Appendix J

Draft Appraisal-Level Design Engineering Report

This report includes the design of components that were not incorporated into the alternatives evaluated in the SEIS.

Northwest Area Water Supply Project
Supplemental Environmental Impact Statement

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Abbreviations and Acronyms

cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
CT	disinfectant concentration (C) x effective contact time (T)
DAF	dissolved air flotation
DIP	ductile iron pipe
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
GIS	geographic information systems
gpm	gallons per minute
gpm/ft^2	gallons per minute per square foot
GWUDI	groundwater under the direct influence of surface water
H_2S	hydrogen sulfide
hp	horsepower
HVAC	heating, ventilation, and air conditioning system
ISRB	International Souris River Board
log	log inactivation (inactivation measured on a logarithmic scale)
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
mg	milligrams
MG	million gallons
mgd	million gallons per day
mg/L	milligrams per liter
mg/L-min	milligrams per liter per minute
msl	mean sea level (feet)
NAVD 88	North American Vertical Datum of 1988
NTU	nephelometric turbidity units
NWR	National Wildlife Refuge
O&M	operation and maintenance
PVC	polyvinyl chloride
PFD	process flow diagram
Project	Northwest Area Water Supply Project
ppd	pounds per day
psi	pounds per square inch
PVC	polyvinyl chloride
Report	Appraisal-Level Design Engineering Report
Reclamation	U.S. Bureau of Reclamation
SCPP	Snake Creek Pumping Plant
SDWA	Safe Drinking Water Act
SEIS	Supplemental Environmental Impact Statement
SWC	North Dakota State Water Commission
SWTR	Surface Water Treatment Rule
USWUD	Upper Souris Water Users District
USGS	U.S. Geological Survey
UV	ultraviolet
WTP	Water Treatment Plant

Appendix J
Draft Appraisal-Level Design Engineering Report

Overview of Alternatives

This Appraisal-Level Design Engineering Report (Report) summarizes the design approach and assumptions used in developing each of the four action alternatives for the Northwest Area Water Supply Project (Project), the engineering features, and estimated costs. These alternatives are designed to provide a reliable source of high-quality, treated water to municipal, rural, and industrial users in northwestern North Dakota. Each alternative would meet a peak water need of 27 million gallons per day (mgd) for the overall Project, 26.3 mgd of which would be treated at the Minot Water Treatment Plant (WTP). The remaining 0.7 mgd would be distributed to communities with their own treatment facilities. The amount of water needed for the Project was estimated in the *Water Needs Assessment Technical Report for the Northwest Area Water Supply Project, North Dakota* (U.S. Bureau of Reclamation [Reclamation] 2012).

Each of the alternatives includes the same existing and proposed water transmission and distribution systems and use of the existing water treatment plants in Minot and Rugby. The primary difference between the alternatives is the source of the water for the Project. Each alternative relies principally on either inbasin or Missouri River water sources. Inbasin sources are contained within the Hudson Bay basin and include groundwater from multiple aquifers and the Souris River. Missouri River sources would be drawn from Lake Sakakawea. Each of the alternatives includes upgrades to the Minot WTP, both to increase capacity and to meet drinking water standards; and each includes the use of existing and proposed storage reservoirs and pump stations. The following provides a brief overview of the components specific to the four alternatives:

- **Alternative 1, Groundwater with Recharge.** This inbasin alternative would provide supplemental recharge to the Minot and Sundre aquifers with water from the Souris River. Water would be withdrawn from these aquifers using the existing Minot and Sundre aquifer wellfields. This alternative includes recharge facilities in the Minot and Sundre aquifers, six new peaking wells, and upgraded collector lines.
- **Alternative 2, Groundwater with Recharge and the Souris River.** This inbasin alternative would consist of the same withdrawal, recharge, and transmission infrastructure as Alternative 1. However, during the months when the Souris River experiences its highest flows, river water would not only be used for aquifer recharge, but would be conveyed directly to the Minot WTP to meet as much of the Project water needs as possible. During the remaining months when flow was reduced but still substantial, river water would be used only for aquifer recharge.

- **Alternative 3, Missouri River and Conjunctive Use.** This alternative would use Missouri River water, which would be conveyed to Minot where it would be added to and blended with existing supplies from the Souris River water along with groundwater from the City of Minot's existing wellfields. This alternative includes a new intake and pump station at Lake Sakakawea (three options), a Biota WTP (five options), and a storage reservoir along the main transmission line south of Minot.
- **Alternative 4, Missouri River and Groundwater.** This alternative would use Missouri River water, which would be conveyed to Minot and blended with groundwater from the City of Minot's existing wellfields. This alternative would not use the Souris River as a direct supply but includes all the other components described for Alternative 3.

Major Design Assumptions

The description of alternatives and their associated components included in this Report is based on the Appraisal-Level (30 percent) Design. Several major assumptions were made regarding the design (structure configuration and functional performance) and location (suitability of soils and access) of Project components and are discussed below. The assumptions are typical for this level of design because detailed, site-specific topographic, geotechnical, and water quality information does not become available until a more advanced level of design. The design has been, and will continue to be, refined as more information becomes available. Specific design assumptions are presented within this Report where different Project components and applicable design options are introduced.

The Missouri River and the Souris River intakes and pump stations are designed to meet peak water demands as developed for each alternative. The number of pumps in the pump stations was established based on space constraints, system flexibility, and reliability of the service. Pump sizes were based on peak demand flow rate and the corresponding calculated dynamic head. The design options chosen are not the only possibilities and were not reached through a site-specific optimization process. Other possible designs could be implemented instead of those presented herein, but the selection of an optimum design requires detailed topographic, geotechnical, and water quality information.

The design of water tanks was developed using two methods of construction: steel and post tensioned reinforced concrete. Specific geotechnical information regarding the sites was not available. Hence, engineering judgment regarding the suitability of each method was applied based on tank capacity and location.

Pipeline alignments were established by considering major design constraints (e.g., the need to cross railroad and roadway embankments or large wetlands), but have not been established at a refined level that is typical for more advanced level of design. Pipe sizes were developed based on a minimum flow velocity of 2 feet (ft) per second.

The proposed Biota WTP and Minot WTP designs used generally accepted process design criteria (i.e., 10 States Standards) for major process component sizing (e.g., clarifiers, flocculation, sedimentation, filtration, and disinfection facilities). In general, conservative assumptions were used to allow a measure of safety for potential future design conditions (i.e., filtration rate, ultraviolet [UV] transmittance, UV dose, etc.) and room for future expansion.

Given the current level of design, engineering judgment was used in developing the process component layouts at both facilities with attention given to how expansion may occur at the Minot WTP. Design criteria tables and additional assumptions for each facility and their various options are provided in Sections 3.2 and 4.3 of this Report.

Construction and operation and maintenance (O&M) costs were developed as part of this Report and are summarized in Chapter 5. Construction costs include all labor, equipment, materials, incidentals, and appurtenances required to comply with typical Reclamation construction specifications. The construction costs summarized below also include mobilization, unlisted costs, contract costs, contingencies, and non-contract costs. Additional details regarding construction costs are provided in the Cost Assumptions and Factors section included in Appendix F. O&M costs include power consumption, equipment maintenance and replacement, labor, chemicals, power, and miscellaneous costs, detailed in the Basis of O&M Costs section included in Appendix F.

A detailed discussion of the methods used to identify potential Project components, assemble them into alternatives, and eliminate those that were not considered technically feasible is included in the Alternatives Identification Review and Selection Process report (Reclamation 2012).

Terminology and Report Organization

Key terms used throughout this Report are defined in Table 1-1.

Certain Project construction activities have been ongoing, as permitted by court orders and amendment to the existing injunction. Several components associated with the bulk distribution system and main transmission pipeline already have been constructed. This Report describes those features and also describes all the necessary components for each of the four action alternatives proposed. Because several of the components are common only to two alternatives and others are common to all of the alternatives, the subsequent sections of this Report include the following:

- Section 2 describes Project components developed for each of the inbasin alternatives (Alternatives 1 and 2).
- Section 3 describes Project components developed for each of the Missouri River alternatives (Alternatives 3 and 4).
- Section 4 describes components that are common to all alternatives.
- Section 5 describes the four alternatives, focusing on components that differ between them, and discusses the costs of each.

Appendices to this Report are as follows:

- Appendix A Inbasin Alternatives Supporting Analysis
- Appendix B Maps and Diagrams
- Appendix C Intake, Transmission and Bulk Distribution, Pump Stations and Reservoir Drawings
- Appendix D Pipeline Alignment Drawings

- Appendix E Treatment Drawings
- Appendix F Cost Opinions for Project Components

Table 1-1 Definitions of Key Terms

Term	Definition
Alternative	A combination of components that together are designed to meet the Project's purpose and need.
Bulk distribution pipeline	A series of pipelines that distribute water from the Minot WTP to service locations throughout the Project Area.
Component	A facility designed for the Project (i.e., pipeline, intake, pump station, reservoir, and treatment facility) that forms an alternative when combined with other components.
Conjunctive use	Combining the use of surface and groundwater sources to minimize physical, environmental, and economical disadvantages and to optimize supply and demand.
Intake	A facility that collects surface water from a surface water source (e.g., river or lake).
Option	An alternate way of implementing a component (e.g., biota treatment process) or an alternate geographic location for a component (e.g., intake).
Transmission pipeline	The pipeline that transports water between the Missouri River intake/pump station and Minot WTP.
Biota WTP	A water treatment facility designed to reduce the risk of transferring invasive species from the Missouri River basin to the Hudson Bay basin.

Water Sources

Evaluating potential water sources to meet the Project's future water demands was part of the alternatives development process. The water source evaluations were conducted in collaboration with the Cooperating Agencies assisting in development of the Supplemental Environmental Impact Statement (SEIS) and were undertaken to determine the amount and quality of water available from the surface water and groundwater sources. Results of the evaluations indicated that the Souris River, the Minot and Sundre aquifers, and the Missouri River could supply water to meet the future water needs. Each section below briefly describes these water sources and the analysis completed to determine the amount of water available for Project use. This information was used to develop the alternatives described in this Report.

Souris River

The Souris River (Figure 1-1) is a source of water for Alternative 1 (Groundwater with Recharge), Alternative 2 (Groundwater with Recharge and the Souris River), and Alternative 3 (Missouri River and Conjunctive Use). The Souris River originates in Canada and heads south into North Dakota near Sherwood, passing through the Upper Souris River National Wildlife Refuge (NWR) and City of Minot. It then makes a loop through North Dakota, flowing in a generally easterly direction until turning northward. It passes through the J. Clark Salyer NWR before crossing back into Canada near Westhope. Water management operations between Canada and the United States are coordinated pursuant to the Boundary Waters Treaty of 1909 and its amendments, particularly the Canada-United States Agreement for Water Supply and Flood Control in the Souris River Basin (1989). This 1989 Agreement governs the apportionment of waters of the Souris River at its two international boundary crossings,

Sherwood and Westhope, and also specifies a minimum flow rate where the Souris River returns to Canada from the United States. An analysis was conducted to determine whether operating the river in accordance with the terms of the 1909 Treaty could reduce the availability of Souris River water as a potential Project water supply. This analysis was based on information from the International Souris River Board (ISRB) of the International Joint Commission (ISRB 2012a); Saskatchewan Watershed Authority (Hallborg, pers. comm., 2012); the North Dakota Office of the State Engineer (White, pers. comm., 2012); Saskatchewan Power (SaskPower 2012), and supplemented by data from the U.S. Army Corps of Engineers (Corps) (2013). An additional analysis was conducted to determine whether water rights on the Souris River in North Dakota could reduce the availability of river water as a Project water supply.

Souris River Water Management under the 1989 Agreement

Water Management in Canada and Inflow to North Dakota

The 1989 Agreement specifies the following in regard to diversions in Canada:

- The annual flow of the Souris River from Saskatchewan into North Dakota shall be at least 50 percent of flow that would have occurred naturally. In wet years, annual flow of the Souris River may be only 40 percent to account for evaporation from the reservoirs in Saskatchewan and to account for the flood control benefits to North Dakota.
- There shall be a minimum flow of the Souris River of 4 cubic feet per second (cfs) flowing from Saskatchewan to North Dakota. The minimum flow may fall below 4 cfs if it would have occurred naturally without the Boundary, Rafferty, and Alameda reservoirs.
- The timing of the flows of the Souris River from Saskatchewan to North Dakota should be close to natural conditions or for the most beneficial use of North Dakota, which could include holding back flows to reduce flooding, or until they would be more useful.

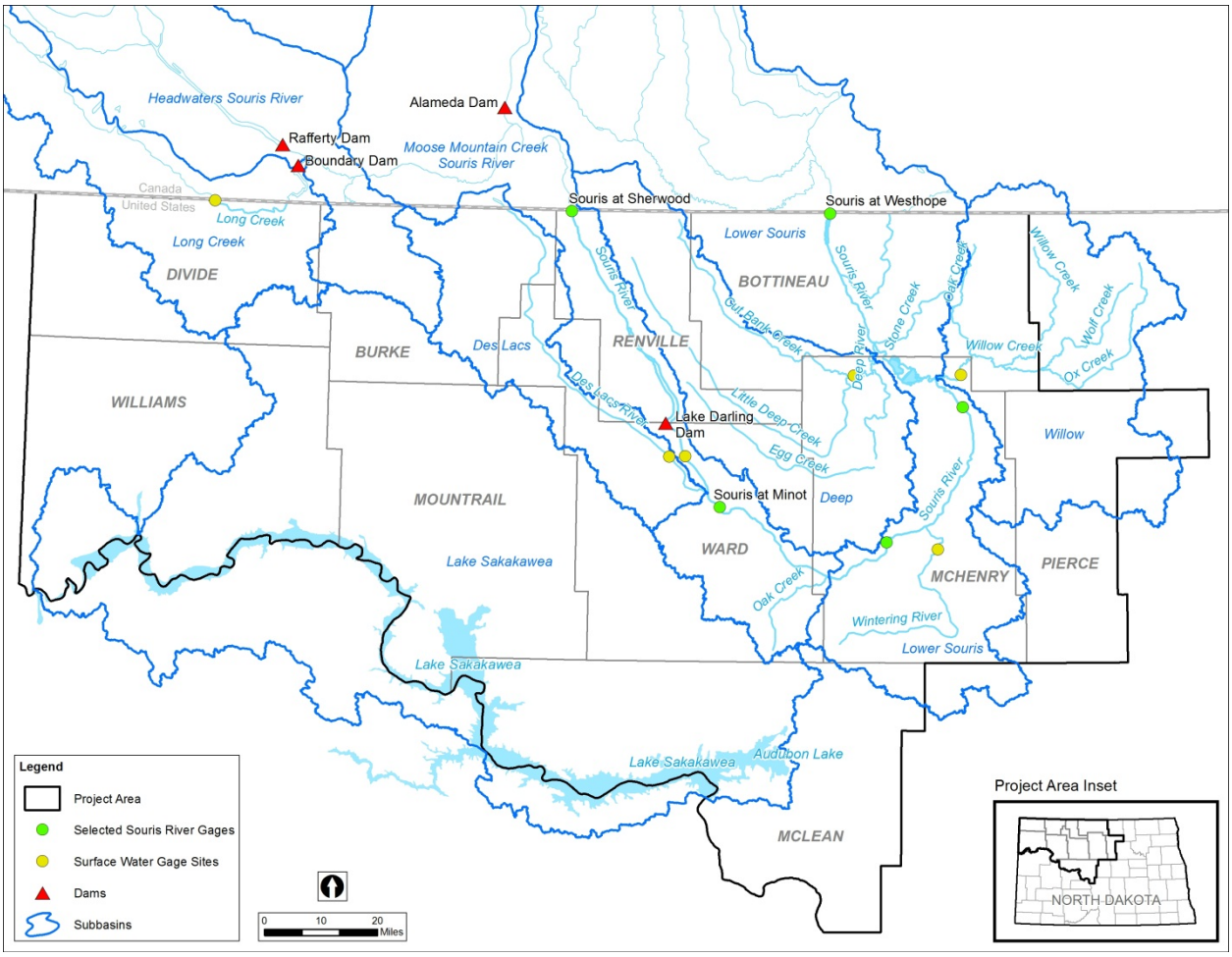

Figure 1-1 Souris River and its Tributaries, Major Reservoirs and Principal Gage Locations

These flow requirements are based on the natural flows that would have occurred prior to the existence of dams, reservoirs, and diversions. To determine the natural flow, the ISRB monitors flows and reservoir levels and calculates whether they exceed or fall below values set by the International Joint Commission. The ISRB then advises the operators of the control dams in Canada to adjust storage amounts and release rates. At the end of each year, the ISRB determines whether the required allocations were achieved. Table 1-2 shows the annual natural flow, United States apportionment, and surplus or deficit volumes between 1981 and 2010; that is, the amount by which flows received in the United States either exceeded or fell below the required allocation. The data were developed by the ISRB and presented in their annual reports (ISRB 2012b). The table indicates that between 1981 and 2010, Canada released more water than was required in all but 4 years, which resulted in surplus flows to the United States for the 30-year period. The median annual surplus was approximately 4,449 acre-feet, as measured at the Sherwood gage. The average annual surplus at this location was 25,122 acre-feet.

Discharge at the Minot Gage

The feasibility of using Souris River water as a supply for Project alternatives was evaluated based on water discharge data from the Minot gage, which includes water that is subject to the

1989 Agreement with Canada and water that originates in North Dakota and is not subject to the Agreement. Under the terms of the 1989 Agreement, Canada is not required to provide surplus flows to the United States (White, pers. comm., 2012). As shown in Table 1-2, the Souris River watershed in Canada has produced more water that can be reasonably and beneficially used or stored in Canada (surplus water) in all but 4 of the past 30 years. The Saskatchewan Watershed Authority (Hallborg, pers. comm., 2012) also has indicated that there are no future plans for additional consumptive use of Souris River water; therefore, there are no plans for providing additional storage for this water. Because there is not a reasonably foreseeable future increase in the demand for Souris River water in Canada and because no new water storage is planned, a reasonable design assumption is that Canada would continue to release surplus flows to the United States during the Project planning horizon (out to the year 2060), as it has over the past 30 years. Therefore, it is concluded that flows at the Minot gage in the future would include surplus flows and that historic conditions at the gage are representative of the future flows.

Minimum Flow Requirement at Westhope

The 1989 Agreement requires a 20-cfs minimum flow during the 5-month period from June through October at Westhope where the Souris River enters Canada. As part of estimating the availability of Souris River water at Minot for use as a Project water supply, it was necessary to evaluate whether water must be reserved at Minot to ensure that the minimum flow requirement at Westhope is met. Under the 1989 Agreement, the U.S. Fish and Wildlife Service, which manages Lake Darling as part of the Upper Souris NWR (except during flood operations) and water impounded at the J. Clark Salyer NWR, is not required to release water from these refuges to assist in meeting the minimum flow. However, during low-flow periods, releases from a number of impoundments in the J. Clark Salyer NWR, immediately upstream of Westhope, have occurred to help meet the requirement in the past. In the event that water releases from this refuge are insufficient to meet the minimum flow requirement, water also could be released from Lake Darling, which is upstream, in order to meet the requirement (White, pers. comm., 2012). Furthermore, under certain low-flow conditions occurring in most years, tributaries downstream of Minot provide an important contribution to the amount of water needed to meet the minimum flow requirement (Corps 2013). Because the tributary inflow downstream from Minot is a significant contributor of water to the mainstem, especially during non-flood periods, and water stored by the U.S. Fish and Wildlife Service in the J. Clark Salyer NWR and Lake Darling has been sufficient to meet the minimum flow requirement, additional water was not reserved from the Minot flow record to ensure that the Project water use would not affect compliance with the 1989 Agreement flow requirement at Westhope.

Table 1-2 Surplus/Deficit Flows in the Souris River at Sherwood based on the 1989 Agreement

Date	Recorded flow at Sherwood (acre-feet)	Natural Flow at Sherwood (acre-feet)	Flow Received by US (acre-feet)	Surplus/Deficit (acre-feet)
1981	12,060	18,070	12,585	3,550
1982	172,500	175,840	173,085	85,165
1983	144,700	129,400	145,282	80,582
1984	9,269	14,822	10,244	2,833
1985	37,884	55,488	38,471	10,727
1986	35,995	54,314	36,699	9,542
1987	38,100	61,000	38,430	7,930
1988	363	363	363	182
1989	18,054	37,281	18,854	214
1990	5,869	22,779	6,369	-5,021
1991	19,116	42,530	19,601	-1,664
1992	19,149	32,640	19,933	3,612
1993	25,480	52,081	26,685	645
1994	53,231	131,674	53,725	1,054
1995	65,091	103,834	66,372	24,840
1996	141,954	220,843	143,234	54,901
1997	169,355	277,195	170,547	59,668
1998	13,336	39,927	14,730	-1,240
1999	268,763	286,331	269,987	155,452
2000	15,095	33,466	16,368	2,983
2001	253,425	248,731	254,714	155,225
2002	12,558	25,829	13,855	940
2003	32,007	76,592	33,450	2,813
2004	28,529	59,198	30,110	6,429
2005	78,631	120,731	80,447	32,153
2006	10,215	22,773	11,666	276
2007	18,646	42,778	19,952	-1,437
2008	13,725	19,215	14,893	5,286
2009	76,137	152,926	77,604	16,436
2010	80,684	107,018	82,406	39,600
Median	30,268	54,901	31,780	4,449
Average	62,331	88,856	63,355	25,122

Source: ISRB Annual Operating Reports (ISRB 2012b)

Water Rights in North Dakota

Information from the North Dakota Office of the State Engineer was reviewed, and office staff was interviewed to determine how existing water rights might affect Souris River water availability as a Project water supply (White, pers. comm., 2012). A number of water rights exist on the Souris River in North Dakota for water supply, irrigation, and maintenance of fish and wildlife habitat (Table 1-3). According to the Office of the State Engineer (White, pers. comm.,

2012), these water rights have been in existence for a long period of time and are therefore incorporated into the Minot flow record back many decades. Therefore, the flow record was not adjusted to account for these downstream water rights when estimating future availability of Souris River water for water supply at Minot. It is important to note, however, that during advanced engineering design phases, this may need further consideration should one of the alternatives requiring the use of water from the Souris River be selected.

Table 1-3 Summary of Water Right Quantities on the Souris River in North Dakota

Use	Perfected	Conditionally Approved	Withheld, Deferred	Total
Water Permits above Minot[a] (acre-ft per year)				
Municipal & Industrial	6700	2423.8		9123.8
Irrigation and Stock	2451.1	354	39	2844.1
Fish and Wildlife	103		10719	10822
Total	9254.1	2777.8	10758	22789.9
Water Permits below Minot[a] (acre-feet per year)				
Municipal & Industrial	678.9	115.9		794.8
Irrigation and Stock	299.3	10160.1	12826	23285.4
Fish and Wildlife		1726	30858	32584
Recreation		29.3		
Total	978.2	12031.3	43684	56693.5

Note:

[a] Surface water permits within 1 mile of the Souris River (there were 5-10 additional permits within 3 miles, but it could not be ascertained whether they withdrew directly from the Souris River).

Source: SWC 2013

Data Used to Determine the Availability of Souris River Water

Stream flow data from the U.S. Geological Survey (USGS) for the Souris River above Minot gage (#05117500) were downloaded from the USGS North Dakota Water Data web portal. Daily flow data from the most recent 30 years (1981-2011) were used to develop the mean monthly flow and flow exceedance statistics. Based on a thorough investigation of potential constraints on Souris River water availability (as discussed in the preceding subsections), it was determined that no adjustment to the Souris River flow record was needed and that it was appropriate to base the estimate of future flows on historical data. The resulting exceedance statistics were used to determine the quantity of water that might be available under high, median, and low river flow conditions throughout the year for use in Alternatives 1 and 2. (Refer to Appendix A for additional information.)

Groundwater

Alternative 1 (Groundwater with Recharge), Alternative 2 (Groundwater with Recharge and the Souris River), Alternative 3 (Missouri River and Conjunctive Use), and Alternative 4 (Missouri River and Groundwater) all include the use of groundwater supplies from the Minot and Sundre aquifers. An analysis of the constraints on the aquifers was performed as part of assessing the availability of groundwater from these sources. Constraints for the aquifers include both water

rights and physical (hydrogeologic) constraints. The following sections discuss these constraints and the sources of data used to evaluate them.

Minot Aquifer

An analysis of water rights in the Minot aquifer was conducted by reviewing the North Dakota State Water Commission (SWC) water permit database. There are approximately 10.1 mgd of existing allocations from the Minot aquifer, with three permitted groundwater users. The City of Minot's allocation is 10 mgd. There are no defined regulatory constraints on the aquifer related to water rights. SWC and the North Dakota Office of the State Engineer assess applications for additional water use and their potential to impact existing water rights from the Minot aquifer on a case-by-case basis. The City of Minot's existing wells and groundwater allocation would be used for Alternatives 1, 2, 3, and 4.

Physical constraints in the aquifer include a limited areal extent, thickness, and annual recharge. The actual extent of the aquifer is not fully known, and additional field testing and characterization would be needed to determine this. The North Dakota Office of the State Engineer originally determined that the sustainable yield of the Minot aquifer was 3.0 mgd, but lowered this estimate to 2.0 mgd in 1993 (Pusc 1994). The continuing downward trend in aquifer levels during the period when withdrawals averaged 2.0 mgd indicates that the aquifer cannot sustain this level of withdrawal or support additional withdrawals without some type of supplemental recharge.

Daily groundwater level data were obtained (for several Minot aquifer wells) from the SWC water data website and analyzed graphically to characterize water levels in the aquifer. Because the aquifer is currently in decline, it was assumed that no additional, sustained withdrawals (above the current pumpage rate) would be possible without supplemental recharge for any of the alternatives. (Refer to Appendix A for additional information.) Therefore, the most important and restrictive constraint considered for the Minot aquifer was the long-term sustainability of groundwater levels.

Sundre Aquifer

An analysis of water rights in the Sundre aquifer was conducted by reviewing the SWC water permit database. There are approximately 6.91 mgd of existing allocations from the Sundre aquifer, with three permitted groundwater users. The City of Minot's allocation is 6.0 mgd. There are no defined regulatory constraints on the aquifer related to water rights. SWC and the North Dakota Office of the State Engineer assess applications for additional water use and their potential to impact existing water rights from the Sundre aquifer on a case-by-case basis. The City of Minot's existing wells and groundwater allocation would be used for Alternatives 1, 2, 3, and 4.

Physical constraints in the aquifer include a limited areal extent, thickness, and annual recharge. The actual extent of the aquifer is not fully known, and additional field testing and characterization would be needed to determine this. The North Dakota Office of the State Engineer determined that the sustainable yield of the Sundre aquifer was 6.0 mgd (Pusc 1987). However, the continuing downward trend of the water level during the period when withdrawals

averaged 3.1 mgd indicates that the aquifer cannot sustain this level of withdrawal or support additional withdrawals without some type of supplemental recharge.

Daily groundwater level data were obtained (for several Sundre aquifer wells) from the SWC water data website and analyzed graphically to characterize water levels in the aquifer. Because the aquifer is currently in decline, it was assumed that no additional, sustained withdrawals (above the current pumpage rate) would be possible without supplemental recharge. (See Appendix A for additional information.) Therefore, the most important and restrictive constraint considered for the Sundre aquifer was the long-term sustainability of groundwater levels.

Missouri River

The Missouri River is a source of water for Alternative 3 (Missouri River and Conjunctive Use) and Alternative 4 (Missouri River and Groundwater). The Missouri River/Lake Sakakawea system has an extremely large water storage capacity and is operated, controlled, and monitored by the Corps. However, an analysis was conducted to ensure that potential constraints on water availability, including dam and reservoir operations, water rights in North Dakota, and navigational requirements, would not negatively affect the ability to implement the alternatives.

Dam and Reservoir Operations

Lake Sakakawea is the reservoir created by Garrison Dam on the Missouri River. It is the largest reservoir on the Missouri River and is the third largest man-made lake in the United States. The reservoir is 178 miles long and up to 6 miles wide. The reservoir covers 368,000 acres and contains almost one-third of the total storage capacity of the Missouri River mainstem system, nearly 24,000,000 acre-feet (Corps 2004b). The storage volume has been controlled at between approximately 10,000,000 acre-feet to 24,000,000 acre-feet over the period of record (1969-present). Lake Sakakawea's storage zones are shown in Figure 1-2. The water surface elevation in Lake Sakakawea is sometimes altered to meet downstream water needs, assimilate large quantities of snow melt or surface-water runoff, and for flood control purposes (Ryberg 2006).

Water rights upstream of the proposed intake on Lake Sakakawea were evaluated. The Corps (2004a) identified approximately 1,600 water intakes on the Missouri River along lake and river reaches from Fort Peck Reservoir to St. Louis, including 302 intakes used by Native American tribes. Intakes on the Missouri River are primarily for municipal, industrial, and individual water supplies; fossil and nuclear-fueled power plant cooling; and irrigation withdrawals. On Lake Sakakawea, there are 142 existing easements for water intakes (Corps 2012) and at least 127 authorized or requested allocations from either Lake Sakakawea or the Missouri River. These allocations account for approximately 231 mgd for a variety of water users (SWC 2012). Water necessary to satisfy water rights and meet the needs of navigation and power generation (upstream and downstream) are accounted for in the "Carry-Over Multiple Use Zone," which consists of approximately 13.1 million acre-feet of water stored in the reservoir. The Corps operates Lake Sakakawea and the Missouri River system pursuant to their operating manual to try and meet water demands for all permitted users. Generally, this approach allows water needs to be met; however, there are instances where demands for all permitted users cannot be met.

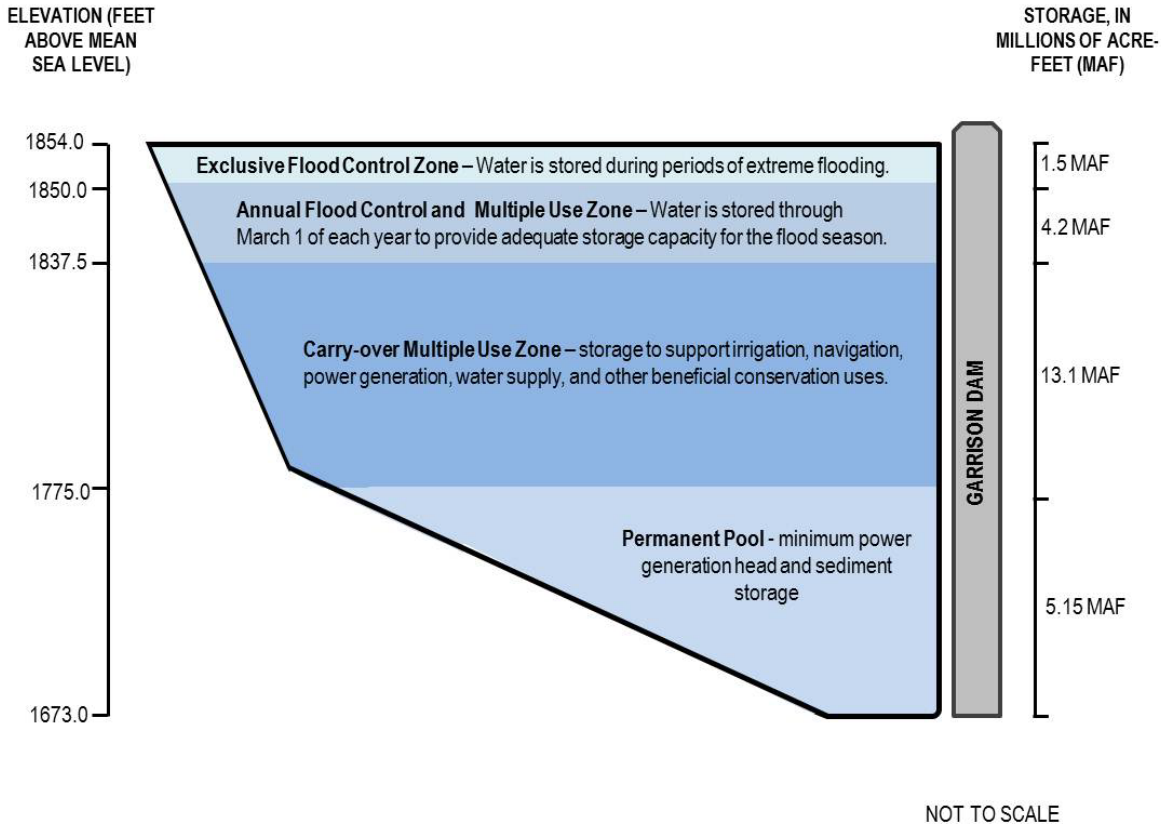

Figure 1-2 Lake Sakakawea Storage Zones

The proposed withdrawals for Alternatives 3 and 4 were assessed with respect to their relationship to Missouri River discharge at Garrison Dam. Monthly mean discharge records for the period between 1969 and 2009 were examined to determine release trends and average flows (Figures 1-3 and 1-4).

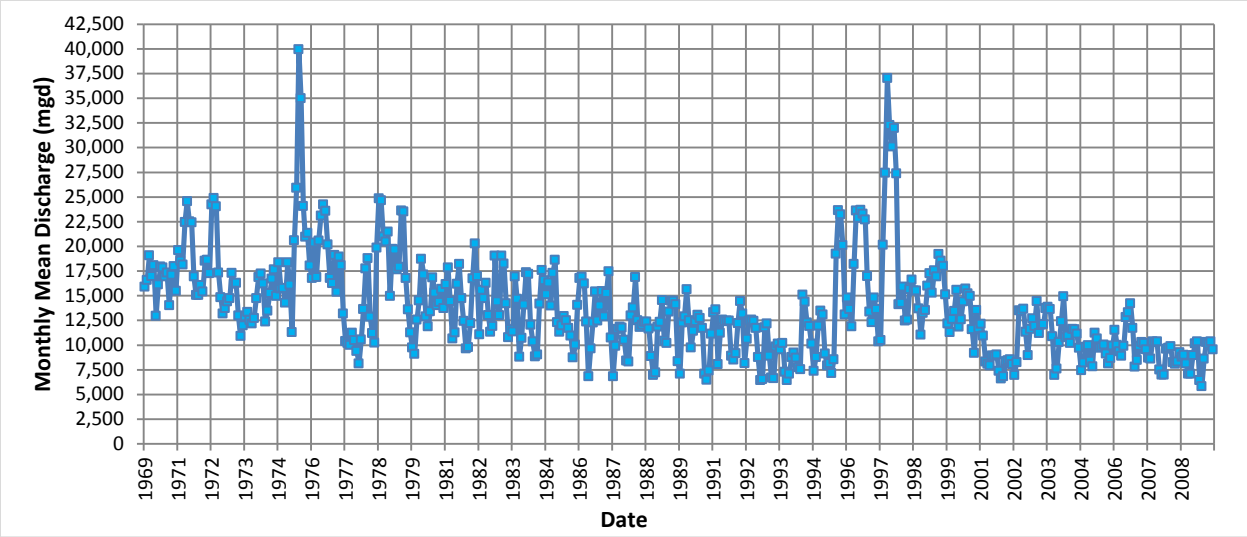

Figure 1-3 Historical Monthly Mean Discharge (mgd) at Garrison Dam

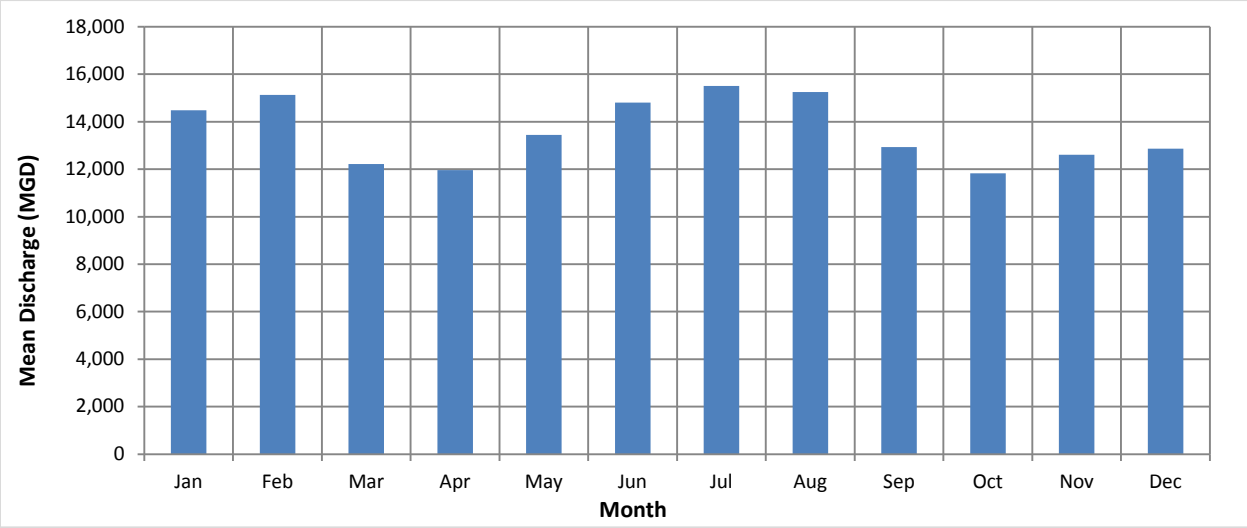

Figure 1-4 Monthly Mean Discharge (mgd) at Garrison Dam (1969-2009)

Flow rates on the Missouri River below Garrison Dam vary considerably from year to year and within a single year. Based on flow conditions over the past 40 years as measured below Garrison Dam, the proposed peak Project withdrawals (approximately 26 mgd) would have a very small effects on flows downstream of the discharge at the dam, at all times being less than 1 percent of the flow of the Missouri River at Garrison Dam (Table 1-4). Under typical flow conditions (represented by dam discharges during 1969-2009), peak Project withdrawals would reduce downstream flows by about 0.19 percent. During higher dam discharges, this amount would reduce downstream flows by 0.07 percent. Under historically low dam discharges, represented by flows during April 2009 (Table 14), peak Project withdrawals would account for 0.45 percent of the daily discharge.

Table 1-4 Garrison Dam Discharge Statistics

Garrison Dam Discharge (mgd)			Date of Occurrence	Proposed Peak Project Withdrawals as a Percent of Daily Discharge[a]
Monthly[b]	Historical Minimum[c]	5,824	Apr-09	0.45
	Historical Maximum[c]	39,940	Jul-75	0.07
	Historical Mean[c]	13,585	1969-2009	0.19
Yearly[d]	Historical Minimum[e]	8,552	2008	0.3
	Historical Maximum[e]	22,470	1975	0.16

Notes:
[a] Peak Project withdrawals are approximately 26 mgd.
[b] Daily flow calculated on a monthly (mean) basis.
[c] Month with lowest or highest historical average daily flow value.
[d] Daily flow calculated on a yearly (mean) basis.
[e] Year with lowest or highest historical average daily flow value.

Based on the data discussed above, it was concluded that Lake Sakakawea is capable of supplying the proposed peak Project demands under any flow conditions that have occurred since Garrison Dam was constructed. Furthermore, Lake Sakakawea near Garrison Dam is of sufficient quality that it can feasibly be treated to meet drinking water standards. The fact that multiple municipalities, including the cities of Pick City, Riverdale, and Garrison, are using water from Lake Sakakawea for potable supplies validates this conclusion.

Inbasin Alternative Components

This section describes Project components (Figure 2-1) that are specific to the inbasin alternatives (Alternative 1, Groundwater with Recharge and Alternative 2, Groundwater with Recharge and the Souris River). The inbasin alternatives rely on groundwater from the Minot and Sundre aquifers and water from the Souris River, which would be used to recharge these aquifers to increase their capacity (both alternatives) and as a direct supply (Alternative 2 only). This section also includes descriptions of (1) recharge facilities; (2) peaking well facilities; (3) upgraded collector lines; (4) flood protection; and (5) proposed operation of wellfields. These components and alternatives are evaluated in the Inbasin Alternatives Supporting Analysis (Appendix A). The appendix includes (1) a brief overview of Alternatives 1 and 2; (2) a siting analysis that used a geographic information systems (GIS)-based approach to identify potential aquifer recharge facility sites; (3) an analysis of the hydrogeology of the Minot and Sundre aquifers with respect to aquifer recharge feasibility; (4) an analysis of the availability of water in the Souris River; (5) the development of a water balance model; (6) groundwater flow modeling simulations designed to determine whether the aquifer recharge/wellfield systems are sustainable; and (7) a detailed description of the recharge and withdrawal facility locations, design specifications, seasonal operations, and cost estimates.

The adequacy of the water supply from the Souris River under each of these alternatives was assessed through an analysis of historical flows, as described in Section 5 of Appendix A. Both alternatives require development of new recharge and peaking well facilities, as well as upgraded collector lines. The primary components associated with these alternatives are shown in Figure 2-1, as are the locations of planned flood control levees. These levees are not part of the Project, but are planned by local authorities. The levees are in the preliminary planning stages, and no information regarding their cross sections and footprints is available; therefore, they are discussed only briefly in this Report and are not integrated into the design of Project components located in their vicinity.

It is important to note that the study that is further described in Appendix A represents an appraisal-level design. The desktop analyses, models, and findings presented herein are based on the best available existing data from SWC, USGS, and a number of peer-reviewed publications. If the decision was made to construct Alternatives 1 or 2, further field testing would likely be required that would include extensive exploratory well drilling, monitoring well construction, aquifer performance testing, and geologic data analysis. These data would be used to support more detailed design including the construction of a much more sophisticated groundwater model that would encompass a significantly larger portion of the Minot and Sundre aquifers. Advanced geochemical modeling would be employed to understand the chemical reactions that would occur if Souris River water was mixed with groundwater in the Minot and Sundre aquifers. Such reactions could cause mineral and bacterial fouling of the recharge wells, which could necessitate enhanced maintenance efforts that might include frequent acidification of the recharge wells and pretreatment of Souris River water. Pilot testing of a small-scale system might also be used to confirm the model results. Another issue is the maintenance of the recharge facilities during the winter months when they would be inactive. A maintenance strategy would need to be developed to ensure that the surface of the recharge wells would not be frozen in March when the facilities would begin operating. While it is likely that engineering solutions could be developed for all of these issues, the cost of implementing them could significantly

increase the overall cost of the Project. A full and accurate accounting of all such costs would be developed upon completion of the design process.

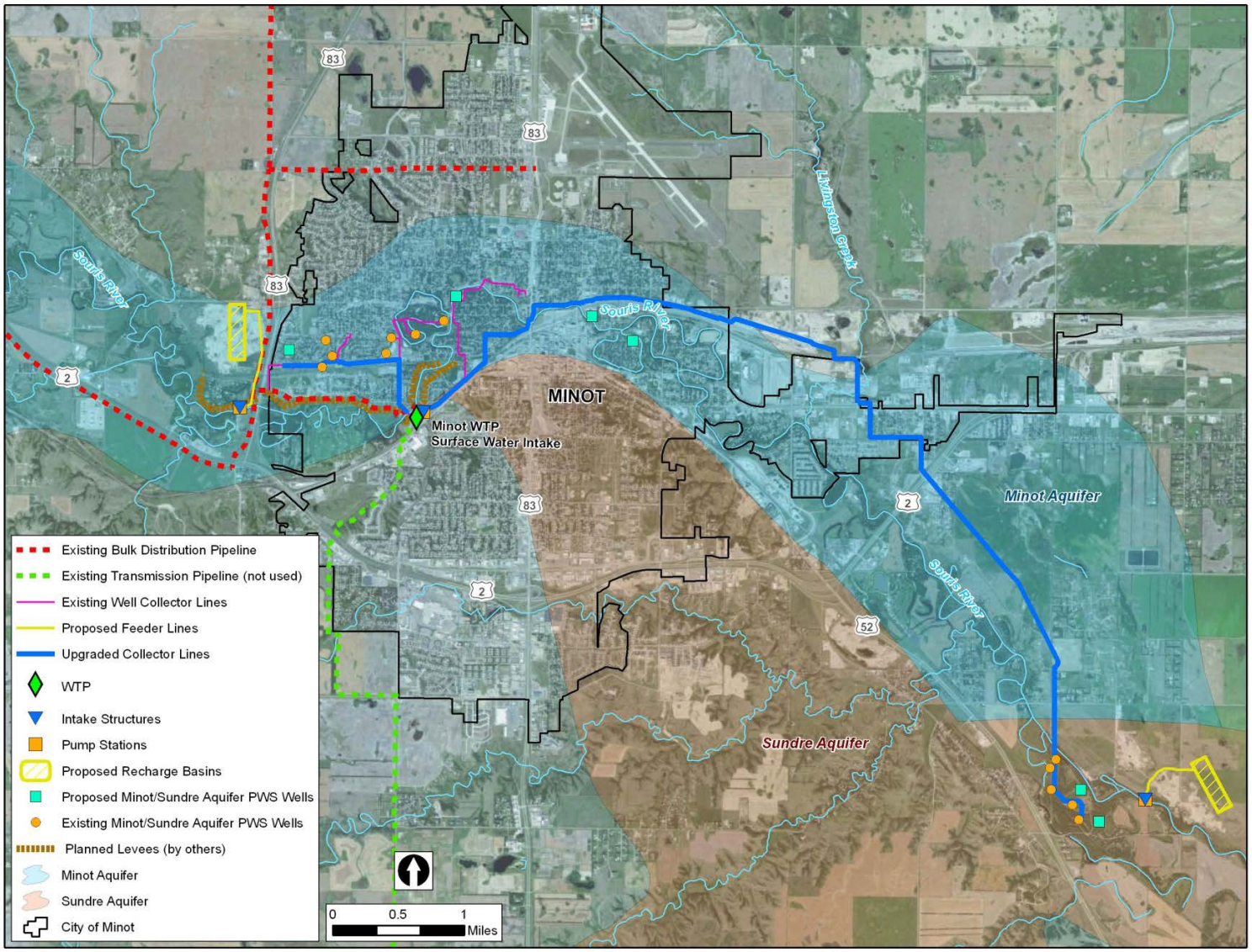

Figure 2-1 Inbasin Alternative Components in the Minot Area

Recharge Facilities

Previous studies by Pettyjohn (1967), Pusc, and others, as explained in Appendix A of this Report, conclude that the combined sustainable yield of the Minot and Sundre aquifers, without artificial recharge, is not sufficient to supply the projected 2060 average annual and peak Project needs. Data collected since the inception of both wellfields indicates that water levels in the vicinity of the City of Minot (in both aquifers) are in long-term decline. This is likely due to increased withdrawals and potentially declining recharge resulting from urbanization of the recharge area. Current withdrawals from the Minot and Sundre aquifers average approximately 2.0 mgd and 3.1 mgd, respectively. If groundwater withdrawals were increased, the declining trend in groundwater levels would accelerate in both aquifers. Thus, supplemental aquifer recharge is required to augment groundwater levels. (Refer to Appendix A for additional detail.) The recharge facilities consist of intake structures and feeder lines, sediment settling facilities, recharge basins, and recharge wells.

Intake Structures and Feeder Lines

The design includes two new surface water intakes located on the Souris River to provide water for aquifer recharge (Appendix C, sheets ALD09 through ALD12; Appendix D, sheets G1, G2, G5 and G6). Each intake would have a maximum capacity of 29 mgd. The intakes would be located on the left bank of the river, a short distance from the proposed recharge basins. Each intake would consist of a wet well that captured Souris River water and a pump station that conveyed it to the recharge basins through a feeder line. The pump stations would be identical in size and each would consist of four three-stage vertical turbine pumps. Each pump would be rated for 7.25 mgd: the Minot operating head would be 138 ft, while the Sundre operating head would be 110 ft. Feeder lines would be 36-inch-diameter pipes designed to convey the peak flow of 29 mgd. They would be installed by trenching, with a minimum cover of 7.5 ft. The length of the feeder lines at the two sites differs slightly: the Minot feeder line would be 2,500 ft, while the Sundre feeder line would be 2,700 ft. Due to their short lengths, friction losses in the pipe would be small. Hence, their service pressure is dictated mainly by the static head of the pump stations (which is the difference in elevation between the recharge basin and the intake). The pipe is designed to operate at medium service pressure, which is outside of the range of reinforced concrete or high-density polyethylene; therefore, ductile iron pipe (DIP) would be used.

Sediment Settling Facilities

Raw water pumped from the Souris River would be routed through two sediment settling facilities located near each recharge basin (Appendix C, Figure ALD 13) to minimize deposition of fine material in the basins. The facilities have been designed to settle sediment particles larger than 0.1 mm, and each would consist of three concrete bays 60 ft long, 9 ft wide, and 8 ft deep that would allow the water to move uniformly and at low speed (Appendix C, Figure ALD 15). Sediment particles larger than 0.1 mm would settle into the dead volume area located at the bottom of each bay. The settling facilities have been designed to operate only two bays at a time at peak flow. When the dead volume becomes filled with sediment in the first bay, flow would be routed to the third bay, after which the first bay would be flushed of sediment. The sediment would be flushed through 30-inch sludge removal pipes into a sludge basin, from where it would

be excavated and removed to a disposal site. Because the volume of sludge would be highly dependent on water quality at the time of use, the disposal quantity is unknown at this level of design; the sludge would be disposed of at an appropriate landfill with adequate capacity in accordance with regulatory requirements.

Recharge Basins

A recharge basin is a large geometric excavated depressional area, with engineered side slopes, engineered fill material in the bottom of the basin, and recharge wells that facilitate infiltration of water into an aquifer. Two new recharge basins are planned (Appendix C, sheets ALD13 and ALD14; Appendix D, sheets G1, G2, G5 and G6). Their purpose is to augment groundwater in the Minot and Sundre aquifers with Souris River water by infiltration through porous strata and recharge wells. A GIS-based land use constraints approach was developed to identify optimal facility locations based on criteria that included the following:

- **Wetlands -** Wherever possible, due to mitigation requirements and their associated costs, wetlands should be avoided when siting a recharge facility. Wetlands provide natural recharge to aquifers and should be preserved to maintain the maximum recharge possible into the Minot and Sundre aquifers.
- **Land Use** - Areas with vacant, recreational, or agricultural land uses would be preferable for the construction of an aquifer recharge facility. Parcels that are currently developed are likely to be smaller, costlier, and more problematic to acquire.
- **Confinement** - Areas with the thinnest confining sediments (or overburden) overlying the Minot and Sundre aquifers are often areas where the most rapid recharge occurs. The faster that water can infiltrate through recharge basins and assimilate into the underlying aquifer, the more water can be recharged during peak river flow conditions. Additionally, costs for recharge wells and basin excavation (less excavation would be needed) would be lower in areas with thinner confining sediments.
- **Floodplain** - The original Minot recharge facility was destroyed by a flood on the Souris River in the 1960s. Flood protection should be a consideration in the construction of a new facility. Minimally, the facility should be located outside of Federal Emergency Management Agency Special Flood Hazard Zones and away from proposed levees or flood control structures.
- **Contaminated Sites** - A recharge facility should be sited a safe distance away from any groundwater contamination sites. Artificially recharging the proposed quantities of water into the aquifer(s) would “mound” groundwater, altering flow gradients in the aquifer, and could cause contamination plumes to migrate.

A ranking system was developed (Appendix A, Section 3.2) and applied to each of the aquifers. Two suitable sites were selected. One site is an existing quarry immediately west of Minot and would augment natural recharge to the Minot aquifer. The other site is an existing agricultural area approximately 7 miles southeast of the City of Minot and would augment natural recharge to the Sundre aquifer.

Each recharge basin would be rectangular, 360 ft wide by 2,100 ft long; this is the size required to capture and recharge recurring peak flows. The entire footprint of each site, including access,

O&M roads, water quality treatment facilities, and administrative and storage spaces, would be approximately 30 to 35 acres. Each basin would extend approximately 20 ft below grade and would have 4:1 slopes. To accommodate the 4:1 slopes, the basin floor would be 200 ft wide by 1,940 ft long.[1] Although recharge primarily would occur through the recharge wells, indirect recharge also would occur through the basin floors. Most of the recharge through the basin floors would take place in the approximately 200-ft^2 area containing the sand and gravel filters, but a base fill of 12 inches of clean, medium-grained sand spread across the basin floor has been included in the facility design to enhance the potential for indirect recharge of the aquifers.

Both recharge basin sites would be located at higher elevations than the Souris River floodplain. River water would be pumped to a sediment settling facility through a feeder line. After deposition of fine sediment, water would then be conveyed to the recharge basins. As river water enters the recharge basins during operation, it would be discharged onto baffled, concrete (or riprap) aprons located along one side. The baffles would diffuse some of the energy from the high flow volume that entered the basins during peak recharge operations. This would prevent scouring of the filter sand and other materials on the basin floor. Over time, silt would deposit and form a layer in the basin bottom and the filter area during the periods of recharge, which would tend to reduce the rate of flow into the recharge wells. Thus, the tops of the filters would need to be cleaned annually by scraping off the top few inches of silt down to clean sand and then replacing the removed material with clean, washed medium-grain sand. Additional information regarding recharge basin design, location, and operation is included in Appendix A.

Recharge Wells

Recharge wells are specially designed wells that act as conduits through which surface waters pumped into the recharge basin can be naturally filtered and easily transmitted to the aquifer(s) below. A series of 48 recharge wells (two rows of 24 wells) would be installed through each basin floor into the aquifer, approximately 10 ft from the base of each of the 4:1 side slopes. The Minot aquifer recharge wells would be 100 ft deep and consist of 60 ft of steel casing, 30 inches in diameter. They would include 40 ft of steel shutter screen. Sundre aquifer recharge wells would be 260 ft deep and consist of 180 ft of steel casing, 30 inches in diameter. They would include 80 ft of steel shutter screen. Estimated recharge flow at each basin would be 420 gallons per minute (gpm). The recharge wells have been designed with a pre-filter basin to provide some filtration prior to allowing surface water to enter the top portion of the wells. Each well pre-filter basin would be composed of four layers of graded sand and gravel that terminate below the top of the casing of the recharge well (Appendix C, ALD 14). Medium-graded (0.01 to 0.02 inch diameter), washed sand would make up the first layer (the surface of the recharge basin). A filter fabric would separate the sand layer from the next layer, which would consist of 1/8-inch buckshot gravel. The third layer would consist of 1/2-inch gravel, and the fourth layer (at the top of the casing) would consist of 1-inch gravel. These four layers of sand and gravel would provide a progressive transition from fine sand to the very coarse gravel (minimum 2-inch diameter) within the well casing.

A system of collector drain pipes would radiate from the center of each well, within the gravel layer at the base of the basin. Eight drain spokes would extend radially approximately 10 ft from

[1] Some adjustments to these dimensions and side slopes could be needed based upon the geotechnical properties of the in-situ geologic materials.

each well. The drains would be 4-inch high-density polyethylene and wrapped with a geotextile filter fabric. Figures ALD 13 and ALD 14 in Appendix C show a design schematic of the wells and upper filter systems, along with a cross-sectional view of the recharge basins.

Peaking Well Facilities

Six peaking wells would be added to the system in the vicinity of the existing Minot and Sundre aquifer wellfields to increase their capacities in order to meet projected peak demands. Four of the wells would be constructed in the Minot aquifer, and two in the Sundre aquifer. Screen and pump specifications for these wells were based on existing wells in each location. Onsite aquifer testing would be necessary to determine whether the projected withdrawal rates would be achievable; additional wells may need to be added if testing shows that the projected rates cannot be achieved with the current design.

The four wells in the vicinity of the Minot aquifer wellfield would consist of 16-inch polyvinyl chloride (PVC) casing installed to a depth of 140 ft with a screened interval between 140 and 160 ft. Each well would have a capacity of 800 gpm (1.52 mgd). The two wells in the vicinity of the Sundre aquifer wellfield would consist of 16-inch PVC casing installed to a depth of 200 ft with a screened interval between 200 and 260 ft. Each well would have a capacity of 2,800 gpm (8.1 mgd).

Upgraded Water Collector Lines

The upgrade of existing untreated water collector lines from the Minot and Sundre aquifers would be accomplished by supplementing existing pipelines with additional lines to allow conveyance of the extra capacity provided by the peaking wells to the Minot WTP. The supplemental pipelines would parallel the existing pipelines and interconnect with them to allow for balancing of hydraulic losses. The upgrades generally would be implemented from Minot WTP to the existing wells and extend to the location of the proposed peaking wells. The upgrades in capacity required for both collector lines that are specific to each aquifer are discussed in Section 5, Description of Project Alternatives.

Flood Protection

A flood control concept plan has been developed for the Souris River between the City of Minot and the City of Velva (SWC 2012), which includes a levee system that would provide protection from the 100-year flood event. The levees would protect residential areas that are already constructed or are being planned and would be laid out along both banks of the Souris River within the Minot city limits. Based on the information provided in the concept plan, proposed peaking wells within the Minot aquifer (which are all located within the Minot city limits) would be protected by the planned flood control facilities. The proposed peaking wells in the Sundre aquifer would not be protected because no existing or planned residential or commercial development is yet envisioned for the area. Both aquifer recharge facilities (for the Minot and Sundre wellfields) would be located outside of the mapped floodplain and would be well above

floodplain elevations (by 60 to 80 ft). The surface water intakes associated with recharge facilities would be located immediately adjacent to the river channel. The surface water pump station at the Minot aquifer would be located behind a planned levee, while the intake would be set in front of the levee. The flood control plan is preliminary, and general design provisions regarding typical configuration of the levees were not made in the appraisal level design of the intake and the pump station. However, the final design of both structures (intake and pump stations) will have to accommodate the layout and the design cross section of the levee. The surface water intake and the pump station at the Sundre aquifer are not located in an area that would be protected by planned levees.

Proposed Operation of Wellfields

For Alternative 1, Project water delivery needs would be met using existing and new aquifer wells. The existing Minot and Sundre aquifer wells would meet the Project's projected 2060 average need of 10.1 mgd from January through May and from September through December. During the months of June through August, the existing Minot and Sundre aquifer wells; four proposed 800 gpm peaking wells for the Minot aquifer; and two proposed 2,800 gpm peaking wells for the Sundre aquifer would provide the Project's peak projected need of 26.3 mgd. Table 6-1 in Appendix A shows the groundwater withdrawal schedule for Alternative 1. For Alternative 2, the same existing and peaking wells would be needed but would be operated at a reduced rate because Souris River water would be used directly to meet some or all of the Project needs from March through August. Table 6-4 in Appendix A shows the groundwater withdrawal schedule for Alternative 2.

Recharge quantities would be the same for both alternatives and would vary from month to month based on seasonal variations in the availability of Souris River water. Table 2-1 shows the estimated volume of water to be withdrawn from the river each month for recharge into the Minot and Sundre aquifers in order to offset groundwater withdrawals. The maximum recharge rate of 58 mgd (including 28.9 mgd at each aquifer) would occur during April under monthly median flows; recharge volumes would diminish from May through August and also would be considerably lower during March. During other months, the intakes may not operate at all, depending on surface water availability.

Table 2-1 Monthly Groundwater Recharge for the Minot and Sundre Aquifers

Month	50 Percent Exceedance Flow in the Souris River		Recharge Rate at each Aquifer to Offset Groundwater Withdrawals (mgd)
	cfs	mgd	
January	4.4	2.8	0.0
February	4.0	2.6	0.0
March	25.0	16.2	3.9
April	184.0	118.9	28.9
May	92.0	59.5	14.5
June	64.0	41.4	10.1
July	41.0	26.5	6.4
August	24.0	15.5	3.8
September	19.0	12.3	0.0
October	14.0	9.0	0.0
November	13.0	8.4	0.0
December	8.0	5.2	0.0

Notes:
cfs cubic feet per second
mgd million gallons per day

Missouri River Alternative Components

This section describes Project components that are specific to the Missouri River alternatives: Alternative 3, Missouri River and Conjunctive Use and Alternative 4, Missouri River and Groundwater. Both alternatives include an intake and pump station at Lake Sakakawea; Biota WTP and pump station, located near Max; and South Prairie storage reservoir, located south of Minot. These alternatives would rely on Missouri River water, which would be blended with Souris River and/or Minot groundwater. These alternatives include several options for the intake and associated facilities at Lake Sakakawea and the Biota WTP. Three options for the intake and pump station were evaluated and included in this design, as well as five biota water treatment options. The primary components associated with these alternatives are shown in Figure 3-1.

Intake and Pump Station at Lake Sakakawea

Three optional intake locations have been identified (Figure 3-2). All use Lake Sakakawea as a water source and have identical design flow parameters.

Option 1 – Modifications at the Snake Creek Pumping Plant

The Snake Creek Pumping Plant (SCPP), which is located on the north shore of Lake Sakakawea immediately adjacent to Highway 83, is owned and operated by Reclamation. The facility lifts water from Lake Sakakawea to Audubon Lake to an agreed level to serve the McClusky Canal and other features of the Garrison Diversion Unit Project. The SCPP's location and the fact that it is equipped with redundant pumping units make it suitable for modification to house and operate pumping equipment for the Project. Modifications to the SCPP would include complete removal of the Pumping Unit No. 1, revising the floor plan, and installing pumps and piping appurtenances for the Project. The discharge pipe would exit the building within the existing 11-ft diameter SCPP discharge pipe and run below the bridge and up the slope to the top of the forebay. It would turn 90 degrees to the north and run parallel to the access road and between the access road and the railroad. Under Option 1, the SCPP would be used by the Project sponsor through an agreement with Reclamation.

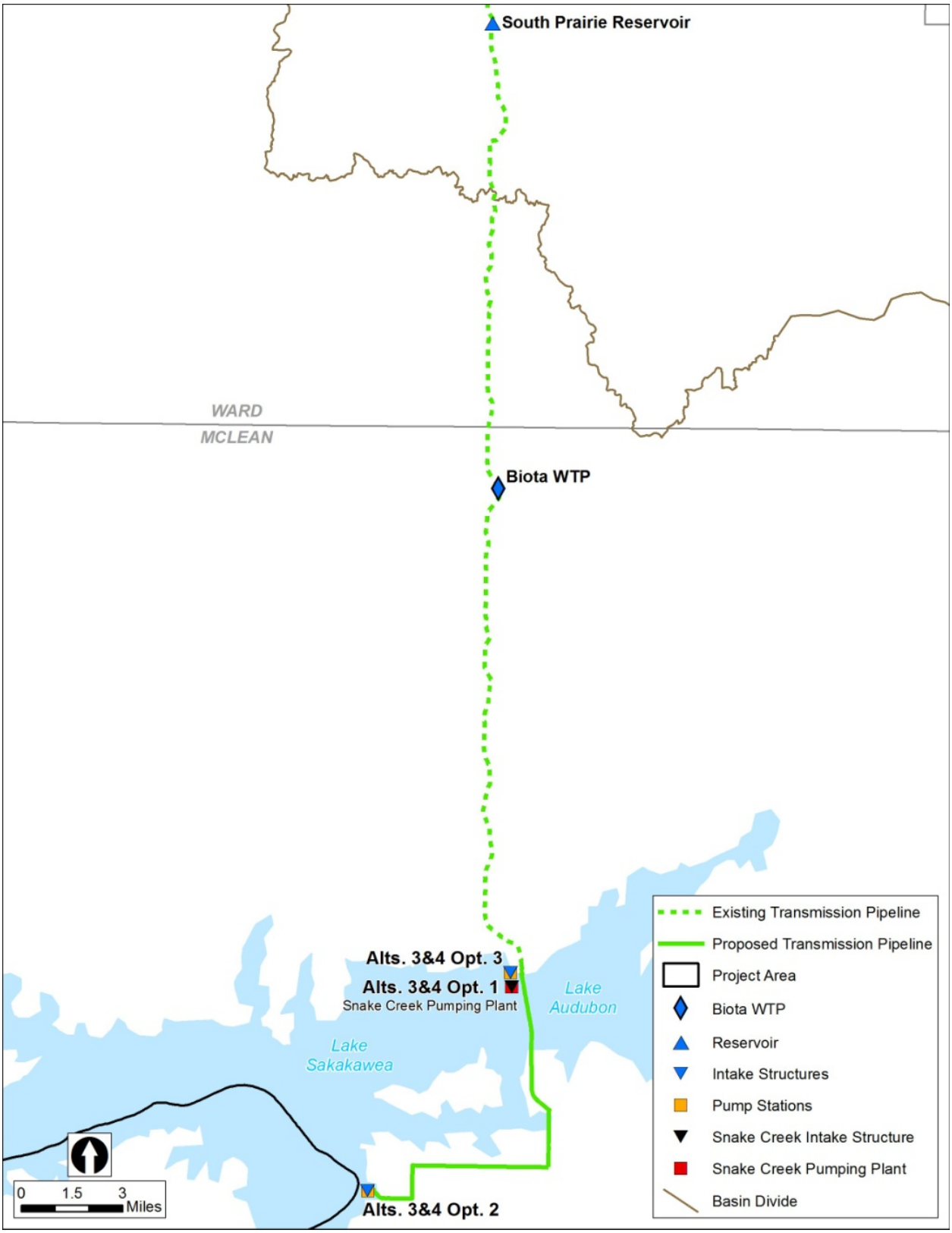

Figure 3-1 Missouri River Alternative Components

Figure 3-2 Missouri River Alternative Intake Options

Design Assumptions

The following design assumptions were used for Option 1:

- Under Alternative 3, full pump plant capacity of 22 mgd (Section 5.3, Table 5-8) would be provided at a minimum pool elevation of 1,775 mean sea level (msl) North American Vertical Datum of 1988 (NAVD 88) (all elevations given in this Report, with the exceptions specified in Appendix A, are based on NAVD 88).
- Under Alternative 4, full pump plant capacity of 25.3 mgd (Section 5.4, Table 5-21) would be provided at a minimum pool elevation of 1,775 msl.

- All pumps and piping equipment would be installed and maintained using the existing overhead crane equipment within the SCPP.
- The proposed pumping equipment design could not interfere with the existing SCPP process piping or operation of the pumping plant.
- The existing 11-ft diameter SCPP discharge pipe would be used as a casing pipe to convey the Project discharge pipeline to the east side of State Highway 83.

Relevant SCPP floor plan and building section drawings (Reclamation 1976) are included in Appendix C, Figures ALD 01 and ALD 02. An aerial view of the SCPP forebay is included here (Figure 3-3).

Figure 3-3 Intake Option 1 – Modifications at the Snake Creek Pumping Plant

Potential Issues

Reclamation (1976) and maintenance memoranda provided information related to potential issues associated with using the SCPP for the Project water pumping system, such as the following:

- The SCPP has experienced minor differential settlement, depending on the lake levels. This could potentially cause misalignment of pump shafts, which in turn could result in accelerated wear and increased maintenance costs.
- The plant undergoes low-level vibrations when the pumps are operated; the Project design would have to take these vibrations into account.
- Existing electrical, mechanical, and structural components affected by Project systems would require modification.

These potential issues would have to be considered in the final design of this intake option if it were included in an alternative selected for implementation.

The profile of the suction pipe that connects the intake screen (located outside of the cofferdam erected during construction of SCPP) to the pump station would also need to be refined during final design. The existing cofferdam elevation within the SCPP forebay is between 1,790 msl and 1,795 msl. The current design level involves breaching the cofferdam by dredging in order to lay the suction pipe at an elevation of approximately 1,770 msl below the minimum water surface elevation of 1,775 msl.

Main Design Elements

The main design elements of Option 1 are described in Table 3-1.

Table 3-1 Main Design Elements of Option 1

Facility	Description
Intake	Trash racks would be modified to reduce inlet velocity and avoid suspension of fine sediment.
Pumps	Four vertical turbines (three active, one standby) are required for either alternative. Alternative 3 requires 5,090 gpm (7.33 mgd) at 485 ft, with 800 horsepower (hp) motors. Alternative 4 requires 6,100 gpm (8.78 mgd) at 490 ft, with 900 hp motors. Power supply would be provided from the existing 115-kilovolt substation already serving the SCPP. The existing power system would require modification, but removal of the existing SCPP Pumping Unit No. 1 (rated 8,000 hp) would provide sufficient power to the new pumps without the need for a new service.
Suction piping	Would be connected to the existing SCPP Pumping Unit No. 1, as shown in Appendix C, Figures ALD 01 and ALD 02.
Discharge piping	Additional surge suppression devices (surge anticipator valves) located near the pump discharge manifold would be required. The surge anticipation valve would discharge outside of the station, requiring a piping penetration to the exterior of the SCPP above the maximum pool elevation of 1,858.5 msl.
Surge tank	14,000 gallons (gal) capacity, located in a separate building as shown on Figure 3-3.

Option 2 – Intake Located on the South Shore of Lake Sakakawea

This option involves a new intake and pump station located on the south shore of Lake Sakakawea (Figure 3-1) within a natural bay that serves as a discharge point for two drainages approaching from the east (Figure 3-4). Floor plan and elevation drawings of this option are included in Appendix C, Figures ALD 03 and ALD 04.

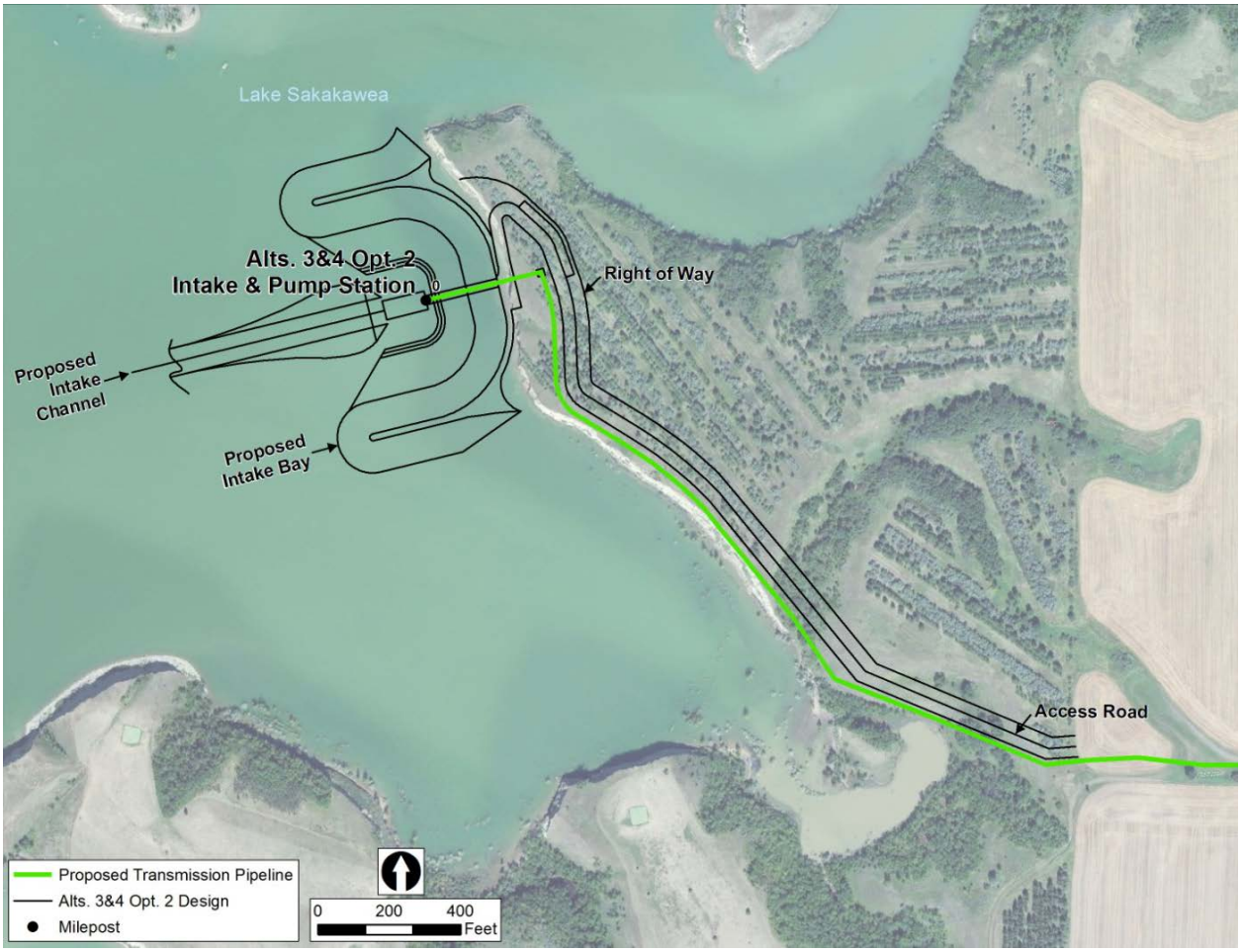

Figure 3-4 Intake Option 2 – South Shore of Lake Sakakawea

The intake and pump station would be housed in the same structure. The deep intake would consist of a caisson constructed to an elevation of 1,745 msl (Appendix C, Figure ALD 04). The intake wet well would be 15 ft by 29 ft and include trash racks (screens) set up at multiple elevations to accommodate operation of the intake at different stages in Lake Sakakawea.

The pump station would be located immediately behind the intake; a deep shaft would house the suction piping and vertical columns of five turbine pumps. The top floor would be located at an elevation of 1,858 msl and house the pumps, surge tank, discharge line, control room, electrical room, and generator room. The overall building footprint would be 120 ft by 53 ft. The main floor could be supported by a series of deep-bore, cast-in-place concrete columns to reduce the footprint of the deep intake.

The intake/pump station buildings would be located within a forebay. An intake channel would extend west into the lake to allow for water conveyance at low stages. The intake channel would be dredged periodically to remove sediment if needed (Appendix C, Figure ALD 05).

Access to the forebay would be provided by a new 28-ft paved access road. A concrete bridge founded on pilings (columns) would provide further access to the intake/pump station building. The bridge would be 220 ft long and 28 ft wide.

A discharge pipe would exit the building and run along the bridge to the top of the forebay. It would continue up the slope to the top of the shore before turning 90 degrees to run parallel to the access road. A reinforced concrete restraining block would be placed at this location to avoid displacement of discharge pipe due to hydraulic transients.

Electricity to power the facility would be provided from the nearest substation, located at Riverdale. Approximately 2.5 miles of overhead electrical line would be installed from the substation to the intake site, where a power transformer would be located.

Design Assumptions

The following design assumptions were used for this option:

- A deepwater intake wet well would be constructed.
- Full station capacity (22 mgd under Alternative 3 and 25.3 mgd under Alternative 4) would be provided at a minimum pool elevation of 1,775 msl.
- The proposed intake location would be graded to accommodate a structure that would provide a minimum of 5 to 6 ft of submergence.
- The intake caisson, vertical pump shaft, and forebay would be constructed “in the dry” by isolating the site with a cofferdam. The exact cofferdam design would be completed as part of a feasibility level design.

Main Design Elements

The main design elements of Option 2 are described below (Table 3-2).

Table 3-2 Main Design Elements of Option 2

Facility	Description
Cofferdam	1,300 ft long, to isolate the construction area.
Intake	15 ft x 29 ft intake concrete wet well.
Pumps	Five multistage, vertical turbines (four active, one standby). Alternative 3 requires 3,820 gpm (5.5 mgd) at 694 ft, with 845 hp motors. Alternative 4 requires 4,392 gpm (6.33 mgd) at 707 ft, with 950 hp motors. Electricity to power the facility would be provided from the nearest substation, located at Riverdale. Approximately 2.5 miles of overhead electrical line would be installed from the substation to the intake site, where a power transformer would be located.
Suction piping	Would be connected to the intake caisson and serve all five pumps as a reversed manifold, as shown in Appendix C, Figure ALD 04.
Discharge piping	36-inch steel and DIP piping (beyond bridge); would not require additional surge suppression devices (surge anticipator valves) in addition to the surge tank.
Surge tank	13,800 to 14,000 gal (approximately 35 ft long and 8 ft in diameter), located immediately after the discharge manifold.
Building	120 ft x 53 ft, supported by intake wet well and multiple 5-ft concrete columns.
Access bridge	Reinforced concrete, 220 ft long, 28 ft wide, supported by 3-ft concrete pilings.
Forebay	675 ft wide, top elevation 1,858 msl; side slopes graded 2.5:1 horizontal to vertical, armored with rock.

Option 3 – Intake Adjacent to the Snake Creek Pumping Plant

This option involves a new intake and pump station structure located immediately north of the SCPP (Figure 3-5). The intake screen would be located in the lake, approximately 250 ft west of the SCPP forebay. The pump station would be located north of the forebay and west of the SCPP access road and would consist of a deep circular caisson and superstructure. The intake and pump station caisson would be connected by a 42-inch tunnel/pipe. The floor plan, elevation drawings, and site plan of this option are presented in Appendix C, Figures ALD 06, ALD 07, and ALD 08. The superstructure configuration would be similar to that of Option 2. The pump station design is mostly identical, including the suction pipe located at an elevation of 1754 msl (Appendix C, Figure ALD 07).

An intake channel would extend southwest into the lake to allow for water conveyance at low stages. This channel would connect to the existing inlet channel serving the SCPP, as indicated in Appendix C, Figure ALD 08. The intake channel would be excavated in the bottom of the lake. Access to the pump station would be provided by a reconfiguration of the existing paved access road (Appendix C, Figure ALD 08).

The discharge pipe would exit the building to the north and run along the access road for a short distance. It would turn 90 degrees to the east and run across the access road the railroad and Highway 83 (Figure 3-5 and Appendix C, Figure ALD 08). Power would be provided to the site using the same infrastructure that supplies the SCPP. Two power poles and a power transformer would be added at the intake site.

Design Assumptions

The following design assumptions were used for this option:

- A deepwater intake wet well would be constructed.

- Full station capacity (22 mgd under Alternative 3 and 25.3 mgd under Alternative 4) would be provided at a minimum pool elevation of 1,775 msl.
- The proposed intake location would be graded to accommodate a structure that would provide a minimum of 5 to 6 ft of submergence.

The intake screen would be constructed on the bottom of the lake at an elevation of approximately 1,770 msl. The intake assembly could be prefabricated and lowered into position after the emplacement was dredged. The pump station wet well is designed as a circular reinforced concrete caisson and would contain the vertical pump columns. Constructed to reach an elevation of 1,746 msl, the wet well would be connected to the inlet through a 42-inch bore and a 42-inch pipe extension.

Main Design Elements

The main design elements of Option 3 are described below (Table 3-3).

Figure 3-5 Intake Option 3 – Intake Adjacent to the Snake Creek Pumping Plant

Table 3-3 Main Design Elements of Option 3

Facility	Description
Cofferdam	500 ft long, to isolate the construction area.
Intake	15-ft x 29-ft intake concrete wet well.
Pumps	Five multistage, vertical turbines (four active, one standby). Alternative 3 requires 3,820 gpm (5.5 mgd) and 488 ft, with 600 hp motors. Alternative 4 requires 4,392 gpm (6.33 mgd) and 543 ft, with 750 hp motors. Power would be provided to the site using the same infrastructure that supplies the SCPP. Two power poles and a power transformer would be added at the intake site.
Suction piping	Connected to the intake caisson and serves all five pumps as a reversed manifold, as shown in Appendix C, Figure ALD 04.
Discharge piping	36-inch, steel and DIP (beyond bridge).
Surge tank	13,800 to 14,000 gal, (approximately 35 ft long and 8 ft in diameter) located immediately after the discharge manifold. (This is an advantageous location because it eliminates the use of surge anticipator valves dedicated to controlling hydraulic transients in the system.)
Building	120 ft x 53 ft, supported by the intake wet well and multiple 5 ft concrete columns.
Access bridge	Reinforced concrete, 220 ft long and 28 ft wide, supported by 3-ft concrete pilings.
Forebay	675 ft wide, top elevation of 1,858 msl; side slopes graded 2.5:1 horizontal to vertical, armored with rock.

Biota Water Treatment Plant and Pump Station

The intent of the Biota WTP is to treat the water from the Missouri River basin to reduce the risk of transferring invasive species to the Hudson Bay basin. This facility would be located on a 41-acre site near Max that was purchased for Project purposes by the State of North Dakota. Treatment would occur before the water was pumped from the Biota WTP to the Minot WTP, where it then would be treated to Safe Drinking Water Act (SDWA) standards prior to distribution to users throughout the Project Area.

Five options for treating potential invasive species are included in this Report. Three options were developed for this appraisal-level design: Chlorination, Chlorination/ UV Inactivation, and Enhanced Chlorination/UV Inactivation. The design of each Biota WTP option was based on the following general assumptions:

- Treatment facilities for biota would be located within the Missouri River watershed near Max.
- Selected biota inactivation would be achieved before water left the Missouri River watershed.
- Up to 26 mgd could be treated, based on the limitations of the existing transmission pipeline. During low demand periods in the diurnal demand cycle (less than 26 mgd), additional water would be treated and stored. Storage would provide the difference to 26.3 mgd at peak demand.
- Chemical disinfection with chlorine would be achieved using chlorine gas.
- Chemical disinfection for the conversion of free chlorine to chloramines would be achieved using aqueous ammonia.

Two additional options, Conventional Treatment and Microfiltration Treatment, previously were developed by Reclamation (2007). These options are discussed briefly in this Report, and the

cost estimates for each were updated so they could be compared with those of the other three treatment options. To the extent possible, the Chlorination, Chlorination/UV Inactivation, UV Irradiation, and Enhanced Chlorination/UV Inactivation options were developed to a comparable level of detail as the Conventional Treatment and Microfiltration options and in some cases, various treatment processes and component sizing have been carried forward from the 2007 Reclamation report in order to provide a more direct comparison with previous design efforts (e.g., chlorine contact basin size). Below is a summary of the design criteria used to develop each Biota WTP option (Table 3-4).

Table 3-4 Biota WTP General Design Criteria

Criteria	Value	Units
Plant Capacity	26	mgd
Giardia Inactivation	3	log
Virus Inactivation	4	log
Cryptosporidium Inactivation	3	log
Myxobolus cerebralis[a] Inactivation	4	log
Free Chlorine Residual	4 [b]	mg/L
Total Chlorine Residual	3 [c]	mg/L
Water Temperature	1 [d]	^{o}C
pH	8.5 [e]	standard unit

Notes:

[a] *Myxobolus cerebralis* is a protozoan parasite that can cause whirling disease in trout and salmon

[b] A value of 3.0 mg/L was used as a conservative estimate for concentration-contact time (CT) calculations. CT is defined as the product of the residual disinfectant concentration (C) and the effective contact time (T), in which the water is in contact with the residual. The calculation is intended to demonstrate that an adequate disinfectant residual is in contact with water for sufficient time to kill or inactivate resistant organisms.

[c] A value of 2.7 mg/L was used as a conservative estimate for CT calculations.

[d] Minimum temperature used as a conservative value for log-inactivation determination.

[e] Maximum pH used as a conservative value for log-inactivation determination.

log log inactivation (inactivation measured on a logarithmic scale)

mgd million gallons per day

mg/L milligrams per liter

Chlorination Biota WTP Option

This option includes chlorination of Missouri River water and conversion of the resulting free chlorine residual to chloramines through the addition of ammonia. Figure 3-6 shows a general process flow diagram (PFD) of this option.

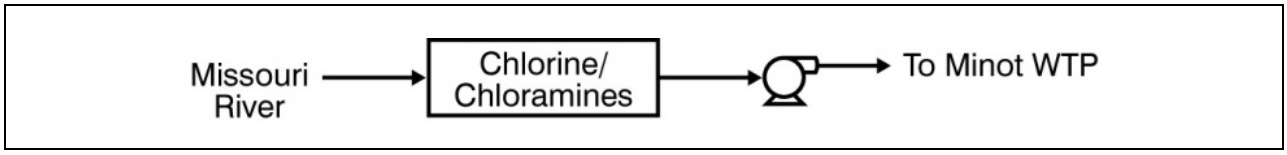

Figure 3-6 Chlorination PFD

This option would provide chemical disinfection with approximately 130 minutes of chlorine contact time in the chlorine contact basin and approximately 140 minutes of chloramines contact

time between the Biota WTP and the divide between the Missouri River and Hudson Bay basins (basin divide). The plan sheets included in Appendix E (TB-01A and TB-01B) illustrate the general arrangement of the facilities at the Biota WTP under this option. Table 3-5 provides the design criteria for the chlorine contact basin, general sizing of the chemical storage and feed equipment, and a summary of contact time in the pipeline between the Biota WTP and the point at which the water would leave the Missouri River watershed.

Table 3-5 Chlorination Facility Design Criteria

Criteria		Value	Units
WTP Capacity		26	mgd
Pipeline (between the Biota WTP and point at which the water would leave the Missouri River watershed)			
Diameter		36	inches
Length		47,700	ft
Baffle Factor (T_{10}/T)		1.0 [a]	–
CT		388	mg/L-min
Chlorine Contact Basin			
Number		1	–
Baffle Factor (T_{10}/T)		0.5 [b]	–
Volume		4.76	MG
Dimensions (L x W)		310 x 210	ft x ft
Depth		10	ft
CT		395	mg/L-min
Booster Pump Station			
Number of Pumps		5	–
Capacity	Pumps 1, 2 and 3	9	mgd
	Pumps 4 and 5	5	mgd
	Total Capacity	37	mgd
	Firm Capacity (largest pump out of service)	28	mgd
Chlorination			
Storage	Type	Gas Cylinders	
	Number	5	–
	Capacity (each)	1	ton
	Days Storage (average dose)	30	days
Chemical Dosage Range		3 to 4	mg/L
Feeders	Type	Chlorinators	
	Number	3	–
	Capacity (each)	500	ppd
Aqueous Ammonia			
Storage	Concentration	29.4	%
	Specific Gravity	0.894	–
	Number of Tanks	1	–
	Capacity (each)	1,200	gal
	Days Storage (average dose, average flow)	30	gal
Chemical Dosage Range		0.75 to 1	mg/L
Feeders	Type	Metering Pumps	
	Number	2	–
	Capacity (each)	5.5	gph

Criteria	Value	Units

Notes:

[a] This is a "perfect (plug flow)" baffling condition as described in Table 3-2 of the U.S. Environmental Protection Agency (EPA) Disinfection Profiling and Benchmarking Guidance Manual. This is typical for pipeline flow.

[b] This is an "average" baffling condition as described in Table 3-2 of the EPA Disinfection Profiling and Benchmarking Guidance Manual. This type of chlorine contact basin would be expected to have a baffled inlet or outlet with some intra-basin baffles.

CT disinfectant concentration (C) x effective contact time (T)
gal gallons
gph gallons per hour
MG million gallons
mgd million gallons per day
mg/L milligrams per liter
mg/L-min milligrams per liter per minute
ppd pounds per day

Source: EPA 2003

The level of biota inactivation achieved at the Chlorination Biota WTP was determined by evaluating the effective contact time (-T) within the pipeline from the Biota WTP to the point where the water would leave the Missouri River watershed.[2] Approximately 47,700 ft of 36-inch-diameter[3] pipe currently exists between the proposed location of the Chlorination Biota WTP and where the water would leave the watershed. This would result in an effective chloramines contact time of slightly more than 144 minutes. Given the assumed chloramines residual (C) of 2.7 mg/L, the available concentration-contact time (CT) in the pipeline would be 388 mg/L-min, which would result in a 0.3-log and a 0.58-log *Giardia* and virus inactivation,[4] respectively.

The chloramines CT result was used to determine the chlorine contact basin size necessary to provide the remaining 2.7-log and 3.42-log inactivation of *Giardia* and viruses, respectively, as summarized in Table 3-4. Because the chlorination CT for *Giardia* inactivation is greater than that required for virus inactivation, CT calculations were based on published values for *Giardia*. The chlorination CT required to achieve 2.7-log *Giardia* is 395 mg/L-min.[5] Given the assumed chlorine residual (3.0 mg/L) and baffle factor (0.5), the effective contact time would be approximately 130 minutes, which would result in a chlorine contact basin volume of 637,300 ft^3 (4.76 MG).

Table 3-6 shows the biota removal/inactivation credits for *Giardia*, viruses, *Cryptosporidium*, and *Myxobolus cerebralis* under the treatment processes proposed for this option. *Giardia*, viruses, and *Cryptosporidium* have been used as surrogates for the selected invasive species to illustrate the level of inactivation that would be attained for each treatment process.

[2] Disinfection Profiling and Benchmarking Guidance Manual, EPA 815-R-99-013, August 1999.

[3] Internal pipe diameter of 36.55 inches, as described on Sheet PP-12 of Contact 2-1C record drawings (36-in DIP with 3/8-in mortar lining).

[4] Inactivation was determined from Tables 6-4 and 6-5 of the EPA Guidance Manual for Alternative Disinfectants and Oxidants, April 1999.

[5] Inactivation was determined from Appendix D of the EPA Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources, October 1989.

Table 3-6 Chlorination Log-Inactivation

Target Biota	Chlorine	Chloramination (Pipeline)	Total
Giardia[a]	2.7	0.30	3
Cumulative Credit	2.7	3	
Viruses[a]	>4	0.5	>4
Cumulative Credit	>4	>4	
Cryptosporidium[a]	0	0	0
Cumulative Credit	0	0	
Myxobolus cerebralis[b]	0	0	0
Cumulative Credit	0	0	

Notes:

[a] Log inactivation is a measure (using a logarithmic scale) of the percent of the biota that are inactivated/removed as a result of a treatment process. For example, 2-log, 3-log, 4-log and 5-log inactivation corresponds to 99%, 99.9%, 99.99%, and 99.999% inactivation/removal, respectively. Inactivation removal credits for drinking water treatment are generally limited to *Giardia*, viruses, and *Cryptosporidium*.

[b] Log inactivation for *Myxobolus cerebralis* based on Hedrick et al. 2007. Inactivation with chlorine was assumed to be zero as chlorine doses employed by Hedrick et al. far exceeded those used in development of this option.

Source: Table IV.B-2. EPA, National Primary Drinking Water Regulations: Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), 40 Code of Federal Regulations (CFR) Parts 9, 141, and 142, January 5, 2006.

Chlorine Storage and Feed

Chlorine gas would be applied as the primary chemical disinfectant upstream of the chlorine contact basin at the Biota WTP. The target chlorine residual leaving the chlorine contact basin is 4 mg/L and would be measured prior to the ammonia application point to confirm the CT achieved while in the Missouri River basin. The proposed chlorine gas system generally consists of chlorine gas ton cylinders, chlorine gas feeders, chlorine residual analyzers, and chlorine gas scrubber facilities.

Chloramination Storage and Feed

Chloramines would be formed by the addition of aqueous ammonia to the chlorinated water to reduce the potential for the formation of disinfection byproducts and biofilm growth within the approximately 26 miles of pipe between the Biota WTP and the Minot WTP. The target for chloramines residual leaving the Biota WTP is 3 mg/L. Ammonia would be applied downstream of the chlorine contact basin. The free chlorine residual would be measured prior to the ammonia application point to monitor that the appropriate chlorine to ammonia ratio (4.5:1) was maintained and that the desired target residual for both free and total chlorine was achieved. Total chlorine would be monitored downstream of the ammonia application point to confirm the conversion of free chlorine to chloramines. The proposed aqueous ammonia system would generally consist of ammonia storage tanks, ammonia feeders, and total chlorine residual analyzers.

Booster Pump Station

The booster pump station would include five vertical turbine pumps with variable frequency drives. Three pumps would have a capacity of 9 mgd, and two pumps would have a capacity of 5 mgd. One of the three 9-mgd pumps would be auxiliary to give the pump station a firm capacity (the pumping capacity with the largest pump out of service) of 28 mgd.

Operation of the booster pumps would be controlled by a gage that measured the level of chlorine in the chlorine contact tank and system demands. Discharge flows from the booster pumping station would be measured with a 30-inch magnetic flowmeter. The booster pumps were sized to achieve a hydraulic gradeline at the Minot WTP to match the existing conditions.

Standby Power

The Chlorination Biota WTP would be equipped with a weatherproof, exterior propane fuel standby engine generator. The generator would provide backup power to the control room supervisory control and data acquisition system, portions of the heating, ventilation, and air conditioning (HVAC) system, lighting, and essential building equipment (e.g., fire suppression).

Auxiliary Equipment and Systems

The facility would also be equipped with the following major equipment:

- Fire suppression system
- HVAC system
- Workshop/garage equipment (compressed air, drills, work benches, etc.)
- Electrical panels
- Monorails and hoists

Chlorination/UV Inactivation Biota WTP Option

This option includes UV irradiation of Missouri River water, followed by chlorine disinfection and conversion of the free chlorine residual to chloramines. UV irradiation would be used to inactivate chlorine-resistant biota (e.g., *Cryptosporidium* and *Myxobolus cerebralis*). Figure 3-7 shows a general PFD of this option. The plan sheets (TB-02A, TB-02B, and TB-02C) included in Appendix E illustrate the general arrangement of the facilities at the Chlorination/UV Inactivation Biota WTP.

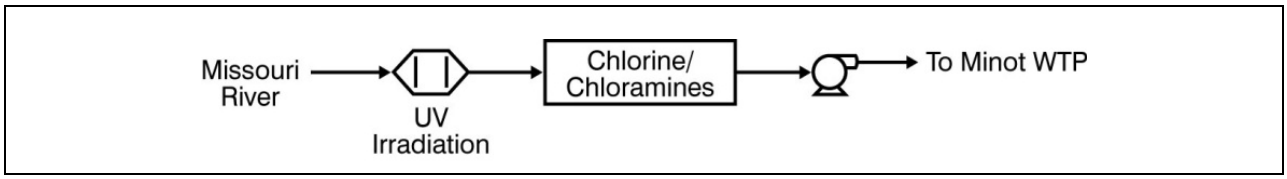

Figure 3-7 Chlorination/UV Inactivation PFD

Table 3-7 provides the design criteria for the UV system and chlorine contact basin, general sizing of the chemical storage and feed equipment, and a summary of contact time in the pipeline between Max and the point at which the water would leave the Missouri River watershed.

Table 3-7 Chlorination/UV Inactivation Facility Design Criteria

Item	Value	Units
Plant Capacity	26	mgd
Pipeline (between the Biota WTP and where water leaves the Missouri River watershed)		
Diameter	36	inches
Length	47,700	ft
Baffle Factor (T10/T)	1.0 [a]	–
CT	388	mg/L-min
Chlorine Contact Basin		
Number	1	–
Baffle Factor (T_{10}/T)	0.5 [a]	–
Volume	1.12	MG
Dimensions (L x W)	150 x 100	ft x ft
Depth	10	ft
CT	93	mg/L-min
UV Irradiation		
Type	Medium Pressure	
UV Transmittance	60	%
Aging and Fouling Factor	80	%
Effective Dosage (MS2 RED)	40 [b]	mJ/cm^2
Number of units (one standby)	4	–
Capacity per Unit	8.7	mgd
Lamps/Sleeves per Unit	18	–
Chlorination		
Storage	Gas Cylinders	
Number	5	–
Capacity (each)	1	ton
Capacity (total)	5	tons
Days Storage (average dose)	30	days
Chemical Dosage Range	3 to 4	mg/L
Feeders	Chlorinators	
Number	3	–
Capacity (each)	500	ppd
Capacity (total)	1,000	ppd
Chloramination		
Concentration	29.4	%
Specific Gravity	0.894	-
Number of Tanks	1	–
Capacity (each)	1,200	gal
Capacity (total)	1,200	gal
Days storage (average dose, average flow)	30	gal
Chemical Dosage Range	0.75 to 1	mg/L

Item	Value	Units
Feeders		
Type	Metering Pumps	
Number	2	–
Capacity (each)	5.5	gph
Capacity (total)	5.5	gph

Notes:
[a] This is an "average" baffling condition as described in Table 3-2 of the EPA's Disinfection Profiling and Benchmarking Guidance Manual. This type of chlorine contact basin is expected to have a baffled inlet or outlet with some intrabasin baffles (EPA 2003).
[b] A UV dose of 40 mJ/cm^2 has been found to completely inactivate *Myxobolus cerebralis (*Hedrick et al. 2007*).*

gal gallons
gph gallons per hour
mJ/cm^2 millijoules per square centimeter
MG million gallons
mgd million gallons per day
mg/L-min milligrams per liter per minute
ppd pounds per day

As with the Chlorination option, the level of biota inactivation achieved with the Chlorination/UV Inactivation option was determined by evaluating the effective contact time (T) within the pipeline from the Biota WTP to the termination of the Missouri River watershed as water was transferred to the Minot WTP. The available CT in the pipeline would be 388 mg/L-min, which would result in 0.3-log and 0.58-log *Giardia* and virus inactivation,[6] respectively. Unlike the Chlorination option, this option also would provide biota inactivation using UV irradiation for *Giardia* (3-log), *Cryptosporidium* (3-log), *Myxobolus cerebralis* (4-log), and virus inactivation (0.5-log).

The biota inactivation achieved in the pipeline with chloramines and at the Biota WTP with UV irradiation was used to determine the chlorine contact basin size necessary to provide the remaining 3-log inactivation of viruses, as summarized in Table 3-4. The required CT to achieve 3-log virus inactivation would be 9 mg/L-min.[7] Given the assumed chlorine residual (3.0 mg/L) and baffle factor (0.5), the effective contact time would be approximately 6 minutes, and the chlorine contact basin volume would be 14,500 ft^3 (0.1 MG). However, in order to provide a more direct comparison to the Conventional Treatment and the Microfiltration Treatment options previously developed by Reclamation (2007), a chlorine contact basin volume of 150,000 ft^3 (1.12 MG) was used for this Biota WTP option (the clearwell would be 150 ft x 100 ft). As a result, the chlorine contact basin would provide approximately 31 minutes of chlorine contact time. The CT achieved under these conditions would be 93 mg/L-min, which would result in approximately 0.6-log inactivation of *Giardia* and more than 4-log inactivation of viruses.[8]

Table 3-8 shows the removal credits for *Giardia*, viruses, *Cryptosporidium*, and *Myxobolus cerebralis* under the treatment processes proposed for this option. *Giardia*, viruses, and

[6] Inactivation was determined from Tables 6-4 and 6-5 of the EPA Guidance Manual for Alternative Disinfectants and Oxidants, April 1999.
[7] Inactivation was determined from Appendix D of the EPA Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources, October 1989.
[8] Inactivation was determined from Appendix D of the EPA Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources, October 1989.

Cryptosporidium have been used as surrogates for the selected invasive species to illustrate the level of inactivation that would be attained for each treatment process.

Table 3-8 Chlorination/UV Log-inactivation

Target Biota	UV Irradiation	Chlorine	Chloramination (Pipeline)	Total
Giardia	3.0	0.63	0.30	>3
Cumulative Credit	3.0	>3	>3	
Viruses	0.5	>4	0.5	>4
Cumulative Credit	0.5	>4	>4	
Cryptosporidium	3.0	0	0	3.0
Cumulative Credit	3.0	3.0	3.0	
Myxobolus cerebralis[a]	>4	0	0	>4
Cumulative Credit	>4	>4	>4	

Note: [a] UV log-inactivation for *Myxobolus cerebralis* based on Hedrick et al. 2007. Inactivation with chlorine was assumed to be zero as chlorine doses employed by Hedrick et al. far exceeded those used in development of this option.

Source: Table IV.B-2. EPA, National Primary Drinking Water Regulations: LT2ESWTR, 40 CFR Parts 9, 141, and 142, January 5, 2006.

This option uses a UV irradiation system to inactivate chorine-resistant biota (i.e., *Cryptosporidium* and *Myxobolus cerebralis*) at the Biota WTP. A medium-pressure UV disinfection system is proposed that would use four reactor vessels with a treatment capacity of 8.7 mgd each. Four reactors would be provided so that the target UV dose would be achieved at full system capacity (26 mgd) with one reactor out of service (i.e., a spare reactor would be provided). Each reactor is designed to provide a UV dose of 40 mJ/cm^2 at a maximum flow rate of 8.7 mgd and minimum 60 percent UV transmittance (Montgomery Watson Harza and Houston Engineering 2007). A UV dose of 40 mJ/cm^2 has been found to completely inactivate *Myxobolus cerebralis (*Hedrick et al. 2007).

The following elements, also included under the Chlorination option, are included under the UV Inactivation option:

- Chlorine storage and feed
- Chloramination storage and feed
- Booster pump station
- Standby power
- Auxiliary equipment and systems

Enhanced Chlorination/UV Inactivation Biota WTP Option

This option includes pressure filtration of Missouri River water, followed by UV irradiation, chlorine disinfection, and conversion of the free chlorine residual to chloramines. Figure 3-8 shows a general PFD of this option. The plan sheets (TB-03A, TB-03B, and TB-03C) included in Appendix E illustrate the general arrangement of the facilities for this option.

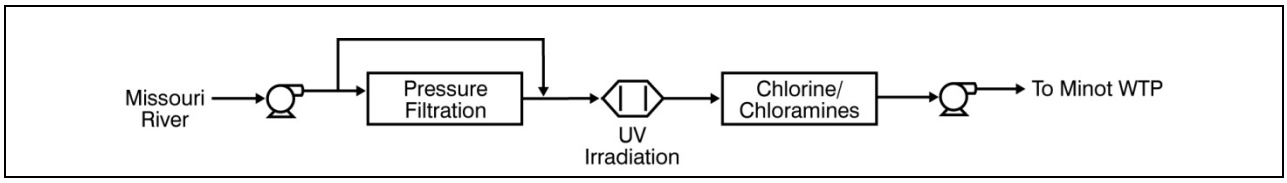

Figure 3-8 Enhanced Chlorination/UV Inactivation PFD

Table 3-9 provides the design criteria for the UV system and chlorine contact basin, general sizing of the chemical storage and feed equipment and the pressure filters, and a summary of contact time in the pipeline between the Biota WTP and where water leaves the Missouri River watershed.

Table 3-9 Enhanced Chlorination/UV Inactivation Facility Design Criteria

Item	Value	Units
Plant Capacity	26	mgd
Pipeline (between the Biota WTP and where water leaves the Missouri River watershed)		
Diameter	36	inches
Length	47,700	ft
Baffle Factor (T_{10}/T)	1.0 [a]	–
CT	388	mg/L-min
Chlorine Contact Basin		
Number	1	–
Baffle Factor (T_{10}/T)	0.5 [a]	–
Volume	1.12	MG
Dimensions (L x W)	150 x 100	ft x ft
Depth	10	ft
CT	93	mg/L-min
UV Irradiation		
Type	Medium Pressure	
UV Transmittance	60	%
Aging and Fouling Factor	80	%
Effective Dosage	40 [b]	mJ/cm^2
Number of Units (one standby)	4	–
Capacity per Unit	8.7	mgd
Lamps/sleeves per Unit	18	–
Filter Pump Station		
Number of Pumps	4	–
Capacity	9	mgd
Total Capacity	36	mgd
Firm Capacity	27	mgd
Filtration		
Filter	Pressure Filters	
Media	Manufacturer recommended media + support gravel	
Size	21 x 7	Length (ft) x Diameter (ft)
Filtration Rate (each)	2,160	gpm
Number of Filters	10	–

Item	Value	Units
Backwash Flow Rate	3,000	gpm
Surface Wash Rate	270	gpm
Chemical Feed		
Coagulant (filtration aid)	Polyaluminum Chloride	
Storage	FRP tank	
Number	1	–
Capacity (each)	See Note c	See Note c
Chemical Dosage Range		See Note c
Feeders	Metering Pumps	
Number	1	–
Capacity (each)		See Note c
Chlorination		
Storage	Ton Cylinders	
Number	5	–
Capacity (each)	1	ton
Days Storage (average dose)	30	days
Chemical Dosage Range	3 to 4	mg/L
Feeders	Chlorinators	
Number	3	–
Capacity (each)	500	ppd
Chloramination		
Concentration	29.4	%
Specific Gravity	0.894	-
Number of Tanks	1	–
Capacity (each)	1,200	gal
Days storage (average dose, average flow)	30	gal
Chemical Dosage Range	0.75 to 1	mg/L
Feeders	Metering Pumps	
Number	2	–
Capacity (each)	5.5	gph

Notes:

[a] This is an "average" baffling condition as described in Table 3-2 of the EPA's Disinfection Profiling and Benchmarking Guidance Manual. This type of chlorine contact basin would be expected to have a baffled inlet or outlet with some intra-basin baffles (EPA 2003).

[b] A UV dose of 40 mJ/cm^2 has been found to completely inactivate *Myxobolus cerebralis (*Hedrick et al. 2007*)*.

[c] Chemical dose and feed range can only be determined following pilot testing of the source of supply.

gal gallons
gph gallons per hour
gpm gallons per minute
MG million gallons
mgd million gallons per day
mg/L milligrams per liter
mg/L-min milligrams per liter per minute
mJ/cm^2 millijoule per square centimeter
ppd pounds per day

As with the Chlorination option, the level of biota inactivation that would be achieved at the Biota WTP under the Enhanced Chlorination/UV Inactivation option was determined by evaluating the effective contact time (T) within the pipeline from the Biota WTP to the termination of the Missouri watershed as water was delivered to the Minot WTP. The available CT in the pipeline would be 388 mg/L-min, which would result in a 0.3-log and a 0.58-log *Giardia* and virus inactivation,[9] respectively. This alternative also would provide biota inactivation using UV irradiation for *Giardia* (3-log), *Cryptosporidium* (3-log), *Myxobolus cerebralis* (4-log), and viruses inactivation (0.5 log).

Pressure filtration has been included as an enhancement to the Chlorination/UV Inactivation option because it provides a physical barrier to remove particles from the Missouri River water during high-turbidity events. Turbidities up to 10 nephelometric turbidity units (NTU) have been shown not to affect the UV dose-response of separately added microorganisms (Reclamation 2007; EPA 2006); therefore, the pressure filtration system in this option would be operated when source water turbidly exceeded 7 NTU. The turbidity value of 7 NTU for pressure filter operation was chosen because it represents a conservative value (30 percent safety factor) below the 10 NTU value known not to affect UV dose-response. During times when the water quality in Lake Sakakawea is good (i.e., low turbidity: <7 NTU), the water would bypass the pressure filtration. In addition, the pilot-scale water treatment study completed in 2007 showed that turbidity levels in the Missouri River during the test period never exceeded a sustained 10 NTU. The pressure filtration process would provide an additional level of treatment should turbidity increase in the future. When operated, the pressure filter would be able provide biota removal of *Giardia* (1-log) and *Cryptosporidium* (1-log). The pressure filters also would provide an operational benefit to the UV irradiation system by enhancing the water quality (i.e., lower turbidity and higher UV transmittance). For purposes of estimating O&M costs, the pressure filtration system and related pump station was conservatively estimated to operate approximately 30 percent of the time.

The biota inactivation that would be achieved in the pipeline with chloramines and UV irradiation results was used to determine the chlorine contact basin size necessary to provide the remaining 3-log inactivation of viruses, as previously summarized in Table 3-4. Because the pressure filter would be bypassed during low turbidity events, biota removal has not been included in developing the size of the chlorine contact basin. The required CT to achieve 3-log virus inactivation is 9 mg/L-min.[10] Given the assumed chlorine residual (3.0 mg/L) and baffle factor (0.5), the effective contact time would be approximately 6 minutes, and the chlorine contact basin volume would be 14,500 ft^3 (0.1 MG). However, as noted under the discussion of the Chlorination/UV Inactivation option, a clearwell size of 150,000 ft^3 (1.12 MG) was selected for the chlorine contact channel in order to provide consistency with Reclamation's earlier options. This would result in a chlorine contact basin that would provide approximately 31 minutes of chlorine contact time and a CT of 93 mg/L-min. Table 3-10 shows the removal credits for *Giardia*, viruses, *Cryptosporidium*, and *Myxobolus cerebralis* under the treatment processes proposed for this option. *Giardia*, viruses, and *Cryptosporidium* have been used as

[9] Inactivation was determined from Tables 6-4 and 6-5 of the EPA Guidance Manual for Alternative Disinfectants and Oxidants, April 1999.

[10] Inactivation was determined from Appendix D of the EPA Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources, October 1989.

surrogates for the selected invasive species to illustrate the level of inactivation that would be attained for each treatment process.

Table 3-10 Enhanced Chlorination/UV Log-inactivation or Removal

Target Biota	Pressure Filtration[a]	UV Irradiation	Chlorine	Chloramination (Pipeline)	Total
Giardia	1 [b]	3.0	0.63	0.30	>3
Cumulative Credit	1	>3	>3	>3	
Viruses	0	0.5	>4	0.5	>4
Cumulative Credit	0	0.5	>4	>4	
Cryptosporidium	1 [b]	3.0	0	0	4.0
Cumulative Credit	1	4.0	4.0	4.0	
Myxobolus cerebralis[c]	1 [b]	>4	0	0	>4
Cumulative Credit	1	>4	>4	>4	

Notes:

[a] Log-inactivation values from "California Surface Water Treatment Alternative Filtration Technology Demonstration Report, June 2001, and includes a 1-log safety factor from the inactivation values demonstrated from the pilot testing as recommended by the California Department of Health Services.

[b] When the pressure filter is in operation and achieving finished water turbidity comparable to conventional filtration and as documented in a pilot study completed prior to design.

[c] UV log-inactivation *for Myxobolus cerebralis* based on Hedrick et al. 2007. Inactivation with chlorine was assumed to be zero as chlorine doses employed by Hedrick et al. far exceeded those used in development of this option. Pressure filtration log-removal for Myxobolus cerebralis based on comparison of particle size with Cryptosporidium oocysts.

Source: Table IV.B-2. EPA, National Primary Drinking Water Regulations: LT2ESWTR, 40 CFR Parts 9, 141, and 142, January 5, 2006.

Filter Pump Station

The proposed filter pump station includes four vertical turbine pumps with variable frequency drives. Each pump would have a capacity of 9 mgd. One of the three 9-mgd pumps would be a spare to give the pump station a firm capacity of 27 mgd. Operation of the filter pumps would be controlled by inlet pressure to the filter vessels and system demands.

Pressure Filtration

Pressure filters use the same filtration process and filter media as gravity filters. However, the media are enclosed in prefabricated vertical or horizontal cylindrical steel tanks (vessels), not cast-in-place concrete boxes. Pressure provided by upstream supply pumps drives the water through the media.

The proposed pressure filters would consist of a filter media, as recommended by the manufacturer, above support gravel in 10 pressure vessels. The pressure loss across each filter is designed to not exceed 10 pounds per square inch (psi), with an allowable pressure of up to 160 psi. Backwash water would be provided to an offline filter vessel by online filter vessels, eliminating the need for a separate backwash storage and feed system. In addition to the filtration vessels, the system would also be equipped with reaction vessels that would serve as mixing/reaction chambers to provide adequate reaction time for the conditioning chemicals prior to filtration.

The California Department of Health Services (2001) has described the use of pressure filtration that resulted in 1-log, 2-log, 2-log removals of viruses, *Giardia*, and *Cryptosporidium*, respectively, for surface waters with turbidities up to 9 NTU and a filter loading rate of 12 gpm/ft^2. The report also provides guidelines indicating that source-by-source pilot studies should be completed and that results from these studies should include a 1-log safety factor. This 1-log safety factor has been applied to the log reduction assumptions in Table 3-10 above.

The following elements are included in this option (they also are included in the Chlorination/UV Inactivation Biota WTP option):

- Chlorine storage and feed
- Chloramination storage and feed
- UV irradiation system
- Booster pump station
- Standby power
- Auxiliary equipment and systems

Chloramination

Ammonia would be added to form combined chlorine as described for the Chlorination option.

Conventional Treatment Biota WTP Option

This is one of the Biota WTP options previously designed by Reclamation (2007). This option includes coagulation and flocculation, followed by clarification via dissolved air flotation (DAF). Clarified water would be filtered through dual media filters, treated with UV irradiation, and chemically disinfected with chlorine, followed by conversion of the resulting free chlorine residual to chloramines with the addition of ammonia. Figure 3-9 shows a general PFD of this option. The Reclamation's 2007 report includes general arrangement plan sheets for this Biota WTP option.

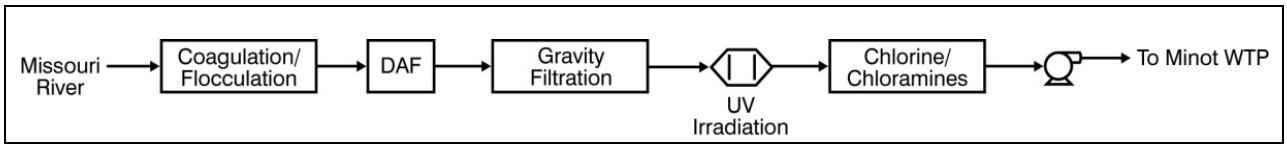

Figure 3-9 Conventional Treatment PFD

This option provides chemical disinfection with approximately 130 minutes of chlorine contact time in the chlorine contact basin and approximately 140 minutes of chloramines contact time between the Biota WTP and the basin divide. Table 3-11 shows the removal credits for *Giardia*, viruses, *Cryptosporidium*, and *Myxobolus cerebralis* under the treatment processes proposed for this option. *Giardia*, viruses, and *Cryptosporidium* have been used as surrogates for the selected invasive species to illustrate the level of inactivation that would be attained for each treatment process.

Table 3-11 Conventional Treatment Log-inactivation or Removal

Target Biota	DAF and media filtration	UV Irradiation	Chlorine	Chloramination (Pipeline)	Total
Giardia	2.5	3.0	0.63	0.30	>3
Cumulative Credit	2.5	>3	>3	>3	
Viruses	2.0	0.5	>4	0.5	>4
Cumulative Credit	2.0	2.5	>4	>4	
Cryptosporidium	2.5	3.0	0	0	>3
Cumulative Credit	2.5	>3	>3	>3	
Myxobolus cerebralisa	2.5	>4	0	0	>4
Cumulative Credit	2.5	>4	0	>4	

Note:

[a] UV log-inactivation for *Myxobolus cerebralis* based on Hedrick et al. 2007. DAF (dissolved air flotation) and media filtration log-removal for *Myxobolus cerebralis* based on comparison of particle size with *Cryptosporidium* oocysts. Inactivation with chlorine was assumed to be zero as chlorine doses employed by Hedrick et al. far exceeded those used in development of this option.

Source: Table IV.B-2. EPA, National Primary Drinking Water Regulations: LT2ESWTR, 40 CFR Parts 9, 141, and 142, January 5, 2006.

Microfiltration Treatment Biota WTP

This is one of the Biota WTP options previously designed by Reclamation (2007). This option includes coagulation and flocculation, followed by microfiltration. Filtered water would be treated with UV irradiation and chemically disinfected with chlorine, followed by conversion of the resulting free chlorine residual to chloramines with the addition of ammonia. Figure 3-10 shows a general PFD of this option. Reclamation's 2007 report includes general arrangement plant sheets for this Biota WTP option.

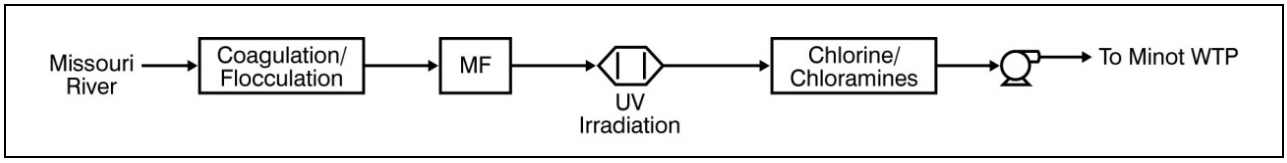

Figure 3-10 Microfiltration Treatment PFD

This alternative would provide chemical disinfection with approximately 130 minutes of chlorine contact time in the chlorine contact basin and approximately 140 minutes of chloramines contact time between the Biota WTP and the basin divide.

Table 3-12 shows the removal credits for *Giardia*, viruses, *Cryptosporidium*, and *Myxobolus cerebralis* under the treatment processes proposed for this option. *Giardia*, viruses, and *Cryptosporidium* have been used as surrogates for the selected invasive species to illustrate the level of inactivation that would be attained for each treatment process.

Table 3-12 Microfiltration Log-inactivation or Removal

Target Biota	Microfiltration	UV Irradiation	Chlorine	Chloramination (Pipeline)	Total
Giardia	4.0	3.0	0.63	0.30	> 3
Cumulative Credit	> 3	> 3	> 3	> 3	
Viruses	0.5	0.5	> 4	0.5	> 4
Cumulative Credit	0.5	1.0	> 4	> 4	
Cryptosporidium	4.0	3.0	0	0	> 3
Cumulative Credit	> 3	> 3	> 3	> 3	
Myxobolus cerebralis[a]	4.0	> 4	0	0	> 4
Cumulative Credit	4.0	> 4	> 4	> 4	

Note:

[a] UV log-inactivation for *Myxobolus cerebralis* based on Hedrick et al. 2007. Microfiltration log-removal for *Myxobolus cerebralis* based on comparison of particle size with *Cryptosporidium* oocysts. Inactivation with chlorine was assumed to be zero as chlorine doses employed by Hedrick et al. far exceeded those used in development of this option.

Source: Table IV.B-2. EPA, National Primary Drinking Water Regulations: LT2ESWTR, 40 CFR Parts 9, 141, and 142, January 5, 2006.

South Prairie Storage Reservoir

This reservoir would be situated on the transmission pipeline to the Minot WTP, north of the Biota WTP (Appendix D, sheet A 13). It would be circular, 105 ft in diameter, approximately 50 ft high (with a maximum storage height of 46.2 ft), and would provide 3 million gallons (MG) of system storage (Appendix C, sheets ALD 16 and ALD 17). The purpose of the reservoir is to provide operational and emergency storage for the Minot WTP. Operational storage would allow water to be stored when the demand is low and released when the demand is high. Emergency storage would allow the Minot WTP to operate on a limited basis in case water transmission was shut down at the Missouri River intake, at the Biota WTP, or anywhere along the transmission pipeline.

Water to fill the reservoir would be supplied from the Biota WTP booster station. Because of its high ground elevation (2,100 msl), the reservoir would feed the north section of the transmission line to the Minot WTP by gravity. An above-ground reservoir currently is being considered because it would allow the reservoir to be constructed from steel plates, which is a more cost-effective material for storage capacities up to 3 MG. However, geotechnical conditions at the site and operational considerations that were not evaluated at this design stage could require a concrete reservoir sited above ground or partially buried.

Components Common to all Alternatives

This section describes existing and proposed components that are included in all alternatives. Existing components include the water transmission pipeline; portions of the bulk distribution pipelines; High Service Pump Station and reservoir at the Minot WTP; three storage reservoirs near Burlington, Berthold, and Kenmare; four pump stations near Berthold and south of Kenmare; and the Rugby WTP. Proposed components include construction of additional segments of the bulk distribution pipelines; upgrades to the Minot WTP; construction of two storage reservoirs near Lansford and Bottineau; and construction of seven pump stations near Landsford, Mohall, Tolley, Renville County Corner, Bottineau (two locations), and Bowbells.

Water Transmission Pipeline

The water transmission pipeline is already largely constructed and is intended to connect a Missouri River water intake and pump station (located on Lake Sakakawea) to the Minot WTP. The transmission pipeline would only be utilized for Alternatives 3 and 4. The 43.11-mile pipeline runs from south to north parallel to State Highway 83, and it consists of four segments of 30- and 36-inch DIP pipe that were constructed between 2002 and 2008 (Table 4-1).

Table 4-1 Transmission Pipeline between Lake Sakakawea and Minot WTP

Description	Length (ft)	Diameter (inches)	Status
Segment 2-1A	39,105	30, 36	Construction completed in 2002
Segment 2-1B	50,001	36	Construction completed in 2003
Segment 2-1C	60,180	36	Construction completed in 2005
Segment 2-1D	78,355	36	Construction completed in 2008

The transmission pipeline is not yet connected to an intake/pump station or to the Minot WTP. The south connection point is situated approximately 1,500 ft north of the SCPP, on the east side of State Highway 83. The north connection point is located approximately 340 ft southwest of the Minot WTP building. The pipeline is interrupted at two locations where proposed facilities are yet to be designed and constructed. The first is in the vicinity of Max, at the location for the proposed Biota WTP. The second interruption is at the proposed location of the South Prairie storage reservoir.

Bulk Distribution Pipelines

The pipelines that would distribute water to Project participants (Table 4-2) represent the largest set of Project components and are the same for each of the alternatives. When the entire system is completed, the length of bulk distribution pipelines would be approximately 300 miles. Many of the pipeline segments have been constructed as permitted by court orders and amendments to the existing injunction. Detailed information regarding the existing and proposed routes is presented in the pipeline alignment sheets included in Appendix D.

Table 4-2 Bulk Distribution Pipelines

Description	Contract	Length (ft)	Pipe Size (in), Type	Status
Minot Area	2-2A	19,533	16-24, PVC	Installed
Berthold Segment	2-2B	108,058	8-16, PVC	Installed
Kenmare and USWUD	2-2C	277,459	8-12, PVC	Installed
Mohall, Sherwood, ASWUD System III	2-2D	332,128	6-12, PVC	Installed
Burlington	2-2E	3,600	8, PVC	Installed
To MAFB	2-3A	64,835	14-18, PVC	Under Construction
MAFB to Glenburn	2-3B	97,873	6-18, PVC; 8, DI	Under Construction
Glenburn to Renville Corner	2-3C	90,700	6-16, PVC	Appraisal Design
Westhope and ASWUD System III	2-4A	104,500	6-16, PVC	Appraisal Design
Souris and ASWUD System I	2-4B, 2-4C	219,700	4-14, PVC	Appraisal Design
To Bowbells, Columbus, and Noonan	2-5	250,100	10, PVC	Appraisal Design
Gardena	2008-1	69,471	6-10, PVC	Installed

Note: Shaded rows in the table identify the components that were "Installed" between 2002 and 2012, or are "Under Construction" and being finalized. The components listed under "Appraisal Design" have not been fully designed or constructed, and are included in the appraisal-level designs of this Report.

USWUD Upper Souris Water District
ASWUD All Seasons Water Users District
MAFB Minot Air Force Base

Design Criteria

Several factors are considered in determining what size and type of pipe is required, such as peak demand, head loss, velocity, and material and installation costs. Combining the design flow through the pipeline with the length, size, and material of the pipe used gives a value for pressure lost through the length of pipe. A determination must be made regarding how much pressure loss is acceptable, and an appropriate pipe size and material must be chosen to satisfy pressure requirements. Among the available materials, PVC pipe was chosen for those pipelines with a smaller diameter. For consistency with designs developed for the Project thus far, pressure losses in pipelines will be determined using the Hazen-Williams formula, assuming a friction factor of 140 to account for any future degradation of pipe hydraulic characteristics.

Pipeline Installation

Pipelines would be installed with a minimum cover as specified by the North Dakota Department of Health; thus, this pipeline would not be graded and would follow surface topography. Pipe bedding and pipe zone material would consist of all of the material surrounding the pipe in the trench zone, from 6 inches below the pipe to 6 to 12 inches above the pipe, depending on pipe size. This material would have to be compacted so that pipe walls were supported and pipe flexure was kept within specified limits. For PVC pressure pipe, the maximum deflection should not exceed 3 percent of the outside diameter of the pipe. If there were any unstable material in the trench bottom or side walls, it would be removed and replaced with stable material to support the pipe zone material.

Changes in pipe direction, cross-sectional area, or isolation points develop additional thrust forces that act on the pipe and cause the need for thrust restraints. For PVC pipe, thrust restraint typically consists of thrust blocks of concrete poured in place to counteract the effects of those forces. Thrust restraints will be designed according to standard engineering practice to accommodate a combination of static and transient pressures with a safety factor and also take into account the bearing strength of the surrounding soil.

Meter and Control Valves

Metering facilities include a master meter at the head of the pipeline, meters at all pump stations, and meters and flow control valves on connecting pipelines. Master and customer meters allow for comparisons of inflow against totalized and metered outflow, although totalized outflow would never exactly equal metered inflow to the pipeline due to minor errors and variations in the meters and pipe losses.

The bulk distribution system includes meters installed in underground vaults at locations where main demand connections are set. They are typically paired along with an upstream combination of rate-of-flow/pressure-sustaining control valves on connecting pipelines. In order to protect the flow meter and control valve, a basket strainer is placed in-line ahead of the meter and control valve. Combination rate-of-flow/pressure-sustaining control valves are used to limit the flow to a preset maximum level and to maintain upstream pressure at or above a minimum level. This way, the pipeline downstream of the control valve is limited from placing too much demand on the supply system, and demand surges and pressure fluctuations are stabilized. The stabilizing effect of control valves allows for less fluctuation in the treatment process and contributes to ease and efficiency of the operation of both the treatment plant and the entire system.

Pipeline Appurtenances

Pipeline appurtenances mainly consist of air vacuums and air releases for allowing air to enter or exit the pipe when being drained or filled and blowoffs to facilitate draining the pipeline for maintenance and repairs.

Combination air-vacuum/air-release valves may be installed at high points along the pipeline profile, on the downhill side of mainline valves, at regular intervals on long stretches lacking clearly defined high points and wherever else deemed necessary. These valves would have a large orifice that vents air from the pipeline during filling and admits air during draining to avoid negative internal pressures that could damage the pipeline. Air-vacuum/air-release valves would be equipped with isolation valves and installed in vaults.

For vacuum relief during pipe draining, the valve would be sized based on the full pipeline design flow plus a 5-psi allowable differential pressure. For air venting during pipeline filling, a flow corresponding to a filling rate of 1 ft per second and an allowable pressure differential of 2 psi would be used. Air release valves are intended to release air accumulated during normal pipeline operation. According to standard engineering practice, the sizing of small-diameter air release valves is based on 2 percent of the design flow and the system pressure. For the purpose of the appraisal level design, one air-vacuum/air-release valve was assumed per mile of pipeline. The exact locations for air-vacuum/air-release valves would be determined during final design.

Flush risers (blowoffs) generally would be installed at low points in the pipeline profile and on the uphill sides of mainline valves. Flush risers would be sized to allow a reasonable time for pipe segments to drain. Typical diameters would be 20 percent of the mainline pipe diameter. Where reasonable, the flush risers would be drained to daylight. An energy dissipater would be provided where pipeline drainage would cause erosion. For the purpose of the appraisal level design, two to four flush risers are set for each pipeline of the same diameter.

Minot WTP Upgrades

The purpose of the Minot WTP is to treat the water supply to meet the rules and regulations implemented under the SDWA prior to distribution. The following discusses general design features that are common to each alternative. Details of Minot WTP upgrades are specific to each alternative, and further discussion can be found in Section 5 of this Report (Description of Project Alternatives).

Table 4-3 summarizes the disinfection and inactivation requirements for the Minot WTP. The design of the Minot WTP upgrades under each alternative was based on the following general assumptions:

- The capacity of the existing Minot WTP would be increased from 18 mgd to 27 mgd with the addition of clarification components.
- Source water is assumed to be Bin 4 under the LT2ESWTR for *Cryptosporidium* inactivation and therefore the facility has been designed to meet the highest level of log reduction. Once a source water assessment has been completed, the Bin classification requirements will be known, since they would have been determined by the results of the assessment.
- UV irradiation would be added for *Cryptosporidium* inactivation.

Table 4-3 Minot WTP Treatment Design Criteria

Item	Value	Units
Plant Capacity	27	mgd
Giardia Inactivation Requirement	3	log
Virus Inactivation Requirement	4	log
Cryptosporidium Inactivation Requirement	5.5[a]	log
Free Chlorine Residual Goal	2.0	mg/L
Total Chlorine Residual Goal	1.5	mg/L
Water Temperature	1	°C
pH	8.5	standard unit

Note: Rules and regulations implemented under the SDWA. Because a source water assessment for the Souris River has not been completed, a worst-case *Cryptosporidium* treatment requirement of Bin 4 classification has been assumed (5.5-log removal). Once a source water assessment has been completed, this requirement will be adjusted to meet the Bin classification requirements as determined by the results of the assessment.

°C degrees Centigrade
log log inactivation (inactivation measured on a logarithmic scale)
mgd million gallons per day
mg/L milligrams per liter

The City of Minot currently operates a lime-softening WTP with a rated capacity of 27 mgd for filtration; WTP operations are, however, limited by the plant's 18 mgd capacity for clarification

(aeration, clarifiers, and recarbonation). The WTP currently has two reactor-clarifier basins. One is rated at 6 mgd; the other is rated at 12 mgd. Each reactor-clarifier is preceded by tray aerators (primarily for hydrogen sulfide [H_2S] oxidation) and is followed by recarbonation basins, which are used to reduce the pH resulting from the lime-softening process. This step also converts hydroxide to carbonate and bicarbonate. High-rate reactor-clarifiers are commonly used for softening and clarification where water characteristics do not vary rapidly and operation is continuous. This type of clarification produces water that is slightly depositing (i.e., non-corrosive) by removing high concentrations of calcium and magnesium from the water, thus reducing its hardness.

The existing Minot WTP has the capability to obtain raw water from the Souris River via a pump station and river intake and also from existing wellfields in the Sundre and Minot aquifers. Currently, water supply is exclusively from the aquifers, and Souris River water has only been used as a direct supply during emergencies. As a result, the Minot WTP plant is currently considered a groundwater treatment plant and is therefore subject to the EPA's Groundwater Rule. Recharging the aquifers with Souris River water is expected to result in the groundwater source being designated as "groundwater under the direct influence" of surface water (GWUDI), which would result in the Minot WTP being subject to the requirements of the EPA's Surface Water Treatment Rule (SWTR) as well as all other applicable regulations.

The SWTR requires systems using surface water or GWUDI to (1) disinfect their water and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the levels indicated in Table 4-4.

Table 4-4 SWTR Contaminant Control Levels

Contaminant	Level
Cryptosporidium	99 percent (2-log) removal
Giardia	99.9 percent (3-log) removal/inactivation
Viruses	99.99 percent (4-log) removal/inactivation
Legionella	No limit, but EPA believes that if *Giardia* and viruses are removed or inactivated, *Legionella* also will be controlled
Turbidity	At no time can turbidity (cloudiness of water) go above 5 NTU; systems that filter must ensure that the turbidity goes no higher than 1 NTU (0.5 NTU for conventional or direct filtration) in at least 95 percent of the daily samples in any month; turbidity may never exceed 1 NTU and must not exceed 0.3 NTU in 95 percent of daily samples in any month
Heterotrophic Plate Count	No more than 500 bacterial colonies/mL

The LT2ESWTR applies to systems that use surface water or GWUDI. The purpose of the LT2ESWTR is to reduce illnesses linked with *Cryptosporidium* and other disease-causing microorganisms in drinking water. The rule supplements existing regulations by targeting additional *Cryptosporidium* treatment requirements to higher risk systems.

Additional treatment requirements are based, in part, on the assumption that conventional treatment plants with filtration performance in compliance with the Interim Enhanced Surface Water Treatment Rule achieve an average of 3-log removal of *Cryptosporidium*. Given this, the total *Cryptosporidium* removal requirements for action Bins 2 to 4 in Table 4-5 correspond to total *Cryptosporidium* removals of 4-log, 5-log, and 5.5-log, respectively.

Table 4-5 *Cryptosporidium* Inactivation Requirements

Bin Number	Average Source Water *Cryptosporidium* Concentration (oocysts/L)	Alternative Treatment Technologies		
		Conventional Filtration[a], Diatomaceous Earth Filtration, or Slow Sand Filtration	Direct Filtration	Alternative Filtration Technology
1	<0.075	No Action		
2	0.075 to <1.0	1-log[b]	1.5-log[b]	b, d
3	1.0 to <3.0	2-log[c]	2.5-log[c]	c, e
4	>3.0	2.5-log[c]	3-log[c]	c, f

Notes:

[a] Applies to a treatment train using separate, sequential, unit processes for coagulation/flocculation, clarification, and granular media filtration.

[b] May use any technology or combination of technologies from the microbial toolbox.

[c] Must achieve at least 1-log of the required treatment using ozone, chlorine dioxide, UV, membranes, bag filtration, cartridge filtration, or bank filtration.

[d] Total *Cryptosporidium* removal and inactivation must be at least 4-log.

[e] Total *Cryptosporidium* removal and inactivation must be at least 5-log.

[f] Total *Cryptosporidium* removal and inactivation must be at least 5.5-log.

Source: Adapted from Table IV.B.2 of the EPA, National Primary Drinking Water Regulations: LT2ESWTR, 40 CFR Parts 9, 141, and 142, January 5, 2006.

A utility determines its bin (or would in the future when a new source is developed) by conducting a 24-month monitoring survey of the source water for the presence of *Cryptosporidium* oocysts. The action bin assignment is based upon the mean concentration measured over this period. With selection of the Souris River as a source of supply for recharging the Minot and Sundre aquifers, the Project sponsor would be required to conduct a 24-month monitoring survey of the Souris River in conjunction with design of the improvements for use of this water. Depending on the bin assignment, a range of options can be chosen from the “microbial toolbox” (40 CFR 141.715). The improvements described in this Report are designed for compliance with Bin 4. The design criteria for the major components proposed for the Minot WTP facilities upgrades is provided in Table 4-6.

Table 4-6 Minot WTP Design Criteria

Item	Units	Alternative 1 Groundwater with Recharge	Alternative 2 Groundwater with Recharge and the Souris River	Alternative 3 Missouri River and Conjunctive Use	Alternative 4 Missouri River and Groundwater
Plant Capacity	mgd	27	27	27	27
Pretreatment Basin					
Type	-		DensaDeg®		
Capacity	mgd	-	4	-	-
Loading Rate	gpm/ft^2	-	8.1	-	-
Rapid Mix	hp	-	5	-	-
Flocculator	hp	-	7.5	-	-
Scraper Drive	hp	-	0.5	-	-
Recycle Pump	hp	-	10	-	-
Sludge Pump	hp	-	10	-	-
Clarification (New)					
Type	-	Accelator®			
Design Flow	mgd	11			
Hydraulic Capacity	mgd	12			
Number	No.	1			
Basin Diameter	ft	86			
Water Depth	ft	13.8			
Surface Loading Rate (@ design flow)	gpm/ft^2	1.47			
Detention Time	minutes	85			
Launder Type	-	Radial			
Impeller Type	-	Softening			
Impeller Drive	hp	15			
Scraper Dive	hp	1.5			
Recarbonation (New)					
Capacity	minutes	15			
Filtration (Existing)					
Type	-	Gravity Granular Media, Rate of Flow Control			
Number	No.	12			
Dimensions	ft x ft	20 x 18			
Surface Area (each)	ft^2	360			
Total Surface Area	ft^2	4,320			
Filtration Rate[a]					
Existing Criteria					
Flow Rate per Filter	mgd	2.17			
All Filters in Service	gpm/ft^2	4.2			
One Filter out of Service	gpm/ft^2	4.6			

Item	Units	Alternative 1 Groundwater with Recharge	Alternative 2 Groundwater with Recharge and the Souris River	Alternative 3 Missouri River and Conjunctive Use	Alternative 4 Missouri River and Groundwater
New Criteria					
Flow Rate per Filter	mgd	2.25			
All Filters in Service	gpm/ft^2	4.3			
One Filter out of Service	gpm/ft^2	4.7			
UV Irradiation (New)					
Type		Medium Pressure			
UV Transmittance	%	80			
Aging and Fouling Factor	%	80			
Effective Dosage (MS2 RED)	mJ/cm^2	36			
Number of Units (one standby)	No.	2			
Capacity per Unit	mgd	27			
Lamps/Sleeves per Unit	No.	9			

Notes: [a] Pilot testing would be required to determine the appropriate filtration rate during advanced phases of engineering design.
gpm/ft^2 gallons per minute per square foot
hp horsepower
mgd million gallons per day
mJ/cm^2 millijoule per square centimeter
No. number

High Service Pump Station and Reservoir at Minot WTP

Located in the immediate vicinity of the Minot WTP, northeast of 16th Street and northwest of the BNSF Railroad, the High Service Pump Station and its reservoir were designed by Houston Engineering and Montgomery Watson Harza and constructed in 2010 (Houston Engineering and MWH 2010). Designed for a total capacity of 26 mgd, the pump station has the purpose of raising the pressure and delivering water to City of Minot and to the Project's bulk distribution system.

Treated water from the Minot WTP is fed through a 42-inch pipe into the 2-MG underground reinforced concrete reservoir (located in the same structure as the pump station). The reservoir provides operational storage between the Minot WTP and the pump station. The pump station is currently equipped with two sets of pumps. The first set is installed and operational, providing water to the City of Minot. It includes four high-service, multistage vertical turbine pumps (three active and one standby) installed in parallel with a total capacity of 14.82 mgd at peak demand. This set of pumps discharges into a 20-inch discharge pipe that connects to the 30-inch trunk line that feeds the City of Minot water distribution system.

The second set of pumps is installed and operational, providing water to the Project's bulk distribution lines. They consist of four high-service, multistage vertical turbine pumps (three active and one standby) installed in parallel. Provisions have been made to add a fifth pump when needed. This set of pumps discharges to a 24-inch discharge pipe that connects to the Project's 36-inch DIP bulk distribution trunk line.

All high-service pumps are located on the top floor, elevation 1,564 msl. The pump sumps extend below the lower floor (elevation 1,545 msl) to elevation 1,534 msl. Two surge tanks located inside the pump station are connected to the city and Project discharge pipes. The surge tanks are 10 ft and 12 ft in diameter, respectively.

Reservoirs

Storage in a transmission system is generally composed of two components: operational storage and emergency storage. Operational storage is the amount of storage that allows the system to operate efficiently. In the case of pump stations, the operational storage requirements are those that allow them to operate without frequent on-off cycles while maintaining adequate suction head on the pumps. Emergency storage is the storage provided to meet demands in the event of a loss of production or transmission capabilities. The most obvious example is the loss of power to either the treatment plant or any of the pumping systems. Other examples of shutdown include maintenance and repair operations and pipeline rupture. For this Project, water would be pumped to users (as opposed to gravity flow), with emergency storage provided at selected locations along the transmission and bulk distribution lines. The amount of emergency storage required depends on several factors: alternative sources of supply, alternative production facilities, and standby facilities. Table 4-7 below identifies Project reservoirs common to all alternatives.

Table 4-7 Project Reservoirs (Tanks) Common to all Alternatives

Description	Contract	Capacity (gallons)	Status
Berthold Reservoirs	5-2B	500,000	Installed
	5-2B	750,000	Installed
Kenmare Reservoir	5-2C	1,000,000	Installed
South Prairie Reservoir	5-2A	3,000,000	Appraisal Design
Lansford Reservoir	5-3A	4,000,000	Appraisal Design
Bottineau Reservoir	5-4C	2,000,000	Appraisal Design

Note: Shaded rows identify the components that were “Installed” between 2002 and 2012. The components with status of as “Appraisal Design” have not been fully designed or constructed, and are included in the appraisal-level designs of this Report.

Design Criteria

The Project system is designed to deliver the combined flow resulting from each customer’s maximum day water demand over a 24-hour period. Actual water demands are subject to both hourly and seasonal fluctuations. To allow for a constant, uninterrupted water supply, the reservoirs must be able to provide the entire downstream water demand during any emergencies. The amount of emergency storage beyond the operational storage volume of the reservoirs is recommended to be of sufficient capacity to supply the average day water demand for 24 hours.

Determining reservoir locations depends on the operational parameters of the water delivery system and the topography of the proposed pipeline route. Reservoirs may be located on the highest elevation land available along the pipeline route between successive pump stations, at pump stations, or at locations where the highest demands exist. Final site selection would be determined during the design by site geology, accessibility, availability of existing electrical services, cost of land, and the potential for overflows and other discharges to affect surrounding land uses.

Reservoirs are fully enclosed watertight structures, to prevent any possible contamination from outside sources. Several types of reservoirs are suitable for use as storage facilities. Above-ground, circular post-stressed reinforced concrete or steel tanks would be used for this Project. Steel tanks are typically a more economical choice for storage volumes below 3 MG, but other considerations (site constructability, schedule, contractor capability) may dictate the tank be constructed from reinforced concrete. The configuration of each tank would be chosen to minimize earthwork, but it would generally have a width or diameter that is two to four times the height. Design and construction of the reservoirs would conform to applicable American Water Works Association standards.

Pump Stations

Pump stations would be sized and located to satisfy a pipeline's pressure and flow requirements. To overcome elevation differences and pressure loss from friction in the pipeline, pump stations would be designed to give an appropriate amount of pressure boost for varying flow rates without exceeding the rated pipe pressure. Certain pump stations, typically called booster stations, would be located on the pipeline to maintain adequate pressure in the pipe under varying demands. Small pump stations (booster stations) would be located underground, typically in climate-controlled vaults to minimize maintenance issues and the effects of environmental conditions. Table 4-8 shows Project pump stations that are common to all alternatives.

Table 4-8 Pump Stations Common to all Alternatives

Description	Contract	Capacity (mgd)	Status
Berthold Segment Pump Stations	4-2B		Installed
	4-2B		Installed
	4-2B		Installed
Kenmare Pump Station	4-2C		Installed
Lansford Pump Station	4-3A	3.89	Appraisal Design
Mohall Pump Station	4-2D	1.41	Appraisal Design
Tolley Pump Station	4-2D	1.34	Appraisal Design
Renville County Corn Pump Station	4-2D	1.34	Appraisal Design
Bottineau Pump Station,	4-4C	1.51	Appraisal Design
ASWU (Bottineau North) Pump Station	4-4C	0.54	Appraisal Design
Bowbells Pump Station	4-5A	0.49	Appraisal Design

Note: Shaded rows identify the components that were "Installed" between 2002 and 2012. The components listed with status of "Appraisal Design" have not been fully designed or constructed, and are included in the appraisal-level designs of this Report.

Design Criteria

Consideration was given to the number of pumping units to be placed in each pump station. More pumps allow greater flexibility in delivering various flow rates, but come at a higher cost. For ease of maintenance, it is generally desirable to have pumps of equal size. The pumps would be cycled on a rotating basis so they would be used evenly. In the case of a malfunction or failure of a

pumping unit, it is recommended that one standby pump, equal to the firm capacity of the largest single unit that might be out of service at any one time, be incorporated at each pump station.

Each pump station would have an electrical supporting system, which typically includes additional transformers, motor control centers, pumping motors, corresponding wiring and conduits, lighting, heating, and ventilation components, lightning protection, and other items associated with the instrumentation and control system. Electrical demands are based on the pump sizes, as well as the demands of the associated equipment present in the pump station. It is desirable to locate pump stations near available power sources; otherwise, new power lines would be routed to the pump station. Small pump stations (booster stations) would be located underground, typically in climate-controlled vaults to minimize maintenance issues and the effects of environmental conditions.

Rugby WTP

The community of Rugby is not physically connected to the Project distribution system, but their water treatment upgrades were funded under the Project; therefore the community is included in all alternatives. The current water system already has been upgraded. The WTP upgrades were implemented in two phases. Phase I received funds from the Project and was completed in 2005; thus, costs of these improvements are included in this Report. Phase II was funded through other sources.

Phase I included upgrades to the existing water treatment plant, consisting of one new and one replacement solids contact unit for lime softening, two new and two rehabilitated filters, new chemical feed equipment, electrical and instrumentation upgrades, upgrades to existing Wells 3 and 4, structural and architectural modifications, and associated equipment required to increase the water treatment plant capacity from 620 gpm (0.89 mgd) to 1,240 gpm (1.78 mgd).

Phase II consisted of the installation of four new wells and 9 miles of new raw water supply line, lime sludge pond improvements, and additional water treatment plant upgrades. No further upgrades are planned as part of this Project.

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Description of Project Alternatives

This section provides an overview of the four alternatives and their costs. Components included in each alternative are shown in Table 5-1. Details included in Sections 2, 3, and 4 are not repeated, but components that are unique to each alternative are discussed below.

Both construction and O&M costs were developed as part of this Report. Construction costs include all labor, equipment, materials, incidentals, and appurtenances required to comply with typical Reclamation construction specifications. The construction costs summarized below also include mobilization, unlisted costs, contract costs, contingencies, and non-contract costs. Additional details regarding construction costs are provided in the Cost Assumptions and Factors section included in Appendix F. O&M costs include power consumption, equipment maintenance and replacement, labor, chemicals, power, and miscellaneous costs, as detailed in the Basis of O&M Costs section included in Appendix F.

Alternative 1, Groundwater with Recharge

Overview

Under Alternative 1, Souris River water would be used to recharge the Minot and Sundre aquifers. The existing groundwater collection system would be upgraded to increase capacity. Two new recharge basins would be constructed, supplemented by six new peaking wells. Two new intake structures would be constructed on the Souris River. New feeder pipelines would be constructed to deliver water from the river to the recharge facilities. Small-scale storage intended to accommodate a peak 24-hour demand would be provided by the reservoirs and tanks located at main distribution nodes. Raw water would be conveyed to the upgraded Minot WTP through a network of upgraded collector lines. Treated water would be distributed throughout the Project Area via existing and planned Project distribution pipelines.

Components Included in Alternative 1

Alternative 1, Groundwater with Recharge, includes the components that are described in Sections 2 and 4 of this Report and shown in Table 5-1; a schematic showing the locations of capture (intake structures), recharge (basins), collection, and treatment components is included in Figure 5-1. Details regarding components that are specific to Alternative 1 are discussed below, and additional details are shown in Appendix B.

Table 5-1 Project Alternatives and their Components

Component	Status	Alternative 1 Groundwater with Recharge	Alternative 2 Groundwater with Recharge and Souris River	Alternative 3 Missouri River and Conjunctive Use	Alternative 4 Missouri River and Groundwater
Recharge Facility 1 – Minot Aquifer (intake structure and feeder lines, sediment settling facility, recharge basin, recharge wells)	Proposed	•	•		

Component	Status	Alternative 1 Groundwater with Recharge	Alternative 2 Groundwater with Recharge and Souris River	Alternative 3 Missouri River and Conjunctive Use	Alternative 4 Missouri River and Groundwater
Recharge Facility 2 – Sundre Aquifer (intake structure and feeder lines, sediment settling facility, recharge basin, recharge wells)	Proposed	●	●		
Peaking Well Facilities (6)	Proposed	●	●		
Upgraded Collector Lines	Proposed	●	●		
Intake and Pump Station at Lake Sakakawea	Proposed			●	●
Biota WTP and Pump Station	Proposed			●	●
South Prairie Storage Reservoir	Proposed			●	●
Transmission Pipeline (new connections need to be constructed under Alternatives 3 and 4)	Existing	●	●	●	●
Bulk Distribution Pipelines	Existing & Proposed	●	●	●	●
Upgraded Minot WTP	Proposed	●	●	●	●
High Service Pump Station and Reservoir at Minot WTP	Existing	●	●	●	●
Storage Reservoirs (3) (near Burlington, Berthold, and Kenmare)	Existing	●	●	●	●
Storage Reservoirs (2) (near Lansford and Bottineau)	Proposed	●	●	●	●
Pump Stations (4) (near Berthold and south of Kenmare)	Existing	●	●	●	●
Pump Stations (7) (near Lansford, Mohall, Tolley, Renville County Corner, Bottineau [2 units]), and Bowbells	Proposed	●	●	●	●
Rugby WTP	Existing	●	●	●	●

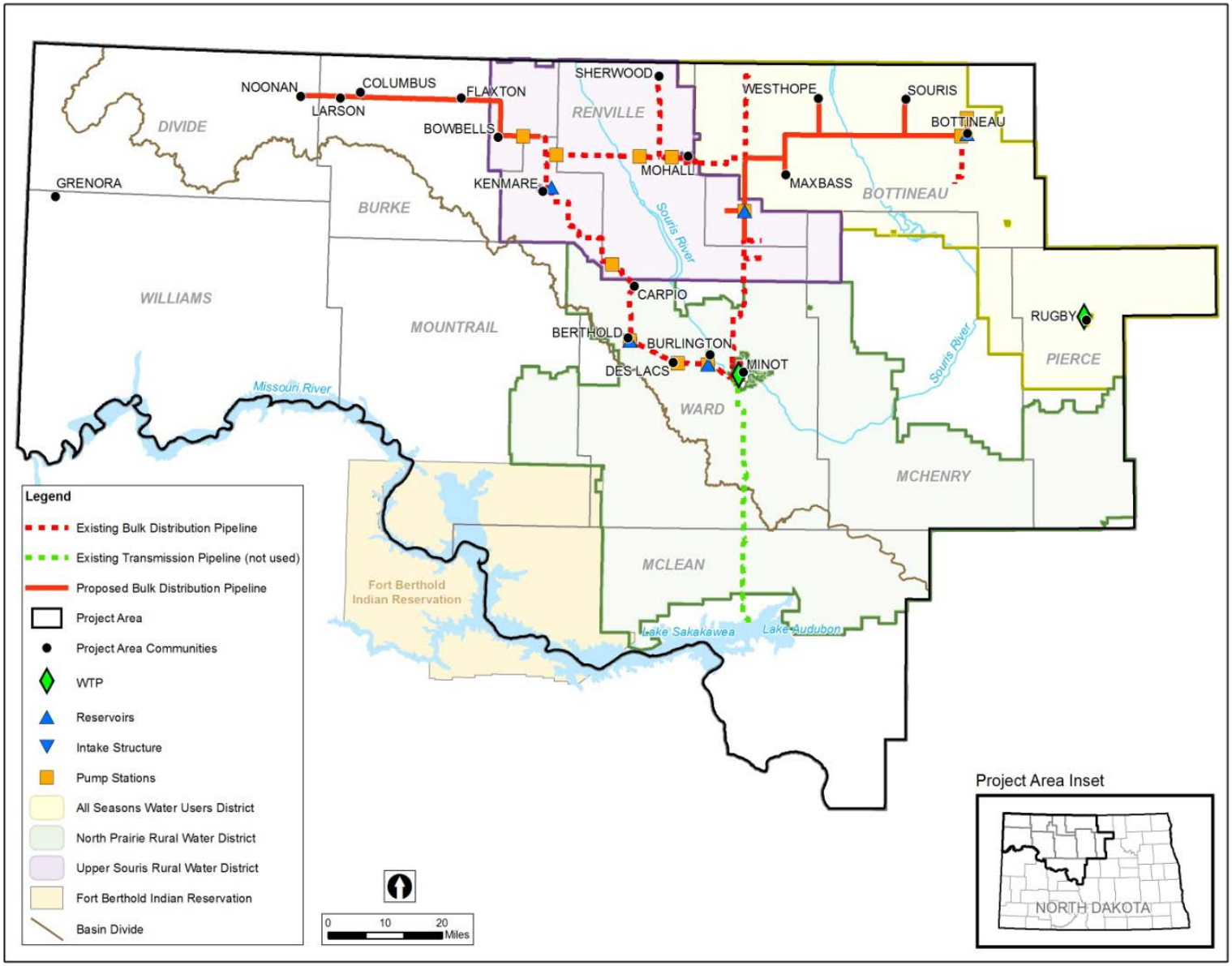


Figure 5-1 Schematic of Inbasin Alternatives

Alternative 1 Water Needs and Sources

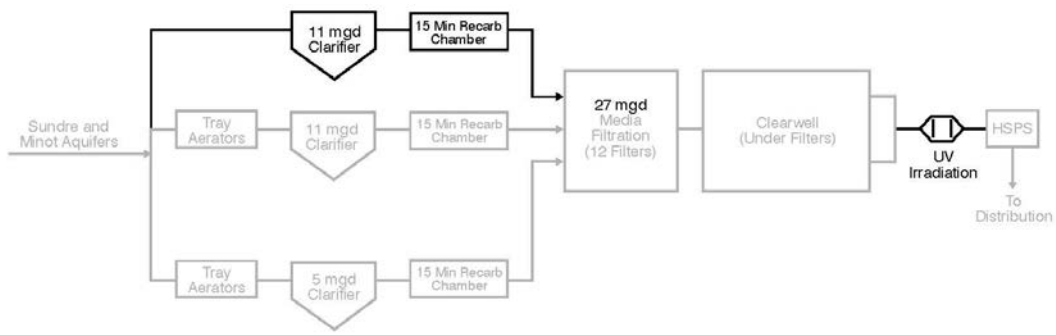
Details regarding water needs and sources under this alternative are presented in Table 5-2.

Table 5-2 Alternative 1 – Estimated Water Needs and Water Sources

	Average (mgd)	Peak (mgd)
Locations		
Treated at the Minot WTP and Distributed	10.1	26.3
Sources		
Minot and Sundre Aquifers	10.1	26.3

Minot WTP Upgrades under Alternative 1

The Minot WTP facility upgrades under this alternative include a new softening and recarbonation process train similar to the existing WTP to increase treatment capacity from 18 mgd to 27 mgd. A UV disinfection system also been proposed for *Cryptosporidium* inactivation, a conservative assumption in the event that a future source water assessment of the Souris River results in a Bin 4 classification under the SWTR. Figure 5-2 is a PFD of the Minot WTP under this alternative.



Note: Darker lines indicate proposed treatment improvements; lighter lines indicate existing features.

Figure 5-2 Minot WTP PFD – Groundwater with Recharge Alternative

The capacity of existing sludge handling and disposal operations has been considered under future conditions associated with this alternative. While existing sludge handling facilities provide adequate capacity for this alternative, future sludge production is highly dependent on water quality at the time of treatment.

Aeration

Although tray aerators are currently installed at the Minot WTP for stripping H_2S from the source water (one for each clarification treatment train), additional aeration capacity at the expanded facility has not been included. Conversations with staff at the City of Minot (Sorenson, pers. comm., 2012) have indicated that H_2S is only a problem in two of their existing wells (Nos. 5 and 6), which are seldom used or blended at lower flows with higher quality wells. Input received indicates that inclusion of aeration in the expanded process would not be necessary. However, the aeration system currently used at the Minot WTP will remain in operation and provide some H_2S removal from the water treated through most of the treatment process (i.e., two-thirds of the treatment capacity).

Clarifier

A new 11-mgd softening clarifier is proposed to increase the capacity of the Minot WTP from 18 mgd to 27 mgd. Figure 5-3 depicts a package softening clarifier from Infilco Degrémont. Water enters the clarifier through the inlet pipe into the primary mixing and reaction zone. Clarified water proceeds into the clarification zone. The finished water is collected through a series of launders or laterals that discharge treated water into the effluent trough and then to the existing filter inlet channel.

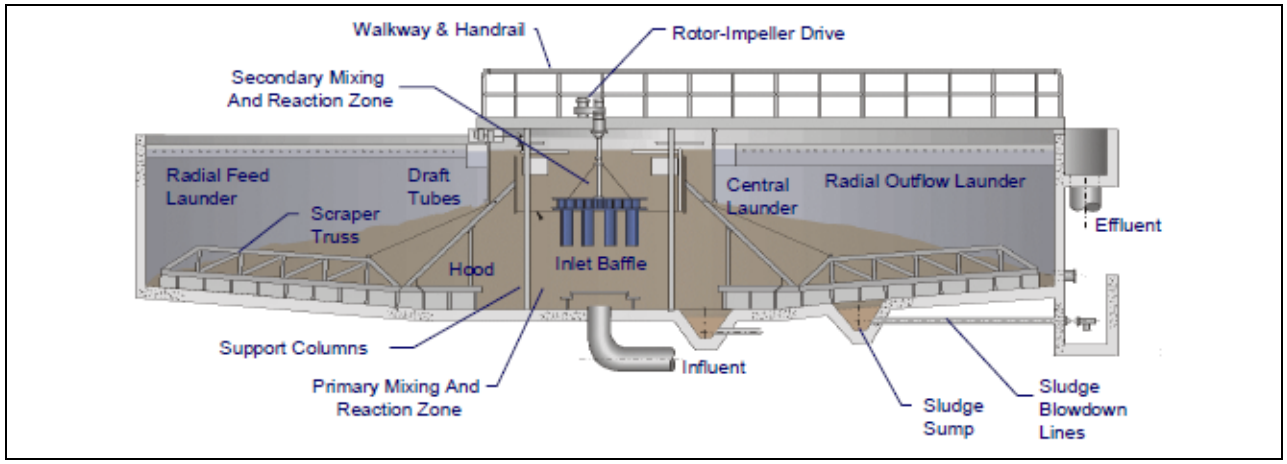


Figure 5-3 Accelator® Clarifier (used with permission from Infilco Degrémont)

Recarbonation

The proposed single stage recarbonation basin would be provided downstream of the new softening clarifier and upstream of the existing filters to reduce the pH and stabilize the water to prevent the deposition of carbonate scale on the filter media and downstream piping. Treated water through the existing and proposed lime softening clarifiers typically has a pH of 10. Carbon dioxide would be added to the water following the softening clarifiers to reduce the pH to 8.5 or 9.0 standard units prior to filtration. The proposed recarbonation basin would have approximately 15 minutes of contact time (similar to the existing recarbonation basins).

Filtration

The filters at the existing Minot WTP were previously upgraded from 18 mgd to 27 mgd. No additional filter upgrades are proposed.

UV Irradiation

The purpose of the proposed UV irradiation system is to provide 3-log inactivation *Cryptosporidium*. A medium-pressure UV irradiation system is proposed, which would employ two reactor vessels with a treatment capacity of 27 mgd each. Two reactors would be provided so that the target UV dose can be achieved at full system capacity (27 mgd) with one reactor out of service (i.e., there is a spare reactor). Each reactor would be designed to provide a UV dose of 36 mJ/cm^2 at a maximum flow rate of 27 mgd and minimum 80 percent UV transmittance.

Collector Lines

Each of the existing collector lines from the Minot and Sundre aquifers would be supplemented with a new (additional) pipeline. The new pipelines would be constructed parallel to the existing

pipelines. The new and existing pipelines would be interconnected to allow for balancing of hydraulic losses and for additional conveyance of the extra capacity provided by the peaking wells to the Minot WTP. Table 5-3 indicates the upgrades in capacity required for both collector lines in two ways: by the size of the additional pipeline required to transport the extra capacity and by the equivalent hydraulic pipe size[11] required to transport the total proposed capacity.

Table 5-3 Alternative 1 – Upgrades to Groundwater Collector Lines to the Minot WTP

Minot Aquifer					Sundre Aquifer				
Existing		Proposed			Existing		Proposed		
Capacity (mgd)	Size (in)	Capacity (mgd)	Additional Size (in)	Equivalent Size (in)	Capacity (mgd)	Size (in)	Capacity (mgd)	Additional Size (in)	Equivalent Size (in)
7.78	16	11.84	4	18	11.36	20	19.44	12	224

The cost of upgrades (developed in Appendix F) is based on constructing the additional pipeline. Replacing the existing pipelines with the equivalent size pipelines would require service interruptions, installation of temporary bypass pipes, and would be more expensive because of the cost of the larger pipe. Upgrades are usually implemented by dividing the pipeline in segments and upgrading each segment individually. Specific alignment conditions and constraints were not analyzed at this level of design, but implementation of the upgrades may require the use of either of the options (new parallel pipeline or replacement of existing pipeline) on a segment-by-segment basis.

The combined total capacity of the aquifers is 32.3 mgd, in excess of the 26.3 mgd required at peak demand. New pipeline sizes and the equivalent hydraulic pipeline sizes were developed based on the total capacity in each aquifer. This is a more expensive solution, but it has operational advantages; the system has more flexibility in shifting groundwater pumpage between the Minot and Sundre aquifers without reaching their maximum capacity at peak consumption.

Alternative 1 Total Costs

The projected total costs for supply, transmission, distribution, storage, and water treatment for Alternative 1, Groundwater with Recharge are provided in Table 5-4. Annual O&M costs include all facilities, not only those required for the expanded capacity. Costs of existing facilities are shaded in the table. Detailed construction and O&M cost estimates are included in Appendix F.

[11] The equivalent hydraulic pipe size is calculated based on the total flow capacity of the two (or more) parallel pipelines. For this level of design, it was assumed that the new pipeline is made of the same material as the existing pipeline. This assumption simplifies the calculation and the equivalent diameter becomes only a function of the sizes of the parallel pipelines.

Table 5-4 Alternative 1 – Components and Costs

Description	Construction Cost[a]	Annual O&M Cost[a]
Supply		
Existing Wells – Minot Aquifer		$255,960
Existing Wells – Sundre Aquifer		$374,460
New Peaking Wells – Minot Aquifer	$1,632,546	$75,840
New Peaking Wells – Sundre Aquifer	$931,650	$132,720
New Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer	$6,623,050	$164,469
New Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer	$6,217,645	$163,397
Transmission		
Pipeline and Appurtenances, SCPP to Minot	$30,940,000	$773,500
Upgraded Collection Line from Minot Aquifer	$1,594,986	$43,040
Upgraded Collection Line from Sundre Aquifer	$4,257,909	$87,875
Distribution		
Minot Area Pipeline	$9,310,042	$232,751
Berthold Segment Pipeline and Pump Stations	$4,445,583	$124,476
Kenmare and USWUD Pipeline, Kenmare Pump Station	$5,259,084	$147,254
Pipelines: Mohall, Sherwood, ASWUD System III	$6,376,723	$159,418
Pipeline to MAFB	$6,969,551	$174,239
Pipeline: MAFB to Glenburn	$4,248,713	$106,218
Pipeline: Glenburn to Renville Corner	$6,275,661	$104,577
Pipelines: Westhope and ASWUD III	$7,686,367	$120,633
Pipeline: Souris and ASWUD System I	$11,981,860	$168,505
Pipeline to Bowbells, Columbus, and Noonan	$11,563,734	$159,789
High Service Pump Station at Minot WTP	$14,075,578	$422,267
Lansford Pump Station	$1,698,229	$203,413
Bowbells Pump Station	$300,458	$41,432
Mohall Segment Pump Stations (Mohall, Tolley and Renville County Corner)	$1,103,973	$182,580
Bottineau West, Bottineau North Pump Stations	$757,632	$110,946
Storage		
Berthold Reservoirs	$1,135,652	$22,700
Kenmare Reservoir	$1,843,199	$36,900
Lansford Reservoir	$5,442,905	$56,469
Bottineau Reservoir	$3,599,543	$46,213
New Recharge, Minot Aquifer	$10,480,881	$156,743
Minot Aquifer Testing and Modeling for Final Design[b]	$2,955,306	–
New Recharge, Sundre Aquifer	$18,154,699	$156,743
Sundre Aquifer Testing and Modeling for Final Design[b]	$3,303,366	–
Treatment		
Minot WTP Proposed Improvements	$11,469,617	
Minot WTP Completed Improvements	$24,000,000	$4,000,000
Rugby WTP Completed Improvements	$1,795,000	–

Description	Construction Cost[a]	Annual O&M Cost[a]
TOTAL – Actual Expenditures and Components Currently under Construction	$110,399,125	$6,830,143
TOTAL – Proposed Components – Costs to Complete this Alternative	$118,032,017	$2,175,384
OVERALL TOTAL	$228,400,000	$9,010,000

Notes:
[a] Shaded cells indicate expenditures or components currently under construction.
[b] Additional costs for testing and modeling as indicated in Appendix A. These costs do not include mobilization, unlisted items, contingencies or noncontract costs.

ASWUD All Seasons Water Users District
MAFT Minot Air Force Base
mgd million gallons per day
USWUD Upper Souris Water District
WTP Water Treatment Plant

Alternative 2, Groundwater with Recharge and the Souris River

Overview

This inbasin alternative uses the existing Minot and Sundre aquifer wellfields as the primary water supply, with the Souris River providing supplemental recharge and a direct supply. The components for the recharge facilities, peaking wells, and collector lines would be the same as described for Alternative 1. The primary difference between this alternative and Alternative 1, Groundwater with Recharge, is that Souris River water would be used to provide water directly to the Minot WTP, in addition to recharging the Minot and Sundre aquifers.

Components Included in Alternative 2

Alternative 2, Groundwater with Recharge and the Souris River, would include the components that are described in Sections 2 and 4 and shown in Table 5-1; a schematic showing the locations of capture (intake structures), recharge (basins), collection, and treatment components is included in Figure 5-1. Details regarding components that are specific to this alternative are discussed below.

Alternative 2 Water Needs and Sources

Details regarding water needs and sources under this alternative are presented in Table 5-5.

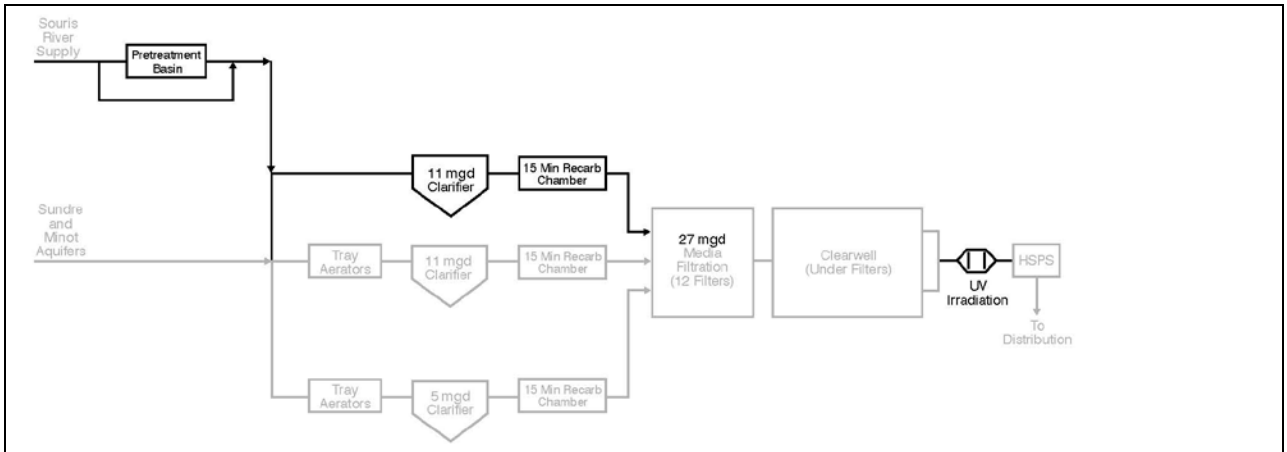
Table 5-5 Alternative 2 – Estimated Water Needs and Water Sources

	Average (mgd)	Peak (mgd)
Locations		
Treated at the Minot WTP and Distributed	10.1	26.3
Sources		
Minot Groundwater	10.1	23.6
Souris River Surface Diversion	0	2.7

Minot WTP Upgrades under Alternative 2

The Minot WTP facility upgrades include a new softening and recarbonation process train similar to the existing WTP to increase treatment capacity from 18 mgd to 27 mgd. A UV disinfection system has also been proposed for *Cryptosporidium* inactivation. In addition, UV disinfection is currently included at the Minot WTP, but may not be needed depending upon results of *Cryptosporidium* testing in the Souris River water (2-year process).

Because the Souris River is known to have fluctuating water quality, both seasonally and on a daily basis, a separate 4 mgd pre-treatment basin is included to reduce the effects on the other water treatment processes for this alternative. Plant staff (Sorenson, pers. comm., 2012) also indicated that operation of the Minot WTP using the Souris River has been a challenge in the past and was one of the reasons the source was abandoned as a primary water source in favor of using groundwater exclusively. A static mixer downstream of the source waters would be combined to provide adequate blending of the waters prior to treatment. Figure 5-4 shows a general PFD of the Minot WTP for Alternative 2.

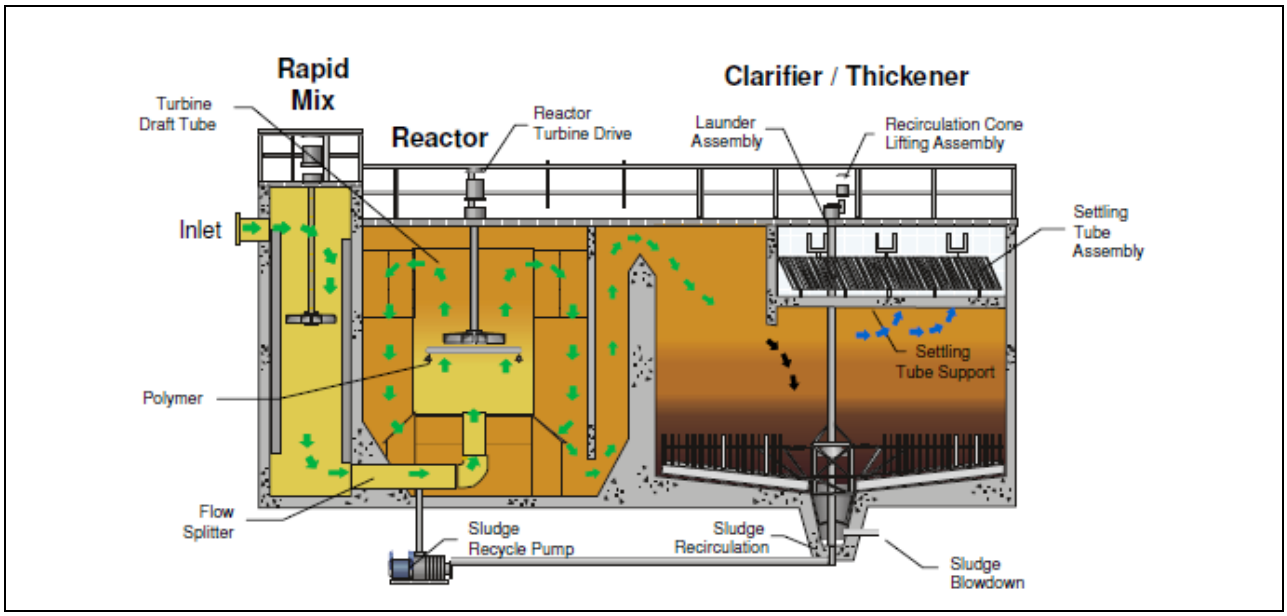


Note: Darker lines indicate proposed treatment improvements; lighter lines indicate existing features.

Figure 5-4 Minot WTP PFD – Groundwater with Recharge and the Souris River Alternative

Pretreatment Basin

Souris River water would enter the proposed pretreatment system, where it would be treated with chemicals for coagulation. It would be further treated in the reactor zone and would then move beneath the baffle into the clarification zone. Finished water would be collected through a series of launders or laterals that discharge treated water into the effluent trough. The clarification, recarbonation, filtration, and UV irradiation elements are as described for Alternative 1, Groundwater with Recharge. Figure 5-5 depicts a package high-rate clarifier from Infilco Degrémont.



Source: Used with permission from Infilco Degrémont

Figure 5-5 DensaDeg® Clarifier

Collector Lines

Each of the existing collector lines from the Minot and Sundre aquifers would be supplemented with a new (additional) pipeline. The new pipelines would be constructed parallel to the existing pipelines. The new and existing pipelines would be interconnected to allow for balancing of hydraulic losses and for additional conveyance of the extra capacity provided by the peaking wells to the Minot WTP. Table 5-6 indicates the upgrades in capacity required for both collector lines in two ways: by the size of the additional pipeline required to transport the extra capacity and by the equivalent hydraulic pipe size required to transport the total proposed capacity. The cost of upgrades (developed in Appendix F) is based on constructing the additional pipeline. Replacing the existing pipelines with the equivalent size pipelines would require service interruptions, installation of temporary bypass pipes, and would be more expensive due to the cost of the larger pipe.

Table 5-6 Alternative 2 – Upgrades to Groundwater Collector Lines to the Minot WTP

Minot Aquifer					Sundre Aquifer				
Existing		Proposed			Existing		Proposed		
Capacity (mgd)	Pipe Size (in)	Capacity (mgd)	Additional Pipe Size (in)	Equivalent Size (in)	Capacity (mgd)	Pipe Size (in)	Capacity (mgd)	Additional Pipe Size (in)	Equivalent Pipe Size (in)
7.78	16	10.0	4	18	11.36	20	13.60	4	22

Upgrades are usually implemented by dividing the pipeline into segments and upgrading each segment. Specific alignment conditions and constraints were not analyzed at this level of design, but implementation of the upgrades may require the use of either of the options (new parallel pipeline or replacement of existing pipeline) on a segment-by-segment basis.

Note that the peak water supply provided from groundwater sources for Alternative 2 is 23.6 mgd, which is significantly less than the 31.3 mgd total capacity from all existing and proposed

wells under Alternative 1, Groundwater with Recharge. Therefore, the sizes of new pipelines presented in Table 5-6 are smaller than those for Alternative 1 (Table 5-3). However, if specific pipeline segment constraints require the upgrades to be performed by pipeline replacement, equivalent pipeline sizes used in this alternative would be identical to those used in Alternative 1.

Alternative 2 Total Costs

The projected total costs for supply, transmission, distribution, storage, and water treatment for the Groundwater with Recharge and the Souris River Alternative are provided in Table 5-7. Annual O&M costs include all facilities, not just those required for the expanded capacity. Costs of existing facilities are shaded in the table. Detailed construction and O&M cost estimates are included in Appendix F.

Table 5-7 Alternative 2 – Components and Costs

Description	Construction Cost[a]	Annual O&M Cost[a]
Supply		
Existing Wells – Minot Aquifer		$255,960
Existing Wells – Sundre Aquifer		$374,460
New Peaking Wells – Minot Aquifer	$1,632,546	$75,840
New Peaking Well – Sundre Aquifer	$931,650	$132,720
Existing Surface Water Intake at Minot WTP (5.75 mgd)		$20,000
New Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer	$6,623,050	$164,469
New Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer	$6,217,645	$163,397
Transmission		
Pipeline and Appurtenances, SCPP to Minot	$30,940,000	773,500
Upgraded collection line from Minot Aquifer	$1,594,986	43,040
Upgraded collection line from Sundre Aquifer	$2,956,100	80,470
Distribution		
Minot Area Pipeline	$9,310,042	$232,751
Berthold Segment Pipeline and Pump Stations	$4,445,583	$124,476
Kenmare and USWUD Pipeline, Kenmare Pump Station	$5,259,084	$147,254
Pipelines: Mohall, Sherwood, ASWUD System III	$6,376,723	$159,418
Pipeline to MAFB	$6,969,551	$174,239
Pipeline: MAFB to Glenburn	$4,248,713	$106,218
Pipeline: Glenburn to Renville Corner	$6,275,661	$104,577
Pipelines: Westhope and ASWUD System III	$7,686,367	$120,633
Pipeline: Minot and ASWUD System I	$11,981,860	$168,505
Pipeline to Bowbells, Columbus and Noonan	$11,563,734	$159,789
High Service Pump Station at Minot WTP	$14,075,578	$422,267
Lansford Pump Station	$1,698,229	$203,413
Bowbells Pump Station	$300,458	$41,432
Mohall Segment Pump Stations (Mohall, Tolley, and Renville County Corner)	$1,103,973	$182,580
Bottineau West, Bottineau North Pump Stations	$757,632	$110,946

Description	Construction Cost[a]	Annual O&M Cost[a]
Storage		
Berthold Reservoirs	$1,135,652	$22,700
Kenmare Reservoir	$1,843,199	$36,900
Lansford Reservoir	$5,442,905	$56,469
Bottineau Reservoir	$3,599,543	$46,213
New Recharge Minot Aquifer	$10,480,881	$156,743
Minot Aquifer Testing and Modeling for Final Design[b]	$2,955,306	–
New Recharge Sundre Aquifer	$18,154,699	$156,743
Sundre Aquifer Testing and Modeling for Final Design[b]	$3,303,367	–
Treatment		
Minot WTP Proposed Improvements	$13,335,511	
Minot WTP Completed Improvements	$24,000,000	$4,000,000
Rugby WTP Completed Improvements	$1,795,000	-
TOTAL – Actual Expenditures and Common Components Currently under Construction	$110,399,125	$6,850,143
TOTAL - Proposed Components – Cost to Complete this Alternative	$118,596,103	$2,167,979
OVERALL TOTAL[c]	$229,000,000	$9,020,000

Notes:
[a] Shaded cells indicate expenditures or components currently under construction.
[b] Additional costs for testing and modeling as indicated in Appendix A. These costs do not include mobilization, unlisted items, contingencies or noncontract costs.
[c] Construction costs were rounded to the nearest $100,000. O&M costs were rounded to the nearest $10,000.

Alternative 3, Missouri River and Conjunctive Use

Overview

The Missouri River is the primary water supply source for this alternative. The water would be diverted from Lake Sakakawea through a surface water intake. Three optional locations for the intake are considered. Water from the Missouri River would be conveyed to the Minot WTP through the existing transmission pipeline, where it would be blended with groundwater from the existing wellfields in the Minot and Sundre aquifers along with Souris River water intercepted at the existing surface water intake at the Minot WTP. Missouri River water also would be treated at the Biota WTP located on the existing transmission line, near the City of Max. Five treatment options are considered for the Biota WTP. The purpose of the Biota WTP is to reduce the Project-related risks of the transfer of microscopic, invasive species from the Missouri River basin to the Hudson Bay basin. After treatment at the Biota WTP, the water would be then delivered to the existing Minot WTP where it would receive final treatment to SDWA standards. The Minot WTP would be upgraded to handle the additional demand. The current processes employed at the existing Minot WTP would not change substantially under this alternative, although its rated treatment capacity would increase from 18 mgd to 27 mgd with the addition of a treatment basin for pretreatment of Souris River water. UV disinfection is proposed at the Minot WTP, but may not be needed depending upon results of *Cryptosporidium* testing in the Souris River water (a 2-year process). Distribution throughout the Project Area would be via planned and constructed

Project distribution pipelines. System storage would be provided by planned and constructed reservoirs and tanks at main distribution nodes within the Project Area.

Components Included in Alternative 3

Alternative 3, Missouri River and Conjunctive Use, would include the components that are described in Sections 3 and 4 and shown in Table 5-1. Costs of existing facilities are shaded in the table. Detailed construction and O&M cost estimates are included in Appendix F. A schematic showing the locations of capture (intake structures) and treatment components is included in Figure 5-6. Details regarding components that are specific to Alternative 3 are discussed below.

Alternative 3 Water Needs and Sources

The water needs and sources under this alternative are presented in Table 5-8.

Table 5-8 Alternative 3 – Estimated Water Needs and Water Sources

	Average (mgd)	Peak (mgd)
Locations		
Treated at the Minot WTP and Distributed	10.1	26.3
Sources		
Minot Groundwater	1.0	2.6
Missouri River	10.92	22.0
Souris River	0	1.7

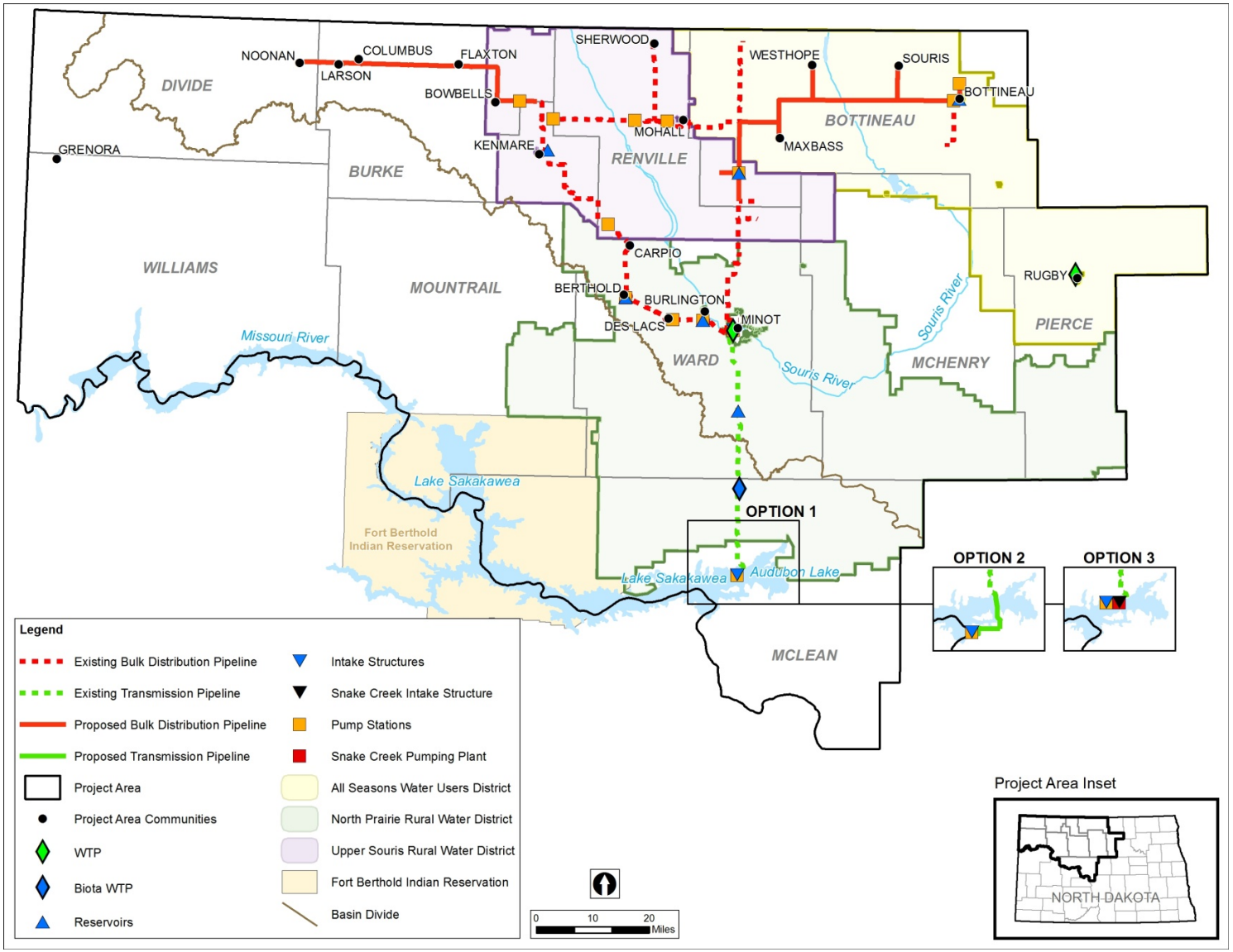
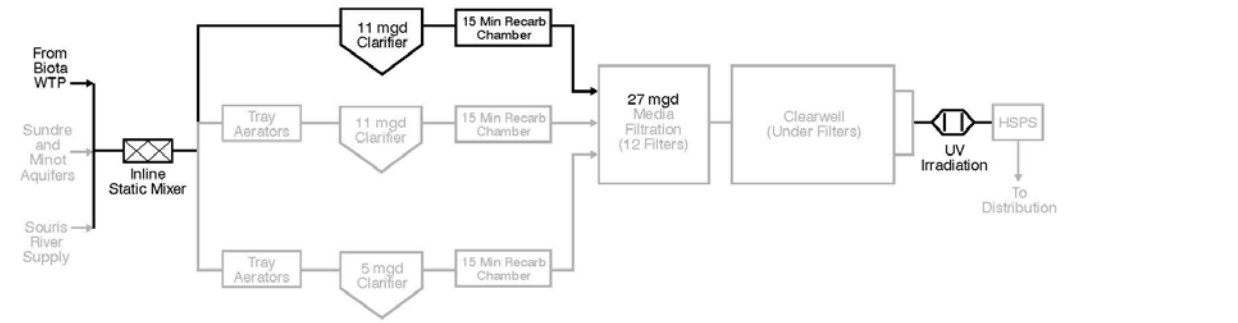


Figure 5-6 Schematic of Missouri River Alternatives

Minot WTP Upgrades under Alternative 3

The Minot WTP facility upgrades would be similar to those under Alternative 1, Groundwater with Recharge. Upgrades would include a new softening and recarbonation process train similar to the existing WTP to increase treatment capacity from 18 mgd to 27 mgd and a static mixer downstream of where the source waters are combined to provide adequate blending of the waters prior to treatment. A UV disinfection system also has been proposed for *Cryptosporidium* inactivation. In addition, UV disinfection is currently included at the Minot WTP, but may not be needed depending upon results of *Cryptosporidium* testing in the Missouri and Souris rivers water (2-year process). Figure 5-7 show a general PFD of the Minot WTP for the Missouri River and Conjunctive Use Alternative.



Note: Darker lines indicate proposed treatment improvements; lighter lines indicate existing features.

Figure 5-7 Minot WTP PFD – Missouri River and Conjunctive Use Alternative

Alternative 3 Total Costs

Construction costs and O&M costs for all common components in this alternative are included in Table 5-9. The costs are inclusive of the Minot WTP, but exclude intake and Biota WTP options.

Construction costs and O&M costs for the proposed Lake Sakakawea intake and pump station options are presented in Tables 5-10, 5-11, and 5-12. The tables include connections to the existing transmission pipeline as part of each option.

Table 5-9 Alternative 3 – Common Components and Costs, Excluding Intake and Biota WTP Options

Description	Construction Cost[a]	Annual O&M Cost[a]
Supply – Common		
Existing Wells – Minot Aquifer		$42,770
Existing Wells – Sundre Aquifer		$42,850
Existing Surface Water Intake at Minot WTP		$20,000
Transmission – Common		
Pipeline and Appurtenances, SCPP to Minot	$30,940,000	$773,500
Distribution – Common		
Minot Area Pipeline	$9,310,042	$232,751
Berthold Segment Pipeline and Pump Stations	$4,445,583	$124,476
Kenmare and USWUD Pipeline, Kenmare Pump Station	$5,259,084	$147,254
Pipelines: Mohall, Sherwood, ASWUD System III	$6,376,723	$159,418
Pipeline to MAFB	$6,969,551	$174,239
Pipeline: MAFB to Glenburn	$4,248,713	$106,218
Pipeline: Glenburn to Renville Corner	$6,275,661	$104,577
Pipelines: Westhope and ASWUD System III	$7,686,367	$120,633
Pipeline: Minot and ASWUD System I	$11,981,860	$168,505
Pipeline to Bowbells, Columbus and Noonan	$11,563,734	$159,789
High Service Pump Station at Minot WTP	$14,075,578	$422,267
Lansford Pump Station	$1,698,229	$203,413
Bowbells Pump Station	$300,458	$41,432
Mohall Segment Pump Stations (Mohall, Tolley, and Renville County Corner)	$1,103,973	$182,580
Bottineau West, Bottineau North Pump Stations	$757,632	$110,946
Storage – Common		
Berthold Reservoirs	$1,135,652	$22,700
Kenmare Reservoir	$1,843,199	$36,900
South Prairie Reservoir	$3,022,666	$40,781
Lansford Reservoir	$5,442,905	$56,469
Bottineau Reservoir	$3,599,543	$46,213
Treatment		
Minot WTP proposed improvements	$11,640,000	
Minot WTP completed improvements	$24,000,000	$4,000,000
Rugby WTP Completed Improvements	$1,795,000	-
TOTAL – Actual Expenditures and Components Currently Under Construction	$110,399,125	$6,305,343
TOTAL – Proposed Common Components – cost to complete	$65,073,028	$1,235,338
OVERALL TOTAL FOR COMMON COMPONENTS[b]	$175,500,000	$7,540,000

Description	Construction Cost[a]	Annual O&M Cost[a]

Notes:
[a] Shaded cells indicate expenditures or components currently under construction.
[b] Construction costs were rounded to the nearest $100,000. O&M costs were rounded to the nearest $10,000.
ASWUD All Seasons Water Users District
MAFB Minot Air Force Base
SCPP Snake Creek Power Plant
USWUD Upper Souris Water District
WTP Water Treatment Plant

Table 5-10 Upgraded SCPP Intake and Pump Station Costs

Description	Qty	Unit	Unit Cost[a]	Construction Cost[a]	Annual O&M Cost
Demolition and Removal	1	LS	$2,408,970	$2,408,970	-
Site Work and Buildings	1	LS	$5,264,635	$5,264,635	-
Plumbing, Fire	1	LS	$170,420	$170,420	-
Piping and Valves	1	LS	$1,721,564	$1,721,564	-
Pumping Units	1	LS	$2,023,271	$2,023,271	-
Flow Meter	1	LS	$67,568	$67,568	-
Surge Tank	1	LS	$564,664	$564,664	-
Power Generator	1	LS	$461,334	$461,334	-
Electrical	1	LS	$569,058	$569,058	-
Upgraded Intake and Pump Station				$13,251,480	$970,668
36-inch Connection, Pump Station to Existing Pipeline	2,400	LF	$243	$583,000	$14,600
TOTAL				$13,834,480	$985,268

Notes:
[a] Costs include mobilization, unlisted items, contingencies and non-contract costs.
LS lump sum
LF linear feet
Qty quantity

Table 5-11 Lake Sakakawea South Shore Intake and Pump Station Costs

Description	Qty	Unit	Unit Cost[a]	Construction Cost[a]	Annual O&M Cost
Forebay Grading	1	LS	$7,210,954	$7,210,954	-
Site Work and Buildings	1	LS	$9,576,043	$9,576,043	-
Plumbing, Fire	1	LS	$493,881	$493,881	-
Piping and Valves	1	LS	$676,614	$676,614	-
Pumping Units	1	LS	$1,956,643	$1,956,643	-
Flow Meter	1	LS	$67,568	$67,568	-
Surge Tank	1	LS	$452,328	$452,328	-
Power Generator	1	LS	$9,121,613	$9,121,613	-
Electrical	1	LS	$2,625,050	$2,625,050	-
New Intake and Pump Station				$32,180,688	$1,296,409
Easements	20	AC	$40,000	$800,000	–
36-inch Connection, Pump Station to Existing Pipeline	66,500	LF	$243	$16,159,500	$403,987
Easements	91.6	AC	$800	$73,300	-
TOTAL				$49,213,488	$1,700,396

Notes:
[a] Costs include mobilization, unlisted items contingencies and noncontract costs.
AC acre
LF linear feet
LS lump sum

Table 5-12 Intake and Pump Station Adjacent to SCPP and Costs

Description	Qty	Unit	Unit Cost[a]	Construction Cost[a]	Annual O&M Cost
Site Work and Buildings	1	LS	$13,422,135	$13,422,135	-
Plumbing, Fire	1	LS	$493,881	$493,881	-
Piping and Valves	1	LS	$440,128	$440,128	-
Pumping Units	1	LS	$1,928,490	$1,928,490	-
Flow Meter	1	LS	$67,568	$67,568	-
Surge Tank	1	LS	$452,328	$452,328	-
Cofferdam	1	LS	$3,364,299	$3,364,299	-
Electrical	1	LS	$1,870,546	$1,870,546	-
New Intake and Pump Station				$22,039,370	$1,049,302
36-inch Connection, Pump Station to Existing Pipeline	2,000	LF	$243	$486,000	$12,200
TOTAL				$22,525,370	$1,061,502

Note: [a] Costs include mobilization, unlisted items, contingencies and noncontract costs.
LF linear feet
LS lump sum

Biota WTP costs for each treatment option are detailed in Table 5-13 (Chlorination), Table 5-14 (Chlorination/UV Inactivation), Table 5-15 (Enhanced Chlorination/UV Inactivation), Table 5-16 (Conventional Treatment), and Table 5-17 (Microfiltration Treatment). A summary of Biota WTP construction and O&M costs for each treatment option is presented in Table 5-18.

Table 5-13 Biota WTP – Chlorination Costs

Description	Construction Cost	Annual O&M Cost[a]
Site Work and Buildings	$16,450,617	$1.2 M
Plumbing, Fire, Shop Equip	$1,167,039	
Piping and Valves	$991,823	
Pumping Units	$1,800,163	
Chem Feed, Cl2 Scrub, Tank	$757,737	
Flow Meter	$127,662	
3Ph Bus, Panel Boards	$2,152,566	
Lights, Trans, PLC, Conduit	$579,597	
Switchgear, Trans, HVAC	$2,905,344	
Solar Walls, Dewatering	$1,408,557	
TOTAL	$28,341,105	$1.2 M

Note: [a] O&M costs were based on information from equipment vendors, previously competed estimates, and various assumptions. A detailed summary of O&M costs is provided in Appendix F.

Table 5-14 Biota WTP – Chlorination/UV Inactivation Costs

Description	Construction Cost	Annual O&M Cost[a]
Site Work and Buildings	$12,743,176	$1.5 M
Plumbing, Fire, Shop Equip	$1,723,377	
Piping and Valves	$1,234,714	
Pumping Units	$1,606,406	
Chem Feed, Cl2 Scrub, Tank	$757,737	
Flow Meter, UV	$3,597,478	
3Ph Bus, DisPa	$1,926,820	
Lights, Trans, PLC, Conduit	$590,825	
Switchgear, Trans, HVAC	$3,992,532	
Solar Walls, Dewatering	$1,633,421	
TOTAL	$29,806,486	$1.5 M

Note: [a] O&M costs were based on information from equipment vendors, previously competed estimates, and various assumptions. A detailed summary of O&M costs is provided in Appendix F.

Table 5-15 Biota WTP – Enhanced Chlorination/UV Inactivation Costs

Description	Construction Cost	Annual O&M Cost[a]
Site Work and Buildings	$18,428,603	$1.8 M
Plumbing, Fire, Shop Equip	$1,723,377	
Piping and Valves	$2,570,339	
Pumping Units	$3,007,132	
Chem Feed, Cl2 Scrub, Tank	$757,737	
Chem Tank, Flow, Centrifuge	$2,392,637	
Flow Meter, UV	$3,597,478	
3Ph Bus, DisPa	$1,926,820	
Lights, Trans, PLC, Conduit	$590,825	
H&V, Sludge Building, IPS Waste	$146,194	
Switchgear, Trans, HVAC	$3,992,532	
Solar Walls, Dewatering	$1,633,421	
Filtration	$7,002,723	
TOTAL	$47,769,818	$1.8 M

Note: [a] O&M costs were based on information from equipment vendors, previously competed estimates, and various assumptions. A detailed summary of O&M costs is provided in Appendix F.

Table 5-16 Biota WTP – Conventional Treatment Costs

Description	Construction Cost	Annual O&M Cost[a]
Site Work and Buildings	$21,669,398	$2.3 M
Plumbing, Fire, Shop Equip	$4,190,796	
DAF, Plate Settlers, Filters	$13,281,192	
Chem Feed, Cl2 Scrub, Tank	$4,204,616	
Chem Tank, Flow, Centrifuge	$2,631,488	
PlateSettler, 3Ph Bus, DisPa	$4,499,556	
Lights, Trans, PLC, Conduit	$956,529	
Switchgear, Trans, HVAC	$4,865,577	
H&V, Sludge Building, IPS Waste	$156,489	
Solar Walls, Dewatering	$2,383,113	
Booster Pump Station	$7,875,611	
TOTAL	$66,714,365	$2.3 M

Note: [a] O&M costs were based on information from equipment vendors, previously competed estimates, and various assumptions. A detailed summary of O&M costs is provided in Appendix F.

Table 5-17 Biota WTP – Microfiltration Treatment Costs

Description	Construction Cost	Annual O&M Cost[a]
Site Work and Buildings	$22,097,856	$2.4 M
Plumbing, Fire, Shop Equip	$4,187,961	
MF, Plate Settlers, Flocs	$37,164,728	
Chem Feed, Cl2 Scrub, Tank	$4,204,616	
Chem Tank, Flow, Centrifuge	$2,392,637	
PlateSettler, 3Ph Bus, DisPa	$4,128,845	
Lights, Trans, PLC, Conduit	$1,079,148	
Switchgear, Trans, HVAC	$4,989,121	
H&V, Sludge Building, IPS Waste	$146,194	
Solar Walls, Dewatering	$2,347,594	
Booster Pump Station	$7,875,611	
TOTAL	$90,614,311	$2.4 M

Note: [a] O&M costs were based on information from equipment vendors, previously competed estimates, and various assumptions. A detailed summary of O&M costs is provided in Appendix F.

Table 5-18 Summary of Biota WTP Costs

Description	Construction Cost	Annual O&M Cost[a]
Chlorination	$28.3 M	$1.2 M
Chlorination/UV Inactivation	$29.8 M	$1.5 M
Enhanced Chlorination/UV Inactivation	$47.8 M	$1.8 M
Conventional Treatment	$66.7 M	$2.3 M
Microfiltration	$90.6 M	$2.4 M

Note: [a] O&M costs were based on information from equipment vendors, previously competed estimates, and various assumptions. A detailed summary of O&M costs is provided in Appendix F.

Alternative 3 – Summary of Total Costs

Projected construction costs for this alternative are provided in Table 5-19, and O&M costs in Table 5-20. The tables present the total alternative costs using different Biota WTP options in combination with the intake and pump station options.

Table 5-19 Alternative 3 – Summary of Construction Costs[a]

		Intake, Transmission, and Pump Station Options		
		Upgraded Snake Creek Intake & Pump Station Pumping Plant	**Intake & Pump Station on South Shore of Lake Sakakawea**	**Intake & Pump Station Adjacent to SCPP**
Biota Water Treatment Options	Chlorination	$217.6 M	$253.0 M	$226.3 M
	Chlorination/ UV Inactivation	$219.1 M	$254.5 M	$227.8 M
	Enhanced Chlorination/ UV Inactivation	$237.1 M	$272.5 M	$245.8 M
	Conventional Treatment	$256.0 M	$291.4 M	$264.7 M
	Microfiltration	$279.9 M	$315.3 M	$288.6 M

Note: Costs were rounded to the nearest $0.1 Million

Table 5-20 Alternative 3 – O&M Costs[a]

		Intake, Transmission, and Pump Station Options		
		Upgraded Snake Creek Intake & Pump Station	**Intake & Pump Station on Southeast Shore of Lake Sakakawea**	**Intake & Pump Station Adjacent to SCPP**
Biota Water Treatment Options	Chlorination	$9.69 M	$10.40 M	$9.76 M
	Chlorination/ UV Inactivation	$9.99 M	$10.70 M	$10.06 M
	Enhanced Chlorination/ UV Inactivation	$10.29 M	$11.00 M	$10.36 M
	Conventional Treatment	$10.79 M	$11.50 M	$10.86 M
	Microfiltration	$10.89 M	$11.60 M	$10.96 M

Note: Costs were rounded to the nearest $0.01 Million.

Alternative 4, Missouri River and Groundwater

Overview

The Missouri River would be the primary water supply source for this alternative. The water would be diverted from Lake Sakakawea through a surface water intake (three optional locations

for the intake are considered). Water from the Missouri River would be conveyed to the City of Minot WTP through the existing transmission pipeline, where it would be blended with groundwater from the existing wellfields in the Minot and Sundre aquifers. Missouri River water also would be treated at the Biota WTP located on the existing transmission line, near the City of Max. Five treatment options are considered for the Biota WTP. This alternative is similar to Alternative 3, Missouri River and Conjunctive Use, except that Missouri River water is not blended with Souris River water.

Components Included in Alternative 4

Alternative 4, Missouri River and Groundwater, includes the components that are described in Sections 3 and 4 and shown in Table 5-1; a schematic showing the locations of capture (intake structures) and treatment components is included in Figure 5-6. Details regarding components that are specific to Alternative 4 are discussed below.

Alternative 4 Water Needs and Sources

The water needs and sources under this alternative are presented in Table 5-21.

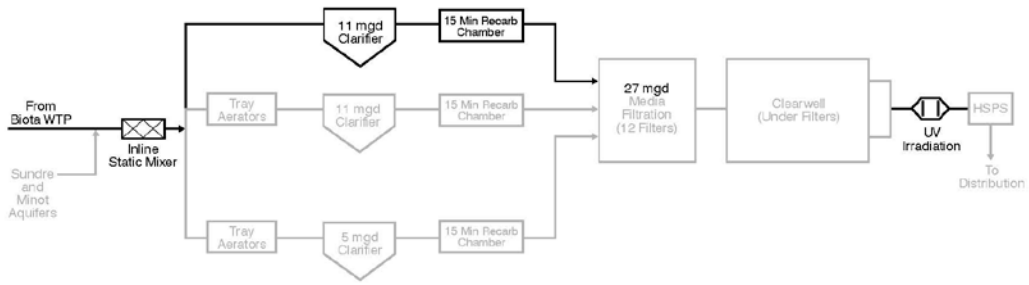
Table 5-21 Alternative 4 – Estimated Water Needs and Water Sources

	Average (mgd)	Peak (mgd)
Locations		
Treated at the Minot WTP and Distributed	10.1	26.3
Sources		
Minot Groundwater	1.0	2.6
Missouri River	10.92	25.3

Minot WTP Upgrades

The Minot WTP facility upgrades under Alternative 4, Missouri River and Groundwater, would be similar to those of Alternative 1, Groundwater with Recharge, particularly regarding clarification, recarbonation, filtration, and UV irradiation. The processes currently used at the Minot WTP would not change substantially under this alternative. Capacity increases are necessary to expand the Minot WTP from its rated treatment capacity of 18 mgd to 27 mgd, and upgrades include a static mixer downstream of where the source waters would be combined to provide adequate blending of the waters prior to treatment. In addition, UV disinfection is currently included at the Minot WTP, but may not be needed depending upon results of *Cryptosporidium* testing in the Missouri River water (2-year process).

Figure 5-8 shows a general PFD of the Minot WTP for Alternative 4, Missouri River and Groundwater.



Note: Darker lines indicate proposed treatment improvements, while lighter lines indicate existing features.

Figure 5-8 Minot WTP PFD – Missouri River and Groundwater Alternative

Alternative 4 Total Costs

Construction and O&M costs for all common components in this alternative are included in Table 5-22. The costs include Minot WTP upgrades, but exclude the intake and Biota WTP options. Costs of existing facilities are shaded in the table. Detailed construction and O&M cost estimates are included in Appendix F. Biota WTP costs applicable to this alternative are presented in Table 5-13.

Construction and O&M costs for intake and pump station options are presented in Tables 5-23, 5-24, and 5-25.

Projected construction and O&M costs for this alternative are provided in Tables 5-26 and 5-27, respectively. The tables present the total cost of this alternative using different Biota WTP options in combination with the intake and pump station options.

Table 5-22 Alternative 4 – Common Components and Costs, Excluding Intake and Biota WTP Options

Description	Construction Cost[a]	O&M Cost/ Year[a]
Supply – Common		
Existing Wells – Minot Aquifer		$255,960
Existing Wells – Sundre Aquifer		$374,460
Transmission – Common		
Pipeline and Appurtenances, SCPP to Minot	$30,940,000	$773,500
Distribution – Common		
Minot Area Pipeline	$9,310,042	$232,751
Berthold Segment Pipeline and Pump Stations	$4,445,583	$124,476
Kenmare and USWUD Pipeline, Kenmare Pump Station	$5,259,084	$147,254
Pipelines: Mohall, Sherwood, ASWUD System III	$6,376,723	$159,418
Pipeline to MAFB	$6,969,551	$174,239
Pipeline: MAFB to Glenburn	$4,248,713	$106,218
Pipeline: Glenburn to Renville Corner	$6,275,661	$104,577
Pipelines: Westhope and ASWUD System III	$7,686,367	$120,633
Pipeline: Minot and ASWUD System I	$11,981,860	$168,505
Pipeline to Bowbells, Columbus and Noonan	$11,563,734	$159,789
High Service Pump Station at Minot WTP	$14,075,578	$422,267
Lansford Pump Station	$1,698,229	$203,413
Bowbells Pump Station	$300,458	$41,432
Mohall Segment Pump Stations (Mohall, Tolley, and Renville County Corner)	$1,103,973	$182,580
Bottineau West, Bottineau North Pump Stations	$757,632	$110,946
Storage – Common		
Berthold Reservoirs	$1,135,652	$22,700
Kenmare Reservoir	$1,843,199	$36,900
South Prairie Reservoir	$3,022,666	$40,781
Lansford Reservoir	$5,442,905	$56,469
Bottineau Reservoir	$3,599,543	$46,213
Treatment		
Minot WTP proposed improvements	$11,374,723	
Minot WTP completed improvements	$24,000,000	$4,000,000
Rugby WTP Completed Improvements	$1,795,000	-
TOTAL – Actual Expenditures and Components Currently Under Construction	$110,399,125	$6,830,143
TOTAL – Proposed Components	$64,807,751	$1,235,338
OVERALL TOTAL[b]	$175,200,000	$8,070,000

Description	Construction Cost[a]	O&M Cost/ Year[a]

Notes:
[a] Shaded cells indicate expenditures or components currently under construction.
[b] Construction costs were rounded to the nearest $100,000. O&M costs were rounded to the nearest $10,000.
ASWUD All Seasons Water Users District
MAFB Minot Air Force Base
SCPP Snake Creek Power Plant
USWUD Upper Souris Water District
WTP Water Treatment Plant

Table 5-23 Upgraded SCPP Intake and Pump Station Costs

Description	Qty	Unit	Unit Cost[a]	Construction Cost[a]	O&M Cost/Year
Demolition and Removal	1	LS	$2,408,970	$2,408,970	-
Site Work and Buildings	1	LS	$5,264,635	$5,264,635	-
Plumbing, Fire	1	LS	$170,420	$170,420	-
Piping and Valves	1	LS	$1,721,564	$1,721,564	-
Pumping Units	1	LS	$2,098,346	$2,098,346	-
Flow Meter	1	LS	$67,568	$67,568	-
Surge Tank	1	LS	$564,664	$564,664	-
Power Generator	1	LS	$461,334	$461,334	-
Electrical	1	LS	$569,058	$569,058	-
Upgraded Intake and Pump Station				$13,326,555	$1,083,560
36-inch Connection, Pump Station to Existing Pipeline	2,400	LF	$243	$583,000	$14,600
TOTAL				$13,909,555	$1,098,160

Note: [a] Costs include mobilization, unlisted items, contingencies and noncontract costs.
LF linear feet
LS lump sum

Table 5-24 Lake Sakakawea South Shore Intake and Pump Station Costs

Description	Qty	Unit	Unit Cost[a]	Construction Cost[a]	O&M Cost/Year
Forebay Grading	1	LS	$7,210,954	$7,210,954	-
Site Work and Buildings	1	LS	$9,576,043	$9,576,043	-
Plumbing, Fire	1	LS	$493,881	$493,881	-
Piping and Valves	1	LS	$676,614	$676,614	-
Pumping Units	1	LS	$2,238,174	$2,238,174	-
Flow Meter	1	LS	$67,568	$67,568	-
Surge Tank	1	LS	$452,328	$452,328	-
Power Generator	1	LS	$9,121,613	$9,121,613	-
Electrical	1	LS	$2,625,050	$2,625,050	-
New Intake and Pump Station				$32,462,219	$1,388,186
Easements	20	AC	$40,000	$800,000	–
36-inch Connection, Pump Station to Existing Pipeline	66,500	LF	$243	$16,160,000	$404,000
Easements	91.6	AC	$800	$73,300	–
TOTAL				$49,495,519	$1,792,186

Note: [a] Costs include mobilization, unlisted items, contingencies and noncontract costs.
AC acre
LF linear feet
LS lump sum

Table 5-25 Intake and Pump Station Adjacent to SCPP Costs

Description	Qty	Unit	Unit Cost[a]	Construction Cost[a]	O&M Cost/Year
Site Work and Buildings	1	LS	$13,422,135	$13,422,135	-
Plumbing, Fire	1	LS	$493,881	$493,881	-
Piping and Valves	1	LS	$440,128	$440,128	-
Pumping Units	1	LS	$2,303,865	$2,303,865	-
Flow Meter	1	LS	$67,568	$67,568	-
Surge Tank	1	LS	$452,328	$452,328	-
Power Generator	1	LS	$3,364,299	$3,364,299	-
Electrical	1	LS	$1,870,546	$1,870,546	-
Intake and Pump Station				$22,414,745	$1,194,783
36-inch Connection, Pump Station to Existing Pipeline	2,000	LF	$243	$486,000	$12,200
TOTAL				$22,900,745	$1,206,983

Note: [a] Costs include mobilization, unlisted items, contingencies and noncontract costs.
LF linear feet
LS lump sum

Table 5-26 Alternative 4 – Construction Costs

		Intake, Transmission, and Pump Station Options[a]		
		Upgraded Snake Creek Intake & Pump Station	**Intake & Pump Station on Southeast Shore of Lake Sakakawea**	**Intake & Pump Station Adjacent to SCPP**
Biota Water Treatment Options	Chlorination	$217.4 M	$253.0 M	$226.4 M
	Chlorination/UV Inactivation	$218.9 M	$254.5 M	$227.9 M
	Enhanced Chlorination/UV Inactivation	$236.9 M	$272.5 M	$245.9 M
	Conventional Treatment	$255.8 M	$291.4 M	$264.8 M
	Microfiltration	$279.7 M	$315.3 M	$288.7 M

Note: Costs were rounded to the nearest $0.1 Million.

Table 5-27 Alternative 4 – O&M Costs

		Intake, Transmission, and Pump Station Options[a]		
		Upgraded Snake Creek Intake & Pump Station	**Intake & Pump Station on Southeast Shore of Lake Sakakawea**	**Intake & Pump Station Adjacent to SCPP**
Biota Water Treatment Options	Chlorination	$10.37 M	$11.06 M	$10.48 M
	Chlorination/UV Inactivation	$10.67 M	$11.36 M	$10.78 M
	Enhanced Chlorination/UV Inactivation	$10.97 M	$11.66 M	$11.08 M
	Conventional Treatment	$11.47 M	$12.16 M	$11.58 M
	Microfiltration	$11.57 M	$12.26 M	$11.68 M

Note: Costs were rounded to the nearest $0.01 Million.

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APPENDIX A

Inbasin Alternatives Supporting Analysis

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Abbreviations and Acronyms

bls	below land surface
cfs	cubic feet per second
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
ft	foot (feet)
GIS	geographic information systems
gpd/ft	gallons per day per foot
gpm	gallons per minute
Inbasin Analysis	Inbasin Alternatives Supporting Analysis
mgd	million gallons per day
NGVD 29	National Geodetic Vertical Datum of 1929
NWS	National Weather Service
Project	Northwest Area Water Supply Project
PVC	polyvinyl chloride
Reclamation	U.S. Bureau of Reclamation
SEIS	Supplemental Environmental Impact Statement
SWC	North Dakota State Water Commission
USGS	U.S. Geological Survey
WTP	Water Treatment Plant

1.0 Introduction

The purpose of the Inbasin Alternatives Supporting Analysis (Inbasin Analysis) is to develop an appraisal-level design for Alternative 1, Groundwater with Recharge and Alternative 2, Groundwater with Recharge and the Souris River, which are evaluated in the Northwest Area Water Supply Project (Project) Supplemental Environmental Impact Statement (SEIS). These alternatives include aquifer recharge facilities and additional water supply wells in the Minot and Sundre aquifers in the vicinity of Minot, North Dakota, as well as the use of Souris River water either for recharge (Alternatives 1 and 2) or as a direct supply (Alternative 2 only).

A preliminary analysis of the feasibility of using a variety of water sources for the Project, including the Missouri and Souris rivers and groundwater from the Minot and Sundre aquifers, was conducted as part of the *Alternatives Identification, Review, and Selection Process* report (Reclamation 2012). After this analysis, it was clear that the Missouri River has sufficient water to supply the Project; however, more investigation was needed to determine whether the inbasin sources (the Souris River and Minot and Sundre aquifers) could provide a sufficient quantity for the Project needs. This more detailed analysis is documented in this Inbasin Analysis, which includes: (1) a brief overview of water supply Alternatives 1 and 2; (2) a siting analysis that used a geographic information systems (GIS)-based analysis to identify potential aquifer recharge facility sites; (3) an analysis of the hydrogeology of the Minot and Sundre aquifers with respect to aquifer recharge feasibility; (4) an analysis of the availability of water in the Souris River; (5) the development of a water balance model; (6) groundwater flow modeling simulations designed to determine whether the aquifer recharge/wellfield systems are sustainable; and (7) preparation of recharge and withdrawal facility locations, design specifications, seasonal operations, and cost estimates. The area included in the hydrogeology analysis (Study Area) includes portions of the areal extents of both the Minot and Sundre aquifers (Figure 1-1). The Study Area extent was limited by the amount of hydrogeologic data available for each aquifer.

It is important to note that this Inbasin Analysis represents an appraisal-level design. The desktop analyses, models, and findings presented herein are based on the best available existing data. If the decision was made to construct Alternatives 1 or 2, field testing would be required that would include extensive exploratory well drilling, monitoring well construction, aquifer performance testing, and geologic data analysis. The data obtained through this testing would be used to construct a much more sophisticated groundwater model that would encompass a significantly larger portion of the Minot and Sundre aquifers. Advanced geochemical modeling would be required to understand the chemical reactions that would occur if Souris River water were mixed with groundwater in the Minot and Sundre aquifers. Such reactions could cause mineral and bacterial fouling of the recharge wells, which could necessitate enhanced maintenance efforts that might include frequent acidification of the recharge wells and pre-treatment of Souris River water. Pilot testing of a small-scale system might also be needed. Another issue is maintenance of the recharge facilities when they would be inactive during the winter months. A strategy would need to be developed to ensure that the

surface of the recharge wells would not be frozen in March when the facilities would begin operating.

While it is likely that engineering solutions could be developed for all of these issues, the cost of implementing them could significantly increase the cost of the Project. A full and accurate accounting of all such costs would be developed during the final design phases.

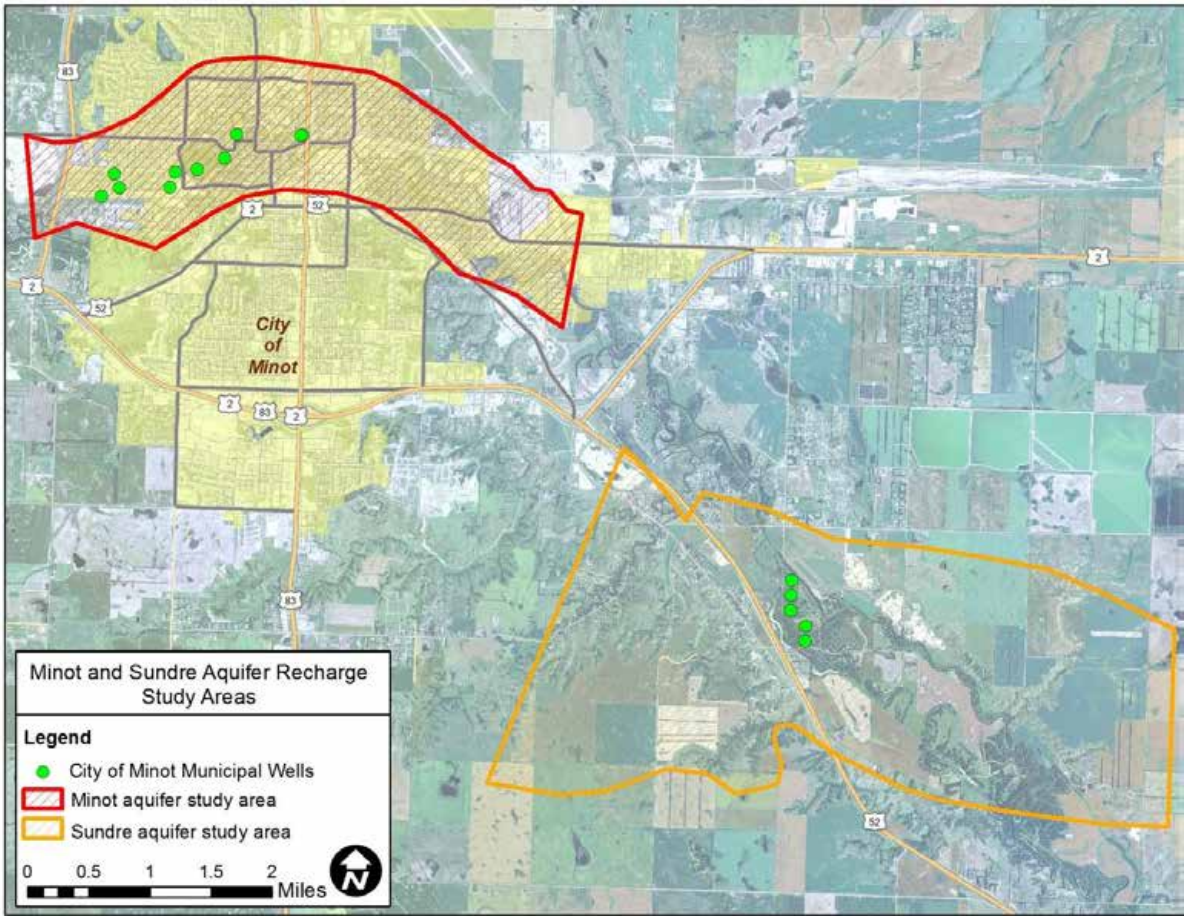

Figure 1-1 Study Area for the Minot and Sundre Aquifers

2.0 Overview of Alternatives 1 and 2

2.1 Alternative 1 – Groundwater with Recharge

This inbasin alternative would provide supplemental recharge to the Minot and Sundre aquifers with water from the Souris River. Water would be withdrawn from these aquifers using the existing Minot and Sundre aquifer wellfields. The City currently withdraws approximately 2.0 million gallons per day (mgd) from the Minot aquifer using nine wells, and approximately 3.1 mgd from the Sundre aquifer using five wells. The Minot Water Treatment Plant (WTP) would be used (and upgraded), along with current and proposed Project pipelines and pumping infrastructure, to treat and supply water to Project members. Table 2-1 provides an overview of Alternative 1.

Table 2-1 Overview of Alternative 1

Description	Meeting Future Demands	Water Treatment	Water Transmission and/or Distribution
The Minot and Sundre aquifers would be recharged with Souris River water. Water would be withdrawn using the existing wellfields. Water would be conveyed to Project members from Minot via existing and planned Project pipelines.	Some potential for expansion of wellfields in Minot vicinity.	Minot WTP would provide treatment but would need to be upgraded to meet all standards.	Existing Project pipelines would convey water to Project members. Additional pipelines would convey raw water from the Souris River to recharge basins. Existing pipelines that would convey water from wellfields to the WTP could be expanded if necessary in the future.

Previous studies by Pettyjohn and Hutchinson (1971), Pusc (1987 and 1994), and others have indicated that the combined sustainable yield of the Minot and Sundre aquifers is not sufficient to supply the projected 2060 average annual and peak Project needs. Data collected since the inception of both wellfields indicates that water levels in the vicinity of the City of Minot (in both aquifers) are in long-term decline. This is likely due to increased withdrawals and potentially declining recharge resulting from urbanization of the natural recharge area.

Because the City's wellfields cannot produce sufficient quantities of water to meet the projected demand of the Project, supplemental aquifer recharge (through recharge basins and recharge wells) would be required to augment groundwater levels. Several additional supply wells would be needed to meet peak demands and surface water intakes, raw water transmission mains, and pumping infrastructure would be needed to transmit surface water from the Souris River to the recharge basins. Aquifer recharge operations would be conducted primarily during peak spring river flows.

2.2 Alternative 2 – Groundwater with Recharge and the Souris River

Alternative 2 is similar to Alternative 1 in that all of the withdrawal, recharge, and transmission infrastructure of Alternative 1 would be constructed and operated similarly. However, during the months when the Souris River experiences its highest flows, river water would not only be used for aquifer recharge, but also would be conveyed directly to the Minot WTP to meet as much of the Project water needs as possible. During the remaining months when flow was reduced but still substantial, river water would only be used for aquifer recharge. The advantage of this alternative is that wellfields could be periodically "rested," which could increase the long-term reliability of Alternative 2 to meet demands. Long-term river flow records indicate that under mean discharge conditions, enough river water could be withdrawn to recharge the aquifer and meet Project needs for 4 to 5 months of the year. Table 2-2 provides an overview of Alternative 2.

Table 2-2 Overview of Alternative 2

Description	Meeting Future Demands	Water Treatment	Water Transmission and/or Distribution
Souris River water would be used when available for direct supply and for aquifer recharge of Minot's wellfields. System would transition to groundwater or blend river water and groundwater when river flows were too low to meet demand.	Some potential for expansion of wellfields in Minot vicinity with aquifer recharge.	Minot WTP would provide treatment but would need to be upgraded to meet all standards.	Existing and planned Project pipelines would convey water to Project members. Additional pipelines would convey raw water from the river to recharge basins. Existing pipelines that would convey water from wellfields to the Minot WTP could be expanded if necessary in the future.

3.0 Facility Siting Analysis

3.1 Siting Criteria

A GIS-based overlay model was developed to identify optimal facility locations based on criteria that included hydrogeology, land use, and sensitive natural surface features. Careful consideration of these criteria could result in a facility with lower initial land acquisition costs, a high degree of physical safety, and lower site development costs. The siting criteria analyzed for the Inbasin Analysis include the following:

- **Wetlands -** Wherever possible, due to mitigation requirements and their associated costs, wetlands should be avoided when siting a recharge facility. Wetlands provide natural recharge to aquifers and should be preserved to maintain the maximum recharge possible into the Minot and Sundre aquifers.
- **Land Use -** Areas with vacant, recreational, or agricultural land uses would be preferable for the construction of an aquifer recharge facility. Parcels that are currently developed are likely to be smaller, costlier, and more problematic to acquire.
- **Confinement -** Areas with the thinnest confining sediments (or overburden) overlying the Minot and Sundre aquifers are often areas where the most rapid recharge occurs. The faster that water can infiltrate through recharge basins and assimilate into the underlying aquifer, the more water can be recharged during peak river flow conditions. Additionally, costs for the recharge wells and basin excavation (less excavation would be needed) would be lower in areas with thinner confining sediments. The original Minot recharge facility was located in an area with less than 25 feet (ft) of confinement.
- **Floodplain -** The original Minot recharge facility was destroyed by a flood on the Souris River in the 1960s. Flood protection should be a consideration in the construction of a new facility. Minimally, the facility should be located outside of Federal Emergency Management Agency (FEMA) Special Flood Hazard Zones, and away from proposed levees or flood control structures.

Contaminated Sites - A recharge facility should be sited a safe distance away from any groundwater contamination sites. Artificially recharging the proposed quantities of water into the aquifer(s) would “mound” groundwater, altering flow gradients in the aquifer, and could cause contamination plumes to migrate.

3.2 Methodology

A relative ranking system was developed to represent different conditions associated with each of the five criteria. Under the ranking system chosen for the Project, rankings ranging from 1 (least suitable condition) to 5 (highly suitable condition) were assigned to each of the criteria. For example, when considering aquifer confinement, the range of aquifer thickness values was divided into five equal categories. As discussed in the preceding section, areas with less confinement are preferred for a recharge facility, so areas with the lowest of the five ranges of

thickness values were assigned a ranking of 5. Tables 3-1 and 3-2 provide an overview of the rankings used for both the Minot and Sundre aquifer siting models.

Table 3-1 Overview of Minot Aquifer Recharge Facility Siting Criteria

Relative Suitability	Ranking[a]	Minot Aquifer Recharge Facility GIS Siting Model Criteria				
		Presence of Wetlands[b]	Land Use[c]	Flood Zone[d]	Proximity to Contaminated Sites[e]	Aquifer Confinement[f]
Highly Suitable	5	No wetlands present	Vacant lands, undeveloped natural lands, quarries	Outside of FEMA Special Flood Hazard Zone, and at an elevation greater than the maximum historic flood stage	No EPA-regulated sites within 3/4 mile	Less than 20 ft thick
More Suitable	4	n/a[g]	n/a	n/a	Active EPA-regulated site within 3/4 mile	Between 20 and 40 ft thick
Marginally Suitable	3	n/a	Agricultural lands, parks, and other recreational land uses	Outside of FEMA Special Flood Hazard Zone, but less than the elevation of the maximum historic flood stage	Active EPA-regulated site within 1/2 mile	Between 40 and 60 ft thick
Less Suitable	2	n/a	n/a	n/a	Active EPA-regulated site within 1/4 mile	Between 60 and 80 ft thick
Unsuitable	1	Wetlands present	Built-out areas	Located within FEMA Special Flood Hazard Zone	Active EPA-regulated site within 1/8 mile	More than 80 ft thick

Notes:

[a] Relative rankings of site suitability based on each of the five criteria. A rank of 5 indicates optimal conditions, while 1 indicates the least suitable conditions.

[b] Based on National Wetlands Inventory spatial dataset (Service 2012).

[c] Based on a visual interpretation of land uses from 2010 and 2011 aerial orthophotos (USDA 2012).

[d] Based on elevation data obtained from the National Weather Service's (NWS's) Advanced Hydrologic Prediction Center (NWS 2012). Elevation used in the analysis reflects the FEMA Special Flood Hazard Zone, based on Souris River elevations as measured at the Broadway Bridge in Minot. Maximum historic flood stage was interpreted from June 2011 aerial orthophotos of the historic Minot flood (State of North Dakota 2012).

[e] Based on spatial data from U.S Environmental Protection Agency's (EPA's) Enviromapper representing Superfund sites; Resource Conservation and Recovery Act sites; Toxics Release Inventory facilities; Brownfield areas; Comprehensive Environmental Response, Compensation, and Liability Information System sites; Toxic Substances Control Act sites; and other discharge sites (EPA 2012).

[f] Minot aquifer overburden varies from 0 to 110 ft thick in the Study Area.

[g] n/a is used to indicate there are no criteria associated with that ranking, so that rank was not used in the model. For instance, wetlands either exist or do not exist, so only a 1 or 5 ranking is possible for wetlands. Therefore, rankings 2-4 are not applicable for wetlands.

Table 3-2 Overview of Sundre Aquifer Recharge Facility Siting Criteria

Relative Suitability	Ranking[a]	Sundre Aquifer Recharge Facility Siting Model Criteria			
		Presence of Wetlands[b]	Land Use[c]	Flood Zone[d]	Aquifer Confinement[e]
Highly Suitable	5	No wetlands present	Vacant lands, undeveloped natural lands, quarries	Outside of FEMA Special Flood Hazard Zone, and at an elevation greater than the maximum historic flood stage	Less than 40 ft thick
More Suitable	4	n/a[f]	n/a	n/a	Between 40 and 70 ft thick
Marginally Suitable	3	n/a	Agricultural lands, parks, and other recreational land uses	Outside of FEMA Special Flood Hazard Zone, but less than the elevation of the maximum historic flood stage	Between 70 and 100 ft thick
Less Suitable	2	n/a	n/a	n/a	Between 100 and 130 ft thick
Unsuitable	1	Wetlands present	Built-out areas	Located within FEMA Special Flood Hazard Zone	More than 130 ft thick

Notes:

[a] Relative rankings of site suitability based on each of the five criteria. A rank of 5 indicates optimal conditions, while 1 indicates the least suitable conditions.

[b] Based on National Wetlands Inventory spatial dataset (Service 2012).

[c] Based on a visual interpretation of land uses from 2010 and 2011 aerial orthophotos (USDA 2012).

[d] Based on elevation data obtained from the NWS's Advanced Hydrologic Prediction Center (NWS 2012). Elevation used in the analysis reflects the FEMA Special Flood Hazard Zone, based on Souris River elevations as measured at the Broadway Bridge in Minot. Maximum historic flood stage was interpreted from June 2011 aerial orthophotos of the historic Minot flood (State of North Dakota 2012).

[e] Sundre aquifer overburden varies from 20 to 180 ft thick in the Study Area.

[f] n/a Is used to indicate there are no criteria associated with that ranking, so that rank was not used in the model. For instance, wetlands either exist or do not exist, so only a 1 or 5 ranking is possible for wetlands. Therefore, rankings 2-4 are not applicable for wetlands.

GIS datasets were developed to represent each of the five criteria for the Minot and Sundre aquifers. A raster format with 20-meter grid cells was used to represent the relative criteria rankings at a detailed level across the Study Area. Each raster cell was assigned a ranking from 5 to 1 based on the tables above. An example of how the relative rankings were geographically ascribed to the raster layers is provided in Figure 3-1. The figure shows examples of the flood zone and wetland criteria.

After raster layers were developed to represent each of the criteria, GIS "raster math" functions were used to add each of the raster layers together. The raster math function overlays each of the raster layers and adds each of the individual overlying cell's values (rankings) together. An example of the raster math process is provided in Figure 3-2. The end result of the raster math calculations is a single raster output layer with 20-meter grid cells, which reflects the sum of the rankings for each of the criteria. The output layer reflects the relative cell-by-cell suitability of all areas of the Study Area for potential use as an aquifer recharge facility.

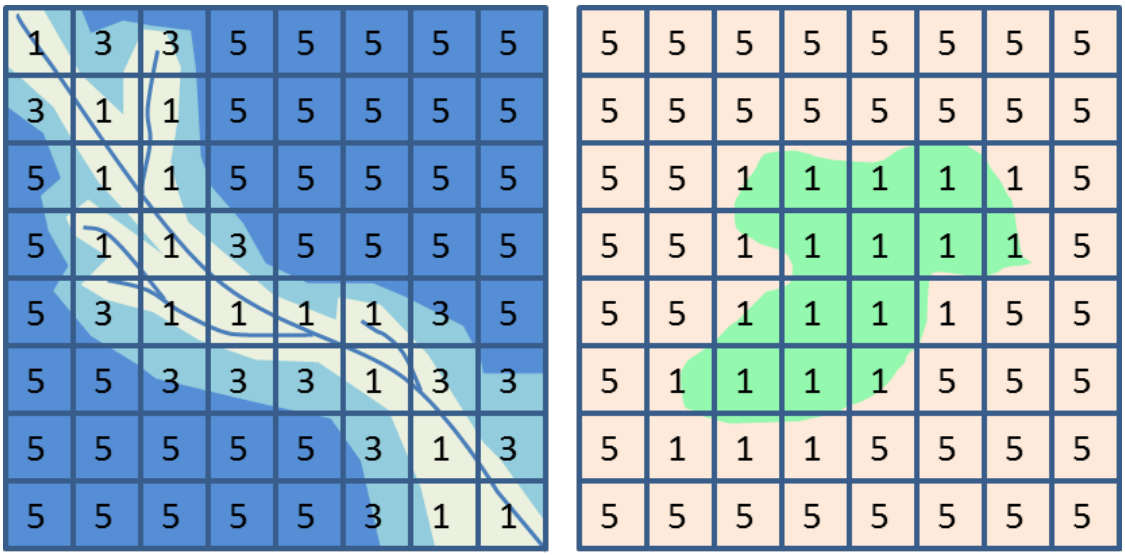

Figure 3-1 Example of Applying Siting Criteria to the Flood Zone or Wetland Area

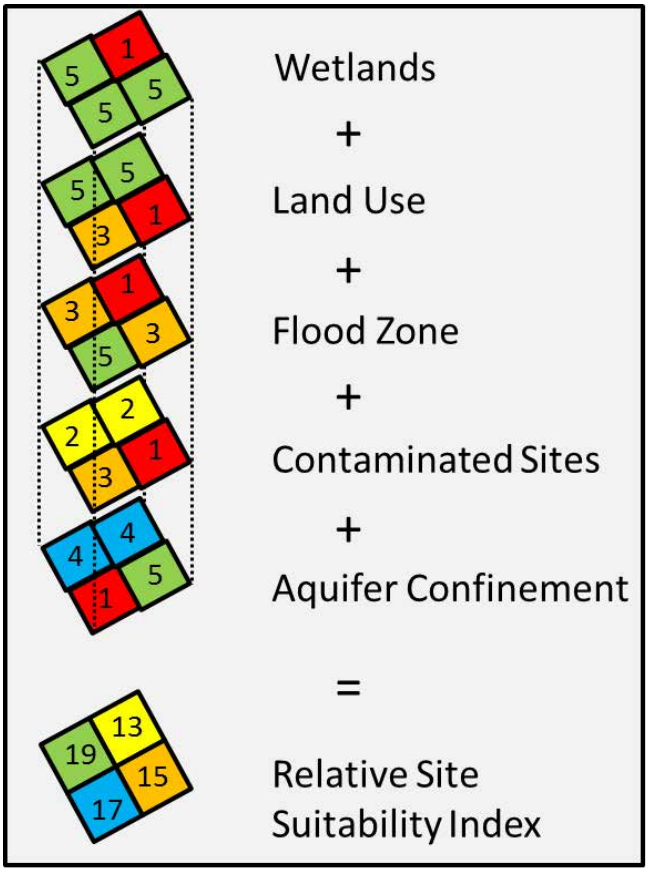

Figure 3-2 Example of Using GIS "Raster Math" Functions to Develop the Relative Site Suitability Index

3.3 Results for the Minot Aquifer

The relative site suitability index output for the Minot aquifer yielded values ranging from 5 to 23, based on the five criteria analyzed (Figure 3-3). Possible ranks ranged from 5 (areas where all criteria were ranked 1, or least suitable) to 25 (areas where all criteria were ranked 5, or highly suitable). Areas with the highest rankings (up to 23) were generally located in the western portion of the model domain. Few areas in the model domain were ranked highly suitable because much of the Study Area is located in the Souris River special flood hazard area, there are multiple nearby EPA-regulated sites, and much of the city is already built out with few vacant areas remaining. Based on the relative site suitability index, an area in the northwestern portion of the model domain, in the current vicinity of the Gravel Products, Inc., quarry was chosen as a suitable potential site for an aquifer recharge facility. The groundwater modeling and other siting analyses conducted and discussed in this report are based on using the current quarry area for aquifer recharge. This site is also up gradient of and in relative proximity to the current Minot aquifer wellfield.

3.4 Results for the Sundre Aquifer

The relative site suitability index output for the Sundre aquifer yielded values ranging from 5 to 19, based on the four criteria analyzed (Figure 3-4). One of the criteria analyzed for the Minot aquifer site suitability model, proximity to contaminated sites, was not used in the Sundre aquifer model because there are no sites located in or around the Sundre aquifer model domain. Possible ranks ranged from 5 (areas where all criteria were ranked 1, or least suitable) to 20 (areas where all criteria were ranked 5, or highly suitable). Because the portion of the Sundre aquifer analyzed for the Inbasin Analysis is located in a rural area, much of which is located outside the special flood hazard zone, significant areas of the model domain received high suitability rankings. An agricultural area in the north-central portion of the domain was selected as a suitable potential site, based on its high suitability rankings and proximity to the current Sundre aquifer wellfield.

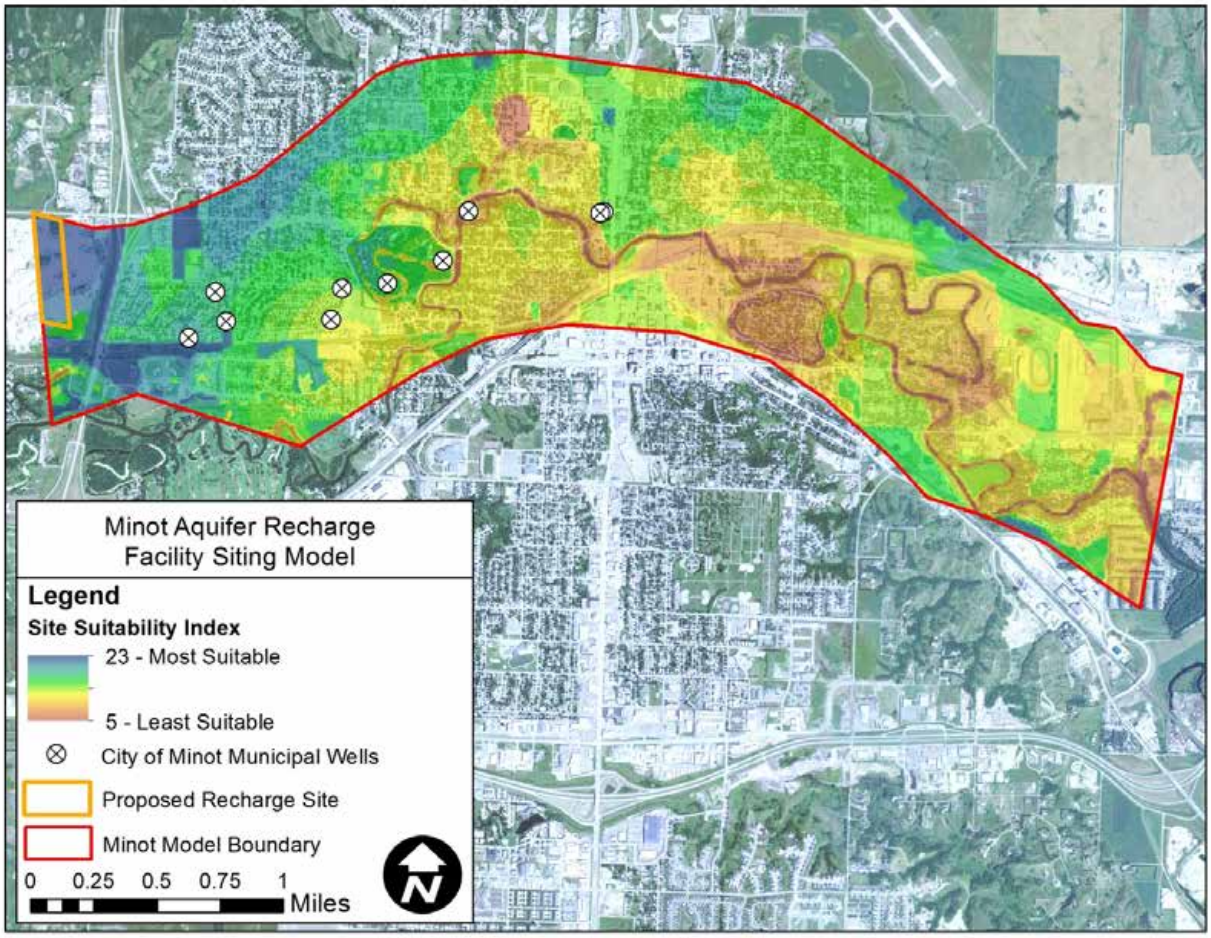

Figure 3-3 Site Suitability Index Output for the Minot Aquifer

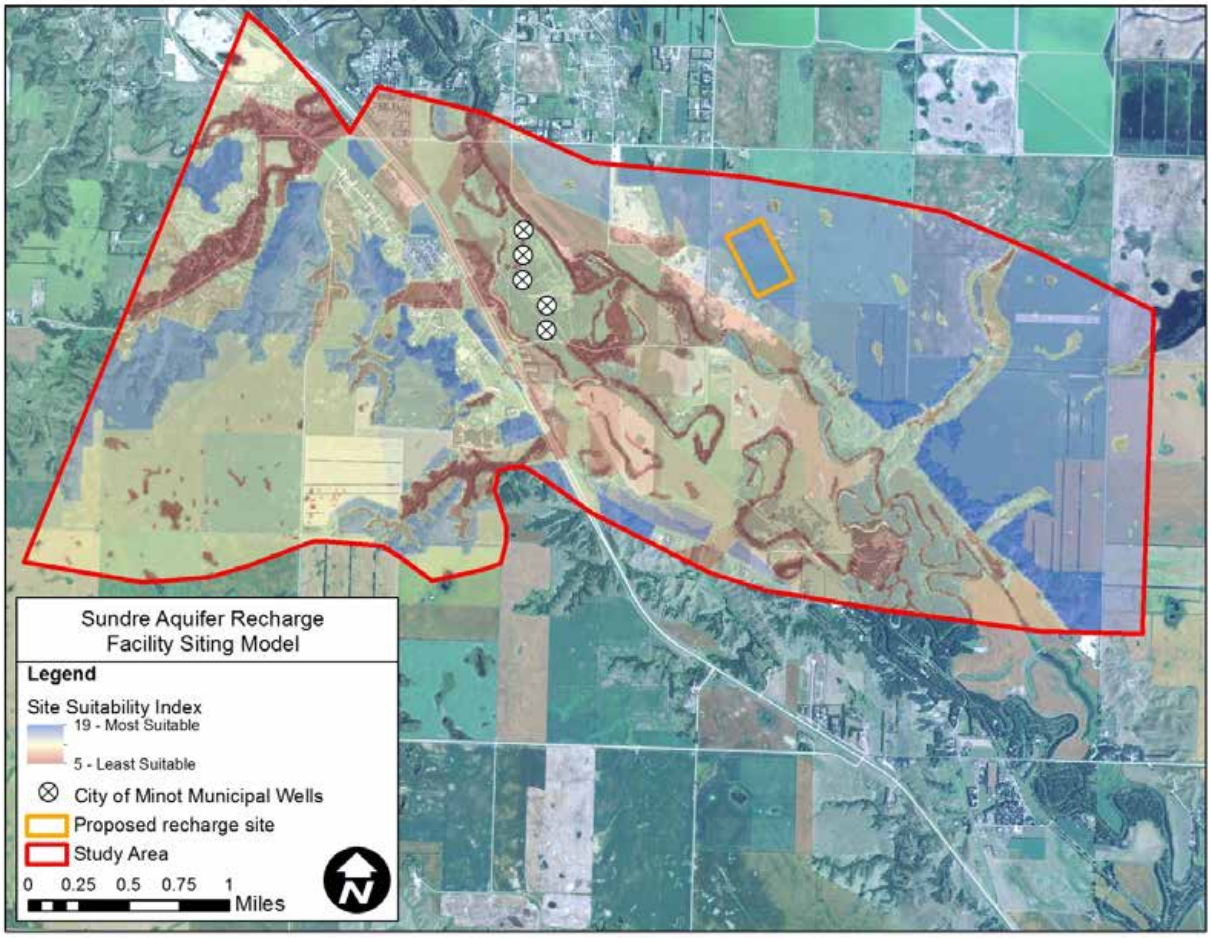

Figure 3-4 Site Suitability Index Output for the Sundre Aquifer

4.0 Hydrogeology of the Minot and Sundre Aquifers

This section describes the hydrogeologic characteristics of the Minot and Sundre aquifers as they pertain to Alternatives 1 and 2. Understanding and properly documenting the hydrogeology of the Study Area was an important part of the groundwater modeling that was conducted in support of the Inbasin Analysis. Additional detailed information regarding the hydrogeology of the Study Area is provided in the *Alternatives Identification, Review, and Selection Process* report (Reclamation 2012).

4.1 Minot Aquifer

4.1.1 Lithology and Extent

The Minot aquifer (Figure 4-1) is the major water-bearing unit of the Souris Valley aquifer system in the vicinity of the City of Minot. The Souris Valley aquifer system is composed of a series of alluvial terrace and glacial outwash deposits which extend along the Souris River Valley in Ward and McHenry counties. The aquifer system is composed of interbedded silts, sands, gravels, and clayey sediments of the Oahe and Coleharbor formations. The Minot aquifer is composed mainly of glacial outwash material with a very coarse sandy gravel matrix that includes an abundance of boulders. The aquifer is surrounded by low-permeability glacial till material and is underlain by the bedrock aquifers of the Fort Union Formation. The extent of the Minot aquifer is approximately 6 to 7 square miles in the vicinity of the City of Minot. The thickness of the aquifer varies from approximately 20 ft to more than 200 ft thick, with a mean thickness of approximately 68 ft, as interpreted through analysis of more than 60 lithologic logs for the aquifer. The aquifer is structurally thickest near the center, due to an eroded valley in the underlying Fort Union Formation (Pusc 1994). The Minot aquifer is confined across the majority of its areal extent, and overburden thickness averages 64 ft across the aquifer, but ranges from 0 to 115 ft thick across the Study Area.

4.1.2 Aquifer Characteristics

Groundwater flow in the Minot aquifer is generally from both the east and west toward the geographic center of the aquifer (Figure 4-1). This flow gradient appears to be mainly related to drawdowns associated with groundwater withdrawals from the City of Minot wellfield, and is likely quite different than the predevelopment potentiometry. Water levels in the aquifer can vary by as much as 20 ft during a typical year, and may vary by more than 20 ft during very dry or wet years. The Minot aquifer is highly transmissive and readily responds to recharge and groundwater withdrawals. Previous studies calculated transmissivities (gallons per day per foot [gpd/ft]) ranging from 12,000 to 354,000, with a mean of 164,563 gpd/ft in the vicinity of the Minot aquifer municipal supply wells. The Minot aquifer has higher per acre yields than any other aquifer known in North Dakota (Pettyjohn and Hutchinson 1971). The total storage capacity of the aquifer is unknown, because field testing by the North Dakota State Water Commission (SWC) and the U.S. Geological Survey (USGS) has not been adequate to define the

thickness and extent of the aquifer. Pettyjohn and Hutchinson estimated in 1971 that the Minot aquifer contained approximately 18.2 billion gallons in storage (Pusc 1994).

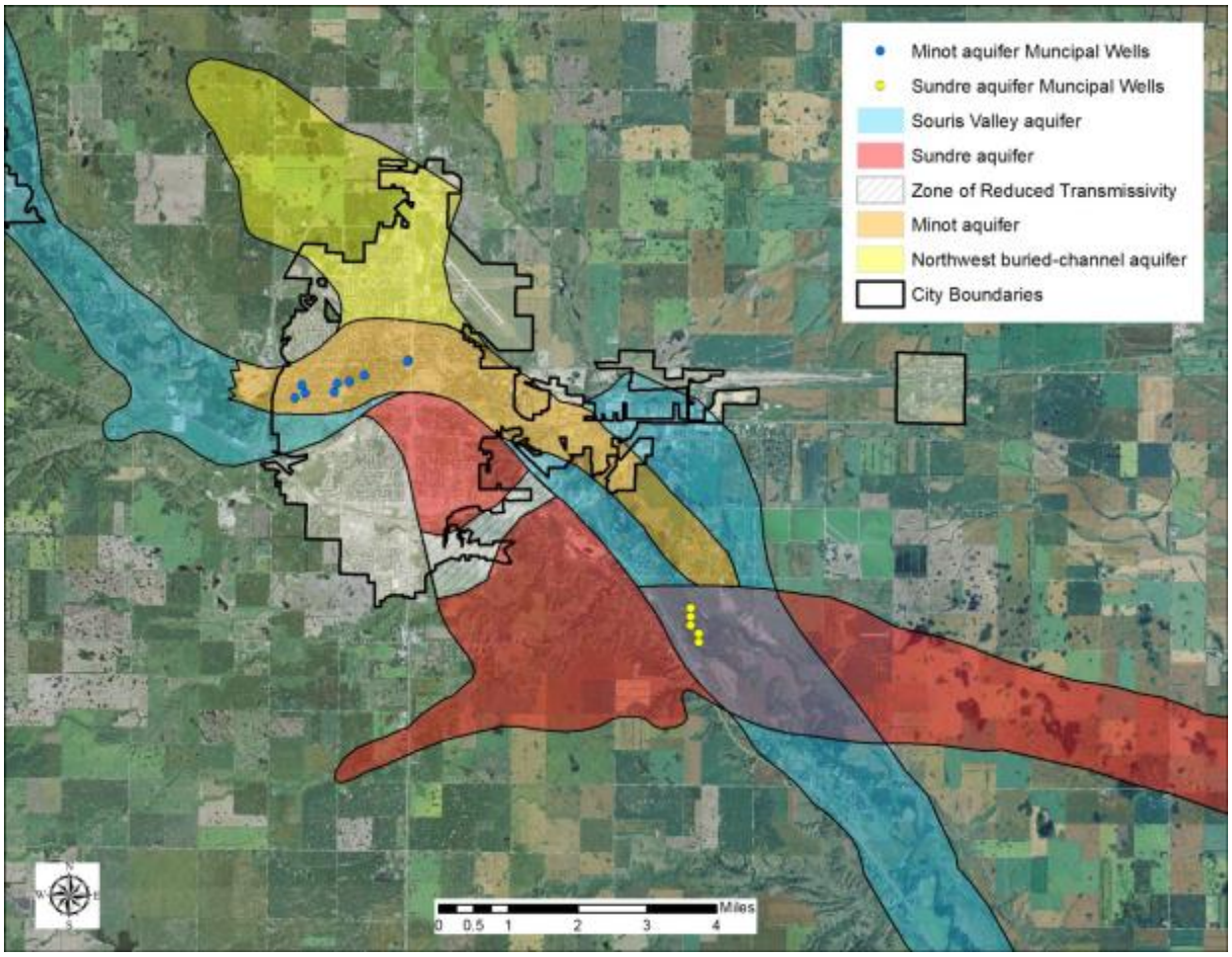

Figure 4-1 Minot Area Aquifers

There are several important conditions (recharge and discharge) that affect the overall water balance of the Minot aquifer. Inputs to the aquifer include:

- A contact with the Northwest Buried Channel aquifer (Figure 4-2), which provides constant inflow to the Minot aquifer due to its higher elevation. The potentiometric surface of the Northwest Buried Channel aquifer is traceable directly into the Minot aquifer.
- Leakage into the aquifer from the surrounding and overlying glacial till.
- Direct infiltration of rainfall, snowmelt, and runoff into the unconfined portions of the aquifer.

Infiltration of Souris River water into the aquifer in areas where confinement is thin and the river flows atop the aquifer.

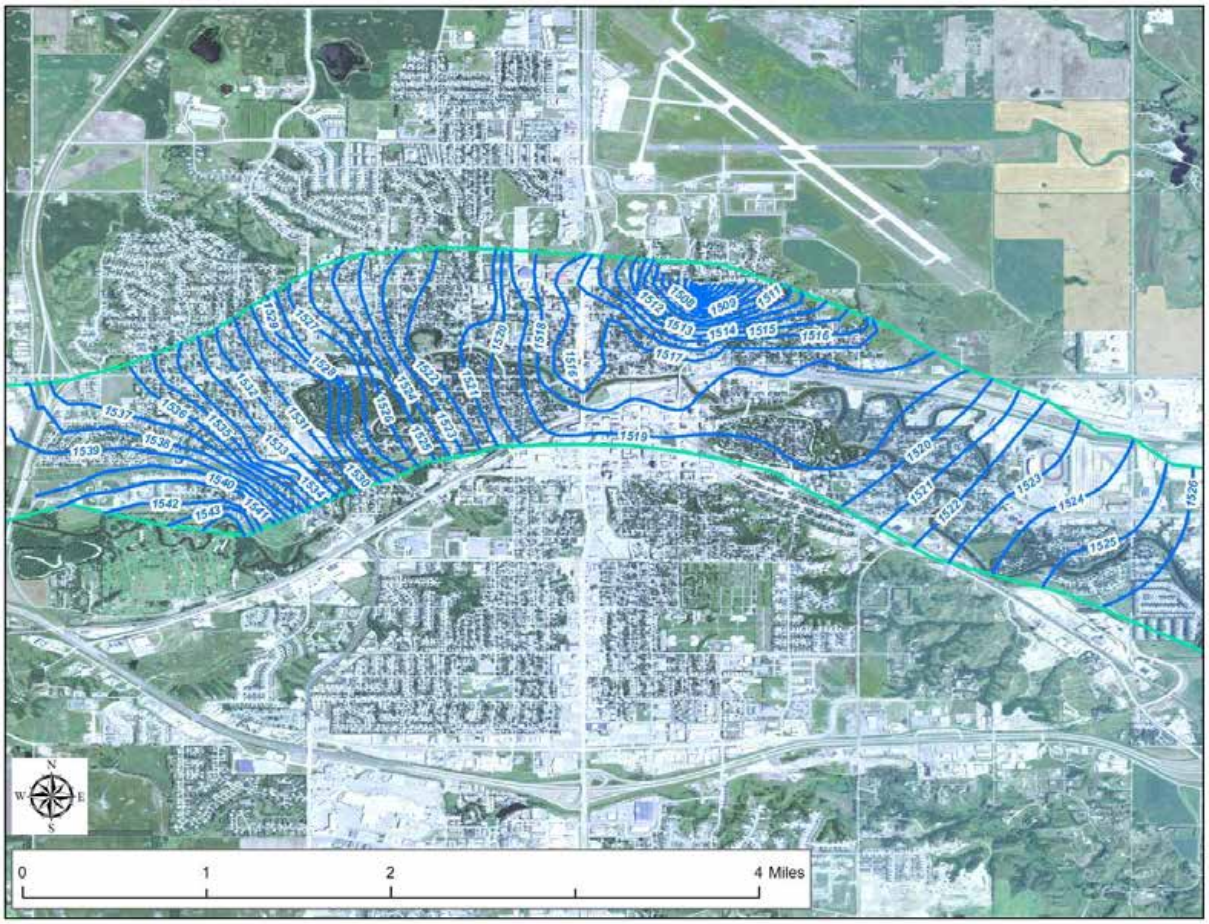

Figure 4-2 Minot Aquifer September 2011 Potentiometric Surface (ft NGVD 29)

Discharges from the aquifer include:

- Discharge into the Souris River through the river bed.
- Leakage from the aquifer to the underlying Fort Union Formation.
- Leakage into the surrounding glacial till and into minor alluvial units of the Souris Valley aquifer.
- Groundwater withdrawals.

Previous field investigations by the SWC and USGS have not been sufficient to accurately estimate recharge and discharge to the aquifer, so approximations provided in previous studies were used in the groundwater model developed for Inbasin Analysis. A discussion of the hydrogeologic characteristics used in the Minot aquifer model is provided in this report in Section 7, Groundwater Flow Simulations.

4.1.3 Water Supply Potential

The Minot aquifer has been used as a source of public water supply by the City of Minot for the past 95 years in conjunction with the Sundre aquifer and the Souris River.

As explained in the *Alternatives Identification, Review, and Selection Process report*, water levels in the Minot aquifer in the vicinity of Minot are in long-term decline due to concentrated groundwater withdrawals in and around the City's wellfield. Current withdrawals from the Minot aquifer average approximately 2.0 mgd. If groundwater withdrawals were increased without artificial recharge of the aquifer, the declining trend in groundwater levels would accelerate.

4.2 Sundre Aquifer

4.2.1 Lithology and Extent

The Sundre aquifer (Figure 4-1) is a water-bearing hydrogeologic unit overlain by the Souris Valley aquifer system near the Souris River floodplain and fluvial silt, clay, and glacial till in areas outside of the floodplain. The Sundre aquifer is composed of fine sand that transitions into coarse sand and medium gravel with occurrences of interbedded silt and clay. The sand and gravel is composed of material from the Canadian Shield and includes varying amounts of silicates, carbonates, shales and lignite (Pusc 1987). The Sundre aquifer appears to be truncated by low transmissivity barriers in the eastern section of the aquifer near the border of McHenry County and the western section of the aquifer immediately southeast of the City of Minot (Pusc 1987). The areas surrounding the Sundre aquifer consist of glacial till material, and the aquifer is underlain by the bedrock aquifers of the Fort Union Formation. The extent of the Sundre aquifer is approximately 1 to 2 miles wide and approximately 12 miles long in the vicinity of the City of Minot wellfield.

The Sundre aquifer is overlain with varying thicknesses of glacial material, sand, silt and clay throughout its extent. In the Souris River floodplain the Sundre aquifer is overlain by approximately 70 to 90 ft of gravel, sand, silt, and clay that constitutes the Souris Valley aquifer (Pusc 1987). In areas to the east and west of the Souris River floodplain, the Sundre aquifer is overlain by 15 to 50 ft of fluvial silt and clay and undifferentiated glacial till material (Pusc 1987). In the Souris River Valley, the depth to the top of the aquifer is approximately 90 to 210 ft below land surface (bls); however, sections of the two aquifers are considered to act as a single hydrologic unit and the top of the Sundre aquifer is indiscernible (Pusc 1987) from the base of the Souris Valley aquifer. The top of the Sundre aquifer in areas outside of the Souris River Valley varies from 110 to 260 ft bls (Pusc 1987). The Sundre aquifer varies in thickness from 30 ft thick in the western section to the deepest at 250 ft thick in the Souris River Valley (Pusc 1987). The average thickness of the Sundre aquifer is 191 ft, based on analysis of lithologic logs acquired from the SWC database.

4.2.2 Aquifer Characteristics

Groundwater flow (Figure 4-3) in the Sundre aquifer is from the eastern and western sections of the aquifer to the Minot wellfield. This flow gradient is caused by withdrawals from the Minot wellfield. This flow regime varies from predevelopment conditions when the aquifer was recharged by the Souris River during high flows and water from the aquifer was discharged to the river during low flow conditions.

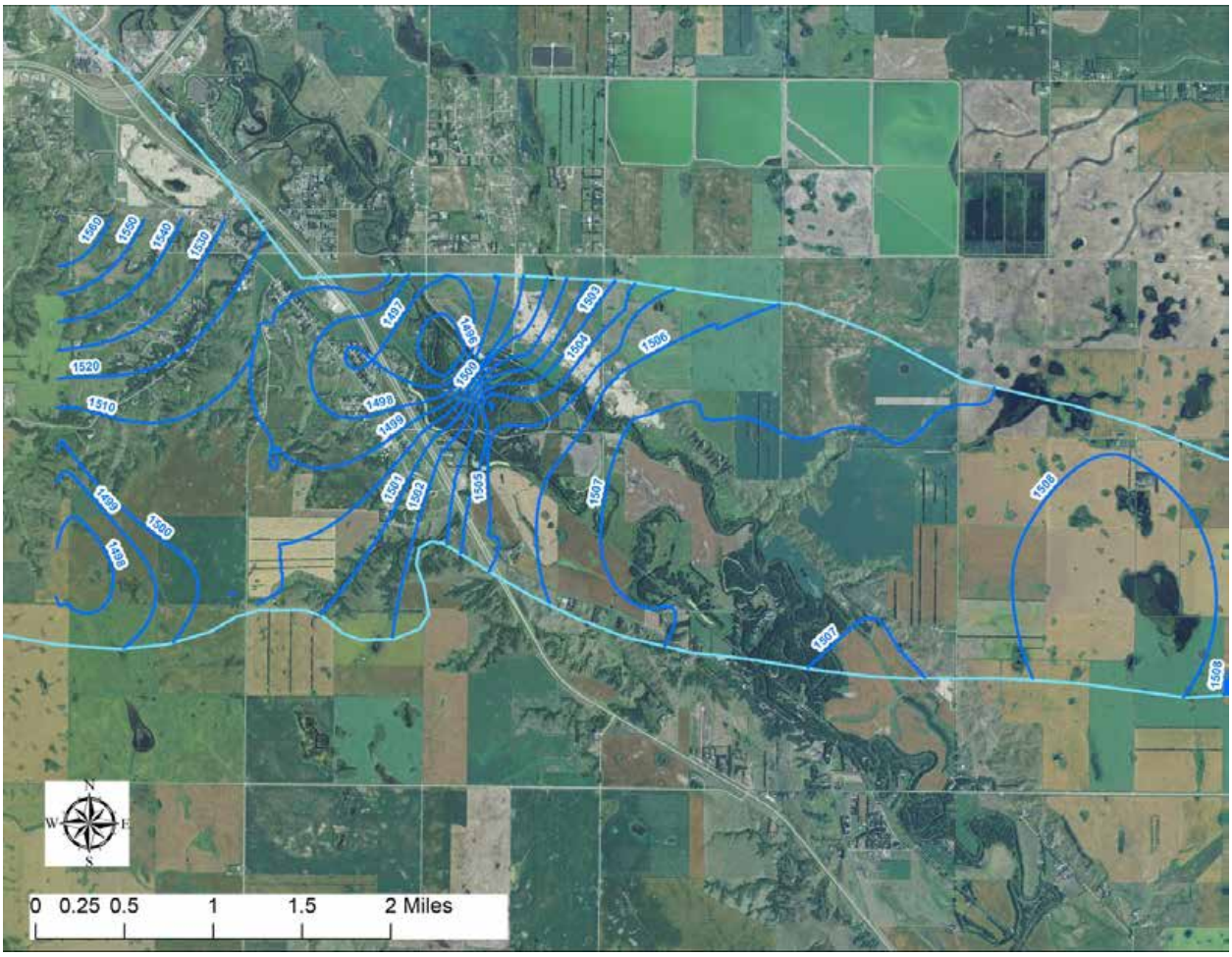

Figure 4-3 Sundre Aquifer April/May 2012 Potentiometric Surface (ft NGVD 29)

The Sundre aquifer is considered to be a highly productive, bounded, and leaky confined aquifer. A previous pump test determined that the Sundre aquifer has transmissivity values ranging from approximately 240,000 gpd/ft to 270,000 gpd/ft. The storage values associated with the aquifer were calculated to range from 1×10^{-3} to 2×10^{-3}. Based on the available data of the Sundre aquifer, total yield potential cannot be determined.

The water balance in the Sundre aquifer (predevelopment) is influenced by several conditions associated with recharge and discharge of water in the aquifer. Inputs into the aquifer include:

- Recharge from the Souris River during high flow conditions.
- Leakage from surrounding and overlying glacial till and alluvial units (low Souris River flow conditions).
- Infiltration of precipitation.
- Upward leakage due to artesian pressure from the underlying Fort Union Formation.

Discharges from the Sundre aquifer include:

- Discharge into the Souris River during low flow conditions.

- Leakage into surrounding and overlying glacial till and alluvial units (high Souris River flow conditions).
- Groundwater withdrawals.

Accurate estimates of recharge and discharge to the aquifer are not available, so approximations provided in previous studies were used in the groundwater model developed for the Inbasin Analysis. A discussion of the hydrogeologic characteristics used in the Sundre aquifer model is provided in Section 7, Groundwater Flow Simulations.

4.2.3 Water Supply Potential

The Sundre aquifer has been used as a source of public water supply by the City of Minot since 1976 in conjunction with the Minot aquifer and the Souris River. As explained in the *Alternatives Identification, Review, and Selection Process* report (Reclamation 2012), water levels in the Sundre aquifer are in long-term decline due to concentrated groundwater withdrawals from the City of Minot's wellfield. Current withdrawals from the Sundre aquifer average approximately 3.1 mgd. If groundwater withdrawals were increased without artificial recharge of the aquifer, the declining trend in groundwater levels would accelerate.

5.0 Availability of Water in the Souris River

A preliminary analysis of Souris River flows was conducted to determine the potential availability of water for Alternatives 1 and 2. The analysis was developed using period of record flow data downloaded from the USGS National Water Information System for the Souris River, Minot Station (USGS 2011). The Souris River receives contributing flow from a drainage area of 3,900 square miles. The majority of flow occurs during spring months as snow melts and runs off into tributaries of the Souris River in the watershed. Flow declines steadily through the summer months and drops to very low levels in the fall and winter. Table 5-1 shows the average and exceedance flows at Minot for each month for the period of record (1903-2011).

Table 5-1 Monthly Souris River Flow Conditions

Month	Average Daily Flow		Exceedance (cfs)		
	mgd	cfs	25%	50%	75%
January	13.7	21.2	23.0	4.4	0.5
February	19.9	30.7	21.0	4.0	0.4
March	90.8	140.6	119.0	25.0	3.6
April	421.0	651.5	794.0	184.0	42.0
May	371.0	574.1	428.0	92.0	16.0
June	188.9	292.3	225.0	64.0	12.0
July	121.0	187.2	165.0	41.0	5.5
August	49.6	76.8	87.0	24.0	3.0
September	37.1	57.4	58.0	19.0	2.0
October	22.6	35.0	43.0	14.0	0.8
November	18.1	27.9	40.0	13.0	1.4
December	14.6	22.6	27.0	8.0	1.0

Notes:
mgd = million gallons per day
cfs = cubic feet per second

An important step in this process was to determine whether the flow record needed to be adjusted to take potential flow constraints in Canada and the United States into account. These constraints include dams and water diversions in Canada; a minimum flow requirement for the river at Westhope, North Dakota, where the river enters Canada; and water rights in North Dakota. If it was concluded that the availability of water in the Souris River at Minot would be reduced by these constraints, the period of record flow data used to determine water availability would be reduced by the magnitude of the constraint.

An analysis of these constraints was conducted in the section of the *Alternatives Identification, Review, and Selection Process* report (Reclamation 2012) entitled *The Availability and Quality of Souris River Water*.

Based on a thorough investigation of potential constraints on Souris River water availability, as discussed in the Appraisal-Level Design Engineering Report, Section 1.2.1, it was determined that no adjustment to the Souris River flow record was needed and that it was appropriate at this level of design to base the estimation of future flows on historical data.

An important component of the appraisal-level design for Alternatives 1 and 2 is to understand the sustainability of the alternatives. Sustainability is the ability of the alternatives to meet projected water needs over an extended period of time. Sustainability in the Inbasin Analysis was assessed using a groundwater flow model as described in Section 7. A critical piece of information for the model is the quantity of recharge that can be expected over time. An understanding of the long-term availability of water in the Souris River was developed by analyzing exceedance flows for the period-of-record data to identify low-flow years and determine their frequency. An exceedance flow is a statistical measurement of flow based on historical discharge records. The exceedance value is the probability of flow exceeding a certain value. For instance a 50 percent exceedance value indicates that the level of flow reported at a gaging station has been equaled or exceeded 50 percent of the time during the period of record. A 75 percent exceedance value would be the level of flow at a gaging station that was equaled or exceeded 75 percent of the time during the period of record. It is widely accepted that a river is experiencing low flow when its flow is below the monthly 75 percent exceedance value and is experiencing normal flow when its flow is between the monthly 25 percent and 75 percent exceedance values. A river is classified as having high flow when its flow is above the monthly 25 percent exceedance level. Table 5-2 outlines the monthly average flows during the past 30 years; the headings show the 75 percent exceedance flow for each month. A 30-year period was used to assess Souris River flows because the mean of the past 30 years of climate data (rainfall, temperature, etc.) is used by the National Oceanic and Atmospheric Administration to define “normal climatic conditions.” Droughts and surplus rainfall years are often defined based on the deviation from normal conditions. Shaded boxes indicate the months of each year where average monthly flows were below the 75 percent exceedance flow. In 1988, 1991, 1992, and 2008, low-flow conditions prevailed in most of the months that normally experience high flows.

The table shows that back-to-back low-flow years (1991, 1992) occurred only once during this 30-year period. Based on this information, it was decided that a historical worst-case recharge scenario would be used for modeling that would consist of the recharge available during 10 normal-flow years followed by the reduced recharge available during 2 low-flow years, followed by additional normal-flow years. For the remainder of this report, this scenario will be referred to as the “primary scenario.”

Table 5-2 Souris River Flow Analysis of Low-Flow Years from 1981 through 2011

Year	Jan (0.5 cfs)	Feb (0.4 cfs)	Mar (3.6 cfs)	Apr (42 cfs)	May (16 cfs)	Jun (12 cfs)	Jul (5.5 cfs)	Aug (3 cfs)	Sep (2 cfs)	Oct (0.83 cfs)	Nov (1.4 cfs)	Dec (1 cfs)
1981	11.0	113.0	19.0	6.0	34.0	17.0	10.0	6.0	1.6	2.0	3.0	3.0
1982	3.0	4.0	272.0	1,237.0	689.0	290.0	76.0	33.0	50.0	58.0	47.0	40.0
1983	38.0	98.0	370.0	1,234.0	703.0	97.0	61.0	30.0	18.0	26.0	34.0	20.0
1984	22.0	28.0	78.0	63.0	67.0	16.0	2.0	44.0	25.0	34.0	4.0	3.0
1985	2.0	5.0	121.0	155.0	112.0	42.0	25.0	43.0	35.0	49.0	41.0	53.0
1986	41.0	49.0	136.0	58.0	62.0	32.0	31.0	119.0	29.0	32.0	23.0	21.0
1987	23.0	19.0	160.0	390.0	31.0	10.0	16.0	17.0	44.0	16.0	11.0	3.0
1988	0.7	1.0	3.0	4.0	4.0	0.0	0.0	45.0	22.0	0.1	0.7	1.0
1989	0.4	0.2	29.0	67.0	13.0	10.0	11.0	2.0	1.7	1.0	1.4	0.8
1990	0.4	0.1	2.0	49.0	122.0	51.0	28.0	0.9	0.0	0.0	0.8	1.0
1991	0.1	0.1	90.0	19.0	0.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	155.0	27.0	0.9	0.0	0.0	3.0	4.0	0.0	0.0	0.1
1993	0.0	0.0	5.0	47.0	0.3	16.0	131.0	32.0	28.0	12.0	3.0	3.0
1994	2.0	0.7	204.0	81.0	30.0	15.0	5.0	0.5	12.0	7.0	4.0	1.5
1995	0.9	37.0	756.0	413.0	107.0	178.0	226.0	74.0	36.0	56.0	22.0	11.0
1996	7.0	8.0	568.0	1,507.0	901.0	78.0	55.0	15.0	20.0	15.0	21.0	9.0
1997	148.0	399.0	636.0	1,492.0	1,172.0	58.0	54.0	9.0	37.0	52.0	16.0	11.0
1998	7.0	7.0	10.0	72.0	16.0	12.0	119.0	16.0	8.0	19.0	45.0	73.0
1999	36.0	6.0	815.0	2,100.0	1,605.0	486.0	493.0	480.0	367.0	198.0	28.0	23.0
2000	16.0	15.0	21.0	13.0	16.0	22.0	32.0	35.0	9.0	11.0	36.0	78.0
2001	35.0	156.0	758.0	1,248.0	1,316.0	122.0	146.0	124.0	116.0	69.0	46.0	6.0
2002	5.0	4.0	5.0	77.0	10.0	16.0	2.0	27.0	6.0	2.0	4.0	4.0
2003	3.0	0.6	66.0	145.0	176.0	12.0	2.0	12.0	0.0	0.0	0.7	2.0
2004	2.0	1.0	6.0	32.0	13.0	139.0	151.0	57.0	124.0	128.0	29.0	8.0
2005	3.0	3.0	49.0	585.0	145.0	415.0	310.0	203.0	64.0	94.0	54.0	7.0
2006	7.0	7.0	9.0	98.0	34.0	5.0	0.8	8.0	4.0	0.1	2.0	2.0

Year	Jan (0.5 cfs)	Feb (0.4 cfs)	Mar (3.6 cfs)	Apr (42 cfs)	May (16 cfs)	Jun (12 cfs)	Jul (5.5 cfs)	Aug (3 cfs)	Sep (2 cfs)	Oct (0.83 cfs)	Nov (1.4 cfs)	Dec (1 cfs)
2007	2.0	0.6	16.0	221.0	261.0	19.0	2.0	0.0	12.0	0.6	0.5	0.4
2008	0.4	0.2	7.0	253.0	14.0	11.0	0.3	0.0	0.0	0.0	0.4	0.9
2009	1.0	0.9	1.0	708.0	87.0	92.0	67.0	75.0	145.0	34.0	4.0	3.0
2010	3.0	4.0	269.0	162.0	81.0	196.0	227.0	212.0	363.0	195.0	139.0	164.0
2011	198.0	481.0	1,067.0	3,743.0	5,385.0	11,469.0	7,249.0	1,704.0	944.0	256.0	141.0	337.0

Note: Column headings include 75% exceedance values. Cells show average monthly flow in cfs (cubic feet per second); shaded cells indicate months where the average monthly flow was below the 75% exceedance value.

6.0 Water Balance Model

A water balance spreadsheet model was developed for Alternatives 1 and 2 to provide an initial estimate of the quantity of water that would be needed from the Souris River for recharge to offset groundwater withdrawals to meet projected needs while maintaining stable aquifer water levels. This was a necessary step in the process of developing the groundwater flow model that is discussed in Section 7 of this report. The spreadsheet water balance model allowed for a preliminary evaluation of the feasibility of the aquifer recharge/wellfield system by determining whether adequate quantities of water exist throughout the year to provide the necessary recharge during differing river flow conditions. The model determined the balance between inputs (recharge) and outputs (projected groundwater withdrawals) as an aide in developing the water budget for the groundwater flow model. The model was also used to determine how the recharge facilities proposed in Alternatives 1 and 2 would operate year-to-year and what size the basins would need to be to accommodate recharge quantities.

Inputs to the model included monthly recharge from the recharge basins and natural recharge from surrounding aquifers and infiltration from the river and rainfall. Artificial recharge was increased to exceed new groundwater withdrawals by 25 percent to provide a reasonable buffer. Total natural recharge is estimated at 3 mgd (Pettyjohn 1967) and is held constant throughout the year. Outputs include groundwater withdrawals to meet the 2060 projected needs of the Project, which are 26.3 mgd for the peak months of June, July, and August and 10.1 mgd for the remaining months.

In keeping with the primary scenario developed in the previous section, the model was run starting with a normal-flow year (50 percent exceedance flow) followed by 2 back-to-back low-flow years (75 percent exceedance flow) followed by a normal-flow year.

The model calculated the storage surplus or deficit in the Minot and Sundre aquifers as running monthly and yearly totals so that the deficit or surplus of water for each year of the 4-year scenario could be tracked. For the purposes of this analysis, it was assumed that 100 percent of 75 percent exceedance flow could be diverted from the river for aquifer recharge. It is understood that a diversion of this magnitude may have environmental and other effects, and these will be evaluated in the SEIS in Chapter 4, Environmental Impacts. However, because the natural condition of the river includes periods of zero flow (during drought periods, especially during fall and winter months), it was not unreasonable to consider such a withdrawal scenario.

6.1 Alternative 1

6.1.1 Water Balance Model Inputs and Outputs

Table 6-1 shows the monthly inputs and outputs that correspond to recharge and groundwater withdrawals for the normal-flow years and the low-flow years for both the Minot and Sundre aquifers. The bold, italicized numbers in the groundwater withdrawal rows are the peak

withdrawals for the Sundre aquifer and are the only differences between the inputs and outputs for the two aquifers.

Table 6-1 Alternative 1 – Monthly Inputs and Outputs to the Water Balance Model for Normal- and Low-Flow Conditions for the Minot and Sundre Aquifers (mgd)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal-Flow Year (50 Percent Exceedance Flow)												
River Flow	1.4	1.3	8.1	59.5	29.8	20.7	13.3	7.8	6.2	4.5	4.2	2.6
Artificial Recharge	0	0	3.9	28.9	14.5	10.1	6.4	3.8	0	0	0	0
Natural Recharge	3	3	3	3	3	3	3	3	3	3	3	3
Groundwater Withdrawals	5.05	5.05	5.05	5.05	5.05	10.5 ***15.81***	10.5 ***15.8***	10.5 ***15.8***	5.05	5.05	5.05	5.05
Low-Flow Year (75 Percent Exceedance Flow)												
River Flow	0.2	0.1	1.2	13.6	5.2	3.9	1.8	1	0.6	0.3	0.5	0.3
Artificial Recharge	0	0	1.2	13.6	5.2	3.9	1.8	1	0	0	0	0
Natural Recharge	3	3	3	3	3	3	3	3	3	3	3	3
Groundwater Withdrawals	5.05	5.05	5.05	5.05	5.05	10.5 ***15.8***	10.5 ***15.8***	10.5 ***15.8***	5.05	5.05	5.05	5.05

Notes: Monthly inputs are shown in the recharge rows and outputs are in the groundwater withdrawals row.
Bold, italicized numbers indicate peak withdrawals for the Sundre aquifer, the only differences between the inputs and outputs for the two aquifers+.

6.1.2 Results

The results of the modeling for the Minot aquifer for Alternative 1 are shown in Table 6-2. The model predicts that at the end of the 4th year, the Minot aquifer would have a surplus of 725.2 million gallons. The surplus is a small percentage of the estimated total storage volume of this aquifer (18.2 billion gallons).

Table 6-2 Alternative 1 – Minot Aquifer Water Balance Model Results

Model Year	Yearly Deficit or Surplus (million gallons)	Cumulative Deficit or Surplus (million gallons)
Year 1 (normal flow)	807.3	807.3
Year 2 (low flow)	-444.7	362.6
Year 3 (low flow)	-444.7	-82.07
Year 4 (normal flow)	807.3	725.2

The results of the modeling for the Sundre aquifer for Alternative 1 are shown in Table 6-3. The model predicts that at the end of the 4th year, the Sundre aquifer would have a deficit of 1.2 billion gallons. Although the storage capacity of the Sundre aquifer is not known, it is probably considerably greater than that of the Minot aquifer due to its greater thickness.

Therefore, the deficit is not a large percentage of the total storage volume of the aquifer, but the results indicate that the aquifer loses water under the primary scenario.

Table 6-3 Alternative 1 – Sundre Aquifer Water Balance Model Results

Model Year	Yearly Deficit or Surplus (million gallons)	Cumulative Deficit or Surplus (million gallons)
Year 1 (normal flow)	319.7	319.7
Year 2 (low flow)	-932.3	-612.6
Year 3 (low flow)	-932.3	-1,544.9
Year 4 (normal flow)	319.7	-1,225.2

6.2 Alternative 2

For Alternative 2, the system outputs (groundwater withdrawals) were reduced by the additional quantities of water harvested from the Souris River for direct conveyance to the Minot WTP and immediate use. These offset quantities would allow the wellfields to reduce production or cease it altogether during 7 months of the year.

6.2.1 Water Balance Model Inputs and Outputs

Table 6-4 shows the monthly inputs and outputs that correspond to recharge and groundwater withdrawals for the normal- and low-flow years for both the Minot and Sundre aquifers. The table also shows the quantities that would be withdrawn from the Souris River for direct conveyance to the Minot WTP and immediate use. Although these quantities are not an input or output of the model, it is important to show their magnitude and when they would be utilized. The bold, italicized numbers in the groundwater withdrawal rows are the peak withdrawals for the Sundre aquifer and are the only differences between the inputs and outputs for the two aquifers.

6.2.2 Results

The results of the modeling for the Minot aquifer for Alternative 2 are presented in Table 6-5. The model predicts that at the end of the 4th year, the Minot aquifer would have a surplus of over 2.1 billion gallons in storage. This result shows that the decrease in groundwater withdrawals due to the increased use of surface water for direct conveyance to the Minot WTP makes the system more reliable in the long term than Alternative 1.

Table 6-4 Alternative 2 – Monthly Inputs and Outputs to the Water Balance Model for Normal- and Low-Flow Conditions for the Minot and Sundre Aquifers (mgd)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal-Flow Year (50 Percent Exceedance Flow)												
River Flow	1.4	1.3	8.1	59.5	29.8	20.7	13.3	7.8	6.2	4.5	4.2	2.6
Artificial Recharge	0	0	3.9	28.9	14.5	10.1	6.4	3.8	0	0	0	0
Natural Recharge	3	3	3	3	3	3	3	3	3	3	3	3
Direct Supply	0	0	4.1	30.5	15.3	10.6	6.8	4	0	0	0	0
Groundwater Withdrawals	5.05	5.05	3	0	0	5.2 ***10.51***	7.1 ***12.4***	8.5 ***13.8***	5.05	5.05	5.05	5.05
Low-Flow Year (75 Percent Exceedance Flow)												
River Flow	0.2	0.1	1.2	13.6	5.2	3.9	1.8	1	0.6	0.3	0.5	0.3
Artificial Recharge	0	0	1.2	13.6	5.2	3.9	1.8	1	0	0	0	0
Natural Recharge	3	3	3	3	3	3	3	3	3	3	3	3
Direct Supply	0	0	0	0	0	0	0	0	0	0	0	0
Groundwater Withdrawals	5.05	5.05	5.05	5.05	5.05	10.5 ***15.8***	10.5 ***15.8***	10.5 ***15.8***	5.05	5.05	5.05	5.05

Notes: Monthly inputs are shown in the recharge rows and outputs are in the groundwater withdrawals row.
Bold, italicized numbers in groundwater withdrawal rows are peak withdrawals for the Sundre aquifer, the only differences between the inputs and outputs for the two aquifers.

Table 6-5 Alternative 2 – Minot Aquifer Water Balance Model Results

Model Year	Yearly Deficit or Surplus (million gallons)	Cumulative Deficit or Surplus (million gallons)
Year 1 (normal flow)	1,506.0	1,506.0
Year 2 (low flow)	-444.7	1,061.4
Year 3 (low flow)	-444.7	616.7
Year 4 (normal flow)	1,506.0	2,122.7

The results of the modeling for the Sundre aquifer for Alternative 2 are presented in Table 6-6. The model predicts that at the end of the 4th year, the Sundre aquifer would have a surplus of approximately 172 million gallons in storage. This result shows that the decrease in groundwater withdrawals due to the increased use of surface water for direct conveyance to the Minot WTP makes the system more reliable in the long term than Alternative 1.

Table 6-6 Alternative 2 – Sundre Aquifer Water Balance Model Results

Model Year Deficit or Surplus (- or +)	Yearly Deficit or Surplus (million gallons)	Cumulative Deficit or Surplus (million gallons)
Year 1 (normal flow)	1,018.4	1,018.4
Year 2 (low flow)	-932.3	86.2
Year 3 (low flow)	-932.3	-846.1
Year 4 (normal flow)	1,018.4	172.3

It must be remembered that the purpose of the water balance model is to determine whether river flows are sufficient to provide sufficient recharge to offset groundwater withdrawals. This facilitates the development of the water budget for the groundwater flow model, helps determine how the recharge facilities would operate year-to-year, and determines what size the recharge basins would need to be. The results derived from the water balance model are not an indication of how the aquifers would actually perform. This is determined through groundwater modeling as presented in Section 7.

6.3 Impacts on River Flow and Groundwater Levels

Alternative 1 includes the withdrawal of water from the Souris River for artificial recharge, while Alternative 2 includes withdrawals for aquifer recharge and direct conveyance to the Minot WTP. Table 6-7 shows the impact of each alternative on Souris River flows during a normal-flow year (50 percent exceedance flow). The table shows that during the highest flow months of March through August, Alternative 1 removes 48 percent of average monthly river flows and Alternative 2 removes 74 percent. The portion of the projected 2060 Project water needs that is completely or partially supplied by direct withdrawals and conveyance to the Minot WTP in Alternative 2 is shown in the far-right column.

A table was not provided to show the impact on river flow of withdrawals for Alternatives 1 and 2 at the low-flow condition (75 percent exceedance flow). This is because there is not enough flow at the 75 percent exceedance level to meet the recharge quantities specified for Alternative 1, let alone the increased quantities for Alternative 2.

Table 6-7 Impact of Alternatives 1 and 2 on Souris River Flow (50 Percent Exceedance Flow)

Month	Median Souris River flow (cfs)	Alternative 1			Alternative 2		
		Withdrawal Rate (cfs)	Reduction in Flow (%)	Remaining River Flow (cfs)	Withdrawal Rate (cfs)	Reduction in Flow (%)	Remaining River Flow (cfs)
January	4.4	0.0	0	4.4	0.0	0	4.4
February	4.0	0.0	0	4.0	0.0	0	4.0
March	25.0	12.1	48	12.9	18.4	74	6.6
April	184.0	89.4	49	94.6	102.7	56	81.3
May	92.0	44.6	48	47.4	63.0	68	29.0
June	64.0	31.3	49	32.7	47.7	74	16.3
July	41.0	19.8	48	21.2	30.3	74	10.7
August	24.0	11.8	49	12.2	17.9	75	6.1
September	19.0	0.0	0	19.0	0.0	0	19.0
October	14.0	0.0	0	14.0	0.0	0	14.0
November	13.0	0.0	0	13.0	0.0	0	13.0
December	8.0	0.0	0	8.0	0.0	0	8.0

7.0 Groundwater Flow Simulations

A groundwater flow model was developed to simulate the aquifer recharge/wellfield system for the Minot and Sundre aquifers proposed in Alternatives 1 and 2, in order to develop an understanding of the ability of the system to meet the 2060 projected water needs of the Project under the primary scenario (historical worst-case scenario) as previously defined(Section 5, Availability of Flows in the Souris River).

7.1 Model Setup – Minot Aquifer

This analysis represents a simplified model conceptualization of the Minot aquifer system commensurate with the appraisal-level design criteria of this Inbasin Analysis. The aquifer was modeled as a single layer, unconfined system assuming the following properties:

- Aquifer thickness – 100 ft
- Transmissivity – 165,000 gpd/ft
- Specific Yield – 0.2

The model was constructed using no-flow boundary conditions for the northern and southern boundaries of the Minot aquifer. Specified head boundary conditions were used to represent the eastern and western model boundaries to account for the natural flow into and out of the Minot aquifer. The model does not explicitly represent the Souris River or connected alluvial aquifers; therefore, the natural recharge into the Minot aquifer from connected alluvial aquifers and the Souris River was represented over the entire model domain at approximately 3 mgd and incorporated into the boundary conditions of the model. This rate is based on the following excerpt from *Hydrogeology of the Minot Aquifer, Ward County, North Dakota* (Pusc 1994):

> Natural recharge to the Minot aquifer occurs by: (1) direct or indirect infiltration of precipitation, (2) inflow from adjacent bedrock and glacial drift deposits, and (3) seepage from the Souris River (Akin 1947; Pettyjohn 1967; and Pettyjohn and Hutchinson, 1971). Pettyjohn (1967) estimated that: “Natural recharge to the Minot aquifer is apparently about 3 million gallons per day.”

The recharge basin (artificial recharge) was simulated using 10 injection wells covering roughly a 20-acre area.

A numerical model was constructed using the USGS MODFLOW 2000 platform via the graphical user interface GMS, to prepare the model input files and visualize the results. The model domain was represented using model cell sizes of 200 ft by100 ft. The top surface of the aquifer was created using ground surface elevation data obtained from the USGS. Average historical water levels (1963 to 2012) of the Minot aquifer were calculated to create a potentiometric surface. A steady-state model of the Minot aquifer was first run to determine a static potentiometric water level surface in the model without interference from groundwater pumping or artificial recharge. The water levels created in the steady-state groundwater flow

model of the Minot aquifer were used for the initial conditions for the transient groundwater flow model of the Minot aquifer. The transient model of the Minot aquifer was designed to calculate fluctuations in water level elevations caused by variations in groundwater withdrawals and artificial recharge scenarios. Figure 7-1 shows the model boundary and elements.

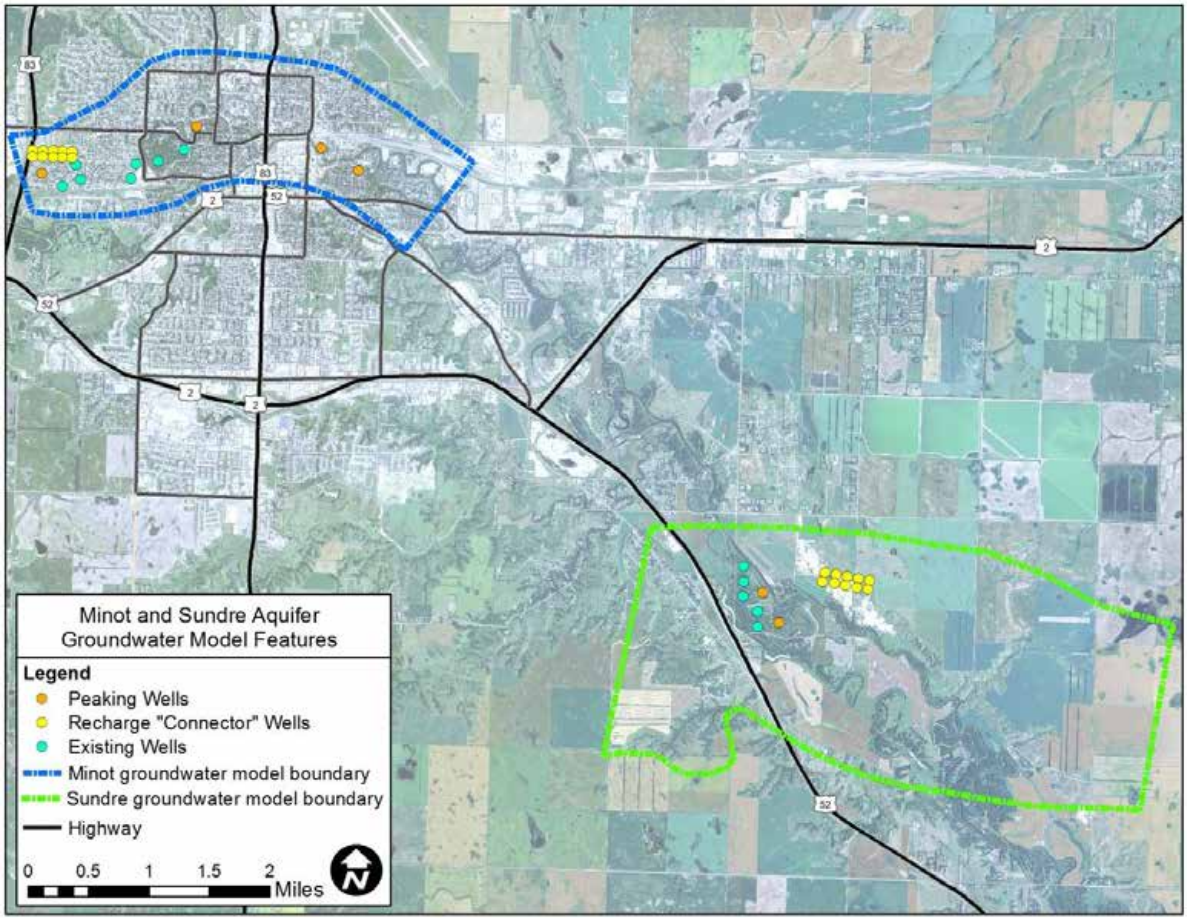

Figure 7-1 Minot and Sundre Aquifer Groundwater Model Features

7.1.1 Modeling Simulations

Two modeling simulations were performed to represent the primary scenario for Alternatives 1 and 2 in the Minot aquifer:

7.1.1.1 Alternative 1 Simulation

- 1 year of historic (2.0 mgd) withdrawals to mimic existing conditions.
- 10 years of Alternative 1 normal-flow recharge (50 percent exceedance flow, Souris River) and Alternative 1 groundwater withdrawals as shown in Section 6.0, Water Balance Model.
- 2 years of low-flow recharge (75 percent exceedance flow, Souris River) and Alternative 1 groundwater withdrawals as shown in Section 6.0, Water Balance Model.

10 years of normal-flow recharge (50 percent exceedance flow, Souris River) and Alternative 1 groundwater withdrawals.

7.1.1.2 Alternative 2 Simulation

- 1 year of historic (2.0 mgd) withdrawals to mimic existing conditions.
- 10 years of Alternative 1 normal-flow recharge (50 percent exceedance flow, Souris River) and Alternative 2 groundwater withdrawals as shown in Section 6, Water Balance Model.
- 2 years of low-flow recharge (75 percent exceedance flow, Souris River) and Alternative 2 groundwater withdrawals as shown in Section 6, Water Balance Model.
- 10 years of normal-flow recharge (50 percent exceedance flow, Souris River) and Alternative 2 groundwater withdrawals.

Seven existing Minot aquifer wells and four new peaking wells, needed to meet peak water needs in June, July, and August, were used in the model. Tables 7-1 and 7-2 provide groundwater withdrawal and artificial recharge quantities on a month-by-month basis for the 50 percent and 75 percent exceedance flows for Alternatives 1 and 2, respectively.

Table 7-1 Alternative 1 – Minot Aquifer Model Inputs for Normal- and Low-Flow Conditions (mgd)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal-Flow Year (50 Percent Exceedance Flow)												
Artificial Recharge	0	0	3.9	28.9	14.9	10.1	6.4	3.8	0	0	0	0
Natural Recharge	3	3	3	3	3	3	3	3	3	3	3	3
Groundwater Withdrawals	5.05	5.05	5.05	5.05	5.05	10.5	10.5	10.5	5.05	5.05	5.05	5.05
Low-Flow Year (75 Percent Exceedance Flow)												
Artificial Recharge	0	0	1.2	13.6	5.2	3.9	1.8	1.0	0	0	0	0
Natural Recharge	3	3	3	3	3	3	3	3	3	3	3	3
Groundwater Withdrawals	5.05	5.05	5.05	5.05	5.05	10.5	10.5	10.5	5.05	5.05	5.05	5.05

Table 7-2 Alternative 2 – Minot Aquifer Model Inputs for Normal-and Low-Flow Conditions (mgd)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal-Flow Year (50 Percent Exceedance Flow)												
Artificial Recharge	0	0	3.9	28.9	14.9	10.1	6.4	3.8	0	0	0	0
Natural Recharge	3	3	3	3	3	3	3	3	3	3	3	3
Groundwater Withdrawals	5.05	5.05	3.0	0	0	5.2	7.1	8.5	5.05	5.05	5.05	5.05
Low-Flow Year (75 Percent Exceedance Flow)												
Artificial Recharge	0	0	1.2	13.6	5.2	3.9	1.8	1.0	0	0	0	0
Natural Recharge	3	3	3	3	3	3	3	3	3	3	3	3
Groundwater Withdrawals	5.05	5.05	5.05	5.05	5.05	10.5	10.5	10.5	5.05	5.05	5.05	5.05

7.1.2 Modeling Results

The average groundwater withdrawal rate from the Minot aquifer has been approximately 2.0 mgd since 1976. The SWC has estimated that the sustainable yield from the Minot aquifer is approximately 2.0 mgd (Pusc 1987). However, the continuing downward trend in aquifer levels during the period when withdrawals averaged 2.0 mgd indicates that the aquifer cannot sustain this level of withdrawal or support additional withdrawals without some type of supplemental recharge (Figure 7-2). The spike in the aquifer level in 2011 is a result of the record Souris River flood event. Because the wells were inundated during the flooding and out of service for a number of months, the aquifer level was likely to have risen significantly. In addition, the high water levels in the floodplain may have recharged the aquifer to an unprecedented degree, which also may have caused the aquifer level to rise.

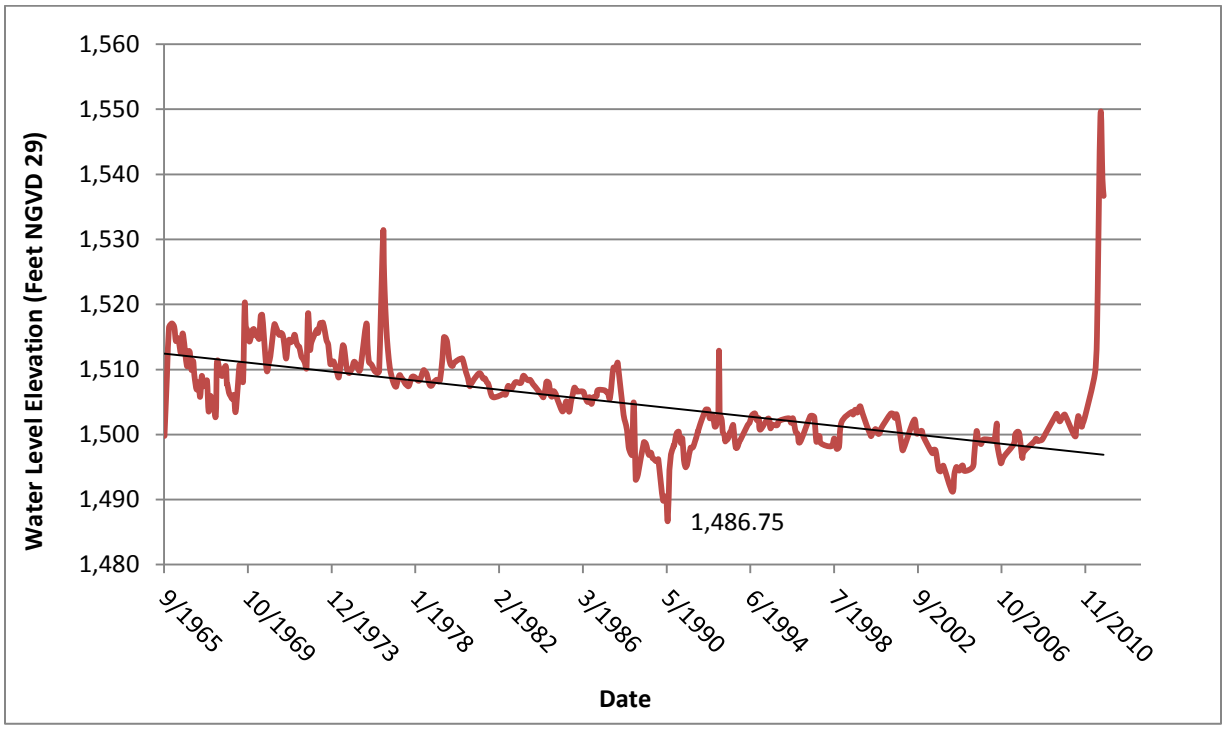

Figure 7-2 Historical Groundwater Level Decline in the Minot Aquifer

The average water level in the Minot aquifer from 1990 to 2010 in vicinity of the wellfield has been approximately 1,500 ft National Geodetic Vertical Datum of 1929 (NGVD 29). With a land surface elevation of approximately 1,550 ft NGVD 29, the water level averaged 50 ft bls.

7.1.2.1 Alternative 1

The results of simulating Alternative 1 in the Minot aquifer show that after a 10-year period of recharge and withdrawals that would occur during the normal-flow portion of the primary scenario, average water levels decline to approximately 77 ft bls (Figure 7-3). Because the top of the screened interval of wells in the Minot aquifer wellfield is approximately 120 ft bls, the operation of the wells at the required groundwater withdrawal rate would not be impaired. In addition, if the low-flow portion of the scenario is followed by 4 years of normal-flow conditions, the model predicts that water levels would recover to an average of approximately

60 ft bls. Based on these results, it is concluded that the Alternative 1 recharge/wellfield system is sustainable in the Minot aquifer.

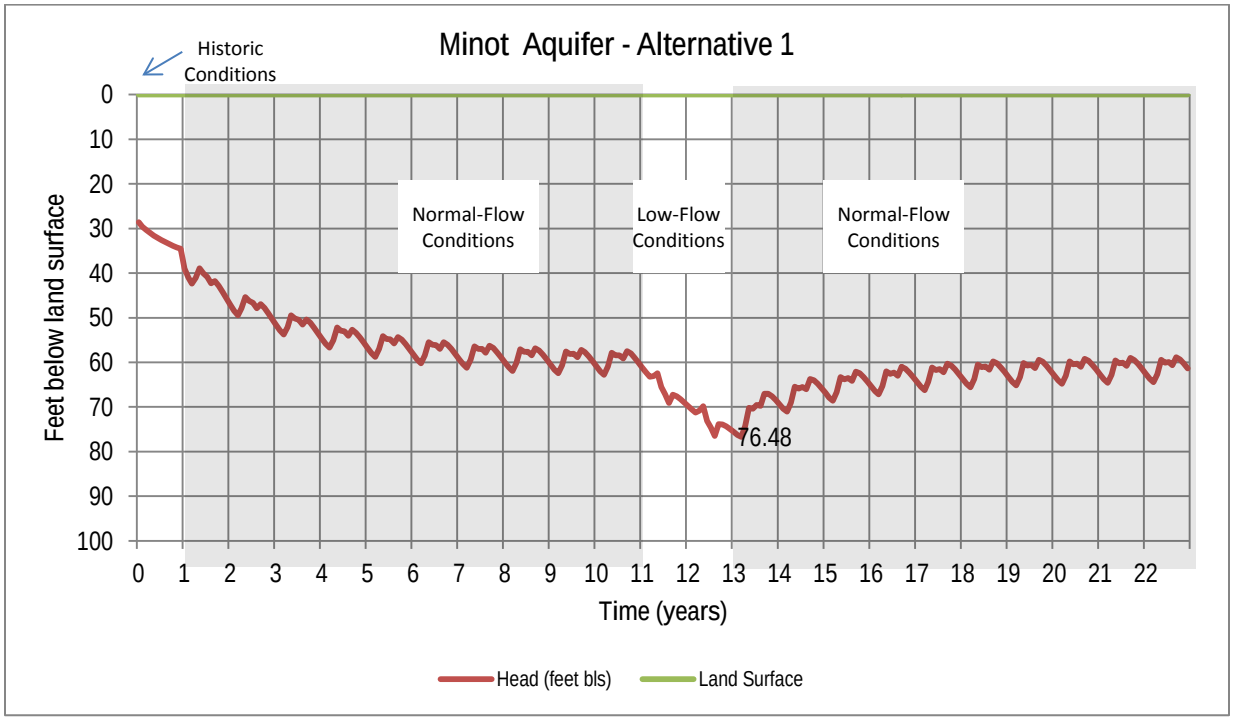

Figure 7-3 Hydrograph Showing Results of the Alternative 1 Simulation for the Minot Aquifer

7.1.2.2 Alternative 2

The results of simulating Alternative 2 in the Minot aquifer (Figure 7-4) show that after a 10-year period of recharge and withdrawals that would occur during normal-flow portion of the primary scenario, average water levels in the Minot aquifer would not decline, but would improve from the 1990 to 2010 average of 50 ft bls to approximately 40 ft bls. The addition of 2 consecutive years of recharge and withdrawal conditions that would occur during the low-flow portion of the scenario would cause water levels to decline by approximately 27 to 67 ft bls. Because the top of the screened interval of wells in the Minot aquifer wellfield is approximately 120 ft bls, the operation of the wells at the required groundwater withdrawal rate would not be impaired. In addition, if the low-flow portion of the scenario is followed by 4 years of normal-flow conditions, the model predicts that water levels would recover to an average of 40 ft bls. Based on these results, it is concluded that the Alternative 2 recharge/wellfield system is sustainable in the Minot aquifer.

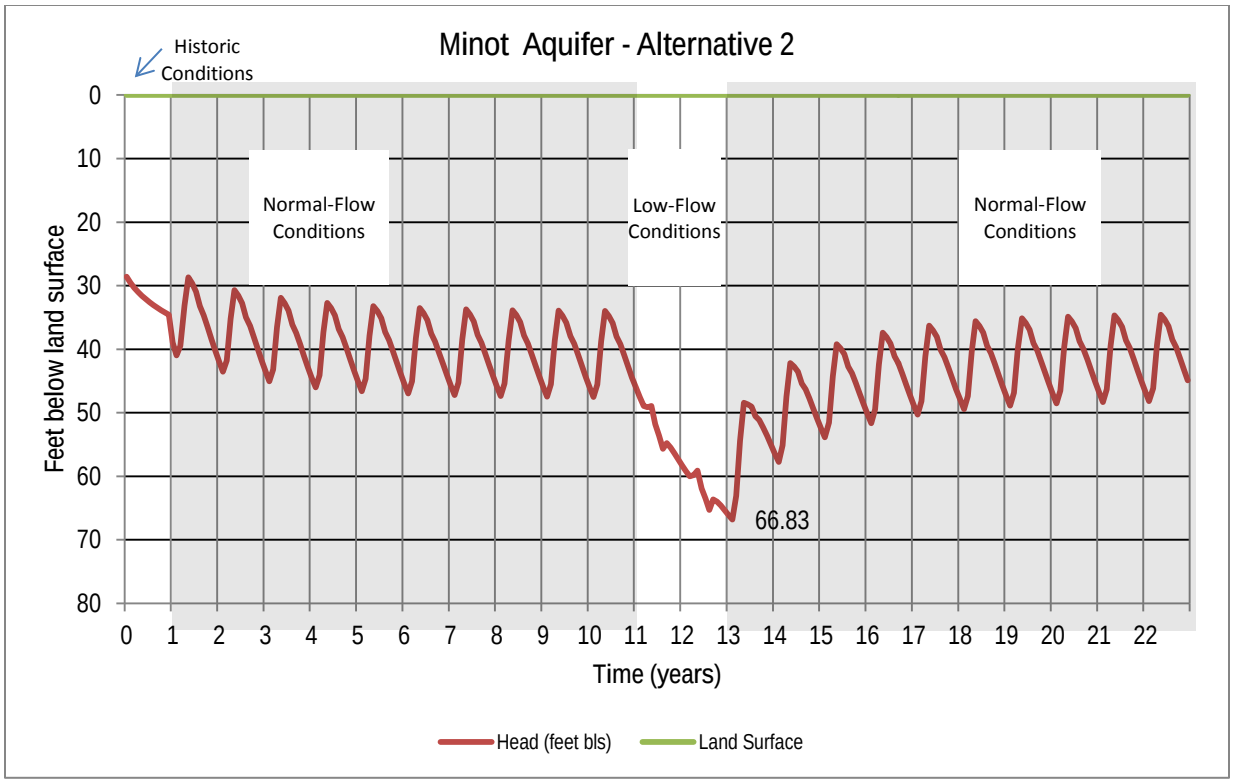

Figure 7-4 Hydrograph Showing the Results of the Alternative 2 Simulation for the Minot Aquifer

7.2 Model Setup - Sundre Aquifer

This analysis represents a simplified model conceptualization of the Sundre aquifer system commensurate with the appraisal-level design criteria of this Inbasin Analysis. The aquifer was modeled as a single layer confined system assuming the following properties:

- Aquifer thickness – 200 ft
- Transmissivity – 260,000 gpd/ft
- Storage Coefficient – 0.0015

Similar to the Minot aquifer model the Sundre model was constructed using no-flow boundary conditions for the northern and southern boundaries of the aquifer and specified head boundary conditions for the eastern and western model boundaries to account for the natural flow into and out of the Sundre aquifer. As with the Minot aquifer model, the Sundre aquifer model does not explicitly represent the Souris River or connected alluvial aquifers. The natural recharge rate is based on using a standardized input similar in conceptualization to that used in the groundwater flow model of the Minot aquifer to implicitly represent recharge flow from the Souris River, Souris Valley aquifer, and surrounding glacial till material. The recharge basin (artificial recharge) was simulated using 10 injection wells covering roughly a 20-acre area.

The USGS MODFLOW 2000 and GMS were used to model the Sundre aquifer similarly to how the Minot aquifer was modeled. The domain was represented using model cell sizes that were approximately 200 ft by100 ft. The upper extent of the groundwater flow model representing land surface was created using ground surface elevation data obtained from the USGS. The top of the Sundre aquifer was created by subtracting a uniform 90 ft from the ground surface elevation data over the entire model domain, representing glacial till material and the Souris Valley aquifer where applicable. Average historical (1969 to 2012) water levels of the Sundre aquifer were calculated to create a potentiometric surface. A steady-state model of Sundre aquifer was first run to determine a static potentiometric water level surface in the model without interference from groundwater pumping or artificial recharge. The water levels created in the steady-state groundwater flow model of the Sundre aquifer were used for the initial conditions for the transient groundwater flow model of the Sundre aquifer. The transient model of the Sundre aquifer was designed to calculate fluctuations in water level elevations caused by variations in groundwater withdrawals and artificial recharge. Figure 7-1 shows the model boundary and elements.

7.2.1 Modeling Simulations

Two modeling simulations were performed to represent the primary scenario for Alternatives 1 and 2 within the Sundre aquifer.

7.2.1.1 Alternative 1 Simulation

- 1 year of historic (2.0 mgd) withdrawals to mimic existing conditions.
- 10 years of Alternative 1 normal-flow recharge (50 percent exceedance flow, Souris River) and Alternative 1 groundwater withdrawals as shown in Section 6.0, Water Balance Model.
- 2 years of low-flow recharge (75 percent exceedance flow, Souris River) and Alternative 1 groundwater withdrawals as shown in Section 6.0, Water Balance Model.
- 10 years of normal-flow recharge (50 percent exceedance flow, Souris River) and Alternative 1 groundwater withdrawals.

7.2.1.2 Alternative 2 Simulation

- 1 year of historic (2.0 mgd) withdrawals to mimic existing conditions.
- 10 years of Alternative 1 normal-flow recharge (50 percent exceedance flow, Souris River) and Alternative 2 groundwater withdrawals as shown in Section 6.0, Water Balance Model.
- 2 years of low-flow recharge (75 percent exceedance flow, Souris River) and Alternative 2 groundwater withdrawals as shown in Section 6.0, Water Balance Model.
- 10 years of normal-flow recharge (50 percent exceedance flow, Souris River) and Alternative 2 groundwater withdrawals.

Five existing wells and two new peaking wells, needed to meet peak demands in June, July, and August, were used in the model. Tables 7-3 and 7-4 show groundwater withdrawal and artificial recharge quantities on a month-by-month basis for the 50 percent and 75 percent exceedance flows for Alternatives 1 and 2, respectively.

Table 7-3 Alternative 1 – Sundre Aquifer Model Inputs for Normal- and Low-Flow Conditions (mgd)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal-Flow Year (50 Percent Exceedance Flow)												
Artificial Recharge	0	0	3.9	28.9	14.9	10.1	6.4	3.8	0	0	0	0
Natural Recharge	3	3	3	3	3	3	3	3	3	3	3	3
Groundwater Withdrawals	5.05	5.05	5.05	5.05	5.05	15.8	15.8	15.8	5.05	5.05	5.05	5.05
Low-Flow Year (75 Percent Exceedance Flow)												
Artificial Recharge	0	0	1.2	13.6	5.2	3.9	1.8	1.0	0	0	0	0
Natural Recharge	3	3	3	3	3	3	3	3	3	3	3	3
Groundwater Withdrawals	5.05	5.05	5.05	5.05	5.05	15.8	15.8	15.8	5.05	5.05	5.05	5.05

Table 7-4 Alternative 2 – Sundre Aquifer Model Inputs for Normal- and Low-Flow Conditions (mgd)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal-Flow Year (50 Percent Exceedance Flow)												
Artificial Recharge	0	0	3.9	28.9	14.9	10.1	6.4	3.8	0	0	0	0
Natural Recharge	3	3	3	3	3	3	3	3	3	3	3	3
Groundwater Withdrawals	5.05	5.05	3.0	0	0	10.5	12.4	13.8	5.05	5.05	5.05	5.05
Low-Flow Year (75 Percent Exceedance Flow)												
Artificial Recharge	0	0	1.2	13.6	5.2	3.9	1.8	1.0	0	0	0	0
Natural Recharge	3	3	3	3	3	3	3	3	3	3	3	3
Groundwater Withdrawals	5.05	5.05	5.05	5.05	5.05	15.8	15.8	15.8	5.05	5.05	5.05	5.05

7.2.2 Modeling Results

The average groundwater withdrawal rate from the Sundre aquifer has been approximately 3.1 mgd since 1976. The SWC estimates that the sustainable yield from the Sundre aquifer is approximately 6.0 mgd (Pusc 1994). However, the continued downward trend in water levels since 1976 indicates the aquifer cannot continue to sustain this level of withdrawal or support additional withdrawals without some type of supplemental recharge (Figure 7-5). Similar to the Minot aquifer, the spike in the Sundre aquifer level in 2011 was due to the record Souris River flood event.

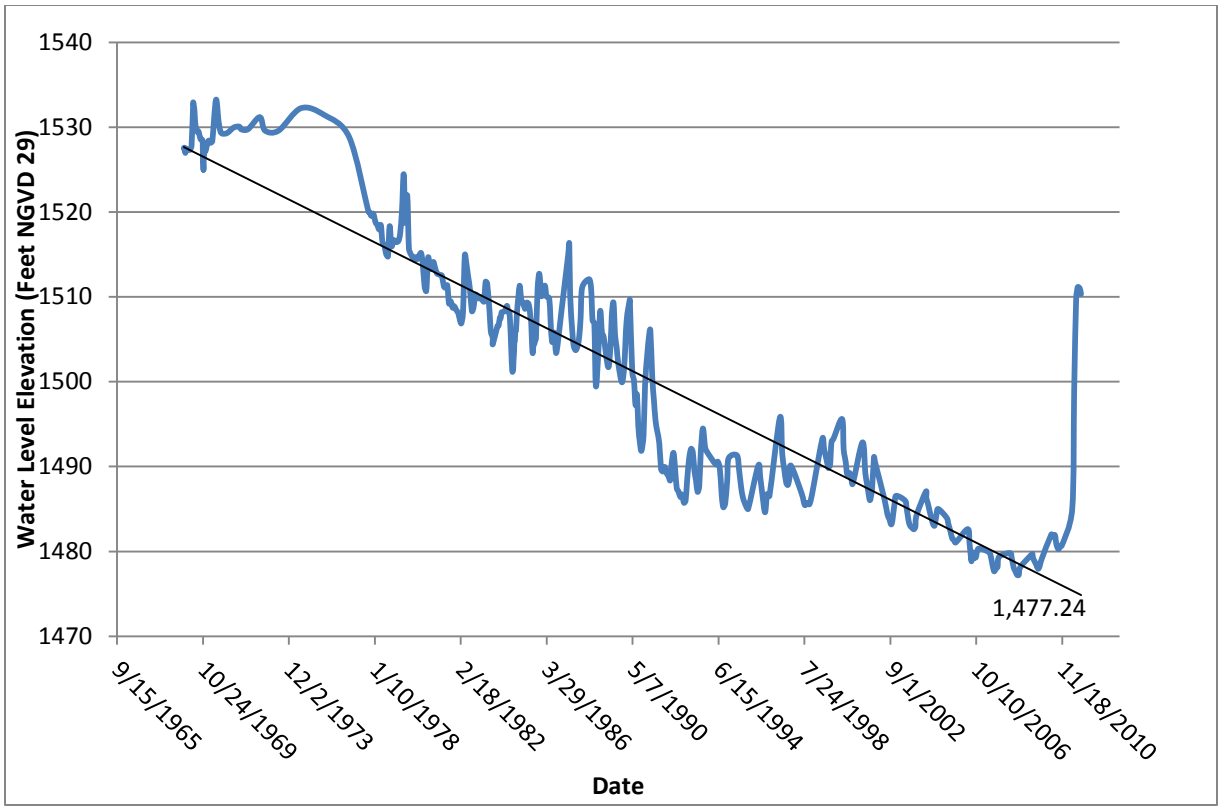

Figure 7-5 Historical Groundwater Level Decline in the Sundre Aquifer

Water levels in the Sundre aquifer from 1975 to 1990 were in the range of 1,510 ft NGVD 29. Following a steep decline in 1990, water levels remained at approximately 1,490 ft NGVD 29 until 2002 when levels declined for several years to approximately 1,480 ft NGVD 29 prior to the 2011 spring flood. With a land surface elevation of approximately 1,542 ft NGVD 29 in the vicinity of the wellfield, the water level was approximately 62 ft bls prior to the flood event.

7.2.2.1 Alternative 1

The results of simulating Alternative 1 in the Sundre aquifer show that after a 10-year period of recharge and withdrawals that would occur during the normal-flow portion of the primary scenario, average water levels are predicted to equilibrate at approximately 50 ft bls (Figure 7-6). The addition of 2 consecutive years of recharge and withdrawal conditions that would occur during the low-flow portion of the scenario would cause water levels to decline to 62 ft bls. Because the top of the screen interval of wells in the Sundre aquifer wellfield is approximately 200 ft bls, the decline in water levels to 62 ft bls would not impair the required groundwater withdrawal rate. In addition, if the low-flow portion of the scenario is followed by 1 year of normal-flow conditions, the model predicts that water levels would recover to an average of 50 ft bls. Based on these results, it is concluded that Alternative 1 is sustainable in the Sundre aquifer.

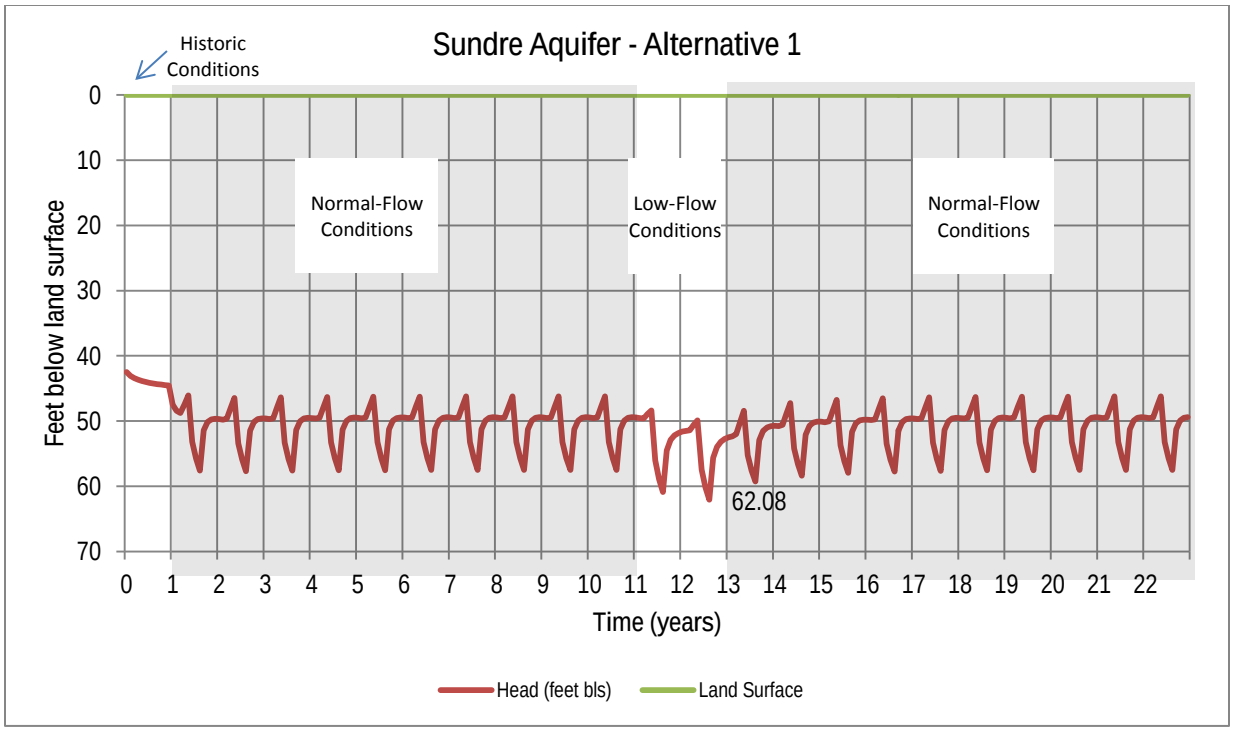

Figure 7-6 Hydrograph Showing the Results of the Alternative 1 Simulation for the Sundre Aquifer

7.2.2.2 Alternative 2

The results of simulating Alternative 2 in the Sundre aquifer show that after a 10-year period of recharge and withdrawals that would occur during the normal-flow portion of the primary scenario, average water levels are predicted to equilibrate at approximately 45 ft bls (Figure 7-7). The addition of 2 consecutive years of recharge and withdrawal conditions that would occur during the low-flow portion of the scenario would cause water levels to decline to an average of 62 ft bls. Because the top of the screened interval of wells in the Sundre aquifer wellfield is approximately 200 ft bls, the decline in water levels to an average of 62 ft bls would not impair the required groundwater withdrawal rate. In addition, if the low-flow portion of the scenario is followed by 1 year of normal-flow conditions, the model predicts that water levels would recover to an average of 45 ft bls. Based on these results, it is concluded that Alternative 2 is sustainable in the Sundre aquifer.

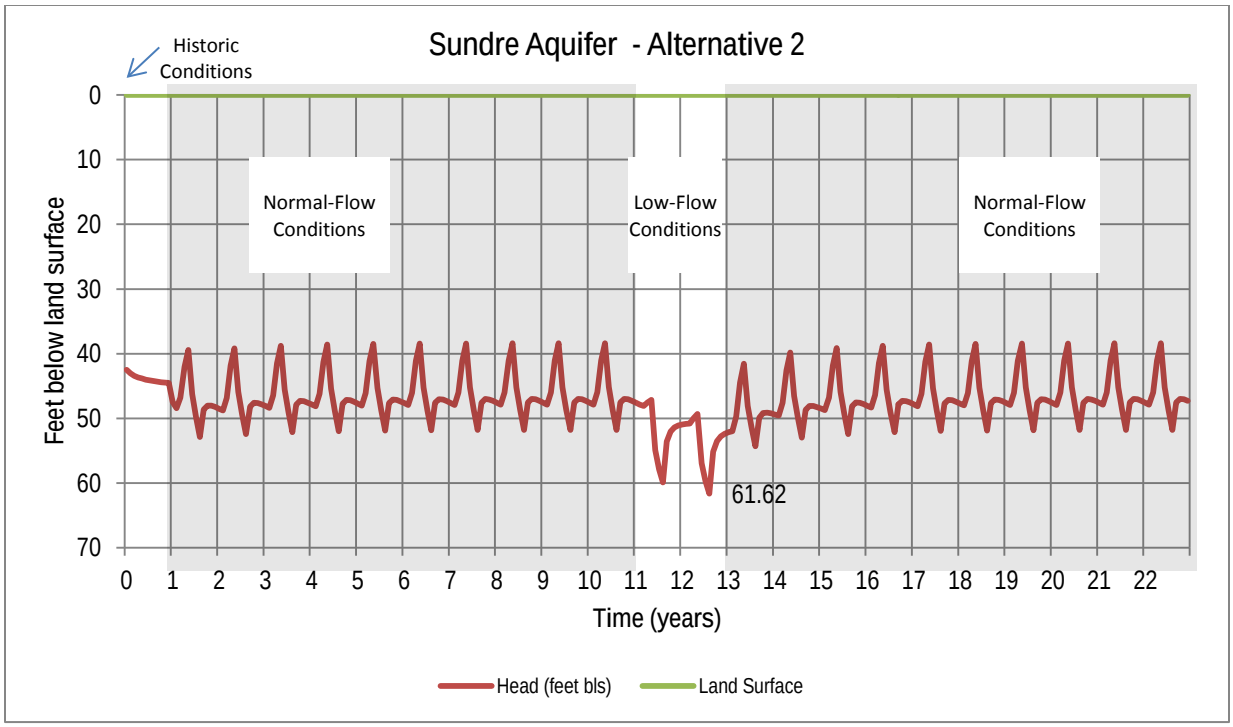

Figure 7-7 Hydrograph Showing the Results of the Alternative 2 Simulation for the Sundre Aquifer

7.2.3 Uncertainty

The primary uncertainty associated with the development and evaluation of alternatives that conjunctively use waters conveyed by the Souris River and groundwater in the Minot and Sundre aquifers is the lack of specific information definitively characterizing the aquifers and boundary conditions.

The use of the simplified model conceptualization of the Minot aquifer system developed for the appraisal-level design is commensurate with the remainder of the appraisal-level design. One simplification is that the model does not explicitly represent the Souris River or connected alluvial aquifers; therefore, the natural recharge into the Minot aquifer from connected aquifers and the river was represented over the entire area encompassed by the model. Acquisition of data to reduce or eliminate this uncertainty would require the installation of test production and monitoring wells in both the Minot and Sundre aquifers and implementation of a multiyear groundwater data acquisition program. These data would support the development of a more comprehensive aquifer system model.

Additional uncertainty is associated with the assumptions made in the construction of the model. For example, the recharge estimate used in the model was developed in the 1960s, and it is likely that declining groundwater levels have changed the recharge conditions since that time. This uncertainty could be reduced through multiple pilot tests of recharge conditions in each aquifer. With sufficient logistical planning and the completion of the land use/permitting process, and if surplus water from the Souris River was available, these pilot tests could be completed in approximately 1 year.

Given the stage of development of the design of these alternatives, the current simple model developed to evaluate these alternatives provides results that reasonably simulate aquifer conditions based on the known information. The model was therefore judged sufficient to provide information necessary to evaluate these alternatives in the SEIS.

8.0 Facility Design

8.1 Minot Aquifer

8.1.1 Facility Configuration

Under Alternative 1, the Minot aquifer recharge facility would include an intake on the Souris River, a pipeline from the river intake to the recharge facility, a turbidity treatment facility, and a series of recharge basins containing recharge wells. Recharge basins are large, constructed depressions that are filled with water. Recharge wells are constructed in recharge basins and they facilitate the movement of water from the recharge basin into the aquifer. River water would be withdrawn through the intake, as warranted by flow conditions in the river, and conveyed to the Minot recharge facility approximately 1.25 miles from the river. Details of the withdrawal and recharge operations are provided in Proposed Operations (Section 8.1.2). The river water would then be treated for turbidity using a clarifier system, located at the recharge site, which would consist of a grit tank with parallel chambers. The clarifier system would remove the majority of the suspended sediments in the river water. After turbidity removal, the river water would be pumped into the Minot aquifer recharge basin. Water would be discharged into the recharge basin onto a concrete apron with baffles, to prevent scouring of the basin floor. Specifications for the recharge basin are provided in Facility Specifications (Section 8.1.3). It is estimated that the total recharge facility footprint would range between 30 and 35 acres. Additionally, Alternative 1 would include four peaking wells to ensure that peak water needs could be met during the summer months. These wells would be installed in the vicinity of the Minot aquifer wellfield.

Under Alternative 2, the footprint for the Minot aquifer recharge facility would be the same as proposed in Alternative 1. The only difference would be that additional water would be withdrawn from the river and conveyed directly to the Minot WTP. Appendix C of the Appraisal-Level Design Engineering Report, Sheet ALD-13 shows a conceptual plan and cross section views of the Minot aquifer recharge facility.

8.1.2 Proposed Operations

Recharge quantities would depend on seasonal variation of available Souris River water in each month of the year as explained previously. Table 8-1 shows the monthly estimate of water to be withdrawn from the river for recharge into the Minot aquifer to offset groundwater withdrawals. Because the system must be designed for peak flows, quantities available in the month of April determined the sizing of the recharge basin facilities.

Using period-of-record 50 percent exceedance flow values, recharge rates were calculated by distributing total recharge among months with the highest flows. The total projected 2060 water need for the Project would annually reach 4.11 billion gallons (including a 25-percent buffer). This is equal to 48.6 percent of the total available flow of the Souris River during normal-flow conditions (50 percent exceedance flow) from March through August.

Table 8-1 Alternative 1 – System Design Results for the Minot Aquifer

Month	50 percent exceedance flow		Recharge rate to offset groundwater withdrawals (mgd)
	cfs	mgd	
January	4.4	2.8	0.0
February	4.0	2.6	0.0
March	25.0	16.2	3.9
April	184.0	118.9	28.9
May	92.0	59.5	14.4
June	64.0	41.4	10.1
July	41.0	26.5	6.4
August	24.0	15.5	3.8
September	19.0	12.3	0.0
October	14.0	9.0	0.0
November	13.0	8.4	0.0
December	8.0	5.2	0.0

The highest capture rates would occur in April, May, and June, the months with the highest flow rates. Based on engineering calculations, the infiltration capacity of the recharge basin is equal to 1.94 mgd per acre. This factor was used to calculate the basin size. Additional acreage was included to accommodate additional recharge that would be available during high-flow years. To meet the peak April aquifer recharge rate, approximately 20 acres of recharge basins would be required for the Minot aquifer.

8.1.3 Facility Specifications

This section describes the specifications, design considerations, and assumptions used in the design of the recharge basins, recharge wells, and peaking wells for the Minot aquifer. Specifications for other infrastructure included in Alternatives 1 and 2, such as pipelines, treatment facilities, and pumps are discussed in the Appraisal-Level Design Engineering Report.

8.1.3.1 Recharge Basin Design

A recharge basin is a geometric excavated depressional area, with engineered side slopes and an engineered fill material in the bottom of the basin. Based on the number of recharge wells needed to supply the necessary recharge quantities and the other design considerations detailed above, one rectangular basin 360 ft wide by 2,100 ft long (approximately 20 acres) would be constructed. The basin would extend approximately 20 ft below grade, and would have 4:1 slopes. To accommodate the 4:1 slope, the basin floor would be 200 ft wide by 1,940 ft long. A series of recharge wells would be installed through the floor of the basin into the aquifer and would be located approximately 10 ft in from the base of the 4:1 slopes. Some adjustments to these dimensions and side slopes could be needed based upon the geotechnical properties of the in-situ geologic materials. Except for the area of the sand and gravel filters (approximately 200 square ft), the material comprising the remainder of the bottom of the recharge basins would not have a significant impact on enhancing recharge through the recharge wells. However, a base fill of 12 inches of clean medium-grain sand spread across the basin floor

may offer some advantage for indirect recharge to the Minot aquifer and has been included in the recommended facility design. During facility operations the basin bottom and the filter area would develop a deposit of silt during the periods of recharge, which would tend to reduce the rate of flow into the recharge wells. Annually the tops of the filters would need to be cleaned by scraping off the top few inches of silt down to clean sand and then replacing the removed material with clean, washed medium-grain sand.

As river water enters the basins it would be discharged onto a baffled, concrete apron on one side of the basin. The baffles would diffuse some of the energy of the high volume of flow that would enter the basins during peak recharge operations. This would prevent scouring of the filter sand and other materials on the basin floor.

Recharge would occur in two ways in the recharge basin. The greatest volume of recharge would occur through the recharge wells, while a lesser volume of recharge would occur through the floor of the basins. At the previous Minot aquifer recharge facility, Pettyjohn (1967) noted that approximately 75 percent of recharge occurred through the recharge wells, while 25 percent occurred via infiltration through the recharge basin floor. The calculations provided in this report only relate to recharge that is possible through the recharge wells, and therefore, can be considered a conservative estimate of how much recharge would likely occur under Alternatives 1 and 2.

8.1.3.2 Recharge Well Design

Recharge wells are specially designed wells, which for the purposes of this Project, would be installed in the floor of the recharge basins. The recharge wells act as conduits through which surface waters pumped into the recharge basin can be naturally filtered and easily transmitted to the aquifer(s) below. A series of recharge wells would be installed through the floor of the basin into the aquifer matrix. The recharge wells would provide a level of filtration prior to allowing surface water to enter the top portion of the wells. This filtration would ensure that any biological constituents or silt present in the basin does not enter the aquifer. Each well prefilter would be composed of four layers of graded sand and gravel which would terminate at the top of the casing of the recharge well. Medium-grain, washed sand would make up the upper layer and a filter fabric would separate the sand layer from the uppermost fine gravel layer. The upper gravel would grade downward to very coarse gravel at the top of the well casing. Within the gravel layer at the base of the basin, a system of collector drain pipes would be installed radiating from the center of each well. Eight drain spokes would extend approximately 10 ft radially from each well. The drains would be 4-inch high density polyethylene and wrapped with a geotextile filter fabric. Appendix C, Sheet ALD-14 shows a design schematic of the wells and upper filter systems, along with a cross-section view of the recharge basin. The wells would be 30 inches in diameter.

The wells would be backfilled from their base with very coarse washed gravel (minimum 2-inch diameter) to within 18 inches of the top of the well. Slightly smaller gravel (1-inch diameter) would be placed on top of the well that would be in contact with the graded upper layers of filter materials. Design flow estimates for each well have been made assuming a minimum of 35 ft of head difference is available between the aquifer and recharge basin. Up to 5 ft of head loss has been allowed between the base of the recharge basin and the top of the recharge wells. The longest flow path would be through very coarse, minimum 2-inch

diameter, gravel. Permeability of the coarse gravel has been estimated at 20,000 to 40,000 ft/day. This material is estimated to allow a maximum of 420 gallons per minute (gpm) of flow for the available recharge head. The Minot aquifer recharge wells would be 100 ft deep and consist of 60 ft of steel casing, 30 inches in diameter. They would be completed with 40 ft of steel shutter screen. Estimated recharge flow is 420 gpm.

Recharge well systems are generally most effective if the wells are arranged linearly, which is a standard engineering practice. Ideally, recharge basins should be narrow and linear, with the wells placed in a single line and spaced approximately 80 to 100 ft apart. For the Inbasin Analysis, and based on the limited space likely available, a parallel alignment of two rows of wells, with a spacing of 180 ft between the rows is recommended. It is reasonable to assume a design recharge rate of approximately 1.4 mgd per acre of recharge basin, assuming a linear alignment. Based on these considerations, the basin would contain two rows of 24 wells each, for a total of 48 recharge wells for the Minot aquifer.

8.1.3.3 Peaking Well Field Design

To help meet the projected 2060 peak Project water needs of 26.3 mgd, four peaking wells would be added to the system to increase the current Minot aquifer wellfield capacity. From January through May and September through December, water needs would be met via the existing Minot aquifer wells. Approximately 5.05 mgd would be withdrawn from the existing wells during this time. During the peak demand months of June through August, the existing Minot wells and four 800-gpm wells would be used to provide approximately 10.5 mgd of groundwater to meet the projected 2060 peak demands

The four wells (Figure 7-1) would be located in the vicinity of the current Minot aquifer wellfield, and would consist of 16-inch polyvinyl chloride (PVC) casing, installed to a depth of 140 ft with a screened interval between 140 and 160 ft. Screen and pump specifications for the wells would be modeled after the existing Minot aquifer wells. The estimate of four additional wells is based on the assumption that wells with the needed capacity (800 gpm) could be developed in the Minot aquifer. The estimate of 800 gpm is based on current well capacities in the Minot aquifer wellfield. Onsite aquifer testing would be necessary to determine whether an 800 gpm withdrawal rate would be achievable. If it was determined that it was not achievable, the number of wells would need to be increased accordingly.

8.1.3.4 Minot Aquifer Facility Costs

Tables 8-2 and 8-3 provide an opinion of cost for the construction of the recharge wells (to be installed within the basins) and the peaking supply wells, respectively. Detailed cost estimates for the **c**onstruction of the basin, pumps, treatment infrastructure, pipeline, and other onsite facilities are provided in Appendix F of the Appraisal-Level Design Engineering Report. Table 8-4 provides an opinion of cost for additional field testing, analysis and modeling that would be required to support final engineering and design.

Table 8-2 Minot Aquifer Recharge Wells - Opinion of Cost

Description	Units	Quantity	Unit Cost	Cost per Well	Number of Wells	Total
Drill and ream 36 inch borehole	ft	110	$245	$26,950	48	$1,293,600
Supply and install 30 inch casing	ft	60	$250	$15,000	48	$720,000
Supply and install 30 inch screen	ft	50	$350	$17,500	48	$840,000
Gravel backfill within casing 2-inch with 1-inch topping	cubic yards	30	$310	$9,300	48	$446,400
Develop well	each	1	$4,000	$4,000	48	$192,000
Supply and Install graded filter gravel and sand	each	1	$5,000	$5,000	48	$240,000
Supply and Install filter drains	lump	1	$4,000	$4,000	48	$192,000
Cost of Recharge Wells				$81,750	48	$3,924,000
Drill and install 4 inch monitor well	ft	110	$32	$3,520	4	$14,080
Total Cost of Wells						$3,938,080

Table 8-3 Minot Aquifer Peak Supply Wells - Opinion of Cost

Description	Units	Quantity	Unit Cost	Cost per Well	Number of Wells	Total
Drill and ream 22 inch	ft	160	$170	$27,200	4	$108,800
Supply and install 16 inch casing	ft	140	$100	$14,000	4	$56,000
supply and install 16 inch screen	ft	20	$150	$3,000	4	$12,000
Gravel pack screen section (may not be necessary	LF	20	$40	$800	4	$3,200
Cement grout	LF	20	$40	$800	4	$3,200
Develop well	each	1	$10,000	$10,000	4	$40,000
Supply Install pump estimate 2000 gpm and wellhead facilities and well pad		1	$150,000	$150,000	4	$600,000
Cost of Wells				$205,800	4	$823,200

Table 8-4 Minot Aquifer Testing and Modeling for Final Design - Opinion of Cost

Task Number	Description	Cost
Task 1	21-Day Aquifer Performance Test (APT) (includes pumping well, three monitoring wells, equipment, water quality testing, and staff hours)	$1,058,606
Task 2	APT Results Analysis and Calibrated Groundwater Model Development	$253,000
Task 3	Recharge Basin Testing (includes construction of scaled recharge basin, geochemical bench testing, equipment, and staff hours)	$1,423,700
Task 4	Water Quality Testing and Geochemical Modeling	$220,000
Subtotal		$2,955,306

8.2 Sundre Aquifer

8.2.1 Facility Configuration

Under Alternative 1, the Sundre aquifer recharge facility would include an intake on Souris River, a pipeline from the river intake to the recharge facility, a turbidity treatment facility, and a recharge basin that would contain recharge wells. Recharge basins are large, constructed depressions that are filled with water. Recharge wells are constructed in recharge basins and they facilitate the movement of water from the recharge basin into the aquifer. River water would be withdrawn through the intake, as warranted by flow conditions in the river, and conveyed to the Sundre recharge facility approximately 0.45 miles from the river. Details of the withdrawal and recharge operations are provided in Proposed Operations (Section 8.2.2). The river water would be treated for turbidity using a clarifier system located at the recharge basin site, which would consist of a grit tank with parallel chambers. The clarifier system would remove the majority of the suspended sediments in the river water. After turbidity removal, the river water would be pumped into the recharge basin. Water would be discharged into the basin onto a concrete apron with baffles, to prevent scouring of the basin floor. Specifications for the recharge basins are provided in Facility Specifications (Section 8.2.3). It is estimated that the total recharge facility footprint would be between 30 and 35 acres.

Additionally, Alternative 1 would include two peaking wells to ensure that peak water needs can be met during the summer months. These wells would be installed in the vicinity of the current Sundre aquifer wellfield.

Under Alternative 2, the footprint for the Sundre aquifer recharge facility would be the same as that proposed for Alternative 1. The only difference would be that a portion of the water withdrawn from the river would be conveyed directly to the Minot WTP, instead of being routed to the recharge facility, to meet daily average and peak water needs. Appendix C, Sheet ALD-13 includes conceptual plan and cross-section views of the Sundre aquifer recharge facility.

8.2.2 Proposed Operations

Seasonal variations in Souris River flows would determine monthly recharge quantities. Table 8-5 shows the monthly estimate of available water to be withdrawn from the river for recharge into the Sundre aquifer. Because peak flows occur in April, quantities available in that month established the size of the recharge basins.

Table 8-5 Alternative 1 – System Design Results for the Sundre Aquifer

Month	50 Percent Exceedance Flow		Recharge Rate to Offset Demand (mgd)
	cfs	mgd	
January	4.4	2.8	0.0
February	4.0	2.6	0.0
March	25.0	16.2	3.9
April	184.0	118.9	28.9
May	92.0	59.5	14.4
June	64.0	41.4	10.1
July	41.0	26.5	6.4
August	24.0	15.5	3.8
September	19.0	12.3	0.0
October	14.0	9.0	0.0
November	13.0	8.4	0.0
December	8.0	5.2	0.0

Using period-of-record 50 percent exceedance flow values, recharge rates were calculated by distributing total recharge among months with the highest flows. The total projected 2060 water needs for the Project would annually reach an average of 4.11 billion gallons, including a 25-percent buffer. The highest capture rates would occur in April, May, and June, the months with the highest river flow rates. Based on engineering calculations, the infiltration capacity of the recharge basins would be 1.94 mgd per acre. This factor was used to calculate basin size. Additional acreage was included to accommodate additional recharge during high flow years. To meet the peak April aquifer recharge rate, approximately 20 acres of recharge basins would be required for the Sundre aquifer.

8.2.3 Facility Specifications

This section describes the specifications, design considerations, and assumptions used in the design of the recharge basins, recharge wells, and peaking wells for the Sundre aquifer. Specifications for other infrastructure included in Alternatives 1 and 2, such as pipelines, treatment facilities, and pumps, are discussed in the Appraisal-Level Design Engineering Report.

8.2.3.1 Recharge Basin Design

Based on the number of recharge wells needed to provide the recharge required for the Project and the other design considerations detailed above, one rectangular basin, 360 ft wide by 2,100 ft long (approximately 20 acres), would be constructed. The basin would extend approximately 20 ft below grade, and would have 4:1 slopes. To accommodate the 4:1 slope, the basin floor would be 200 ft wide by 1,940 ft long. A series of recharge wells would be installed through the floor of each basin into the aquifer and would be located approximately 10 ft in from the base of the 4:1 slopes in the basin floor. Some adjustments to these dimensions and side slopes could be needed based upon the geotechnical properties of the in-situ geologic materials. If

Alternative 1 or 2 was to be developed, this would be determined during onsite geotechnical engineering assessments.

Except for the area of the sand and gravel filters (approximately 200 square ft), the material comprising the remainder of the bottom of the recharge basins would not have a significant impact on enhancing recharge through the recharge wells. However, a base fill of 12 inches of clean, medium-grain sand spread across the basin floor could offer some advantage for indirect recharge to the Sundre Aquifer, and has been included in the recommended facility design. During facility operations the basin bottom and the filter area would develop a deposit of silt, which would tend to reduce the rate of flow into the recharge wells. Annually the tops of the filters would need to be cleaned by scraping off the top few inches of silt down to clean sand and then replacing the material removed with clean, washed, medium-grain sand.

As river water enters the basin, it would be discharged onto a baffled, concrete apron on one side of the basin. The baffles would diffuse some of the energy of the high volume of flow that would enter the basins during peak recharge operations. This would prevent scouring of the filter sand and other materials on basin floor.

Recharge would occur in two ways through the recharge basin. The greatest volume of recharge would occur through the recharge wells, while a lesser volume of recharge would occur through the floor of the basins. At the previous Minot aquifer recharge facility, Pettyjohn (1967) noted that approximately 75 percent of recharge occurred through the recharge wells, while 25 percent occurred via infiltration through the recharge basin floor. The calculations provided in this report only relate to the recharge that could occur through the recharge wells, and therefore, can be considered a conservative estimate of how much recharge would actually occur under Alternatives 1 and 2.

8.2.3.2 Recharge Well Design

A series of recharge wells would be installed through the floor of the basin into the aquifer matrix. The recharge wells would provide a level of filtration prior to allowing river water to enter the top portion of the wells. Each well prefilter would be composed of four layers of graded sand and gravel which would terminate at the top of the casing of the recharge well. Medium-grain, washed sand would make up the upper layer and a filter fabric would separate the sand layer from the uppermost fine gravel layer. The upper gravel would grade to very coarse gravel at the top of the well casing. Within the gravel layer at the base of the basin, a system of collector drain pipes would be installed radiating from the center of each well. Eight drain spokes would extend approximately 10 ft radially from each well. The drains would be 4-inch high density polyethylene and wrapped with a geotextile filter fabric. The wells would be 30 inches in diameter. Appendix C, Sheet ALD-14 shows the design schematic of the wells and upper filter system, along with a cross-section view of the recharge basins. The wells would be backfilled from their base with very coarse washed gravel (minimum 2-inch diameter) to within 18 inches of the top of the well. Slightly smaller gravel (1-inch diameter) would be placed on top of the well that would be in contact with the graded upper layers of filter materials.

Based on analysis of groundwater-level data, design flow estimates for each well have been made assuming that a minimum of 35 ft of head difference would be available between the

aquifer and the recharge basin. Up to 5 ft of head loss has been allowed between the base of the recharge basin and the top of the recharge wells. The longest flow path would be through very coarse (minimum 2-inch diameter) gravel. Permeability of the coarse gravel has been estimated at 20,000 to 40,000 ft/day. This material is estimated to allow a maximum of 420 gpm of flow for the available recharge head. The Sundre aquifer recharge wells would be 100 ft deep and consist of 180 ft of steel casing, 30 inches in diameter. The wells would be completed with 80 ft of steel shutter screen. Estimated recharge flow would be 420 gpm.

Recharge well systems are generally most effective if the wells are arranged linearly. Ideally, recharge basins should be narrow and linear, with the wells placed in a single line and spaced approximately 80 to 100 ft apart. For the Inbasin Analysis, and based on the limited space likely to be available, a parallel alignment of two rows of wells spaced 180 ft apart between the rows is recommended. It is reasonable to assume a design recharge rate of about 1.94 mgd per acre of recharge basin, assuming a linear alignment. Based on these considerations, the basin would contain two rows of 24 wells, for a total of 48 recharge wells for the Sundre aquifer.

8.2.3.3 Peaking Well Field Design

To meet the 2060 peak Project water needs, two peaking wells would be added to the system to increase the current Sundre aquifer wellfield capacity. From January through May and September through December, water needs would be met using existing Sundre aquifer wells. Approximately 5.05 mgd would be withdrawn from the existing wells during this time. During the peak demand months of June through August the existing Sundre wells and two 2,800-gpm peaking wells would be used to provide approximately 15.8 mgd of groundwater to meet the 2060 peak demands. The two wells (Figure 7-1), would be located in the vicinity of the Sundre aquifer wellfield, and would consist of 16-inch PVC casing, installed to a depth of 200 ft with a screened interval between 200 and 260 ft in depth. Screen and pump specifications for the wells would be modeled after the existing Sundre aquifer wells. The estimate of two additional wells is based on the assumption that wells with the needed capacity of 2,800 gpm could be developed in the Sundre aquifer. The estimate of 2,800 gpm is based on current well capacities in the Sundre aquifer wellfield. Onsite aquifer testing would be necessary to determine whether 2,800 gpm could be achieved. If testing determined it could not be achieved, the number of wells would need to be increased accordingly. An opinion of cost to construct the peaking wells and associated facilities is provided in the following section.

8.2.3.4 Sundre Aquifer Facility Costs

Tables 8-6 and 8-7 provide an opinion of cost for the construction of the recharge wells (to be installed within the basins) and the peaking supply wells, respectively. Detailed cost estimates for the construction of the basins, pumps, treatment infrastructure, pipeline, and other onsite facilities are provided in Appendix F of the Appraisal-Level Design Engineering Report. Table 8-8 provides an opinion of cost for additional field testing, analysis and modeling that would be required to support final engineering and design.

Table 8-6 Sundre Aquifer Recharge Wells – Opinion of Cost

Description	Units	Quantity	Unit Cost	Cost per Well	Number of Wells	Total
Drill and ream 36-inch borehole	ft	260	$245	$63,700	48	$3,057,600
Supply and install 30-inch casing	ft	180	$250	$45,000	48	$2,160,000
Supply and install 30-inch screen	ft	80	$350	$28,000	48	$1,344,000
Gravel backfill within casing 2-inch with 1-inch topping	cubic yards	70	$310	$21,700	48	$1,041,600
Develop well	each	1	$4,000	$4,000	48	$192,000
Supply and install graded filter gravel and sand	each	1	$5,000	$5,000	48	$240,000
Supply and install filter drains	lump sum	1	$4,000	$4,000	48	$192,000
Cost of Recharge Wells				$171,400	48	$8,227,200
Drill and install 4-inch monitor well	ft	260	$32	$8,320	4	$33,280
Total Cost of Wells						$8,260,480

Table 8-7 Sundre Aquifer Peak Supply Wells - Opinion of Cost

Description	Units	Quantity	Unit Cost	Cost per Well	Number of Wells	Total
Drill and ream 22-inch borehole	ft	260	$170	$44,200	2	$88,400
Supply and install 16-inch casing	ft	200	$100	$20,000	2	$40,000
Supply and install 16-inch screen	ft	60	$150	$9,000	2	$18,000
Gravel pack screen section (may not be necessary)	LF	60	$40	$2,400	2	$4,800
Cement grout	LF	60	$40	$2,400	2	$4,800
Develop well	each	1	$10,000	$10,000	2	$20,000
Supply and install pump estimate 2000 gpm and (wellhead facilities and well pad)		1	$150,000	$150,000	2	$300,000
Cost of Wells				$238,000	2	$476,000

Table 8-8 Sundre Aquifer Testing and Modeling for Final Design - Opinion of Cost

Task Number	Description	Cost
Task 1	21-Day Aquifer Performance Test (APT) (includes pumping well, three monitoring wells, equipment, water quality testing, and staff hours)	$730,279
Task 2	APT Results Analysis and Calibrated Groundwater Model Development	$253,000
Task 3	Recharge Basin Testing (includes construction of scaled recharge basin, geochemical bench testing, equipment, and staff hours)	$2,100,088
Task 4	Water Quality Testing and Geochemical Modeling	$220,000
Subtotal		$3,303,367

9.0 Conclusions

Based on the analyses conducted as part of this assessment, the following conclusions regarding the feasibility of Alternatives 1 and 2 are offered:

- A GIS-based overlay analysis of selected siting criteria was performed to identify suitable locations at which to construct an aquifer recharge facility. The relative site suitability system used in the GIS analysis analyzed the existence of wetlands, the proximity to contaminated or hazardous waste sites, proximity to flood zones, confining unit thickness, and the current land use on a cell-by-cell basis across the Study Area. Based on the relative site suitability index, an area in the northwestern portion of the model domain in the vicinity of the Gravel Products, Inc., quarry was chosen as the most suitable site for an aquifer recharge facility for the Minot aquifer. An agricultural area in the north-central portion of the domain was selected as the most suitable site for an aquifer recharge facility for the Sundre aquifer.
- The Minot and Sundre aquifers appear to be hydrogeologically conducive to artificial aquifer recharge. Under average conditions, there is ample unsaturated aquifer matrix to assimilate substantial quantities of additional water. Previous artificial recharge operations were conducted in the Minot aquifer with success (Pettyjohn 1967). Both aquifers readily respond to natural recharge associated with major flood events. In the vicinity of the wellfields in the Minot and Sundre aquifers, water levels are in long-term decline, and any expansion of groundwater withdrawals would further this declining trend in the absence of artificial recharge.
- A Souris River flow analysis indicates that peak flows typically occur during the spring months. During those months, under normal climatic conditions, large volumes of water pass through the Minot area. A portion of this volume could be used to meet municipal needs or in aquifer recharge operations. Lesser volumes of water would potentially be available for use during lower flow months. An analysis of low-flow conditions indicates that back-to-back low flow years (defined as the 75 percent exceedance flow) may occur once every 30 years. Based on this information, it was decided that a historical worst-case recharge scenario (primary scenario) would be used for modeling that would consist of the recharge available during 10 normal-flow years followed by the reduced recharge available during 2 low-flow years, followed by additional normal-flow years.
- A simple water balance spreadsheet model was developed for Alternatives 1 and 2 to provide an initial estimate of the quantity of water that would be needed from the Souris River for recharge to offset groundwater withdrawals to meet the projected 2060 water needs of the Project while maintaining stable aquifer water levels. The water balance model provided an initial evaluation of the feasibility of the aquifer recharge/wellfield system by determining whether adequate quantities of water exist in the Souris River to provide the necessary recharge during differing river flow conditions. The model determined the balance between inputs (recharge) and outputs (projected groundwater withdrawals) as an aide in developing the water budget for the groundwater flow model. The model indicated that meeting the water needs for Alternatives 1 and 2 would necessitate withdrawing 48 and

74 percent of the total river flow volume, respectively, at Minot, during the months of March to August. The model was also used to determine how the recharge facilities proposed in Alternatives 1 and 2 would operate year-to-year and what the size of the basins would need to be to accommodate recharge quantities. Uncertainties are associated with the use of this model as discussed in Section 7.2.3.

- A groundwater flow model was developed to simulate the operations associated with Alternatives 1 and 2 and their impacts on Minot and Sundre aquifer water levels. The primary scenario, which consists of the recharge available during 10 normal-flow years followed by the reduced recharge available during 2 low-flow years, followed by the recharge available in additional normal-flow years, was used for modeling to test the potential reliability of each alternative during historical worst-case conditions. Results of the modeling indicated that groundwater withdrawals proposed as part of Alternatives 1 and 2 could be sustained without reducing water levels in the Minot and Sundre aquifers to the degree that the wells could not function at the necessary capacities. Some uncertainty is associated with the use of the groundwater flow model. The primary uncertainty is the is the lack of specific information definitively characterizing the aquifers and boundary conditions, although the use of the simplified model conceptualization of the Minot aquifer system developed for the appraisal-level design is commensurate with the remainder of appraisal-level design. Additional uncertainty is associated with the assumptions made when constructing the model. Obtaining sufficient information to eliminate these uncertainties would require lengthy testing and data acquisition, and given the stage of development of the design of these alternatives, the current simple model developed to evaluate these alternatives provides results that reasonably simulate aquifer conditions based on the known information. The model was therefore judged sufficient to provide information necessary to evaluate these alternatives in the SEIS.
- The recommended configuration for a Minot aquifer recharge facility would consist of a 30- to 35-acre footprint, with a 20-acre recharge basin. The basin would incorporate a total of 48 recharge wells, to provide direct recharge to the aquifer. Indirect artificial recharge would also occur through the floor of the recharge basin. A clarifier system would be located at the recharge facility, to treat the raw Souris River water for turbidity prior to its entry into the recharge basins.
- The recommended configuration for a Sundre aquifer recharge facility would consist of a 30- to 35-acre footprint, with a 20-acre recharge basin. The basin would incorporate a total of 48 recharge wells, to provide direct recharge to the aquifer. Indirect artificial recharge would also occur through the floor of the recharge basin. A clarifier system would be located at the recharge facility to treat the raw Souris River water for turbidity prior to its entry into the recharge basin.
- A total of six peaking wells would be needed to help meet peak water needs in the months of June, July, and August. These wells would help distribute groundwater withdrawals and stabilize water levels in the aquifers during the peak months. Four 16-inch-diameter wells with a capacity of 800 gpm would be needed in the Minot aquifer wellfield and two 16-inch-diameter wells with a capacity of 2,800 gpm would be needed in the Sundre aquifer.

It is important to note that this Inbasin Analysis represents an appraisal-level design. The desktop analyses, models, and findings presented herein are based on the best available

existing data from the SWC, USGS, and a number of peer-reviewed publications. If the decision were made to construct Alternative 1 or 2, field testing would be required that would include extensive exploratory well drilling, monitoring well construction, aquifer performance testing, and geologic data analysis. These data would be used to construct a much more sophisticated groundwater model that would encompass a significantly larger portion of the Minot and Sundre aquifers. Advanced geochemical modeling would be required to understand the chemical reactions that would occur when Souris River water is mixed with groundwater in the Minot and Sundre aquifers. Such reactions could cause mineral and bacterial fouling of the recharge wells, which could necessitate enhanced maintenance efforts that might include frequent acidification of the recharge wells and pretreatment of Souris River water. Pilot testing of a small-scale system might also be needed. Another issue is the maintenance of the recharge facilities when they would be inactive during the winter months. A strategy would need to be developed to ensure that the surface of the recharge wells would not be frozen in March when the facilities would begin operating. While it is likely that engineering solutions could be developed for all of these issues, the cost of implementing them could significantly increase the overall cost of the Project. A full and accurate accounting of all such costs would be developed upon completion of the 100 percent design process.

10.0 References

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APPENDIX B

Maps and Diagrams

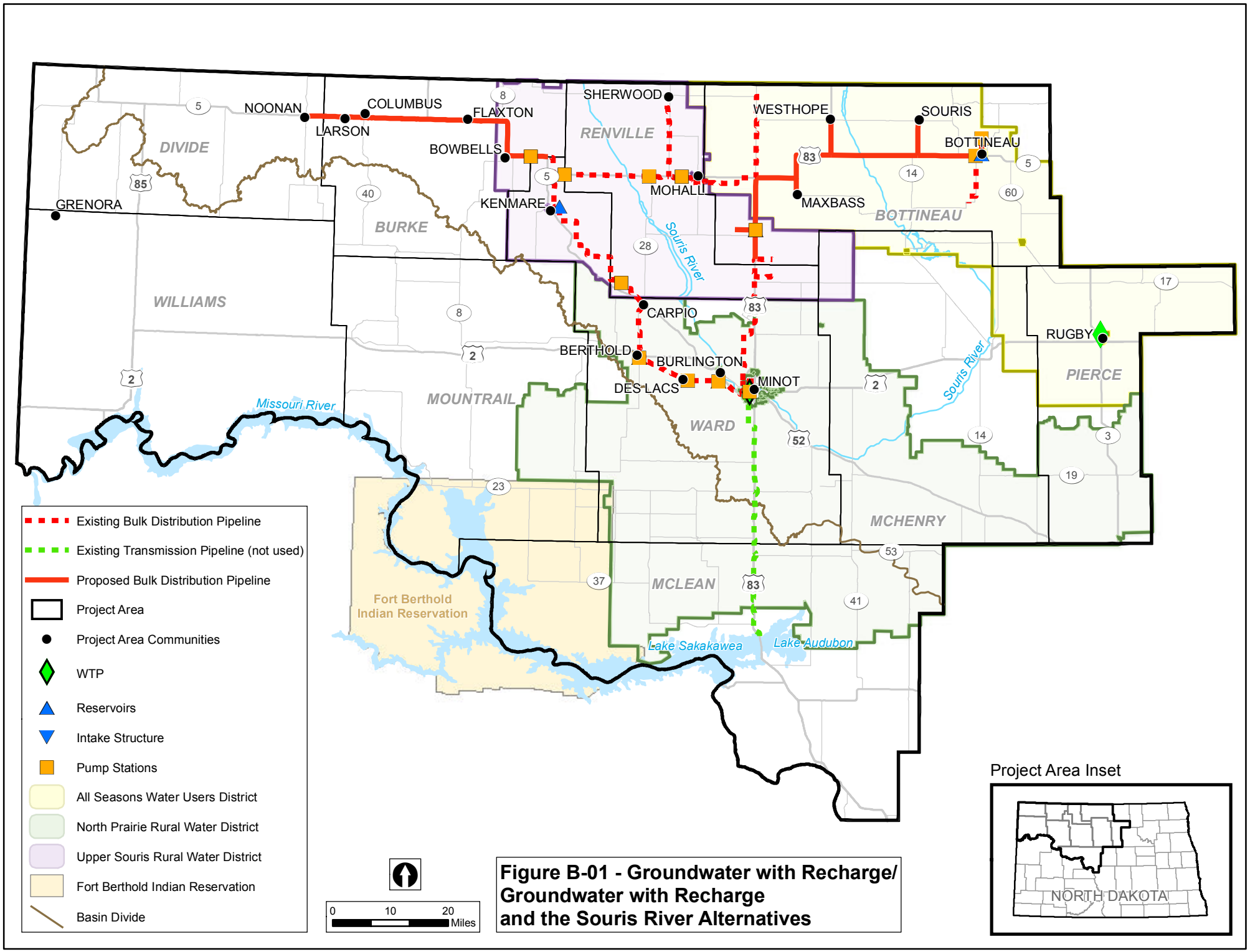


Figure B-01 - Groundwater with Recharge/ Groundwater with Recharge and the Souris River Alternatives

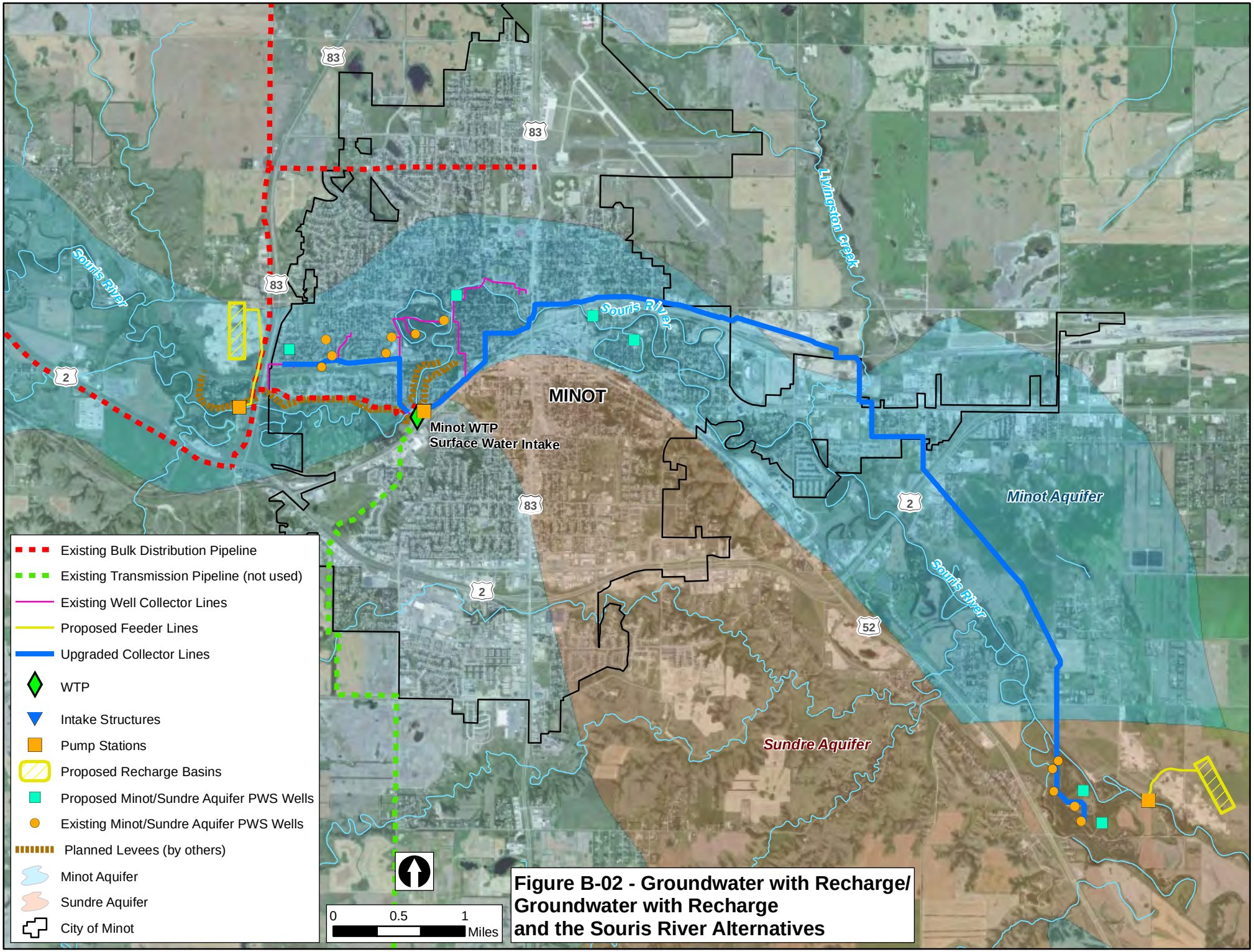
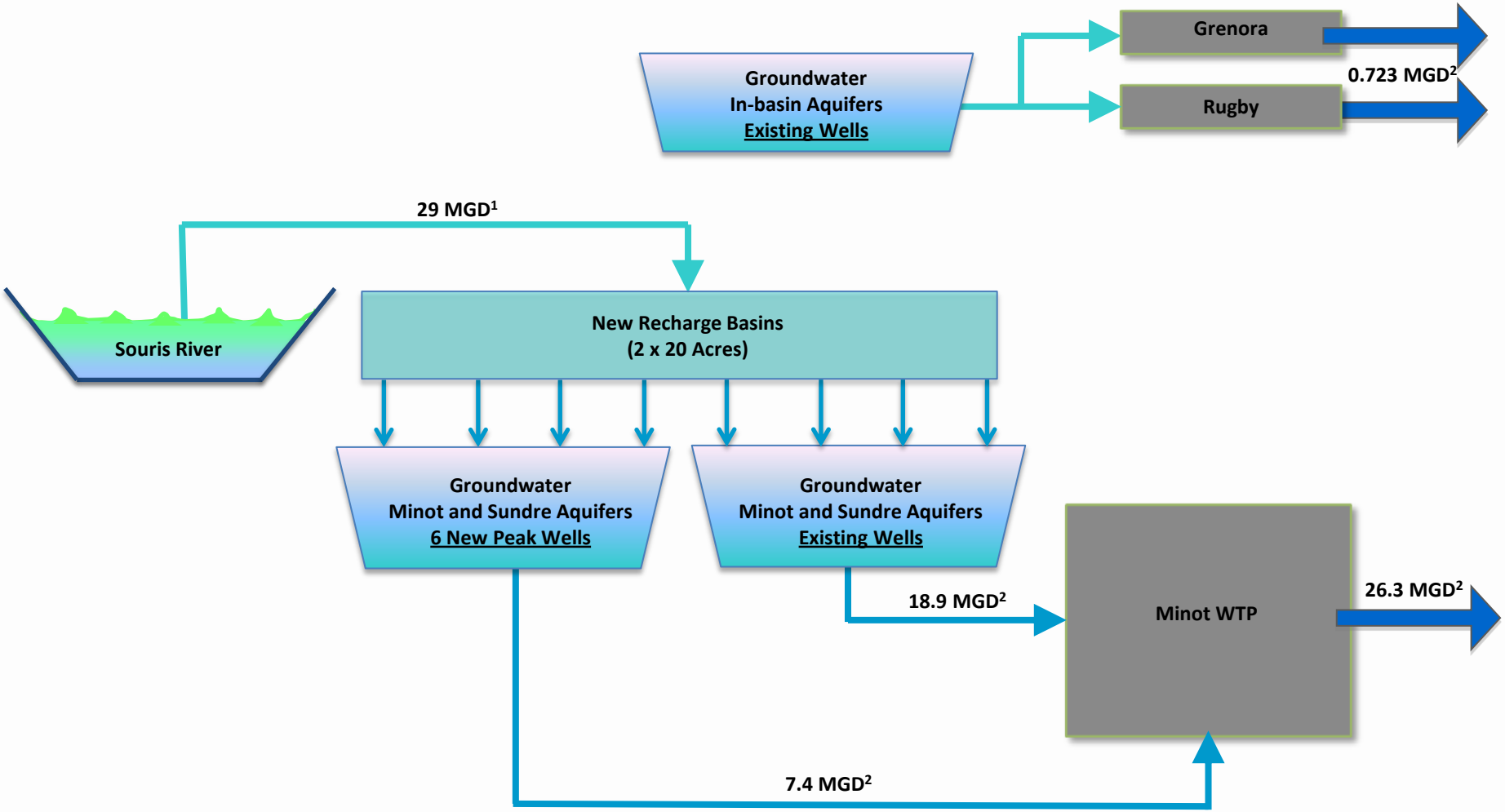


Figure B-02 - Groundwater with Recharge/ Groundwater with Recharge and the Souris River Alternatives

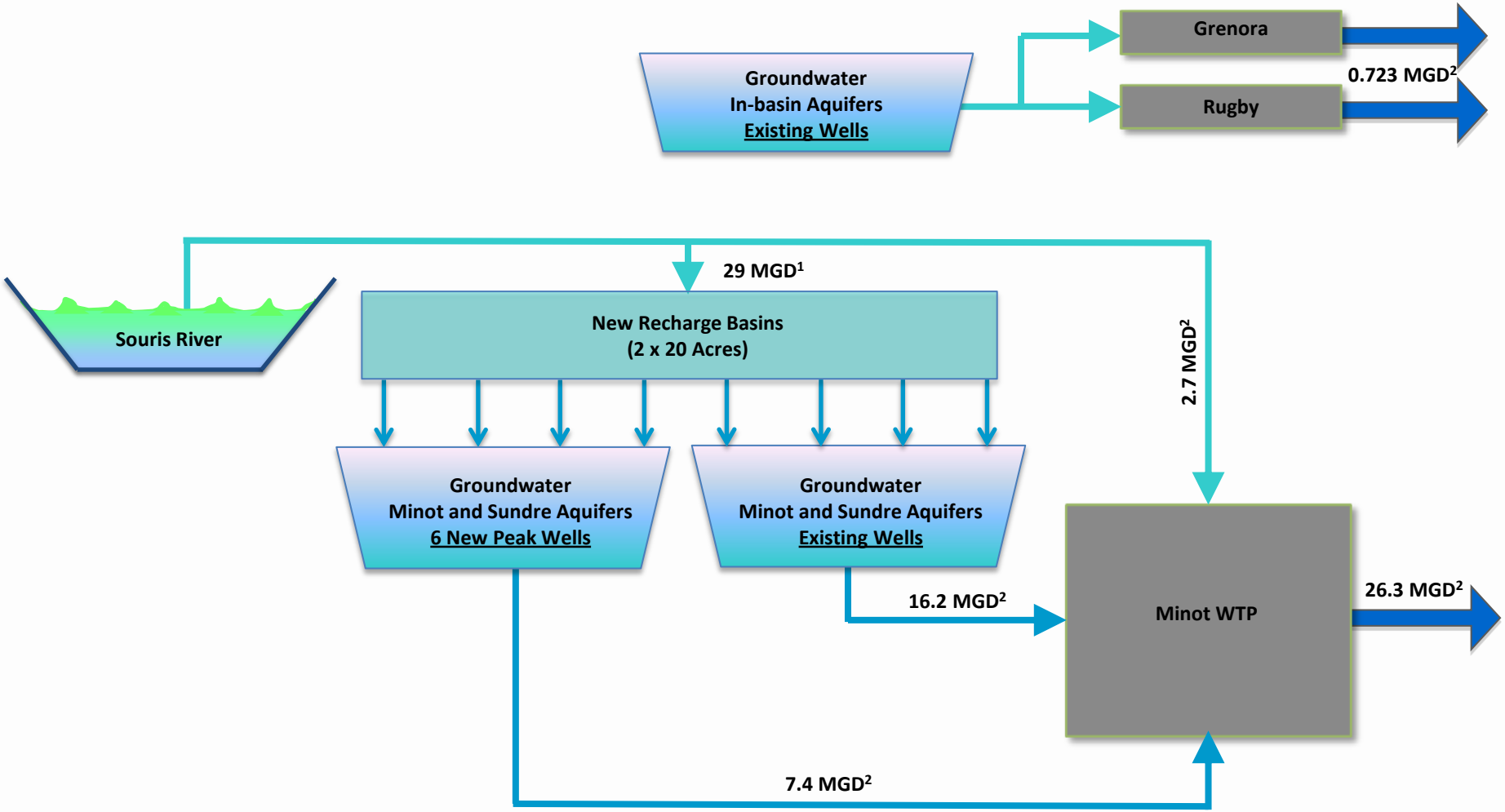
- Minot groundwater (new peak wells and existing wells with upgrades)
- Aquifer recharge with Souris River water (new basins)



Notes:
[1] Intake capacity sized to accommodate recharge during seasonal peak flow
[2] Estimated Peak Demand

Figure B-03 **Groundwater with Recharge Alternative**

- Conjunctive use of Minot groundwater (new and existing wells) and Souris River water
- Aquifer recharge with Souris River water (new basins)



Notes:

[1] Intake capacity sized to accommodate recharge during seasonal peak flow

[2] Estimated Peak Demand

Figure B-04 **Groundwater with Recharge and the Souris River Alternative**

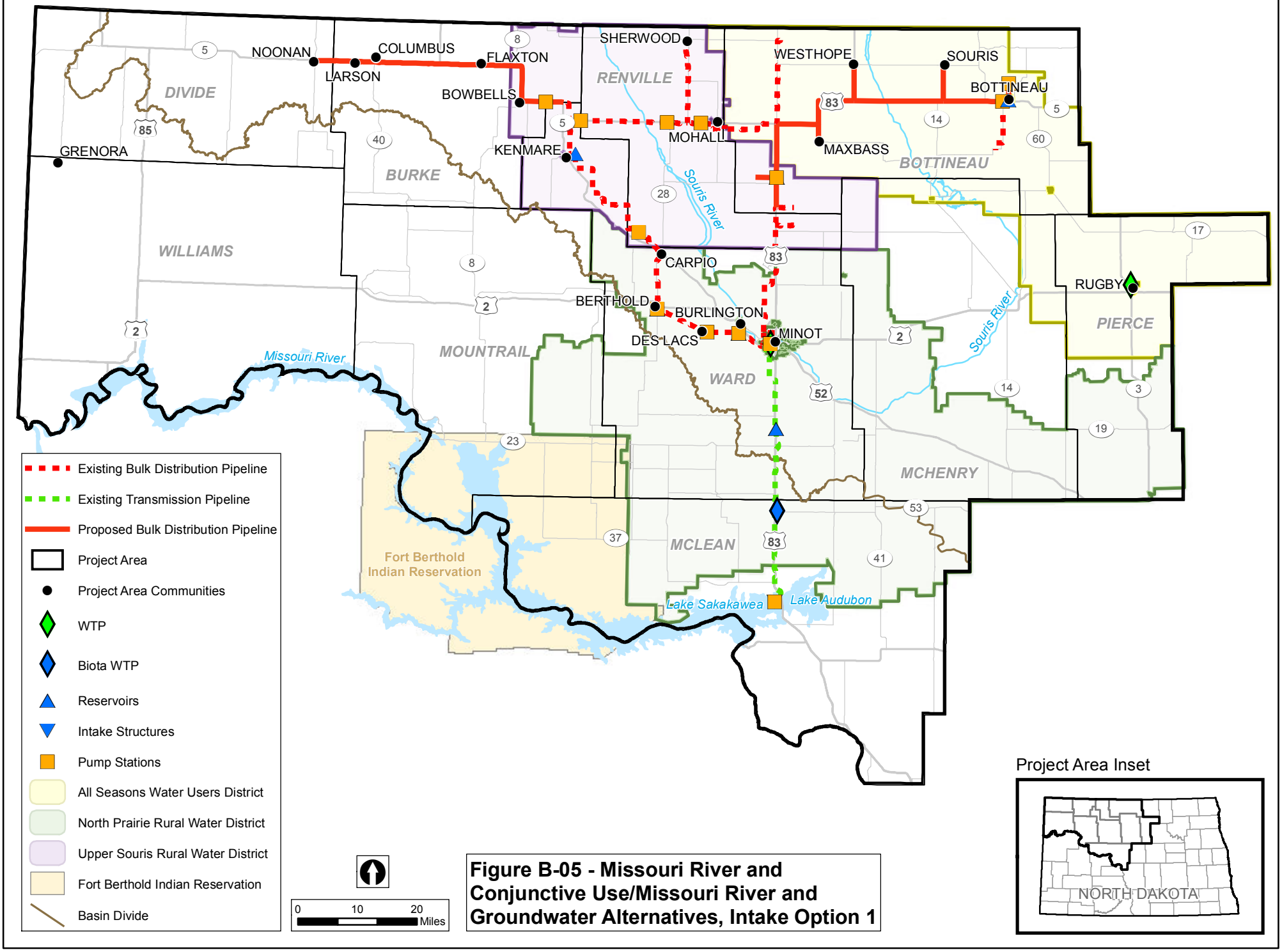


Figure B-05 - Missouri River and Conjunctive Use/Missouri River and Groundwater Alternatives, Intake Option 1

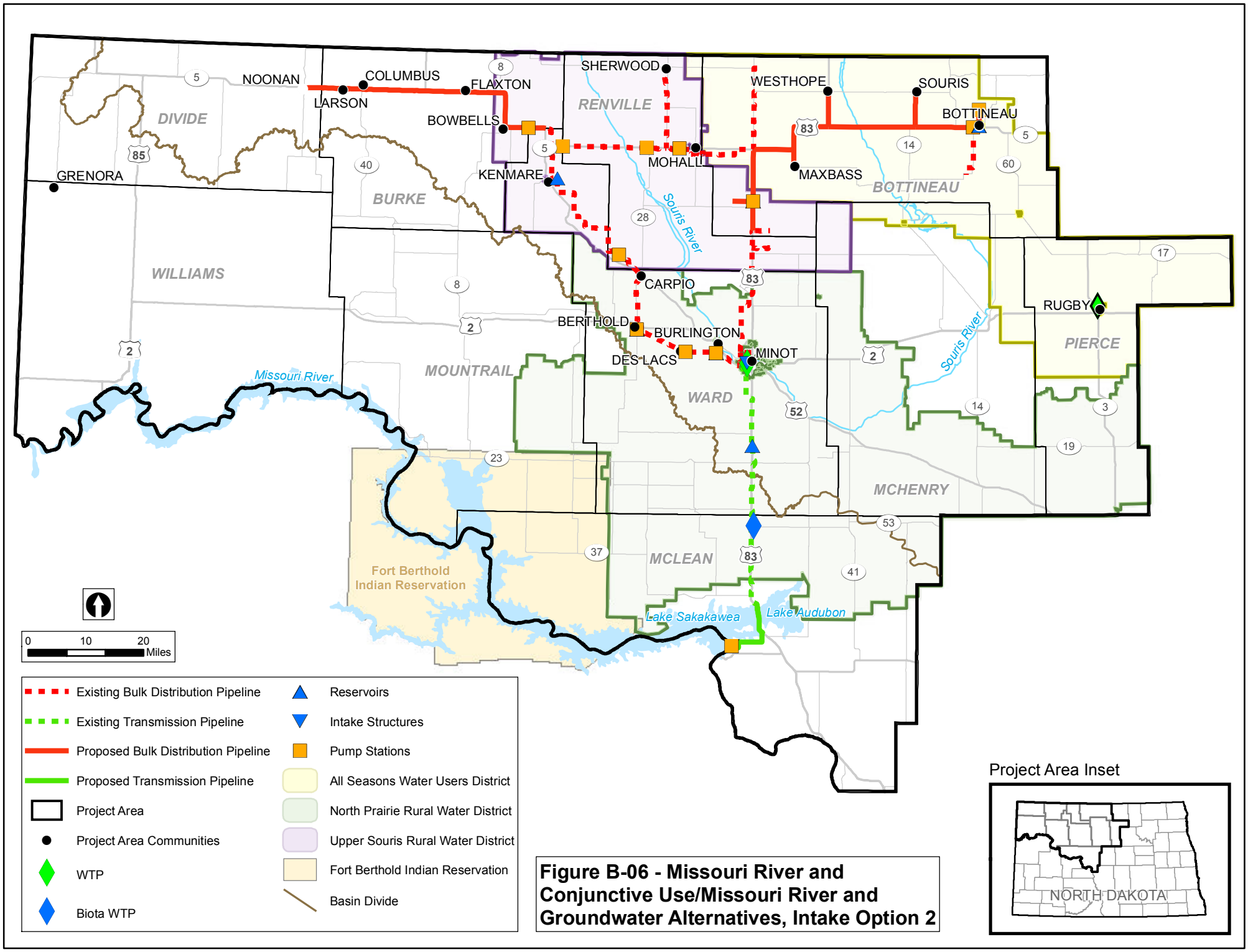


Figure B-06 - Missouri River and Conjunctive Use/Missouri River and Groundwater Alternatives, Intake Option 2

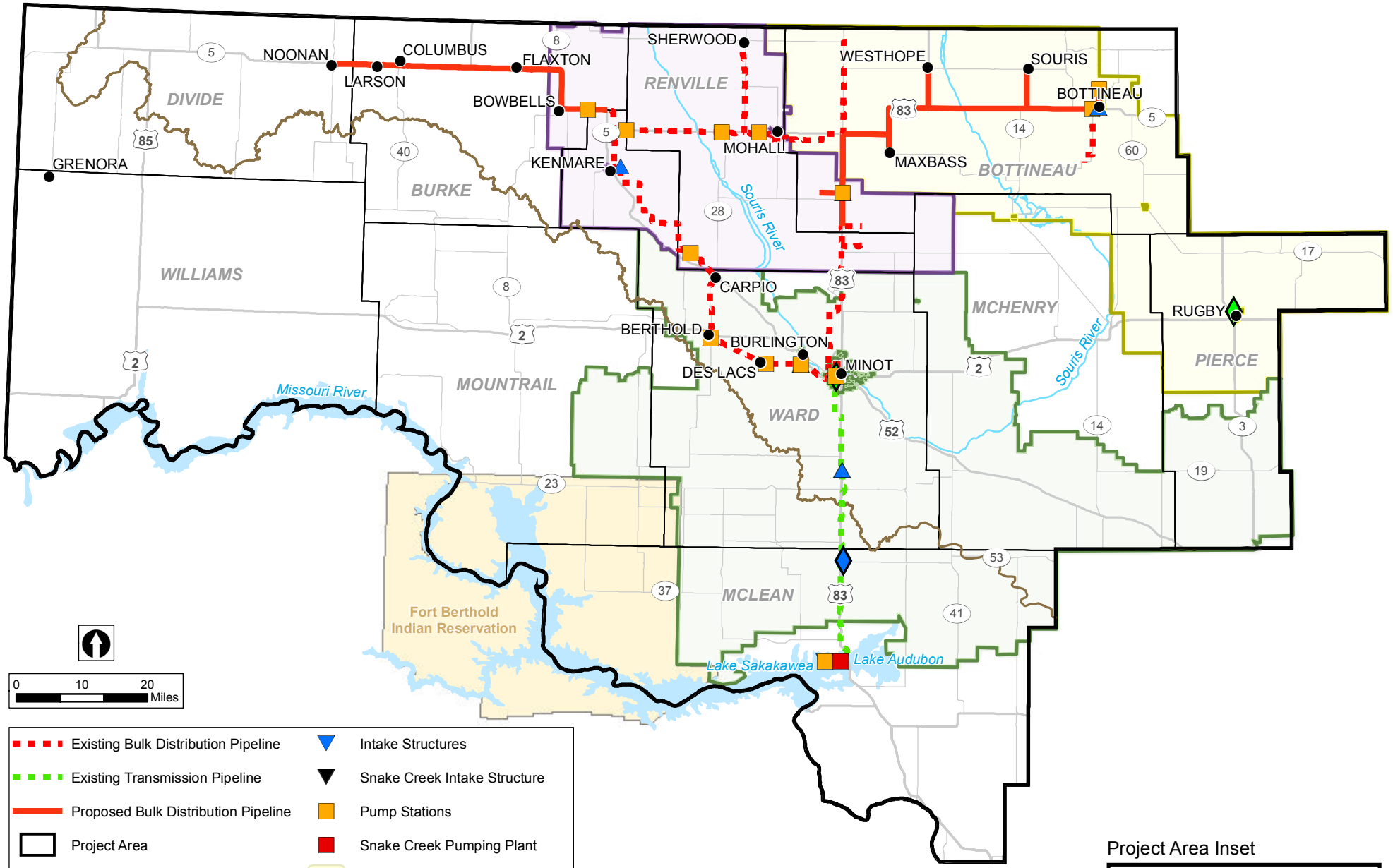


Figure B-07 - Missouri River and Conjunctive Use/Missouri River and Groundwater Alternatives, Intake Option 3

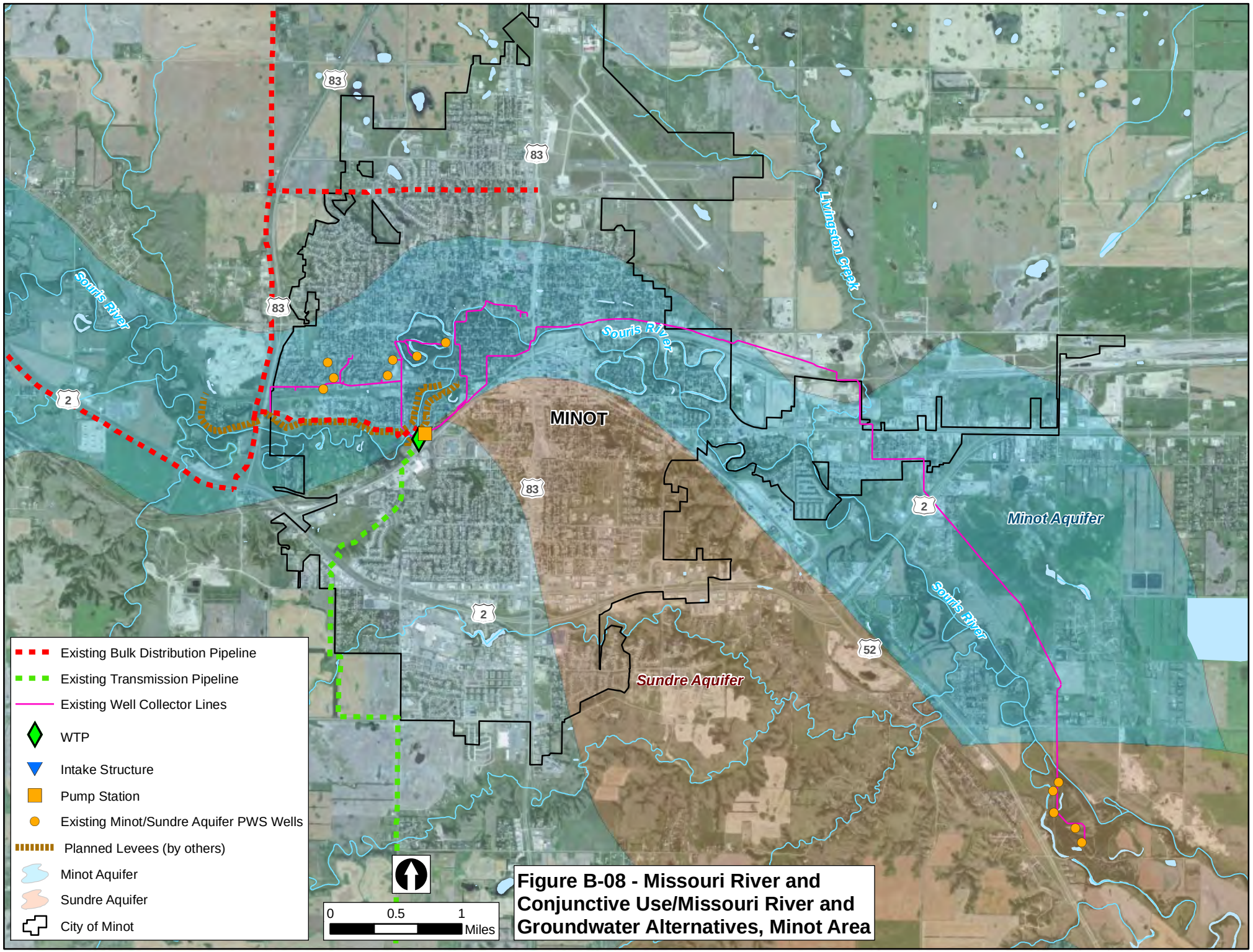
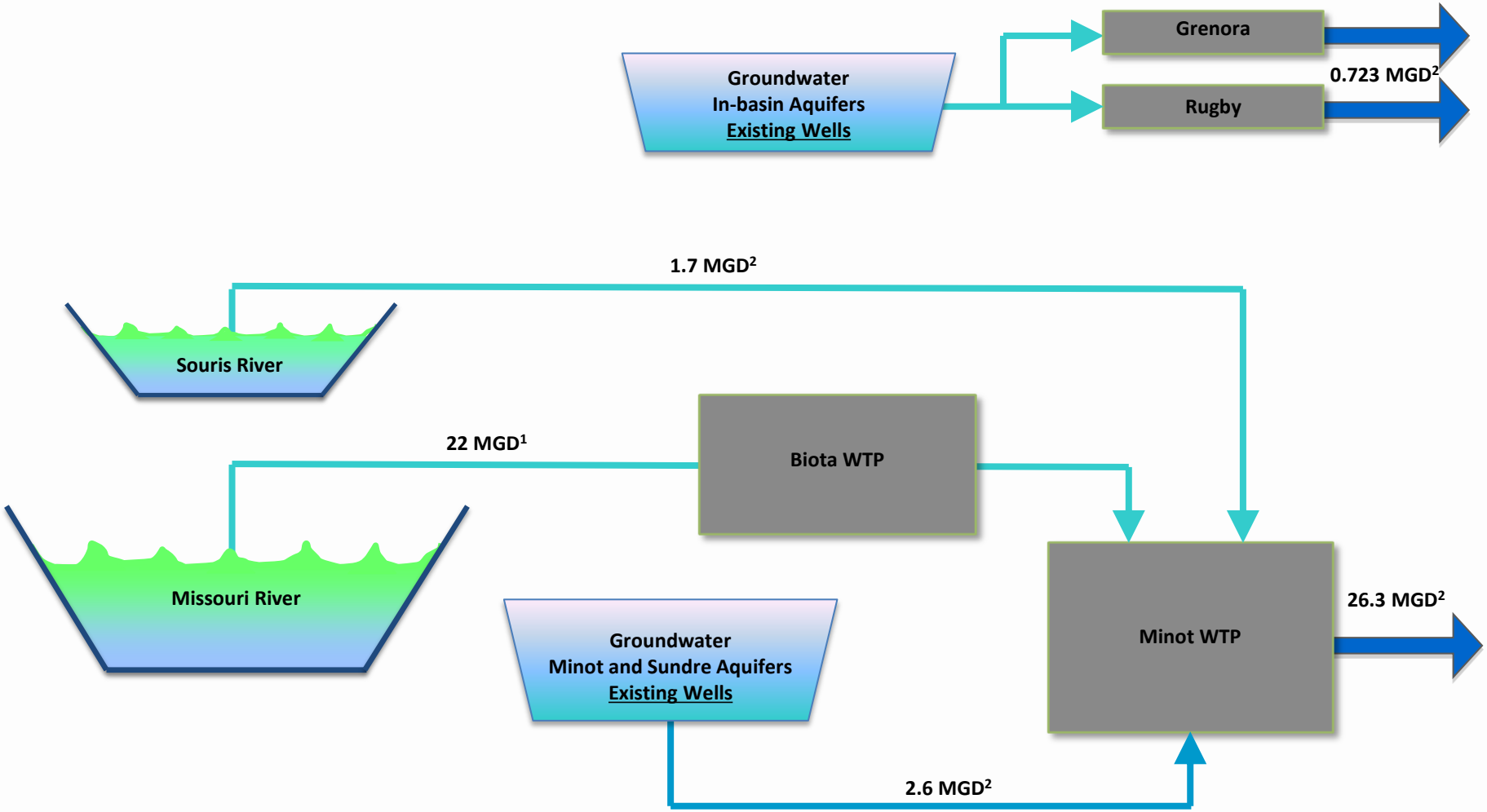


Figure B-08 - Missouri River and Conjunctive Use/Missouri River and Groundwater Alternatives, Minot Area

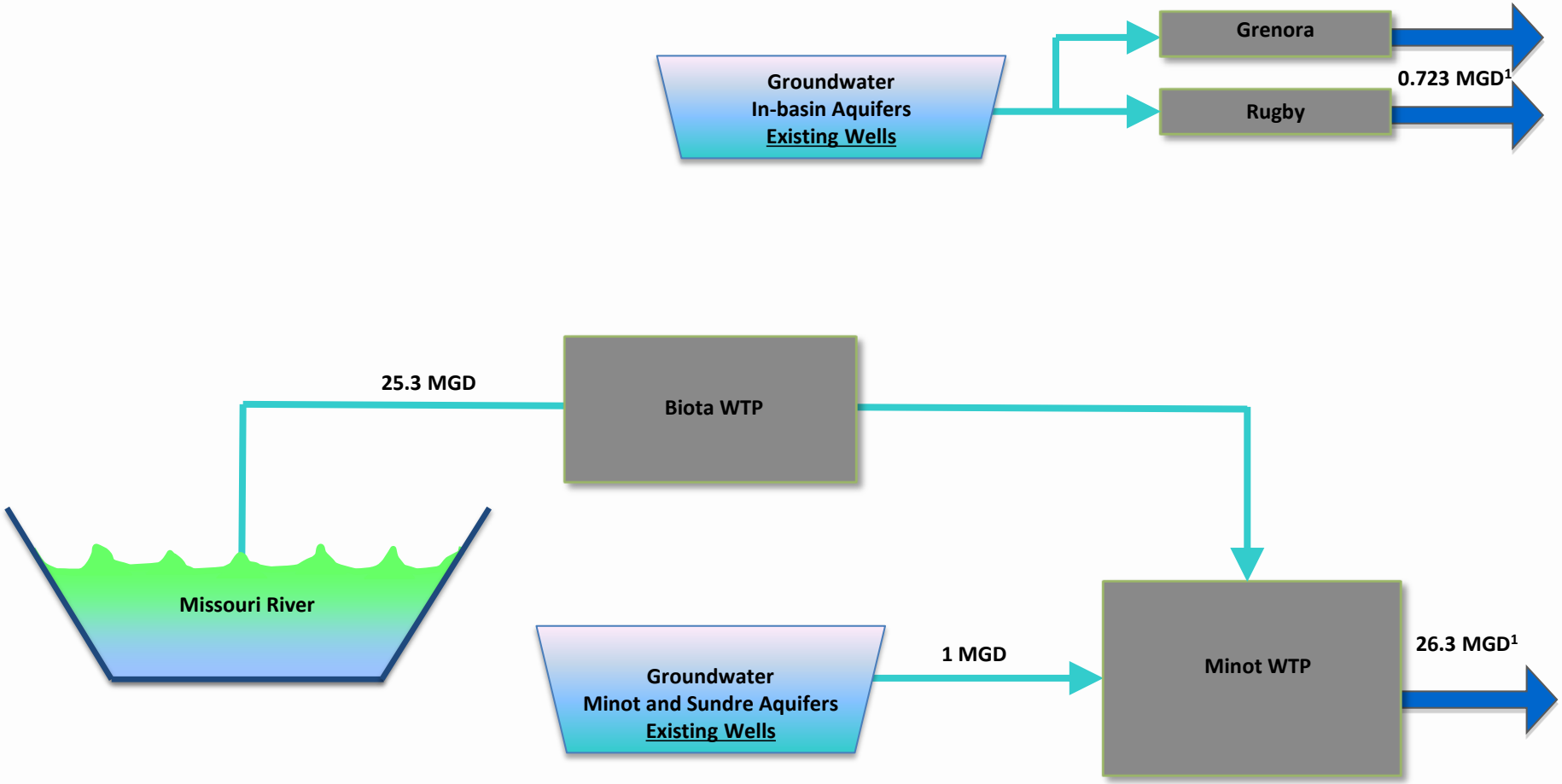
• Missouri River water blended with Minot groundwater (existing wells) and Souris River water



Notes:
[1]Design Capacity (includes allowance for treatment efficiencies)
[2] Estimated Peak Demand

Figure B-09 **Missouri River and Conjunctive Use Alternative**

• Missouri River water and Groundwater (existing wells)



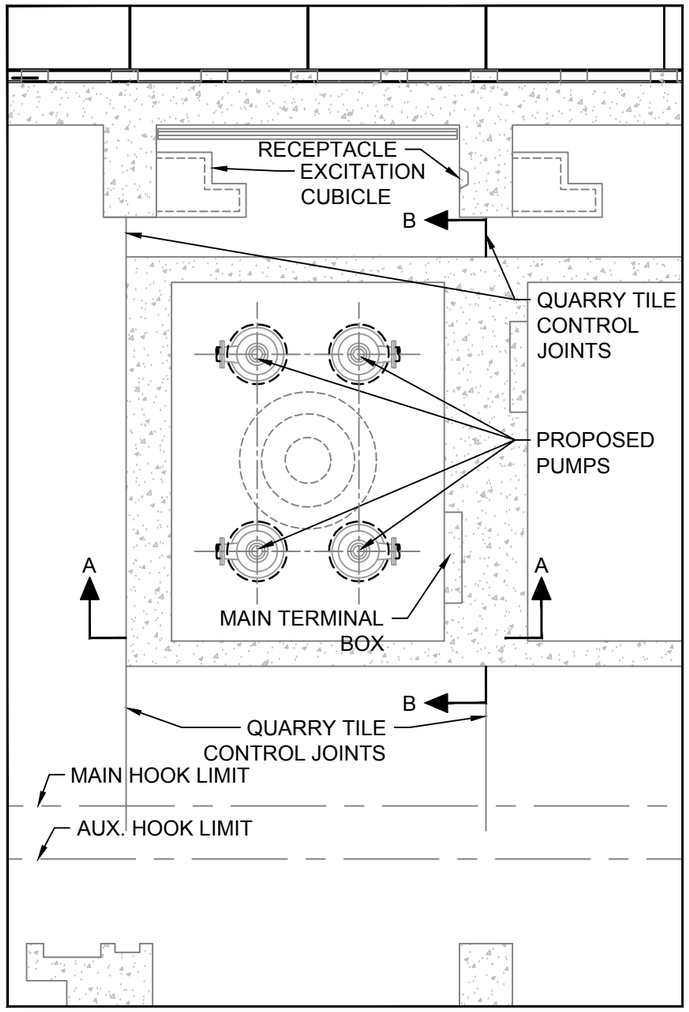
Notes:
[1] Estimated Peak Demand

Figure B-10 **Missouri River and Groundwater Alternative**

APPENDIX C

Intake,

Transmission and Bulk Distribution, Pump Stations and Reservoir Drawings



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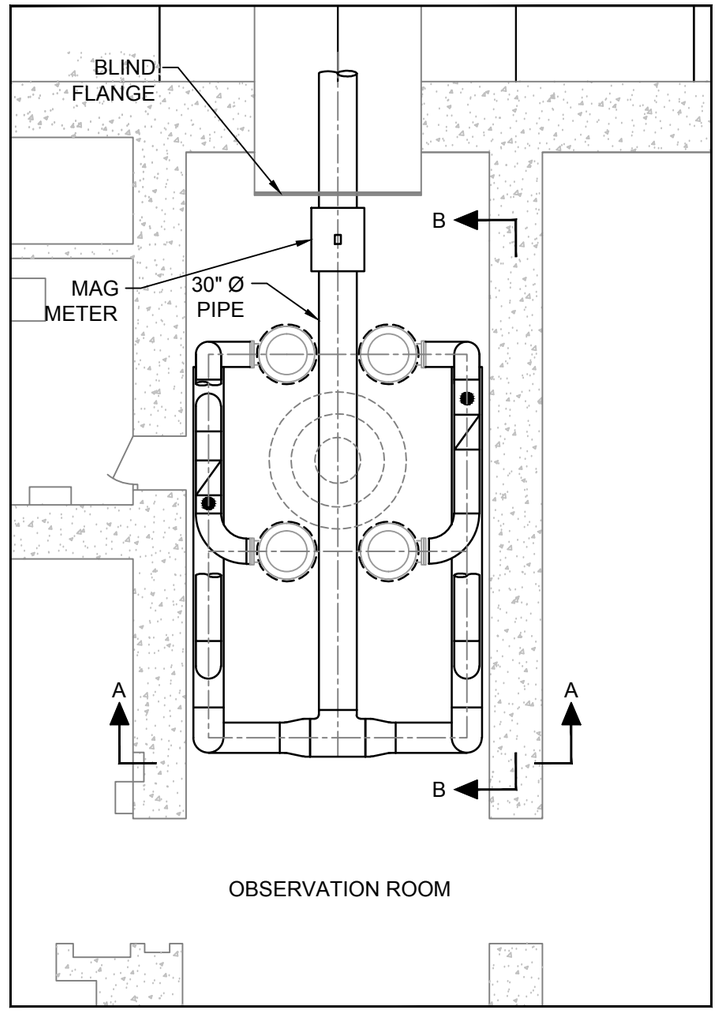
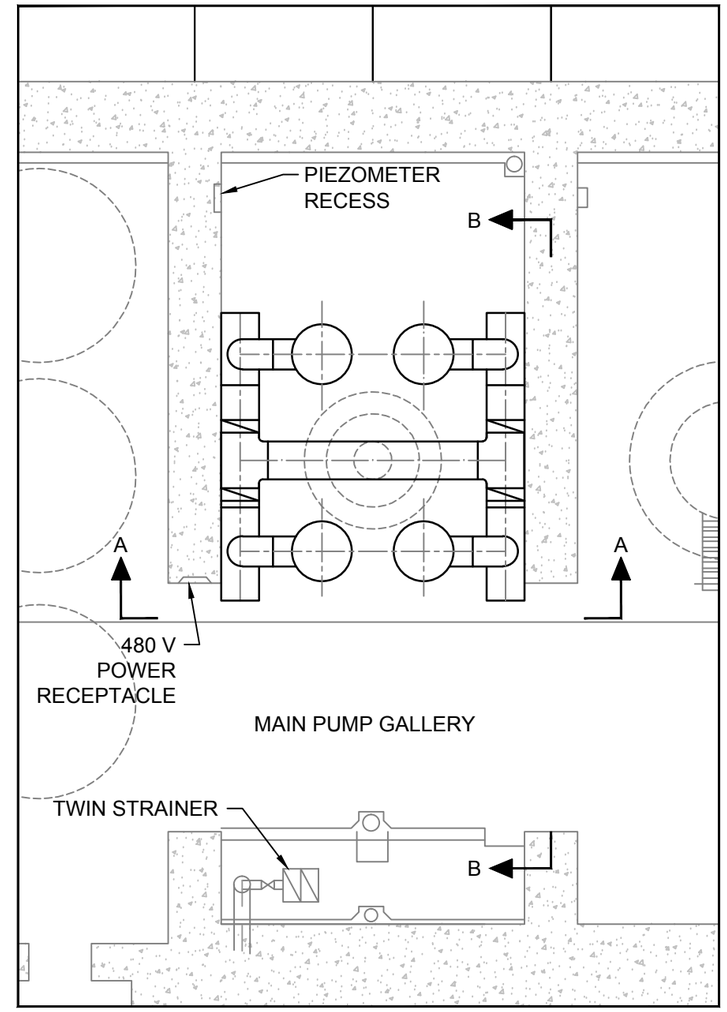


PUMP DISCHARGE PIPING PLAN - EL. 1801.25'



PUMP SECTION PIPING PLAN - EL. 1761.00'

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OPTION 1, SCPP MODIFICATIONS - PLAN SHEET

NORTHWEST AREA WATER SUPPLY

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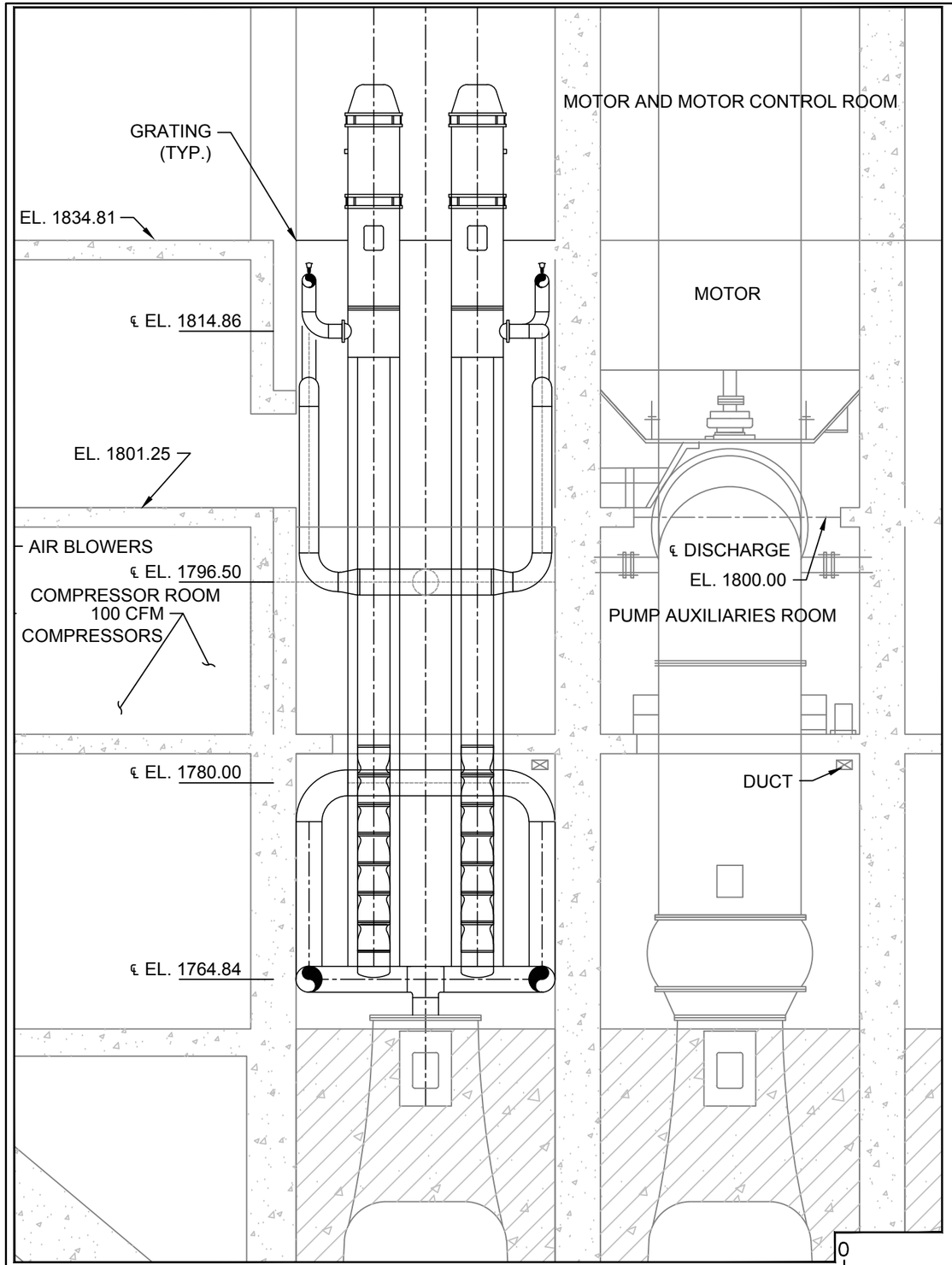
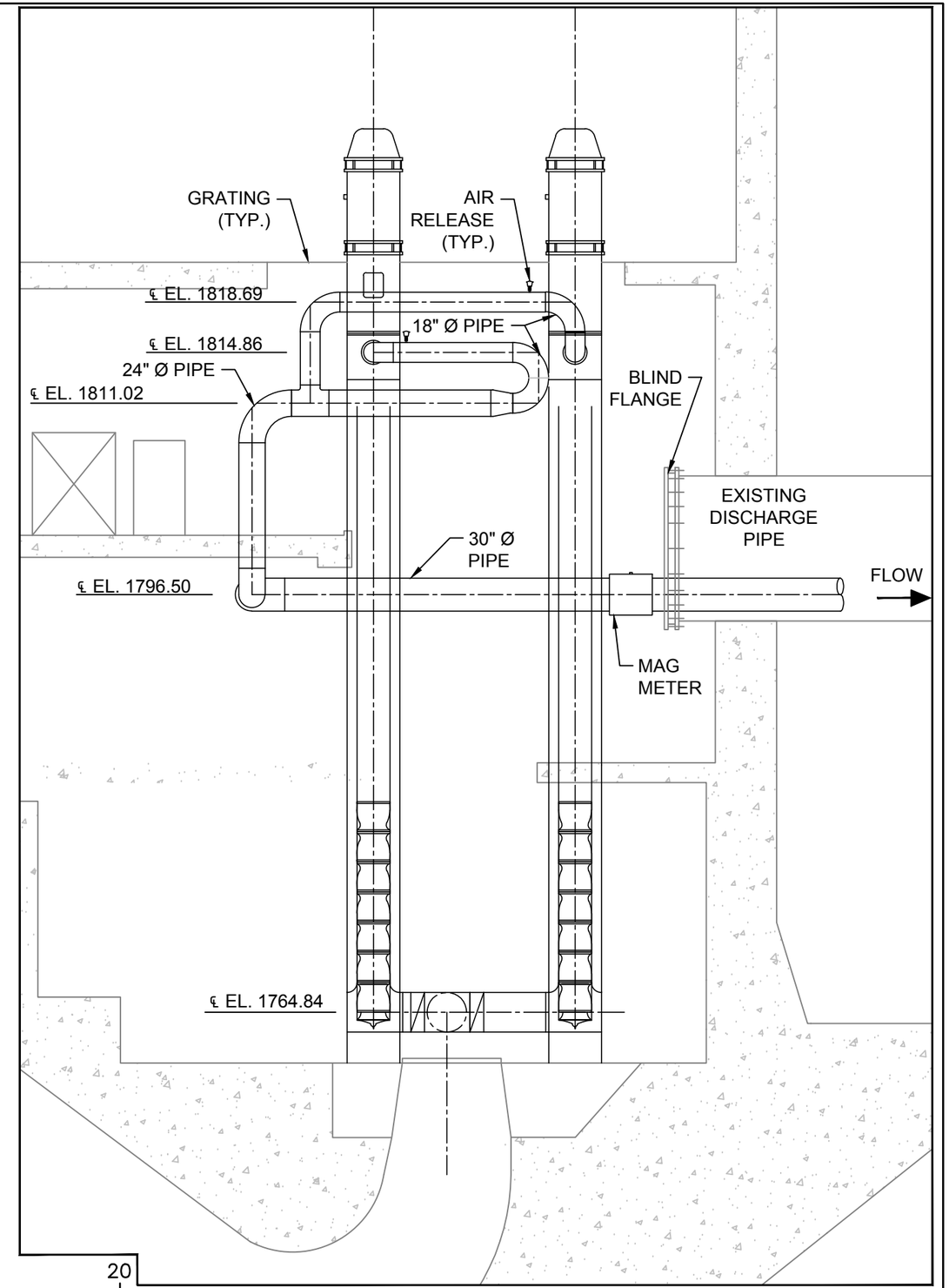


SECTION A



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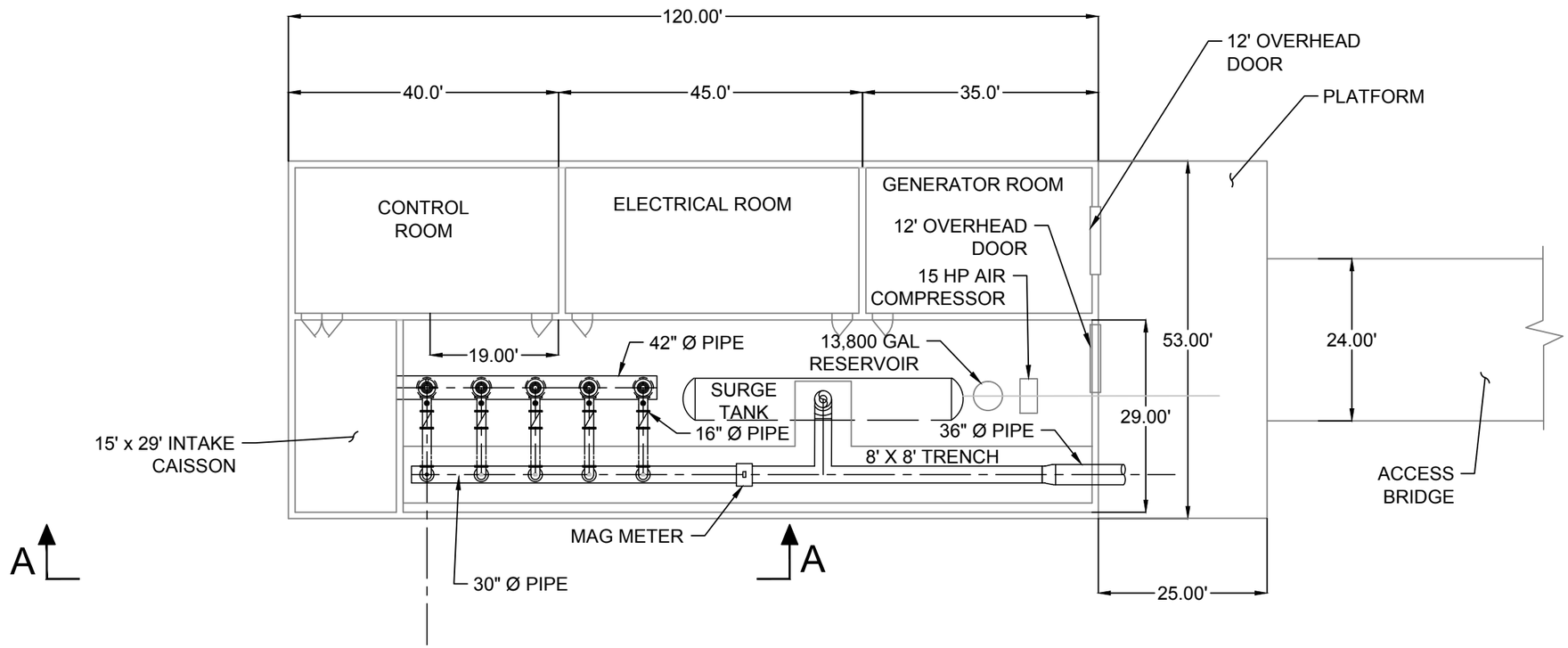

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OPTION 2 SOUTH SHORE - PLAN SHEET

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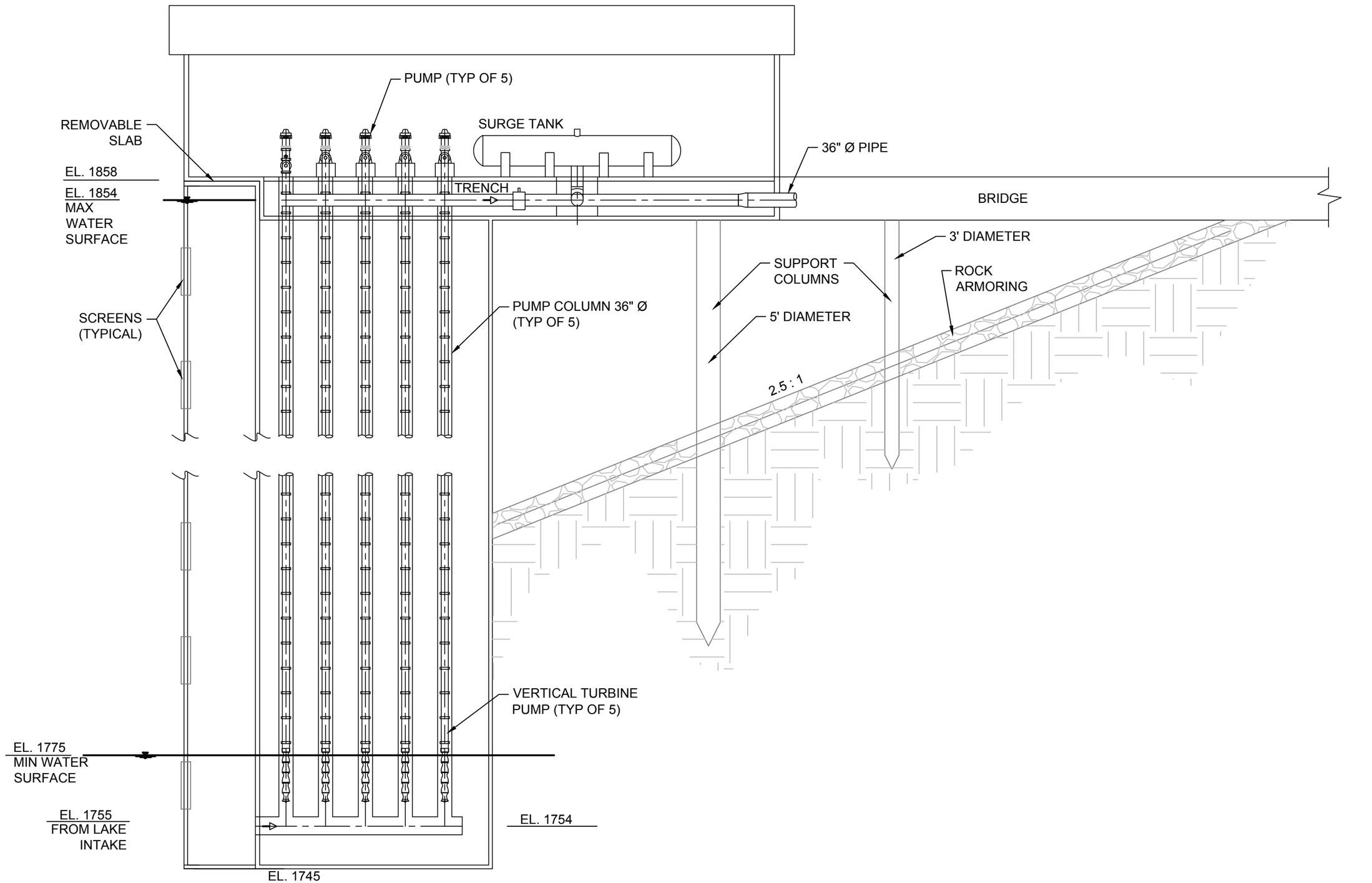

SECTION

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OPTION 2 SOUTH SHORE - SECTION SHEET

NORTHWEST AREA WATER SUPPLY

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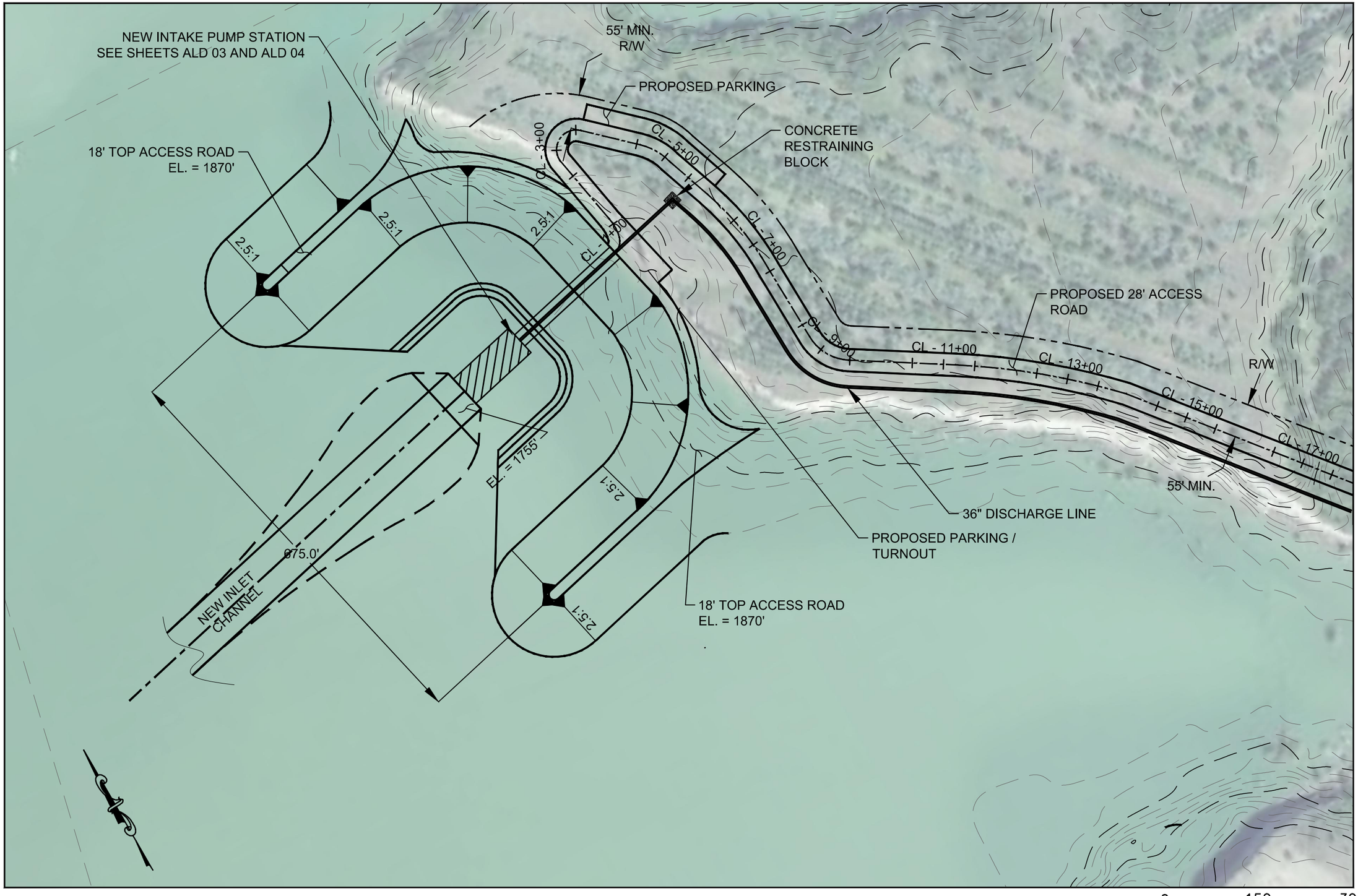

OPTION 2 - SITE PLAN

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SCALE IN FEET

NO.	REVISIONS	DATE

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NOT FOR
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MISSOURI RIVER INTAKE

OPTION 2 SOUTH SHORE - SITE PLAN

NORTHWEST AREA WATER SUPPLY

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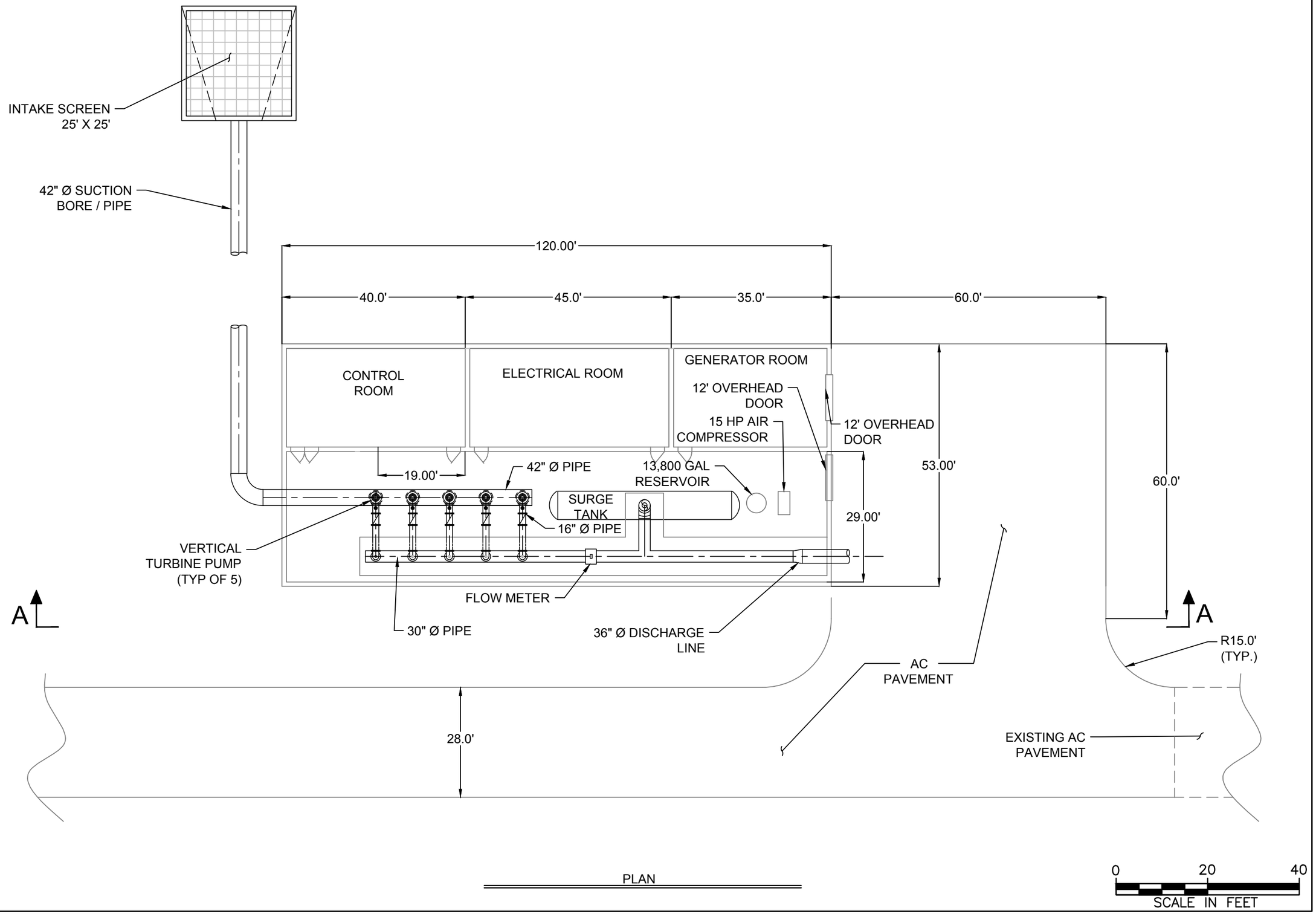
FIGURE NO.
ALD 05



PLAN

NO.	REVISIONS	DATE

SEAL

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CONSTRUCTION

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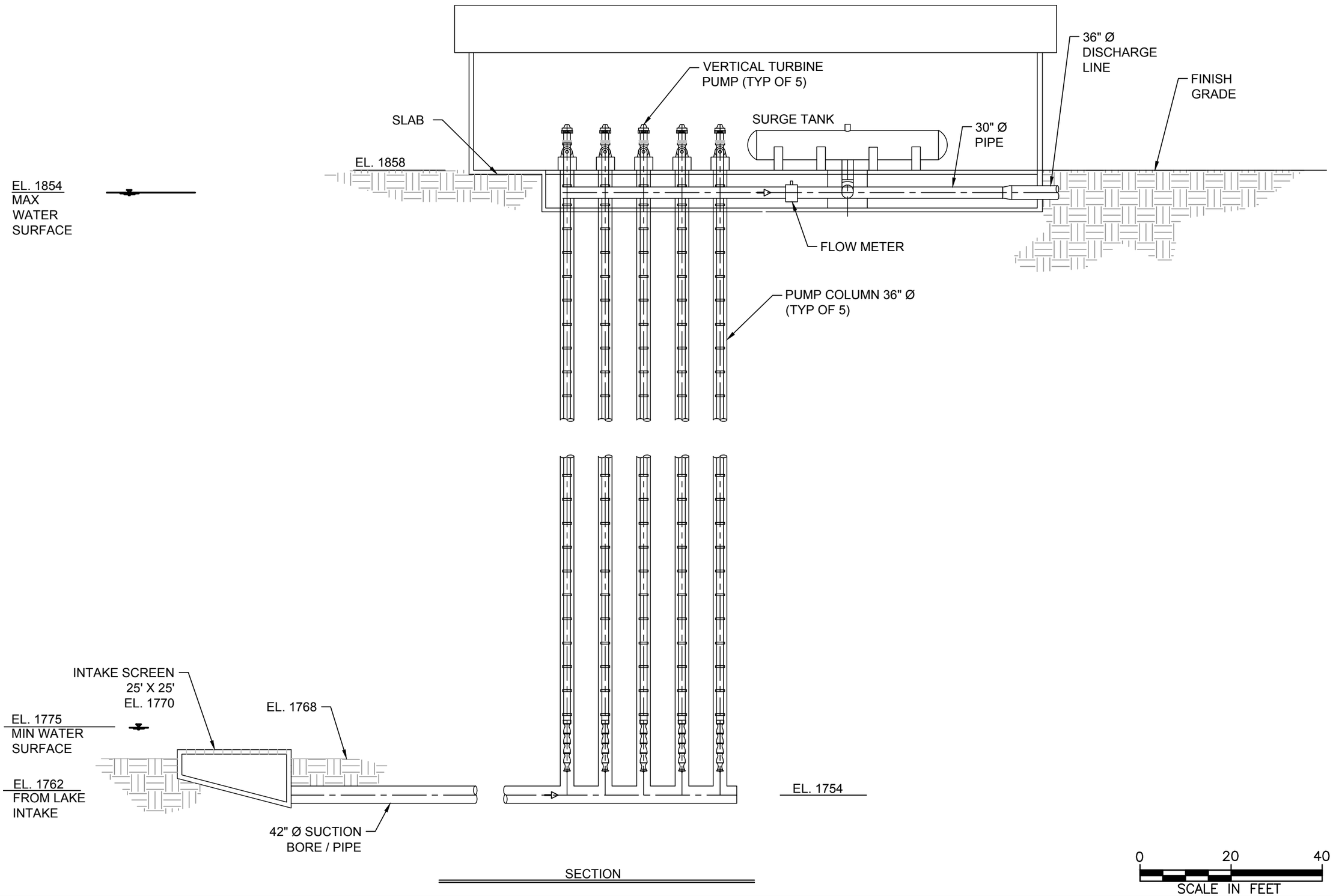
RECLAMATION
Managing Water in the West

MISSOURI RIVER INTAKE

OPTION 3, ADJACENT TO SNAKE CREEK - PLAN SHEET

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 06



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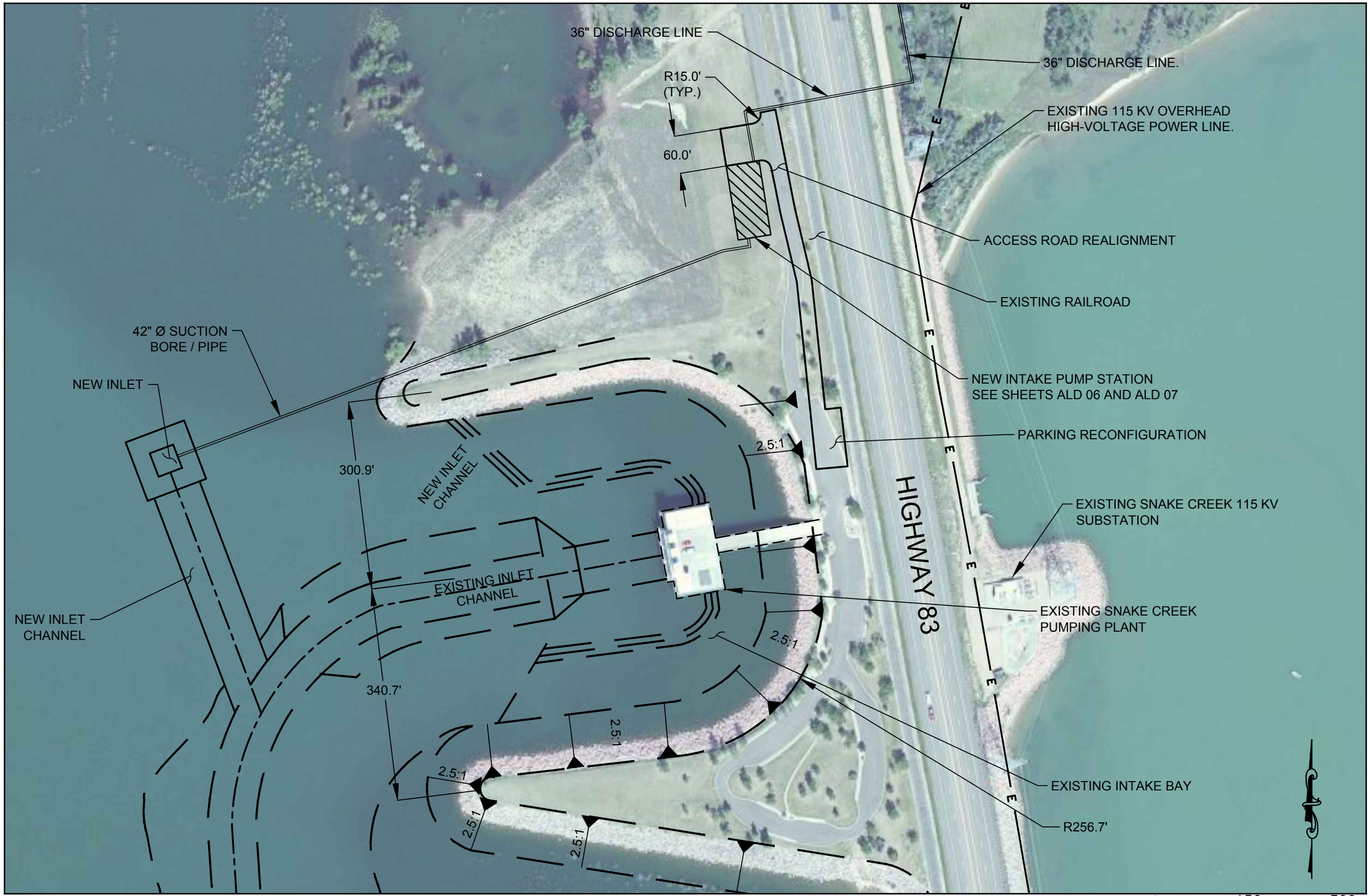
MISSOURI RIVER INTAKE

OPTION 3, ADJACENT TO SNAKE CREEK
SECTION SHEET

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 07



OPTION 3 - SITE PLAN

NO.	REVISIONS	DATE

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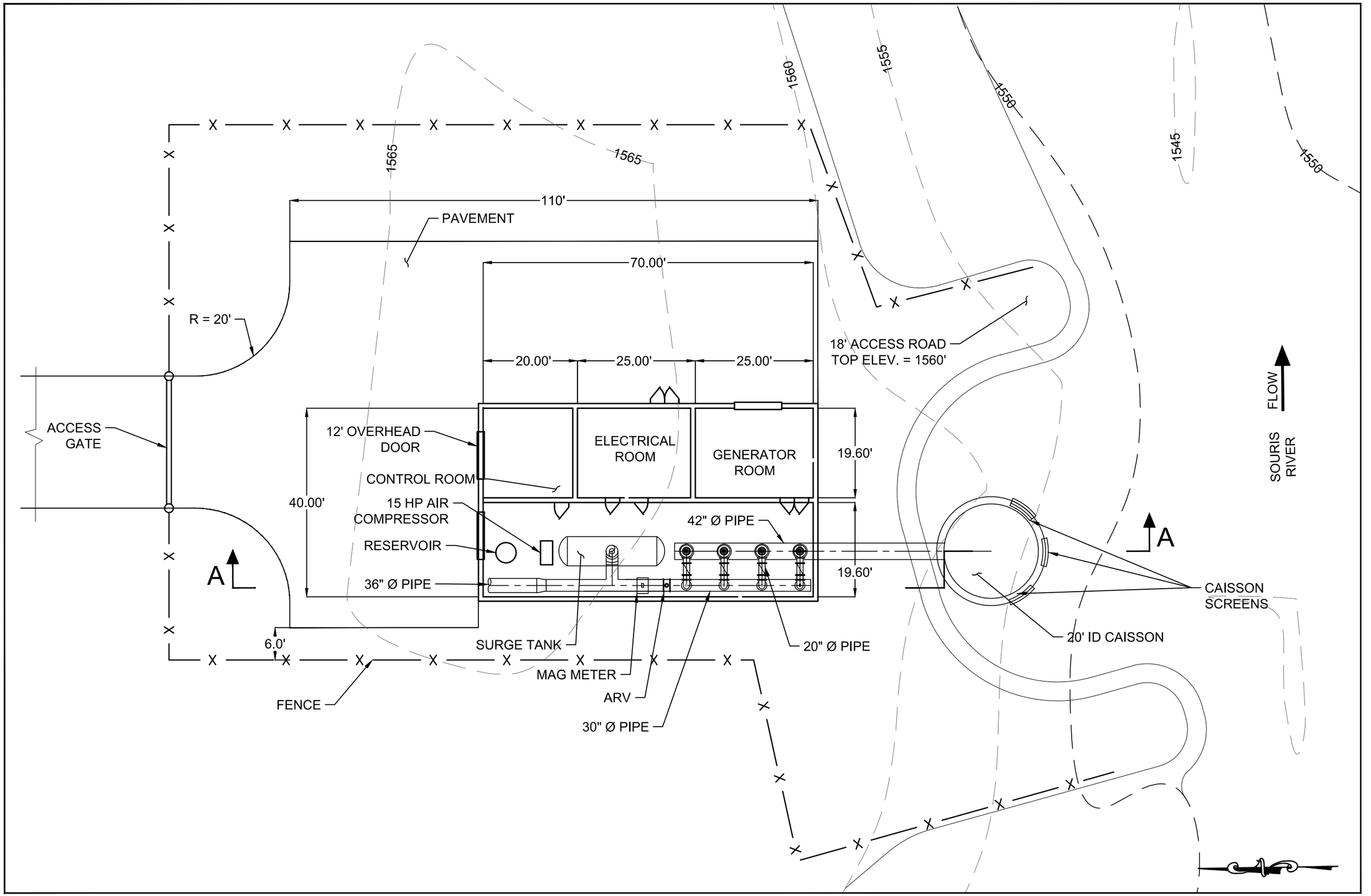
MISSOURI RIVER INTAKE

OPTION 3, ADJACENT TO SNAKE CREEK - SITE PLAN

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 08



INTAKE, ALTERNATIVES 1 AND 2 - SITE PLAN

NO.	REVISIONS	DATE

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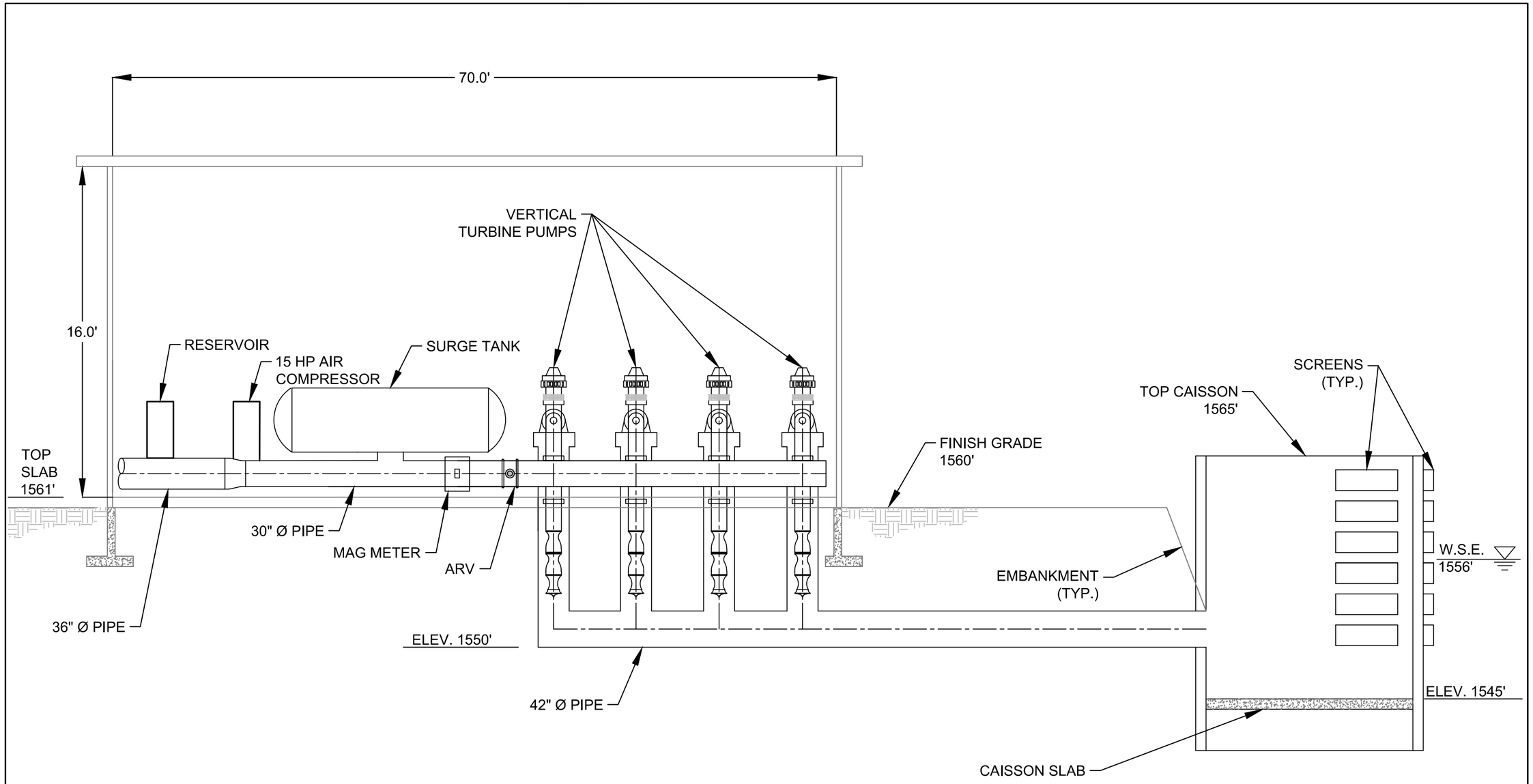
SOURIS RIVER INTAKE

MINOT AQUIFER RECHARGE FACILITY
SITE PLAN

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 09



INTAKE, ALTERNATIVES 1 AND 2 - SECTION A - A

N.T.S.

NO.	REVISIONS	DATE

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CONSTRUCTION

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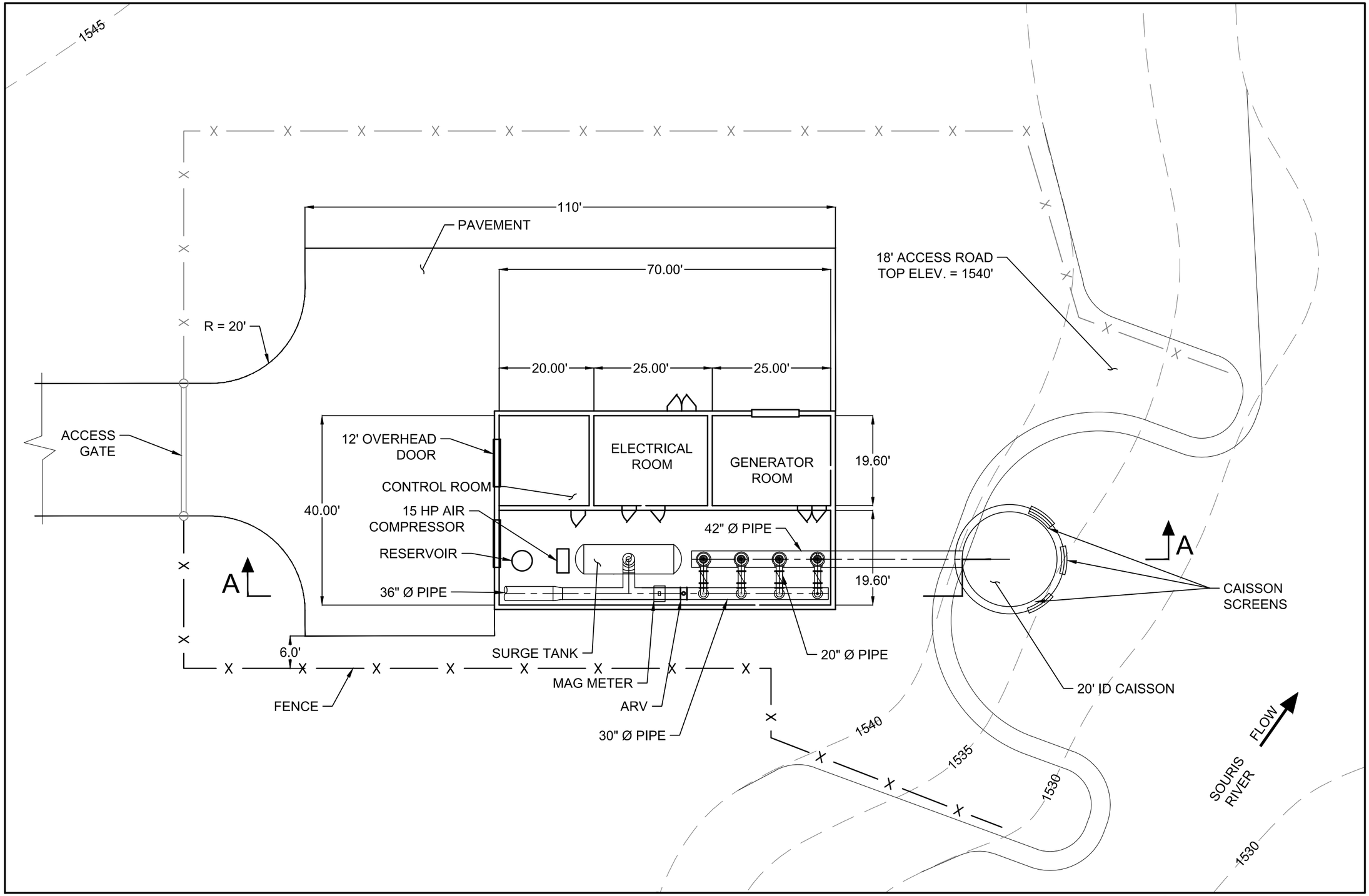
SOURIS RIVER INTAKE

MINOT AQUIFER RECHARGE FACILITY
SECTION

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 10



INTAKE, ALTERNATIVES 1 AND 2 SOURIS (RECHARGE) SITE PLAN

0 20 40
SCALE IN FEET

NO.	REVISIONS	DATE

SEAL

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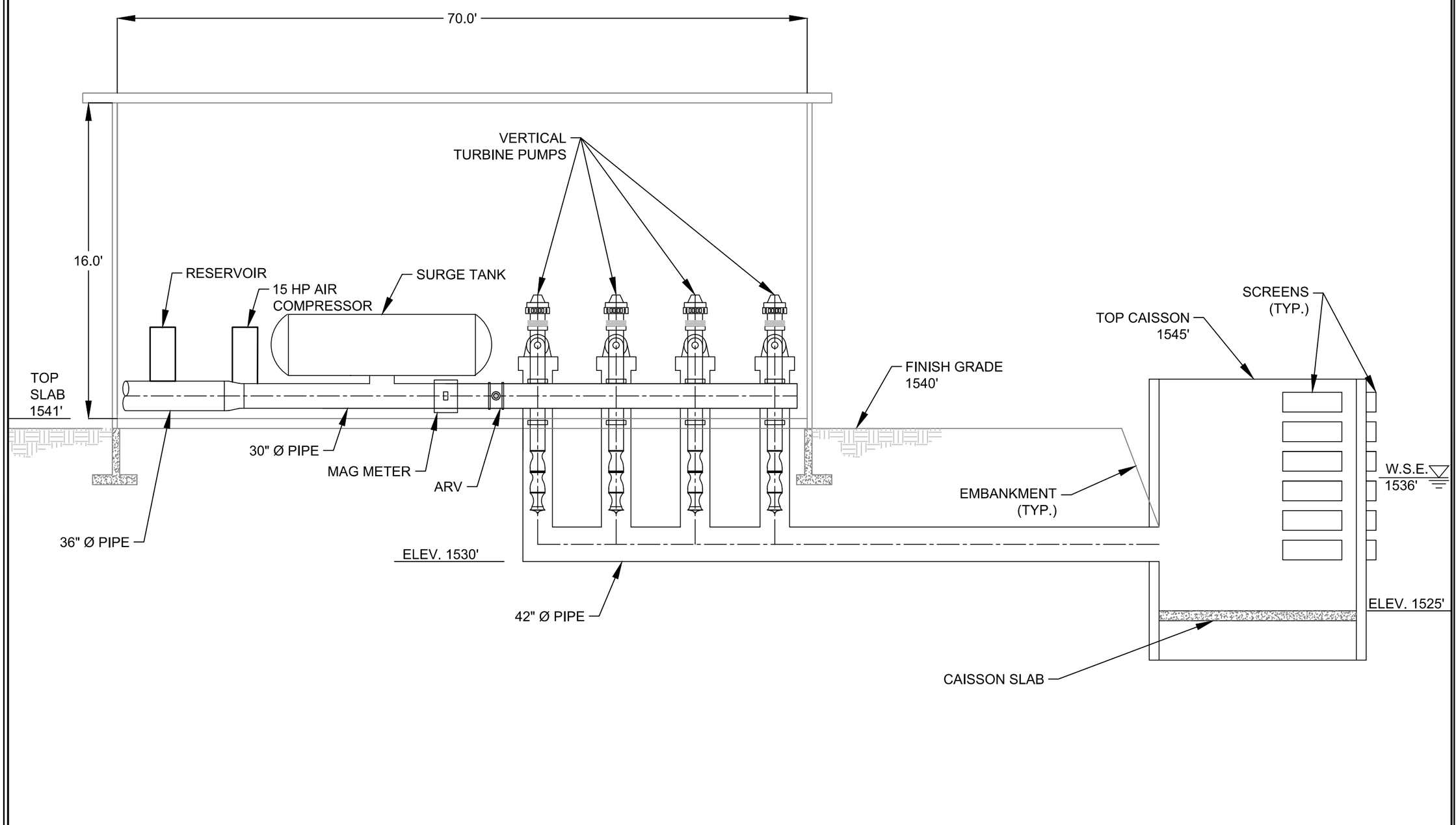
SOURIS RIVER INTAKE

SUNDRE AQUIFER RECHARGE FACILITY
SITE PLAN

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 11



INTAKE, ALTERNATIVES 1 AND 2 - SECTION A-A

N.T.S.

NO.	REVISIONS	DATE

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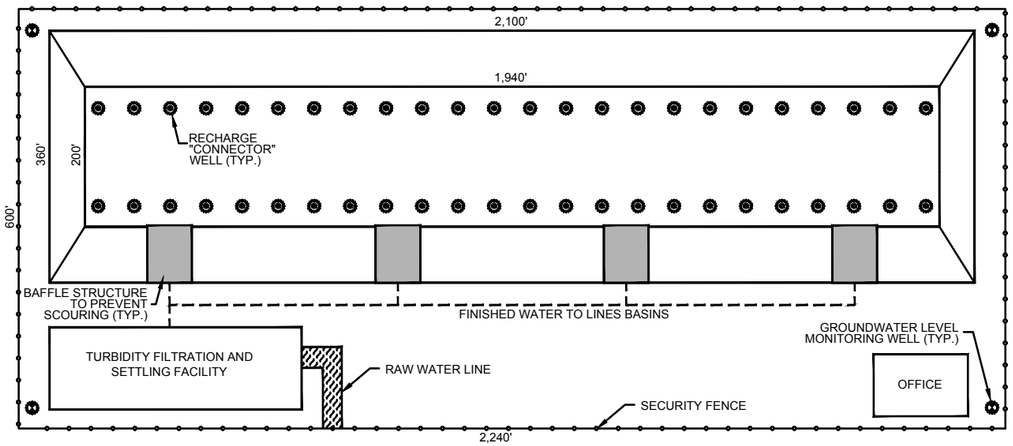
SOURIS RIVER INTAKE

SUNDRE AQUIFER RECHARGE FACILITY
SECTION

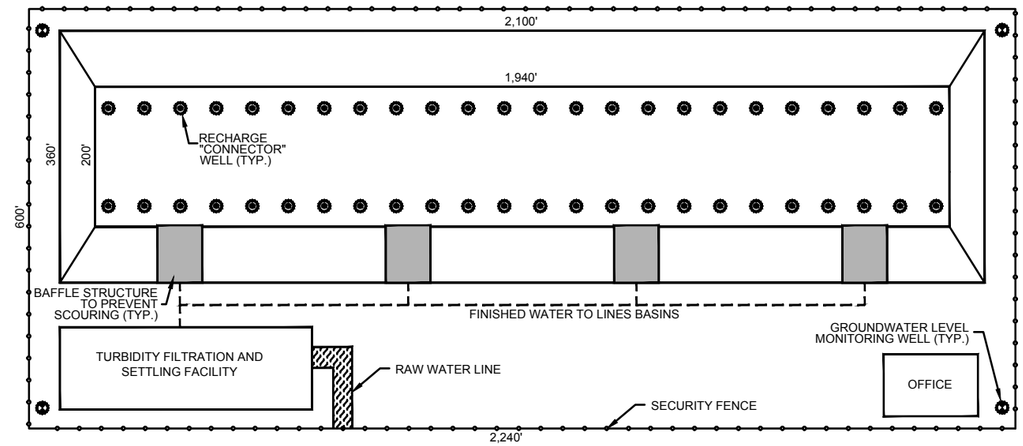
NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 12

PLAN VIEW - MINOT AQUIFER RECHARGE FACILITY

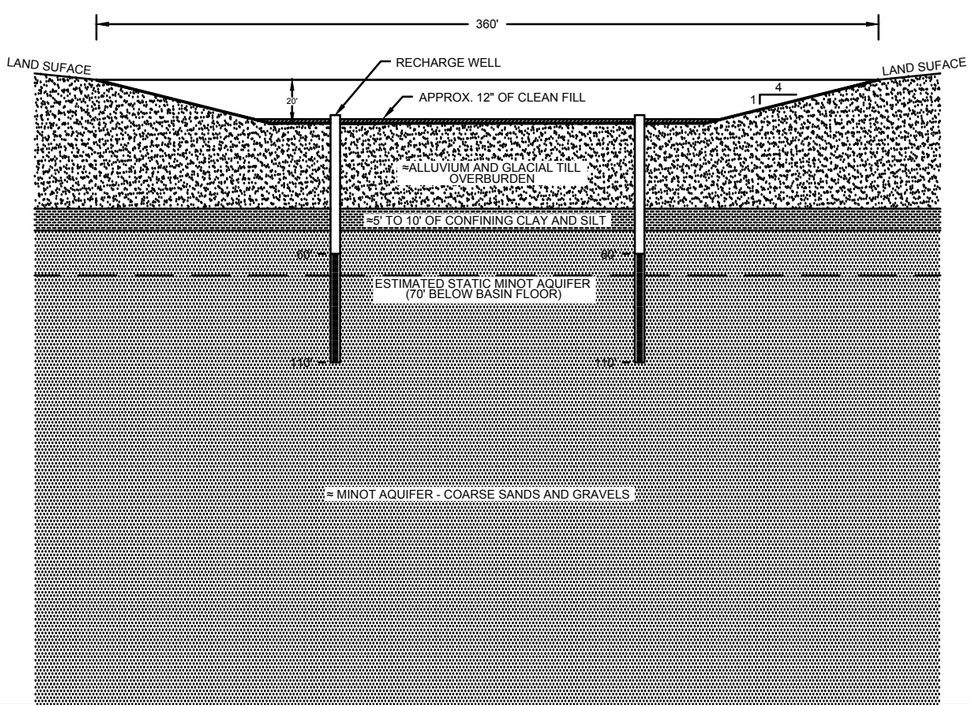


PLAN VIEW - SUNDRE AQUIFER RECHARGE FACILITY

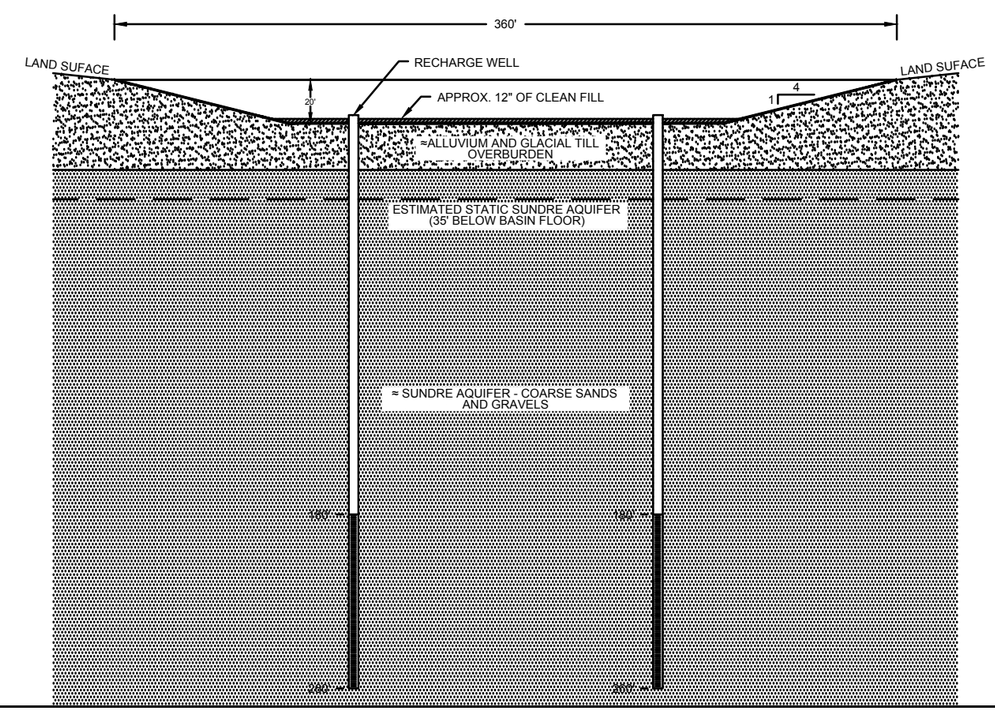


NOT TO SCALE

CROSS SECTION - MINOT AQUIFER RECHARGE FACILITY



CROSS SECTION - SUNDRE AQUIFER RECHARGE FACILITY



NO.	REVISIONS	DATE

SEAL

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RECLAMATION
Managing Water in the West

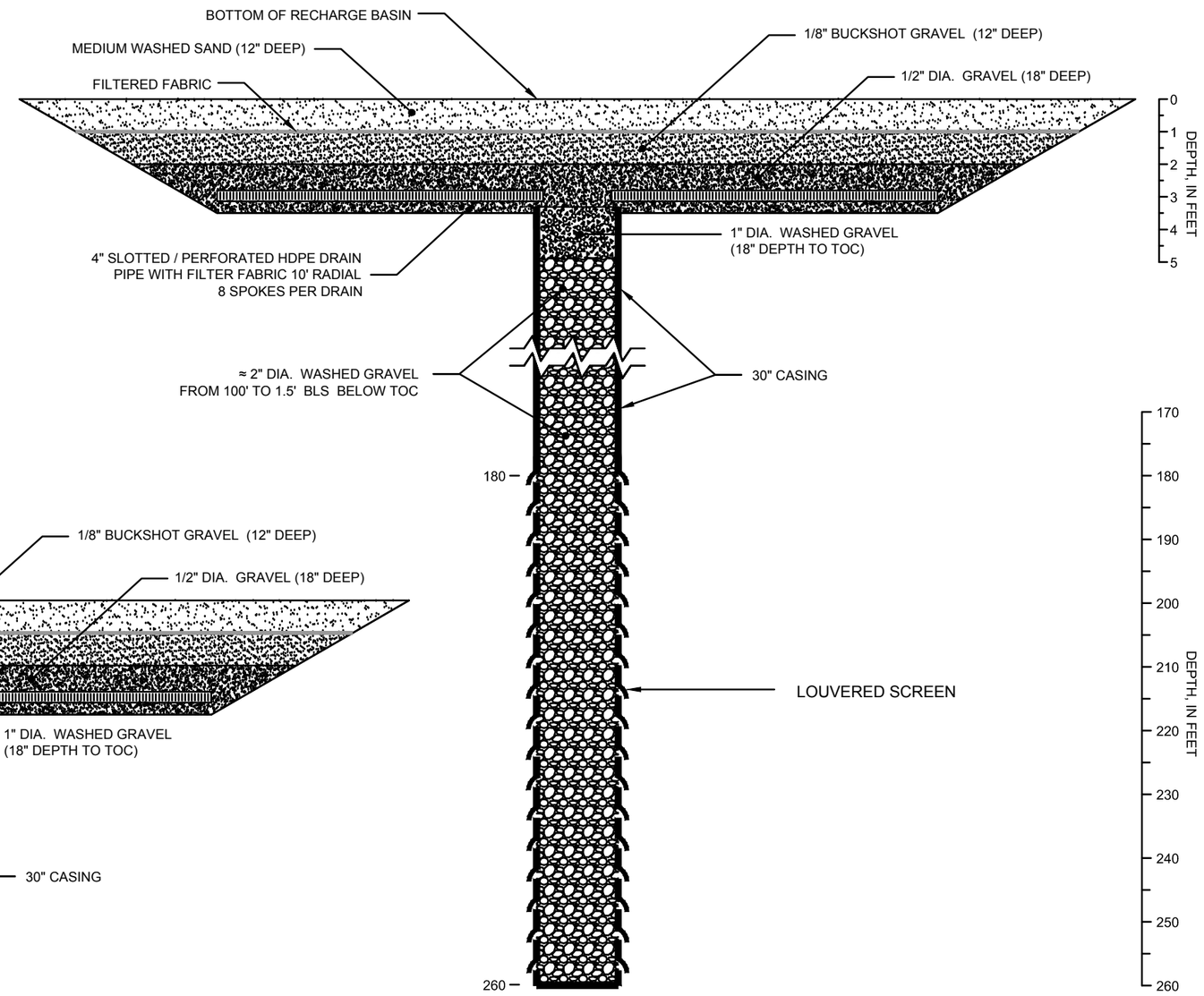
MINOT AND SUNDRE AQUIFER RECHARGE FACILITIES

PLAN VIEW AND CROSS SECTION

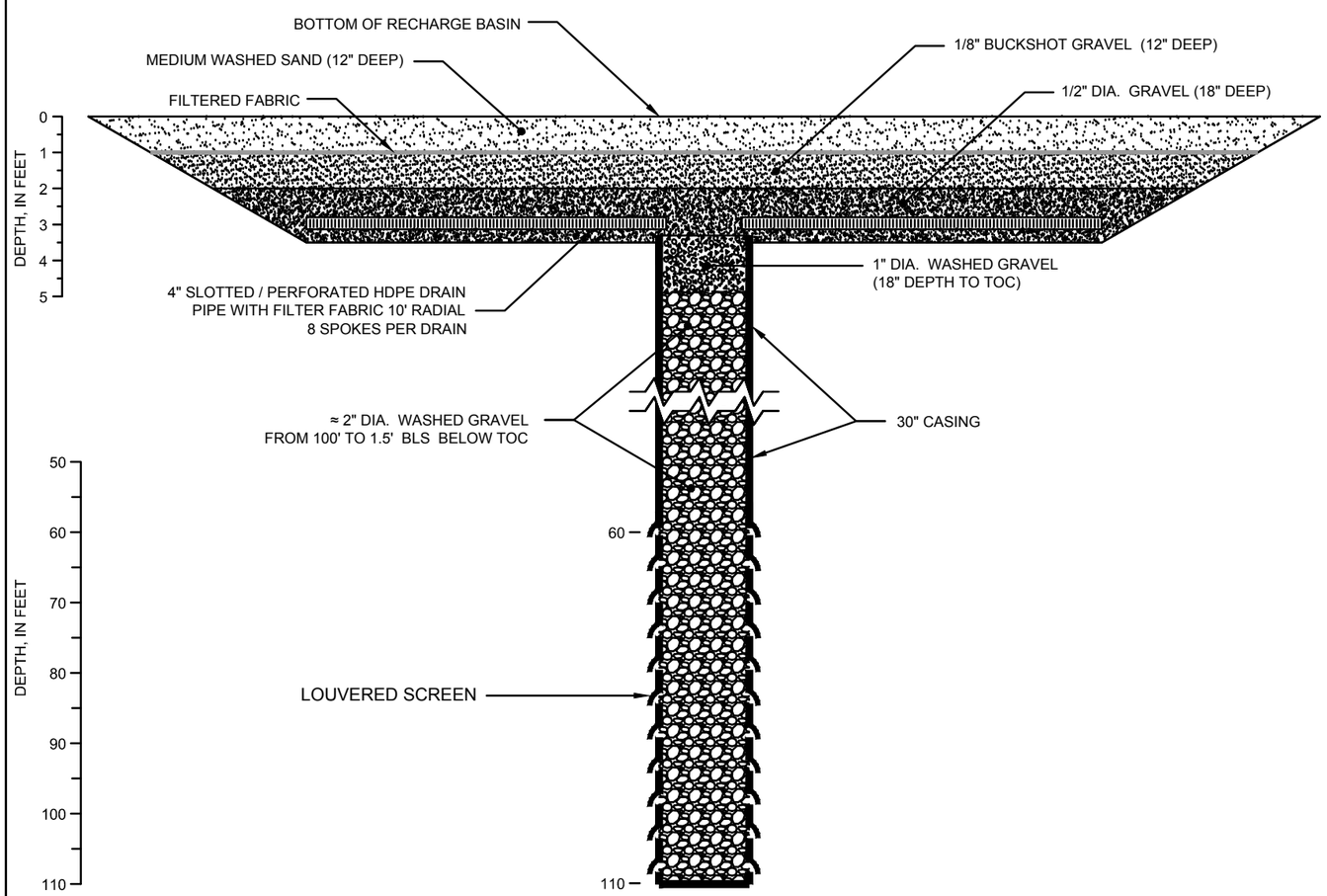
NORTHWEST AREA WATER SUPPLY

DATE: 7/17/2012
DRAWN BY: IL
CHECKED BY:
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
SHEET NO.
ALD 13

SUNDRE AQUIFER RECHARGE WELL



MINOT AQUIFER RECHARGE WELL



NOT TO SCALE

NO.	REVISIONS	DATE

SEAL

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RECLAMATION
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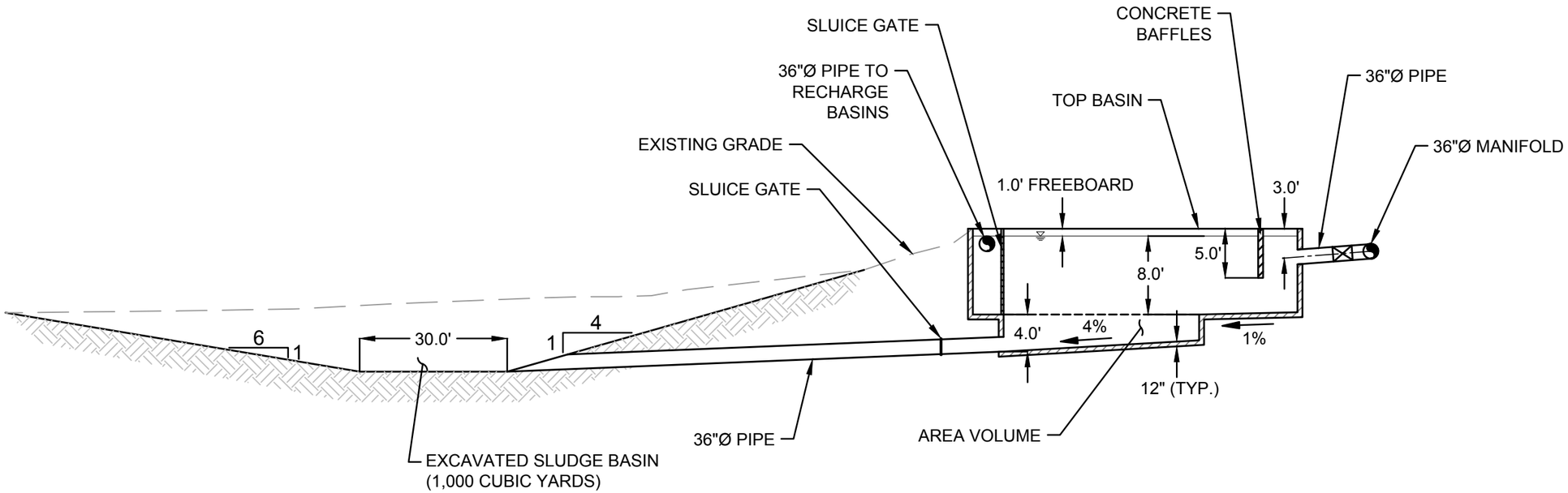
MINOT AND SUNDRE AQUIFER RECHARGE WELLS

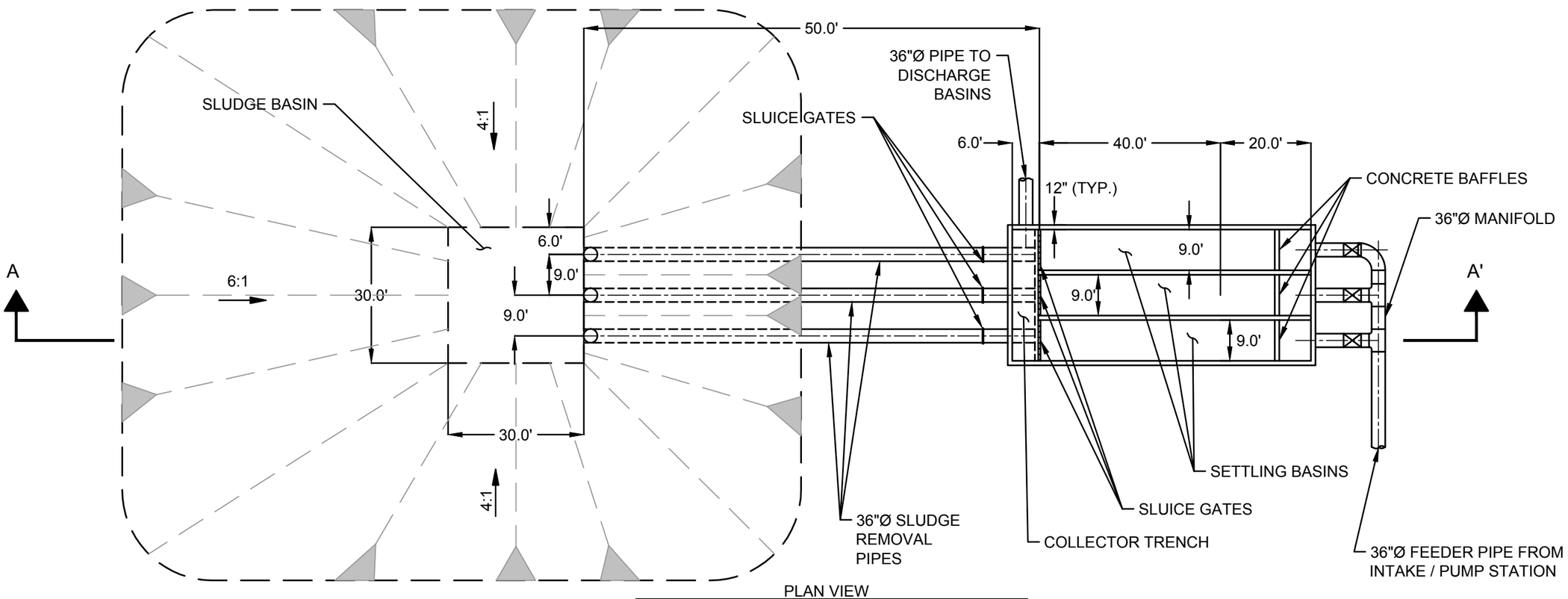
TYPICAL SCHEMATIC

NORTHWEST AREA WATER SUPPLY

DATE: 7/17/2012
DRAWN BY: IL
CHECKED BY:
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
SHEET NO.
ALD 14



SECTION A-A'
N.T.S.



PLAN VIEW
N.T.S.

NO.	REVISIONS	DATE

SEAL

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CONSTRUCTION

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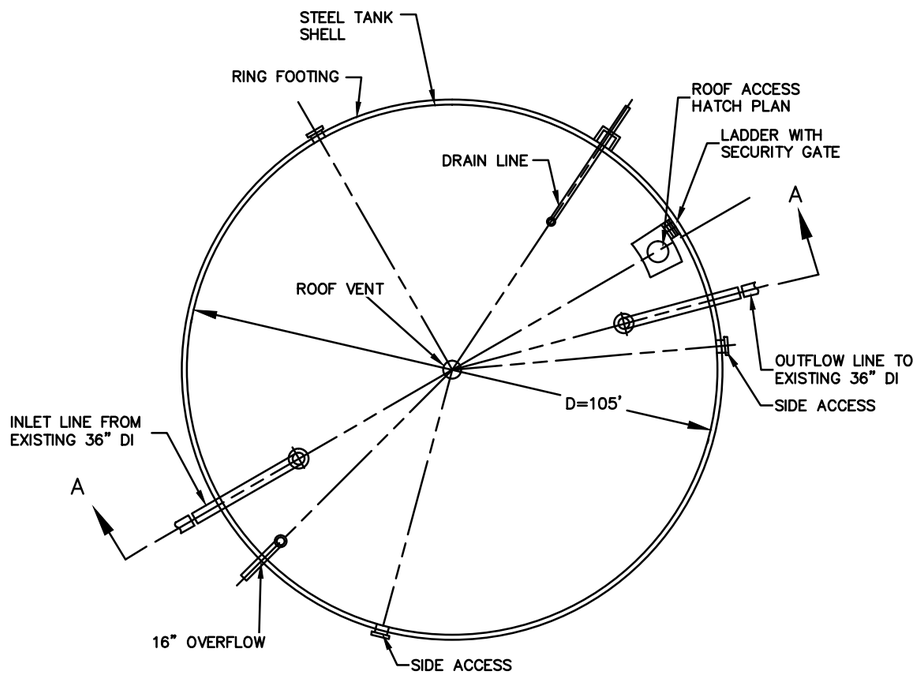
RECHARGE BASIN SETTLING FACILITY

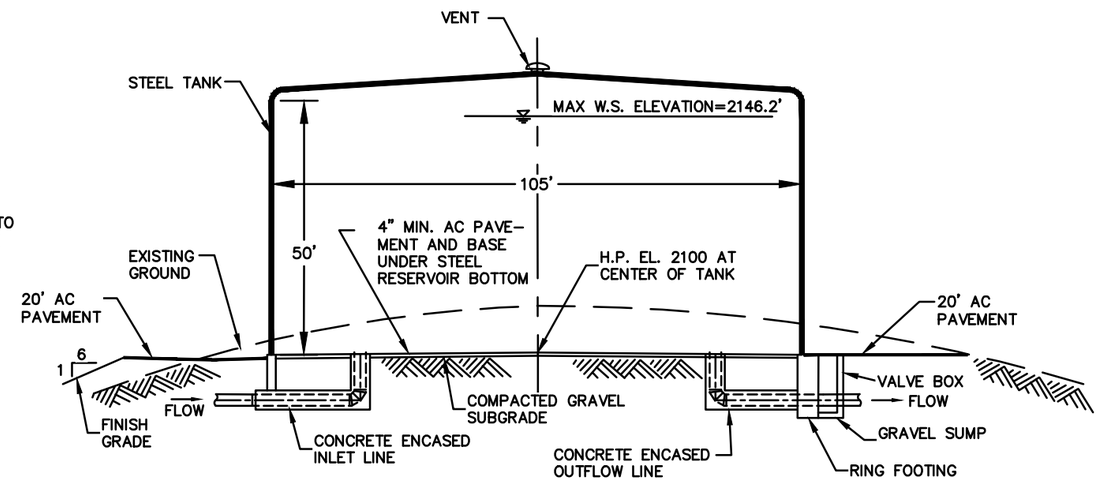
PLAN AND SECTION SHEET

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 15



STEEL RESERVOIR PLAN
N.T.S.



SECTION A–A
N.T.S.

NO.	REVISIONS	DATE

SEAL

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RECLAMATION
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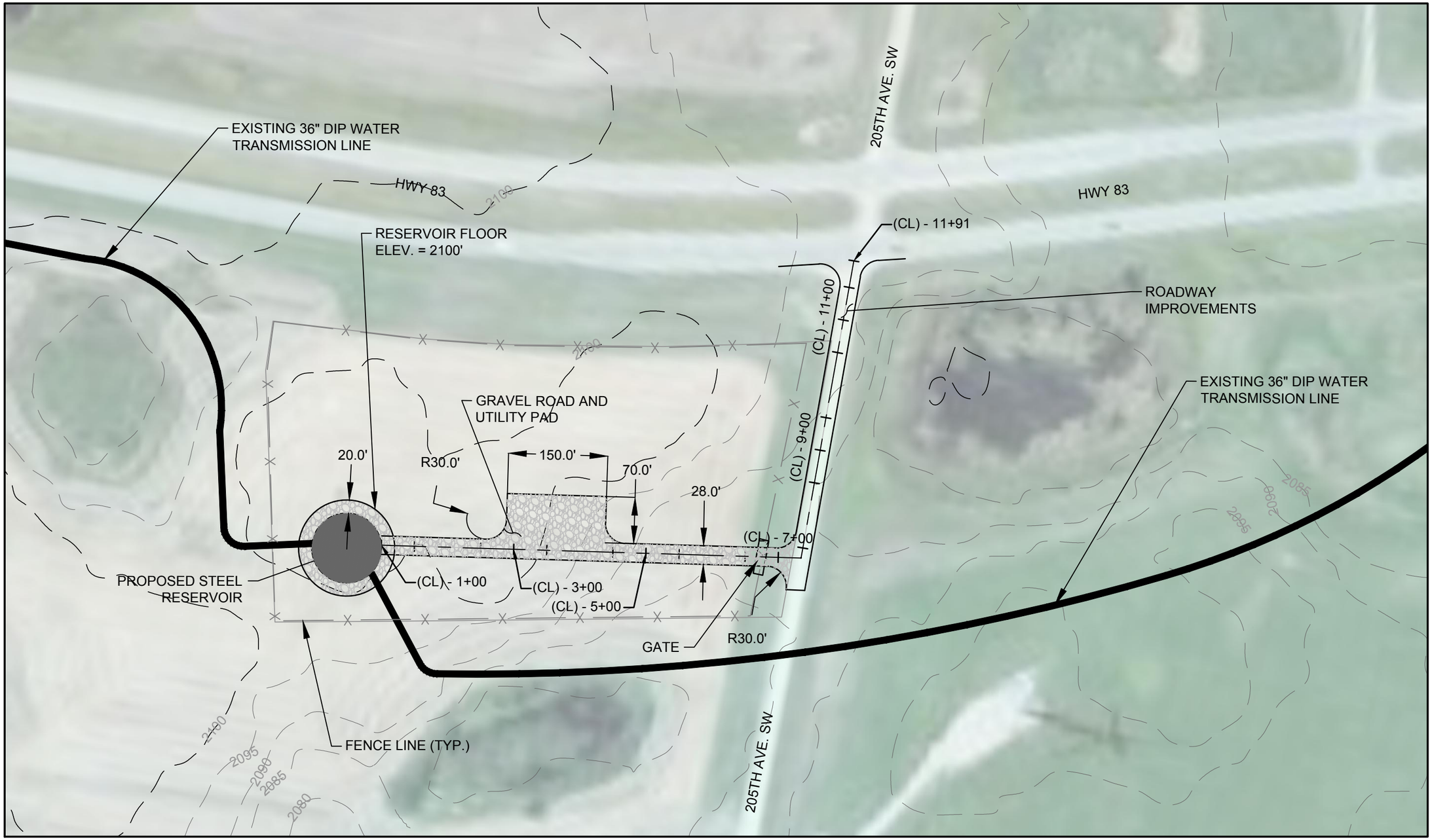
SOUTH PRAIRIE RESERVOIR

PLAN AND SECTION SHEET

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 16



3 MG STEEL RESERVOIR SITE PLAN

0 150 300
SCALE IN FEET

NO.	REVISIONS	DATE

SEAL

PRELIMINARY NOT FOR CONSTRUCTION

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RECLAMATION
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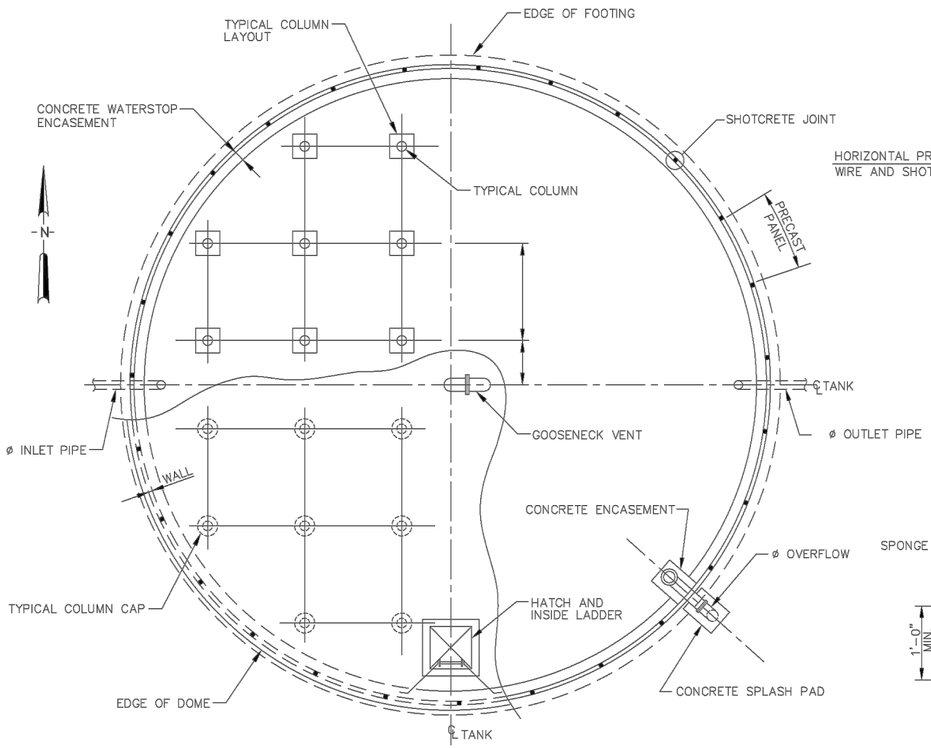
SOUTH PRAIRIE RESERVOIR

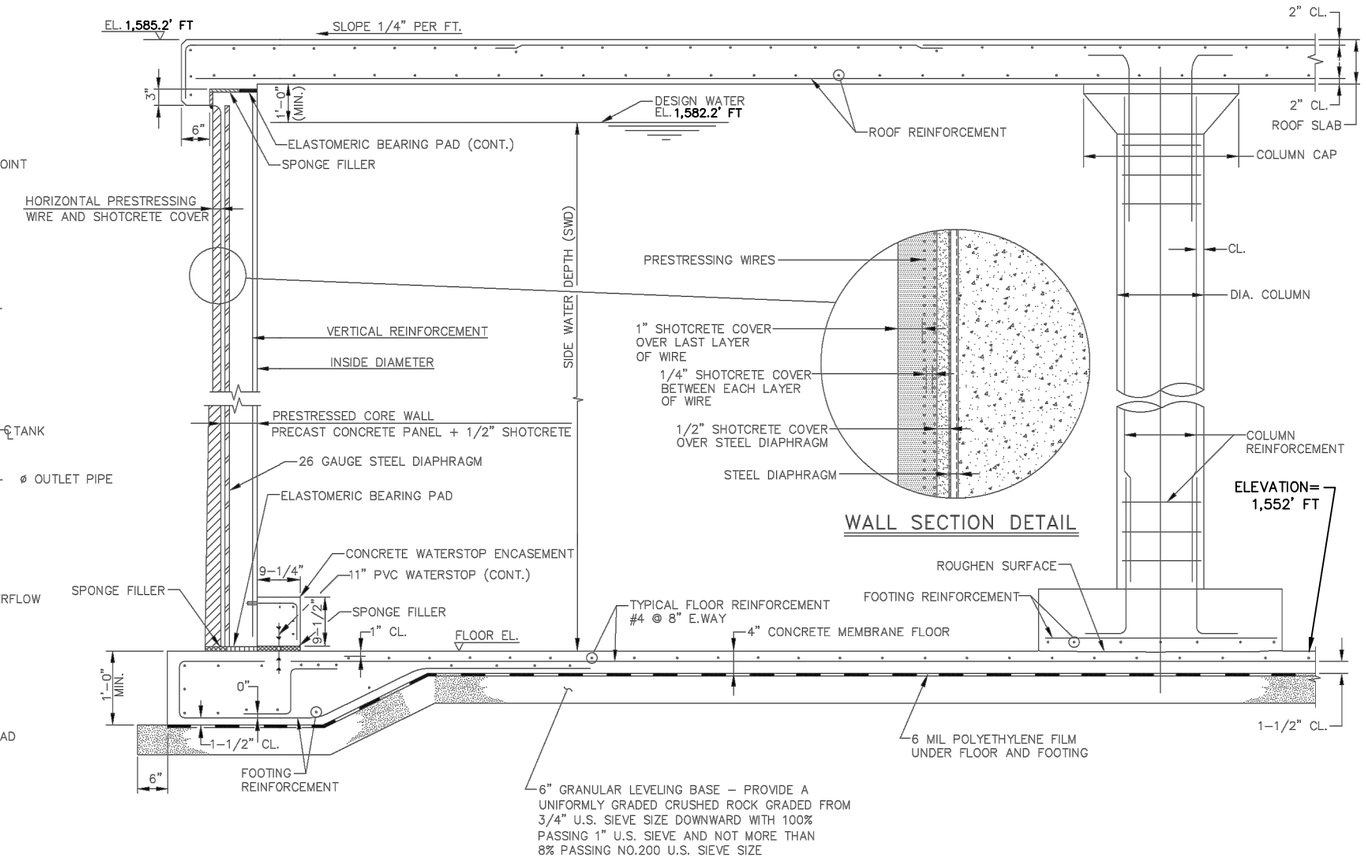
SITE PLAN

NORTHWEST AREA WATER SUPPLY

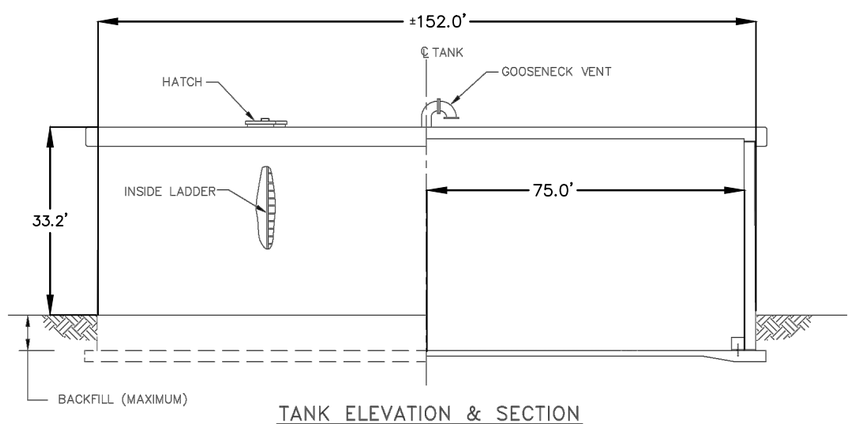
DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO. ALD 17



TANK PLAN



TYPICAL TANK SECTION



TANK ELEVATION & SECTION

NOTES:

1. TANK DESIGN IN ACCORDANCE WITH ANSI/AWWA D110, TYPE III.
2. CONCRETE AND SHOTCRETE SHALL CONFORM TO ACI 301 AND 506 RESPECTIVELY.
   MINIMUM 28 – DAY STRENGTHS:
   SHOTCRETE — — — — — — — — 4500 PSI
   FOOTING AND FLOOR CONCRETE — — 3500 PSI
   WALL AND ROOF CONCRETE — — — — 4000 PSI
3. ALLOWABLE SOIL BEARING PRESSURE = PSF
4. ROOF LIVE LOAD = PSF
5. REINFORCING STEEL SHALL CONFORM TO ASTM A615, GRADE 60.
6. DETAILS SHOWN ARE REPRESENTATIVE OF ANSI/AWWA STANDARD D110, TYPE III. SIMILAR DETAILS MEETING THIS STANDARD AND TYPE ARE ACCEPTABLE, SUBJECT TO APPROVAL BY THE ENGINEER.
7. DETAILS PROVIDED BY PRELOAD INC.

4 MG WATER TANK - TYPICAL DETAILS

NO.	REVISIONS	DATE

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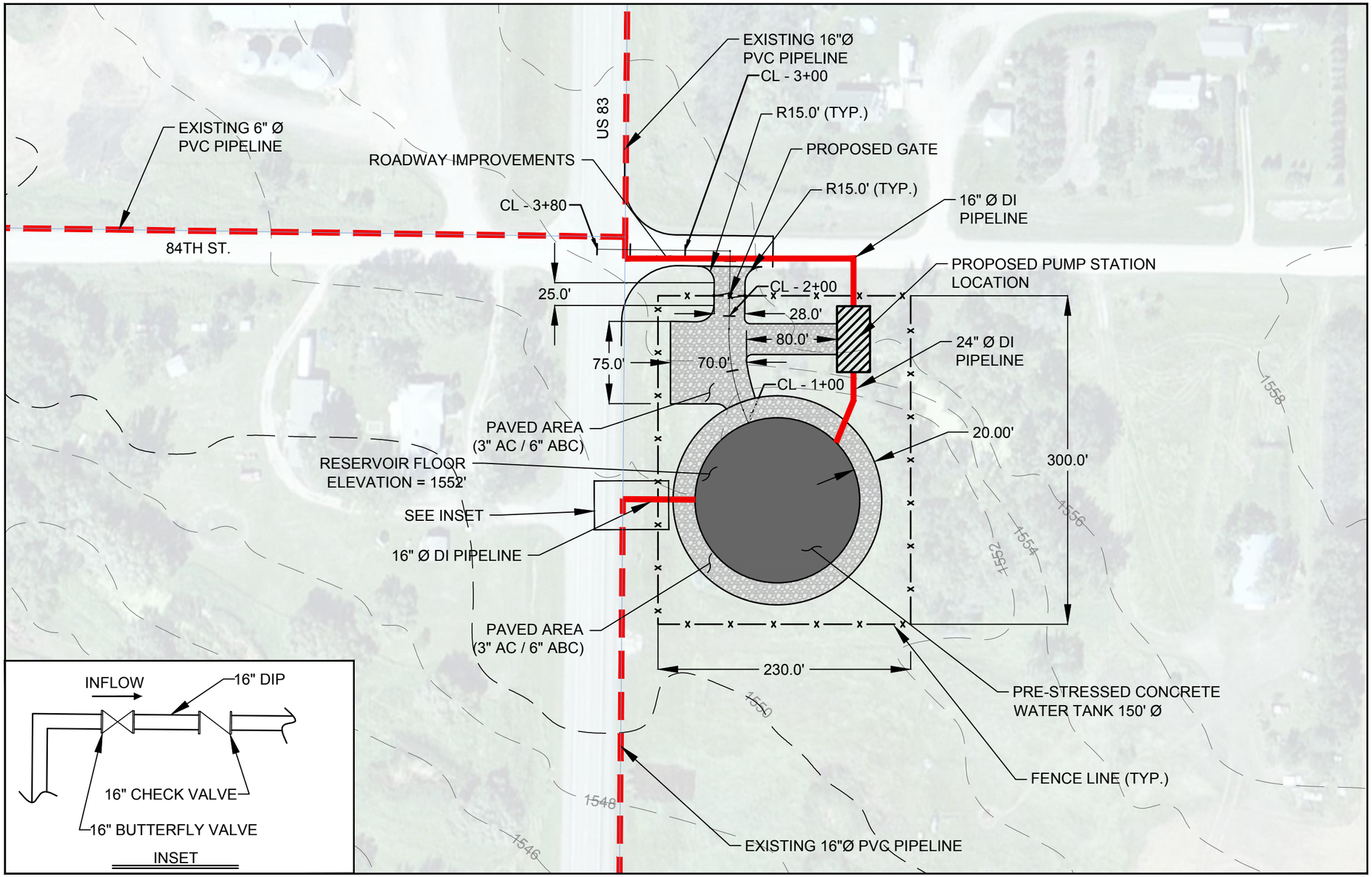
LANSFORD RESERVOIR

DETAIL SHEET

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO. ALD 18



PROPOSED 4 MG WATER TANK - SITE PLAN

0 100 200
HORIZONTAL SCALE: 1" = 100'
SCALE IN FEET

NO.	REVISIONS	DATE

SEAL

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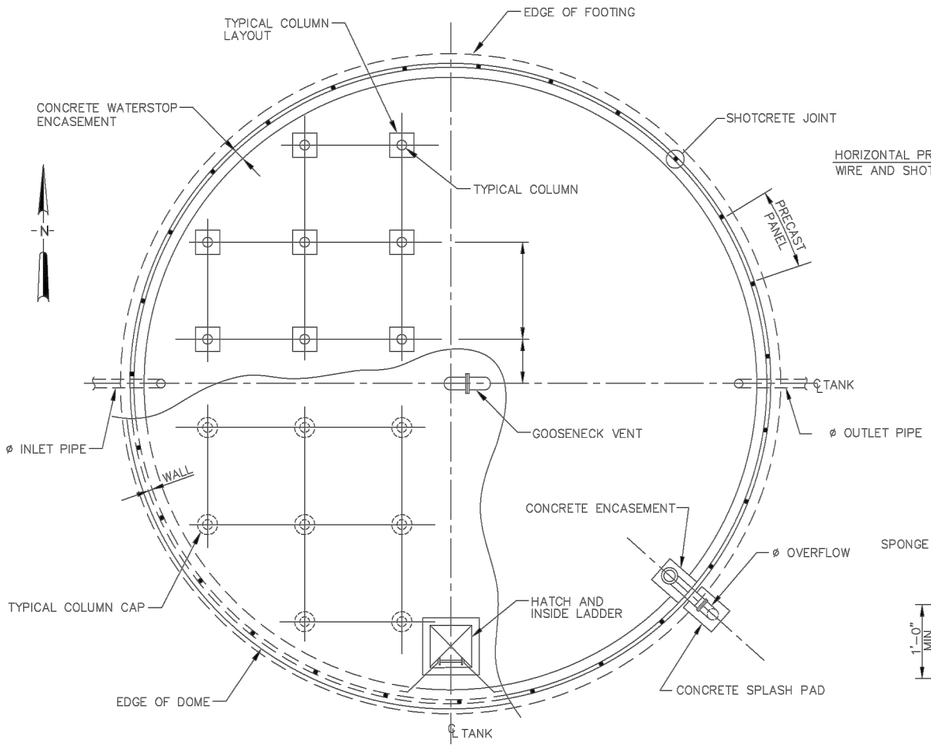
LANSFORD RESERVOIR

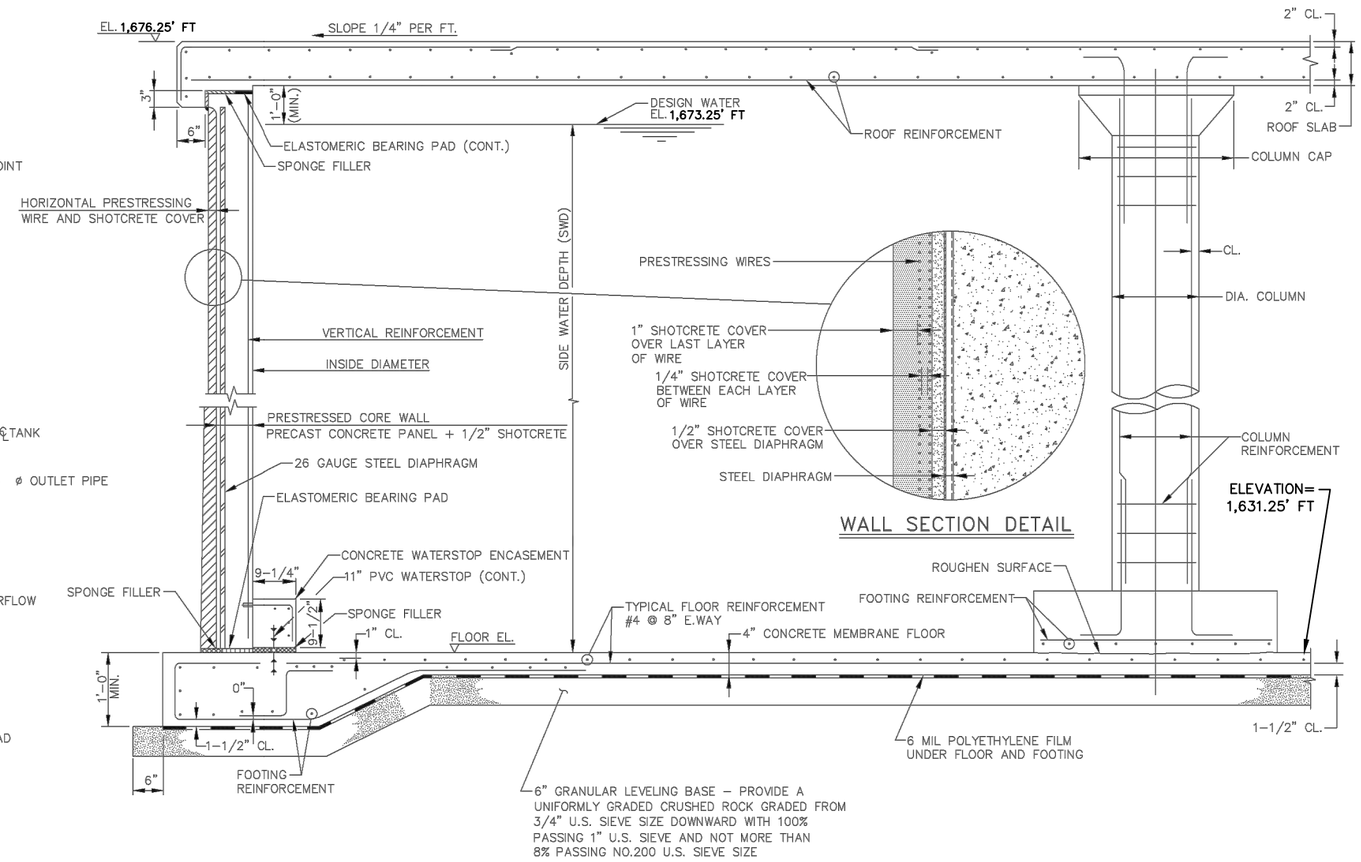
SITE PLAN

NORTHWEST AREA WATER SUPPLY

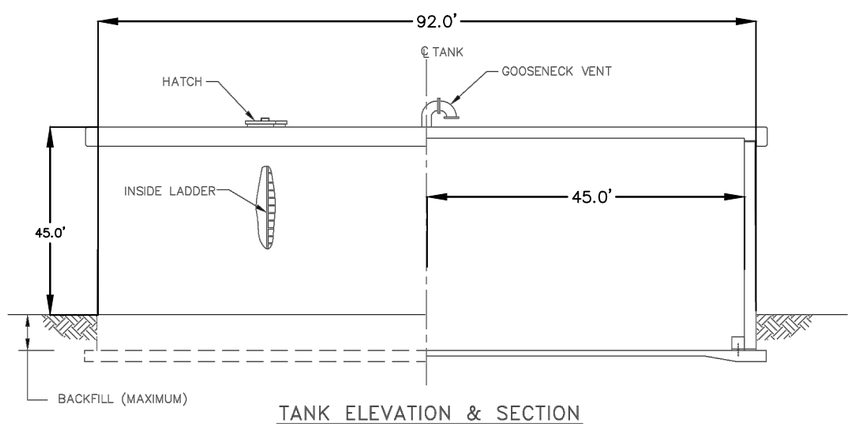
DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 19



TANK PLAN



TYPICAL TANK SECTION



TANK ELEVATION & SECTION

NOTES:

1. TANK DESIGN IN ACCORDANCE WITH ANSI/AWWA D110, TYPE III.
2. CONCRETE AND SHOTCRETE SHALL CONFORM TO ACI 301 AND 506 RESPECTIVELY.
   MINIMUM 28 – DAY STRENGTHS:
   SHOTCRETE ____ 4500 PSI
   FOOTING AND FLOOR CONCRETE ____ 3500 PSI
   WALL AND ROOF CONCRETE ____ 4000 PSI
3. ALLOWABLE SOIL BEARING PRESSURE = PSF
4. ROOF LIVE LOAD = PSF
5. REINFORCING STEEL SHALL CONFORM TO ASTM A615, GRADE 60.
6. DETAILS SHOWN ARE REPRESENTATIVE OF ANSI/AWWA STANDARD D110, TYPE III. SIMILAR DETAILS MEETING THIS STANDARD AND TYPE ARE ACCEPTABLE, SUBJECT TO APPROVAL BY THE ENGINEER.
7. **DETAILS PROVIDED BY PRELOAD INC.**

2 MG WATER TANK - TYPICAL DETAILS

NO.	REVISIONS	DATE

SEAL

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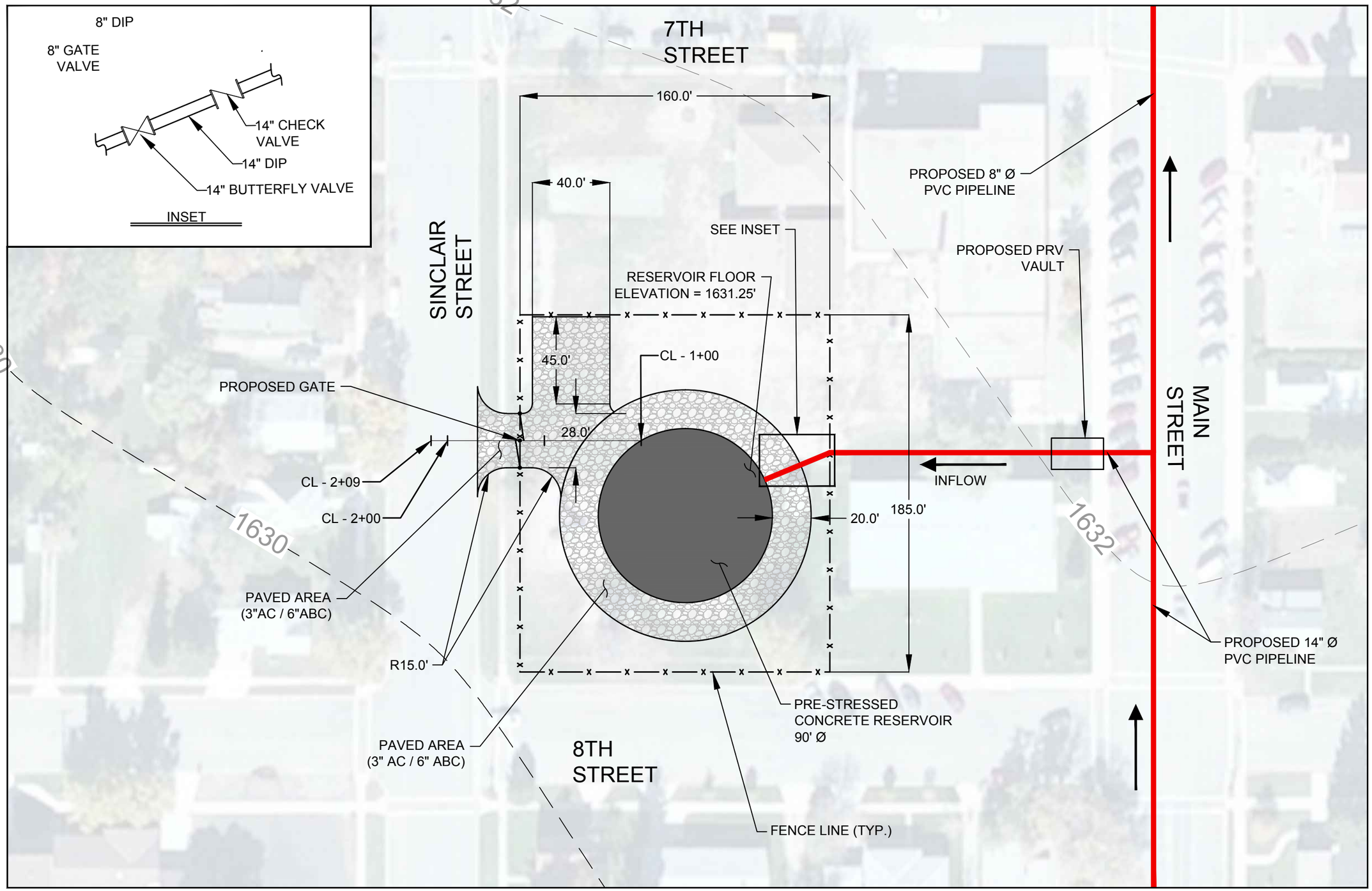
RECLAMATION Managing Water in the West

BOTTINEAU RESERVOIR

DETAIL SHEET

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO. ALD 20



0 50 100
HORIZONTAL SCALE: 1" = 100'
SCALE IN FEET

PROPOSED 2 MG WATER TANK - SITE PLAN

NO.	REVISIONS	DATE

SEAL
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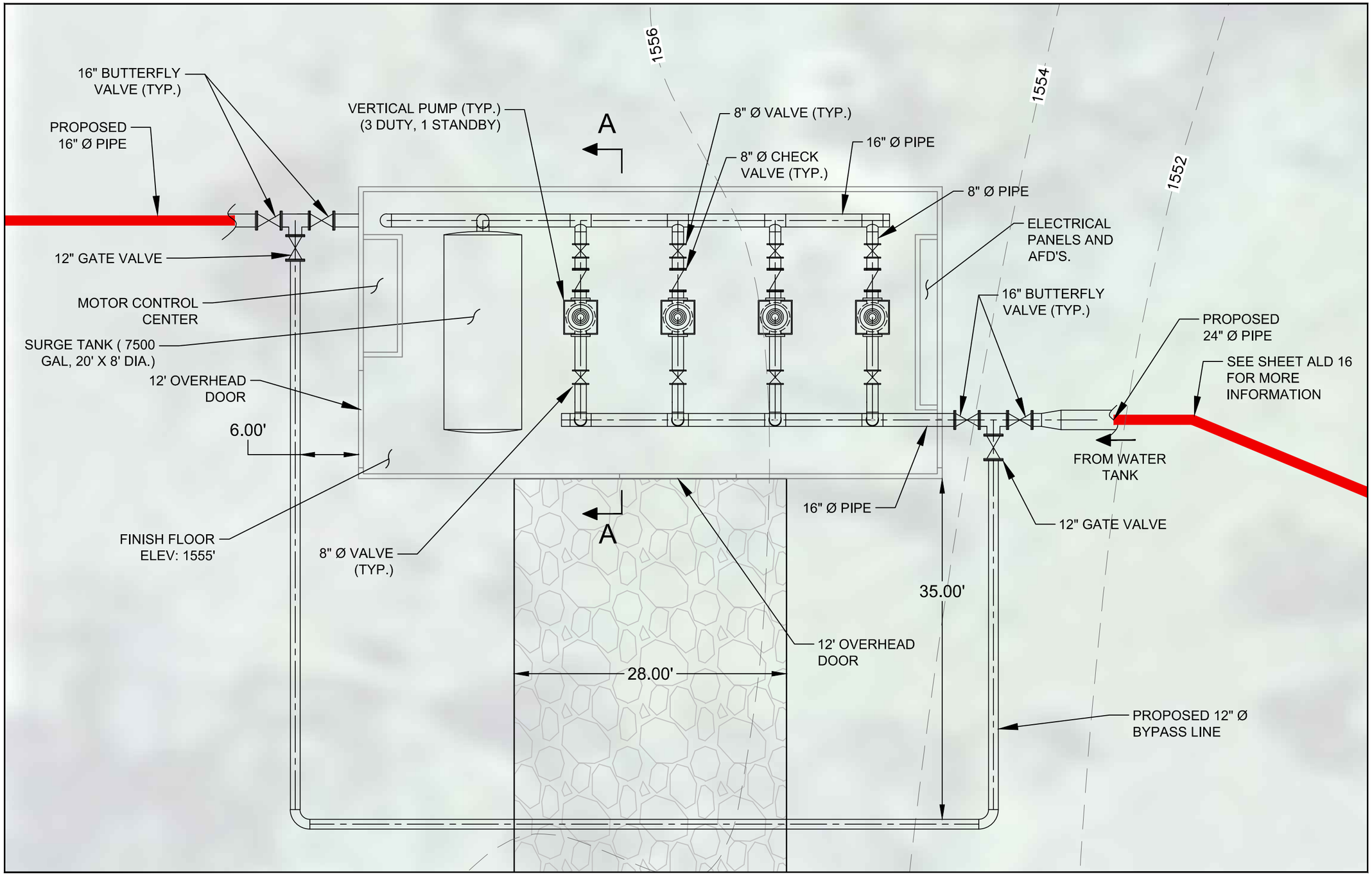
BOTTINEAU RESERVOIR
SITE PLAN
NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 21



0 10 20
HORIZONTAL SCALE: 1" = 10'
SCALE IN FEET

PROPOSED 30' X 60' PUMP STATION (4MGD)

NO.	REVISIONS	DATE

SEAL

PRELIMINARY NOT FOR CONSTRUCTION

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RECLAMATION
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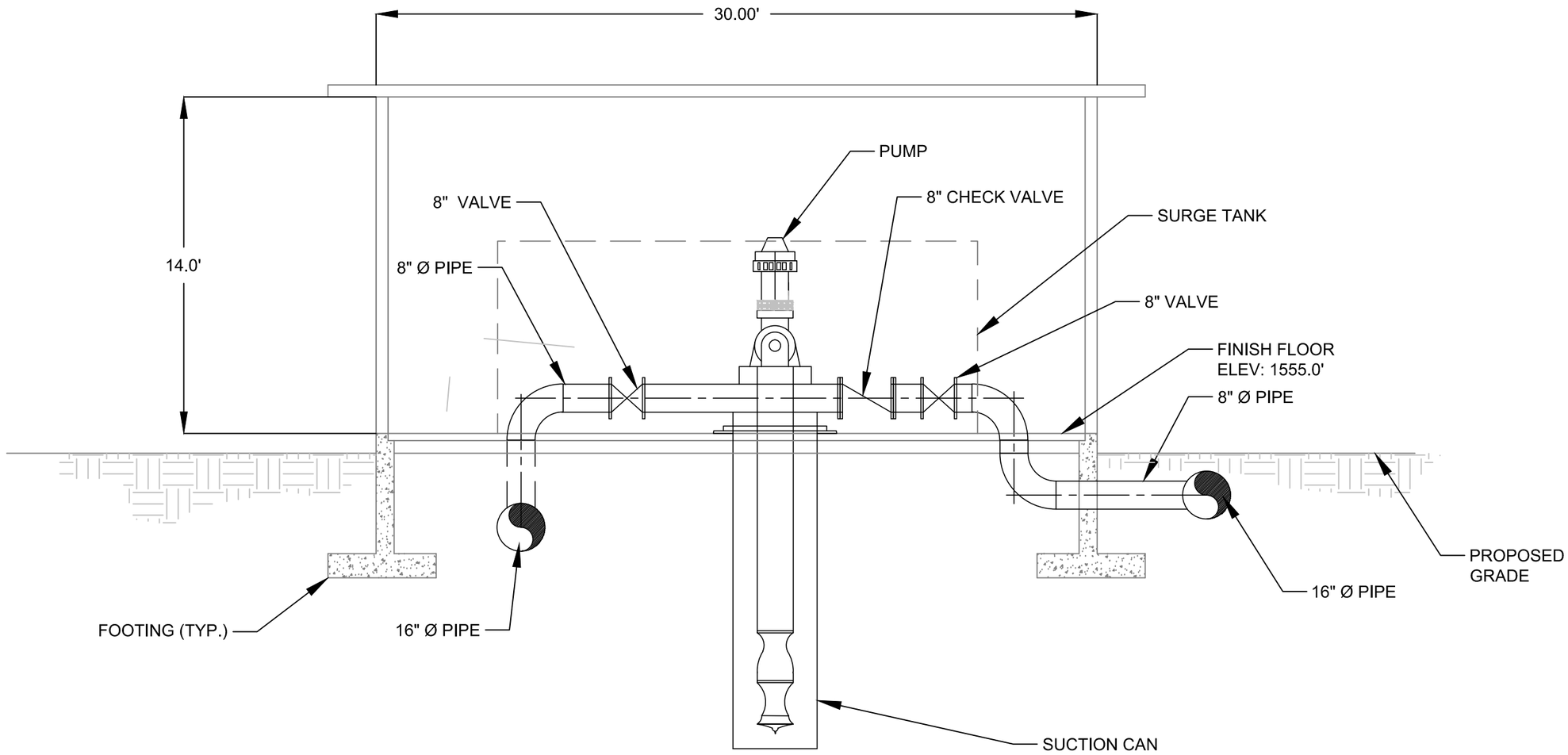
LANSFORD PUMP STATION

SITE PLAN

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 22



PROPOSED 30' X 60' PUMP STATION (4MGD) - SECTION A-A

0 10 20

HORIZONTAL SCALE: 1" = 10'
SCALE IN FEET

NO.	REVISIONS	DATE

SEAL

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CONSTRUCTION

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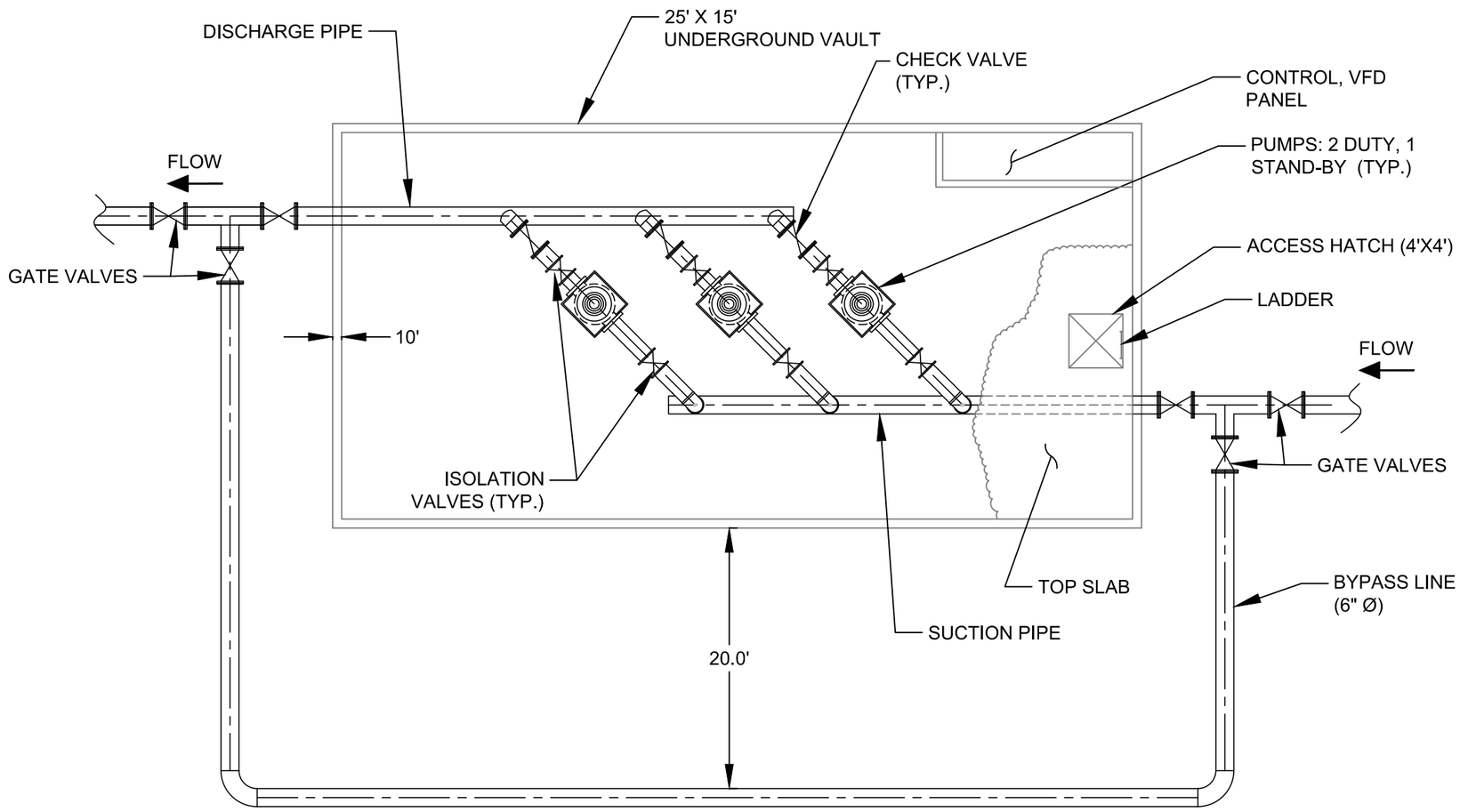
LANSFORD PUMP STATION

SECTION

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 23



PUMP STATION	SUCTION PIPE Ø (IN)	DISCHARGE PIPE Ø (IN)	PUMP SUCTION PIPE Ø (IN)	PUMP DISCHARGE PIPE Ø (IN)
BOTTINEAU WEST	14	14	8	8
MOHALL	12	12	4	4
TOLLEY	12	12	4	3
RENVILLE COUNTY CORNER	12	12	4	3

PROPOSED 2+1 UNITS PUMP STATION
N.T.S.

NO.	REVISIONS	DATE

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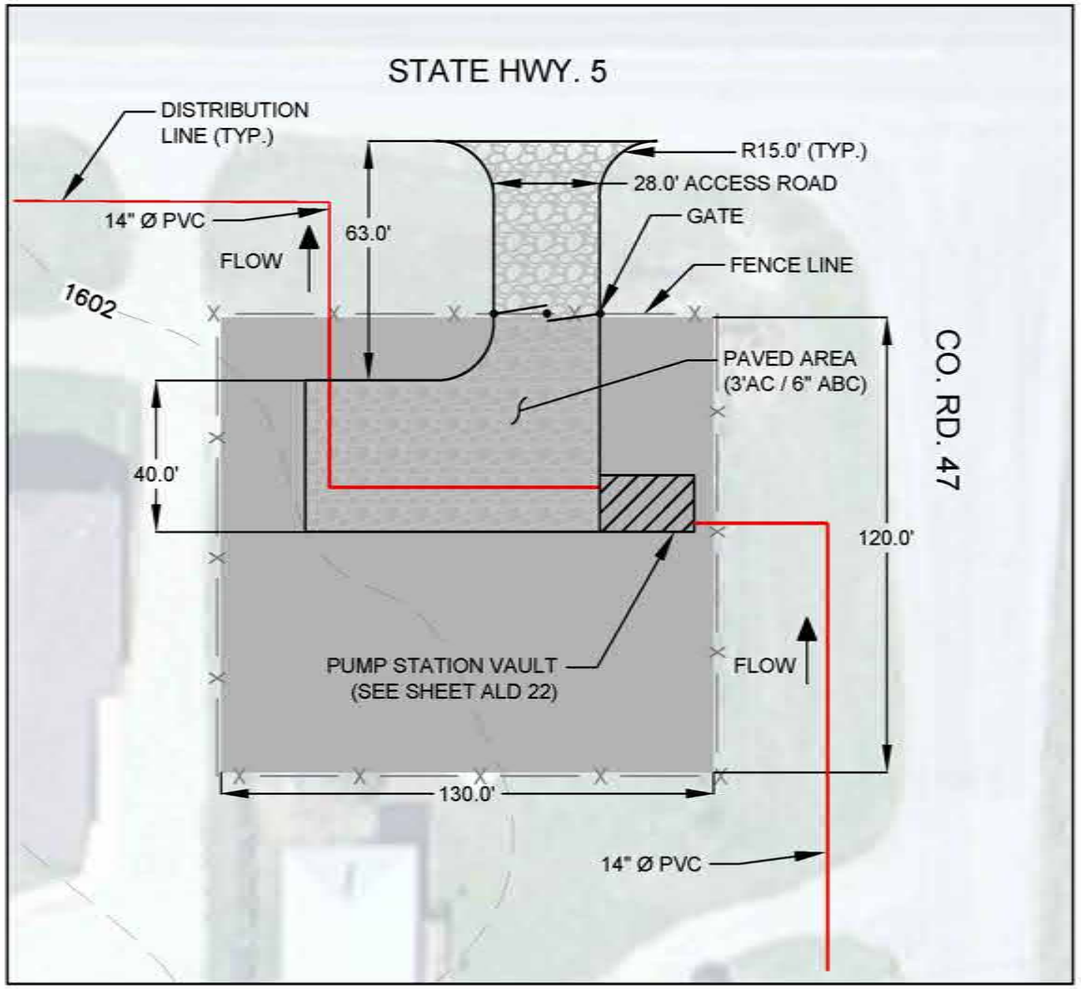
Managing Water in the West

2+1 UNITS PUMP STATION

TYPICAL LAYOUT

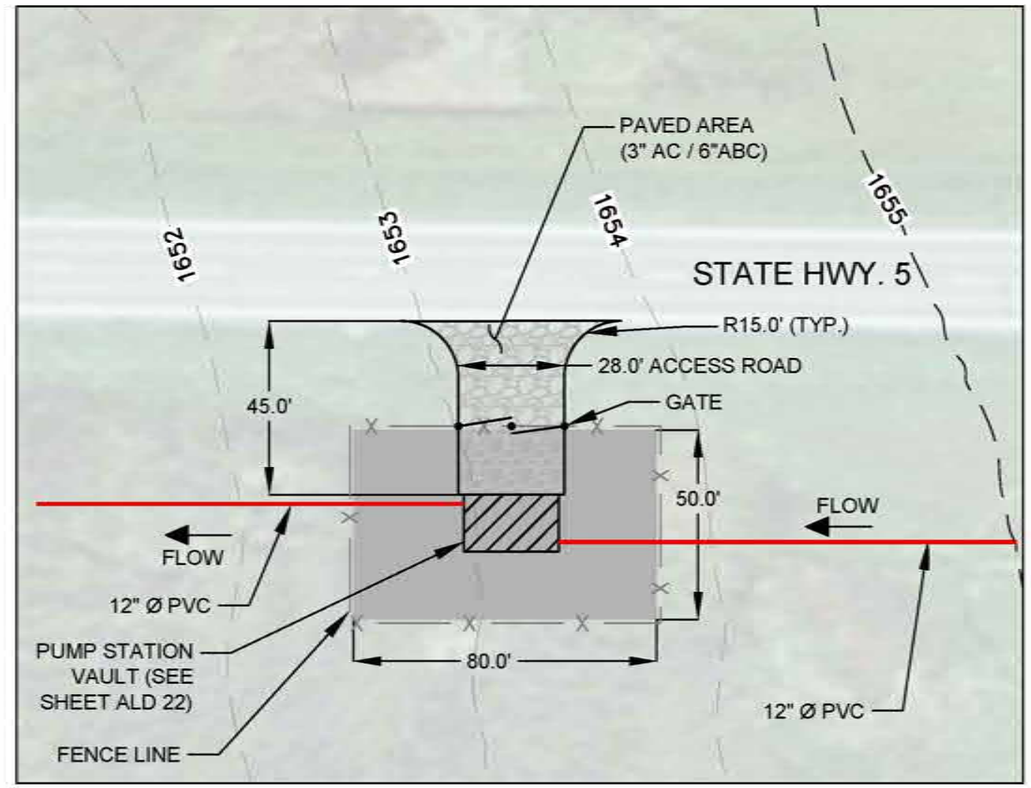
NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
DRAWN BY: CD
CHECKED BY: FB
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 24



PROPOSED BOTTINEAU PUMP STATION, WEST (1.51 MGD) - SITE PLAN

T162N R76W S35



PROPOSED MOHALL PUMP STATION (1.41 MGD) - SITE PLAN

T161N R84W S16

0 20 40

HORIZONTAL SCALE: 1" = 20'

SCALE IN FEET

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PUMP STATIONS

BOTTINEAU W. AND MOHALL SITE PLANS

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12

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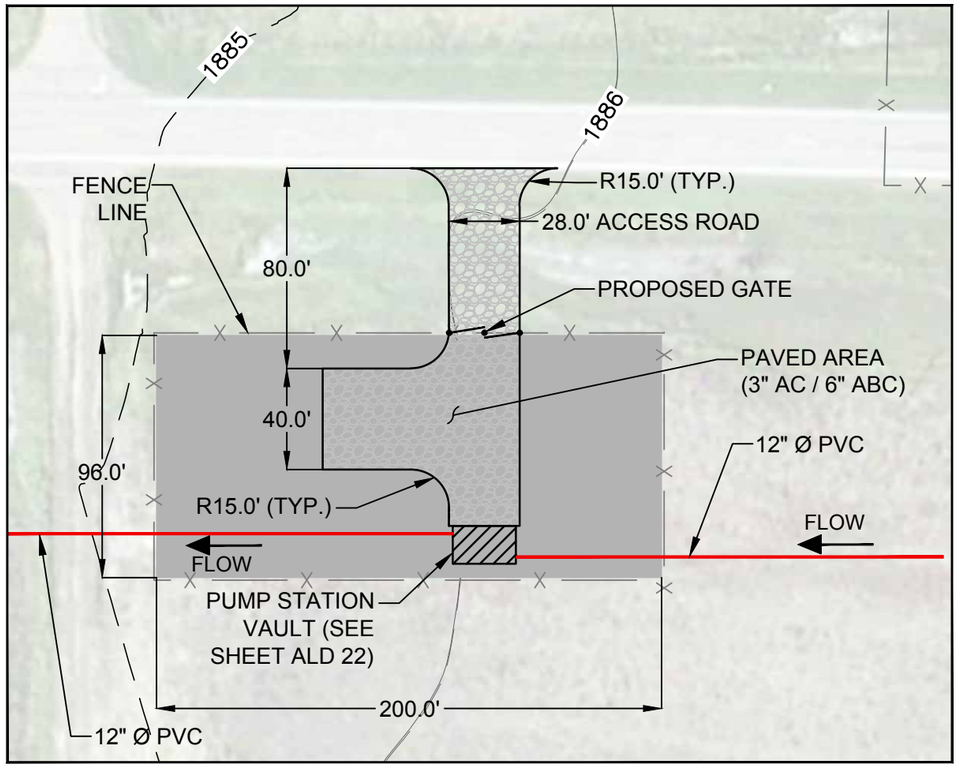
CHECKED BY: FB

SCALE: NOT TO SCALE

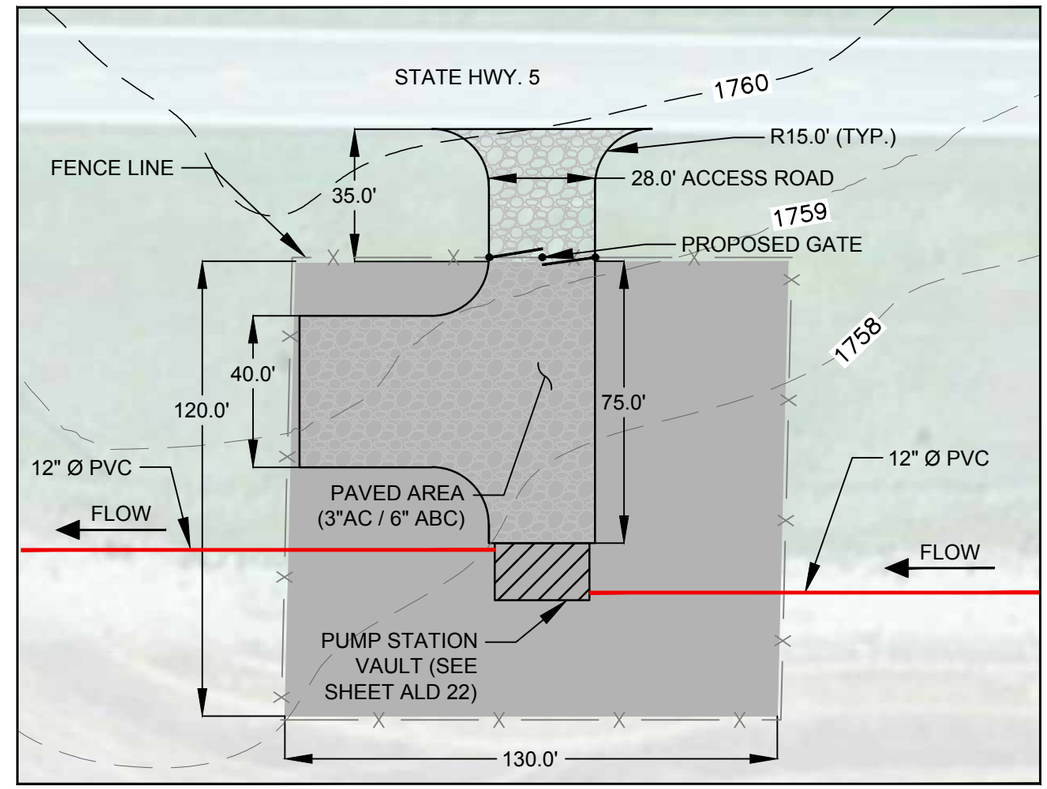
ENTRIX JOB NO. 30442091

FIGURE NO. ALD 25



PROPOSED RENVILLE COUNTY CORNER PUMP STATION (1.34 MGD) - SITE PLAN

T159N R82W S5



PROPOSED TOLLEY PUMP STATION (1.34 MGD) - SITE PLAN

T161N R85W S21

0 60 120

HORIZONTAL SCALE: 1" = 80'
SCALE IN FEET

0 40 80

HORIZONTAL SCALE: 1" = 40'
SCALE IN FEET

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PUMP STATIONS

LANSFORD AND TOLLEY SITE PLANS

NORTHWEST AREA WATER SUPPLY

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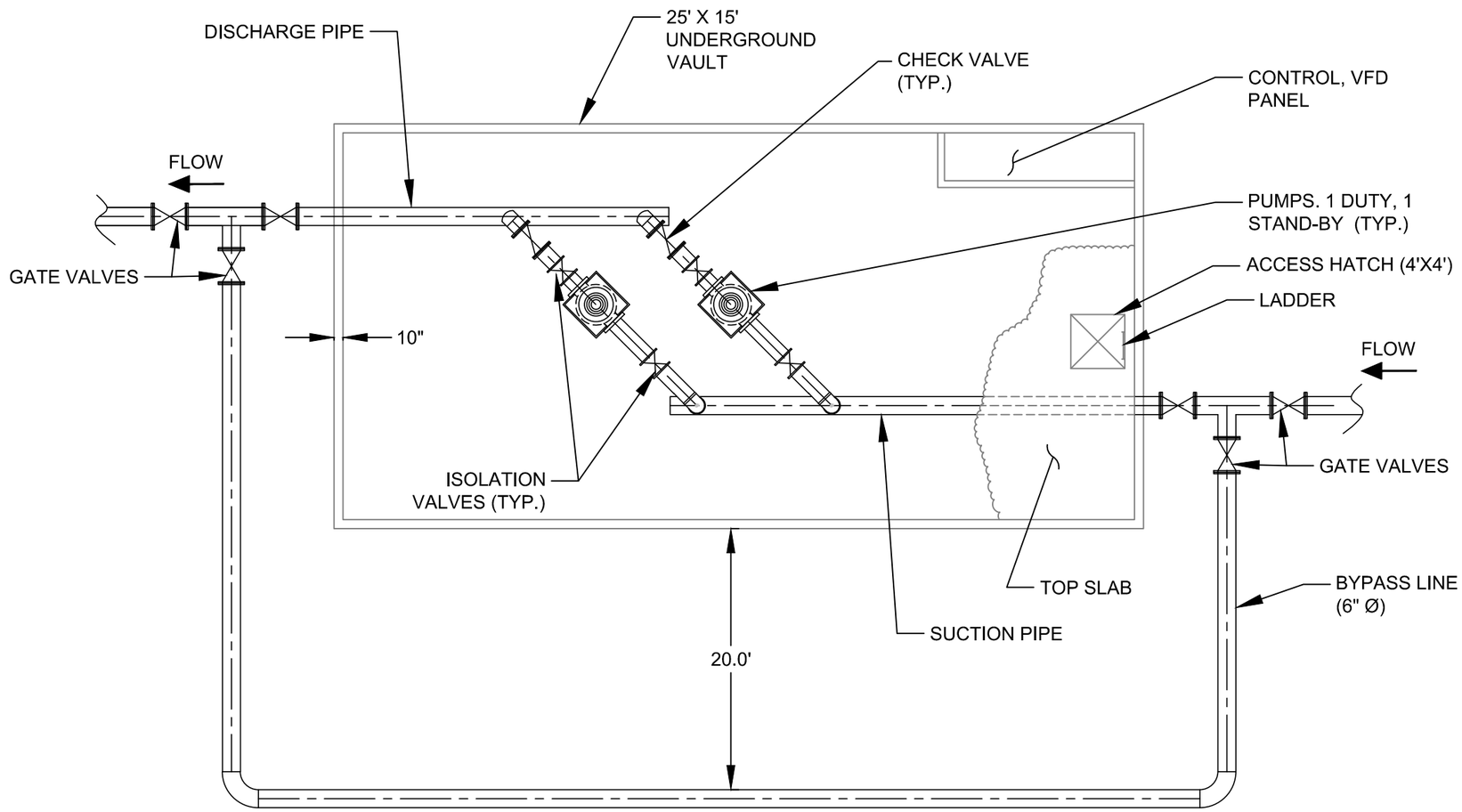
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 26



PUMP STATION	SUCTION PIPE Ø (IN)	DISCHARGE PIPE Ø (IN)	PUMP SUCTION PIPE Ø (IN)	PUMP DISCHARGE PIPE Ø (IN)
BOTTINEAU NORTH	8	8	5	6
BOWBELLS	10	10	4	3

PROPOSED 1+1 UNITS PUMP STATION
N.T.S.

NO.	REVISIONS	DATE

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1+1 UNITS PUMP STATION

TYPICAL LAYOUT

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12
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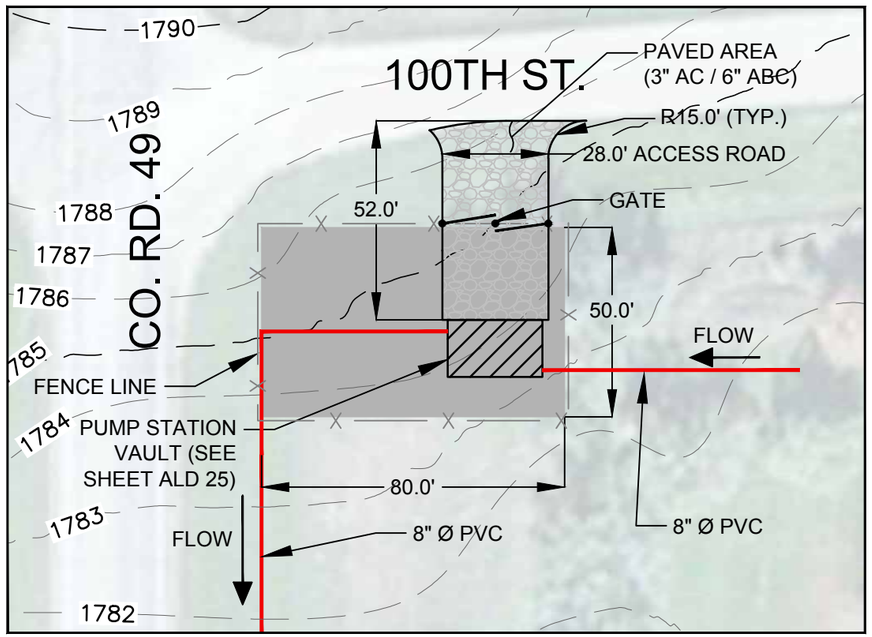
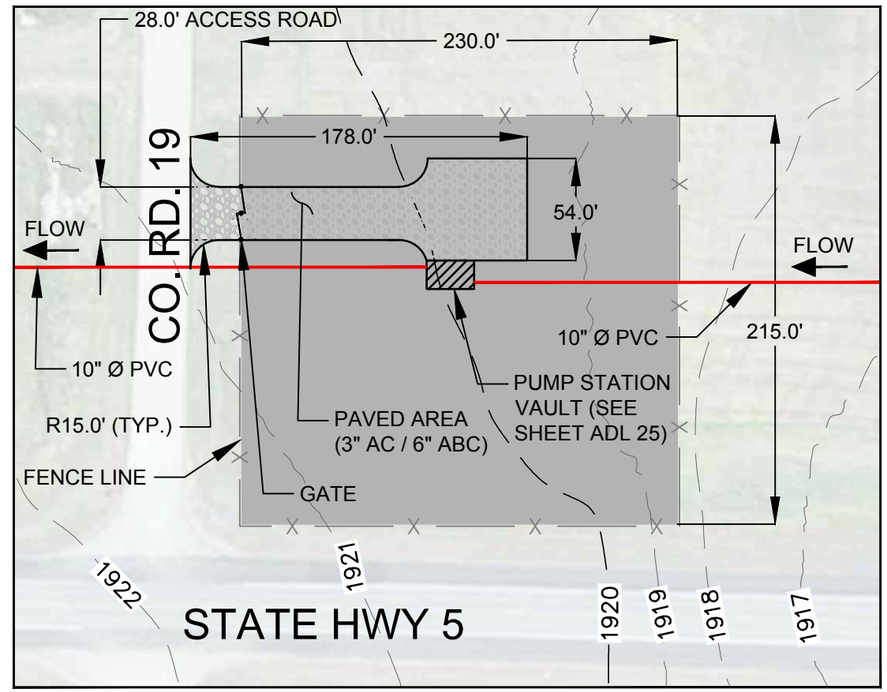
SCALE: NOT TO SCALE
ENTRIX JOB NO. 30442091
FIGURE NO.
ALD 27



PROPOSED BOTTINEAU PUMP STATION, NORTH (0.54 MGD) - SITE PLAN

T162N R75W S18



PROPOSED BOWBELLS PUMP STATION (0.49 MGD) - SITE PLAN

T162N R88W S31

0 40 80

HORIZONTAL SCALE: 1" = 40'

SCALE IN FEET

0 80 160

HORIZONTAL SCALE: 1" = 80'

SCALE IN FEET

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PUMP STATIONS

BOTTINEAU N. / BOWBELLS - SITE PLANS

NORTHWEST AREA WATER SUPPLY

DATE: 9/19/12

DRAWN BY: CD

CHECKED BY: FB

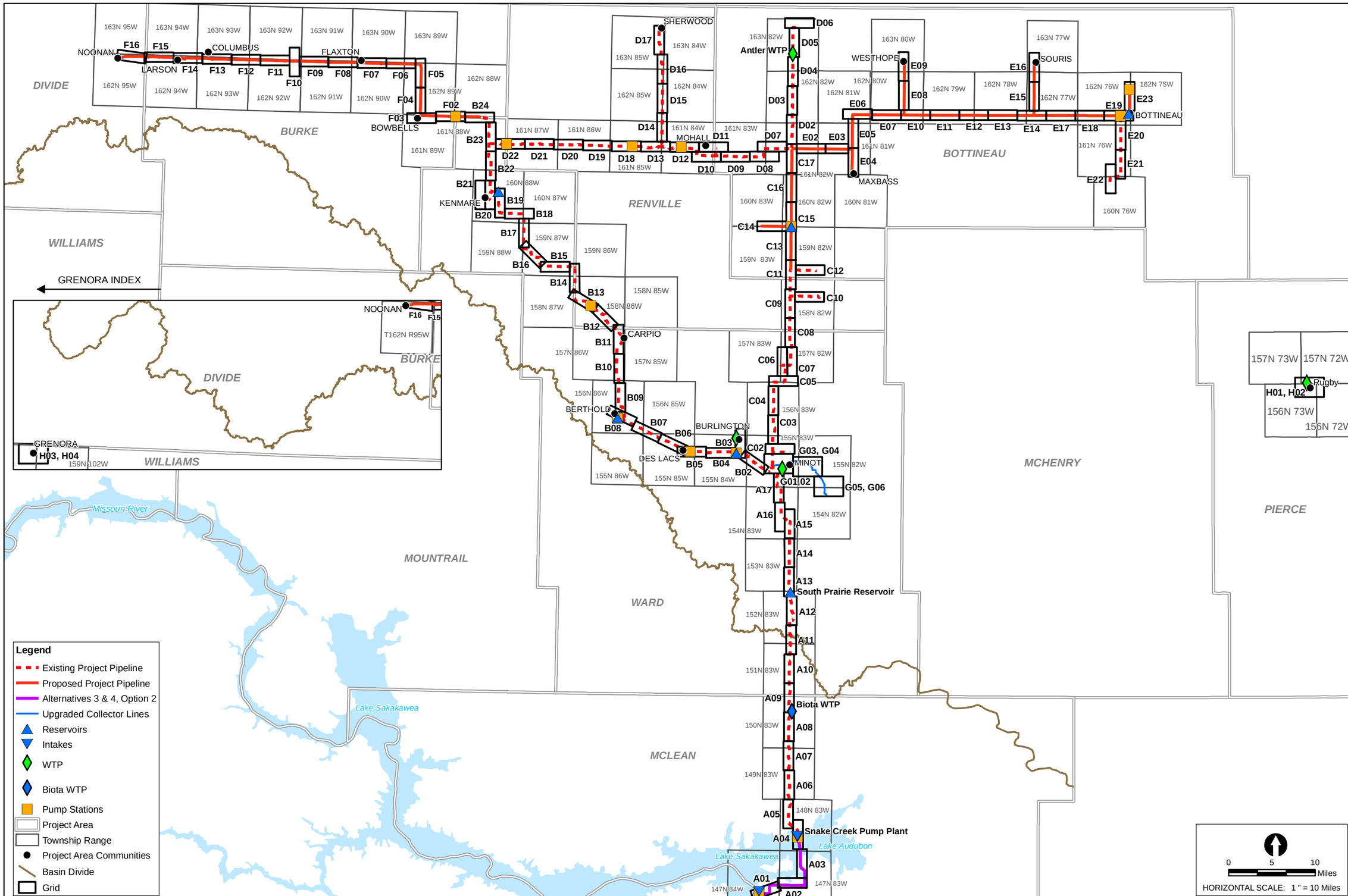
SCALE: NOT TO SCALE

ENTRIX JOB NO. 30442091

FIGURE NO.
ALD 28

APPENDIX D

Pipeline Alignment Drawings



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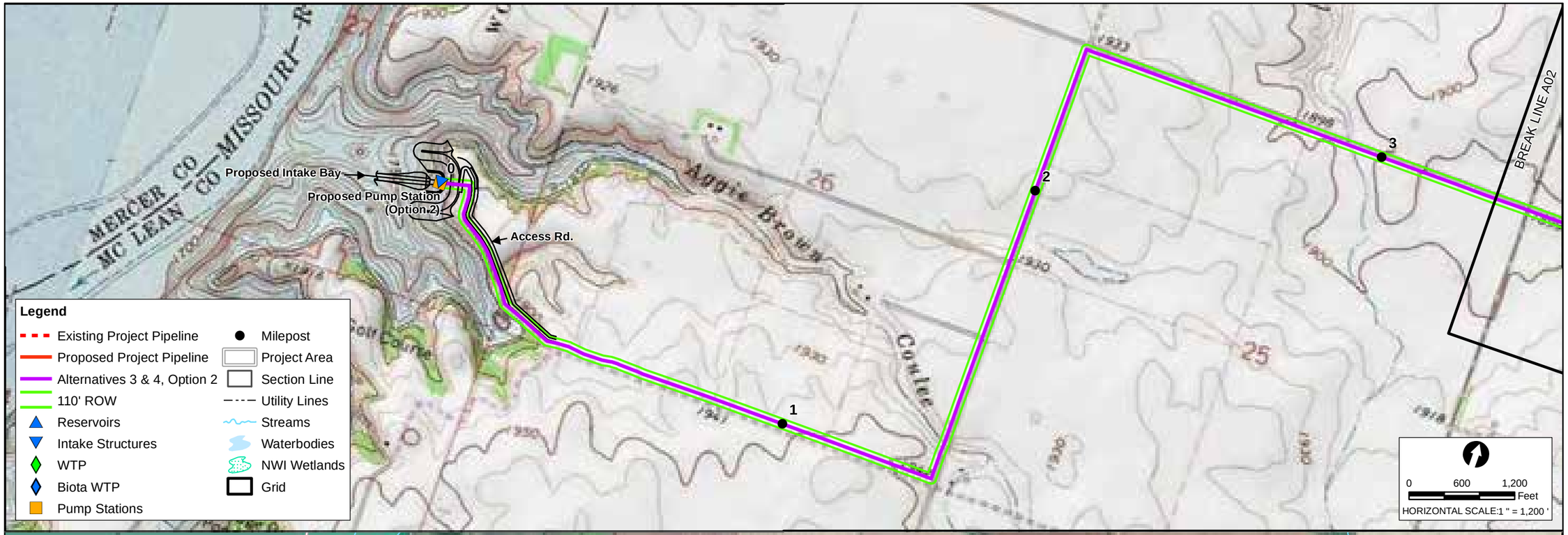
PROJECT PIPELINES

INDEX SHEET

Northwest Area Water Supply

DATE: 12/18/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. 01

Segment	Grid	County	Mileposts		Alternatives
			Begin	End	
A	A01-A04	McLean	0	12.7	Alts 3&4, Opt 2
A	A04-A17, G01	McLean, Ward	100	145.3	Alts 3&4, Opts 1-3
B	B02-B24, G01	Ward, Renville, Burke	200	272.2	Alts 1-4
B	G01, C02	Ward	280	281.7	Alts 1-4
B	B02	Ward	285	285.2	Alts 1-4
B	B08	Ward	290	290.6	Alts 1-4
B	B20	Ward	295	296.3	Alts 1-4
C	C02-C17	Ward, Renville, Bottineau	300	337.4	Alts 1-4
C	C02	Ward	340	342.1	Alts 1-4
C	C06	Ward	350	350.5	Alts 1-4
C	C09, C10	Renville	360	363.7	Alts 1-4
C	C11, C12	Bottineau	370	373.1	Alts 1-4
C	C14, C15	Bottineau	380	383.5	Alts 1-4
D	D07-D22, C17, B23	Bottineau, Renville, Ward	400	437.5	Alts 1-4
D	D02-D06, C17	Bottineau	440	451.1	Alts 1-4
D	D10, D11	Bottineau	460	461	Alts 1-4
D	D13-D17	Renville	470	484.1	Alts 1-4
E	E02-E19, C17	Bottineau	500	543	Alts 1-4
E	E04	Bottineau	550	553	Alts 1-4
E	E08-E10	Bottineau	560	566.1	Alts 1-4
E	E14-E16	Bottineau	570	576.4	Alts 1-4
E	E19-E22	Bottineau	580	589.4	Alts 1-4
E	E19, E23	Bottineau	590	593.1	Alts 1-4
F	F02-F16, B24	Burke, Divide	600	647.7	Alts 1-4
G	G01-G06	Ward	-	-	Alts 1-4
H	H01-H04	Pierce, Williams	-	-	Alts 1-4



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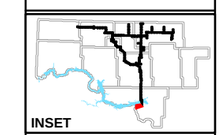

WATER TRANSMISSION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 10/8/2012
DRAWN BY: NJH
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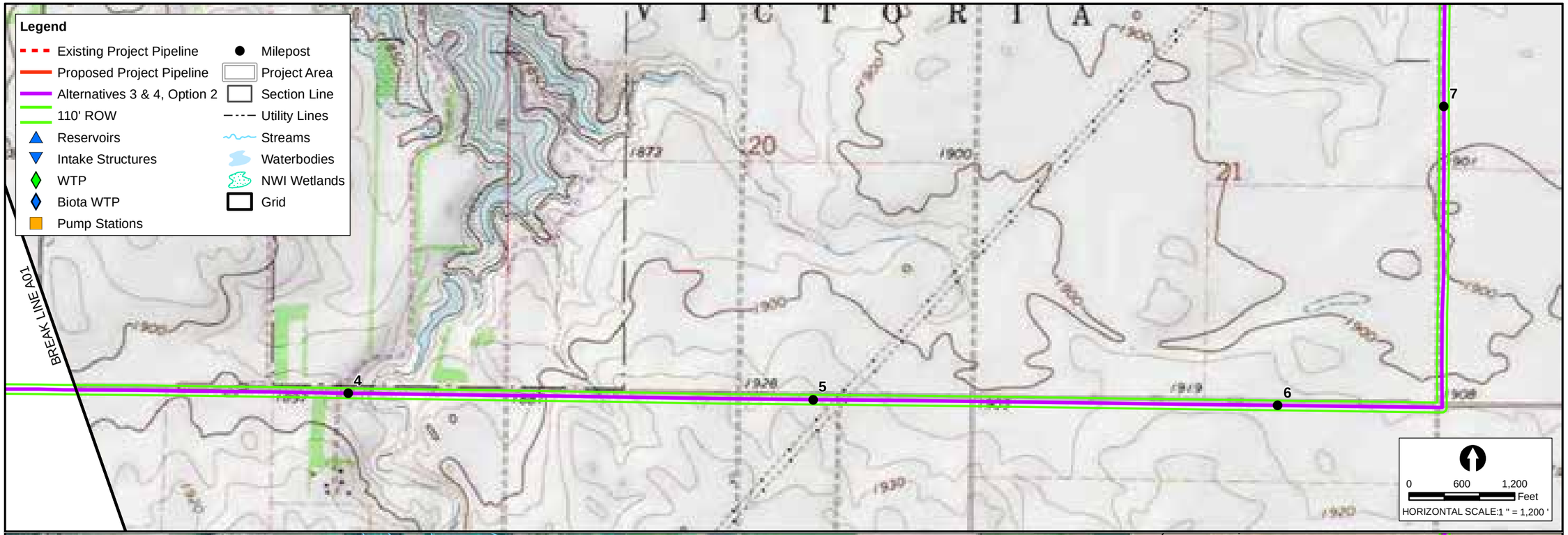
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A01



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INSET

WATER TRANSMISSION PIPELINE

PLAN SHEET

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ENTRIX JOB NO. 30442091
FIGURE NO. A02

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WATER TRANSMISSION PIPELINE

PLAN SHEET

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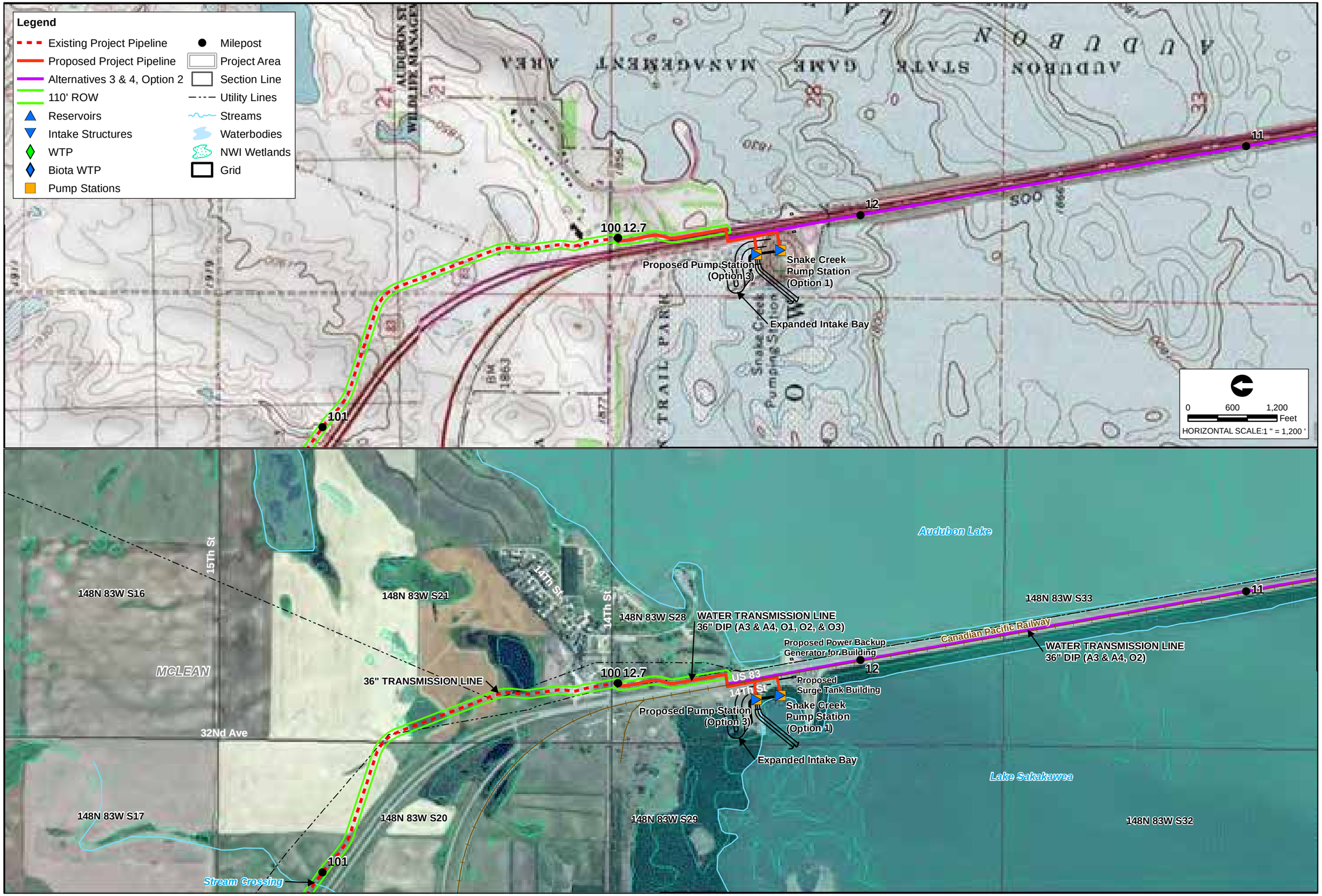
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A03



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WATER TRANSMISSION PIPELINE

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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A04

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WATER TRANSMISSION PIPELINE

PLAN SHEET

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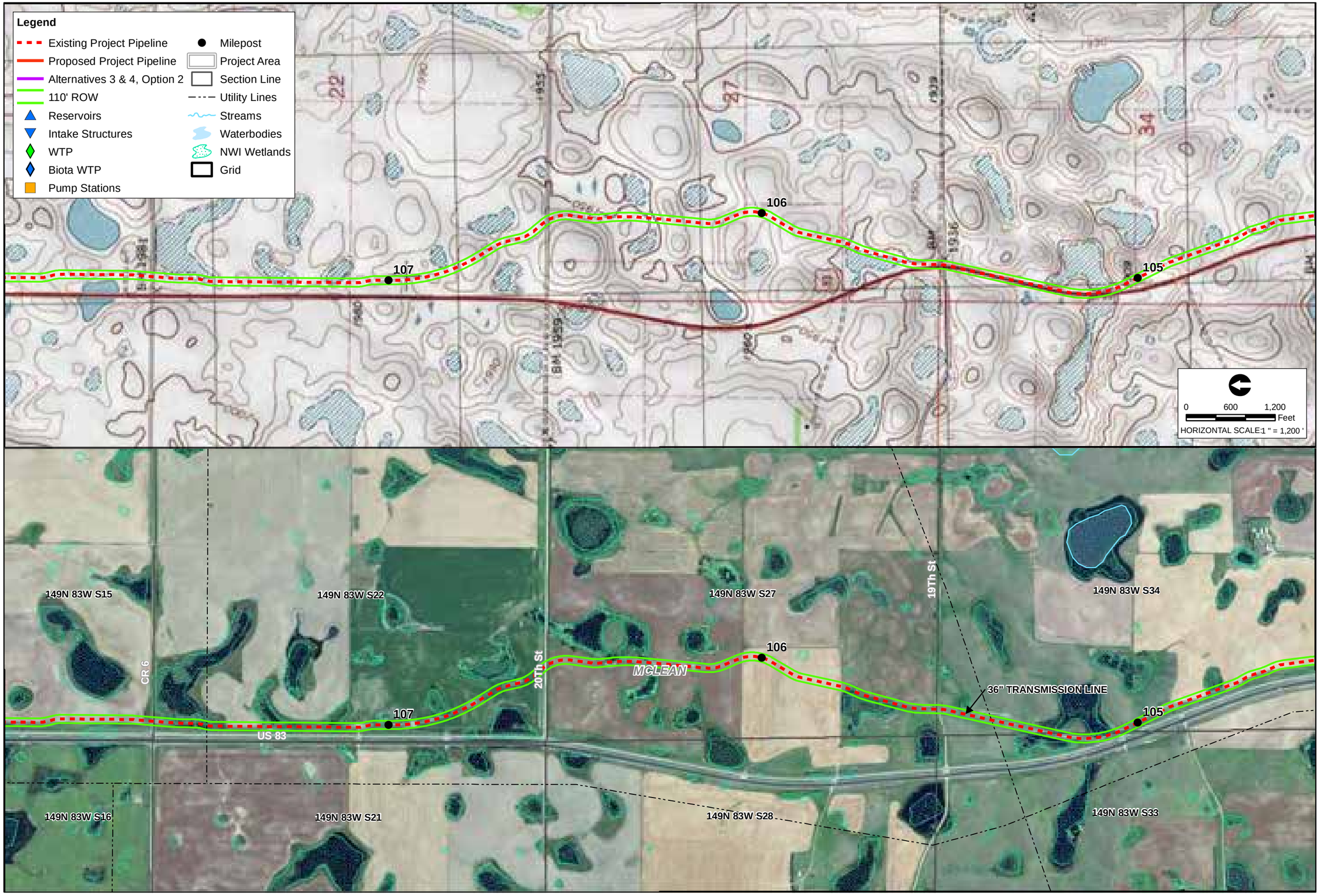
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A05



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WATER TRANSMISSION PIPELINE

PLAN SHEET

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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A06

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WATER TRANSMISSION PIPELINE

PLAN SHEET

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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A07

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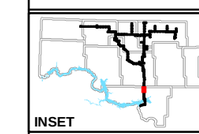
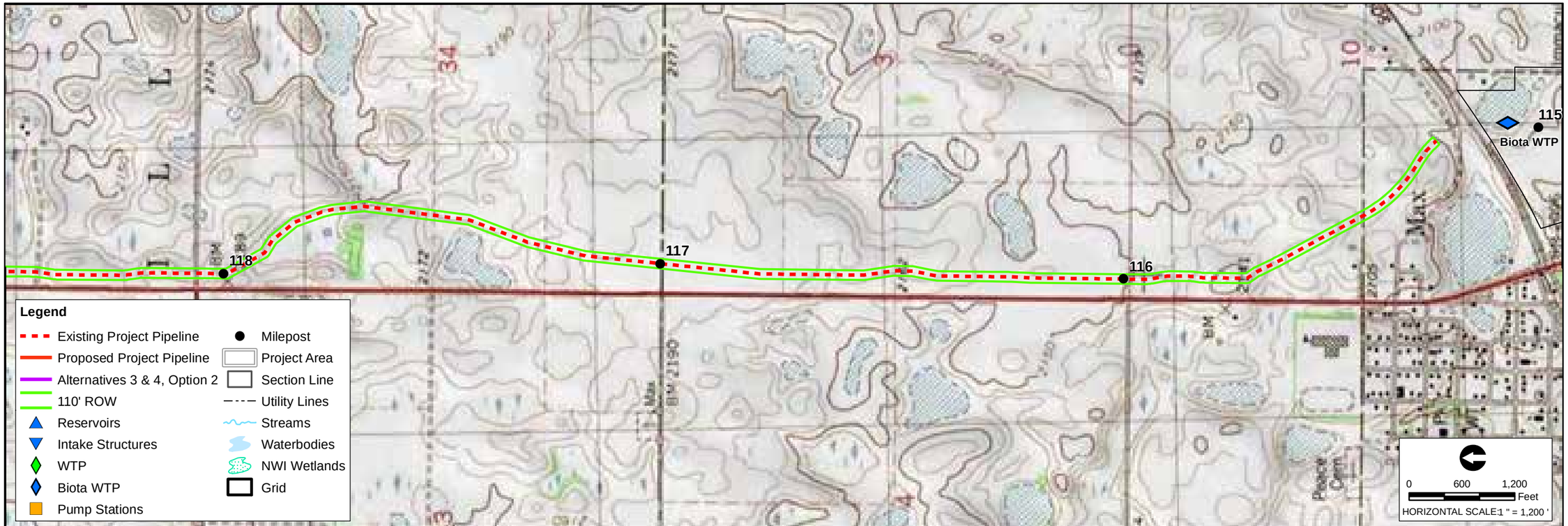


WATER TRANSMISSION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A08



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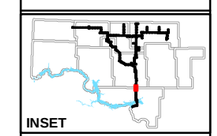

WATER TRANSMISSION PIPELINE

PLAN SHEET

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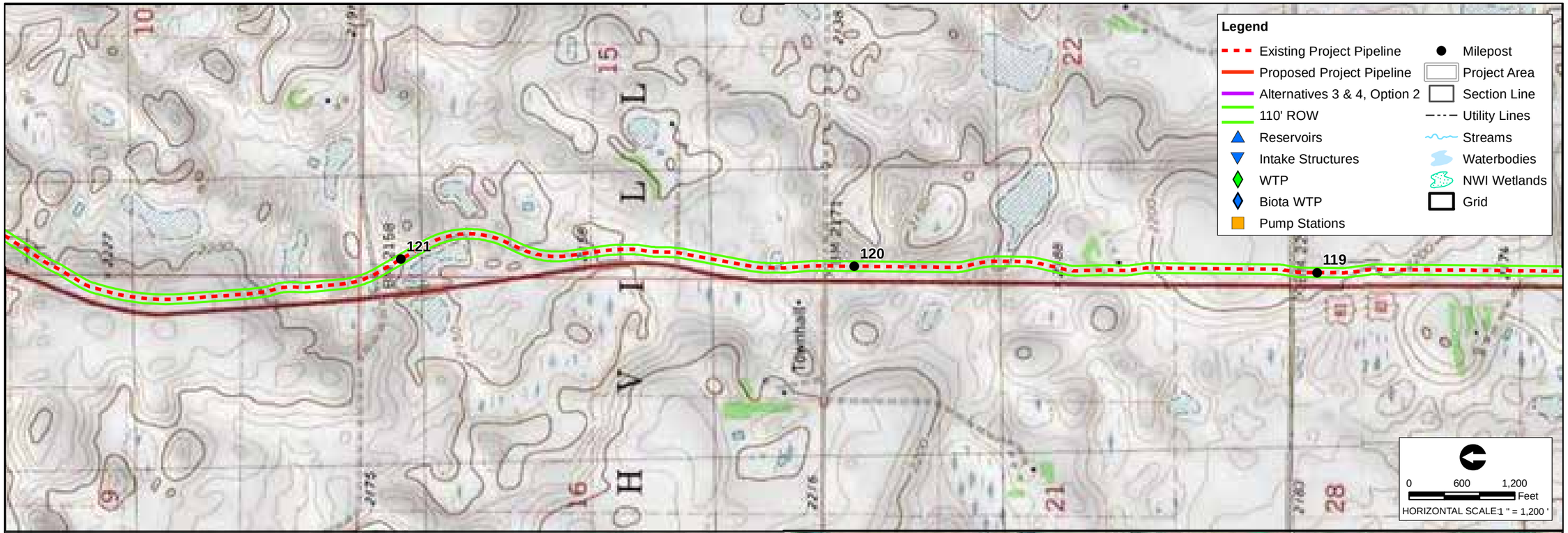
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A09



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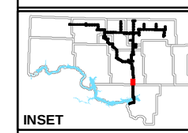

WATER TRANSMISSION PIPELINE

PLAN SHEET

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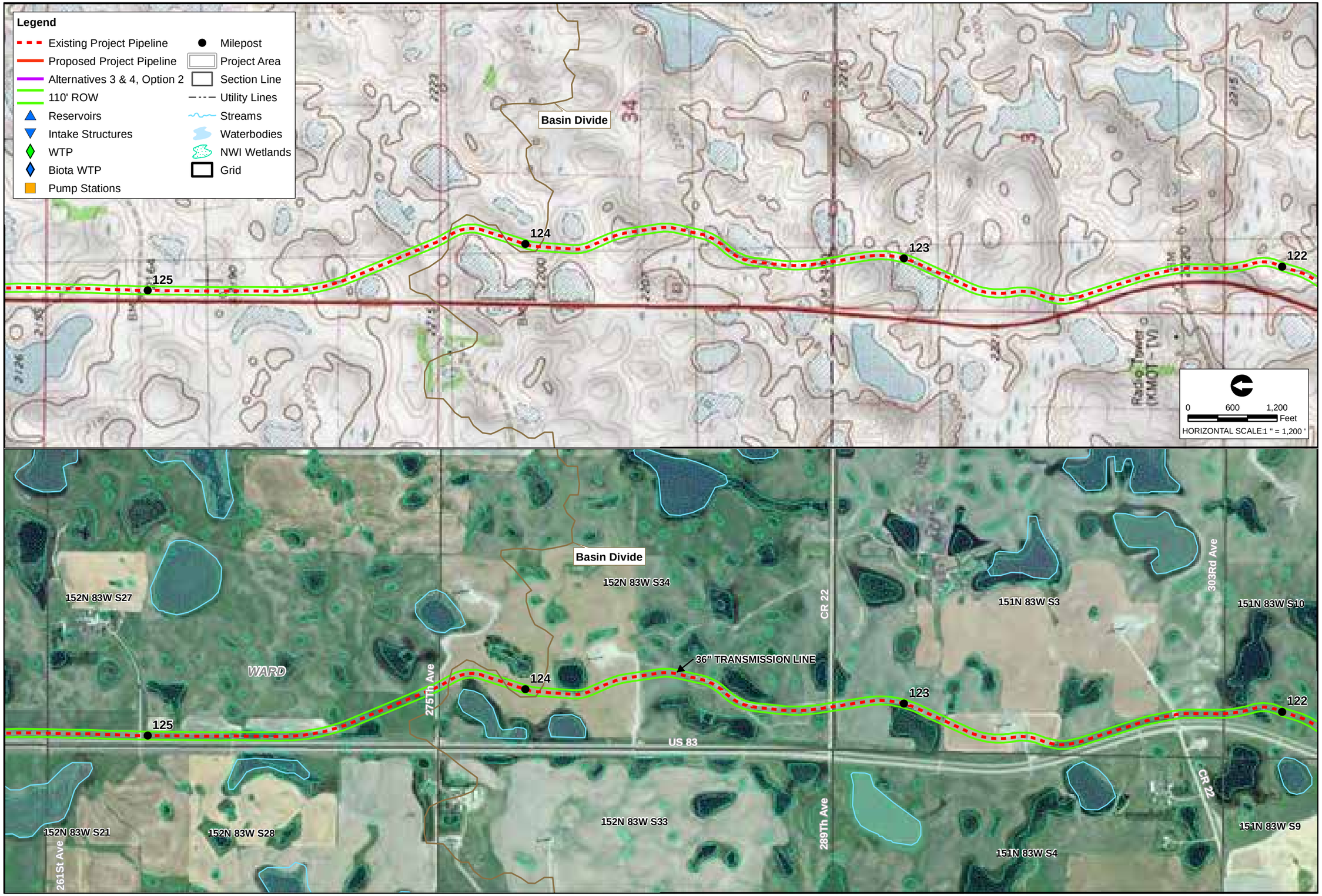
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A10



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WATER TRANSMISSION PIPELINE

PLAN SHEET

Northwest Area Water Supply

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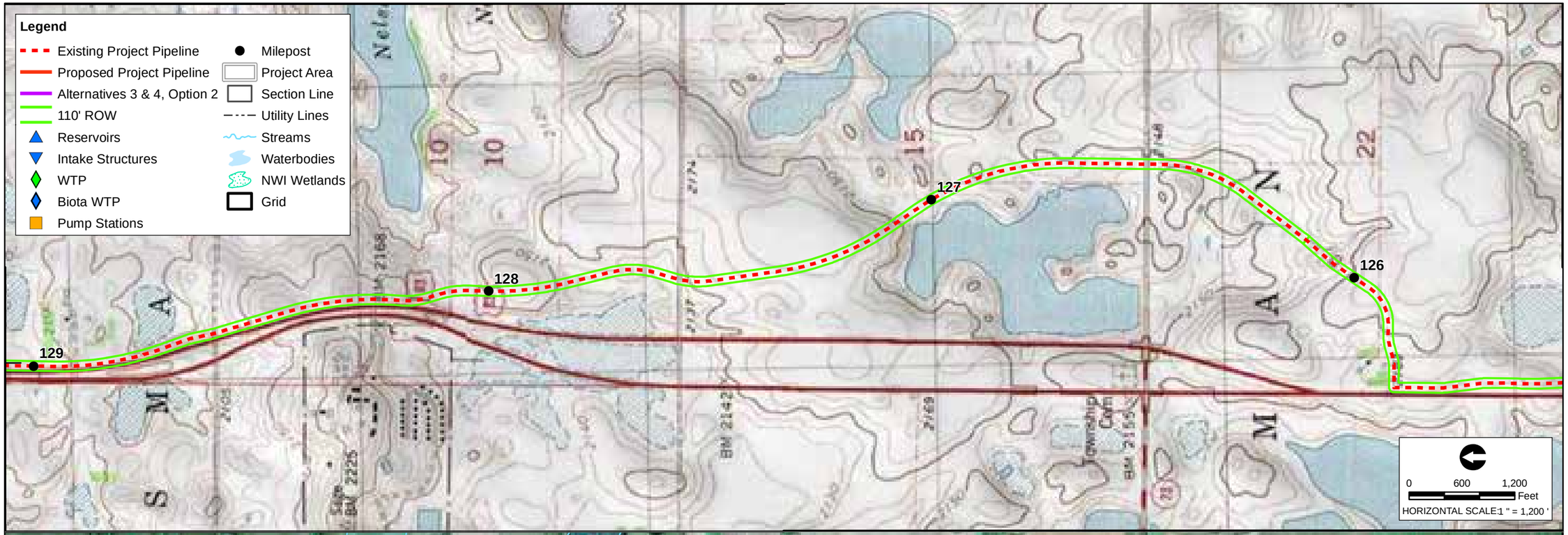
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A11



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WATER TRANSMISSION PIPELINE

PLAN SHEET

Northwest Area Water Supply

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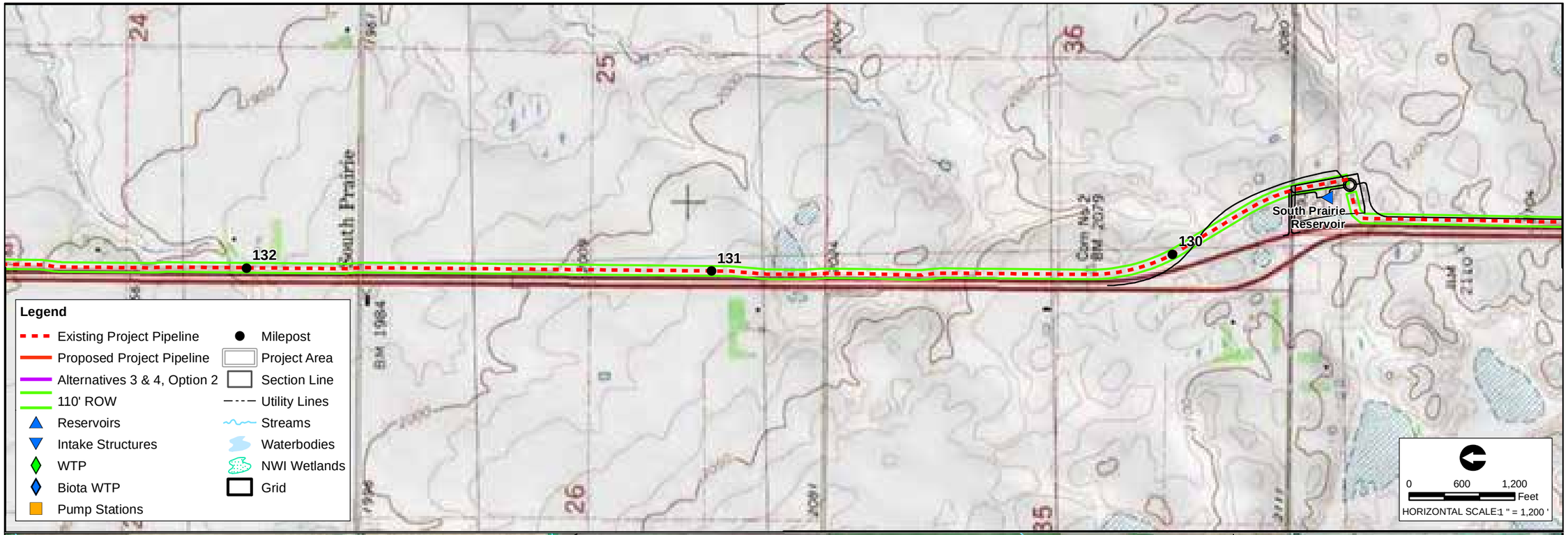
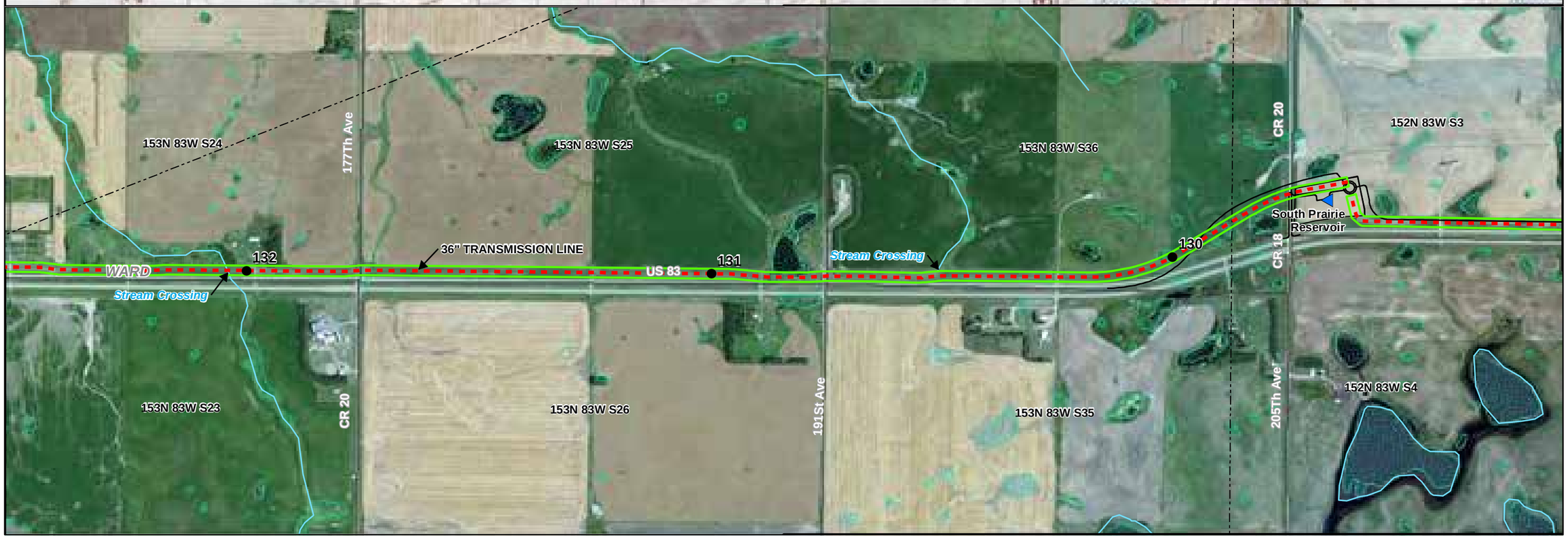
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A12





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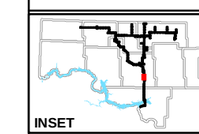

WATER TRANSMISSION PIPELINE

PLAN SHEET

Northwest Area Water Supply

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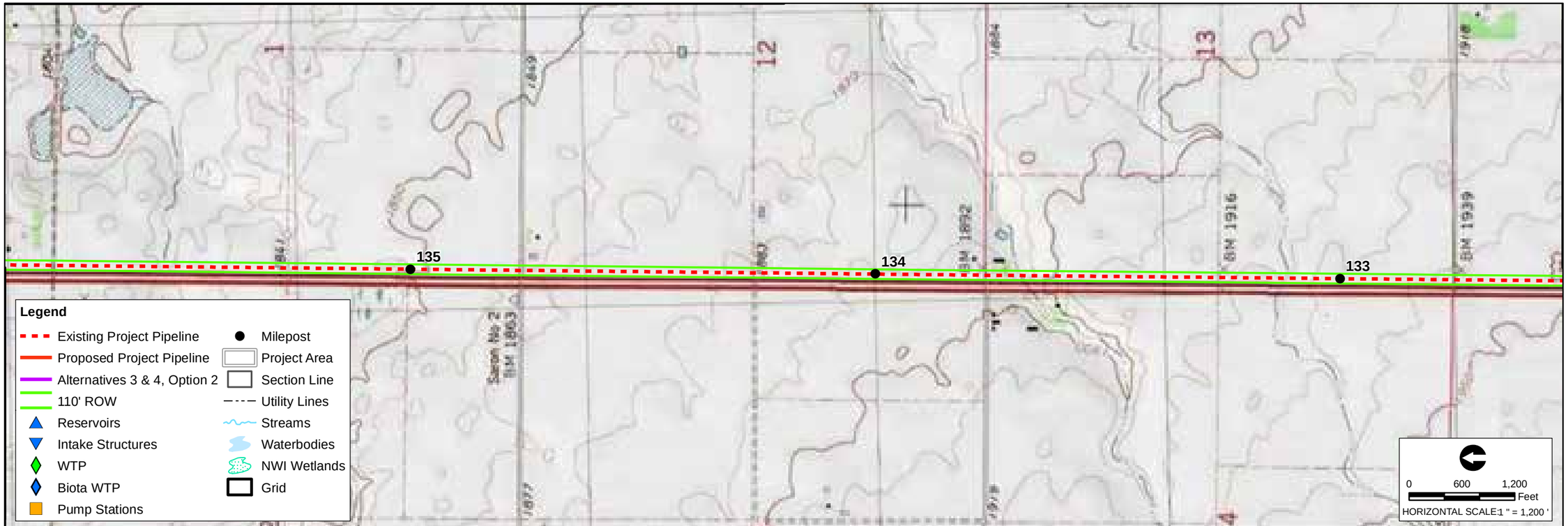
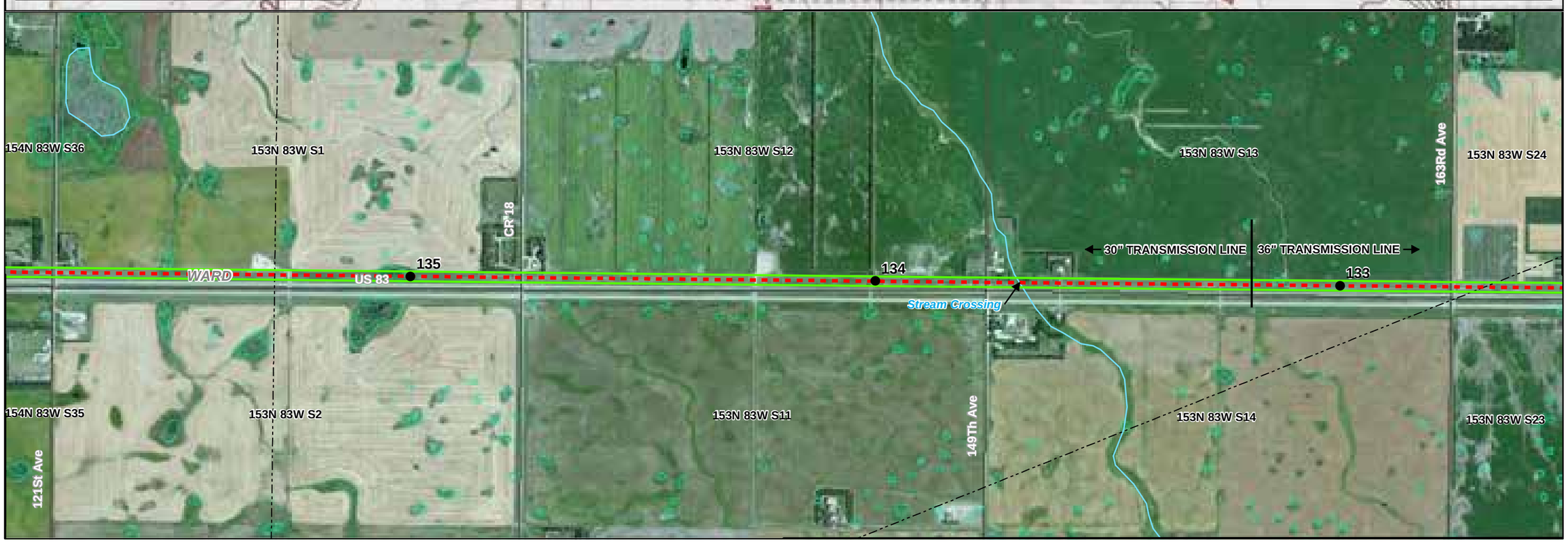
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A13





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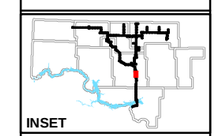

WATER TRANSMISSION PIPELINE

PLAN SHEET

Northwest Area Water Supply

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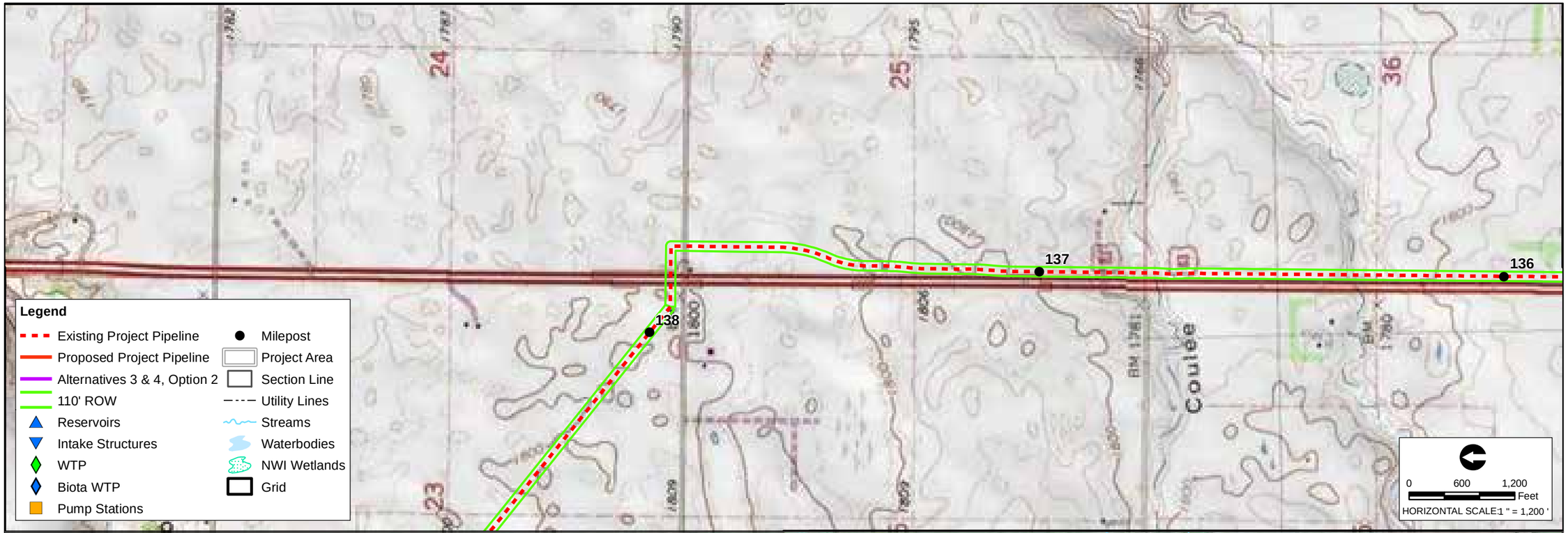
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A14



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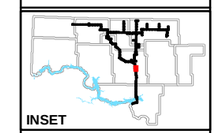


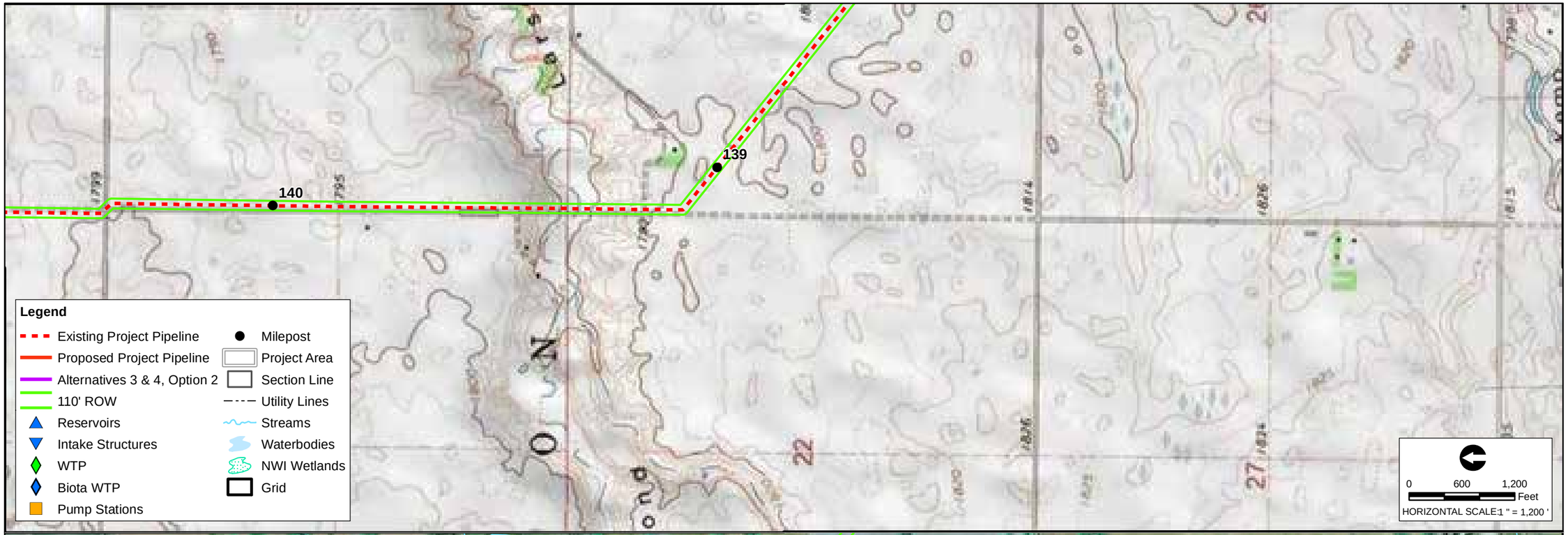
INSET

WATER TRANSMISSION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A15



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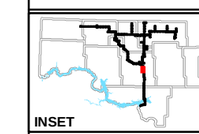
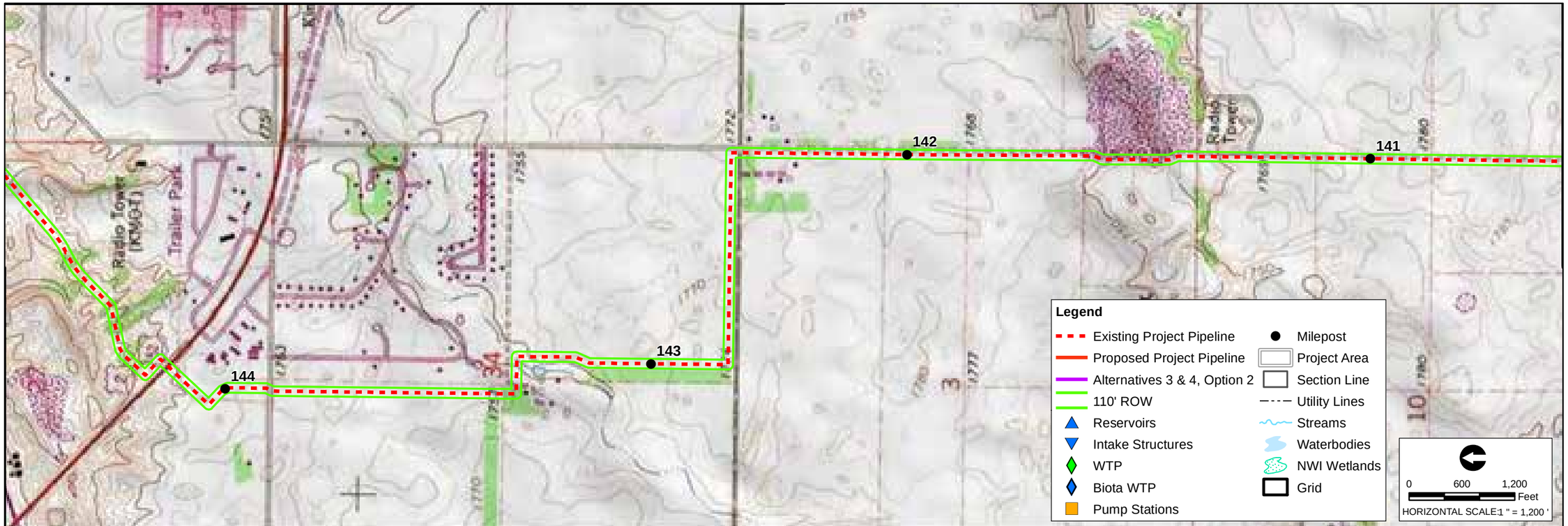


WATER TRANSMISSION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A16



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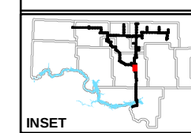
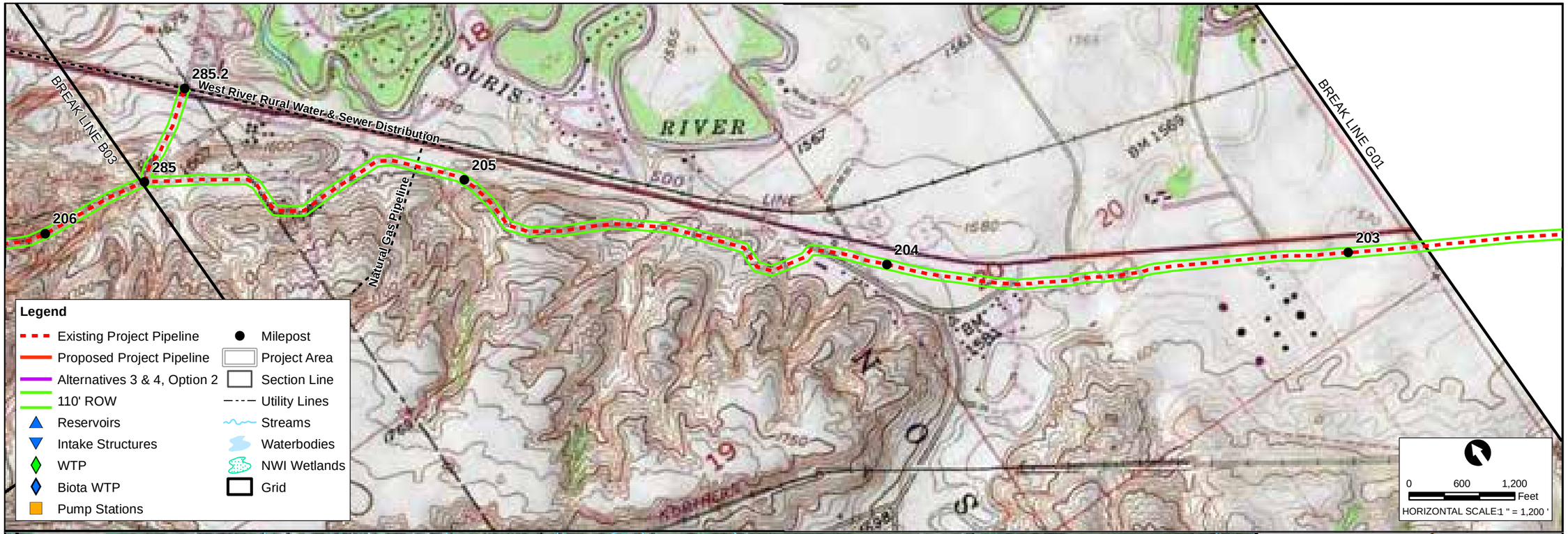


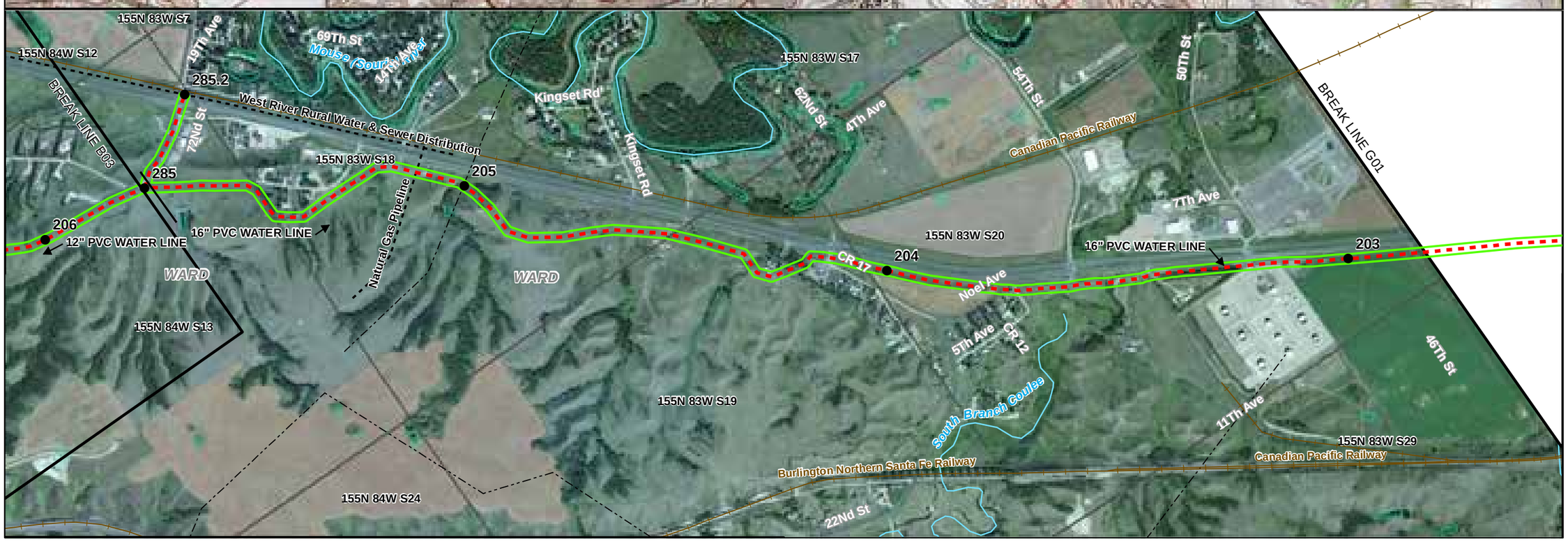
WATER TRANSMISSION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. A17





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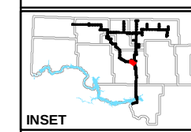
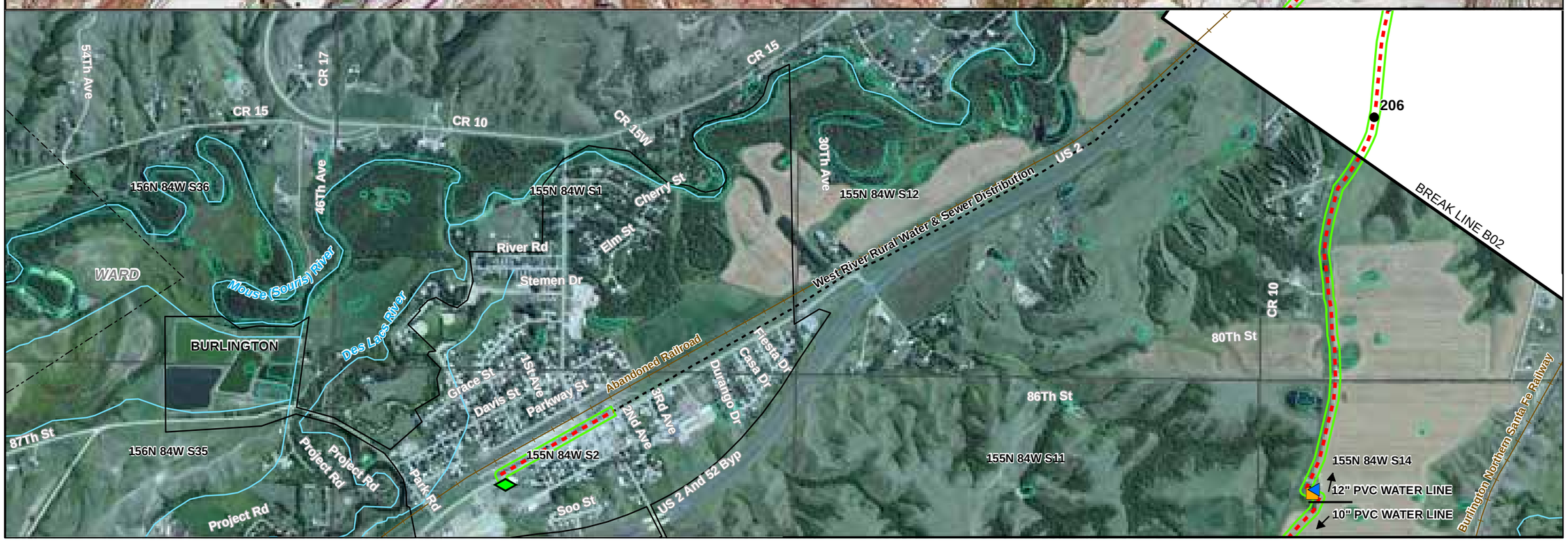


BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B02



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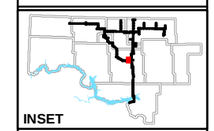
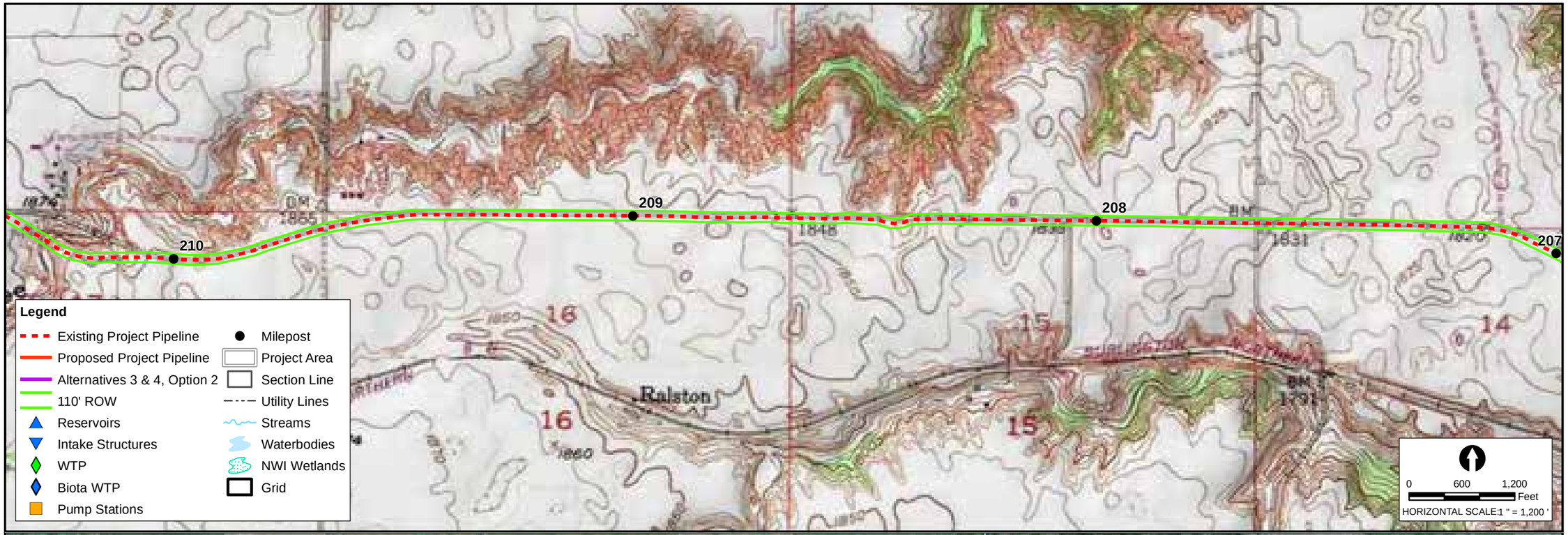


BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B03



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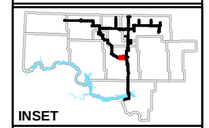


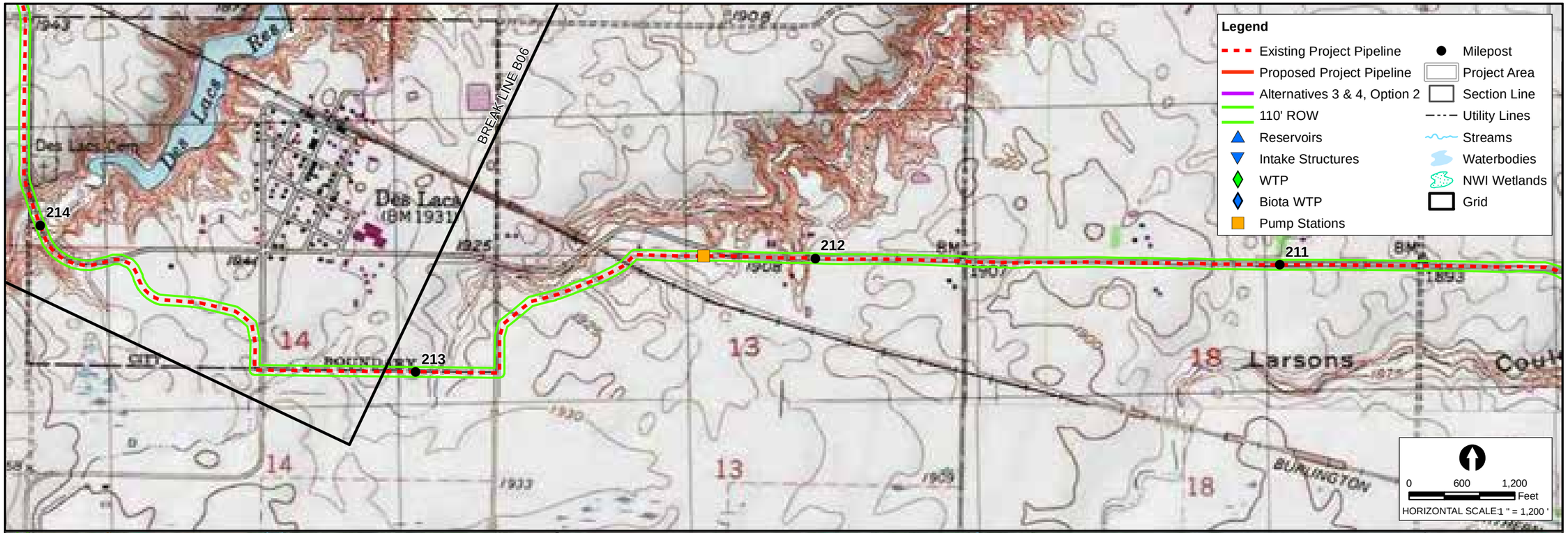
INSET

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B04



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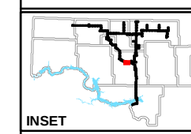

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PLAN SHEET

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DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
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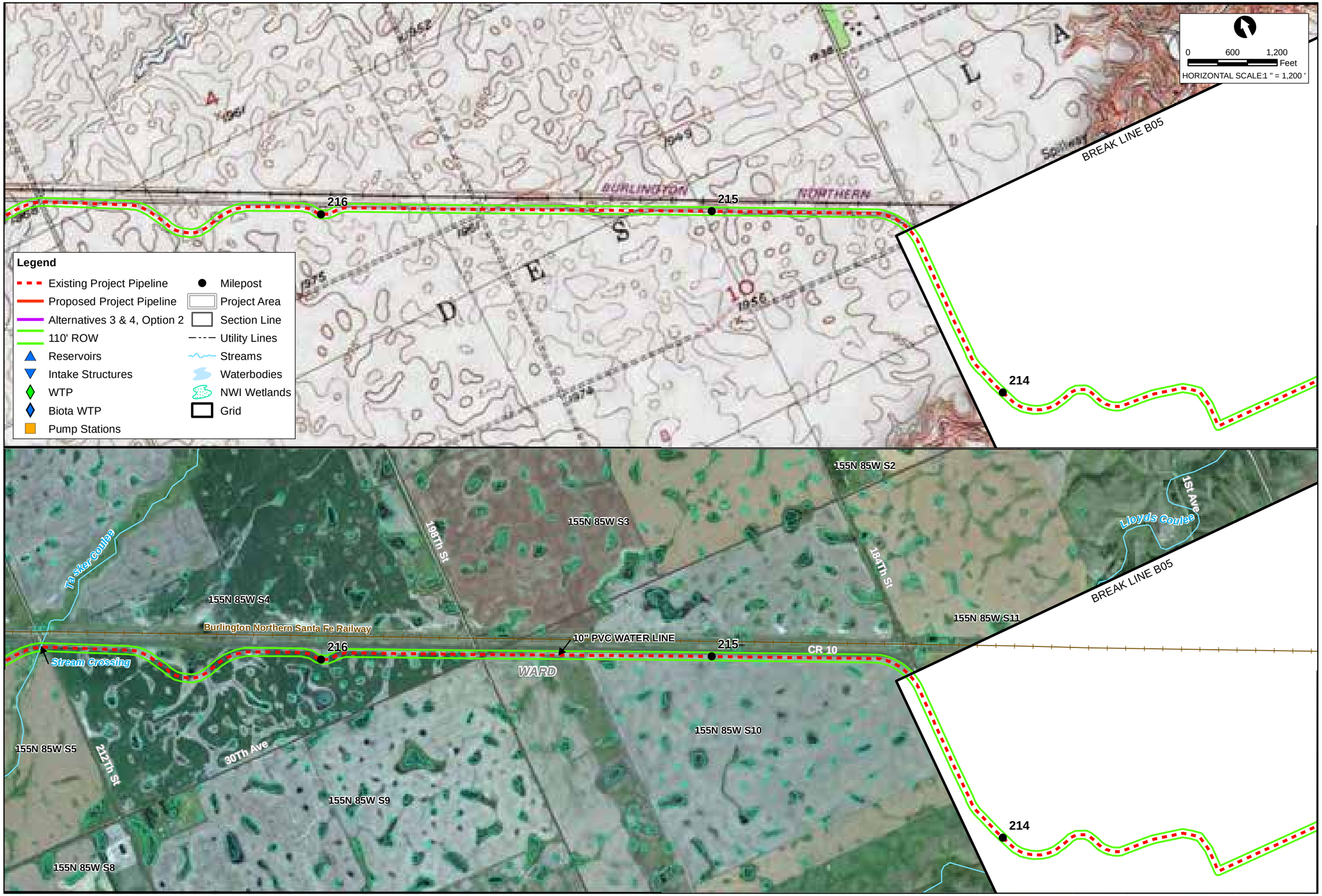
FIGURE NO. B05



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Northwest Area Water Supply

DATE: 09/25/2012
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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B06

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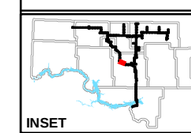

INSET

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

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DRAWN BY: NJH
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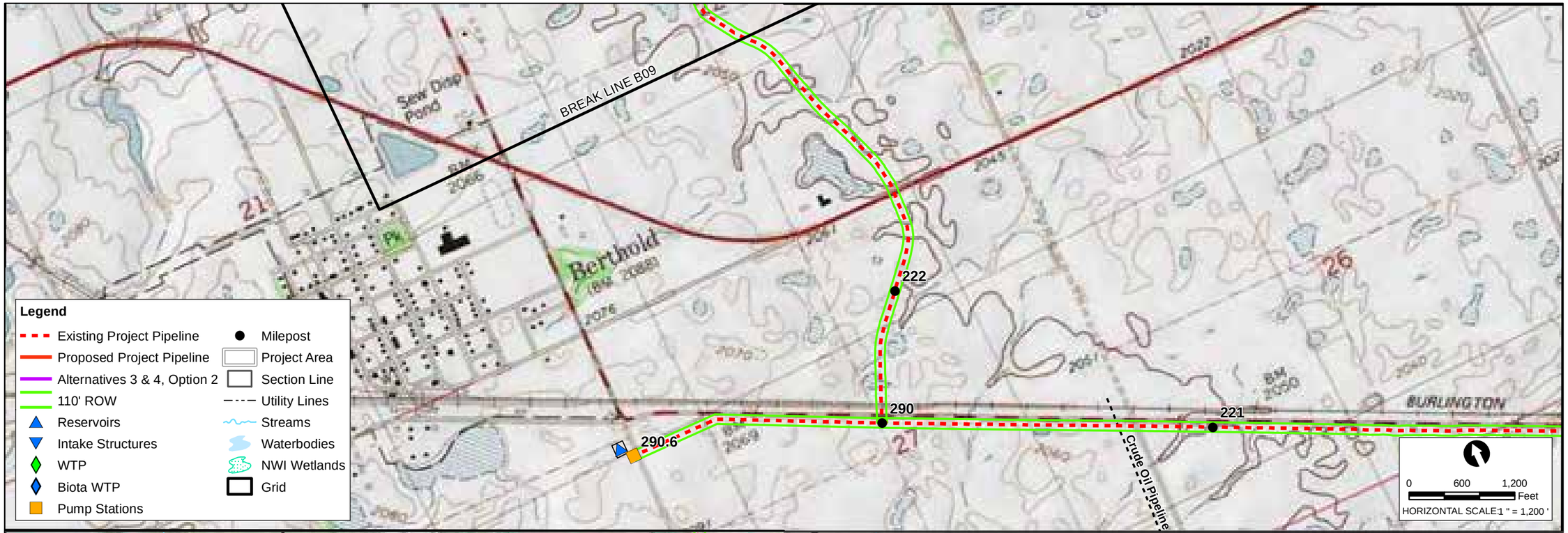
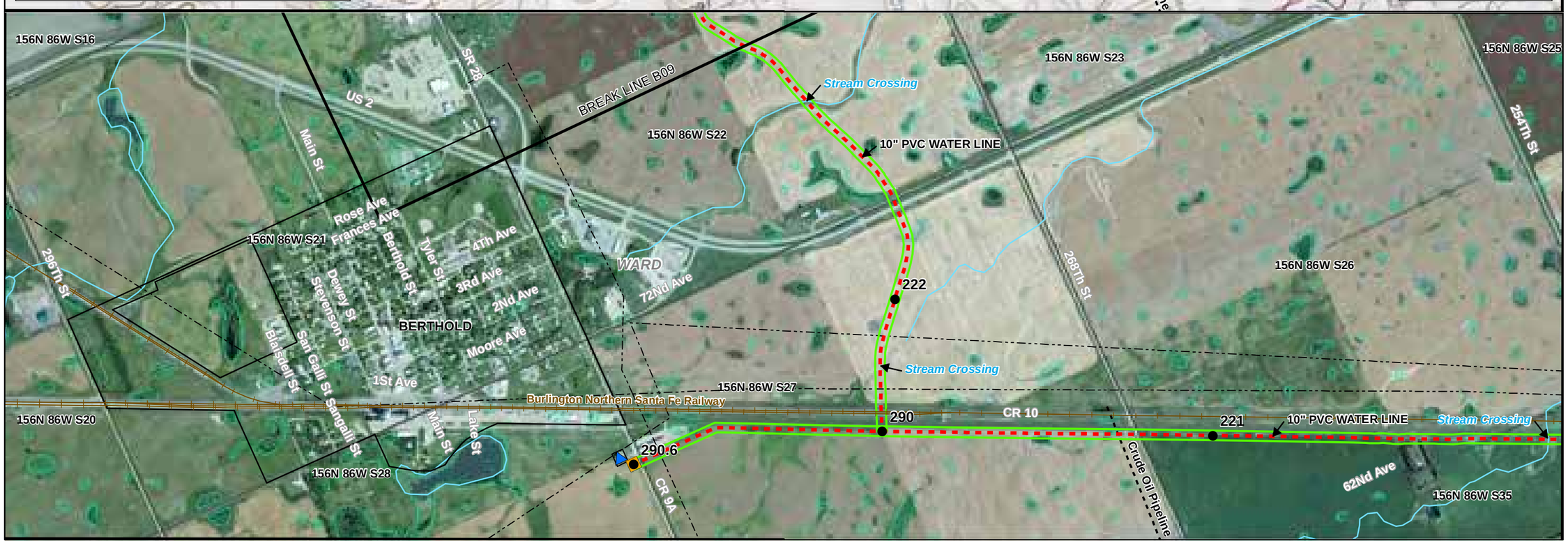
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B07





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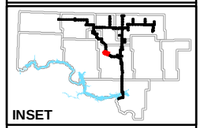

INSET

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B08

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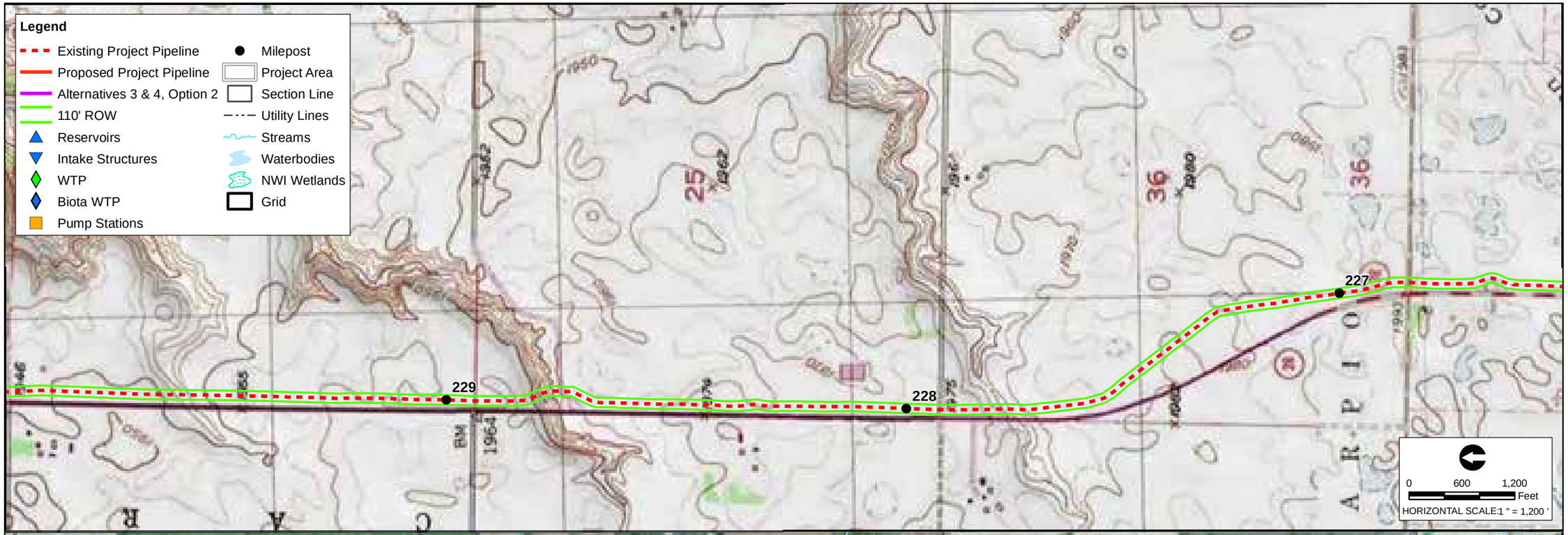
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B09



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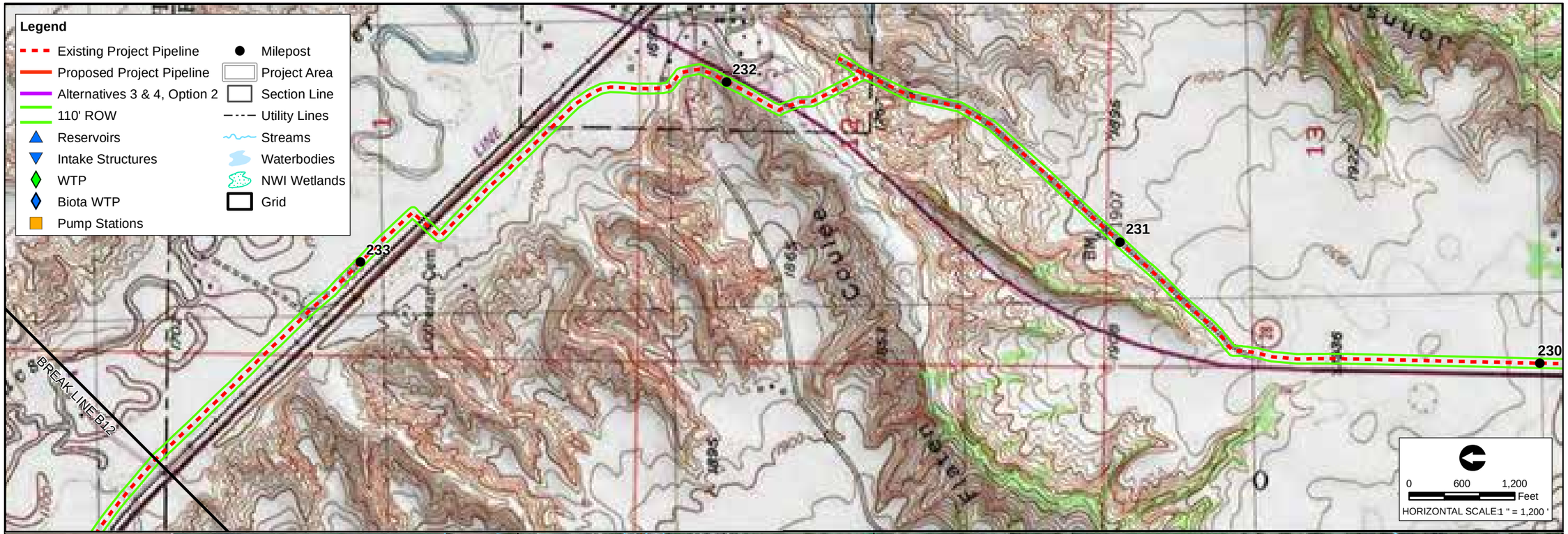
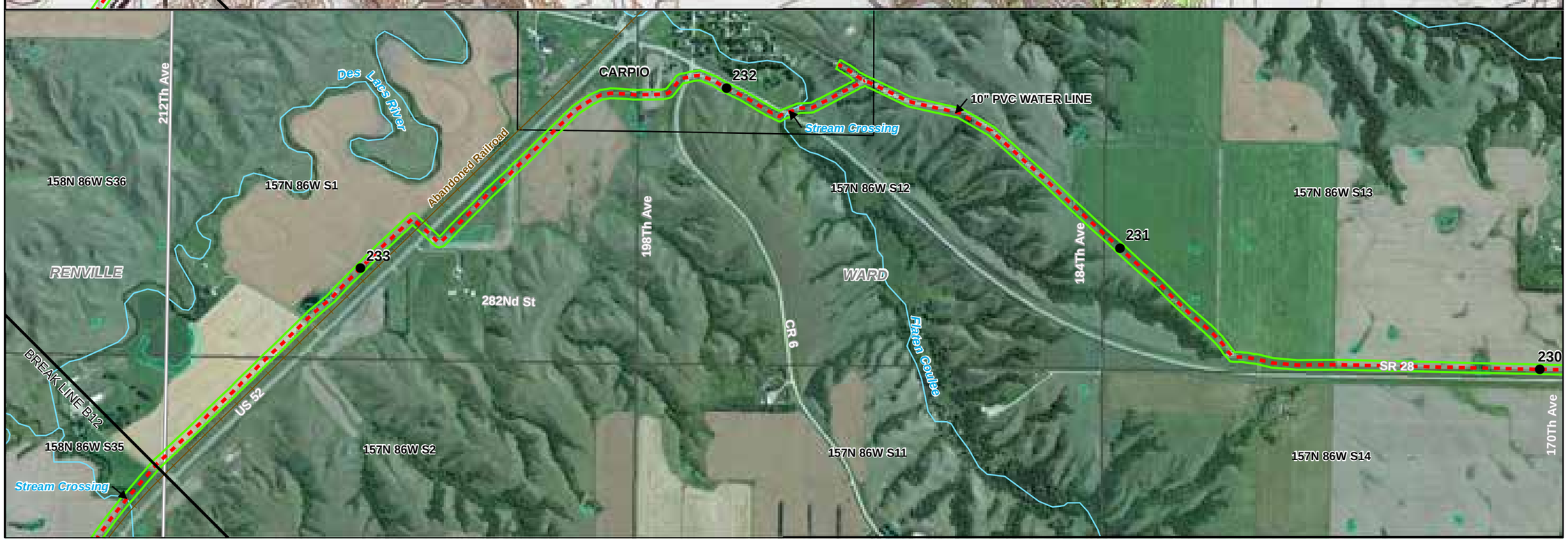
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B10





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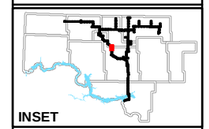

BULK DISTRIBUTION PIPELINE

PLAN SHEET

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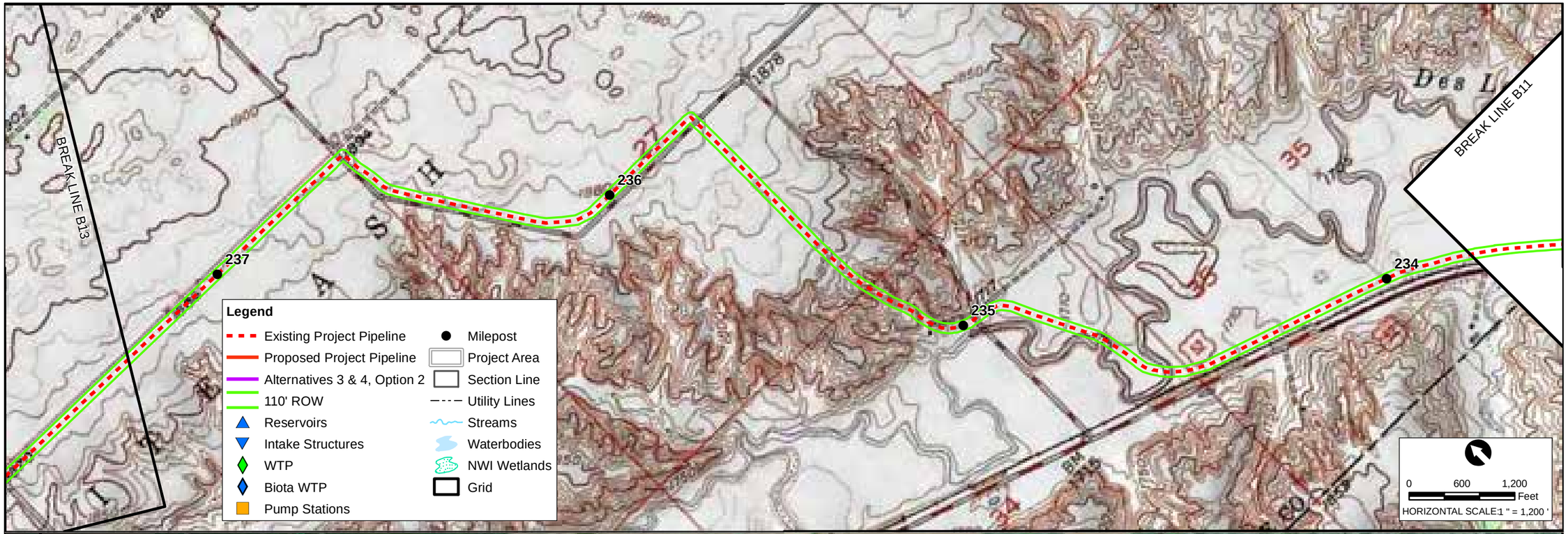
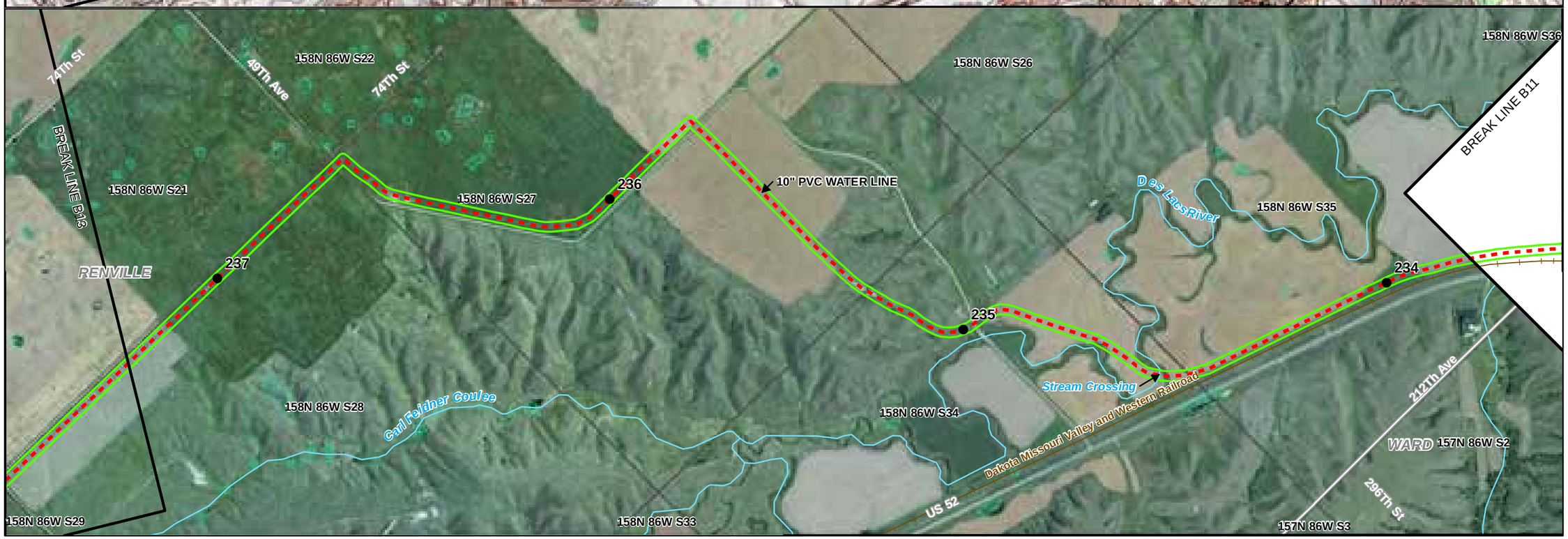
DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B11





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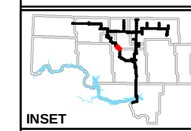

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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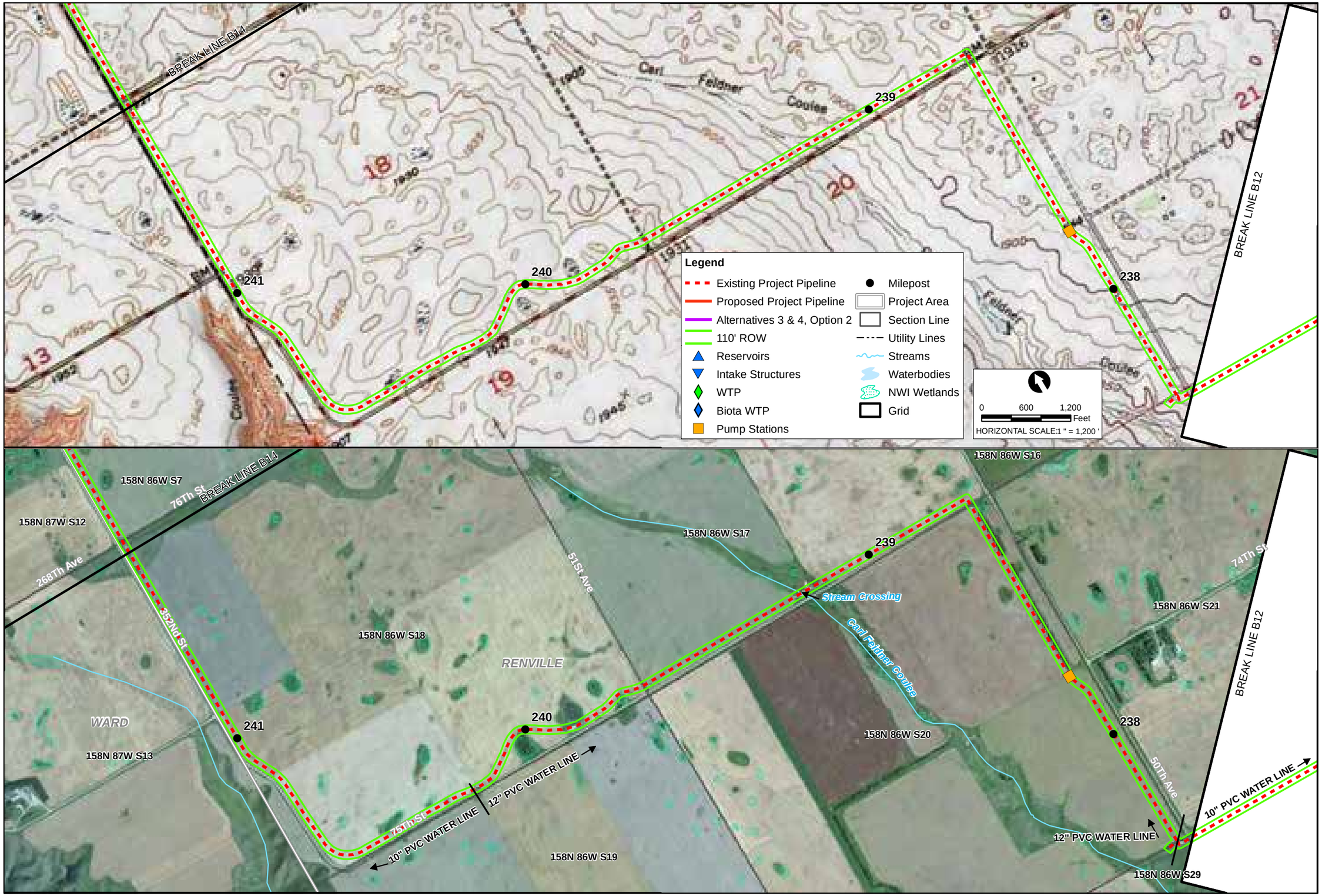
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B12



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PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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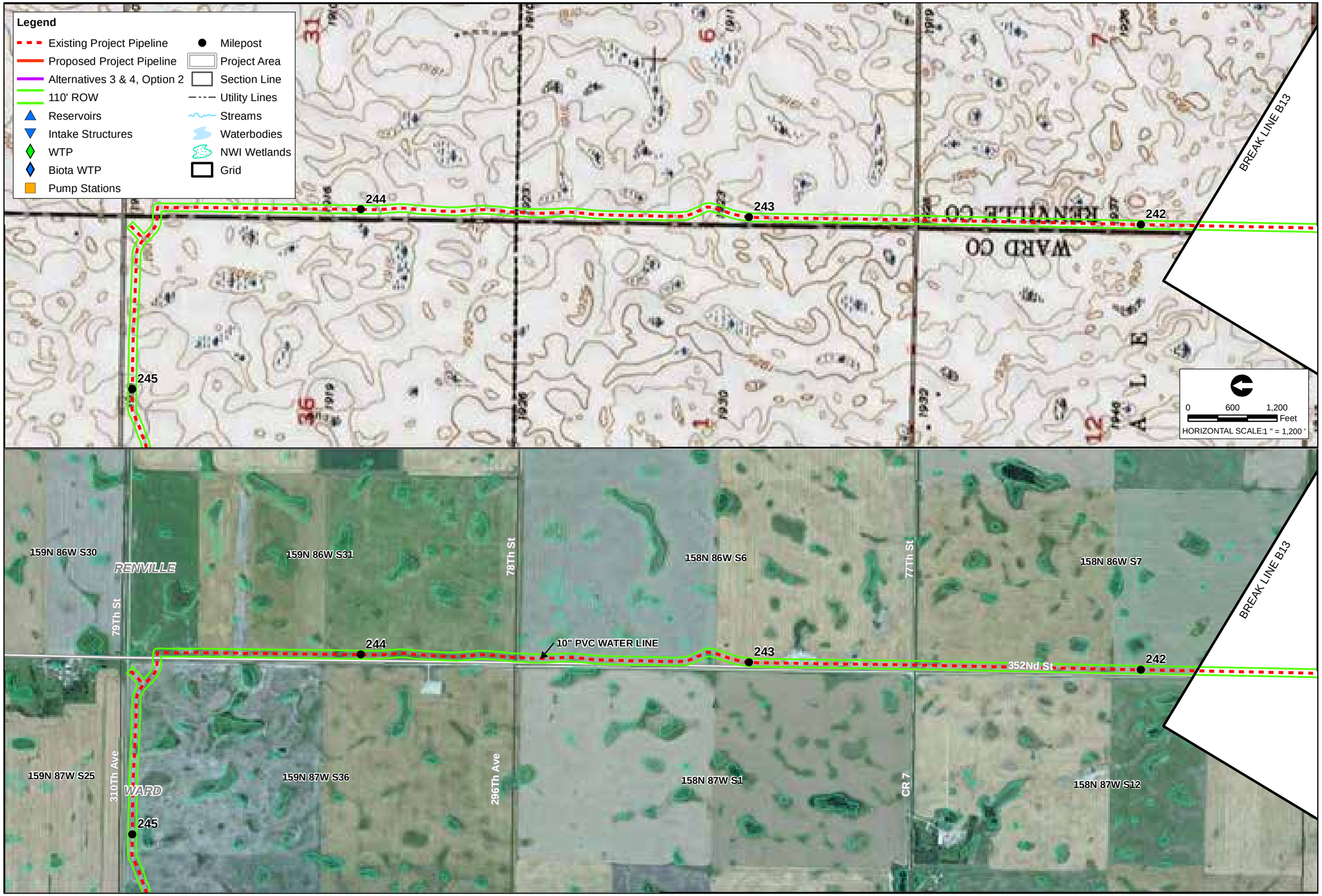
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B13



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PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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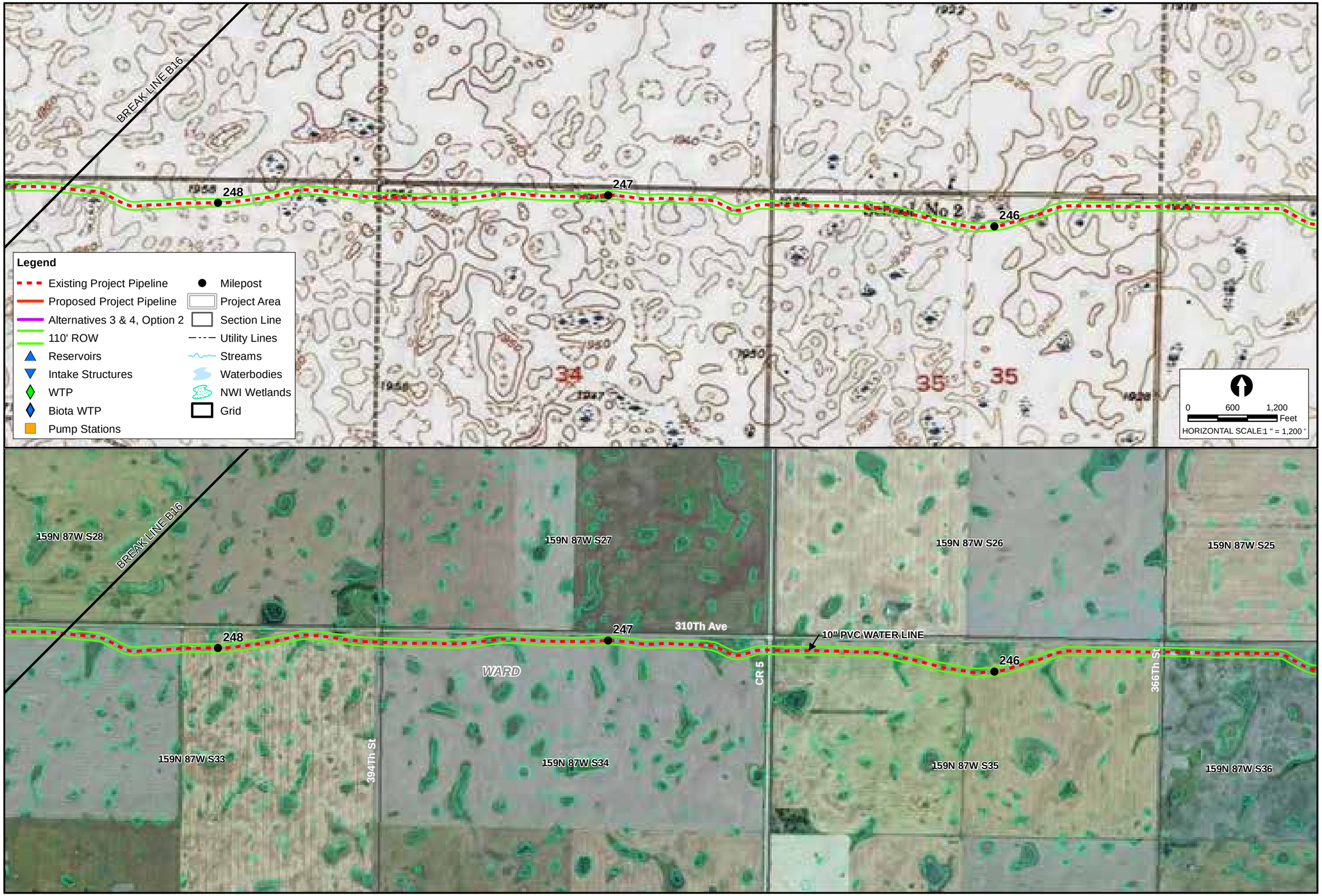
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B14



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PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012

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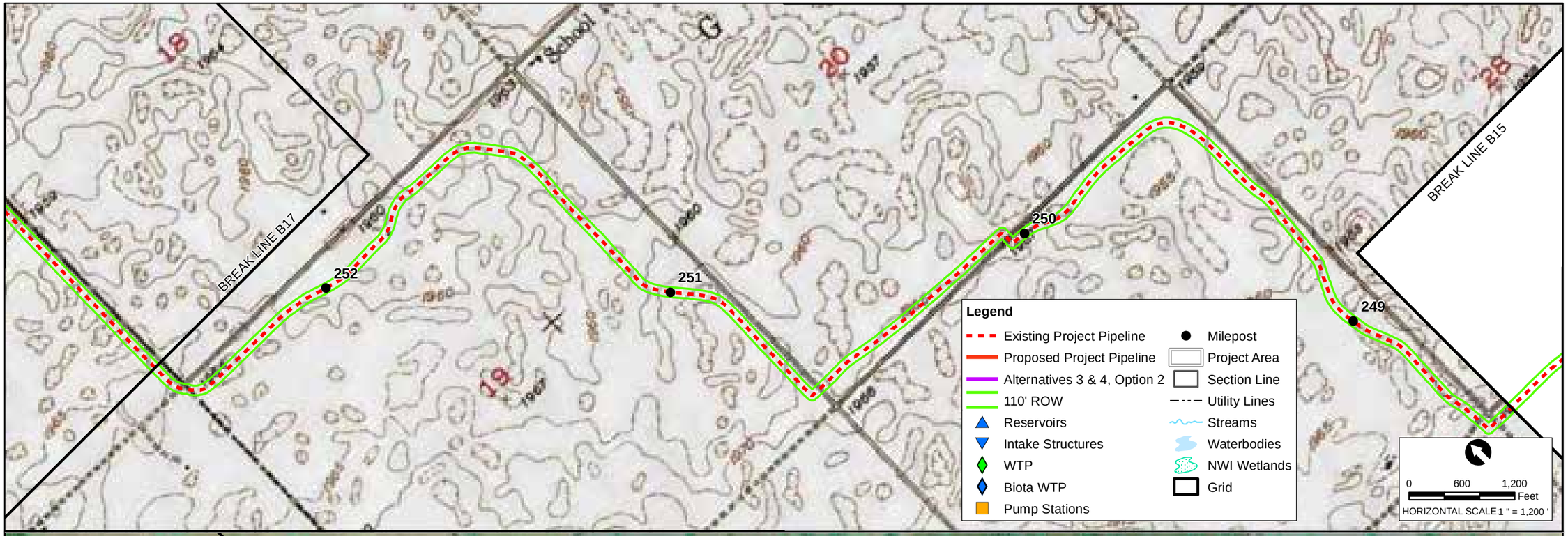
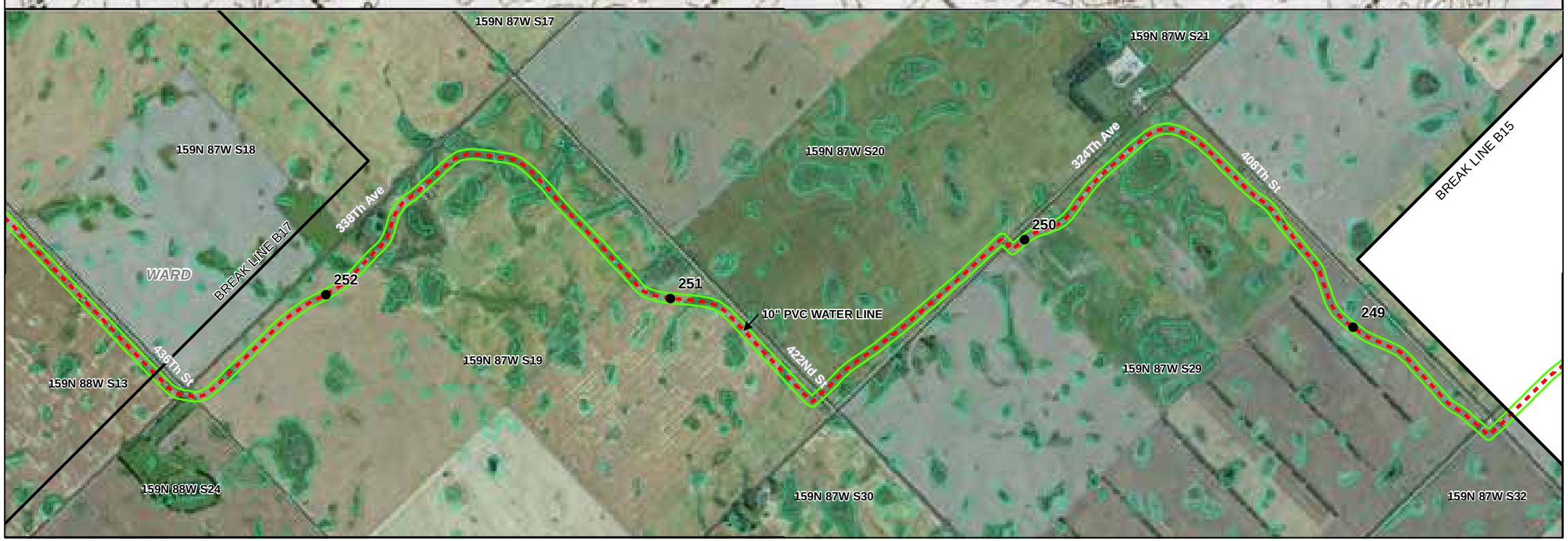
SCALE: AS SHOWN

ENTRIX JOB NO. 30442091

FIGURE NO. B15





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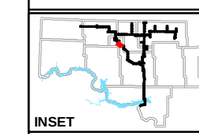

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B16

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PLAN SHEET

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DATE: 09/25/2012
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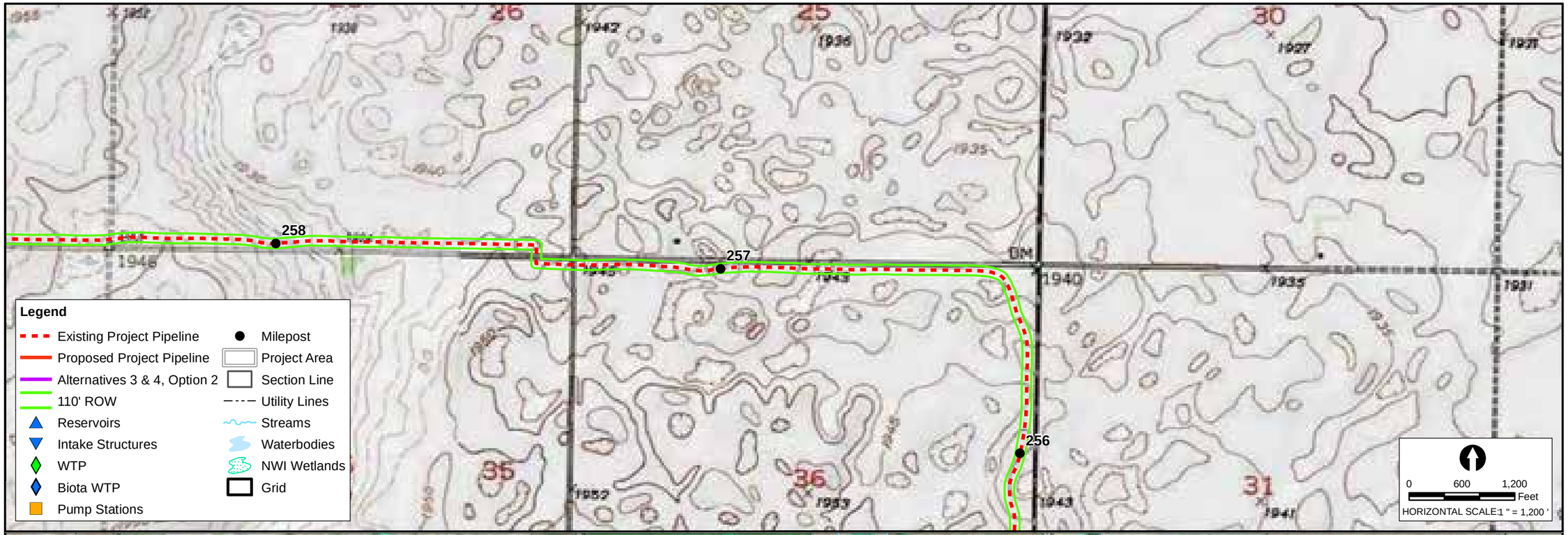
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B17



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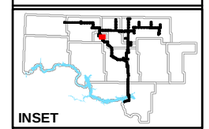

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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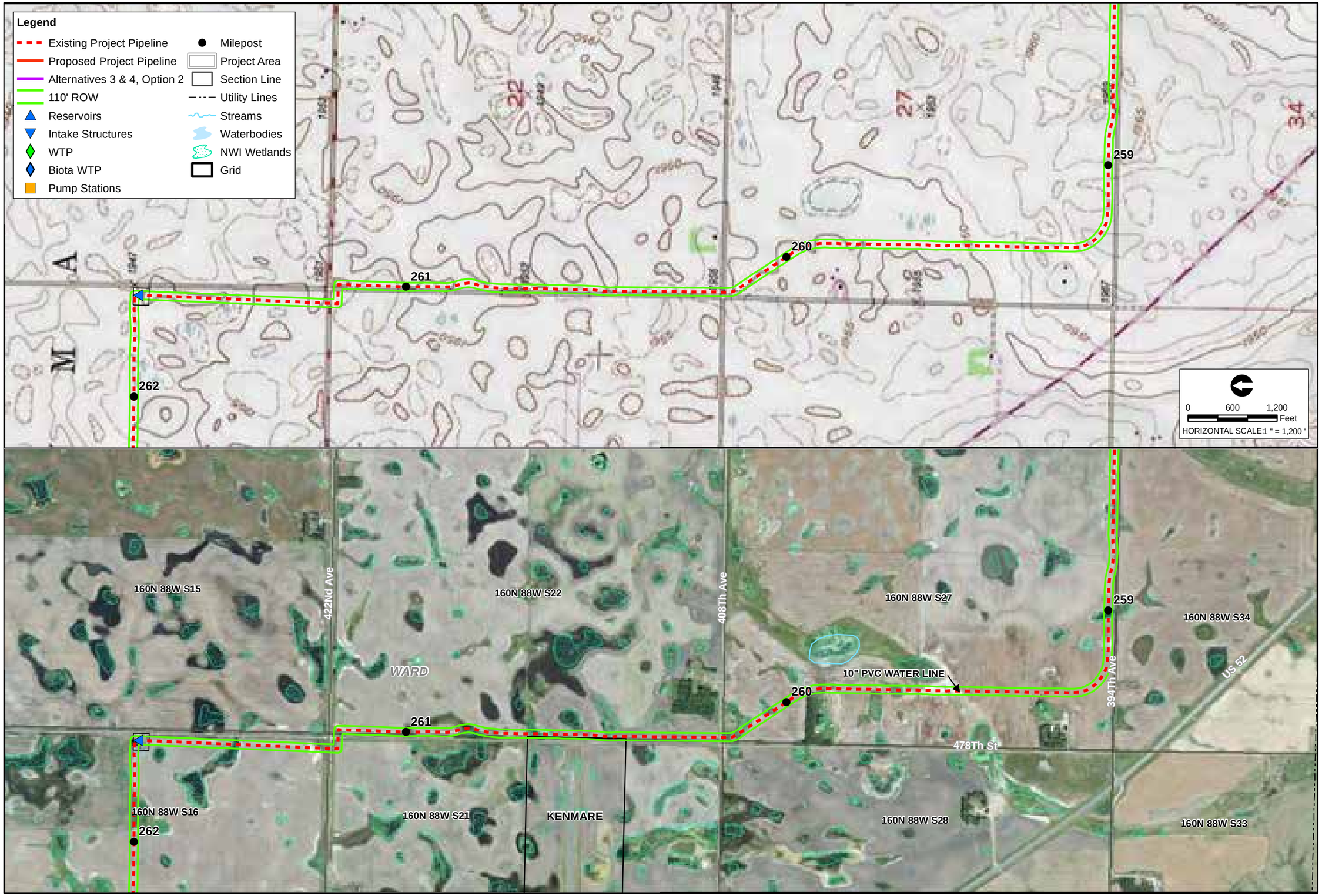
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B18



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PLAN SHEET

Northwest Area Water Supply

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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B19

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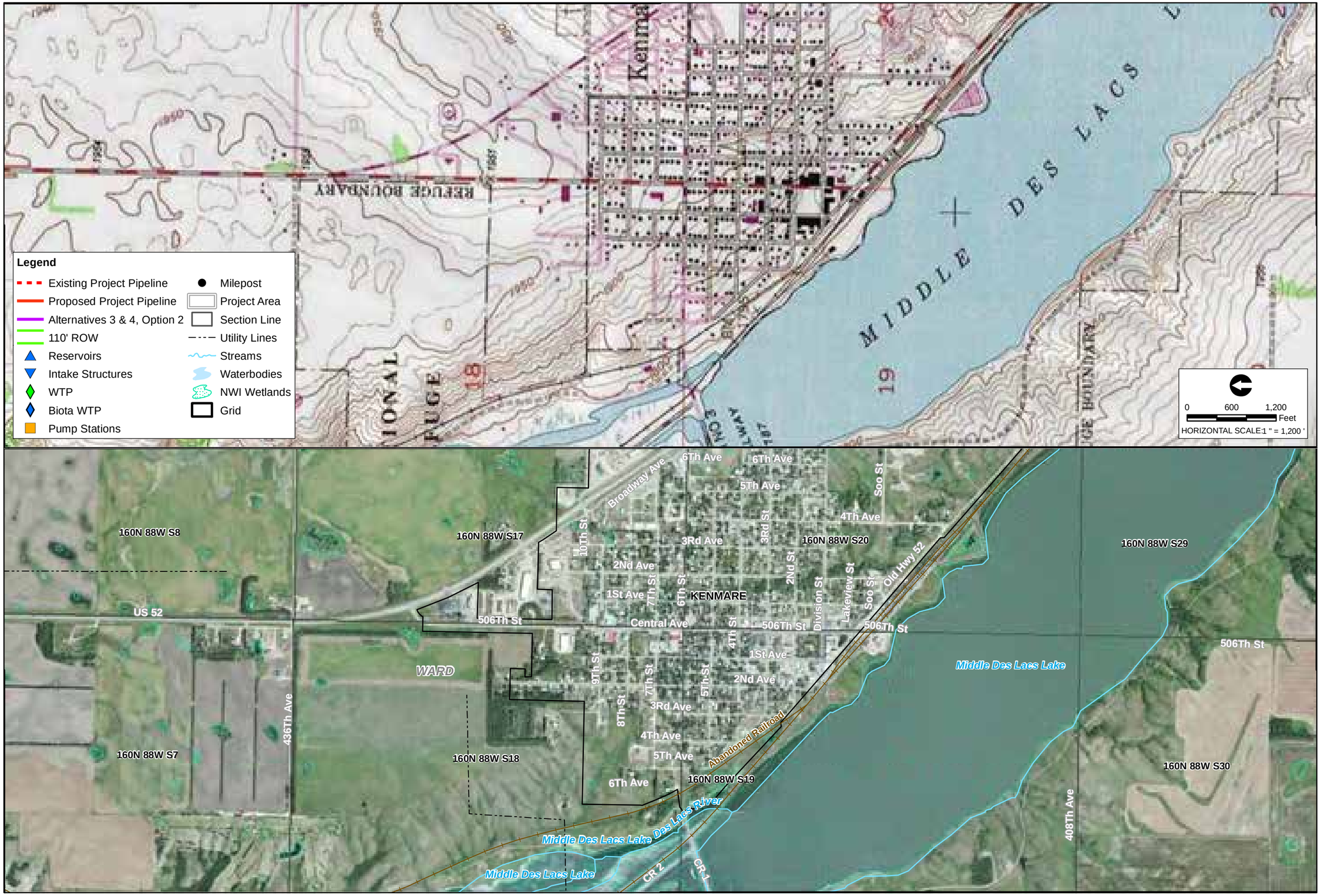
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B20



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ENTRIX JOB NO. 30442091
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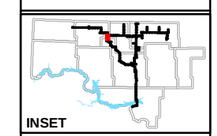


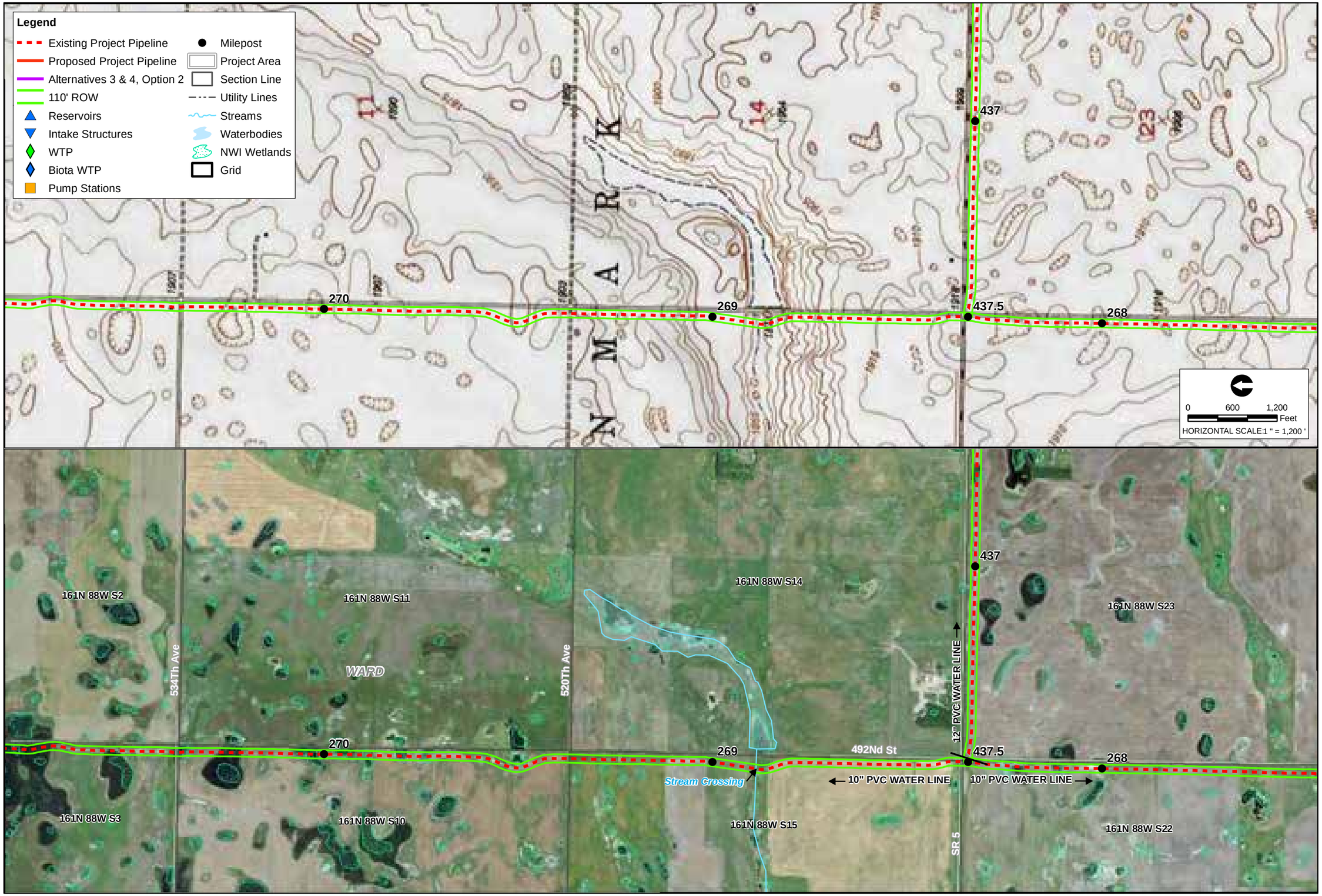
INSET

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B22



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BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B23

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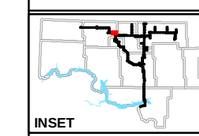

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Northwest Area Water Supply

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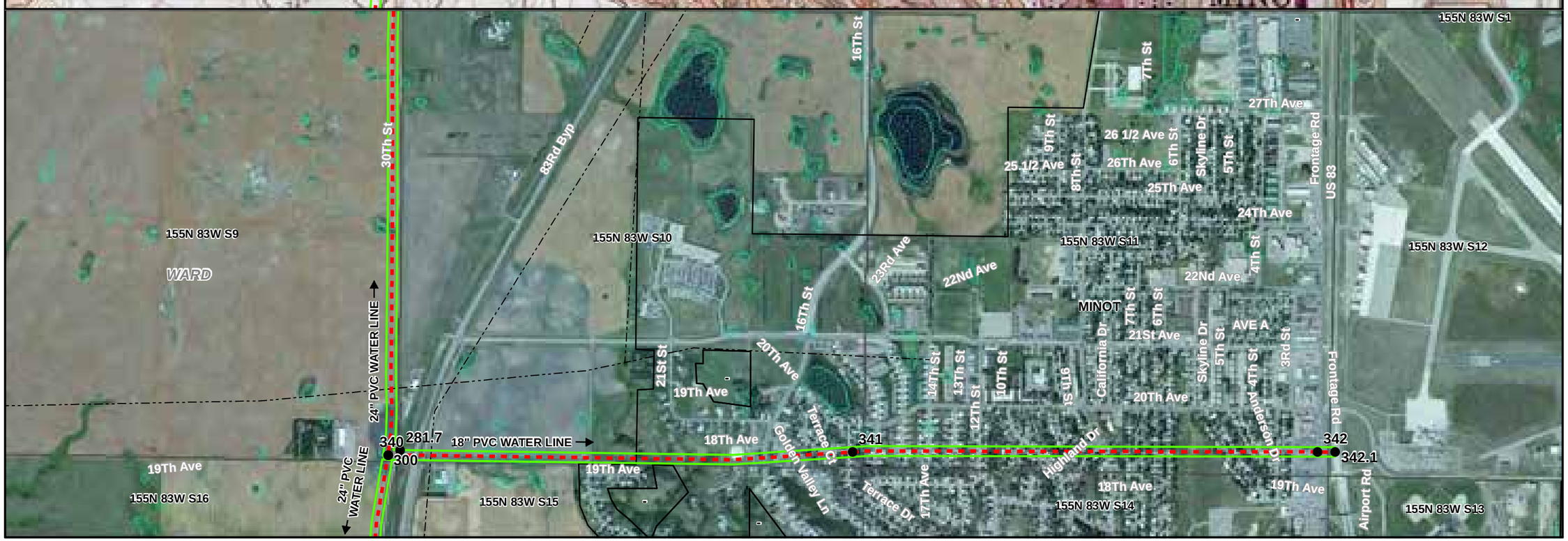
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. B24



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PLAN SHEET

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DATE: 09/25/2012
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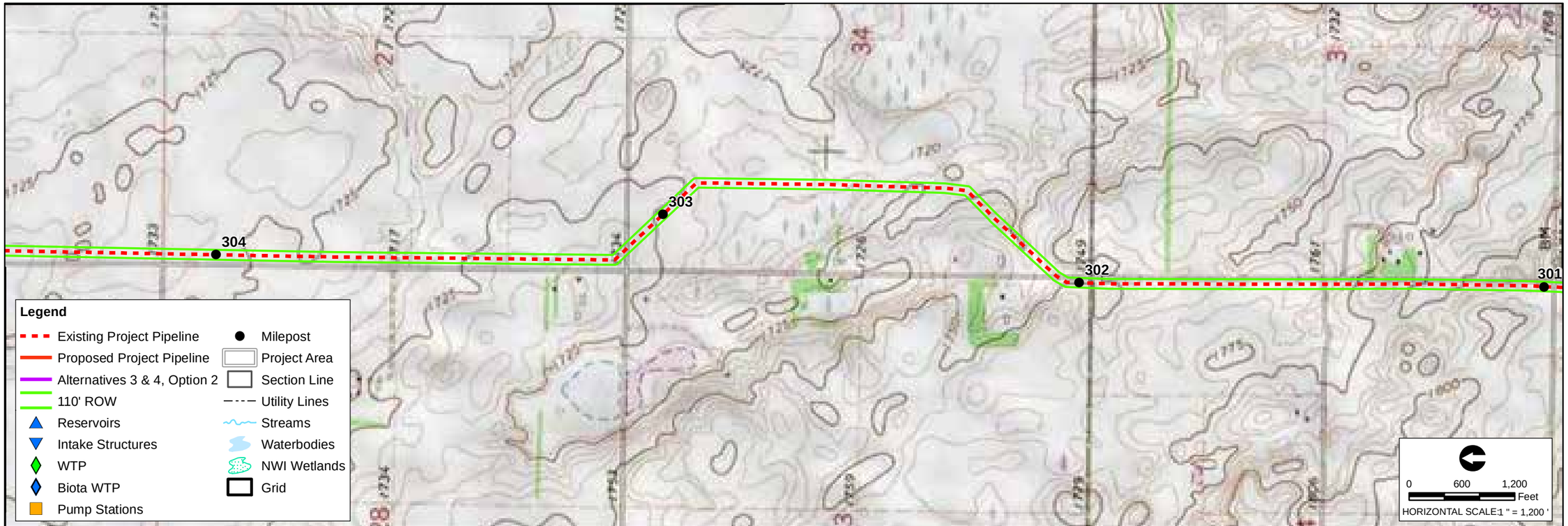
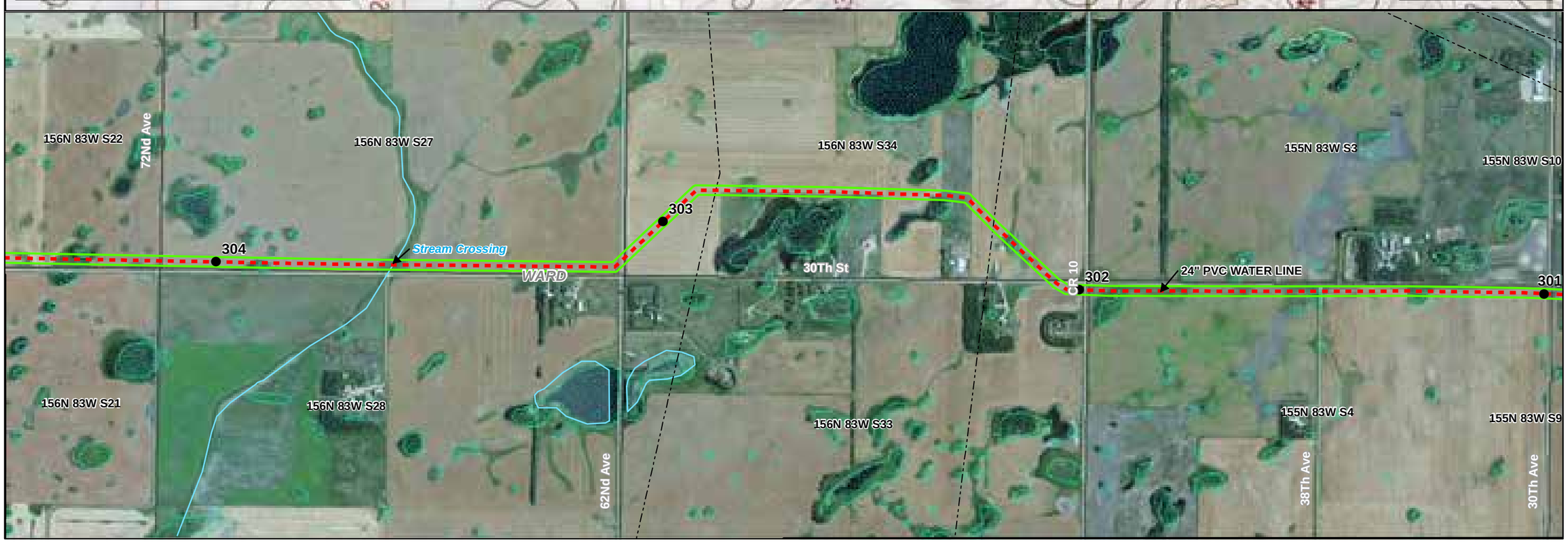
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C02





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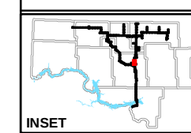

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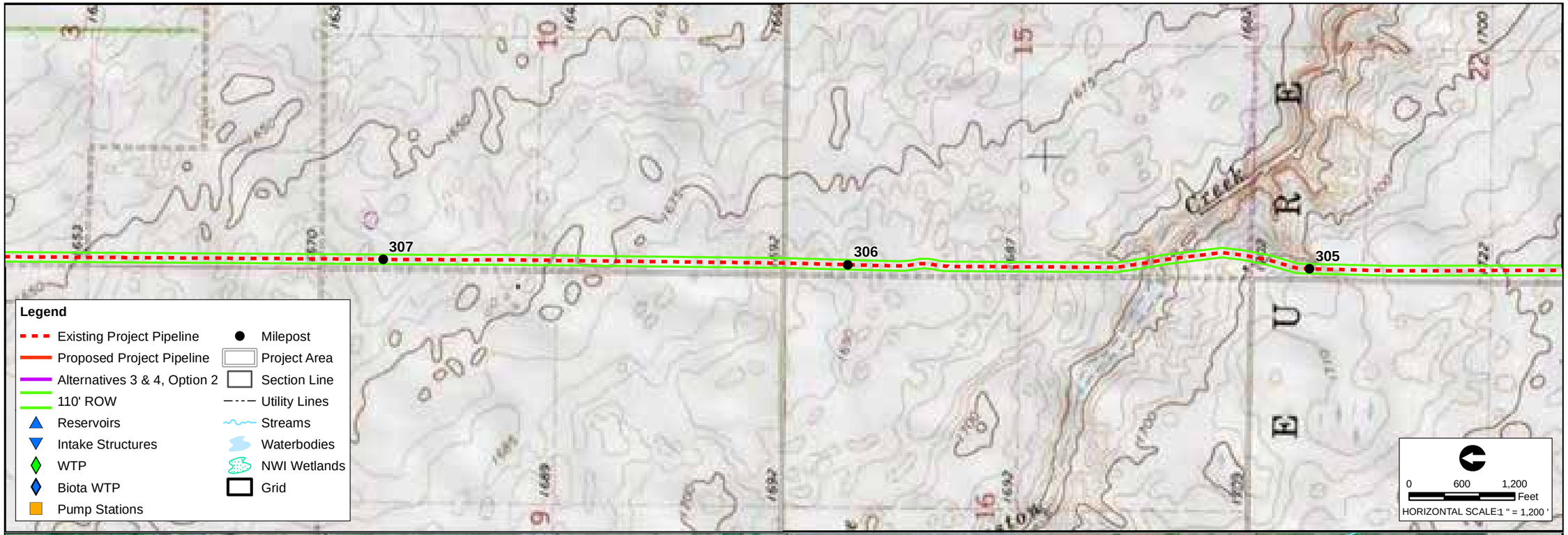
PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C03



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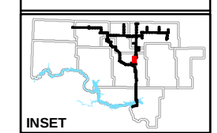

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Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
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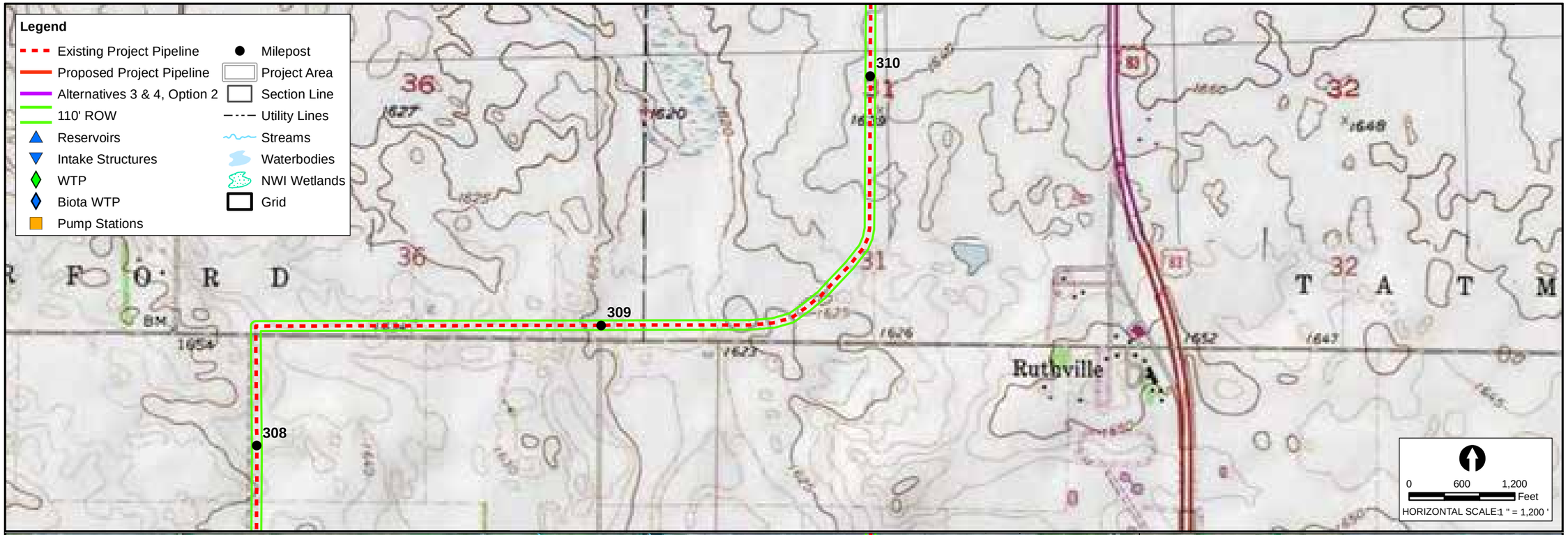
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C04



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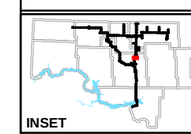

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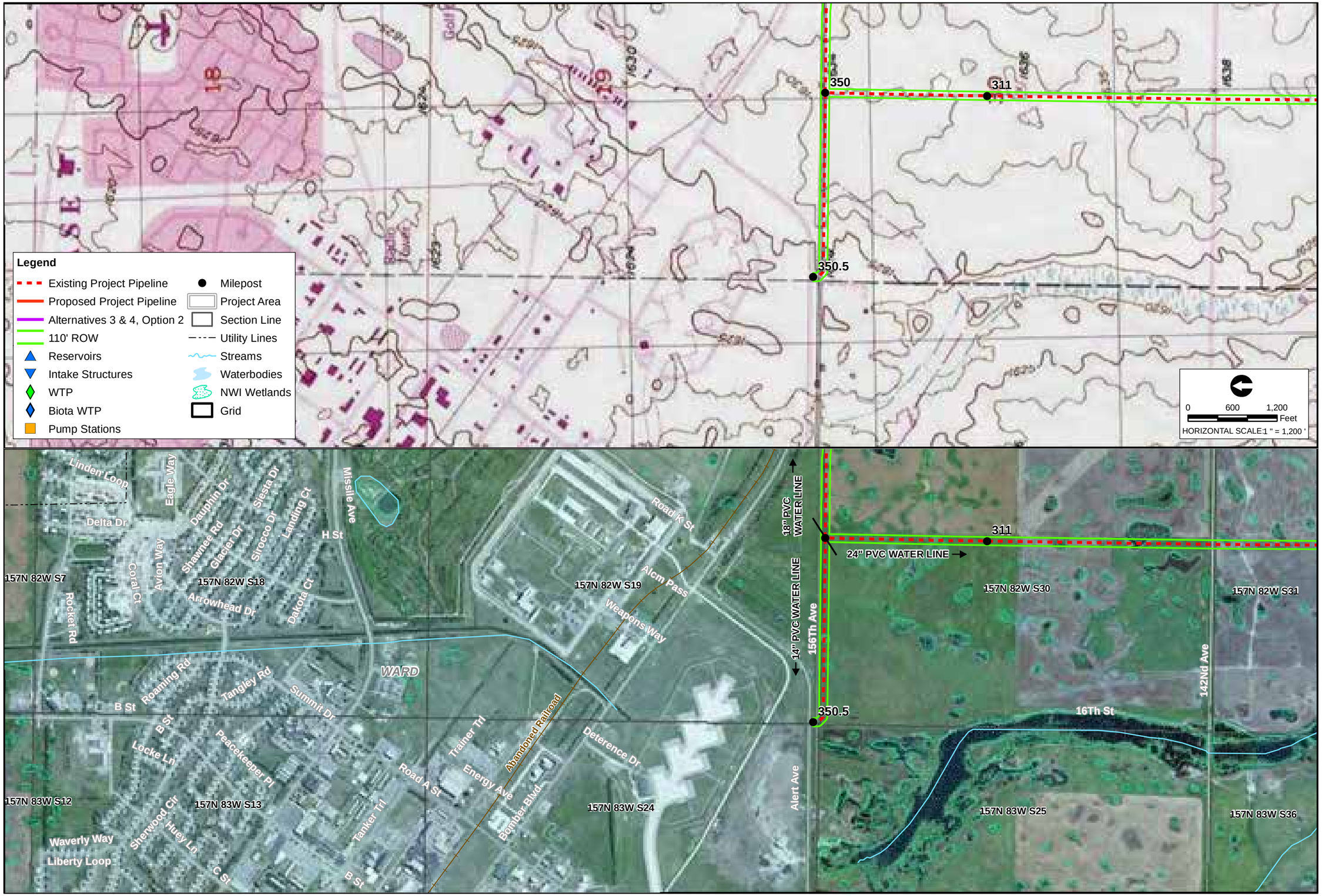
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C05



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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C06

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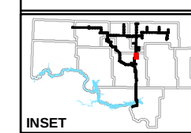

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PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
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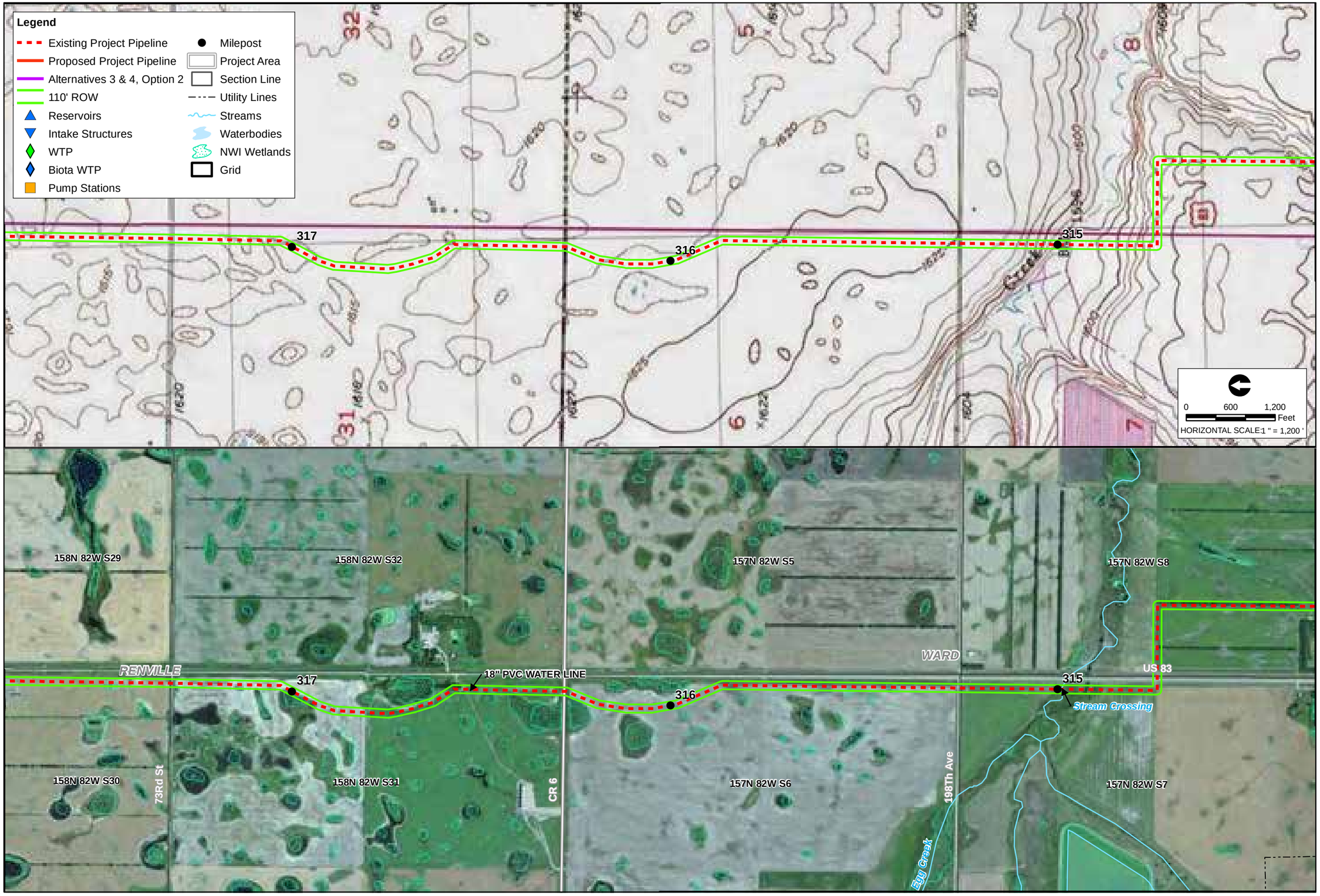
FIGURE NO. C07



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PLAN SHEET

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DRAWN BY: NJH
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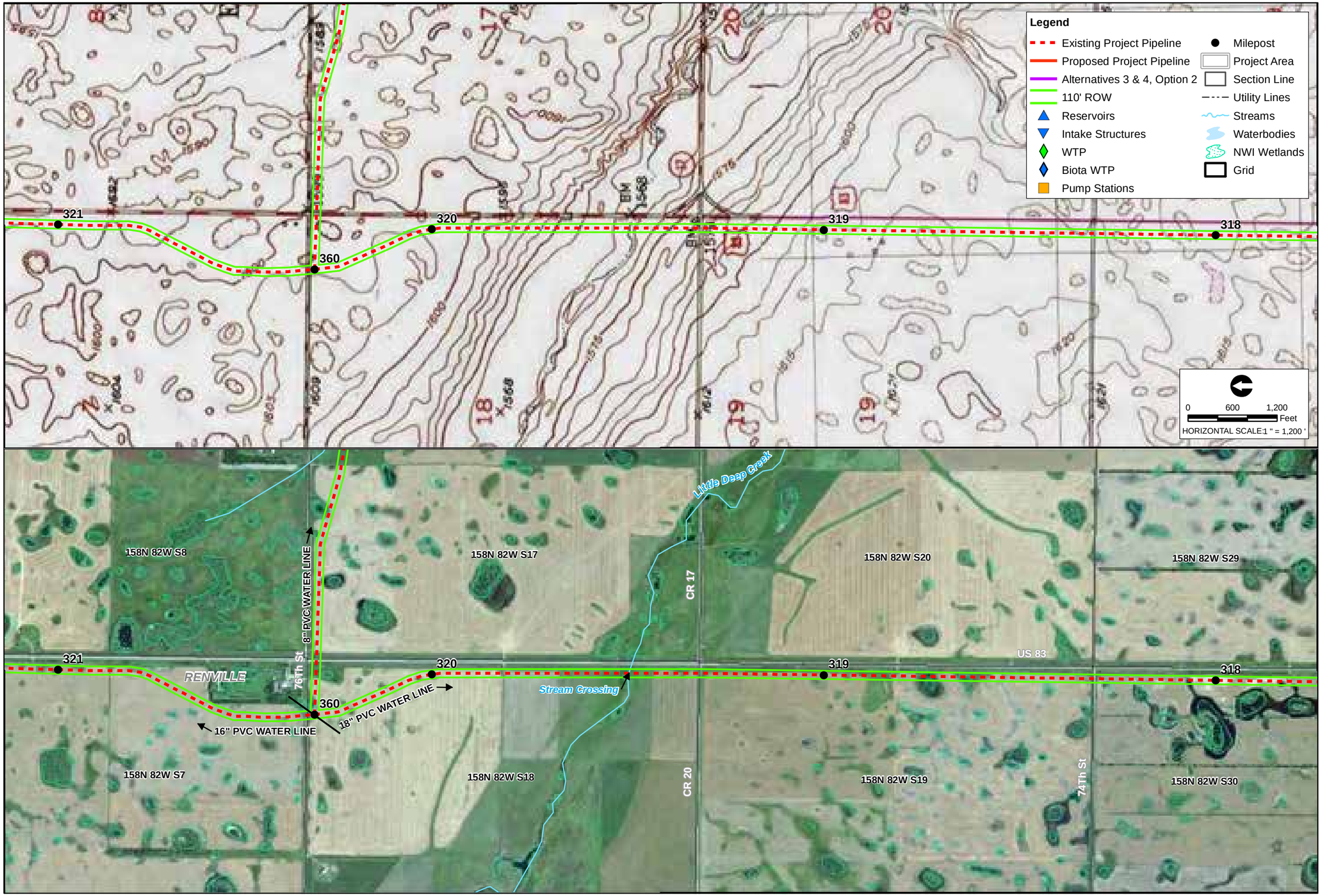
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C08



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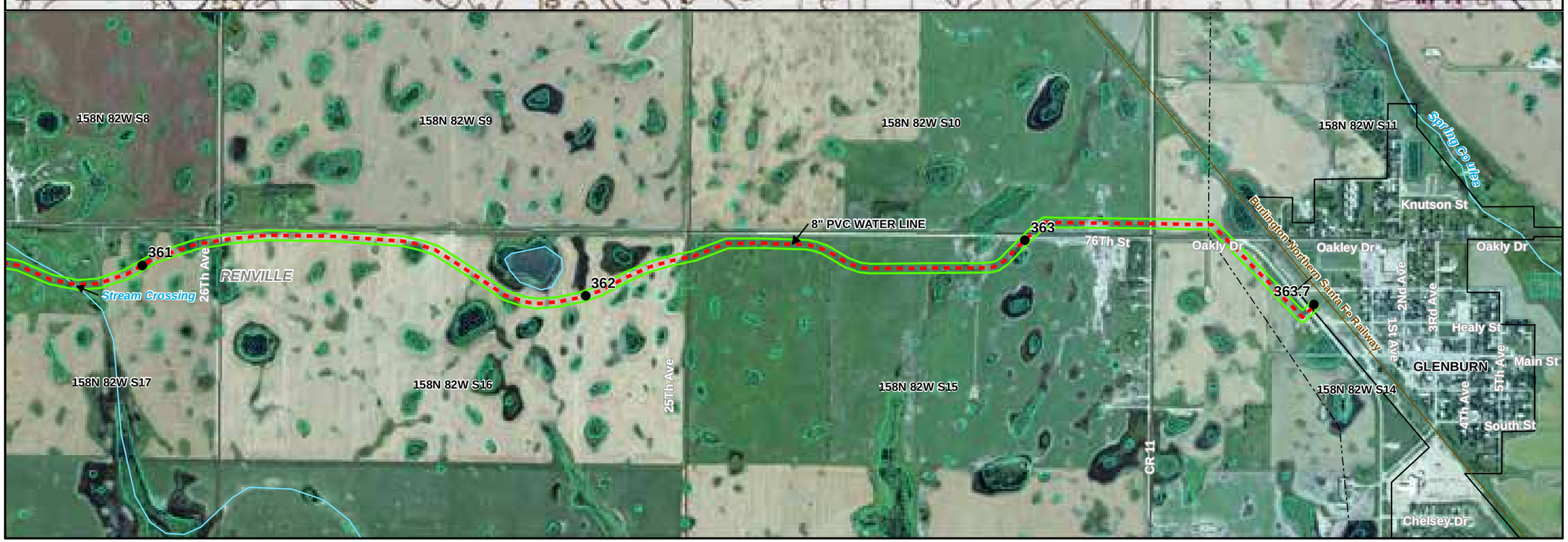
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C09



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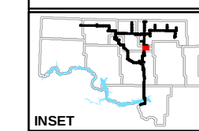

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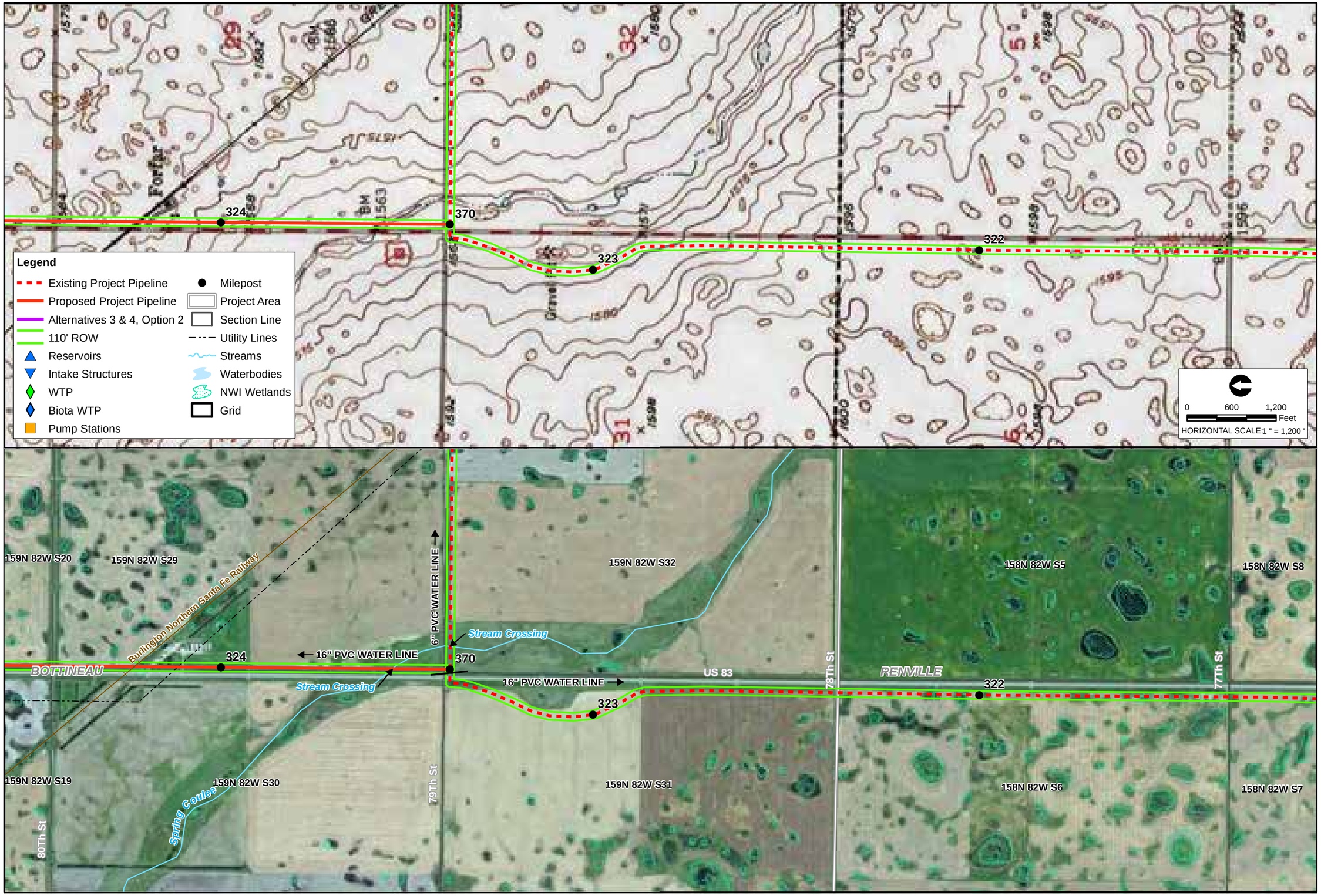
BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C10



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PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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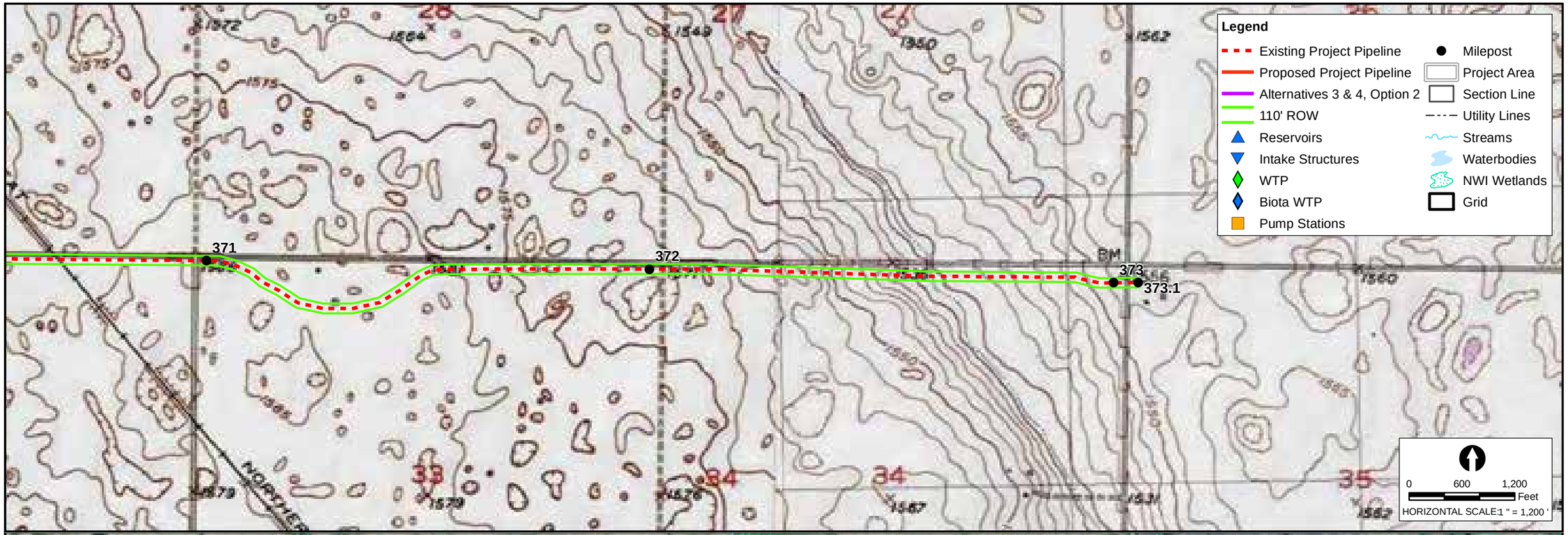
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C11



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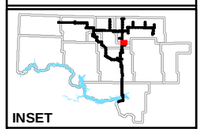
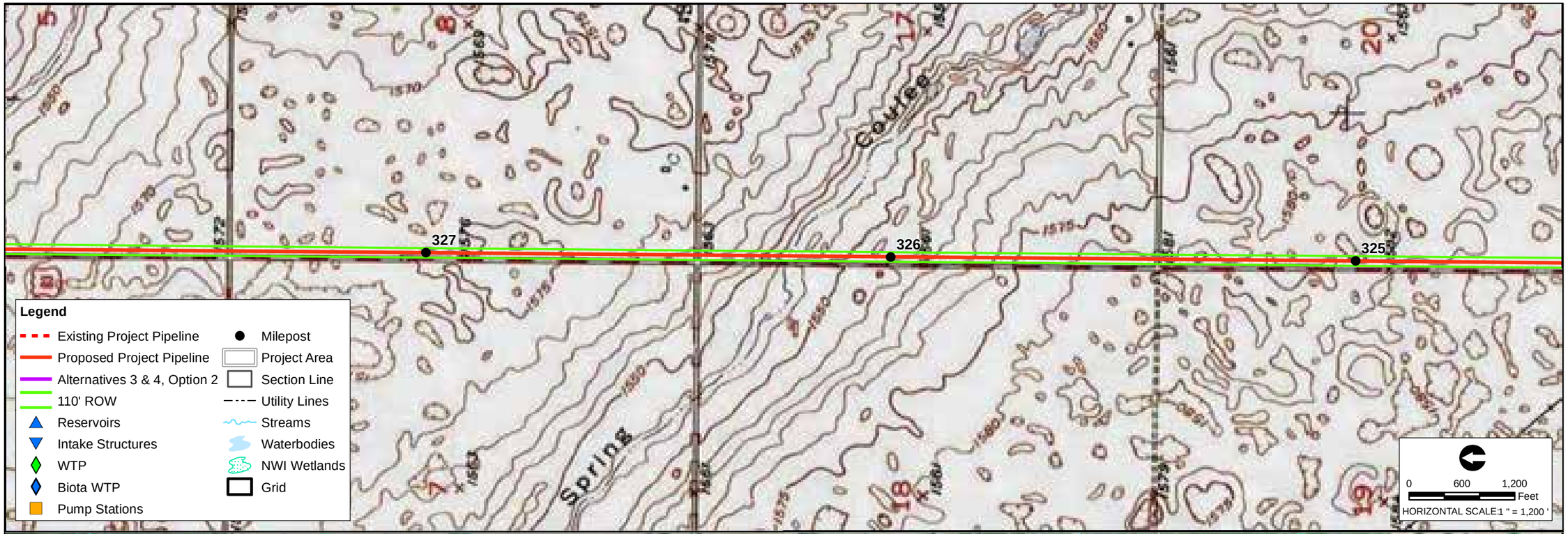


BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C12



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PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
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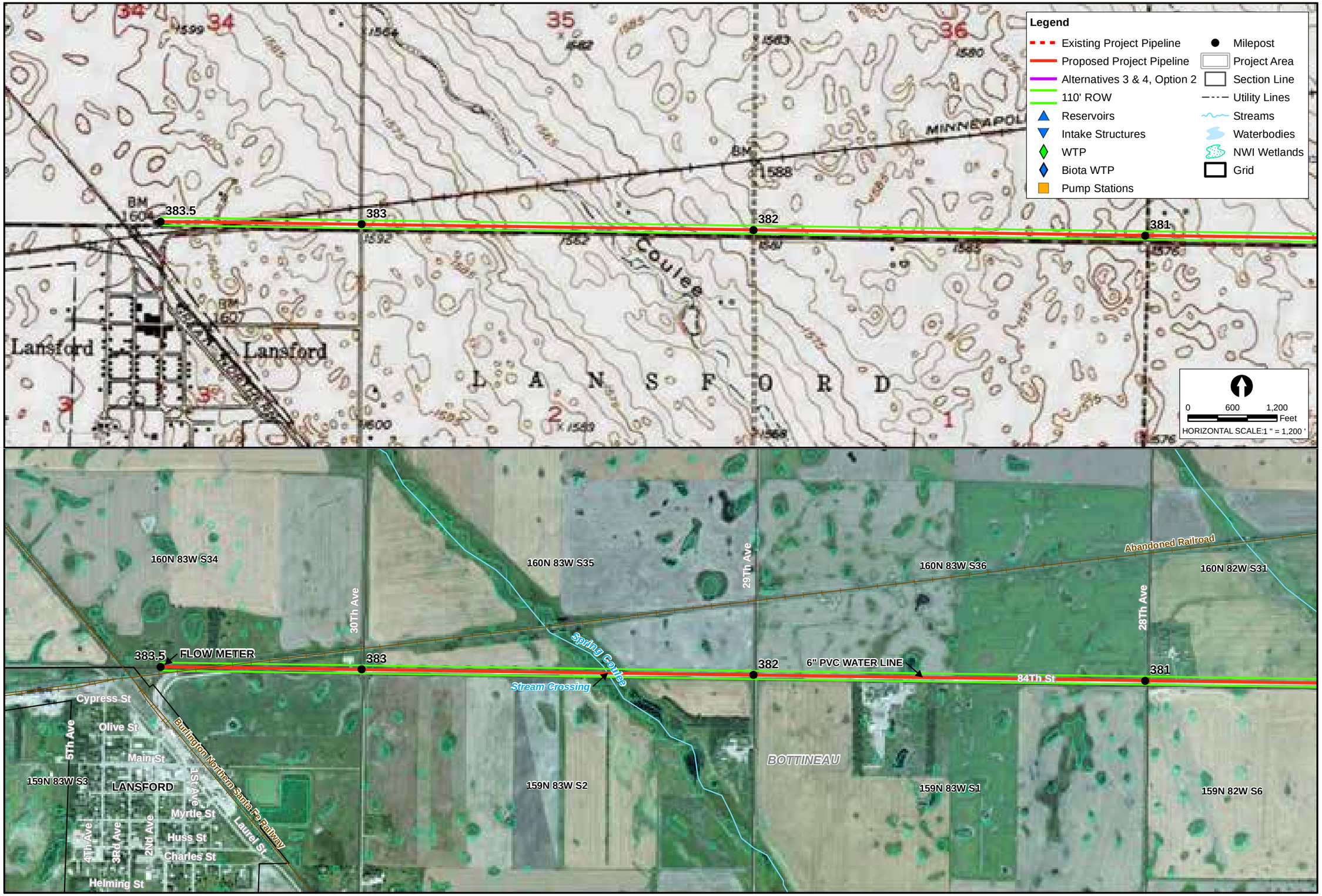
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C13



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PLAN SHEET

Northwest Area Water Supply

DATE: 12/18/2012
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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C14

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PLAN SHEET

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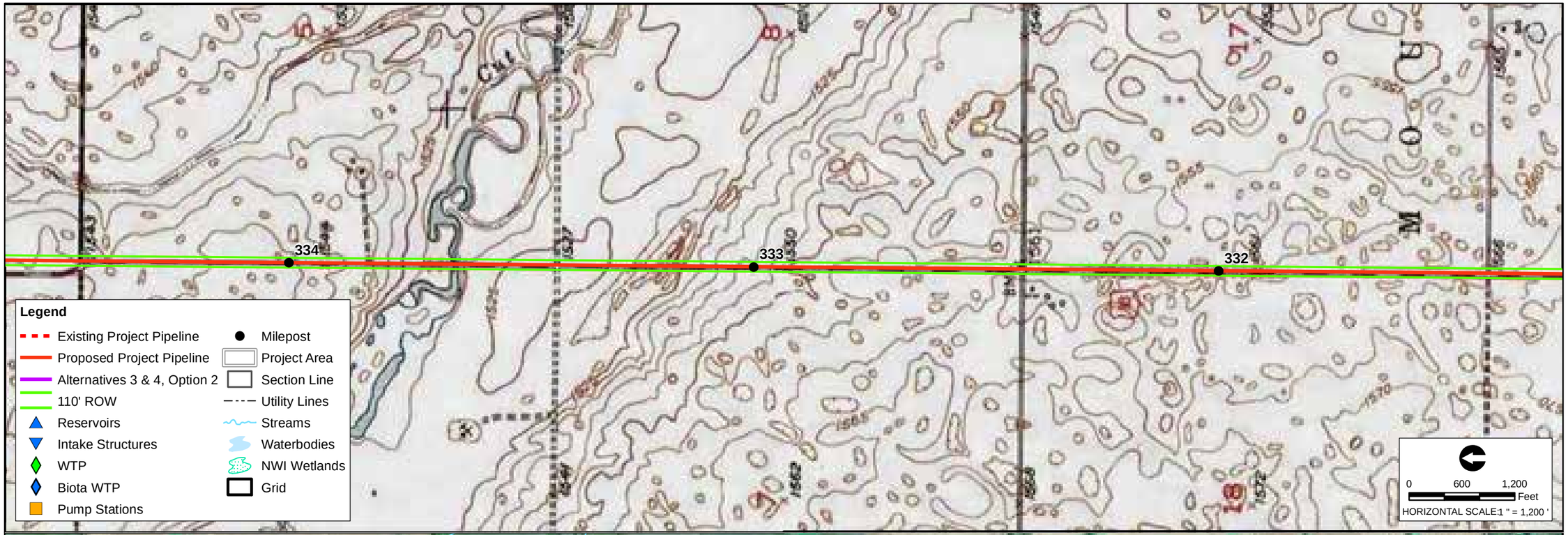
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C15



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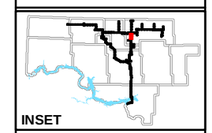

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Northwest Area Water Supply

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DRAWN BY: NJH
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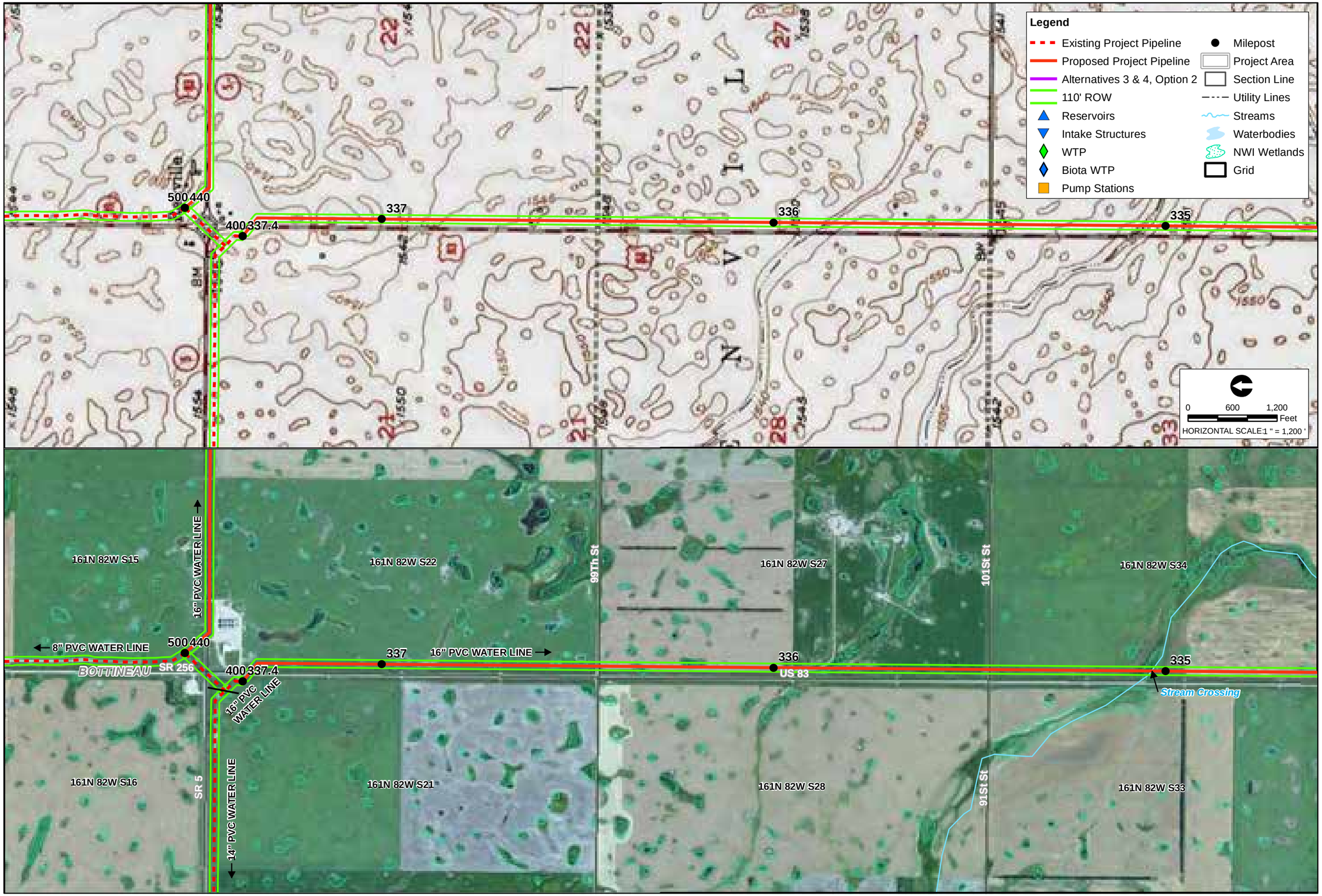
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C16



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PLAN SHEET

Northwest Area Water Supply

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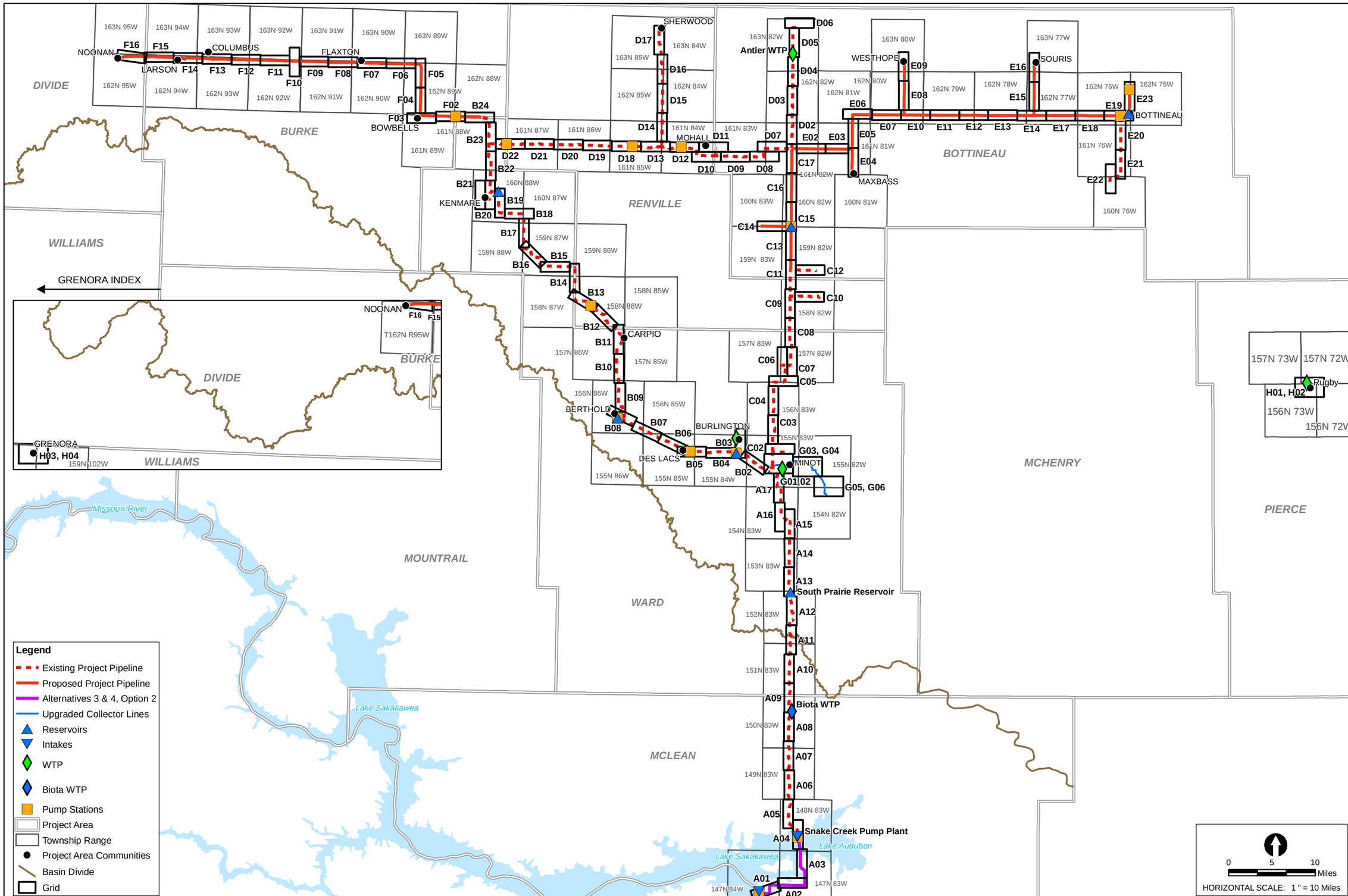
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. C17



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PROJECT PIPELINES

INDEX SHEET

Northwest Area Water Supply

DATE: 12/18/2012
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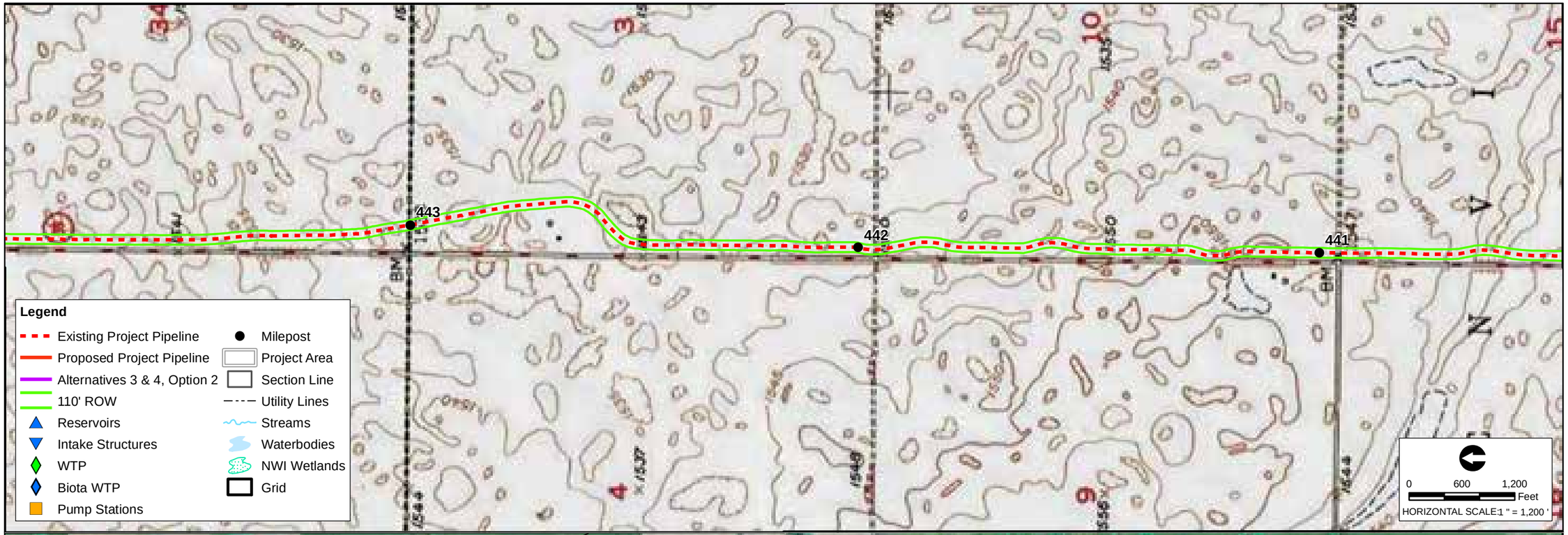
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. 01

Segment	Grid	County	Mileposts		Alternatives
			Begin	End	
A	A01-A04	McLean	0	12.7	Alts 3&4, Opt 2
A	A04-A17, G01	McLean, Ward	100	145.3	Alts 3&4, Opts 1-3
B	B02-B24, G01	Ward, Renville, Burke	200	272.2	Alts 1-4
B	G01, C02	Ward	280	281.7	Alts 1-4
B	B02	Ward	285	285.2	Alts 1-4
B	B08	Ward	290	290.6	Alts 1-4
B	B20	Ward	295	296.3	Alts 1-4
C	C02-C17	Ward, Renville, Bottineau	300	337.4	Alts 1-4
C	C02	Ward	340	342.1	Alts 1-4
C	C06	Ward	350	350.5	Alts 1-4
C	C09, C10	Renville	360	363.7	Alts 1-4
C	C11, C12	Bottineau	370	373.1	Alts 1-4
C	C14, C15	Bottineau	380	383.5	Alts 1-4
D	D07-D22, C17, B23	Bottineau, Renville, Ward	400	437.5	Alts 1-4
D	D02-D06, C17	Bottineau	440	451.1	Alts 1-4
D	D10, D11	Bottineau	460	461	Alts 1-4
D	D13-D17	Renville	470	484.1	Alts 1-4
E	E02-E19, C17	Bottineau	500	543	Alts 1-4
E	E04	Bottineau	550	553	Alts 1-4
E	E08-E10	Bottineau	560	566.1	Alts 1-4
E	E14-E16	Bottineau	570	576.4	Alts 1-4
E	E19-E22	Bottineau	580	589.4	Alts 1-4
E	E19, E23	Bottineau	590	593.1	Alts 1-4
F	F02-F16, B24	Burke, Divide	600	647.7	Alts 1-4
G	G01-G06	Ward	-	-	Alts 1-4
H	H01-H04	Pierce, Williams	-	-	Alts 1-4



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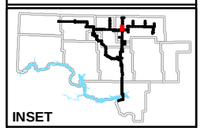

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D02

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BULK DISTRIBUTION PIPELINE

PLAN SHEET

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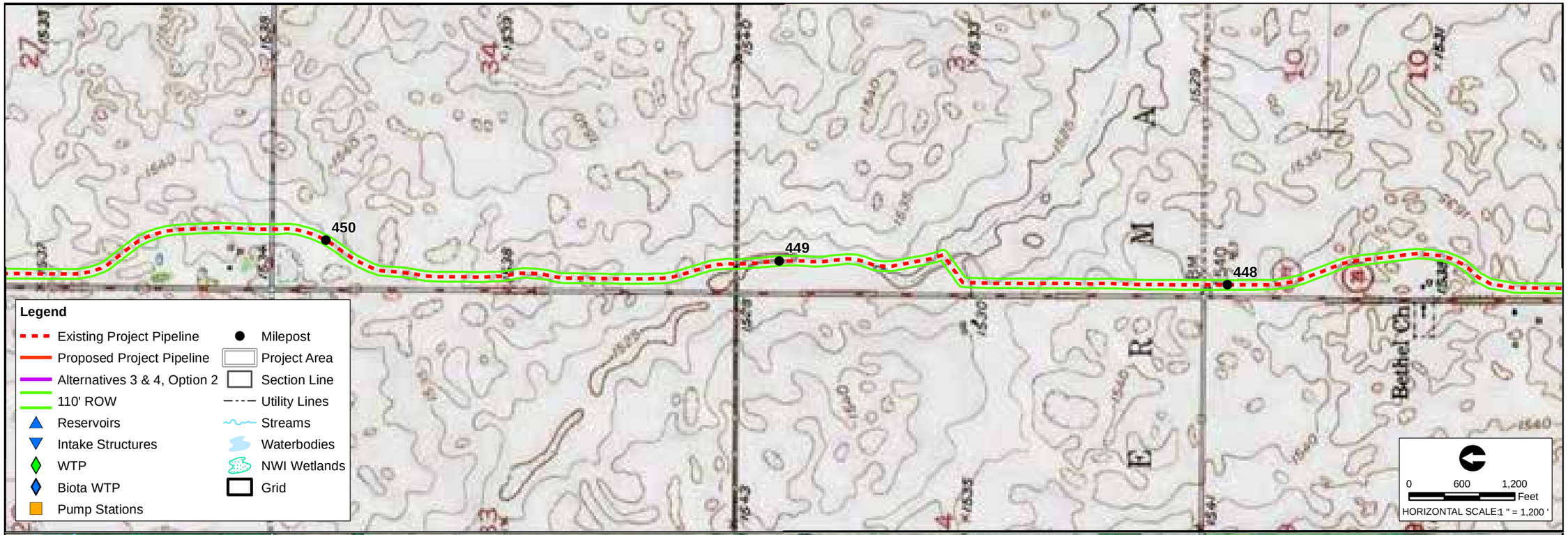
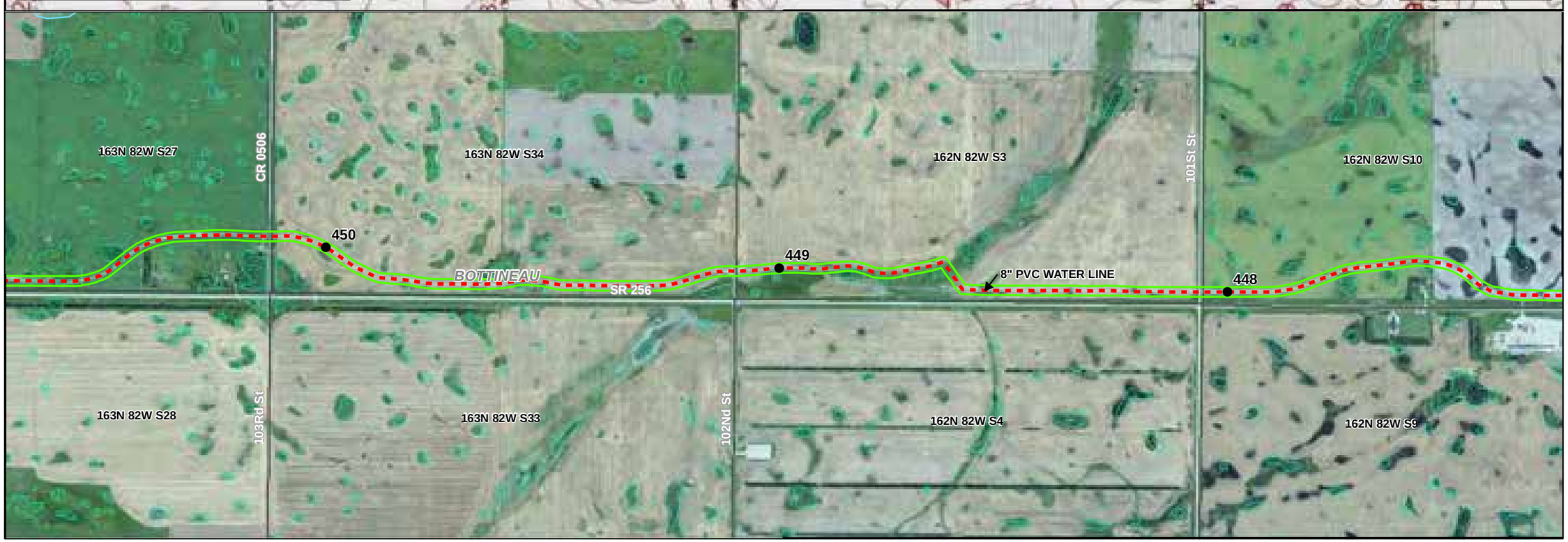
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D03





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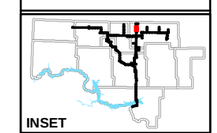

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Northwest Area Water Supply

DATE: 09/25/2012
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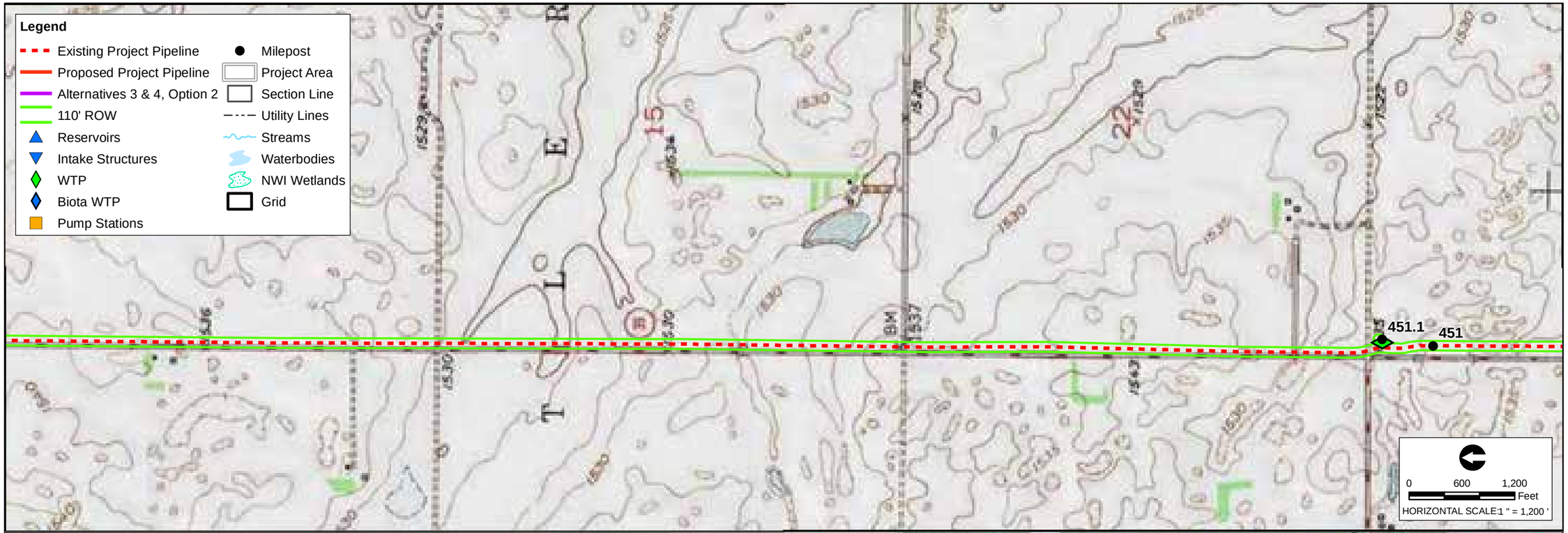
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D04



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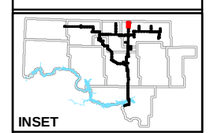

INSET

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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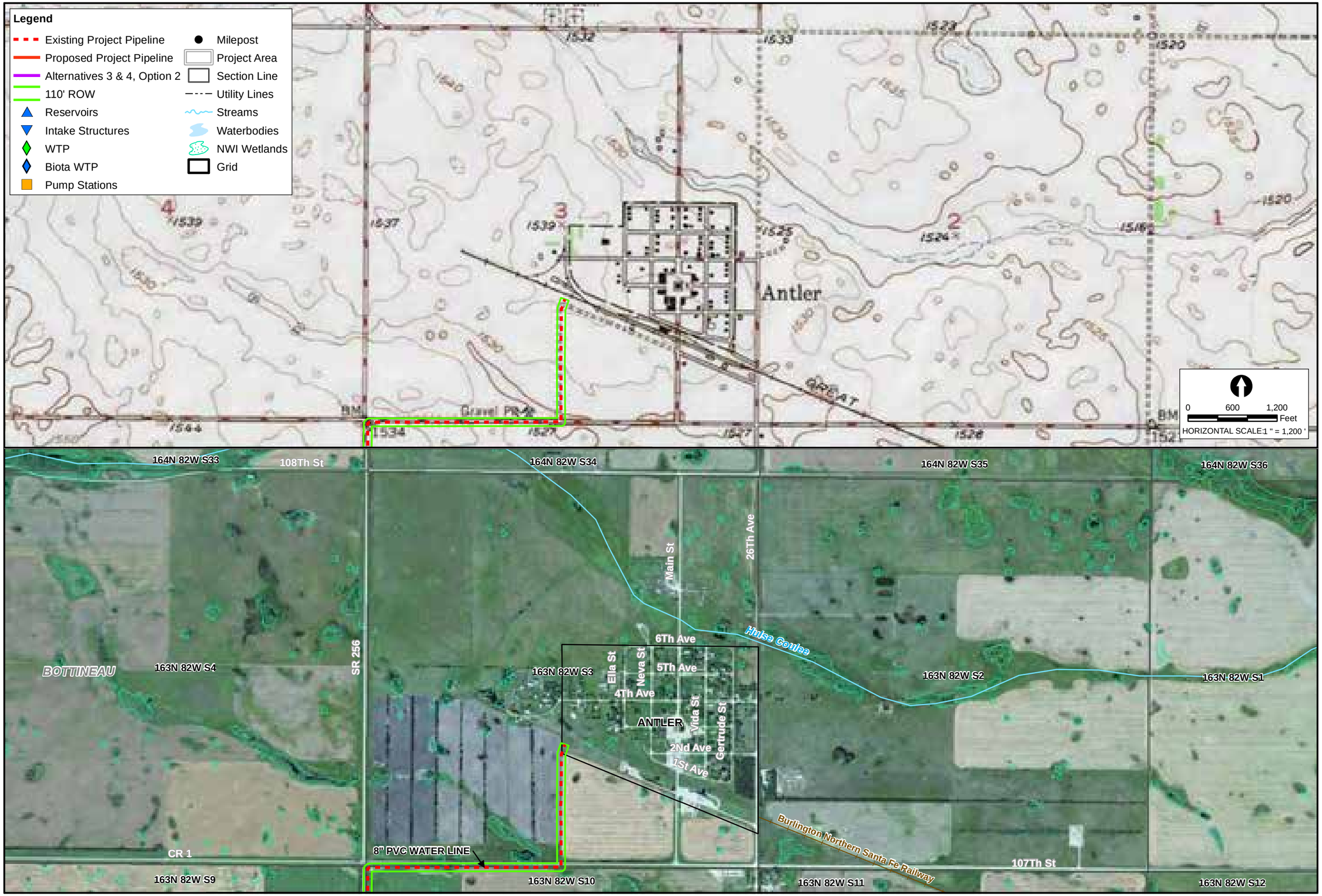
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D05



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Northwest Area Water Supply

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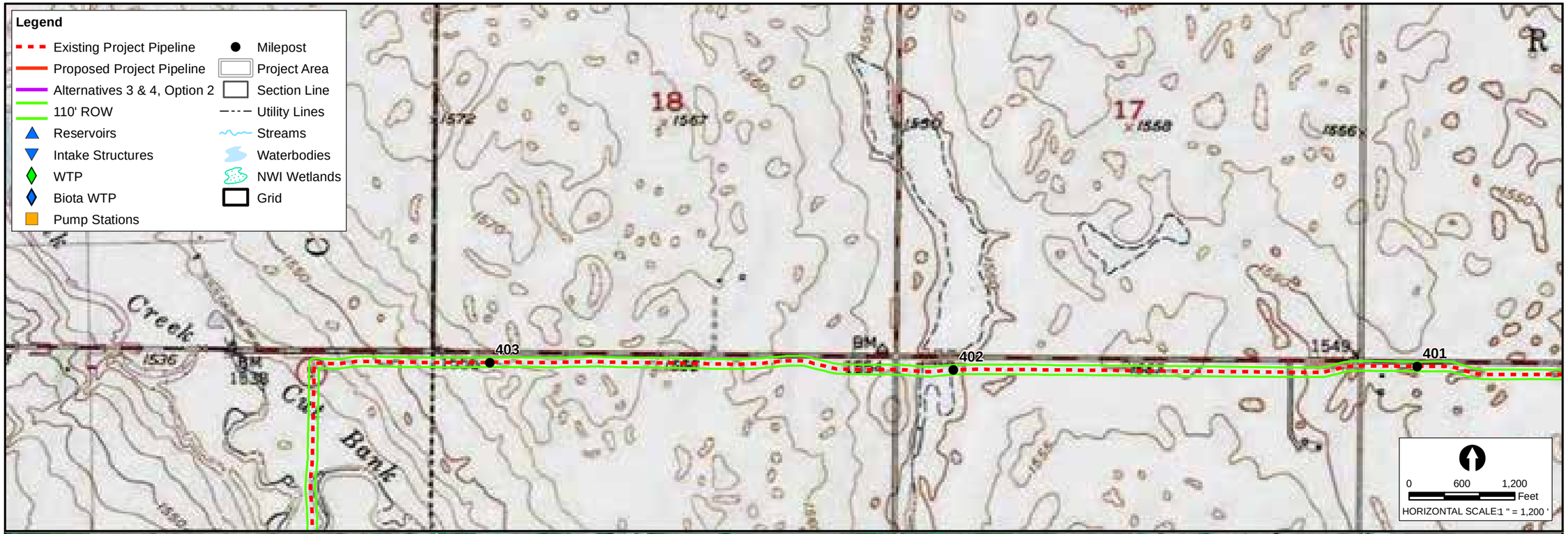
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D06



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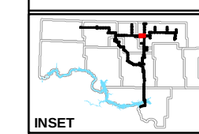

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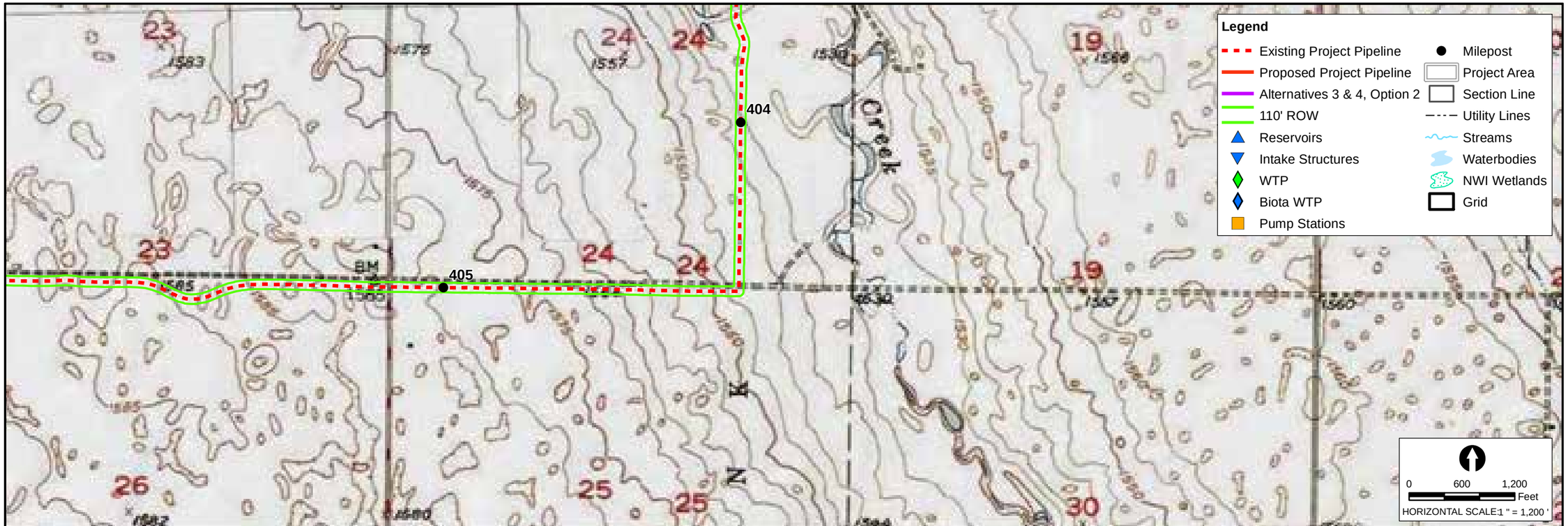
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D07



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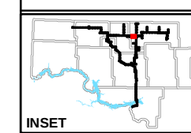

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PLAN SHEET

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DRAWN BY: NJH
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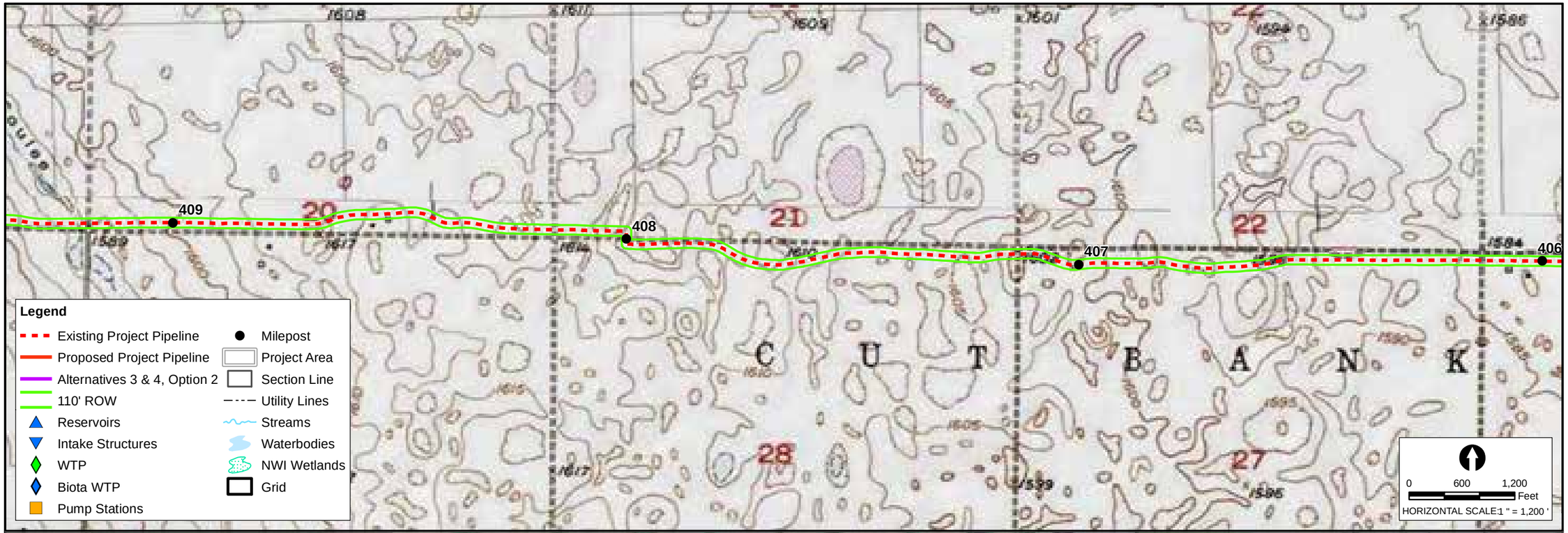
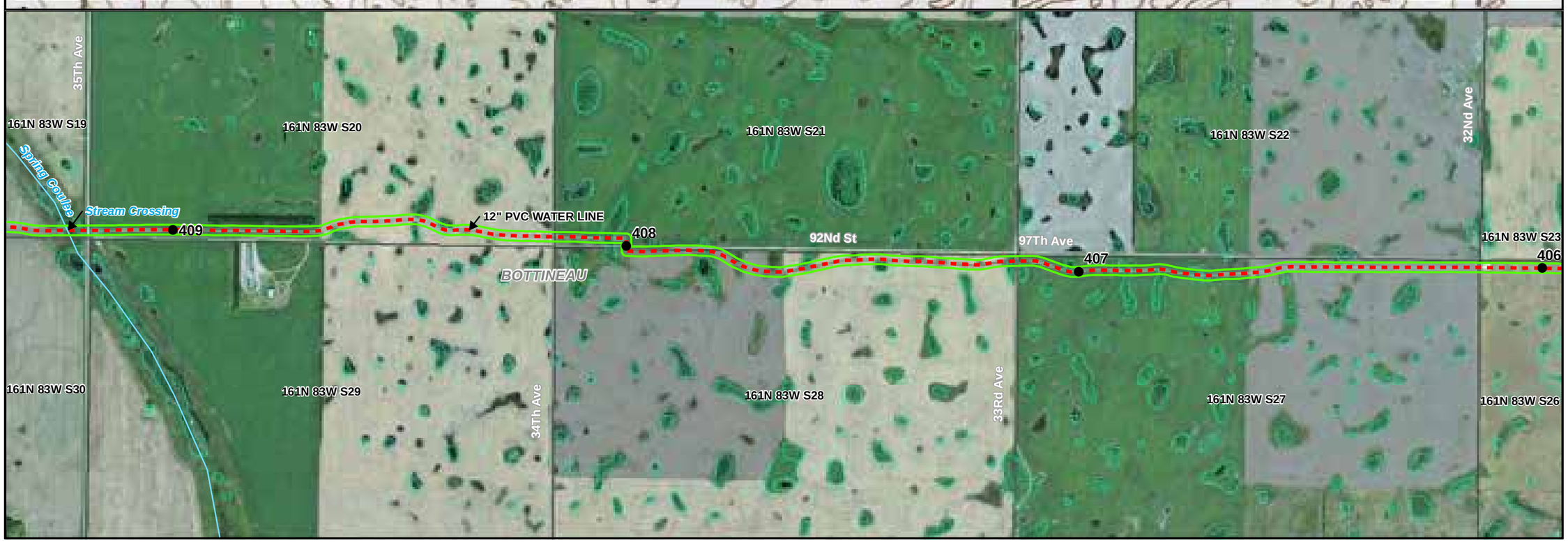
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D08





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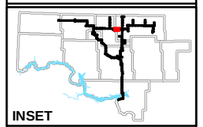

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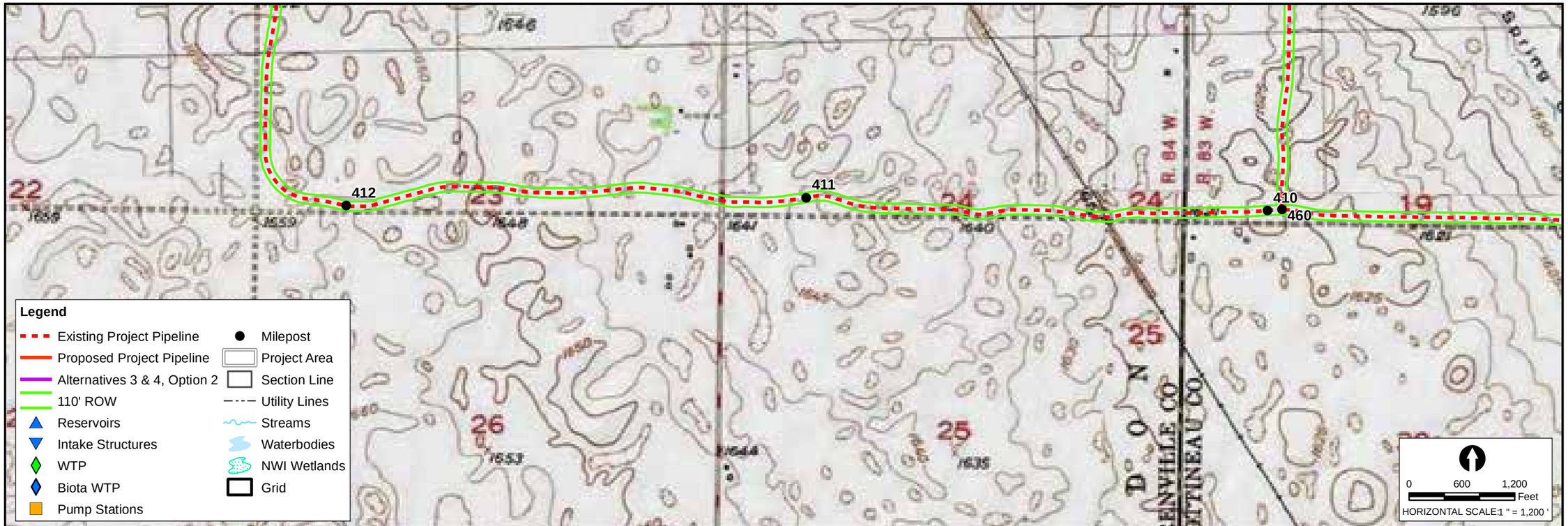
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D09



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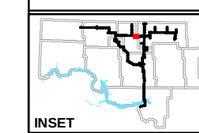

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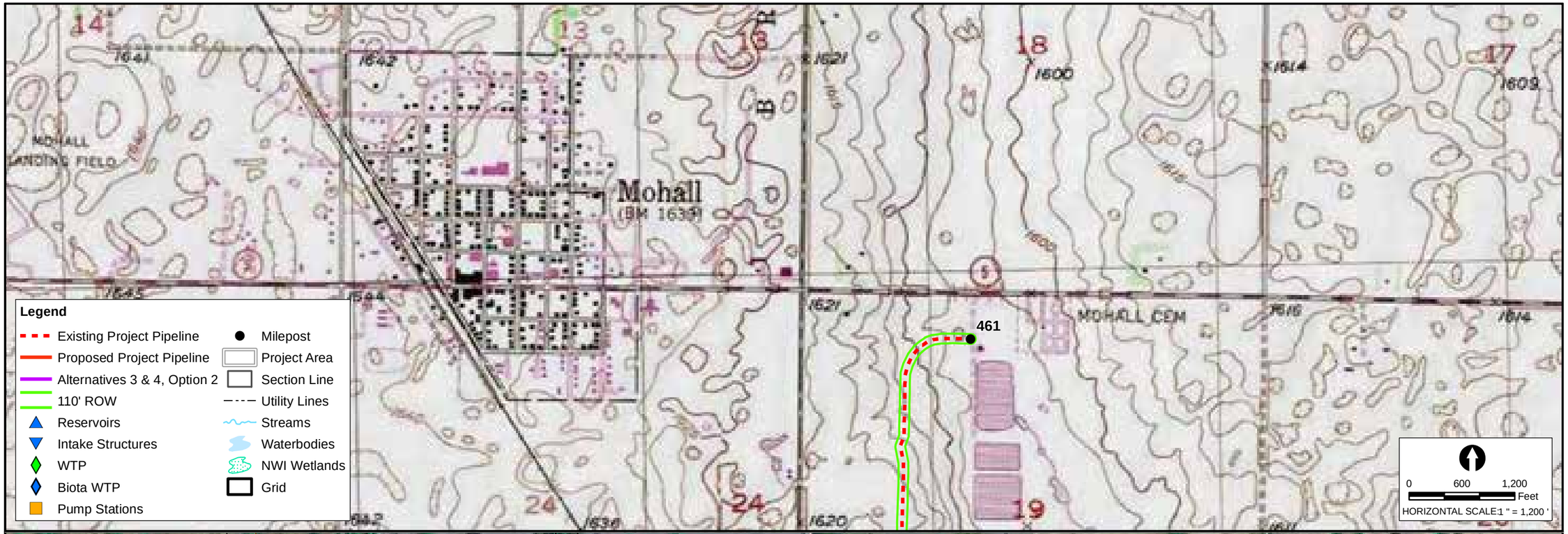
PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D10



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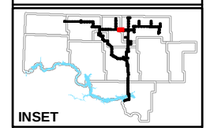

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Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
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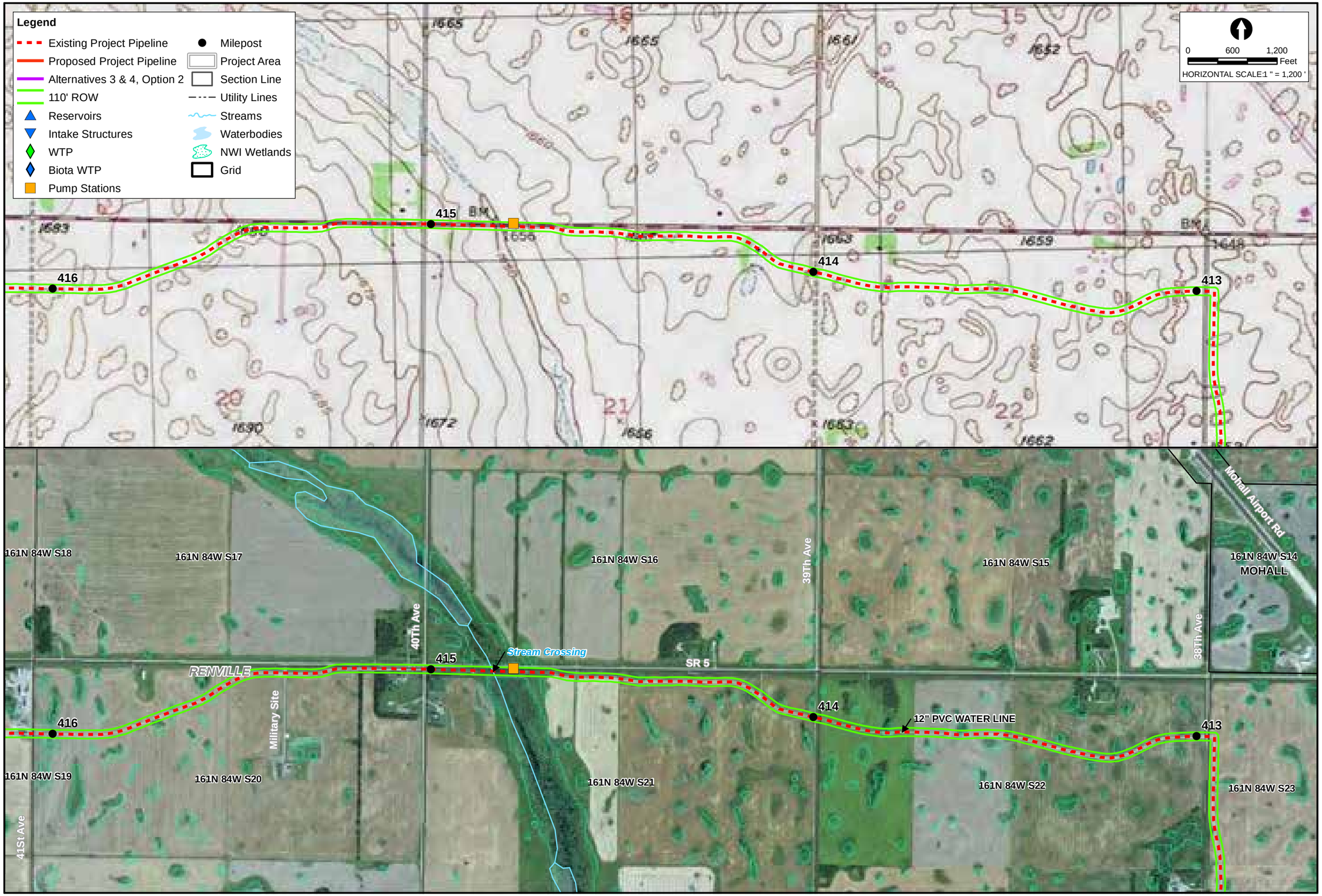
FIGURE NO. D11



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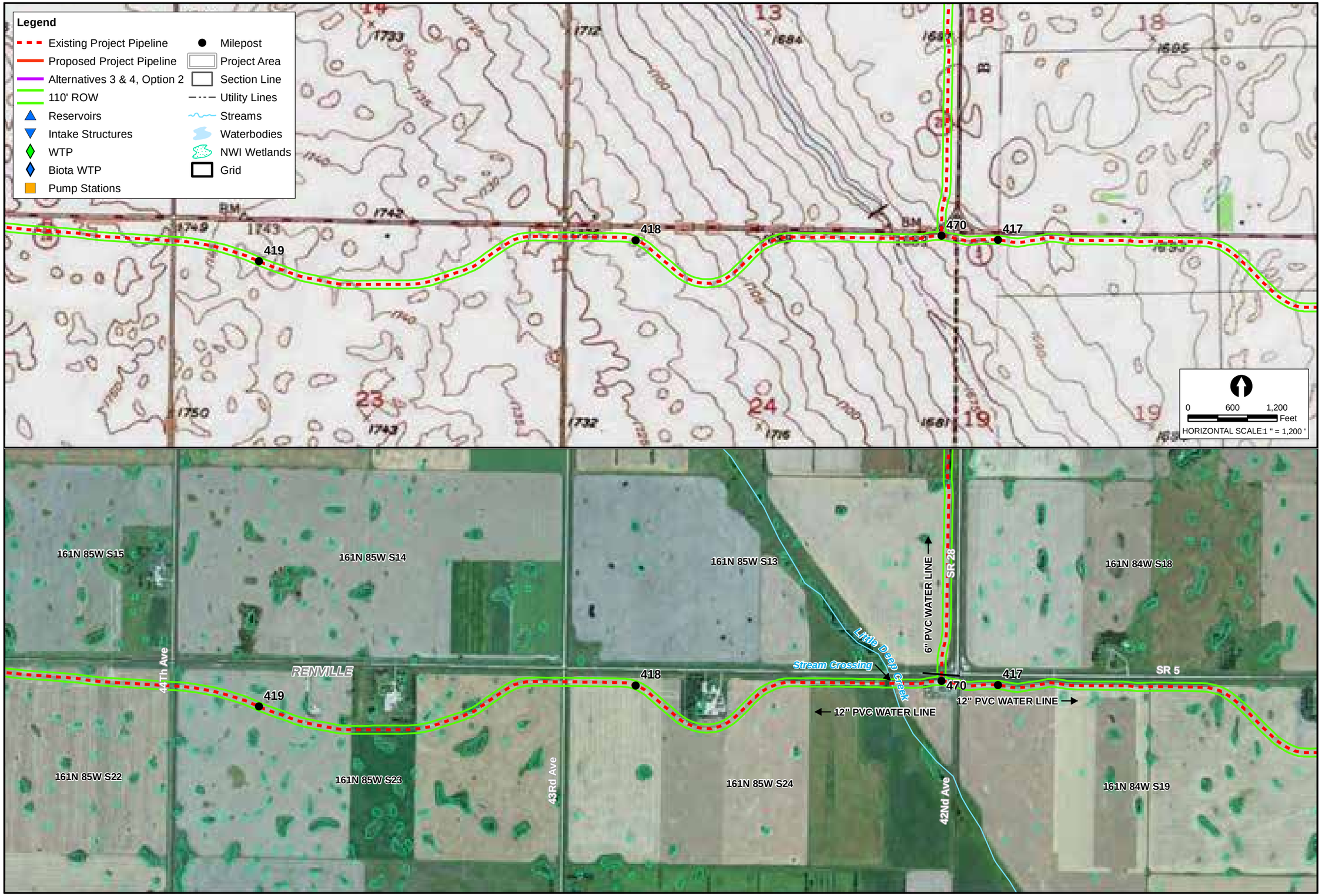
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D12



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DATE: 09/25/2012
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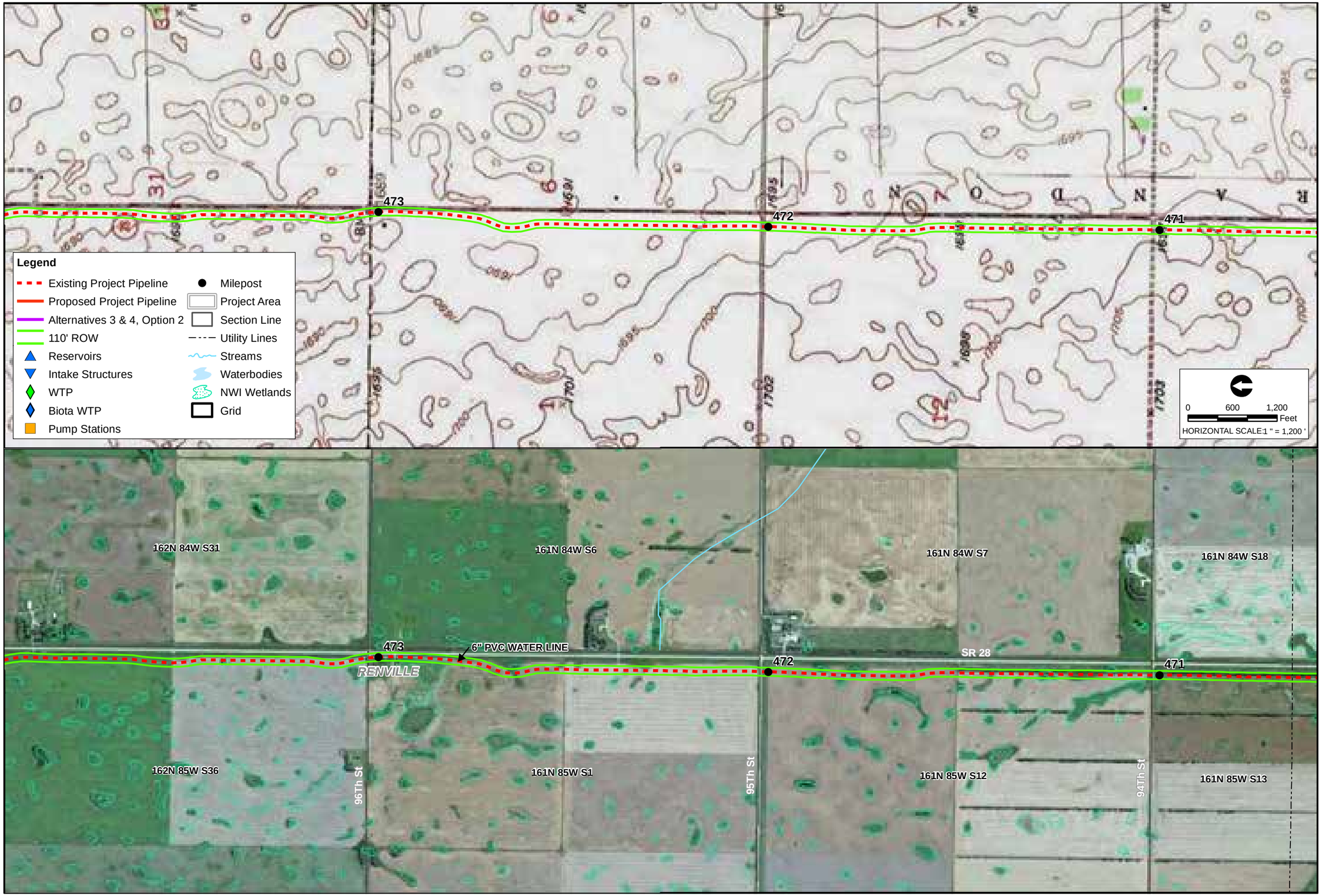
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D13



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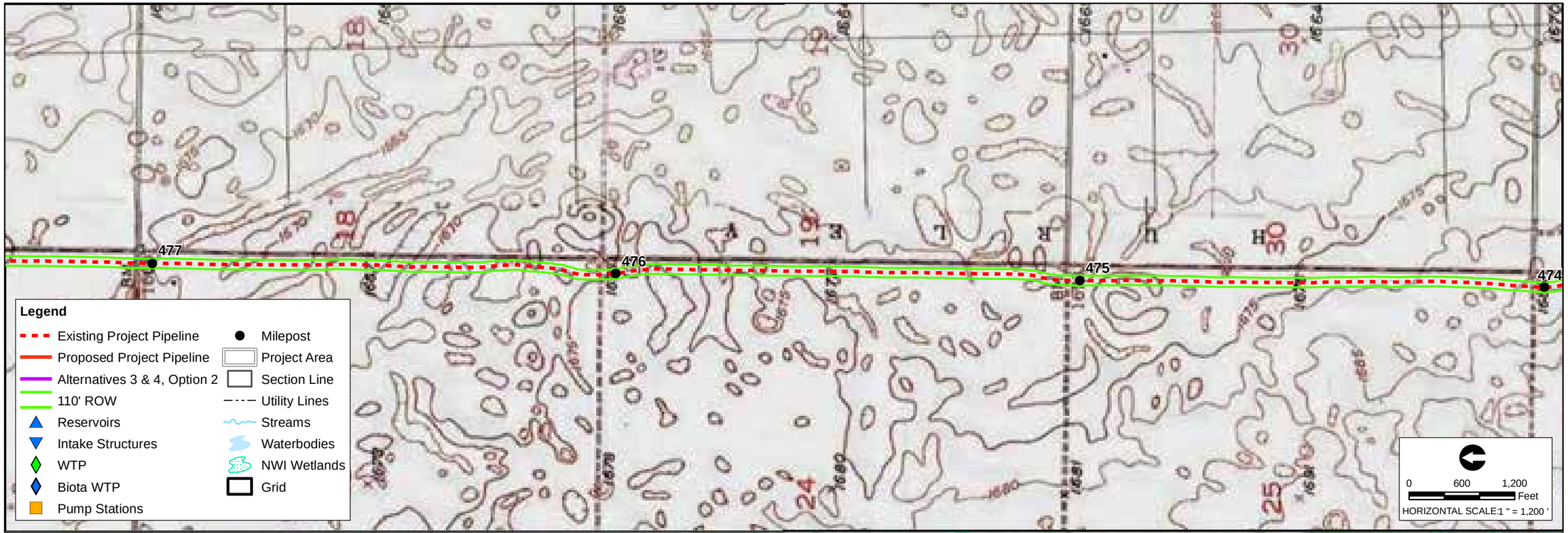
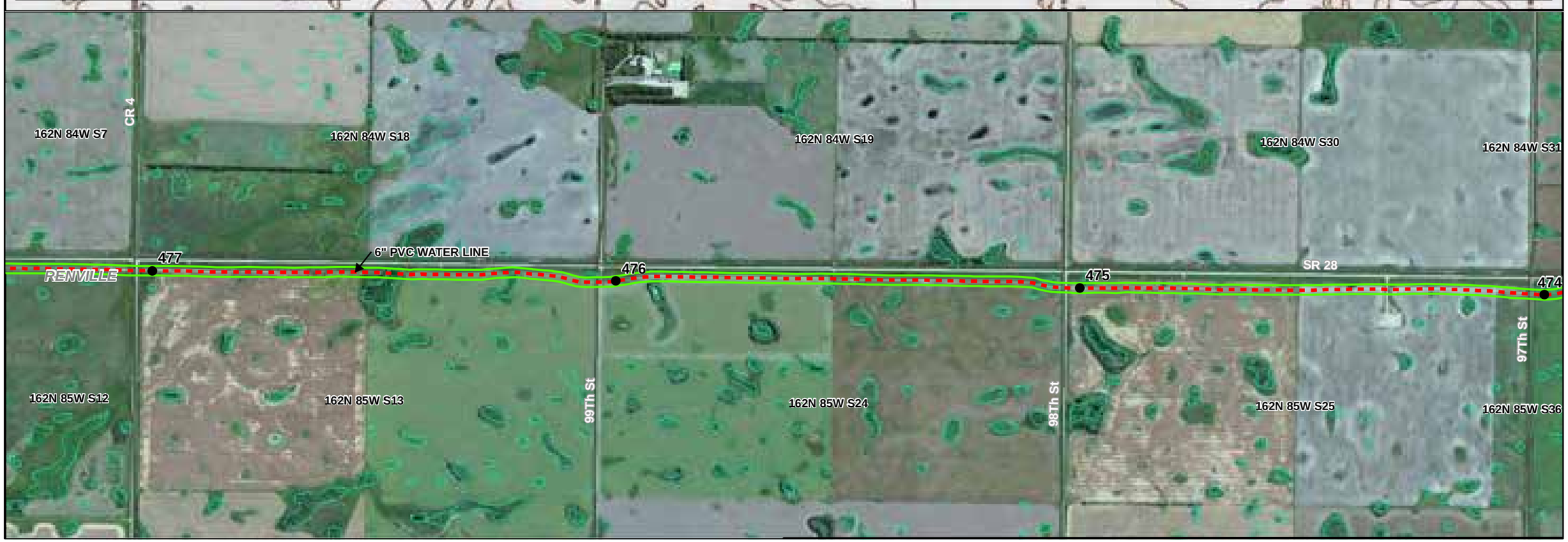
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D14





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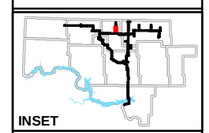

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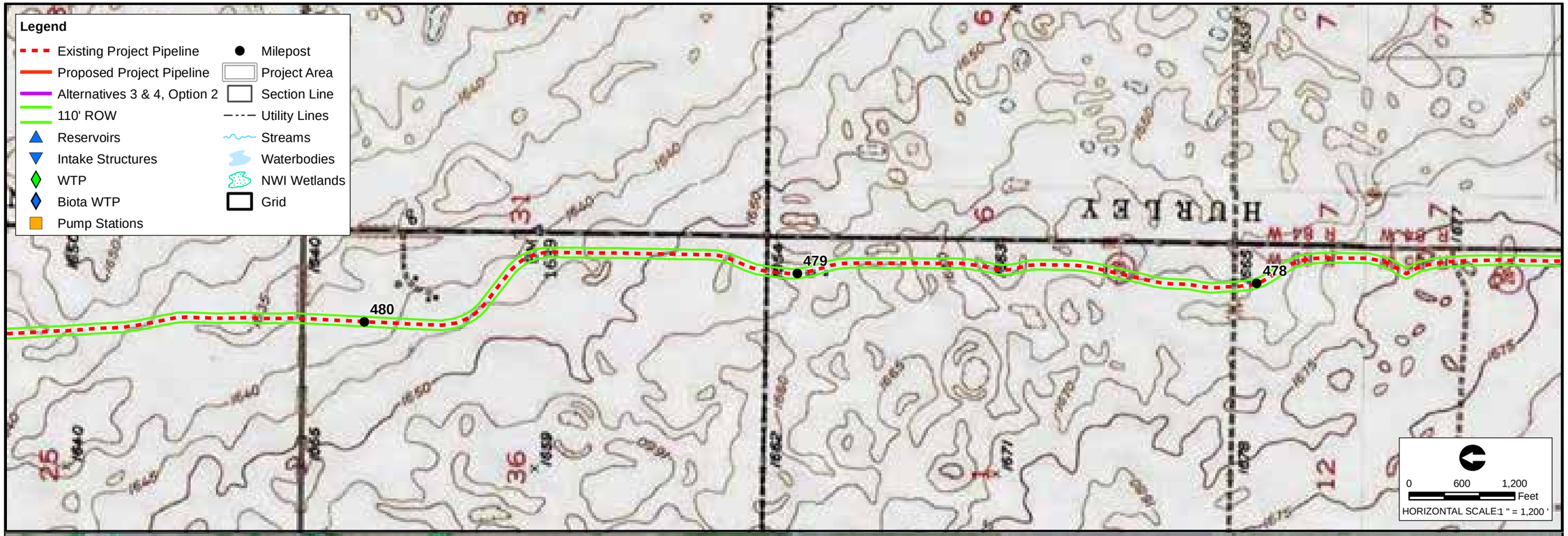
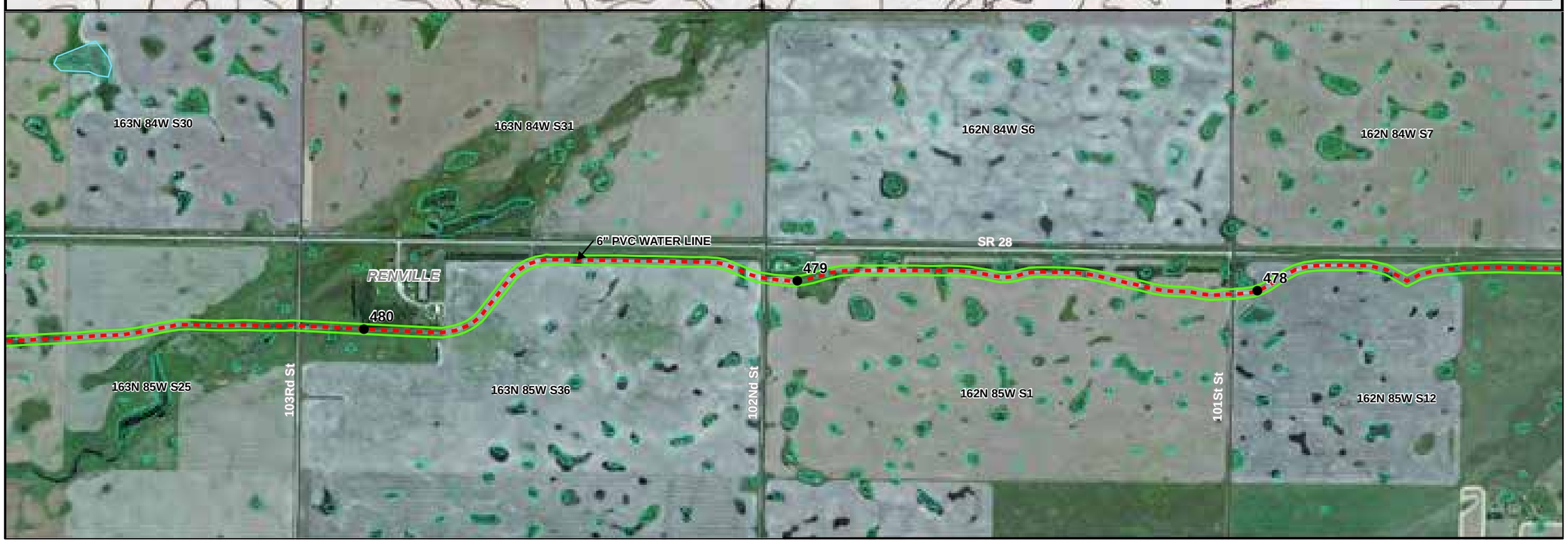
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D15





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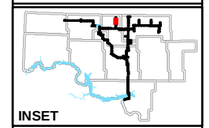

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DATE: 09/25/2012
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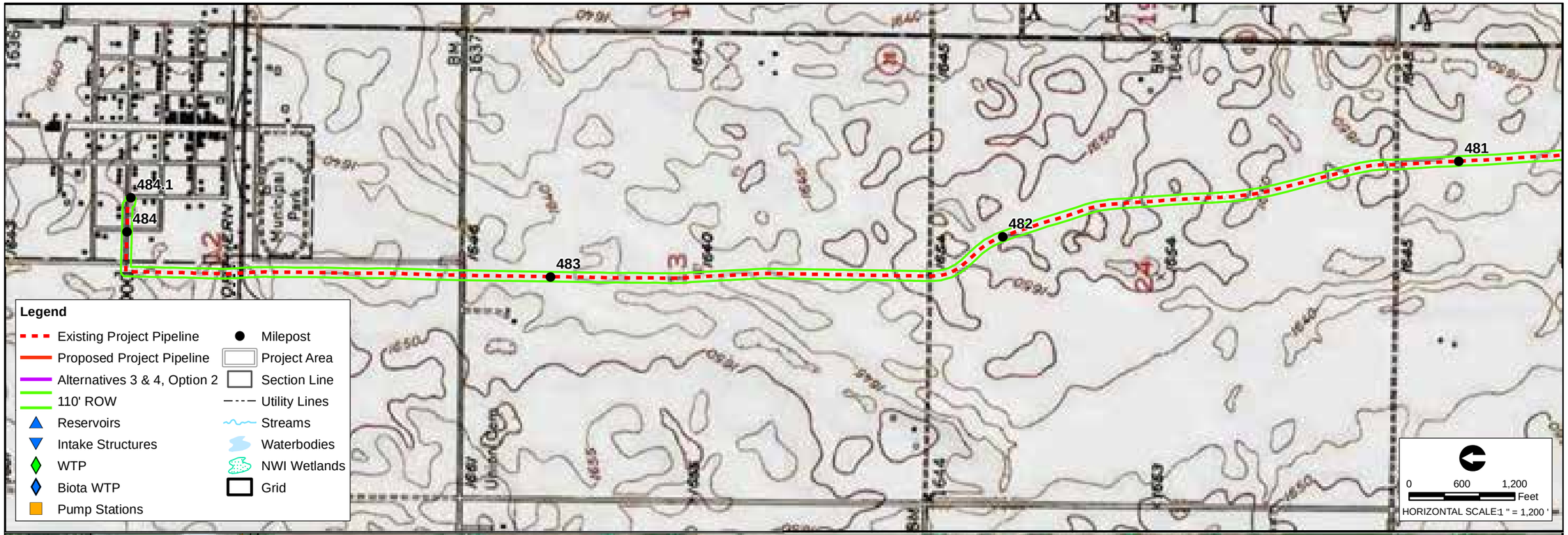
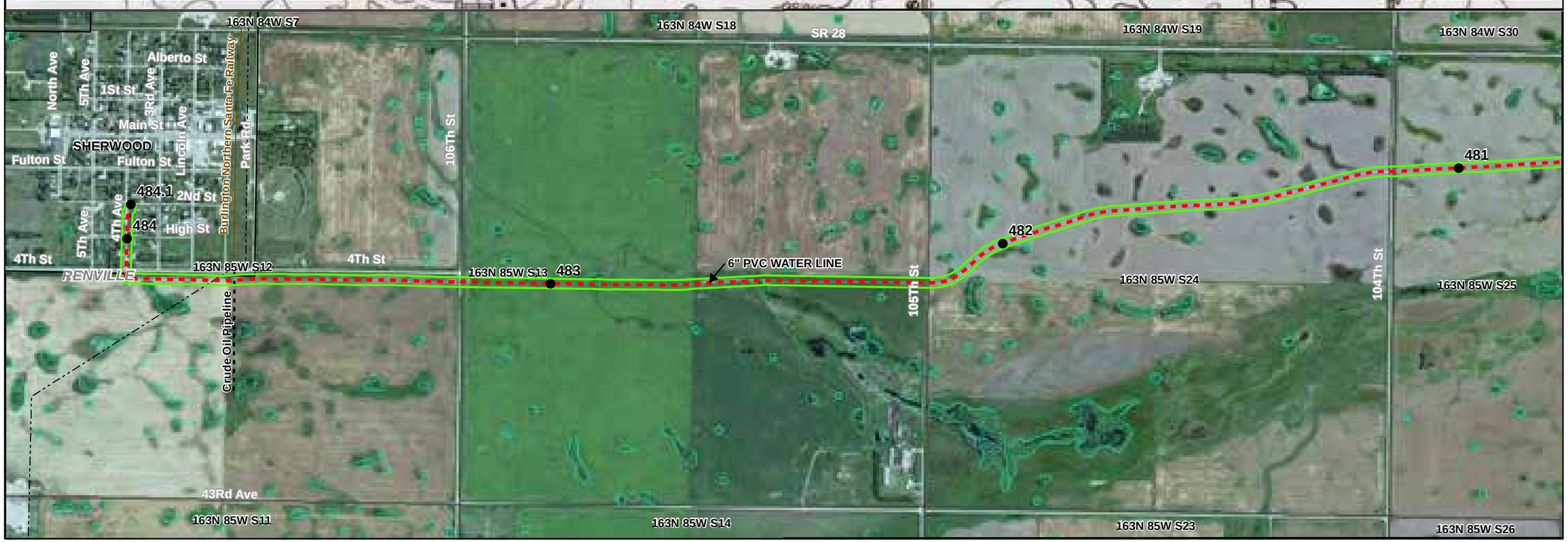
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D16





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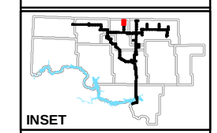

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DATE: 09/25/2012
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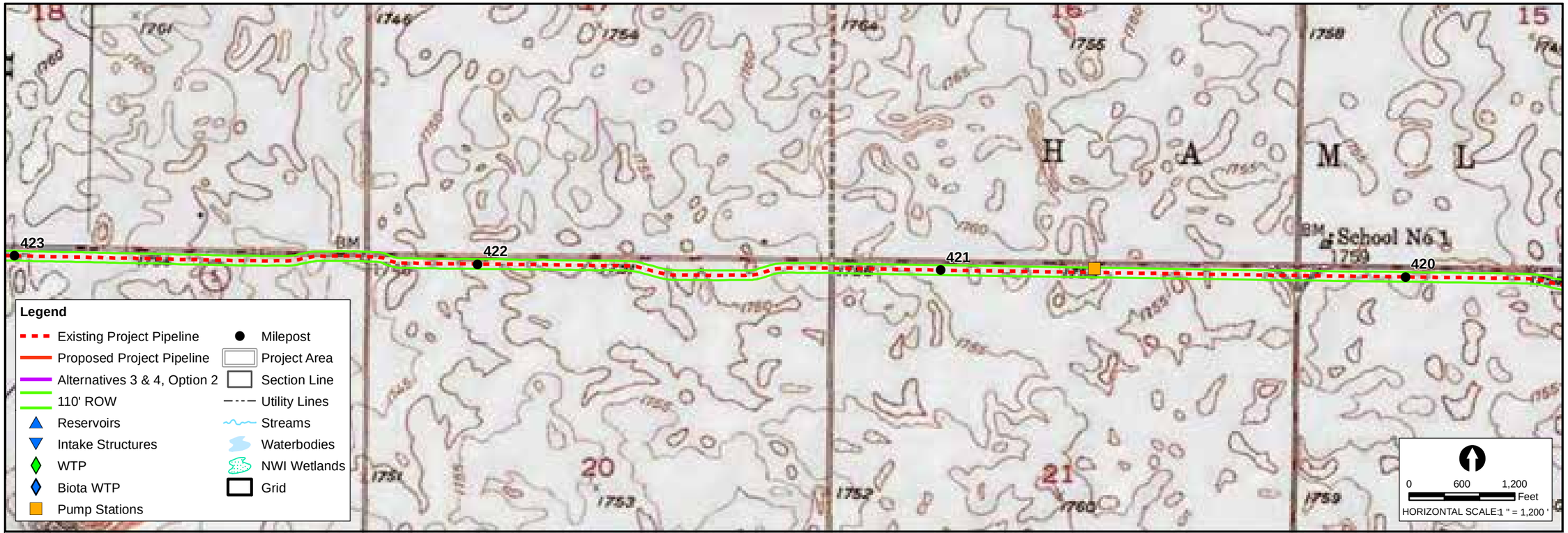
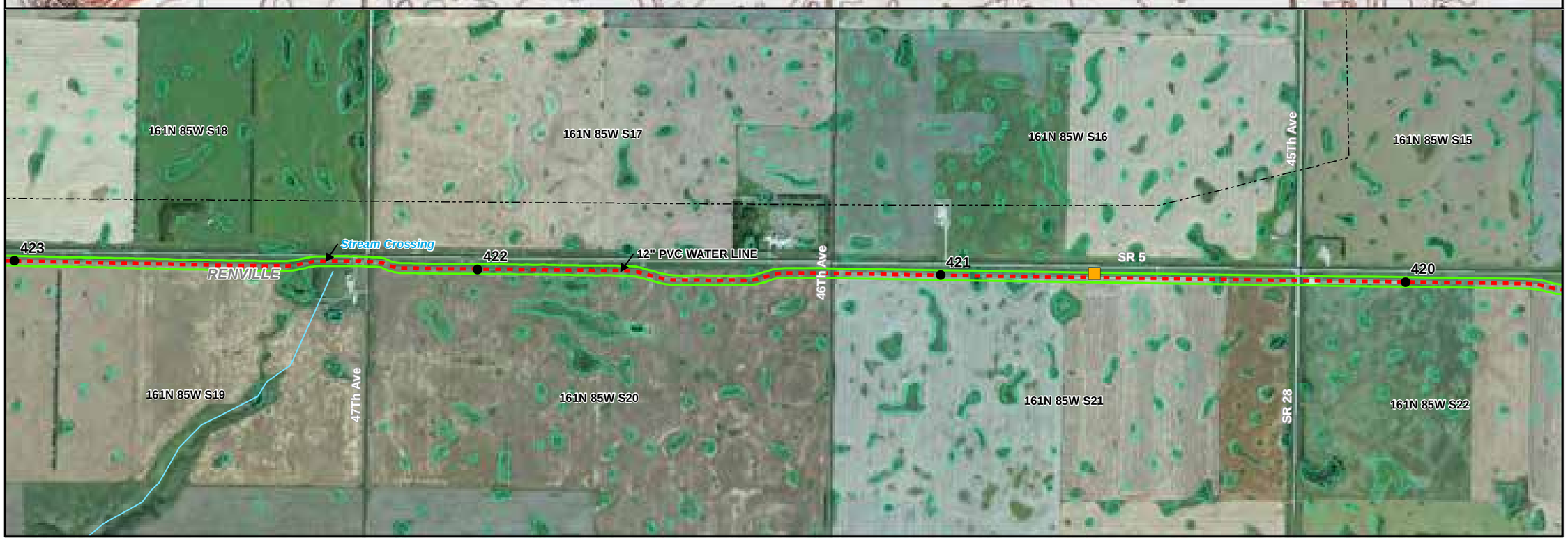
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D17





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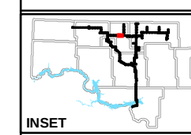

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PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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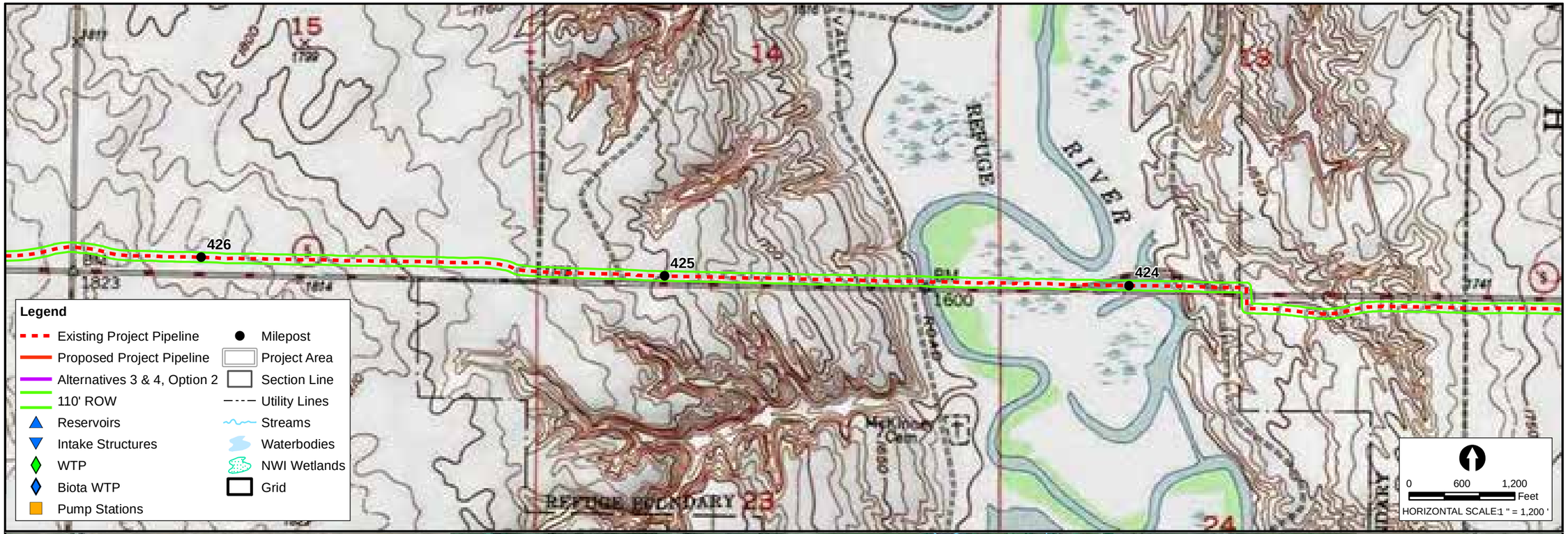
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D18



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DATE: 09/25/2012
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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D19

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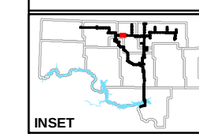

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PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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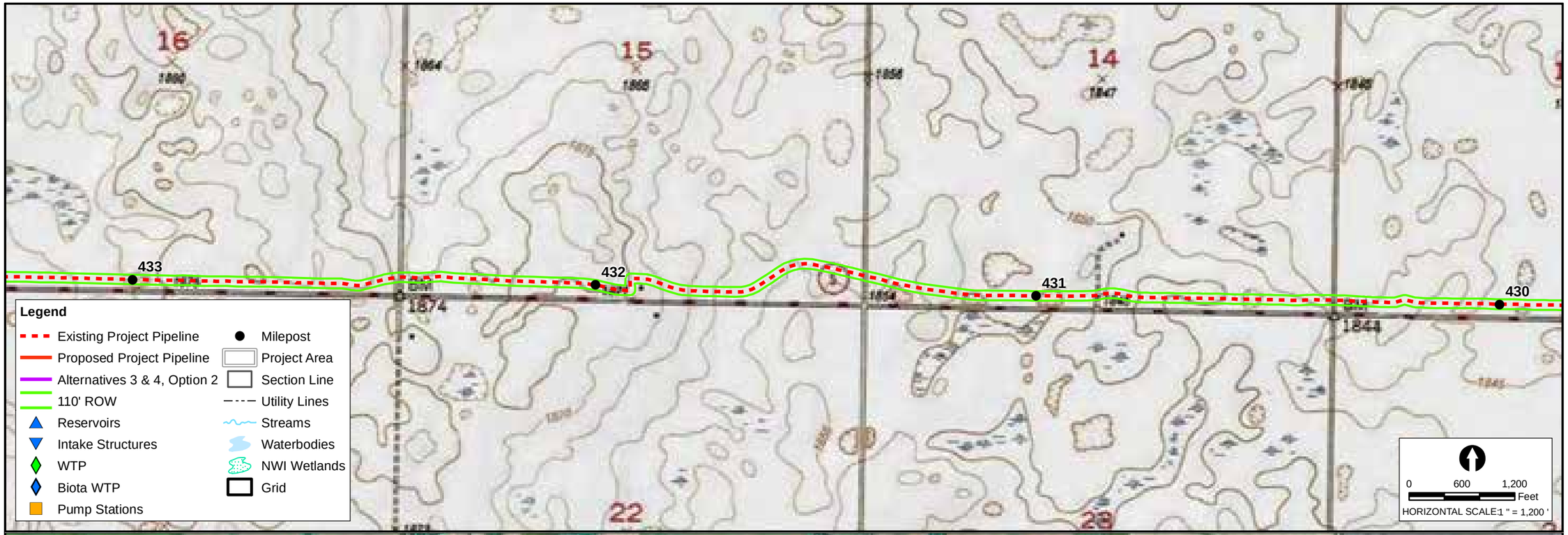
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D20



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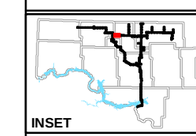

INSET

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
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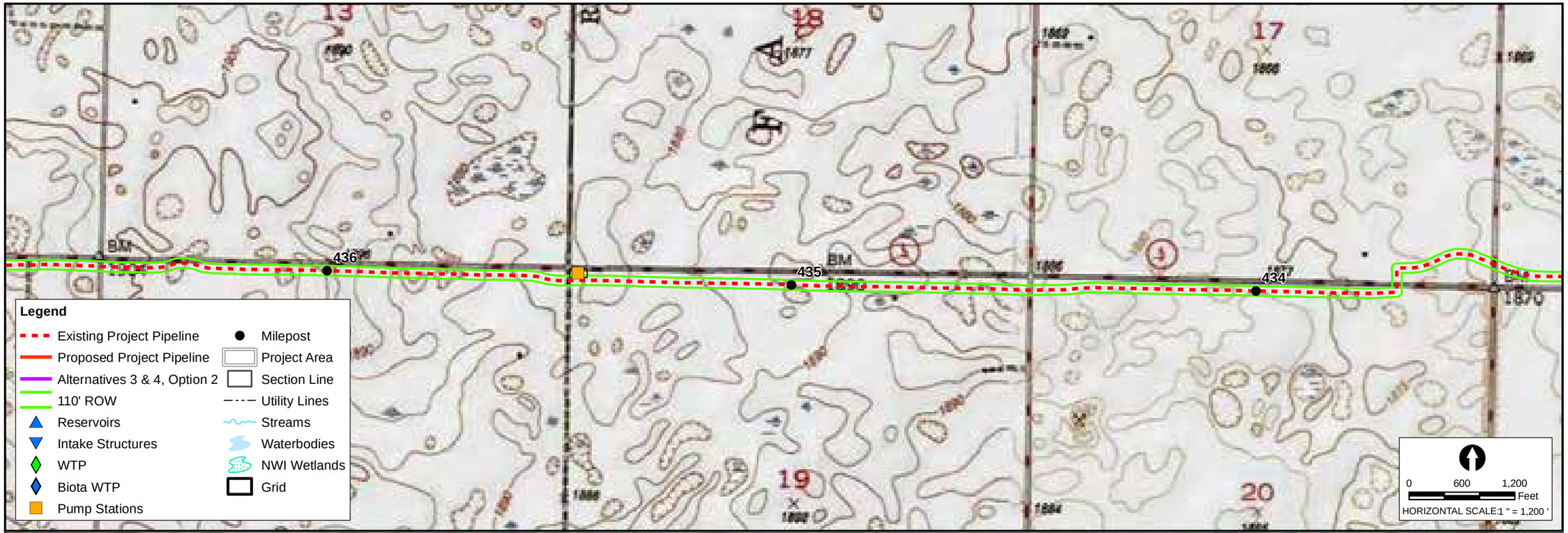
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D21



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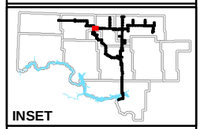

BULK DISTRIBUTION PIPELINE

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Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
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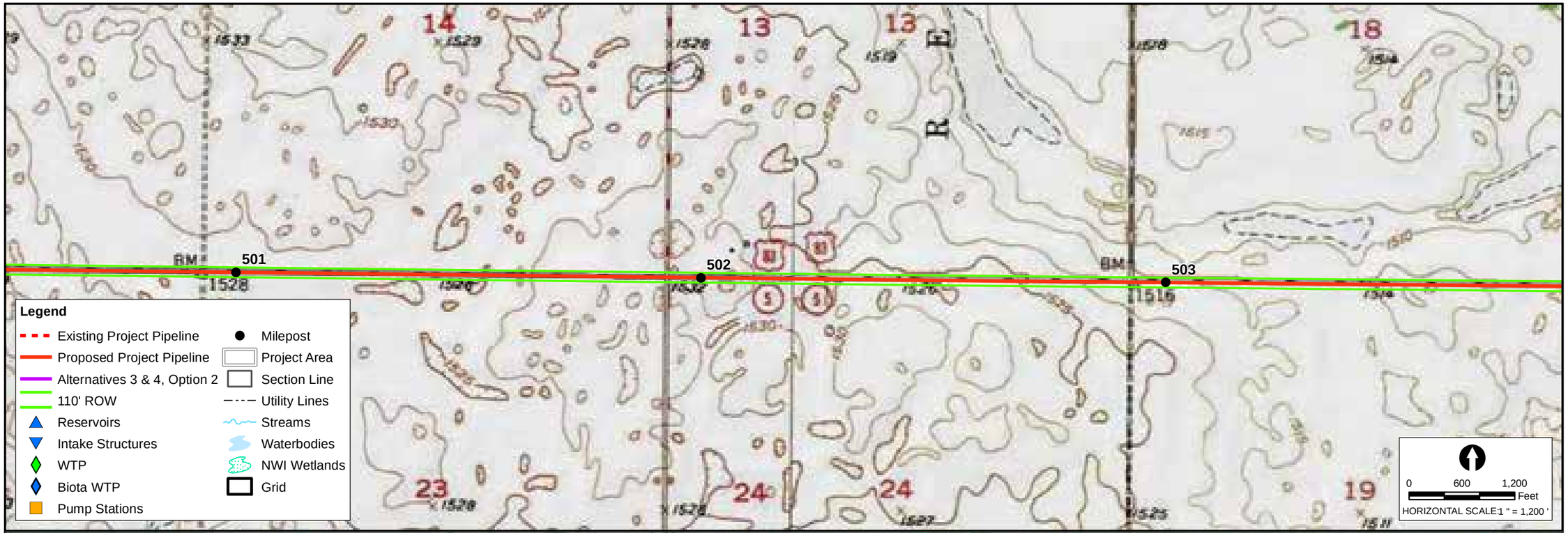
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. D22



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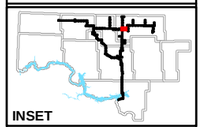


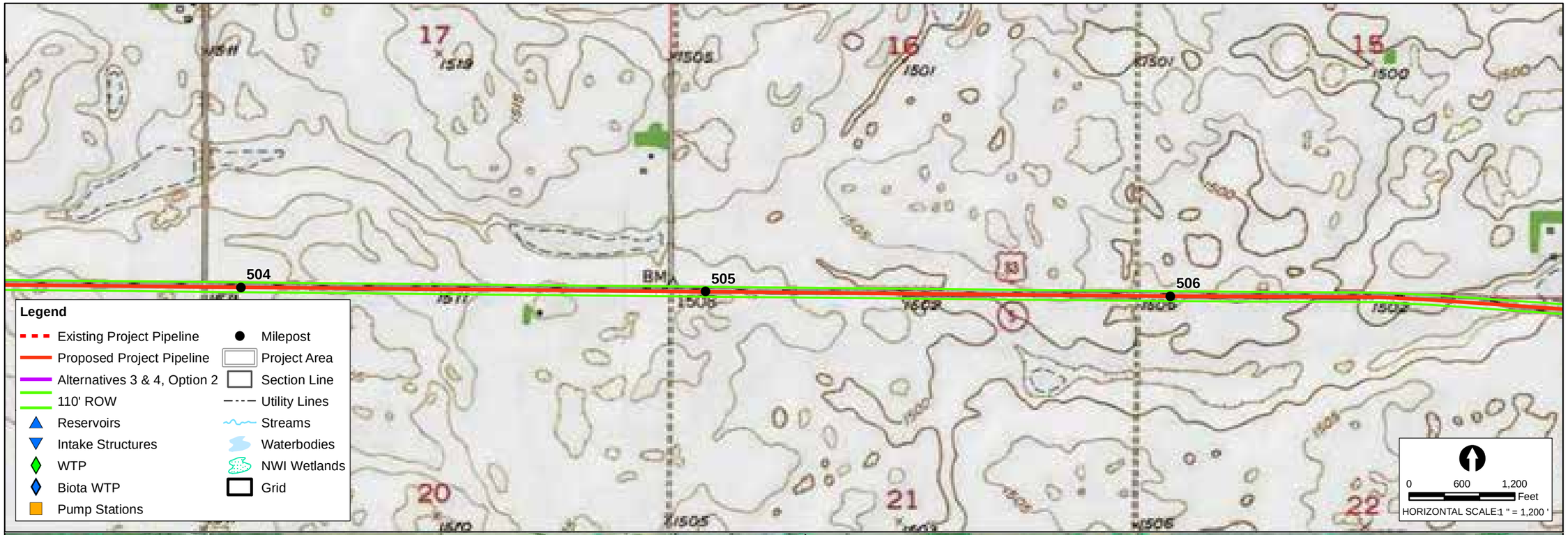
INSET

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. E02



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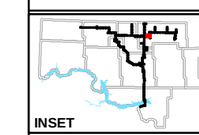

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Northwest Area Water Supply

DATE: 09/25/2012
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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. E03

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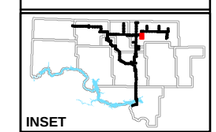

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DATE: 12/18/2012
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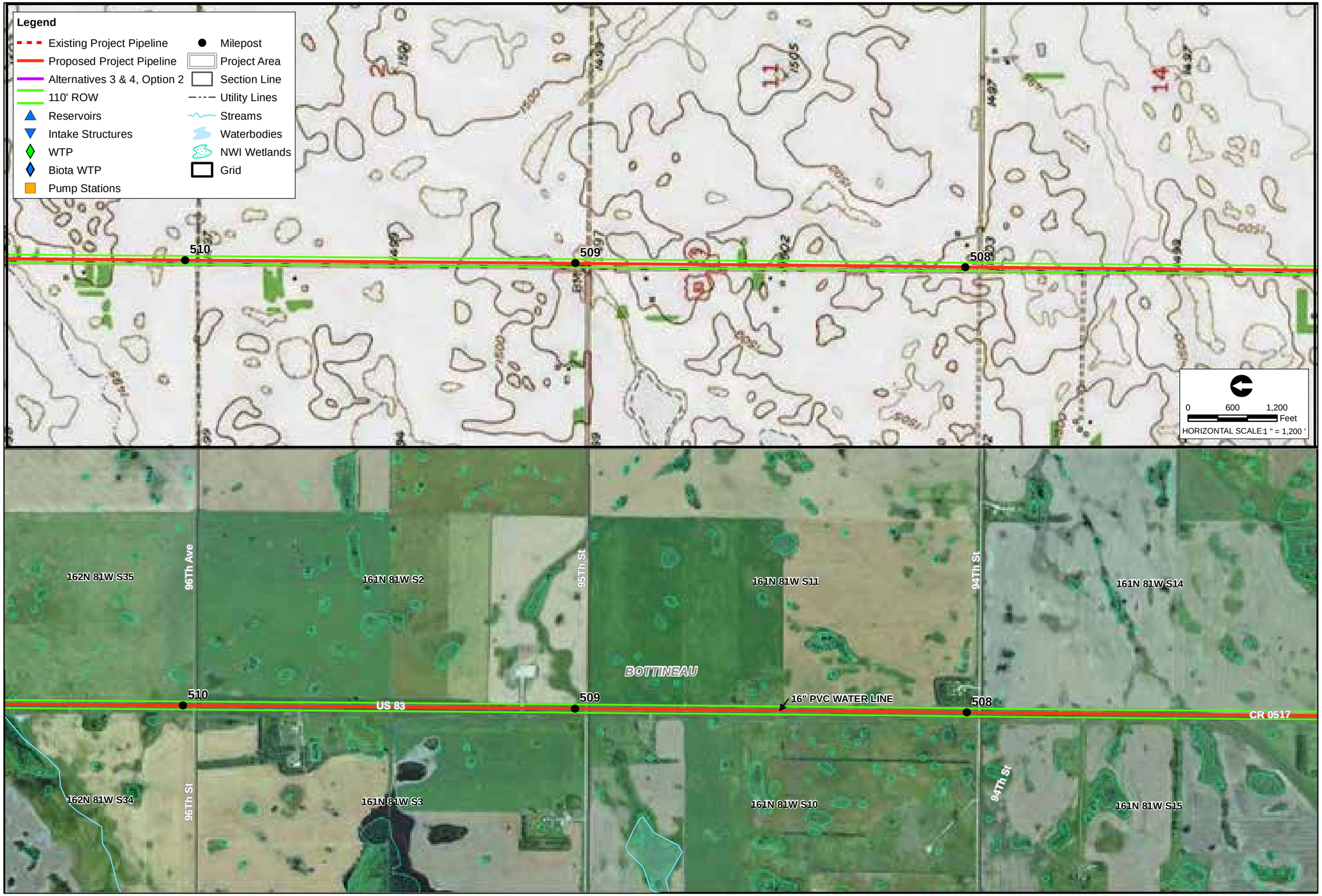
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. E04



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PLAN SHEET

Northwest Area Water Supply

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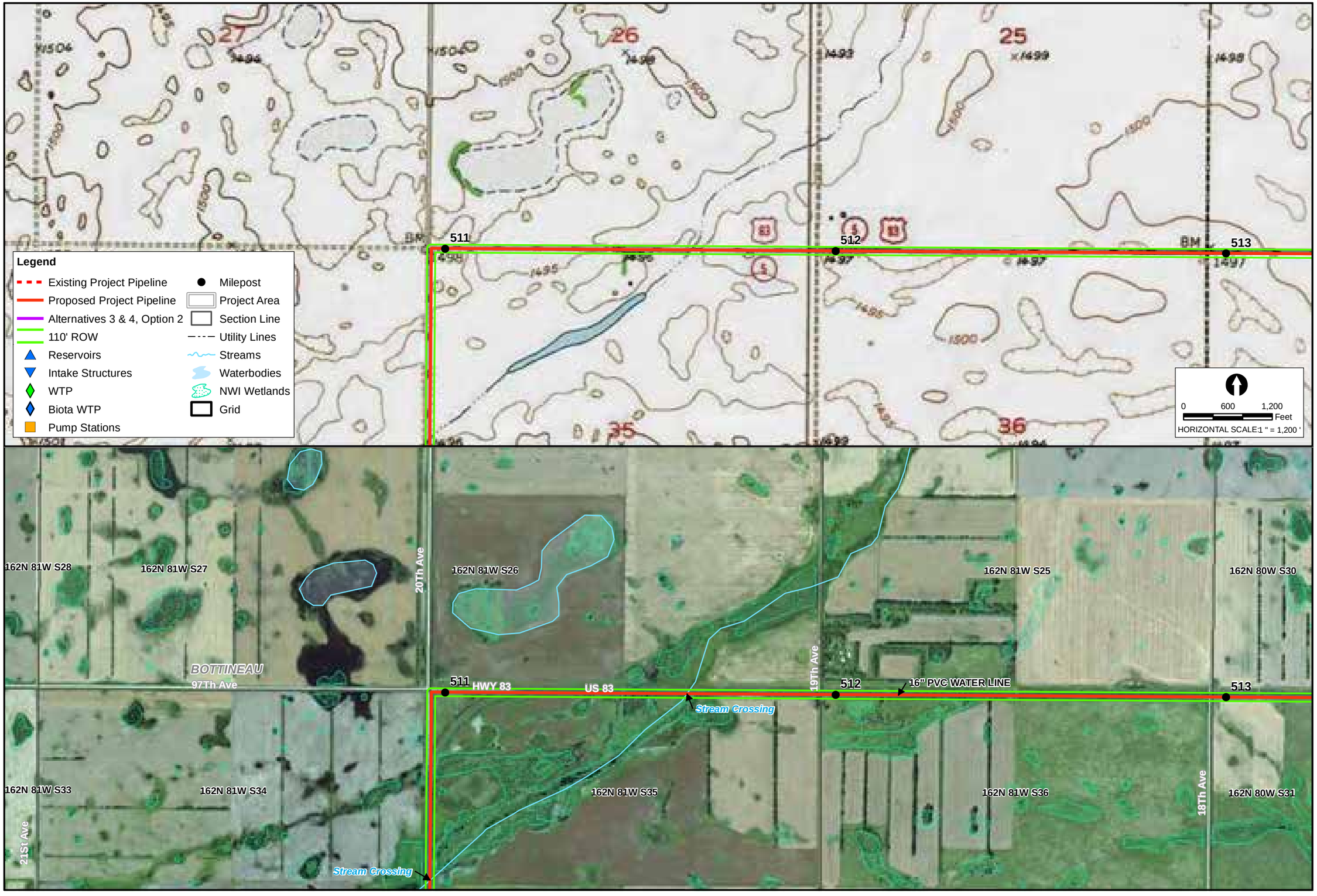
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. E05



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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. E06

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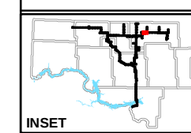

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DRAWN BY: NJH
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SCALE: AS SHOWN
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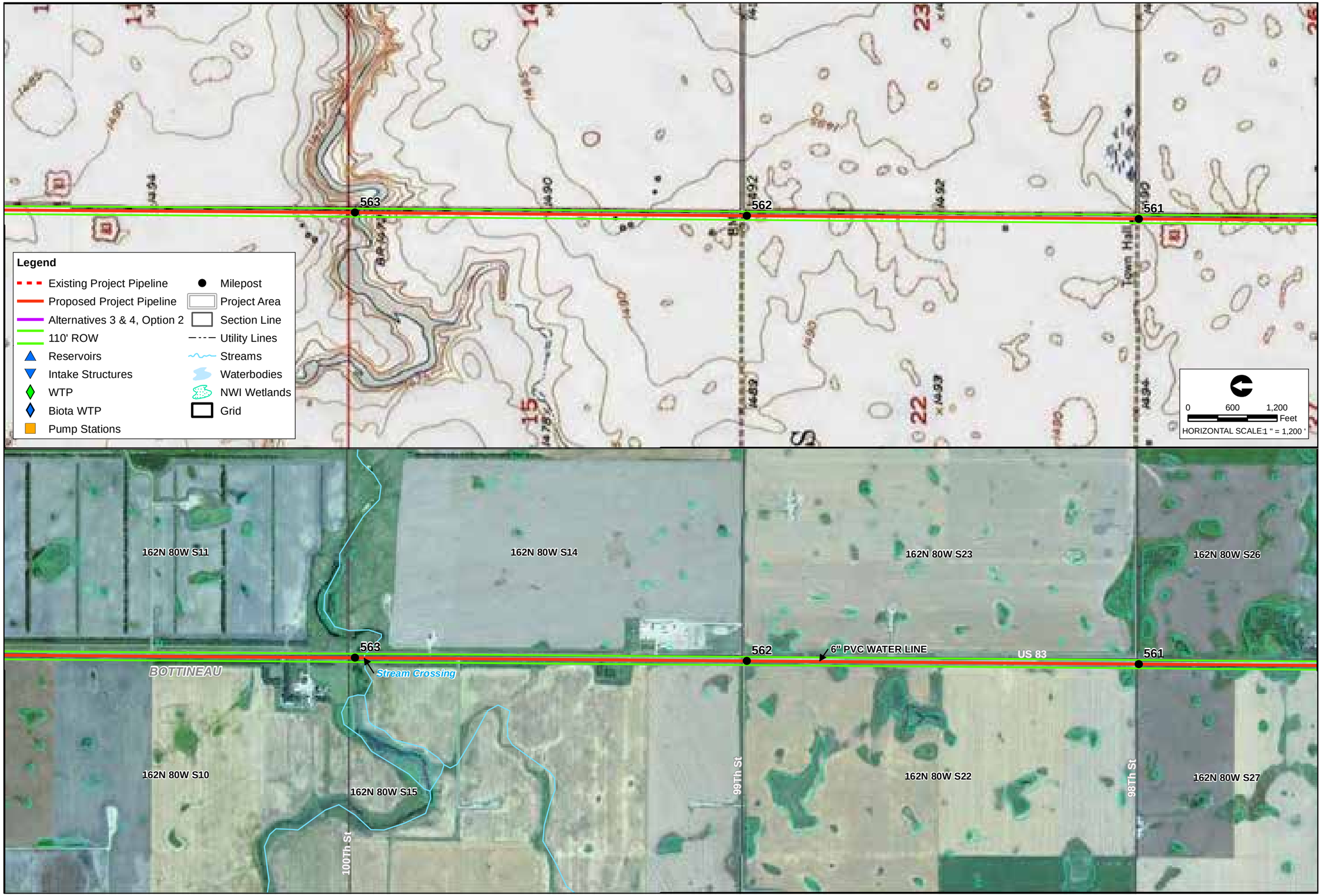

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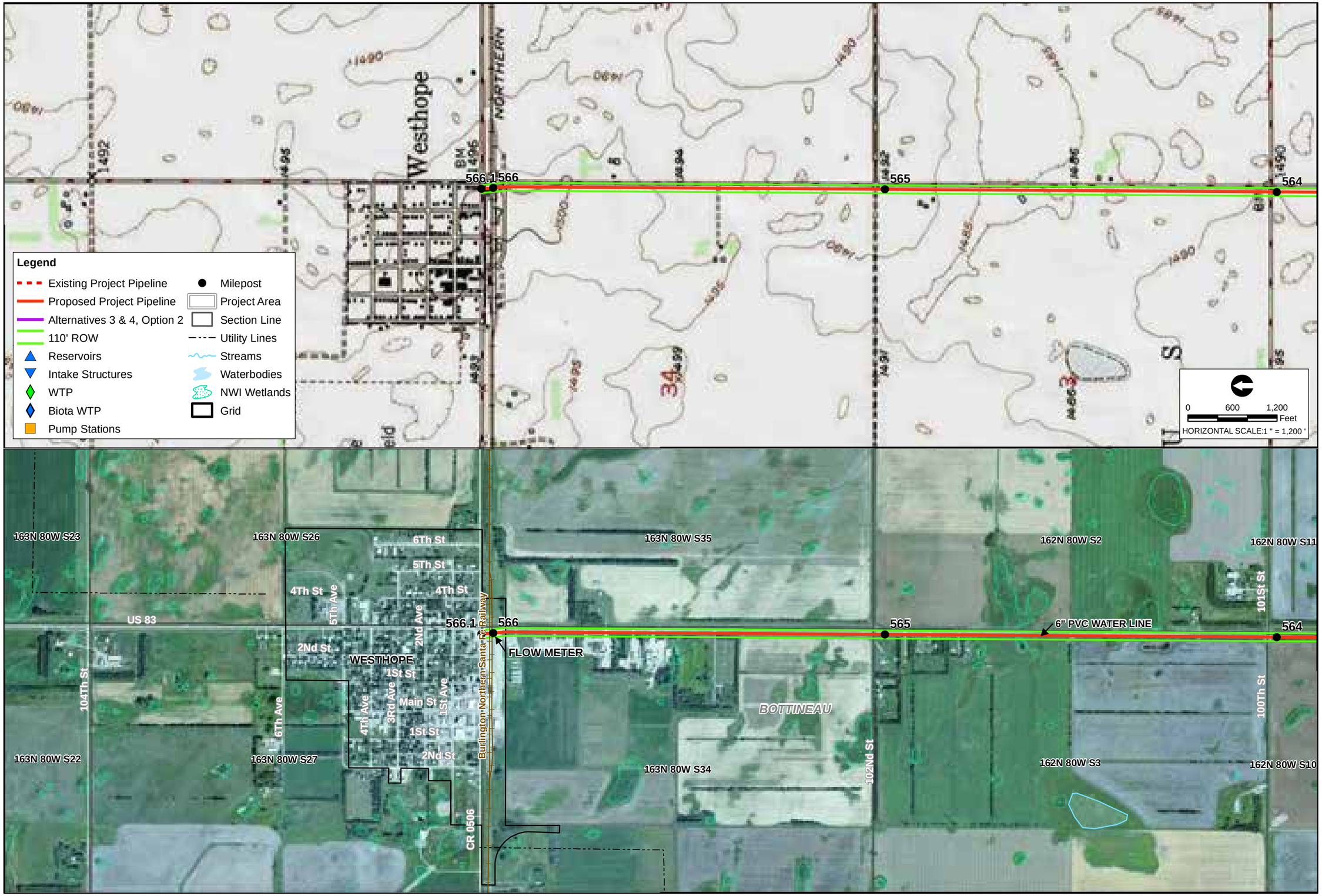
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. E08



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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. E09

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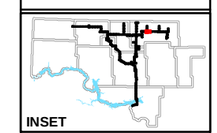

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CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
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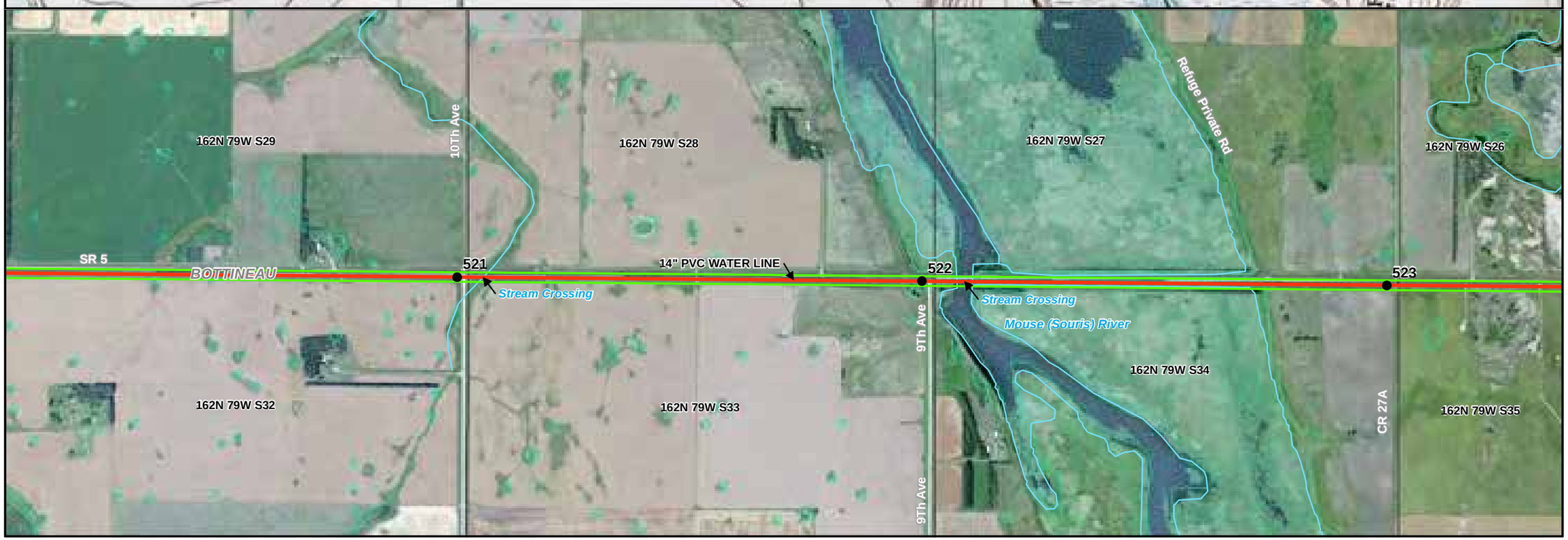

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ENTRIX JOB NO. 30442091
FIGURE NO. E11

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SCALE: AS SHOWN
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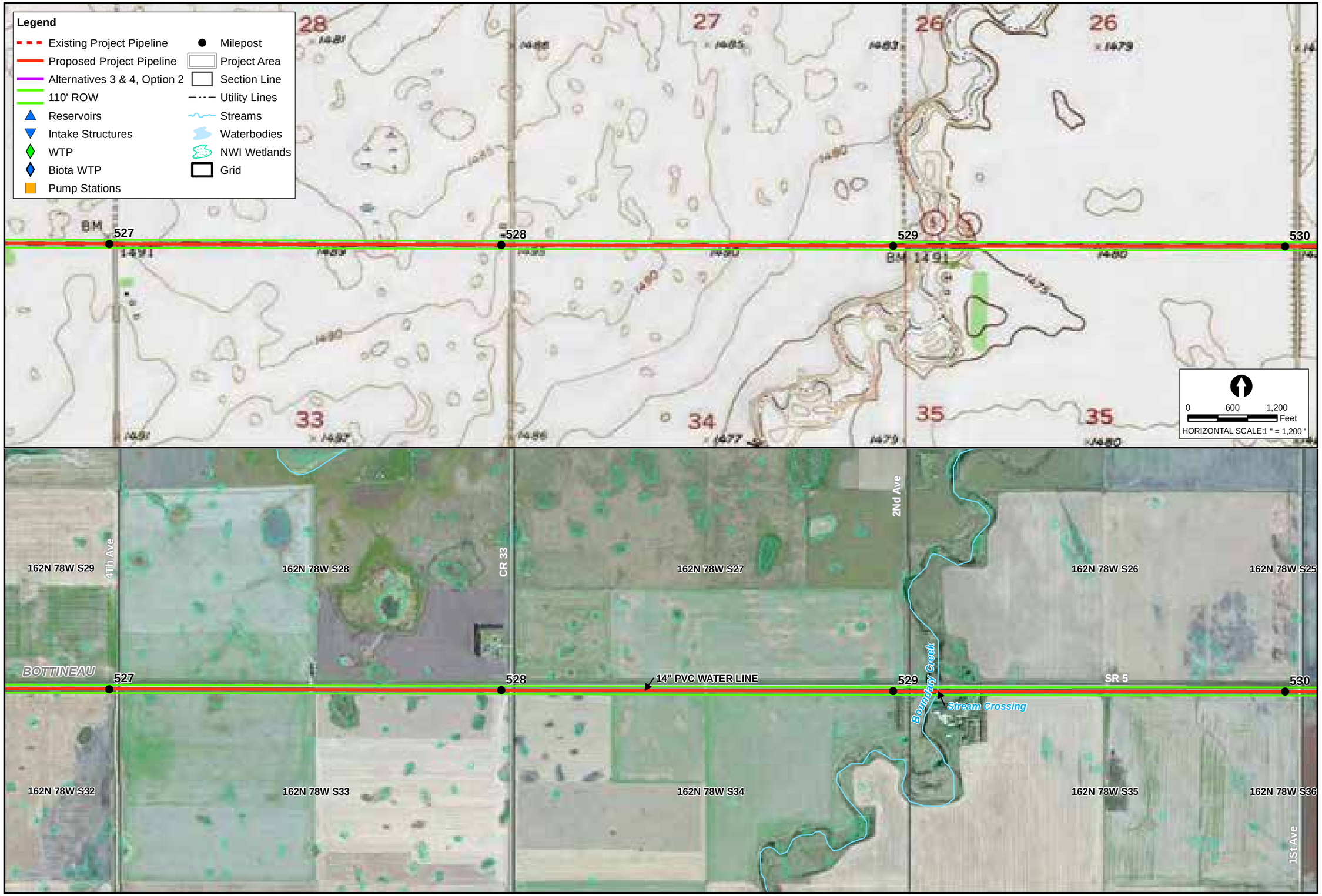

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SCALE: AS SHOWN
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FIGURE NO. E13

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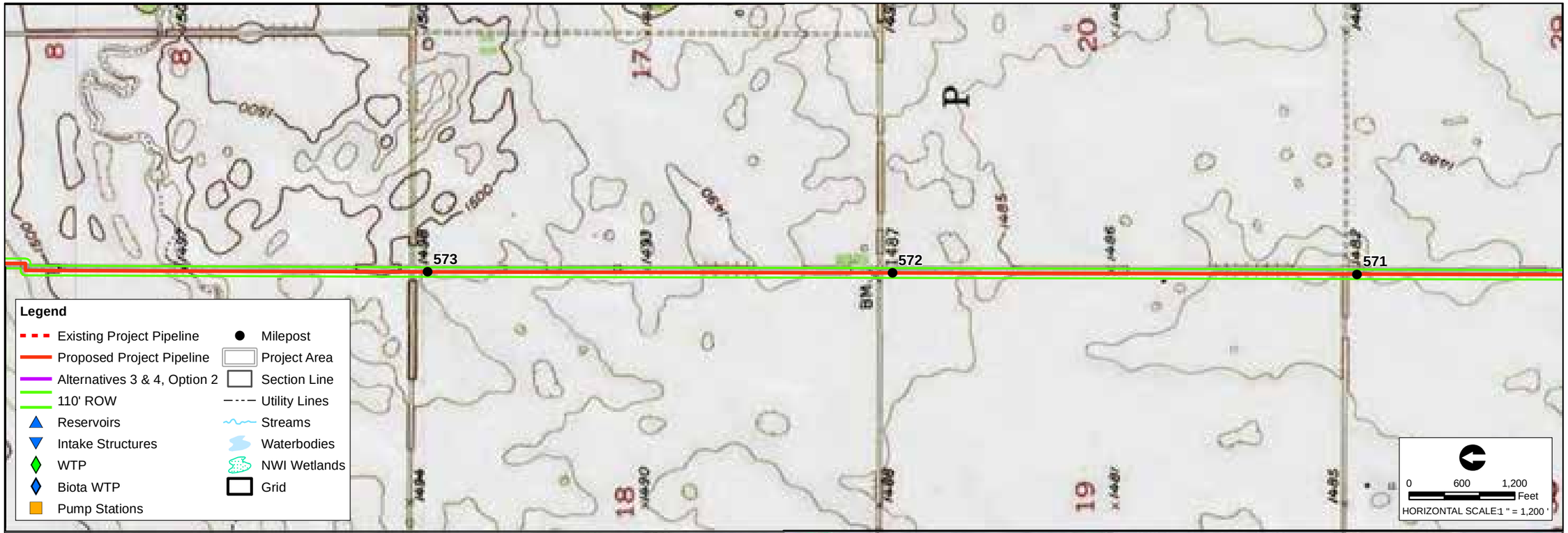
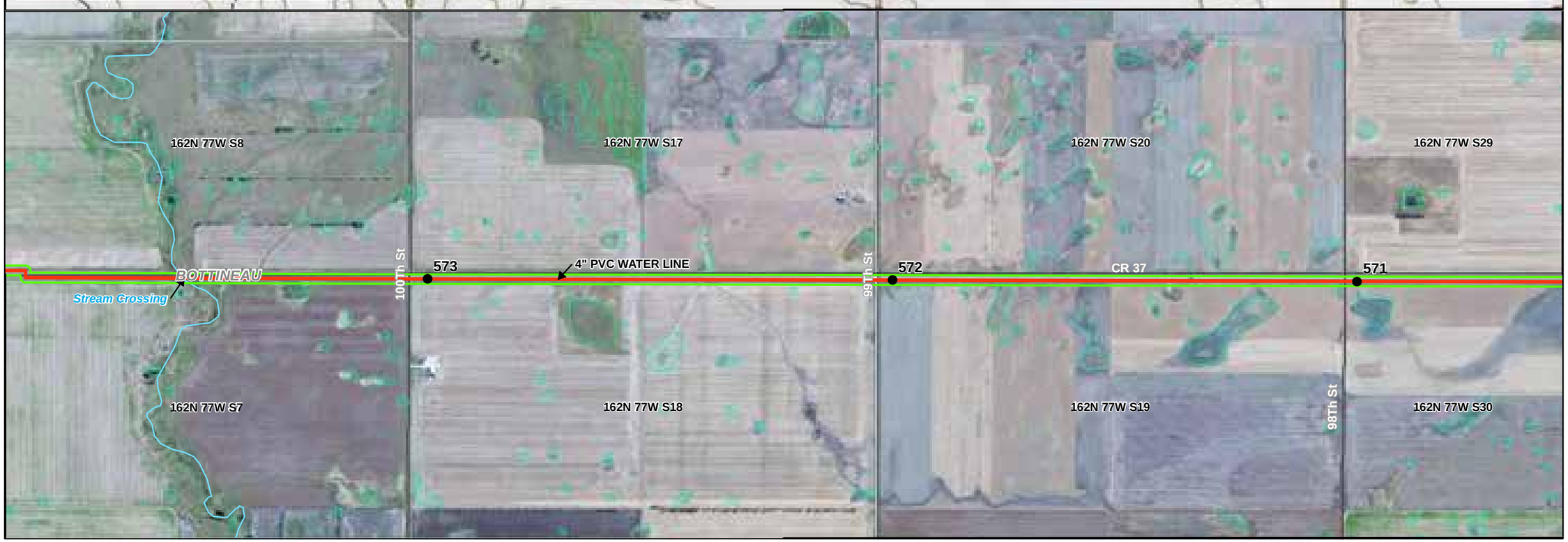
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. E14





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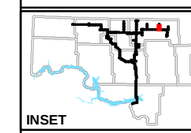

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SCALE: AS SHOWN
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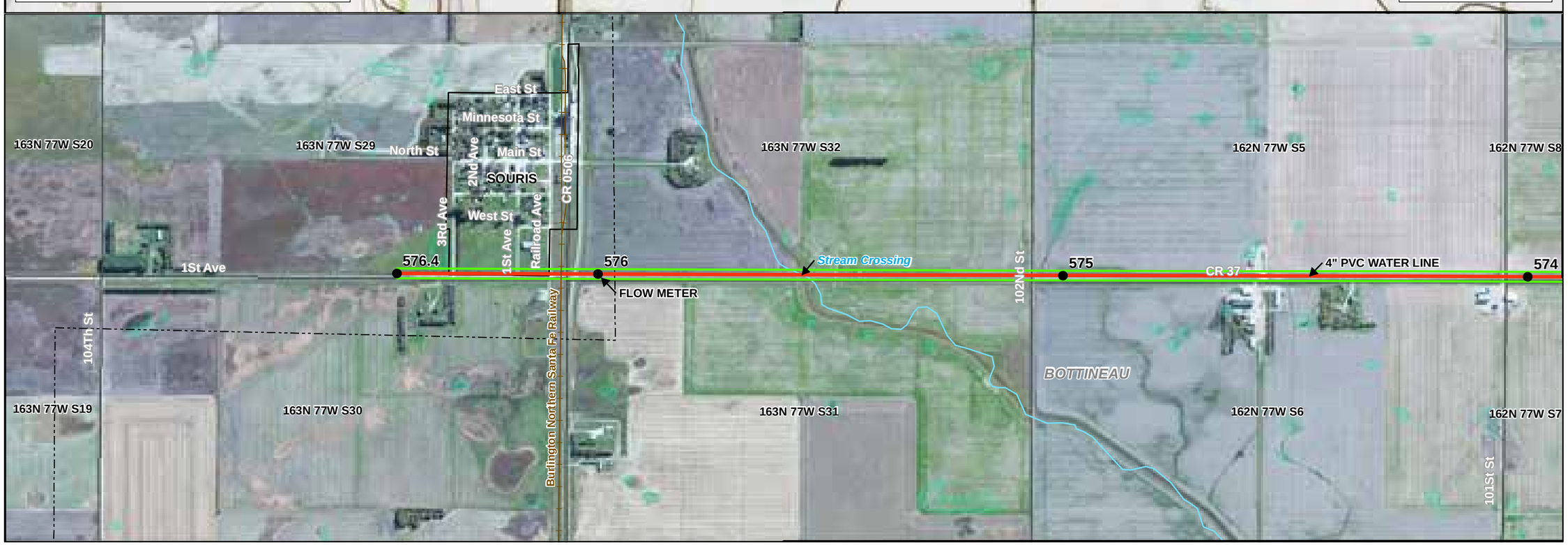

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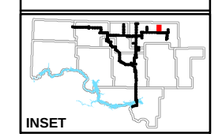

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SCALE: AS SHOWN
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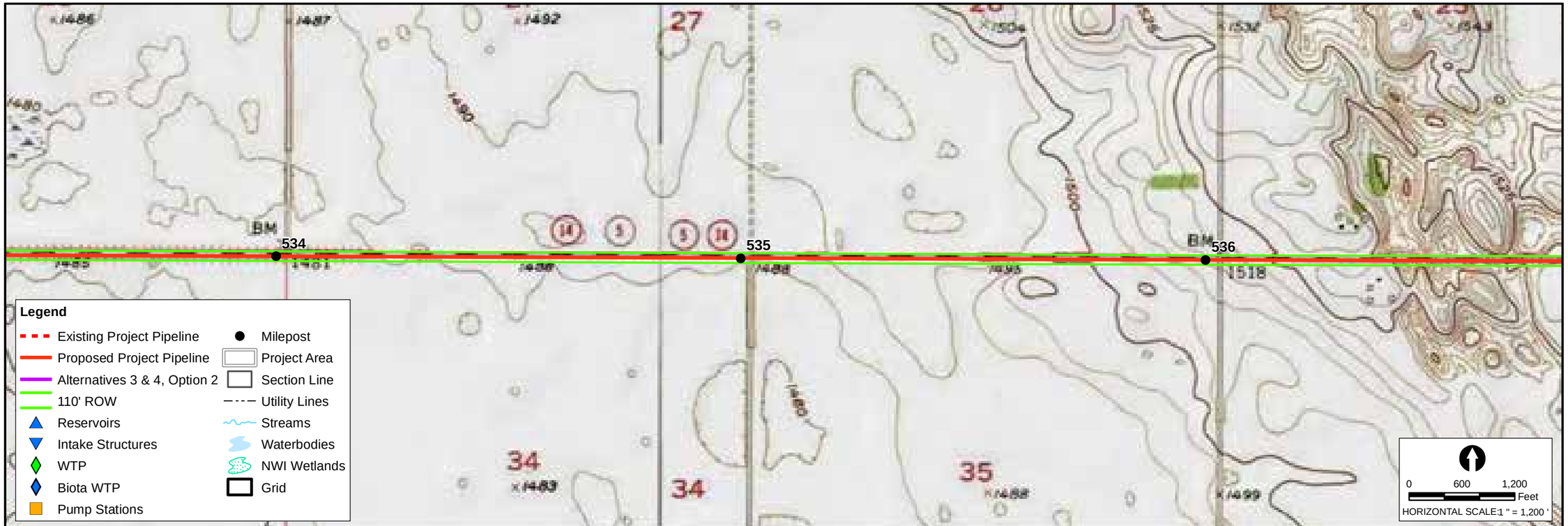
FIGURE NO. E16



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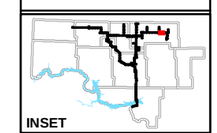

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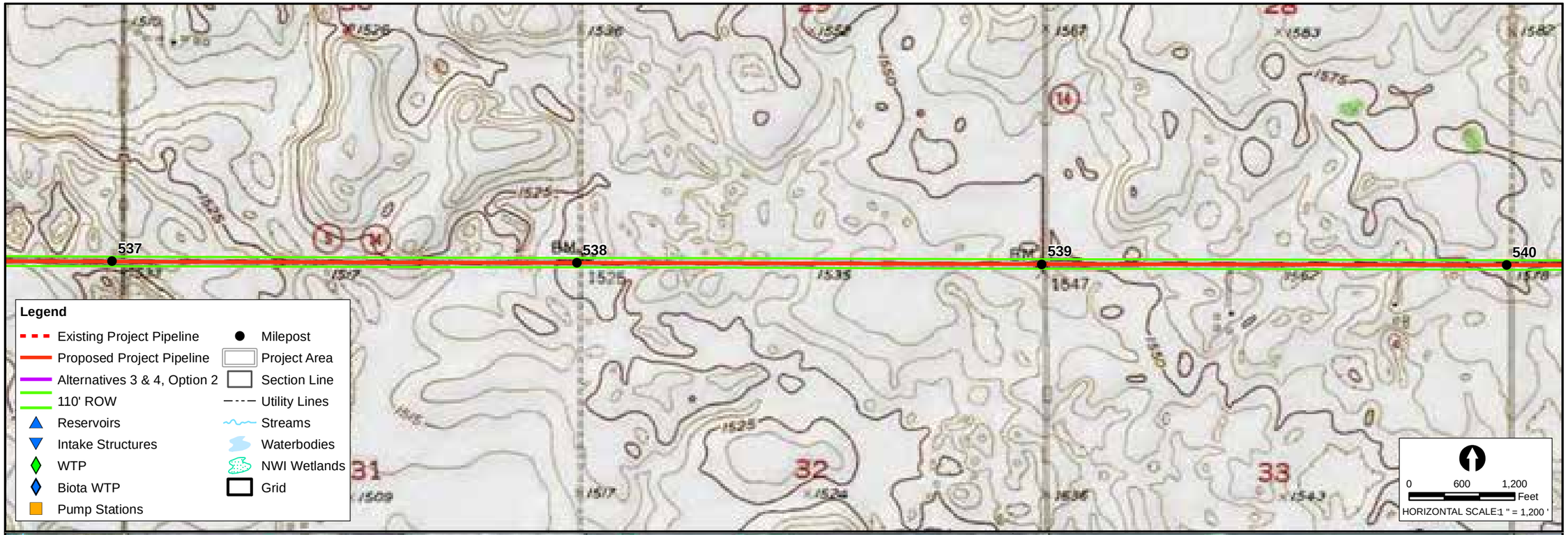
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. E17



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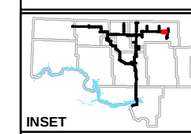

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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
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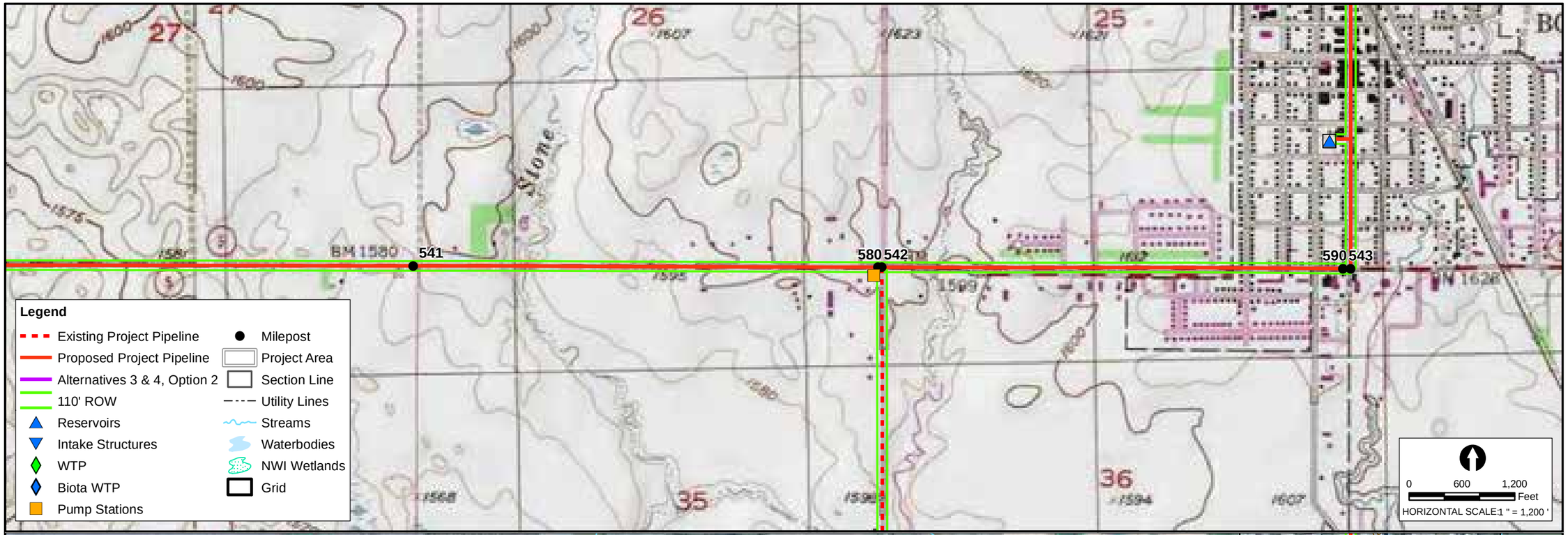

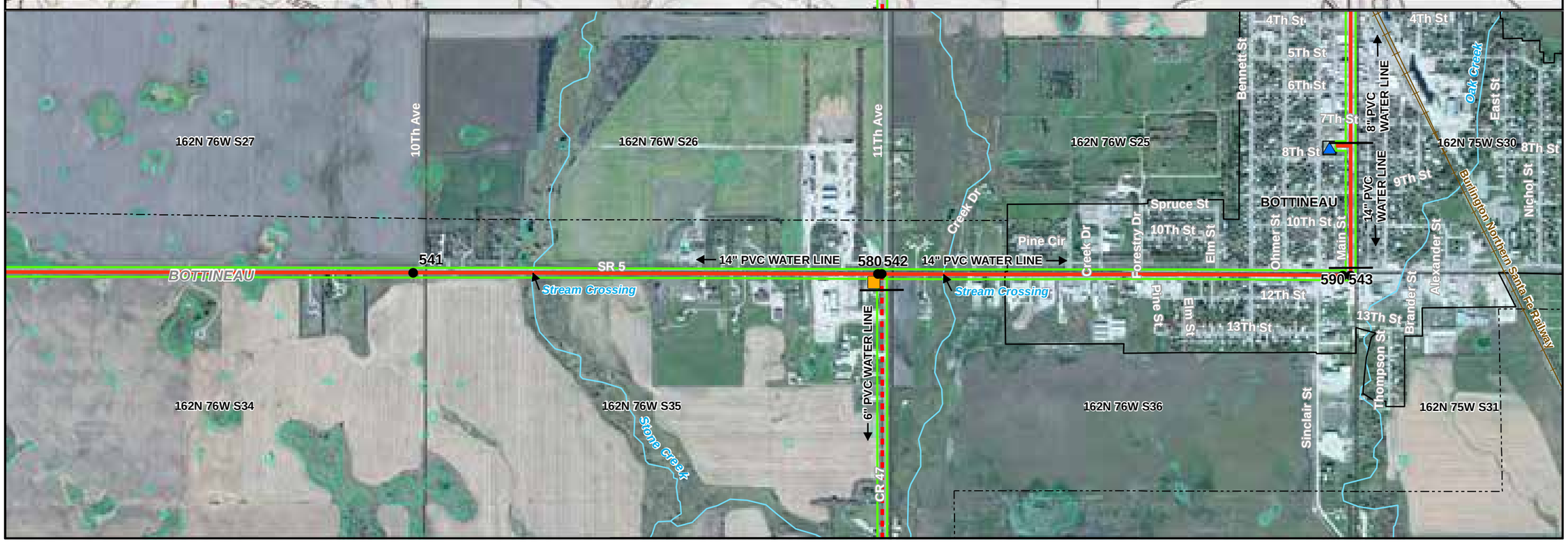

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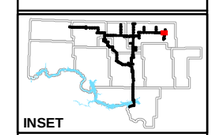

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SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
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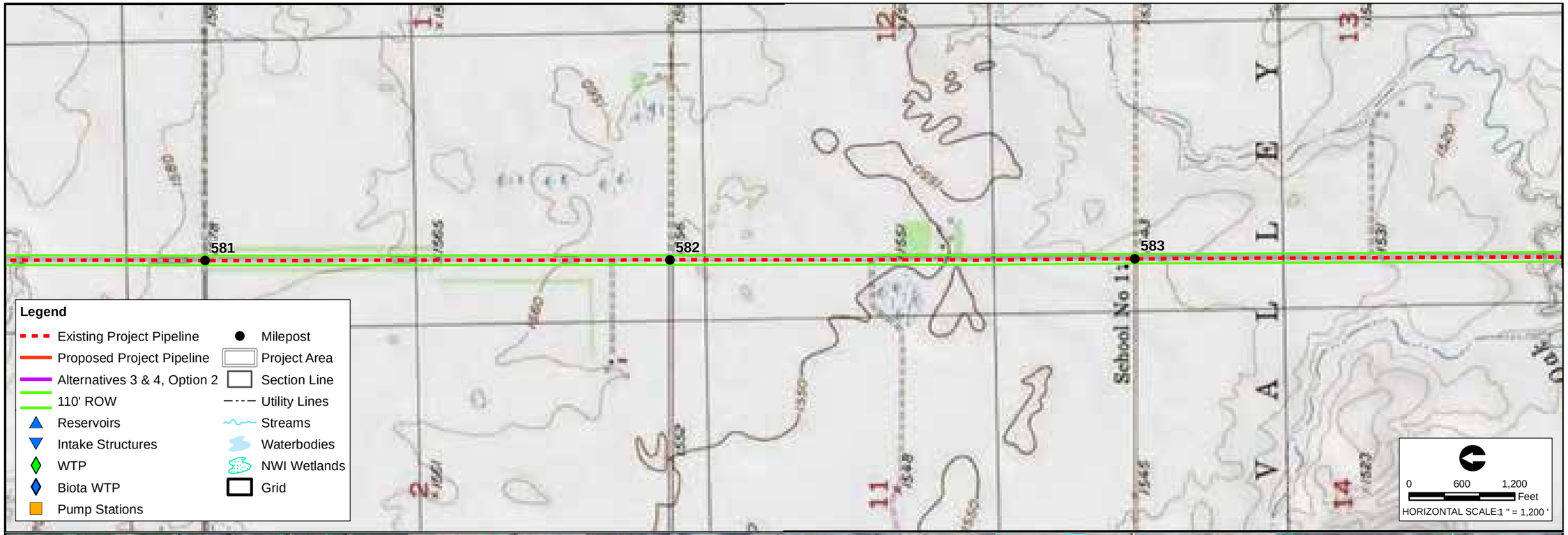

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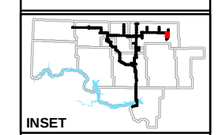

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FIGURE NO. E20

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ENTRIX JOB NO. 30442091
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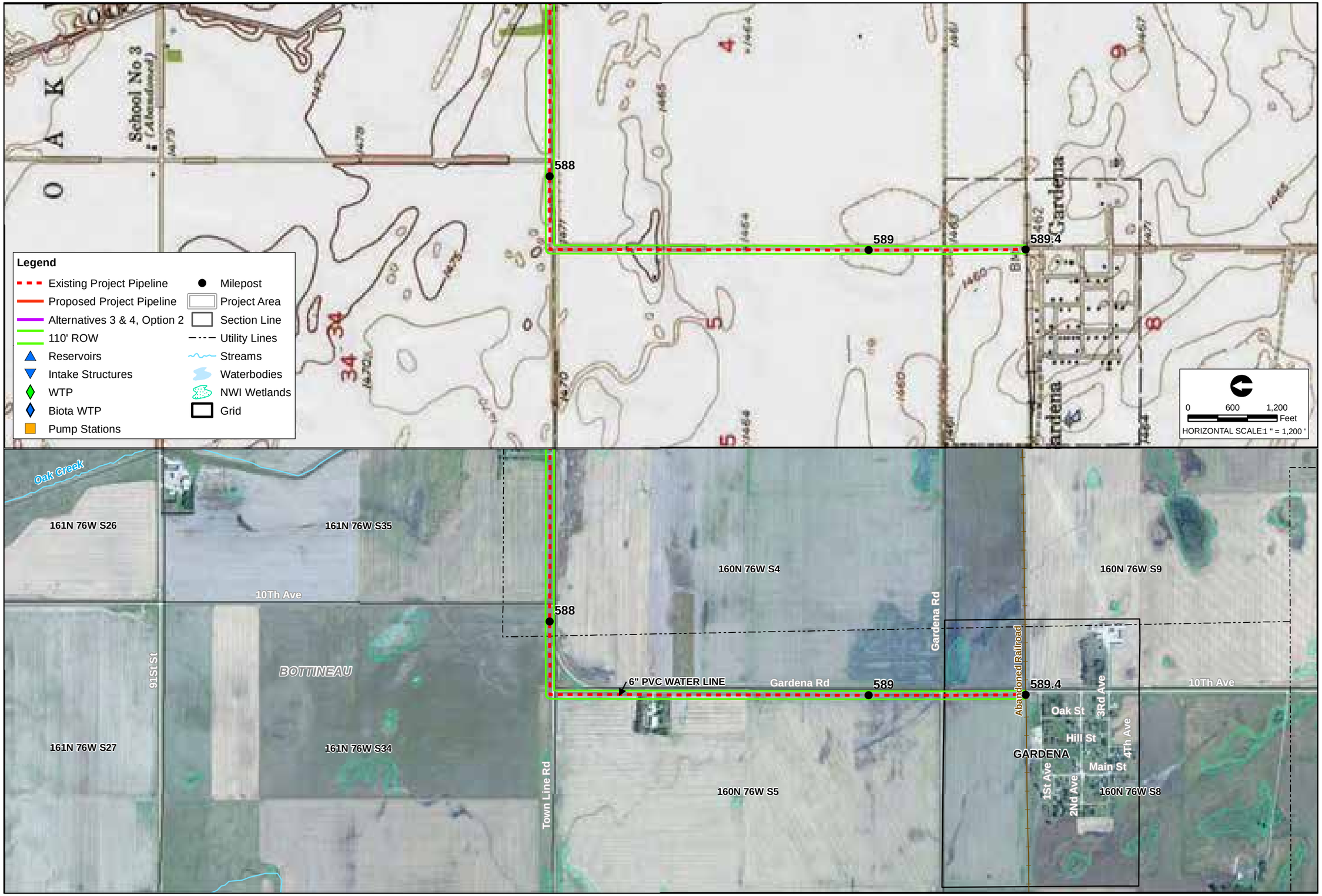

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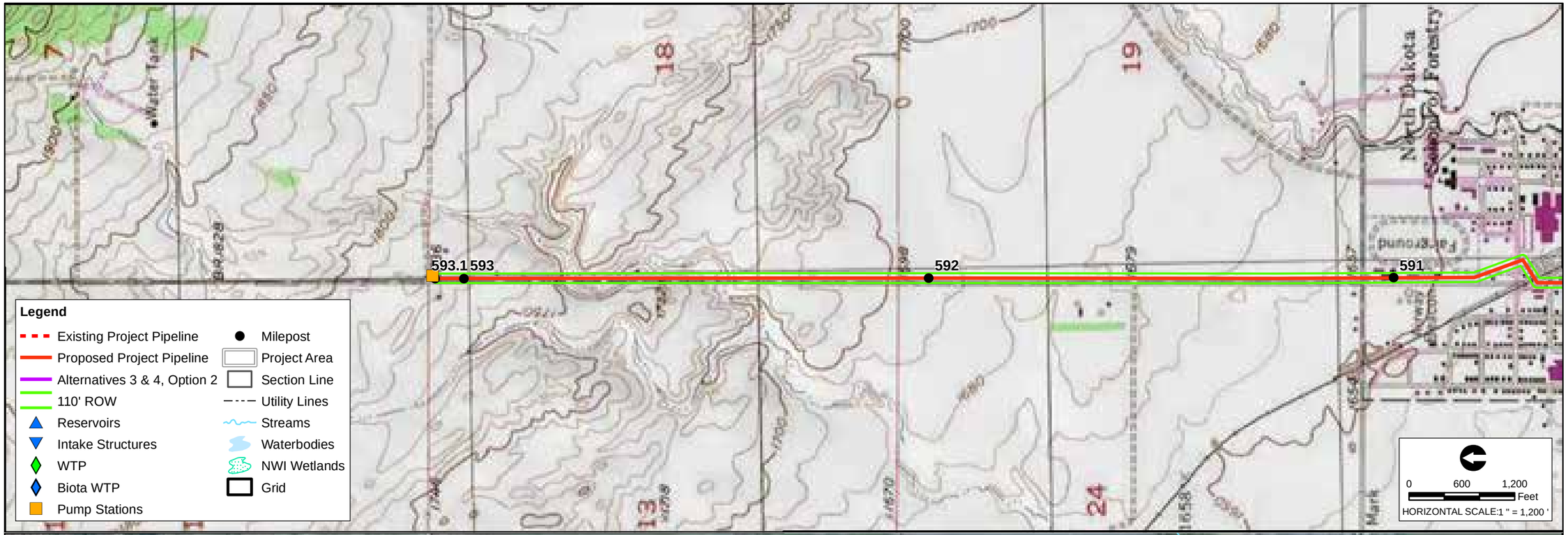
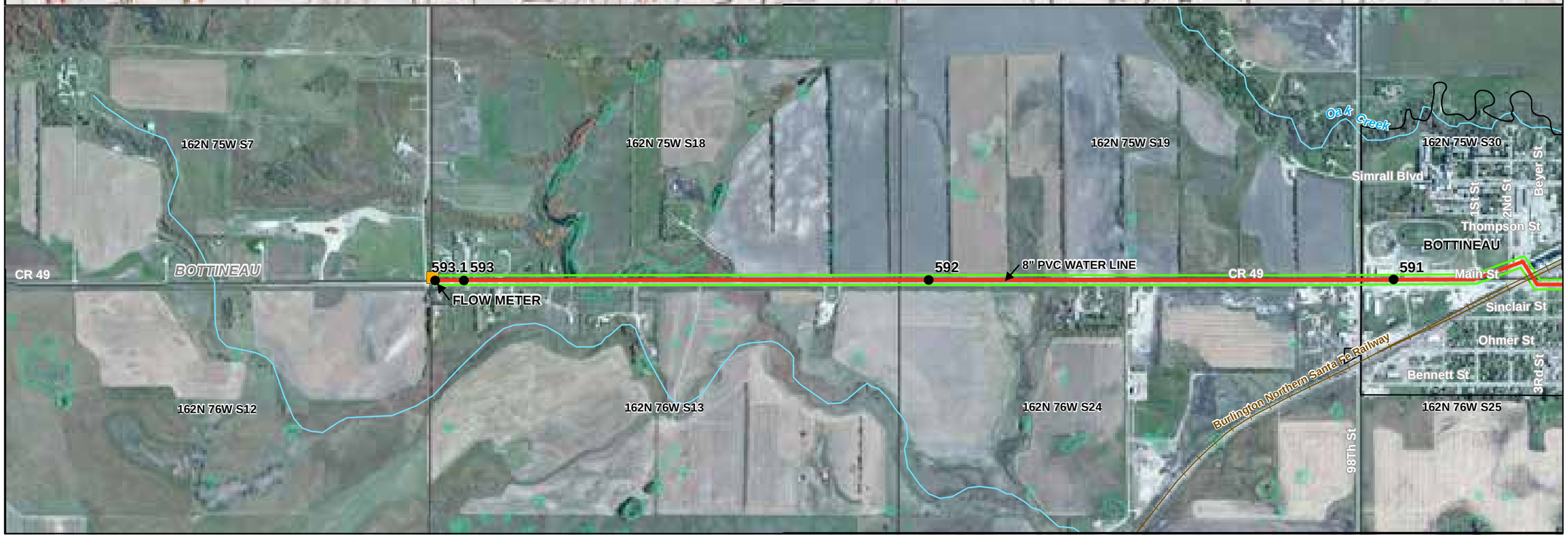
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. E22





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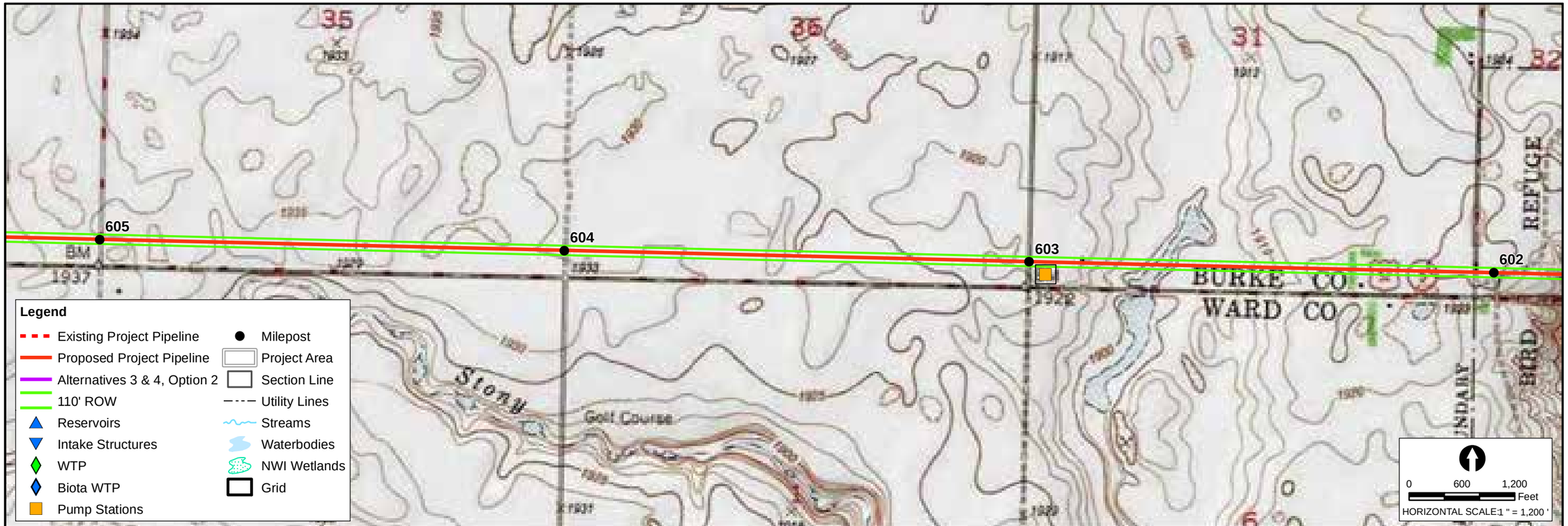
ENTRIX JOB NO. 30442091
FIGURE NO. E23



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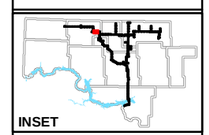

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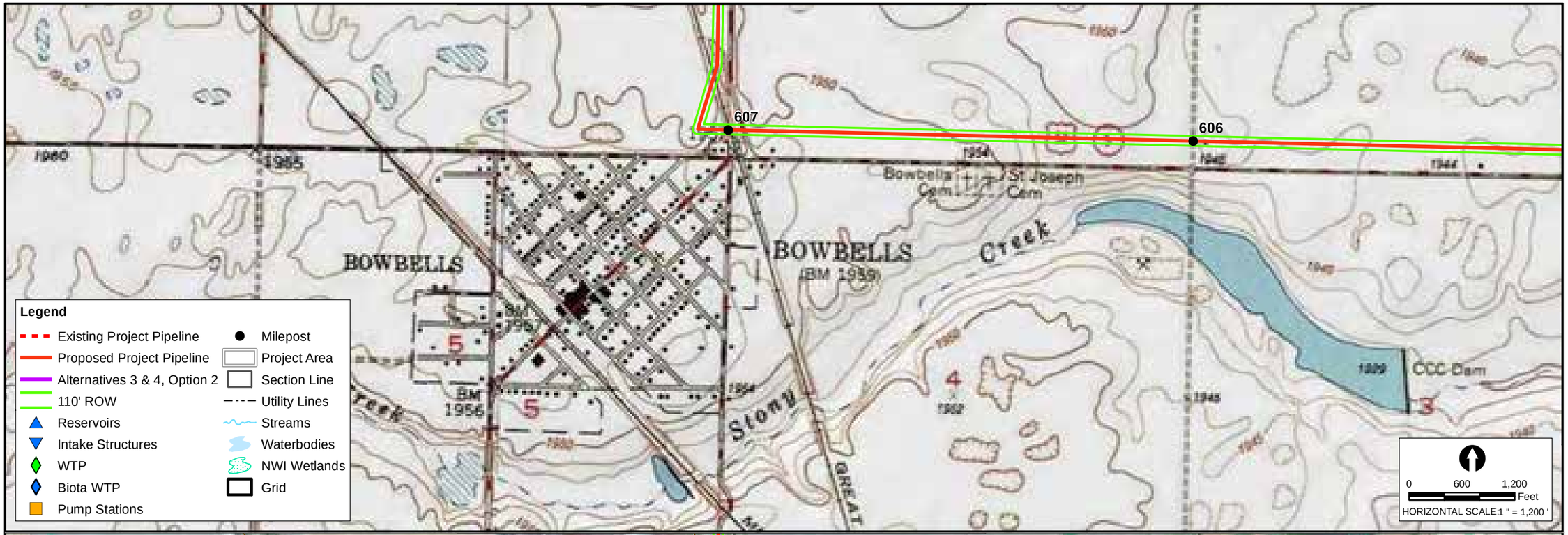
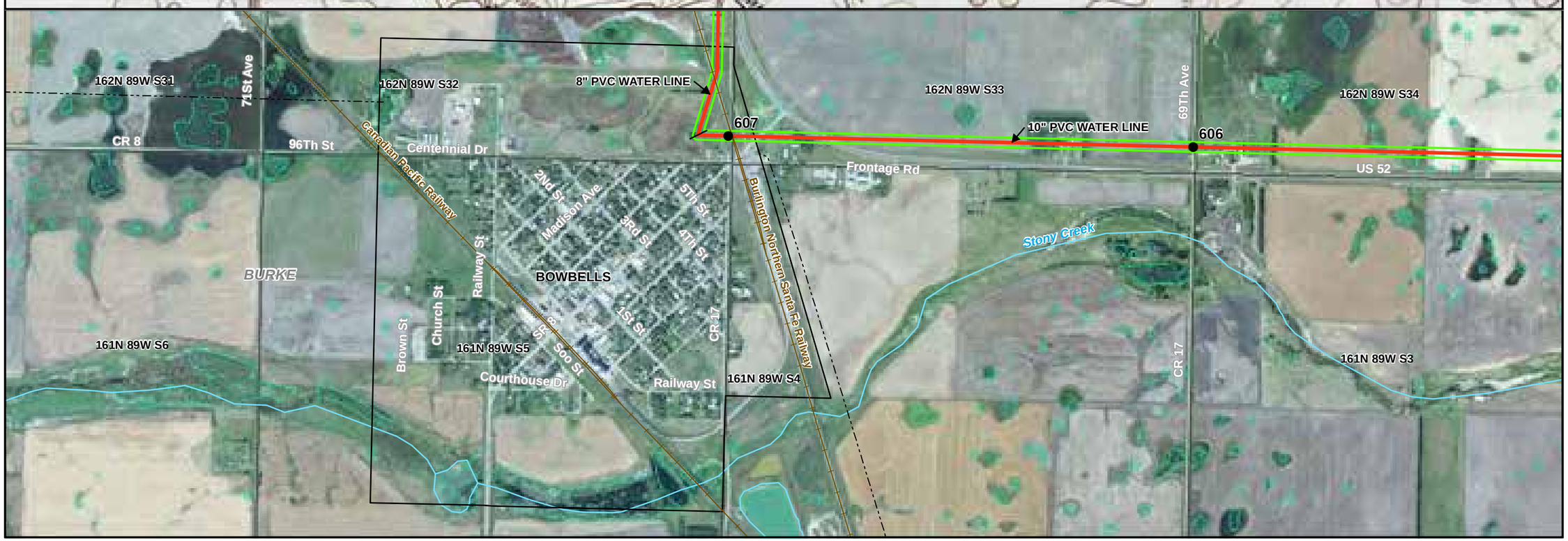
FIGURE NO. F02





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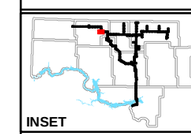

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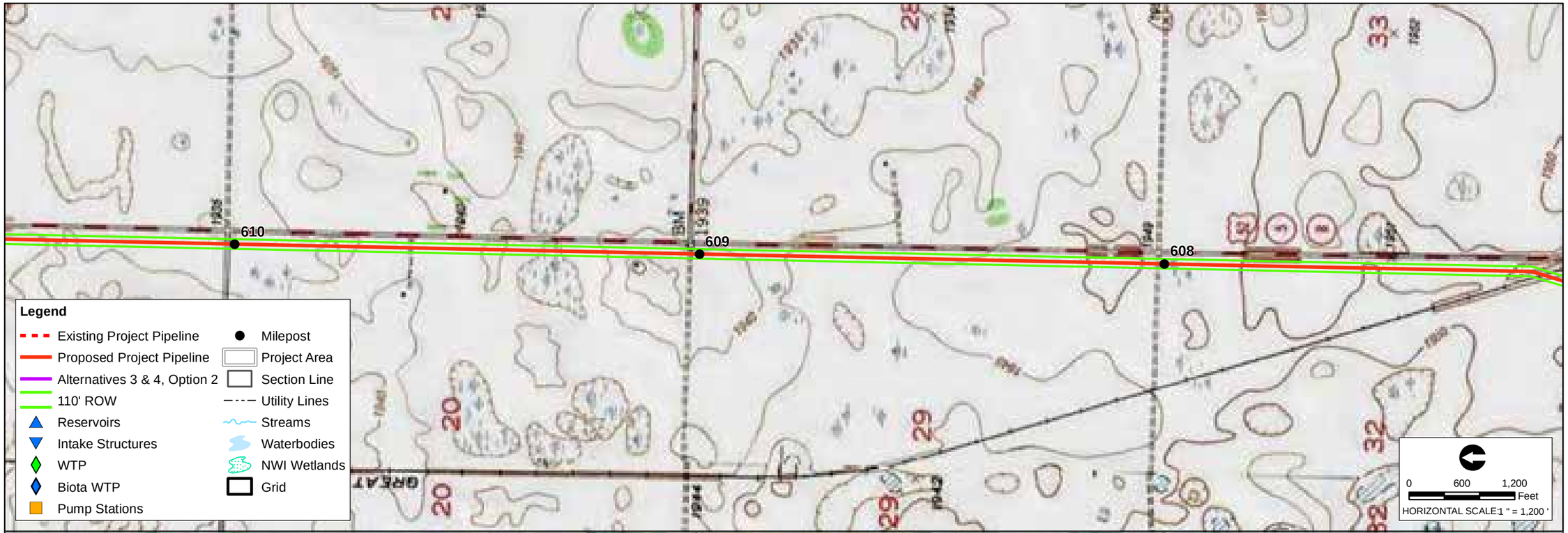

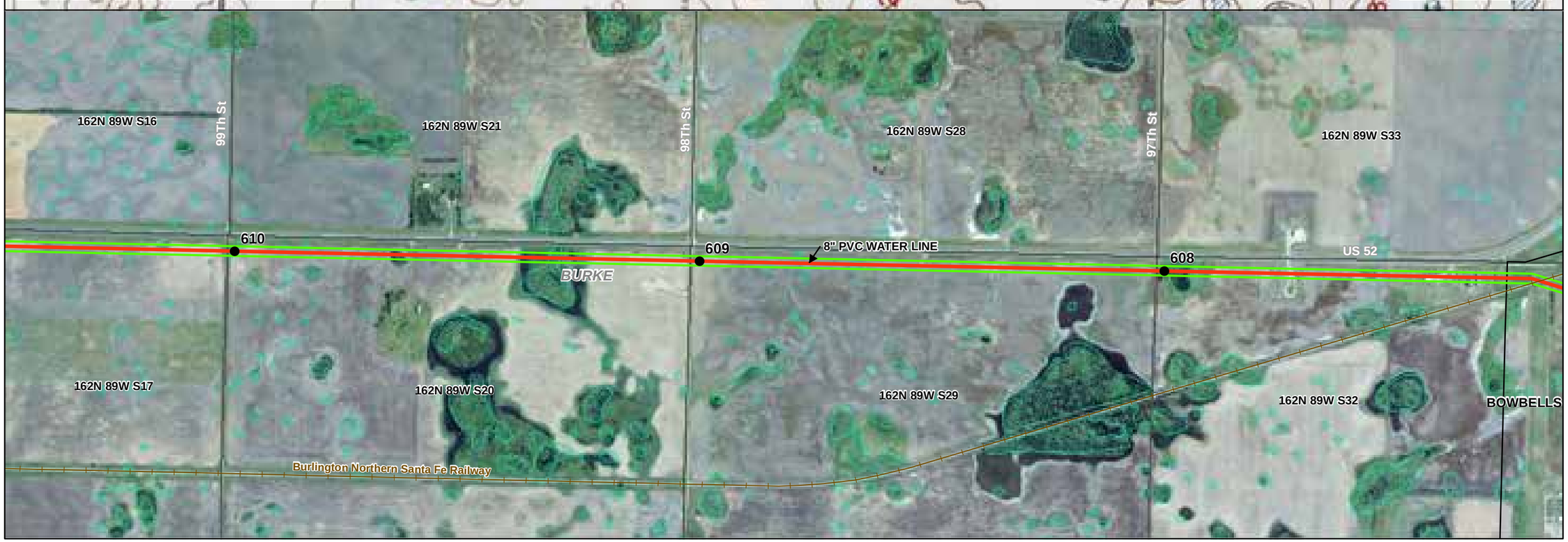

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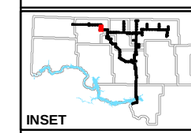

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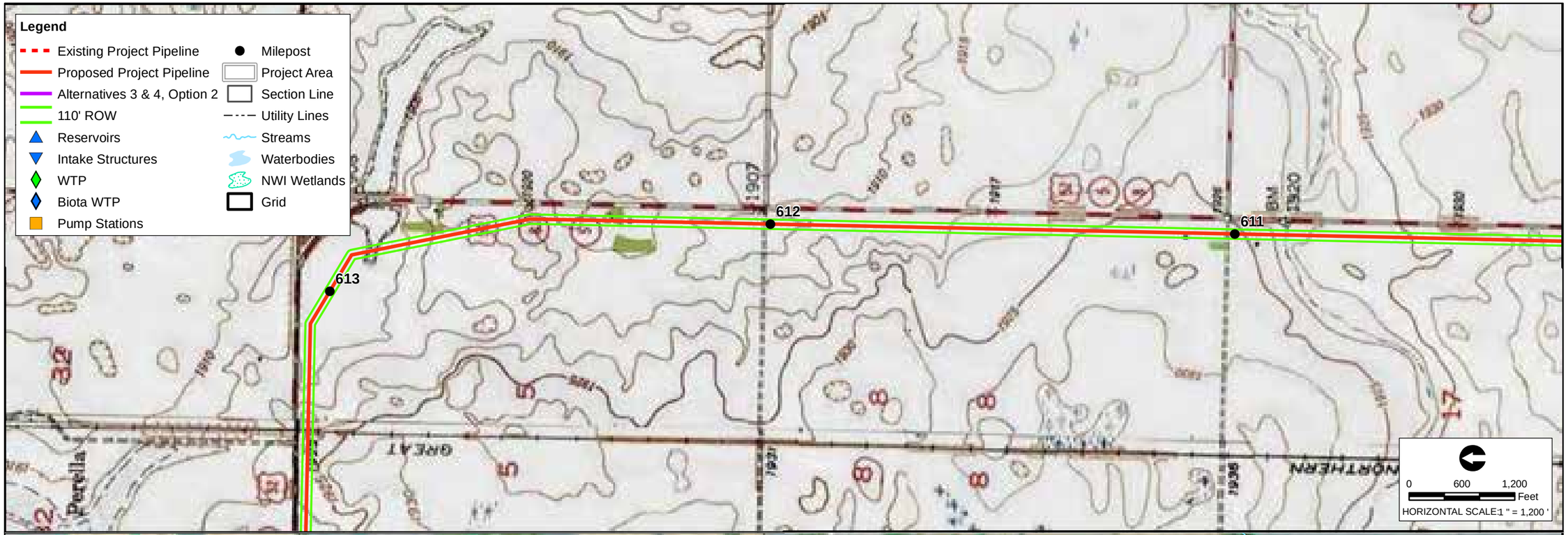
FIGURE NO. F04



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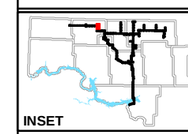

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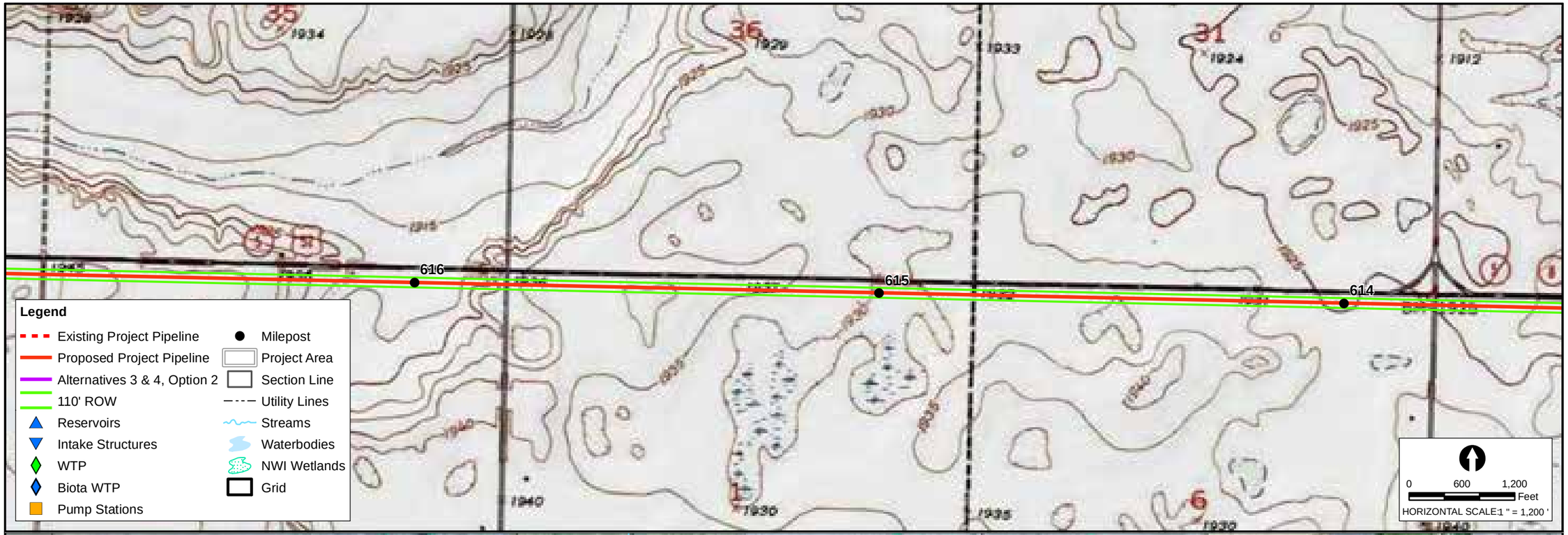
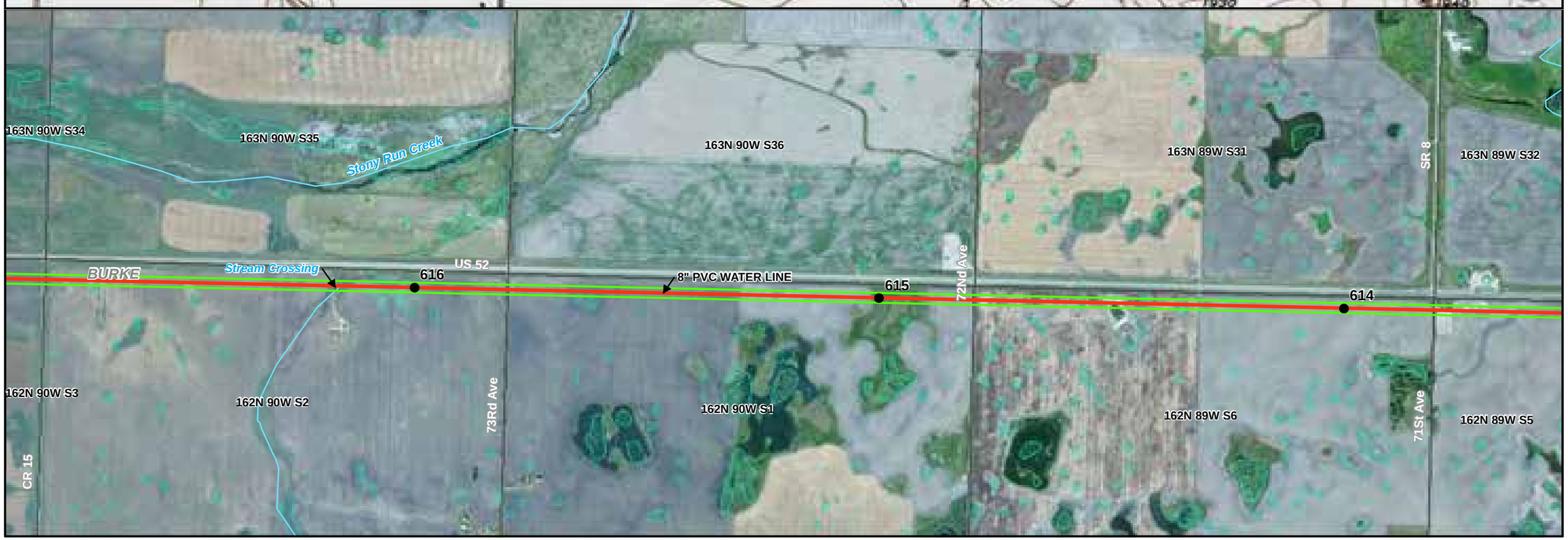
FIGURE NO. F05





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200 1st Ave.W.
Seattle, WA 98119
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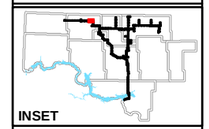
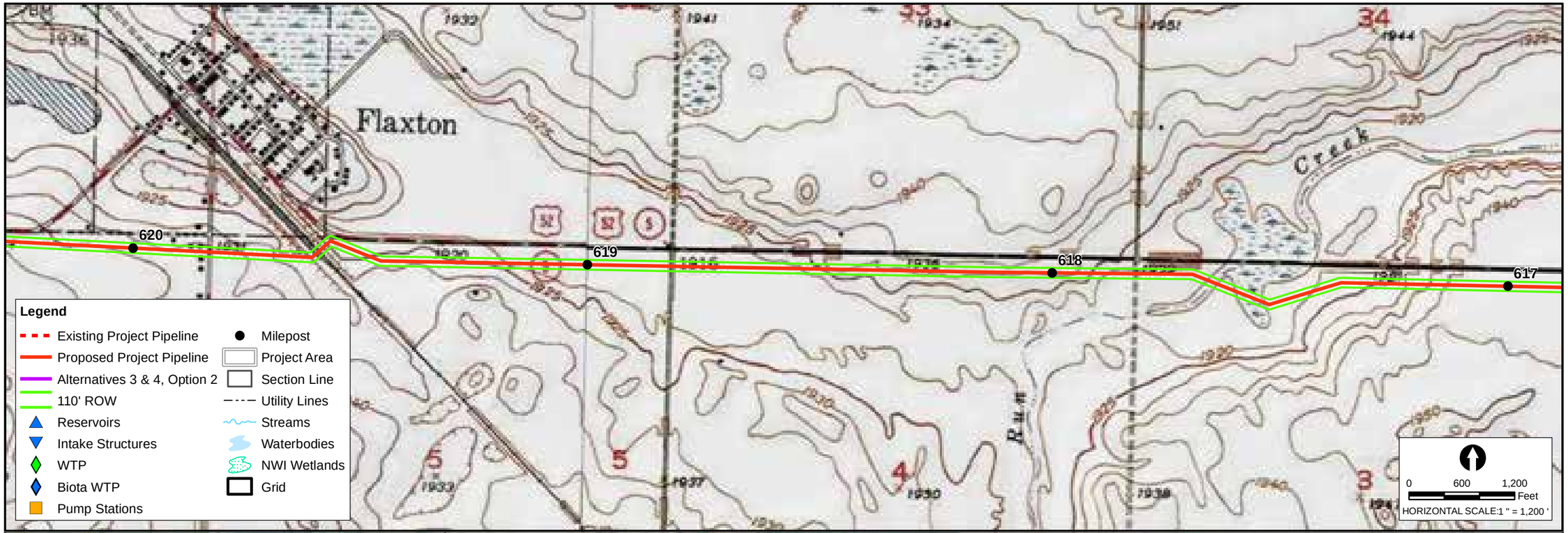


BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. F06



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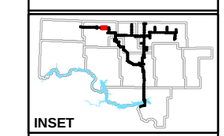

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 12/18/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
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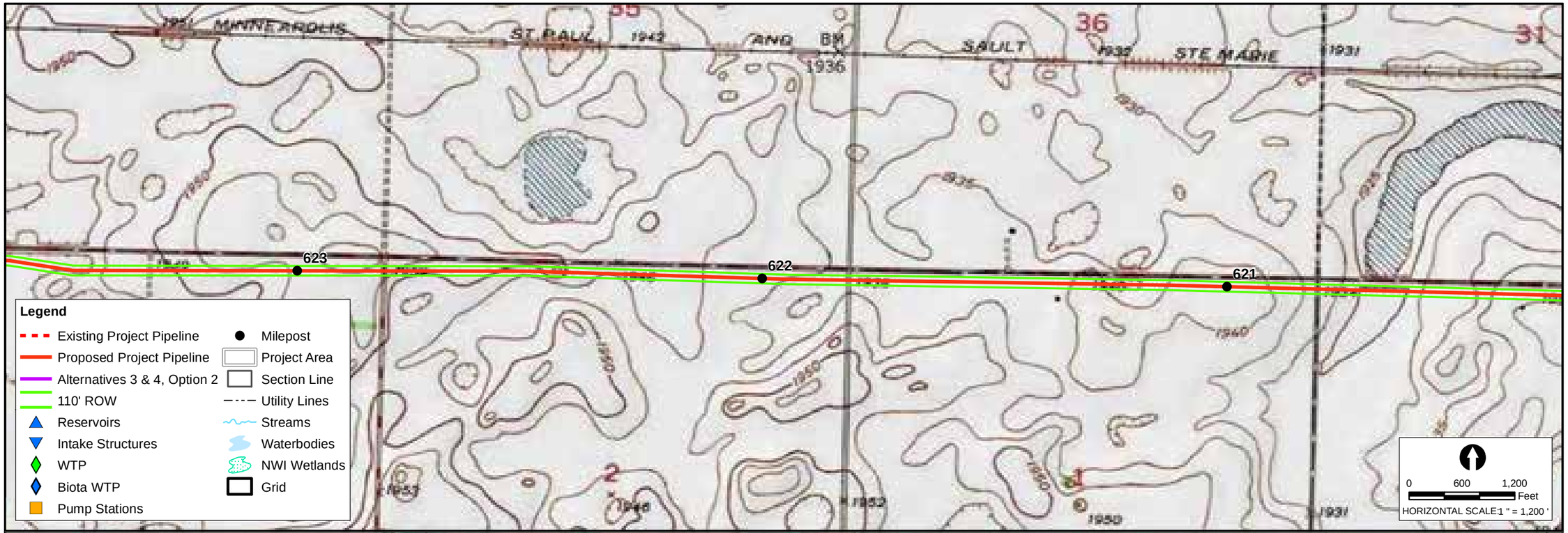
FIGURE NO. F07



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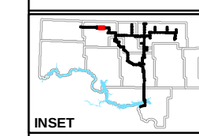
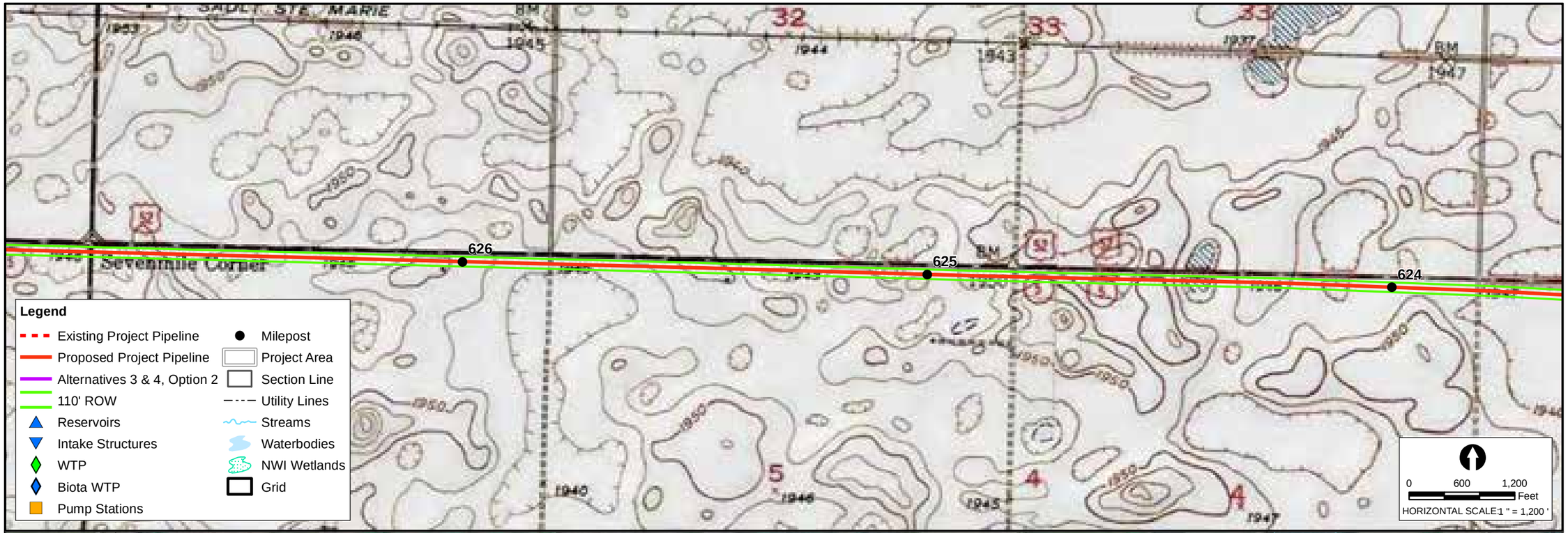


BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. F08



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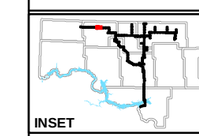

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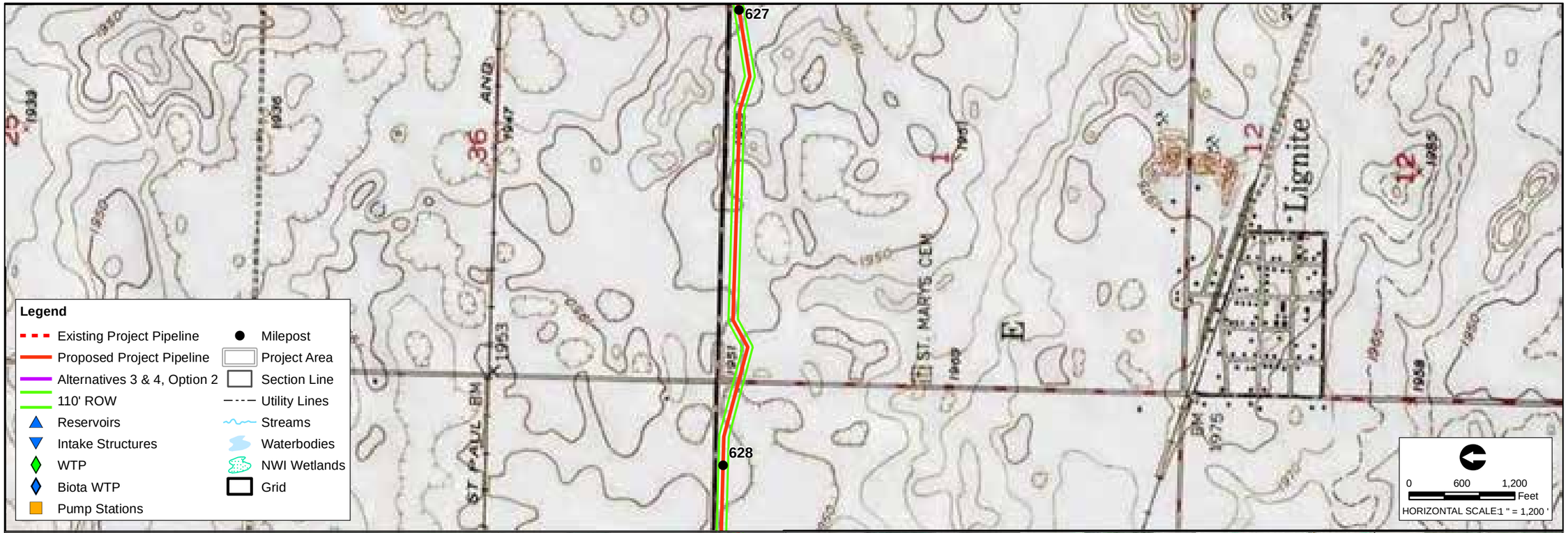
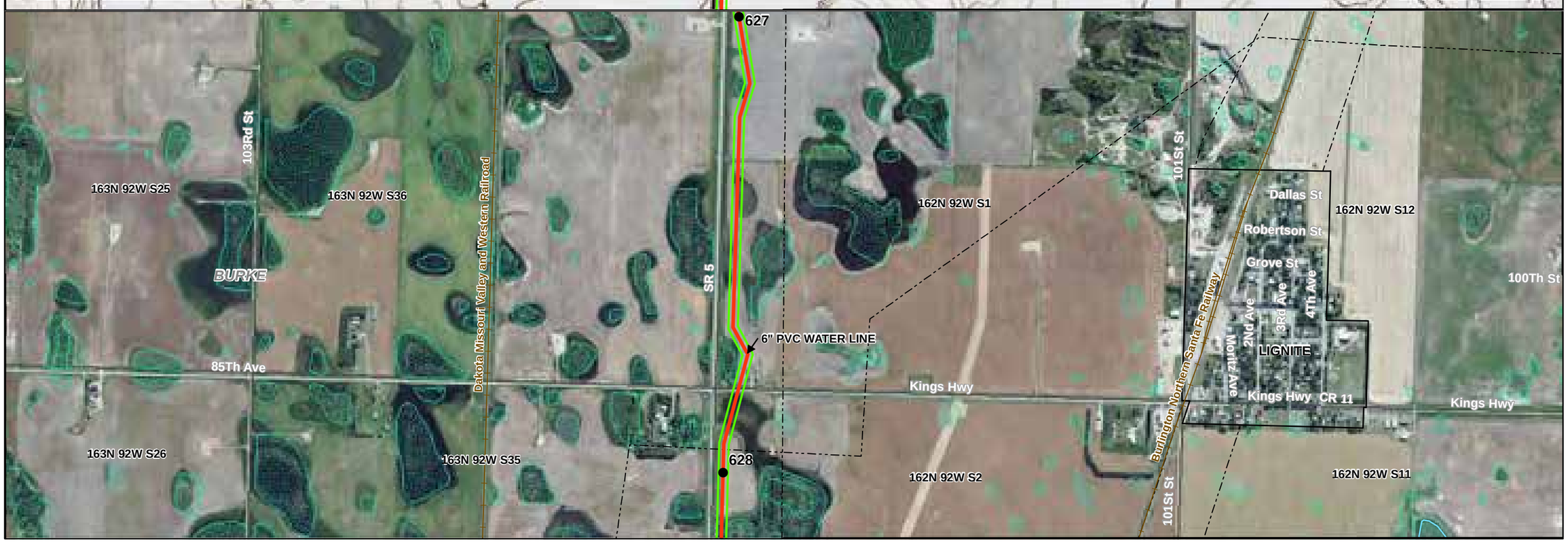
PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. F09





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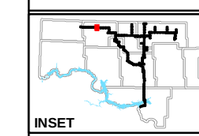


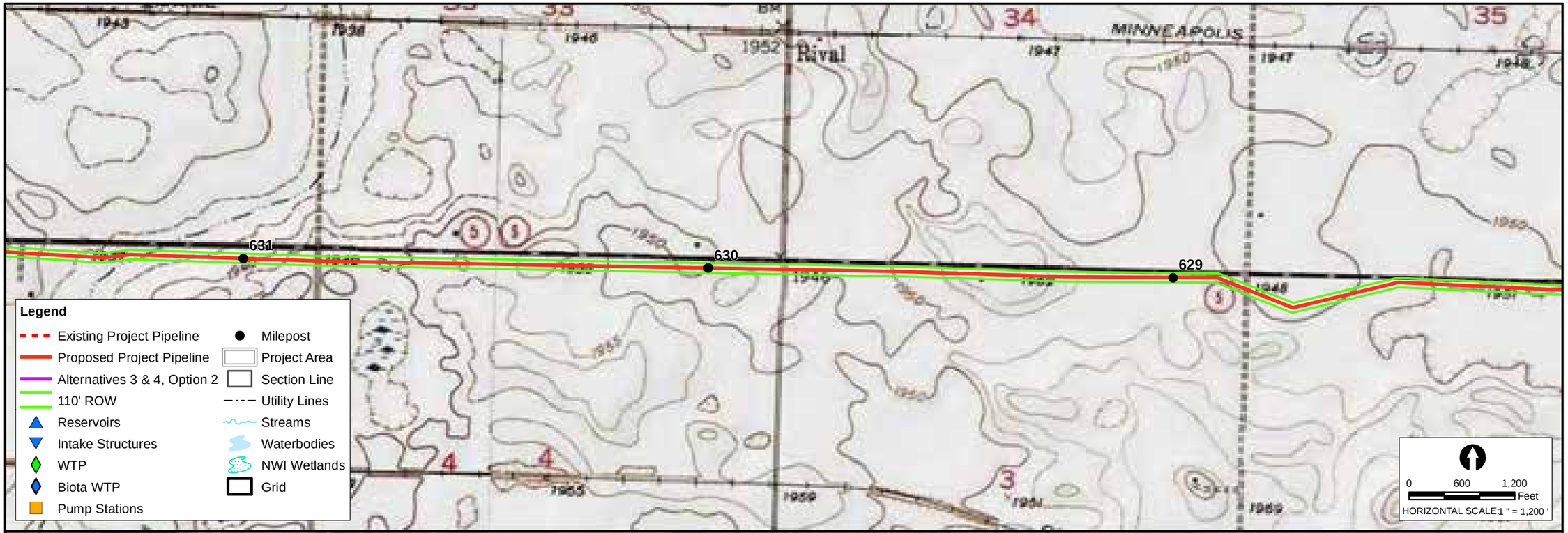
INSET

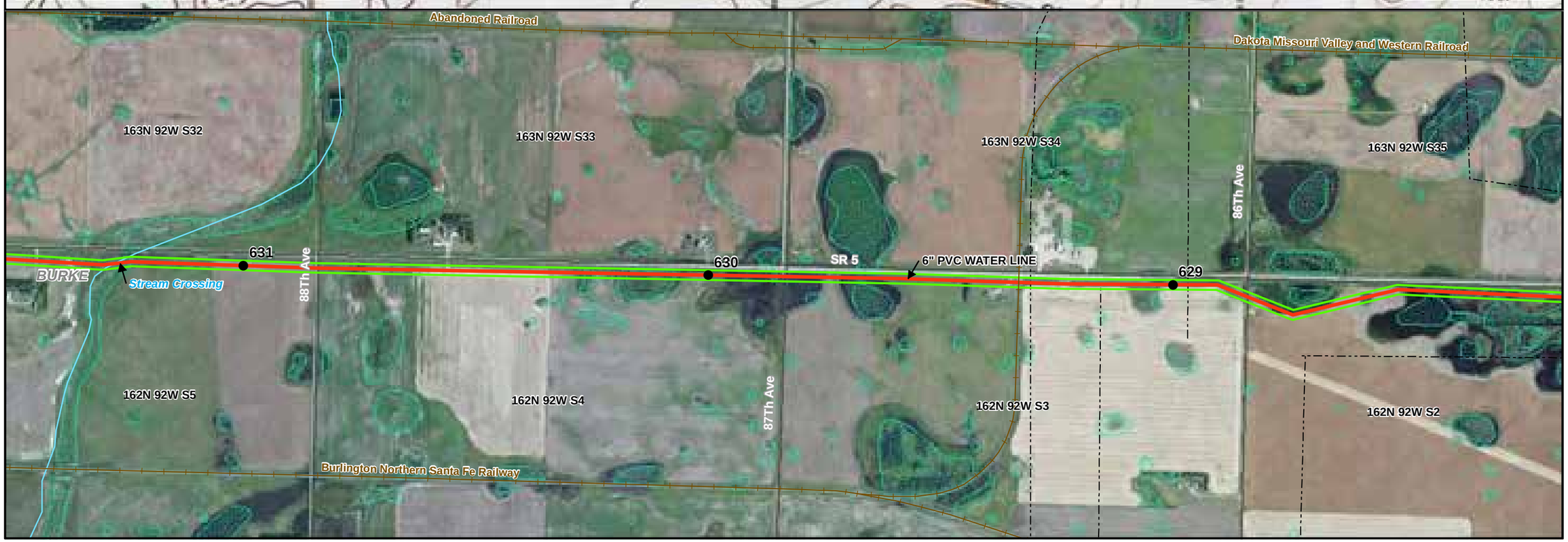
BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. F10





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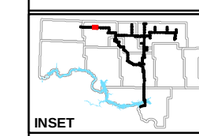
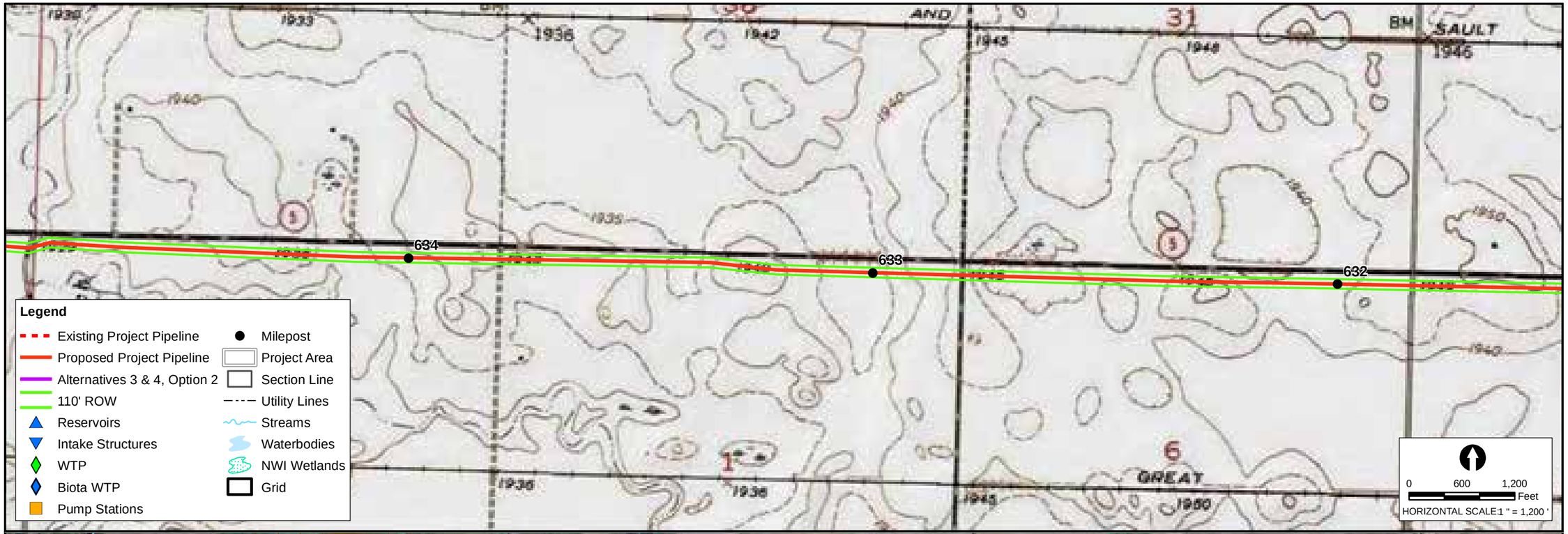


BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. F11



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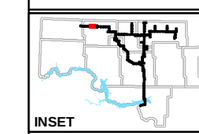

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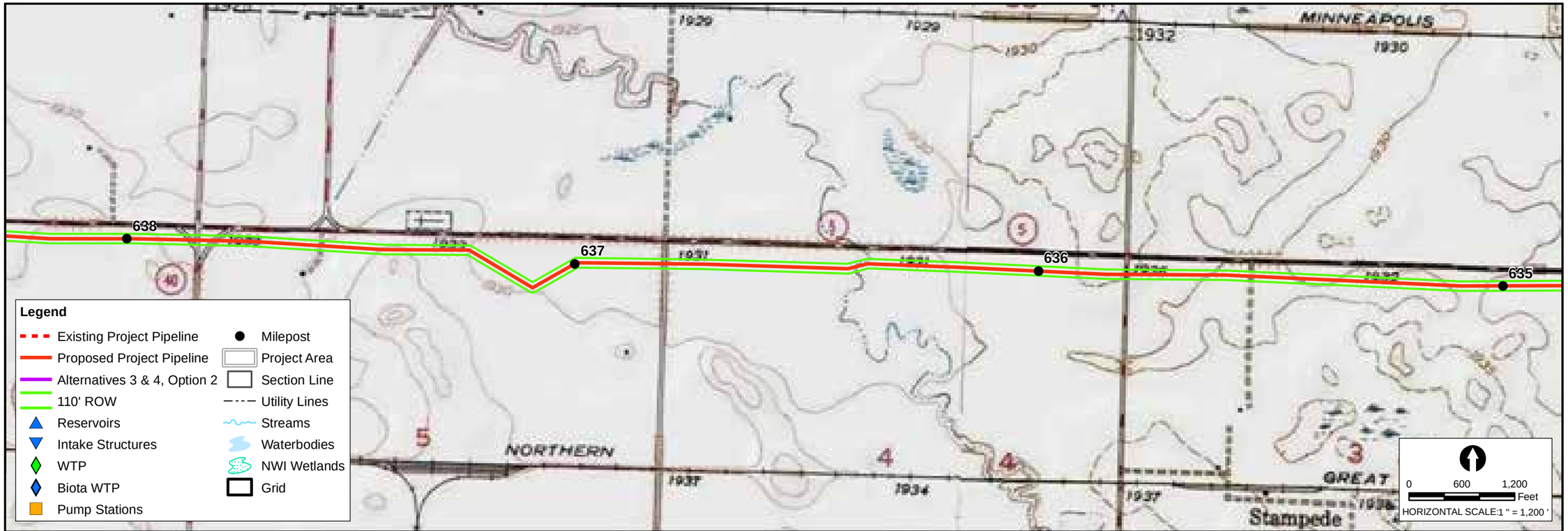
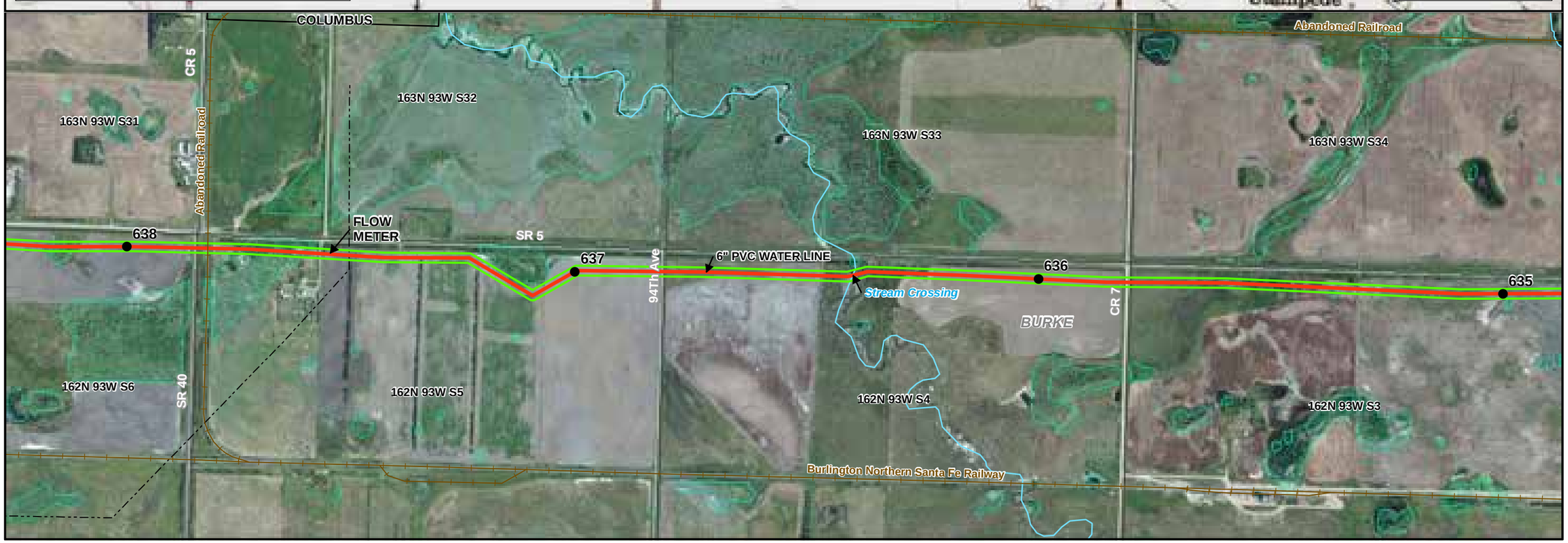
BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. F12





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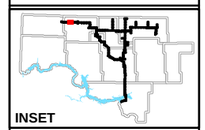

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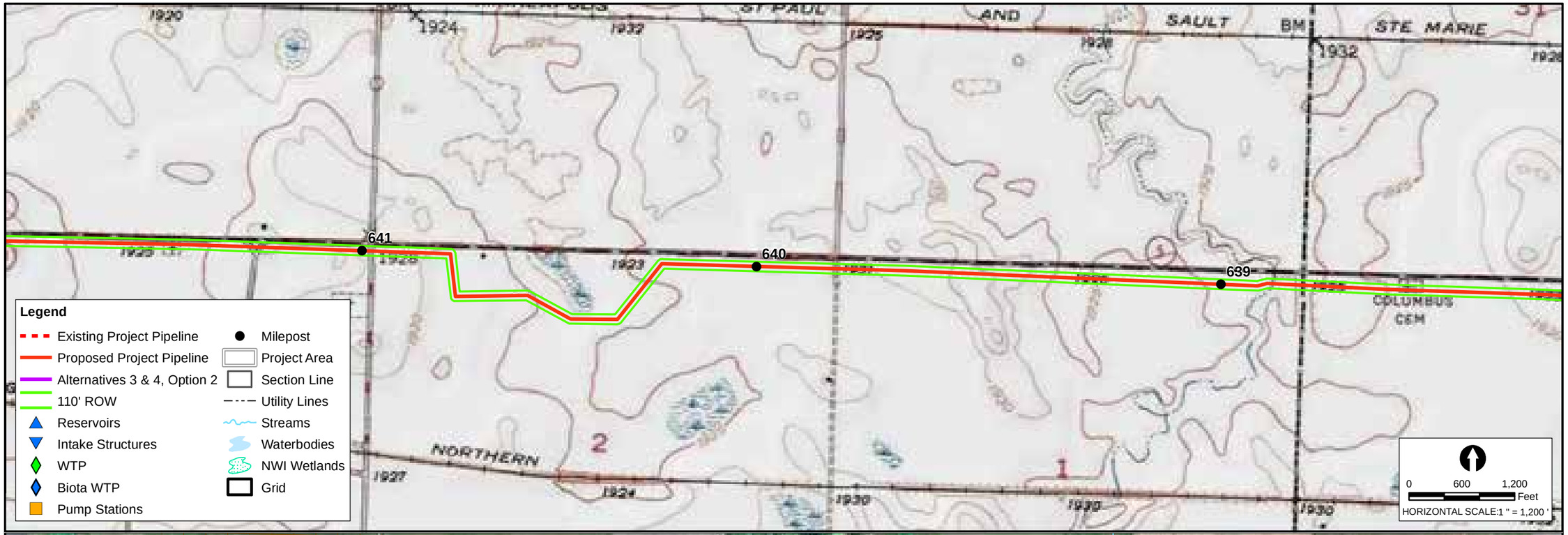
PLAN SHEET

Northwest Area Water Supply

DATE: 12/18/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. F13



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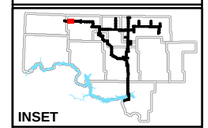
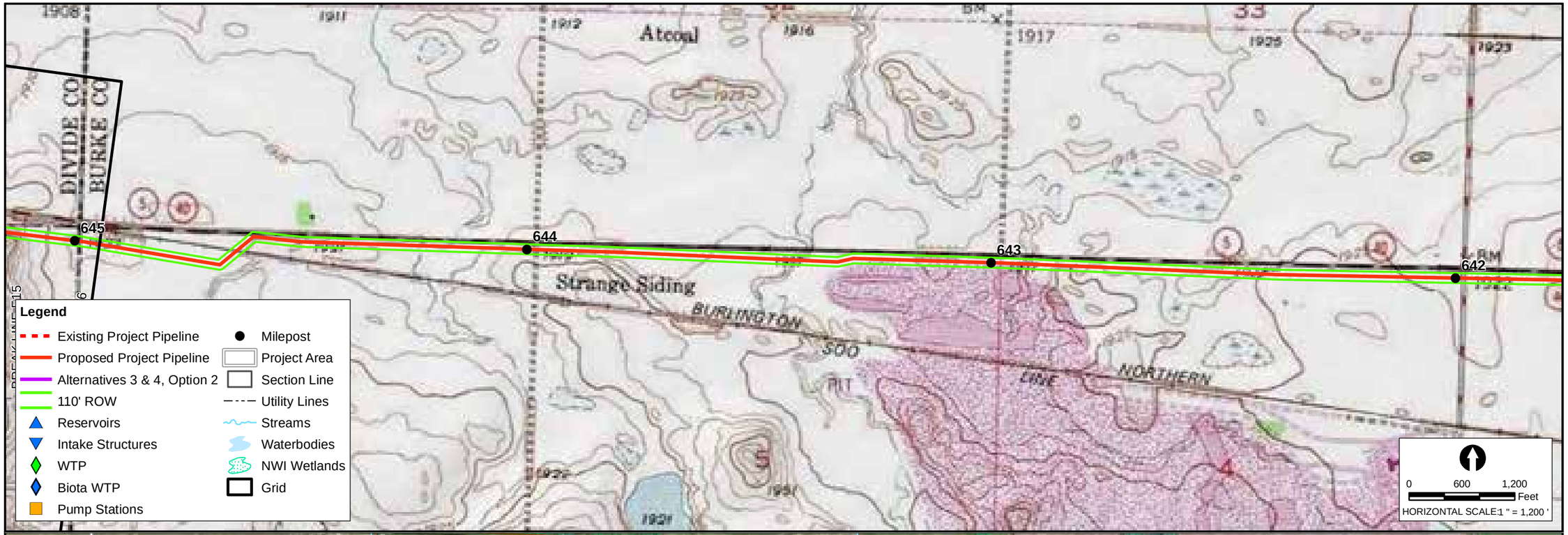


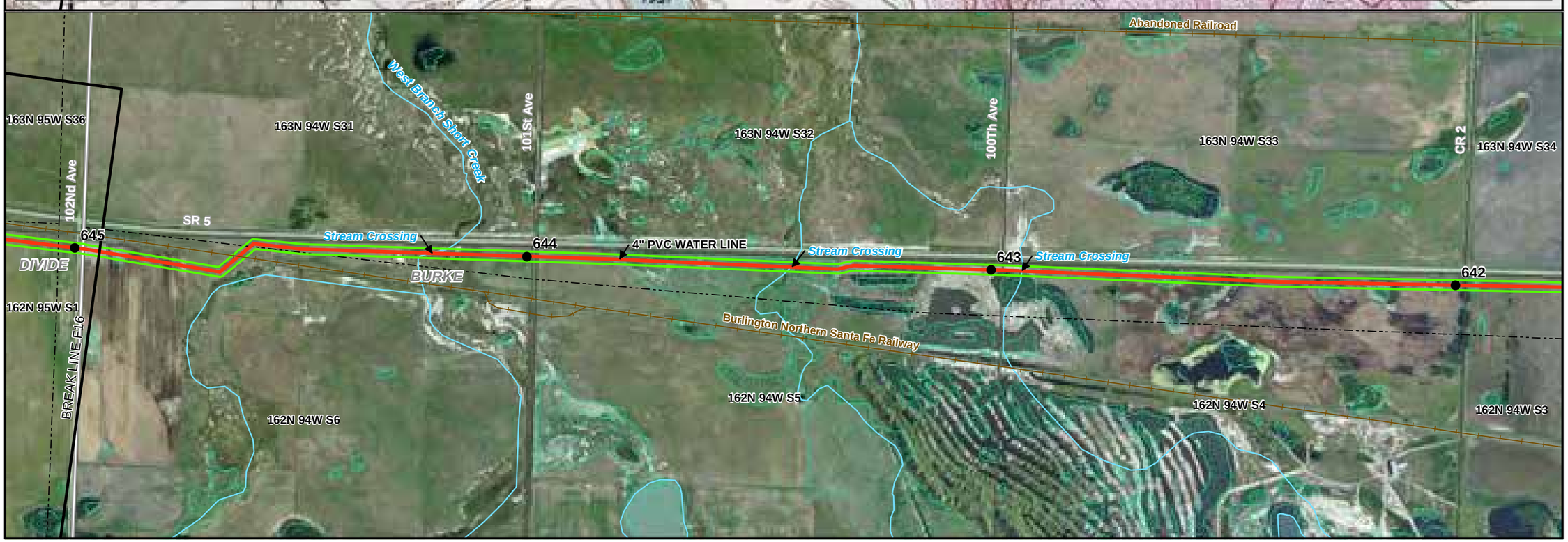
BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 12/18/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. F14





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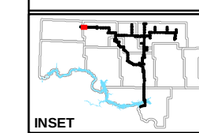

BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. F15

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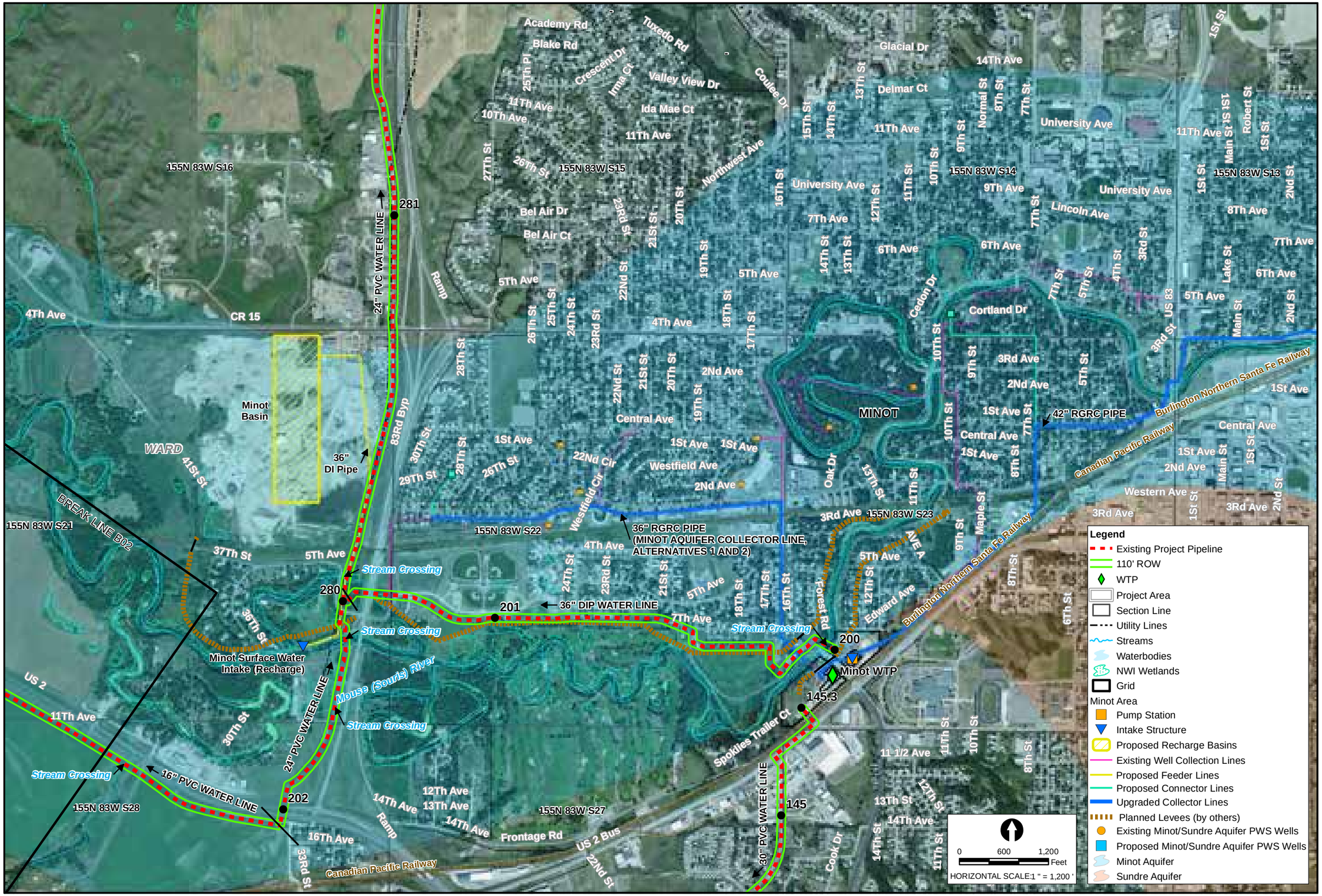
BULK DISTRIBUTION PIPELINE

PLAN SHEET

Northwest Area Water Supply

DATE: 12/18/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. F16



DATE	REVISIONS	NO.

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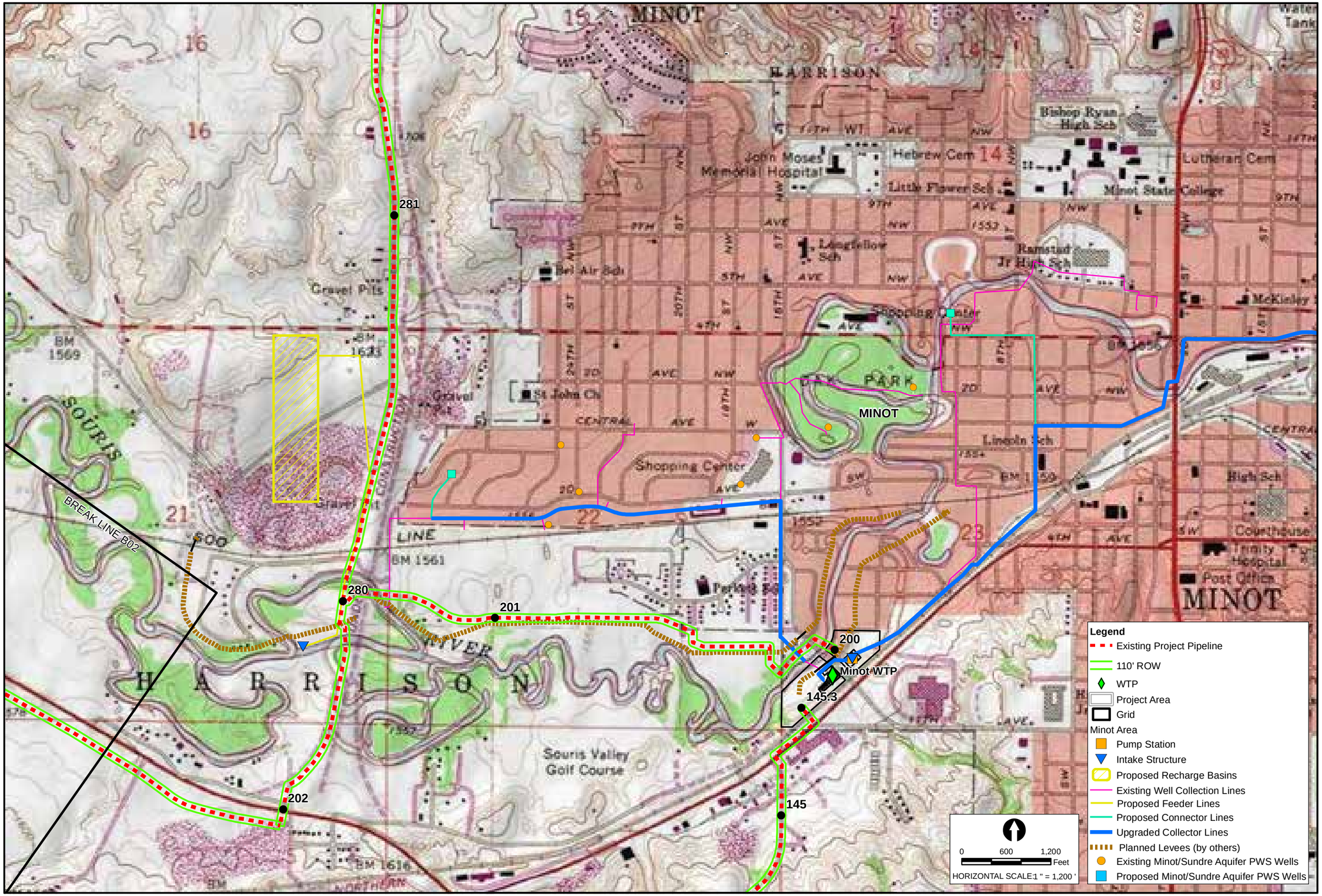
PROJECT IMPROVEMENTS

MINOT - PLAN SHEET - 1

Northwest Area Water Supply

DATE:	10/2/2012
DRAWN BY:	NJH
CHECKED BY:	FB
SCALE:	AS SHOWN
ENTRIX JOB NO.	30442091
FIGURE NO.	G01



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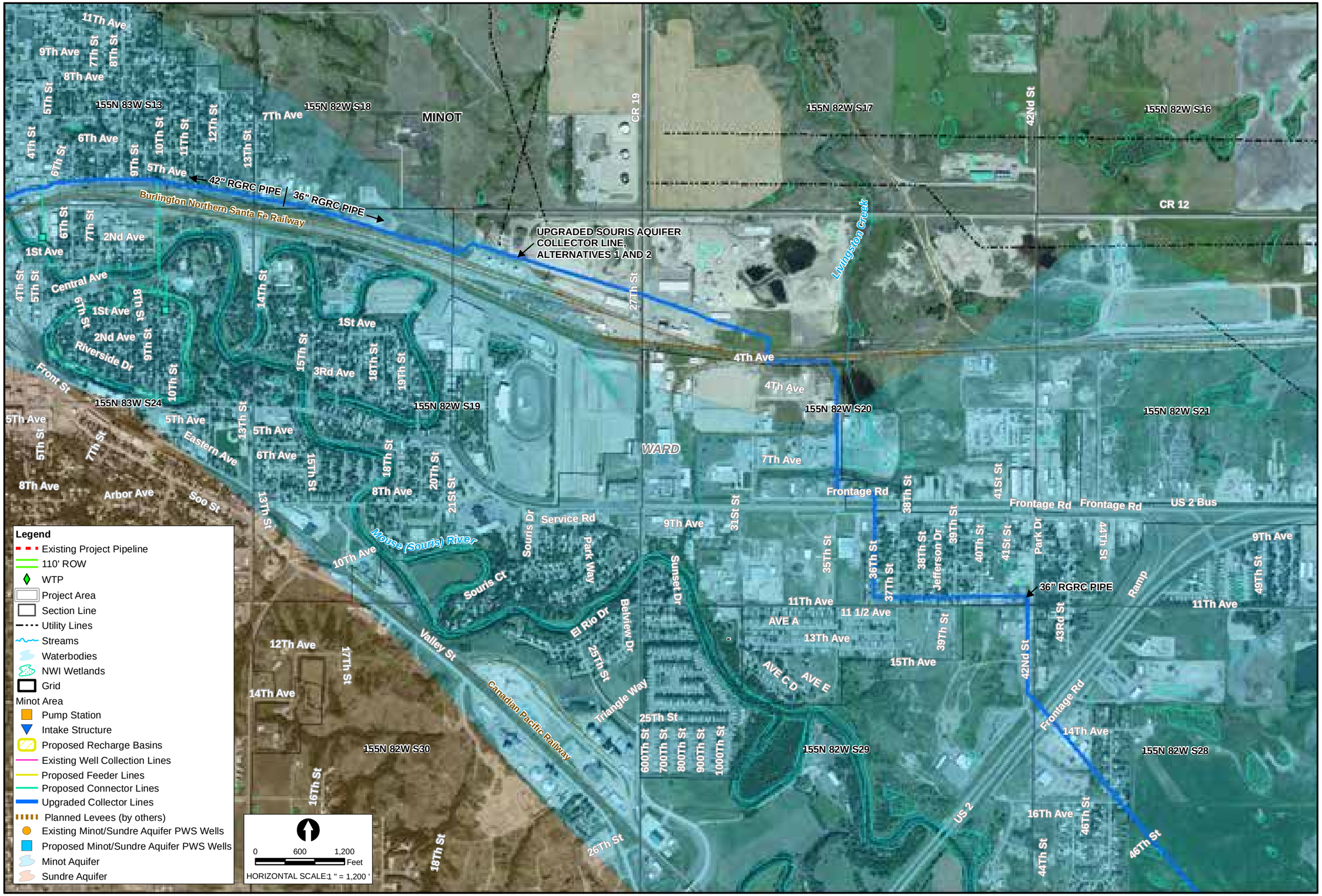
PROJECT IMPROVEMENTS

MINOT - PLAN SHEET - 2

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. G02



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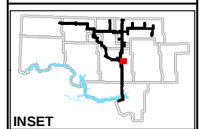
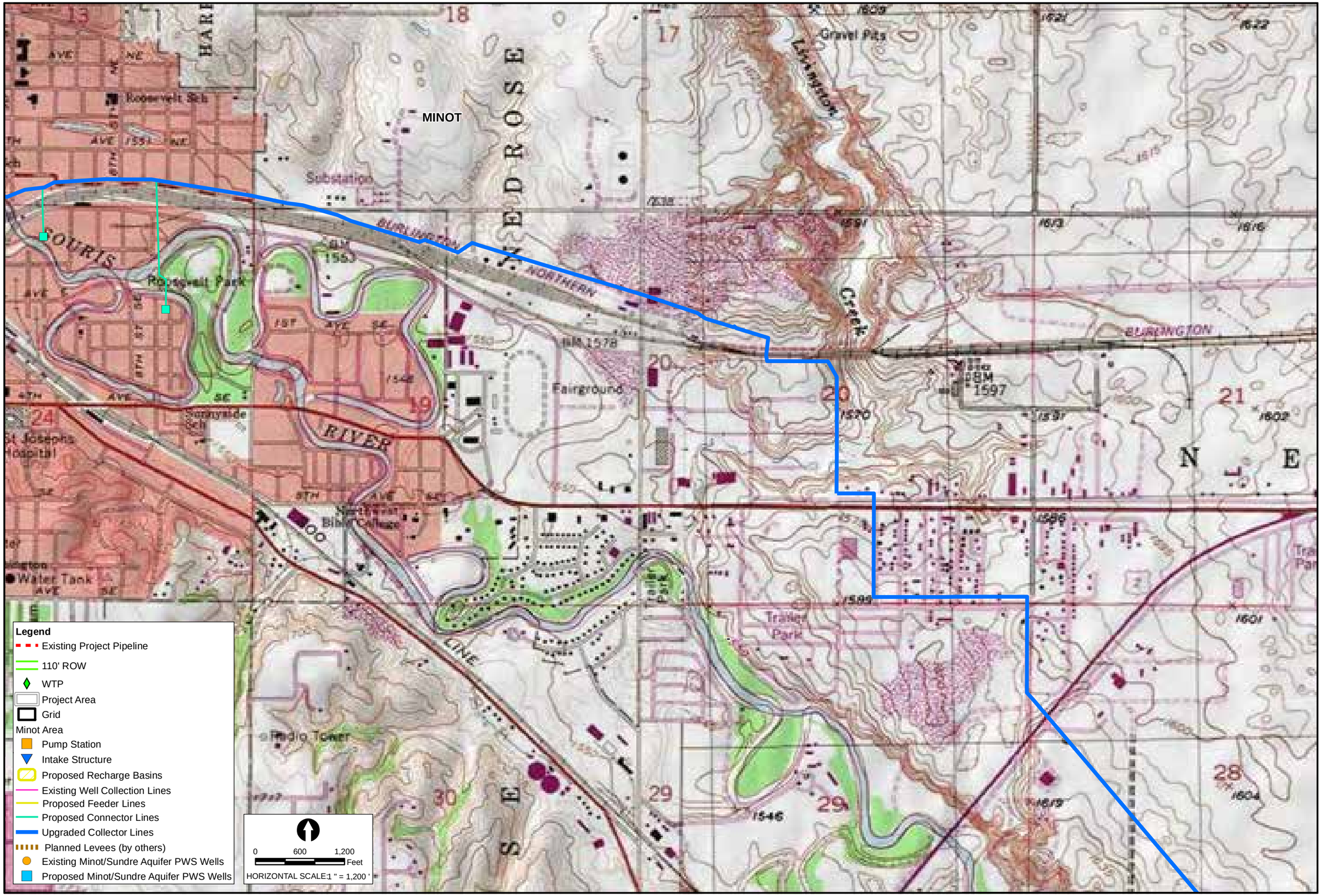


PROJECT IMPROVEMENTS

MINOT - PLAN SHEET - 3

Northwest Area Water Supply

DATE: 10/2/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. G03



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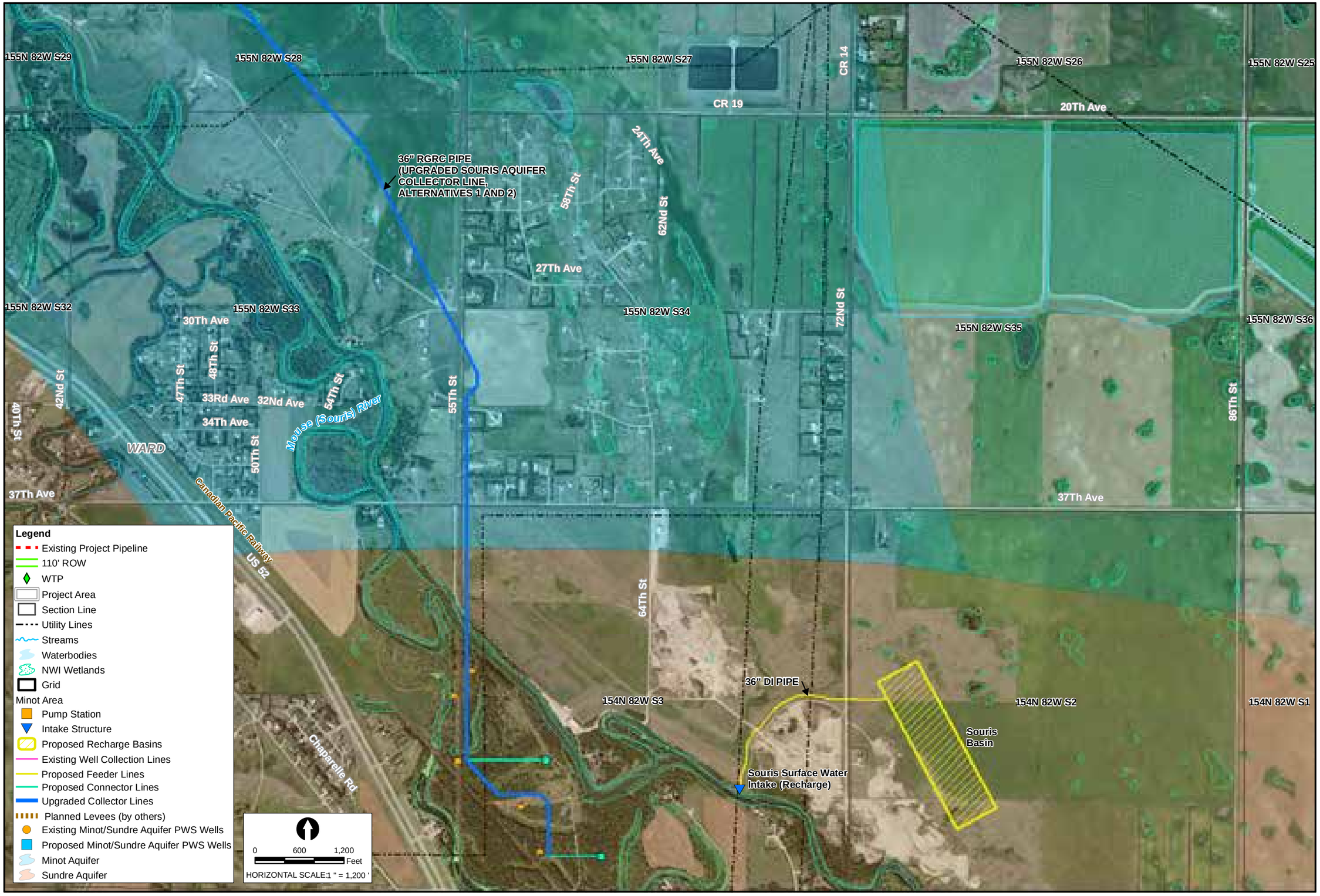
PROJECT IMPROVEMENTS

MINOT - PLAN SHEET - 4

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. G04



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PROJECT IMPROVEMENTS

MINOT - PLAN SHEET - 5

Northwest Area Water Supply

DATE: 10/2/2012

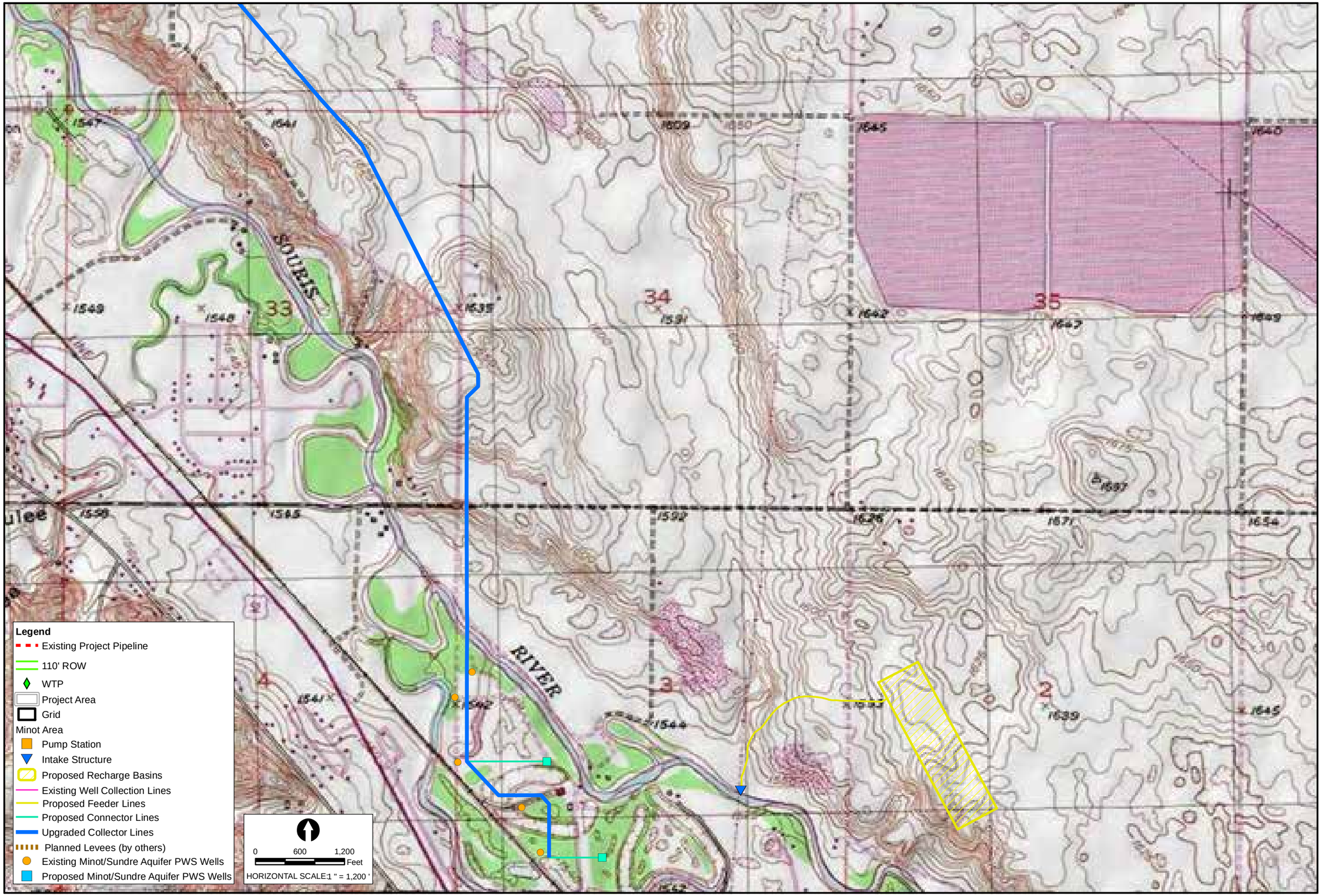
DRAWN BY: NJH

CHECKED BY: FB

SCALE: AS SHOWN

ENTRIX JOB NO. 30442091

FIGURE NO. G05



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PROJECT IMPROVEMENTS

MINOT - PLAN SHEET - 6

Northwest Area Water Supply

DATE: 09/25/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. G06

NO.	REVISIONS	DATE

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RECLAMATION

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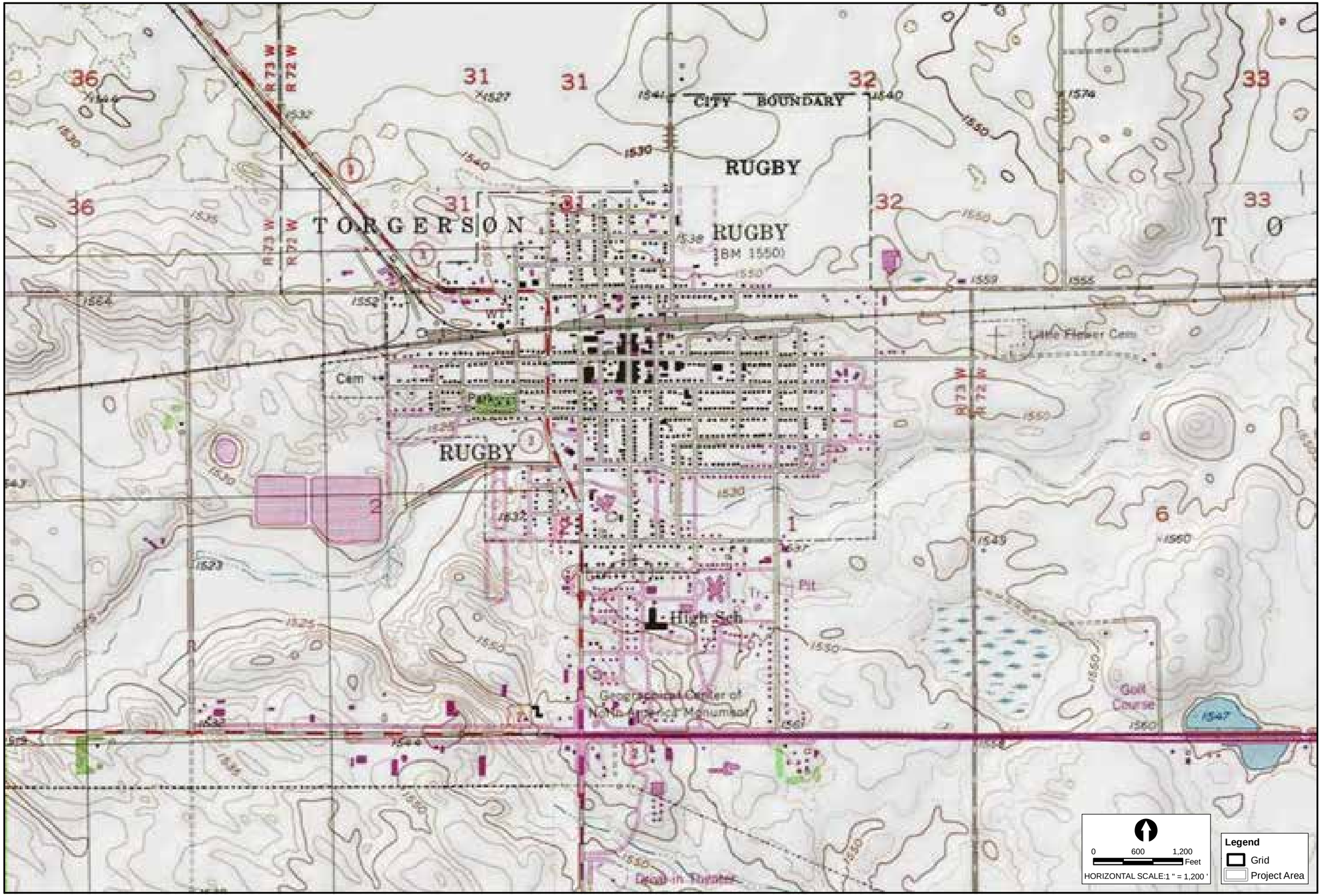
PROJECT IMPROVEMENTS

RUGBY - PLAN SHEET - 1

Northwest Area Water Supply

DATE: 12/18/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. H01



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PROJECT IMPROVEMENTS

RUGBY - PLAN SHEET - 2

Northwest Area Water Supply

DATE: 12/18/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. H02

NO.	REVISIONS	DATE

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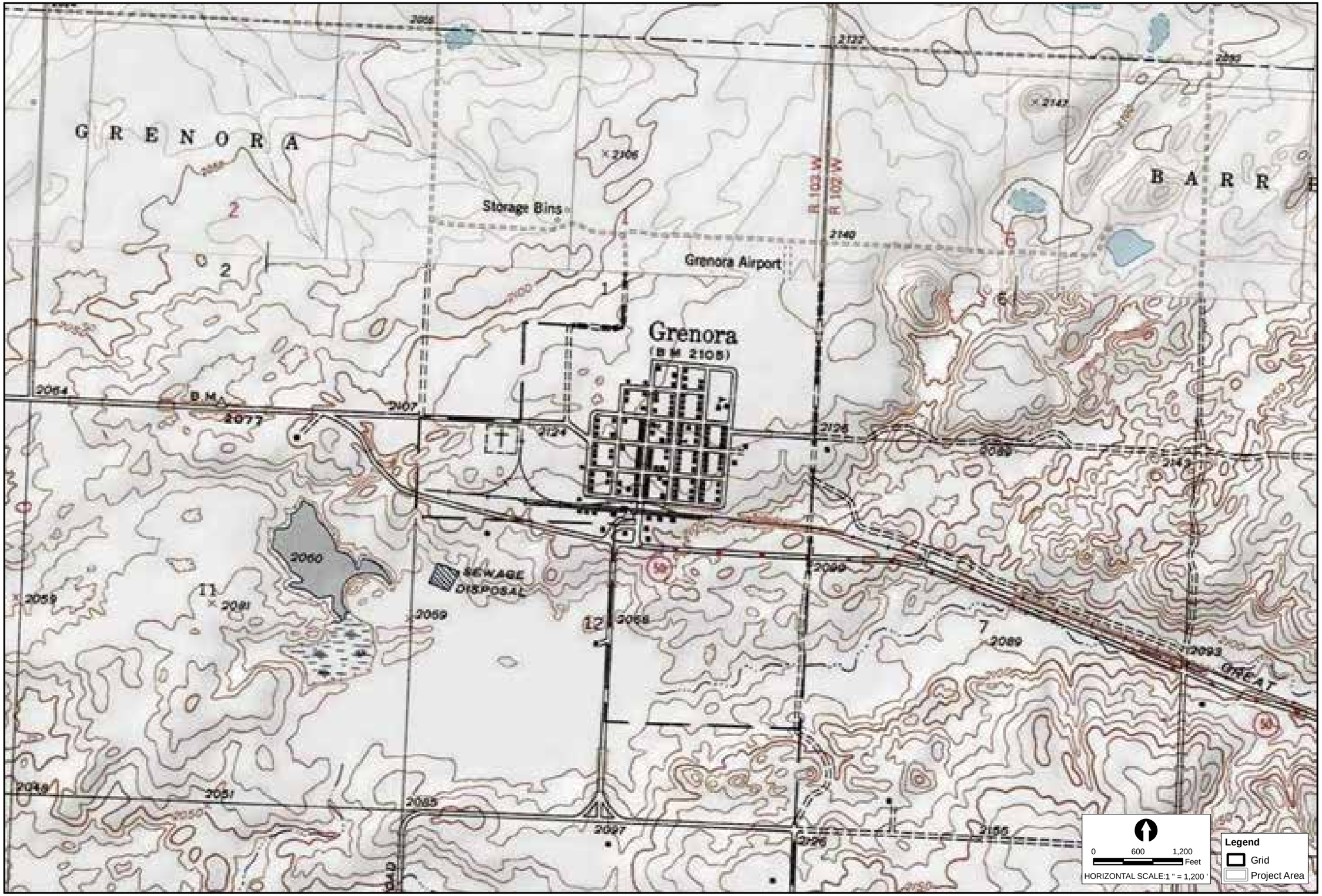
PROJECT IMPROVEMENTS

GRENORA - PLAN SHEET - 1

Northwest Area Water Supply

DATE: 12/18/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. H03



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PROJECT IMPROVEMENTS

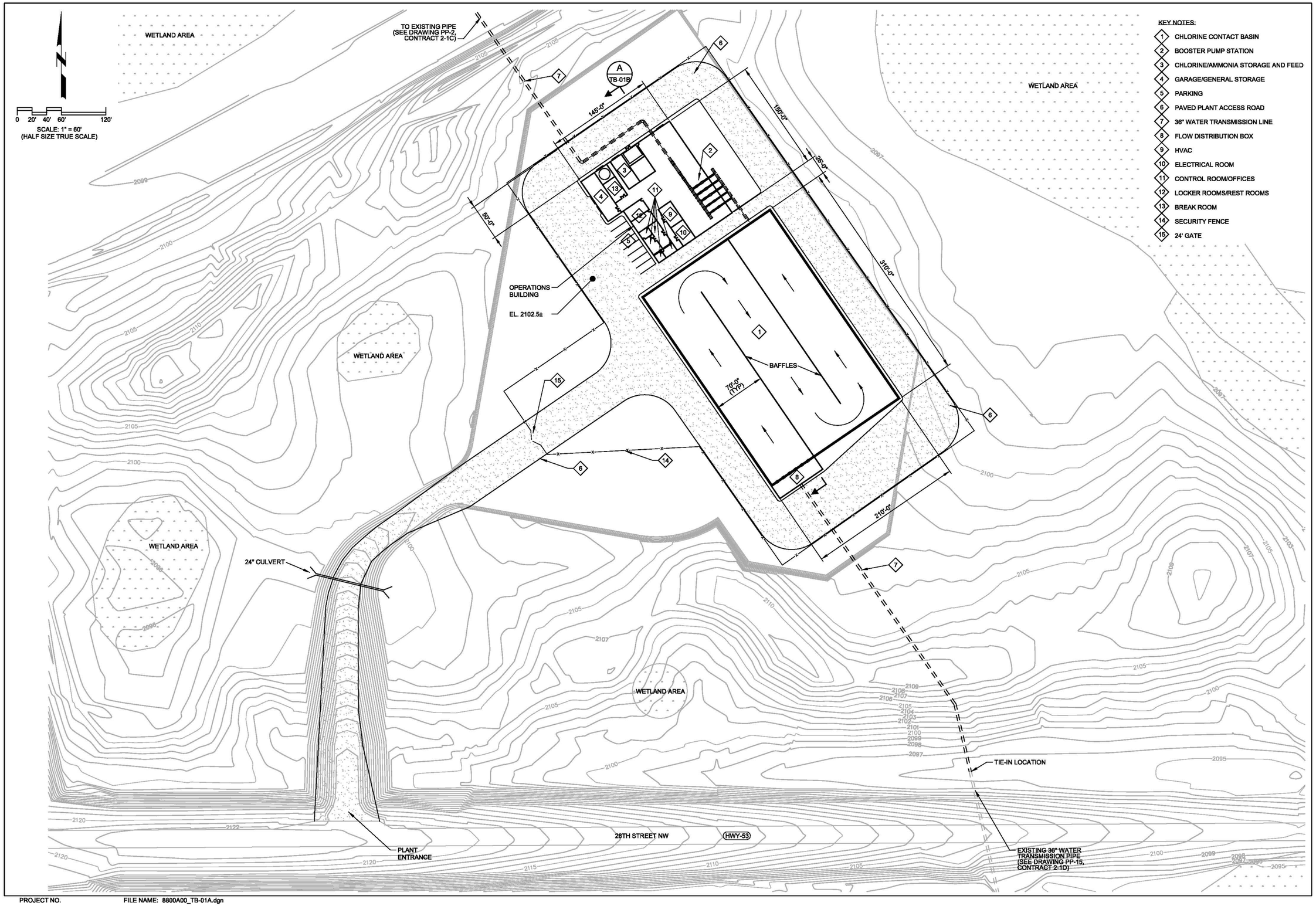
GRENORA - PLAN SHEET - 2

Northwest Area Water Supply

DATE: 12/18/2012
DRAWN BY: NJH
CHECKED BY: FB
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. H04

APPENDIX E

Treatment Drawings



KEY NOTES:

1. CHLORINE CONTACT BASIN
2. BOOSTER PUMP STATION
3. CHLORINE/AMMONIA STORAGE AND FEED
4. GARAGE/GENERAL STORAGE
5. PARKING
6. PAVED PLANT ACCESS ROAD
7. 36" WATER TRANSMISSION LINE
8. FLOW DISTRIBUTION BOX
9. HVAC
10. ELECTRICAL ROOM
11. CONTROL ROOM/OFFICES
12. LOCKER ROOMS/REST ROOMS
13. BREAK ROOM
14. SECURITY FENCE
15. 24' GATE

NO.	REVISIONS	DATE

SEAL

PRELIMINARY
NOT FOR
CONSTRUCTION

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RECLAMATION
Managing Water in the West

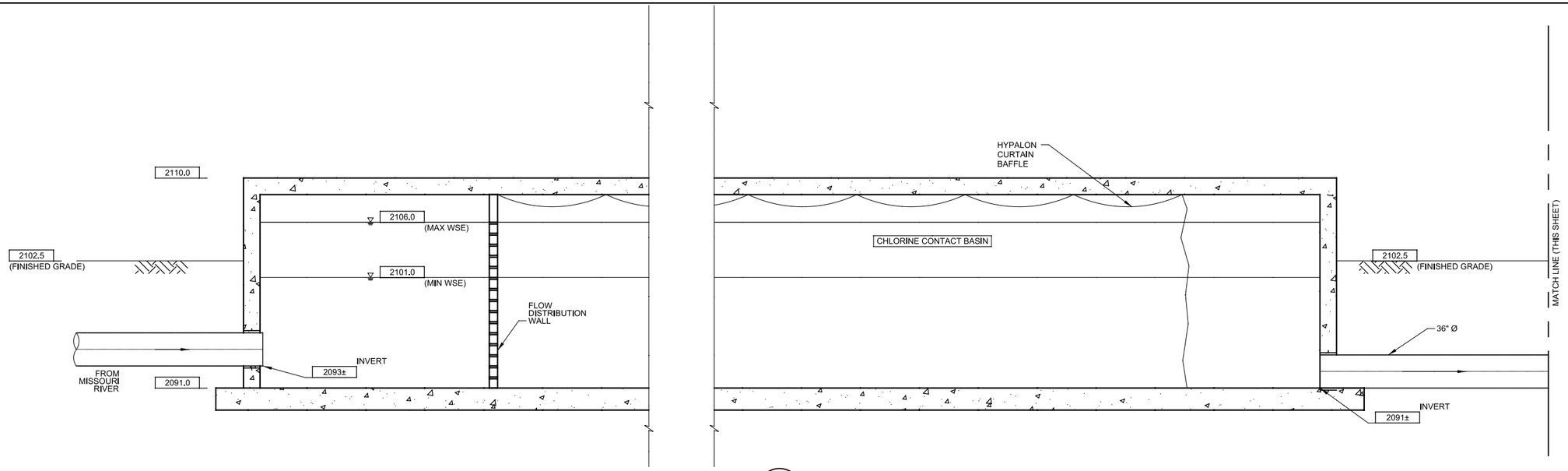
BIOTA WATER TREATMENT PLANT

CHLORINATION - SITE PLAN

NORTHWEST AREA WATER SUPPLY

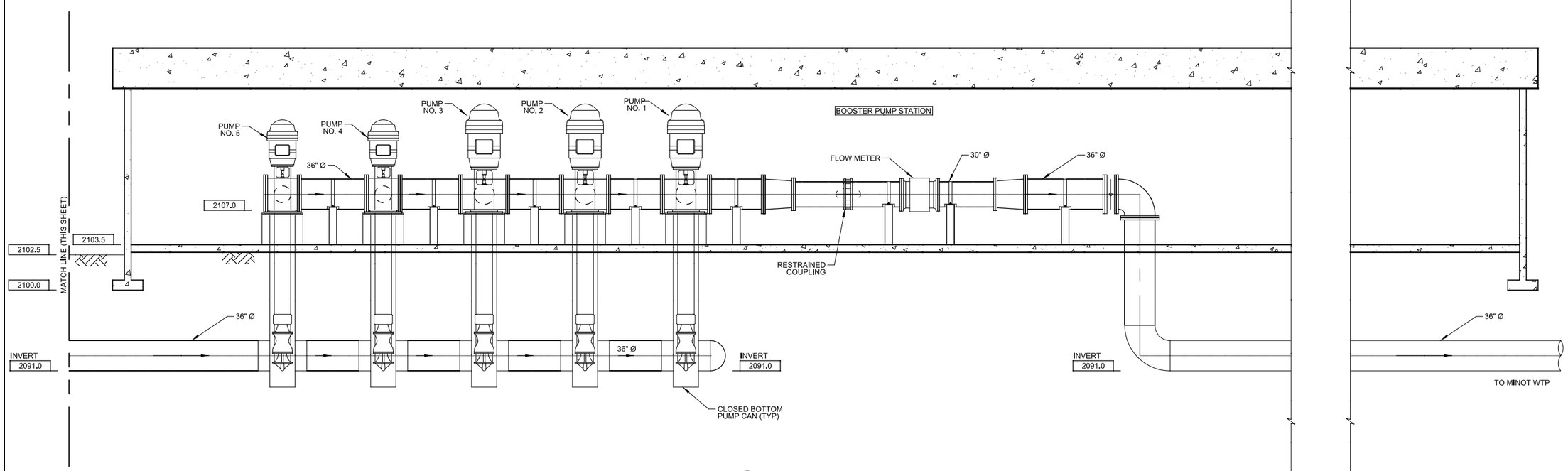
DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TB-01A

PROJECT NO.
FILE NAME: 8800A00_TB-01A.dgn



A SECTION
TB-01A

SCALE: 3/32" = 1'-0" (TRUE HALF SIZE SCALE)
FILE: 8800A00_050-300; 8800A00_040-300



A SECTION
TB-01A

SCALE: 3/32" = 1'-0" (TRUE HALF SIZE SCALE)
FILE: 8800A00_050-300; 8800A00_040-300

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RECLAMATION
Managing Water in the West

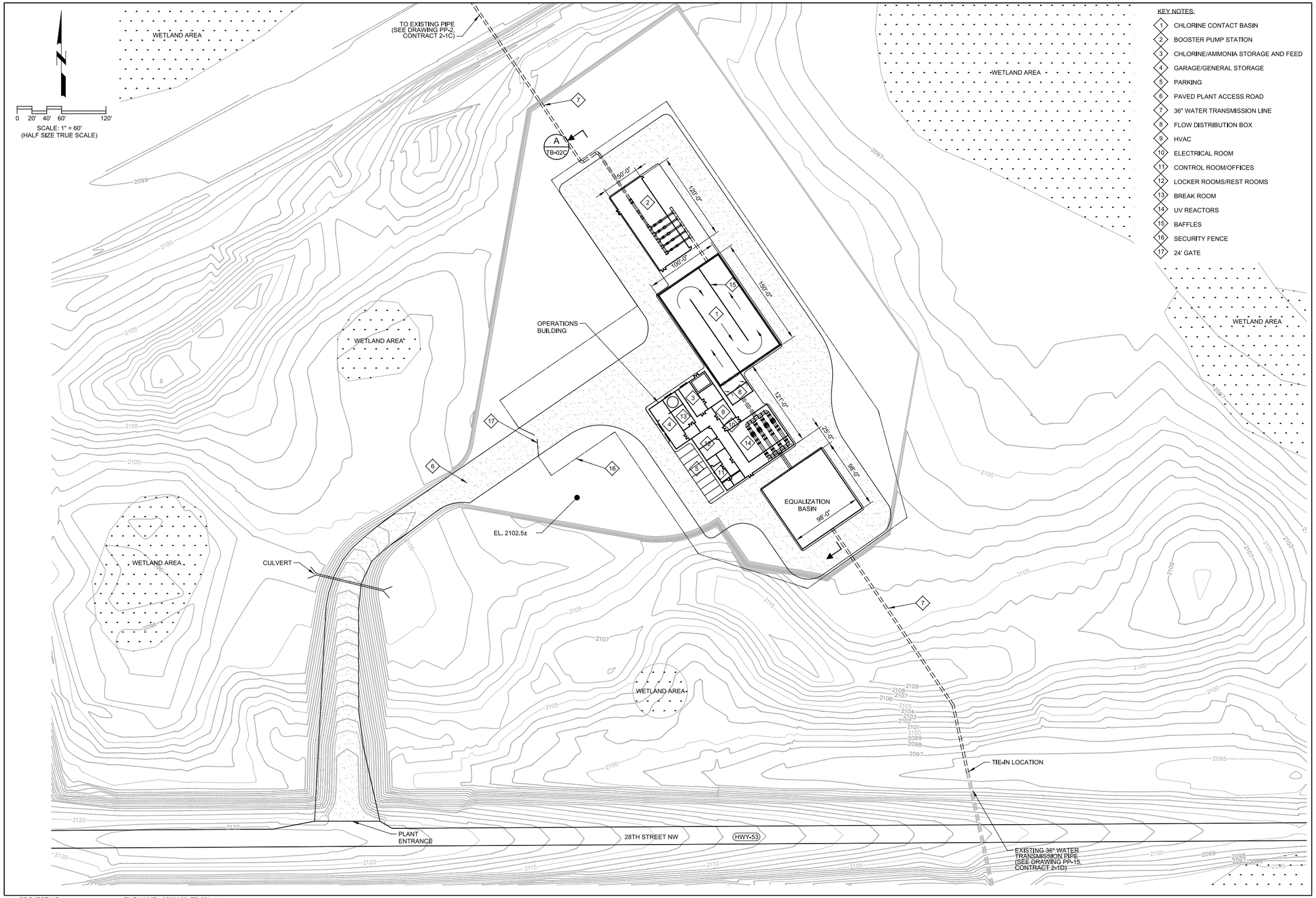
BIOTA WATER TREATMENT PLANT

CHLORINATION - SECTIONS

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TB-01B

PROJECT NO.
FILE NAME: 8800A00_TB-01B.dgn



KEY NOTES:

1. CHLORINE CONTACT BASIN
2. BOOSTER PUMP STATION
3. CHLORINE/AMMONIA STORAGE AND FEED
4. GARAGE/GENERAL STORAGE
5. PARKING
6. PAVED PLANT ACCESS ROAD
7. 36" WATER TRANSMISSION LINE
8. FLOW DISTRIBUTION BOX
9. HVAC
10. ELECTRICAL ROOM
11. CONTROL ROOM/OFFICES
12. LOCKER ROOMS/REST ROOMS
13. BREAK ROOM
14. UV REACTORS
15. BAFFLES
16. SECURITY FENCE
17. 24' GATE

NO.	REVISIONS	DATE

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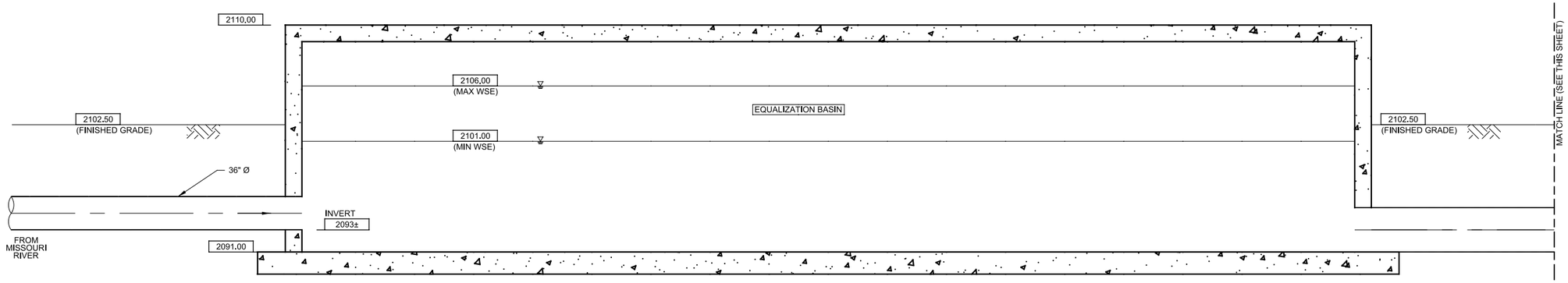
BIOTA WATER TREATMENT PLANT

CHLORINATION/UV INACTIVATION - PLAN

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TB-02A

PROJECT NO.
FILE NAME: 8800A00_TB-02A.dgn



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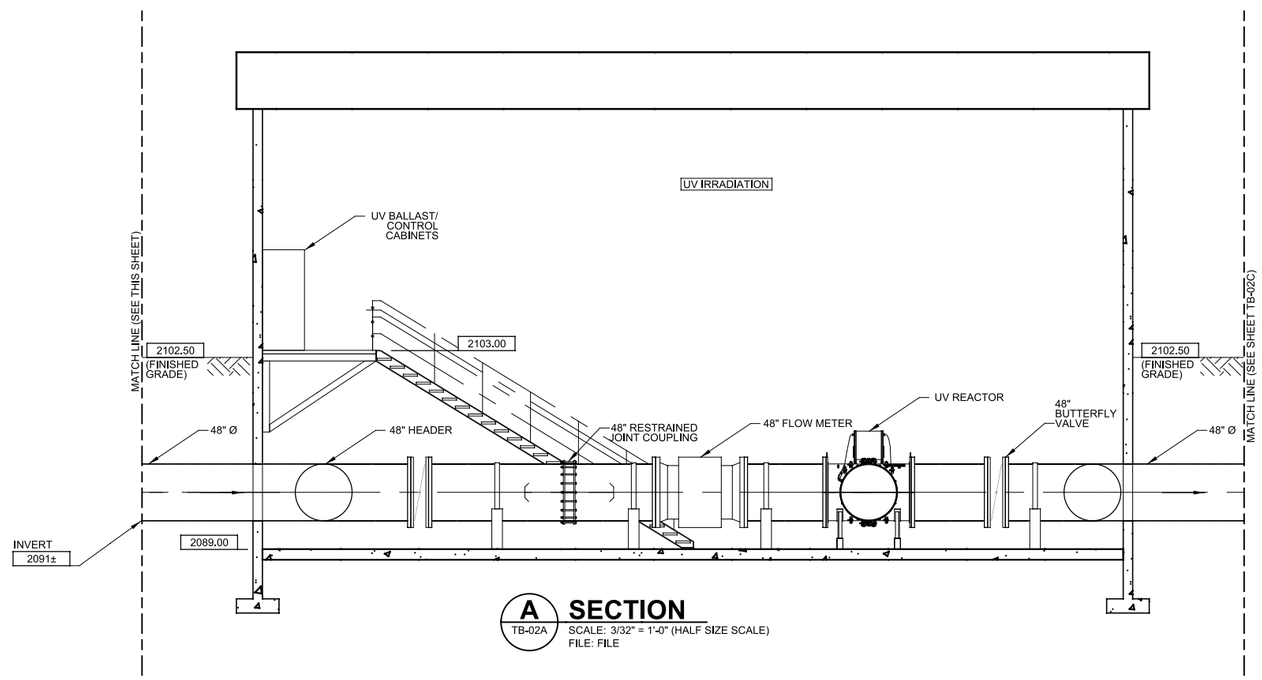

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SCALE: 3/32" = 1'-0" (HALF SIZE SCALE)
FILE: FILE

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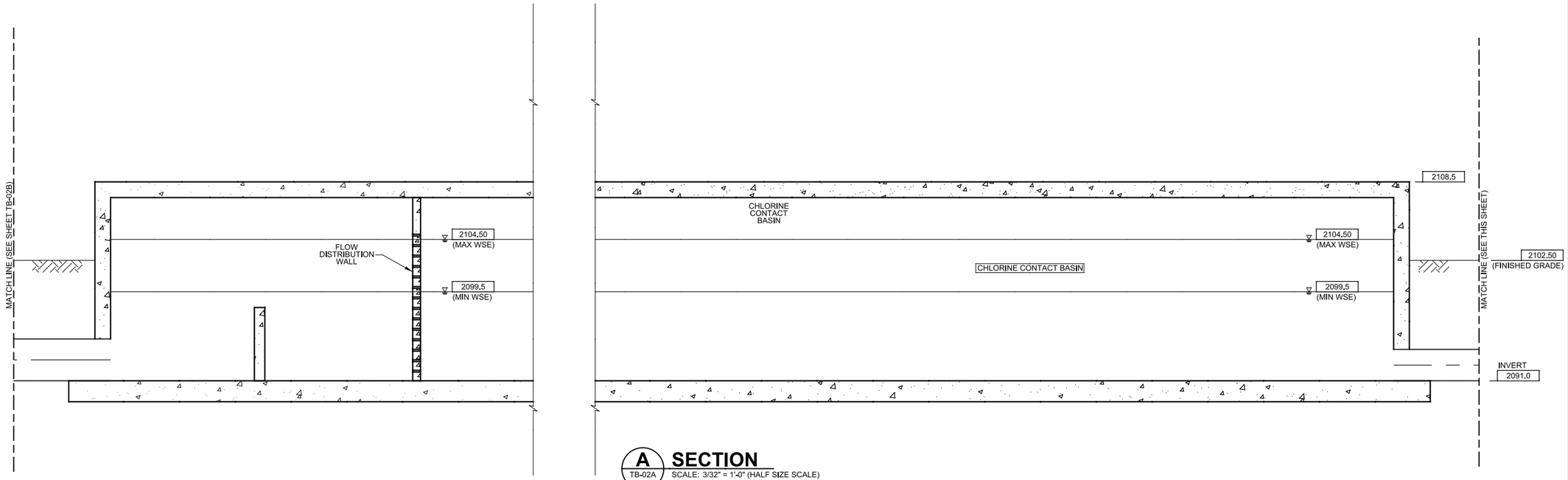
CHLORINATION/UV INACTIVATION - SECTIONS

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TB-02B

PROJECT NO.
FILE NAME: 8800A00_TB-02B.dgn



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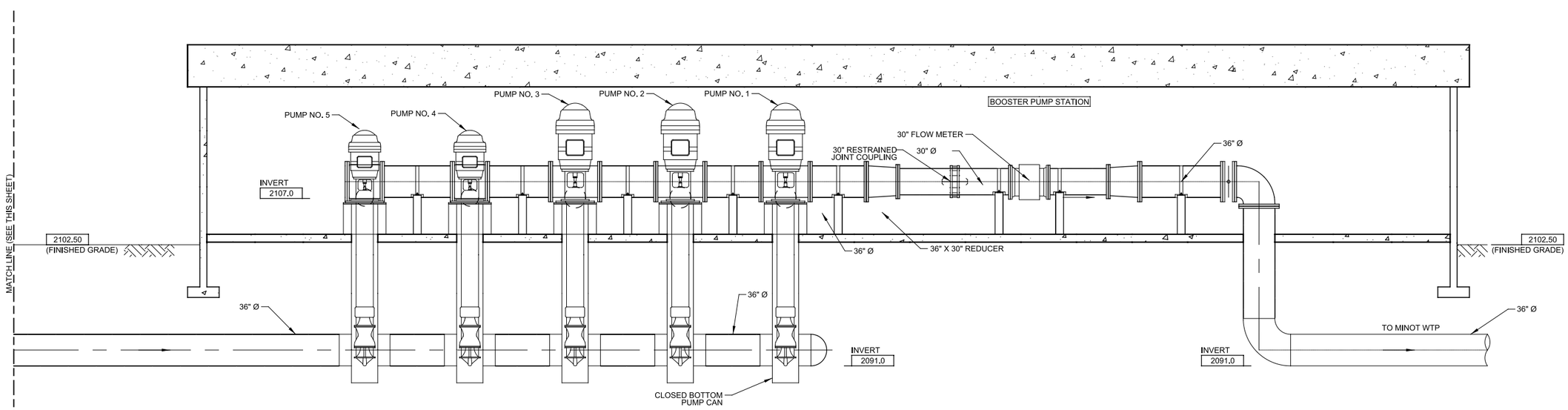
FILE: FILE



A TB-02A **SECTION**
SCALE: 3/32" = 1'-0" (HALF SIZE SCALE)
FILE: FILE

TSD

JDN

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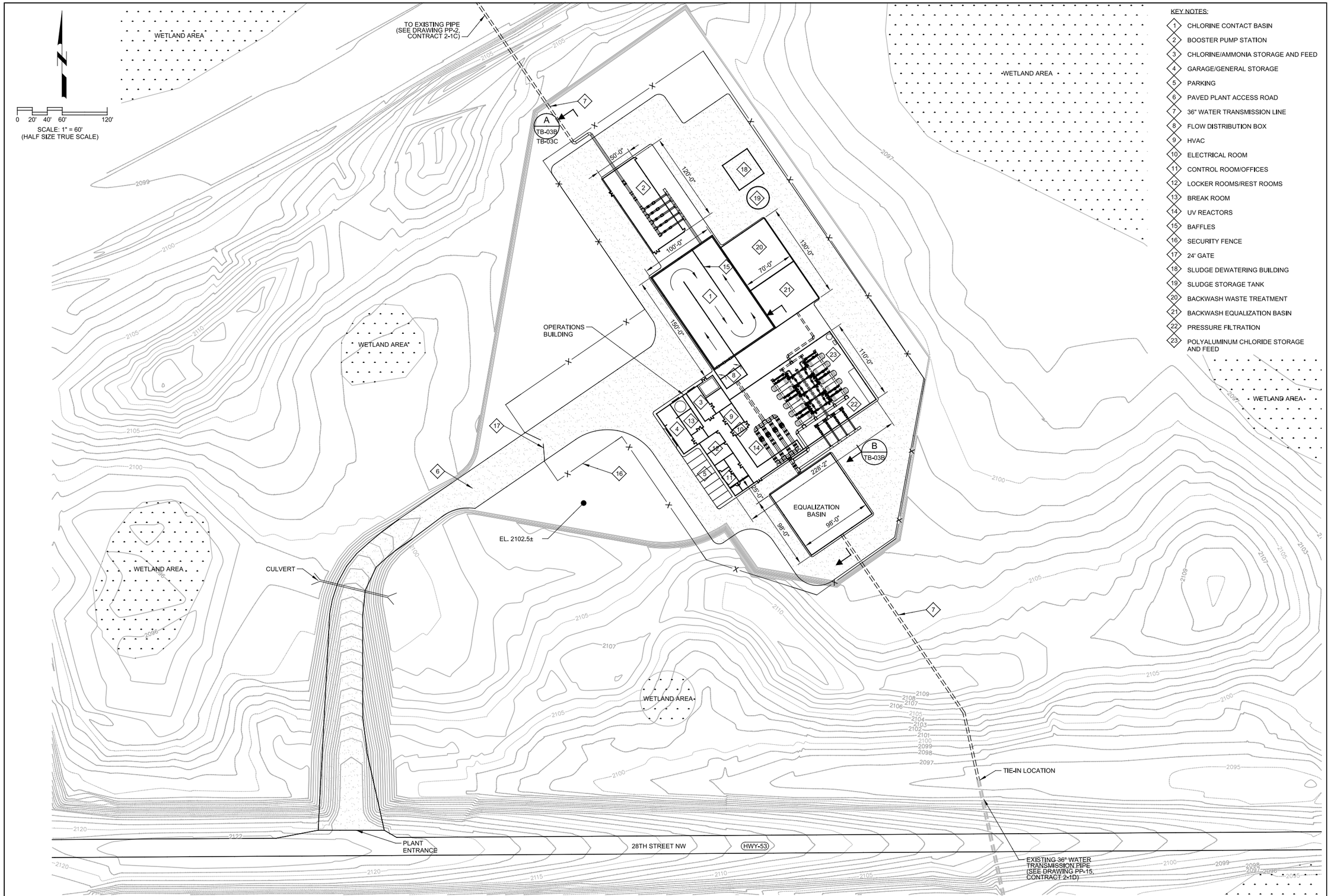
BIOTA WATER TREATMENT PLANT

CHLORINATION/UV INACTIVATION - SECTIONS

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY:
CHECKED BY:
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TB-02C

PROJECT NO.
FILE NAME: 8800A00_TB-02C.dgn



KEY NOTES:

1. CHLORINE CONTACT BASIN
2. BOOSTER PUMP STATION
3. CHLORINE/AMMONIA STORAGE AND FEED
4. GARAGE/GENERAL STORAGE
5. PARKING
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9. HVAC
10. ELECTRICAL ROOM
11. CONTROL ROOM/OFFICES
12. LOCKER ROOMS/REST ROOMS
13. BREAK ROOM
14. UV REACTORS
15. BAFFLES
16. SECURITY FENCE
17. 24' GATE
18. SLUDGE DEWATERING BUILDING
19. SLUDGE STORAGE TANK
20. BACKWASH WASTE TREATMENT
21. BACKWASH EQUALIZATION BASIN
22. PRESSURE FILTRATION
23. POLYALUMINUM CHLORIDE STORAGE AND FEED

NO.	REVISIONS	DATE

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RECLAMATION
Managing Water in the West

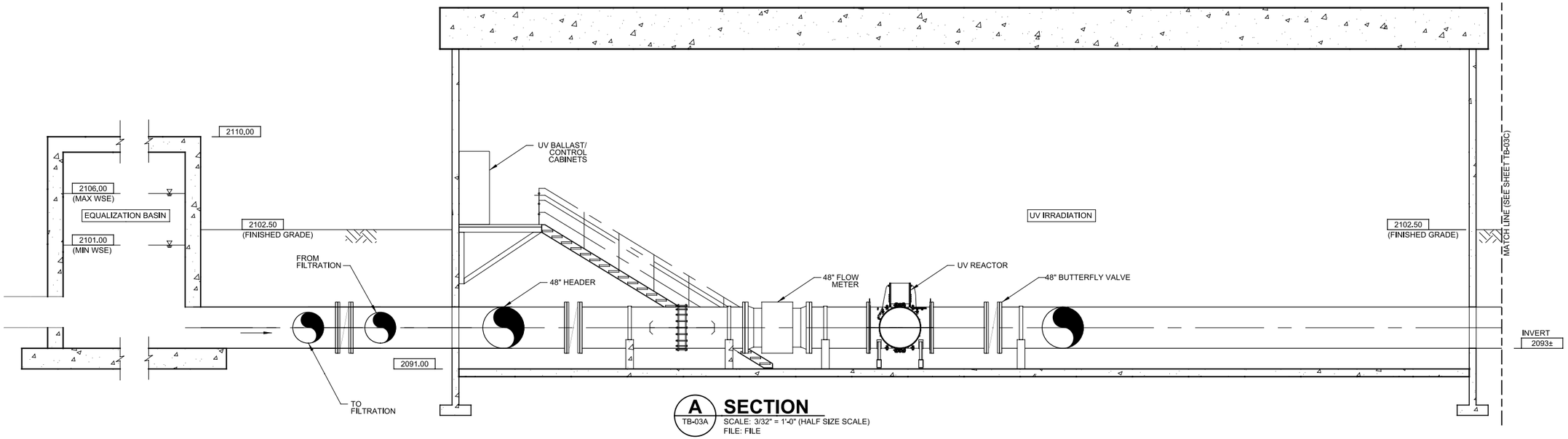
BIOTA WATER TREATMENT PLANT

ENHANCED CHLORINATION/ UV INACTIVATION - PLAN

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TB-03A

PROJECT NO. FILE NAME: 8800A00_TB-03A.dgn



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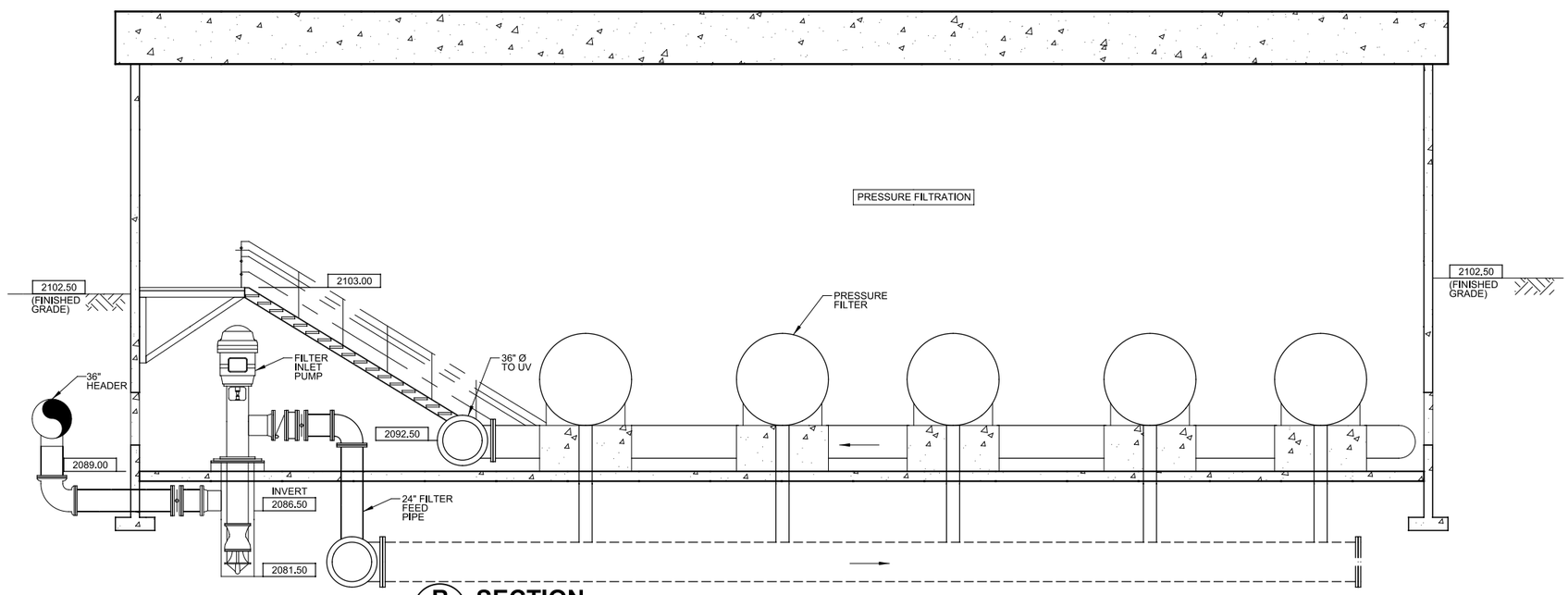

B TB-03A **SECTION**
SCALE: 3/32" = 1'-0" (HALF SIZE SCALE)
FILE: FILE

NO.	REVISIONS	DATE

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RECLAMATION
Managing Water in the West

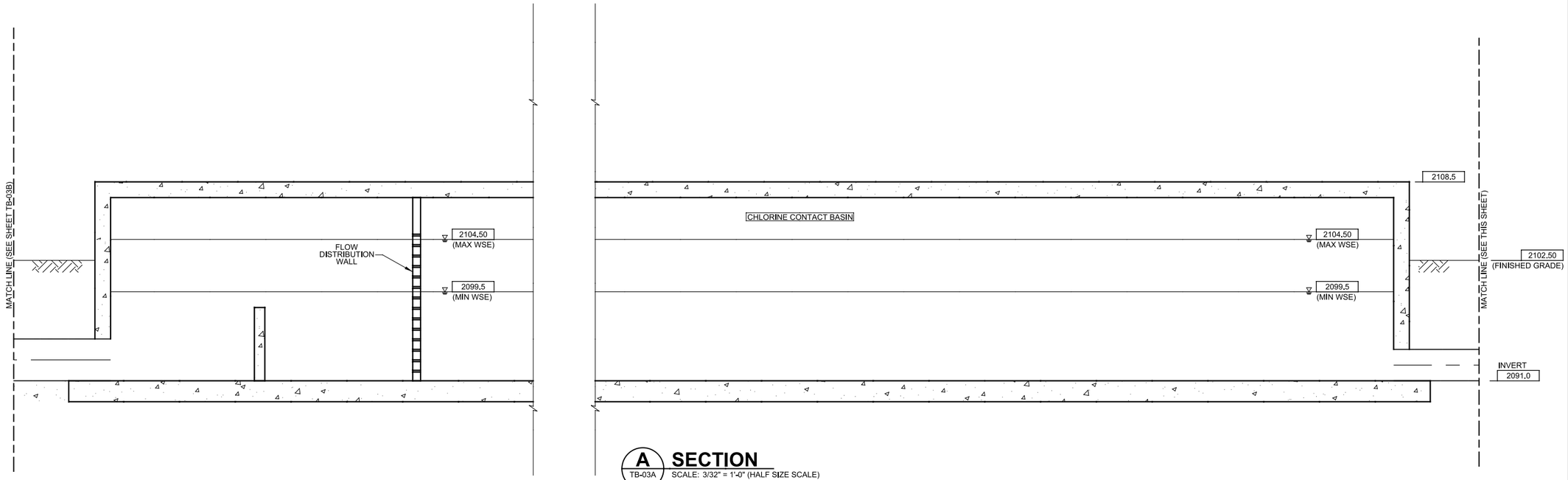
BIOTA WATER TREATMENT PLANT

ENHANCED CHLORINATION/ UV
INACTIVATION - SECTIONS

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TB-03B

PROJECT NO.
FILE NAME: 8800A00_TB-03B.dgn



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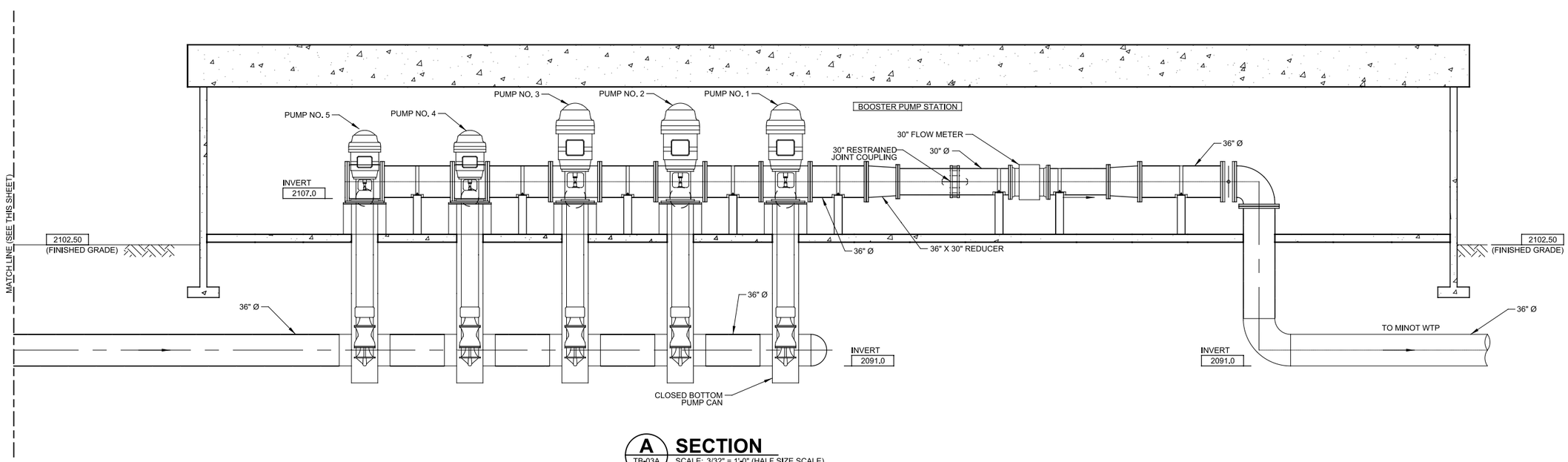

A TB-03A **SECTION**
SCALE: 3/32" = 1'-0" (HALF SIZE SCALE)
FILE: FILE

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Managing Water in the West

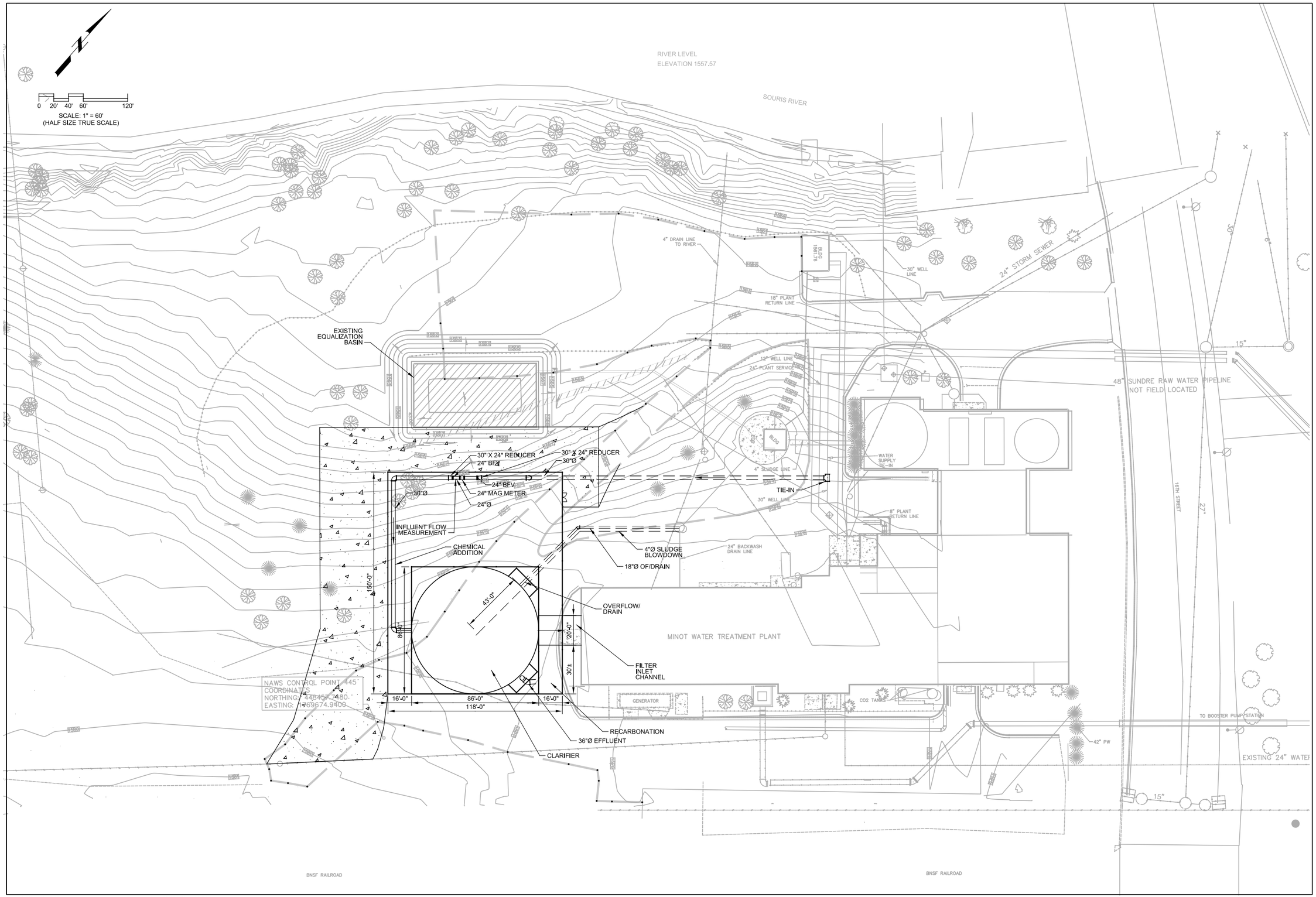
BIOTA WATER TREATMENT PLANT

ENHANCED CHLORINATION/ UV INACTIVATION - SECTIONS

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TB-03C

PROJECT NO.
FILE NAME: 8800A00_TB-03C.dgn



NO.	REVISIONS	DATE

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RECLAMATION
Managing Water in the West

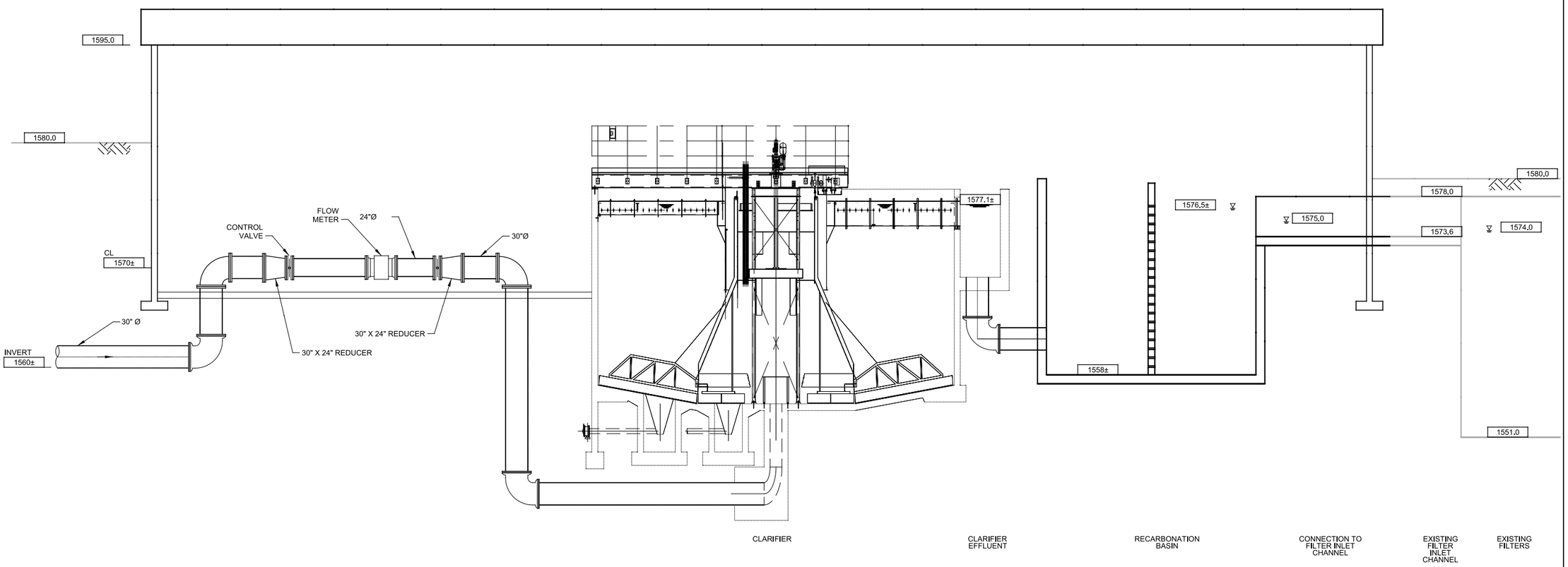
MINOT WATER TREATMENT PLANT

GROUNDWATER WITH RECHARGE - PLAN

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TM-01A

PROJECT NO.
FILE NAME: 8800A00_TM-01A.dgn



A TB-01A **SECTION**

SCALE: 3/32" = 1'-0" (TRUE HALF SIZE SCALE)
FILE: 8800A00_050-300; 8800A00_040-300

NO.	REVISIONS	DATE

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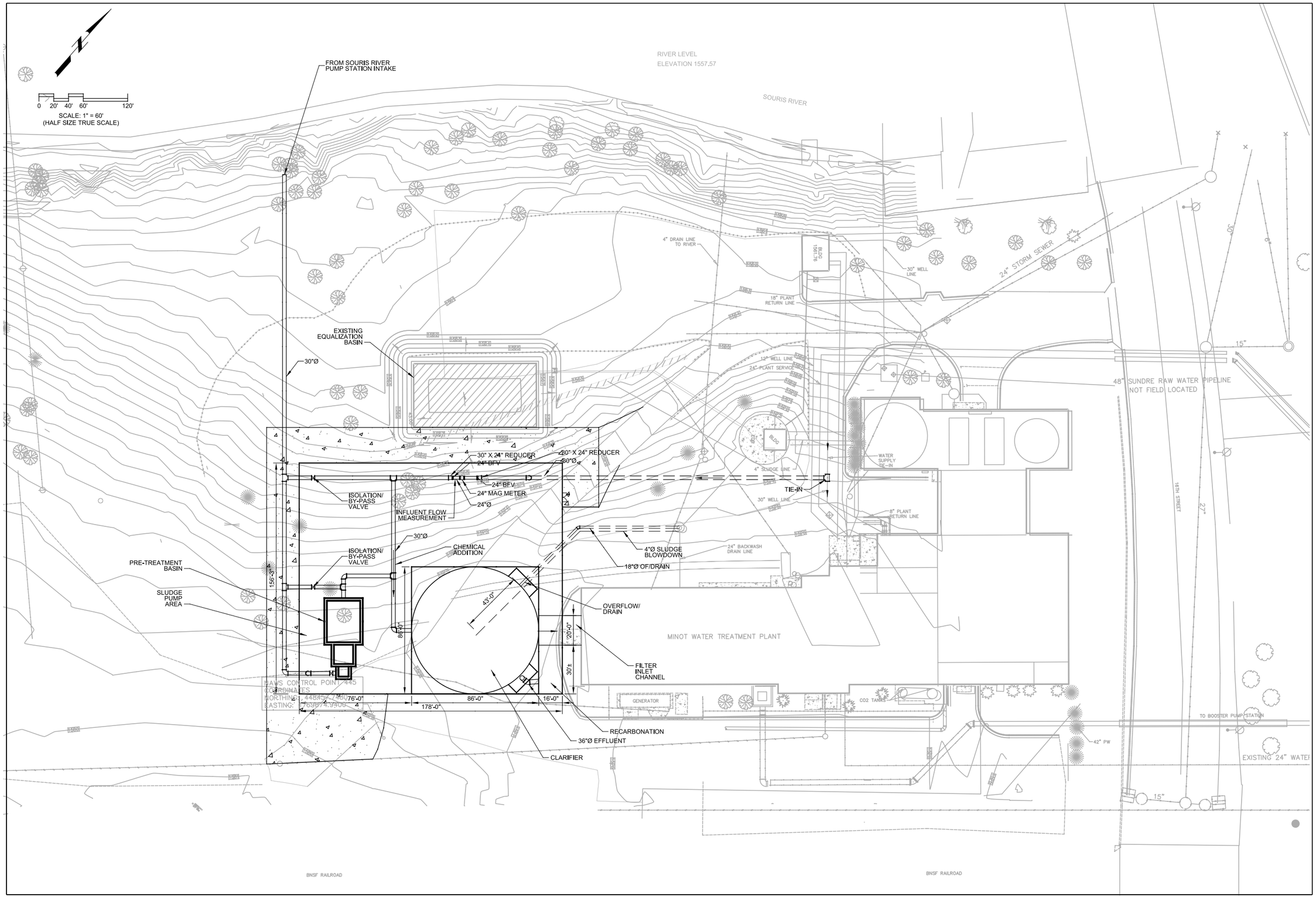
RECLAMATION
Managing Water in the West

MINOT WATER TREATMENT PLANT

GROUNDWATER WITH RECHARGE - HYDRAULIC SECTION

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TM-01B



NO.	REVISIONS	DATE

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Managing Water in the West

MINOT WATER TREATMENT PLANT

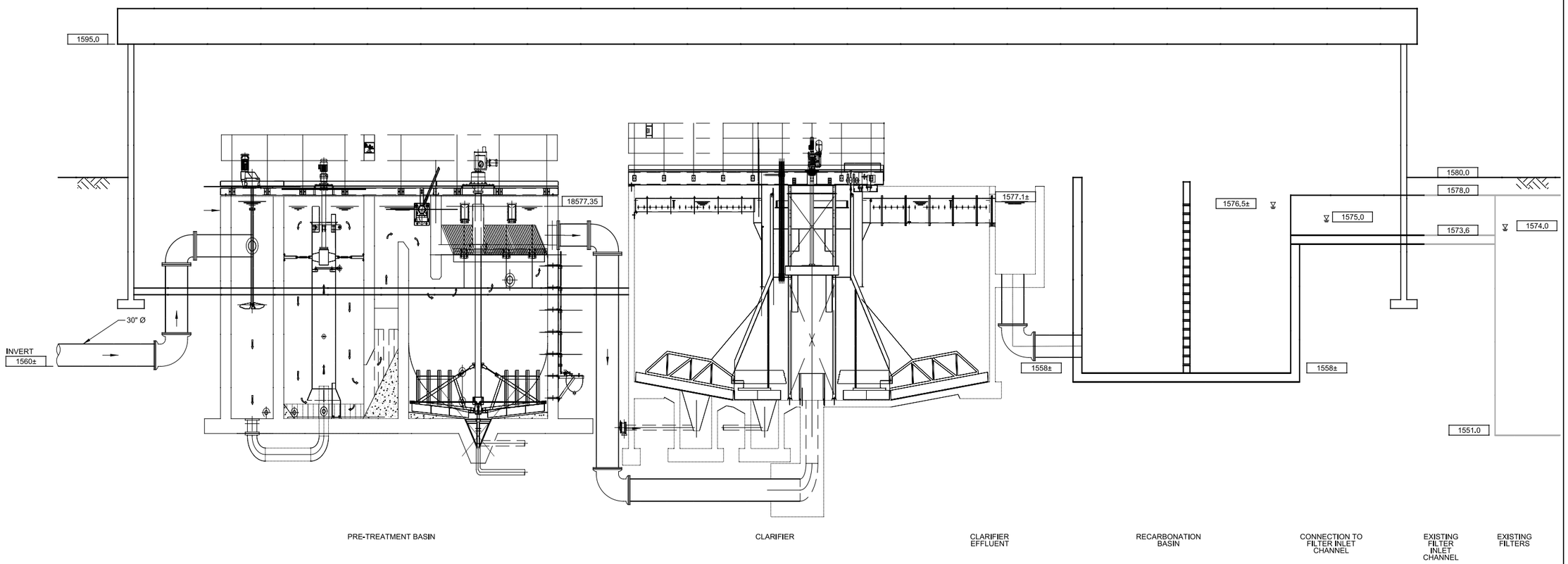
GROUNDWATER WITH RECHARGE AND THE SOURIS RIVER - PLAN

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TM-02A

PROJECT NO.

FILE NAME: 8800A00_TM-02A.dgn



A
TB-01A

SECTION

SCALE: 3/32" = 1'-0" (TRUE HALF SIZE SCALE)
FILE: 8800A00_050-300; 8800A00_040-300

NO.	REVISIONS	DATE

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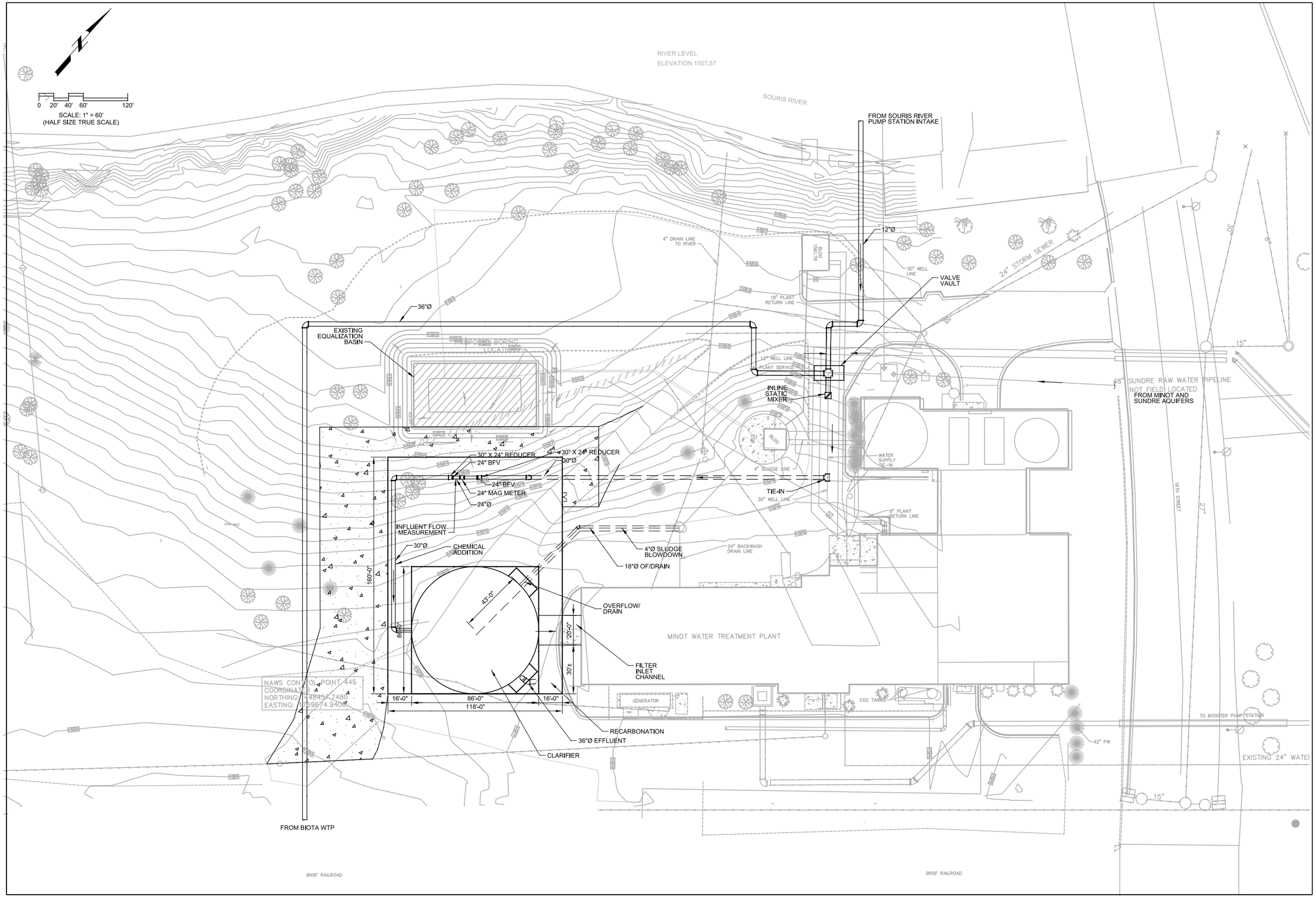
MINOT WATER TREATMENT PLANT

GROUNDWATER WITH RECHARGE AND THE SOURIS RIVER - HYDRAULIC SECTION

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TM-02B

PROJECT NO.
FILE NAME: 8800A00_TM-02B.dgn



NO.	REVISIONS	DATE

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MINOT WATER TREATMENT PLANT

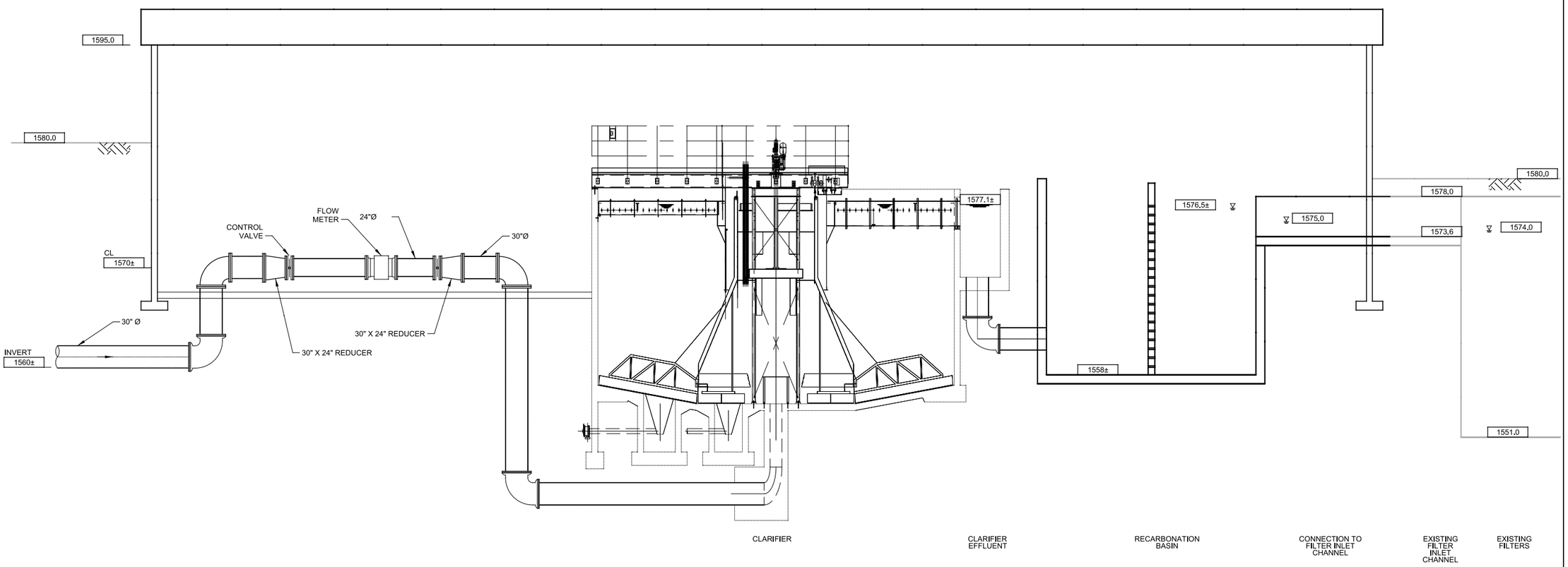
MISSOURI RIVER AND
CONJUNCTIVE USE - SITE PLAN

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TM-03A

PROJECT NO.

FILE NAME: 8800A00_TM-03A.dgn



A
TB-01A

SECTION

SCALE: 3/32" = 1'-0" (TRUE HALF SIZE SCALE)
FILE: 8800A00_050-300; 8800A00_040-300

NO.	REVISIONS	DATE

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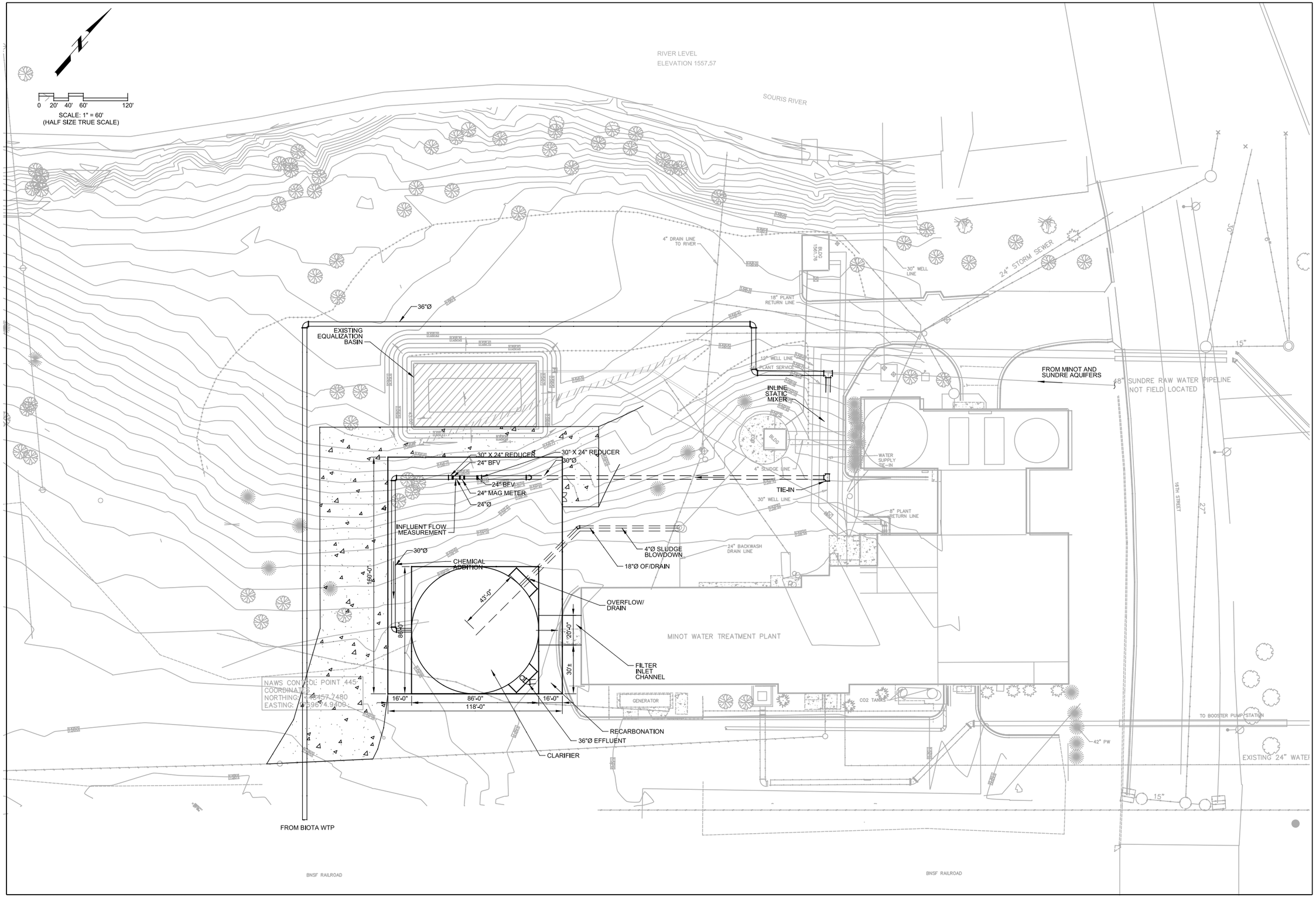
MINOT WATER TREATMENT PLANT

MISSOURI RIVER ALTERNATIVES - HYDRAULIC SECTION

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TM-03B

PROJECT NO.
FILE NAME: 8800A00_TM-03B.dgn



NO.	REVISIONS	DATE

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RECLAMATION
Managing Water in the West

MINOT WATER TREATMENT PLANT

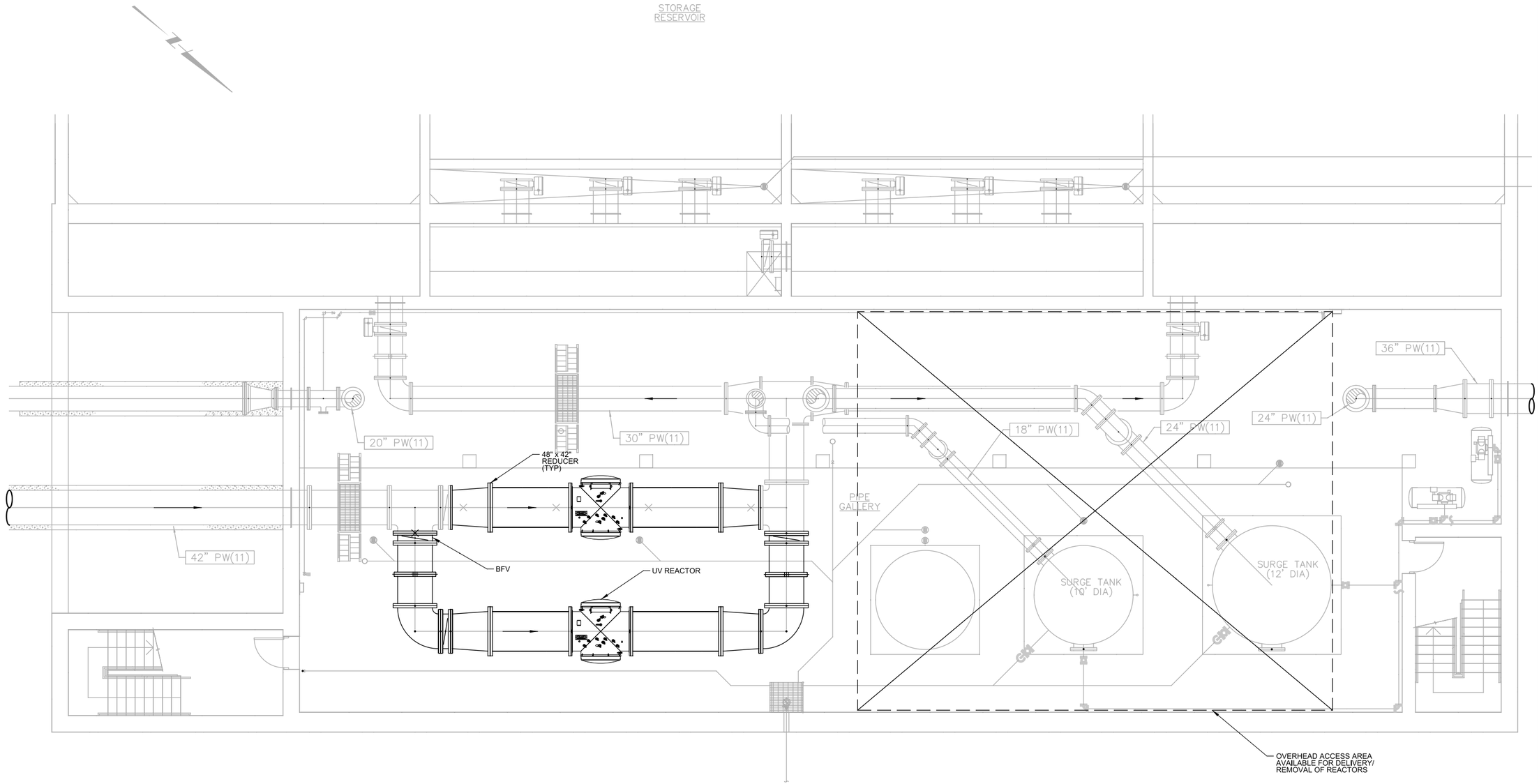
MISSOURI RIVER AND GROUNDWATER - SITE PLAN

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TM-04

PROJECT NO.

FILE NAME: 8800A00_TM-04.dgn



A LOWER LEVEL MECHANICAL FLOOR PLAN

SCALE: 3/32" = 1'-0" (TRUE HALF SIZE SCALE)
FILE: 8800A00_050-107

NO.	REVISIONS	DATE

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RECLAMATION Managing Water in the West

MINOT WATER TREATMENT PLANT

UV DISINFECTION SYSTEM - ALL ALTERNATIVES

NORTHWEST AREA WATER SUPPLY

DATE: 11/15/12
DRAWN BY: JDN
CHECKED BY: TSD
SCALE: AS SHOWN
ENTRIX JOB NO. 30442091
FIGURE NO. TM-05

PROJECT NO.
FILE NAME: 8800A00_TM-05.dgn

APPENDIX F

Cost Opinions for Project Components

Cost Assumptions and Factors

Scope of Costs

Costs listed on the estimate worksheets include furnishing and installing the item complete and in place. These installed costs include furnishing all labor, equipment, materials, incidentals and appurtenances required to comply with typical Bureau of Reclamation Construction Specifications.

Mobilization

Mobilization costs include mobilizing contractor personnel and equipment to the project site during initial project start-up. The 5% value for mobilization reflects a value based on experience with similar projects.

Unlisted

Per Reclamation Cost Estimating Handbook guidelines, the allowance for unlisted items in appraisal estimates should be at least 10%. A variable value of 5 percent to 10 percent (fraction) was used for this report based upon the completeness of the cost estimate listed items, as presented below. (*Unlisted = fraction x (subtotal + installation + mobilization)*).

- Water treatment, storage and pipeline estimates used a value of 5 percent.
- Surface water intakes and associated pump station estimates used a value of 10 percent.

This item is also considered a contingency for potential **minor** design changes. This allowance for unlisted items represents the amount required to achieve comparability between these preliminary estimates and the prevalidation estimate or IGCE. Professional judgment is to be used in assigning reasonable percentage allowances for unlisted items, but in general, the less refined the estimate, the higher the percentages used. The availability and quality of applicable design data and the magnitude of the work items that may be affected by deficient design data shall be considered when establishing the percentage allowance to be used for the unlisted items.

Contract Cost

The contract cost is intended to represent the estimated cost of the contract at time of bid or award. This value will include mobilization and allowances for unlisted items but not contingencies. (*Contract Cost = subtotal + installation + mobilization + unlisted*)

Contingencies

This cost estimate was prepared in accordance with Reclamation Manual requirements for appraisal level estimates. This estimate includes a percentage allowance for contingencies as a separate item to cover minor differences in actual and estimated quantities, unforeseeable difficulties at the site, changed site conditions, possible minor changes in plans, and other uncertainties. Estimated quantities or unit prices were not to be increased as a means for including contingencies. The allowance used was based on engineering judgment of the major pay items in the estimate, reliability of the data, adequacy of the projected quantities, and general knowledge of site conditions. The allowance is related to the certainty of

the engineering and geological information and data. A value between 21 percent and 30 percent was added for contingencies for all the features cost estimated, (*Contingencies = fraction x Contract Cost*) as follows:

- Water treatment and pipeline estimates used a value of 21 percent.
- Water reservoirs, large scale storage (recharge basins) and surface water intakes (and associated pump station) estimates used a value of 30 percent.

Non-Contract Cost

Non-contract costs refer to the costs of work or services provided by Reclamation staff and/or service contractors in support of the Project.

Non-contract costs are included to cover work or services provided in support of the contract such as design and specifications development, procurement services, contract administration, construction supervision, etc.

Past estimates completed by Reclamation have included non-contract costs at 25% and local data for similar on-going work on the project supports that value. It was determined that 25% be added for non-contract costs, assuming this project is locally contracted and administered. (*Non-Contract Cost = 0.25 x Field Cost*)

General Note

Part of the standard cost estimating methodology used by Reclamation may include rounding and back calculating of some values. Therefore the direct sequential application of percentages to each cost will not produce the same values as shown.

Cardno ENTRIX
Shaping the Future

PROJECT SUMMARY

Project: NAWS
Type: In-basin Alternative Component
Component: Minot Peaking Wells

NO.	DESCRIPTION			TOTAL
1	Site Work			$88,042
2	Peak Wells			$823,200
TOTAL				**$911,242**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$911,242**
	Mobilization		5.0%	$45,562
		Subtotal		**$956,804**
	Unlisted Items		5.0%	$47,840
		Subtotal		**$1,004,644**
	Contingencies		30.0%	$301,393
		Subtotal		**$1,306,037**
	Noncontract Costs		25.0%	$326,509
		Subtotal		**$1,632,546**
TOTAL				**$1,632,546**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Cardno ENTRIX has no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Cardno ENTRIX cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Minot Peaking Wells
Element: Site Work

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing (0.5 AC, each)	2.0	AC	$2,500	$5,000	
	Total					$5,000
	Metal					
	Galv. Chain Link Fence, 8' W/Barbed Wire, No Gates (50 ft x 50 ft, each)	720	LF	$43	$30,960	
	8' H Double Swing Gate, Chain Link, 20' Opening	4	EA	$2,860	$11,442	
	Total					$42,402
	Electrical					
	Miscellaneous Electrical Wire (450 LF, each)	1,800	LF	$5	$9,000	
	400 Watt Single Unit High Pressure Sodium Light Fixture, All Weather	4	EA	$110	$440	
	150 Kv, Three Phase, Dry Distribution Transformer	4	EA	$7,800	$31,200	
	Total					$40,640
	Grand Total					**$88,042**

DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Minot Peaking Wells
Element: Peak Wells

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Peak Wells					
	22 inch borehole, drill and ream (160 ft, each)	4	LS	$27,200	$108,800	
	16 inch casing, Supply and install (140 LF, each)	4	LS	$14,000	$56,000	
	16 inch screen, supply and install (20 LF, each)	4	LS	$3,000	$12,000	
	Gravel pack screen section (20 LF, each)	4	LS	$800	$3,200	
	Cement grout (20 LF, each)	4	LS	$800	$3,200	
	Develop well	4	EA	$10,000	$40,000	
	Pump, wellhead facilities and well pad	4	EA	$150,000	$600,000	
	Total					$823,200
	Grand Total					**$823,200**

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PROJECT SUMMARY

Project: NAWS
Type: In-basin Alternative Component
Component: Sundre Peaking Wells

NO.	DESCRIPTION			TOTAL
1	Site Work			$44,021
2	Peak Wells			$476,000
TOTAL				**$520,021**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$520,021**
	Mobilization		5.0%	$26,001
		Subtotal		**$546,022**
	Unlisted Items		5.0%	$27,301
		Subtotal		**$573,323**
	Contingencies		30.0%	$171,997
		Subtotal		**$745,320**
	Noncontract Costs		25.0%	$186,330
		Subtotal		**$931,650**
TOTAL				**$931,650**

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DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Sundre Peaking Wells
Element: Site Work

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing (0.5 AC, each)	1.0	AC	$2,500	$2,500	
	Total					$2,500
	Metal					
	Galv. Chain Link Fence, 8' W/Barbed Wire, No Gates (50 ft x 50 ft, each)	360	LF	$43	$15,480	
	8' H Double Swing Gate, Chain Link, 20' Opening	2	EA	$2,860	$5,721	
	Total					$21,201
	Electrical					
	Miscellaneous Electrical Wire (450 LF, each)	900	LF	$5	$4,500	
	400 Watt Single Unit High Pressure Sodium Light Fixture, All Weather	2	EA	$110	$220	
	150 Kv, Three Phase, Dry Distribution Transformer	2	EA	$7,800	$15,600	
	Total					$20,320
	Grand Total					**$44,021**

DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Sundre Peaking Wells
Element: Peak Wells

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Peak Wells					
	22 inch borehole, drill and ream (260 ft, each)	2	LS	$44,200	$88,400	
	16 inch casing, Supply and install (200 LF, each)	2	LS	$20,000	$40,000	
	16 inch screen, supply and install (60 LF, each)	2	LS	$9,000	$18,000	
	Gravel pack screen section (60 LF, each)	2	LS	$2,400	$4,800	
	Cement grout (60 LF, each)	2	LS	$2,400	$4,800	
	Develop well	2	EA	$10,000	$20,000	
	Pump, wellhead facilities and well pad	2	EA	$150,000	$300,000	
	Total					$476,000
	Grand Total					**$476,000**

PROJECT SUMMARY

Project: NAWS:
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer

NO.	DESCRIPTION			TOTAL
1	Forebay Grading			$124,540
2	Site Work and Buildings			$957,150
3	Plumbing, Fire			$150,740
4	Piping and Valves			$1,022,895
5	Pumping Units			$650,000
6	Flow Meter			$36,000
7	Surge Tank			$148,500
8	Electrical			$438,940
TOTAL				**$3,528,765**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$3,528,765**
	Mobilization		5.0%	$176,438
		Subtotal		**$3,705,203**
	Unlisted Items		10.0%	$370,520
		Subtotal		**$4,075,723**
	Contingencies		30.0%	$1,222,717
		Subtotal		**$5,298,440**
	Noncontract Costs		25.0%	$1,324,610
		Subtotal		**$6,623,050**
TOTAL				**$6,623,050**

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DETAILED COST ESTIMATE

Project: NAWS:
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer
Element: Forebay Grading

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Grading					
	Excavation for Canal, Intake Forebay and Roadway	520	CY	$6	$3,120	
	Compaction and Backfill for Intake Bay	740	CY	$8	$5,920	
	John Deere 450D LC Excavator	60	DAY	$800	$48,000	
	John Deere 872G/GP Motor Grader	30	DAY	$650	$19,500	
	John Deere 850J Dozer	60	DAY	$800	$48,000	
	Total					$124,540
	Grand Total					**$124,540**

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DETAILED COST ESTIMATE

Project: NAWS:
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	3	AC	$2,500	$7,500	
	Install New Trash Rack/Fish Screen	6	EA	$12,500	$75,000	
	Stainless Trash Rack - Pump Suction Pipe	1	EA	$2,500	$2,500	
	Dewatering	45	DAY	$1,000	$45,000	
	Site Paving, 3" AC on 6" ABC	890	SY	$8	$7,120	
	MIscellaneous Building Specialties	1	LS	$100,000	$100,000	
	Site Work (Landscaping)	1	LS	$15,000	$15,000	
	Temporary Trailer	9	MO	$12,500	$112,500	
	Staging Site Preparation	1	LS	$20,000	$20,000	
	Total					$384,620
	Concrete					
	Intake Caisson (Shaft), 20' Int Dia	70	CY	$850	$59,500	
	Lower Slab, 18"	17	CY	$850	$14,450	
	Pumpstation Main Slab, 12"	236	CY	$750	$177,000	
	Pump Shaft, 12"	67	CY	$850	$56,950	
	Lower Slab, 18"	30	CY	$1,000	$30,000	
	12" x 18" Rectangular Column (8)	8	CY	$650	$5,200	
	Hoist Guideway (18" x 8" x 70') (2)	6	CY	$650	$3,900	
	Total					$347,000
	Conveying					
	10-Ton Bridge Crane, 29'-0" Span, Single Girder, Top Running, 120 ft Track	1	EA	$62,570	$62,570	
	Total					$62,570
	Masonry					
	Standard Concrete Block, 12"	3,960	SF	$16	$63,360	
	Total					$63,360
	Metals					
	Steel Trusses	14,000	LB	$3	$42,000	
	Miscellaneous Metals	1	LS	$30,000	$30,000	
	Chain-link Fence	560	LF	$5	$2,800	
	Total					$74,800
	Thermal and Moisture					
	24 Ga Mr3-36 Versacor Roofing	3,100	SF	$8	$24,800	

DETAILED COST ESTIMATE

Project: NAWS:
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Total					$24,800
	Grand Total					**$957,150**

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DETAILED COST ESTIMATE

Project: NAWS:
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$75,000	$75,000	
	Interior Plumbing System	1	LS	$20,000	$20,000	
	Total					$95,000
	Electrical					
	Fire Detection and Alarm System	1	EA	$17,640	$17,640	
	125 Ekw 1800Rpm,60Hz Stdby Gen Set	1	EA	$32,500	$32,500	
	Total					$50,140
	Grand Total					**$150,740**

DETAILED COST ESTIMATE

Project: NAWS:
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	16" Steel Pipe	60	LF	$72	$4,320	
	16" X 30" Tees	3	EA	$2,500	$7,500	
	16" X 30" 90 Degree Bend	1	EA	$2,200	$2,200	
	16" Flex Coupling	5	EA	$3,500	$17,500	
	16" Check Valve	4	EA	$13,500	$54,000	
	30" Steel Pipe	60	EA	$125	$7,500	
	36" Steel Pipe (to Fence Line)	70	LF	$360	$25,200	
	36" Ductile Iron Feeder Line (to Recharge Basins)	2,500	LF	$350	$875,000	
	42" Steel Intake Pipe	60	LF	$160	$9,600	
	36" Butterfly Valve (outside building)	1	EA	$14,500	$14,500	
	Pipe Specials - (30" to 36")	1	EA	$700	$700	
	30" X 30" Tee	1	EA	$3,000	$3,000	
	30" Steel Pipe (to Surge Tank)	15	LF	$125	$1,875	
	Total					$1,022,895
	Grand Total					**$1,022,895**

DETAILED COST ESTIMATE

Project: NAWS:
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	205 HP 3-Stage Vertical Turbine Pumps, 7.25 MGD @ 138 FT, 900 rpm	4	EA	$162,500	$650,000	
	Total					$650,000
	Grand Total					**$650,000**

DETAILED COST ESTIMATE

Project: NAWS:
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	30" Magnetic Flow Meter	1	EA	$36,000	$36,000	
	Total					$36,000
	Grand Total					**$36,000**

DETAILED COST ESTIMATE

Project: NAWS:
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer
Element: Surge Tank

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Surge Tank and Appurtenances	1	EA	$126,500	$126,500	
	Air Valve	2	EA	$11,000	$22,000	
	Total					$148,500
	Grand Total					**$148,500**

DETAILED COST ESTIMATE

Project: NAWS:
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	Local Power Distribution	1	EA	$28,000	$28,000	
	Electric Wire to Pumps, 480 V Cu	400	LF	$40	$16,000	
	Miscellaneous Electrical Wire	10,000	LF	$5	$50,000	
	3" Aluminum Conduit	200	LF	$22	$4,400	
	1" Aluminum Conduit	400	LF	$8	$3,200	
	E - 460VAC Variable Speed Drive,	5	EA	$14,200	$71,000	
	Control Panel	1	EA	$58,000	$58,000	
	Grounding System	200	EA	$5	$1,000	
	Distribution Transformer	1	EA	$31,900	$31,900	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	20	EA	$662	$13,240	
	Recessed Light Fixture, 12' Max	20	EA	$110	$2,200	
	CAT 500 ekW 625 Kva Standby Diesel Generator	1	EA	$160,000	$160,000	
	Total					$438,940
	Grand Total					**$438,940**

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PROJECT SUMMARY

Project: NAWS
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer

NO.	DESCRIPTION			TOTAL
1	Forebay Grading			$124,540
2	Site Work and Buildings			$957,150
3	Plumbing, Fire			$150,740
4	Piping and Valves			$822,895
5	Pumping Units			$634,000
6	Flow Meter			$36,000
7	Surge Tank			$148,500
8	Electrical			$438,940
TOTAL				**$3,312,765**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$3,312,765**
	Mobilization		5.0%	$165,638
		Subtotal		**$3,478,403**
	Unlisted Items		10.0%	$347,840
		Subtotal		**$3,826,243**
	Contingencies		30.0%	$1,147,873
		Subtotal		**$4,974,116**
	Noncontract Costs		25.0%	$1,243,529
		Subtotal		**$6,217,645**
TOTAL				**$6,217,645**

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DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer
Element: Forebay Grading

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Grading					
	Excavation for Canal, Intake Forebay and Roadway	520	CY	$6	$3,120	
	Compaction and Backfill for Intake Bay	740	CY	$8	$5,920	
	John Deere 450D LC Excavator	60	DAY	$800	$48,000	
	John Deere 872G/GP Motor Grader	30	DAY	$650	$19,500	
	John Deere 850J Dozer	60	DAY	$800	$48,000	
	Total					$124,540
	Grand Total					**$124,540**

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DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	3	AC	$2,500	$7,500	
	Install New Trash Rack/Fish Screen	6	EA	$12,500	$75,000	
	Stainless Trash Rack - Pump Suction Pipe	1	EA	$2,500	$2,500	
	Dewatering	45	DAY	$1,000	$45,000	
	Site Paving, 3" AC on 6" ABC	890	SY	$8	$7,120	
	MIscellaneous Building Specialties	1	LS	$100,000	$100,000	
	Site Work (Landscaping)	1	LS	$15,000	$15,000	
	Temporary Trailer	9	MO	$12,500	$112,500	
	Staging Site Preparation	1	LS	$20,000	$20,000	
	Total					$384,620
	Concrete					
	Intake Caisson (Shaft), 20' Int Dia	70	CY	$850	$59,500	
	Lower Slab, 18"	17	CY	$850	$14,450	
	Pumpstation Main Slab, 12"	236	CY	$750	$177,000	
	Pump Shaft, 12"	67	CY	$850	$56,950	
	Lower Slab, 18"	30	CY	$1,000	$30,000	
	12" x 18" Rectangular Column (8)	8	CY	$650	$5,200	
	Hoist Guideway (18" x 8" x 70') (2)	6	CY	$650	$3,900	
	Total					$347,000
	Conveying					
	10-Ton Bridge Crane, 29'-0" Span, Single Girder, Top Running, 120 ft Track	1	EA	$62,570	$62,570	
	Total					$62,570
	Masonry					
	Standard Concrete Block, 12"	3,960	SF	$16	$63,360	
	Total					$63,360
	Metals					
	Steel Trusses	14,000	LB	$3	$42,000	
	Miscellaneous Metals	1	LS	$30,000	$30,000	
	Chain-link Fence	560	LF	$5	$2,800	
	Total					$74,800

DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Thermal and Moisture					
	24 Ga Mr3-36 Versacor Roofing	3,100	SF	$8	$24,800	
	Total					$24,800
	Grand Total					**$957,150**

DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$75,000	$75,000	
	Interior Plumbing System	1	LS	$20,000	$20,000	
	Total					$95,000
	Electrical					
	Fire Detection and Alarm System	1	EA	$17,640	$17,640	
	125 Ekw 1800Rpm,60Hz Stdby Gen Set	1	EA	$32,500	$32,500	
	Total					$50,140
	Grand Total					**$150,740**

DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	16" Steel Pipe	60	LF	$72	$4,320	
	16" X 30" Tees	3	EA	$2,500	$7,500	
	16" X 30" 90 Degree Bend	1	EA	$2,200	$2,200	
	16" Flex Coupling	5	EA	$3,500	$17,500	
	16" Check Valve	4	EA	$13,500	$54,000	
	30" Steel Pipe	60	EA	$125	$7,500	
	36" Steel Pipe (to Fence Line)	70	LF	$360	$25,200	
	36" Feeder Line (to Recharge Basins)	2,700	LF	$250	$675,000	
	42" Steel Intake Pipe	60	LF	$160	$9,600	
	36" Butterfly Valve (outside building)	1	EA	$14,500	$14,500	
	Pipe Specials - (30" to 36")	1	EA	$700	$700	
	30" X 30" Tee	1	EA	$3,000	$3,000	
	30" Steel Pipe (to Surge Tank)	15	LF	$125	$1,875	
	Total					$822,895
	Grand Total					**$822,895**

DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	164 HP 3-Stage Vertical Turbine Pumps, 7.25 MGD @ 110 FT, 900 rpm	4	EA	$158,500	$634,000	
	Total					$634,000
	Grand Total					**$634,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	30" Magnetic Flow Meter	1	EA	$36,000	$36,000	
	Total					$36,000
	Grand Total					**$36,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer
Element: Surge Tank

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Surge Tank and Appurtenances	1	EA	$126,500	$126,500	
	Air Valve	2	EA	$11,000	$22,000	
	Total					$148,500
	Grand Total					**$148,500**

DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	Local Power Distribution	1	EA	$28,000	$28,000	
	Electric Wire to Pumps, 480 V Cu	400	LF	$40	$16,000	
	Miscellaneous Electrical Wire	10,000	LF	$5	$50,000	
	3" Aluminum Conduit	200	LF	$22	$4,400	
	1" Aluminum Conduit	400	LF	$8	$3,200	
	E - 460VAC Variable Speed Drive,	5	EA	$14,200	$71,000	
	Control Panel	1	EA	$58,000	$58,000	
	Bare Copper Wire Stranded, Grounding System	200	EA	$5	$1,000	
	Distribution Transformer	1	EA	$31,900	$31,900	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	20	EA	$662	$13,240	
	Recessed Light Fixture, 12' Max	20	EA	$110	$2,200	
	CAT 500 ekW 625 Kva Standby Diesel Generator	1	EA	$160,000	$160,000	
	Total					$438,940
	Grand Total					**$438,940**

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PROJECT SUMMARY

Project: NAWS
Type: Inbasin Alternative Component
Component: Collection line from Minot Aquifer, Alternatives 1 and 2

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$183,825
2	Piping and Valves			$772,670
TOTAL				**$956,495**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$956,495**
	Mobilization		5.0%	$47,825
		Subtotal		**$1,004,320**
	Unlisted Items		5.0%	$50,216
		Subtotal		**$1,054,536**
	Contingencies		21.0%	$221,453
		Subtotal		**$1,275,989**
	Noncontract Costs		25.0%	$318,997
		Subtotal		**$1,594,986**
TOTAL				**$1,594,986**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Inbasin Alternative Component
Component: Collection line from Minot Aquifer, Alternatives 1 and 2
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	0.25	AC	$2,500	$625	
	Sawcut Pavement	23,760	LF	$5	$118,800	
	Pavement Removal	2,350	SY	$2	$4,700	
	Street Paving, 6" Aggregate Base	2,350	SY	$12	$28,200	
	Street Paving, 3" AC	2,350	SY	$9	$21,150	
	Total					$173,475
	Metals					
	3-Piece Cast Iron Valve Box, 48" To 60"	75	EA	$138	$10,350	
	Total					$10,350
	Grand Total					**$183,825**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Inbasin Alternative Component
Component: Collection line from Minot Aquifer, Alternatives 1 and 2
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	4" DR17 PVC Pipe, Bedding	15,840	LF	$40.00	$633,600	
	4" Gate Valve, Restrained	51	EA	$721	$36,771	
	4" x 4" DI Tee, Restrained	17	EA	$375	$6,375	
	16" Butterfly Valve	24	EA	$2,838	$68,100	
	16" x 6" x 16" DI Tee	12	EA	$786	$9,432	
	6" x 4" DI Reducer	12	EA	$116	$1,392	
	Air Valve	3	EA	$5,000	$15,000	
	Flush Riser (includes 2" Gate Valve, 2" PVC Pipe and accessories)	2	EA	$1,000	$2,000	
	Total					$772,670
	Grand Total					**$772,670**

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PROJECT SUMMARY

Project: NAWS
Type: Inbasin Alternative Component
Component: Collection line from Sundre Aquifer, Alternative 1

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$297,260
2	Piping and Valves			$2,256,160
TOTAL				**$2,553,420**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$2,553,420**
	Mobilization		5.0%	$127,671
		Subtotal		**$2,681,091**
	Unlisted Items		5.0%	$134,055
		Subtotal		**$2,815,146**
	Contingencies		21.0%	$591,181
		Subtotal		**$3,406,327**
	Noncontract Costs		25.0%	$851,582
		Subtotal		**$4,257,909**
TOTAL				**$4,257,909**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Inbasin Alternative Component
Component: Collection line from Sundre Aquifer, Alternative 1
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	2.00	AC	$2,500	$5,000	
	Sawcut Pavement	31,680	LF	$5	$158,400	
	Pavement Removal	5,280	SY	$2	$10,560	
	Street Paving, 6" Aggregate Base	5,280	SY	$12	$63,360	
	Street Paving, 3" AC	5,280	SY	$9	$47,520	
	Total					$284,840
	Metals					
	3-Piece Cast Iron Valve Box, 48" To 60"	90	EA	$138	$12,420	
	Total					$12,420
	Grand Total					**$297,260**

DETAILED COST ESTIMATE

Project: NAWS
Type: Inbasin Alternative Component
Component: Collection line from Sundre Aquifer, Alternative 1
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	12" C905 DR18 PVC Pipe, Bedding	39,070	LF	$50.00	$1,953,500	
	12" Gate Valve	54	EA	$1,450	$78,300	
	12" x 12" DI Tee, Restrained	18	EA	$900	$16,200	
	20" Butterfly Valve	36	EA	$4,500	$162,000	
	20" x 16" x 20" DI Tee	18	EA	$1,620	$29,160	
	Air Valve	3	EA	$5,000	$15,000	
	Flush Riser (includes 2" Gate Valve, 2" PVC Pipe and accessories)	2	EA	$1,000	$2,000	
	Total					$2,256,160
	Grand Total					**$2,256,160**

PROJECT SUMMARY

Project: NAWS
Type: Inbasin Alternative Component
Component: Collection line from Sundre Aquifer, Alternative 2

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$257,010
2	Piping and Valves			$1,515,730
TOTAL				**$1,772,740**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$1,772,740**
	Mobilization		5.0%	$88,637
		Subtotal		**$1,861,377**
	Unlisted Items		5.0%	$93,069
		Subtotal		**$1,954,446**
	Contingencies		21.0%	$410,434
		Subtotal		**$2,364,880**
	Noncontract Costs		25.0%	$591,220
		Subtotal		**$2,956,100**
TOTAL				**$2,956,100**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Inbasin Alternative Component
Component: Collection line from Sundre Aquifer, Alternative 2
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	2.00	AC	$2,500	$5,000	
	Sawcut Pavement	31,680	LF	$5	$158,400	
	Pavement Removal	3,530	SY	$2	$7,060	
	Street Paving, 6" Aggregate Base	3,530	SY	$12	$42,360	
	Street Paving, 3" AC	3,530	SY	$9	$31,770	
	Total					$244,590
	Metals					
	3-Piece Cast Iron Valve Box, 48" To 60"	90	EA	$138	$12,420	
	Total					$12,420
	Grand Total					**$257,010**

DETAILED COST ESTIMATE

Project: NAWS
Type: Inbasin Alternative Component
Component: Collection line from Sundre Aquifer, Alternative 2
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	4" DR17 PVC Pipe, Bedding	39,070	LF	$32.00	$1,250,240	
	4" Gate Valve, Restrained	54	EA	$721	$38,934	
	4" x 4" DI Tee, Restrained	18	EA	$375	$6,750	
	20" Butterfly Valve	36	EA	$4,500	$162,000	
	20" x 16" x 20" DI Tee	18	EA	$1,620	$29,160	
	16" x 8" DI Reducer	18	EA	$423	$7,614	
	8" x 4" DI Reducer	18	EA	$224	$4,032	
	Air Valve	3	EA	$5,000	$15,000	
	Flush Riser (includes 2" Gate Valve, 2" PVC Pipe and accessories)	2	EA	$1,000	$2,000	
	Total					$1,515,730
	Grand Total					**$1,515,730**

PROJECT SUMMARY

Project: NAWS
Type: Common Component
Component: Pipeline: Glenburn to Renville Corner

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$37,182
2	Piping and Valves			$3,715,315
3	Flow Meter			$10,948
TOTAL				**$3,763,445**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$3,763,445**
	Mobilization		5.0%	$188,172
		Subtotal		**$3,951,617**
	Unlisted Items		5.0%	$197,581
		Subtotal		**$4,149,198**
	Contingencies		21.0%	$871,331
		Subtotal		**$5,020,529**
	Noncontract Costs		25.0%	$1,255,132
		Subtotal		**$6,275,661**
TOTAL				**$6,275,661**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Glenburn to Renville Corner
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	63.6	AC	$500	$31,800	
	Total					$31,800
	Metals					
	3-Piece Cast Iron Valve Box, 48" To 60"	38	EA	$138	$5,244	
	Meter Box & Cover 12"Wx16"Lx16"D Meter	1	EA	$138	$138	
	Total					$5,382
	Grand Total					**$37,182**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Glenburn to Renville Corner
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	6" DR17 PVC Pipe	17,800	LF	$25.25	$449,450	
	6" Gate Valve, Restrained	7	EA	$750	$5,250	
	6" x 2" DI Tee, Restrained	2	EA	$361	$722	
	16" C905 DR18 PVC Pipe	72,800	LF	$42.50	$3,094,000	
	16" Butterfly Valve	31	EA	$2,838	$87,963	
	16" x 6" x 16" DI Tee	5	EA	$786	$3,930	
	Air Valve	14	EA	$5,000	$70,000	
	Flush Riser (includes 2" Gate Valve, 2" PVC Pipe and accessories)	4	EA	$1,000	$4,000	
	Total					$3,715,315
	Grand Total					**$3,715,315**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Glenburn to Renville Corner
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	6" Electromagnetic Flow Meter (150 psi)	1	EA	$2,690	$2,690	
	16" Electromagnetic Flow Meter (150 psi)	1	EA	$8,258	$8,258	
	Total					$10,948
	Grand Total					**$10,948**

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PROJECT SUMMARY

Project: NAWS
Type: Common Component
Component: Pipeline: Westhope and ASWUD III

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$80,498
2	Piping and Valves			$4,526,242
3	Flow Meter			$2,690
TOTAL				**$4,609,430**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$4,609,430**
	Mobilization		5.0%	$230,471
		Subtotal		**$4,839,901**
	Unlisted Items		5.0%	$241,995
		Subtotal		**$5,081,896**
	Contingencies		21.0%	$1,067,198
		Subtotal		**$6,149,094**
	Noncontract Costs		25.0%	$1,537,273
		Subtotal		**$7,686,367**
TOTAL				**$7,686,367**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Westhope and ASWUD III
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	75.2	AC	$500	$37,600	
	Directional Drilling (4 Stream Crossings x 400 LF)	1,600	LF	$25	$40,000	
	Total					$77,600
	Metals					
	3-Piece Cast Iron Valve Box, 48" To 60"	20	EA	$138	$2,760	
	Meter Box & Cover 12"Wx16"Lx16"D Meter	1	EA	$138	$138	
	Total					$2,898
	Grand Total					**$80,498**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Westhope and ASWUD III
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	6" DR17 PVC Pipe	15,840	LF	$25.25	$399,960	
	6" Gate Valve, Restrained	3	EA	$750	$2,250	
	6" x 2" DI Tee, Restrained	2	EA	$361	$722	
	16" C905 DR18 PVC Pipe	93,400	LF	$42.50	$3,969,500	
	16" Butterfly Valve, Restrained (1/mile)	17	EA	$2,838	$48,238	
	16" x 6" x 16" DI Tee	2	EA	$786	$1,572	
	Air Valve	20	EA	$5,000	$100,000	
	Flush Riser (includes 2" Gate Valve, 2" PVC Pipe and accessories)	4	EA	$1,000	$4,000	
	Total					$4,526,242
	Grand Total					**$4,526,242**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Westhope and ASWUD III
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	6" Electromagnetic Flow Meter (150 psi)	1	EA	$2,690	$2,690	
	Total					$2,690
	Grand Total					**$2,690**

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PROJECT SUMMARY

Project: NAWS
Type: Common Component
Component: Pipeline: Souris and ASWUD I

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$242,688
2	Piping and Valves			$6,933,686
3	Flow Meter			$9,015
TOTAL				**$7,185,389**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$7,185,389**
	Mobilization		5.0%	$359,269
		Subtotal		**$7,544,658**
	Unlisted Items		5.0%	$377,233
		Subtotal		**$7,921,891**
	Contingencies		21.0%	$1,663,597
		Subtotal		**$9,585,488**
	Noncontract Costs		25.0%	$2,396,372
		Subtotal		**$11,981,860**
TOTAL				**$11,981,860**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Souris and ASWUD I
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	151	AC	$500	$75,650	
	Directional Drilling (8 Stream Crossings x 400 LF)	3,200	LF	$25	$80,000	
	Directional Drilling (Souris River Crossing)	4,000	LF	$20	$80,000	
	Total					$235,650
	Metals					
	3-Piece Cast Iron Valve Box, 48" To 60"	48	EA	$138	$6,624	
	Meter Box & Cover 12"Wx16"Lx16"D Meter	3	EA	$138	$414	
	Total					$7,038
	Grand Total					**$242,688**

Cardno ENTRIX
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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Souris and ASWUD I
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	4" DR17 PVC Pipe	33,792	LF	$20.00	$675,840	
	4" Gate Valve, Restrained	8	EA	$721	$5,768	
	4" x 2" DI Tee, Restrained	2	EA	$292	$584	
	6" DR17 PVC Pipe	32,208	LF	$25.25	$813,252	
	6" Gate Valve, Restrained	8	EA	$750	$6,000	
	6" x 2" DI Tee, Restrained	2	EA	$361	$722	
	8" DR17 PVC Pipe	16,368	LF	$26	$425,568	
	8" Gate Valve, Restrained	6	EA	$1,078	$6,468	
	8" x 2" DI Tee, Restrained	2	EA	$405	$810	
	14" C905 DR18 PVC Pipe	137,280	LF	$35.50	$4,873,440	
	14" Butterfly Valve, Restrained (1/mile)	26	EA	$2,364	$61,464	
	14" DI Bend, Restrained	1	EA	$1,512	$1,512	
	14" x 4" x 14" DI Tee	2	EA	$749	$1,498	
	14" x 6" x 14" DI Tee	1	EA	$760	$760	
	Air Valve	10	EA	$5,000	$50,000	
	Flush Riser (includes 2" Gate Valve, 2" PVC Pipe and accessories)	10	EA	$1,000	$10,000	
	Total					$6,933,686
	Grand Total					**$6,933,686**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Souris and ASWUD I
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	4" Electromagnetic Flow Meter (150 psi)	1	EA	$2,376	$2,376	
	6" Electromagnetic Flow Meter (150 psi)	1	EA	$2,690	$2,690	
	8" Electromagnetic Flow Meter (150 psi)	1	EA	$3,949	$3,949	
	Total					$9,015
	Grand Total					**$9,015**

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PROJECT SUMMARY

Project: NAWS
Type: Common Component
Component: Pipeline: Bowbells, Columbus and Noonan

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$447,228
2	Piping and Valves			$6,476,024
3	Flow Meter			$11,391
TOTAL				**$6,934,643**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$6,934,643**
	Mobilization		5.0%	$346,732
		Subtotal		**$7,281,375**
	Unlisted Items		5.0%	$364,069
		Subtotal		**$7,645,444**
	Contingencies		21.0%	$1,605,543
		Subtotal		**$9,250,987**
	Noncontract Costs		25.0%	$2,312,747
		Subtotal		**$11,563,734**
TOTAL				**$11,563,734**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Bowbells, Columbus and Noonan
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	347	AC	$500	$173,500	
	Directional Drilling (11 Stream Crossings x 400 LF)	4,400	LF	$25	$110,000	
	Directional Drilling (Upper Des Lacs Lake)	1,800	LF	$20	$36,000	
	Railroad Embankment 16" Casing Bore (4 sites)	400	LF	$300	$120,000	
	Total					$439,500
	Metals					
	3-Piece Cast Iron Valve Box, 48" To 60"	52	EA	$138	$7,176	
	Meter Box & Cover 12"Wx16"Lx16"D Meter	4	EA	$138	$552	
	Total					$7,728
	Grand Total					**$447,228**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Bowbells, Columbus and Noonan
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	4" DR17 PVC Pipe	47,520	LF	$20.00	$950,400	
	4" Gate Valve, Restrained	10	EA	$721	$7,210	
	4" 11.25 Degrees DI Bend, Restrained	1	EA	$190	$190	
	4" x 2" DI Tee, Restrained	2	EA	$292	$584	
	6" x 6" x 6" DI Tee, Restrained	1	EA	$533	$533	
	6" DR17 PVC Pipe	98,736	LF	$25.25	$2,493,084	
	6" Gate Valve, Restrained	20	EA	$750	$15,000	
	6" x 2" DI Tee, Restrained	2	EA	$361	$722	
	8" DR17 PVC Pipe	68,640	LF	$26	$1,784,640	
	8" Gate Valve, Restrained	14	EA	$1,078	$15,092	
	8" 22.5 Degrees DI Bend, Restrained	6	EA	$367	$2,202	
	8" 45 Degrees DI Bend, Restrained	2	EA	$375	$750	
	8" x 2" DI Tee, Restrained	2	EA	$405	$810	
	8" x 8" x 10" DI Tee, Restrained	1	EA	$1,057	$1,057	
	10" DR17 PVC Pipe	36,960	LF	$28.75	$1,062,600	
	10" Gate Valve, Restrained	8	EA	$1,367	$10,936	
	10" 11.25 Degrees DI Bend, Restrained	1	EA	$645	$645	
	10" 90 Degrees Bend, Restrained	1	EA	$675	$675	
	10" x 2" DI Tee, Restrained	2	EA	$447	$894	
	Air Valve (every 2 miles)	24	EA	$5,000	$120,000	
	Flush Riser (includes 2" Gate Valve, 2" PVC Pipe and accessories)	8	EA	$1,000	$8,000	
	Total					$6,476,024
	Grand Total					**$6,476,024**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Bowbells, Columbus and Noonan
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	4" Electromagnetic Flow Meter (150 psi)	2	EA	$2,376	$4,752	
	6" Electromagnetic Flow Meter (150 psi)	1	EA	$2,690	$2,690	
	8" Electromagnetic Flow Meter (150 psi)	1	EA	$3,949	$3,949	
	Total					$11,391
	Grand Total					**$11,391**

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PROJECT SUMMARY

Project: NAWS
Type: Common Component
Component: Lansford Pump Station

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$216,920
2	Plumbing, Fire			$86,940
3	Piping and Valves			$114,339
4	Pumping Units			$194,000
5	Flow Meter			$8,258
6	Surge Tank			$58,500
7	Electrical			$225,860
TOTAL				**$904,817**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$904,817**
	Mobilization		5.0%	$45,241
		Subtotal		**$950,058**
	Unlisted Items		10.0%	$95,006
		Subtotal		**$1,045,064**
	Contingencies		30.0%	$313,519
		Subtotal		**$1,358,583**
	Noncontract Costs		25.0%	$339,646
		Subtotal		**$1,698,229**
TOTAL				**$1,698,229**

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Cardno ENTRIX
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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Pump Station
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Concrete					
	Pumpstation Main Slab, 12"	58	CY	$750	$43,500	
	Pump Can Slab, 12"	3	CY	$850	$2,550	
	12" x 18" Rectangular Column (8)	8	CY	$650	$5,200	
	Hoist Guideway (18" x 8" x 60') (2)	5	CY	$650	$3,250	
	14" Foundation wall, 4 ft deep	31	CY	$650	$20,150	
	Foundation Footing (36" x 12")	19	CY	$650	$12,350	
	Total					$87,000
	Conveying					
	5-Ton Bridge Crane, 28'-0" Span, Single Girder, Top Running, 60 ft Track	1	EA	$40,700	$40,700	
	Total					$40,700
	Masonry					
	Standard Concrete Block, 12"	2,520	SF	$16	$40,320	
	Total					$40,320
	Metals					
	Steel Trusses	6,500	LB	$3	$19,500	
	Miscellaneous Metals	1	LS	$15,000	$15,000	
	Total					$34,500
	Thermal and Moisture					
	24 Ga Mr3-36 Versacor Roofing	1,800	SF	$8	$14,400	
	Total					$14,400
	Grand Total					**$216,920**

NOTES - Site construction costs were included for the reservoir.

Cardno ENTRIX
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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Pump Station
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$21,200	$21,200	
	Interior Plumbing System	1	LS	$10,000	$10,000	
	Total					$31,200
	Electrical					
	Fire Detection and Alarm System	1	EA	$17,640	$17,640	
	125 Ekw 1800Rpm,60Hz Stdby Gen Set	1	EA	$32,500	$32,500	
	Total					$50,140
	Grand Total					**$86,940**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Pump Station
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	8" Steel Pipe	80	LF	$34	$2,720	
	8" Flex Coupling	4	EA	$1,900	$7,600	
	8" Check Valve	4	EA	$7,700	$30,800	
	8" Gate Valve	8	EA	$1,078	$8,624	
	12" Ductile Iron Pipe	136	LF	$45	$6,120	
	12" 90 Degree Bend	2	EA	$501	$1,002	
	12" Gate Valve	2	EA	$1,450	$2,900	
	16" Steel Pipe	70	LF	$72	$5,040	
	16" C905 DR18 PVC Pipe	250	LF	$42.50	$10,625	
	16" X 12" Tees	2	EA	$880	$1,760	
	16" X 8" Tees	8	EA	$812	$6,496	
	16" 90 Degree Bend	12	EA	$1,550	$18,600	
	16" Butterfly Valve	4	EA	$2,838	$11,352	
	Pipe Specials - (24" to 16")	1	EA	$700	$700	
	Total					$114,339
	Grand Total					**$114,339**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Pump Station
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	140 HP 7-Stage Vertical Turbine Pumps, 1.3 MGD @ 524 FT, 1,800 rpm	4	EA	$48,500	$194,000	
	Total					$194,000
	Grand Total					**$194,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Pump Station
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	16" Magnetic Flow Meter	1	EA	$8,258	$8,258	
	Total					$8,258
	Grand Total					**$8,258**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Pump Station
Element: Surge Tank

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Surge Tank and Appurtenances	1	EA	$48,500	$48,500	
	Air Valve	2	EA	$5,000	$10,000	
	Total					$58,500
	Grand Total					**$58,500**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Pump Station
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	Electric Wire to Pumps, 480 V Cu	360	LF	$40	$14,400	
	Miscellaneous Electrical Wire	5,000	LF	$5	$25,000	
	3" Aluminum Conduit	180	LF	$22	$3,960	
	1" Aluminum Conduit	360	LF	$8	$2,880	
	E - 460VAC Variable Speed Drive,	1	EA	$14,200	$14,200	
	Control Panel	1	EA	$58,000	$58,000	
	Bare Copper Wire Stranded, Grounding System	160	EA	$5	$800	
	Distribution Transformer	1	EA	$31,900	$31,900	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	8	EA	$662	$5,296	
	Recessed Light Fixture, 12' Max Drop Ceiling	8	EA	$110	$880	
	400 Watt Single Unit High Pressure Sodium Light Fixture, All Weather	4	EA	$110	$440	
	125 Ekw 1800Rpm, 60Hz Turbocharged Stdby Generator	1	EA	$32,404	$32,404	
	VMX Series Soft Start VMX-VMX-210-P - 460VAC Variable Speed Drive, 200 hp	1	EA	$7,200	$7,200	
	Control Panel	1	EA	$28,500	$28,500	
	Total					$225,860
	Grand Total					**$225,860**

Cardno ENTRIX
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PROJECT SUMMARY

Project: NAWS
Type: Reclamation
Component: Bowbells Pump Station

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$63,251
2	Plumbing, Fire			$23,600
3	Piping and Valves			$25,724
4	Pumping Units			$17,000
5	Flow Meter			$5,087
6	Electrical			$25,422
TOTAL				**$160,084**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$160,084**
	Mobilization		5.0%	$8,004
		Subtotal		**$168,088**
	Unlisted Items		10.0%	$16,809
		Subtotal		**$184,897**
	Contingencies		30.0%	$55,469
		Subtotal		**$240,366**
	Noncontract Costs		25.0%	$60,092
		Subtotal		**$300,458**
TOTAL				**$300,458**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Reclamation
Component: Bowbells Pump Station
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	1.1	AC	$2,500	$2,750	
	Site Paving, 3" AC on 6" ABC	712	SY	$8	$5,696	
	6" Compacted ABC Foundation	7	CY	$25	$175	
	Site Work (Landscaping)	1	LS	$5,000	$5,000	
	Temporary Trailer	2	MO	$7,500	$15,000	
	Staging Site Preparation	1	LS	$5,000	$5,000	
	Chain-link Fence	934	LF	$5	$4,670	
	Double Swing Gate	1	EA	$2,860	$2,860	
	Total					$41,151
	Concrete Vault					
	Pumpstation Main Slab, 12"	14	CY	$450	$6,300	
	Pump Can Slab, 12"	2	CY	$450	$900	
	12" Walls, 8' High	24	CY	$450	$10,800	
	Pumpstation Top Slab, 8"	10	CY	$410	$4,100	
	Total					$22,100
	Grand Total					**$63,251**

NOTES

Cardno ENTRIX
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DETAILED COST ESTIMATE

Project: NAWS
Type: Reclamation
Component: Bowbells Pump Station
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$8,500	$8,500	
	Interior Plumbing System	1	LS	$2,000	$2,000	
	Total					$10,500
	Electrical					
	Fire Detection and Alarm System	1	EA	$7,500	$7,500	
	Total					$7,500
	Grand Total					**$23,600**

DETAILED COST ESTIMATE

Project: NAWS
Type: Reclamation
Component: Bowbells Pump Station
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	4" Steel Pipe	20	LF	$27	$540	
	4" 90 Degree Bend	4	EA	$98	$392	
	4" Flex Coupling	2	EA	$1,025	$2,050	
	4" Check Valve	2	EA	$2,800	$5,600	
	4" Gate Valve	4	EA	$638	$2,552	
	6" Gate Valve	2	EA	$750	$1,500	
	6" Ductile Iron Pipe	65	LF	$28	$1,820	
	10" Steel Pipe	30	LF	$34	$1,020	
	10" Gate Valve	4	EA	$1,078	$4,312	
	10" X 4" Tees	4	EA	$972	$3,888	
	10" X 6" Tees	2	EA	$800	$1,600	
	Transition (4" to 3")	3	EA	$150	$450	
	Total					$25,724
	Grand Total					**$25,724**

DETAILED COST ESTIMATE

Project: NAWS
Type: Reclamation
Component: Bowbells Pump Station
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	10 HP 1200-Horiz SplitCase, 0.25 MGD @ 50 FT, 1,800 rpm	2	EA	$8,500	$17,000	
	Total					$17,000
	Grand Total					**$17,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: Reclamation
Component: Bowbells Pump Station
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	10" Magnetic Flow Meter	1	EA	$5,087	$5,087	
	Total					$5,087
	Grand Total					**$5,087**

DETAILED COST ESTIMATE

Project: NAWS
Type: Reclamation
Component: Bowbells Pump Station
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	Electric Wire to Pumps, 220 V Cu	80	LF	$15	$1,200	
	Miscellaneous Electrical Wire	500	LF	$5	$2,500	
	1" Aluminum Conduit	80	LF	$8	$640	
	VMX Series Soft Start VMX-18-BP - Variable Speed Drive, 28 hp	1	EA	$3,700	$3,700	
	Control Panel	1	EA	$4,500	$4,500	
	Bare Copper Wire Stranded, Grounding System	60	EA	$5	$300	
	150 Kv, Three Phase, Dry Distribution Transformer	1	EA	$7,800	$7,800	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	1	EA	$662	$662	
	Recessed Light Fixture, 12' Max Drop Ceiling	1	EA	$110	$110	
	400 Watt Single Unit High Pressure Sodium Light Fixture, All Weather	1	EA	$110	$110	
	Generac 5734 GP15000E 22,500 Watt 992cc OHV Portable Gas Powered Generator	1	EA	$3,900	$3,900	
	Total					$25,422
	Grand Total					**$25,422**

Cardno ENTRIX
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PROJECT SUMMARY

Project: NAWS
Type: Common Component
Component: Mohall Pump Station

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$52,745
2	Plumbing, Fire			$23,600
3	Piping and Valves			$37,103
4	Pumping Units			$43,500
5	Flow Meter			$5,911
6	Electrical			$31,742
TOTAL				**$194,601**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$194,601**
	Mobilization		5.0%	$9,730
		Subtotal		**$204,331**
	Unlisted Items		10.0%	$20,433
		Subtotal		**$224,764**
	Contingencies		30.0%	$67,429
		Subtotal		**$292,193**
	Noncontract Costs		25.0%	$73,048
		Subtotal		**$365,241**
TOTAL				**$365,241**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Mohall Pump Station
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	0.1	AC	$2,500	$250	
	Site Paving, 3" AC on 6" ABC	150	SY	$8	$1,200	
	6" Compacted ABC Foundation	7	CY	$25	$175	
	Site Work (Landscaping)	1	LS	$5,000	$5,000	
	Temporary Trailer	2	MO	$7,500	$15,000	
	Staging Site Preparation	1	LS	$5,000	$5,000	
	Chain-link Fence	232	LF	$5	$1,160	
	Double Swing Gate	1	EA	$2,860	$2,860	
	Total					$30,645
	Concrete Vault					
	Pumpstation Main Slab, 12"	14	CY	$450	$6,300	
	Pump Can Slab, 12"	2	CY	$450	$900	
	12" Walls, 8' High	24	CY	$450	$10,800	
	Pumpstation Top Slab, 8"	10	CY	$410	$4,100	
	Total					$22,100
	Grand Total					**$52,745**

NOTES - Site construction costs were included for the reservoir.

Cardno ENTRIX
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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Mohall Pump Station
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$8,500	$8,500	
	Interior Plumbing System	1	LS	$2,000	$2,000	
	Total					$10,500
	Electrical					
	Fire Detection and Alarm System	1	EA	$7,500	$7,500	
	Total					$7,500
	Grand Total					**$23,600**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Mohall Pump Station
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	6" Gate Valve	2	EA	$750	$1,500	
	6" Ductile Iron Pipe	65	LF	$28	$1,820	
	4" Steel Pipe	30	LF	$27	$810	
	4" 90 Degree Bend	6	EA	$98	$588	
	4" Flex Coupling	3	EA	$1,025	$3,075	
	4" Check Valve	3	EA	$2,800	$8,400	
	4" Gate Valve	6	EA	$638	$3,828	
	12" Steel Pipe	30	LF	$54	$1,620	
	12" Gate Valve	4	EA	$1,450	$5,800	
	12" X 4" Tees	6	EA	$1,234	$7,404	
	12" X 6" Tees	2	EA	$1,129	$2,258	
	Total					$37,103
	Grand Total					**$37,103**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Mohall Pump Station
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	60 HP 1200-Horiz SplitCase, 0.71 MGD @ 291 FT, 3,600 rpm	3	EA	$14,500	$43,500	
	Total					$43,500
	Grand Total					**$43,500**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Mohall Pump Station
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	12" Magnetic Flow Meter	1	EA	$5,911	$5,911	
	Total					$5,911
	Grand Total					**$5,911**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Mohall Pump Station
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	Electric Wire to Pumps, 480 V Cu	120	LF	$40	$4,800	
	Miscellaneous Electrical Wire	600	LF	$5	$3,000	
	1" Aluminum Conduit	120	LF	$8	$960	
	VMX Series Soft Start VMX-62-BP - Variable Speed Drive, 62 hp	1	EA	$5,450	$5,450	
	Control Panel	1	EA	$4,500	$4,500	
	Bare Copper Wire Stranded, Grounding System	90	EA	$5	$450	
	150 Kv, Three Phase, Dry Distribution Transformer	1	EA	$7,800	$7,800	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	1	EA	$662	$662	
	Recessed Light Fixture, 12' Max Drop Ceiling	1	EA	$110	$110	
	400 Watt Single Unit High Pressure Sodium Light Fixture, All Weather	1	EA	$110	$110	
	Generac 5734 GP15000E 22,500 Watt 992cc OHV Portable Gas Powered Generator	1	EA	$3,900	$3,900	
	Total					$31,742
	Grand Total					**$31,742**

Cardno ENTRIX
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PROJECT SUMMARY

Project: NAWS
Type: Common Component
Component: Tolley Pump Station

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$57,855
2	Plumbing, Fire			$23,600
3	Piping and Valves			$37,553
4	Pumping Units			$41,700
5	Flow Meter			$5,911
6	Electrical			$31,742
TOTAL				**$198,361**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$198,361**
	Mobilization		5.0%	$9,918
		Subtotal		**$208,279**
	Unlisted Items		10.0%	$20,828
		Subtotal		**$229,107**
	Contingencies		30.0%	$68,732
		Subtotal		**$297,839**
	Noncontract Costs		25.0%	$74,460
		Subtotal		**$372,299**
TOTAL				**$372,299**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Tolley Pump Station
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	0.4	AC	$2,500	$1,000	
	Site Paving, 3" AC on 6" ABC	545	SY	$8	$4,360	
	6" Compacted ABC Foundation	7	CY	$25	$175	
	Site Work (Landscaping)	1	LS	$5,000	$5,000	
	Temporary Trailer	2	MO	$7,500	$15,000	
	Staging Site Preparation	1	LS	$5,000	$5,000	
	Chain-link Fence	472	LF	$5	$2,360	
	Double Swing Gate	1	EA	$2,860	$2,860	
	Total					$35,755
	Concrete Vault					
	Pumpstation Main Slab, 12"	14	CY	$450	$6,300	
	Pump Can Slab, 12"	2	CY	$450	$900	
	12" Walls, 8' High	24	CY	$450	$10,800	
	Pumpstation Top Slab, 8"	10	CY	$410	$4,100	
	Total					$22,100
	Grand Total					**$57,855**

NOTES - Site construction costs were included for the reservoir.

Cardno ENTRIX
Shaping the Future

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Tolley Pump Station
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$8,500	$8,500	
	Interior Plumbing System	1	LS	$2,000	$2,000	
	Total					$10,500
	Electrical					
	Fire Detection and Alarm System	1	EA	$7,500	$7,500	
	Total					$7,500
	Grand Total					**$23,600**

Cardno ENTRIX
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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Tolley Pump Station
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	6" Gate Valve	2	EA	$750	$1,500	
	6" Ductile Iron Pipe	65	LF	$28	$1,820	
	4" Steel Pipe	30	LF	$27	$810	
	4" 90 Degree Bend	6	EA	$98	$588	
	4" Flex Coupling	3	EA	$1,025	$3,075	
	4" Check Valve	3	EA	$2,800	$8,400	
	4" Gate Valve	6	EA	$638	$3,828	
	12" Steel Pipe	30	LF	$54	$1,620	
	12" Gate Valve	4	EA	$1,450	$5,800	
	12" X 4" Tees	6	EA	$1,234	$7,404	
	12" X 6" Tees	2	EA	$1,129	$2,258	
	Transition (4" to 3")	3	EA	$150	$450	
	Total					$37,553
	Grand Total					**$37,553**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Tolley Pump Station
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	50 HP 1100-Vert SplitCase, 0.67 MGD @ 260 FT, 3,600 rpm	3	EA	$13,900	$41,700	
	Total					$41,700
	Grand Total					**$41,700**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Tolley Pump Station
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	12" Magnetic Flow Meter	1	EA	$5,911	$5,911	
	Total					$5,911
	Grand Total					**$5,911**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Tolley Pump Station
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	Electric Wire to Pumps, 480 V Cu	120	LF	$40	$4,800	
	Miscellaneous Electrical Wire	600	LF	$5	$3,000	
	1" Aluminum Conduit	120	LF	$8	$960	
	VMX Series Soft Start VMX-62-BP - Variable Speed Drive, 62 hp	1	EA	$5,450	$5,450	
	Control Panel	1	EA	$4,500	$4,500	
	Bare Copper Wire Stranded, Grounding System	90	EA	$5	$450	
	150 Kv, Three Phase, Dry Distribution Transformer	1	EA	$7,800	$7,800	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	1	EA	$662	$662	
	Recessed Light Fixture, 12' Max Drop Ceiling	1	EA	$110	$110	
	400 Watt Single Unit High Pressure Sodium Light Fixture, All Weather	1	EA	$110	$110	
	Generac 5734 GP15000E 22,500 Watt 992cc OHV Portable Gas Powered Generator	1	EA	$3,900	$3,900	
	Total					$31,742
	Grand Total					**$31,742**

Cardno ENTRIX
Shaping the Future

PROJECT SUMMARY

Project: NAWS
Type: Common Component
Component: Renville County Corner Pump Station

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$59,229
2	Plumbing, Fire			$23,600
3	Piping and Valves			$37,553
4	Pumping Units			$37,500
5	Flow Meter			$5,911
6	Electrical			$31,442
TOTAL				**$195,235**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$195,235**
	Mobilization		5.0%	$9,762
		Subtotal		**$204,997**
	Unlisted Items		10.0%	$20,500
		Subtotal		**$225,497**
	Contingencies		30.0%	$67,649
		Subtotal		**$293,146**
	Noncontract Costs		25.0%	$73,287
		Subtotal		**$366,433**
TOTAL				**$366,433**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Renville County Corner Pump Station
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	0.5	AC	$2,500	$1,250	
	Site Paving, 3" AC on 6" ABC	628	SY	$8	$5,024	
	6" Compacted ABC Foundation	7	CY	$25	$175	
	Site Work (Landscaping)	1	LS	$5,000	$5,000	
	Temporary Trailer	2	MO	$7,500	$15,000	
	Staging Site Preparation	1	LS	$5,000	$5,000	
	Chain-link Fence	564	LF	$5	$2,820	
	Double Swing Gate	1	EA	$2,860	$2,860	
	Total					$37,129
	Concrete Vault					
	Pumpstation Main Slab, 12"	14	CY	$450	$6,300	
	Pump Can Slab, 12"	2	CY	$450	$900	
	12" Walls, 8' High	24	CY	$450	$10,800	
	Pumpstation Top Slab, 8"	10	CY	$410	$4,100	
	Total					$22,100
	Grand Total					**$59,229**

NOTES - Site construction costs were included for the reservoir.

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Renville County Corner Pump Station
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$8,500	$8,500	
	Interior Plumbing System	1	LS	$2,000	$2,000	
	Total					$10,500
	Electrical					
	Fire Detection and Alarm System	1	EA	$7,500	$7,500	
	Total					$7,500
	Grand Total					**$23,600**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Renville County Corner Pump Station
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	6" Gate Valve	2	EA	$750	$1,500	
	6" Ductile Iron Pipe	65	LF	$28	$1,820	
	4" Steel Pipe	30	LF	$27	$810	
	4" 90 Degree Bend	6	EA	$98	$588	
	4" Flex Coupling	3	EA	$1,025	$3,075	
	4" Check Valve	3	EA	$2,800	$8,400	
	4" Gate Valve	6	EA	$638	$3,828	
	12" Steel Pipe	30	LF	$54	$1,620	
	12" Gate Valve	4	EA	$1,450	$5,800	
	12" X 4" Tees	6	EA	$1,234	$7,404	
	12" X 6" Tees	2	EA	$1,129	$2,258	
	Transition (4" to 3")	3	EA	$150	$450	
	Total					$37,553
	Grand Total					**$37,553**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Renville County Corner Pump Station
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	30 HP 1200-Horiz SplitCase, 0.67 MGD @ 466 FT, 3,600 rpm	3	EA	$12,500	$37,500	
	Total					$37,500
	Grand Total					**$37,500**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Renville County Corner Pump Station
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	12" Magnetic Flow Meter	1	EA	$5,911	$5,911	
	Total					$5,911
	Grand Total					**$5,911**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Renville County Corner Pump Station
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	Electric Wire to Pumps, 480 V Cu	120	LF	$40	$4,800	
	Miscellaneous Electrical Wire	600	LF	$5	$3,000	
	1" Aluminum Conduit	120	LF	$8	$960	
	VMX Series Soft Start VMX-48-BP - Variable Speed Drive, 48 hp	1	EA	$5,150	$5,150	
	Control Panel	1	EA	$4,500	$4,500	
	Bare Copper Wire Stranded, Grounding System	90	EA	$5	$450	
	150 Kv, Three Phase, Dry Distribution Transformer	1	EA	$7,800	$7,800	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	1	EA	$662	$662	
	Recessed Light Fixture, 12' Max Drop Ceiling	1	EA	$110	$110	
	400 Watt Single Unit High Pressure Sodium Light Fixture, All Weather	1	EA	$110	$110	
	Generac 5734 GP15000E 22,500 Watt 992cc OHV Portable Gas Powered Generator	1	EA	$3,900	$3,900	
	Total					$31,442
	Grand Total					**$31,442**

Cardno ENTRIX
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PROJECT SUMMARY

Project: NAWS
Type: Common Component
Component: Bottineau West Pump Station

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$57,847
2	Plumbing, Fire			$23,600
3	Piping and Valves			$47,756
4	Pumping Units			$70,500
5	Flow Meter			$7,241
6	Electrical			$31,742
TOTAL				**$238,686**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$238,686**
	Mobilization		5.0%	$11,934
		Subtotal		**$250,620**
	Unlisted Items		10.0%	$25,062
		Subtotal		**$275,682**
	Contingencies		30.0%	$82,705
		Subtotal		**$358,387**
	Noncontract Costs		25.0%	$89,597
		Subtotal		**$447,984**
TOTAL				**$447,984**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau West Pump Station
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	0.4	AC	$2,500	$1,000	
	Site Paving, 3" AC on 6" ABC	544	SY	$8	$4,352	
	6" Compacted ABC Foundation	7	CY	$25	$175	
	Site Work (Landscaping)	1	LS	$5,000	$5,000	
	Temporary Trailer	2	MO	$7,500	$15,000	
	Staging Site Preparation	1	LS	$5,000	$5,000	
	Chain-link Fence	472	LF	$5	$2,360	
	Double Swing Gate	1	EA	$2,860	$2,860	
	Total					$35,747
	Concrete Vault					
	Pumpstation Main Slab, 12"	14	CY	$450	$6,300	
	Pump Can Slab, 12"	2	CY	$450	$900	
	12" Walls, 8' High	24	CY	$450	$10,800	
	Pumpstation Top Slab, 8"	10	CY	$410	$4,100	
	Total					$22,100
	Grand Total					**$57,847**

NOTES - Site construction costs were included for the reservoir.

Cardno ENTRIX
Shaping the Future

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau West Pump Station
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$8,500	$8,500	
	Interior Plumbing System	1	LS	$2,000	$2,000	
	Total					$10,500
	Electrical					
	Fire Detection and Alarm System	1	EA	$7,500	$7,500	
	Total					$7,500
	Grand Total					**$23,600**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau West Pump Station
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	6" Gate Valve	2	EA	$750	$1,500	
	6" Ductile Iron Pipe	65	LF	$28	$1,820	
	8" Steel Pipe	30	LF	$34	$1,020	
	8" 90 Degree Bend	6	EA	$251	$1,506	
	8" Flex Coupling	3	EA	$1,250	$3,750	
	8" Check Valve	3	EA	$4,200	$12,600	
	8" Gate Valve	6	EA	$1,078	$6,468	
	14" Steel Pipe	30	LF	$61	$1,830	
	14" Butterfly Valve	4	EA	$2,364	$9,456	
	14" X 8" Tees	6	EA	$986	$5,916	
	14" X 6" Tees	2	EA	$945	$1,890	
	Total					$47,756
	Grand Total					**$47,756**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau West Pump Station
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	50 HP 10-Stage Vertical Turbine Pump, 0.76 MGD @ 267 FT, 1,200 rpm	3	EA	$23,500	$70,500	
	Total					$70,500
	Grand Total					**$70,500**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau West Pump Station
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	14" Magnetic Flow Meter	1	EA	$7,241	$7,241	
	Total					$7,241
	Grand Total					**$7,241**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau West Pump Station
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	Electric Wire to Pumps, 480 V Cu	120	LF	$40	$4,800	
	Miscellaneous Electrical Wire	600	LF	$5	$3,000	
	1" Aluminum Conduit	120	LF	$8	$960	
	VMX Series Soft Start VMX-62-BP - Variable Speed Drive, 62 hp	1	EA	$5,450	$5,450	
	Control Panel	1	EA	$4,500	$4,500	
	Bare Copper Wire Stranded, Grounding System	90	EA	$5	$450	
	150 Kv, Three Phase, Dry Distribution Transformer	1	EA	$7,800	$7,800	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	1	EA	$662	$662	
	Recessed Light Fixture, 12' Max Drop Ceiling	1	EA	$110	$110	
	400 Watt Single Unit High Pressure Sodium Light Fixture, All Weather	1	EA	$110	$110	
	Generac 5734 GP15000E 22,500 Watt 992cc OHV Portable Gas Powered Generator	1	EA	$3,900	$3,900	
	Total					$31,742
	Grand Total					**$31,742**

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PROJECT SUMMARY

Project: NAWS
Type: Common Component
Component: Bottineau North Pump Station

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$52,841
2	Plumbing, Fire			$23,600
3	Piping and Valves			$25,268
4	Pumping Units			$27,000
5	Flow Meter			$3,949
6	Electrical			$32,322
TOTAL				**$164,980**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$164,980**
	Mobilization		5.0%	$8,249
		Subtotal		**$173,229**
	Unlisted Items		10.0%	$17,323
		Subtotal		**$190,552**
	Contingencies		30.0%	$57,166
		Subtotal		**$247,718**
	Noncontract Costs		25.0%	$61,930
		Subtotal		**$309,648**
TOTAL				**$309,648**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau North Pump Station
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	0.1	AC	$2,500	$250	
	Site Paving, 3" AC on 6" ABC	162	SY	$8	$1,296	
	6" Compacted ABC Foundation	7	CY	$25	$175	
	Site Work (Landscaping)	1	LS	$5,000	$5,000	
	Temporary Trailer	2	MO	$7,500	$15,000	
	Staging Site Preparation	1	LS	$5,000	$5,000	
	Chain-link Fence	232	LF	$5	$1,160	
	Double Swing Gate	1	EA	$2,860	$2,860	
	Total					$30,741
	Concrete Vault					
	Pumpstation Main Slab, 12"	14	CY	$450	$6,300	
	Pump Can Slab, 12"	2	CY	$450	$900	
	12" Walls, 8' High	24	CY	$450	$10,800	
	Pumpstation Top Slab, 8"	10	CY	$410	$4,100	
	Total					$22,100
	Grand Total					**$52,841**

NOTES - Site construction costs were included for the reservoir.

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau North Pump Station
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$8,500	$8,500	
	Interior Plumbing System	1	LS	$2,000	$2,000	
	Total					$10,500
	Electrical					
	Fire Detection and Alarm System	1	EA	$7,500	$7,500	
	Total					$7,500
	Grand Total					**$23,600**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau North Pump Station
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	6" Steel Pipe	20	LF	$31	$620	
	6" Ductile Iron Pipe	65	LF	$28	$1,820	
	6" 90 Degree Bend	4	EA	$195	$780	
	6" Flex Coupling	2	EA	$1,150	$2,300	
	6" Check Valve	2	EA	$3,500	$7,000	
	6" Gate Valve	6	EA	$750	$4,500	
	8" Steel Pipe	30	LF	$34	$1,020	
	8" Gate Valve	4	EA	$1,078	$4,312	
	8" X 6" Tees	6	EA	$486	$2,916	
	Total					$25,268
	Grand Total					**$25,268**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau North Pump Station
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	20 HP 10-Stage Vertical Turbine Pumps, 0.27 MGD @ 246 FT, 1,800 rpm	2	EA	$13,500	$27,000	
	Total					$27,000
	Grand Total					**$27,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau North Pump Station
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	8" Magnetic Flow Meter	1	EA	$3,949	$3,949	
	Total					$3,949
	Grand Total					**$3,949**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau North Pump Station
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	Electric Wire to Pumps, 480 V Cu	80	LF	$40	$3,200	
	Miscellaneous Electrical Wire	500	LF	$5	$2,500	
	1" Aluminum Conduit	80	LF	$8	$640	
	VMX Series Soft Start VMX-28-BP - Variable Speed Drive, 28 hp	2	EA	$4,300	$8,600	
	Control Panel	1	EA	$4,500	$4,500	
	Bare Copper Wire Stranded, Grounding System	60	EA	$5	$300	
	150 Kv, Three Phase, Dry Distribution Transformer	1	EA	$7,800	$7,800	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	1	EA	$662	$662	
	Recessed Light Fixture, 12' Max Drop Ceiling	1	EA	$110	$110	
	400 Watt Single Unit High Pressure Sodium Light Fixture, All Weather	1	EA	$110	$110	
	Generac 5734 GP15000E 22,500 Watt 992cc OHV Portable Gas Powered Generator	1	EA	$3,900	$3,900	
	Total					$32,322
	Grand Total					**$32,322**

Cardno ENTRIX
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PROJECT SUMMARY

Project: NAWS
Type: Common Component
Component: Lansford Reservoir

NO.	DESCRIPTION			TOTAL
1	Site Work			$274,522
2	Reservoir, 4 MG			$2,693,430
3	Piping and Valves			$52,685
4	Electrical			$17,440
TOTAL				**$3,038,077**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$3,038,077**
	Mobilization		5.0%	$151,904
		Subtotal		**$3,189,981**
	Unlisted Items		5.0%	$159,499
		Subtotal		**$3,349,480**
	Contingencies		30.0%	$1,004,844
		Subtotal		**$4,354,324**
	Noncontract Costs		25.0%	$1,088,581
		Subtotal		**$5,442,905**
TOTAL				**$5,442,905**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Reservoir
Element: Site Work

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Grading					
	Excavation for Reservoir Foundation	1,350	CY	$6	$8,100	
	Backfill	1,000	CY	$8	$8,000	
	Total					$16,100
	Equipment					
	Case CX250C Excavator	30	DAY	$500	$15,000	
	John Deere 872G/GP Motor Grader	30	DAY	$650	$19,500	
	Terex AC100 All-terrain Crane	3	MO	$25,000	$75,000	
	Total					$109,500
	Site Construction					
	Clearing and Grubbing	1.6	AC	$2,500	$4,000	
	Site Paving, 3" AC on 6" ABC	734	SY	$8	$5,872	
	6" Compacted ABC Foundation Subgrade	350	CY	$25	$8,750	
	Site Work (Landscaping)	1	LS	$15,000	$15,000	
	Temporary Trailer	8	MO	$12,500	$100,000	
	Staging Site Preparation	1	LS	$10,000	$10,000	
	Chain-link Fence	1,060	LF	$5	$5,300	
	Total					$148,922
	Grand Total					**$274,522**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Reservoir
Element: Reservoir, 4 MG

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Concrete					
	Concrete, Reinforcement, and Framework for Foundation (4' x 1.5' x 150' Cl Dia Footing, 144' Dia x 4" Slab)	235	CY	$650	$152,750	
	Prestressed Reinforced Concrete Reservoir, 4 MG, 150' Dia x 33' (includes circular prestressed concrete tank using machine strand-wrap system, circumferential and vertical prestressing, shotcreting and including the prestressing system, complete with all appurtenances as required)	1	LS	$2,494,000	$2,494,000	
	Valve Box	3	EA	$5,000	$15,000	
	Pipe Encasement	29	CY	$450	$13,050	
	Total					$2,674,800
	Plastics					
	6 mil Polyethilene Film under floor and Footing, installed.	18,630	SF	$1.00	$18,630	
	Total					$18,630
	Grand Total					**$2,693,430**

Cardno ENTRIX
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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Reservoir
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	16" Check Valve, Restrained	1	EA	$22,000	$22,000	
	16" Butterfly Valve, Restrained	1	EA	$2,838	$2,838	
	16" DI Pipe (between 90 Degree bend and tank, 6' to 8' deep), Restrained	80	LF	$95	$7,600	
	16" Overflow Pipe (Steel)	50	LF	$72	$3,600	
	16" 90 Degrees DI Bend, Restrained	1	EA	$1,207	$1,207	
	24" DI Pipe (between tank and pump station, 6' to 8' deep), Restrained	95	LF	$140	$13,300	
	24" 22.5 Degrees Bend, Restrained	1	EA	$2,140	$2,140	
	Total					$52,685
	Grand Total					**$52,685**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Reservoir
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	Local Power Connection	1	LS	$12,000	$12,000	
	Miscellaneous Electrical	1	LS	$5,000	$5,000	
	400 Watt Single Unit High Pressure Sodium Light Fixture, All Weather	4	EA	$110	$440	
	Total					$17,440
	Grand Total					**$17,440**

Cardno ENTRIX
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PROJECT SUMMARY

Project: NAWS
Type: Common Component
Component: Bottineau Reservoir

NO.	DESCRIPTION			TOTAL
1	Site Work			$208,553
2	Reservoir, 2 MG			$1,669,240
3	Piping and Valves			$113,931
4	Electrical			$17,440
TOTAL				**$2,009,164**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$2,009,164**
	Mobilization		5.0%	$100,458
		Subtotal		**$2,109,622**
	Unlisted Items		5.0%	$105,481
		Subtotal		**$2,215,103**
	Contingencies		30.0%	$664,531
		Subtotal		**$2,879,634**
	Noncontract Costs		25.0%	$719,909
		Subtotal		**$3,599,543**
TOTAL				**$3,599,543**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau Reservoir
Element: Site Work

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Grading					
	Excavation for Reservoir Foundation	500	CY	$6	$3,000	
	Backfill	235	CY	$8	$1,880	
	Total					$4,880
	Equipment					
	Case CX250C Excavator	20	DAY	$500	$10,000	
	John Deere 872G/GP Motor Grader	20	DAY	$650	$13,000	
	Terex AC100 All-terrain Crane	3	MO	$25,000	$75,000	
	Total					$98,000
	Site Construction					
	Clearing and Grubbing	1	AC	$2,500	$1,750	
	Site Paving, 3" AC on 6" ABC	1,186	SY	$8	$9,488	
	6" Compacted ABC Foundation Subgrade	265	CY	$25	$6,625	
	6" Compacted ABC Foundation Subgrade for PRV Vault	4	CY	$25	$100	
	Site Work (Landscaping)	1	LS	$15,000	$15,000	
	Temporary Trailer	4	MO	$12,500	$50,000	
	Staging Site Preparation	1	LS	$10,000	$10,000	
	Chain-link Fence	652	LF	$5	$3,260	
	Total					$96,223
	Concrete					
	8" PRV Vault Base Slab (15'x12')	4.5	CY	$450	$2,025	
	8" PRV Vault Top Slab (15'x12')	4.5	CY	$450	$2,025	
	8" PRV Wall, 9' high	12	CY	$450	$5,400	
	Total					$9,450
	Grand Total					**$208,553**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau Reservoir
Element: Reservoir, 2 MG

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Concrete					
	Concrete, Reinforcement, and Framework for Foundation (4' x 1.5' x 90' Cl Dia Footing, 84' Dia x 4" Slab)	131	CY	$650	$85,150	
	Prestressed Reinforced Concrete Reservoir, 2 MG, 90' Dia x 45' (includes circular prestressed concrete tank using machine strand-wrap system, circumferential and vertical prestressing, shotcreting and including the prestressing system, complete with all appurtenances as required)	1	LS	$1,550,000	$1,550,000	
	Valve Box	3	EA	$5,000	$15,000	
	Pipe Encasement	27	CY	$450	$12,150	
	Total					$1,662,300
	Plastics					
	6 mil Polyethilene Film under floor and Footing, installed.	6,940	SF	$1.00	$6,940	
	Total					$6,940
	Grand Total					**$1,669,240**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau Reservoir
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	8" Gate Valve, Restrained	1	EA	$1,078	$1,078	
	8" DI Pipe (from fenceline, 6' to 8' deep)	150	LF	$37.50	$5,625	
	8" 22.5 Degrees Bend, Restrained	1	EA	$2,200	$2,200	
	14" Check Valve, Restrained	1	EA	$22,000	$22,000	
	14" Butterfly Valve, Restrained	2	EA	$2,364	$4,728	
	14" DI Pipe (from fenceline, 6' to 8' deep)	150	LF	$70.00	$10,500	
	14" 22.5 Degrees Bend, Restrained	1	EA	$2,200	$2,200	
	16" Overflow Pipe (Steel)	50	LF	$72	$3,600	
	14" PRV Assembly	1	LS	$62,000	$62,000	
	Total					$113,931
	Grand Total					**$113,931**

DETAILED COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau Reservoir
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	Local Power Connection	1	LS	$12,000	$12,000	
	Miscellaneous Electrical	1	LS	$5,000	$5,000	
	400 Watt Single Unit High Pressure Sodium Light Fixture, All Weather	4	EA	$110	$440	
	Total					$17,440
	Grand Total					**$17,440**

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PROJECT SUMMARY

Project: NAWS
Type: In-basin Alternative Component
Component: Minot Recharge Basins

NO.	DESCRIPTION			TOTAL
1	Site Work			$5,350,144
2	Office Building			$87,645
3	Piping, Valves and Gates			$412,345
TOTAL				**$5,850,134**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$5,850,134**
	Mobilization		5.0%	$292,507
		Subtotal		**$6,142,641**
	Unlisted Items		5.0%	$307,132
		Subtotal		**$6,449,773**
	Contingencies		30.0%	$1,934,932
		Subtotal		**$8,384,705**
	Noncontract Costs		25.0%	$2,096,176
		Subtotal		**$10,480,881**
TOTAL				**$10,480,881**

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Cardno ENTRIX
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DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Minot Recharge Basins
Element: Site Work

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Site Mass Grading	235,000	CY	$4	$940,000	
	Grit Tank Site Excavation and Backfill	2,200	CY	$6	$13,200	
	Sludge Basin Excavation	1,000	CY	$6	$6,000	
	6" Gravel Paving, In Place (200'x200')	40,000	SF	$1	$40,000	
	16" Riprap (D50 = 8") spillway, 50' x 10', stepped (per basin)	99	CY	$90	$8,910	
	Total					$1,008,110
	Concrete					
	12" Straight Wall >8' High (for grit tank cells)	128	CY	$571	$73,088	
	12" Bottom Slab, Sloping (grit tank)	78	CY	$571	$44,538	
	Concrete Baffle at Recharge Basins (one per basin)	4	EA	$12,000	$48,000	
	Total					$165,626
	Recharge Wells					
	36 inch borehole, drill and ream (110 LF/well)	5,280	LF	$245	$1,293,600	
	30 inch casing, supply and install (60 LF/well)	2,880	LF	$250	$720,000	
	30 inch screen, supply and install (50 LF/well)	2,400	LF	$350	$840,000	
	Gravel backfill within casing 2-inch with 1-inch topping (30 CY/well)	1,440	CY	$310	$446,400	
	Develop well	48	EA	$4,000	$192,000	
	Graded filter gravel and sand, supply and Install	48	EA	$5,000	$240,000	
	Filter drains, supply and Install	48	LS	$4,000	$192,000	
	Total					$3,924,000
	Monitor Wells					
	Drill and install 4 inch monitor wells (4 units x 110 LF)	440	LF	$32	$14,080	
	Total					$14,080
	Metal					
	Galv. Chain Link Fence, 8' W/Barbed Wire, No Gates	5,476	LF	$43	$235,468	
	8' H Double Swing Gate, Chain Link, 20' Opening	1	EA	$2,860	$2,860	
	Total					$238,328
	Grand Total					**$5,350,144**

Cardno ENTRIX
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DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Minot Recharge Basins
Element: Office Building

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Concrete					
	Office Bldg - 12" Slab 20'x 25'	19	CY	$401	$7,619	
	8" x 8" x 14' Square Column (8)	2	CY	$650	$1,300	
	Total					$8,919
	Masonry					
	Office Bldg - 20'x 25' X 14' - Standard Concrete Block, 12"	1,160	SF	$16	$18,560	
	Total					$18,560
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Electrical					
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	3	EA	$662	$1,986	
	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	3	EA	$110	$330	
	Interior wiring	150	FT	$6	$900	
	.75" Grs Conduit, In A Bldg With Unlimited Ht	150	FT	$8	$1,200	
	125 Ekw 1800Rpm,60Hz Stdby Gen Set	1	EA	$32,500	$32,500	
	Total					$36,916
	Metal					
	Steel Trusses	2,750	LB	$3	$8,250	
	Total					$8,250
	Thermal and Moisture					
	24 Ga Mr3-36 Versacor Roofing	550	SF	$8	$4,400	
	Total					$4,400
	Mechanical					
	Interior Plumbing System	1	LS	$5,000	$5,000	
	Total					$5,000
	Grand Total					**$87,645**

Cardno ENTRIX
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DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Minot Recharge Basins
Element: Piping, Valves and Gates

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	36" X 36" Tee	3	EA	$3,000	$9,000	
	36" 90 Degrees Bend	2	EA	$2,200	$4,400	
	36" Steel Pipe (between grit tank cells)	35	LF	$360	$12,600	
	36" Pipe (from fenceline to grit tank connection)	300	LF	$250	$75,000	
	36" Reinforced Concrete Gravity Pipe to Sludge Disposal Basin (from grit tank)	150	LF	$240	$36,000	
	36" Butterfly Valve (at inflow manifold)	3	EA	$14,715	$44,145	
	Pipe Supports/Restraints	1	LS	$70,000	$70,000	
	Miscellaneous Pipe Conections	1	LS	$10,000	$10,000	
	Sluice Gate 9'X9' (at grit tank outlet)	3	EA	$42,000	$126,000	
	Sluice Gate, 3'X3' (at hydraulic removal lines)	3	EA	$8,400	$25,200	
	Total					$412,345
	Grand Total					**$412,345**

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PROJECT SUMMARY

Project: NAWS
Type: In-basin Alternative Component
Component: Sundre Recharge Basins

NO.	DESCRIPTION			TOTAL
1	Site Work			$9,633,454
2	Office Building			$87,645
3	Piping, Valves and Gates			$412,345
TOTAL				**$10,133,444**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$10,133,444**
	Mobilization		5.0%	$506,672
		Subtotal		**$10,640,116**
	Unlisted Items		5.0%	$532,006
		Subtotal		**$11,172,122**
	Contingencies		30.0%	$3,351,637
		Subtotal		**$14,523,759**
	Noncontract Costs		25.0%	$3,630,940
		Subtotal		**$18,154,699**
TOTAL				**$18,154,699**

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DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Sundre Recharge Basins
Element: Site Work

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Site Mass Grading	235,000	CY	$4	$940,000	
	Grit Tank Site Excavation and Backfill	2,200	CY	$6	$13,200	
	Sludge Basin Excavation	1,000	CY	$6	$6,000	
	6" Gravel Paving, In Place (200'x200')	40,000	SF	$1	$40,000	
	16" Riprap (D50 = 8") spillway, 50' x 10', stepped (per basin)	99	CY	$90	$8,910	
	Total					$1,008,110
	Concrete					
	12" Straight Wall >8' High (for grit tank cells)	128	CY	$571	$73,088	
	12" Bottom Slab, Sloping (grit tank)	78	CY	$571	$44,538	
	Total					$117,626
	Riprap					
	16" Riprap (D50 = 8") spillway, 50' x 10', stepped (per basin)	99	CY	$90	$8,910	
	Total					$8,910
	Recharge Wells					
	36 inch borehole, drill and ream (260 LF/well)	12,480	LF	$245	$3,057,600	
	30 inch casing supply and install (180 LF/well)	8,640	LF	$250	$2,160,000	
	30 inch screen, supply and install (80 LF/well)	3,840	LF	$350	$1,344,000	
	Gravel backfill within casing 2-inch with 1-inch topping (70 CY/well)	3,360	CY	$310	$1,041,600	
	Develop well	48	EA	$4,000	$192,000	
	Graded filter gravel and sand, supply and Install	48	EA	$5,000	$240,000	
	Filter drains, supply and Install	48	LS	$4,000	$192,000	
	Total					$8,227,200
	Monitor Wells					
	Drill and install 4 inch monitor wells (4 units x 260LF)	1,040	LF	$32	$33,280	
	Total					$33,280
	Metal					
	Galv. Chain Link Fence, 8' W/Barbed Wire, No Gates	5,476	LF	$43	$235,468	
	8' H Double Swing Gate, Chain Link, 20' Opening	1	EA	$2,860	$2,860	
	Total					$238,328

DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Sundre Recharge Basins
Element: Site Work

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Grand Total					**$9,633,454**

Cardno ENTRIX
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DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Sundre Recharge Basins
Element: Office Building

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Concrete					
	Office Bldg - 12" Slab 20'x 25'	19	CY	$401	$7,619	
	8" x 8" x 14' Square Column (8)	2	CY	$650	$1,300	
	Total					$8,919
	Masonry					
	Office Bldg - 20'x 25' X 14' - Standard Concrete Block, 12"	1,160	SF	$16	$18,560	
	Total					$18,560
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Electrical					
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	3	EA	$662	$1,986	
	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	3	EA	$110	$330	
	Interior wiring	150	FT	$6	$900	
	.75" Grs Conduit, In A Bldg With Unlimited Ht	150	FT	$8	$1,200	
	125 Ekw 1800Rpm,60Hz Stdby Gen Set	1	EA	$32,500	$32,500	
	Total					$36,916
	Metal					
	Steel Trusses	2,750	LB	$3	$8,250	
	Total					$8,250
	Thermal and Moisture					
	24 Ga Mr3-36 Versacor Roofing	550	SF	$8	$4,400	
	Total					$4,400
	Mechanical					
	Interior Plumbing System	1	LS	$5,000	$5,000	
	Total					$5,000
	Grand Total					**$87,645**

Cardno ENTRIX
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DETAILED COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Sundre Recharge Basins
Element: Piping, Valves and Gates

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	36" X 36" Tee	3	EA	$3,000	$9,000	
	36" 90 Degrees Bend	2	EA	$2,200	$4,400	
	36" Steel Pipe (between grit tank cells)	35	LF	$360	$12,600	
	36" Pipe (from fenceline to grit tank connection)	300	LF	$250	$75,000	
	36" Reinforced Concrete Gravity Pipe to Sludge Disposal Basin (from grit tank)	150	LF	$240	$36,000	
	36" Butterfly Valve (at inflow manifold)	3	EA	$14,715	$44,145	
	Pipe Supports/Restraints	1	LS	$70,000	$70,000	
	Miscellaneous Pipe Conections	1	LS	$10,000	$10,000	
	Sluice Gate 9'X9' (at grit tank outlet)	3	EA	$42,000	$126,000	
	Sluice Gate, 3'X3' (at hydraulic removal lines)	3	EA	$8,400	$25,200	
	Total					$412,345
	Grand Total					**$412,345**

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PROJECT SUMMARY

Project: NAWS
Type: Missouri River Alternative Component
Component: South Prairie Reservoir

NO.	DESCRIPTION			TOTAL
1	Site Work			$212,050
2	Reservoir, 3 MG			$1,317,650
3	Piping and Valves			$140,028
4	Electrical			$17,440
TOTAL				**$1,687,168**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$1,687,168**
	Mobilization		5.0%	$84,358
		Subtotal		**$1,771,526**
	Unlisted Items		5.0%	$88,576
		Subtotal		**$1,860,102**
	Contingencies		30.0%	$558,031
		Subtotal		**$2,418,133**
	Noncontract Costs		25.0%	$604,533
		Subtotal		**$3,022,666**
TOTAL				**$3,022,666**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: South Prairie Reservoir
Element: Site Work

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Grading					
	Excavation for Reservoir Foundation	1,000	CY	$6	$6,000	
	Backfill	250	CY	$8	$2,000	
	Total					**$8,000**
	Equipment					
	Case CX250C Excavator	10	DAY	$500	$5,000	
	John Deere 872G/GP Motor Grader	10	DAY	$650	$6,500	
	Terex AC100 All-terrain Crane	2	MO	$25,000	$37,500	
	Total					$49,000
	Site Construction					
	Clearing and Grubbing	7	AC	$2,500	$17,500	
	Site Paving, 3" AC on 6" ABC	6,600	SY	$8	$52,800	
	Compacted ABC Foundation	390	CY	$25	$9,750	
	Site Work (Landscaping)	1	LS	$15,000	$15,000	
	Temporary Trailer	4	MO	$12,500	$50,000	
	Staging Site Preparation	1	LS	$10,000	$10,000	
	Total					$155,050
	Grand Total					**$212,050**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: South Prairie Reservoir
Element: Reservoir, 3 MG

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Concrete					
	Concrete, Reinforcement, and Framework for Foundation, 105' Dia	150	CY	$650	$97,500	
	Valve Box	2	EA	$5,000	$10,000	
	Pipe Encasement	27	CY	$450	$12,150	
	Total					$119,650
	Metals					
	Steel Reservoir, 3 MG	1	LS	$1,186,000	$1,186,000	
	Chain-link Fence	2,400	LF	$5	$12,000	
	Total					$1,198,000
	Grand Total					**$1,317,650**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: South Prairie Reservoir
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	16" Overflow Pipe (Steel)	50	LF	$72	$3,600	
	36" Check Valve	1	EA	$22,000	$22,000	
	36" Butterfly Valve	2	EA	$14,714	$29,428	
	36" 90 Degrees Bend	6	EA	$2,200	$13,200	
	36" Steel Pipe	370	LF	$140	$51,800	
	Air Valve	2	EA	$10,000	$20,000	
	Total					$140,028
	Grand Total					**$140,028**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: South Prairie Reservoir
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	Local Power Connection	1	LS	$12,000	$12,000	
	Miscellaneous Electrical	1	LS	$5,000	$5,000	
	400 Watt Single Unit High Pressure Sodium Light Fixture, All Weather	4	EA	$110	$440	
	Total					$17,440
	Grand Total					**$17,440**

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PROJECT SUMMARY

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 3

NO.	DESCRIPTION			TOTAL
1	Demolition and Removal			$1,283,500
2	Site Work and Buildings			$2,805,000
3	Plumbing, Fire			$90,800
4	Piping and Valves			$917,250
5	Pumping Units			$1,078,000
6	Flow Meter			$36,000
7	Surge Tank			$300,852
8	Power Generator			$245,799
9	Electrical			$303,194
TOTAL				**$7,060,395**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$7,060,395**
	Mobilization		5.0%	$353,020
		Subtotal		**$7,413,415**
	Unlisted Items		10.0%	$741,342
		Subtotal		**$8,154,757**
	Contingencies		30.0%	$2,446,427
		Subtotal		**$10,601,184**
	Noncontract Costs		25.0%	$2,650,296
		Subtotal		**$13,251,480**
TOTAL				**$13,251,480**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 3
Element: Demolition and Removal

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Demolition and Removal					
	Remove Pump Unit No. 1. and Motor	1	LS	$750,000	$750,000	
	Remove Miscellaneous Equipment	1	LS	$75,000	$75,000	
	Remove Trash Rack	1	LS	$2,500	$2,500	
	Concrete Demolition in Confined Space	1	LS	$50,000	$50,000	
	Debris Removal	600	CY	$135	$81,000	
	Terex AC100 Crane	12	MO	$25,000	$300,000	
	Scaffolds/Access Ladders/Safety	1	LS	$25,000	$25,000	
	Total					$1,283,500
	Grand Total					**$1,283,500**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 3
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Install New Trash Rack/Fish Screen	400	SF	$375	$150,000	
	Stainless Trash Rack - Pump Suction Pipe	1	EA	$7,500	$7,500	
	Dewatering	90	DAY	$2,000	$180,000	
	Diving Support	90	DAY	$6,000	$540,000	
	MIscellaneous Building Specialties	1	LS	$125,000	$125,000	
	Site Work (Paving/Landscaping)	1	LS	$25,000	$25,000	
	Temporary Trailer	12	MO	$12,500	$150,000	
	Staging Site Preparation	1	LS	$15,000	$15,000	
	Total					$1,192,500
	Underground Work					
	Jack and bore 60" casing, 42" carrier pipe	750	LF	$1,750	$1,312,500	
	Total					$1,312,500
	Concrete					
	Structural Pump Support	1	LS	$250,000	$250,000	
	Total					$250,000
	Metals					
	Miscellaneous Metals	1	LS	$50,000	$50,000	
	Total					$50,000
	Grand Total					**$2,805,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 3
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Conveying					
	1 Ton Lug Mounted 31' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$12,700	$12,700	
	Total					$12,700
	Mechanical					
	Interior Plumbing System	1	LS	$40,000	$40,000	
	Total					$40,000
	Electrical					
	125 Ekw 1800Rpm,60Hz Stdby Gen Set	1	EA	$32,500	$32,500	
	Total					$32,500
	Grand Total					**$90,800**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 3
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	18" Steel Pipe	50	LF	$90	$4,500	
	18" 90 Degrees Bend	8	EA	$1,000	$8,000	
	18" X 24" Tee	2	EA	$2,500	$5,000	
	18" Flex Coupling	4	EA	$3,500	$14,000	
	18" Check Valve	4	EA	$15,000	$60,000	
	18" Butterfly Valve	6	EA	$17,000	$102,000	
	24" Steel Pipe	50	LF	$110	$5,500	
	24" 90 Degrees Bend	4	EA	$1,500	$6,000	
	24" X 30" Tee	1	EA	$3,000	$3,000	
	30" Steel Pipe	350	EA	$125	$43,750	
	30" x 36" 90 Degrees Bend	1	EA	$2,200	$2,200	
	36" Steel Pipe (to Restraining Block)	450	LF	$360	$162,000	
	36" Steel Pipe (to Surge Tank)	300	LF	$361	$108,300	
	11 ft dia blind flange with 36" suction tee	1	EA	$110,000	$110,000	
	11 ft dia blind flange on discharge pipe w/ 36" spool	1	EA	$110,000	$110,000	
	Pipe Specials - (16" to 30")	120	EA	$650	$78,000	
	Pipe Supports/Restraints	1	LS	$70,000	$70,000	
	Pipe Exit Modification(From 11' Discharge Line)	1	LS	$15,000	$15,000	
	Miscellaneous Pipe Conections	1	LS	$10,000	$10,000	
	Total					$917,250
	Grand Total					**$917,250**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 3
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	800 HP 6-Stage Vertical Turbine Pumps, 7.33MGD @ 485 FT, 1200 rpm	4	EA	$269,500	$1,078,000	
	Total					$1,078,000
	Grand Total					**$1,078,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 3
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Magnetic Flow Meter	1	EA	$36,000	$36,000	
	Total					$36,000
	Grand Total					**$36,000**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 3
Element: Surge Tank

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Concrete					
	Surge Tank Bldg - 12" Slab x 945 sf	35	CY	$400	$14,000	
	8" x 8" x 14' Square Column (12)	2.8	CY	$650	$1,820	
	Total					$15,820
	Masonry					
	Surge Tank Bldg - 45' X 21' X 14' - Standard Concrete Block, 12"	1,500	SF	$16	$24,000	
	Total					$24,000
	Equipment					
	Surge Tank and Appurtenances	1	EA	$197,000	$197,000	
	Air Valve	4	EA	$11,000	$44,000	
	Total					$241,000
	Electrical					
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	6	EA	$662	$3,972	
	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	6	EA	$110	$660	
	Interior wiring	200	FT	$6	$1,200	
	.75" Grs Conduit, In A Bldg With Unlimited Ht	200	FT	$8	$1,600	
	Total					$7,432
	Metal					
	Steel Trusses	4,200	LB	$3	$12,600	
	Total					$12,600
	Grand Total					**$300,852**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 3
Element: Power Generator

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Concrete					
	Power Backup Generator Bldg - 12" Slab x 840 sf	31	CY	$450	$13,950	
	8" x 8" x 14' Square Column (10)	2.5	CY	$650	$1,625	
	Total					$15,575
	Masonry					
	Power Backup Generator Bldg - 35' X 24' X 14' - Standard Concrete Block, 12"	1,300	SF	$16	$20,800	
	Total					$20,800
	Equipment					
	640 ekW 813 kVA Power Generator	1	EA	$182,000	$182,000	
	Total					$182,000
	Electrical					
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	6	EA	$662	$3,972	
	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	6	EA	$110	$660	
	Interior wiring	200	FT	$6	$1,200	
	.75" Grs Conduit, In A Bldg With Unlimited Ht	200	FT	$8	$1,600	
	Total					$7,432
	Metal					
	Steel Trusses	4,200	LB	$3	$12,600	
	Total					$12,600
	Thermal and Moisture					
	24 Ga Mr3-36 Versacor Roofing	924	SF	$8	$7,392	
	Total					$7,392
	Grand Total					**$245,799**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 3
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	New 6.6 kV/ 800 V Electrical Power Transformer, Three Phase, 880 KVA Output, Installed	1	EA	$117,500	$117,500	
	Local Power Distribution Connections	1	EA	$12,000	$12,000	
	Electric Wire to Pumps, 800 V Cu	600	LF	$40	$24,000	
	3" Aluminum Conduit	200	LF	$22	$4,400	
	VMX Series Soft Start VMX-1006-BP-E - 460VAC Variable Speed Drive, 800 hp, 800 V	4	EA	$14,200	$56,800	
	Control Panel	1	EA	$79,800	$79,800	
	Bare Copper Wire Stranded, Grounding System	150	LF	$5	$750	
	400 Watt Single Unit High Pressure Sodium Type Light	12	MO	$662	$7,944	
	Total					$303,194
	Grand Total					**$303,194**

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PROJECT SUMMARY

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 4

NO.	DESCRIPTION			TOTAL
1	Demolition and Removal			$1,283,500
2	Site Work and Buildings			$2,805,000
3	Plumbing, Fire			$90,800
4	Piping and Valves			$917,250
5	Pumping Units			$1,118,000
6	Flow Meter			$36,000
7	Surge Tank			$300,852
8	Power Generator			$245,799
9	Electrical			$303,194
TOTAL				**$7,100,395**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$7,100,395**
	Mobilization		5.0%	$355,020
		Subtotal		**$7,455,415**
	Unlisted Items		10.0%	$745,542
		Subtotal		**$8,200,957**
	Contingencies		30.0%	$2,460,287
		Subtotal		**$10,661,244**
	Noncontract Costs		25.0%	$2,665,311
		Subtotal		**$13,326,555**
TOTAL				**$13,326,555**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Cardno ENTRIX has no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Cardno ENTRIX cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 4
Element: Demolition and Removal

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Demolition and Removal					
	Remove Pump Unit No. 1. and Motor	1	LS	$750,000	$750,000	
	Remove Miscellaneous Equipment	1	LS	$75,000	$75,000	
	Remove Trash Rack	1	LS	$2,500	$2,500	
	Concrete Demolition in Confined Space	1	LS	$50,000	$50,000	
	Debris Removal	600	CY	$135	$81,000	
	Terex AC100 Crane	12	MO	$25,000	$300,000	
	Scaffolds/Access Ladders/Safety	1	LS	$25,000	$25,000	
	Total					$1,283,500
	Grand Total					**$1,283,500**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 4
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Install New Trash Rack/Fish Screen	400	SF	$375	$150,000	
	Stainless Trash Rack - Pump Suction Pipe	1	EA	$7,500	$7,500	
	Dewatering	90	DAY	$2,000	$180,000	
	Diving Support	90	DAY	$6,000	$540,000	
	MIscellaneous Building Specialties	1	LS	$125,000	$125,000	
	Site Work (Paving/Landscaping)	1	LS	$25,000	$25,000	
	Temporary Trailer	12	MO	$12,500	$150,000	
	Staging Site Preparation	1	LS	$15,000	$15,000	
	Total					$1,192,500
	Underground Work					
	Jack and bore 60" casing, 42" carrier pipe	750	LF	$1,750	$1,312,500	
	Total					$1,312,500
	Concrete					
	Structural Pump Support	1	LS	$250,000	$250,000	
	Total					$250,000
	Metals					
	Miscellaneous Metals	1	LS	$50,000	$50,000	
	Total					$50,000
	Grand Total					**$2,805,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 4
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Conveying					
	1 Ton Lug Mounted 31' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$12,700	$12,700	
	Total					$12,700
	Mechanical					
	Interior Plumbing System	1	LS	$40,000	$40,000	
	Total					$40,000
	Electrical					
	125 Ekw 1800Rpm,60Hz Stdby Gen Set	1	EA	$32,500	$32,500	
	Total					$32,500
	Grand Total					**$90,800**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 4
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	18" Steel Pipe	50	LF	$90	$4,500	
	18" 90 Degrees Bend	8	EA	$1,000	$8,000	
	18" X 24" Tee	2	EA	$2,500	$5,000	
	18" Flex Coupling	4	EA	$3,500	$14,000	
	18" Check Valve	4	EA	$15,000	$60,000	
	18" Butterfly Valve	6	EA	$17,000	$102,000	
	24" Steel Pipe	50	LF	$110	$5,500	
	24" 90 Degrees Bend	4	EA	$1,500	$6,000	
	24" X 30" Tee	1	EA	$3,000	$3,000	
	30" Steel Pipe	350	EA	$125	$43,750	
	30" x 36" 90 Degrees Bend	1	EA	$2,200	$2,200	
	36" Steel Pipe (to Restraining Block)	450	LF	$360	$162,000	
	36" Steel Pipe (to Surge Tank)	300	LF	$361	$108,300	
	11 ft dia blind flange with 36" suction tee	1	EA	$110,000	$110,000	
	11 ft dia blind flange on discharge pipe w/ 36" spool	1	EA	$110,000	$110,000	
	Pipe Specials - (16" to 30")	120	EA	$650	$78,000	
	Pipe Supports/Restraints	1	LS	$70,000	$70,000	
	Pipe Exit Modification(From 11' Discharge Line)	1	LS	$15,000	$15,000	
	Miscellaneous Pipe Conections	1	LS	$10,000	$10,000	
	Total					$917,250
	Grand Total					**$917,250**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 4
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	900 HP 6-Stage Vertical Turbine Pumps, 8.77MGD @ 490 FT, 1200 rpm	4	EA	$279,500	$1,118,000	
	Total					$1,118,000
	Grand Total					**$1,118,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 4
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Magnetic Flow Meter	1	EA	$36,000	$36,000	
	Total					$36,000
	Grand Total					**$36,000**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 4
Element: Surge Tank

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Concrete					
	Surge Tank Bldg - 12" Slab x 945 sf	35	CY	$400	$14,000	
	8" x 8" x 14' Square Column (12)	2.8	CY	$650	$1,820	
	Total					$15,820
	Masonry					
	Surge Tank Bldg - 45' X 21' X 14' - Standard Concrete Block, 12"	1,500	SF	$16	$24,000	
	Total					$24,000
	Equipment					
	Surge Tank and Appurtenances	1	EA	$197,000	$197,000	
	Air Valve	4	EA	$11,000	$44,000	
	Total					$241,000
	Electrical					
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	6	EA	$662	$3,972	
	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	6	EA	$110	$660	
	Interior wiring	200	FT	$6	$1,200	
	.75" Grs Conduit, In A Bldg With Unlimited Ht	200	FT	$8	$1,600	
	Total					$7,432
	Metal					
	Steel Trusses	4,200	LB	$3	$12,600	
	Total					$12,600
	Grand Total					**$300,852**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 4
Element: Power Generator

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Concrete					
	Power Backup Generator Bldg - 12" Slab x 840 sf	31	CY	$450	$13,950	
	8" x 8" x 14' Square Column (10)	2.5	CY	$650	$1,625	
	Total					$15,575
	Masonry					
	Power Backup Generator Bldg - 35' X 24' X 14' - Standard Concrete Block, 12"	1,300	SF	$16	$20,800	
	Total					$20,800
	Equipment					
	640 ekW 813 kVA Power Generator	1	EA	$182,000	$182,000	
	Total					$182,000
	Electrical					
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	6	EA	$662	$3,972	
	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	6	EA	$110	$660	
	Interior wiring	200	FT	$6	$1,200	
	.75" Grs Conduit, In A Bldg With Unlimited Ht	200	FT	$8	$1,600	
	Total					$7,432
	Metal					
	Steel Trusses	4,200	LB	$3	$12,600	
	Total					$12,600
	Thermal and Moisture					
	24 Ga Mr3-36 Versacor Roofing	924	SF	$8	$7,392	
	Total					$7,392
	Grand Total					**$245,799**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Upgraded SCPP Intake and Pump Station, Alternative 4
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical					
	New 6.6 kV/ 800 V Electrical Power Transformer, Three Phase, 880 KVA Output, Installed	1	EA	$117,500	$117,500	
	Local Power Distribution Connections	1	EA	$12,000	$12,000	
	Electric Wire to Pumps, 800 V Cu	600	LF	$40	$24,000	
	3" Aluminum Conduit	200	LF	$22	$4,400	
	VMX Series Soft Start VMX-1006-BP-E - 460VAC Variable Speed Drive, 800 hp, 800 V	4	EA	$14,200	$56,800	
	Control Panel	1	EA	$79,800	$79,800	
	Bare Copper Wire Stranded, Grounding System	150	LF	$5	$750	
	400 Watt Single Unit High Pressure Sodium Type Light	12	MO	$662	$7,944	
	Total					$303,194
	Grand Total					**$303,194**

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PROJECT SUMMARY

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake, South Shore, Alternative 3

NO.	DESCRIPTION			TOTAL
1	Forebay Grading			$3,842,000
2	Site Work and Buildings			$5,102,120
3	Plumbing, Fire			$263,140
4	Piping and Valves			$360,500
5	Pumping Units			$1,042,500
6	Flow Meter			$36,000
7	Surge Tank			$241,000
8	Cofferdam			$4,860,000
9	Electrical			$1,398,628
TOTAL				**$17,145,888**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$17,145,888**
	Mobilization		5.0%	$857,294
		Subtotal		**$18,003,182**
	Unlisted Items		10.0%	$1,800,318
		Subtotal		**$19,803,500**
	Contingencies		30.0%	$5,941,050
		Subtotal		**$25,744,550**
	Noncontract Costs		25.0%	$6,436,138
		Subtotal		**$32,180,688**
TOTAL				**$32,180,688**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Cardno ENTRIX has no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Cardno ENTRIX cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 3
Element: Forebay Grading

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Grading					
	Excavation for Canal, Intake Forebay and Roadway	350,950	CY	$6	$2,105,700	
	Compaction and Backfill for Intake Bay	184,600	CY	$8	$1,476,800	
	John Deere 450D LC Excavator	150	DAY	$800	$120,000	
	John Deere 872G/GP Motor Grader	30	DAY	$650	$19,500	
	John Deere 850J Dozer	150	DAY	$800	$120,000	
	Total					$3,842,000
	Grand Total					**$3,842,000**

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DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 3
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	6	AC	$2,500	$15,000	
	Install New Trash Rack/Fish Screen	600	SF	$375	$225,000	
	Stainless Trash Rack - Pump Suction Pipe	1	EA	$7,500	$7,500	
	Dewatering	90	DAY	$4,500	$405,000	
	Diving Support	60	DAY	$7,000	$420,000	
	Site Paving, 3" AC on 6" ABC	7,800	SY	$8	$62,400	
	MIscellaneous Building Specialties	1	LS	$125,000	$125,000	
	Site Work (Landscaping)	1	LS	$25,000	$25,000	
	Temporary Trailer	12	MO	$12,500	$150,000	
	Staging Site Preparation	1	LS	$40,000	$40,000	
	Total					$1,474,900
	Concrete					
	Intake Caisson (Shaft)	886	CY	$850	$753,100	
	Lower Slab, 18"	24	CY	$850	$20,400	
	Main Slab, 12"	236	CY	$750	$177,000	
	Pump Shaft, 24"	1,892	CY	$850	$1,608,200	
	Lower Slab, 18"	48	CY	$1,000	$48,000	
	12" Concrete Walls, 18 ft tall	199	CY	$650	$129,350	
	12" x 18" Rectangular Column (8)	8	CY	$650	$5,200	
	Hoist Guideway (18" x 8" x 120') (2)	9	CY	$650	$5,850	
	3' Dia Concrete Shafts	80	LF	$450	$36,000	
	5' Dia Concrete Shafts	300	LF	$600	$180,000	
	Concrete Restraining Block	44	CY	$450	$19,800	
	Total					$2,982,900
	Conveying					
	10 ton Hoist, 29 ft Span, 120 ft Track	1	EA	$450,000	$450,000	
	Total					$450,000
	Masonry					
	Total					
	Metals					

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 3
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Steel Trusses	25,440	LB	$3	$76,320	
	Miscellaneous Metals	1	LS	$50,000	$50,000	
	Chain-link Fence	2,400	LF	$5	$12,000	
	Total					$138,320
	Thermal and Moisture					
	24 Ga Mr3-36 Versacor Roofing	7,000	SF	$8	$56,000	
	Total					$56,000
	Mechanical					
	Total					
	Grand Total					**$5,102,120**

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 3
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$167,400	$167,400	
	Interior Plumbing System	1	LS	$40,000	$40,000	
	Total					$207,400
	Electrical					
	Fire Detection and Alarm System	1	EA	$17,640	$17,640	
	125 Ekw 1800Rpm,60Hz Stdby Gen Set	1	EA	$32,500	$32,500	
	Total					$50,140
	Grand Total					**$263,140**

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 3
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	16" Steel Pipe	100	LF	$72	$7,200	
	16" X 30" Tees	4	EA	$2,500	$10,000	
	16" X 30" 90 Degree Bend	1	EA	$2,200	$2,200	
	16" Flex Coupling	5	EA	$3,500	$17,500	
	16" Check Valve	5	EA	$13,500	$67,500	
	30" Steel Pipe	100	EA	$125	$12,500	
	36" Steel Pipe (to Restraining Block)	550	LF	$360	$198,000	
	42" Steel Intake Pipe	45	LF	$160	$7,200	
	24" X 30" Tee	1	EA	$3,000	$3,000	
	30" Steel Pipe	100	EA	$125	$12,500	
	30" x 30" 90 Degrees Bend	1	EA	$2,200	$2,200	
	36" Butterfly Valve (outside building)	1	EA	$14,500	$14,500	
	Pipe Specials - (30" to 36")	1	EA	$700	$700	
	30" X 30" Tee	1	EA	$3,000	$3,000	
	30" Steel Pipe (to Surge Tank)	20	LF	$125	$2,500	
	Total					$360,500
	Grand Total					**$360,500**

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 3
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	845 HP 6-Stage Vertical Turbine Pumps, 5.5 MGD @ 694 FT, 1,800 rpm	5	EA	$208,500	$1,042,500	
	Total					$1,042,500
	Grand Total					**$1,042,500**

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 3
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	30" Magnetic Flow Meter	1	EA	$36,000	$36,000	
	Total					$36,000
	Grand Total					**$36,000**

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 3
Element: Surge Tank

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Surge Tank and Appurtenances	1	EA	$197,000	$197,000	
	Air Valve	4	EA	$11,000	$44,000	
	Total					$241,000
	Grand Total					**$241,000**

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 3
Element: Cofferdam

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Barge with Hydraulic Hammer	120	DAY	$2,500	$300,000	
	Total					$300,000
	Metal					
	Sheetpiles, 60',	1,200	LF	$3,800	$4,560,000	
	Total					$4,560,000
	Grand Total					**$4,860,000**

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DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 3
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical - off site					
	Construct Tap on 115kV line	1	LS	$55,000	$55,000	
	Construct 1.5 miles 115kV line to site	1	LS	$220,000	$220,000	
	Construct 115-4.16kV, 3.75/5.25 MVA substation (3) 546/612 Amp Regulators, (1) ACR	1	LS	$610,000	$610,000	
	Total					$885,000
	Electrical - on site					
	640 ekW 813 kVA Power Generator	1	EA	$182,000	$182,000	
	Local Power Distribution	1	EA	$28,000	$28,000	
	Electric Wire to Pumps, 800 V Cu	550	LF	$40	$22,000	
	Miscellaneous Electrical Wire	15,000	LF	$5	$75,000	
	3" Aluminum Conduit	200	LF	$22	$4,400	
	1" Aluminum Conduit					
	VMX Series Soft Start VMX-1006-BP-E - 460VAC Variable Speed Drive, 850 HP, 800 V	5	EA	$14,200	$71,000	
	Control Panel	1	EA	$79,800	$79,800	
	Bare Copper Wire Stranded, Grounding System	200	EA	$5	$1,000	
	750 Kv, Three Phase, Oil Distribution Transformer	1	EA	$31,900	$31,900	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	24	EA	$662	$15,888	
	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	24	EA	$110	$2,640	
	Total					$513,628
	Grand Total					**$1,398,628**

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PROJECT SUMMARY

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake, South Shore, Alternative 4

NO.	DESCRIPTION			TOTAL
1	Forebay Grading			$3,842,000
2	Site Work and Buildings			$5,102,120
3	Plumbing, Fire			$263,140
4	Piping and Valves			$360,500
5	Pumping Units			$1,192,500
6	Flow Meter			$36,000
7	Surge Tank			$241,000
8	Cofferdam			$4,860,000
9	Electrical			$1,398,628
TOTAL				**$17,295,888**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$17,295,888**
	Mobilization		5.0%	$864,794
		Subtotal		**$18,160,682**
	Unlisted Items		10.0%	$1,816,068
		Subtotal		**$19,976,750**
	Contingencies		30.0%	$5,993,025
		Subtotal		**$25,969,775**
	Noncontract Costs		25.0%	$6,492,444
		Subtotal		**$32,462,219**
TOTAL				**$32,462,219**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Cardno ENTRIX has no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Cardno ENTRIX cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 4
Element: Forebay Grading

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Grading					
	Excavation for Canal, Intake Forebay and Roadway	350,950	CY	$6	$2,105,700	
	Compaction and Backfill for Intake Bay	184,600	CY	$8	$1,476,800	
	John Deere 450D LC Excavator	150	DAY	$800	$120,000	
	John Deere 872G/GP Motor Grader	30	DAY	$650	$19,500	
	John Deere 850J Dozer	150	DAY	$800	$120,000	
	Total					$3,842,000
	Grand Total					**$3,842,000**

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DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 4
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	6	AC	$2,500	$15,000	
	Install New Trash Rack/Fish Screen	600	SF	$375	$225,000	
	Stainless Trash Rack - Pump Suction Pipe	1	EA	$7,500	$7,500	
	Dewatering	90	DAY	$4,500	$405,000	
	Diving Support	60	DAY	$7,000	$420,000	
	Site Paving, 3" AC on 6" ABC	7,800	SY	$8	$62,400	
	MIscellaneous Building Specialties	1	LS	$125,000	$125,000	
	Site Work (Landscaping)	1	LS	$25,000	$25,000	
	Temporary Trailer	12	MO	$12,500	$150,000	
	Staging Site Preparation	1	LS	$40,000	$40,000	
	Total					$1,474,900
	Concrete					
	Intake Caisson (Shaft)	886	CY	$850	$753,100	
	Lower Slab, 18"	24	CY	$850	$20,400	
	Main Slab, 12"	236	CY	$750	$177,000	
	Pump Shaft, 24"	1,892	CY	$850	$1,608,200	
	Lower Slab, 18"	48	CY	$1,000	$48,000	
	12" Concrete Walls, 18 ft tall	199	CY	$650	$129,350	
	12" x 18" Rectangular Column (8)	8	CY	$650	$5,200	
	Hoist Guideway (18" x 8" x 120') (2)	9	CY	$650	$5,850	
	3' Dia Concrete Shafts	80	LF	$450	$36,000	
	5' Dia Concrete Shafts	300	LF	$600	$180,000	
	Concrete Restraining Block	44	CY	$450	$19,800	
	Total					$2,982,900
	Conveying					
	10 ton Hoist, 29 ft Span, 120 ft Track	1	EA	$450,000	$450,000	
	Total					$450,000
	Masonry					
	Total					
	Metals					

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 4
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Steel Trusses	25,440	LB	$3	$76,320	
	Miscellaneous Metals	1	LS	$50,000	$50,000	
	Chain-link Fence	2,400	LF	$5	$12,000	
	Total					$138,320
	Thermal and Moisture					
	24 Ga Mr3-36 Versacor Roofing	7,000	SF	$8	$56,000	
	Total					$56,000
	Mechanical					
	Total					
	Grand Total					**$5,102,120**

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 4
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$167,400	$167,400	
	Interior Plumbing System	1	LS	$40,000	$40,000	
	Total					$207,400
	Electrical					
	Fire Detection and Alarm System	1	EA	$17,640	$17,640	
	125 Ekw 1800Rpm,60Hz Stdby Gen Set	1	EA	$32,500	$32,500	
	Total					$50,140
	Grand Total					**$263,140**

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 4
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	16" Steel Pipe	100	LF	$72	$7,200	
	16" X 30" Tees	4	EA	$2,500	$10,000	
	16" X 30" 90 Degree Bend	1	EA	$2,200	$2,200	
	16" Flex Coupling	5	EA	$3,500	$17,500	
	16" Check Valve	5	EA	$13,500	$67,500	
	30" Steel Pipe	100	EA	$125	$12,500	
	36" Steel Pipe (to Restraining Block)	550	LF	$360	$198,000	
	42" Steel Intake Pipe	45	LF	$160	$7,200	
	24" X 30" Tee	1	EA	$3,000	$3,000	
	30" Steel Pipe	100	EA	$125	$12,500	
	30" x 30" 90 Degrees Bend	1	EA	$2,200	$2,200	
	36" Butterfly Valve (outside building)	1	EA	$14,500	$14,500	
	Pipe Specials - (30" to 36")	1	EA	$700	$700	
	30" X 30" Tee	1	EA	$3,000	$3,000	
	30" Steel Pipe (to Surge Tank)	20	LF	$125	$2,500	
	Total					$360,500
	Grand Total					**$360,500**

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 4
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	950 HP 7-Stage Vertical Turbine Pumps, 6.33 MGD @ 707 FT, 1,800 rpm	5	EA	$238,500	$1,192,500	
	Total					$1,192,500
	Grand Total					**$1,192,500**

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 4
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	30" Magnetic Flow Meter	1	EA	$36,000	$36,000	
	Total					$36,000
	Grand Total					**$36,000**

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 4
Element: Surge Tank

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Surge Tank and Appurtenances	1	EA	$197,000	$197,000	
	Air Valve	4	EA	$11,000	$44,000	
	Total					$241,000
	Grand Total					**$241,000**

DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 4
Element: Cofferdam

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Barge with Hydraulic Hammer	120	DAY	$2,500	$300,000	
	Total					$300,000
	Metal					
	Sheetpiles, 60',	1,200	LF	$3,800	$4,560,000	
	Total					$4,560,000
	Grand Total					**$4,860,000**

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DETAILED COST ESTIMATE

Project: NAWS
Missouri River Alternative
Type: Component
Component: Intake, South Shore, Alternative 4
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical - off site					
	Construct Tap on 115kV line	1	LS	$55,000	$55,000	
	Construct 1.5 miles 115kV line to site	1	LS	$220,000	$220,000	
	Construct 115-4.16kV, 3.75/5.25 MVA substation (3) 546/612 Amp Regulators, (1) ACR	1	LS	$610,000	$610,000	
	Total					$885,000
	Electrical - on site					
	640 ekW 813 kVA Power Generator	1	EA	$182,000	$182,000	
	Local Power Distribution	1	EA	$28,000	$28,000	
	Electric Wire to Pumps, 800 V Cu	550	LF	$40	$22,000	
	Miscellaneous Electrical Wire	15,000	LF	$5	$75,000	
	3" Aluminum Conduit	200	LF	$22	$4,400	
	1" Aluminum Conduit					
	VMX Series Soft Start VMX-1006-BP-E - 460VAC Variable Speed Drive, 850 HP, 800 V	5	EA	$14,200	$71,000	
	Control Panel	1	EA	$79,800	$79,800	
	Bare Copper Wire Stranded, Grounding System	200	EA	$5	$1,000	
	750 Kv, Three Phase, Oil Distribution Transformer	1	EA	$31,900	$31,900	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	24	EA	$662	$15,888	
	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	24	EA	$110	$2,640	
	Total					$513,628
	Grand Total					**$1,398,628**

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PROJECT SUMMARY

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 3

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$7,151,320
2	Plumbing, Fire			$263,140
3	Piping and Valves			$234,500
4	Pumping Units			$1,027,500
5	Flow Meter			$36,000
6	Surge Tank			$241,000
7	Cofferdam			$1,792,500
8	Electrical			$996,628
TOTAL				**$11,742,588**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$11,742,588**
	Mobilization		5.0%	$587,129
		Subtotal		**$12,329,717**
	Unlisted Items		10.0%	$1,232,972
		Subtotal		**$13,562,689**
	Contingencies		30.0%	$4,068,807
		Subtotal		**$17,631,496**
	Noncontract Costs		25.0%	$4,407,874
		Subtotal		**$22,039,370**
TOTAL				**$22,039,370**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 3
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	6	AC	$2,500	$15,000	
	Install New Trash Rack/Fish Screen	600	SF	$375	$225,000	
	Stainless Trash Rack - Pump Suction Pipe	1	EA	$7,500	$7,500	
	Dewatering	90	DAY	$4,500	$405,000	
	Diving Support	90	DAY	$6,000	$540,000	
	Site Paving, 3" AC on 6" ABC	1,400	SY	$8	$11,200	
	MIscellaneous Building Specialties	1	LS	$125,000	$125,000	
	Site Work (Landscaping)	1	LS	$25,000	$25,000	
	Temporary Trailer	12	MO	$12,500	$150,000	
	Staging Site Preparation	1	LS	$40,000	$40,000	
	Total					$1,543,700
	Underground Work					
	Jack and bore 60" casing, 42" carrier pipe	1,020	LF	$1,750	$1,785,000	
	Total					$1,785,000
	Concrete					
	50 ft Intake Caisson (Shaft)	1,370	CY	$850	$1,164,500	
	Lower Slab, 18"	24	CY	$850	$20,400	
	Main Slab, 12"	236	CY	$750	$177,000	
	Pump Shaft, 24"	1,892	CY	$850	$1,608,200	
	Lower Slab, 18"	48	CY	$1,000	$48,000	
	12" Concrete Walls, 18 ft tall	199	CY	$650	$129,350	
	12" x 18" Rectangular Column (8)	8	CY	$650	$5,200	
	Hoist Guideway (18" x 8" x 120') (2)	9	CY	$650	$5,850	
	Concrete Restraining Block	44	CY	$450	$19,800	
	Total					$3,178,300
	Conveying					
	10 ton Hoist, 29 ft Span, 120 ft Track	1	EA	$450,000	$450,000	
	Total					$450,000
	Metals					
	Steel Trusses	25,440	LB	$3	$76,320	
	Miscellaneous Metals	1	LS	$50,000	$50,000	
	Chain-link Fence	2,400	LF	$5	$12,000	

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 3
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Total					$138,320
	Thermal and Moisture					
	24 Ga Mr3-36 Versacor Roofing	7,000	SF	$8	$56,000	
	Total					$56,000
	Grand Total					**$7,151,320**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 3
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$167,400	$167,400	
	Interior Plumbing System	1	LS	$40,000	$40,000	
	Total					$207,400
	Electrical					
	Fire Detection and Alarm System	1	EA	$17,640	$17,640	
	125 Ekw 1800Rpm,60Hz Stdby Gen Set	1	EA	$32,500	$32,500	
	Total					$50,140
	Grand Total					**$263,140**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 3
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	16" Steel Pipe	100	LF	$72	$7,200	
	16" X 30" Tees	4	EA	$2,500	$10,000	
	16" X 30" 90 Degree Bend	1	EA	$2,200	$2,200	
	16" Flex Coupling	5	EA	$3,500	$17,500	
	16" Check Valve	5	EA	$13,500	$67,500	
	30" Steel Pipe	100	EA	$125	$12,500	
	36" Steel Pipe (to Restraining Block)	200	LF	$360	$72,000	
	42" Steel Intake Pipe	45	LF	$160	$7,200	
	24" X 30" Tee	1	EA	$3,000	$3,000	
	30" Steel Pipe	100	EA	$125	$12,500	
	30" x 30" 90 Degrees Bend	1	EA	$2,200	$2,200	
	36" Butterfly Valve (outside building)	1	EA	$14,500	$14,500	
	Pipe Specials - (30" to 36")	1	EA	$700	$700	
	30" X 30" Tee	1	EA	$3,000	$3,000	
	30" Steel Pipe (to Surge Tank)	20	LF	$125	$2,500	
	Total					$234,500
	Grand Total					**$234,500**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 3
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	600 HP 8-Stage Vertical Turbine Pumps, 5.5 MGD @ 488 FT, 1,200 rpm	5	EA	$205,500	$1,027,500	
	Total					$1,027,500
	Grand Total					**$1,027,500**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 3
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	30" Magnetic Flow Meter	1	EA	$36,000	$36,000	
	Total					$36,000
	Grand Total					**$36,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 3
Element: Surge Tank

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Surge Tank and Appurtenances	1	EA	$197,000	$197,000	
	Air Valve	4	EA	$11,000	$44,000	
	Total					$241,000
	Grand Total					**$241,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 3
Element: Cofferdam

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Barge with Hydraulic Hammer	90	DAY	$2,500	$225,000	
	Total					$225,000
	Metal					
	Sheetpiles, 40',	550	LF	$2,850	$1,567,500	
	Total					$1,567,500
	Grand Total					**$1,792,500**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 3
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical - off site					
	Construct Tap on 115kV line from Snake Creek Substation	1	LS	$55,000	$55,000	
	Construct 115-4.16kV, 3.75/5.25 MVA substation (3) 546/612 Amp Regulators, (1) ACR	1	LS	$610,000	$610,000	
	Total					$665,000
	Electrical - on site					
	Local Power Distribution	1	EA	$28,000	$28,000	
	Electric Wire to Pumps, 800 V Cu	550	LF	$40	$22,000	
	Miscellaneous Electrical Wire	15,000	LF	$5	$75,000	
	3" Aluminum Conduit	200	LF	$22	$4,400	
	VMX Series Soft Start VMX-1006-BP-E - 460VAC Variable Speed Drive, 800 hp, 800 V	5	EA	$14,200	$71,000	
	Control Panel	1	EA	$79,800	$79,800	
	Bare Copper Wire Stranded, Grounding System	200	EA	$5	$1,000	
	750 Kv, Three Phase, Oil Distribution Transformer	1	EA	$31,900	$31,900	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	24	EA	$662	$15,888	
	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	24	EA	$110	$2,640	
	Total					$331,628
	Grand Total					**$996,628**

Cardno ENTRIX
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PROJECT SUMMARY

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 4

NO.	DESCRIPTION			TOTAL
1	Site Work and Buildings			$7,151,320
2	Plumbing, Fire			$263,140
3	Piping and Valves			$234,500
4	Pumping Units			$1,227,500
5	Flow Meter			$36,000
6	Surge Tank			$241,000
7	Cofferdam			$1,792,500
8	Electrical			$996,628
TOTAL				**$11,942,588**
	Additional Unlisted Items		0.0%	$0
		Subtotal		**$11,942,588**
	Mobilization		5.0%	$597,129
		Subtotal		**$12,539,717**
	Unlisted Items		10.0%	$1,253,972
		Subtotal		**$13,793,689**
	Contingencies		30.0%	$4,138,107
		Subtotal		**$17,931,796**
	Noncontract Costs		25.0%	$4,482,949
		Subtotal		**$22,414,745**
TOTAL				**$22,414,745**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Cardno ENTRIX has no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Cardno ENTRIX cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

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DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 4
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Site Construction					
	Clearing and Grubbing	6	AC	$2,500	$15,000	
	Install New Trash Rack/Fish Screen	600	SF	$375	$225,000	
	Stainless Trash Rack - Pump Suction Pipe	1	EA	$7,500	$7,500	
	Dewatering	90	DAY	$4,500	$405,000	
	Diving Support	90	DAY	$6,000	$540,000	
	Site Paving, 3" AC on 6" ABC	1,400	SY	$8	$11,200	
	MIscellaneous Building Specialties	1	LS	$125,000	$125,000	
	Site Work (Landscaping)	1	LS	$25,000	$25,000	
	Temporary Trailer	12	MO	$12,500	$150,000	
	Staging Site Preparation	1	LS	$40,000	$40,000	
	Total					$1,543,700
	Underground Work					
	Jack and bore 60" casing, 42" carrier pipe	1,020	LF	$1,750	$1,785,000	
	Total					$1,785,000
	Concrete					
	50 ft Intake Caisson (Shaft)	1,370	CY	$850	$1,164,500	
	Lower Slab, 18"	24	CY	$850	$20,400	
	Main Slab, 12"	236	CY	$750	$177,000	
	Pump Shaft, 24"	1,892	CY	$850	$1,608,200	
	Lower Slab, 18"	48	CY	$1,000	$48,000	
	12" Concrete Walls, 18 ft tall	199	CY	$650	$129,350	
	12" x 18" Rectangular Column (8)	8	CY	$650	$5,200	
	Hoist Guideway (18" x 8" x 120') (2)	9	CY	$650	$5,850	
	Concrete Restraining Block	44	CY	$450	$19,800	
	Total					$3,178,300
	Conveying					
	10 ton Hoist, 29 ft Span, 120 ft Track	1	EA	$450,000	$450,000	
	Total					$450,000
	Metals					
	Steel Trusses	25,440	LB	$3	$76,320	
	Miscellaneous Metals	1	LS	$50,000	$50,000	
	Chain-link Fence	2,400	LF	$5	$12,000	

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 4
Element: Site Work and Buildings

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Total					$138,320
	Thermal and Moisture					
	24 Ga Mr3-36 Versacor Roofing	7,000	SF	$8	$56,000	
	Total					$56,000
	Grand Total					**$7,151,320**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 4
Element: Plumbing, Fire

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Compressed Air System 15CFM @125psi	1	EA	$5,600	$5,600	
	Total					$5,600
	Mechanical					
	Fire Supression System	1	LS	$167,400	$167,400	
	Interior Plumbing System	1	LS	$40,000	$40,000	
	Total					$207,400
	Electrical					
	Fire Detection and Alarm System	1	EA	$17,640	$17,640	
	125 Ekw 1800Rpm,60Hz Stdby Gen Set	1	EA	$32,500	$32,500	
	Total					$50,140
	Grand Total					**$263,140**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 4
Element: Piping and Valves

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Mechanical					
	16" Steel Pipe	100	LF	$72	$7,200	
	16" X 30" Tees	4	EA	$2,500	$10,000	
	16" X 30" 90 Degree Bend	1	EA	$2,200	$2,200	
	16" Flex Coupling	5	EA	$3,500	$17,500	
	16" Check Valve	5	EA	$13,500	$67,500	
	30" Steel Pipe	100	EA	$125	$12,500	
	36" Steel Pipe (to Restraining Block)	200	LF	$360	$72,000	
	42" Steel Intake Pipe	45	LF	$160	$7,200	
	24" X 30" Tee	1	EA	$3,000	$3,000	
	30" Steel Pipe	100	EA	$125	$12,500	
	30" x 30" 90 Degrees Bend	1	EA	$2,200	$2,200	
	36" Butterfly Valve (outside building)	1	EA	$14,500	$14,500	
	Pipe Specials - (30" to 36")	1	EA	$700	$700	
	30" X 30" Tee	1	EA	$3,000	$3,000	
	30" Steel Pipe (to Surge Tank)	20	LF	$125	$2,500	
	Total					$234,500
	Grand Total					**$234,500**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 4
Element: Pumping Units

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	750 HP 10-Stage Vertical Turbine Pumps, 6.33 MGD @ 543 FT, 1,200 rpm	5	EA	$245,500	$1,227,500	
	Total					$1,227,500
	Grand Total					**$1,227,500**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 4
Element: Flow Meter

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	30" Magnetic Flow Meter	1	EA	$36,000	$36,000	
	Total					$36,000
	Grand Total					**$36,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 4
Element: Surge Tank

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Surge Tank and Appurtenances	1	EA	$197,000	$197,000	
	Air Valve	4	EA	$11,000	$44,000	
	Total					$241,000
	Grand Total					**$241,000**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 4
Element: Cofferdam

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Barge with Hydraulic Hammer	90	DAY	$2,500	$225,000	
	Total					$225,000
	Metal					
	Sheetpiles, 40'	550	LF	$2,850	$1,567,500	
	Total					$1,567,500
	Grand Total					**$1,792,500**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 4
Element: Electrical

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Electrical - off site					
	Construct Tap on 115kV line from Snake Creek Substation	1	LS	$55,000	$55,000	
	Construct 115-4.16kV, 3.75/5.25 MVA substation (3) 546/612 Amp Regulators, (1) ACR	1	LS	$610,000	$610,000	
	Total					$665,000
	Electrical - on site					
	Local Power Distribution	1	EA	$28,000	$28,000	
	Electric Wire to Pumps, 800 V Cu	550	LF	$40	$22,000	
	Miscellaneous Electrical Wire	15,000	LF	$5	$75,000	
	3" Aluminum Conduit	200	LF	$22	$4,400	
	VMX Series Soft Start VMX-1006-BP-E - 460VAC Variable Speed Drive, 800 hp, 800 V	5	EA	$14,200	$71,000	
	Control Panel	1	EA	$79,800	$79,800	
	Bare Copper Wire Stranded, Grounding System	200	EA	$5	$1,000	
	750 Kv, Three Phase, Oil Distribution Transformer	1	EA	$31,900	$31,900	
	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	24	EA	$662	$15,888	
	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	24	EA	$110	$2,640	
	Total					$331,628
	Grand Total					**$996,628**

PROJECT SUMMARY

Project: NAWS
Type: Missouri River Alternarive Component
Component: Biota WTP: Chlorination Option

NO.	DESCRIPTION			TOTAL
01	Site Work and Buildings			$9,395,479
02	Plumbing, Fire, Shop Equip			$666,533
03	Piping and Valves			$566,462
04	Pumping Units			$1,028,131
05	Chem Feed, Cl2 Scrub, Tank			$432,768
06	Flow Meter			$72,912
07	3Ph Bus, PanelBoards			$1,229,400
08	Lights, Trans, PLC, Conduit			$331,027
09	Switchgear, Trans, HVAC			$1,659,336
10	Solar Walls, Dewatering			$804,472
		TOTAL DIRECT COST		**$16,186,520**
	Additional Unlisted Items		5.0%	$809,326
		Subtotal		**$16,995,846**
	Mobilization		5.0%	$849,792
		Subtotal		**$17,845,638**
	Unlisted Items		5.0%	$892,282
		Subtotal		**$18,737,920**
	Contingencies		21.0%	$3,934,963
		Subtotal		**$22,672,884**
	Noncontract Costs		25.0%	$5,668,221
		Subtotal		**$28,341,105**
	TOTAL ESTIMATED CONSTRUCTION COST			**$28,341,105**

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DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternarive Component
Component: Biota WTP: Chlorination Option
Element: 01 Site Work and Buildings

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Topsoil Strip & Stockpile Over 500 Cy	9481.48	CY	$7.01	$66,495	
02300	Cat 235 Trackhoe 2.75Cy Bucket, Class B (Medium Digging), 0-20' D	60681.48	CY	$1.82	$110,434	
02300	Native Pipe Bed & Zone/Confined Structure Backfill, Class A Material	45511.11	CY	$24.57	$1,118,263	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	4500	CY	$59.57	$268,070	
02300	Controlled Density Fill (Cdf)	3792.59	CY	$90.00	$341,333	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	160	CY	$59.57	$9,531	
02742	3" Ac Overlay W/Tack Coat	112000	SF	$1.67	$186,547	
02742	3" Ac Paving On 6" Abc	112000	SF	$2.66	$297,427	
02820	8' H Double Swing Gate, Chain Link, 20' Opening	1	EA	$3,250.00	$3,250	
02820	Galv. Chain Link Fence, 8' W/Barbed Wire, No Gates	1890	LF	$48.50	$91,665	
02900	Hydroseeding	63000	SF	$.06	$3,919	
	Total					**$2,496,934**
	Division 03 - Concrete					
03300	12" X 24" Straight Continuous Footing	111.11	CY	$482.40	$53,600	
03300	18" Straight Wall >8' High	1666.67	CY	$649.29	$1,082,152	
03300	12" Elevated Slab, 21'-26' High	2411.11	CY	$461.93	$1,113,763	
03300	24" X 24" Square Column/Pier	115.49	CY	$776.35	$89,661	
03300	18" Straight Wall >8' High	1666.67	CY	$649.29	$1,082,152	
03300	18" Structural Flat Mat On Grade	1208.33	CY	$338.27	$408,739	
03300	18" Edge Forms, Slab On Grade, Add	1040	LF	$23.39	$24,329	
03300	18" Structural Flat Mat On Grade	3616.67	CY	$338.27	$1,223,403	
03300	24" X 24" Square Column/Pier	592.59	CY	$776.35	$460,060	
	Total					**$5,537,859**
	Division 04 - Masonry					
04220	Standard Concrete Block, 12"	6645.82	SF	$17.87	$118,732	
04220	Standard Concrete Block, 8"	5074.99	SF	$15.76	$79,996	
	Total					**$198,727**
	Division 05 - Metals					
05126	Steel Trusses	269457.59	LB	$2.62	$704,793	
	Total					**$704,793**
	Division 07 - Thermal and Moisture					
07200	3" R-23.07 Polyurethane Board Insulation	43500	SF	$6.13	$266,655	
07400	24 Ga Mr3-36 Versacor Roofing	21750	SF	$8.58	$186,691	
	Total					**$453,346**
	Division 15 - Mechanical					
15279	Corrugate Metal Pipe AASHTO M036	100	LF	$38.19	$3,819	
	Total					**$3,819**
	Grand Total					**$9,395,479**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternarive Component
Component: Biota WTP: Chlorination Option
Element: 02 Plumbing, Fire, Shop Equip

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02240	10Hp Submersible Pump, 3" Elect.	120	DAY	$139.00	$16,680	
	Total					**$16,680**
	Division 11 - Equipment					
11000	Workshop/Machine Shop Equip.	1	LS	$49,392.00	$49,392	
11000	Compressed Air System 10CFM @125psi	1	EA	$4,468.80	$4,469	
11000	Propane Storage Tank + Appurt.	1	EA	$13,524.00	$13,524	
	Total					**$67,385**
	Division 14 - Conveying Systems					
14624	1 Ton Lug Mounted 20' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$13,186.78	$13,187	
14624	1 Ton Lug Mounted 31' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$14,386.78	$14,387	
	Total					**$27,574**
	Division 15 - Mechanical					
15000	Gravity Floor Drainage System	0.6	LS	$99,960.00	$59,976	
15000	Fire Suppression System	0.6	LS	$552,720.00	$331,632	
15000	Interior Plumbing System	1	LS	$82,320.00	$82,320	
15112	36" 150# Fxf Awwa Butterfly Valve, No Op	3	EA	$14,714.61	$44,144	
	Total					**$518,072**
	Division 16 - Electrical					
16232	125 Ekw 1800Rpm,60Hz Turbocharged Stdby Gen Set	1	EA	$36,823.19	$36,823	
	Total					**$36,823**
	Grand Total					**$666,533**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternarive Component
Component: Biota WTP: Chlorination Option
Element: 03 Piping and Valves

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 15 - Mechanical					
15114	16"- 125# Di Fxf Swing Check Valve	2	EA	$23,168.87	$46,338	
15114	20" - 125# Di Fxf Swing Check Valve	3	EA	$30,316.00	$90,948	
15119	Air/Vac Valve, 300# Flange, 4"	5	EA	$2,483.91	$12,420	
15252	36" C200 3/8" Wall Wld Cs Pipe In Open Trench	450	LF	$331.97	$149,387	
15252	30" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	20	LF	$347.90	$6,958	
15252	36" 3/8" (Std) Wall A-234 Buttweld Straight Tee	10	EA	$22,265.73	$222,657	
15252	36" X 30" 3/8" (Std) Wall A-234 Buttwld Con Rdcr	2	EA	$9,818.34	$19,637	
15252	36" 3/8" Wall 90° Lr Buttweld Ell	2	EA	$9,058.94	$18,118	
	Total					**$566,462**
	Grand Total					**$566,462**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternarive Component
Component: Biota WTP: Chlorination Option
Element: 04 Pumping Units

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Drain Forwarding Pumping Units	2	EA	$52,978.80	$105,958	
11312	175Hp Vertical Turbine Pump	3	EA	$204,640.96	$613,923	
11312	100Hp Vertical Turbine Pump	2	EA	$154,125.30	$308,251	
	Total					**$1,028,131**
	Grand Total					**$1,028,131**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternarive Component
Component: Biota WTP: Chlorination Option
Element: 05 Chem Feed, Cl2 Scrub, Tank

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Chlorine Feed System	1	EA	$105,840.00	$105,840	
11000	Chlorine Scrubber	1	EA	$211,680.00	$211,680	
11000	Aqueous Ammonia Feed System	1	EA	$35,280.00	$35,280	
11000	Aqueous Ammonia Storage Tank	1	EA	$79,968.00	$79,968	
	Total					**$432,768**
	Grand Total					**$432,768**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternarive Component
Component: Biota WTP: Chlorination Option
Element: 06 Flow Meter

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Magnetic Flow Meter	2	EA	$36,456.00	$72,912	
	Total					**$72,912**
	Grand Total					**$72,912**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternarive Component
Component: Biota WTP: Chlorination Option
Element: 07 3Ph Bus, PanelBoards

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 16 - Electrical					
16000	600V 600A indoor motor contol center with four sections	1	EA	$94,080.00	$94,080	
16444	1200 Amp Distribution Section	3	EA	$6,089.30	$18,268	
16446	Nema 1 480V Mn Lug 3 Phs Panelbrds/Loadctrs Gp, 100Amp, 3Ph 18 Circ. 480V	4	EA	$2,214.85	$8,859	
16452	1200 Amp Cu 3P/3W 600V Wthrproof Feeder Bus Duct 12-20' Ht	1000	LF	$1,091.19	$1,091,193	
16491	100 Ampere Automatic Transfer Switch Type Astbm, 12X Space Factor	1	EA	$17,000.00	$17,000	
	Total					**$1,229,400**
	Grand Total					**$1,229,400**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternarive Component
Component: Biota WTP: Chlorination Option
Element: 08 Lights, Trans, PLC, Conduit

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 16 - Electrical					
16000	12-fiber fiber optic cable	2000	LF	$16.46	$32,928	
16000	Ex 37 22 PLC	1	EA	$12,348.00	$12,348	
16000	Modicon TWD LCA 10 DRF Twido PLC	2	EA	$411.60	$823	
16000	Configuration and programming of PLC	20	EA	$700.00	$14,000	
16000	Fire Detection and Alarm System	1	EA	$17,640.00	$17,640	
16060	#4/0 B.C. Bare Copper Wire Stranded, Grounding System	950	LF	$5.65	$5,368	
16123	12 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	6460	LF	$7.37	$47,621	
16123	7 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	1520	LF	$4.20	$6,386	
16123	2 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	3040	LF	$1.67	$5,066	
16123	4 4/0 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	114	LF	$85.51	$9,749	
16123	4 350Mcm 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	380	LF	$116.87	$44,412	
16123	2 Shielded Pairs 16 Ga Instrument Cable & Multi-Conductor Cable, In Cable Tray	1520	LF	$1.11	$1,693	
16130	3" Rigid Aluminum Conduit, In A Process Area To 20' Ht	114	LF	$24.89	$2,838	
16130	2" Rigid Aluminum Conduit, In A Process Area To 20' Ht	1520	LF	$15.51	$23,571	
16130	1" Rigid Aluminum Conduit, In A Process Area To 20' Ht	2280	LF	$9.25	$21,086	
16130	1.5" Grs Conduit, In A Bldg With Unlimited Ht	760	LF	$12.14	$9,223	
16130	.75" Grs Conduit, In A Bldg With Unlimited Ht	760	LF	$8.85	$6,730	
16272	750 Kva Three Phase 4160 Delta Primary Dry Type Distribution Transformer	1	EA	$16,042.44	$16,042	
16446	Nema 1 240V Mn Brkr 1 Phs Panelbrds/Loadctrs Gp, 225Amp, 1Ph 24 Circ. 120V	3	EA	$3,213.53	$9,641	
16500	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	50	EA	$752.33	$37,616	
16500	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	50	EA	$124.89	$6,244	
	Total					**$331,027**
	Grand Total					**$331,027**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternarive Component
Component: Biota WTP: Chlorination Option
Element: 09 Switchgear, Trans, HVAC

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	HVAC System	0.4	LS	$1,552,320.00	$620,928	
	Total					**$620,928**
	Division 16 - Electrical					
16000	Metal Clad Switchgear	2	EA	$188,160.00	$376,320	
16000	Outdoor Nonsegregated phase bus 1200 amper	100	LF	$1,293.60	$129,360	
16000	Metal Clad Switchgear2	1	EA	$158,760.00	$158,760	
16000	Outdoor Nonsegregated-phase bus 480V,1200 Amp	100	EA	$917.28	$91,728	
16000	Add 7.5 MVA to three-phase 115 delta/4.16-KV Grd-Y	1	LS	$282,240.00	$282,240	
	Total					**$1,038,408**
	Grand Total					**$1,659,336**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternarive Component
Component: Biota WTP: Chlorination Option
Element: 10 Solar Walls, Dewatering

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02000	Dewatering	0.6	LS	$1,046,640	$627,984	
	Total					**$627,984**
	Division 10 - Specialties					
10000	Solar Walls	0.6	LS	$294,147.00	$176,488	
	Total					**$176,488**
	Grand Total					**$804,472**

PROJECT SUMMARY

Project: NAWS
Type: Missouri River Alternative Component
Component: Boita WTP: Chlorination/UV Inactivation

NO.	DESCRIPTION			TOTAL
01	Site Work and Buildings			$7,278,039
02	Plumbing, Fire, Shop Equip			$984,276
03	Piping and Valves			$705,185
04	Pumping Units			$917,470
05	Chem Feed, Cl2 Scrub, Tank			$432,768
06	Flow Meter, UV			$2,054,636
07	3Ph Bus, DisPa			$1,100,469
08	Lights, Trans, PLC, Conduit			$337,439
09	Switchgear, Trans, HVAC			$2,280,264
10	Solar Walls, Dewatering			$932,900
		TOTAL DIRECT COST		**$17,023,447**
	Additional Unlisted Items		5.0%	$851,172
		Subtotal		**$17,874,619**
	Mobilization		5.0%	$893,731
		Subtotal		**$18,768,350**
	Unlisted Items		5.0%	$938,418
		Subtotal		**$19,706,768**
	Contingencies		21.0%	$4,138,421
		Subtotal		**$23,845,189**
	Noncontract Costs		25.0%	$5,961,297
		Subtotal		**$29,806,486**
	TOTAL ESTIMATED CONSTRUCTION COST			**$29,806,486**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Boita WTP: Chlorination/UV Inactivation
Element: 01 Site Work and Buildings

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Topsoil Strip & Stockpile Over 500 Cy	7111.11	CY	$6.17	$43,886	
02300	Cat 235 Trackhoe 2.75Cy Bucket, Class B (Medium Digging), 0-20' D	42666.67	CY	$1.60	$68,331	
02300	Native Pipe Bed & Zone/Confined Structure Backfill, Class A Material	28444.44	CY	$21.62	$615,044	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	4600	CY	$52.42	$241,144	
02300	Controlled Density Fill (Cdf)	2844.44	CY	$79.20	$225,280	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	160	CY	$52.42	$8,388	
02742	3" Ac Overlay W/Tack Coat	110000	SF	$1.47	$161,230	
02742	3" Ac Paving On 6" Abc	110000	SF	$2.34	$257,062	
02820	8' H Double Swing Gate, Chain Link, 20' Opening	1	EA	$2,860.00	$2,860	
02820	Galv. Chain Link Fence, 8' W/Barbed Wire, No Gates	1890	LF	$42.68	$80,665	
02900	Hydroseeding	63000	SF	$.05	$3,448	
	Total					**$1,707,339**
	Division 03 - Concrete					
03300	12" X 24" Straight Continuous Footing	87.11	CY	$424.51	$36,979	
03300	18" Straight Wall >8' High	435.56	CY	$571.38	$248,868	
03300	12" Elevated Slab, 21'-26' High	355.7	CY	$406.50	$144,591	
03300	24" X 24" Square Column/Pier	118.94	CY	$683.19	$81,259	
03300	18" Straight Wall >8' High	1666.67	CY	$571.38	$952,294	
03300	12" Elevated Slab, 21'-26' High	555.56	CY	$406.50	$225,834	
03300	18" Straight Wall >8' High	1666.67	CY	$571.38	$952,294	
03300	18" Structural Flat Mat On Grade	1244.44	CY	$297.68	$370,440	
03300	18" Edge Forms, Slab On Grade, Add	800	LF	$20.59	$16,469	
03300	18" Structural Flat Mat On Grade	533.56	CY	$297.68	$158,828	
03300	18" Edge Forms, Slab On Grade, Add	1200	LF	$20.59	$24,704	
03300	18" Structural Flat Mat On Grade	833.33	CY	$297.68	$248,062	
03300	12" X 24" Straight Continuous Footing	111.11	CY	$424.51	$47,168	
03300	18" Straight Wall >8' High	377.78	CY	$571.38	$215,854	
03300	18" Structural Flat Mat On Grade	333.33	CY	$297.68	$99,224	
03300	24" X 24" Square Column/Pier	31.86	CY	$683.19	$21,767	
03300	24" X 24" Square Column/Pier	296.3	CY	$683.19	$202,430	
	Total					**$4,047,064**
	Division 04 - Masonry					
04220	Standard Concrete Block, 12"	6844.42	SF	$15.72	$107,606	
04220	Standard Concrete Block, 8"	5226.65	SF	$13.87	$72,500	
04220	Standard Concrete Block, 12"	1833.32	SF	$15.72	$28,823	
04220	Standard Concrete Block, 8"	1399.99	SF	$13.87	$19,420	
	Total					**$228,348**
	Division 05 - Metals					
05126	Steel Trusses	277510.12	LB	$2.30	$638,753	
05126	Steel Trusses	74332.59	LB	$2.30	$171,093	
	Total					**$809,846**
	Division 07 - Thermal and Moisture					
07200	3" R-23.07 Polyurethane Board Insulation	44800	SF	$5.39	$241,669	
07200	3" R-23.07 Polyurethane Board Insulation	4800	SF	$5.39	$25,893	
07400	24 Ga Mr3-36 Versacor Roofing	22400	SF	$7.55	$169,198	
07400	24 Ga Mr3-36 Versacor Roofing	6000	SF	$7.55	$45,321	
	Total					**$482,081**
	Division 15 - Mechanical					
15279	Corrugate Metal Pipe AASHTO M036	100	LF	$33.61	$3,361	
	Total					**$3,361**
	Grand Total					**$7,278,039**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Boita WTP: Chlorination/UV Inactivation
Element: 02 Plumbing, Fire, Shop Equip

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02240	10Hp Submersible Pump, 3" Elect.	120	DAY	$122.32	$14,678	
	Total					**$14,678**
	Division 11 - Equipment					
11000	Workshop/Machine Shop Equip.	1	LS	$49,392.00	$49,392	
11000	Compressed Air System 10CFM @125psi	1	EA	$4,468.80	$4,469	
11000	Propane Storage Tank + Appurt.	1	EA	$13,524.00	$13,524	
	Total					**$67,385**
	Division 14 - Conveying Systems					
14624	1 Ton Lug Mounted 20' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$11,604.37	$11,604	
14624	1 Ton Lug Mounted 31' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$12,660.37	$12,660	
	Total					**$24,265**
	Division 15 - Mechanical					
15000	Gravity Floor Drainage System	1	LS	$99,960.00	$99,960	
15000	Fire Suppression System	1.2	LS	$552,720.00	$663,264	
15000	Interior Plumbing System	1	LS	$82,320.00	$82,320	
	Total					**$845,544**
	Division 16 - Electrical					
16232	125 Ekw 1800Rpm,60Hz Turbocharged Stdby Gen Set	1	EA	$32,404.41	$32,404	
	Total					**$32,404**
	Grand Total					**$984,276**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Boita WTP: Chlorination/UV Inactivation
Element: 03 Piping and Valves

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 15 - Mechanical					
15112	48" 150# Fxf Awwa Butterfly Valve, No Op	1	EA	$15,714.92	$15,715	
15112	36" 150# Fxf Awwa Butterfly Valve, No Op	5	EA	$14,714.61	$73,573	
15114	16"- 125# Di Fxf Swing Check Valve	2	EA	$20,388.61	$40,777	
15114	20" - 125# Di Fxf Swing Check Valve	3	EA	$26,678.08	$80,034	
15119	Air/Vac Valve, 300# Flange, 4"	5	EA	$2,185.84	$10,929	
15252	36" C200 3/8" Wall Wld Cs Pipe In Open Trench	450	LF	$292.13	$131,461	
15252	48" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	150	LF	$676.45	$101,467	
15252	30" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	20	LF	$306.15	$6,123	
15252	36" 3/8" (Std) Wall A-234 Buttweld Straight Tee	10	EA	$19,593.84	$195,938	
15252	36" X 30" 3/8" (Std) Wall A-234 Buttwld Con Rdcr	2	EA	$8,640.14	$17,280	
15252	36" 3/8" Wall 90° Lr Buttweld Ell	4	EA	$7,971.87	$31,887	
	Total					**$705,185**
	Grand Total					**$705,185**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Boita WTP: Chlorination/UV Inactivation
Element: 04 Pumping Units

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Drain Forwarding Pumping Units	2	EA	$52,978.80	$105,958	
11312	175Hp Vertical Turbine Pump	3	EA	$180,084.04	$540,252	
11312	100Hp Vertical Turbine Pump	2	EA	$135,630.26	$271,261	
	Total					**$917,470**
	Grand Total					**$917,470**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Boita WTP: Chlorination/UV Inactivation
Element: 05 Chem Feed, Cl2 Scrub, Tank

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Chlorine Feed System	1	EA	$105,840.00	$105,840	
11000	Chlorine Scrubber	1	EA	$211,680.00	$211,680	
11000	Aqueous Ammonia Feed System	1	EA	$35,280.00	$35,280	
11000	Aqueous Ammonia Storage Tank	1	EA	$79,968.00	$79,968	
	Total					**$432,768**
	Grand Total					**$432,768**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Boita WTP: Chlorination/UV Inactivation
Element: 06 Flow Meter, UV

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Magnetic Flow Meter	6	EA	$36,456.00	$218,736	
11000	UV Reactors	1	LS	$1,835,899.99	$1,835,900	
	Total					**$2,054,636**
	Grand Total					**$2,054,636**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Boita WTP: Chlorination/UV Inactivation
Element: 07 3Ph Bus, DisPa

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 16 - Electrical					
16000	600V 600A indoor motor contol center with four sections	1	EA	$94,080.00	$94,080	
16444	1200 Amp Distribution Section	4	EA	$5,358.58	$21,434	
16446	Nema 1 480V Mn Lug 3 Phs Panelbrds/Loadctrs Gp, 100Amp, 3Ph 18 Circ. 480V	5	EA	$1,949.07	$9,745	
16452	1200 Amp Cu 3P/3W 600V Wthrproof Feeder Bus Duct 12-20' Ht	1000	LF	$960.25	$960,249	
16491	100 Ampere Automatic Transfer Switch Type Astbm, 12X Space Factor	1	EA	$14,960.00	$14,960	
	Total					**$1,100,469**
	Grand Total					**$1,100,469**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Boita WTP: Chlorination/UV Inactivation
Element: 08 Lights, Trans, PLC, Conduit

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 16 - Electrical					
16000	12-fiber fiber optic cable	1500	LF	$16.46	$24,696	
16000	Ex 37 22 PLC	1	EA	$12,348.00	$12,348	
16000	Modicon TWD LCA 10 DRF Twido PLC	2	EA	$411.60	$823	
16000	Configuration and programming of PLC	20	EA	$700.00	$14,000	
16000	Fire Detection and Alarm System	1	EA	$17,640.00	$17,640	
16060	#4/0 B.C. Bare Copper Wire Stranded, Grounding System	1200	LF	$4.97	$5,967	
16123	12 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	8000	LF	$6.49	$51,896	
16123	7 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	200	LF	$3.70	$739	
16123	2 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	3500	LF	$1.47	$5,133	
16123	4 4/0 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	200	LF	$75.25	$15,051	
16123	4 350Mcm 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	500	LF	$102.85	$51,425	
16123	2 Shielded Pairs 16 Ga Instrument Cable & Multi-Conductor Cable, In Cable Tray	2000	LF	$.98	$1,961	
16130	3" Rigid Aluminum Conduit, In A Process Area To 20' Ht	200	LF	$21.91	$4,381	
16130	2" Rigid Aluminum Conduit, In A Process Area To 20' Ht	2000	LF	$13.65	$27,293	
16130	1" Rigid Aluminum Conduit, In A Process Area To 20' Ht	3000	LF	$8.14	$24,416	
16130	1.5" Grs Conduit, In A Bldg With Unlimited Ht	1000	LF	$10.68	$10,680	
16130	.75" Grs Conduit, In A Bldg With Unlimited Ht	1000	LF	$7.79	$7,792	
16272	750 Kva Three Phase 4160 Delta Primary Dry Type Distribution Transformer	1	EA	$14,117.35	$14,117	
16446	Nema 1 240V Mn Brkr 1 Phs Panelbrds/Loadctrs Gp, 225Amp, 1Ph 24 Circ. 120V	3	EA	$2,827.90	$8,484	
16500	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	50	EA	$662.05	$33,102	
16500	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	50	EA	$109.90	$5,495	
	Total					**$337,439**
	Grand Total					**$337,439**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Boita WTP: Chlorination/UV Inactivation
Element: 09 Switchgear, Trans, HVAC

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	HVAC System	0.8	LS	$1,552,320.00	$1,241,856	
	Total					**$1,241,856**
	Division 16 - Electrical					
16000	Metal Clad Switchgear	2	EA	$188,160.00	$376,320	
16000	Outdoor Nonsegregated phase bus 1200 amper	100	LF	$1,293.60	$129,360	
16000	Metal Clad Switchgear2	1	EA	$158,760.00	$158,760	
16000	Outdoor Nonsegregated-phase bus 480V,1200 Amp	100	EA	$917.28	$91,728	
16000	Add 7.5 MVA to three-phase 115 delta/4.16-KV Grd-Y	1	LS	$282,240.00	$282,240	
	Total					**$1,038,408**
	Grand Total					**$2,280,264**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Boita WTP: Chlorination/UV Inactivation
Element: 10 Solar Walls, Dewatering

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02000	Dewatering	0.8	LS	$1,046,640.00	$837,312	
	Total					**$837,312**
	Division 10 - Specialties					
10000	Solar Walls	0.8	LS	$119,484.54	$95,588	
	Total					**$95,588**
	Grand Total					**$932,900**

PROJECT SUMMARY

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV

NO.	DESCRIPTION			TOTAL
01	Site Work and Buildings			$10,525,170
02	Plumbing, Fire, Shop Equip			$984,276
03	Piping and Valves			$1,468,003
04	Pumping Units			$1,717,470
05	Chem Feed, Cl2 Scrub, Tank			$432,768
06	Chem Tank, Flow, Cntrfuge			$1,366,512
07	Flow Meter, UV			$2,054,636
08	3Ph Bus, DisPa			$1,100,469
09	Lights, Trans, PLC, Conduit			$337,439
10	H&V, Sludge Bldg, IPS Waste			$83,496
11	Switchgear, Trans, HVAC			$2,280,264
12	Solar Walls, Dewatering			$932,900
13	Filtration			$3,999,481
	TOTAL DIRECT COST			**$27,282,886**
	Additional Unlisted Items		5.0%	$1,364,144
		Subtotal		**$28,647,030**
	Mobilization		5.0%	$1,432,351
		Subtotal		**$30,079,381**
	Unlisted Items		5.0%	$1,503,969
		Subtotal		**$31,583,350**
	Contingencies		21.0%	$6,632,504
		Subtotal		**$38,215,854**
	Noncontract Costs		25.0%	$9,553,964
		Subtotal		**$47,769,818**
	TOTAL ESTIMATED CONSTRUCTION COST			**$47,769,818**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 01 Site Work and Buildings

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02260	10"Soldier Piles W/Wood Lagging, To 25' Deep, Incl Removal	12,900.00	SF	$36.17	$466,565	
02300	Topsoil Strip & Stockpile Over 500 Cy	7111.11	CY	$6.17	$43,886	
02300	Cat 235 Trackhoe 2.75Cy Bucket, Class B (Medium Digging), 0-20' D	42666.67	CY	$1.60	$68,331	
02300	Native Pipe Bed & Zone/Confined Structure Backfill, Class A Material	28444.44	CY	$21.62	$615,044	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	4600	CY	$52.42	$241,144	
02300	Controlled Density Fill (Cdf)	2844.44	CY	$79.20	$225,280	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	160	CY	$52.42	$8,388	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	4,714.00	CY	$58.89	$277,607	
02300	Cat 225 Trackhoe, 2Cy Bucket, Class B (Medium Digging), 0-16' D	12,634.07	CY	$2.11	$26,680	
02742	3" Ac Overlay W/Tack Coat	110000	SF	$1.47	$161,230	
02742	3" Ac Paving On 6" Abc	110000	SF	$2.34	$257,062	
02820	8' H Double Swing Gate, Chain Link, 20' Opening	1	EA	$2,860.00	$2,860	
02820	Galv. Chain Link Fence, 8' W/Barbed Wire, No Gates	1890	LF	$42.68	$80,665	
02900	Hydroseeding	63000	SF	$.05	$3,448	
	Total					**$2,478,191**
	Division 03 - Concrete					
03300	12" X 24" Straight Continuous Footing	87.11	CY	$424.51	$36,979	
03300	18" Straight Wall >8' High	435.56	CY	$571.38	$248,868	
03300	12" Elevated Slab, 21'-26' High	355.7	CY	$406.50	$144,591	
03300	24" X 24" Square Column/Pier	118.94	CY	$683.19	$81,259	
03300	18" Straight Wall >8' High	1666.67	CY	$571.38	$952,294	
03300	12" Elevated Slab, 21'-26' High	555.56	CY	$406.50	$225,834	
03300	18" Straight Wall >8' High	1666.67	CY	$571.38	$952,294	
03300	18" Structural Flat Mat On Grade	1244.44	CY	$297.68	$370,440	
03300	18" Edge Forms, Slab On Grade, Add	800	LF	$20.59	$16,469	
03300	18" Structural Flat Mat On Grade	533.56	CY	$297.68	$158,828	
03300	18" Edge Forms, Slab On Grade, Add	1200	LF	$20.59	$24,704	
03300	18" Structural Flat Mat On Grade	833.33	CY	$297.68	$248,062	
03300	12" X 24" Straight Continuous Footing	111.11	CY	$424.51	$47,168	
03300	18" Straight Wall >8' High	377.78	CY	$571.38	$215,854	
03300	18" Structural Flat Mat On Grade	333.33	CY	$297.68	$99,224	
03300	24" X 24" Square Column/Pier	31.86	CY	$683.19	$21,767	
03300	24" X 24" Square Column/Pier	296.3	CY	$683.19	$202,430	
03300	12" Edge Forms, Slab On Grade, Add	160	LF	$12.19	$1,950	
03300	12" Structural Flat Mat On Grade	59.26	CY	$295.64	$17,520	
03300	18" Curved Wall, 16'-30' Dia, >8' High	39.27	CY	$775.61	$30,458	
03300	12" Elevated Slab To 20'	26.18	CY	$355.41	$9,305	
03300	12" X 30" Curved Cont Footing, (20'-50')	26.18	CY	$723.04	$18,929	
03300	18" Edge Forms, Slab On Grade, Add	94.2	LF	$20.59	$1,939	
03300	18" Structural Flat Mat On Grade	39.27	CY	$297.68	$11,690	
03300	30" Edge Forms, Slab On Grade, Add	94.2	LF	$31.19	$2,938	
03300	18" Edge Forms, Slab On Grade, Add	280	LF	$20.59	$5,764	
03300	18" Structural Flat Mat On Grade	272.22	CY	$297.68	$81,033	
03300	18" Edge Forms, Slab On Grade, Add	260.00	LF	$20.59	$5,352	
03300	18" Structural Flat Mat On Grade	233.33	CY	$297.68	$69,457	
03300	18" Straight Wall >8' High	938.89	CY	$571.38	$536,458	
03300	18" Edge Forms, Slab On Grade, Add	476.00	LF	$20.59	$9,799	
03300	18" Structural Flat Mat On Grade	786.67	CY	$297.68	$234,173	
03300	18" Straight Wall >8' High	739.56	CY	$571.38	$422,566	
03300	24" X 24" Square Column/Pier	1.87	CY	$683.19	$1,278	

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 01 Site Work and Buildings

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
03300	12"T X 36"W Straight Continuous Footing	52.89	CY	$343.13	$18,148	
	Total					**$5,525,820**
	Division 04 - Masonry					
04220	Standard Concrete Block, 12"	6844.42	SF	$15.72	$107,606	
04220	Standard Concrete Block, 8"	5226.65	SF	$13.87	$72,500	
04220	Standard Concrete Block, 12"	1833.32	SF	$15.72	$28,823	
04220	Standard Concrete Block, 8"	1399.99	SF	$13.87	$19,420	
	Total					**$228,348**
	Division 05 - Metals					
05000	Pre-Engineered Metal Building	1	EA	$160,000.00	$160,000	
05000	Pre-Engineered Metal Building	1	EA	$160,000.00	$160,000	
05126	Steel Trusses	277510.12	LB	$2.30	$638,753	
05126	Steel Trusses	74332.59	LB	$2.30	$171,093	
05126	Steel Trusses	175,426.04	LB	$2.30	$403,783	
	Total					**$1,533,629**
	Division 07 - Thermal and Moisture					
07200	3" R-23.07 Polyurethane Board Insulation	44800	SF	$5.39	$241,669	
07200	3" R-23.07 Polyurethane Board Insulation	4800	SF	$5.39	$25,893	
07200	3" R-23.07 Polyurethane Board Insulation	28,320.00	SF	$5.39	$152,769	
07400	24 Ga Mr3-36 Versacor Roofing	22400	SF	$7.55	$169,198	
07400	24 Ga Mr3-36 Versacor Roofing	6000	SF	$7.55	$45,321	
07400	24 Ga Mr3-36 Versacor Siding	14,160.00	SF	$8.54	$120,971	
	Total					**$755,821**
	Division 15 - Mechanical					
15279	Corrugate Metal Pipe AASHTO M036	100	LF	$33.61	$3,361	
	Total					**$3,361**
	Grand Total					**$10,525,170**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 02 Plumbing, Fire, Shop Equip

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02240	10Hp Submersible Pump, 3" Elect.	120	DAY	$122.32	$14,678	
	Total					**$14,678**
	Division 11 - Equipment					
11000	Workshop/Machine Shop Equip.	1	LS	$49,392.00	$49,392	
11000	Compressed Air System 10CFM @125psi	1	EA	$4,468.80	$4,469	
11000	Propane Storage Tank + Appurt.	1	EA	$13,524.00	$13,524	
	Total					**$67,385**
	Division 14 - Conveying Systems					
14624	1 Ton Lug Mounted 20' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$11,604.37	$11,604	
14624	1 Ton Lug Mounted 31' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$12,660.37	$12,660	
	Total					**$24,265**
	Division 15 - Mechanical					
15000	Gravity Floor Drainage System	1	LS	$99,960.00	$99,960	
15000	Fire Suppression System	1.2	LS	$552,720.00	$663,264	
15000	Interior Plumbing System	1	LS	$82,320.00	$82,320	
	Total					**$845,544**
	Division 16 - Electrical					
16232	125 Ekw 1800Rpm,60Hz Turbocharged Stdby Gen Set	1	EA	$32,404.41	$32,404	
	Total					**$32,404**
	Grand Total					**$984,276**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 03 Piping and Valves

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 03 - Concrete					
03300	36" filtration pipe encasement	130.37	CY	$466.99	$60,881	
03300	24" filtration pipe encasement	13.33	CY	$515.44	$6,871	
	Total					**$67,752**
	Division 15 - Mechanical					
15112	48" 150# Fxf Awwa Butterfly Valve, No Op	1	EA	$15,714.92	$15,715	
15112	36" 150# Fxf Awwa Butterfly Valve, No Op	5	EA	$14,714.61	$73,573	
15112	36" 150# Fxf Awwa Butterfly Valve, No Op	3.00	EA	$14,714.61	$44,144	
15112	24" 150# Fxf Awwa Butterfly Valve, No Op	8.00	EA	$5,578.89	$44,631	
15114	16"- 125# Di Fxf Swing Check Valve	2	EA	$20,388.61	$40,777	
15114	20" - 125# Di Fxf Swing Check Valve	3	EA	$26,678.08	$80,034	
15114	16"- 125# Di Fxf Swing Check Valve	4.00	EA	$20,388.61	$81,554	
15119	Air/Vac Valve, 300# Flange, 4"	5	EA	$2,185.84	$10,929	
15251	36" 125# Cast Iron Blind Flange	4.00	EA	$4,633.11	$18,532	
15251	30" 125# Cast Iron Blind Flange	2.00	EA	$2,502.06	$5,004	
15251	16" 125# Cast Iron Blind Flange	2.00	EA	$1,423.44	$2,847	
15252	36" C200 3/8" Wall Wld Cs Pipe In Open Trench	220.00	LF	$292.13	$64,270	
15252	24" C200 3/8" Wall Wld Cs Pipe In Open Trench	40.00	LF	$208.40	$8,336	
15252	16" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	310.00	LF	$160.43	$49,734	
15252	30" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	170.00	LF	$306.15	$52,046	
15252	24"A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	40.00	LF	$246.04	$9,842	
15252	36" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	100.00	LF	$401.15	$40,115	
15252	36" 3/8" Wall 90° Lr Buttweld Ell	6.00	EA	$7,971.87	$47,831	
15252	36" 3/8" (Std) Wall A-234 Buttweld Straight Tee	5.00	EA	$19,593.84	$97,969	
15252	24" 3/8" (Std) Wall A-234 Buttweld Straight Tee	11.00	EA	$8,777.75	$96,555	
15252	24" 3/8" (Std) Wall 90° Lr Buttweld Ell	8.00	EA	$3,956.97	$31,656	
15252	36" C200 3/8" Wall Wld Cs Pipe In Open Trench	450	LF	$292.13	$131,461	
15252	48" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	150	LF	$676.45	$101,467	
15252	30" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	20	LF	$306.15	$6,123	
15252	36" 3/8" (Std) Wall A-234 Buttweld Straight Tee	10	EA	$19,593.84	$195,938	
15252	36" X 30" 3/8" (Std) Wall A-234 Buttwld Con Rdcr	2	EA	$8,640.14	$17,280	
15252	36" 3/8" Wall 90° Lr Buttweld Ell	4	EA	$7,971.87	$31,887	
	Total					**$1,400,252**
	Grand Total					**$1,468,003**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 04 Pumping Units

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Drain Forwarding Pumping Units	2	EA	$52,978.80	$105,958	
11000	Filter Pump	4	EA	$200,000.00	$800,000	
11312	175Hp Vertical Turbine Pump	3	EA	$180,084.04	$540,252	
11312	100Hp Vertical Turbine Pump	2	EA	$135,630.26	$271,261	
	Total					**$1,717,470**
	Grand Total					**$1,717,470**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 05 Chem Feed, Cl2 Scrub, Tank

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Chlorine Feed System	1	EA	$105,840.00	$105,840	
11000	Chlorine Scrubber	1	EA	$211,680.00	$211,680	
11000	Aqueous Ammonia Feed System	1	EA	$35,280.00	$35,280	
11000	Aqueous Ammonia Storage Tank	1	EA	$79,968.00	$79,968	
	Total					**$432,768**
	Grand Total					**$432,768**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 06 Chem Tank, Flow, Cntrfuge

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Magnetic Flow Meter	2	EA	$36,456.00	$72,912	
11000	Flow Meter DN 400/16	1	EA	$22,344.00	$22,344	
11000	Magnetic Flow Meter DN 150/6	1	EA	$17,640.00	$17,640	
11000	Centrifuge	2	EA	$626,808.00	$1,253,616	
	Total					**$1,366,512**
	Grand Total					**$1,366,512**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 07 Flow Meter, UV

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Magnetic Flow Meter	6	EA	$36,456.00	$218,736	
11000	UV Reactors	1	LS	$1,835,899.99	$1,835,900	
	Total					**$2,054,636**
	Grand Total					**$2,054,636**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 08 3Ph Bus, DisPa

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 16 - Electrical					
16000	600V 600A indoor motor contol center with four sections	1	EA	$94,080.00	$94,080	
16444	1200 Amp Distribution Section	4	EA	$5,358.58	$21,434	
16446	Nema 1 480V Mn Lug 3 Phs Panelbrds/Loadctrs Gp, 100Amp, 3Ph 18 Circ. 480V	5	EA	$1,949.07	$9,745	
16452	1200 Amp Cu 3P/3W 600V Wthrproof Feeder Bus Duct 12-20' Ht	1000	LF	$960.25	$960,249	
16491	100 Ampere Automatic Transfer Switch Type Astbm, 12X Space Factor	1	EA	$14,960.00	$14,960	
	Total					**$1,100,469**
	Grand Total					**$1,100,469**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 09 Lights, Trans, PLC, Conduit

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 16 - Electrical					
16000	12-fiber fiber optic cable	1500	LF	$16.46	$24,696	
16000	Ex 37 22 PLC	1	EA	$12,348.00	$12,348	
16000	Modicon TWD LCA 10 DRF Twido PLC	2	EA	$411.60	$823	
16000	Configuration and programming of PLC	20	EA	$700.00	$14,000	
16000	Fire Detection and Alarm System	1	EA	$17,640.00	$17,640	
16060	#4/0 B.C. Bare Copper Wire Stranded, Grounding System	1200	LF	$4.97	$5,967	
16123	12 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	8000	LF	$6.49	$51,896	
16123	7 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	200	LF	$3.70	$739	
16123	2 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	3500	LF	$1.47	$5,133	
16123	4 4/0 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	200	LF	$75.25	$15,051	
16123	4 350Mcm 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	500	LF	$102.85	$51,425	
16123	2 Shielded Pairs 16 Ga Instrument Cable & Multi-Conductor Cable, In Cable Tray	2000	LF	$.98	$1,961	
16130	3" Rigid Aluminum Conduit, In A Process Area To 20' Ht	200	LF	$21.91	$4,381	
16130	2" Rigid Aluminum Conduit, In A Process Area To 20' Ht	2000	LF	$13.65	$27,293	
16130	1" Rigid Aluminum Conduit, In A Process Area To 20' Ht	3000	LF	$8.14	$24,416	
16130	1.5" Grs Conduit, In A Bldg With Unlimited Ht	1000	LF	$10.68	$10,680	
16130	.75" Grs Conduit, In A Bldg With Unlimited Ht	1000	LF	$7.79	$7,792	
16272	750 Kva Three Phase 4160 Delta Primary Dry Type Distribution Transformer	1	EA	$14,117.35	$14,117	
16446	Nema 1 240V Mn Brkr 1 Phs Panelbrds/Loadctrs Gp, 225Amp, 1Ph 24 Circ. 120V	3	EA	$2,827.90	$8,484	
16500	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	50	EA	$662.05	$33,102	
16500	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	50	EA	$109.90	$5,495	
	Total					**$337,439**
	Grand Total					**$337,439**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 10 H&V, Sludge Bldg, IPS Waste

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	H&V System	1	LS	$83,496.00	$83,496	
	Total					**$83,496**
	Grand Total					**$83,496**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 11 Switchgear, Trans, HVAC

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	HVAC System	0.8	LS	$1,552,320.00	$1,241,856	
	Total					**$1,241,856**
	Division 16 - Electrical					
16000	Metal Clad Switchgear	2	EA	$188,160.00	$376,320	
16000	Outdoor Nonsegregated phase bus 1200 amper	100	LF	$1,293.60	$129,360	
16000	Metal Clad Switchgear2	1	EA	$158,760.00	$158,760	
16000	Outdoor Nonsegregated-phase bus 480V,1200 Amp	100	EA	$917.28	$91,728	
16000	Add 7.5 MVA to three-phase 115 delta/4.16-KV Grd-Y	1	LS	$282,240.00	$282,240	
	Total					**$1,038,408**
	Grand Total					**$2,280,264**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component Biota WTP: Enhanced Chlorination/UV
Element: 12 Solar Walls, Dewatering

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02000	Dewatering	0.8	LS	$1,046,640.00	$837,312	
	Total					**$837,312**
	Division 10 - Specialties					
10000	Solar Walls	0.8	LS	$119,484.54	$95,588	
	Total					**$95,588**
	Grand Total					**$932,900**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV
Element: 13 Filtration

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 03 - Concrete					
03300	Filter Supports	62.22	CY	$297.68	$18,521	
	Total					**$18,521**
	Division 11 - Equipment					
11000	Filtration Equipment	1	LS	$3,980,960.00	$3,980,960	
	Total					**$3,980,960**
	Grand Total					**$3,999,481**

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PROJECT SUMMARY

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment

NO.	DESCRIPTION			TOTAL
01	Site Work and Buildings			$12,376,093
02	Plumbing, Fire, Shop Equip			$2,351,010
03	Floor Drains, Hoist			$42,489
04	DAF, Plate Settlers, Filters			$7,585,318
05	Chem Feed, Cl2 Scrub, Tank			$2,401,392
06	Chem Tank, Flow, Cntrfuge			$1,502,928
07	PlateSettler, 3Ph Bus, DisPa			$2,569,842
08	Lights, Trans, PLC, Conduit			$546,305
09	Switchgear, Trans, HVAC			$2,778,888
10	H&V, Sludge Bldg, IPS Waste			$89,376
11	Solar Walls, Dewatering			$1,361,073
12	Booster Pump Station			$4,498,016
		TOTAL DIRECT COST		**$38,102,729**
	Additional Unlisted Items		5.0%	$1,905,136
		Subtotal		**$40,007,865**
	Mobilization		5.0%	$2,000,393
		Subtotal		**$42,008,258**
	Unlisted Items		5.0%	$2,100,413
		Subtotal		**$44,108,671**
	Contingencies		21.0%	$9,262,821
		Subtotal		**$53,371,492**
	Noncontract Costs		25.0%	$13,342,873
		Subtotal		**$66,714,365**
	TOTAL ESTIMATED CONSTRUCTION COST			**$66,714,365**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 01 Site Work and Buildings

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Topsoil Strip & Stockpile Over 500 Cy	13170	CY	$6.17	$81,279	
02300	Cat 235 Trackhoe 2.75Cy Bucket, Class B (Medium Digging), 0-20' D	125350	CY	$1.60	$200,750	
02300	Native Pipe Bed & Zone/Confined Structure Backfill, Class A Material	85500	CY	$21.62	$1,848,737	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	9775	CY	$52.42	$512,431	
02300	Controlled Density Fill (Cdf)	10680	CY	$79.20	$845,856	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	160	CY	$52.42	$8,388	
02742	3" Ac Overlay W/Tack Coat	98280	SF	$1.47	$144,052	
02742	3" Ac Paving On 6" Abc	98280	SF	$2.34	$229,673	
02742	6" Gravel Paving, In Place	62370	SF	$1.08	$67,081	
02820	8' H Double Swing Gate, Chain Link, 20' Opening	2	EA	$2,860.00	$5,720	
02820	Galv. Chain Link Fence, 8' W/Barbed Wire, No Gates	1890	LF	$42.68	$80,665	
02900	Hydroseeding	63000	SF	$.05	$3,448	
	Total					**$4,028,080**
	Division 03 - Concrete					
03300	12" Structural Flat Mat On Grade	115.41	CY	$295.64	$34,120	
03300	12" X 24" Straight Continuous Footing	87.11	CY	$424.51	$36,979	
03300	18" Straight Wall >8' High	435.56	CY	$571.38	$248,868	
03300	12" Elevated Slab, 21'-26' High	355.7	CY	$406.50	$144,591	
03300	24" X 24" Square Column/Pier	296.3	CY	$683.19	$202,430	
03300	18" Straight Wall >8' High	333.33	CY	$571.38	$190,456	
03300	12" Elevated Slab, 21'-26' High	555.56	CY	$406.50	$225,834	
03300	24" X 24" Square Column/Pier	296.3	CY	$683.19	$202,430	
03300	10" W X 18" D Conc Beam	27.78	CY	$1,166.66	$32,410	
03300	12" X 30" Curved Cont Footing, (20'-50')	39.82	CY	$723.04	$28,791	
03300	30" Edge Forms, Slab On Grade, Add	116	LF	$31.19	$3,618	
03300	18" Structural Flat Mat On Grade	361.11	CY	$297.68	$107,494	
03300	18" Straight Wall >8' High	361.11	CY	$571.38	$206,329	
03300	18" Edge Forms, Slab On Grade, Add	330.00	LF	$20.59	$6,794	
03300	18" Edge Forms, Slab On Grade, Add	170.00	LF	$20.59	$3,500	
03300	18" Structural Flat Mat On Grade	97.22	CY	$297.68	$28,940	
03300	18" Straight Wall >8' High	97.22	CY	$571.38	$55,549	
03300	18" Straight Wall >8' High	1666.67	CY	$571.38	$952,294	
03300	18" Structural Flat Mat On Grade	3125	CY	$297.68	$930,236	
03300	12" Elevated Slab To 20'	39.82	CY	$355.41	$14,152	
03300	18" Curved Wall, 16'-30' Dia, >8' High	79.65	CY	$775.61	$61,777	
03300	18" Structural Flat Mat On Grade	59.73	CY	$297.68	$17,780	
03300	18" Structural Flat Mat On Grade	277.78	CY	$297.68	$82,688	
03300	18" Edge Forms, Slab On Grade, Add	800	LF	$20.59	$16,469	
03300	18" Structural Flat Mat On Grade	533.56	CY	$297.68	$158,828	
03300	18" Edge Forms, Slab On Grade, Add	1200	LF	$20.59	$24,704	
03300	18" Structural Flat Mat On Grade	833.33	CY	$297.68	$248,062	
03300	12" X 24" Straight Continuous Footing	555.56	CY	$424.51	$235,843	
	Total					**$4,501,967**
	Division 04 - Masonry					
04220	Standard Concrete Block, 12"	21720	SF	$15.72	$341,476	
04220	Standard Concrete Block, 8"	16550	SF	$13.87	$229,568	
	Total					**$571,044**
	Division 05 - Metals					
05000	Pre-Engineered Metal Building	1	EA	$140,800.00	$140,800	
05000	Pre-Engineered Metal Building	1.00	EA	$140,800.00	$140,800	
05126	Steel Trusses	797000	LB	$2.30	$1,834,477	
	Total					**$2,116,077**
	Division 07 - Thermal and Moisture					

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 01 Site Work and Buildings

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
07200	3" R-23.07 Polyurethane Board Insulation	126000	SF	$5.39	$679,694	
07400	24 Ga Mr3-36 Versacor Roofing	63000	SF	$7.55	$475,869	
	Total					**$1,155,564**
	Division 15 - Mechanical					
15279	Corrugate Metal Pipe AASHTO M036	100	LF	$33.61	$3,361	
	Total					**$3,361**
	Grand Total					**$12,376,093**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 02 Plumbing, Fire, Shop Equip

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02240	10Hp Submersible Pump, 3" Elect.	120	DAY	$122.32	$14,678	
	Total					**$14,678**
	Division 11 - Equipment					
11000	Workshop/Machine Shop Equip.	1	LS	$49,392.00	$49,392	
11000	Air Scour Compressed Air Blower 3040 CFM@10PSI	1	EA	$125,000.00	$125,000	
11000	Compressed Air System 10CFM @125psi	1	EA	$4,468.80	$4,469	
11000	Propane Storage Tank + Appurt.	2	EA	$13,524.00	$27,048	
11293	Slide Gate, 36" X 36"	1	EA	$6,088.29	$6,088	
11293	Slide Gate, 24" X 24"	6	EA	$5,297.56	$31,785	
	Total					**$243,782**
	Division 14 - Conveying Systems					
14624	1 Ton Lug Mounted 20' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$11,604.37	$11,604	
14624	1 Ton Lug Mounted 31' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$12,660.37	$12,660	
14624	1 Ton Lug Mounted 56' Lift 1 Spd 1 Hp Electric Hoist W/Cable	5	EA	$13,628.37	$68,142	
	Total					**$92,407**
	Division 15 - Mechanical					
15000	Slide Weir Gate	6	EA	$29,400.00	$176,400	
15000	Gravity Floor Drainage System	1	LS	$99,960.00	$99,960	
15000	Fire Suppression System	1	LS	$552,720.00	$552,720	
15000	Interior Plumbing System	1	LS	$82,320.00	$82,320	
15112	36" 150# Fxf Awwa Butterfly Valve, No Op	12	EA	$14,714.61	$176,575	
15112	16" 150# Fxf Awwa Butterfly Valve, No Op	28	EA	$3,569.42	$99,944	
15112	12" 150# Fxf Awwa Butterfly Valve, No Op	3	EA	$2,294.03	$6,882	
15112	10" 150# Fxf Awwa Butterfly Valve, No Op	7	EA	$2,133.60	$14,935	
15112	6" 150# Fxf Awwa Butterfly Valve, No Op	16	EA	$1,862.94	$29,807	
15251	36" Cl 52 Cldi Mj Pipe In Open Trench	1320	LF	$294.86	$389,210	
15251	30" Cl 52 Cldi Mj Pipe In Open Trench	20	LF	$252.50	$5,050	
15251	16" Flg Cldi Pipe In Bldg	1000	LF	$171.66	$171,660	
15251	12" Flg Cldi Pipe In Bldg	675	LF	$115.23	$77,780	
15251	10" Flg Cldi Pipe In Bldg	70	LF	$91.57	$6,410	
15251	6" Flg Cldi Pipe In Bldg	830	LF	$55.03	$45,678	
	Total					**$1,935,333**
	Division 16 - Electrical					
16232	125 Ekw 1800Rpm,60Hz Turbocharged Stdby Gen Set	2	EA	$32,404.41	$64,809	
	Total					**$64,809**
	Grand Total					**$2,351,010**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 03 Floor Drains, Hoist

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 14 - Conveying Systems					
14624	2 Ton Lug Mtd 71' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$22,497.27	$22,497	
	Total					**$22,497**
	Division 15 - Mechanical					
15000	Gravity Floor Drainage System	1	LS	$12,936.00	$12,936	
15000	Gravity Floor Drainage System	1	LS	$7,056.00	$7,056	
	Total					**$19,992**
	Grand Total					**$42,489**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 04 DAF, Plate Settlers, Filters

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	DAF Waste Stream Pumping Units	2	EA	$35,280.00	$70,560	
11000	Inclined Plate Settler Feed Pumping Units	2	EA	$29,988.00	$59,976	
11000	Vertical TEFC motor	2	EA	$6,468.00	$12,936	
11000	Inclined Plate Settler Sludge Pumping Units	2	EA	$45,864.00	$91,728	
11000	Drain Forwarding Pumping Units	2	EA	$52,978.80	$105,958	
11000	Pumping Unit to Backwash Media Filters	3	EA	$164,640.00	$493,920	
11000	DAF System	1	EA	$3,998,400.00	$3,998,400	
11000	Impeller Type Rapid Mixers	1	EA	$47,040.00	$47,040	
11000	Media Filter System	1	EA	$2,704,800.00	$2,704,800	
	Total					**$7,585,318**
	Grand Total					**$7,585,318**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 05 Chem Feed, Cl2 Scrub, Tank

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	UV Reactors	1	EA	$1,881,600.00	$1,881,600	
11000	Chlorine Feed System	1	EA	$105,840.00	$105,840	
11000	Chlorine Scrubber	1	EA	$211,680.00	$211,680	
11000	Aqueous Ammonia Feed System	1	EA	$35,280.00	$35,280	
11000	Aqueous Ammonia Storage Tank	1	EA	$79,968.00	$79,968	
11000	Ferric Chloride Feed System	1	EA	$49,392.00	$49,392	
11000	Ferric Chloride Storage Tank	1	EA	$37,632.00	$37,632	
	Total					**$2,401,392**
	Grand Total					**$2,401,392**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 06 Chem Tank, Flow, Cntrfuge

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Polymer Feed System	1	EA	$27,048.00	$27,048	
11000	Magnetic Flow Meter	5	EA	$36,456.00	$182,280	
11000	Flow Meter DN 400/16	1	EA	$22,344.00	$22,344	
11000	Magnetic Flow Meter DN 150/6	1	EA	$17,640.00	$17,640	
11000	Centrifuge	2	EA	$626,808.00	$1,253,616	
	Total					**$1,502,928**
	Grand Total					**$1,502,928**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 07 PlateSettler, 3Ph Bus, DisPa

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Packaged Inclined Plate Settler System	1	EA	$1,340,640.00	$1,340,640	
11000	Magnetic Flow Meter DN 150/6	3	EA	$17,640.00	$52,920	
	Total					**$1,393,560**
	Division 16 - Electrical					
16000	600V 600A Indoor Motor Control Center	1	EA	$76,440.00	$76,440	
16000	600V 600A indoor motor contol center with four sections	1	EA	$94,080.00	$94,080	
16446	Nema 1 480V Mn Lug 3 Phs Panelbrds/Loadctrs Gp, 100Amp, 3Ph 18 Circ. 480V	8	EA	$1,949.07	$15,593	
16452	1200 Amp Cu 3P/3W 600V Wthrproof Feeder Bus Duct 12-20' Ht	1000	LF	$960.25	$960,249	
16491	100 Ampere Automatic Transfer Switch Type Astbm, 12X Space Factor	2	EA	$14,960.00	$29,920	
	Total					**$1,176,282**
	Grand Total					**$2,569,842**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 08 Lights, Trans, PLC, Conduit

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 16 - Electrical					
16000	12-fiber fiber optic cable	2000	LF	$16.50	$33,000	
16000	Ex 37 22 PLC	1	EA	$12,348.00	$12,348	
16000	Modicon TWD LCA 10 DRF Twido PLC	2	EA	$411.60	$823	
16000	Configuration and programming of PLC	20	EA	$700.00	$14,000	
16000	Fire Detection and Alarm System	1	EA	$17,640.00	$17,640	
16060	#4/0 B.C. Bare Copper Wire Stranded, Grounding System	1300	LF	$4.97	$6,465	
16123	12 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	15000	LF	$6.49	$97,305	
16123	7 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	3000	LF	$3.70	$11,091	
16123	2 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	5000	LF	$1.47	$7,333	
16123	4 4/0 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	300	LF	$75.25	$22,576	
16123	4 350Mcm 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	1000	LF	$102.85	$102,849	
16123	2 Shielded Pairs 16 Ga Instrument Cable & Multi-Conductor Cable, In Cable Tray	4000	LF	$.98	$3,921	
16130	3" Rigid Aluminum Conduit, In A Process Area To 20' Ht	300	LF	$21.91	$6,572	
16130	2" Rigid Aluminum Conduit, In A Process Area To 20' Ht	2000	LF	$13.65	$27,293	
16130	1" Rigid Aluminum Conduit, In A Process Area To 20' Ht	5000	LF	$8.14	$40,693	
16130	1.5" Grs Conduit, In A Bldg With Unlimited Ht	2000	LF	$10.68	$21,359	
16130	.75" Grs Conduit, In A Bldg With Unlimited Ht	2000	LF	$7.79	$15,584	
16272	750 Kva Three Phase 4160 Delta Primary Dry Type Distribution Transformer	1	EA	$14,117.35	$14,117	
16446	Nema 1 240V Mn Brkr 1 Phs Panelbrds/Loadctrs Gp, 225Amp, 1Ph 24 Circ. 120V	5	EA	$2,827.90	$14,140	
16500	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	100	EA	$662.05	$66,205	
16500	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	100	EA	$109.90	$10,990	
	Total					**$546,305**
	Grand Total					**$546,305**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 09 Switchgear, Trans, HVAC

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	HVAC System	1	LS	$1,552,320.00	$1,552,320	
	Total					**$1,552,320**
	Division 16 - Electrical					
16000	Metal Clad Switchgear	3	EA	$188,160.00	$564,480	
16000	Outdoor Nonsegregated phase bus 1200 amper	100	LF	$1,293.60	$129,360	
16000	Metal Clad Switchgear2	1	EA	$158,760.00	$158,760	
16000	Outdoor Nonsegregated-phase bus 480V,1200 Amp	100	EA	$917.28	$91,728	
16000	Add 7.5 MVA to three-phase 115 delta/4.16-KV Grd-Y	1	LS	$282,240.00	$282,240	
	Total					**$1,226,568**
	Grand Total					**$2,778,888**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 10 H&V, Sludge Bldg, IPS Waste

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	H&V System	1	LS	$89,376.00	$89,376	
	Total					**$89,376**
	Grand Total					**$89,376**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 11 Solar Walls, Dewatering

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02000	Dewatering	1	LS	$1,046,640.00	$1,046,640	
	Total					**$1,046,640**
	Division 10 - Specialties					
10000	Solar Walls	1	LS	$314,433.00	$314,433	
	Total					**$314,433**
	Grand Total					**$1,361,073**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment
Element: 12 Booster Pump Station

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 15 - Mechanical					
15000	Booster Pump Station (Table 2.8 FEIS)	1	LS	$4,498,016.00	$4,498,016	
	Total					**$4,498,016**
	Grand Total					**$4,498,016**

PROJECT SUMMARY

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment

NO.	DESCRIPTION			TOTAL
01	Site Work and Buildings			$12,620,799
02	Plumbing, Fire, Shop Equip			$2,349,391
03	Floor Drains, Hoist			$42,489
04	MF, Plate Settlers, Flocs			$21,225,977
05	Chem Feed, Cl2 Scrub, Tank			$2,401,392
06	Chem Tank, Flow, Cntrfuge			$1,366,512
07	PlateSettler, 3Ph Bus, DisPa			$2,358,117
08	Lights, Trans, PLC, Conduit			$616,336
09	Switchgear, Trans, HVAC			$2,849,448
10	H&V, Sludge Bldg, IPS Waste			$83,496
11	Solar Walls, Dewatering			$1,340,787
12	Booster Pump Station			$4,498,016
		TOTAL DIRECT COST		**$51,752,760**
	Additional Unlisted Items		5.0%	$2,587,638
		Subtotal		**$54,340,398**
	Mobilization		5.0%	$2,717,020
		Subtotal		**$57,057,418**
	Unlisted Items		5.0%	$2,852,871
		Subtotal		**$59,910,288**
	Contingencies		21.0%	$12,581,161
		Subtotal		**$72,491,449**
	Noncontract Costs		25.0%	$18,122,862
		Subtotal		**$90,614,311**
	TOTAL ESTIMATED CONSTRUCTION COST			**$90,614,311**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 01 Site Work and Buildings

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Topsoil Strip & Stockpile Over 500 Cy	13840	CY	$6.17	$85,414	
02300	Cat 235 Trackhoe 2.75Cy Bucket, Class B (Medium Digging), 0-20' D	95000	CY	$1.60	$152,144	
02300	Native Pipe Bed & Zone/Confined Structure Backfill, Class A Material	60000	CY	$21.62	$1,297,359	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	9775	CY	$52.42	$512,431	
02300	Controlled Density Fill (Cdf)	10680	CY	$79.20	$845,856	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	160	CY	$52.42	$8,388	
02742	3" Ac Overlay W/Tack Coat	99900	SF	$1.47	$146,426	
02742	3" Ac Paving On 6" Abc	99900	SF	$2.34	$233,459	
02742	6" Gravel Paving, In Place	76410	SF	$1.08	$82,182	
02820	8' H Double Swing Gate, Chain Link, 20' Opening	2	EA	$2,860.00	$5,720	
02820	Galv. Chain Link Fence, 8' W/Barbed Wire, No Gates	1890	LF	$42.68	$80,665	
02900	Hydroseeding	63000	SF	$.05	$3,448	
	Total					**$3,453,493**
	Division 03 - Concrete					
03000	Cement	933	TON	$269.00	$250,977	
03300	12" Structural Flat Mat On Grade	115.41	CY	$295.64	$34,120	
03300	12" X 24" Straight Continuous Footing	87.11	CY	$424.51	$36,979	
03300	30" Edge Forms, Slab On Grade, Add	784	LF	$31.19	$24,449	
03300	30" Structural Flat Mat On Grade	889.26	CY	$243.02	$216,107	
03300	18" Straight Wall >8' High	435.56	CY	$571.38	$248,868	
03300	12" Elevated Slab, 21'-26' High	355.7	CY	$406.50	$144,591	
03300	24" X 24" Square Column/Pier	296.3	CY	$683.19	$202,430	
03300	18" Straight Wall >8' High	333.33	CY	$571.38	$190,456	
03300	12" Elevated Slab, 21'-26' High	555.56	CY	$406.50	$225,834	
03300	24" X 24" Square Column/Pier	296.3	CY	$683.19	$202,430	
03300	10" W X 18" D Conc Beam	27.78	CY	$1,166.66	$32,410	
03300	12" X 30" Curved Cont Footing, (20'-50')	39.82	CY	$723.04	$28,791	
03300	30" Edge Forms, Slab On Grade, Add	116	LF	$31.19	$3,618	
03300	18" Structural Flat Mat On Grade	216.67	CY	$297.68	$64,497	
03300	18" Straight Wall >8' High	216.67	CY	$571.38	$123,800	
03300	18" Edge Forms, Slab On Grade, Add	330.00	LF	$20.59	$6,794	
03300	18" Edge Forms, Slab On Grade, Add	170.00	LF	$20.59	$3,500	
03300	18" Structural Flat Mat On Grade	97.22	CY	$297.68	$28,940	
03300	18" Straight Wall >8' High	97.22	CY	$571.38	$55,549	
03300	18" Straight Wall >8' High	1111.11	CY	$571.38	$634,860	
03300	18" Structural Flat Mat On Grade	3472.22	CY	$297.68	$1,033,595	
03300	12" Elevated Slab To 20'	39.82	CY	$355.41	$14,152	
03300	18" Curved Wall, 16'-30' Dia, >8' High	79.65	CY	$775.61	$61,777	
03300	18" Structural Flat Mat On Grade	59.73	CY	$297.68	$17,780	
03300	18" Structural Flat Mat On Grade	144.44	CY	$297.68	$42,996	
03300	18" Structural Flat Mat On Grade	555.56	CY	$297.68	$165,377	
03300	18" Edge Forms, Slab On Grade, Add	400	LF	$20.59	$8,235	
03300	12" X 24" Straight Continuous Footing	555.56	CY	$424.51	$235,843	
03300	18" Edge Forms, Slab On Grade, Add	200	LF	$20.59	$4,117	
03300	18" Structural Flat Mat On Grade	91.67	CY	$297.68	$27,288	
03300	18" Straight Wall >8' High	91.67	CY	$571.38	$52,378	
	Total					**$4,423,540**
	Division 04 - Masonry					
04220	Standard Concrete Block, 12"	21850	SF	$15.72	$343,520	
04220	Standard Concrete Block, 8"	16000	SF	$13.87	$221,939	
	Total					**$565,459**
	Division 05 - Metals					
05000	Pre-Engineered Metal Building	1	EA	$140,800.00	$140,800	

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 01 Site Work and Buildings

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
05000	Pre-Engineered Metal Building	1.00	EA	$140,800.00	$140,800	
05126	Open Web Steel Joists	496500	LB	$1.24	$617,892	
05126	Steel Trusses	921000	LB	$2.30	$2,119,891	
	Total					**$3,019,384**
	Division 07 - Thermal and Moisture					
07200	3" R-23.07 Polyurethane Board Insulation	126000	SF	$5.39	$679,694	
07400	24 Ga Mr3-36 Versacor Roofing	63000	SF	$7.55	$475,869	
	Total					**$1,155,564**
	Division 15 - Mechanical					
15279	Corrugate Metal Pipe AASHTO M036	100	LF	$33.61	$3,361	
	Total					**$3,361**
	Grand Total					**$12,620,799**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 02 Plumbing, Fire, Shop Equip

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02240	10Hp Submersible Pump, 3" Elect.	120	DAY	$122.32	$14,678	
	Total					**$14,678**
	Division 11 - Equipment					
11000	Workshop/Machine Shop Equip.	1	LS	$49,392.00	$49,392	
11000	Air Scour Compressed Air Blower 3040 CFM@10PSI	1	EA	$125,000.00	$125,000	
11000	Compressed Air System 10CFM @125psi	1	EA	$4,468.80	$4,469	
11000	Propane Storage Tank + Appurt.	2	EA	$13,524.00	$27,048	
11293	Slide Gate, 36" X 36"	2	EA	$6,088.29	$12,177	
11293	Slide Gate, 24" X 24"	6	EA	$5,297.56	$31,785	
	Total					**$249,871**
	Division 14 - Conveying Systems					
14624	1 Ton Lug Mounted 20' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$11,604.37	$11,604	
14624	1 Ton Lug Mounted 31' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$12,660.37	$12,660	
14624	1 Ton Lug Mounted 56' Lift 1 Spd 1 Hp Electric Hoist W/Cable	5	EA	$13,628.37	$68,142	
	Total					**$92,407**
	Division 15 - Mechanical					
15000	Gravity Floor Drainage System	1	LS	$99,960.00	$99,960	
15000	Fire Suppression System	1	LS	$552,720.00	$552,720	
15000	Interior Plumbing System	1	LS	$82,320.00	$82,320	
15000	Slide Weir Gate	12	EA	$29,400.00	$352,800	
15112	36" 150# Fxf Awwa Butterfly Valve, No Op	6	EA	$14,714.61	$88,288	
15112	16" 150# Fxf Awwa Butterfly Valve, No Op	16	EA	$3,569.42	$57,111	
15112	10" 150# Fxf Awwa Butterfly Valve, No Op	1	EA	$2,133.60	$2,134	
15112	6" 150# Fxf Awwa Butterfly Valve, No Op	16	EA	$1,862.94	$29,807	
15251	36" Cl 52 Cldi Mj Pipe In Open Trench	880	LF	$294.86	$259,474	
15251	30" Cl 52 Cldi Mj Pipe In Open Trench	20	LF	$252.50	$5,050	
15251	16" Flg Cldi Pipe In Bldg	709	LF	$171.66	$121,707	
15251	12" Flg Cldi Pipe In Bldg	960	LF	$115.23	$110,621	
15251	10" Flg Cldi Pipe In Bldg	974	LF	$91.57	$89,193	
15251	6" Flg Cldi Pipe In Bldg	1389	LF	$55.03	$76,442	
	Total					**$1,927,626**
	Division 16 - Electrical					
16232	125 Ekw 1800Rpm,60Hz Turbocharged Stdby Gen Set	2	EA	$32,404.41	$64,809	
	Total					**$64,809**
	Grand Total					**$2,349,391**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 03 Floor Drains, Hoist

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 14 - Conveying Systems					
14624	2 Ton Lug Mtd 71' Lift 2 Spd 1.5 Hp Electric Hoist W/Cable	1	EA	$22,497.27	$22,497	
	Total					**$22,497**
	Division 15 - Mechanical					
15000	Gravity Floor Drainage System	1	LS	$12,936.00	$12,936	
15000	Gravity Floor Drainage System	1	LS	$7,056.00	$7,056	
	Total					**$19,992**
	Grand Total					**$42,489**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 04 MF, Plate Settlers, Flocs

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Inclined Plate Settler Feed Pumping Units	2	EA	$15,993.60	$31,987	
11000	Vertical TEFC motor	2	EA	$2,352.00	$4,704	
11000	Inclined Plate Settler Sludge Pumping Units	2	EA	$35,280.00	$70,560	
11000	Drain Forwarding Pumping Units	2	EA	$52,978.80	$105,958	
11000	Impeller Type Rapid Mixers	1	EA	$37,632.00	$37,632	
11000	Stage 1 Impeller Type Flocculators	1	LS	$51,744.00	$51,744	
11000	Stage 2 Impeller Type Flocculators	1	LS	$225,792.00	$225,792	
11000	Microfiltration System	1	LS	$20,697,600.00	$20,697,600	
	Total					**$21,225,977**
	Grand Total					**$21,225,977**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 05 Chem Feed, Cl2 Scrub, Tank

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	UV Reactors	1	LS	$1,881,600.00	$1,881,600	
11000	Chlorine Feed System	1	LS	$105,840.00	$105,840	
11000	Chlorine Scrubber	1	EA	$211,680.00	$211,680	
11000	Aqueous Ammonia Feed System	1	LS	$35,280.00	$35,280	
11000	Aqueous Ammonia Storage Tank	1	EA	$79,968.00	$79,968	
11000	Ferric Chloride Feed System	1	EA	$49,392.00	$49,392	
11000	Ferric Chloride Storage Tank	1	EA	$37,632.00	$37,632	
	Total					**$2,401,392**
	Grand Total					**$2,401,392**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 06 Chem Tank, Flow, Cntrfuge

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Magnetic Flow Meter	2	EA	$36,456.00	$72,912	
11000	Flow Meter DN 400/16	1	EA	$22,344.00	$22,344	
11000	Magnetic Flow Meter DN 150/6	1	EA	$17,640.00	$17,640	
11000	Centrifuge	2	EA	$626,808.00	$1,253,616	
	Total					**$1,366,512**
	Grand Total					**$1,366,512**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 07 PlateSettler, 3Ph Bus, DisPa

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	Packaged Inclined Plate Settler System	1	EA	$823,200.00	$823,200	
11000	Magnetic Flow Meter DN 150/6	5	EA	$17,640.00	$88,200	
	Total					**$911,400**
	Division 16 - Electrical					
16000	600V 600A Indoor Motor Control Center	1	EA	$58,800.00	$58,800	
16000	600V 600A indoor motor contol center with four sections	1	EA	$94,080.00	$94,080	
16446	Nema 1 480V Mn Lug 3 Phs Panelbrds/Loadctrs Gp, 100Amp, 3Ph 18 Circ. 480V	8	EA	$1,949.07	$15,593	
16452	1200 Amp Cu 3P/3W 600V Wthrproof Feeder Bus Duct 12-20' Ht	1300	LF	$960.25	$1,248,324	
16491	100 Ampere Automatic Transfer Switch Type Astbm, 12X Space Factor	2	EA	$14,960.00	$29,920	
	Total					**$1,446,717**
	Grand Total					**$2,358,117**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 08 Lights, Trans, PLC, Conduit

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 16 - Electrical					
16000	12-fiber fiber optic cable	2000	LF	$16.50	$33,000	
16000	Ex 37 22 PLC	1	EA	$12,348.00	$12,348	
16000	Modicon TWD LCA 10 DRF Twido PLC	2	EA	$411.60	$823	
16000	Configuration and programming of PLC	20	EA	$700.00	$14,000	
16000	Fire Detection and Alarm System	1	EA	$17,640.00	$17,640	
16060	#4/0 B.C. Bare Copper Wire Stranded, Grounding System	2500	LF	$4.97	$12,432	
16123	12 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	17000	LF	$6.49	$110,279	
16123	7 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	4000	LF	$3.70	$14,789	
16123	2 #12 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	8000	LF	$1.47	$11,733	
16123	4 4/0 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	300	LF	$75.25	$22,576	
16123	4 350Mcm 600V Cu Multi-Conductor Thhn/Thwn-Tfn Ctrl & Multi-Conductor Cable Cable Tray	1000	LF	$102.85	$102,849	
16123	2 Shielded Pairs 16 Ga Instrument Cable & Multi-Conductor Cable, In Cable Tray	4000	LF	$.98	$3,921	
16130	3" Rigid Aluminum Conduit, In A Process Area To 20' Ht	300	LF	$21.91	$6,572	
16130	2" Rigid Aluminum Conduit, In A Process Area To 20' Ht	4000	LF	$13.65	$54,586	
16130	1" Rigid Aluminum Conduit, In A Process Area To 20' Ht	6000	LF	$8.14	$48,831	
16130	1.5" Grs Conduit, In A Bldg With Unlimited Ht	2000	LF	$10.68	$21,359	
16130	.75" Grs Conduit, In A Bldg With Unlimited Ht	2000	LF	$7.79	$15,584	
16272	750 Kva Three Phase 4160 Delta Primary Dry Type Distribution Transformer	1	EA	$14,117.35	$14,117	
16446	Nema 1 240V Mn Brkr 1 Phs Panelbrds/Loadctrs Gp, 225Amp, 1Ph 24 Circ. 120V	6	EA	$2,827.90	$16,967	
16500	400 Watt Single Unit High Pressure Sodium Type Light, Open Reflector	103	EA	$662.05	$68,191	
16500	2' X 4' Troffer 4-F40Cw Rs, Recessed Light Fixture, 12' Max Drop Ceiling	125	EA	$109.90	$13,738	
	Total					**$616,336**
	Grand Total					**$616,336**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 09 Switchgear, Trans, HVAC

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	HVAC System	1	LS	$1,622,880.00	$1,622,880	
	Total					**$1,622,880**
	Division 16 - Electrical					
16000	Metal Clad Switchgear	3	EA	$188,160.00	$564,480	
16000	Outdoor Nonsegregated phase bus 1200 amper	100	LF	$1,293.60	$129,360	
16000	Metal Clad Switchgear2	1	EA	$158,760.00	$158,760	
16000	Outdoor Nonsegregated-phase bus 480V,1200 Amp	100	EA	$917.28	$91,728	
16000	Add 7.5 MVA to three-phase 115 delta/4.16-KV Grd-Y	1	LS	$282,240.00	$282,240	
	Total					**$1,226,568**
	Grand Total					**$2,849,448**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 10 H&V, Sludge Bldg, IPS Waste

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	H&V System	1	LS	$83,496.00	$83,496	
	Total					**$83,496**
	Grand Total					**$83,496**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 11 Solar Walls, Dewatering

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02000	Dewatering	1	LS	$1,046,640.00	$1,046,640	
	Total					**$1,046,640**
	Division 10 - Specialties					
10000	Solar Walls	1	LS	$294,147.00	$294,147	
	Total					**$294,147**
	Grand Total					**$1,340,787**

DETAILED COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment
Element: 12 Booster Pump Station

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 15 - Mechanical					
15000	Booster Pump Station (Table 2.8 FEIS)	1	LS	$4,498,016.00	$4,498,016	
	Total					**$4,498,016**
	Grand Total					**$4,498,016**

PROJECT SUMMARY

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 1

NO.	DESCRIPTION			TOTAL
01	Sitework and Buildings			$2,623,224
02	Clarifier and Equipment			$1,719,994
03	Piping and Valves			$339,821
04	UV Disinfection			$775,851
05	Electrical, Instrumentation			$1,091,778
	TOTAL DIRECT COST			**$6,550,669**
	Additional Unlisted Items		5.0%	$327,533
		Subtotal		**$6,878,202**
	Mobilization		5.0%	$343,910
		Subtotal		**$7,222,112**
	Unlisted Items		5.0%	$361,106
		Subtotal		**$7,583,218**
	Contingencies		21.0%	$1,592,476
		Subtotal		**$9,175,693**
	Noncontract Costs		25.0%	$2,293,923
	TOTAL ESTIMATED CONSTRUCTION COST			**$11,469,617**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 1
Element: 01 Sitework and Buildings

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02260	10"Soldier Piles W/Wood Lagging, To 25' Deep, Incl Removal	14900	SF	$41.10	$612,387	
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	9600	CY	$4.58	$43,985	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	2600	CY	$66.92	$173,993	
02300	Remove Grass & Shrubs, 4" Depth To 1 Acre	0.58	AC	$2,131.54	$1,236	
	Total					**$831,601**
	Division 03 - Concrete					
03300	18" Edge Forms, Slab On Grade, Add	556	LF	$24.62	$13,689	
03300	18" Structural Flat Mat On Grade	727	CY	$338.27	$245,921	
03300	12" X 24" Straight Continuous Footing	123.56	CY	$482.40	$59,606	
	Total					**$319,215**
	Division 04 - Masonry					
04220	Standard Concrete Block, 12"	11120	SF	$18.50	$205,689	
	Total					**$205,689**
	Division 05 - Metals					
05126	Steel Trusses	264320	LB	$1.44	$379,564	
	Total					**$379,564**
	Division 07 - Thermal and Moisture					
07200	3" R-23.07 Polyurethane Board Insulation	18880	SF	$6.13	$115,734	
07400	24 Ga Mr3-36 Versacor Roofing	18880	SF	$9.08	$171,421	
	Total					**$287,155**
	Division 15 - Mechanical					
15000	HVAC	1	LS	$600,000.00	$600,000	
	Total					**$600,000**
	Grand Total					**$2,623,224**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 1
Element: 02 Clarifier and Equipment

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	1,375.00	CY	$66.92	$92,015	
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	5,000.00	CY	$4.58	$22,909	
	Total					**$114,924**
	Division 03 - Concrete					
03300	18" Edge Forms, Conic Mat On Grade >70', Add	270	LF	$16.82	$4,542	
03300	18" Conical Structural Mat On Grade (To 10%)	170	CY	$325.30	$55,302	
03300	18" Curved Wall Over 50' Dia, >8' High	184	CY	$767.50	$141,220	
03300	18" Edge Forms, Slab On Grade, Add	100.00	LF	$24.62	$2,462	
03300	18" Structural Flat Mat On Grade	33.33	CY	$338.27	$11,274	
03300	12" Straight Wall >8' High	74.07	CY	$836.05	$61,926	
	Total					**$276,726**
	Division 05 - Metals					
05500	Galvanized Steel Osha Handrail	270	LF	$76.60	$20,683	
05500	Galvanized Steel Osha Handrail	100.00	LF	$76.60	$7,660	
	Total					**$28,344**
	Division 11 - Equipment					
11000	Clarifier Equipment	1	LS	$1,300,000.00	$1,300,000	
	Total					**$1,300,000**
	Grand Total					**$1,719,994**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 1
Element: 03 Piping and Valves

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	341	CY	$4.58	$1,562	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	297	CY	$66.92	$19,875	
	Total					**$21,438**
	Division 11 - Equipment					
11000	24" Magnetic Flow Meter	1	EA	$17,640.00	$17,640	
	Total					**$17,640**
	Division 15 - Mechanical					
15000	Process Piping Supports	1	LS	$10,000.00	$10,000	
15112	Add For Motor Operator 22" Through 48"	1	EA	$8,470.00	$8,470	
15112	24" Vic Bfy Valve, Ci Body, Ss Bearing, Viton Disc, Manual Gear Op	1	EA	$11,380.55	$11,381	
15251	4" 90° Cldi Mj Bend	4	EA	$698.05	$2,792	
15251	4" Adder For Restrained Joints	150	LF	$5.18	$777	
15251	4" Cl 52 Cldi Mj Pipe In Open Trench	150	LF	$30.55	$4,583	
15252	30" C200 3/8" Wall Wld Cs Pipe In Open Trench	200	LF	$267.11	$53,422	
15252	18"C200 1/4" Wall Wld Cs Pipe In Open Trench	140	LF	$106.65	$14,931	
15252	24"A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	15	LF	$279.60	$4,194	
15252	30" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	230	LF	$347.90	$80,017	
15252	30" 3/8" (Std) Wall A-234 Buttweld Straight Tee	1	EA	$15,155.40	$15,155	
15252	30" X 24" 3/8" (Std) Wall A-234 Buttwld Con Rdcr	2	EA	$6,366.69	$12,733	
15252	30" 3/8" Wall 90° Lr Buttweld Ell	6	EA	$6,427.69	$38,566	
15252	18" 3/8" (Std) Wall 90° Lr Buttweld Ell	4	EA	$2,967.69	$11,871	
15252	36" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	50	LF	$455.85	$22,793	
15252	36" 3/8" Wall 90° Lr Buttweld Ell	1	EA	$9,058.94	$9,059	
	Total					**$300,744**
	Grand Total					**$339,821**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 1
Element: 04 UV Disinfection

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	UV Equipment	1	LS	$568,000.00	$568,000	
	Total					**$568,000**
	Division 15 - Mechanical					
15000	Process Piping Supports	1	LS	$15,000.00	$15,000	
15112	Add For Motor Operator Over 20"	3	EA	$7,000.00	$21,000	
15112	42" 150# Fxf Awwa Butterfly Valve, No Op	3	EA	$13,550.94	$40,653	
15252	42" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	12	LF	$604.99	$7,260	
15252	48" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	10	LF	$768.69	$7,687	
15252	48" X 42" 3/8" (Std) Wall A-234 Buttwld Con Rdcr	4	EA	$22,563.36	$90,253	
15252	42" 3/8" Wall 90° Lr Buttweld Ell	2	EA	$12,998.84	$25,998	
	Total					**$207,851**
	Grand Total					**$775,851**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 1
Element: 05 Electrical, Instrumentation

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
16000	Electrical Allowance	1	LS	$1,091,778.09	$1,091,778	

PROJECT SUMMARY

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 2

NO.	DESCRIPTION			TOTAL
01	Sitework and Buildings			$2,388,530
02	Clarifier and Equipment			$1,671,275
03	Pre-Treatment and Equipment			$1,050,180
04	Piping and Valves			$483,486
05	UV Disinfection			$753,480
06	Electrical, Instrumentation			$1,269,390
		TOTAL DIRECT COST		**$7,616,341**
	Additional Unlisted Items		5.0%	$380,817
		Subtotal		**$7,997,158**
	Mobilization		5.0%	$399,858
		Subtotal		**$8,397,016**
	Unlisted Items		5.0%	$419,851
		Subtotal		**$8,816,867**
	Contingencies		21.0%	$1,851,542
		Subtotal		**$10,668,409**
	Noncontract Costs		25.0%	$2,667,102
	TOTAL ESTIMATED CONSTRUCTION COST			**$13,335,511**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 2
Element: 01 Sitework and Buildings

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02260	10"Soldier Piles W/Wood Lagging, To 25' Deep, Incl Removal	14900	SF	$36.33	$541,350	
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	9600	CY	$4.05	$38,883	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	2600	CY	$59.16	$153,810	
02300	Remove Grass & Shrubs, 4" Depth To 1 Acre	0.58	AC	$1,884.28	$1,093	
	Total					**$735,136**
	Division 03 - Concrete					
03300	18" Edge Forms, Slab On Grade, Add	556	LF	$21.76	$12,101	
03300	18" Structural Flat Mat On Grade	727	CY	$299.03	$217,394	
03300	12" X 24" Straight Continuous Footing	123.56	CY	$426.44	$52,691	
	Total					**$282,186**
	Division 04 - Masonry					
04220	Standard Concrete Block, 12"	11120	SF	$16.35	$181,829	
	Total					**$181,829**
	Division 05 - Metals					
05126	Steel Trusses	264320	LB	$1.27	$335,534	
	Total					**$335,534**
	Division 07 - Thermal and Moisture					
07200	3" R-23.07 Polyurethane Board Insulation	18880	SF	$5.42	$102,309	
07400	24 Ga Mr3-36 Versacor Roofing	18880	SF	$8.03	$151,536	
	Total					**$253,845**
	Division 15 - Mechanical					
15000	HVAC	1	LS	$600,000.00	$600,000	
	Total					**$600,000**
	Grand Total					**$2,388,530**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 2
Element: 02 Clarifier and Equipment

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	1,375.00	CY	$59.16	$81,342	
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	5,000.00	CY	$4.05	$20,252	
	Total					**$101,593**
	Division 03 - Concrete					
03300	18" Edge Forms, Conic Mat On Grade >70', Add	270	LF	$14.87	$4,015	
03300	18" Conical Structural Mat On Grade (To 10%)	170	CY	$287.57	$48,887	
03300	18" Curved Wall Over 50' Dia, >8' High	184	CY	$678.47	$124,838	
03300	18" Edge Forms, Slab On Grade, Add	100.00	LF	$21.76	$2,176	
03300	18" Structural Flat Mat On Grade	33.33	CY	$299.03	$9,967	
03300	12" Straight Wall >8' High	74.07	CY	$739.07	$54,743	
	Total					**$244,626**
	Division 05 - Metals					
05500	Galvanized Steel Osha Handrail	270	LF	$67.72	$18,284	
05500	Galvanized Steel Osha Handrail	100.00	LF	$67.72	$6,772	
	Total					**$25,056**
	Division 11 - Equipment					
11000	Clarifier Equipment	1	LS	$1,300,000.00	$1,300,000	
	Total					**$1,300,000**
	Grand Total					**$1,671,275**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 2
Element: 03 Pre-Treatment and Equipment

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	1037	CY	$59.16	$61,346	
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	2037	CY	$4.05	$8,250	
	Total					**$69,597**
	Division 03 - Concrete					
03300	18" Edge Forms, Slab On Grade, Add	162	LF	$21.76	$3,526	
03300	18" Structural Flat Mat On Grade	67	CY	$299.03	$20,035	
03300	12" Straight Wall >8' High	204	CY	$739.07	$150,771	
	Total					**$174,331**
	Division 05 - Metals					
05500	Galvanized Steel Osha Handrail	162	LF	$67.72	$10,970	
05500	Galvanized Steel Grating, 2"	1200	SF	$29.40	$35,282	
	Total					**$46,252**
	Division 11 - Equipment					
11000	Pre-Treatment Equipment	1	LS	$760,000.00	$760,000	
	Total					**$760,000**
	Grand Total					**$1,050,180**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 2
Element: 04 Piping and Valves

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	341	CY	$4.05	$1,381	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	297	CY	$59.16	$17,570	
	Total					**$18,951**
	Division 11 - Equipment					
11000	24" Magnetic Flow Meter	1	EA	$17,640.00	$17,640	
	Total					**$17,640**
	Division 15 - Mechanical					
15000	Process Piping Supports	1	LS	$10,000.00	$10,000	
15112	Add For Motor Operator 22" Through 48"	1	EA	$7,487.48	$7,487	
15112	24" Vic Bfy Valve, Ci Body, Ss Bearing, Viton Disc, Manual Gear Op	1	EA	$10,060.41	$10,060	
15112	Add For Motor Operator Over 20"	2	EA	$6,188.00	$12,376	
15112	30" 150# Fxf Awwa Butterfly Valve, No Op	2	EA	$7,685.39	$15,371	
15251	4" 90° Cldi Mj Bend	4	EA	$617.07	$2,468	
15251	4" Adder For Restrained Joints	150	LF	$4.58	$687	
15251	4" Cl 52 Cldi Mj Pipe In Open Trench	150	LF	$27.01	$4,051	
15252	30" C200 3/8" Wall Wld Cs Pipe In Open Trench	650	LF	$236.13	$153,482	
15252	18"C200 1/4" Wall Wld Cs Pipe In Open Trench	140	LF	$94.28	$13,199	
15252	24"A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	15	LF	$247.16	$3,707	
15252	30" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	230	LF	$307.54	$70,735	
15252	30" 3/8" (Std) Wall A-234 Buttweld Straight Tee	4	EA	$13,397.37	$53,589	
15252	30" X 24" 3/8" (Std) Wall A-234 Buttwld Con Rdcr	2	EA	$5,628.16	$11,256	
15252	30" 3/8" Wall 90° Lr Buttweld Ell	7	EA	$5,682.08	$39,775	
15252	18" 3/8" (Std) Wall 90° Lr Buttweld Ell	4	EA	$2,623.44	$10,494	
15252	36" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	50	LF	$402.97	$20,149	
15252	36" 3/8" Wall 90° Lr Buttweld Ell	1	EA	$8,008.10	$8,008	
	Total					**$446,895**
	Grand Total					**$483,486**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 2
Element: 05 UV Disinfection

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	UV Equipment	1	LS	$568,000.00	$568,000	
	Total					**$568,000**
	Division 15 - Mechanical					
15000	Process Piping Supports	1	LS	$15,000.00	$15,000	
15112	Add For Motor Operator Over 20"	3	EA	$6,188.00	$18,564	
15112	42" 150# Fxf Awwa Butterfly Valve, No Op	3	EA	$11,979.03	$35,937	
15252	42" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	12	LF	$534.81	$6,418	
15252	48" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	10	LF	$679.52	$6,795	
15252	48" X 42" 3/8" (Std) Wall A-234 Buttwld Con Rdcr	4	EA	$19,946.01	$79,784	
15252	42" 3/8" Wall 90° Lr Buttweld Ell	2	EA	$11,490.98	$22,982	
	Total					**$185,480**
	Grand Total					**$753,480**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 2
Element: 06 Electrical, Instrumentation

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
16000	Electrical Allowance	1	LS	$1,269,390.21	$1,269,390	

PROJECT SUMMARY

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 3

NO.	DESCRIPTION			TOTAL
01	Sitework and Buildings			$2,388,530
02	Clarifier and Equipment			$1,671,275
03	Piping and Valves			$726,698
04	UV Disinfection			$753,480
05	Electrical, Instrumentation			$1,107,997
		TOTAL DIRECT COST		**$6,647,980**
	Additional Unlisted Items		5.0%	$332,399
		Subtotal		**$6,980,379**
	Mobilization		5.0%	$349,019
		Subtotal		**$7,329,398**
	Unlisted Items		5.0%	$366,470
		Subtotal		**$7,695,867**
	Contingencies		21.0%	$1,616,132
		Subtotal		**$9,312,000**
	Noncontract Costs		25.0%	$2,328,000
	TOTAL ESTIMATED CONSTRUCTION COST			**$11,640,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 3
Element: 01 Sitework and Buildings

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02260	10"Soldier Piles W/Wood Lagging, To 25' Deep, Incl Removal	14900	SF	$36.33	$541,350	
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	9600	CY	$4.05	$38,883	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	2600	CY	$59.16	$153,810	
02300	Remove Grass & Shrubs, 4" Depth To 1 Acre	0.58	AC	$1,884.28	$1,093	
	Total					**$735,136**
	Division 03 - Concrete					
03300	18" Edge Forms, Slab On Grade, Add	556	LF	$21.76	$12,101	
03300	18" Structural Flat Mat On Grade	727	CY	$299.03	$217,394	
03300	12" X 24" Straight Continuous Footing	123.56	CY	$426.44	$52,691	
	Total					**$282,186**
	Division 04 - Masonry					
04220	Standard Concrete Block, 12"	11120	SF	$16.35	$181,829	
	Total					**$181,829**
	Division 05 - Metals					
05126	Steel Trusses	264320	LB	$1.27	$335,534	
	Total					**$335,534**
	Division 07 - Thermal and Moisture					
07200	3" R-23.07 Polyurethane Board Insulation	18880	SF	$5.42	$102,309	
07400	24 Ga Mr3-36 Versacor Roofing	18880	SF	$8.03	$151,536	
	Total					**$253,845**
	Division 15 - Mechanical					
15000	HVAC	1	LS	$600,000.00	$600,000	
	Total					**$600,000**
	Grand Total					**$2,388,530**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 3
Element: 02 Clarifier and Equipment

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	1,375.00	CY	$59.16	$81,342	
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	5,000.00	CY	$4.05	$20,252	
	Total					**$101,593**
	Division 03 - Concrete					
03300	18" Edge Forms, Conic Mat On Grade >70', Add	270	LF	$14.87	$4,015	
03300	18" Conical Structural Mat On Grade (To 10%)	170	CY	$287.57	$48,887	
03300	18" Curved Wall Over 50' Dia, >8' High	184	CY	$678.47	$124,838	
03300	18" Edge Forms, Slab On Grade, Add	100.00	LF	$21.76	$2,176	
03300	18" Structural Flat Mat On Grade	33.33	CY	$299.03	$9,967	
03300	12" Straight Wall >8' High	74.07	CY	$739.07	$54,743	
	Total					**$244,626**
	Division 05 - Metals					
05500	Galvanized Steel Osha Handrail	270	LF	$67.72	$18,284	
05500	Galvanized Steel Osha Handrail	100.00	LF	$67.72	$6,772	
	Total					**$25,056**
	Division 11 - Equipment					
11000	Clarifier Equipment	1	LS	$1,300,000.00	$1,300,000	
	Total					**$1,300,000**
	Grand Total					**$1,671,275**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 3
Element: 03 Piping and Valves

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	1308	CY	$4.05	$5,298	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	1070	CY	$59.16	$63,299	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	104	CY	$59.16	$6,152	
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	134	CY	$4.05	$543	
	Total					**$75,292**
	Division 03 - Concrete					
03300	18" Edge Forms, Slab On Grade, Add	40	LF	$21.76	$871	
03300	18" Structural Flat Mat On Grade	6	CY	$299.03	$1,794	
03300	12" Straight Wall, To 8' High	12	CY	$733.21	$8,798	
	Total					**$11,463**
	Division 11 - Equipment					
11000	24" Magnetic Flow Meter	1	EA	$17,640.00	$17,640	
11000	Inline Static Mixer	1	EA	$30,000.00	$30,000	
	Total					**$47,640**
	Division 15 - Mechanical					
15000	Process Piping Supports	1	LS	$10,000.00	$10,000	
15000	36" Cross	1	EA	$30,000.00	$30,000	
15112	Add For Motor Operator 22" Through 48"	1	EA	$7,487.48	$7,487	
15112	24" Vic Bfy Valve, Ci Body, Ss Bearing, Viton Disc, Manual Gear Op	1	EA	$10,060.41	$10,060	
15112	Add For Motor Operator Over 20"	3	EA	$6,188.00	$18,564	
15112	Add For Motor Operator 12" Through 20"	1	EA	$3,536.00	$3,536	
15112	36" 150# Fxf Awwa Butterfly Valve, No Op	1	EA	$8,567.74	$8,568	
15112	30" 150# Fxf Awwa Butterfly Valve, No Op	2	EA	$7,685.39	$15,371	
15112	12" 150# Fxf Awwa Butterfly Valve, No Op	1	EA	$3,099.60	$3,100	
15251	4" 90° Cldi Mj Bend	4	EA	$617.07	$2,468	
15251	4" Adder For Restrained Joints	150	LF	$4.58	$687	
15251	4" Cl 52 Cldi Mj Pipe In Open Trench	150	LF	$27.01	$4,051	
15251	12" 90° Cldi Mj Bend	2	EA	$1,296.35	$2,593	
15251	12" Adder For Restrained Joints	190	LF	$8.97	$1,705	
15251	12" Cl 52 Cldi Mj Pipe In Open Trench	190	LF	$42.11	$8,000	
15252	30" C200 3/8" Wall Wld Cs Pipe In Open Trench	200	LF	$236.13	$47,225	
15252	18"C200 1/4" Wall Wld Cs Pipe In Open Trench	140	LF	$94.28	$13,199	
15252	24"A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	15	LF	$247.16	$3,707	
15252	30" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	230	LF	$307.54	$70,735	
15252	30" 3/8" (Std) Wall A-234 Buttweld Straight Tee	1	EA	$13,397.37	$13,397	
15252	30" X 24" 3/8" (Std) Wall A-234 Buttwld Con Rdcr	2	EA	$5,628.16	$11,256	
15252	30" 3/8" Wall 90° Lr Buttweld Ell	6	EA	$5,682.08	$34,092	
15252	18" 3/8" (Std) Wall 90° Lr Buttweld Ell	4	EA	$2,623.44	$10,494	
15252	36" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	50	LF	$402.97	$20,149	
15252	36" 3/8" Wall 90° Lr Buttweld Ell	1	EA	$8,008.10	$8,008	
15252	36" C200 3/8" Wall Wld Cs Pipe In Open Trench	715	LF	$293.46	$209,826	
15252	36" 3/8" Wall 90° Lr Buttweld Ell	3	EA	$8,008.10	$24,024	
	Total					**$592,303**
	Grand Total					**$726,698**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 3
Element: 04 UV Disinfection

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	UV Equipment	1	LS	$568,000.00	$568,000	
	Total					**$568,000**
	Division 15 - Mechanical					
15000	Process Piping Supports	1	LS	$15,000.00	$15,000	
15112	Add For Motor Operator Over 20"	3	EA	$6,188.00	$18,564	
15112	42" 150# Fxf Awwa Butterfly Valve, No Op	3	EA	$11,979.03	$35,937	
15252	42" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	12	LF	$534.81	$6,418	
15252	48" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	10	LF	$679.52	$6,795	
15252	48" X 42" 3/8" (Std) Wall A-234 Buttwld Con Rdcr	4	EA	$19,946.01	$79,784	
15252	42" 3/8" Wall 90° Lr Buttweld Ell	2	EA	$11,490.98	$22,982	
	Total					**$185,480**
	Grand Total					**$753,480**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 3
Element: 05 Electrical, Instrumentation

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
16000	Electrical Allowance	1	LS	$1,107,996.62	$1,107,997	

PROJECT SUMMARY

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 4

NO.	DESCRIPTION			TOTAL
01	Sitework and Buildings			$2,388,530
02	Clarifier and Equipment			$1,671,275
03	Piping and Valves			$600,441
04	UV Disinfection			$753,480
05	Electrical, Instrumentation			$1,082,745
		TOTAL DIRECT COST		**$6,496,472**
	Additional Unlisted Items		5.0%	$324,824
		Subtotal		**$6,821,296**
	Mobilization		5.0%	$341,065
		Subtotal		**$7,162,360**
	Unlisted Items		5.0%	$358,118
		Subtotal		**$7,520,478**
	Contingencies		21.0%	$1,579,300
		Subtotal		**$9,099,779**
	Noncontract Costs		25.0%	$2,274,945
	TOTAL ESTIMATED CONSTRUCTION COST			**$11,374,723**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 4
Element: 01 Sitework and Buildings

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02260	10"Soldier Piles W/Wood Lagging, To 25' Deep, Incl Removal	14900	SF	$36.33	$541,350	
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	9600	CY	$4.05	$38,883	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	2600	CY	$59.16	$153,810	
02300	Remove Grass & Shrubs, 4" Depth To 1 Acre	0.58	AC	$1,884.28	$1,093	
	Total					**$735,136**
	Division 03 - Concrete					
03300	18" Edge Forms, Slab On Grade, Add	556	LF	$21.76	$12,101	
03300	18" Structural Flat Mat On Grade	727	CY	$299.03	$217,394	
03300	12" X 24" Straight Continuous Footing	123.56	CY	$426.44	$52,691	
	Total					**$282,186**
	Division 04 - Masonry					
04220	Standard Concrete Block, 12"	11120	SF	$16.35	$181,829	
	Total					**$181,829**
	Division 05 - Metals					
05126	Steel Trusses	264320	LB	$1.27	$335,534	
	Total					**$335,534**
	Division 07 - Thermal and Moisture					
07200	3" R-23.07 Polyurethane Board Insulation	18880	SF	$5.42	$102,309	
07400	24 Ga Mr3-36 Versacor Roofing	18880	SF	$8.03	$151,536	
	Total					**$253,845**
	Division 15 - Mechanical					
15000	HVAC	1	LS	$600,000.00	$600,000	
	Total					**$600,000**
	Grand Total					**$2,388,530**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 4
Element: 02 Clarifier and Equipment

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	1,375.00	CY	$59.16	$81,342	
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	5,000.00	CY	$4.05	$20,252	
	Total					**$101,593**
	Division 03 - Concrete					
03300	18" Edge Forms, Conic Mat On Grade >70', Add	270	LF	$14.87	$4,015	
03300	18" Conical Structural Mat On Grade (To 10%)	170	CY	$287.57	$48,887	
03300	18" Curved Wall Over 50' Dia, >8' High	184	CY	$678.47	$124,838	
03300	18" Edge Forms, Slab On Grade, Add	100.00	LF	$21.76	$2,176	
03300	18" Structural Flat Mat On Grade	33.33	CY	$299.03	$9,967	
03300	12" Straight Wall >8' High	74.07	CY	$739.07	$54,743	
	Total					**$244,626**
	Division 05 - Metals					
05500	Galvanized Steel Osha Handrail	270	LF	$67.72	$18,284	
05500	Galvanized Steel Osha Handrail	100.00	LF	$67.72	$6,772	
	Total					**$25,056**
	Division 11 - Equipment					
11000	Clarifier Equipment	1	LS	$1,300,000.00	$1,300,000	
	Total					**$1,300,000**
	Grand Total					**$1,671,275**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 4
Element: 03 Piping and Valves

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	1202	CY	$4.05	$4,868	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	970	CY	$59.16	$57,383	
	Total					**$62,251**
	Division 11 - Equipment					
11000	24" Magnetic Flow Meter	1	EA	$17,640.00	$17,640	
	Total					**$17,640**
	Division 15 - Mechanical					
15000	Process Piping Supports	1	LS	$10,000.00	$10,000	
15112	Add For Motor Operator 22" Through 48"	1	EA	$7,487.48	$7,487	
15112	24" Vic Bfy Valve, Ci Body, Ss Bearing, Viton Disc, Manual Gear Op	1	EA	$10,060.41	$10,060	
15251	4" 90° Cldi Mj Bend	4	EA	$617.07	$2,468	
15251	4" Adder For Restrained Joints	150	LF	$4.58	$687	
15251	4" Cl 52 Cldi Mj Pipe In Open Trench	150	LF	$27.01	$4,051	
15252	30" C200 3/8" Wall Wld Cs Pipe In Open Trench	200	LF	$236.13	$47,225	
15252	18"C200 1/4" Wall Wld Cs Pipe In Open Trench	140	LF	$94.28	$13,199	
15252	24"A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	15	LF	$247.16	$3,707	
15252	30" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	230	LF	$307.54	$70,735	
15252	30" 3/8" (Std) Wall A-234 Buttweld Straight Tee	1	EA	$13,397.37	$13,397	
15252	30" X 24" 3/8" (Std) Wall A-234 Buttwld Con Rdcr	2	EA	$5,628.16	$11,256	
15252	30" 3/8" Wall 90° Lr Buttweld Ell	6	EA	$5,682.08	$34,092	
15252	18" 3/8" (Std) Wall 90° Lr Buttweld Ell	4	EA	$2,623.44	$10,494	
15252	36" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	50	LF	$402.97	$20,149	
15252	36" 3/8" Wall 90° Lr Buttweld Ell	1	EA	$8,008.10	$8,008	
15252	36" C200 3/8" Wall Wld Cs Pipe In Open Trench	715	LF	$293.46	$209,826	
15252	36" 3/8" (Std) Wall A-234 Buttweld Straight Tee	1	EA	$19,682.90	$19,683	
15252	36" 3/8" Wall 90° Lr Buttweld Ell	3	EA	$8,008.10	$24,024	
	Total					**$520,550**
	Grand Total					**$600,441**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 4
Element: 04 UV Disinfection

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 11 - Equipment					
11000	UV Equipment	1	LS	$568,000.00	$568,000	
	Total					**$568,000**
	Division 15 - Mechanical					
15000	Process Piping Supports	1	LS	$15,000.00	$15,000	
15112	Add For Motor Operator Over 20"	3	EA	$6,188.00	$18,564	
15112	42" 150# Fxf Awwa Butterfly Valve, No Op	3	EA	$11,979.03	$35,937	
15252	42" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	12	LF	$534.81	$6,418	
15252	48" A-53 Wld Steel 3/8" (Std) Wall Pipe In A Bldg	10	LF	$679.52	$6,795	
15252	48" X 42" 3/8" (Std) Wall A-234 Buttwld Con Rdcr	4	EA	$19,946.01	$79,784	
15252	42" 3/8" Wall 90° Lr Buttweld Ell	2	EA	$11,490.98	$22,982	
	Total					**$185,480**
	Grand Total					**$753,480**

DETAILED COST ESTIMATE

Project: NAWS
Type: Components Common to all Alternatives
Component: Minot WTP: Alternative 4
Element: 05 Electrical, Instrumentation

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
16000	Electrical Allowance	1	LS	$1,082,745.32	$1,082,745	

O&M Cost Assumptions and Factors

Annual costs for the operation and maintenance (O&M) of the NAWS Project were developed. O&M costs include energy consumption, equipment maintenance and replacement, labor, chemicals, and miscellaneous costs. In some cases maintenance costs were developed as a percentage of the estimated equipment costs. The design life for pumping equipment and treatment facilities was considered 20 years, while a 40 year design life was considered for water tanks and pipelines.

BASIS OF O&M COSTS

The assumptions and unit costs used to develop these O&M cost estimates have been divided into the following categories and are presented below:

- Power Costs
- Equipment Costs
- Cost of Parts
- Chemical Costs
- Labor Costs

Power Costs

A cost of $0.05/kwh was used for all power consumption in the Project. Actual power rates may vary, depending on the location of the individual project facility. A service charge of $250/month was used for all facilities that require new electric service.

Pumping energy represents a large fraction of energy consumption in the system; it was determined based on the design flow rate and pumping head at each pump. The consumption rate was developed and applied to the estimated duration of operation of each active pump. Standby pumps were not considered.

HVAC energy requirements were estimated assuming 25 kwh/ft^2 per year of floor plan area. This estimate accounts for heating during winter months to maintain the interior space above freezing as well as for ventilation during the summer months. For the Biota WTP, the HVAC system was sized and estimated using the system sized in Reclamation (2007) report and estimated based on power consumption.

Equipment Costs

Annual costs for equipment were estimated using monthly lease rates over a one year period. The following lease rates on equipment were used:

- Pickup Truck - $750/month
- Loader/Backhoe - $3,800/month
- Wheel Loader - $1,200/day

Parts

The cost of parts was developed on an annual basis as a percentage of the construction cost per category. For example, the cost for each pump station is calculated as a fraction of the construction costs for plumbing and fire, piping and valves, pumping units and flow meter combined. The typical fraction applied to construction costs is two percent, with the following exceptions:

- Water tank (reservoir) – 1%/year
- Internal (Plant) Piping – 1%/year
- Pump Stations – 2.5%/year

Chemical Costs

Chemical costs are based on the annual use of chemicals at the dose or concentration required for the average flow over 365 days per year.

Lifecycle costs

Life cycle costs for project facilities are not part of this report.

Labor

Labor rates were based on three personnel classifications for staffing intakes, pump stations, treatment plants and delivery systems. Labor for operation of the water treatment plants was based on present labor costs and was adjusted to reflect the additional staffing requirements resulting from plant upgrades and expansions. Labor classes and labor costs (including benefits), are presented below:

- Supervisor II - $ 117,600/Year
- Supervisor I - $94,080/Year
- Operator - $94,080/Year
- Maintenance - $56,500/Year
- Chemist - $47,040/Year
- Secretary - $29,400/Year

Minot WTP O&M

Operation and Maintenance (O&M) Costs for the Minot WTP were developed using O&M costs from the existing facility between 2009 and 2011. These costs included employee salaries and benefits, plant operation costs, and facility maintenance costs. Given the level of design detail and the use of similar treatment technologies currently employed at the WTP, the average daily treatment flow rates between 2009 and 2011 were used to escalate the O&M costs to the projected future average daily demand. Although the possibility of reduced treatment costs resulting from use of treated water (i.e., treated water from the Missouri River) is acknowledged, the potential costs savings are not reflected due to the unknowns associated with future operation, and the various potential water sources, blending strategies, and resulting treated water qualities. Once the preferred alternative has been established and detailed design development begins, these potential cost savings can be estimated.

REFERENCES

Reclamation. 2007. Water Treatment Plant for Biota Removal and Inactivation - Appraisal Level Design & Cost Estimates. U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Denver, CO, September.

Cardno ENTRIX
Shaping the Future

PROJECT O&M SUMMARY

Project: NAWS
Type: Common, In-basin and Missouri River Components

NO.	DESCRIPTION	TOTAL
1	Minot Peak Well Facilities (4 units)	$75,840
2	Sundre Peak Well Facilities (2 units)	$132,720
3	Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer	$164,469
4	Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer	$163,397
5	Minot Aquifer Collector Line	$43,040
6	Sundre Aquifer Collector Line, Alternative 1	$87,875
7	Sundre Aquifer Collector Line, Alternative 2	$80,470
8	Pipeline: Glenburn to Renville Corner	$104,577
9	Pipeline: Westhope and ASWUD III	$120,633
10	Pipeline: Souris and ASWUD I	$168,505
11	Pipeline: Bowbells, Columbus and Noonan	$159,789
12	Lansford Pump Station	$203,413
13	Bowbells Pump Station	$41,432
14	Mohall Pump Station	$65,371
15	Tolley Pump Station	$61,702
16	Renville County Corner Pump Station	$55,507
17	Bottineau West Pump Station	$62,811
18	Bottineau North Pump Station	$48,135
19	Lansford Reservoir	$56,469
20	Bottineau Reservoir	$46,213
21	Minot Recharge Facility	$156,743

PROJECT O&M SUMMARY

Project: NAWS
Type: Common, In-basin and Missouri River Components

NO.	DESCRIPTION	TOTAL
22	Sundre Recharge Facility	$156,743
23	South Prairie Reservoir	$40,781
24	SCPP Modifications, Alternative 3	$970,668
25	SCPP Modifications, Alternative 4	$1,083,560
26	Intake, South Shore, Alternative 3	$1,296,409
27	Intake, South Shore, Alternative 4	$1,388,186
28	Intake Adjacent to SCPP, Alternative 3	$1,049,302
29	Intake Adjacent to SCPP, Alternative 4	$1,194,783
30	Biota WTP: Chlorination	$1,206,105
31	Biota WTP: Chlorination/UV Inactivation	$1,453,662
32	Biota WTP: Enhanced	$1,754,387
33	Biota WTP: Conventional Treatment	$2,256,852
34	Biota WTP: Microfiltration Treatment	$2,360,894

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Cardno ENTRIX and Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Cardno ENTRIX and Carollo Engineers cannot and do not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Minot Peak Well Facilities (4 units)

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power, Labor and Equipment					
	Peak Well No.1 (800 gpm)	6	MO	$3,160	$18,960	
	Peak Well No.2 (800 gpm)	6	MO	$3,160	$18,960	
	Peak Well No.3 (800 gpm)	6	MO	$3,160	$18,960	
	Peak Well No.4 (800 gpm)	6	MO	$3,160	$18,960	
	Total					$75,840
	Grand Total					**$75,840**

NOTES
- Costs were prorated based on City of Minot current O&M costs of $4.39/gpm/MO of installed capacity.
- Ninety percent of the unit cost ($3.95/gpm/MO) was alocated for O&M of peak wells.
- New peak wells are assumed to operate six months per year (6 MO/YR).

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Sundre Peak Well Facilities (2 units)

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power, Labor and Equipment					
	Peak Well No.1 (2,800 gpm)	6	MO	$11,060	$66,360	
	Peak Well No.2 (2,800 gpm)	6	MO	$11,060	$66,360	
	Total					$132,720
	Grand Total					**$132,720**

NOTES
- Costs were prorated based on City of Minot current O&M costs of $4.39/gpm/MO of installed capacity.
- Ninety percent of the unit cost ($3.95/gpm/MO) was alocated for O&M of peak wells.
- New peak wells are assumed to operate six months per year (6 MO/YR).

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Minot Aquifer

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 (4 months, $0.05/kW-hr)	4	MO	$5,887	$23,548	
	Pump No.2 (2 months, $0.05/kW-hr)	2	MO	$5,887	$11,774	
	Pump No.3 (1 months, $0.05/kW-hr)	1	MO	$5,887	$5,887	
	Pump No.4 (1 months, $0.05/kW-hr)	1	MO	$5,887	$5,887	
	Service Charge, Pump Station (power)	12	MO	$250	$3,000	
	Miscelaneous Lighting (32-400 W lamps at $0.05/kW-hr)	12	MO	$171	$2,052	
	HVAC ($/SF/YR) (Souris River Pump Station, 70' x 40', 6 MO/YR)	2,800	SF	$12.50	$35,000	
	Total					$87,148
	Parts					
	Pump Station	1	LS	$8,200	$8,200	
	Feeder Pipeline	1	LS	$12,500	$12,500	
	Total					$20,700
	Labor					
	Supervisor (1/4 Time)	0.25	YR	$94,080	$23,520	
	Maintenance (3 Operators, 1/6 time)	0.50	YR	$56,500	$28,250	
	Secretarial (1/6 time)	0.17	YR	$29,400	$4,851	
	Total					$56,621
	Grand Total					**$164,469**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Surface Water Intake for Recharge Basins (29 mgd) – Sundre Aquifer

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 (4 months, $0.05/kW-hr)	4	MO	$5,753	$23,012	
	Pump No.2 (2 months, $0.05/kW-hr)	2	MO	$5,753	$11,506	
	Pump No.3 (1 months, $0.05/kW-hr)	1	MO	$5,753	$5,753	
	Pump No.4 (1 months, $0.05/kW-hr)	1	MO	$5,753	$5,753	
	Service Charge, Pump Station (power)	12	MO	$250	$3,000	
	Miscelaneous Lighting (24-400 W lamps at $0.05/kW-hr)	12	MO	$171	$2,052	
	HVAC ($/SF/YR) (Souris River Pump Station, 70' x 40', 6 MO/YR)	2,800	SF	$12.50	$35,000	
	Total					$86,076
	Parts					
	Pump Station	1	LS	$8,200	$8,200	
	Feeder Pipeline	1	LS	$12,500	$12,500	
	Total					$20,700
	Labor					
	Supervisor (1/4 Time)	0.25	YR	$94,080	$23,520	
	Maintenance (3 Operators, 1/6 time)	0.50	YR	$56,500	$28,250	
	Secretarial (1/6 time)	0.17	YR	$29,400	$4,851	
	Total					$56,621
	Grand Total					**$163,397**

NOTES
- Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.
- Souris River Intake O&M costs account for 89.3% of Power, 79% of Parts and 50% of Labor ($165,794)

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Minot Aquifer Collector Line

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Labor and Equipment					
	Existing costs	12	MO	$1,667	$20,004	
	Total					$20,004
	New 4-in Pipeline					
	Equipment					
	Pickup Truck (1/8 time)	1.5	MO	$750	$1,125	
	Loader/Backhoe (1/24 time)	0.5	MO	$3,800	$1,900	
	Total					$3,025
	Parts					
	Piping and Valves	1	LS	$7,727	$7,727	
	Total					$7,727
	Labor					
	Supervisor (1/24 time)	0.04	YR	$94,080	$3,763	
	Maintenance (1/8 time)	0.13	YR	$56,500	$7,345	
	Secretarial (1/24 time)	0.04	YR	$29,400	$1,176	
	Total					$12,284
	Grand Total					**$43,040**

NOTES

- Existing costs were prorated based on City of Minot current O&M costs of $4.39/gpm/MO of installed capacity.
- Ten percent of the unit cost ($0.44/gpm/MO) was alocated as an "add on" for O&M of collector line. This accounts for the added capacity of 3,200 gpm ($1,408/MO).
- Existing O&M for the Minot Aquifer collector line were estimated at $20,000/YR ($1,667/MO).
- New peak wells are assumed to operate six months per year (6 MO/YR).
- Parts costs are assumed one percent of construction cost in the category.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Sundre Aquifer Collector Line, Alternative 1

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Labor and Equipment					
	Existing costs	12	MO	$4,167	$50,004	
	Total					$50,004
	New 4-in Pipeline					
	Equipment					
	Pickup Truck (1/8 time)	1.5	MO	$750	$1,125	
	Loader/Backhoe (1/24 time)	0.5	MO	$3,800	$1,900	
	Total					$3,025
	Parts					
	Piping and Valves	1	LS	$22,562	$22,562	
	Total					$22,562
	Labor					
	Supervisor (1/24 time)	0.04	YR	$94,080	$3,763	
	Maintenance (1/8 time)	0.13	YR	$56,500	$7,345	
	Secretarial (1/24 time)	0.04	YR	$29,400	$1,176	
	Total					$12,284
	Grand Total					**$87,875**

NOTES

- Existing costs were prorated based on City of Minot current O&M costs of $4.39/gpm/MO of installed capacity.

- Ten percent of the unit cost ($0.44/gpm/MO) was alocated as an "add on" for O&M of collector line. This accounts for the added capacity of 5,600 gpm ($2,464/MO).

- Existing O&M for the Sundre Aquifer collector line were estimated at $50,000/YR ($4,167/MO).

- New peak wells are assumed to operate six months per year (6 MO/YR).

- Parts costs are assumed one percent of construction cost in the category.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Sundre Aquifer Collector Line, Alternative 2

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Labor and Equipment					
	Existing costs	12	MO	$4,167	$50,004	
	Total					$50,004
	New 4-in Pipeline					
	Equipment					
	Pickup Truck (1/8 time)	1.5	MO	$750	$1,125	
	Loader/Backhoe (1/24 time)	0.5	MO	$3,800	$1,900	
	Total					$3,025
	Parts					
	Piping and Valves	1	LS	$15,157	$15,157	
	Total					$15,157
	Labor					
	Supervisor (1/24 time)	0.04	YR	$94,080	$3,763	
	Maintenance (1/8 time)	0.13	YR	$56,500	$7,345	
	Secretarial (1/24 time)	0.04	YR	$29,400	$1,176	
	Total					$12,284
	Grand Total					**$80,470**

NOTES

- Existing costs were prorated based on City of Minot current O&M costs of $4.39/gpm/MO of installed capacity.

- Ten percent of the unit cost ($0.44/gpm/MO) was alocated as an "add on" for O&M of collector line. This accounts for the added capacity of 5,600 gpm ($2,464/MO).

- Existing O&M for the Sundre Aquifer collector line were estimated at $50,000/YR ($4,167/MO).

- New peak wells are assumed to operate six months per year (6 MO/YR).

- Parts costs are assumed one percent of construction cost in the category.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Glenburn to Renville Corner

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Pickup Truck (1/4 time)	3	MO	$750	$2,250	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$6,050
	Parts					
	Piping and Valves	1	LS	$74,524	$74,524	
	Total					$74,524
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/4 time)	0.25	YR	$56,500	$14,125	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$24,003
	Grand Total					**$104,577**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Westhope and ASWUD III

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Pickup Truck (1/4 time)	3	MO	$750	$2,250	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$6,050
	Parts					
	Piping and Valves	1	LS	$90,580	$90,580	
	Total					$90,580
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/4 time)	0.25	YR	$56,500	$14,125	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$24,003
	Grand Total					**$120,633**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Souris and ASWUD I

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Pickup Truck (1/4 time)	3	MO	$750	$2,250	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$6,050
	Parts					
	Piping and Valves	1	LS	$138,452	$138,452	
	Total					$138,452
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/4 time)	0.25	YR	$56,500	$14,125	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$24,003
	Grand Total					**$168,505**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Pipeline: Bowbells, Columbus and Noonan

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Equipment					
	Pickup Truck (1/4 time)	3	MO	$750	$2,250	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$6,050
	Parts					
	Piping and Valves	1	LS	$129,736	$129,736	
	Total					$129,736
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/4 time)	0.25	YR	$56,500	$14,125	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$24,003
	Grand Total					**$159,789**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Pump Station

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$3,948	$47,376	
	Pump No.2 ($0.05/kW-hr)	12	MO	$3,948	$47,376	
	Pump No.3 ($0.05/kW-hr)	6	MO	$3,948	$23,688	
	Pump No.4 ($0.05/kW-hr)		MO			
	Service Charge	12	MO	$250	$3,000	
	Miscelaneous Lighting (12-400 W lamps at $0.05/kW-hr) @ Auxiliary Buildings	12	MO	$85	$1,020	
	HVAC ($/SF/YR)	1,624	SF	$25	$40,600	
	Total					$163,060
	Equipment					
	Pickup Truck (1/6 time)	2	MO	$750	$1,500	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$5,300
	Parts					
	Pump Station (2.5%/YR)	1	LS	$9,880	$9,880	
	Surge Tank	1	LS	$1,170	$1,170	
	Electrical	1	LS	$4,520	$4,520	
	Total					$15,570
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/6 time)	0.17	YR	$56,500	$9,605	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$19,483
	Grand Total					**$203,413**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bowbells Pump Station

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$86	$1,032	
	Pump No.2 ($0.05/kW-hr)	12	MO	$86	$1,032	
	Service Charge	12	MO	$250	$3,000	
	Miscelaneous Lighting (2-400 W lamps at $0.05/kW-hr)	12	MO	$15	$180	
	HVAC ($/SF/YR)	375	SF	$25	$9,375	
	Total					$14,619
	Equipment					
	Pickup Truck (1/6 time)	2	MO	$750	$1,500	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$5,300
	Parts					
	Pump Station (2.5%/YR)	1	LS	$1,515	$1,515	
	Electrical	1	LS	$515	$515	
	Total					$2,030
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/6 time)	0.17	YR	$56,500	$9,605	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$19,483
	Grand Total					**$41,432**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Mohall Pump Station

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$1,380	$16,560	
	Pump No.2 ($0.05/kW-hr)	6	MO	$1,380	$8,280	
	Pump No.3 ($0.05/kW-hr)		MO			
	Service Charge	12	MO	$250	$3,000	
	Miscelaneous Lighting (2-400 W lamps at $0.05/kW-hr)	12	MO	$15	$180	
	HVAC ($/SF/YR)	375	SF	$25	$9,375	
	Total					$37,395
	Equipment					
	Pickup Truck (1/6 time)	2	MO	$750	$1,500	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$5,300
	Parts					
	Pump Station (2.5%/YR)	1	LS	$2,552	$2,552	
	Electrical	1	LS	$641	$641	
	Total					$3,193
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/6 time)	0.17	YR	$56,500	$9,605	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$19,483
	Grand Total					**$65,371**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Tolley Pump Station

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$1,178	$14,136	
	Pump No.2 ($0.05/kW-hr)	6	MO	$1,178	$7,068	
	Pump No.3 ($0.05/kW-hr)		MO			
	Service Charge	12	MO	$250	$3,000	
	Miscelaneous Lighting (2-400 W lamps at $0.05/kW-hr)	12	MO	$15	$180	
	HVAC ($/SF/YR)	375	SF	$25	$9,375	
	Total					$33,759
	Equipment					
	Pickup Truck (1/6 time)	2	MO	$750	$1,500	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$5,300
	Parts					
	Pump Station (2.5%/YR)	1	LS	$2,519	$2,519	
	Electrical	1	LS	$641	$641	
	Total					$3,160
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/6 time)	0.17	YR	$56,500	$9,605	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$19,483
	Grand Total					**$61,702**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Renville County Corner Pump Station

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$840	$10,080	
	Pump No.2 ($0.05/kW-hr)	6	MO	$840	$5,040	
	Pump No.3 ($0.05/kW-hr)		MO			
	Service Charge	12	MO	$250	$3,000	
	Miscelaneous Lighting (2-400 W lamps at $0.05/kW-hr)	12	MO	$15	$180	
	HVAC ($/SF/YR)	375	SF	$25	$9,375	
	Total					$27,675
	Equipment					
	Pickup Truck (1/6 time)	2	MO	$750	$1,500	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$5,300
	Parts					
	Pump Station (2.5%/YR)	1	LS	$2,414	$2,414	
	Electrical	1	LS	$635	$635	
	Total					$3,049
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/6 time)	0.17	YR	$56,500	$9,605	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$19,483
	Grand Total					**$55,507**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau West Pump Station

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$1,199	$14,388	
	Pump No.2 ($0.05/kW-hr)	6	MO	$1,199	$7,194	
	Pump No.3 ($0.05/kW-hr)		MO			
	Service Charge	12	MO	$250	$3,000	
	Miscelaneous Lighting (2-400 W lamps at $0.05/kW-hr)	12	MO	$15	$180	
	HVAC ($/SF/YR)	375	SF	$25	$9,375	
	Total					$34,137
	Equipment					
	Pickup Truck (1/6 time)	2	MO	$750	$1,500	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$5,300
	Parts					
	Pump Station (2.5%/YR)	1	LS	$3,250	$3,250	
	Electrical	1	LS	$641	$641	
	Total					$3,891
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/6 time)	0.17	YR	$56,500	$9,605	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$19,483
	Grand Total					**$62,811**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau North Pump Station

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$464	$5,568	
	Pump No.2 ($0.05/kW-hr)	6	MO	$464	$2,784	
	Service Charge	12	MO	$250	$3,000	
	Miscelaneous Lighting (2-400 W lamps at $0.05/kW-hr)	12	MO	$15	$180	
	HVAC ($/SF/YR)	375	SF	$25	$9,375	
	Total					$20,907
	Equipment					
	Pickup Truck (1/6 time)	2	MO	$750	$1,500	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$5,300
	Parts					
	Pump Station (2.5%/YR)	1	LS	$1,795	$1,795	
	Electrical	1	LS	$650	$650	
	Total					$2,445
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/6 time)	0.17	YR	$56,500	$9,605	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$19,483
	Grand Total					**$48,135**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Lansford Reservoir
4 MG

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Service Charge, Recharge Basin (power)	12	MO	$250	$3,000	
	Miscelaneous Lighting (4-400 W lamps at $0.05/kW-hr)	12	MO	$29	$348	
	Total					$3,348
	Equipment					
	Pickup Truck (1/6 time)	2	MO	$750	$1,500	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$5,300
	Parts					
	Pipes, Valves	1	LS	$1,054	$1,054	
	Electrical	1	LS	$350	$350	
	Tank (at 1%)	1	LS	$26,934	$26,934	
	Total					$28,338
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/6 time)	0.17	YR	$56,500	$9,605	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$19,483
	Grand Total					**$56,469**

NOTES
- Maintenance equipment is shared within the NAWS bulk distribution system.
- Labor costs are shared within the NAWS bulk distribution system.
- Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Common Component
Component: Bottineau Reservoir
2 MG

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Service Charge, Recharge Basin (power)	12	MO	$250	$3,000	
	Miscelaneous Lighting (4-400 W lamps at $0.05/kW-hr)	12	MO	$29	$348	
	Total					$3,348
	Equipment					
	Pickup Truck (1/6 time)	2	MO	$750	$1,500	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$5,300
	Parts					
	Pipes, Valves	1	LS	$1,040	$1,040	
	Electrical	1	LS	$350	$350	
	Tank (at 1%)	1	LS	$16,692	$16,692	
	Total					$18,082
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/6 time)	0.17	YR	$56,500	$9,605	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$19,483
	Grand Total					**$46,213**

NOTES
- Maintenance equipment is shared within the NAWS bulk distribution system.
- Labor costs are shared within the NAWS bulk distribution system.
- Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Minot Recharge Facility

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Service Charge, Recharge Basin (power)	12	MO	$250	$3,000	
	Miscelaneous Lighting (8-400 W lamps at $0.05/kW-hr)	12	MO	$56	$672	
	HVAC ($/SF/YR) (Office Building, 20' x 25', 6 MO/YR)	500	SF	$12.50	$6,250	
	Total					$9,922
	Recharge Basin and Grit Tank					
	Remove and Replace Graded Filter Gravel (8 wells/YR)	8	LS	$5,000	$40,000	
	Refurbish Filter Drains (8 wells/YR)	8	LS	$4,000	$32,000	
	Pickup Truck (1/3 time)	4	MO	$750	$3,000	
	Wheel Loader for Sludge Removal at Grit Tank (2 days/MO)	8	DAY	$1,200	$9,600	
	Total					$84,600
	Parts					
	Grit Tank and Recharge Basin Piping	1	LS	$5,600	$5,600	
	Total					$5,600
	Labor					
	Supervisor (1/4 Time)	0.25	YR	$94,080	$23,520	
	Maintenance (3 Operators, 1/6 time)	0.50	YR	$56,500	$28,250	
	Secretarial (1/6 time)	0.17	YR	$29,400	$4,851	
	Total					$56,621
	Grand Total					**$156,743**

NOTES
- Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.
- Souris River Intake O&M costs account for 89.4% of Power, 79% of Parts and 50% of Labor ($164,178)

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: In-basin Alternative Component
Component: Sundre Recharge Facility

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Service Charge, Recharge Basin (power)	12	MO	$250	$3,000	
	Miscelaneous Lighting (8-400 W lamps at $0.05/kW-hr)	12	MO	$56	$672	
	HVAC ($/SF/YR) (Office Building, 20' x 25', 6 MO/YR)	500	SF	$12.50	$6,250	
	Total					$9,922
	Recharge Basin and Grit Tank					
	Remove and Replace Graded Filter Gravel (8 wells/YR)	8	LS	$5,000	$40,000	
	Refurbish Filter Drains (8 wells/YR)	8	LS	$4,000	$32,000	
	Pickup Truck (1/3 time)	4	MO	$750	$3,000	
	Wheel Loader for Sludge Removal at Grit Tank (2 days/MO)	8	DAY	$1,200	$9,600	
	Total					$84,600
	Parts					
	Grit Tank and Recharge Basin Piping	1	LS	$5,600	$5,600	
	Total					$5,600
	Labor					
	Supervisor (1/4 Time)	0.25	YR	$94,080	$23,520	
	Maintenance (3 Operators, 1/6 time)	0.50	YR	$56,500	$28,250	
	Secretarial (1/6 time)	0.17	YR	$29,400	$4,851	
	Total					$56,621
	Grand Total					**$156,743**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: South Prairie Reservoir
3 MG

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Service Charge, Recharge Basin (power)	12	MO	$250	$3,000	
	Miscelaneous Lighting (4-400 W lamps at $0.05/kW-hr)	12	MO	$29	$348	
	Total					$3,348
	Equipment					
	Pickup Truck (1/6 time)	2	MO	$750	$1,500	
	Loader/Backhoe (1/12 time)	1	MO	$3,800	$3,800	
	Total					$5,300
	Parts					
	Pipes, Valves	1	LS	$2,800	$2,800	
	Electrical	1	LS	$350	$350	
	Tank (at 1%)	1	LS	$9,500	$9,500	
	Total					$12,650
	Labor					
	Supervisor (1/12 time)	0.08	YR	$94,080	$7,526	
	Maintenance (1/4 time)	0.17	YR	$56,500	$9,605	
	Secretarial (1/12 time)	0.08	YR	$29,400	$2,352	
	Total					$19,483
	Grand Total					**$40,781**

NOTES
- Maintenance equipment is shared with transmission line.
- Labor costs are shared with transmission line.
- Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: SCPP Modifications, Alternative 3

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$20,196	$242,350	
	Pump No.2 ($0.05/kW-hr)	12	MO	$20,196	$242,350	
	Pump No.3 ($0.05/kW-hr)	3	MO	$20,196	$60,588	
	Pump No.4 ($0.05/kW-hr)		MO	$20,196		
	Miscelaneous Lighting (12-400 W lamps at $0.05/kW-hr) @ Auxiliary Buildings	12	MO	$85	$1,020	
	HVAC ($/SF/YR)	1,200	SF	$25	$30,000	
	Total					$576,308
	Equipment					
	Pickup Truck	12	MO	$750	$9,000	
	Total					$9,000
	Parts					
	Intake	1	LS	$2,000	$2,000	
	Pump Station (2.5%/YR)	1	LS	$53,000	$53,000	
	Surge Tank	1	LS	$5,100	$5,100	
	Power Generator	1	LS	$4,800	$4,800	
	Total					$64,900
	Labor					
	Supervisor II	1	YR	$117,600	$117,600	
	Operator	2	YR	$94,080	$188,160	
	Secretarial (1/2 time)	0.5	YR	$29,400	$14,700	
	Total					$320,460
	Grand Total					**$970,668**

NOTES
- Costs for HVAC were based on 1,200 sq. ft. floor area. The actual floor area used by NAWS may differ.
- Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: SCPP Modifications, Alternative 4

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$24,340	$292,080	
	Pump No.2 ($0.05/kW-hr)	12	MO	$24,340	$292,080	
	Pump No.3 ($0.05/kW-hr)	3	MO	$24,340	$73,020	
	Pump No.4 ($0.05/kW-hr)		MO	$24,340		
	Miscelaneous Lighting (12-400 W lamps at $0.05/kW-hr) @ Auxiliary Buildings	12	MO	$85	$1,020	
	HVAC ($/SF/YR)	1,200	SF	$25	$30,000	
	Total					$688,200
	Equipment					
	Pickup Truck	12	MO	$750	$9,000	
	Total					$9,000
	Parts					
	Intake	1	LS	$2,000	$2,000	
	Pump Station (2.5%/YR)	1	LS	$54,000	$54,000	
	Surge Tank	1	LS	$5,100	$5,100	
	Power Generator	1	LS	$4,800	$4,800	
	Total					$65,900
	Labor					
	Supervisor II	1	YR	$117,600	$117,600	
	Operator	2	YR	$94,080	$188,160	
	Secretarial (1/2 time)	0.5	YR	$29,400	$14,700	
	Total					$320,460
	Grand Total					**$1,083,560**

NOTES
- Costs for HVAC were based on 1,200 sq. ft. floor area. The actual floor area used by NAWS may differ.
- Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake, South Shore, Alternative 3

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$23,013	$276,156	
	Pump No.2 ($0.05/kW-hr)	12	MO	$23,013	$276,156	
	Pump No.3 ($0.05/kW-hr)	6	MO	$23,013	$138,078	
	Pump No.4 ($0.05/kW-hr)	3	MO	$23,013	$69,039	
	Pump No.5 ($0.05/kW-hr)					
	Service Charge	12	MO	$250	$3,000	
	Miscelaneous Lighting (12-400 W lamps at $0.05/kW-hr) @ Auxiliary Buildings	12	MO	$85	$1,020	
	HVAC ($/SF/YR)	6,018	SF	$25	$150,450	
	Total					$913,899
	Equipment					
	Pickup Truck	12	MO	$750	$9,000	
	Total					$9,000
	Parts					
	Intake	1	LS	$2,000	$2,000	
	Pump Station (2.5%/YR)	1	LS	$42,600	$42,600	
	Surge Tank	1	LS	$4,800	$4,800	
	Power Generator	1	LS	$3,650	$3,650	
	Total					$53,050
	Labor					
	Supervisor II	1	YR	$117,600	$117,600	
	Operator	2	YR	$94,080	$188,160	
	Secretarial (1/2 time)	0.5	YR	$29,400	$14,700	
	Total					$320,460
	Grand Total					**$1,296,409**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake, South Shore, Alternative 4

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$25,682	$308,184	
	Pump No.2 ($0.05/kW-hr)	12	MO	$25,682	$308,184	
	Pump No.3 ($0.05/kW-hr)	6	MO	$25,682	$154,092	
	Pump No.4 ($0.05/kW-hr)	3	MO	$25,682	$77,046	
	Pump No.5 ($0.05/kW-hr)					
	Service Charge	12	MO	$250	$3,000	
	Miscelaneous Lighting (12-400 W lamps at $0.05/kW-hr) @ Auxiliary Buildings	12	MO	$85	$1,020	
	HVAC ($/SF/YR)	6,018	SF	$25	$150,450	
	Total					$1,001,976
	Equipment					
	Pickup Truck	12	MO	$750	$9,000	
	Total					$9,000
	Parts					
	Intake	1	LS	$2,000	$2,000	
	Pump Station (2.5%/YR)	1	LS	$46,300	$46,300	
	Surge Tank	1	LS	$4,800	$4,800	
	Power Generator	1	LS	$3,650	$3,650	
	Total					$56,750
	Labor					
	Supervisor II	1	YR	$117,600	$117,600	
	Operator	2	YR	$94,080	$188,160	
	Secretarial (1/2 time)	0.5	YR	$29,400	$14,700	
	Total					$320,460
	Grand Total					**$1,388,186**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 3

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$15,634	$187,608	
	Pump No.2 ($0.05/kW-hr)	12	MO	$15,634	$187,608	
	Pump No.3 ($0.05/kW-hr)	6	MO	$15,634	$93,804	
	Pump No.4 ($0.05/kW-hr)	3	MO	$15,634	$46,902	
	Pump No.5 ($0.05/kW-hr)					
	Service Charge	12	MO	$250	$3,000	
	Miscelaneous Lighting (12-400 W lamps at $0.05/kW-hr) @ Auxiliary Buildings	12	MO	$85	$1,020	
	HVAC ($/SF/YR)	6,018	SF	$25	$150,450	
	Total					$670,392
	Equipment					
	Pickup Truck	12	MO	$750	$9,000	
	Total					$9,000
	Parts					
	Intake	1	LS	$2,000	$2,000	
	Pump Station (2.5%/YR)	1	LS	$39,000	$39,000	
	Surge Tank	1	LS	$4,800	$4,800	
	Power Generator	1	LS	$3,650	$3,650	
	Total					$49,450
	Labor					
	Supervisor II	1	YR	$117,600	$117,600	
	Operator	2	YR	$94,080	$188,160	
	Secretarial (1/2 time)	0.5	YR	$29,400	$14,700	
	Total					$320,460
	Grand Total					**$1,049,302**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Intake Adjacent to SCPP, Alternative 4

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Power					
	Pump No.1 ($0.05/kW-hr)	12	MO	$19,891	$238,692	
	Pump No.2 ($0.05/kW-hr)	12	MO	$19,891	$238,692	
	Pump No.3 ($0.05/kW-hr)	6	MO	$19,891	$119,346	
	Pump No.4 ($0.05/kW-hr)	3	MO	$19,891	$59,673	
	Pump No.5 ($0.05/kW-hr)					
	Service Charge	12	MO	$250	$3,000	
	Miscelaneous Lighting (12-400 W lamps at $0.05/kW-hr) @ Auxiliary Buildings	12	MO	$85	$1,020	
	HVAC ($/SF/YR)	6,018	SF	$25	$150,450	
	Total					$810,873
	Equipment					
	Pickup Truck	12	MO	$750	$9,000	
	Total					$9,000
	Parts					
	Intake	1	LS	$2,000	$2,000	
	Pump Station (2.5%/YR)	1	LS	$44,000	$44,000	
	Surge Tank	1	LS	$4,800	$4,800	
	Power Generator	1	LS	$3,650	$3,650	
	Total					$54,450
	Labor					
	Supervisor II	1	YR	$117,600	$117,600	
	Operator	2	YR	$94,080	$188,160	
	Secretarial (1/2 time)	0.5	YR	$29,400	$14,700	
	Total					$320,460
	Grand Total					**$1,194,783**

NOTES - Parts costs are assumed two percent of construction cost in the category, unless otherwise noted.

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PROJECT O&M SUMMARY

Project: NAWS
Type: Missouri River Alternarive Component
Component: Biota WTP

NO.	DESCRIPTION	TOTAL
1	Chlorination	$1,206,105
2	Chlorination/UV Inactivation	$1,453,662
3	Enhanced Chlorination/UV Inactivation	$1,754,387
4	Conventional Treatment	$2,256,852
5	Microfiltration Treatment	$2,360,894

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Chloriation Treatment Option

Item	Unit cost	Unit	Amount	Amount/yr	Cost/yr	Total/yr
Chemicals						
Chlorine gas	$788	per ton cylinder	0.433	158	$124,527	
Ammonia – Liquid	$1.49	per gal	102	37230	$55,604	
					Total	**$180,131**
Equipment and Mainteance						
Chlorine Feed	$25,000	ea (every 10 yrs)	3	3	$7,500	
Ammonia Metering Pumps	$22,109	ea (every 10 yrs)	2	2	$4,422	
Standby Power	$5,000	per year	1	1	$5,000	
Pump Station	$25,000	per year	1	1	$25,000	
					Total	**$41,922**
Labor						
Employee – Supervisor	$117,600	per year	1	1	$117,600	
Operator	$94,080	per year	1	1	$94,080	
Chemist (1/2 time)	$47,040	per year	1	0.5	$23,520	
Secretary (1/2 time)	$29,400	per year	1	0.5	$14,700	
					Total	**$249,900**
Power						
HVAC	$0.05	per KW-hr	652	5708016	$285,401	
Booster Pump Station	$0.05	per KW-hr	689	2345039	$117,252	
General	$0.05	per KW-hr	750	6570000	$328,500	
Monthly Service Charge	$250	per month	12	12	$3,000	
					Total	**$734,153**
					Grand Total	**$1,206,105**

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Chlorination/UV Inactivation Option

Item	Unit cost	Unit	Amount	Amount/yr	Cost/yr		Total/yr
Chemicals							
Chlorine gas	$788	per ton cylinder	0.433	158	$124,527		
Ammonia – Liquid	$1.49	per gal	102	37230	$55,604		
						Total	**$180,131**
Equipment and Mainteance							
UV Replacement Lamps	$12,236	per year (@13 mgd)	1	1	$9,506		
Chlorine Feed	$25,000	ea (every 10 yrs)	3	3	$7,500		
Ammonia Metering Pumps	$22,109	ea (every 10 yrs)	2	2	$4,422		
Standby Power	$5,000	per year	1	1	$5,000		
Pump Station	$25,000	per year	1	1	$25,000		
						Total	**$51,428**
Labor							
Employee – Supervisor	$117,600	per year	1	1	$117,600		
Operator	$94,080	per year	2	2	$188,160		
Chemist (1/2 time)	$47,040	per year	1	1	$47,040		
Secretary (1/2 time)	$29,400	per year	1	0.5	$14,700		
						Total	**$367,500**
Power							
HVAC	$0.05	per KW-hr	652	5708016	$285,401		
Booster Pump Station	$0.05	per KW-hr	689	2345039	$117,252		
UV	$0.05	per KW-hr	275	2409000	$120,450		
General	$0.05	per KW-hr	750	6570000	$328,500		
Monthly Service Charge	$250	per month	12	12	$3,000		
						Total	**$854,603**
						Grand Total	**$1,453,662**

DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Enhanced Chlorination/UV Inactivation Option

Item	Unit cost	Unit	Amount	Amount/yr	Cost/yr		Total/yr
Chemicals							
Polymer	$10.10	per gal	10	3650	$36,872		
Chlorine gas	$788	per ton cylinder	0.433	158	$124,527		
Ammonia – Liquid	$1.49	per gal	102	37230	$55,604		
Centerfuge Polymer	$13.64	per gal	10	3650	$49,792		
						Total	**$266,794**
Equipment and Mainteance							
Filter Equipment	$70,000	per year	1	0.3	$21,000		
UV Replacement Lamps	$12,236	per year (@13 mgd)	1	1	$9,506		
Chlorine Feed	$25,000	ea (every 10 yrs)	3	3	$7,500		
Ammonia Metering Pumps	$22,109	ea (every 10 yrs)	2	2	$4,422		
Chemical Metering Pumps	$3,500	ea (every 10 yrs)	7	7	$2,450		
Filter Media Replacement	$100,000	all media (ea 10 yrs)	1	0.3	$3,000		
Standby Power	$5,000	per year	1	1	$5,000		
Pump Stations	$40,000	per year	1	1	$40,000		
						Total	**$92,878**
Labor							
Employee – Supervisor	$117,600	per year	1	1	$117,600		
Operator	$94,080	per year	2	2	$188,160		
Chemist	$47,040	per year	1	1	$47,040		
Secretary	$29,400	per year	1	1	$29,400		
						Total	**$382,200**
Power							
HVAC	$0.05	per KW-hr	977	8562024	$428,101		
Booster Pump Station	$0.05	per KW-hr	689	2345039	$117,252		
Filter Pump Station	$0.05	per KW-hr	89	304221	$15,211		
UV	$0.05	per KW-hr	275	2409000	$120,450		
General	$0.05	per KW-hr	750	6570000	$328,500		
Monthly Service Charge	$250	per month	12	12	$3,000		
						Total	**$1,012,514**
						Grand Total	**$1,754,387**

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DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Conventional Treatment Option

Item	Unit cost	Unit	Amount	Amount/yr	Cost/yr		Total/yr
Chemicals							
Coagulant	$1.73	per gal	190	69350	$119,887		
Polymer	$10.10	per gal	26	9490	$95,866		
Chlorine gas	$788	per ton cylinder	0.433	158	$124,527		
Ammonia – Liquid	$1.49	per gal	102	37230	$55,604		
Centerfuge Polymer	$13.64	per gal	10	3650	$49,792		
						Total	**$445,676**
Equipment and Mainteance							
DAF Equipment	$100,000	per year	1	1	$100,000		
Rapid Mixers	$35,280.00	ea (every 10 yrs)	2	2	$7,056		
First Stage Flocculators	$26,413	ea (every 10 yrs)	6	6	$15,848		
Second Stage Flocculators	$17,131.97	ea (every 10 yrs)	6	6	$10,279		
Third Stage Flocculators	$14,568.00	ea (every 10 yrs)	6	6	$8,741		
UV Replacement Lamps	$4,468.00	per year (@13 mgd)	1	1	$3,471		
Chlorine Feed	$25,000	ea (every 10 yrs)	3	3	$7,500		
Ammonia Metering Pumps	$22,109	ea (every 10 yrs)	2	2	$4,422		
Chemical Metering Pumps	$3,500	ea (every 10 yrs)	7	7	$2,450		
Filter Media Replacement	$235,200	all media (ea 10 yrs)	1	1	$23,520		
Standby Power	$5,000	per year	1	1	$5,000		
Pump Station	$25,000	per year	1	1	$25,000		
						Total	**$213,287**
Labor							
Employee – Supervisor	$117,600	per year	1	1	$117,600		
Operator	$94,080	per year	2	2	$188,160		
Chemist	$47,040	per year	1	1	$47,040		
Secretary	$29,400	per year	1	1	$29,400		
						Total	**$382,200**
Power							
HVAC	$0.05	per KW-hr	1086	9513360	$475,668		
Booster Pump Station	$0.05	per KW-hr	689	2345039	$117,252		
UV	$0.05	per KW-hr	275	2409000	$120,450		
General+Process	$0.05	per KW-hr	1140	9986400	$499,320		
Monthly Service Charge	$250	per month	12	12	$3,000		
						Total	**$1,215,690**
						Grand Total	**$2,256,852**

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DETAILED O&M COST ESTIMATE

Project: NAWS
Type: Missouri River Alternative Component
Component: Biota WTP: Microfiltration Treatment Option

Item	Unit cost	Unit	Amount	Amount/yr	Cost/yr		Total/yr
Chemicals							
Coagulant	$1.73	per gal	75	27375	$47,324		
Primary MF Cleaning Chem.	$0.02	per 1000 gal	26000	9490000	$167,404		
Secondary MF Cleaning Chem.	$0.001	per 1000 gal	26000	9490000	$11,160		
Chlorine gas	$788	per ton cylinder	0.433	158	$124,527		
Ammonia – Liquid	$1.49	per gal	102	37230	$55,604		
Centerfuge Polymer	$13.64	per gal	10	3650	$49,792		
						Total	**$455,810**
Equipment and Mainteance							
Membrane Replacement	$150,000	per year	1	1	$150,000		
Rapid Mixers	$35,280	ea (every 10 yrs)	2	2	$7,056		
First Stage Flocculators	$26,413	ea (every 10 yrs)	6	6	$15,848		
Second Stage Flocculators	$17,132	ea (every 10 yrs)	6	6	$10,279		
Third Stage Flocculators	$14,568	ea (every 10 yrs)	6	6	$8,741		
UV Replacement Lamps	$1,787	per year (@13 mgd)	1	1	$1,388		
Chlorine Feed	$25,000	ea (every 10 yrs)	3	3	$7,500		
Ammonia Metering Pumps	$22,109	ea (every 10 yrs)	2	2	$4,422		
Chemical Metering Pumps	$3,500	ea (every 10 yrs)	4	4	$1,400		
Filter Media Replacement	$235,200	all media (ea 10 yrs)	1	1	$23,520		
Standby Power	$5,000	per year	1	1	$5,000		
Pump Station	$25,000	per year	1	1	$25,000		
						Total	**$260,154**
Labor							
Employee – Supervisor	$117,600	per year	1	1	$117,600		
Operator	$94,080	per year	2.5	2.5	$235,200		
Chemist	$47,040	per year	1	1	$47,040		
Secretary	$29,400	per year	1	1	$29,400		
						Total	**$429,240**
Power							
HVAC	$0.05	per KW-hr	1086	9513360	$475,668		
Booster Pump Station	$0.05	per KW-hr	689	2345039	$117,252		
UV	$0.05	per KW-hr	275	2409000	$120,450		
General+Process	$0.05	per KW-hr	1140	9986400	$499,320		
Monthly Service Charge	$250	per month	12	12	$3,000		
						Total	**$1,215,690**
						Grand Total	**$2,360,894**