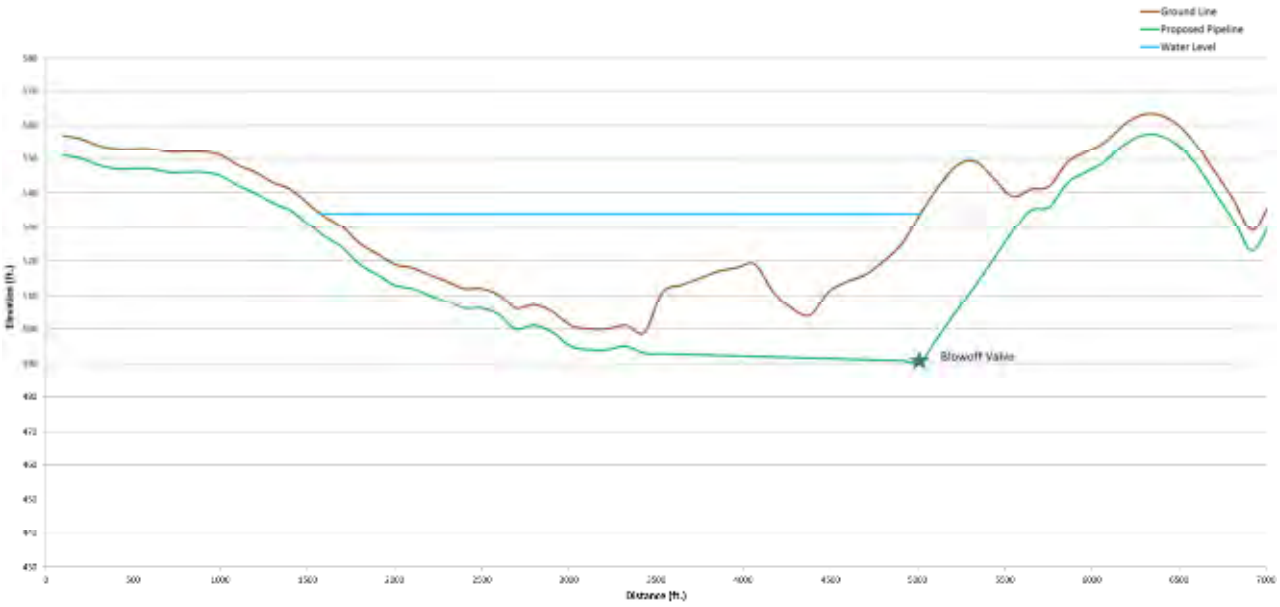


Figure 2 – Corridor A2 LBCR Crossing Profile

Another possible design concern with a submerged pipe is floating of the pipe. This would be of concern while the reservoir is being impounded or when the pipe is dewatered for maintenance. This buoyancy issue has been analyzed with the following assumptions being made. The weight of the pipe, liner plate and the grout in the void between the pipe and liner plate were ignored as an additional factor of safety. The buoyancy force used in the calculations is the air volume for the cross section of the liner plate and not the carrier pipe. All of the above assumptions were used to provide a conservative answer for the required depth of cover. The analysis indicated that with the suggested factor of safety of greater than 1.47 the pipe would need to be buried with a minimum of six feet of cover. For reference, the buoyancy calculations have been included in **Appendix A**.

The aerial crossing option would also have inherent maintenance and design concerns. The maintenance issues associated with an aerial crossing are that the exterior of the pipe would be exposed to a wider array of elements than if it was buried, and the pipe is more vulnerable to major weather events. The constant exposure to the elements could cause accelerated deterioration of the exterior pipe coating, resulting in additional work, in the form of recoating to maintain the exterior coating in order to avoid negatively affecting the design life of the pipe. The aerial crossing developed for this corridor option was a 24 foot wide bridge with vehicle access for maintenance and 100 foot spans.

The aerial crossing is significantly more expensive than the buried option, approximately $15 million. If

the corridor crossing the reservoir is chosen, FNI would recommend the buried option for two reasons. It would be less expensive both in the construction phase and maintenance phase of the pipeline and the previously mentioned design and maintenance concerns that the aerial option presents.

Another option for crossing the proposed reservoir is Corridor A3A which continues south at the convergence of Corridor A1 and A2. Corridor A3A then crosses the reservoir arm south of the Corridor A2 reservoir crossing location. After crossing the reservoir, Corridor A3A travels through open uncultivated land before turning southwest. Shortly after turning southwest, Corridor A3A crosses through a wooded area that does not appear to present any environmental issues. During this wooded area the corridor encounters several small ponds, abandoned structures and one house. After passing through the wooded area, the terrain opens up into uncultivated land and converges with Corridor A3 just west of FM 1396. Overall this alignment avoids environmental concerns, shortens the reservoir crossing by approximately 1,000 feet and shallows out the conceptual pipe profile in comparison to Corridor A2. The profile can be seen below in **Figure 3**.

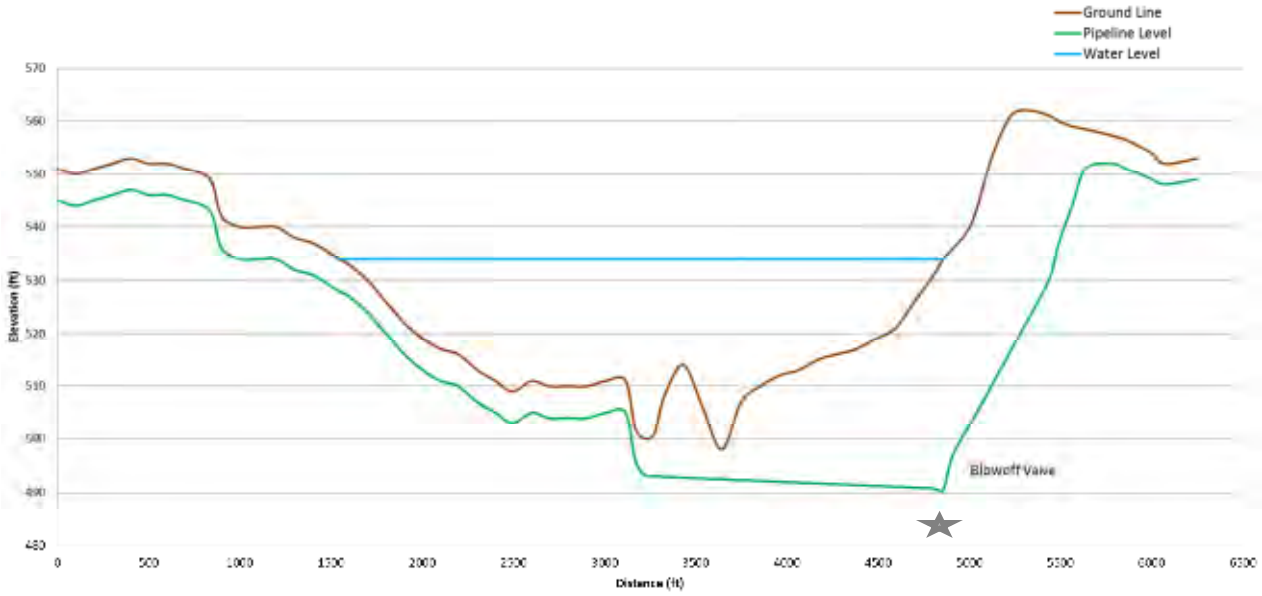


Figure 3 – Corridor A3A LBCR Crossing Profile

Corridor A3 separates from Corridor A2 south of the reservoir crossing and then heads south following through mostly open fields before crossing FM 1396. After crossing FM 1396, the corridor follows just to the west of FM 1396 to avoid the houses near the road. The corridor then travels through sparsely wooded areas before crossing CR 2980. After crossing CR 2980, the terrain changes to a mix of uncultivated and cultivated land and the corridor turns heading southwest. While in this open land the

corridor crosses an Oncor electrical transmission corridor. The A3 corridor continues to head southwest crossing Yoakum Creek and associated riparian zone. This crossing at Yoakum Creek shows signs of potential environmental issues. After crossing the creek the corridor continues southwest across open and cultivated fields. Corridor A3 then crosses Ward Creek near its headwaters, which also shows signs of potential environmental issues. The corridor then continues through open land where it crosses an Atmos 10" transmission gas line. The corridor then crosses CR 2992 shortly before converging with Corridor B. Overall Corridor A3 travels mostly through open and cultivated fields. The locations where it does cross creeks is upstream of Corridor A2 and the riparian zones of the creeks are smaller therefore minimizing the possible environmental impact of the pipeline.

As Corridor B separates from Corridor A1 and continues to head southeast, it travels through a small patch of densely wooded area before crossing through a cultivated field. The corridor then encounters a house and barn located within a densely wooded area just south of the junction of Corridors A2 and B. As the corridor continues heading southeast, it conflicts with a house and several small sheds as well as several ponds before turning to head south. Soon after turning south and going through a clearing, the corridor crosses a small tributary that feeds the reservoir. After clearing the small tributary, the corridor continues through open land and cultivated fields for another mile until crossing a tributary of Honey Grove Creek and turning and to head southwest. Shortly after this change in direction the corridor crosses Honey Grove Creek. These creek crossings may have some environmentally sensitive areas. The corridor then crosses an Oncor electrical transmission corridor as it travels through open land. Shortly after crossing the Oncor electrical transmission corridor, the corridor runs between a house and a large stock tank that has approximately 350 feet of clearance between the two obstacles. The corridor continues heading southwest through mostly open land. Then, just before crossing FM 1396 the corridor crosses three small tributaries and their respective riparian zones. Initial analysis indicates this area may be environmentally sensitive. The corridor then crosses FM 1396 traveling mostly through open and cultivated land before crossing Ward Creek near its headwaters and its corresponding riparian zone. The corridor then travels through open land and cultivated fields. During this portion of the corridor, Corridor B crosses an Atmos 10" transmission gas line before converging with Corridor A3. Soon after converging with Corridor A3, Corridor B encounters two houses and several sheds which shall be avoided. The corridor then crosses US 82 at the CR 2989 intersection. Shortly after this the corridor converges with Corridor A2 just south of FM 1743. Overall Corridor B travels through mostly open lands

or cultivated fields; however, the corridor does include several creek crossings due to Corridor B intersecting the creeks before they converge with one another downstream. This also means that the crossing of the creeks and the respective riparian zones are not as wide as after they converge.

The Shared Southern Corridor has not changed significantly since it was first proposed. At this point the corridors have converged just south of FM 1743. Shortly after they converge, the shared corridor crosses a 3" Atmos distribution line supplying the town of Windom. The corridor then travels through a sparsely wooded area to a more densely wooded area that contains a seasonally flooded creek bed. The shared corridor continues heading southwest through mostly open land with a minor creek crossing. The corridor travels between two adjacent homes with the centerline of the shared corridor approximately 200 feet from either house. Shortly after passing between the houses, there is a creek crossing with associated riparian zones that are not believed to be wetlands. The corridor then travels across open pasture land with a barn and holding pens. Shortly after passing the barn, the shared corridor then crosses Bullard creek just downstream of where Burnett Creek and Bullard Creek converge. The shared corridor then travels through mostly open land and some sporadically wooded areas as the corridor parallels a small creek approximately 400 feet from the centerline of the corridor. The shared corridor then turns and heads due south towards SH 56 to make the connection with Section B. Overall the shared southern corridor travels mostly through open pastures and cultivated land with limited environmental concerns

1.1.4 Environmental Analysis

During the preliminary environmental analysis of the proposed corridors, several areas of concern were identified related to Section 404 permitting. These areas consisted of crossings through potential forested wetland areas as well as areas where the proposed corridor appears to be within, and run parallel to, existing stream beds and crossings at locations where two or more streams converge. The types of data utilized to identify these sites included existing aerial photography, the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) data, and U.S. Geological Survey (USGS) 7.5-minute topographic maps. It should be noted that these areas were identified at a desktop level with no field work or on-site verification. A more definitive assessment of these sites would require on-site investigations by qualified biologists/environmental scientists to determine if these sites are wetlands (as defined by the USACE) and if the proposed corridor would be within, and parallel to, existing streams, or cross at the confluence of two or more streams.

1.1.5 Opinion of Probable Construction Cost

Below is a summary table of the Opinion of Probable Construction Cost (OPCC). **Table 1** shows length, landowner count, linear feet of pipe in a potential environmentally sensitive area, number of creek crossings, linear feet of pipe crossing under LBCR and the costs associated with the project: construction, land, and total corridor cost. Potential environmentally sensitive areas were defined as any low lying wooded areas and riparian zones in a specific corridor. Corridor A1 is shorter than Corridor A1-A3A by about 2,500 feet but it is only slightly less expensive. Corridor A1's reservoir crossing is 1,000 feet longer than Corridor A1-A3A's crossing and it travels through greater amounts of wooded areas resulting in an increased installation cost. Corridor A2-Aerial is the most expensive due to the cost associated with constructing a 24 foot wide bridge with vehicle access for maintenance and 100 foot spans. While Corridor B is significantly longer (approximately 11,000 feet on average) than the other corridors, it is not proportionally more expensive. Corridor B is roughly 15-20% longer than the other corridors but yields a cost only about 5-6% more than the other corridors (excluding the aerial crossing option). This is due to the substantial length of reservoir that the other corridors must cross.

Table 1 – Analysis for Section A North of US 82 Conflict Areas

Segment	Corridor A1	Corridor A2	Corridor A2 Aerial	Corridor A3	Corridor A1-A3	Corridor A1-A3A	Corridor B
Length	66,220	68,345	68,345	69,885	68,035	68,830	78,849
Landowner Count	47	56	56	54	45	48	62
Pipe in Potential Environmentally Sensitive Areas (ft)	22,273	22,827	22,698	13,434	12,662	13,861	18,022
Creek Crossings	9	8	8	5	6	7	11
Pipe Crossing under LBCR (ft)	4,485	4,485	0	4,485	4,485	3,677	0
Construction Cost	$68,860,000	$70,690,000	$85,860,000	$71,090,000	$69,440,000	$68,810,000	$72,000,000
Land Cost	$ 5,000,000	$ 5,310,000	$ 5,310,000	$ 5,350,000	$ 5,020,000	$ 5,100,000	$ 5,790,000
Total Corridor Cost	$73,830,000	$76,000,000	$91,170,000	$76,440,000	$74,460,000	$73,910,000	$77,790,000

*For further cost analysis data see **Tables 3-9**.

1.1.6 Recommendation Summary

FNI recommends Corridor B, as it avoids several possible forested wetland areas by crossing creeks farther upstream and eliminates crossing any large portion of the reservoir with minimal additional cost. Per our discussion on June 21, 2013 with the NTMWD the additional operations and maintenance concerns associated with crossing under the reservoir outweigh the additional length and cost

associated with this corridor. Corridor A2-Aerial also does not cross underneath the reservoir but the additional cost and recurring maintenance associated with the aerial crossing led to the ultimate selection of Corridor B.

1.1.7 Corridor Crossings

All known utility, transportation and creek crossings for Corridor B are listed below in **Table 2**.

Table 2 – Major Transportation, Utility, and Creek Crossings

Road
Fannin CR 2725
Fannin CR 2720
Fannin CR 2710
Fannin CR 2730
Fannin CR 2770
Fannin CR 2765
Farm to Market 1396
Fannin CR 2992
United States Route 82
Fannin CR 2989
Farm to Market 1743
Utility
Oncor Overhead Electric Transmission Lines
Atmos 10" Gas Distribution Line
Waterbody
Tributary of Honey Grove Creek
LBCR Finger (Fox Creek)
Tributary of Honey Grove Creek (2)
Honey Grove Creek
Tributary of Honey Grove Creek
Allen's Creek
Tributary of Allen's Creek (2)
Tributary of Ward Creek
Ward Creek

1.1.8 Conflict Area Cost Analysis

Tables 3-9 on the following pages show a detailed breakdown of how the costs for each alternate were calculated. Land classification can be either rural or urban but for all of Section A it is rural which is shown as an "R" in the tables. The installation class coincides with the type of land the pipe is traveling through. For instance, Installation Class 1 is "Type 1-Open" which is used when the pipeline is traveling through open land and Installation Class 2 is "Type 2-Wooded" which is used when the pipeline is traveling through wooded land and the same relationship between type and installation class are true for the other installation classes. The line item described as "NTMWD Easement Land Cost Reduction" is meant to show the amount of easement that is to be subtracted from the total land costs because this portion of the line is on property that is already owned by the NTMWD.

Table 3 – Corridor A1 Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length [ft]	Land Class	Instll. Class	Land [$/ft]	M&I [$/ft]	EASEMENT LAND COSTS [$]	Material & Installation [$]	Appurtenances & Miscelaneous [1] [$]
Type 1- Open	43,621	R	1	53.72	771	2,343,320	33,631,791	909,030
Type 2- Wooded	19,952	R	2	53.72	786	1,071,821	15,682,272	415,785
Type 3 - Creek Crossings	2,321	R	3	53.72	1211	124,684	2,810,731	48,368
Type 4 - Road/Parking Lot Crossings	126	R	4	53.72	1166	6,769	146,916	2,626
Type 5 - Bore or Tunnel Crossings	200	R	5	53.72	2015	10,744	403,000	4,168
Type 6 - Deep Cut (10-15' cover)	-	R	6	53.72	858	-	-	-
Type 7 - Open Cut With Liner	4,485	R	7	53.72	1436	240,934	6,440,460	93,464
Landowner Count Count[2]	47	EA		25000	$/EA	1,175,000		
Totals:	**66,220**					**$4,973,273**	**$59,115,170**	**$1,473,442**
						CONSTRUCTION COST		**$60,588,612**
						CONTINGENCY	20%	**$12,117,722**
						TOTAL CONSTRUCTION COST:		**$72,710,000**
						TOTAL LAND COST		**$4,970,000**
						TOTAL ROUTE COST		**$77,680,000**

1. Appurtenances & Miscelaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for ROE and acquisition related costs

Table 4 – Corridor A2 Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	Appurtenances & Miscelaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	45,160	R	1	53.72	771	2,425,995	34,818,360	941,102
Type 2- Wooded	20,695	R	2	53.72	786	1,111,735	16,266,270	431,269
Type 3 - Creek Crossings	2,132	R	3	53.72	1211	114,531	2,581,852	44,429
Type 4 - Road/Parking Lot Crossings	158	R	4	53.72	1166	8,488	184,228	3,293
Type 5 - Bore or Tunnel Crossings	200	R	5	53.72	2015	10,744	403,000	4,168
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	858	-	-	-
Type 7 - Open Cut With Liner	4,485	R	7	53.72	1436	240,934	6,440,460	93,464
Landowner Count Count[2]	56	EA		25000	$/EA	1,400,000		
Totals:	**68,345**					**$5,312,428**	**$60,694,170**	**$1,517,725**
							CONSTRUCTION COST	**$62,211,895**
							CONTINGENCY 20%	**$12,442,379**
1. Appurtenances & Miscelaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$74,650,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$5,310,000**
							TOTAL ROUTE COST	**$79,960,000**

Table 5 – Corridor A2-Aerial Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	Appurtenances & Miscelaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	45,309	R	1	53.72	771	2,433,999	34,933,239	944,207
Type 2- Wooded	20,566	R	2	53.72	786	1,104,806	16,164,876	428,581
Type 3 - Creek Crossings	2,132	R	3	53.72	1211	114,531	2,581,852	44,429
Type 4 - Road/Parking Lot Crossings	138	R	4	53.72	1166	7,413	160,908	2,876
Type 5 - Bore or Tunnel Crossings	200	R	5	53.72	2015	10,744	403,000	4,168
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	858	-	-	-
Type 7 - Open Cut With Liner		R	7	53.72	1436	-	-	-
Type 8 - Aerial Crossing	4,485	R	8	53.72	1436	240,934	6,440,460	93,464
Landowner Count Count[2]	56	EA		25000	$/EA	1,400,000		
Totals:	**68,345**					**$5,312,428**	**$60,684,335**	**$1,517,725**
							CONSTRUCTION COST	**$62,202,060**
							CONTINGENCY 20%	**$12,440,412**
1. Appurtenances & Miscelaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$74,640,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$5,310,000**
							TOTAL ROUTE COST	**$79,950,000**

Table 6 – Corridor A3 Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	Appurtenances & Miscelaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	56,100	R	1	53.72	771	3,013,692	43,253,100	1,169,084
Type 2- Wooded	12,916	R	2	53.72	786	693,848	10,151,976	269,160
Type 3 - Creek Crossings	518	R	3	53.72	1211	27,827	627,298	10,795
Type 4 - Road/Parking Lot Crossings	151	R	4	53.72	1166	8,112	176,066	3,147
Type 5 - Bore or Tunnel Crossings	200	R	5	53.72	2015	10,744	403,000	4,168
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	858	-	-	-
Type 7 - Open Cut With Liner	4,485	R	7	53.72	1436	240,934	6,440,460	93,464
Landowner Count Count[2]	54	EA		25000	$/EA	1,350,000		
Totals:	**69,885**					**$5,345,156**	**$61,051,900**	**$1,549,818**
							CONSTRUCTION COST	**$62,601,718**
							CONTINGENCY 20%	**$12,520,344**
1. Appurtenances & Miscelaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$75,120,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$5,350,000**
							TOTAL ROUTE COST	**$80,470,000**

Table 7 – Corridor A1-A3 Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	Appurtenances & Miscelaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	55,017	R	1	53.72	771	2,955,513	42,418,107	1,146,515
Type 2- Wooded	12,144	R	2	53.72	786	652,376	9,545,184	253,072
Type 3 - Creek Crossings	518	R	3	53.72	1211	27,827	627,298	10,795
Type 4 - Road/Parking Lot Crossings	131	R	4	53.72	1166	7,037	152,746	2,730
Type 5 - Bore or Tunnel Crossings	225	R	5	53.72	2015	12,087	453,375	4,689
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	858	-	-	-
Type 7 - Open Cut With Liner	4,485	R	7	53.72	1436	240,934	6,440,460	93,464
Landowner Count Count[2]	45	EA		25000	$/EA	1,125,000		
Totals:	**68,035**					**$5,020,774**	**$59,637,170**	**$1,511,265**
							CONSTRUCTION COST	**$61,148,435**
							CONTINGENCY 20%	**$12,229,687**
1. Appurtenances & Miscelaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$73,380,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$5,020,000**
							TOTAL ROUTE COST	**$78,400,000**

Table 8 – Corridor A1-A3A Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	Appurtenances & Miscelaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	54,616	R	1	53.72	771	2,933,972	42,108,936	1,138,158
Type 2- Wooded	13,343	R	2	53.72	786	716,786	10,487,598	278,059
Type 3 - Creek Crossings	518	R	3	53.72	1211	27,827	627,298	10,795
Type 4 - Road/Parking Lot Crossings	128	R	4	53.72	1166	6,876	149,248	2,667
Type 5 - Bore or Tunnel Crossings	225	R	5	53.72	2015	12,087	453,375	4,689
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	858	-	-	-
Type 7 - Open Cut With Liner	3,677	R	7	53.72	1436	197,528	5,280,172	76,626
Landowner Count Count[2]	48	EA		25000	$/EA	1,200,000		
Totals:	**68,830**					**$5,095,076**	**$59,106,627**	**$1,510,994**
							CONSTRUCTION COST	**$60,617,621**
							CONTINGENCY 20%	**$12,123,524**
1. Appurtenances & Miscelaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$72,740,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$5,100,000**
							TOTAL ROUTE COST	**$77,840,000**

Table 9 – Corridor B Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	Appurtenances & Miscelaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	60,406	R	1	53.72	771	3,245,010	46,573,026	1,258,818
Type 2- Wooded	16,857	R	2	53.72	786	905,558	13,249,602	351,288
Type 3 - Creek Crossings	1,165	R	3	53.72	1211	62,584	1,410,815	24,278
Type 4 - Road/Parking Lot Crossings	196	R	4	53.72	1166	10,529	228,536	4,085
Type 5 - Bore or Tunnel Crossings	225	R	5	53.72	2015	12,087	453,375	4,689
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	858	-	-	-
Type 7 - Open Cut With Liner		R	7	53.72	1436	-	-	-
Landowner Count[2]	62	EA		25000	$/EA	1,550,000		
Totals:	**78,849**					**$5,785,768**	**$61,915,354**	**$1,643,157**
							CONSTRUCTION COST	**$63,558,511**
							CONTINGENCY 20%	**$12,711,702**
1. Appurtenances & Miscelaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$76,270,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$5,790,000**
							TOTAL ROUTE COST	**$82,060,000**

2.0 PIPELINE ALIGNMENT

2.1 SECTION A - NORTH

2.1.1 Introduction

Section A of the LBCR Raw Water Pipeline project was split into two portions, because the location of the LBCR pump station was yet to be determined during preliminary phases of the pipeline alignment analysis. It was determined the southern portion of Section A would be common to both pump station locations being considered and therefore could be analyzed before the pump station location was determined. However, the northern portion of Section A was dependent on the pump station location and thus the alignment evaluation was postponed until the pump station location was determined in the meeting held on April 24, 2013. The dividing point between the southern and northern alignment studies is FM 1743, which is slightly south of US 82. The end point of the southern alignment study for Section A is the proposed connection to LBCR Pipeline Section B located at SH 56. The northern portion of Section A is approximately 11.1 miles and begins by heading southeast around the Honey Grove Arm of the reservoir before heading southwest to the beginning of the southern portion of Section A at FM 1743.

Figure 4 – Evaluated Corridor

The analysis described below was used to determine the recommended alignment for the northern portion of the LBCR Pipeline Section A alignment. The southern portion of Section A was presented in the "Pipeline Alignment Selection Memorandum" dated 19 July 2013 and was accepted by NTMWD at the Alignment review meeting that took place on 8 August 2013. The Technical Memorandum for the southern portion of Section A has been incorporated in this PDR as **Section 2.2**. The following general parameters were adopted to generate acceptable alignments, from the preliminary alignment corridor, for analysis: avoid or minimize environmental permitting potential, align beginning with the proposed Pump Station site and ending with the beginning of the southern portion of Section A, minimize pipeline length where it does not impact other parameters, minimize impact to landowners along route, minimize constructability concerns, and avoid significant terrain that negatively affects hydraulics.

Figure 5 – Overall Segment A – North Alignments

2.1.2 Evaluation of Corridors

The corridor which these alternates are based on is presented in red on **Figure 4** and was originally presented in the "Pipeline Section A Corridor Selection Technical Memorandum" dated June 28, 2013 and incorporated in this PDR as **Section 1.0** – Corridor Study – Section A North of US 82.

2.1.3 Route Alternatives

The northern Section A corridor was analyzed in further detail to identify conflicts and develop

alignment alternatives. Conflict areas were determined based upon aerial imagery and field work. Initial conflict development revealed five conflict areas and are shown in **Figure 5**. The five conflict areas are labeled in descending order from North to South starting at six and going to two. These conflict areas were numbered from South to North in order to keep the numbers in sequence with the established conflict area of the southern portion of Section A. For purposes of this discussion we will cover the conflict areas from North to South which will be in descending order. The reason for covering them from North to South is because this is the order the other sections have used during analysis of their conflict areas.

Figures 5-10 all have a consistent color scheme to show each alternate for the individual conflict areas. The original alignment corridor centerline is shown in blue for each conflict area figure and described as Alternate A in this memorandum. The rest of the alternates are shown in the figures as follows; Alternate B's are magenta, Alternate C's are teal and Alternate D's are pink.

Conflict Area #6 is a house and barn that is directly north of a densely wooded area. Conflict Area #5 is a confluence of several creeks which will form a small finger of LBCR. Conflict Area #4 is a large conflict area that involves avoiding two large stock ponds and crossing an Oncor Electrical Transmission Line and a meandering Honey Grove Creek. Conflict Area #3 is a diversion around a small stock pond and associated creek drainage area along with a 10" Atmos Gas Line that will be crossed in this area. Conflict Area #2 is a tight cluster of buildings that includes two homes, several small sheds and two barn structures. The rest of the terrain in this corridor consists of primarily open and cultivated land with all possible alignment alternatives sharing three major creek crossings. The alignments shown have had an initial field environmental study performed and there are no anticipated wetland concerns. From the localized analysis of each conflict area, alignment alternatives were developed.

The preferred alternative was determined by analysis that compared the total length, number of parcels affected, open cut length, wooded length, tunnel length, construction cost, and land acquisition cost. The recommended alignment was chosen based on the overall cost analysis and engineering judgment. The detailed route analysis of these alignment alternatives is discussed below.

2.1.4 Detailed Route Analysis

Installation cost factors were developed to take into account the varying costs of pipeline construction through different land classifications. Cost data was updated in order to closely coincide with recent bid

information. Routes were classified by the type of land in which they would be installed: open, wooded, open cut creek crossings, open cut road crossings, or tunneled crossings. A construction cost and land acquisition cost was associated with each classification in order to estimate the total route cost per linear foot. This allowed a cost to be generated for each alternate based upon the linear footage of the land classification. From this, a cost comparison was performed for the alternates in order to determine the most cost effective route.

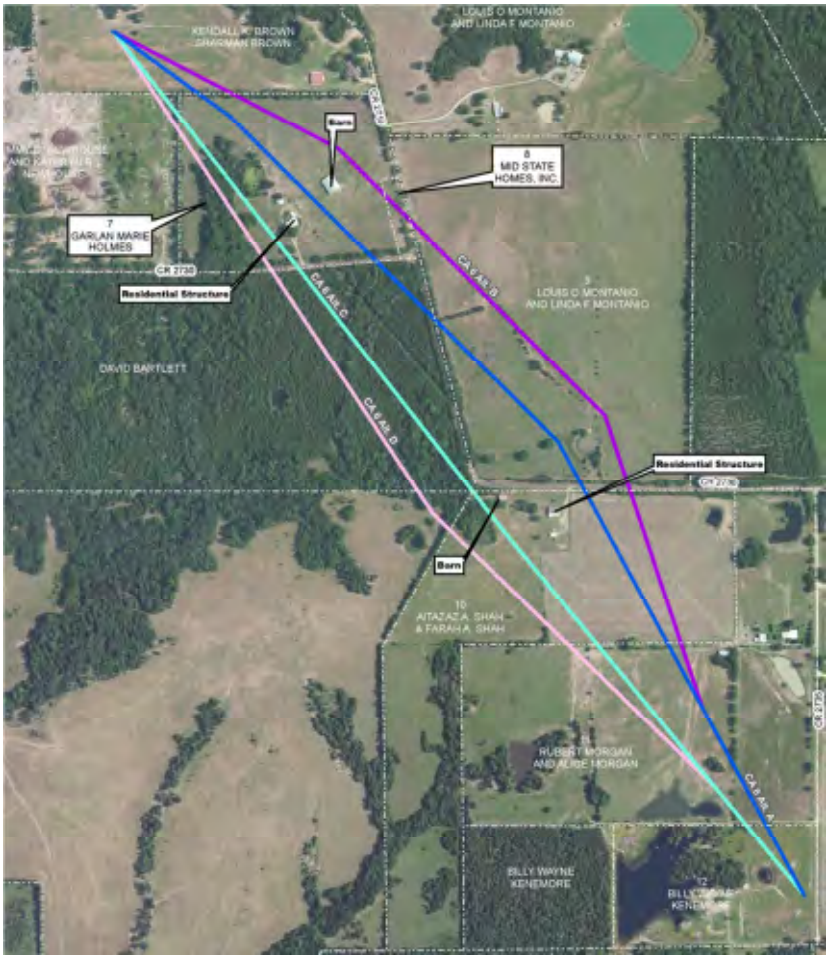


Figure 6 – Aerial View of Conflict Area #6

Conflict Area #6 was identified because of the close proximity of two homesteads to a densely wooded area along CR 2730. The two homesteads are located to the north and south of the densely wooded area and both include uninhabited structures as well as small ponds. The densely wooded area also has several ponds visible from aerial imagery. Four alternatives have been proposed to provide a compromise between landowner impact, constructability, and cost. All of the alternatives diverge at the same point approximately 1300 feet northwest of the house that is north of the densely wooded area. Alternate A was the original centerline of the preliminary alignment corridor and provides a compromise between going around the homes and wooded area or going through the wooded area west of CR 2710. Alternate B was developed to provide a route that avoids the conflict area. Alternate C was developed to show a straight line between the limits of the conflict area. Alternate D shows a slight bend in order to provide adequate spacing from the existing ponds. Conflict Area #6 and the four alternatives can be seen in **Figure 6**.

All of the alternates are similar in cost. Only $150K separates all of the options, as shown in **Table 10** below. Alternates C and D are the two least expensive options but they cross through over 2,000 feet of forested land. While Alternate A eliminates two-thirds of the wooded crossing, it comes within 150 feet of the homes to the north and south of the densely wooded area. Alternate B is the most expensive but it also has the least amount of pipe in a wooded area and allows for more space between the pipeline and the homes in this conflict while affecting the least amount of parcels. Alternate B is the preferred alignment because it minimizes environmental and land owner impact.

Table 10 – Analysis for Conflict Area #6

Option	Alternate A	Alternate B	Alternate C	Alternate D
Length (ft.)	5,944	6,121	5,873	5,902
Number of Parcels	7	7	8	8
Open Length (ft.)	5,153	5,898	3,759	3,786
Wooded Length (ft.)	791	223	2,114	2,116
Tunnel/Bore Length	0	0	0	0
Construction Cost	$ 4,880,000	$ 5,000,000	$ 4,830,000	$ 4,860,000
Land Acquisition Cost	$ 490,000	$ 500,000	$ 520,000	$ 500,000
Total Cost	$ 5,370,000	$ 5,500,000	$ 5,350,000	$ 5,360,000

*For further cost analysis data see **Tables 30-33**.

Conflict Area #5 is the confluence of several branches of Fox Creek as well as a small finger of LBCR. Due to environmental and constructability concerns, proceeding directly through the creek confluence was not considered within the alignment options. Four alternatives were developed for proceeding through this conflict area. Alternate A crosses a small finger of LBCR slightly west and downstream of the Fox Creek Confluence. Alternate B swings east of the Fox Creek Confluence and the finger of LBCR. Alternate C was developed to provide a shorter alternative that also traveled east around the Fox Creek Confluence and finger of LBCR. Alternate D takes a more direct route closely hugging the Fox Creek Confluence then continuing in open land as oppose to forested land as shown for Alternates B and C. Conflict Area #5 and the four alternatives can be seen in **Figure 7** to the right.

Figure 7 – Aerial View of Conflict Area #5

All of the alternates cross Fox Creek. Alternate A is the shortest most direct route to navigate this conflict and therefore the least expensive. It also goes through less wooded areas than the other three alternates; however, it crosses under approximately 500 feet of LBCR when it is at the 534 foot pool elevation. All of the other alternates are similar in cost as shown in **Table 11** on the next page and have multiple creek crossings because they cross upstream of the Fox Creek Confluence. Alternate A is the preferred route through this conflict area because it minimizes the number of creek crossings, parcels and has the lowest cost.

Table 11 – Analysis for Conflict Area #5

Option	Alternate A	Alternate B	Alternate C	Alternate D
Length (ft.)	10,198	10,700	10,673	10,609
Number of Parcels	4	5	5	6
Open Length (ft.)	8,279	7,328	7,327	8,028
Wooded Length (ft.)	1,923	3,372	3,346	2,581
Tunnel/Bore Length	0	0	0	0
Construction Cost	$ 8,570,000	$ 8,85,000	$ 8,840,000	$ 8,800,000
Land Acquisition Cost	$ 260,000	$ 430,000	$ 410,000	$ 360,000
Total Cost	$ 8,830,000	$ 9,280,000	$ 9,250,000	$ 9,160,000

*For further cost analysis data see **Tables 26-29**.

Conflict Area #4 was identified because of two large private ponds that are in close proximity to each other. This conflict area is very large due to the Honey Grove Creek Confluence near the northern boundary of this conflict area and the string of four houses along CR 2765 that are in the immediate area of the two large ponds near the southern boundary of this conflict area. Four alternatives have been proposed to traverse this conflict area. Alternate A crosses Honey Grove Creek downstream of the confluence and then cuts through open land offset from a tributary by 180 feet at its closest point until crossing between a house and the northernmost pond. Alternate B closely parallels Alternate A to the North hugging CR 2765 at a slight bend to squeeze between a mobile home and the road. Alternate C goes farther south and crosses in between the two ponds. Alternate D is an off shoot of Alternate B providing a route around the mobile home and a house to the North. Conflict Area #4 and the four alternatives can be seen in **Figure 8**.

All of the alternates in this conflict will cross Honey Grove Creek, an Oncor Transmission Corridor and two County Roads. Due to the high steep banks of Honey Grove Creek in the area that all of these alignments cross the creek, the pipeline would be installed by bore or tunnel to cross Honey Grove Creek. Alternate C is the longest and most expensive option as it travels upstream and south of the Honey Grove Creek Confluence. This allows it to cross smaller creeks and stay on a ridge line between the two large ponds near CR 2765. Alternates A, B and D follow similar paths crossing Honey Grove Creek downstream of the confluence. Alternate A then follows a tributary of Honey Grove Creek before it crosses in between the northern large pond and a home. It is approximately 140 feet from both the home and the water's edge. Alternate B is the shortest and least expensive route. As it crosses CR 2765 it passes in between two homes, 120 feet from a mobile home and 200 feet from a house. Alternate D follows Alternate B with the exception of the crossing of CR 2765. Alternate D goes around the homes that Alternate B splits which causes Alternate D to be slightly longer. **Table 12** details each alternate below. Alternate B is the preferred route through this conflict area because it is not only the least expensive but also minimizes landowner impact and length of pipe in wooded land.

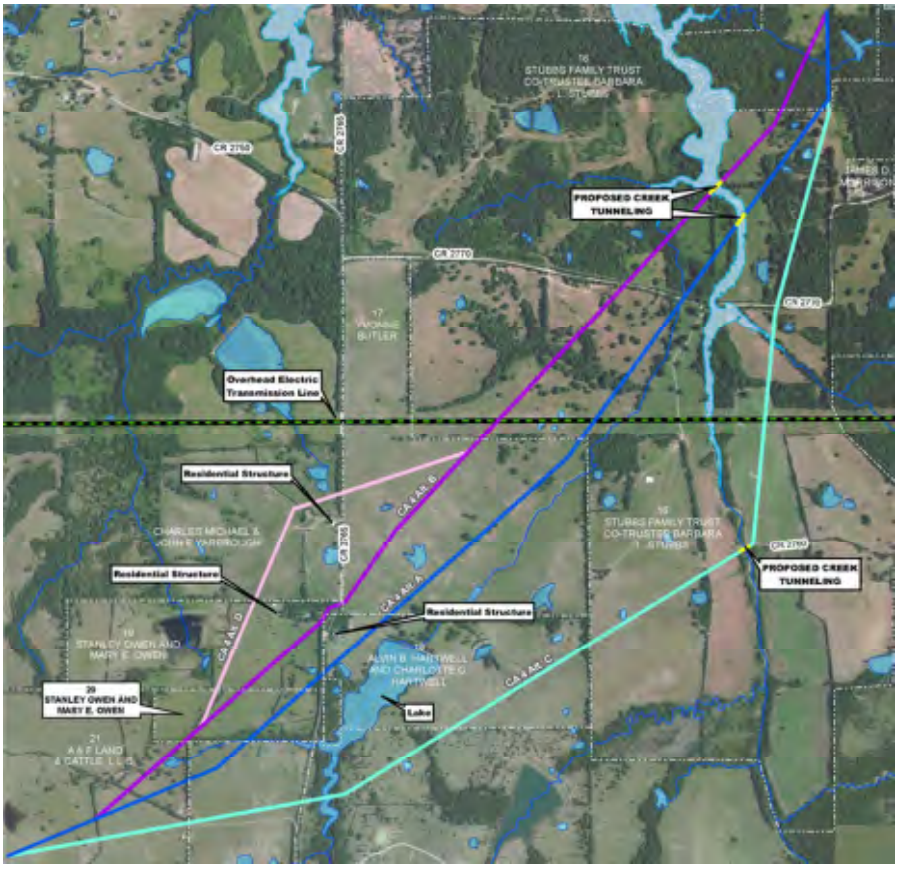


Figure 8 – Aerial View of Conflict Area #4

Table 12 – Analysis for Conflict Area #4

Option	Alternate A	Alternate B	Alternate C	Alternate D
Length (ft.)	13,347	13,006	14,826	13,395
Number of Parcels	7	6	5	6
Open Length (ft.)	10,073	10,204	6,611	10,692
Wooded Length (ft.)	3,079	2,592	8,095	2,493
Tunnel/Bore Length	195	210	120	210
Construction Cost	$ 11,270,000	$ 11,020,000	$ 12,510,000	$ 11,330,000
Land Acquisition Cost	$ 830,000	$ 780,000	$ 860,000	$ 800,000
Total Cost	$ 12,100,000	$ 11,800,000	$ 13,370,000	$ 12,130,000

*For further cost analysis data see **Tables 22-25**.

Conflict Area #3 was identified because of a stock pond that feeds a small creek and there is also 10" Atmos gas line that runs east-west in this area. Two alternatives have been proposed to travel around this conflict area. Alternate A travels to the north of the pond and creek. Alternate B heads south around the pond and creek. Conflict Area #3 and the two alternatives can be seen in **Figure 9** below.

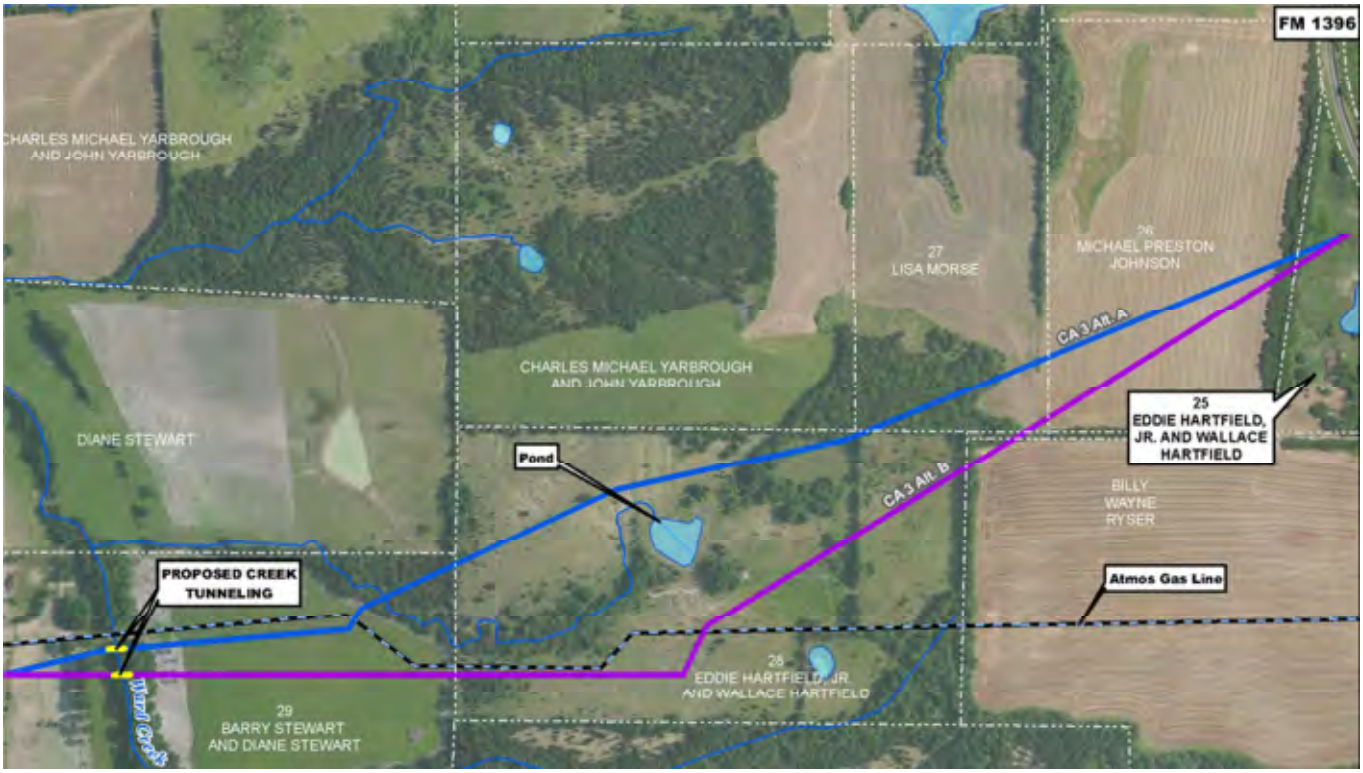


Figure 9 – Aerial View of Conflict Area #3

Both alternates will cross Ward Creek and the 10" Atmos gas line. The crossing of Ward Creek will be installed by bore or tunnel. This is due to the steep banks of Ward Creek. Alternate B heads south of the pond and then parallels the Atmos gas line until shortly after crossing Ward Creek. Alternate A stays north of the pond and is least expensive option and our preferred route, for specific numbers see **Table 13** below.

Table 13 – Analysis for Conflict Area #3

Option	Alternate A	Alternate B
Length (ft.)	5,469	5,691
Number of Parcels	5	6
Open Length (ft.)	4,075	5,013
Wooded Length (ft.)	1,294	578
Tunnel/Bore Length	100	100
Construction Cost	$ 4,610,000	$ 4,780,000
Land Acquisition Cost	$ 420,000	$ 460,000
Total Cost	$ 5,030,000	$ 5,240,000

*For further cost analysis data see **Tables 20 & 21**.

Conflict Area #2 consists of two homesteads that are very close to each other. This conflict area includes two houses as well as a barn and several sheds. Three alternatives were developed for this conflict area. Alternate A goes south around the cluster of buildings while Alternate C goes north around the cluster of buildings. Alternate B also goes south around the houses but it is a more direct route than Alternate A. Conflict Area #2 and the three alternatives can be seen in **Figure 10**.

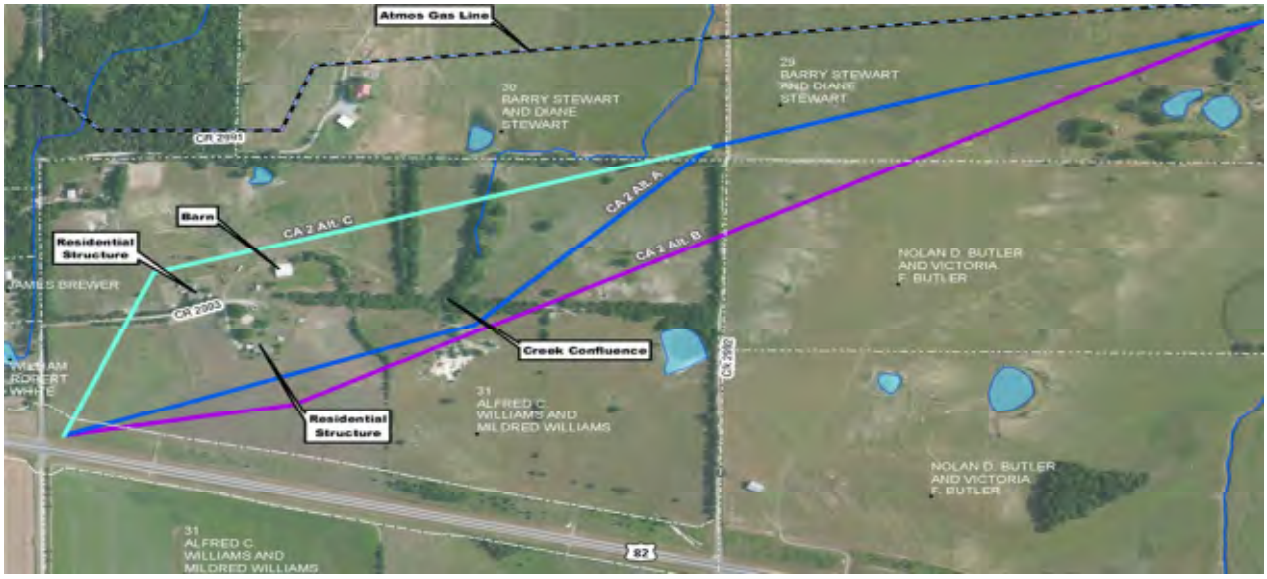


Figure 10 – Aerial View of Conflict Area #2

Alternate C is the longest and most expensive alternate and also crosses a small creek which the other two alternates do not. Alternate B is the least expensive option as it is the shortest route. Alternate B's direct route does encounter two small drainage features that may present maintenance concerns as the scours in the drainage features change after construction. One drainage feature is an old borrow pit that has had a channel scoured out over time connecting it to a small pond to the north. The other drainage feature is an erosion area that has scoured out over time but does not seem to drain to a distinguishable water body. Alternate A is slightly longer and more expensive than Alternate B, for specific numbers see **Table 14**. Alternate A however avoids one of the erosion areas that Alternate B travels through and it passes through a smaller section of the borrow pit than Alternate B.

Table 14 – Analysis for Conflict Area #2

Option	Alternate A	Alternate B	Alternate C
Length (ft.)	5,310	5,235	5,485
Number of Parcels	3	3	3
Open Length (ft.)	5,145	5,055	5,055
Wooded Length (ft.)	165	180	430
Tunnel/Bore Length	0	0	0
Construction Cost	$ 4,350,000	$ 4,280,000	$ 4,500,000
Land Acquisition Cost	$ 360,000	$ 360,000	$ 370,000
Total Cost	$ 4,710,000	$ 4,640,000	$ 4,870,000

*For further cost analysis data see **Tables 17-19**.

2.1.5 Opinion of Probable Construction Cost

The Opinion of Probable Construction Cost (OPCC) for the northern portion of the Section A recommended alignment as described above is $60,653,050. A detailed breakdown of the OPCC for the preferred alignment is shown in **Table 15** below.

Table 15 – Opinion of Probable Construction Costs

NTMWD
Lower Bois d'Arc Creek
Reservoir Raw Water
Pipeline

FREESE AND NICHOLS

1701 N Market St., #500, LB51 • Dallas, Texas 75202 • 214-217-2200 • fax 214-217-2201

OPINION OF PROBABLE CONSTRUCTION COSTS (INCLUDING EASEMENTS) — November 25, 2013

ESTIMATOR	CHECKED BY	ACCOUNT NO
WRS	ASM	NTD13136

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	90-INCH PIPELINE	58,005	LF	$650.00	$ 37,703,250
2	TUNNELED CROSSINGS	230	LF	$1,970.00	$ 453,100
3	PIPELINE ROW CLEARING	160	AC	$5,000.00	$ 800,000
4	TRENCH SAFETY	58,005	LF	$1.00	$ 58,005
5	AIR RELEASE VALVES	17	EA	$25,000.00	$ 415,000
6	BUTTERFLY VALVES	2	EA	$165,000.00	$ 330,000
7	BLOW OFF VALVES	17	EA	$25,000.00	$ 415,000
8	PAVEMENT RESTORATION	940	SY	$70.00	$ 65,800
9	CREEK CROSSINGS	1,053	LF	$445.00	$ 468,585
10	REVEGETATION	160	AC	$1,160.00	$ 185,600
11	FIBER OPTIC CONDUIT	58,235	LF	$3.00	$ 174,705
12	FIBER	58,235	LF	$2.00	$ 116,470
13	CATHODIC PROTECTION	58,235	LF	$2.00	$ 116,470
14	ACCESS MANWAYS	17	EA	$10,000.00	$ 166,000
15	TESTING	58,235	LF	$2.00	$ 116,470
16	MOBILIZATION	1	LS	$2,079,223.00	$ 2,079,223
	CONSTRUCTION SUBTOTAL				$ 43,660,000
	CONSTRUCTION CONTINGENCY	15%			$ 6,549,000
	CONTRUCTION TOTAL				$ 50,209,000
	ESTIMATED EASEMENT/PROPERTY COSTS				
	PERMANENT EASEMENT W/ ASSOCIATED TEMPORARY [1]	2,188,900	SF	$1.00	$2,188,900.00
	TOTAL ESTIMATED COSTS (INCLUDING EASEMENT)				$52,397,900.00

1. Estimated Easement Costs Based on a 50' Perm Easement & 70' Temp Easement for Section A Northern Portion exluding easement on NTMWD land

2.1.6 Recommendation Summary

The recommended alignment for Section A is Alternate A for Conflict Area #2, #3 and #5 and Alternate B for Conflict Area #4 and #6. Although not all options are the least expensive, all of the routes were chosen based on a balance between landowner impact, constructability and cost. Based on the recommended routes the total length of the preferred alignment for the northern portion of Section A is 11.07 miles.

2.1.7 Pipeline Crossings

Table 16 presents identified utility, roadway, and creek crossings associated with the recommended route.

Table 16 – Major Transportation, Utility, and Creek Crossings

Road
Fannin CR 2725
CR 2710
CR 2730
CR 2735
CR 2770
CR 2765
Farm to Market 1396
CR 2992
United States Route 82
CR 2989
Farm to Market 1793
Utility
Oncor Overhead Electric Transmission Lines
Atmos 10" Gas Distribution Line
Waterbody
Tributary of Honey Grove Creek
LBCR Finger (Fox Creek)
Tributary of Honey Grove Creek (2)
Honey Grove Creek
Tributary of Honey Grove Creek
Allen's Creek
Tributary of Allen's Creek (2)
Tributary of Ward Creek
Ward Creek

Table 17 - Conflict Area #2 Alt A Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	5,125	R	1	53.72	656	275,315	3,362,000	106,801
Type 2- Wooded	125	R	2	53.72	669	6,715	83,625	2,605
Type 3 - Creek Crossings	40	R	3	53.72	1094	2,149	43,760	834
Type 4 - Road/Parking Lot Crossings	20	R	4	53.72	1047	1,074	20,940	417
Type 5 - Bore or Tunnel Crossings		R	5	53.72	1900	-	-	-
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]		R		53.72		-	-	-
Parcel Count [3]	3	EA		25000	$/EA	75,000		
Totals:	**5,310**					**$360,253**	**$3,510,325**	**$110,657**
						CONSTRUCTION COST		**$3,620,982**
						CONTINGENCY	20%	**$724,196**
						TOTAL CONSTRUCTION COST:		**$4,350,000**
						TOTAL LAND COST		**$360,000**
						TOTAL ROUTE COST		**$4,710,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

Table 18 - Conflict Area #2 Alt B Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	5,035	R	1	53.72	656	270,480	3,302,960	104,926
Type 2- Wooded	150	R	2	53.72	669	8,058	100,350	3,126
Type 3 - Creek Crossings	30	R	3	53.72	1094	1,612	32,820	625
Type 4 - Road/Parking Lot Crossings	20	R	4	53.72	1047	1,074	20,940	417
Type 5 - Bore or Tunnel Crossings		R	5	53.72	1900	-	-	-
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]		R		53.72		-	-	-
Parcel Count [3]	3	EA		25000	$/EA	75,000		
Totals:	**5,235**					**$356,224**	**$3,457,070**	**$109,094**
						CONSTRUCTION COST		**$3,566,164**
						CONTINGENCY	20%	**$713,233**
						TOTAL CONSTRUCTION COST:		**$4,280,000**
						TOTAL LAND COST		**$360,000**
						TOTAL ROUTE COST		**$4,640,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

Table 19 - Conflict Area #2 Alt C Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	5,015	R	1	53.72	656	269,406	3,289,840	104,509
Type 2- Wooded	390	R	2	53.72	669	20,951	260,910	8,127
Type 3 - Creek Crossings	40	R	3	53.72	1094	2,149	43,760	834
Type 4 - Road/Parking Lot Crossings	40	R	4	53.72	1047	2,149	41,880	834
Type 5 - Bore or Tunnel Crossings		R	5	53.72	1900	-	-	-
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]		R		53.72		-	-	-
Parcel Count [3]	3	EA		25000	$/EA	75,000		
Totals:	**5,485**					**$369,654**	**$3,636,390**	**$114,303**
						CONSTRUCTION COST		**$3,750,693**
						CONTINGENCY	20%	**$750,139**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$4,500,000**
2. This is for easements that will be required on NTMWD owned land						TOTAL LAND COST		**$370,000**
3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount						TOTAL ROUTE COST		**$4,870,000**

Table 20 - Conflict Area #3 Alt A Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	4,070	R	1	53.72	656	218,640	2,669,920	84,816
Type 2- Wooded	1,299	R	2	53.72	669	69,782	869,031	27,070
Type 3 - Creek Crossings	-	R	3	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings		R	4	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings	100	R	5	53.72	1900	5,372	190,000	2,084
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]		R		53.72		-	-	-
Parcel Count [3]	5	EA		25000	$/EA	125,000		
Totals:	**5,469**					**$418,795**	**$3,728,951**	**$113,970**
						CONSTRUCTION COST		**$3,842,921**
						CONTINGENCY	20%	**$768,584**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$4,610,000**
2. This is for easements that will be required on NTMWD owned land						TOTAL LAND COST		**$420,000**
3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount						TOTAL ROUTE COST		**$5,030,000**

Table 21 - Conflict Area #3 Alt B Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	4,983	R	1	53.72	656	267,687	3,268,848	103,842
Type 2- Wooded	608	R	2	53.72	669	32,662	406,752	12,670
Type 3 - Creek Crossings	-	R	3	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings		R	4	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings	100	R	5	53.72	1900	5,372	190,000	2,084
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]		R		53.72		-	-	-
Parcel Count [3]	6	EA		25000	$/EA	150,000		
Totals:	**5,691**					**$455,721**	**$3,865,600**	**$118,596**
						CONSTRUCTION COST		**$3,984,196**
						CONTINGENCY	20%	**$796,839**
						TOTAL CONSTRUCTION COST:		**$4,780,000**
						TOTAL LAND COST		**$460,000**
						TOTAL ROUTE COST		**$5,240,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

Table 22 - Conflict Area #4 Alt A Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	10,073	R	1	53.72	656	541,122	6,607,888	209,914
Type 2- Wooded	2,901	R	2	53.72	669	155,842	1,940,769	60,455
Type 3 - Creek Crossings	138	R	3	53.72	1094	7,413	150,972	2,876
Type 4 - Road/Parking Lot Crossings	40	R	4	53.72	1047	2,149	41,880	834
Type 5 - Bore or Tunnel Crossings	195	R	5	53.72	1900	10,475	370,500	4,064
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]	1,104	R		53.72		(59,307)	-	-
Parcel Count [3]	7	EA		25000	$/EA	175,000		
Totals:	**13,347**					**$832,694**	**$9,112,009**	**$278,142**
						CONSTRUCTION COST		**$9,390,151**
						CONTINGENCY	20%	**$1,878,030**
						TOTAL CONSTRUCTION COST:		**$11,270,000**
						TOTAL LAND COST		**$830,000**
						TOTAL ROUTE COST		**$12,100,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

Table 23 - Conflict Area #4 Alt B Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	10,204	R	1	53.72	656	548,159	6,693,824	212,644
Type 2- Wooded	2,392	R	2	53.72	669	128,498	1,600,248	49,848
Type 3 - Creek Crossings	160	R	3	53.72	1094	8,595	175,040	3,334
Type 4 - Road/Parking Lot Crossings	40	R	4	53.72	1047	2,149	41,880	834
Type 5 - Bore or Tunnel Crossings	210	R	5	53.72	1900	11,281	399,000	4,376
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]	1,229	R		53.72		(66,022)	-	-
Parcel Count [3]	6	EA		25000	$/EA	150,000		
Totals:	**13,006**					**$782,660**	**$8,909,992**	**$271,036**
							CONSTRUCTION COST	**$9,181,028**
						CONTINGENCY	20%	**$1,836,206**
							TOTAL CONSTRUCTION COST:	**$11,020,000**
							TOTAL LAND COST	**$780,000**
							TOTAL ROUTE COST	**$11,800,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

Table 24 - Conflict Area #4 Alt C Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	6,611	R	1	53.72	656	355,143	4,336,816	137,769
Type 2- Wooded	7,765	R	2	53.72	669	417,136	5,194,785	161,817
Type 3 - Creek Crossings	290	R	3	53.72	1094	15,579	317,260	6,043
Type 4 - Road/Parking Lot Crossings	40	R	4	53.72	1047	2,149	41,880	834
Type 5 - Bore or Tunnel Crossings	120	R	5	53.72	1900	6,446	228,000	2,501
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]	1,118	R		53.72		(60,059)	-	-
Parcel Count [3]	5	EA		25000	$/EA	125,000		
Totals:	**14,826**					**$861,394**	**$10,118,741**	**$308,963**
							CONSTRUCTION COST	**$10,427,704**
						CONTINGENCY	20%	**$2,085,541**
							TOTAL CONSTRUCTION COST:	**$12,510,000**
							TOTAL LAND COST	**$860,000**
							TOTAL ROUTE COST	**$13,370,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

Table 25 - Conflict Area #4 Alt D Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	10,692	R	1	53.72	656	574,374	7,013,952	222,814
Type 2- Wooded	2,293	R	2	53.72	669	123,180	1,534,017	47,784
Type 3 - Creek Crossings	160	R	3	53.72	1094	8,595	175,040	3,334
Type 4 - Road/Parking Lot Crossings	40	R	4	53.72	1047	2,149	41,880	834
Type 5 - Bore or Tunnel Crossings	210	R	5	53.72	1900	11,281	399,000	4,376
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]	1,229	R		53.72		(66,022)	-	-
Parcel Count [3]	6	EA		25000	$/EA	150,000		
Totals:	**13,395**					**$803,558**	**$9,163,889**	**$279,142**
						CONSTRUCTION COST		**$9,443,031**
						CONTINGENCY	20%	**$1,888,606**
						TOTAL CONSTRUCTION COST:		**$11,330,000**
						TOTAL LAND COST		**$800,000**
						TOTAL ROUTE COST		**$12,130,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

Table 26 - Conflict Area #5 Alt A Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	8,279	R	1	53.72	656	444,748	5,431,024	172,528
Type 2- Wooded	1,411	R	2	53.72	669	75,799	943,959	29,404
Type 3 - Creek Crossings	508	R	3	53.72	1094	27,290	555,752	10,586
Type 4 - Road/Parking Lot Crossings		R	4	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings		R	5	53.72	1900	-	-	-
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]	7,211	R		53.72		(387,375)	-	-
Parcel Count [3]	4	EA		25000	$/EA	100,000		
Totals:	**10,198**					**$260,462**	**$6,930,735**	**$212,519**
						CONSTRUCTION COST		**$7,143,254**
						CONTINGENCY	20%	**$1,428,651**
						TOTAL CONSTRUCTION COST:		**$8,570,000**
						TOTAL LAND COST		**$260,000**
						TOTAL ROUTE COST		**$8,830,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

Table 27 - Conflict Area #5 Alt B Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	7,328	R	1	53.72	656	393,660	4,807,168	152,710
Type 2- Wooded	3,162	R	2	53.72	669	169,863	2,115,378	65,894
Type 3 - Creek Crossings	210	R	3	53.72	1094	11,281	229,740	4,376
Type 4 - Road/Parking Lot Crossings		R	4	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings		R	5	53.72	1900	-	-	-
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]	5,016	R		53.72		(269,460)	-	-
Parcel Count [3]	5	EA		25000	$/EA	125,000		
Totals:	**10,700**					**$430,344**	**$7,152,286**	**$222,980**
							CONSTRUCTION COST	**$7,375,266**
							CONTINGENCY 20%	**$1,475,053**
							TOTAL CONSTRUCTION COST:	**$8,850,000**
							TOTAL LAND COST	**$430,000**
							TOTAL ROUTE COST	**$9,280,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

Table 28 - Conflict Area #5 Alt C Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	7,327	R	1	53.72	656	393,606	4,806,512	152,689
Type 2- Wooded	3,106	R	2	53.72	669	166,854	2,077,914	64,727
Type 3 - Creek Crossings	240	R	3	53.72	1094	12,893	262,560	5,001
Type 4 - Road/Parking Lot Crossings		R	4	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings		R	5	53.72	1900	-	-	-
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]	5,448	R		53.72		(292,667)	-	-
Parcel Count [3]	5	EA		25000	$/EA	125,000		
Totals:	**10,673**					**$405,687**	**$7,146,986**	**$222,418**
							CONSTRUCTION COST	**$7,369,404**
							CONTINGENCY 20%	**$1,473,881**
							TOTAL CONSTRUCTION COST:	**$8,840,000**
							TOTAL LAND COST	**$410,000**
							TOTAL ROUTE COST	**$9,250,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

Table 29 - Conflict Area #5 Alt D Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	8,028	R	1	53.72	656	431,264	5,266,368	167,298
Type 2- Wooded	2,293	R	2	53.72	669	123,180	1,534,017	47,784
Type 3 - Creek Crossings	288	R	3	53.72	1094	15,471	315,072	6,002
Type 4 - Road/Parking Lot Crossings		R	4	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings		R	5	53.72	1900	-	-	-
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]	6,738	R		53.72		(361,965)	-	-
Parcel Count [3]	6	EA		25000	$/EA	150,000		
Totals:	**10,609**					**$357,950**	**$7,115,457**	**$221,084**
							CONSTRUCTION COST	**$7,336,541**
							CONTINGENCY 20%	**$1,467,308**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$8,800,000**
2. This is for easements that will be required on NTMWD owned land							TOTAL LAND COST	**$360,000**
3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount							TOTAL ROUTE COST	**$9,160,000**

Table 30 - Conflict Area #6 Alt A Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	5,068	R	1	53.72	656	272,253	3,324,608	105,614
Type 2- Wooded	791	R	2	53.72	669	42,493	529,179	16,484
Type 3 - Creek Crossings		R	3	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	85	R	4	53.72	1047	4,566	88,995	1,771
Type 5 - Bore or Tunnel Crossings		R	5	53.72	1900	-	-	-
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]		R		53.72		-	-	-
Parcel Count [3]	7	EA		25000	$/EA	175,000		
Totals:	**5,944**					**$494,312**	**$3,942,782**	**$123,869**
							CONSTRUCTION COST	**$4,066,651**
							CONTINGENCY 20%	**$813,330**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$4,880,000**
2. This is for easements that will be required on NTMWD owned land							TOTAL LAND COST	**$490,000**
3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount							TOTAL ROUTE COST	**$5,370,000**

Table 31 - Conflict Area #6 Alt B Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	5,848	R	1	53.72	656	314,155	3,836,288	121,868
Type 2- Wooded	223	R	2	53.72	669	11,980	149,187	4,647
Type 3 - Creek Crossings		R	3	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	50	R	4	53.72	1047	2,686	52,350	1,042
Type 5 - Bore or Tunnel Crossings		R	5	53.72	1900	-	-	-
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]		R		53.72		-	-	-
Parcel Count [3]	7	EA		25000	$/EA	175,000		
Totals:	**6,121**					**$503,820**	**$4,037,825**	**$127,557**
						CONSTRUCTION COST		**$4,165,382**
						CONTINGENCY	20%	**$833,076**
						TOTAL CONSTRUCTION COST:		**$5,000,000**
						TOTAL LAND COST		**$500,000**
						TOTAL ROUTE COST		**$5,500,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

Table 32 - Conflict Area #6 Alt C Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	3,729	R	1	53.72	656	200,322	2,446,224	77,710
Type 2- Wooded	2,079	R	2	53.72	669	111,684	1,390,851	43,325
Type 3 - Creek Crossings	35	R	3	53.72	1094	1,880	38,290	729
Type 4 - Road/Parking Lot Crossings	30	R	4	53.72	1047	1,612	31,410	625
Type 5 - Bore or Tunnel Crossings		R	5	53.72	1900	-	-	-
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]		R		53.72		-	-	-
Parcel Count [3]	8	EA		25000	$/EA	200,000		
Totals:	**5,873**					**$515,498**	**$3,906,775**	**$122,389**
						CONSTRUCTION COST		**$4,029,164**
						CONTINGENCY	20%	**$805,833**
						TOTAL CONSTRUCTION COST:		**$4,830,000**
						TOTAL LAND COST		**$520,000**
						TOTAL ROUTE COST		**$5,350,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

Table 33 - Conflict Area #6 Alt D Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	3,756	R	1	53.72	656	201,772	2,463,936	78,272
Type 2- Wooded	2,081	R	2	53.72	669	111,791	1,392,189	43,367
Type 3 - Creek Crossings	35	R	3	53.72	1094	1,880	38,290	729
Type 4 - Road/Parking Lot Crossings	30	R	4	53.72	1047	1,612	31,410	625
Type 5 - Bore or Tunnel Crossings		R	5	53.72	1900	-	-	-
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
NTMWD Easement Land Cost Reduction [2]	250	R		53.72		(13,430)	-	-
Parcel Count [3]	8	EA		25000	$/EA	200,000		
Totals:	**5,902**					**$503,625**	**$3,925,825**	**$122,993**
						CONSTRUCTION COST		**$4,048,818**
						CONTINGENCY	20%	**$809,764**
						TOTAL CONSTRUCTION COST:		**$4,860,000**
						TOTAL LAND COST		**$500,000**
						TOTAL ROUTE COST		**$5,360,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for easements that will be required on NTMWD owned land

3. This is for ROE and acquisition related costs - NTMWD parcels crossed are not included in this amount

2.2 SECTION A - SOUTH

2.2.1 Introduction

Section A of the LBCR Raw Water Pipeline project was split into two portions as described in **Section 2.1.1**. The dividing point between the southern and northern alignment studies is FM 1743, which is slightly south of US 82. The end point of the southern alignment study is the proposed connection to LBCR Pipeline Section B located at SH 56. The southern portion of Section A is approximately 3.8 miles and is characterized by a general southwesterly bearing.

The analysis described below was used to determine the recommended alignment for the southern portion of the LBCR Pipeline Section A alignment. The alignment selection for the northern portion of Section A has been included in this PDR as **Section 2.1**. The following general parameters were adopted to generate acceptable alignments from the preliminary alignment corridor for analysis: avoid or minimize environmental permitting potential, align beginning with the proposed Section A northern corridor (North of FM 1743), align end with beginning of Section B, minimize pipeline length where it does not impact other parameters, minimize impact to landowners along route, minimize constructability concerns, and avoid significant terrain that negatively affects hydraulics.

2.2.2 Evaluation of Corridors

The preliminary alignment for the southern portion of Section A from FM 1743 to SH 56 is shown in **Figure 11** below as the "Shared Southern Corridor". This corridor was originally presented in the "Conceptual Facilities Design Route Study Memorandum" dated March 11, 2008. Corridors north of FM 1743 were discussed in the "Section A Corridor Selection Technical Memorandum" dated June 10, 2013.

Figure 11 – Evaluated Corridor

2.2.3 Route Alternatives

The southern Section A corridor was analyzed in further detail to identify conflicts and develop alignment alternatives. Conflicts were determined based upon aerial imagery and field work. Initial conflict development revealed two conflicts. The first conflict area was a string of several houses along CR 2998 and the second conflict area was the Burnett/Bullard creek confluence area. The rest of the terrain in this corridor consists of primarily open and cultivated land with all possible alignment

alternatives sharing three creek crossings. The alignments shown have had an initial field environmental study performed and there are no anticipated wetland concerns. Alternate B was set outside of the original corridor and therefore direct field investigations within portions of this alignment were not executed. However, the areas investigated within the corridor near Alternate B and desktop reviews did not provide evidence of environmental impact; therefore, no environmental impacts would be expected along alternate B.

From this analysis, four alignment alternatives were developed to navigate the conflict areas. Due to the size and close proximity between the two conflict areas, merging the alignment alternatives between them was not a beneficial option. The alignment alternatives were evaluated based on the parameters listed in the introduction and are shown in **Figure 12**.

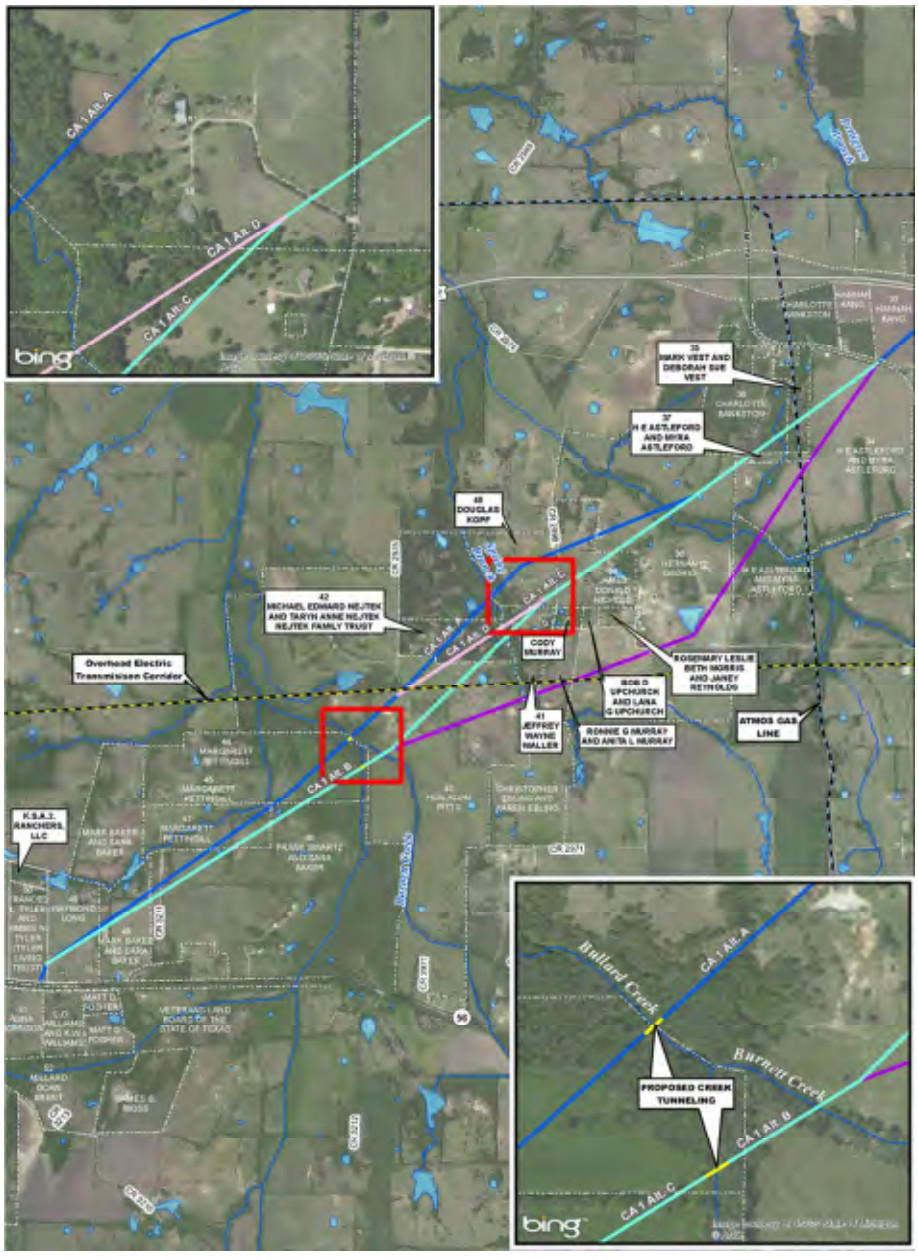


Figure 12 – Overall Segment A – South Alignments

The preferred alternative was determined by analysis that compared the total length, number of parcels affected, open cut length, wooded length, tunnel length, construction cost, and land acquisition cost. The recommended alignment was chosen based on the completed cost analysis and engineering

judgment. The detailed route analysis of these four alignment alternatives is discussed below.

Conflict Area #1 was identified because of the close proximity of the string of houses along CR 2998 to each other. The seven homesteads run mainly east-west across the general southwest direction of the alignment alternatives. Four alignments have been proposed to provide a compromise between landowner impact, constructability, and cost. Three alternatives were developed to cross through this conflict area. Two alternatives diverged either north or south of the conflict area, adding additional length while minimizing the impact to the land owners. The third option aligned between two homesteads as a more direct route. Conflict Area #1 and the three alternatives can be seen in **Figure 13**.

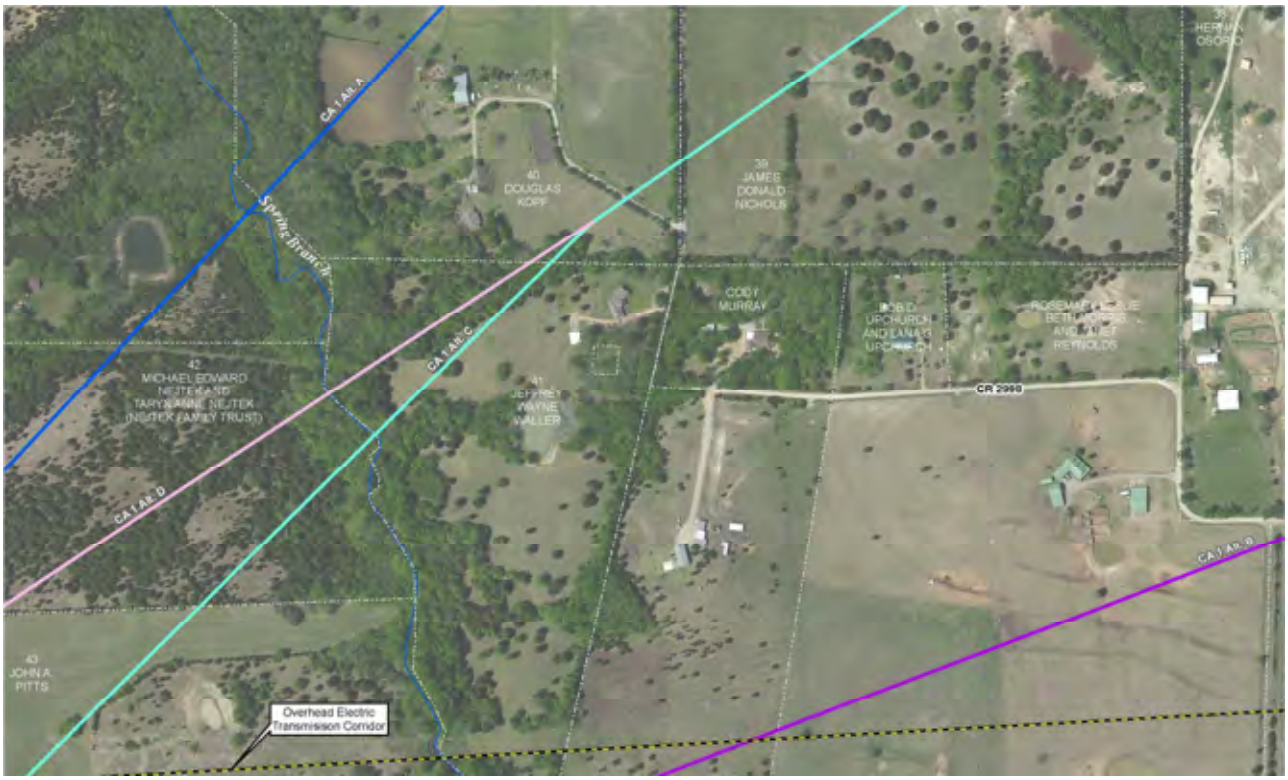


Figure 13 – Aerial View of Conflict Area #1

Conflict Area #2 is the Bullard/Burnett Creek confluence. **Figure 14** on the next page shows a close up view of the conflict area and the possible alignments through the area. Due to environmental and constructability concerns, proceeding directly through the creek confluence was not considered within the alignment options. Two alternatives were developed for proceeding through this conflict area. One option would be to cross Bullard Creek northwest and downstream of the confluence. This option

would result in a larger creek and riparian area crossing, but only crosses the creek once. A second option would be to cross Bullard and Burnett Creeks separately southeast and upstream of their confluence. This option would yield much smaller creek and riparian area crossings; however, two creek crossings would be required which may cause access issues for maintenance and operation of the pipeline. The crossing associated with Bullard Creek would be installed by bore or tunnel due to its deep channel and steep banks. The pipeline crossing at Burnett Creek would be installed by open cut because its creek channel is shallower with more gently sloped banks.

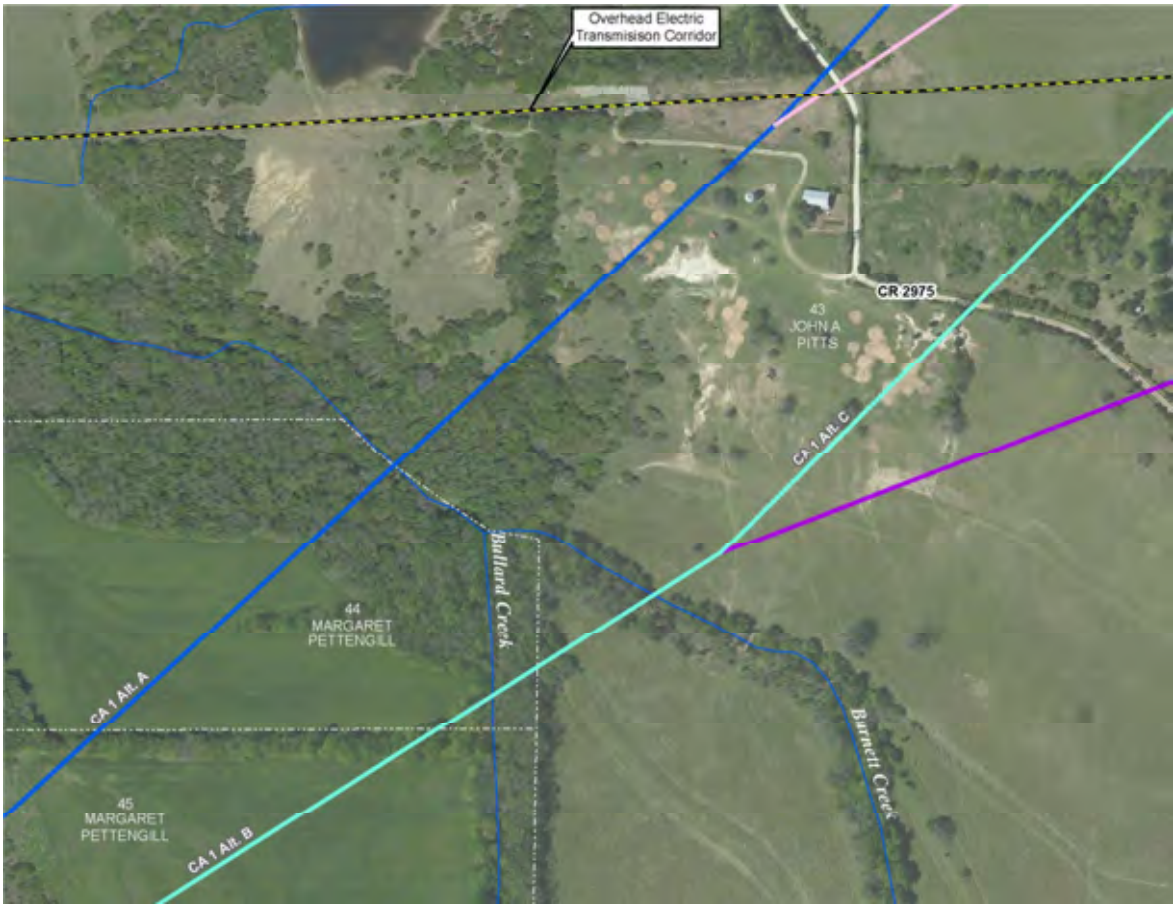


Figure 14 – Aerial View of Conflict Area #2

2.2.4 Detailed Route Analysis

Installation cost factors were developed to take into account the varying costs of pipeline construction through different land classifications. Cost data was updated in order to closely coincide with recent bid information. Routes were classified by the type of land they would be installed in: open, wooded, open

cut creek crossings, open cut road crossings, or tunneled crossings. A construction and land acquisition cost was associated with each classification in order to estimate the total route cost per linear foot. This allowed a cost to be generated for each alternate based upon the linear feet of the land classification. From this, a cost comparison was performed for the alternates in order to determine the most cost effective route.

Alternate A begins at the common starting point along FM 1743. From there, the alignment proceeds southwest crossing a small seasonal tributary of Cottonwood Creek and its associated riparian area. The alignment continues into a field where a slight northern deviation occurs before crossing Cottonwood Creek. Alternate A then crosses CR 2998 before nearing the northern edge of the previously mentioned Conflict Area #1. The alignment centerline at its closest point is 150 feet away from a non-residential structure and 450 feet away from the property's residential structure further to the south. While near the property's non-residential structure, the alignment makes an approximate 30 degree bend to the south where it proceeds to cross Spring Branch and its riparian area. After crossing the branch, the alignment nears a half acre pond before crossing an overhead electrical distribution line and CR 2975. The alignment then declines down a hill towards Conflict Area #2, the Bullard and Burnett Creek Confluence. Alternate A crosses Bullard Creek downstream and to the north of the confluence before traveling between a small pond and a seasonal tributary for Bullard Creek. The alignment then crosses CR 3211 while continuing in a southwest bearing. The alignment ends by taking a 60 degree southern turn just after traveling past a residential and non-residential structure. The alternate has approximately 270 feet and 200 feet of clearance between the residential and non-residential structures, respectively. Shortly after turning south, the alignment reaches SH 56 and the beginning of Section B.

Alternate B begins at the common starting point along FM 1743. From there, the alignment proceeds southwest crossing Cottonwood Creek and its riparian areas. The alignment proceeds southwest around a large pond before turning approximately 45 degrees to the west and crossing the intersection of CRs 2998 and 2970. Alternate B then nears the southern edge of the previously mentioned Conflict Area #1. The alignment centerline at its closest point is 165 feet away from a non-residential structure and 330 feet away from the property's residential structure further to the northwest. The alignment proceeds southwest through open pasture land before crossing an overhead electric distribution line and Spring

Branch and its riparian area. Alternate B then crosses CR 2975 before approaching Conflict Area #2. Alternate B crosses the creek confluence upstream and to the southeast to cross the two creeks individually. The alignment crosses the shallower and narrower Burnett Creek before crossing the larger Bullard Creek to the southwest. Alternate B then passes through primarily open land before crossing CR 3211. Alternate B then merges with Alternate A and turns south toward SH 56 and the beginning of Section B. It should be noted that part of Alternate B is outside of the proposed corridor set in the "Conceptual Facilities Design Route Study Memo" dated March 11, 2008. Therefore, there are four parcels that the alignment crosses that were not included in the original ROE mailing list. Also, the desktop review and initial environmental study conducted was in the general area of Alternate B and did not yield any areas of environmental concern.

Alternate C begins merged with Alternate A until just before the Cottonwood Creek crossing. At this point, Alignment C continues on from the previous bearing and crosses CR 2998 and enters the previously mentioned Conflict Area #1. Alignment C proceeds between two of the homesteads as to keep a more direct route to the beginning of Section B. The alignment splits these houses with approximately 200 feet from centerline to either residential structure. Alternate C then crosses Spring Branch along with its associated riparian area before continuing through open pasture land to cross an overhead electric distribution line and CR 2975. After crossing CR 2975, the alignment merges with the previously stated Alternate B before crossing Burnett and Bullard Creeks separately upstream and to the southeast of the creek confluence. The alignment continues along the same route as Alternate B to SH 56 and the beginning of Section B.

Alternate D begins merged with Alternate A until just before the Cottonwood Creek crossing. At this point, the alignment continues with Alternate C until splitting the two residential structures to the southwest. At this point, the alignment proceeds in a more continuous bearing and is approximately 165 feet from the northern structure and 215 feet from the southern structure at their closest points. Alternate D then crosses through approximately 650 feet of wooded area before crossing Spring Branch. The alignment then continues south and connects to Alternate A after crossing an overhead electric distribution line and CR 2975. This alignment crosses Bullard Creek downstream and to the northwest of the Bullard/Burnett Creek Confluence and continues along Alternate A to SH 56 and the beginning of Section B.

In order to properly analyze the various alternatives developed for the conflict areas, data was collected and is summarized in **Table 34**. The weighted route scores analysis was utilized in determining the preferred route across the southern portion of Section A. **Table 35** shows a breakdown of these scores. This analysis utilized various factors such as length, parcel crossings, environmental crossings and transportation right-of-way crossings. These factors were weighted in relevance to their general impact throughout the project. For example, route length is the highest weighted factor due to its general correlation with cost, landowner easement acquisition quantity, and construction time. Through the summation and analysis of the weighted factors a preferred alignment can be chosen.

Preliminary cost estimating spreadsheets were utilized in determining the associated costs of the four evaluated alignments. These cost estimating spreadsheets incorporate bid data from recent pipeline projects to develop the costs for the type of pipe, pipe installation, relevant appurtenances, and easement acquisition costs. The cost analysis for the conflict areas is shown below in **Table 34**.

Table 34 – Analysis for Section A Conflict Areas

Option	Alternate A	Alternate B	Alternate C	Alternate D
Length (ft.)	20,040	20,438	19,919	19,863
Number of Parcels	18	17	17	19
Open Length (ft.)	14,122	16,858	14,429	13,893
Wooded Length (ft.)	5,768	3,480	5,390	5,820
Tunnel/Bore Length	150	100	100	150
Construction Cost	$16,800,000	$17,060,000	$16,650,000	$16,670,000
Land Acquisition Cost	$1,530,000	$1,520,000	$1,500,000	$1,540,000
Total Cost	$18,330,000	$18,580,000	$18,150,000	$18,210,000

*For further cost analysis data see **Tables 38-41**.

The pipeline route evaluation criteria spreadsheet that was mentioned previously to analyze the characteristics of the alignments from FM 1743 to SH 56 can be seen on the next page in **Table 35**. FNI filled in the weights based on our engineering judgment and input from the NTMWD.

Table 35 – Weighted Route Scores

Raw Quantities (Low is Best)					
Item Description	**Item Weight** (High = Most Important) (0 = Not Considered)	**Routes**			
		Proposed A	**Proposed B**	**Proposed C**	**Proposed D**
Route Length, ft	40	20,040	20,438	19,919	19,863
Parcel Count, ea	15	18	17	17	19
Wooded Crossing, ft	10	5,358	2,965	4,905	5,370
Perennial Stream Crossing, ea	10	-	-	-	-
Intermittent Stream Crossing, ea	9	4	4	5	4
Hydric Soil Crossing, ft	9	-	-	-	-
Bored Crossing (TXDOT & RR), ea	7	1	1	1	1
Total	100				

Normalized Score (Low is Best)					
Item Description	**Item Weight**	**Proposed A**	**Proposed B**	**Proposed C**	**Proposed D**
Route Length, ft	40.00	34.85	35.54	34.64	34.54
Parcel Count, ea	15.00	9.00	8.50	8.50	9.50
Wooded Crossing, ft	10.00	2.23	1.23	2.04	2.23
Perennial Stream Crossing, ea	10.00	1.00	1.00	1.00	1.00
Intermittent Stream Crossing, ea	9.00	4.00	4.00	5.00	4.00
Hydric Soil Crossing, ft	9.00	1.00	1.00	1.00	1.00
Bored Crossing (TXDOT & RR), ea	7.00	1.00	1.00	1.00	1.00
Total	100.00	53.08	52.28	53.18	53.28

Weighted Score (Low is Best)					
Item Description	**Item Weight**	**Proposed A**	**Proposed B**	**Proposed C**	**Proposed D**
Route Length, ft	40.00	13.94	14.22	13.86	13.82
Parcel Count, ea	15.00	1.35	1.28	1.28	1.43
Wooded Crossing, ft	10.00	0.22	0.12	0.20	0.22
Perennial Stream Crossing, ea	10.00	0.10	0.10	0.10	0.10
Intermittent Stream Crossing, ea	9.00	0.36	0.36	0.45	0.36
Hydric Soil Crossing, ft	9.00	0.09	0.09	0.09	0.09
Bored Crossing (TXDOT & RR), ea	7.00	0.07	0.07	0.07	0.07
Total	100.00	**16.13**	**16.24**	**16.05**	**16.09**

Based on the analysis, Alternate C was selected as the recommended alignment due to a number of factors such as: length, parcel count, wooded areas, stream crossings, and number of bored locations (**Table 35**). From the analysis, it can be seen that the scores presented a small variance; however, Alternate C presented the best score in regards to the Section A alignment analysis and therefore is the recommended route.

A summary of costs for Alternates A-D is shown in **Table 34**. This summary of costs does not take into account the pipe length between FM 1743 and US 82. The OPCC for the northern portion of Section A has been included in this PDR as **Section 2.1.5**.

2.2.5 Opinion of Probable Construction Cost

The OPCC for the Section A southern recommended alignment (Alternative C) is $20,902,450. A detailed breakdown of the OPCC for Alternate C is shown in **Table 36**.

Table 36 – Opinion of Probable Construction Costs

NTMWD
Lower Bois d'Arc Creek
Reservoir Raw Water
Pipeline

FREESE AND NICHOLS

1701 N Market St., #500, LB51 • Dallas, Texas 75202 • 214-217-2200 • fax 214-217-2201

OPINION OF PROBABLE CONSTRUCTION COSTS (INCLUDING EASEMENTS) — November 25, 2013

ESTIMATOR	CHECKED BY	ACCOUNT NO
WRS	ASM	NTD13136

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	90-INCH PIPELINE	19,919	LF	$650.00	$ 12,947,350
2	TUNNELED CROSSINGS	0	LF	$1,970.00	$ -
3	PIPELINE ROW CLEARING	50	AC	$5,000.00	$ 250,000
4	TRENCH SAFETY	19,919	LF	$1.00	$ 19,919
5	AIR RELEASE VALVES	6	EA	$25,000.00	$ 142,500
6	BUTTERFLY VALVES	1	EA	$165,000.00	$ 165,000
7	BLOW OFF VALVES	6	EA	$25,000.00	$ 142,500
8	PAVEMENT RESTORATION	440	SY	$70.00	$ 30,800
9	CREEK CROSSINGS	455	LF	$445.00	$ 202,475
10	REVEGETATION	50	AC	$1,160.00	$ 58,000
11	FIBER OPTIC CONDUIT	19,919	LF	$3.00	$ 59,757
12	FIBER	19,919	LF	$2.00	$ 39,838
13	CATHODIC PROTECTION	19,919	LF	$2.00	$ 39,838
14	ACCESS MANHOLES	6	EA	$10,000.00	$ 57,000
15	TESTING	19,919	LF	$2.00	$ 39,838
16	MOBILIZATION	1	LS	$709,741.00	$ 709,741
	CONSTRUCTION SUBTOTAL				$ 14,900,000
	CONSTRUCTION CONTINGENCY	15%			$ 2,235,000
	CONTRUCTION TOTAL				$ 17,135,000
	ESTIMATED EASEMENT/PROPERTY COSTS				
	PERMANENT EASEMENT W/ ASSOCIATED TEMPORARY (Note 1)	995,950	SF	$1.00	$995,950.00
	TOTAL ESTIMATED COSTS (INCLUDING EASEMENT)				$18,130,950.00

1. Estimated Easement Costs Based on a 50' Perm Easement & 70' Temp Easement for the Entire Route

2.2.6 Recommendations Summary

The proposed Alternate C is the recommended alignment selection for this specific corridor between FM 1743 and SH 56. Alternate C is the shortest route through the Conflict Area #1 and therefore will reduce cost and length of pipe while still providing a reasonable distance from the nearby structures. The southeast crossing of Conflict Area #2 by Alternate C also provides an additional benefit over the other route at this crossing. Alternate C's creek crossings in this area are narrower and shallower and provide significantly less wooded area to cross than the other alternates. It is because of these advantages and the numerical analysis shown in **Table 35** that FNI recommends Alternate C for the alignment of the

southern portion of Section A.

2.2.7 Pipeline Crossings

Table 37 below presents identified utility, roadway, and creek crossings associated with the recommended route.

Table 37 – Major Transportation, Utility, and Waterbody Crossings

Road
Fannin CR 2998
Fannin CR 2970
Fannin CR 2975
Fannin CR 3211
Utility
Atmos 3.5" Gas Distribution Line
Oncor Overhead Electric Distribution Lines
Waterbody
Cottonwood Creek
Spring Branch
Bullard Creek
Burnett Creek

Table 38 - Conflict Area #1 Alt A Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	14,122	R	1	53.72	656	758,634	9,264,032	294,292
Type 2- Wooded	5,358	R	2	53.72	669	287,832	3,584,502	111,657
Type 3 - Creek Crossings	350	R	3	53.72	1094	18,802	382,900	7,294
Type 4 - Road/Parking Lot Crossings	60	R	4	53.72	1047	3,223	62,820	1,250
Type 5 - Bore or Tunnel Crossings	150	R	5	53.72	1900	8,058	285,000	3,126
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
Parcel Count [2]	18	EA		25000	$/EA	450,000		
Totals:	**20,040**					**$1,526,549**	**$13,579,254**	**$417,619**
							CONSTRUCTION COST	**$13,996,873**
							CONTINGENCY 20%	**$2,799,375**
							TOTAL CONSTRUCTION COST:	**$16,800,000**
							TOTAL LAND COST	**$1,530,000**
							TOTAL ROUTE COST	**$18,330,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for ROE and acquisition related costs

Table 39 - Conflict Area #1 Alt B Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	16,858	R	1	53.72	656	905,612	11,058,848	351,309
Type 2- Wooded	2,965	R	2	53.72	669	159,280	1,983,585	61,788
Type 3 - Creek Crossings	455	R	3	53.72	1094	24,443	497,770	9,482
Type 4 - Road/Parking Lot Crossings	60	R	4	53.72	1047	3,223	62,820	1,250
Type 5 - Bore or Tunnel Crossings	100	R	5	53.72	1900	5,372	190,000	2,084
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
Parcel Count [2]	17	EA		25000	$/EA	425,000		
Totals:	**20,438**					**$1,522,929**	**$13,793,023**	**$425,913**
							CONSTRUCTION COST	**$14,218,936**
							CONTINGENCY 20%	**$2,843,787**
							TOTAL CONSTRUCTION COST:	**$17,060,000**
							TOTAL LAND COST	**$1,520,000**
							TOTAL ROUTE COST	**$18,580,000**

1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.

2. This is for ROE and acquisition related costs

Table 40 - Conflict Area #1 Alt C Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	14,429	R	1	53.72	656	775,126	9,465,424	300,690
Type 2- Wooded	4,905	R	2	53.72	669	263,497	3,281,445	102,217
Type 3 - Creek Crossings	405	R	3	53.72	1094	21,757	443,070	8,440
Type 4 - Road/Parking Lot Crossings	80	R	4	53.72	1047	4,298	83,760	1,667
Type 5 - Bore or Tunnel Crossings	100	R	5	53.72	1900	5,372	190,000	2,084
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
Parcel Count [2]	17	EA		25000	$/EA	425,000		
Totals:	**19,919**					**$1,495,049**	**$13,463,699**	**$415,098**
							CONSTRUCTION COST	**$13,878,797**
						CONTINGENCY	20%	**$2,775,759**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$16,650,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$1,500,000**
							TOTAL ROUTE COST	**$18,150,000**

Table 41 - Conflict Area #1 Alt D Cost Analysis

ORIGINAL ALIGNMENT	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	13,893	R	1	53.72	656	746,332	9,113,808	289,520
Type 2- Wooded	5,370	R	2	53.72	669	288,476	3,592,530	111,907
Type 3 - Creek Crossings	350	R	3	53.72	1094	18,802	382,900	7,294
Type 4 - Road/Parking Lot Crossings	100	R	4	53.72	1047	5,372	104,700	2,084
Type 5 - Bore or Tunnel Crossings	150	R	5	53.72	1900	8,058	285,000	3,126
Type 6 - Deep Cut (10-15' cover)		R	6	53.72	735	-	-	-
Parcel Count [2]	19	EA		25000	$/EA	475,000		
Totals:	**19,863**					**$1,542,040**	**$13,478,938**	**$413,931**
							CONSTRUCTION COST	**$13,892,869**
						CONTINGENCY	20%	**$2,778,574**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$16,670,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$1,540,000**
							TOTAL ROUTE COST	**$18,210,000**

2.3 SECTION B

2.3.1 Introduction

Section B of the LBCR Raw Water Pipeline connects with Section A approximately 1 mile east of Dodd City at the north right of way line of SH 56. The route crosses the highway and the adjacent Texas Northeastern Railroad (TNER) track and generally routed to the southwest for approximately 9.89 miles terminating at Section C on the southwest corner of FM 68 and FM 3115.

The original preliminary pipeline corridor was determined in "NTMWD Preliminary Pipeline Routing Study and Conceptual Pump Station Design Report" by completing a high level analysis of pipeline corridors from the proposed LBCR pump station to the proposed NWTP site. The pump station was relocated as a portion of this project, but this did not change the pipeline corridor for Section B. The preliminary alignment corridor was reviewed for modifications to shorten the route but minimize additional tree loss and not intrude on forested wetlands, while minimizing overall construction costs. Since this area has typical large tracts paralleling property lines was not a high priority in the analysis. Various options were examined at identified conflict areas and additional analysis was completed to take into account costs associated with easements, road crossings, and construction. The analysis discussed in this PDR details the process of determining the final pipeline alignment from the preliminary corridor and various alternatives developed during this phase of the pipeline route selection.

2.3.2 Route Alternatives

The preliminary pipeline alignment corridor was investigated further in order to identify potential conflict areas along the route. Conflicts were determined based upon aerial imagery and field work walking the potential pipeline routes. A detailed evaluation of localized alternatives was performed to optimize the pipeline alignment and avoid potential conflicts in land acquisition and construction. Environmental constraints such as stream crossings, perennial water bodies, and possible wetlands along with impacts to property owners were taken into account during the analysis.

The original alignment corridor centerline is shown in blue and in each conflict area and described as Alternate A in this memorandum. On all figures, Conflict Area Alternate B's are magenta, Alternate C's are teal and Alternate D's are pink.

Six conflict areas were identified on the potential pipeline route of Section B. Conflict Area #1 begins in the first parcel south of SH 56 and the TNER tracks and comes back to the original alignment at CR 3200. The Conflict Area #2 is located between CR 3205 and FM 2077. The alternates for this conflict area either parallel property lines or cut across country. Conflict Area #3 is between FM 2077 and FM 1550 and again the alternates either parallel property lines or cut across country. The Conflict Area #4 is between FM1550 and CR 3302 and again an alternate was developed to cut across country instead of following property lines. Conflict Area #5 is from the end of Conflict Area #4 at CR 3302 to CR 3120. Alternates involve routing to reducing pipeline length, along with one stream crossing or reducing the number of property owners impacted by the construction. Conflict Area #6 is between CR 3120 and FM 3115. The alternate parallels a 36 inch natural gas line rather than paralleling a property line. The overall route is shown in **Figure 15**.

The preferred alternatives were determined by analysis that compared the total length, number of parcels crossed, open cut length, wooded length, tunnel length, construction cost, and land acquisition cost. The recommended alignment was chosen based on the cost analysis and engineering judgment of the above mentioned impacts. The detailed route analysis of these six conflict areas is discussed below.

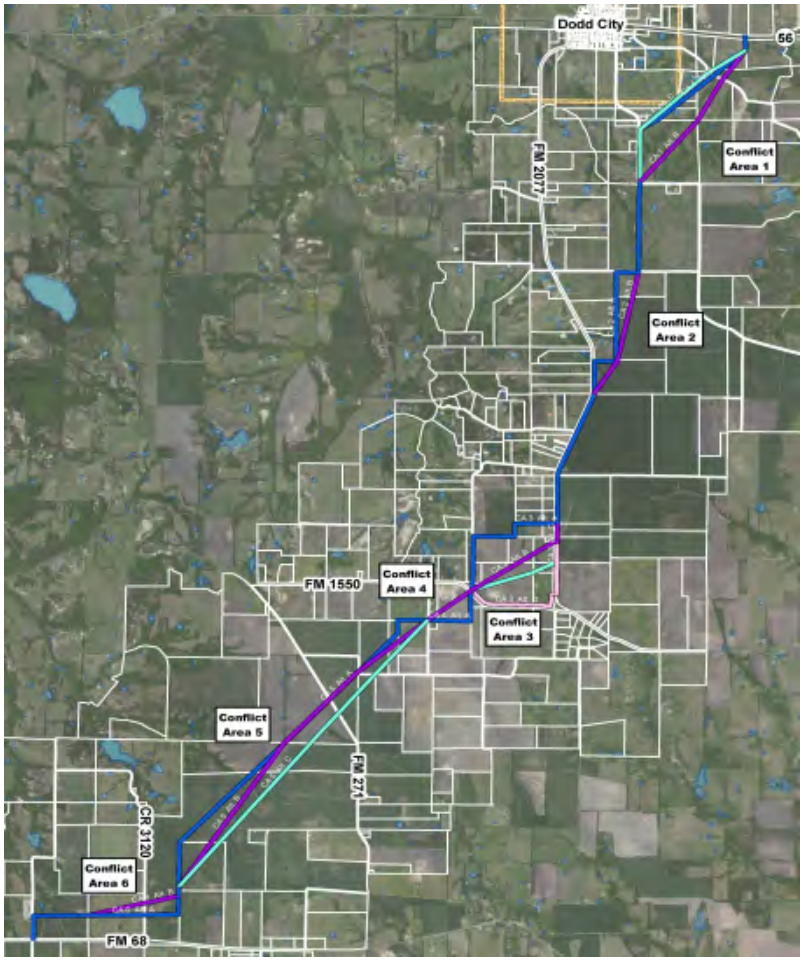


Figure 15 – Overall Segment B Alignment

2.3.3 Detailed Route Analysis

In order to properly analyze the various alternatives developed for the conflict areas, data was collected and input into a pipeline route evaluation criteria spreadsheet. Cost data was updated to estimate future pipeline construction costs based on recent bid information. Routes were classified by the type of land the pipeline would be installed in: open area,

wooded, open cut creek crossings, open cut road crossings, or tunneled crossings. A construction cost and land acquisition cost was associated with each classification in order to estimate the total route cost per linear foot. This allowed a cost to be generated for each alternate based upon the linear feet of the land classification. A cost comparison was performed for the alternates of each conflict area to determine the most cost effective route. The route with the lowest cost was generally selected as the preferred route; however, engineering judgment was also used to ensure that potential complications were also evaluated.

Conflict Area #1 was identified because of the potential to reduce the number of properties affected and shorten the route while maintaining creek crossing construction viability as seen in **Figure 16**. Three alternatives were analyzed for this conflict area.

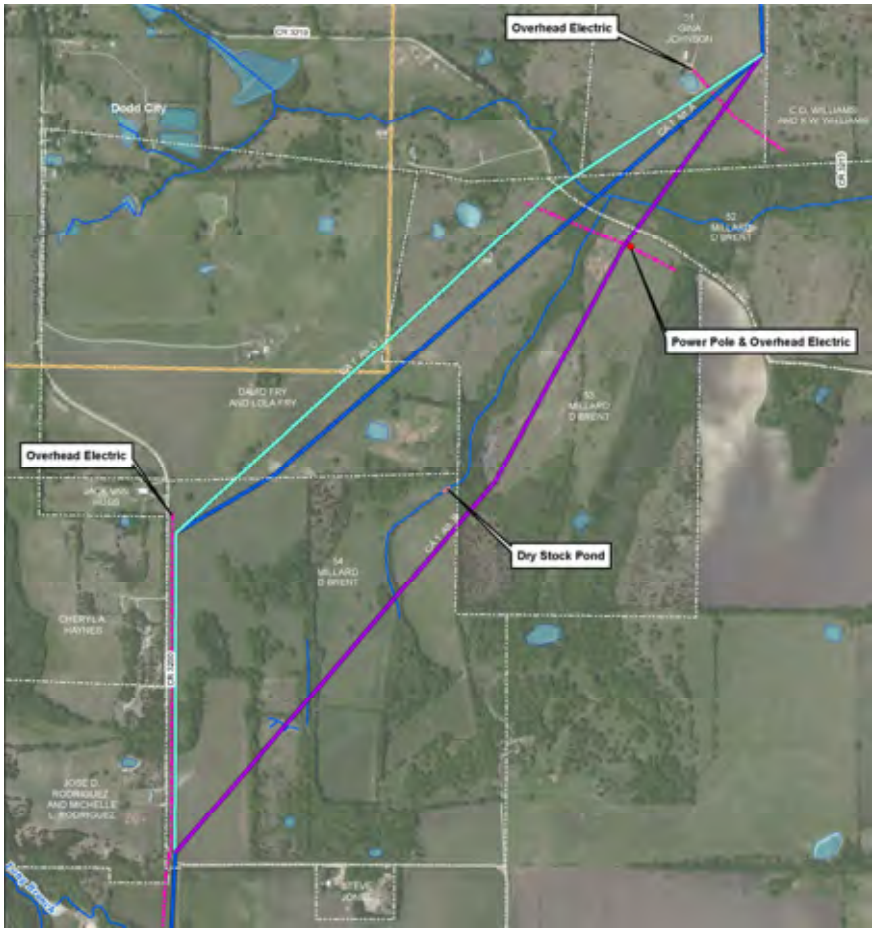


Figure 16 – Aerial View of Conflict Area #1

Alternate A was the original preliminary alignment corridor. Alternate B was developed to minimize the number of parcels crossed, along with providing the shortest pipeline route. Alternate C was developed to minimize the pipeline wooded length and provide a more favorable creek crossing scenario. The creek crossings for each alternate can be done by open cut method with bank restoration in compliance with Nationwide Permit 12 crossing parameters. Analysis of Conflict Area #1 is shown in **Table 42**.

Table 42 – Analysis for Conflict Area #1

Option	Alternate A	Alternate B	Alternate C
Length	7622	7034	7626
Number of Parcels	5	4	6
Open Length (ft.)	6577	5487	6825
Wooded Length (ft.)	1045	1547	697
Tunnel/Bore Length	0	0	0
Construction Cost	$6,260,000	$5,850,000	$6,260,000
Land Acquisition Cost	$530,000	$480,000	$560,000
Total Cost	$6,790,000	$6,330,000	$6,820,000

*For further cost analysis data see **Tables 50-52**.

From the analysis performed, Alternate A and C are very similar in construction cost, but Alternate B is recommended. Alternate B is considerably cheaper due to the reduced length and parcel crossings. In addition, the main property owner, Millard Brent owns three of the four parcels in Alternate B.

Conflict Area #2 was identified because of the potential to reduce the overall length, avoid a small pond, and potential forested wetland area in the vicinity of the property corner between two of the properties. The two alternatives analyzed for this conflict area can be seen in **Figure 17**.

Alternate A routed the pipeline parallel to the south side of CR 3205 before crossing south and following property lines. Alternate B crossed CR 3205 and routed the pipe across an open field, bisecting three properties. Analysis of Conflict Area #2 is shown in **Table 43**.

Figure 17 – Aerial View of Conflict Area #2

Table 43 – Analysis for Conflict Area #2

Option	Alternate A	Alternate B
Length	6965	5578
Number of Parcels	3	3
Open Length (ft.)	5806	5500
Wooded Length (ft.)	1082	78
Tunnel/Bore Length	77	0
Construction Cost	$5,810,000	$4,530,000
Land Acquisition Cost	$450,000	$370,000
Total Cost	$6,260,000	$4,900,000

*For further cost analysis data see **Tables 53 & 54**.

Alternate B is the recommended route due to the fact it is the shorter alternate, considerably cheaper, and eliminates potential issues with the pond and wetland area. Both alternate alignments cross the same number of parcels. Alternate B bisects properties but avoids the pond and wetland area by approximately 75 feet, while Alternate A crosses very close to the pond and through the wetland area.

Conflict Area #3 was evaluated in order to shorten the pipeline alignment and reduce the number of bends required. Four alternatives were analyzed for this conflict area and can be seen in **Figure 18**. Alternate A proposed to align the pipe parallel to property lines and traveled due west or due south through the conflict area. Alternates B and C route through open land, bisecting several properties in order to reduce the pipeline length. Alternate D follows the right of

Figure 18 – Aerial View of Conflict Area #3

way of FM 2077 and FM 1550. Alternates B, C, and D all cross creeks at select locations, but the proposed crossings can be accomplished with open cut methods and bank restoration in compliance with Nationwide Permit 12 requirements. Analysis of Conflict Area #3 is shown in **Table 44**.

Table 44 – Analysis for Conflict Area #3

Option	Alternate A	Alternate B	Alternate C	Alternate D
Length	6170	4757	5266	7084
Number of Parcels	5	6	6	5
Open Length (ft.)	5763	4458	5054	6890
Wooded Length (ft.)	297	195	112	58
Tunnel/Bore Length	110	105	100	100
Construction Cost	$5,180,000	$4,030,000	$4,430,000	$5,920,000
Land Acquisition Cost	$460,00	$410,000	$430,000	$510,000
Total Cost	$5,660,000	$4,440,000	$4,840,000	$6,430,000

*For further cost analysis data see **Tables 55-58.**

Alternate B is the recommended route because it is the shortest option and the least expensive of the alternatives. Alternate A, C, and D are all longer and therefore have a greater construction cost and land acquisition cost than Alternate B. In addition, Alternate C and D pass an old barn structure that has been preliminarily flagged as a potential historical structure. These routes should still miss the structure, but will require further historical investigation. Alternate B veers westward cross country prior to this structure, therefore avoiding any further investigation of the structure.

Conflict Area #4 was identified due to potential savings for cutting cross country rather than paralleling property lines between FM 1550 and CR 3302. Two alternates were analyzed for this conflict area shown in **Figure 19**.

Alternate A paralleled property lines to head south after crossing FM 1550. Alternate B routed cross country between FM 1550 and CR 3302. Analysis of Conflict Area #4 is shown in **Table 45**.

Figure 19 – Aerial View of Conflict Area #4

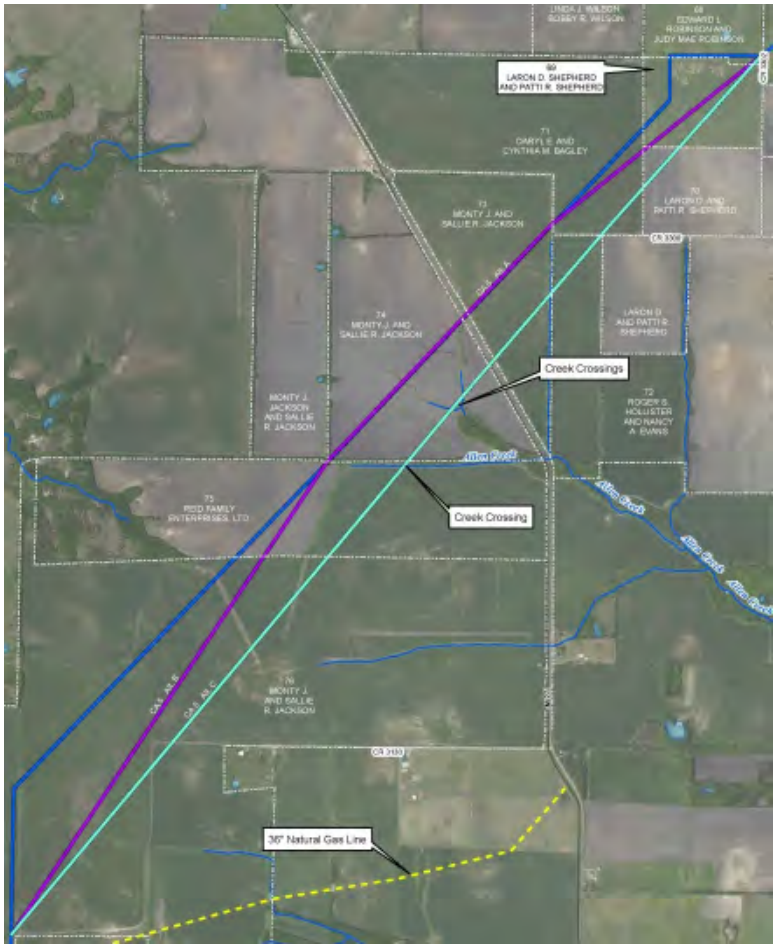
Table 45 – Analysis for Conflict Area #4

Option	Alternate A	Alternate B
Length	3023	2155
Number of Parcels	2	2
Open Length (ft.)	2862	2016
Wooded Length (ft.)	53	39
Tunnel/Bore Length	108	101
Construction Cost	$2,620,000	$1,910,000
Land Acquisition Cost	$210,000	$170,000
Total Cost	$2,830,000	$2,080,000

*For further cost analysis data see **Tables 59 & 60**.

Alternate B was selected as the recommended route since it is significantly shorter and less expensive than Alternate A.

Conflict Area #5 was identified due to potential savings for cutting cross country with slightly different alignments at the end of Conflict Area #4, between CR 3302 and CR 3120. Three alternatives were considered for this conflict area shown below in **Figure 20**.



The original preliminary alignment, Alternate A, paralleled property lines at the north and south ends of the conflict area, but routed through open land for most of the conflict area. Alternate B and C routed cross country between CR 3302 and CR 3120. Analysis of Conflict Area #5 is shown in **Table 46**.

Table 46 – Analysis for Conflict Area #5

Option	Alternate A	Alternate B	Alternate C
Length	16062	15169	15054
Number of Parcels	7	8	9
Open Length (ft.)	15883	14999	14724
Wooded Length (ft.)	104	96	98
Tunnel/Bore Length	50	52	54
Construction Cost	$13,130,000	$12,410,000	$12,400,000
Land Acquisition Cost	$1,010,000	$1,010,100	$1,030,000
Total Cost	$14,140,000	$13,420,000	$13,430,000

*For further cost analysis data see **Tables 61-63**.

Alternate C is the recommended route because it is the shortest route and the least expensive. Alternate A crosses the least number of parcels, but is approximately 1,000 feet longer than Alternate C and the most costly. Alternate C has two creek crossings, but they do not have wetlands associated with them and can be accomplished with open cut methods and bank restoration in compliance with Nationwide Permit 12 requirements.

Conflict Area #6 was identified due to potential savings for cutting cross country rather than paralleling property lines between CR 3120 and CR 3116. Two alternates were analyzed for this conflict area shown in **Figure 21**.

Alternate A was the preliminary alignment and paralleled property lines. Alternate B routed cross country aligning with an existing cross country 36 inch natural gas line. Analysis of Conflict Area #6 is shown in **Table 47**.

Figure 21 – Aerial View of Conflict Area #6

Table 47 – Analysis for Conflict Area #6

Option	Alternate A	Alternate B
Length	4357	3655
Number of Parcels	1	1
Open Length (ft.)	4255	3594
Wooded Length (ft.)	85	42
Tunnel/Bore Length	0	0
Construction Cost	$3,550,000	$2,980,000
Land Acquisition Cost	$260,000	$220,000
Total Cost	$3,810,000	$3,200,000

*For further cost analysis data see **Tables 64 & 65**.

Alternate B is recommended because of the reduced length and cost savings associated with it. Even though the Alternate B bisects properties, the alignment would be following an existing pipeline. Also, Alternate A crosses the gas pipeline twice, which would result in a greater construction cost.

2.3.4 Opinion of Probable Construction Cost

The Opinion of Probable Construction Cost (OPCC) for the Section B recommended alignment is $55,104,900. A detailed breakout of this OPCC is shown in **Table 48.**

Table 48 – Opinion of Probable Construction Costs

NTMWD
Lower Bois d'Arc Creek
Reservoir Raw Water
Pipeline (Section B)

FREESE AND NICHOLS

1701 N Market St., #500, LB51 • Dallas, Texas 75202 • 214-217-2200 • fax 214-217-2201

OPINION OF PROBABLE CONSTRUCTION COSTS (INCLUDING EASEMENTS) — September 16, 2013

ESTIMATOR	CHECKED BY	ACCOUNT NO
DWH	JB	NTD13136

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	90-INCH PIPELINE	51,688	LF	$650.00	$ 33,597,264
2	TUNNELED CROSSINGS	551	LF	$1,970.00	$ 1,084,520
3	PIPELINE ROW CLEARING	140	AC	$5,000.00	$ 700,000
4	TRENCH SAFETY	51,688	LF	$1.00	$ 51,688
5	AIR RELEASE VALVES	15	EA	$25,000.00	$ 372,500
6	BUTTERFLY VALVES	2	EA	$165,000.00	$ 330,000
7	BLOW OFF VALVES	15	EA	$25,000.00	$ 372,500
8	PAVEMENT RESTORATION	830	SY	$70.00	$ 58,100
9	CREEK CROSSINGS	468	LF	$445.00	$ 208,273
10	REVEGETATION	140	AC	$1,160.00	$ 162,400
11	FIBER OPTIC CONDUIT	51,688	LF	$3.00	$ 155,064
12	FIBER	51,688	LF	$2.00	$ 103,376
13	CATHODIC PROTECTION	51,688	LF	$2.00	$ 103,370
14	ACCESS MANWAYS	15	EA	$10,000.00	$ 149,000
15	TESTING	51,688	LF	$2.00	$ 103,376
16	MOBILIZATION	1	LS	$1,877,572.00	$ 1,877,572
	CONSTRUCTION SUBTOTAL				$ 39,430,000
	CONSTRUCTION CONTINGENCY	15%			$ 5,914,500
	CONTRUCTION TOTAL				$ 45,344,500
	ESTIMATED EASEMENT/PROPERTY COSTS				
	PERMANENT EASEMENT W/ ASSOCIATED TEMPORARY (Note 1)	2,584,405	SF	$1.00	$2,584,400.00
	TOTAL ESTIMATED COSTS (INCLUDING EASEMENT)				$47,928,900.00

1. Estimated Easement Costs Based on a 50' Perm Easement & 70' Temp Easement for the Entire Route

2.3.5 Recommendations Summary

The recommended alignment for Section B is Alternate B for Conflict Area #1, #2, #3, #4, and #6, and Alternate C for Conflict Area #5. Each of these routes is expected to be the least expensive option for their corresponding conflict area. All conflict areas avoid potential complications in land acquisition and construction. Based on the recommended routes the proposed Section B alignment has been shortened from 11.02 miles to 9.89 miles, a savings of 1.13 miles of 90 inch pipeline.

2.3.6 Pipeline Crossings

Table 49 below presents identified utility, roadway, and creek crossings associated with the recommended route.

Table 49– Major Transportation, Utility, and W Crossings

Road
State Highway 56
Fannin CR 3210
Fannin CR 3200
Fannin CR 3205
Farm to Market 2077
Farm to Market 1550
Fannin CR 3302
Fannin CR 3300
Farm to Market 271
Fannin CR 3120
Fannin CR 3115
Farm to Market 68
Railroad
Texas Northeastern Railroad (TNER) - Genesee & Wyoming Inc.
Utility
36" Natural Gas Pipeline - Energy Transfer Company
Waterbody
Bullard Creek Tributary
Long Branch Creek Tributary
Pot Creek
Allen Creek

Table 50 – Conflict Area #1 Alt A Cost Analysis

ALTERNATE A	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	6,547	R	1	53.72	656	351,705	4,294,832	136,435
Type 2- Wooded	974	R	2	53.72	669	52,323	651,606	20,297
Type 3 - Creek Crossings	70	R	4	53.72	1094	3,760	76,580	1,459
Type 4 - Road/Parking Lot Crossings	30	R	5	53.72	1047	1,612	31,410	625
Type 5 - Bore or Tunnel Crossings	-	R	6	53.72	1900	-	-	-
Parcel Count [2]	5	EA		25000	$/EA	125,000		
Totals:	**7,621**					**$534,400**	**$5,054,428**	**$158,816**
						CONSTRUCTION COST		**$5,213,244**
						CONTINGENCY	20%	**$1,042,649**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$6,260,000**
2. This is for ROE and acquisition related costs						TOTAL LAND COST		**$530,000**
						TOTAL ROUTE COST		**$6,790,000**

Table 51 – Conflict Area #1 Alt B Cost Analysis

ALTERNATE B	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	5,461	R	1	53.72	656	293,365	3,582,416	113,803
Type 2- Wooded	1,340	R	2	53.72	669	71,985	896,460	27,925
Type 3 - Creek Crossings	207	R	4	53.72	1094	11,120	226,458	4,314
Type 4 - Road/Parking Lot Crossings	26	R	5	53.72	1047	1,397	27,222	542
Type 5 - Bore or Tunnel Crossings	-	R	6	53.72	1900	-	-	-
Parcel Count [2]	4	EA		25000	$/EA	100,000		
Totals:	**7,034**					**$477,866**	**$4,732,556**	**$146,584**
						CONSTRUCTION COST		**$4,879,140**
						CONTINGENCY	20%	**$975,828**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$5,850,000**
2. This is for ROE and acquisition related costs						TOTAL LAND COST		**$480,000**
						TOTAL ROUTE COST		**$6,330,000**

Table 52 – Conflict Area #1 Alt C Cost Analysis

ALTERNATE C	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	6,825	R	1	53.72	656	366,639	4,477,200	142,228
Type 2- Wooded	697	R	2	53.72	669	37,443	466,293	14,525
Type 3 - Creek Crossings	74	R	4	53.72	1094	3,975	80,956	1,542
Type 4 - Road/Parking Lot Crossings	30	R	5	53.72	1047	1,612	31,410	625
Type 5 - Bore or Tunnel Crossings	-	R	6	53.72	1900	-	-	-
Parcel Count [2]	6	EA		25000	$/EA	150,000		
Totals:	**7,626**					**$559,669**	**$5,055,859**	**$158,920**
							CONSTRUCTION COST	**$5,214,779**
						CONTINGENCY	20%	**$1,042,956**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$6,260,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$560,000**
							TOTAL ROUTE COST	**$6,820,000**

Table 53 – Conflict Area #2 Alt A Cost Analysis

ALTERNATE A	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	5,806	R	1	53.72	656	311,898	3,808,736	120,993
Type 2- Wooded	1,034	R	2	53.72	669	55,546	691,746	21,548
Type 3 - Creek Crossings	48	R	4	53.72	1094	2,579	52,512	1,000
Type 4 - Road/Parking Lot Crossings	-	R	5	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings	77	R	6	53.72	1900	4,136	146,300	1,605
Parcel Count [2]	3	EA		25000	$/EA	75,000		
Totals:	**6,965**					**$449,160**	**$4,699,294**	**$145,146**
							CONSTRUCTION COST	**$4,844,440**
						CONTINGENCY	20%	**$968,888**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$5,810,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$450,000**
							TOTAL ROUTE COST	**$6,260,000**

Table 54 – Conflict Area #2 Alt B Cost Analysis

ALTERNATE B	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	5,500	R	1	53.72	656	295,460	3,608,000	114,616
Type 2- Wooded	78	R	2	53.72	669	4,190	52,182	1,625
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	-	R	5	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings	-	R	6	53.72	1900	-	-	-
Parcel Count [2]	3	EA		25000	$/EA	75,000		
Totals:	**5,578**					**$374,650**	**$3,660,182**	**$116,242**
							CONSTRUCTION COST	**$3,776,424**
						CONTINGENCY	20%	**$755,285**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$4,530,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$370,000**
							TOTAL ROUTE COST	**$4,900,000**

Table 55 – Conflict Area #3 Alt A Cost Analysis

ALTERNATE A	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	5,763	R	1	53.72	656	309,588	3,780,528	120,097
Type 2- Wooded	297	R	2	53.72	669	15,955	198,693	6,189
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	-	R	5	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings	110	R	6	53.72	1900	5,909	209,000	2,292
Parcel Count [2]	5	EA		25000	$/EA	125,000		
Totals:	**6,170**					**$456,452**	**$4,188,221**	**$128,578**
							CONSTRUCTION COST	**$4,316,799**
						CONTINGENCY	20%	**$863,360**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$5,180,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$460,000**
							TOTAL ROUTE COST	**$5,640,000**

Table 56 – Conflict Area #3 Alt B Cost Analysis

ALTERNATE B	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	4,458	R	1	53.72	656	239,484	2,924,448	92,902
Type 2- Wooded	180	R	2	53.72	669	9,670	120,420	3,751
Type 3 - Creek Crossings	15	R	4	53.72	1094	806	16,410	313
Type 4 - Road/Parking Lot Crossings	-	R	5	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings	105	R	6	53.72	1900	5,641	199,500	2,188
Parcel Count [2]	6	EA		25000	$/EA	150,000		
Totals:	**4,758**					**$405,600**	**$3,260,778**	**$99,153**
						CONSTRUCTION COST		**$3,359,931**
						CONTINGENCY	20%	**$671,986**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$4,030,000**
2. This is for ROE and acquisition related costs						TOTAL LAND COST		**$410,000**
						TOTAL ROUTE COST		**$4,440,000**

Table 57 – Conflict Area #3 Alt C Cost Analysis

ALTERNATE C	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	5,054	R	1	53.72	656	271,501	3,315,424	105,322
Type 2- Wooded	112	R	2	53.72	669	6,017	74,928	2,334
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	-	R	5	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings	100	R	6	53.72	1900	5,372	190,000	2,084
Parcel Count [2]	6	EA		25000	$/EA	150,000		
Totals:	**5,266**					**$432,890**	**$3,580,352**	**$109,740**
						CONSTRUCTION COST		**$3,690,092**
						CONTINGENCY	20%	**$738,018**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$4,430,000**
2. This is for ROE and acquisition related costs						TOTAL LAND COST		**$430,000**
						TOTAL ROUTE COST		**$4,860,000**

Table 58 – Conflict Area #3 Alt D Cost Analysis

ALTERNATE D	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	6,890	R	1	53.72	656	370,131	4,519,840	143,583
Type 2- Wooded	58	R	2	53.72	669	3,116	38,802	1,209
Type 3 - Creek Crossings	36	R	4	53.72	1094	1,934	39,384	750
Type 4 - Road/Parking Lot Crossings	-	R	5	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings	100	R	6	53.72	1900	5,372	190,000	2,084
Parcel Count [2]	5	EA		25000	$/EA	125,000		
Totals:	**7,084**					**$505,552**	**$4,788,026**	**$147,626**
						CONSTRUCTION COST		**$4,935,652**
						CONTINGENCY	20%	**$987,130**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$5,920,000**
2. This is for ROE and acquisition related costs						TOTAL LAND COST		**$510,000**
						TOTAL ROUTE COST		**$6,430,000**

Table 59 – Conflict Area #4 Alt A Cost Analysis

ALTERNATE A	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	2,850	R	1	53.72	656	153,102	1,869,600	59,392
Type 2- Wooded	53	R	2	53.72	669	2,847	35,457	1,104
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	12	R	5	53.72	1047	645	12,564	250
Type 5 - Bore or Tunnel Crossings	108	R	6	53.72	1900	5,802	205,200	2,251
Parcel Count [2]	2	EA		25000	$/EA	50,000		
Totals:	**3,023**					**$212,396**	**$2,122,821**	**$62,997**
						CONSTRUCTION COST		**$2,185,818**
						CONTINGENCY	20%	**$437,164**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$2,620,000**
2. This is for ROE and acquisition related costs						TOTAL LAND COST		**$210,000**
						TOTAL ROUTE COST		**$2,830,000**

Table 60 – Conflict Area #4 Alt B Cost Analysis

ALTERNATE B	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	2,003	R	1	53.72	656	107,601	1,313,968	41,741
Type 2- Wooded	39	R	2	53.72	669	2,095	26,091	813
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	13	R	5	53.72	1047	698	13,611	271
Type 5 - Bore or Tunnel Crossings	101	R	6	53.72	1900	5,426	191,900	2,105
Parcel Count [2]	2	EA		25000	$/EA	50,000		
Totals:	**2,156**					**$165,820**	**$1,545,570**	**$44,930**
						CONSTRUCTION COST		**$1,590,500**
						CONTINGENCY	20%	**$318,100**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$1,910,000**
2. This is for ROE and acquisition related costs						TOTAL LAND COST		**$170,000**
						TOTAL ROUTE COST		**$2,080,000**

Table 61 – Conflict Area #5 Alt A Cost Analysis

ALTERNATE A	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	15,883	R	1	53.72	656	853,235	10,419,248	330,990
Type 2- Wooded	104	R	2	53.72	669	5,587	69,576	2,167
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	24	R	5	53.72	1047	1,289	25,128	500
Type 5 - Bore or Tunnel Crossings	50	R	6	53.72	1900	2,686	95,000	1,042
Parcel Count [2]	7	EA		25000	$/EA	175,000		
Totals:	**16,061**					**$1,037,797**	**$10,608,952**	**$334,700**
						CONSTRUCTION COST		**$10,943,652**
						CONTINGENCY	20%	**$2,188,730**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$13,130,000**
2. This is for ROE and acquisition related costs						TOTAL LAND COST		**$1,040,000**
						TOTAL ROUTE COST		**$14,170,000**

Table 62 – Conflict Area #5 Alt B Cost Analysis

ALTERNATE B	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	14,999	R	1	53.72	656	805,746	9,839,344	312,568
Type 2- Wooded	96	R	2	53.72	669	5,157	64,224	2,001
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	22	R	5	53.72	1047	1,182	23,034	458
Type 5 - Bore or Tunnel Crossings	52	R	6	53.72	1900	2,793	98,800	1,084
Parcel Count [2]	8	EA		25000	$/EA	200,000		
Totals:	**15,169**					**$1,014,879**	**$10,025,402**	**$316,111**
							CONSTRUCTION COST	**$10,341,513**
						CONTINGENCY	20%	**$2,068,303**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$12,410,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$1,010,000**
							TOTAL ROUTE COST	**$13,420,000**

Table 63 – Conflict Area #5 Alt C Cost Analysis

ALTERNATE C	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	14,724	R	1	53.72	656	790,973	9,658,944	306,838
Type 2- Wooded	98	R	2	53.72	669	5,265	65,562	2,042
Type 3 - Creek Crossings	162	R	4	53.72	1094	8,703	177,228	3,376
Type 4 - Road/Parking Lot Crossings	16	R	5	53.72	1047	860	16,752	333
Type 5 - Bore or Tunnel Crossings	54	R	6	53.72	1900	2,901	102,600	1,125
Parcel Count [2]	9	EA		25000	$/EA	225,000		
Totals:	**15,054**					**$1,033,701**	**$10,021,086**	**$313,715**
							CONSTRUCTION COST	**$10,334,801**
						CONTINGENCY	20%	**$2,066,960**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$12,400,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$1,030,000**
							TOTAL ROUTE COST	**$13,430,000**

Table 64 – Conflict Area #6 Alt A Cost Analysis

ALTERNATE A	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	4,255	R	1	53.72	656	228,579	2,791,280	88,671
Type 2- Wooded	85	R	2	53.72	669	4,566	56,865	1,771
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	17	R	5	53.72	1047	913	17,799	354
Type 5 - Bore or Tunnel Crossings	-	R	6	53.72	1900	-	-	-
Parcel Count [2]	1	EA		25000	$/EA	25,000		
Totals:	**4,357**					**$259,058**	**$2,865,944**	**$90,797**
						CONSTRUCTION COST		**$2,956,741**
						CONTINGENCY	20%	**$591,348**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$3,550,000**
2. This is for ROE and acquisition related costs						TOTAL LAND COST		**$260,000**
						TOTAL ROUTE COST		**$3,810,000**

Table 65 – Conflict Area #6 Alt B Cost Analysis

ALTERNATE B	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	3,594	R	1	53.72	656	193,070	2,357,664	74,896
Type 2- Wooded	42	R	2	53.72	669	2,256	28,098	875
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	19	R	5	53.72	1047	1,021	19,893	396
Type 5 - Bore or Tunnel Crossings	-	R	6	53.72	1900	-	-	-
Parcel Count [2]	1	EA		25000	$/EA	25,000		
Totals:	**3,655**					**$221,347**	**$2,405,655**	**$76,168**
						CONSTRUCTION COST		**$2,481,823**
						CONTINGENCY	20%	**$496,365**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$2,980,000**
2. This is for ROE and acquisition related costs						TOTAL LAND COST		**$220,000**
						TOTAL ROUTE COST		**$3,200,000**

2.4 SECTION C

2.4.1 Introduction

Section C of the LBCR Raw Water Pipeline connects with Section B approximately 2.5 miles north of Bailey. The connection is near the intersection of FM 68 and CR 3700, which is slightly less than a mile due east of SH 78. The pipeline alignment ends at the proposed site of the North Water Treatment Plant (NWTP) on the west side of Leonard. Section C is approximately 11 miles long and runs generally southwest.

The original preliminary pipeline corridor was determined in "NTMWD Preliminary Pipeline Routing Study and Conceptual Pump Station Design Report" by completing a high level analysis of pipeline corridors from the proposed LBCR pump station to the proposed NWTP site. The pump station was relocated as a portion of this project, but this did not change the pipeline corridor for Section C. The preliminary alignment was modified to generally parallel existing roads and property lines. Various options were examined at identified conflict areas and additional analysis was completed to take into account costs associated with easements, road crossings, and construction. The analysis discussed in this report details the process of determining the final pipeline alignment from the preliminary alignment and various alternatives developed during this phase of the pipeline route selection.

2.4.2 Evaluation of Corridors

The preliminary alignment corridor for Section C of the LBCR Pipeline northeast of Leonard routed the pipe south along the east side of SH 78 until just before crossing CR 4850 where the pipeline routed west. While investigating potential conflicts, a family cemetery was identified to be in the path of the preliminary alignment. In order to avoid the cemetery and several other potential conflicts along the preliminary alignment, alternates to the West of SH 78 were investigated. The new proposed route alternatives were developed by first finding a SH 78 crossing north of the cemetery, and then determining where was the best location for the new route to connect back with the preliminary pipeline alignment. An alignment was routed around a house on the west side of SH 78 and then traveled through mostly open land before ending at the preliminary alignment. The preliminary alignment was named Proposed Route A and the western cross-country alternative Proposed Route B.

Figure 22, below, shows a map of both proposed routes.

Figure 22 – Map of Proposed Routes

The two corridors developed were compared using a High Level Analysis shown below in **Table 66**. The routes were evaluated based on length, parcel count, wooded crossings length, number of stream crossings, hydric soil crossings, and number of bored crossings. Each item was weighted, and the routes were scored and compared. Proposed Route B is approximately 100 feet shorter than Proposed Route A, crosses fewer parcels, fewer wooded areas, and does not cross a perennial stream. Also, Proposed Route A travels through the family cemetery, within 20 feet of a pond, and within 30 feet of a house. Proposed Route B scored the lowest (Best) in this analysis and was selected as the preferred route.

Table 66 – Weighted High Level Route Scores

Raw Quantities (Low is Best)			
Item Description	**Item Weight** (High = Most Important) (0 = Not Considered)	**Routes**	
		Proposed A	**Proposed B**
Route Length, ft	40	7,863	7,668
Parcel Count, ea	15	9	5
Wooded Crossing, ft	10	523	313
Perennial Stream Crossing, ea	10	1	-
Intermittent Stream Crossing, ea	9	2	2
Hydric Soil Crossing, ft	9	-	-
Bored Crossing (TXDOT & RR), ea	7	1	1
Total	100		

Normalized Score (Low is Best)			
Item Description	**Item Weight**	**Proposed A**	**Proposed B**
Route Length, ft	40.00	40.34	39.34
Parcel Count, ea	15.00	2.25	1.25
Wooded Crossing, ft	10.00	2.49	1.49
Perennial Stream Crossing, ea	10.00	1.00	-
Intermittent Stream Crossing, ea	9.00	1.00	1.00
Hydric Soil Crossing, ft	9.00	1.00	1.00
Bored Crossing (TXDOT & RR), ea	7.00	1.00	1.00
Total	100.00	49.07	45.07

Weighted Score (Low is Best)			
Item Description	**Item Weight**	**Proposed A**	**Proposed B**
Route Length, ft	40.00	16.14	15.74
Parcel Count, ea	15.00	0.34	0.19
Wooded Crossing, ft	10.00	0.25	0.15
Perennial Stream Crossing, ea	10.00	0.10	-
Intermittent Stream Crossing, ea	9.00	0.09	0.09
Hydric Soil Crossing, ft	9.00	0.09	0.09
Bored Crossing (TXDOT & RR), ea	7.00	0.07	0.07
Total	100.00	**17.07**	**16.32**

2.4.3 Route Alternatives

The preliminary pipeline alignment corridor was investigated further in order to identify potential conflict areas along the route. Conflicts were determined based upon aerial imagery and field work walking the potential pipeline routes. A detailed evaluation of localized alternatives was performed to optimize the pipeline alignment and avoid potential conflicts in land acquisition and construction. Environmental constraints such as stream crossings, perennial water bodies, and possible wetlands along with impacts to property owners were taken into account during the analysis.

Four main conflict areas were identified on the potential pipeline route. The first conflict area is south of FM 68 along CR 3700, which is the beginning of Section C. The preliminary pipeline alignment routed in front of a house. An alternate was included to route the pipeline on the other side of the road to avoid complications with land acquisition. The second conflict area is near the intersection of CR 3700 and FM 1552. The original alignment routed close to a house and would require several fittings to follow property lines. A new alternative was developed to shorten up the alignment and avoid passing close by to the house. The third conflict area is located directly south of Bailey where the pipeline travels between FM 816 and SH 78. The preliminary alignment heads due west following property lines. Other alternatives were evaluated to travel through open land and avoid a large wooded creek area just east of SH 78. Also, this conflict area was used to determine the best location to cross to the west side of SH 78. The fourth conflict area is located between FM 1553 and CR 4670. The preliminary pipeline follows property lines and existing overhead electric lines. An alternate route was developed to cross through open land and minimize the pipeline route.

The preferred alternatives were determined by analysis that compared the total length, number of parcels crossed, open cut length, wooded length, tunnel length, construction cost, and land acquisition cost. The recommended alignment was chosen based on the cost analysis completed and engineering judgment. The detailed route analysis of these four conflict areas is discussed below.

2.4.4 Detailed Route Analysis

In order to properly analyze the various alternatives developed for the conflict areas, data was collected and input into a pipeline route evaluation criteria spreadsheet. Cost data was updated to estimate future pipeline construction costs based on recent bid information. Routes were classified by the type

of land they would be installed in: open area, wooded, open cut creek crossings, open cut road crossings, or tunneled crossings. A construction cost and land acquisition cost was associated with each classification in order to estimate the total route cost per linear foot. This allowed a cost to be generated for each alternate based upon the linear feet of the land classification. A cost comparison was performed for the alternates of each conflict area to determine the most cost effective route. The route with the lowest cost was selected as the preferred route; however, engineering judgment was also used to ensure that potential complications with an unknown cost were also evaluated.

Conflict Area #1 was identified because of the proximity of the pipeline alignment to a house on the east side of CR 3115 as seen in **Figure 23**. Two alternatives were analyzed for this conflict area.

Alternate A paralleled the east side of CR 3700. Alternate B paralleled the west side of CR 3700. Analysis of Conflict Area #1 is shown in **Table 67**.

Figure 23 – Aerial View of Conflict Area #1

Table 67 – Analysis for Conflict Area #1

Option	Alternate A	Alternate B
Length	8435	8328
Number of Parcels	8	6
Open Length (ft.)	8435	8192
Wooded Length (ft.)	0	136
Tunnel/Bore Length	0	0
Construction Cost	$6,860,000	$6,780,000
Land Acquisition Cost	$650,000	$600,000
Total Cost	$7,510,000	$7,380,000

*For further cost analysis data see **Tables 73 & 74**

From the analysis performed, Alternate A and B are very similar in construction cost, but Alternate B is recommended. Alternate B is approximately 100 feet shorter than Alternate A and has a lower total cost. Also, Alternate B avoids construction near the house on the east side of CR 3700.

Conflict Area #2 was identified because of the possibility to minimize pipeline fittings and move the route a greater distance from the house on FM 1552. Two alternatives were analyzed for this conflict area and can be seen in **Figure 24**.

Alternate A routed the pipeline parallel to the north side of FM 1552 before crossing south and following property lines. Alternate B crossed FM 1552 on the west side of the intersection with CR 3700 and routed the pipe across an open field, bisecting two properties. Analysis of Conflict Area #2 is shown in **Table 68**.

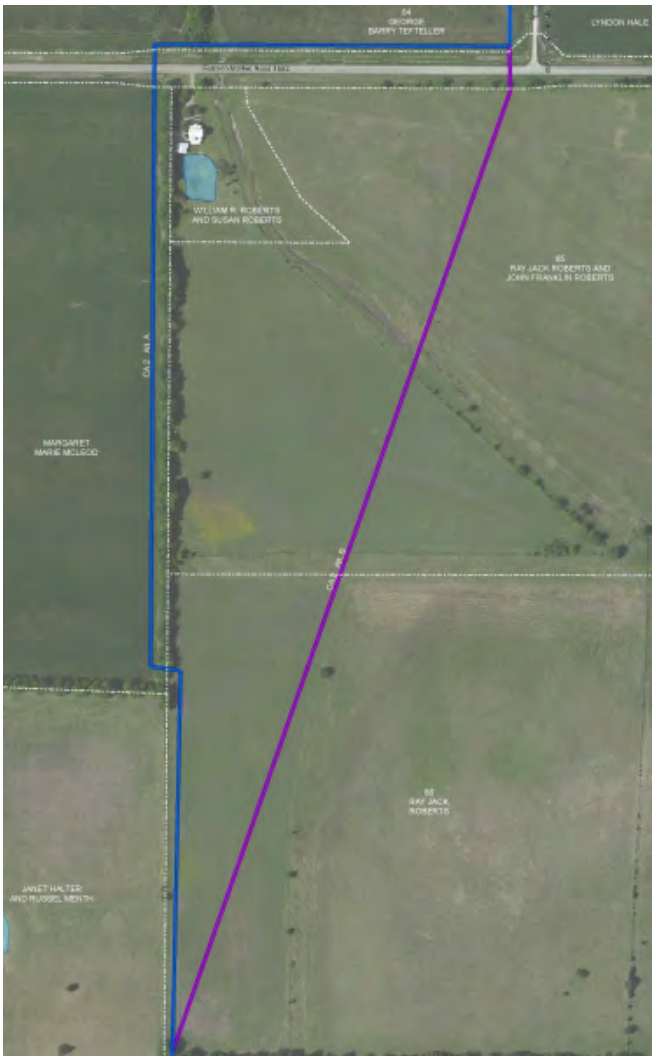


Figure 24 – Aerial View of Conflict Area #2

Table 68 – Analysis for Conflict Area #2

Option	Alternate A	Alternate B
Length	3759	2879
Number of Parcels	3	3
Open Length (ft.)	3485	2777
Wooded Length (ft.)	223	52
Tunnel/Bore Length	51	50
Construction Cost	$3,160,000	$2,440,000
Land Acquisition Cost	$280,000	$230,000
Total Cost	$3,440,000	$3,670,000

*For further cost analysis data see **Tables 75 & 76**.

Alternate B was selected as the recommended route due to the fact it is the shorter alternative and would give the contractor more distance from the house on FM 1552. Alternate B is the less expensive approach even though it bisects two parcels, while Alternate A follows property lines. In addition to being longer, Alternate A would require land acquisition from three landowners, while only two would be required for Alternate B.

Conflict Area #3 was investigated to determine the best route to align the pipe south of the city of Bailey. As shown in **Figure 25**, the area has several creek crossings, large wooded areas, and structures within a close distance to the SH 78 right-of-way. Five route alternatives were analyzed for this conflict area.

Figure 25 – Aerial View of Conflict Area #3

Alternate A proposed to align the pipe along property lines heading due west before crossing a creek and large wooded area in order to parallel the east side of SH 78. Alternate B traveled through open land on two properties before following property lines while heading due west to parallel the east side of SH 78. Alternate C routed through open land, bisecting several properties in order to avoid conflicts

along SH 78. Alternate D followed the first half of Alternate A before crossing to the west side of SH 78 to avoid a house on the east ROW line. Alternate E crossed through open land and then followed the alignment of Alternate D. Analysis of Conflict Area #3 is shown in **Table 69**.

Table 69 – Analysis for Conflict Area #3

Option	Alternate A	Alternate B	Alternate C	Alternate D	Alternate E
Length	18859	19312	18671	18787	17251
Number of Parcels	19	18	18	16	16
Open Length (ft.)	16546	18270	17358	16947	16583
Wooded Length (ft.)	1944	678	1079	1674	504
Tunnel/Bore Length	369	364	234	165	164
Construction Cost	$16,300,000	$16,410,000	$15,730,000	$15,790,000	$14,490,000
Land Acquisition Cost	$1,490,000	$1,490,000	$1,450,000	$1,410,000	$1,330,000
Total Cost	$17,790,00	$17,900,000	$17,180,000	$17,200,000	$15,820,000

*For further cost analysis data see **Tables 77-81**.

Alternate E is the recommended route because it is the shortest option, the least expensive, and successfully bypasses the majority of the conflicts. Alternate D is one of the shorter options and follows property lines, but is more expensive than Alternate E. Alternate C is the second shortest alternative, but has a high potential increase in land acquisition cost due to bisecting smaller properties. Neither Alternate A nor B avoids the house on the east ROW line, which could result in higher construction and land acquisition costs.

Conflict Area #4 was identified in order to find the best route around the north side of Leonard and avoid several houses in the area. Two alternates were analyzed for this conflict area and can be found in **Figure 26**.

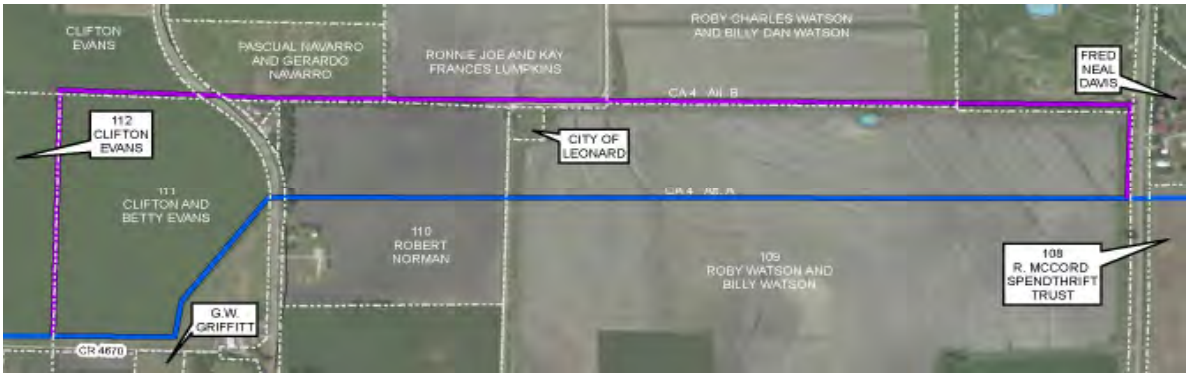


Figure 26 – Aerial View of Conflict Area #4

Alternate A traveled through open farmland, followed the edge of a field, and then aligned parallel to CR 4670 as it headed west. Alternate B routed west parallel to property lines to the north and then angled south parallel to overhead electric lines until just north of CR 4670. Analysis of Conflict Area #4 is shown in **Table 70**.

Table 70 – Analysis for Conflict Area #4

Option	Alternate A	Alternate B
Length	6940	8593
Number of Parcels	4	7
Open Length (ft.)	6817	8463
Wooded Length (ft.)	44	0
Tunnel/Bore Length	80	130
Construction Cost	$5,770,000	$7,170,000
Land Acquisition Cost	$470,000	$640,000
Total Cost	$6,240,000	$7,810,000

*For further cost analysis data see **Tables 82 & 83**.

Alternate A is the recommended route since it is significantly shorter and maintains a greater distance from houses in the area than Alternate B. Alternate B follows property lines and overhead electric lines, but routes within 50 feet of a pond, 150 feet of a house, and adds length to follow property lines. Alternate B crosses three more parcels, but Alternate A bisects several properties.

2.4.5 Opinion of Probable Construction Cost

The Opinion of Probable Construction Cost (OPCC) for the Section C recommended alignment is $61,243,100. A detailed breakout of this OPCC is shown in **Table 71**.

Table 71 – Opinion of Probable Construction Costs

NTMWD
Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

FREESE AND NICHOLS

1701 N Market St., #500, LB51 • Dallas, Texas 75202 • 214-217-2200 • fax 214-217-2201

OPINION OF PROBABLE CONSTRUCTION COSTS (INCLUDING EASEMENTS) — September 10, 2013

ESTIMATOR	CHECKED BY	ACCOUNT NO
EJE	JVW	NTD13136

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	90-INCH PIPELINE	56,462	LF	$650.00	$ 36,700,300
2	TUNNELED CROSSINGS	749	LF	$1,970.00	$ 1,475,530
3	PIPELINE ROW CLEARING	150	AC	$5,000.00	$ 750,000
4	TRENCH SAFETY	56,462	LF	$1.00	$ 56,462
5	AIR RELEASE VALVES	16	EA	$25,000.00	$ 407,500
6	BUTTERFLY VALVES	5	EA	$165,000.00	$ 825,000
7	BLOW OFF VALVES	16	EA	$25,000.00	$ 407,500
8	PAVEMENT RESTORATION	1,360	SY	$70.00	$ 81,200
9	CREEK CROSSINGS	752	LF	$445.00	$ 334,640
10	REVEGETATION	150	AC	$1,160.00	$ 174,000
11	FIBER OPTIC CONDUIT	56,462	LF	$3.00	$ 169,386
12	FIBER	56,462	LF	$2.00	$ 112,924
13	CATHODIC PROTECTION	56,462	LF	$2.00	$ 112,924
14	ACCESS MANWAYS	16	EA	$10,000.00	$ 161,000
15	TESTING	56,462	LF	$2.00	$ 112,924
16	MOBILIZATION	1	LS	$2,094,165.00	$ 2,094,165

CONSTRUCTION SUBTOTAL			$ 43,980,000
CONSTRUCTION CONTINGENCY	15%		$ 6,597,000
CONTRUCTION TOTAL			$ 50,577,000

ESTIMATED EASEMENT/PROPERTY COSTS				
PERMANENT EASEMENT W/ ASSOCIATED TEMPORARY (Note 1)	2,823,100	SF	$1.00	$2,823,100.00

TOTAL ESTIMATED CONSTRUCTION COSTS (INCLUDING EASEMENT)	$53,400,100.00

1. Estimated Easement Costs Based on a 50' Perm Easement & 70' Temp Easement for the Entire Route
2. Estimated Butterfly Valves includes valves for the Terminal Storage Reservoir

2.4.6 Recommendations Summary

The recommended alignment for Section C is Alternate B for Conflict Area #1 and #2, Alternate D for Conflict Area #3, Alternate A for Conflict Area #4, and Proposed Route B for the two high level corridors evaluated. Each of these routes is expected to be the least expensive option for their corresponding Conflict Area and also avoid potential complications in land acquisition and construction.

2.4.7 Pipeline Crossings

Table 72 below presents identified utility, roadway, and creek crossings associated with the recommended route.

Table 72 – Major Transportation, Utility, and Creek Crossings

Road
Farm to Market 1552
Fannin CR 3725
State Highway 11
Farm to Market 816
Fannin CR 4845
State Highway 78
Fannin CR 4827
Fannin CR 4825
Fannin CR 4830
Farm to Market 1553
Fannin CR 4720
Farm to Market 896
Fannin CR 4670
State Highway 69
Fannin CR 4965
Railroad
M. K. & T. Railroad – Union Pacific
Utility
28" Petroleum Pipeline - Explorer Pipeline Company
Sanitary Sewer Line - City of Bailey
Waterbody
Spring Creek
Loring Creek
Mustang Creek
South Sulphur River

Table 73 – Conflict Area #1 Alt A Cost Analysis

ALTERNATE A	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	8,420	R	1	53.72	656	452,322	5,523,520	175,467
Type 2- Wooded	-	R	2	53.72	669	-	-	-
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	15	R	5	53.72	1047	806	15,705	313
Type 5 - Bore or Tunnel Crossings	-	R	6	53.72	1900	-	-	-
Parcel Count [2]	8	EA		25000	$/EA	200,000		
Totals:	**8,435**					**$653,128**	**$5,539,225**	**$175,779**
							CONSTRUCTION COST	**$5,715,004**
						CONTINGENCY	20%	**$1,143,001**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$6,860,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$650,000**
							TOTAL ROUTE COST	**$7,510,000**

Table 74 – Conflict Area #1 Alt B Cost Analysis

ALTERNATE B	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	8,165	R	1	53.72	656	438,624	5,356,240	170,153
Type 2- Wooded	136	R	2	53.72	669	7,306	90,984	2,834
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	28	R	5	53.72	1047	1,504	29,316	584
Type 5 - Bore or Tunnel Crossings	-	R	6	53.72	1900	-	-	-
Parcel Count [2]	6	EA		25000	$/EA	150,000		
Totals:	**8,329**					**$597,434**	**$5,476,540**	**$173,570**
							CONSTRUCTION COST	**$5,650,110**
						CONTINGENCY	20%	**$1,130,022**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$6,780,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$600,000**
							TOTAL ROUTE COST	**$7,380,000**

Table 75 – Conflict Area #2 Alt A Cost Analysis

ALTERNATE A	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	3,485	R	1	53.72	656	187,214	2,286,160	72,625
Type 2- Wooded	174	R	2	53.72	669	9,347	116,406	3,626
Type 3 - Creek Crossings	49	R	4	53.72	1094	2,632	53,606	1,021
Type 4 - Road/Parking Lot Crossings	-	R	5	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings	51	R	6	53.72	1900	2,740	96,900	1,063
Parcel Count [2]	3	EA		25000	$/EA	75,000		
Totals:	**3,759**					**$276,933**	**$2,553,072**	**$78,335**
							CONSTRUCTION COST	**$2,631,407**
						CONTINGENCY	20%	**$526,281**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$3,160,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$280,000**
							TOTAL ROUTE COST	**$3,440,000**

Table 76 – Conflict Area #2 Alt B Cost Analysis

ALTERNATE B	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	2,777	R	1	53.72	656	149,180	1,821,712	57,871
Type 2- Wooded	-	R	2	53.72	669	-	-	-
Type 3 - Creek Crossings	52	R	4	53.72	1094	2,793	56,888	1,084
Type 4 - Road/Parking Lot Crossings	-	R	5	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings	50	R	6	53.72	1900	2,686	95,000	1,042
Parcel Count [2]	3	EA		25000	$/EA	75,000		
Totals:	**2,879**					**$229,660**	**$1,973,600**	**$59,996**
							CONSTRUCTION COST	**$2,033,596**
						CONTINGENCY	20%	**$406,719**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$2,440,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$230,000**
							TOTAL ROUTE COST	**$2,670,000**

Table 77 – Conflict Area #3 Alt A Cost Analysis

ALTERNATE A	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	16,329	R	1	53.72	656	877,194	10,711,824	340,285
Type 2- Wooded	1,368	R	2	53.72	669	73,489	915,192	28,508
Type 3 - Creek Crossings	576	R	4	53.72	1094	30,943	630,144	12,003
Type 4 - Road/Parking Lot Crossings	218	R	5	53.72	1047	11,711	228,246	4,543
Type 5 - Bore or Tunnel Crossings	369	R	6	53.72	1900	19,823	701,100	7,690
Parcel Count [2]	19	EA		25000	$/EA	475,000		
Totals:	**18,860**					**$1,488,159**	**$13,186,506**	**$393,029**
							CONSTRUCTION COST	**$13,579,535**
						CONTINGENCY	20%	**$2,715,907**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$16,300,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$1,490,000**
							TOTAL ROUTE COST	**$17,790,000**

Table 78 – Conflict Area #3 Alt B Cost Analysis

ALTERNATE B	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	18,125	R	1	53.72	656	973,675	11,890,000	377,712
Type 2- Wooded	483	R	2	53.72	669	25,947	323,127	10,065
Type 3 - Creek Crossings	195	R	4	53.72	1094	10,475	213,330	4,064
Type 4 - Road/Parking Lot Crossings	144	R	5	53.72	1047	7,736	150,768	3,001
Type 5 - Bore or Tunnel Crossings	364	R	6	53.72	1900	19,554	691,600	7,586
Parcel Count [2]	18	EA		25000	$/EA	450,000		
Totals:	**19,311**					**$1,487,387**	**$13,268,825**	**$402,427**
							CONSTRUCTION COST	**$13,671,252**
						CONTINGENCY	20%	**$2,734,250**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$16,410,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$1,490,000**
							TOTAL ROUTE COST	**$17,900,000**

Table 79 – Conflict Area #3 Alt C Cost Analysis

ALTERNATE C	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	17,242	R	1	53.72	656	926,240	11,310,752	359,311
Type 2- Wooded	794	R	2	53.72	669	42,654	531,186	16,546
Type 3 - Creek Crossings	285	R	4	53.72	1094	15,310	311,790	5,939
Type 4 - Road/Parking Lot Crossings	116	R	5	53.72	1047	6,232	121,452	2,417
Type 5 - Bore or Tunnel Crossings	234	R	6	53.72	1900	12,570	444,600	4,876
Parcel Count [2]	18	EA		25000	$/EA	450,000		
Totals:	**18,671**					**$1,453,006**	**$12,719,780**	**$389,090**
							CONSTRUCTION COST	**$13,108,870**
						CONTINGENCY	20%	**$2,621,774**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$15,730,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$1,450,000**
							TOTAL ROUTE COST	**$17,180,000**

Table 80 – Conflict Area #3 Alt D Cost Analysis

ALTERNATE D	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	16,852	R	1	53.72	656	905,289	11,054,912	351,184
Type 2- Wooded	1,246	R	2	53.72	669	66,935	833,574	25,966
Type 3 - Creek Crossings	428	R	4	53.72	1094	22,992	468,232	8,919
Type 4 - Road/Parking Lot Crossings	96	R	5	53.72	1047	5,157	100,512	2,001
Type 5 - Bore or Tunnel Crossings	165	R	6	53.72	1900	8,864	313,500	3,438
Parcel Count [2]	16	EA		25000	$/EA	400,000		
Totals:	**18,787**					**$1,409,238**	**$12,770,730**	**$391,508**
							CONSTRUCTION COST	**$13,162,238**
						CONTINGENCY	20%	**$2,632,448**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$15,790,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$1,410,000**
							TOTAL ROUTE COST	**$17,200,000**

Table 81 – Conflict Area #3 Alt E Cost Analysis

ALTERNATE E	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	16,494	R	1	53.72	656	886,058	10,820,064	343,723
Type 2- Wooded	138	R	2	53.72	669	7,413	92,322	2,876
Type 3 - Creek Crossings	366	R	4	53.72	1094	19,662	400,404	7,627
Type 4 - Road/Parking Lot Crossings	89	R	5	53.72	1047	4,781	93,183	1,855
Type 5 - Bore or Tunnel Crossings	164	R	6	53.72	1900	8,810	311,600	3,418
Parcel Count [2]	16	EA		25000	$/EA	400,000		
Totals:	**17,251**					**$1,326,724**	**$11,717,573**	**$359,499**
							CONSTRUCTION COST	**$12,077,072**
						CONTINGENCY	20%	**$2,415,414**
1. Appurtenances & Miscelaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$14,490,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$1,330,000**
							TOTAL ROUTE COST	**$15,820,000**

Table 82 – Conflict Area #4 Alt A Cost Analysis

ALTERNATE A	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	6,794	R	1	53.72	656	364,974	4,456,864	141,582
Type 2- Wooded	44	R	2	53.72	669	2,364	29,436	917
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	23	R	5	53.72	1047	1,236	24,081	479
Type 5 - Bore or Tunnel Crossings	80	R	6	53.72	1900	4,298	152,000	1,667
Parcel Count [2]	4	EA		25000	$/EA	100,000		
Totals:	**6,941**					**$472,871**	**$4,662,381**	**$144,645**
							CONSTRUCTION COST	**$4,807,026**
						CONTINGENCY	20%	**$961,405**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.							TOTAL CONSTRUCTION COST:	**$5,770,000**
2. This is for ROE and acquisition related costs							TOTAL LAND COST	**$470,000**
							TOTAL ROUTE COST	**$6,240,000**

Table 83 – Conflict Area #4 Alt B Cost Analysis

ALTERNATE B	SEGMENT PARAMETERS			UNIT COSTS			CONSTRUCTION COST	
Type & Description	Length	Land Class	Instll. Class	Land	M&I	EASEMENT LAND COSTS	Material & Installation	& Miscellaneous [1]
	[ft]			[$/ft]	[$/ft]	[$]	[$]	[$]
Type 1- Open	8,463	R	1	53.72	656	454,632	5,551,728	176,363
Type 2- Wooded	-	R	2	53.72	669	-	-	-
Type 3 - Creek Crossings	-	R	4	53.72	1094	-	-	-
Type 4 - Road/Parking Lot Crossings	-	R	5	53.72	1047	-	-	-
Type 5 - Bore or Tunnel Crossings	130	R	6	53.72	1900	6,984	247,000	2,709
Parcel Count [2]	7	EA		25000	$/EA	175,000		
Totals:	**8,593**					**$636,616**	**$5,798,728**	**$179,072**
						CONSTRUCTION COST		**$5,977,800**
					CONTINGENCY	20%		**$1,195,560**
1. Appurtenances & Miscellaneous - Includes air valves, blow off valves, butterfly valves, etc.						TOTAL CONSTRUCTION COST:		**$7,170,000**
2. This is for ROE and acquisition related costs						TOTAL LAND COST		**$640,000**
						TOTAL ROUTE COST		**$7,810,000**

2.5 LBCR RAW WATER PIPELINE FINAL ALIGNMENT

2.5.1 Alignment Summary

The entire recommended alignment for the LBCR Raw Water Pipeline from the Proposed Pump Station to the Terminal Storage Reservoir is shown in **Figure 27**. Although not all alternates selected for the various conflict areas are the least expensive, all of the routes were chosen based on a balance between landowner impact, constructability and cost. Based on the recommended routes the total length of the preferred alignment for the LBCR Raw Water Pipeline is 36.08 miles.

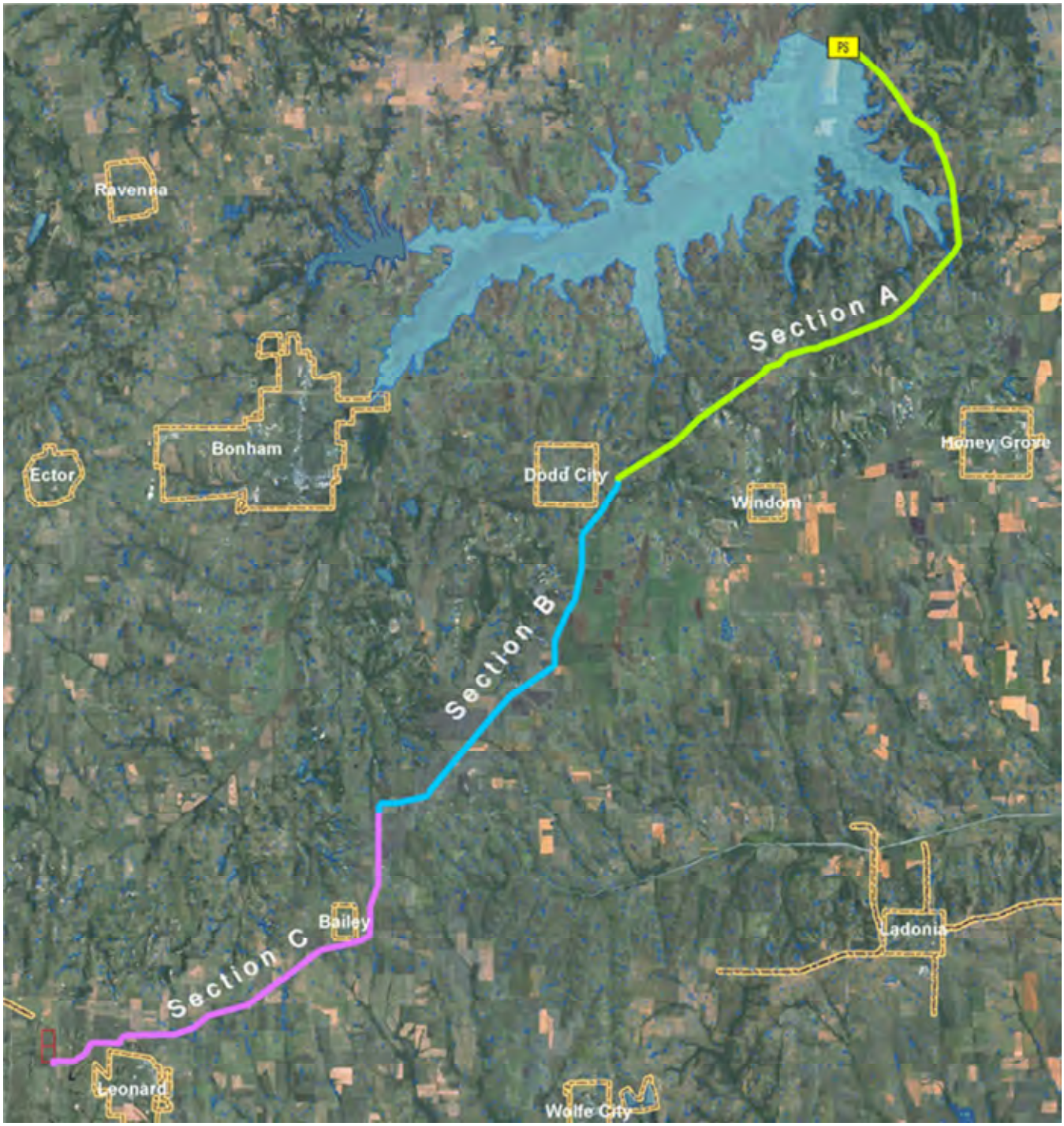


Figure 27 – LBCR Overall Recommended Alignment

2.5.2 Opinion of Probable Construction Cost

The OPCC for the entire recommended alignment of the LBCR Raw Water Pipeline as described below is $197,926,510. A detailed breakdown of the OPCC for the recommended alignment is shown below in **Table 84**.

Table 84 – Final Alignment Opinion of Probable Costs

NTMWD
Lower Bois d'Arc Creek
Reservoir Raw Water
Pipeline

FREESE AND NICHOLS

1701 N Market St., #500, LB51 • Dallas, Texas 75202 • 214-217-2200 • fax 214-217-2201

OPINION OF PROBABLE CONSTRUCTION COSTS (INCLUDING EASEMENTS) — November 25, 2013

ESTIMATOR	CHECKED BY	ACCOUNT NO
ABC	ASM	NTD13136

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	90-INCH PIPELINE	186,267	LF	$650.00	$ 121,073,550
2	TUNNELED CROSSINGS	1,530	LF	$1,970.00	$ 3,014,100
3	PIPELINE ROW CLEARING	500	AC	$5,000.00	$ 2,500,000
4	TRENCH SAFETY	186,267	LF	$1.00	$ 186,267
5	AIR RELEASE VALVES	54	EA	$25,000.00	$ 1,350,000
6	BUTTERFLY VALVES	10	EA	$165,000.00	$ 1,650,000
7	BLOW OFF VALVES	54	EA	$25,000.00	$ 1,350,000
8	PAVEMENT RESTORATION	3,370	SY	$70.00	$ 235,900
9	CREEK CROSSINGS	2,728	LF	$445.00	$ 1,213,960
10	REVEGETATION	500	AC	$1,160.00	$ 580,000
11	FIBER OPTIC CONDUIT	186,267	LF	$3.00	$ 558,801
12	FIBER	186,267	LF	$2.00	$ 372,534
13	CATHODIC PROTECTION	186,267	LF	$2.00	$ 372,534
14	ACCESS MANWAYS	54	EA	$10,000.00	$ 540,000
15	TESTING	186,267	LF	$2.00	$ 372,534
16	MOBILIZATION	1	LS	$6,768,509.00	$ 6,768,509
	CONSTRUCTION SUBTOTAL				$ 142,140,000
	CONSTRUCTION CONTINGENCY	15%			$ 21,321,000
	CONTRUCTION TOTAL				$ 163,461,000
	ESTIMATED EASEMENT/PROPERTY COSTS				
	PERMANENT EASEMENT W/ ASSOCIATED TEMPORARY (Note 1)	8,602,805	SF	$1.00	$8,602,810
	TOTAL ESTIMATED COSTS (INCLUDING EASEMENT)				$172,063,010

1. Estimated Easement Costs are based on a 50' Permanent Easement & 70' Temporary Easement for the entire route. This total excludes the length of pipe on land currently owned by NTMWD.

3.0 PRELIMINARY SYSTEM HYDRAULICS AND PIPE DIAMETERS

An initial hydraulic analysis was conducted to determine the required pipeline diameter and potential pump station sizing for the project. Hydraulic grade lines (HGLs) were developed for various pipe diameters and flow rates using the routes described in **Section 2.0** and TNRIS 10-foot interval contour data. A 50-year Life Cycle Cost Analysis (LCCA) was performed to determine the most economical pipe diameter.

3.1 FLOW RATE ANALYSIS

3.1.1 LBCR Permitted Diversions

The Lower Bois d'Arc Creek Reservoir is permitted expected to be with an annual yield of 123,200 acre-feet per year in 2060. Converted into an annual average, this equates to a pumping rate of approximately 110 million gallons per day (MGD). The maximum permitted diversion amount is 175,000 acre-feet per year (157 MGD annual average).

3.1.2 Design Flow Rates

The raw water pumping facilities will be designed with the capacity to pump the full yield of the reservoir with additional capacity to account for seasonal peak demands. For design purposes, a 1.5 peaking factor was applied to the maximum permitted diversion amount. This results in sizing the raw water transmission facilities for an ultimate peak flow rate of 236 MGD.

3.1.3 Life Cycle Analysis Flow Rates

The North Water Treatment Plant will be constructed with an ultimate capacity of 280 MGD. For the purposes of the life cycle cost analysis, the plant was assumed to be constructed in four 70 MGD phases (**Table 84**). Pumping rates were assumed to be 3% above these values to account for losses in the terminal storage reservoir and treatment processes.

Table 85 – North Water Treatment Plant Phasing

Year	Maximum (MGD)	Average (MGD)
2021	70	40
2026	140	80
2030	210	120
2035	280	165

Seasonal variations in flow were accounted for in the life cycle analysis. A 1.4 peaking factor was applied to the average annual flow for 4 months out of the year, and a 0.8 factor applied for the remaining 8 months. These values were based on the ratio of monthly average to annual average flows in the existing NTMWD system between 2007 and 2012.

In the first phase of the plant, the annual flow was assumed to be the same in year 1 as in year 5. For the subsequent expansions, the flow increases annually with the flow rate matching current plant capacity in the expansion year (i.e. expand from 140 MGD to 210 MGD in 2030 and hit peak flow of 140 MGD in 2030). Of the 280 MGD ultimate capacity, a future connection to the Texoma-Wylie raw water pipeline will supply 70-80 MGD of the needed raw water supply for the plant. This future connection to the Texoma-Wylie raw water line is discussed further in the Technical Memorandum titled "NTWP Terminal Storage Reservoir Analysis".

3.2 DESIGN ASSUMPTIONS

Friction losses through the pipeline were calculated using the Hazen-Williams equation with a long-term roughness coefficient (C-value) of 120. This C-value is typical for aged raw water pipelines. It is assumed that all maintenance required to maintain this value will be conducted by the NTMWD, including cleaning the pipeline as necessary. Velocity in the pipe was limited to 9 feet per second under all flows to limit surge potential and maintain headloss in an acceptable range.

A 420 million gallon Terminal Storage Reservoir (TSR) will be constructed north of the proposed treatment plant site. Several locations were considered with a final recommendation made for a site west of Leonard, off of CR 4965. This site will have a normal water surface elevation of 731 and a minimum elevation of 714. The water surface elevation for the treatment plant headworks was assumed to be 711. Evaluation of the hydraulics from the TSR to the WTP determined that dual 102"

pipes are required for the peak flow of 236 MGD. Further information regarding the TSR, site selection, and pipe sizing can be found in the "NWTP Terminal Storage Reservoir Analysis" technical memorandum that was submitted on the same day as this report.

3.3 PIPE DIAMETER OPTIMIZATION

The required pipe diameter was determined using a life cycle cost analysis. As pipe diameter decreases, the capital cost to construct the line also decreases. However, the power required to push a given flow through a smaller pipe is greater due to increased friction losses within the pipe. The purpose of the life cycle cost analysis was to balance the capital and power costs to determine an optimum pipe diameter. The flows used in the analysis are shown above in **Table 85**, and the other variables used are included in **Table 86**.

Table 86 – Life Cycle Analysis Variables

Variable	Value
Analysis Duration	50 years
Bond Interest Rate	4.5%
Bond Term	25 Years
Inflation Rate	3%
Discount Rate	5%
Electricity Rate (2013)	5.5¢/kW-hr

The total annual cost was determined for each year of the analysis period and included debt service and inflated power cost. These future values were returned to present values and summed to determine the total present worth. This analysis was performed for 78- through 108-inch pipe and can be found in **Appendix B**. A summary of the results are shown in **Figure 28** and **Table 87**.

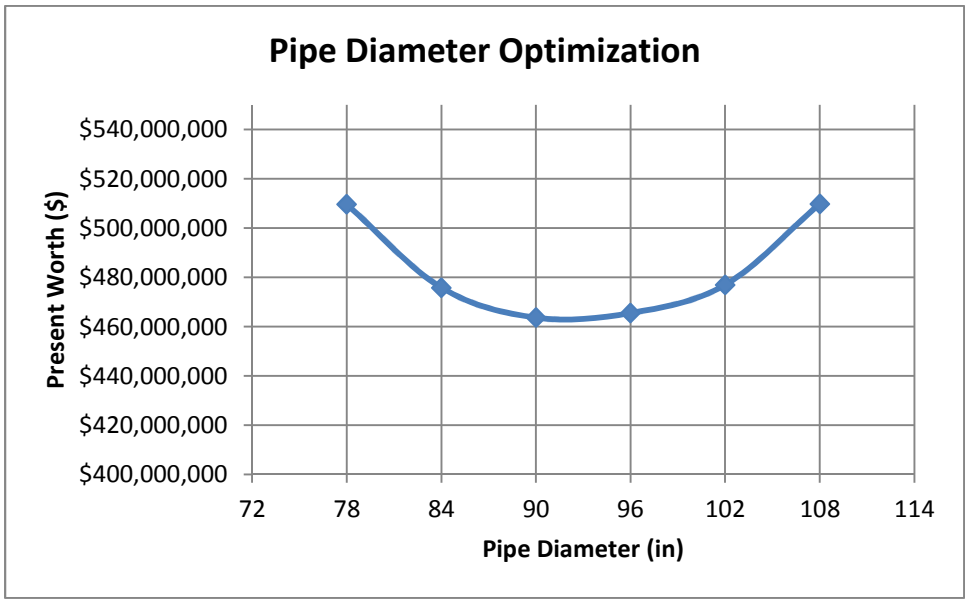


Figure 28 – Pipe Diameter Optimization

Table 87 – Pipe Diameter Present Worth Comparison

Diameter (in)	Total Present Worth (50 yr LCCA)
78	$509,616,901
84	$475,802,222
90	$463,620,281
96	$465,470,732
102	$476,890,428
108	$509,799,096

Both the 78-inch and 84-inch lines were inadequate since the velocity in the pipe (9.44 fps) at the ultimate peak flow of 236 MGD was beyond the 9 feet per second limit, and were removed from consideration. Also, a 78 or 84-inch line would cause the pressure near the pump station to exceed 300 psi, which is not desirable by the NTMWD. Hydraulic grade lines were developed for both 90-inch and 96-inch pipelines (**Figure 29** and **Figure 30**, respectively). Both the 90-inch and 96-inch lines have velocities and pressures at acceptable levels during normal flows. The 90-inch line causes peak flow pressure to exceed 250 psi near the pump station, but was determined to have the lowest present worth (as seen in **Table 87**). Pressures exceeding 250 psi can be significant because it requires special

valve castings and pushes the pipeline pressure class up to 300 psi, which may be able to be reduced somewhat during final design. The 102 and 108-inch lines were determined to require high capital cost for limited energy savings.

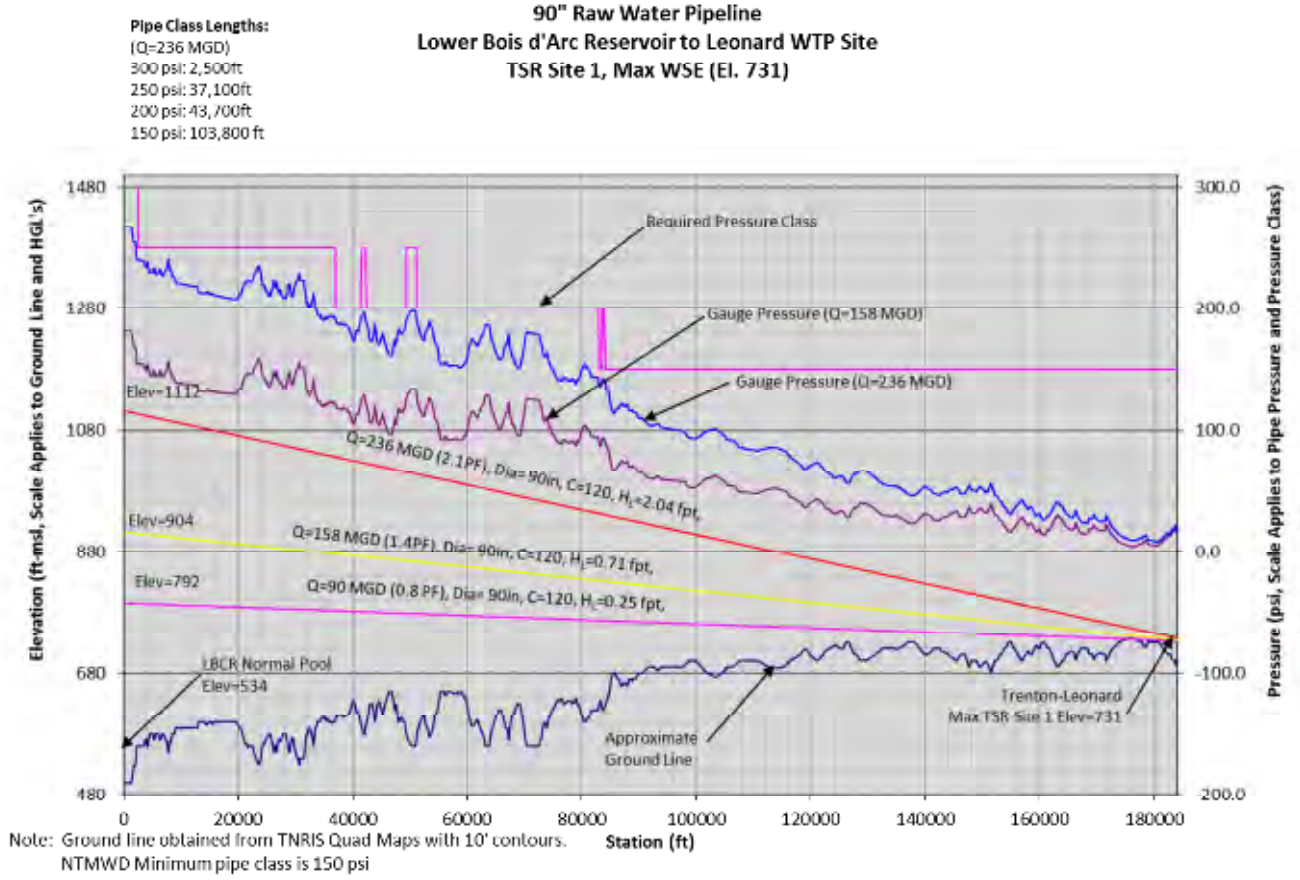


Figure 29 – 90-inch Pipeline HGL

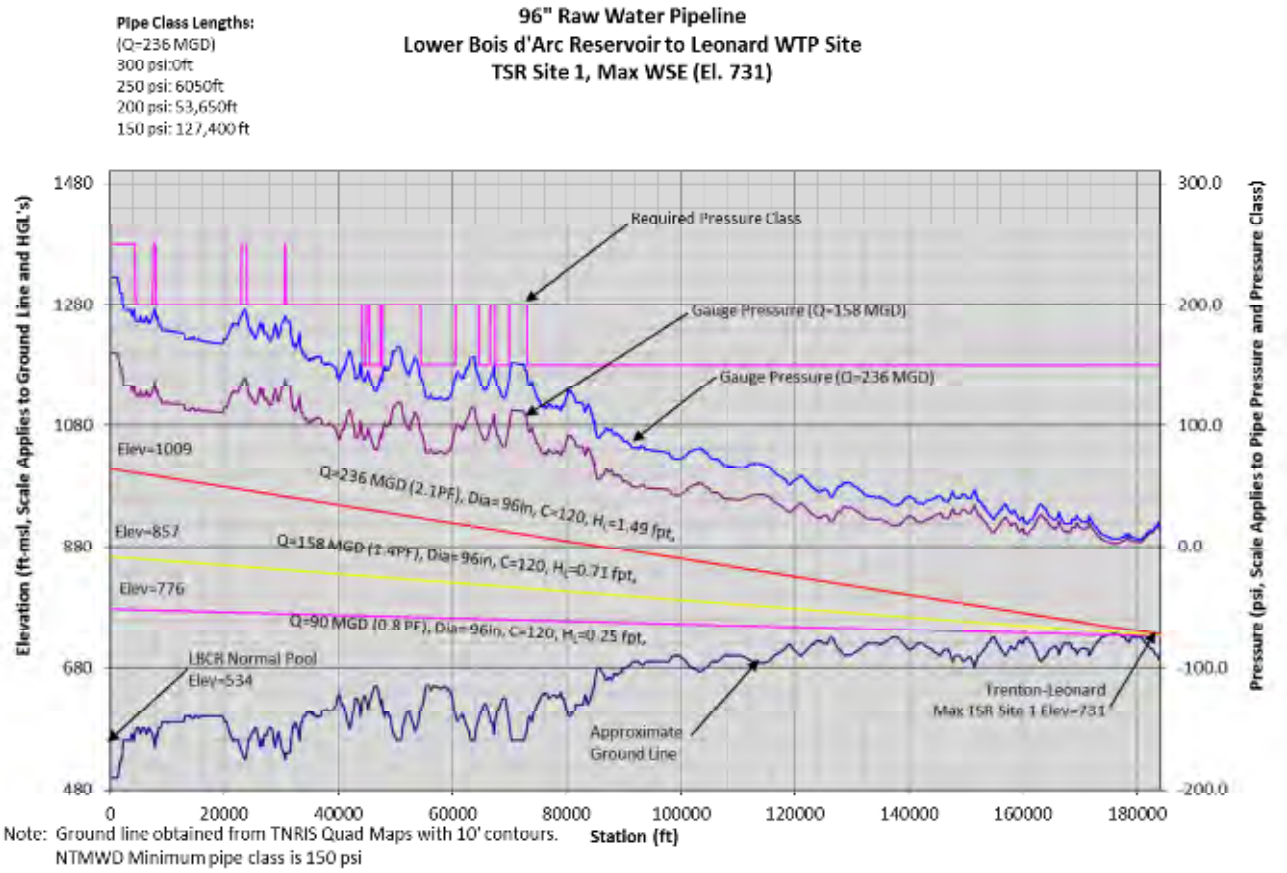


Figure 30 – 96-inch Pipeline HGL

Based on this analysis, the pipeline between LBCR and the TSR is recommended to be 90 inches in diameter. This size provides the lowest total present worth and effectively balances the capital and power costs through the life of the project. The additional capital cost necessary for constructing a 96 inch diameter pipeline is more significant than the increased cost of fabricating 90 inch 300 psi pressure class pipe and valves.

APPENDIX A
DESIGN REPORT FIGURES

Proposed Lower Bois d'Arc Creek Reservoir
534' Spillway Elevation

FM 2029
Shared Northern Corridor
Corridor A1
FM 1396
FM 1396
Corridor A3A
Corridor A2
Corridor A3
Oncor Electrical Transmission Corridor
FM 1743
Corridor B
Atmos 10" Gas Line
US 82
FM 897
Corridor
Shared Southern Corridor
Electrical Transmission Line
FM 1396
Honey Grove
TX 56
TX 56
Section B
TX 56
Windom
Loop 391
TX 56

Feet
0 3,000 6,000

N
W E
S

© Harris Corp, Earthstar Geographics LLC Stat

FN PROJECT NO.	NTD13136
DATE CREATED	Date: 10/24/201
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas North Central
FILE NAME	LBR_6_28_2013 Cost Estimate Section A.mxd
PREPARED BY	WRS

NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

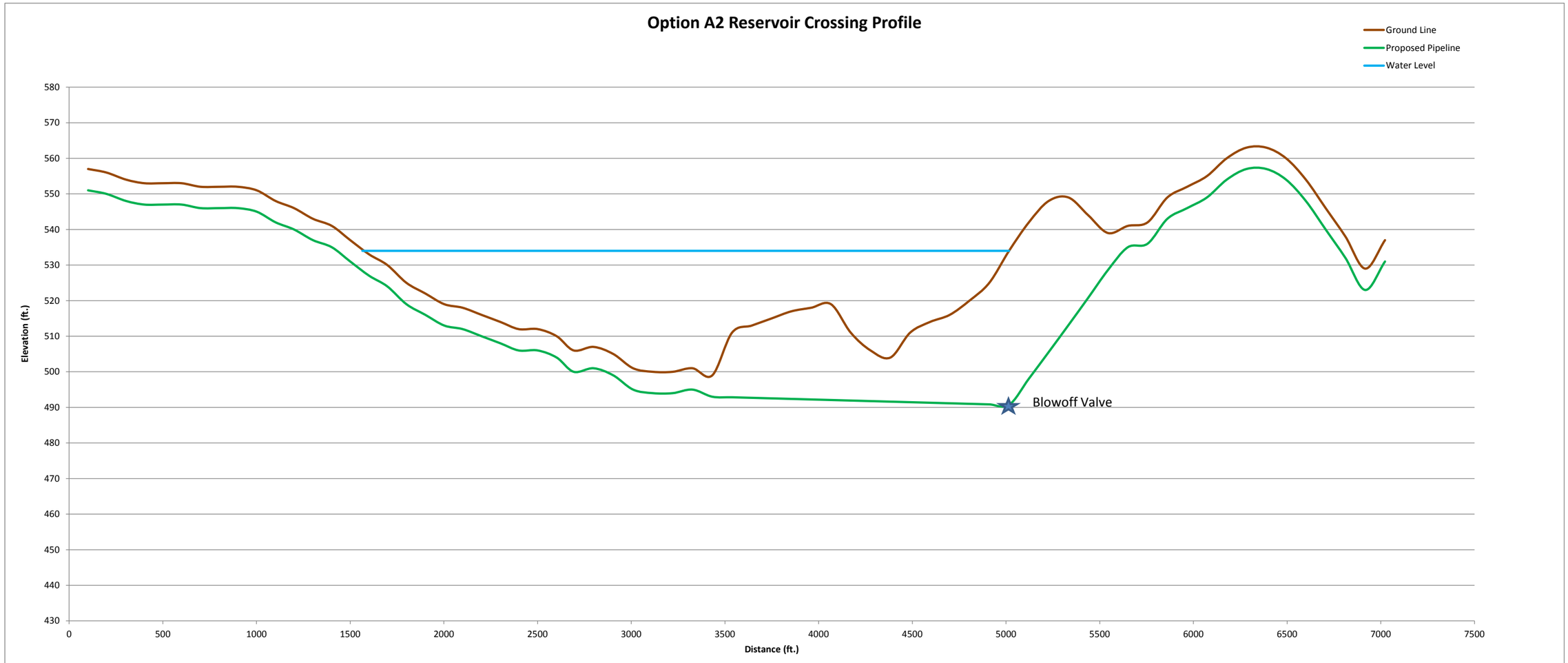
Section A Corridor

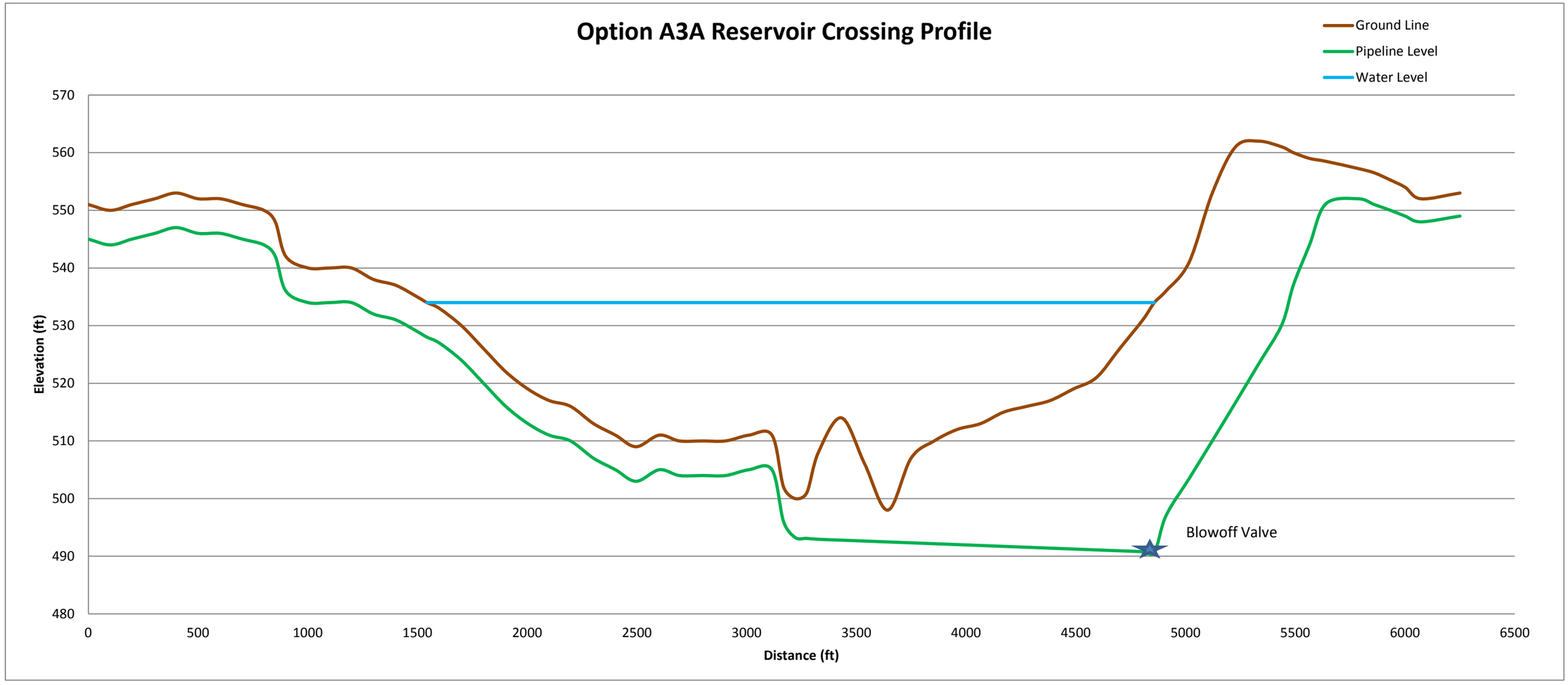
FREESE AND NICHOLS
2711 NORTH HASKELL AVENUE
SUITE 3300
DALLAS, TEXAS 75204
P: 214-217-2200
F: 214-217-2201

Section A

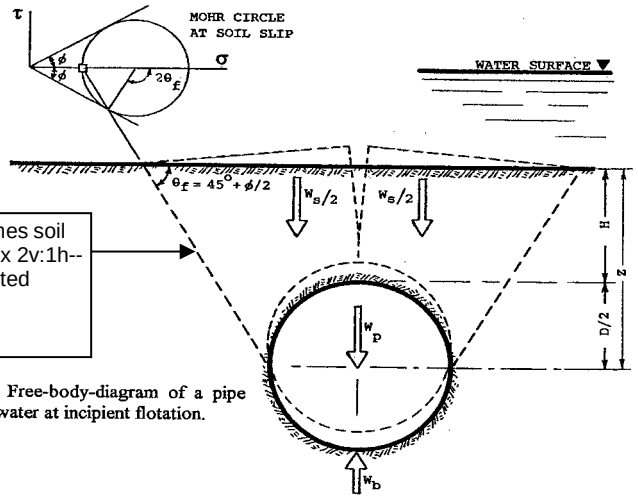
Exhibit 1

Job No.: NTD13136
Location: H:\PIPES_PUMPS\WORKING\02-LBR_Alignment_to_NWTP\Section A Exhibits\Cost Estimates\LBR_6_28_2013 Cost Estimate Section A.mxd
Updated: Thursday, October 24, 2013 1:36:31 PM


Option A2 Reservoir Crossing Profile
Ground Line
Proposed Pipeline
Water Level
Elevation (ft.)
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
Blowoff Valve
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
Distance (ft.)


Option A3A Reservoir Crossing Profile
Ground Line
Pipeline Level
Water Level
Elevation (ft)
570
560
550
540
530
520
510
500
490
480
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Distance (ft)
Blowoff Valve

PIPE BUOYANCY DESIGN PROCESS--FLOTATION OF PIPES SIMPLIFIED, WORST CASE EXAMPLE



This process assumes soil slip planes of approx 2v:1h--Pipe under compacted granular backfill.

Figure 21-2 Free-body-diagram of a pipe buried under water at incipient flotation.

Reference: "Structural Mechanics of Buried Pipes" by Watkins & Anderson

VARIABLES: = user input = constant or calculated

W_p =	0.00	lb/lf (Weight of empty pipe per unit length)		
W_c =	0.00	lb/lf (Weight of pipe contents per unit length, set to zero for worst case)		
OD =	116.00	inches (outside pipe diameter)	9.67	feet
ID =	114.00	inches (inside pipe diameter)	9.50	feet
γ_w =	62.40	lb/ft^3 (unit weight of water, or other liquid pipe is immersed in)		

CALCULATED VALUES:

W = $W_c + W_p =$ 0.00 lb/lf (Weight of Pipe & Contents)

γ_b =	62.40	lb/ft^3 (buoyant unit weight of soil)--see embedded comment		
D =	115.00	inches (mean diameter)	9.58	feet

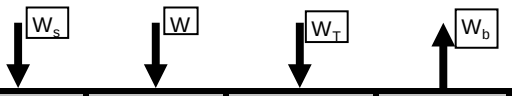
W_s = Buoyant weight of soil wedges above a buried pipe per (lb/lf)
Assumes soil slip planes of approximately 2v:1h

$$W_s = \gamma_b[Z(D + 0.5Z) - \pi D^2/8]$$ See below for values

W_b = Buoyant (uplift force) on pipe (lb/lf) = weight of liquid displaced

$$W_b = \pi(OD)^2 \gamma_w / 4$$ 4577.28 lb/ft

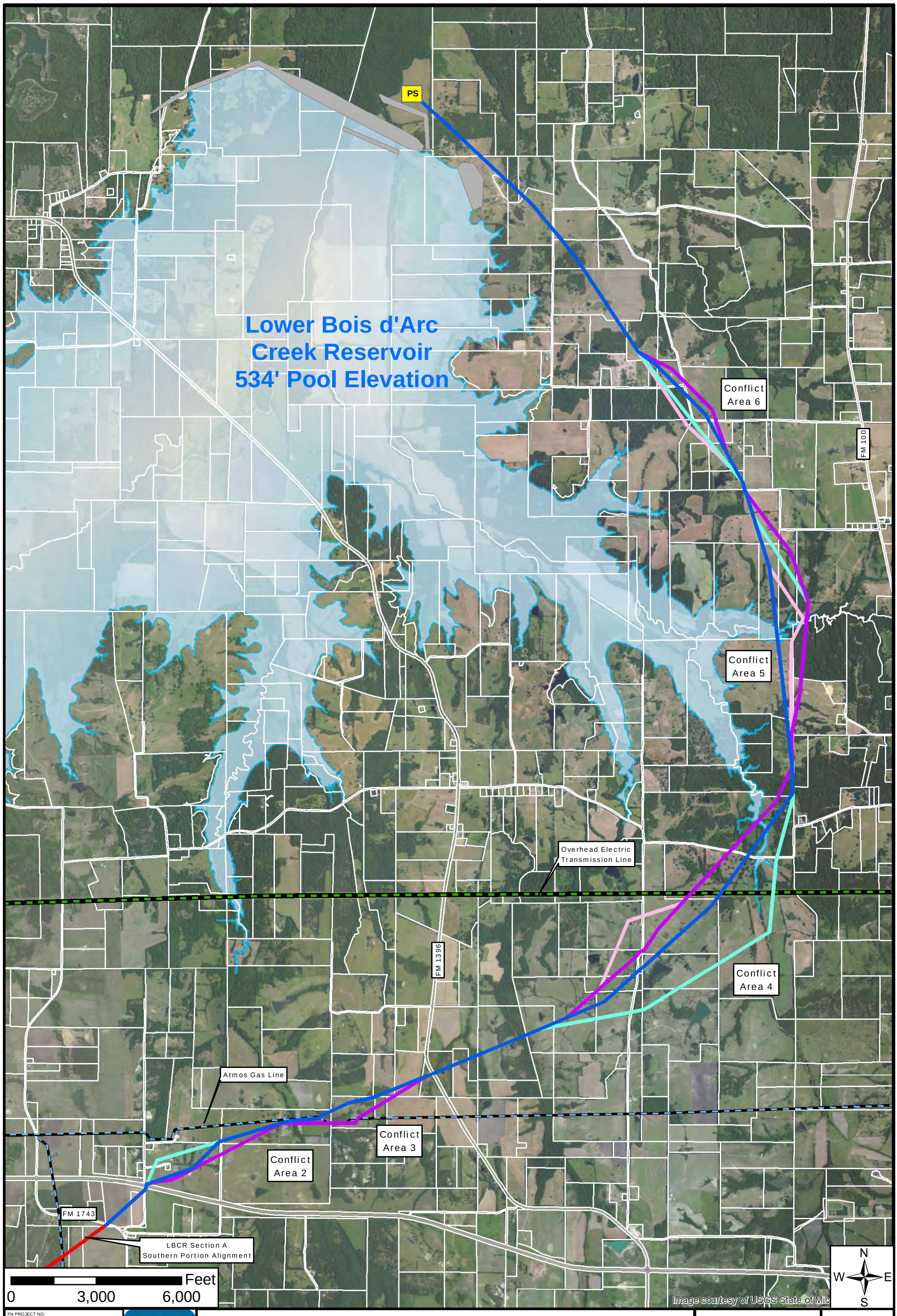
fs = $$fs = \frac{ABS(W_T)}{W_b}$$ safety factor (see below for values)



H (ft)	Z (ft)	fs	W_s (lb/ft)	W (lb/ft)	W_T (lb/ft)	W_b (lb/ft)
1	5.79	0.49	-2260.62	0.00	-2260.62	4577.28
2	6.79	0.71	-3251.22	0.00	-3251.22	4577.28
3	7.79	0.94	-4304.22	0.00	-4304.22	4577.28
4	8.79	1.18	-5419.62	0.00	-5419.62	4577.28
5	9.79	1.44	-6597.42	0.00	-6597.42	4577.28
6	10.79	1.71	-7837.62	0.00	-7837.62	4577.28
7	11.79	2.00	-9140.22	0.00	-9140.22	4577.28
8	12.79	2.30	-10505.2	0.00	-10505.22	4577.28
9	13.79	2.61	-11932.6	0.00	-11932.62	4577.28
10	14.79	2.93	-13422.4	0.00	-13422.42	4577.28
11	15.79	3.27	-14974.6	0.00	-14974.62	4577.28
12	16.79	3.62	-16589.2	0.00	-16589.22	4577.28
13	17.79	3.99	-18266.2	0.00	-18266.22	4577.28
14	18.79	4.37	-20005.6	0.00	-20005.62	4577.28
15	19.79	4.76	-21807.4	0.00	-21807.42	4577.28
16	20.79	5.17	-23671.6	0.00	-23671.62	4577.28
17	21.79	5.59	-25598.2	0.00	-25598.22	4577.28
18	22.79	6.03	-27587.2	0.00	-27587.22	4577.28
19	23.79	6.48	-29638.6	0.00	-29638.62	4577.28
20	24.79	6.94	-31752.4	0.00	-31752.42	4577.28
H >= 0.5D		fs >= 1.47222				
H < 0.5D		fs < 1.47222				

According to Watkins & Anderson, the height of cover should be at least half the pipe diamter. This correlates to a factor of safety of approximately 1.47222. This only applies when you have granular embedment or better compacted to at least 90% density. Also, if the designer has specified all welded joints, this added resistance is sufficient to resist uplift with only half the diameter of cover.

If the designer is unsure of the control of backfill or the embedment material is something other than granular, then a conservative rule of thumb would be to specify soil cover equal to pipe diameter.



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DATE CREATED	Date: 11/22/201
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas North Central
FILE NAME	LBCR Section A Northern-APP.mxd
PREPARED BY	WRS

NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section A Corridor

FREESE AND NICHOLS
2711 NORTH HASKELL AVENUE
SUITE 3300
DALLAS, TEXAS 75204
P: 214-217-2200
F: 214-217-2201

Section A

Exhibit 5

Ward Creek

DIANE
STEWART

Ward Creek

CR 2990

Atmos Gas Line

30
BARRY STEWART
AND DIANE
STEWART

29
BARRY STEWART
AND DIANE
STEWART

CR 2991

CA 2 Alt. A

CA 2 Alt. C

CA 2 Alt. B

Barn

Residential
Structure

NOLAN D. BUTLER
AND VICTORIA
F. BUTLER

JAMES BREWER

CR 2993

Creek Confluence

CR 2992

WILLIAM
ROBERT
WHITE

31
ALFRED C.
WILLIAMS AND
MILDRED WILLIAMS

Residential
Structure

NOLAN D. BUTLER
AND VICTORIA
F. BUTLER

82

31
ALFRED C.
WILLIAMS AND
MILDRED WILLIAMS

CR 2989

Feet
0 600 1,200

N
W E
S

Image courtesy of USGS State of Mic

FN PROJECT NO.
NTD13136

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DATUM & COORDINATE SYSTEM
NAD83 State Plane (feet) Texas North Central

FILE NAME
CA2-APP.mxd

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WRS

NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section A Corridor - Conflict Area #2

FREESE AND NICHOLS
2711 NORTH HASKELL AVENUE
SUITE 3300
DALLAS, TEXAS 75204
P: 214-217-2200
F: 214-217-2201

Section
A

Exhibit
6

Yoakum Creek

FM 1396

CHARLES MICHAEL YARBROUGH
AND JOHN YARBROUGH

27
LISA MORSE

26
MICHAEL PRESTON
JOHNSON

CA 3 Alt. A

CHARLES MICHAEL YARBROUGH
AND JOHN YARBROUGH

25
EDDIE HARTFIELD, JR. AND WALLACE HARTFIELD

DIANE STEWART

Pond

CA 3 Alt. B

BILLY
WAYNE
RYSER

PROPOSED CREEK
TUNNELING

Atmos Gas Line

28
EDDIE HARTFIELD, JR.
AND WALLACE HARTFIELD

Ward Creek

29
BARRY STEWART
AND DIANE STEWART

Feet
0 600 1,200

N
W E
S

Image courtesy of USGS State of Mic

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FILE NAME	CA3-APP.mxd
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NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section A Corridor - Conflict Area #3

FREESE AND NICHOLS
2711 NORTH HASKELL AVENUE
SUITE 3300
DALLAS, TEXAS 75204
P: 214-217-2200
F: 214-217-2201

Section A

Exhibit 7

Allens Creek
Honey Grove Creek
Lower Bois d'Arc Creek Reservoir 534' Pool Elevation
CR 2765
CR 2750
CR 2770
CR 2760
15 THOMAS BRADLEY LANE
14 KEVIN BLAKE LANE
NORTH TEXAS MUNICIPAL WATER DISTRICT
GARY BEAVERS
JAMES D. MORRISON
16 STUBBS FAMILY TRUST CO-TRUSTEE BARBARA L. STUBBS
17 YVONNE BUTLER
PROPOSED CREEK TUNNELING
Overhead Electric Transmission Line
Residential Structure
CHARLES MICHAEL & JOHN E YARBROUGH
Residential Structure
Residential Structure
CA 4 Alt. B
CA 4 Alt. A
CA 4 Alt. C
CA 4 Alt. D
19 STANLEY OWEN AND MARY E. OWEN
18 ALVIN B. HARTWELL AND CHARLOTTE G. HARTWELL
20 STANLEY OWEN AND MARY E. OWEN
Lake
21 A & F LAND & CATTLE, L.L.C.
A & F LAND & CATTLE, L.L.C.
Allens Creek
Feet
0 1,000 2,000
Image courtesy of USGS State of Mic
N
W E
S

FN PROJECT NO.	NTD13136
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DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas North Central
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NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section A Corridor - Conflict Area #4

FREESE AND NICHOLS
2711 NORTH HASKELL AVENUE
SUITE 3300
DALLAS, TEXAS 75204
P: 214-217-2200
F: 214-217-2201

Section A

Exhibit 8

BILLY WAYNE KENEMORE
12.
BILLY WAYNE KENEMORE
13
BILLY WAYNE KENEMORE
BILLY WAYNE KENEMORE
CR 2735
NORTH TEXAS MUNICIPAL WATER DISTRICT
CA 5 Alt. C
CA 5 Alt. D
CR 2735
FM 100
CR 2860
NORTH TEXAS MUNICIPAL WATER DISTRICT
Creek Confluence
Fox Creek
Lower Bois d'Arc Creek Reservoir 534' Pool Elevation
14
KEVIN BLAKE LANE
DAVID NEWHOUSE
CA 5 Alt. A
CA 5 Alt. B
Honey Grove Creek
15
THOMAS BRADLEY LANE
NORTH TEXAS MUNICIPAL WATER DISTRICT
NTMWD
NORTH TEXAS MUNICIPAL WATER DISTRICT
CR 2780
Image courtesy of USGS State of Mic
N
W
E
S
Feet
0
750
1,500

FN PROJECT NO. NTD13136
DATE CREATED Date: 11/22/201
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central
FILE NAME CA5-APP.mxd
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NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section A Corridor - Conflict Area #5

FREESE AND NICHOLS
2711 NORTH HASKELL AVENUE
SUITE 3300
DALLAS, TEXAS 75204
P: 214-217-2200
F: 214-217-2201

Section A

Exhibit 9

3
KENNETH H &
JANET E JONES

4
ASHLEY
LANE KEMP

5
KENDALL K. BROWN
SHARMAN BROWN

6
KENDALL K. BROWN
SHARMAN BROWN

LOUIS O MONTANIO
AND LINDA F MONTANIO

CR 2720

CR 2710

Barn

JIMMY D. NEWHOUSE
AND KATHRYN R.
NEWHOUSE

8
MID STATE
HOMES, INC.

7
GARLAN MARIE
HOLMES

CR 2730

Residential Structure

CA 6 Alt. C

CA 6 Alt. B

9
LOUIS O MONTANIO
AND LINDA F MONTANIO

DAVID BARTLETT

CA 6 Alt. D

Residential Structure

CR 2730

Barn

10
AITAZAZ A. SHAH
& FARAH A. SHAH

CR 2735

11
RUBERT MORGAN
AND ALICE MORGAN

CA 6 Alt. A

BILLY WAYNE
KENEMORE

12
BILLY WAYNE
KENEMORE

13
BILLY WAYNE
KENEMORE

BILLY WAYNE
KENEMORE

NORTH TEXAS
MUNICIPAL WATER
DISTRICT

Lower Bois d'Arc
Creek Reservoir
534' Pool Elevation

Feet
0 500 1,000

N
W E
S

Image courtesy of USGS State of Mic

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NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section A Corridor - Conflict Area #6

FREESE AND NICHOLS
2711 NORTH HASKELL AVENUE
SUITE 3300
DALLAS, TEXAS 75204
P: 214-217-2200
F: 214-217-2201

Section
A

Exhibit
10

Section B
56
Bullard Creek
Burnett Creek
Electrical Transmission Line
CR 2975
Spring Branch
CR 2975
CR 2971
CR 2998
Cottonwood Creek
CR 2970
CR 2998
Atmos Gas Line
FM 1743
82
Section A Northern Portion
W
S
N
E
Feet
0
1,200
2,400

FN PROJECT NO.	NTD13136
DATE CREATED	Date: 11/26/2013
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas North Central
FILE NAME	Attachment 1 - Corridor Map1.mxd
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NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section A Corridor

FREESE NICHOLS
2711 NORTH HASKELL AVENUE
SUITE 3300
DALLAS, TEXAS 75204
P: 214-217-2200
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Section A

Exhibit 11

Created By Freese and Nichols, Inc.
Job No.: NTD13136
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Updated: Friday, October 25, 2013 8:54:58 AM

CA 1 Alt. A
CA 1 Alt. D
CA 1 Alt. C
Image courtesy of USGS State of Michigan © AND
CR 2965
Petigrew Branch
FM 1743
CR 2974
CHARLOTTE BANKSTON
HANNAH KANG
33 HANNAH KANG
35 MARK VEST AND DEBORAH SUE VEST
36 CHARLOTTE BANKSTON
37 H E ASTLEFORD AND MYRA ASTLEFORD
34 H E ASTLEFORD AND MYRA ASTLEFORD
40 DOUGLAS KOPF
CR 2975
CR 2998
Spring Branch
38 HERNAN OSORIO
39 JAMES DONALD NICHOLS
H E ASLTEFORD AND MYRA ASTLEFORD
42 MICHAEL EDWARD NEJTEK AND TARYN ANNE NEJTEK NEJTEK FAMILY TRUST
CA 1 Alt. A
CA 1 Alt. D
CA 1 Alt. C
CODY MURRAY
ROSEMARY LESLIE BETH MORRIS AND JANEY REYNOLDS
BOB D UPCHURCH AND LANA G UPCHURCH
Overhead Electric Transmisison Corridor
41 JEFFREY WAYNE WALLER
RONNIE G MURRAY AND ANITA L MURRAY
ATMOS GAS LINE
44 MARGARETT PETTINGILL
45 MARGARETT PETTINGILL
CA 1 Alt. B
43 HON ALVIN PITTS
CHRISTOPHER EBLING AND KAREN EBLING
K.S.A.2. RANCHERS, LLC
MARK BAKER AND SARA BAKER
47 MARGARETT PETTINGILL
46 FRANK SWARTZ AND SARA BAKER
Burnett Creek
CR 2971
50 FRANCES L. TYLER AND JIMMIE N. TYLER (TYLER LIVING TRUST)
49 WAYMOND LONG
48 MARK BAKER AND SARA BAKER
CR 3211
MATT D. FOSHER
VETERANS LAND BOARD OF THE STATE OF TEXAS
51 GINA JOHNSON
C.O. WILLIAMS AND K.W. WILLIAMS
MATT D. FOSHER
56
52 MILLARD DOAN BRENT
JAMES S. MOSS
CR 3213
CR 3212
CR 3210
CR 3230
Bullard Creek
CA 1 Alt. A
Burnett Creek
PROPOSED CREEK TUNNELING
CA 1 Alt. B
CA 1 Alt. C
Image courtesy of USGS State of Michigan © AND
Image courtesy of USGS State of Mic
Feet
0 1,500 3,000
N
W E
S

FN PROJECT NO.	NTD13136
DATE CREATED	Date: 11/25/201
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas North Central
FILE NAME	CA1-APP.mxd
PREPARED BY	WRS

NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section A Corridor - Conflict Area #1

FREESE AND NICHOLS
2711 NORTH HASKELL AVENUE
SUITE 3300
DALLAS, TEXAS 75204
P: 214-217-2200
F: 214-217-2201

Section A

Exhibit 12

Bonham
Dodd City
56
FM 2077
CA 1 Alt. C
CA 1 Alt. A
CA 1 Alt. B
Conflict Area 1
CA 2 Alt. A
CA 2 Alt. B
Conflict Area 2
CA 3 Alt. A
CA 3 Alt. C
CA 3 Alt. B
CA 3 Alt. D
FM 1550
Conflict Area 4
CA 4 Alt. A
Conflict Area 3
CA 5 Alt. A
Conflict Area 5
FM 271
CA 5 Alt. C
CA 5 Alt. B
CR 3120
Conflict Area 6
CA 6 Alt. B
CA 6 Alt. A
FM 68
Feet
0
4,000
8,000
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IG
swisstopo, and the GIS User Community
N
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FN PROJECT NO.
NTD13136
DATE CREATED
Date: 10/25/2013
DATUM & COORDINATE SYSTEM
NAD83 State Plane (feet) Texas North Central
FILE NAME
SectionB_overall.mxd
PREPARED BY
RP

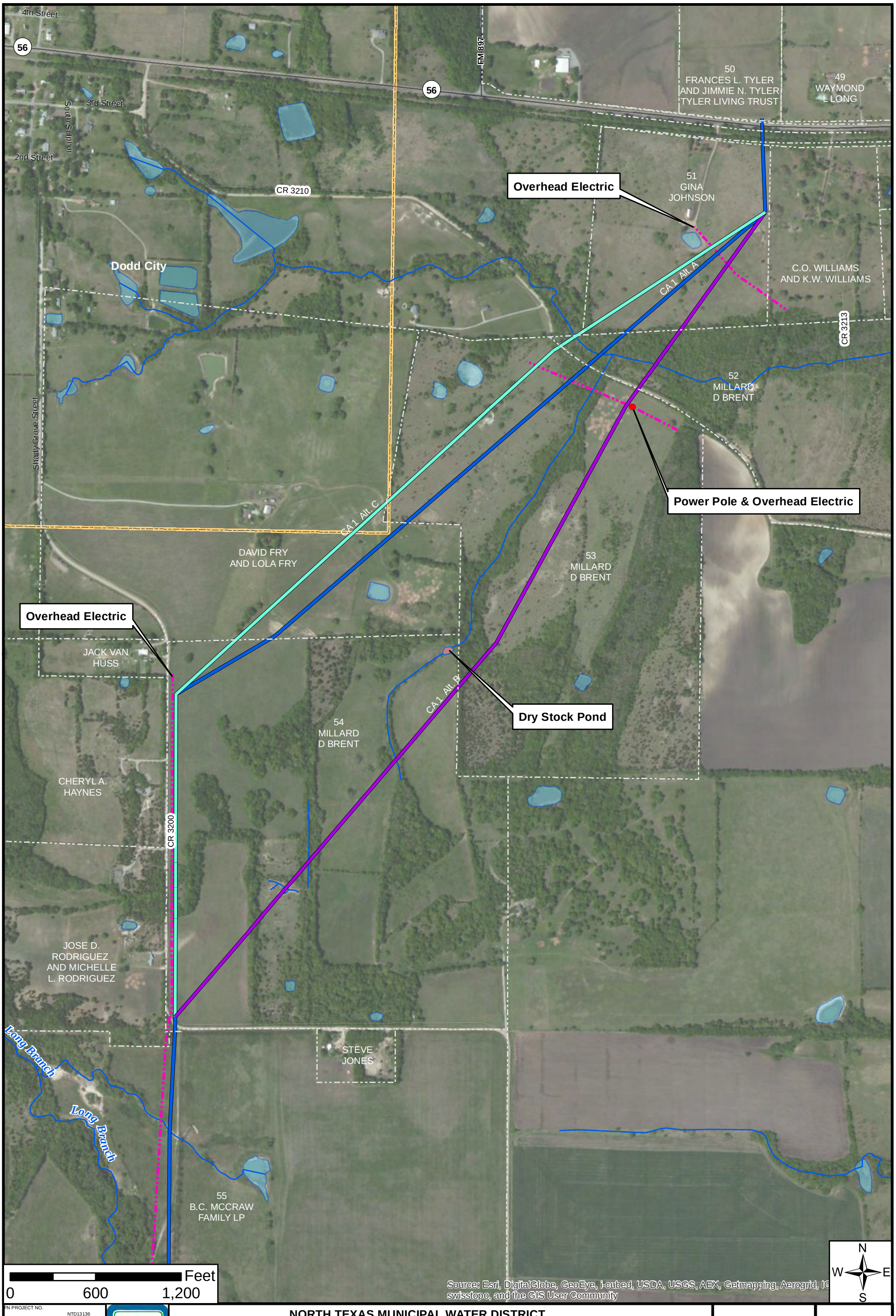
NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section B Corridor

FREESE NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
F: 713-600-6801

Section B
Exhibit 1



FN PROJECT NO.
NTD13136

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DATUM & COORDINATE SYSTEM
NAD83 State Plane (feet) Texas North Central

FILE NAME
SectionB_CA1.mxd

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NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section B Corridor - Conflict Area #1

FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
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P: 713-600-6800
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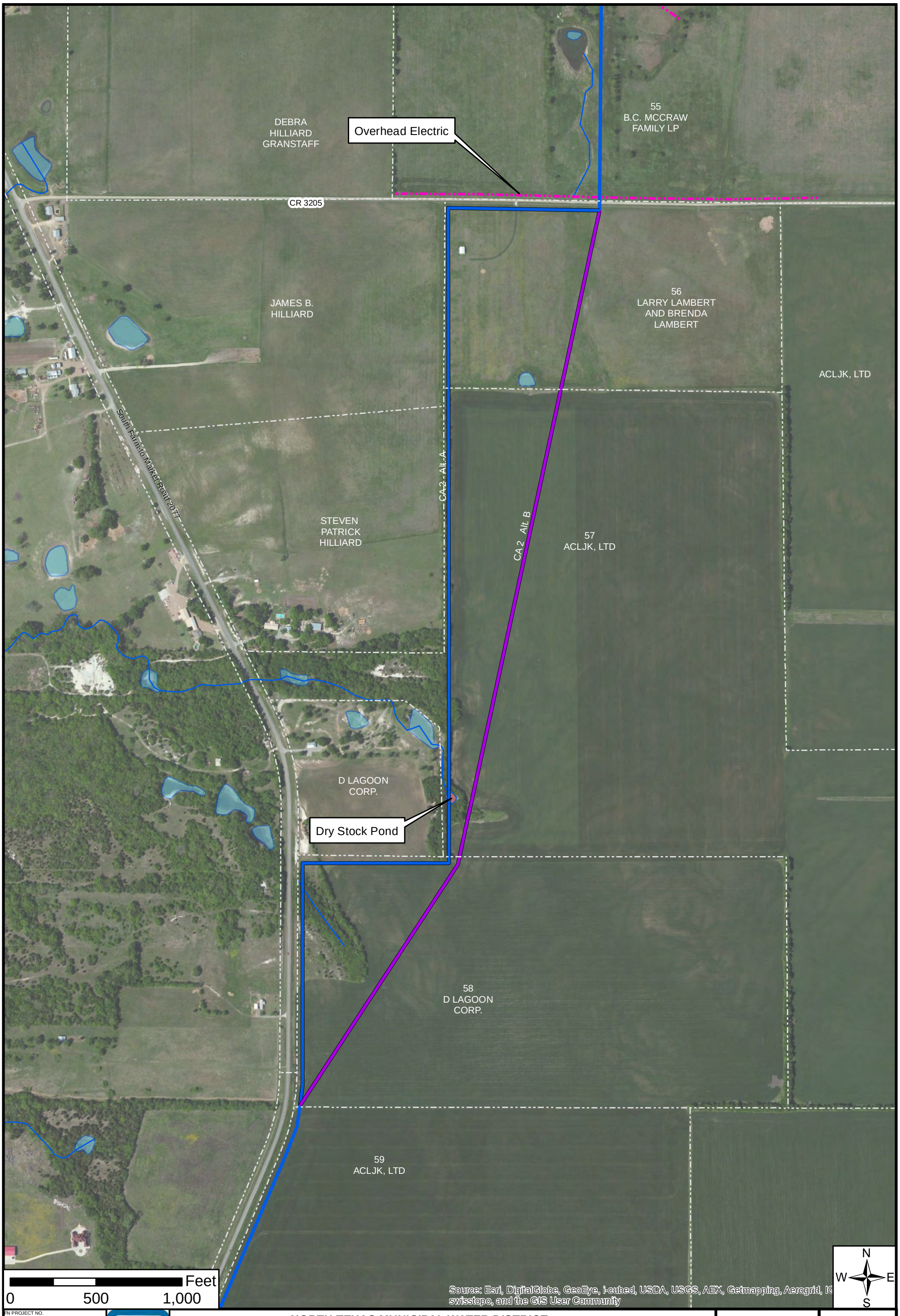
Section B

Exhibit 2



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NTD13136

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DATUM & COORDINATE SYSTEM
NAD83 State Plane (feet) Texas North Central

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SectionB_CA2.mxd

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NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section B Corridor - Conflict Area #2

FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
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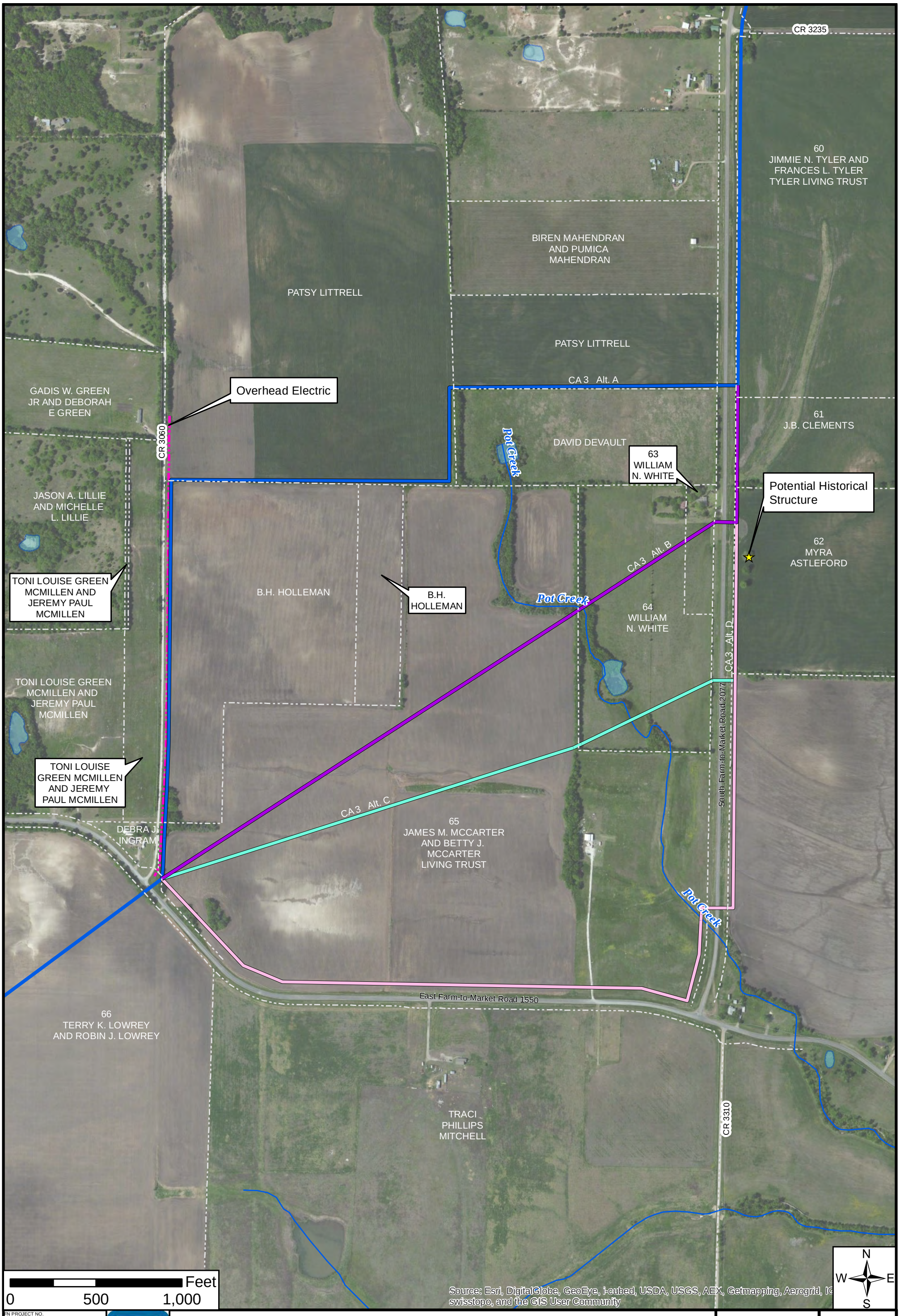
Section B

Exhibit 3



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NTD13136

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DATUM & COORDINATE SYSTEM
NAD83 State Plane (feet) Texas North Central

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SectionB_CA3.mxd

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NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section B Corridor - Conflict Area #3

FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
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Section B

Exhibit 4

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NTD13136

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DATUM & COORDINATE SYSTEM
NAD83 State Plane (feet) Texas North Central

FILE NAME
SectionB_CA4.mxd

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NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section B Corridor - Conflict Area #4

FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
F: 713-600-6801

Section B

Exhibit 5

East Farm-to-Market Road 1550
Sloans Creek
67
JUAN
HUERTA
SHERRY WILSON,
LINDA J. WILSON,
BOBBY R. WILSON
68
EDWARD L
ROBINSON AND
JUDY MAE ROBINSON
CR 3302
69
LARON D. SHEPHERD
AND PATTI R. SHEPHERD
71
DARYL E. AND
CYNTHIA M. BAGLEY
70
LARON D. AND
PATTI R. SHEPHERD
73
MONTY J. AND
SALLIE R. JACKSON
CR 3300
CA 5 Alt. A
74
MONTY J. AND
SALLIE R. JACKSON
LARON D.
AND PATTI R.
SHEPHERD
Creek Crossings
MONTY J.
JACKSON
AND SALLIE
R. JACKSON
72
ROGER S.
HOLLISTER
AND NANCY
A. EVANS
Allen Creek
Allen Creek
Allen Creek
Allen Creek
Creek Crossing
75
REID FAMILY
ENTERPRISES, LTD.
CA 5 Alt. B
CA 5 Alt. C
76
MONTY J.
AND SALLIE
R. JACKSON
FM 271
CR 3130
36" Natural Gas Line
CR 3135
JOHN
O'NEAL
0 1,000 2,000 Feet
N
W E
S
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IG
swisstopo, and the GIS User Community

EN PROJECT NO. NTD13136
DATE CREATED Date: 11/22/2013
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central
FILE NAME SectionB_CA5.mxd
PREPARED BY RP

NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section B Corridor - Conflict Area #5

FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
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Section B

Exhibit 6

FN PROJECT NO. NTD13136
DATE CREATED Date: 11/22/2013
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central
FILE NAME SectionB_CA6.mxd
PREPARED BY RP

NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section B Corridor - Conflict Area #6

FREESE NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
F: 713-600-6801

Section B

Exhibit 7

FM 68

Conflict Area 1

78

FM 1552

Conflict Area 2

11

Bailey

Conflict Area 3

FM 1553

Conflict Area 4

69

78

Leonard

Feet
0 4,000 8,000

N
W E
S

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IG swisstopo, and the GIS User Community

FN PROJECT NO.
NTD13136

DATE CREATED
Date: 10/24/2013

DATUM & COORDINATE SYSTEM
NAD83 State Plane (feet) Texas North Central

FILE NAME
SectionC_overall.mxd

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NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section C Corridor

FREESE NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
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Section C
Exhibit 1

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NTD13136

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DATUM & COORDINATE SYSTEM
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FILE NAME
SectionC_CA1.mxd

PREPARED BY
RP

NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section C Corridor - Conflict Area #1

FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
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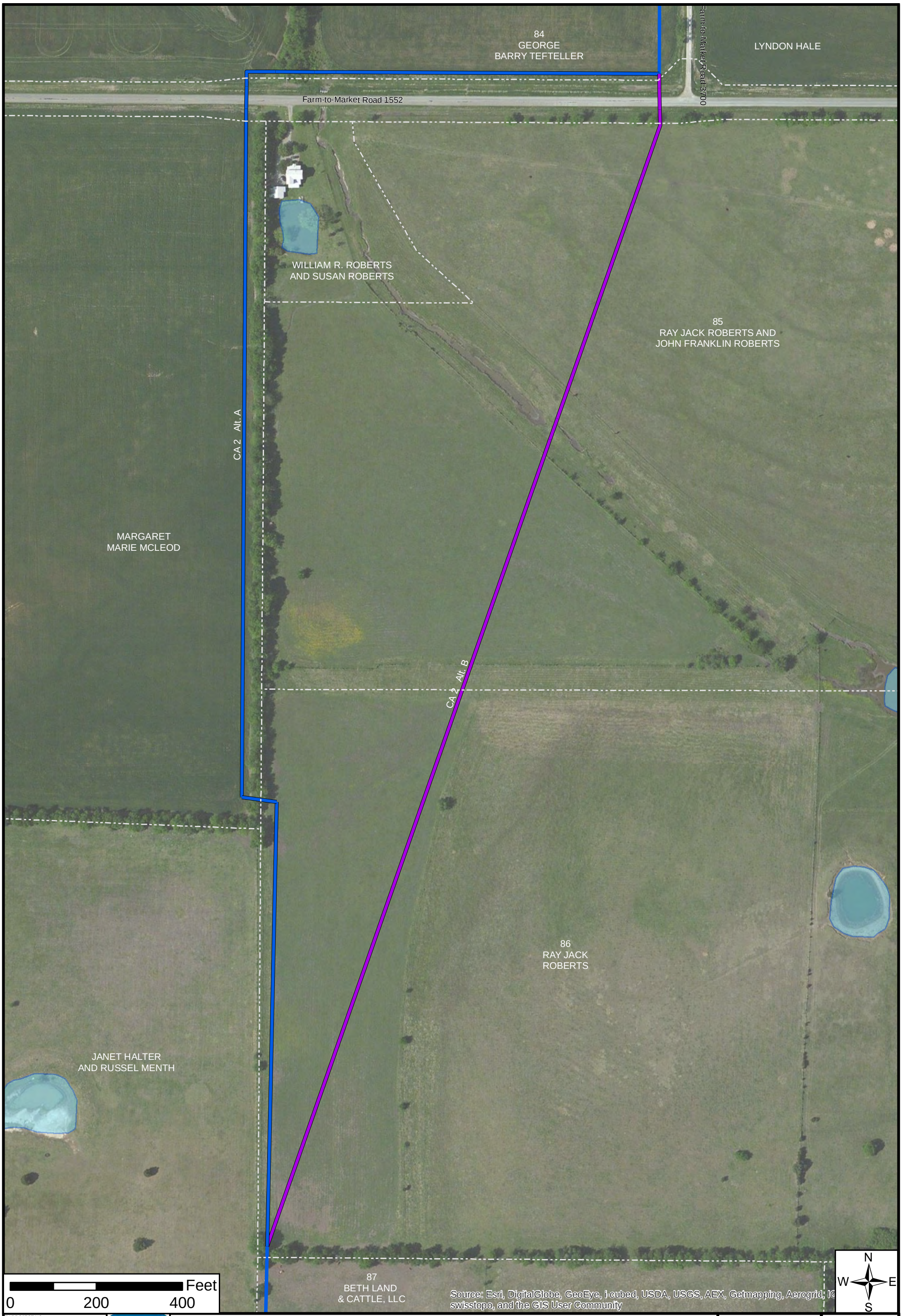
Section C

Exhibit 2



FN PROJECT NO.
NTD13136

DATE CREATED
Date: 11/22/2013

DATUM & COORDINATE SYSTEM
NAD83 State Plane (feet) Texas North Central

FILE NAME
SectionC_CA2.mxd

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RP

NORTH TEXAS MUNICIPAL WATER DISTRICT

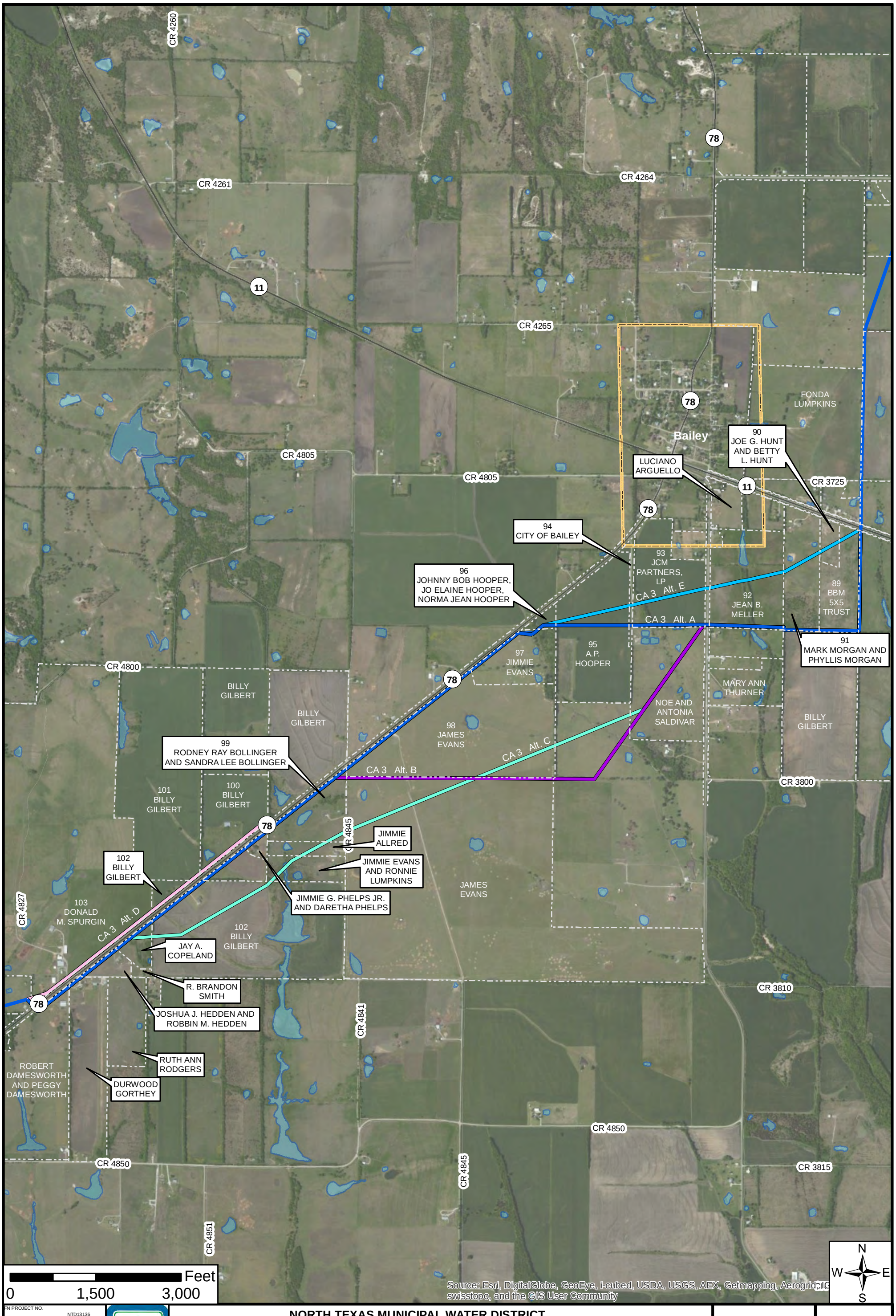
Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section C Corridor - Conflict Area #2

FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
F: 713-600-6801

Section C

Exhibit 3



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NTD13136

DATE CREATED
Date: 11/22/2013

DATUM & COORDINATE SYSTEM
NAD83 State Plane (feet) Texas North Central

FILE NAME
SectionC_CA3.mxd

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NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section C Corridor - Conflict Area #3

FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
F: 713-600-6801

Section C

Exhibit 4

FN PROJECT NO. NTD13136

DATE CREATED Date: 11/22/2013

DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central

FILE NAME SectionC_CA4.mxd

PREPARED BY RP

NORTH TEXAS MUNICIPAL WATER DISTRICT

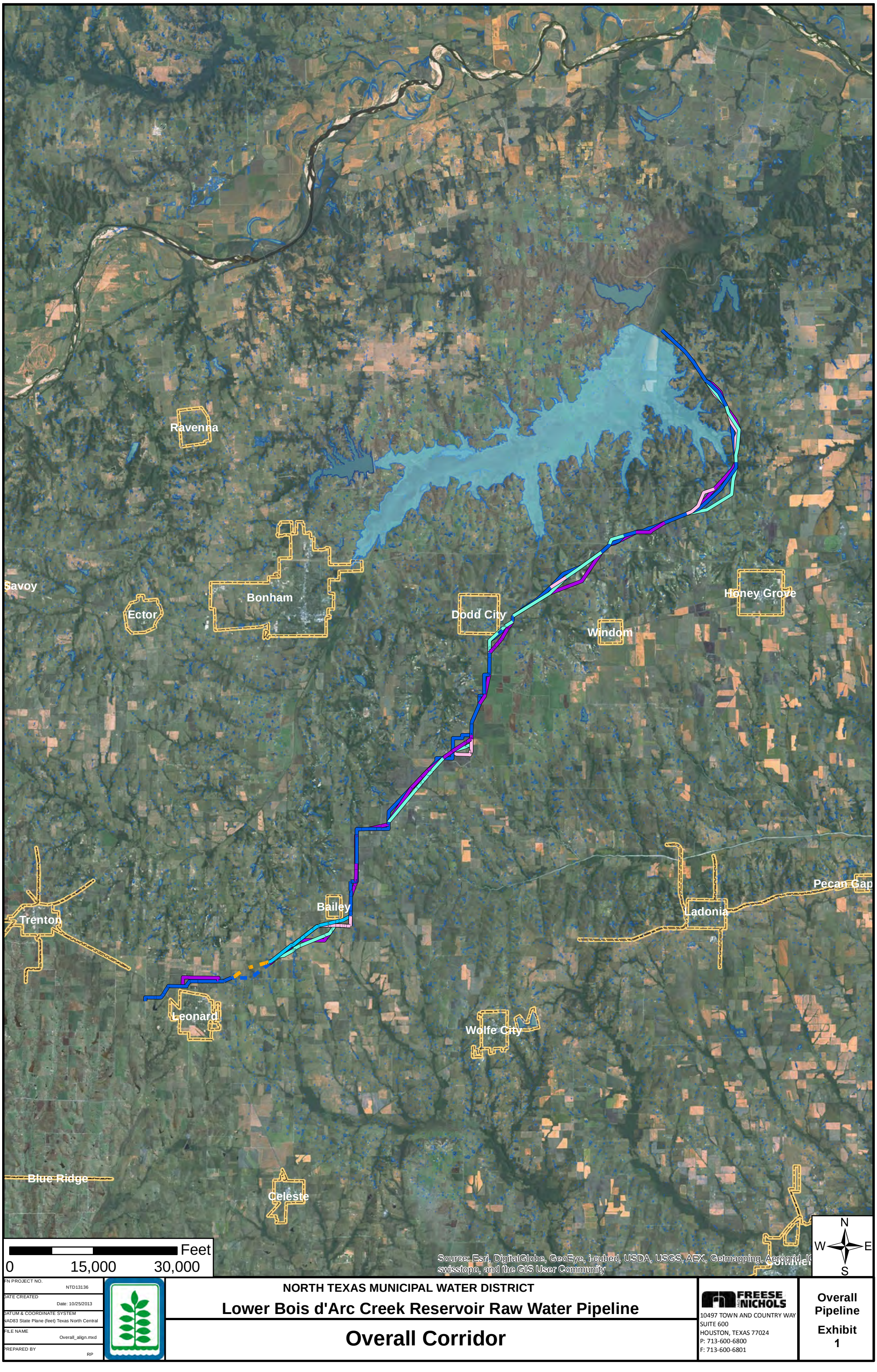
Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Section C Corridor - Conflict Area #4

FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
F: 713-600-6801

Section C

Exhibit 5



FN PROJECT NO.
NTD13136

DATE CREATED
Date: 10/25/2013

DATUM & COORDINATE SYSTEM
NAD83 State Plane (feet) Texas North Central

FILE NAME
Overall_align.mxd

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RP

NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Overall Corridor

FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
F: 713-600-6801

Overall Pipeline

Exhibit 1

PS

Section A

Section B

Section C

Ravenna

Savoy

Ector

Bonham

Dodd City

Windom

Honey Grove

Trenton

Bailey

Ladonia

Pecan Gap

Leonard

Wolfe City

Blue Ridge

Celeste

Feet
0 15,000 30,000

N
W E
S

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IG
swisstopo, and the GIS User Community

FN PROJECT NO.
NTD13136

DATE CREATED
Date: 10/24/2013

DATUM & COORDINATE SYSTEM
NAD83 State Plane (feet) Texas North Central

FILE NAME
Overall_align20131024.mxd

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RP

NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Overall Recommended Alignment

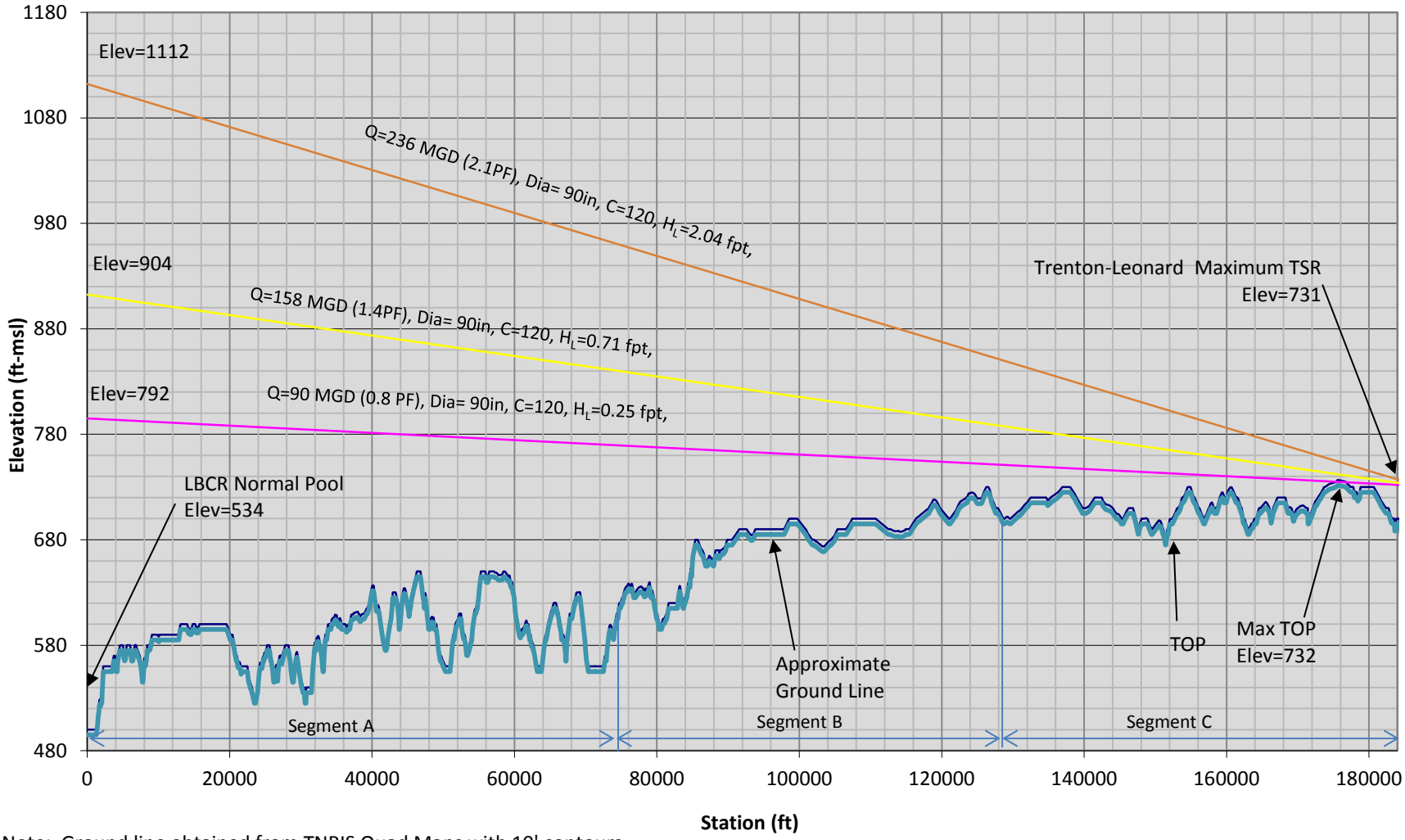
FREESE AND NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
F: 713-600-6801

Overall Pipeline

Exhibit 2

APPENDIX B
HYDRAULICS DATA

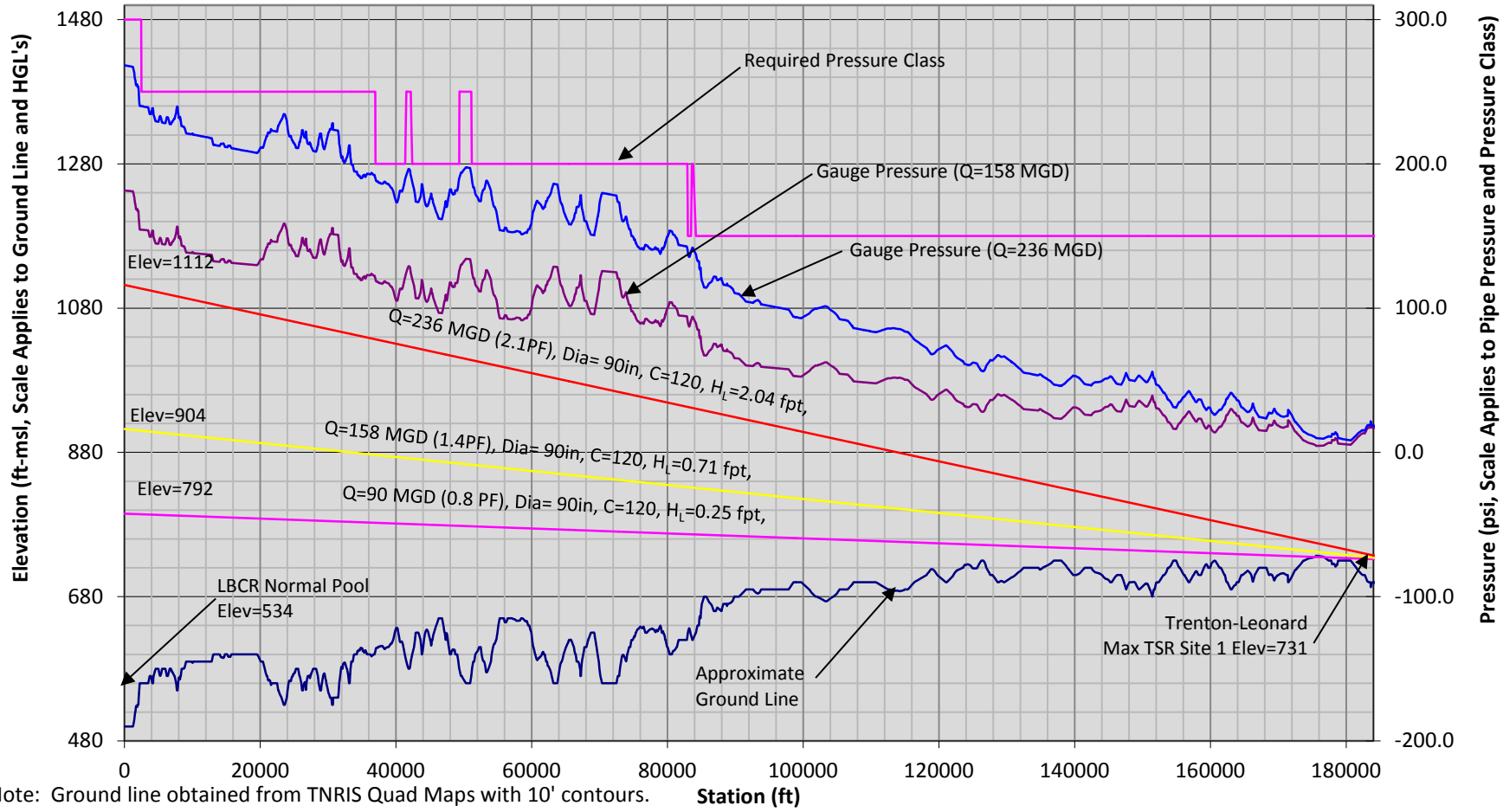
90" Raw Water Pipeline
Lower Bois d'Arc Reservoir to Leonard WTP Site
TSR Site 1, Max WSE (El. 731)



Note: Ground line obtained from TNRIS Quad Maps with 10' contours.

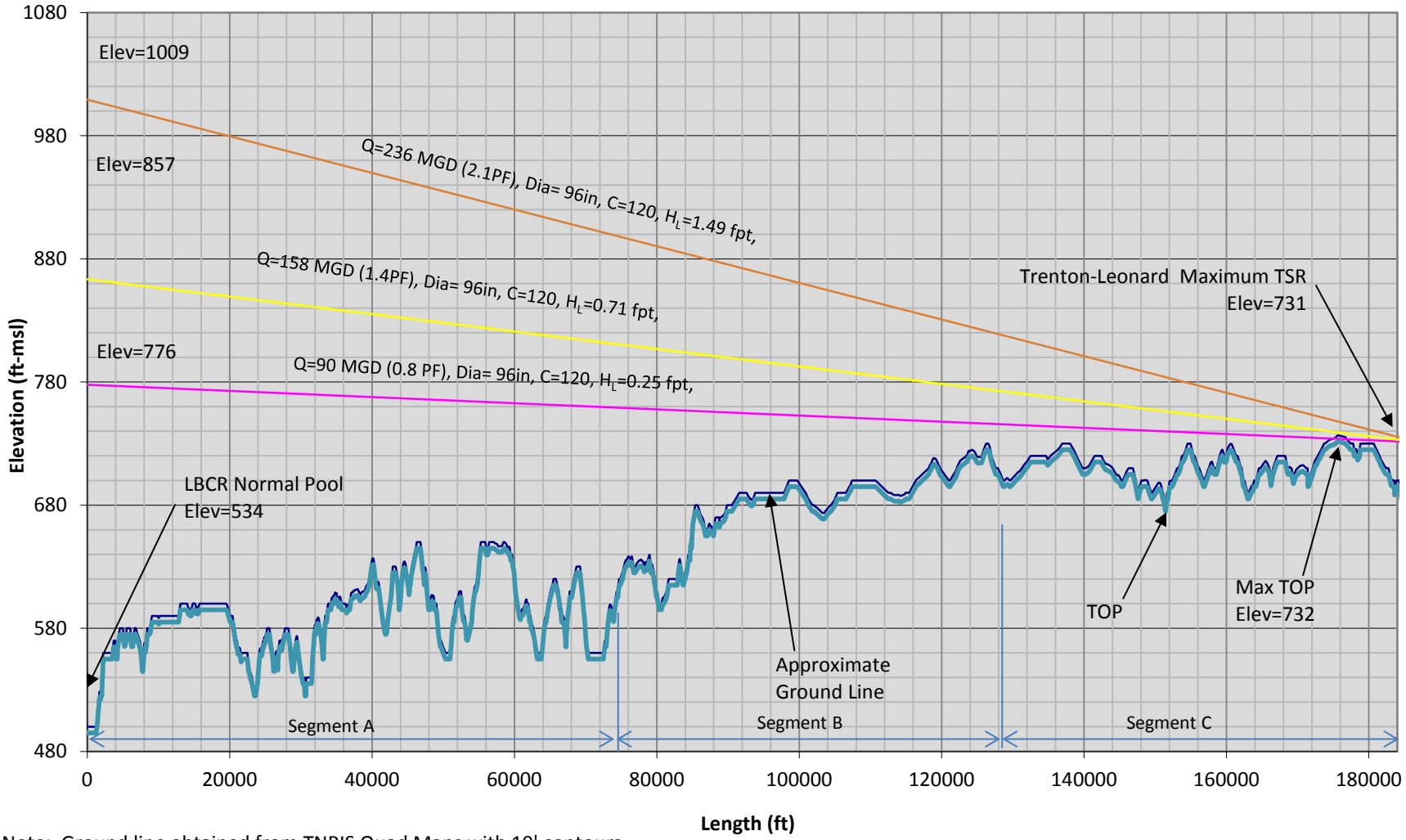
Pipe Class Lengths:
(Q=236 MGD)
300 psi: 2,500ft
250 psi: 37,100ft
200 psi: 43,700ft
150 psi: 103,800 ft

90" Raw Water Pipeline
Lower Bois d'Arc Reservoir to Leonard WTP Site
TSR Site 1, Max WSE (El. 731)



Note: Ground line obtained from TNRIS Quad Maps with 10' contours.
NTMWD Minimum pipe class is 150 psi

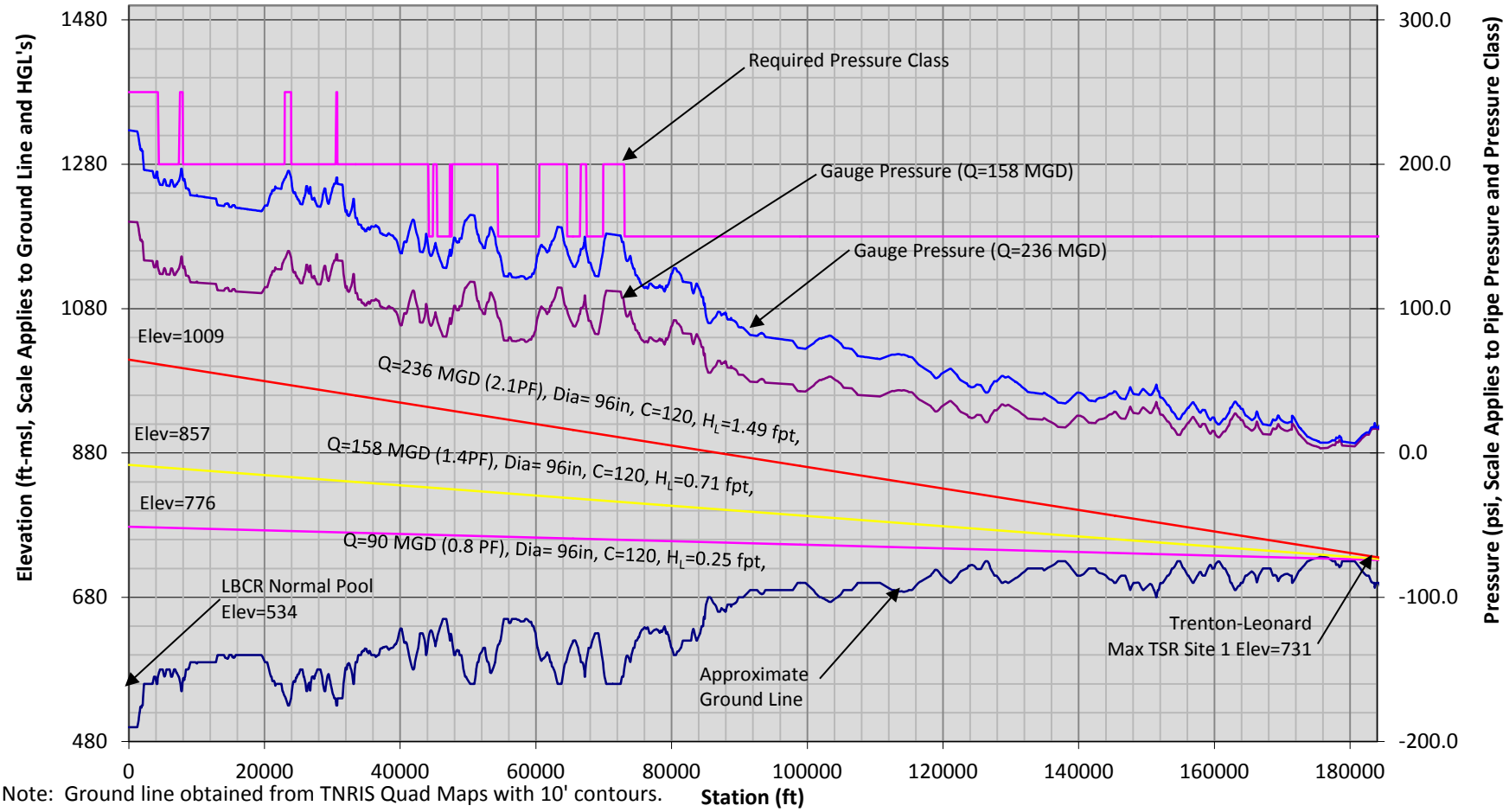
96" Raw Water Pipeline
Lower Bois d'Arc Reservoir to Leonard WTP Site
TSR Site 1, Max WSE (El. 731)



Note: Ground line obtained from TNRIS Quad Maps with 10' contours.

Pipe Class Lengths:
(Q=236 MGD)
300 psi:0ft
250 psi: 6050ft
200 psi: 53,650ft
150 psi: 127,400 ft

96" Raw Water Pipeline
Lower Bois d'Arc Reservoir to Leonard WTP Site
TSR Site 1, Max WSE (El. 731)



Note: Ground line obtained from TNRIS Quad Maps with 10' contours.
NTMWD Minimum pipe class is 150 psi

North Texas Municipal Water District
Lower Bois d'Arc Creek Reservoir Water Supply Project
Pipeline Diameter Optimization
Terminal Storage Reservoir Site 1

Assumptions:

Raw Water Pipeline
1.4 PF (158 MGD) for → 4 months
0.8 PF (90 MGD) for → 8 months
Average Flow (MGD) 110

Parameters	Pipe Diameter					
	78	84	90	96	102	108
Peak Flow Velocity Check						
Peak Flow, MGD (2.145 PF)	236	236	236	236	236	236
Peak Velocity, fps	10.95	9.44	8.23	7.23	6.40	5.71
Design Flows						
1.4 PF Flow, MGD	158	158	158	158	158	158
1.4 PF Velocity, fps	7	6.32	5.51	5	4	4
0.8 PF Flow, MGD	90	90	90	90	90	90
0.8 PF Velocity, fps	4.18	3.60	3.14	2.76	2.44	2.18
Elevation Data						
Max. Site 2 TSR Elev, ft-msl	731	731	731	731	731	731
LBCR Normal Lake Elev, ft-msl	534	534	534	534	534	534
Pipe Data						
Pressure Pipe Length, ft	187,605	187,605	187,605	187,605	187,605	187,605
Pipe Length, ft	187,605	187,605	187,605	187,605	187,605	187,605
H-W C Factor	120	120	120	120	120	120
Pump Head Calculation (1.4 PF)						
Static Head, ft	197	197	197	197	197	197
Friction Head, ft	366	256	183	133	99	75
Total Head, ft	563	453	380	330	296	272
Pump Head Calculation (0.8 PF)						
Static Head, ft	197	197	197	197	197	197
Friction Head, ft	129	90	64	47	35	27
Total Head, ft	326	287	261	244	232	224
Power Required (1.4 PF)						
Wire-to-Water Efficiency, %	75	74	75	75	75	75
Horsepower	20,838	16,961	14,041	12,220	10,960	10,068
kW	15,539	12,648	10,470	9,113	8,173	7,508
Days operating per year (3 mo)	90	89	90	90	90	90
Hours per year	2,160	2,136	2,160	2,160	2,160	2,160
kWh/yr	33,563,767	27,016,439	22,615,539	19,683,369	17,653,018	16,216,251
Power Required (0.8 PF)						
Wire-to-Water Efficiency, %	75	74	75	75	75	75
Horsepower	6,875	6,132	5,509	5,142	4,889	4,710
kW	5,127	4,573	4,108	3,835	3,646	3,512
Days operating per year (9 mo)	275	274	275	275	275	275
Hours per year	6,600	6,576	6,600	6,600	6,600	6,600
kWh/yr	33,838,313	30,070,454	27,110,833	25,309,069	24,061,457	23,178,590
Pipe Cost (2021 Dollars)	$ 148,295,098	$ 169,683,814	$ 192,498,445	$ 216,738,990	$ 242,405,449	$ 282,331,053
Total Present Worth (50 yr LCCA)	**$ 509,616,901**	**$ 475,802,222**	**$ 463,620,281**	**$ 465,470,732**	**$ 476,890,428**	**$ 509,799,096**

Life Cycle Cost Analysis Variables

Assumed Variables		
Lake Level		534
TSR Elevation		731
Static Head		197
Pipe Diameter (in)		78
Friction Factor, C		120
Pressure Pipe Length (ft)		187605
Peaking Factor 1		1.4
PF 1 Duration (Mo)		4
Peaking Factor 2		0.8
PF 2 Duration (Mo)		8
Power Variables		
Electricity Cost (kW-hr)	$	0.05
Run Time (PF 1, hrs)		2920
Run Time (PF 2, hrs)		5840
Pumping Efficiency		75%
Finanical Variables		
Bond Interest Rate		4.50%
Bond Term (yrs)		25
Discount Rate		5%
Inflation Rate		3%
Construction Cost		
$/dia-in/ft	$	8.00
Construction Cost	$	117,065,520.00
Inflated Const. Cost (2021 Dollars)	$	148,295,098.30

	Average		
	Year	Sequence	Surface Water Delivered (MGD)
70 MGD WTP	2021	8	40
	2022	9	40
	2023	10	40
	2024	11	40
	2025	12	40
Expand to 140 MGD WTP	2026	13	40
	2027	14	50
	2028	15	60
	2029	16	70
Expand to 210 MGD WTP	2030	17	80
	2031	18	88
	2032	19	96
	2033	20	104
	2034	21	110
Expand to 280 MGD WTP	2035	22	110
	2036	23	110
	2037	24	110
	2038	25	110
	2039	26	110
	2040	27	110
	2041	28	110
	2042	29	110
	2043	30	110
	2044	31	110
	2045	32	110
	2046	33	110
	2047	34	110
	2048	35	110
	2049	36	110
	2050	37	110
	2051	38	110
	2052	39	110
	2053	40	110
	2054	41	110
	2055	42	110
	2056	43	110
	2057	44	110
	2058	45	110
	2059	46	110
	2060	47	110
	2061	48	110
	2062	49	110
	2063	50	110
	2064	51	110
	2065	52	110
	2066	53	110
	2067	54	110
	2068	55	110
	2069	56	110
	2070	57	110

Peak					
Surface Water Pumped (MGD)	Friction Head (ft)	Total Head (ft)	Power (kW)	Power Used (kW-hr)	Power Cost ($)
56	54	251	3285	9591069	$ 479,553.44
56	54	251	3285	9591069	$ 479,553.44
56	54	251	3285	9591069	$ 479,553.44
56	54	251	3285	9591069	$ 479,553.44
56	54	251	3285	9591069	$ 479,553.44
56	54	251	3285	9591069	$ 479,553.44
70	81	278	4555	13299645	$ 664,982.26
84	114	311	6105	17825250	$ 891,262.50
98	151	348	7981	23304964	$ 1,165,248.18
112	193	390	10230	29872447	$ 1,493,622.33
123.2	231	428	12328	35997613	$ 1,799,880.65
134.4	271	468	14715	42968545	$ 2,148,427.23
145.6	314	511	17414	50850178	$ 2,542,508.92
154	348	545	19657	57397657	$ 2,869,882.85
154	348	545	19657	57397657	$ 2,869,882.85
154	348	545	19657	57397657	$ 2,869,882.85
154	348	545	19657	57397657	$ 2,869,882.85
154	348	545	19657	57397657	$ 2,869,882.85
154	348	545	19657	57397657	$ 2,869,882.85
154	348	545	19657	57397657	$ 2,869,882.85
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154	348	545	19657	57397657	$ 2,869,882.85
154	348	545	19657	57397657	$ 2,869,882.85

Off-Peak					
Surface Water Pumped (MGD)	Friction Head (ft)	Total Head (ft)	Power (kW)	Power Used (kW-hr)	Power Cost ($)
32	19	216	1618	4724491	$ 236,224.55
32	19	216	1618	4724491	$ 236,224.55
32	19	216	1618	4724491	$ 236,224.55
32	19	216	1618	4724491	$ 236,224.55
32	19	216	1618	4724491	$ 236,224.55
32	19	216	1618	4724491	$ 236,224.55
40	29	226	2114	6171613	$ 308,580.67
48	40	237	2666	7784533	$ 389,226.67
56	54	251	3285	9591069	$ 479,553.44
64	69	266	3979	11618343	$ 580,917.14
70	82	279	4595	13416949	$ 670,847.43
77	96	293	5270	15387184	$ 769,359.19
83	112	309	6008	17542226	$ 877,111.29
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
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88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04
88	124	321	6605	19287621	$ 964,381.04

Total Cost				
Total Power Cost ($)	Inflated Power Cost ($)	Debt Service ($)	Total Cost ($)	Present Worth ($)
$ 715,777.99	$ 906,726.14	$10,001,000.00	$ 10,907,726.14	$ 7,382,778.40
$ 715,777.99	$ 933,927.93	$10,001,000.00	$ 10,934,927.93	$ 7,401,189.64
$ 715,777.99	$ 961,945.76	$10,001,000.00	$ 10,962,945.76	$ 7,420,153.22
$ 715,777.99	$ 990,804.14	$10,001,000.00	$ 10,991,804.14	$ 7,439,685.70
$ 715,777.99	$ 1,020,528.26	$10,001,000.00	$ 11,021,528.26	$ 7,459,804.16
$ 715,777.99	$ 1,051,144.11	$10,001,000.00	$ 11,052,144.11	$ 7,480,526.17
$ 973,562.93	$ 1,472,601.29	$10,001,000.00	$ 11,473,601.29	$ 7,765,784.97
$ 1,280,489.18	$ 1,994,960.41	$10,001,000.00	$ 11,995,960.41	$ 8,119,338.19
$ 1,644,801.62	$ 2,639,423.76	$10,001,000.00	$ 12,640,423.76	$ 8,555,536.35
$ 2,074,539.47	$ 3,428,897.65	$10,001,000.00	$ 13,429,897.65	$ 9,089,883.36
$ 2,470,728.08	$ 4,206,249.17	$10,001,000.00	$ 14,207,249.17	$ 9,616,025.46
$ 2,917,786.42	$ 5,116,356.16	$10,001,000.00	$ 15,117,356.16	$ 10,232,021.70
$ 3,419,620.21	$ 6,176,214.47	$10,001,000.00	$ 16,177,214.47	$ 10,949,375.52
$ 3,834,263.89	$ 7,132,860.30	$10,001,000.00	$ 17,133,860.30	$ 11,596,871.08
$ 3,834,263.89	$ 7,346,846.11	$10,001,000.00	$ 17,347,846.11	$ 11,741,705.10
$ 3,834,263.89	$ 7,567,251.50	$10,001,000.00	$ 17,568,251.50	$ 11,890,884.13
$ 3,834,263.89	$ 7,794,269.04	$10,001,000.00	$ 17,795,269.04	$ 12,044,538.54
$ 3,834,263.89	$ 8,028,097.11	$10,001,000.00	$ 18,029,097.11	$ 12,202,802.59
$ 3,834,263.89	$ 8,268,940.03	$10,001,000.00	$ 18,269,940.03	$ 12,365,814.55
$ 3,834,263.89	$ 8,517,008.23	$10,001,000.00	$ 18,518,008.23	$ 12,533,716.87
$ 3,834,263.89	$ 8,772,518.47	$10,001,000.00	$ 18,773,518.47	$ 12,706,656.27
$ 3,834,263.89	$ 9,035,694.03	$10,001,000.00	$ 19,036,694.03	$ 12,884,783.84
$ 3,834,263.89	$ 9,306,764.85	$10,001,000.00	$ 19,307,764.85	$ 13,068,255.24
$ 3,834,263.89	$ 9,585,967.79	$10,001,000.00	$ 19,586,967.79	$ 13,257,230.79
$ 3,834,263.89	$ 9,873,546.83	$10,001,000.00	$ 19,874,546.83	$ 13,451,875.59
$ 3,834,263.89	$ 10,169,753.23	$0.00	$ 10,169,753.23	$ 6,883,289.29
$ 3,834,263.89	$ 10,474,845.83	$0.00	$ 10,474,845.83	$ 7,089,787.97
$ 3,834,263.89	$ 10,789,091.20	$0.00	$ 10,789,091.20	$ 7,302,481.61
$ 3,834,263.89	$ 11,112,763.94	$0.00	$ 11,112,763.94	$ 7,521,556.06
$ 3,834,263.89	$ 11,446,146.86	$0.00	$ 11,446,146.86	$ 7,747,202.74
$ 3,834,263.89	$ 11,789,531.26	$0.00	$ 11,789,531.26	$ 7,979,618.82
$ 3,834,263.89	$ 12,143,217.20	$0.00	$ 12,143,217.20	$ 8,219,007.38
$ 3,834,263.89	$ 12,507,513.72	$0.00	$ 12,507,513.72	$ 8,465,577.60
$ 3,834,263.89	$ 12,882,739.13	$0.00	$ 12,882,739.13	$ 8,719,544.93
$ 3,834,263.89	$ 13,269,221.30	$0.00	$ 13,269,221.30	$ 8,981,131.28
$ 3,834,263.89	$ 13,667,297.94	$0.00	$ 13,667,297.94	$ 9,250,565.22
$ 3,834,263.89	$ 14,077,316.88	$0.00	$ 14,077,316.88	$ 9,528,082.18
$ 3,834,263.89	$ 14,499,636.39	$0.00	$ 14,499,636.39	$ 9,813,924.64
$ 3,834,263.89	$ 14,934,625.48	$0.00	$ 14,934,625.48	$ 10,108,342.38
$ 3,834,263.89	$ 15,382,664.24	$0.00	$ 15,382,664.24	$ 10,411,592.65
$ 3,834,263.89	$ 15,844,144.17	$0.00	$ 15,844,144.17	$ 10,723,940.43
$ 3,834,263.89	$ 16,319,468.49	$0.00	$ 16,319,468.49	$ 11,045,658.64
$ 3,834,263.89	$ 16,809,052.55	$0.00	$ 16,809,052.55	$ 11,377,028.40
$ 3,834,263.89	$ 17,313,324.13	$0.00	$ 17,313,324.13	$ 11,718,339.26
$ 3,834,263.89	$ 17,832,723.85	$0.00	$ 17,832,723.85	$ 12,069,889.43
$ 3,834,263.89	$ 18,367,705.57	$0.00	$ 18,367,705.57	$ 12,431,986.12
$ 3,834,263.89	$ 18,918,736.73	$0.00	$ 18,918,736.73	$ 12,804,945.70
$ 3,834,263.89	$ 19,486,298.83	$0.00	$ 19,486,298.83	$ 13,189,094.07
$ 3,834,263.89	$ 20,070,887.80	$0.00	$ 20,070,887.80	$ 13,584,766.89
$ 3,834,263.89	$ 20,673,014.43	$0.00	$ 20,673,014.43	$ 13,992,309.90
		Total	**$ 752,936,264.68**	**$ 509,616,901.03**

Life Cycle Cost Analysis Variables

Assumed Variables		
Lake Level		534
TSR Elevation		731
Static Head		197
Pipe Diameter (in)		84
Friction Factor, C		120
Pressure Pipe Length (ft)		187605
Peaking Factor 1		1.4
PF 1 Duration (Mo)		4
Peaking Factor 2		0.8
PF 2 Duration (Mo)		8
Power Variables		
Electricity Cost (kW-hr)	$	0.05
Run Time (PF 1, hrs)		2920
Run Time (PF 2, hrs)		5840
Pumping Efficiency		75%
Finanical Variables		
Bond Interest Rate		4.50%
Bond Term (yrs)		25
Discount Rate		5%
Inflation Rate		3%
Construction Cost		
$/dia-in/ft	$	8.50
Construction Cost	$	133,949,970.00
Inflated Const. Cost (2021 Dollars)	$	169,683,814.40

	Average		
	Year	Sequence	Surface Water Delivered (MGD)
70 MGD WTP	2021	8	40
	2022	9	40
	2023	10	40
	2024	11	40
	2025	12	40
Expand to 140 MGD WTP	2026	13	40
	2027	14	50
	2028	15	60
	2029	16	70
Expand to 210 MGD WTP	2030	17	80
	2031	18	88
	2032	19	96
	2033	20	104
	2034	21	110
Expand to 280 MGD WTP	2035	22	110
	2036	23	110
	2037	24	110
	2038	25	110
	2039	26	110
	2040	27	110
	2041	28	110
	2042	29	110
	2043	30	110
	2044	31	110
	2045	32	110
	2046	33	110
	2047	34	110
	2048	35	110
	2049	36	110
	2050	37	110
	2051	38	110
	2052	39	110
	2053	40	110
	2054	41	110
	2055	42	110
	2056	43	110
	2057	44	110
	2058	45	110
	2059	46	110
	2060	47	110
	2061	48	110
	2062	49	110
	2063	50	110
	2064	51	110
	2065	52	110
	2066	53	110
	2067	54	110
	2068	55	110
	2069	56	110
	2070	57	110

Peak					
Surface Water Pumped (MGD)	Friction Head (ft)	Total Head (ft)	Power (kW)	Power Used (kW-hr)	Power Cost ($)
56	37	234	3072	8969440	$ 448,472.02
56	37	234	3072	8969440	$ 448,472.02
56	37	234	3072	8969440	$ 448,472.02
56	37	234	3072	8969440	$ 448,472.02
56	37	234	3072	8969440	$ 448,472.02
56	37	234	3072	8969440	$ 448,472.02
70	56	253	4153	12125493	$ 606,274.65
84	79	276	5428	15851051	$ 792,552.55
98	105	302	6932	20241665	$ 1,012,083.26
112	135	332	8695	25390503	$ 1,269,525.17
123.2	161	358	10314	30116825	$ 1,505,841.26
134.4	189	386	12134	35432683	$ 1,771,634.16
145.6	219	416	14172	41383341	$ 2,069,167.06
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
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154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
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154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59
154	243	440	15853	46289832	$ 2,314,491.59

Off-Peak

Surface Water Pumped (MGD)	Friction Head (ft)	Total Head (ft)	Power (kW)	Power Used (kW-hr)	Power Cost ($)
32	13	210	1575	4598345	$ 229,917.26
32	13	210	1575	4598345	$ 229,917.26
32	13	210	1575	4598345	$ 229,917.26
32	13	210	1575	4598345	$ 229,917.26
32	13	210	1575	4598345	$ 229,917.26
32	13	210	1575	4598345	$ 229,917.26
40	20	217	2032	5933345	$ 296,667.26
48	28	225	2529	7383914	$ 369,195.68
56	37	234	3072	8969440	$ 448,472.02
64	48	245	3667	10708832	$ 535,441.60
70	57	254	4186	12223573	$ 611,178.67
77	67	264	4746	13857948	$ 692,897.40
83	78	275	5350	15621141	$ 781,057.06
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70
88	86	283	5833	17033534	$ 851,676.70

Total Cost				
Total Power Cost ($)	Inflated Power Cost ($)	Debt Service ($)	Total Cost ($)	Present Worth ($)
$ 678,389.28	$ 859,363.25	$11,443,000.00	$ 12,302,363.25	$ 8,326,723.69
$ 678,389.28	$ 885,144.15	$11,443,000.00	$ 12,328,144.15	$ 8,344,173.22
$ 678,389.28	$ 911,698.47	$11,443,000.00	$ 12,354,698.47	$ 8,362,146.23
$ 678,389.28	$ 939,049.42	$11,443,000.00	$ 12,382,049.42	$ 8,380,658.43
$ 678,389.28	$ 967,220.91	$11,443,000.00	$ 12,410,220.91	$ 8,399,726.00
$ 678,389.28	$ 996,237.53	$11,443,000.00	$ 12,439,237.53	$ 8,419,365.60
$ 902,941.91	$ 1,365,780.66	$11,443,000.00	$ 12,808,780.66	$ 8,669,486.93
$ 1,161,748.23	$ 1,809,965.88	$11,443,000.00	$ 13,252,965.88	$ 8,970,128.97
$ 1,460,555.28	$ 2,343,762.47	$11,443,000.00	$ 13,786,762.47	$ 9,331,423.51
$ 1,804,966.76	$ 2,983,335.04	$11,443,000.00	$ 14,426,335.04	$ 9,764,311.41
$ 2,117,019.92	$ 3,604,084.71	$11,443,000.00	$ 15,047,084.71	$ 10,184,459.22
$ 2,464,531.56	$ 4,321,571.01	$11,443,000.00	$ 15,764,571.01	$ 10,670,082.19
$ 2,850,224.12	$ 5,147,821.81	$11,443,000.00	$ 16,590,821.81	$ 11,229,321.25
$ 3,166,168.29	$ 5,890,005.69	$11,443,000.00	$ 17,333,005.69	$ 11,731,660.51
$ 3,166,168.29	$ 6,066,705.86	$11,443,000.00	$ 17,509,705.86	$ 11,851,258.14
$ 3,166,168.29	$ 6,248,707.04	$11,443,000.00	$ 17,691,707.04	$ 11,974,443.70
$ 3,166,168.29	$ 6,436,168.25	$11,443,000.00	$ 17,879,168.25	$ 12,101,324.83
$ 3,166,168.29	$ 6,629,253.29	$11,443,000.00	$ 18,072,253.29	$ 12,232,012.39
$ 3,166,168.29	$ 6,828,130.89	$11,443,000.00	$ 18,271,130.89	$ 12,366,620.58
$ 3,166,168.29	$ 7,032,974.82	$11,443,000.00	$ 18,475,974.82	$ 12,505,267.01
$ 3,166,168.29	$ 7,243,964.06	$11,443,000.00	$ 18,686,964.06	$ 12,648,072.84
$ 3,166,168.29	$ 7,461,282.99	$11,443,000.00	$ 18,904,282.99	$ 12,795,162.84
$ 3,166,168.29	$ 7,685,121.48	$11,443,000.00	$ 19,128,121.48	$ 12,946,665.54
$ 3,166,168.29	$ 7,915,675.12	$11,443,000.00	$ 19,358,675.12	$ 13,102,713.32
$ 3,166,168.29	$ 8,153,145.37	$11,443,000.00	$ 19,596,145.37	$ 13,263,442.53
$ 3,166,168.29	$ 8,397,739.73	$0.00	$ 8,397,739.73	$ 5,683,920.80
$ 3,166,168.29	$ 8,649,671.93	$0.00	$ 8,649,671.93	$ 5,854,438.43
$ 3,166,168.29	$ 8,909,162.08	$0.00	$ 8,909,162.08	$ 6,030,071.58
$ 3,166,168.29	$ 9,176,436.95	$0.00	$ 9,176,436.95	$ 6,210,973.73
$ 3,166,168.29	$ 9,451,730.06	$0.00	$ 9,451,730.06	$ 6,397,302.94
$ 3,166,168.29	$ 9,735,281.96	$0.00	$ 9,735,281.96	$ 6,589,222.03
$ 3,166,168.29	$ 10,027,340.42	$0.00	$ 10,027,340.42	$ 6,786,898.69
$ 3,166,168.29	$ 10,328,160.63	$0.00	$ 10,328,160.63	$ 6,990,505.65
$ 3,166,168.29	$ 10,638,005.45	$0.00	$ 10,638,005.45	$ 7,200,220.82
$ 3,166,168.29	$ 10,957,145.61	$0.00	$ 10,957,145.61	$ 7,416,227.44
$ 3,166,168.29	$ 11,285,859.98	$0.00	$ 11,285,859.98	$ 7,638,714.27
$ 3,166,168.29	$ 11,624,435.78	$0.00	$ 11,624,435.78	$ 7,867,875.70
$ 3,166,168.29	$ 11,973,168.85	$0.00	$ 11,973,168.85	$ 8,103,911.97
$ 3,166,168.29	$ 12,332,363.92	$0.00	$ 12,332,363.92	$ 8,347,029.33
$ 3,166,168.29	$ 12,702,334.83	$0.00	$ 12,702,334.83	$ 8,597,440.21
$ 3,166,168.29	$ 13,083,404.88	$0.00	$ 13,083,404.88	$ 8,855,363.41
$ 3,166,168.29	$ 13,475,907.03	$0.00	$ 13,475,907.03	$ 9,121,024.31
$ 3,166,168.29	$ 13,880,184.24	$0.00	$ 13,880,184.24	$ 9,394,655.04
$ 3,166,168.29	$ 14,296,589.76	$0.00	$ 14,296,589.76	$ 9,676,494.69
$ 3,166,168.29	$ 14,725,487.46	$0.00	$ 14,725,487.46	$ 9,966,789.54
$ 3,166,168.29	$ 15,167,252.08	$0.00	$ 15,167,252.08	$ 10,265,793.22
$ 3,166,168.29	$ 15,622,269.64	$0.00	$ 15,622,269.64	$ 10,573,767.02
$ 3,166,168.29	$ 16,090,937.73	$0.00	$ 16,090,937.73	$ 10,890,980.03
$ 3,166,168.29	$ 16,573,665.86	$0.00	$ 16,573,665.86	$ 11,217,709.43
$ 3,166,168.29	$ 17,070,875.84	$0.00	$ 17,070,875.84	$ 11,554,240.71
		Total	**$ 702,976,582.85**	**$ 475,802,221.85**

Life Cycle Cost Analysis Variables

Assumed Variables		
Lake Level		534
TSR Elevation		731
Static Head		197
Pipe Diameter (in)		90
Friction Factor, C		120
Pressure Pipe Length (ft)		187605
Peaking Factor 1		1.4
PF 1 Duration (Mo)		4
Peaking Factor 2		0.8
PF 2 Duration (Mo)		8
Power Variables		
Electricity Cost (kW-hr)	$	0.05
Run Time (PF 1, hrs)		2920
Run Time (PF 2, hrs)		5840
Pumping Efficiency		75%
Finanical Variables		
Bond Interest Rate		4.50%
Bond Term (yrs)		25
Discount Rate		5%
Inflation Rate		3%
Construction Cost		
$/dia-in/ft	$	9.00
Construction Cost	$	151,960,050.00
Inflated Const. Cost (2021 Dollars)	$	192,498,444.91

	Average		
	Year	Sequence	Surface Water Delivered (MGD)
70 MGD WTP	2021	8	40
	2022	9	40
	2023	10	40
	2024	11	40
	2025	12	40
Expand to 140 MGD WTP	2026	13	40
	2027	14	50
	2028	15	60
	2029	16	70
Expand to 210 MGD WTP	2030	17	80
	2031	18	88
	2032	19	96
	2033	20	104
	2034	21	110
Expand to 280 MGD WTP	2035	22	110
	2036	23	110
	2037	24	110
	2038	25	110
	2039	26	110
	2040	27	110
	2041	28	110
	2042	29	110
	2043	30	110
	2044	31	110
	2045	32	110
	2046	33	110
	2047	34	110
	2048	35	110
	2049	36	110
	2050	37	110
	2051	38	110
	2052	39	110
	2053	40	110
	2054	41	110
	2055	42	110
	2056	43	110
	2057	44	110
	2058	45	110
	2059	46	110
	2060	47	110
	2061	48	110
	2062	49	110
	2063	50	110
	2064	51	110
	2065	52	110
	2066	53	110
	2067	54	110
	2068	55	110
	2069	56	110
	2070	57	110

Peak					
Surface Water Pumped (MGD)	Friction Head (ft)	Total Head (ft)	Power (kW)	Power Used (kW-hr)	Power Cost ($)
56	27	224	2932	8561284	$ 428,064.21
56	27	224	2932	8561284	$ 428,064.21
56	27	224	2932	8561284	$ 428,064.21
56	27	224	2932	8561284	$ 428,064.21
56	27	224	2932	8561284	$ 428,064.21
56	27	224	2932	8561284	$ 428,064.21
70	40	237	3889	11354554	$ 567,727.70
84	57	254	4985	14554807	$ 727,740.37
98	75	272	6243	18230328	$ 911,516.39
112	96	293	7688	22447695	$ 1,122,384.75
123.2	115	312	8992	26255547	$ 1,312,777.33
134.4	135	332	10440	30484696	$ 1,524,234.82
145.6	156	353	12044	35167491	$ 1,758,374.55
154	174	371	13355	38996522	$ 1,949,826.09
154	174	371	13355	38996522	$ 1,949,826.09
154	174	371	13355	38996522	$ 1,949,826.09
154	174	371	13355	38996522	$ 1,949,826.09
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154	174	371	13355	38996522	$ 1,949,826.09
154	174	371	13355	38996522	$ 1,949,826.09
154	174	371	13355	38996522	$ 1,949,826.09
154	174	371	13355	38996522	$ 1,949,826.09

Off-Peak					
Surface Water Pumped (MGD)	Friction Head (ft)	Total Head (ft)	Power (kW)	Power Used (kW-hr)	Power Cost ($)
32	9	206	1546	4515519	$ 225,775.95
32	9	206	1546	4515519	$ 225,775.95
32	9	206	1546	4515519	$ 225,775.95
32	9	206	1546	4515519	$ 225,775.95
32	9	206	1546	4515519	$ 225,775.95
32	9	206	1546	4515519	$ 225,775.95
40	14	211	1978	5776900	$ 288,845.01
48	20	217	2439	7120870	$ 356,043.49
56	27	224	2932	8561284	$ 428,064.21
64	34	231	3463	10111654	$ 505,582.71
70	41	238	3918	11440013	$ 572,000.63
77	48	245	4402	12853864	$ 642,693.20
83	56	253	4918	14359772	$ 717,988.62
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94
88	62	259	5327	15553519	$ 777,675.94

Total Cost				
Total Power Cost ($)	Inflated Power Cost ($)	Debt Service ($)	Total Cost ($)	Present Worth ($)
$ 653,840.16	$ 828,265.15	$12,982,000.00	$ 13,810,265.15	$ 9,347,331.05
$ 653,840.16	$ 853,113.10	$12,982,000.00	$ 13,835,113.10	$ 9,364,149.13
$ 653,840.16	$ 878,706.49	$12,982,000.00	$ 13,860,706.49	$ 9,381,471.74
$ 653,840.16	$ 905,067.69	$12,982,000.00	$ 13,887,067.69	$ 9,399,314.04
$ 653,840.16	$ 932,219.72	$12,982,000.00	$ 13,914,219.72	$ 9,417,691.60
$ 653,840.16	$ 960,186.31	$12,982,000.00	$ 13,942,186.31	$ 9,436,620.49
$ 856,572.71	$ 1,295,643.08	$12,982,000.00	$ 14,277,643.08	$ 9,663,670.84
$ 1,083,783.86	$ 1,688,499.94	$12,982,000.00	$ 14,670,499.94	$ 9,929,571.82
$ 1,339,580.60	$ 2,149,633.61	$12,982,000.00	$ 15,131,633.61	$ 10,241,685.24
$ 1,627,967.46	$ 2,690,782.17	$12,982,000.00	$ 15,672,782.17	$ 10,607,955.88
$ 1,884,777.96	$ 3,208,708.31	$12,982,000.00	$ 16,190,708.31	$ 10,958,508.68
$ 2,166,928.02	$ 3,799,721.39	$12,982,000.00	$ 16,781,721.39	$ 11,358,529.60
$ 2,476,363.18	$ 4,472,587.35	$12,982,000.00	$ 17,454,587.35	$ 11,813,951.77
$ 2,727,502.02	$ 5,073,957.21	$12,982,000.00	$ 18,055,957.21	$ 12,220,982.56
$ 2,727,502.02	$ 5,226,175.93	$12,982,000.00	$ 18,208,175.93	$ 12,324,010.18
$ 2,727,502.02	$ 5,382,961.21	$12,982,000.00	$ 18,364,961.21	$ 12,430,128.63
$ 2,727,502.02	$ 5,544,450.04	$12,982,000.00	$ 18,526,450.04	$ 12,539,430.63
$ 2,727,502.02	$ 5,710,783.54	$12,982,000.00	$ 18,692,783.54	$ 12,652,011.69
$ 2,727,502.02	$ 5,882,107.05	$12,982,000.00	$ 18,864,107.05	$ 12,767,970.18
$ 2,727,502.02	$ 6,058,570.26	$12,982,000.00	$ 19,040,570.26	$ 12,887,407.43
$ 2,727,502.02	$ 6,240,327.37	$12,982,000.00	$ 19,222,327.37	$ 13,010,427.79
$ 2,727,502.02	$ 6,427,537.19	$12,982,000.00	$ 19,409,537.19	$ 13,137,138.77
$ 2,727,502.02	$ 6,620,363.31	$12,982,000.00	$ 19,602,363.31	$ 13,267,651.07
$ 2,727,502.02	$ 6,818,974.20	$12,982,000.00	$ 19,800,974.20	$ 13,402,078.75
$ 2,727,502.02	$ 7,023,543.43	$12,982,000.00	$ 20,005,543.43	$ 13,540,539.25
$ 2,727,502.02	$ 7,234,249.73	$0.00	$ 7,234,249.73	$ 4,896,424.97
$ 2,727,502.02	$ 7,451,277.23	$0.00	$ 7,451,277.23	$ 5,043,317.72
$ 2,727,502.02	$ 7,674,815.54	$0.00	$ 7,674,815.54	$ 5,194,617.26
$ 2,727,502.02	$ 7,905,060.01	$0.00	$ 7,905,060.01	$ 5,350,455.77
$ 2,727,502.02	$ 8,142,211.81	$0.00	$ 8,142,211.81	$ 5,510,969.45
$ 2,727,502.02	$ 8,386,478.16	$0.00	$ 8,386,478.16	$ 5,676,298.53
$ 2,727,502.02	$ 8,638,072.51	$0.00	$ 8,638,072.51	$ 5,846,587.49
$ 2,727,502.02	$ 8,897,214.68	$0.00	$ 8,897,214.68	$ 6,021,985.11
$ 2,727,502.02	$ 9,164,131.12	$0.00	$ 9,164,131.12	$ 6,202,644.66
$ 2,727,502.02	$ 9,439,055.06	$0.00	$ 9,439,055.06	$ 6,388,724.00
$ 2,727,502.02	$ 9,722,226.71	$0.00	$ 9,722,226.71	$ 6,580,385.72
$ 2,727,502.02	$ 10,013,893.51	$0.00	$ 10,013,893.51	$ 6,777,797.29
$ 2,727,502.02	$ 10,314,310.32	$0.00	$ 10,314,310.32	$ 6,981,131.21
$ 2,727,502.02	$ 10,623,739.63	$0.00	$ 10,623,739.63	$ 7,190,565.15
$ 2,727,502.02	$ 10,942,451.81	$0.00	$ 10,942,451.81	$ 7,406,282.10
$ 2,727,502.02	$ 11,270,725.37	$0.00	$ 11,270,725.37	$ 7,628,470.57
$ 2,727,502.02	$ 11,608,847.13	$0.00	$ 11,608,847.13	$ 7,857,324.68
$ 2,727,502.02	$ 11,957,112.54	$0.00	$ 11,957,112.54	$ 8,093,044.43
$ 2,727,502.02	$ 12,315,825.92	$0.00	$ 12,315,825.92	$ 8,335,835.76
$ 2,727,502.02	$ 12,685,300.70	$0.00	$ 12,685,300.70	$ 8,585,910.83
$ 2,727,502.02	$ 13,065,859.72	$0.00	$ 13,065,859.72	$ 8,843,488.16
$ 2,727,502.02	$ 13,457,835.51	$0.00	$ 13,457,835.51	$ 9,108,792.80
$ 2,727,502.02	$ 13,861,570.57	$0.00	$ 13,861,570.57	$ 9,382,056.58
$ 2,727,502.02	$ 14,277,417.69	$0.00	$ 14,277,417.69	$ 9,663,518.28
$ 2,727,502.02	$ 14,705,740.22	$0.00	$ 14,705,740.22	$ 9,953,423.83
		Total	**$ 684,978,308.26**	**$ 463,620,281.17**

Life Cycle Cost Analysis Variables

Assumed Variables		
Lake Level		534
TSR Elevation		731
Static Head		197
Pipe Diameter (in)		96
Friction Factor, C		120
Pressure Pipe Length (ft)		187605
Peaking Factor 1		1.4
PF 1 Duration (Mo)		4
Peaking Factor 2		0.8
PF 2 Duration (Mo)		8
Power Variables		
Electricity Cost (kW-hr)	$	0.05
Run Time (PF 1, hrs)		2920
Run Time (PF 2, hrs)		5840
Pumping Efficiency		75%
Finanical Variables		
Bond Interest Rate		4.50%
Bond Term (yrs)		25
Discount Rate		5%
Inflation Rate		3%
Construction Cost		
$/dia-in/ft	$	9.50
Construction Cost	$	171,095,760.00
Inflated Const. Cost (2021 Dollars)	$	216,738,989.82

	Average		
	Year	Sequence	Surface Water Delivered (MGD)
70 MGD WTP	2021	8	40
	2022	9	40
	2023	10	40
	2024	11	40
	2025	12	40
Expand to 140 MGD WTP	2026	13	40
	2027	14	50
	2028	15	60
	2029	16	70
Expand to 210 MGD WTP	2030	17	80
	2031	18	88
	2032	19	96
	2033	20	104
	2034	21	110
Expand to 280 MGD WTP	2035	22	110
	2036	23	110
	2037	24	110
	2038	25	110
	2039	26	110
	2040	27	110
	2041	28	110
	2042	29	110
	2043	30	110
	2044	31	110
	2045	32	110
	2046	33	110
	2047	34	110
	2048	35	110
	2049	36	110
	2050	37	110
	2051	38	110
	2052	39	110
	2053	40	110
	2054	41	110
	2055	42	110
	2056	43	110
	2057	44	110
	2058	45	110
	2059	46	110
	2060	47	110
	2061	48	110
	2062	49	110
	2063	50	110
	2064	51	110
	2065	52	110
	2066	53	110
	2067	54	110
	2068	55	110
	2069	56	110
	2070	57	110

Peak					
Surface Water Pumped (MGD)	Friction Head (ft)	Total Head (ft)	Power (kW)	Power Used (kW-hr)	Power Cost ($)
56	20	217	2838	8285623	$ 414,281.13
56	20	217	2838	8285623	$ 414,281.13
56	20	217	2838	8285623	$ 414,281.13
56	20	217	2838	8285623	$ 414,281.13
56	20	217	2838	8285623	$ 414,281.13
56	20	217	2838	8285623	$ 414,281.13
70	29	226	3710	10833876	$ 541,693.78
84	41	238	4685	13679348	$ 683,967.39
98	55	252	5778	16871906	$ 843,595.32
112	70	267	7007	20460175	$ 1,023,008.74
123.2	84	281	8099	23647708	$ 1,182,385.40
134.4	99	296	9296	27142914	$ 1,357,145.72
145.6	114	311	10606	30969417	$ 1,548,470.84
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
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154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52
154	127	324	11668	34070750	$ 1,703,537.52

Off-Peak					
Surface Water Pumped (MGD)	Friction Head (ft)	Total Head (ft)	Power (kW)	Power Used (kW-hr)	Power Cost ($)
32	7	204	1527	4459580	$ 222,978.98
32	7	204	1527	4459580	$ 222,978.98
32	7	204	1527	4459580	$ 222,978.98
32	7	204	1527	4459580	$ 222,978.98
32	7	204	1527	4459580	$ 222,978.98
32	7	204	1527	4459580	$ 222,978.98
40	10	207	1942	5671240	$ 283,562.00
48	15	212	2378	6943215	$ 347,160.73
56	20	217	2838	8285623	$ 414,281.13
64	25	222	3325	9708331	$ 485,416.56
70	30	227	3737	10910810	$ 545,540.48
77	35	232	4170	12175723	$ 608,786.17
83	41	238	4626	13507866	$ 675,393.32
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14
88	45	242	4984	14553943	$ 727,697.14

Total Cost				
Total Power Cost ($)	Inflated Power Cost ($)	Debt Service ($)	Total Cost ($)	Present Worth ($)
$ 637,260.11	$ 807,262.05	$14,617,000.00	$ 15,424,262.05	$ 10,439,747.68
$ 637,260.11	$ 831,479.91	$14,617,000.00	$ 15,448,479.91	$ 10,456,139.28
$ 637,260.11	$ 856,424.30	$14,617,000.00	$ 15,473,424.30	$ 10,473,022.63
$ 637,260.11	$ 882,117.03	$14,617,000.00	$ 15,499,117.03	$ 10,490,412.48
$ 637,260.11	$ 908,580.54	$14,617,000.00	$ 15,525,580.54	$ 10,508,324.03
$ 637,260.11	$ 935,837.96	$14,617,000.00	$ 15,552,837.96	$ 10,526,772.92
$ 825,255.78	$ 1,248,273.42	$14,617,000.00	$ 15,865,273.42	$ 10,738,241.54
$ 1,031,128.12	$ 1,606,464.01	$14,617,000.00	$ 16,223,464.01	$ 10,980,679.03
$ 1,257,876.45	$ 2,018,522.44	$14,617,000.00	$ 16,635,522.44	$ 11,259,576.40
$ 1,508,425.30	$ 2,493,197.18	$14,617,000.00	$ 17,110,197.18	$ 11,580,854.94
$ 1,727,925.88	$ 2,941,678.14	$14,617,000.00	$ 17,558,678.14	$ 11,884,404.51
$ 1,965,931.89	$ 3,447,273.47	$14,617,000.00	$ 18,064,273.47	$ 12,226,611.33
$ 2,223,864.16	$ 4,016,546.05	$14,617,000.00	$ 18,633,546.05	$ 12,611,917.42
$ 2,431,234.66	$ 4,522,812.64	$14,617,000.00	$ 19,139,812.64	$ 12,954,578.57
$ 2,431,234.66	$ 4,658,497.02	$14,617,000.00	$ 19,275,497.02	$ 13,046,415.10
$ 2,431,234.66	$ 4,798,251.93	$14,617,000.00	$ 19,415,251.93	$ 13,141,006.73
$ 2,431,234.66	$ 4,942,199.48	$14,617,000.00	$ 19,559,199.48	$ 13,238,436.10
$ 2,431,234.66	$ 5,090,465.47	$14,617,000.00	$ 19,707,465.47	$ 13,338,788.36
$ 2,431,234.66	$ 5,243,179.43	$14,617,000.00	$ 19,860,179.43	$ 13,442,151.18
$ 2,431,234.66	$ 5,400,474.82	$14,617,000.00	$ 20,017,474.82	$ 13,548,614.88
$ 2,431,234.66	$ 5,562,489.06	$14,617,000.00	$ 20,179,489.06	$ 13,658,272.50
$ 2,431,234.66	$ 5,729,363.73	$14,617,000.00	$ 20,346,363.73	$ 13,771,219.85
$ 2,431,234.66	$ 5,901,244.64	$14,617,000.00	$ 20,518,244.64	$ 13,887,555.61
$ 2,431,234.66	$ 6,078,281.98	$14,617,000.00	$ 20,695,281.98	$ 14,007,381.45
$ 2,431,234.66	$ 6,260,630.44	$14,617,000.00	$ 20,877,630.44	$ 14,130,802.07
$ 2,431,234.66	$ 6,448,449.36	$0.00	$ 6,448,449.36	$ 4,364,564.35
$ 2,431,234.66	$ 6,641,902.84	$0.00	$ 6,641,902.84	$ 4,495,501.28
$ 2,431,234.66	$ 6,841,159.92	$0.00	$ 6,841,159.92	$ 4,630,366.32
$ 2,431,234.66	$ 7,046,394.72	$0.00	$ 7,046,394.72	$ 4,769,277.31
$ 2,431,234.66	$ 7,257,786.56	$0.00	$ 7,257,786.56	$ 4,912,355.63
$ 2,431,234.66	$ 7,475,520.16	$0.00	$ 7,475,520.16	$ 5,059,726.29
$ 2,431,234.66	$ 7,699,785.76	$0.00	$ 7,699,785.76	$ 5,211,518.08
$ 2,431,234.66	$ 7,930,779.34	$0.00	$ 7,930,779.34	$ 5,367,863.63
$ 2,431,234.66	$ 8,168,702.72	$0.00	$ 8,168,702.72	$ 5,528,899.53
$ 2,431,234.66	$ 8,413,763.80	$0.00	$ 8,413,763.80	$ 5,694,766.52
$ 2,431,234.66	$ 8,666,176.71	$0.00	$ 8,666,176.71	$ 5,865,609.52
$ 2,431,234.66	$ 8,926,162.01	$0.00	$ 8,926,162.01	$ 6,041,577.80
$ 2,431,234.66	$ 9,193,946.87	$0.00	$ 9,193,946.87	$ 6,222,825.14
$ 2,431,234.66	$ 9,469,765.28	$0.00	$ 9,469,765.28	$ 6,409,509.89
$ 2,431,234.66	$ 9,753,858.24	$0.00	$ 9,753,858.24	$ 6,601,795.19
$ 2,431,234.66	$ 10,046,473.98	$0.00	$ 10,046,473.98	$ 6,799,849.04
$ 2,431,234.66	$ 10,347,868.20	$0.00	$ 10,347,868.20	$ 7,003,844.51
$ 2,431,234.66	$ 10,658,304.25	$0.00	$ 10,658,304.25	$ 7,213,959.85
$ 2,431,234.66	$ 10,978,053.38	$0.00	$ 10,978,053.38	$ 7,430,378.64
$ 2,431,234.66	$ 11,307,394.98	$0.00	$ 11,307,394.98	$ 7,653,290.00
$ 2,431,234.66	$ 11,646,616.83	$0.00	$ 11,646,616.83	$ 7,882,888.70
$ 2,431,234.66	$ 11,996,015.33	$0.00	$ 11,996,015.33	$ 8,119,375.36
$ 2,431,234.66	$ 12,355,895.79	$0.00	$ 12,355,895.79	$ 8,362,956.63
$ 2,431,234.66	$ 12,726,572.67	$0.00	$ 12,726,572.67	$ 8,613,845.32
$ 2,431,234.66	$ 13,108,369.85	$0.00	$ 13,108,369.85	$ 8,872,260.68
		Total	**$ 687,712,266.69**	**$ 465,470,731.85**

Life Cycle Cost Analysis Variables

Assumed Variables		
Lake Level		534
TSR Elevation		731
Static Head		197
Pipe Diameter (in)		102
Friction Factor, C		120
Pressure Pipe Length (ft)		187605
Peaking Factor 1		1.4
PF 1 Duration (Mo)		4
Peaking Factor 2		0.8
PF 2 Duration (Mo)		8
Power Variables		
Electricity Cost (kW-hr)	$	0.05
Run Time (PF 1, hrs)		2920
Run Time (PF 2, hrs)		5840
Pumping Efficiency		75%
Finanical Variables		
Bond Interest Rate		4.50%
Bond Term (yrs)		25
Discount Rate		5%
Inflation Rate		3%
Construction Cost		
$/dia-in/ft	$	10.00
Construction Cost	$	191,357,100.00
Inflated Const. Cost (2021 Dollars)	$	242,405,449.14

	Average		
	Year	Sequence	Surface Water Delivered (MGD)
70 MGD WTP	2021	8	40
	2022	9	40
	2023	10	40
	2024	11	40
	2025	12	40
Expand to 140 MGD WTP	2026	13	40
	2027	14	50
	2028	15	60
	2029	16	70
Expand to 210 MGD WTP	2030	17	80
	2031	18	88
	2032	19	96
	2033	20	104
	2034	21	110
Expand to 280 MGD WTP	2035	22	110
	2036	23	110
	2037	24	110
	2038	25	110
	2039	26	110
	2040	27	110
	2041	28	110
	2042	29	110
	2043	30	110
	2044	31	110
	2045	32	110
	2046	33	110
	2047	34	110
	2048	35	110
	2049	36	110
	2050	37	110
	2051	38	110
	2052	39	110
	2053	40	110
	2054	41	110
	2055	42	110
	2056	43	110
	2057	44	110
	2058	45	110
	2059	46	110
	2060	47	110
	2061	48	110
	2062	49	110
	2063	50	110
	2064	51	110
	2065	52	110
	2066	53	110
	2067	54	110
	2068	55	110
	2069	56	110
	2070	57	110

Peak

Surface Water Pumped (MGD)	Friction Head (ft)	Total Head (ft)	Power (kW)	Power Used (kW-hr)	Power Cost ($)
56	15	212	2772	8094798	$ 404,739.88
56	15	212	2772	8094798	$ 404,739.88
56	15	212	2772	8094798	$ 404,739.88
56	15	212	2772	8094798	$ 404,739.88
56	15	212	2772	8094798	$ 404,739.88
56	15	212	2772	8094798	$ 404,739.88
70	22	219	3587	10473439	$ 523,671.95
84	31	228	4477	13073316	$ 653,665.80
98	41	238	5456	15931547	$ 796,577.37
112	52	249	6536	19084326	$ 954,216.29
123.2	62	259	7480	21842447	$ 1,092,122.36
134.4	73	270	8503	24829586	$ 1,241,479.29
145.6	85	282	9611	28063325	$ 1,403,166.25
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73
154	94	291	10500	30660915	$ 1,533,045.73

Off-Peak					
Surface Water Pumped (MGD)	Friction Head (ft)	Total Head (ft)	Power (kW)	Power Used (kW-hr)	Power Cost ($)
32	5	202	1514	4420856	$ 221,042.80
32	5	202	1514	4420856	$ 221,042.80
32	5	202	1514	4420856	$ 221,042.80
32	5	202	1514	4420856	$ 221,042.80
32	5	202	1514	4420856	$ 221,042.80
32	5	202	1514	4420856	$ 221,042.80
40	8	205	1917	5598097	$ 279,904.87
48	11	208	2336	6820234	$ 341,011.70
56	15	212	2772	8094798	$ 404,739.88
64	19	216	3229	9429133	$ 471,456.66
70	22	219	3611	10544472	$ 527,223.60
77	26	223	4009	11706285	$ 585,314.24
83	30	227	4424	12918140	$ 645,906.98
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61
88	34	231	4747	13861992	$ 693,099.61

Total Cost				
Total Power Cost ($)	Inflated Power Cost ($)	Debt Service ($)	Total Cost ($)	Present Worth ($)
$ 625,782.68	$ 792,722.77	$16,348,000.00	$ 17,140,722.77	$ 11,601,515.87
$ 625,782.68	$ 816,504.46	$16,348,000.00	$ 17,164,504.46	$ 11,617,612.25
$ 625,782.68	$ 840,999.59	$16,348,000.00	$ 17,188,999.59	$ 11,634,191.52
$ 625,782.68	$ 866,229.58	$16,348,000.00	$ 17,214,229.58	$ 11,651,268.17
$ 625,782.68	$ 892,216.47	$16,348,000.00	$ 17,240,216.47	$ 11,668,857.11
$ 625,782.68	$ 918,982.96	$16,348,000.00	$ 17,266,982.96	$ 11,686,973.73
$ 803,576.83	$ 1,215,482.05	$16,348,000.00	$ 17,563,482.05	$ 11,887,655.99
$ 994,677.50	$ 1,549,675.13	$16,348,000.00	$ 17,897,675.13	$ 12,113,851.02
$ 1,201,317.25	$ 1,927,761.53	$16,348,000.00	$ 18,275,761.53	$ 12,369,754.77
$ 1,425,672.95	$ 2,356,420.15	$16,348,000.00	$ 18,704,420.15	$ 12,659,887.80
$ 1,619,345.96	$ 2,756,828.11	$16,348,000.00	$ 19,104,828.11	$ 12,930,899.67
$ 1,826,793.53	$ 3,203,293.51	$16,348,000.00	$ 19,551,293.51	$ 13,233,085.03
$ 2,049,073.23	$ 3,700,854.19	$16,348,000.00	$ 20,048,854.19	$ 13,569,853.68
$ 2,226,145.35	$ 4,141,286.10	$16,348,000.00	$ 20,489,286.10	$ 13,867,955.33
$ 2,226,145.35	$ 4,265,524.69	$16,348,000.00	$ 20,613,524.69	$ 13,952,044.90
$ 2,226,145.35	$ 4,393,490.43	$16,348,000.00	$ 20,741,490.43	$ 14,038,657.15
$ 2,226,145.35	$ 4,525,295.14	$16,348,000.00	$ 20,873,295.14	$ 14,127,867.77
$ 2,226,145.35	$ 4,661,053.99	$16,348,000.00	$ 21,009,053.99	$ 14,219,754.70
$ 2,226,145.35	$ 4,800,885.61	$16,348,000.00	$ 21,148,885.61	$ 14,314,398.25
$ 2,226,145.35	$ 4,944,912.18	$16,348,000.00	$ 21,292,912.18	$ 14,411,881.10
$ 2,226,145.35	$ 5,093,259.55	$16,348,000.00	$ 21,441,259.55	$ 14,512,288.43
$ 2,226,145.35	$ 5,246,057.33	$16,348,000.00	$ 21,594,057.33	$ 14,615,707.99
$ 2,226,145.35	$ 5,403,439.05	$16,348,000.00	$ 21,751,439.05	$ 14,722,230.13
$ 2,226,145.35	$ 5,565,542.23	$16,348,000.00	$ 21,913,542.23	$ 14,831,947.94
$ 2,226,145.35	$ 5,732,508.49	$16,348,000.00	$ 22,080,508.49	$ 14,944,957.28
$ 2,226,145.35	$ 5,904,483.75	$0.00	$ 5,904,483.75	$ 3,996,387.01
$ 2,226,145.35	$ 6,081,618.26	$0.00	$ 6,081,618.26	$ 4,116,278.62
$ 2,226,145.35	$ 6,264,066.81	$0.00	$ 6,264,066.81	$ 4,239,766.98
$ 2,226,145.35	$ 6,451,988.81	$0.00	$ 6,451,988.81	$ 4,366,959.99
$ 2,226,145.35	$ 6,645,548.48	$0.00	$ 6,645,548.48	$ 4,497,968.79
$ 2,226,145.35	$ 6,844,914.93	$0.00	$ 6,844,914.93	$ 4,632,907.86
$ 2,226,145.35	$ 7,050,262.38	$0.00	$ 7,050,262.38	$ 4,771,895.09
$ 2,226,145.35	$ 7,261,770.25	$0.00	$ 7,261,770.25	$ 4,915,051.94
$ 2,226,145.35	$ 7,479,623.36	$0.00	$ 7,479,623.36	$ 5,062,503.50
$ 2,226,145.35	$ 7,704,012.06	$0.00	$ 7,704,012.06	$ 5,214,378.61
$ 2,226,145.35	$ 7,935,132.42	$0.00	$ 7,935,132.42	$ 5,370,809.97
$ 2,226,145.35	$ 8,173,186.39	$0.00	$ 8,173,186.39	$ 5,531,934.26
$ 2,226,145.35	$ 8,418,381.99	$0.00	$ 8,418,381.99	$ 5,697,892.29
$ 2,226,145.35	$ 8,670,933.44	$0.00	$ 8,670,933.44	$ 5,868,829.06
$ 2,226,145.35	$ 8,931,061.45	$0.00	$ 8,931,061.45	$ 6,044,893.93
$ 2,226,145.35	$ 9,198,993.29	$0.00	$ 9,198,993.29	$ 6,226,240.75
$ 2,226,145.35	$ 9,474,963.09	$0.00	$ 9,474,963.09	$ 6,413,027.97
$ 2,226,145.35	$ 9,759,211.98	$0.00	$ 9,759,211.98	$ 6,605,418.81
$ 2,226,145.35	$ 10,051,988.34	$0.00	$ 10,051,988.34	$ 6,803,581.38
$ 2,226,145.35	$ 10,353,547.99	$0.00	$ 10,353,547.99	$ 7,007,688.82
$ 2,226,145.35	$ 10,664,154.43	$0.00	$ 10,664,154.43	$ 7,217,919.48
$ 2,226,145.35	$ 10,984,079.07	$0.00	$ 10,984,079.07	$ 7,434,457.07
$ 2,226,145.35	$ 11,313,601.44	$0.00	$ 11,313,601.44	$ 7,657,490.78
$ 2,226,145.35	$ 11,653,009.48	$0.00	$ 11,653,009.48	$ 7,887,215.50
$ 2,226,145.35	$ 12,002,599.76	$0.00	$ 12,002,599.76	$ 8,123,831.97
		Total	**$ 704,584,358.96**	**$ 476,890,428.02**

Life Cycle Cost Analysis Variables

Assumed Variables		
Lake Level		534
TSR Elevation		731
Static Head		197
Pipe Diameter (in)		108
Friction Factor, C		120
Pressure Pipe Length (ft)		187605
Peaking Factor 1		1.4
PF 1 Duration (Mo)		4
Peaking Factor 2		0.8
PF 2 Duration (Mo)		8
Power Variables		
Electricity Cost (kW-hr)	$	0.05
Run Time (PF 1, hrs)		2920
Run Time (PF 2, hrs)		5840
Pumping Efficiency		75%
Finanical Variables		
Bond Interest Rate		4.50%
Bond Term (yrs)		25
Discount Rate		5%
Inflation Rate		3%
Construction Cost		
$/dia-in/ft	$	11.00
Construction Cost	$	222,874,740.00
Inflated Const. Cost (2021 Dollars)	$	282,331,052.53

	Average		
	Year	Sequence	Surface Water Delivered (MGD)
70 MGD WTP	2021	8	40
	2022	9	40
	2023	10	40
	2024	11	40
	2025	12	40
Expand to 140 MGD WTP	2026	13	40
	2027	14	50
	2028	15	60
	2029	16	70
Expand to 210 MGD WTP	2030	17	80
	2031	18	88
	2032	19	96
	2033	20	104
	2034	21	110
Expand to 280 MGD WTP	2035	22	110
	2036	23	110
	2037	24	110
	2038	25	110
	2039	26	110
	2040	27	110
	2041	28	110
	2042	29	110
	2043	30	110
	2044	31	110
	2045	32	110
	2046	33	110
	2047	34	110
	2048	35	110
	2049	36	110
	2050	37	110
	2051	38	110
	2052	39	110
	2053	40	110
	2054	41	110
	2055	42	110
	2056	43	110
	2057	44	110
	2058	45	110
	2059	46	110
	2060	47	110
	2061	48	110
	2062	49	110
	2063	50	110
	2064	51	110
	2065	52	110
	2066	53	110
	2067	54	110
	2068	55	110
	2069	56	110
	2070	57	110

Peak					
Surface Water Pumped (MGD)	Friction Head (ft)	Total Head (ft)	Power (kW)	Power Used (kW-hr)	Power Cost ($)
56	11	208	2726	7959797	$ 397,989.86
56	11	208	2726	7959797	$ 397,989.86
56	11	208	2726	7959797	$ 397,989.86
56	11	208	2726	7959797	$ 397,989.86
56	11	208	2726	7959797	$ 397,989.86
56	11	208	2726	7959797	$ 397,989.86
70	17	214	3499	10218446	$ 510,922.29
84	23	220	4330	12644575	$ 632,228.75
98	31	228	5228	15266284	$ 763,314.21
112	40	237	6202	18110972	$ 905,548.62
123.2	47	244	7043	20565304	$ 1,028,265.19
134.4	56	253	7943	23193006	$ 1,159,650.32
145.6	64	261	8907	26007391	$ 1,300,369.57
154	71	268	9674	28248604	$ 1,412,430.21
154	71	268	9674	28248604	$ 1,412,430.21
154	71	268	9674	28248604	$ 1,412,430.21
154	71	268	9674	28248604	$ 1,412,430.21
154	71	268	9674	28248604	$ 1,412,430.21
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154	71	268	9674	28248604	$ 1,412,430.21
154	71	268	9674	28248604	$ 1,412,430.21
154	71	268	9674	28248604	$ 1,412,430.21
154	71	268	9674	28248604	$ 1,412,430.21

Off-Peak					
Surface Water Pumped (MGD)	Friction Head (ft)	Total Head (ft)	Power (kW)	Power Used (kW-hr)	Power Cost ($)
32	4	201	1505	4393461	$ 219,673.03
32	4	201	1505	4393461	$ 219,673.03
32	4	201	1505	4393461	$ 219,673.03
32	4	201	1505	4393461	$ 219,673.03
32	4	201	1505	4393461	$ 219,673.03
32	4	201	1505	4393461	$ 219,673.03
40	6	203	1899	5546352	$ 277,317.61
48	8	205	2306	6733230	$ 336,661.52
56	11	208	2726	7959797	$ 397,989.86
64	14	211	3162	9231613	$ 461,580.63
70	17	214	3522	10285304	$ 514,265.20
77	20	217	3895	11374177	$ 568,708.86
83	23	220	4281	12500934	$ 625,046.68
88	25	222	4580	13372467	$ 668,623.37
88	25	222	4580	13372467	$ 668,623.37
88	25	222	4580	13372467	$ 668,623.37
88	25	222	4580	13372467	$ 668,623.37
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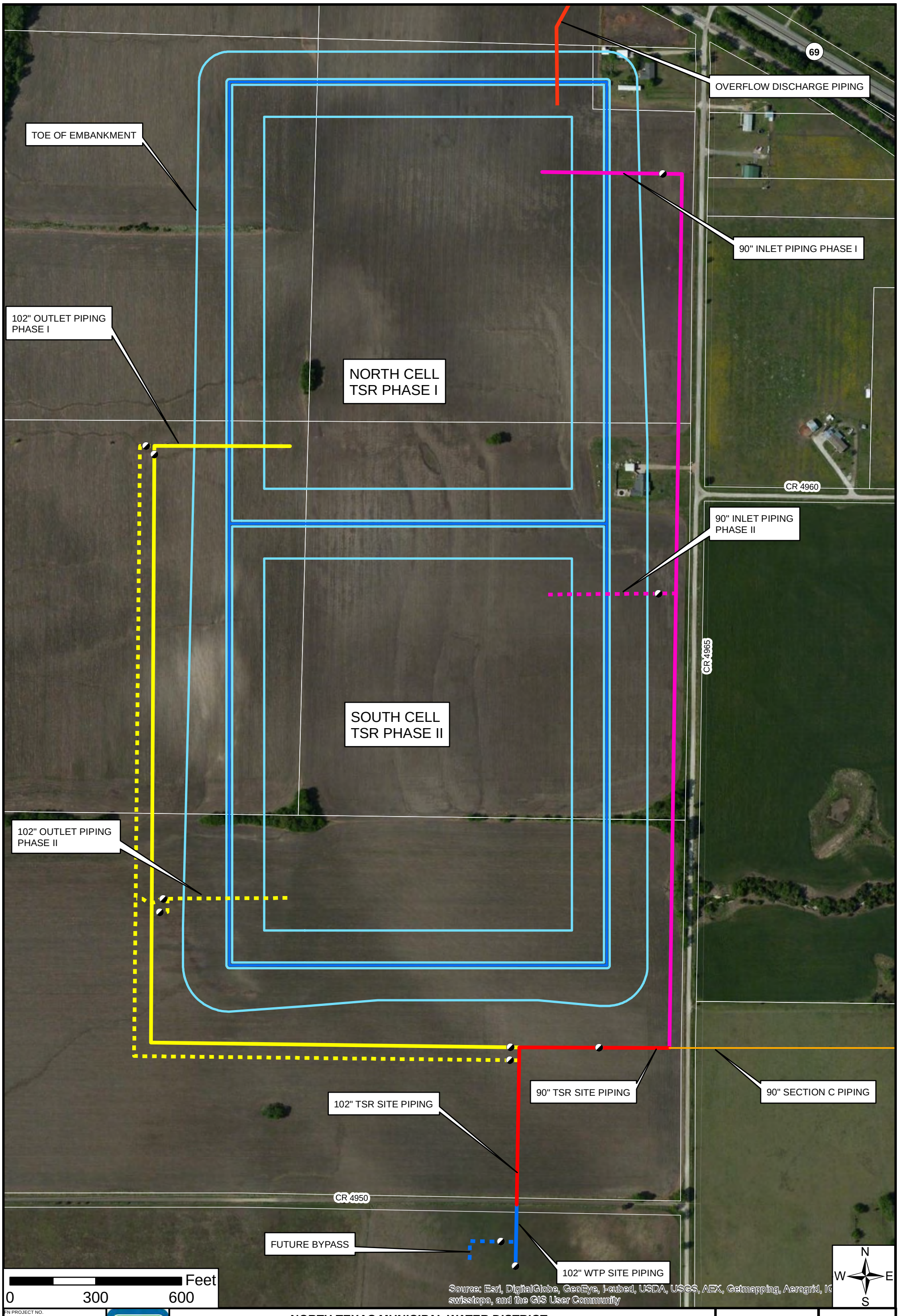
88	25	222	4580	13372467	$ 668,623.37
88	25	222	4580	13372467	$ 668,623.37
88	25	222	4580	13372467	$ 668,623.37
88	25	222	4580	13372467	$ 668,623.37
88	25	222	4580	13372467	$ 668,623.37

Total Cost				
Total Power Cost ($)	Inflated Power Cost ($)	Debt Service ($)	Total Cost ($)	Present Worth ($)
$ 617,662.89	$ 782,436.87	$19,040,000.00	$ 19,822,436.87	$ 13,416,605.53
$ 617,662.89	$ 805,909.98	$19,040,000.00	$ 19,845,909.98	$ 13,432,493.05
$ 617,662.89	$ 830,087.28	$19,040,000.00	$ 19,870,087.28	$ 13,448,857.20
$ 617,662.89	$ 854,989.90	$19,040,000.00	$ 19,894,989.90	$ 13,465,712.27
$ 617,662.89	$ 880,639.59	$19,040,000.00	$ 19,920,639.59	$ 13,483,072.99
$ 617,662.89	$ 907,058.78	$19,040,000.00	$ 19,947,058.78	$ 13,500,954.54
$ 788,239.91	$ 1,192,283.58	$19,040,000.00	$ 20,232,283.58	$ 13,694,005.91
$ 968,890.27	$ 1,509,499.47	$19,040,000.00	$ 20,549,499.47	$ 13,908,710.11
$ 1,161,304.07	$ 1,863,552.12	$19,040,000.00	$ 20,903,552.12	$ 14,148,346.88
$ 1,367,129.25	$ 2,259,656.35	$19,040,000.00	$ 21,299,656.35	$ 14,416,445.82
$ 1,542,530.40	$ 2,626,054.74	$19,040,000.00	$ 21,666,054.74	$ 14,664,438.67
$ 1,728,359.19	$ 3,030,688.30	$19,040,000.00	$ 22,070,688.30	$ 14,938,310.59
$ 1,925,416.25	$ 3,477,515.92	$19,040,000.00	$ 22,517,515.92	$ 15,240,741.11
$ 2,081,053.57	$ 3,871,372.67	$19,040,000.00	$ 22,911,372.67	$ 15,507,318.86
$ 2,081,053.57	$ 3,987,513.85	$19,040,000.00	$ 23,027,513.85	$ 15,585,927.78
$ 2,081,053.57	$ 4,107,139.26	$19,040,000.00	$ 23,147,139.26	$ 15,666,894.97
$ 2,081,053.57	$ 4,230,353.44	$19,040,000.00	$ 23,270,353.44	$ 15,750,291.18
$ 2,081,053.57	$ 4,357,264.04	$19,040,000.00	$ 23,397,264.04	$ 15,836,189.27
$ 2,081,053.57	$ 4,487,981.96	$19,040,000.00	$ 23,527,981.96	$ 15,924,664.30
$ 2,081,053.57	$ 4,622,621.42	$19,040,000.00	$ 23,662,621.42	$ 16,015,793.59
$ 2,081,053.57	$ 4,761,300.07	$19,040,000.00	$ 23,801,300.07	$ 16,109,656.75
$ 2,081,053.57	$ 4,904,139.07	$19,040,000.00	$ 23,944,139.07	$ 16,206,335.81
$ 2,081,053.57	$ 5,051,263.24	$19,040,000.00	$ 24,091,263.24	$ 16,305,915.24
$ 2,081,053.57	$ 5,202,801.14	$19,040,000.00	$ 24,242,801.14	$ 16,408,482.06
$ 2,081,053.57	$ 5,358,885.17	$19,040,000.00	$ 24,398,885.17	$ 16,514,125.87
$ 2,081,053.57	$ 5,519,651.73	$0.00	$ 5,519,651.73	$ 3,735,917.55
$ 2,081,053.57	$ 5,685,241.28	$0.00	$ 5,685,241.28	$ 3,847,995.08
$ 2,081,053.57	$ 5,855,798.52	$0.00	$ 5,855,798.52	$ 3,963,434.93
$ 2,081,053.57	$ 6,031,472.47	$0.00	$ 6,031,472.47	$ 4,082,337.98
$ 2,081,053.57	$ 6,212,416.65	$0.00	$ 6,212,416.65	$ 4,204,808.12
$ 2,081,053.57	$ 6,398,789.15	$0.00	$ 6,398,789.15	$ 4,330,952.36
$ 2,081,053.57	$ 6,590,752.82	$0.00	$ 6,590,752.82	$ 4,460,880.93
$ 2,081,053.57	$ 6,788,475.40	$0.00	$ 6,788,475.40	$ 4,594,707.36
$ 2,081,053.57	$ 6,992,129.67	$0.00	$ 6,992,129.67	$ 4,732,548.58
$ 2,081,053.57	$ 7,201,893.56	$0.00	$ 7,201,893.56	$ 4,874,525.04
$ 2,081,053.57	$ 7,417,950.36	$0.00	$ 7,417,950.36	$ 5,020,760.79
$ 2,081,053.57	$ 7,640,488.87	$0.00	$ 7,640,488.87	$ 5,171,383.62
$ 2,081,053.57	$ 7,869,703.54	$0.00	$ 7,869,703.54	$ 5,326,525.12
$ 2,081,053.57	$ 8,105,794.65	$0.00	$ 8,105,794.65	$ 5,486,320.88
$ 2,081,053.57	$ 8,348,968.49	$0.00	$ 8,348,968.49	$ 5,650,910.50
$ 2,081,053.57	$ 8,599,437.54	$0.00	$ 8,599,437.54	$ 5,820,437.82
$ 2,081,053.57	$ 8,857,420.67	$0.00	$ 8,857,420.67	$ 5,995,050.95
$ 2,081,053.57	$ 9,123,143.29	$0.00	$ 9,123,143.29	$ 6,174,902.48
$ 2,081,053.57	$ 9,396,837.59	$0.00	$ 9,396,837.59	$ 6,360,149.56
$ 2,081,053.57	$ 9,678,742.71	$0.00	$ 9,678,742.71	$ 6,550,954.04
$ 2,081,053.57	$ 9,969,104.99	$0.00	$ 9,969,104.99	$ 6,747,482.66
$ 2,081,053.57	$ 10,268,178.14	$0.00	$ 10,268,178.14	$ 6,949,907.14
$ 2,081,053.57	$ 10,576,223.49	$0.00	$ 10,576,223.49	$ 7,158,404.36
$ 2,081,053.57	$ 10,893,510.19	$0.00	$ 10,893,510.19	$ 7,373,156.49
$ 2,081,053.57	$ 11,220,315.50	$0.00	$ 11,220,315.50	$ 7,594,351.18
		Total	**$ 753,205,449.46**	**$ 509,799,095.89**



FN PROJECT NO.
NTD13136

DATE CREATED
Date: 11/12/2013

DATUM & COORDINATE SYSTEM
NAD83 State Plane (feet) Texas North Central

FILE NAME
TSR Piping.mxd

PREPARED BY
EJE

NORTH TEXAS MUNICIPAL WATER DISTRICT

Lower Bois d'Arc Creek Reservoir Raw Water Pipeline

Terminal Storage Reservoir - Location 1

FREESE NICHOLS
10497 TOWN AND COUNTRY WAY
SUITE 600
HOUSTON, TEXAS 77024
P: 713-600-6800
F: 713-600-6801

TSR

Exhibit 1