Eagle River Reservoir and Transmission Main
UAA Senior Design Project

Conceptual Design Study Report

Prepared for:

Municipality of Anchorage
Anchorage Water & Wastewater Utility
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Executive Summary

A need for a reservoir at the upper pressure zone in the Northeast of Eagle River has been identified as an acute concern for bringing the Eagle River community up to the standard detailed in the Anchorage Water and Wastewater Utility (AWWU) 2012 master plan. The reservoir serves to fill three crucial roles: the first, in increasing the total capacity of the Eagle River subdivision to meet emergency water reserve standards. Secondly the area that the proposed reservoir would serve does not have any reservoir to aid in meeting peak demand requiring the pumps in the Eagle River Lane Booster Station to compensate by increasing power output, thus decreasing efficiency.

This report describes 35% design recommendations for reservoir material, transmission main route, pipe size, and layout. The final conclusions for these are based on several different criterion such as cost, geotechnical results, environmental wetlands, Not In My BackYard (NIMBY), and AWWU's 2018 Design and Construction Practices Manual (DCPM).

One of the challenges in the design considerations was evaluating the soil profile and types. The available boring logs were not sufficient to establish the existing soil profile at the proposed site since they were not in proximity to the area that could affect the design. The problem was solved by estimating the soil profile through an investigation of the closest boring logs and plotting the similar soil levels against the elevation. This allowed for the progression of assessing the different pipe material alternatives.

The final reservoir site is located on a parcel acquired by AWWU located at the end of Lucas Ave. The reservoir will be filled and connected to the Eagle River Lane Booster Station. The final path of the transmission main is to head north on Eagle River Lane Rd, turn east, extend to the end of Lucas Ave, and track to our final graded site pad.

A final material and dimensions for a reservoir and piping, as well as a transmission main layout are recommended. Design and construction costs of materials are analyzed.

1.0 Project Introduction

1.1 Project Background

The evaluation of the water distribution system and water storage capacity in Eagle River during the preparation of AWWU's 2012 water master plan indicates the Eagle River area to be significantly short on emergency water storage. Currently, there exists 3.75 MG of water storage capacity in Eagle River and approximately 10 MG is needed to meet the desired three day average demand storage capacity for the current water demand. The standard states that there should be at least three times the daily water supply in emergency storages.

AWWU began work on finding a suitable location for a 1 MG reservoir located in the upper hydraulic zones of its Eagle River distribution system. In 2018, it finalized the acquisition of a 7-acre parcel near Eagle River Road and Preuss Lane. This 1MG water storage reservoir is placed in the Eagle River distribution system at the 900-foot hydraulic grade line (HGL) to serve the future operational and fire storage requirements for the upper zones of Eagle River (HGLs 600, 730-1100). Storage is needed to provide demand equalization in the upper zones, mitigate operational risks associated with pressure surges, and reduce long-term capital and operational costs.

There exists now an order to develop, design, and construct a 1 MG reservoir and associated transmission main. The location of this reservoir is at the end of Lucas Ave., adjacent to the existing Hylen Crest booster station. The Hylen Crest booster helps serve and maintain the pressure at elevations greater than the 900 HGL.

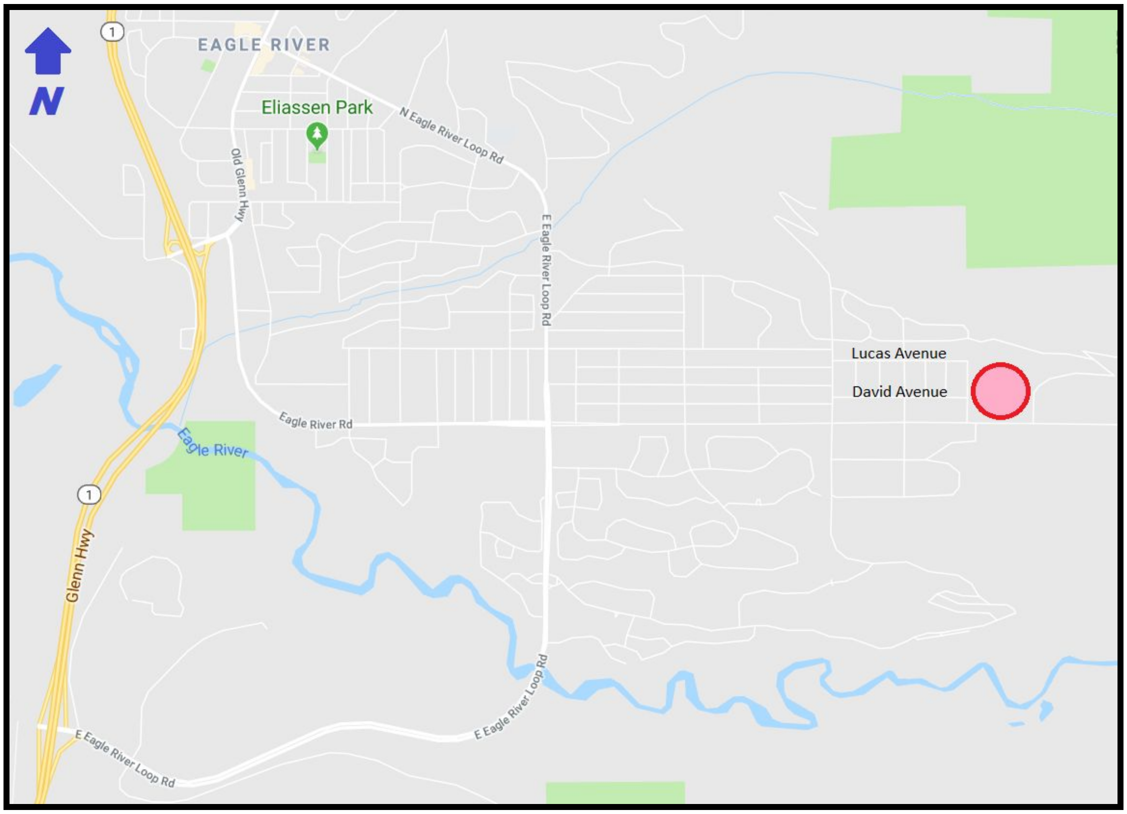


Figure 1: Project General Location

1.2 Project Goals

The purpose of this project is to provide a 35% plan of design and construction of a 1 MG water reservoir to provide operational and emergency storage capacity in the upper hydraulic zones of Eagle River's water distribution system. In order to achieve this, it is necessary to analyze the reservoir site including; the selection of reservoir construction materials, solve the appropriate dimensions of the reservoir, select the route of the transmission main to connect the reservoir to AWWU's distribution system, select transmission main construction materials, and design the dimensions of the transmission main.

1.3 Project Scope and Approach

This project will contribute to the AWWU's mission to "Provide safe and reliable water and wastewater services today and into the future". R&R Consultants agreed to complete the following deliverables by April 22, 2019.

1. Review all existing reports, records, construction methods, and material requirements; identify any constraints for construction methods and materials; present construction methods and material options not previously considered.
2. Focus on costs of installation & long-term maintenance, longevity and reliability.
3. Create a digital terrain model (DTM) of the project vicinity using data provided by AWWU.
4. Provide, a 35% level design and supporting design study report that includes evaluation of all alternatives considered, and cost analysis of alternatives.

1.4 Relationship to Existing Water System

The primary supply of water to Eagle River is the Eklutna Water Treatment Facility. Eklutna's Facility utilizes a 15 MG Clearwell to store treated water. This Clearwell has a finished floor elevation of 600' and an overflow of 630'. Water flows into Anchorage through the Eklutna Water Transmission Main Line and is distributed to Eagle River via three valve vaults (North Eagle River, Artillery, and Hiland) along the way. The Eagle River Water System is comprised of three general areas (lower, middle, and upper). Water is transferred through common corridors between these areas but each has several pressure zones within them. The project area located in the upper zones of Eagle River (660, 720, 730, 790, 880, 900, 980, 1000, 1020, 1100) are all supplied through two separate series of pump stations shown in Appendix A. With no storage in any of these zones, each station must be capable of pumping peak hour demands plus fire flows. The Hylen Crest booster station must also be relocated near the location of the new reservoir site.

2.0 Geotechnical Report

A geotechnical report is needed to determine the soil layers beneath the project area. The report must be detailed and accurate due to its impact on design considerations. Especially when evaluating This is why we recommend that further investigation is necessary before design conclusions in this report are ratified.
The soil layers were determined by evaluating the surrounding existing boring logs found in publicly accessed Geographic Information Systems maps.

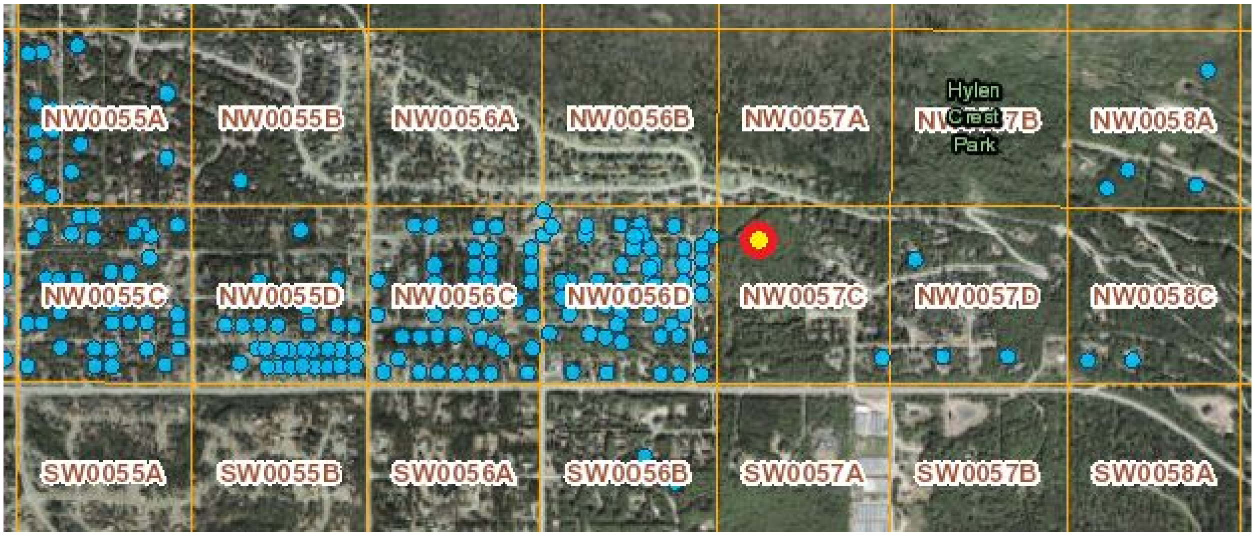


Figure 2: Boring Log Map

Note: This is an updated version of the boring log map. None of the displayed (in blue) boring logs were available at the time of the original boring log survey.

The actual boring logs were not close enough to be representative of the actual location of the transmission main and new reservoir. In order to resolve this problem and approximate the existing ground conditions, the closest boring logs were then assessed at layers of similar soils in the but found at varying depths. The different depths of the similar layers were then plotted against their elevation. The boring logs used to perform this analysis can be found in Appendix D. A best-fit line showed that at the elevation of interest at ~900 feet, the soil layers are:

Table 1: Soil Profiles

Soil Types	Depth (ft)
Sand,Silt/Organics	**1-2**
Silty Sand ~ Silty Gravel	**2- 5**
Sandy or Silty Gravel	**5-13**
Gravel	**>13**

No Water Table Found on Boring Logs

This soil profile and the lack of a water table indicates that when evaluating the different piping materials the soil does not factor in a significant way.

Newly available data arrived and confirmed, on the edge of our parcel, the lower end values of

our estimation.
A new soil investigation must be conducted to confirm and assess gaps from the results of this soil analysis. The specific results need to encompass the ph of the soil, the type of soil, the reactivity of the soil, and the possible volatile organic compounds (VOC) and other contaminants that are in the soil layers.
Based on the geotechnical data estimation, the existing soil conditions are not suitable for the bearing capacity necessary for the construction of a reservoir. It will be required to cut the existing material and replace it with more suitable soil. The fill will be Type IIA, Type II and a surface layer of asphalt. The reservoir will rest on a concrete base.

3.0 Reservoir Material Alternatives

To determine the best reservoir material for the project, the following criteria was used:

- ➢ Minimal corrosion issues
- ➢ Operations and Maintenance
- ➢ Longevity
- ➢ Cost
- ➢ Resistant to seismic activity

The design for all reservoir alternatives will be based on the American Water Works Association D classification. All reservoir alternatives will also abide by the National Sanitation Foundation 61st standard. Every design incorporates the addition of freeboard (clearance maintained between the maximum water level and the roof slab), while still within the height/diameter 1/3rd-moment rule with adherence to dead loading of internal moments within the tank to maintain structural integrity. Recommendations here were evaluated based on the tables found in appendix F.

3.1 Bolted Steel

The primary advantages of bolted tanks are the cost savings of initial construction.
Bolted tanks are made of smaller sections which allows them to be erected more easily in locations. Every bolt is a potential point of weakness. Consequently, there have been more catastrophic failures of bolted tanks than welded tanks from seismic activity. The lifespan of a bolted tank is between 25-30 years. While a bolted tank can be less expensive initially, this cost advantage disappears over time due to constant maintenance for recoating and quality control of rusting around bolt locations on this type of reservoir.

3.2 Welded Steel

A welded tank can be built in any size and capacity up to 20 MG, made of thicker steel adding years to its useful life. Welded tanks can be easily and cost-effectively adapted for cathodic protection systems. This extends the useful life of the tank's steel and its coating. With proper maintenance of recoating, the useful life of a welded tank is between 75-100 years.

3.3 Concrete

Concrete water tanks are generally the strongest and often the longest lasting alternative. Concrete can withstand extreme temperatures on both ends of the spectrum, and can be expected to safely last 40-50 years, but its life can be stretched up to 80 in some cases. They are very heavy, and difficult to handle, a 0.5 MG tank would weigh about 8 tons. Concrete water tanks are most often installed underground however smaller tanks are available for above ground. Cracking and leaking is one of the most common complaints suffered by concrete tanks. As long as the tank can be drained, the cracks can be repaired. In some unideal cases, a plastic liner is required, which can be very expensive. The tank may not perform well in earthquakes unless large quantities of steel reinforcement are incorporated into the design.

3.4 Glass Fused to Steel Bolted

Glass fused steel is a material that incorporates the strength and flexibility of steel and the corrosion resistance of glass. The glass fused-to-steel tanks possess the similar benefits as bolted steel in regards to initial cost savings of construction, but lasts longer due to the corrosion resistant glass. Glass fused tanks have a 60 year life cycle. These tanks need little to no maintenance since it is not necessary to re-coat them, nor are the bolts on the tank as susceptible to rust as its non glass fused bolted counterpart.

3.5 Reservoir Material Recommendation

The glass fused to steel bolted tank is the recommended reservoir material for this project. Due to its exceptional life cycle performance, effectively low initial cost, with no maintenance needed for re-coating, and virtually no post-construction maintenance, glass fused to steel material shows to be the superior option and is the material recommendation. The design for the dimensions of a glass fused to steel bolted reservoir include:

- Diameter: 90'
- Height: 30'
- Roof slab thickness: 1/8"
- Circumference thickness: 1/4"
- Base plate thickness: 1/4"

4.0 Transmission Main Route Alternatives

Three routing options were reviewed as shown in Figure 3. The options reviewed are:

Route A: North along Eagle River Ln from the intersection of Eagle River Ln and Lucas Ave to the Hylen booster station.

Route B: Route from the intersection of Eagle River Ln and David Ave, North along Eagle River Ln, East on David Ave

Route C: Route from the intersection of Eagle River Ln and David Ave, North along Eagle River Ln, East on David Ave to Preuss Ln, turn north on Preuss Ln, turn East on Lucas Ave, and follow to the Hylen Crest booster station.

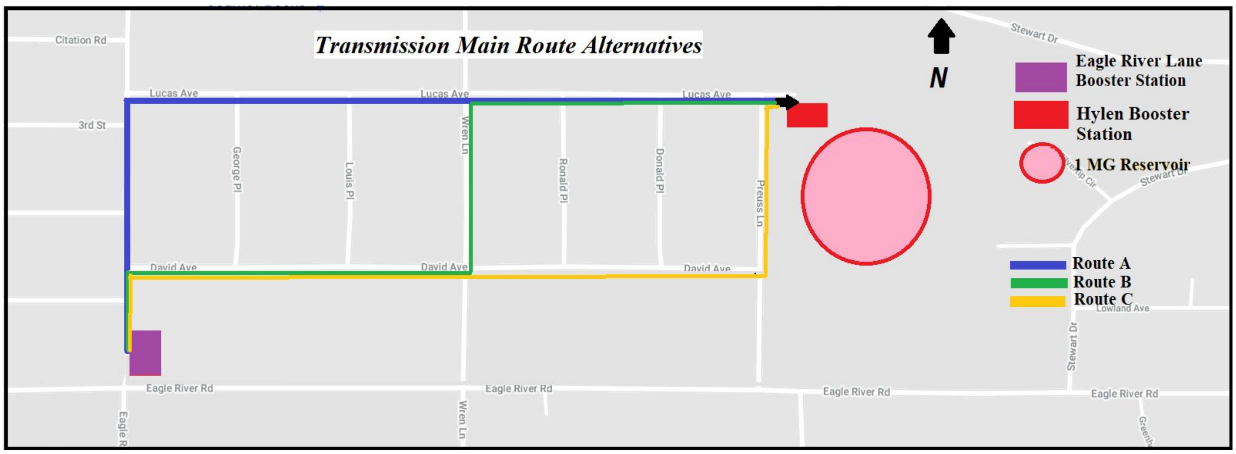


Figure 3: Transmission Main Route Alternatives

Table 2: Transmission Main Routes Alternatives

Transmission Main Routes	Comments
Route A	**One 90 degree turn, shortest length, Least conflicts with utilities**
Route B	**Three 90 degree turns**
Route C	**Three 90 degree turns, longest length**

The recommended alternative is Route A. Within this corridor the selected pipe route minimizes existing utility conflict, traffic impacts, and property owner impacts. Safe slopes indicate the following path is superior.

5.0 Environmental Considerations

Wetlands

The Municipality of Anchorage (MOA) Wetlands Atlas and the National Wetlands Inventory (NWI) has not been identified a wetland in the project area. The steep slope and lack the of a groundwater table and other water features would indicate a very low ranking.

Contaminated site

According to the Alaska Department of Environmental Conservation (ADEC) map, the project property is not suspected to be on or near a contaminated site within 1 mile to 2 mile radii. This will help in the evaluation of our pipe materials.

6.0 Pipe Material Alternatives

Two piping materials, Ductile Iron Pipe (DIP), and PolyVinyl Chloride (PVC), were evaluated. The primary consideration when evaluating the pipe materials is its known and expected performance based on the soil conditions. The different types of soils that a pipe may be embedded in could eliminate it as a candidate or require that alteration be made to make it compatible with the soils known condition.

The dominant consideration from the soil that would apply is the likelyhood or known existing presence of contaminated soil, the most intrusive of which are known as volatile organic compounds (VOC). A VOC is defined as:

Secondly pipe materials were evaluate based on water content of the soil and water table. The results of this will impact the types of joints that are used and level of cathodic protection that is required for DIP mains.

All design conclusions must be checked against AWWU's Design Construction Practices Manual (DCPM), American Water Works Association (AWWA), and the Municipality of Anchorage Standard Specifications (MASS).

6.1 High Density Polyethylene (HDPE)

HDPE was quickly ruled out as a pipe material alternative. AWWU does not permit the use of HDPE pipe for use as a transmission main.

6.2 Ductile Iron Pipe (DIP)

The existing pipe infrastructure in the Eagle River area is largely DIP, which is an acceptable material per AWWU standards for transmission mains. The ductile iron pipe for potable water needs to be a pressure class 52 pipe and conform to the American Water Works Association (AWWA) C-151 which describes allowable joint types. When designing ductile iron pipe, it should be noted that it includes a 100 psi surge allowance and a 2:1 nominal safety factor. Being a pressure class 52 pipe with a minimum design value of 200 psi would indicate an expected failure pressure at 500 psi. This pipe would be very strong and would be expected to perform for at least 50 years.

DIP requires a cathodic protection system to protect against the electrolytic corrosion phenomena that occurs in metal pipe buried in soil. This system is commonly implemented in the form of sacrificial anodes. In certain soils improved cathodic protection might be necessary if it is determined that the soil corrosivity is greater than average. All cathodic protection (CP) systems must be stamped by a Professional Engineer (PE) and co-stamped by a National Association of Corrosion Engineers (NACE)-certified corrosion specialist: the exception being simply placed anodes.

6.3 Polyvinyl Chloride (PVC)

While PVC C900 is a viable material, it is not used in common practice for transmission mains and requires special permission by AWWU’s Engineering Division Director to use in this capacity and size. Though PVC is cheaper, the price of the piping is not a large concern. PVC would be best to use in soils with high corrosivity and significant VOC concerns. Based on the estimations and analysis of the given area this is not the case and therefore PVC was eliminated as our candidate.

6.3 Pipe Sizing

The pipe size was determined by evaluating the pressure and flow speed, and how it would be affected by the different pipe cross sections. It was determined that in order to maintain a conservative and safe mass flow rate through the piping system, a pipe with an inside diameter of 12” would be effective and economical. This was done by way of hydraulic pressure analysis and observations of other reservoir tanks with similar circumstances to this projects needs.

6.5 Pipe Product Recommendation

The pipe products listed below were the result of a collaboration with a local vendor, HD Supply, for different water pipes. All material listed is compliant with AWWU standards, or is regarded as a higher tier product than what meets the minimum qualifications.

TR FLEX CL 52 Ductile Iron Pipe
TR FLEX 90 C110 USA
NORTHTOWN 20#MAGNESIUM ANODE W/ #10 WIRE LEAD CP-A-M 20#-10- 10HMW
THERMOWELD M-161-16 16”-24” MOLD
THERMOWELD CI32 SHOT

WIRE HMWPE 2 BLK 7STR CU 500 FT
ROYSTON HANDY CAP IP/PRIMERLES
14-16 VBIO POLYWRAP 34 LAYFLAT 8 MIL 300’ ROLL WHITE
16” TF2 TIDEFLEX CHECK VALVE

7.0 Permits

Utility permits will need to be obtained from the the Municipality of Anchorage (MOA). The permit from the municipality is required for the construction of utilities on the municipality’s right of way. The project will also require a traffic control plan to be submitted to the MOA.

It is required that approvals from the Alaska Department of Environmental Conservation (ADEC) be obtained, this will include Approval to Construct and Approval to Operate for the extension of the mainline. Building permits will be needed for the construction of the reservoir and the booster station. Construction easements should be acquired to allow access to the site.

8.0 Public Involvement and Property Owner Relations

The project property is located in the Northeast region of Eagle River. It is located in a residential area that is notably concerned with large infrastructure impacting the local environment and unsightly projects ruining the superb natural view. When considering public involvement, the objective was focused on the needs and goals of the project, and how the residents and project development team can work in tandem with the public's concerns in mind to create a better product for everyone affected by this project’s final results.

Prior to construction, all affected landowners should be notified of the planned construction impacts as well as any right-of-way land acquisition by mail. AWWU should maintain a mailing list, and use it as a means to distribute valuable information to affected landowners. The mailing list should also include elected members, agencies, and any other people AWWU feels would benefit from the information. AWWU should also initiate and maintain a 24/7 project telephone that should allow landowners to contact project officials with any questions.

An informal 3rd party person survey of the residents near the area of operation was conducted. The results of the survey indicated favorably for a reservoir over more residential development. . The interviewed persons also indicated that the tank should be painted to make it blend in and be generally more aesthetically pleasing.

9.0 Cost Estimate

The total construction cost estimated for the project is 2.1 million dollars. The total cost that includes the cost of design, administration, management and overhead comes to 3.15 million dollars. The breakdown of these costs are located in Table 5.

Table 5: Estimated Costs

Item	Unit	Unit Cost	Quantity	Total
Mobilization & Demobilization (max 6% bid)	LS	$92,044	1	$92,044
Temporary Erosion Control	LS	$20,000	1	$20,000
Steel Tank	LS	$640,000	1	$640,000
Clearing and Grubbing	ACRE	$20,000	1	$20,000
Furnish Trench Backfill (Type II)	TON	$21	980	$20,600
Leveling Course	TON	$35	2508	$87,780
Trench Excavation and Backfill	LF	$50	3762	$188,100
Bedding Material	LF	$20	3762	$75,300
Shoring, Sheeting and Bracing	LF	$10	3762	$37,620
Removal of Existing Pavement	SY	$5	2508	$12,540
A.C. Pavement	TON	$85	980	$83,300
Furnish and Install 12" Pipe	LF	$89	3762	$334,818
Connect to Existing Water Line	EA	$4,000	2	$8,000
Traffic Control and Maintenance (8% of Construction Costs)	LS	$122,725	1	$122,725
Subtotal				$1,748,827
Contingency		20%		$349,766
Total Estimated Cost				**$2,098,593**

Engineering, Administration and Right-of-Way Costs

Design, permitting, public participation	LS	$200,000
Construction Management	12%	$251,832
AWWU Administration and Legal Fees	5%	$104,930
Real Estate/TCPs	2%	$41,972
Engineering/Admin Subtotal		$598,734
Construction/Engineering/Admin/ROW Subtotal		$2,697,327
AWWU Overhead	10%	$269,733
Subtotal		$2,967,060
AFUDC	6.1%	$180,991
Total Project Cost		**$3,148,318**

10.0 Recommendations

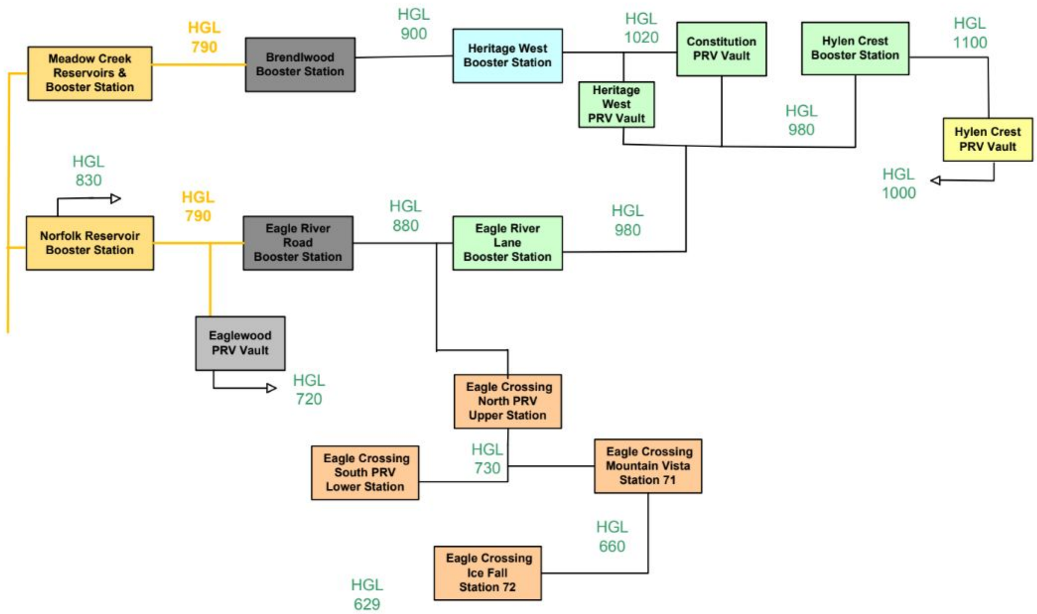
Here is the complete summary of the recommendations based on the results of this report. The existing Hylen Crest booster station is suggested to be demolitioned, and a new booster station shall be constructed on the proposed site. Excavation of the existing soil must be removed and replaced with a soil with a larger bearing capacity. The surface layer of the proposed site will be covered with asphalt with the addition of a concrete base pad with a 92’ diameter to support the reservoir. The suggested reservoir material is a glassed fused to steel bolted tank. The design for the dimensions of the glass fused to steel bolted reservoir include:

- Diameter: 90’
- Height: 30’
- Roof slab thickness: 1/8”
- Circumference thickness: 1/4”
- Base plate thickness: 1/4”

Route A was selected as the effective route (North along Eagle River Ln, turn East along Lucas Ave, follow Lucas Ave to its end, and then connect to the proposed site pad) is the optimum route for selection with a 12” diameter ductile iron pipe for the transmission main material. Utility permits must be obtained, approvals to construct and operate are required, traffic control plans must be submitted, building permits will be needed, and construction easements must be required.

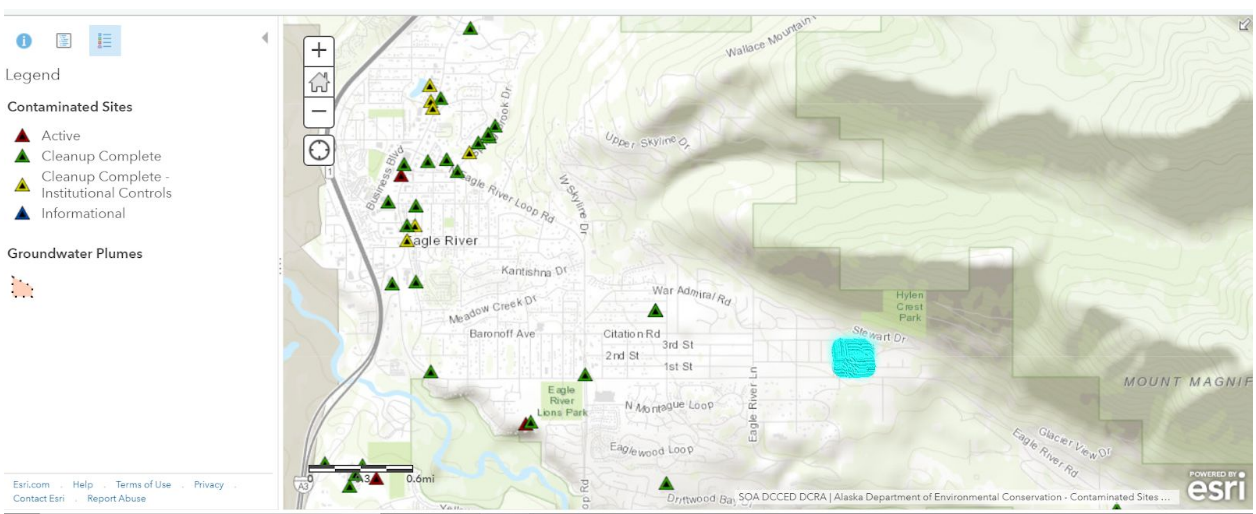
Appendix A

Current Eagle River Water System

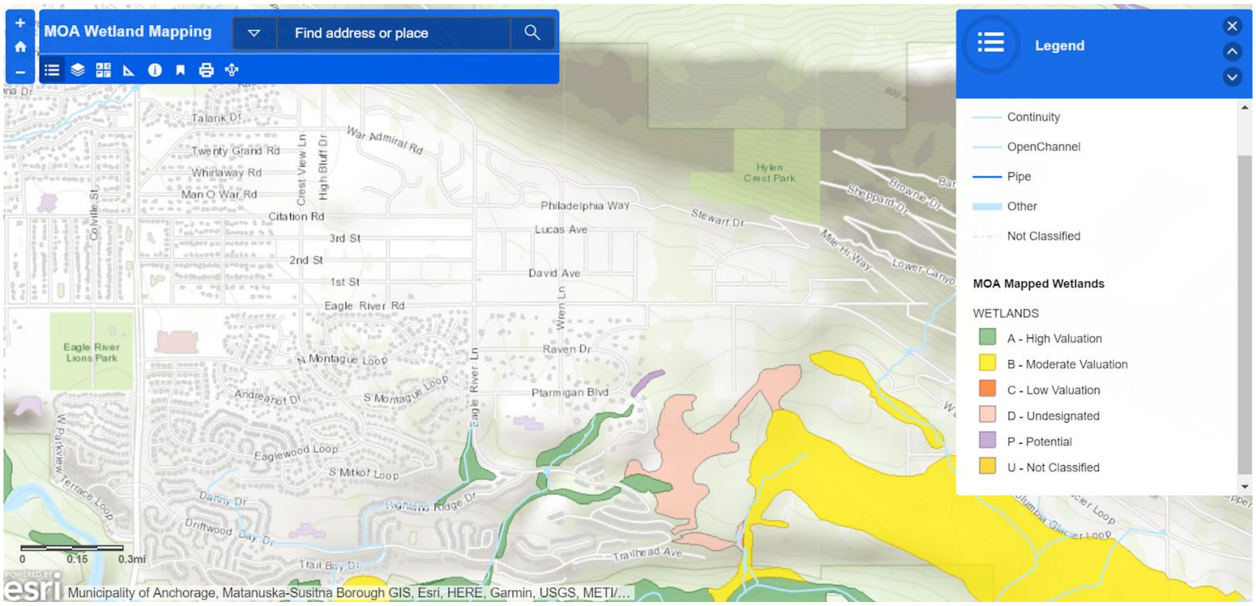


Appendix B

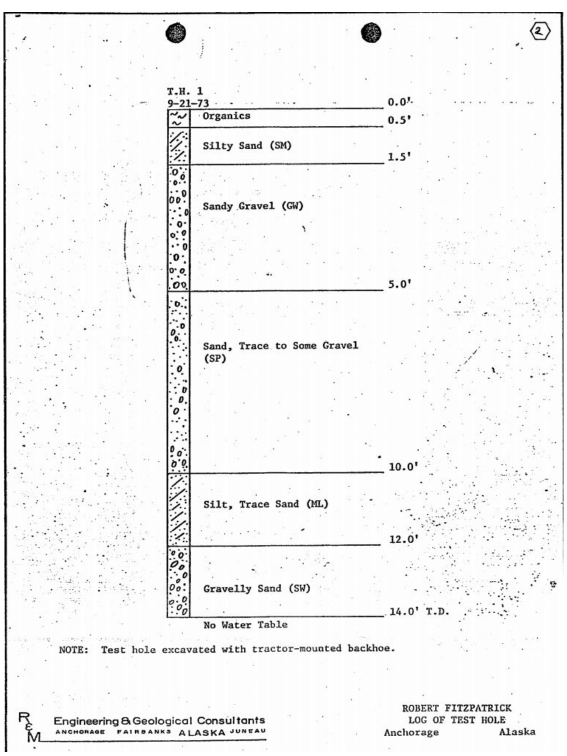
Contaminated Site Map

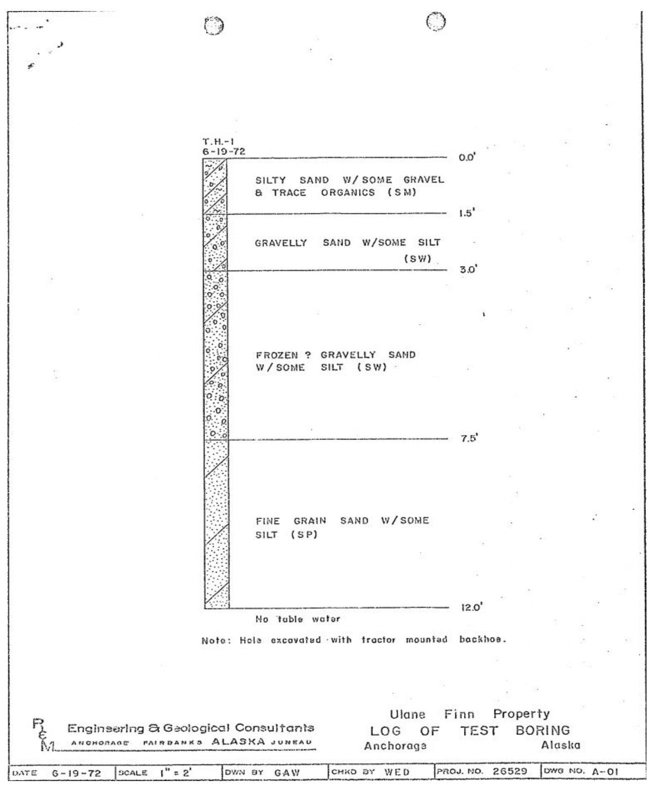


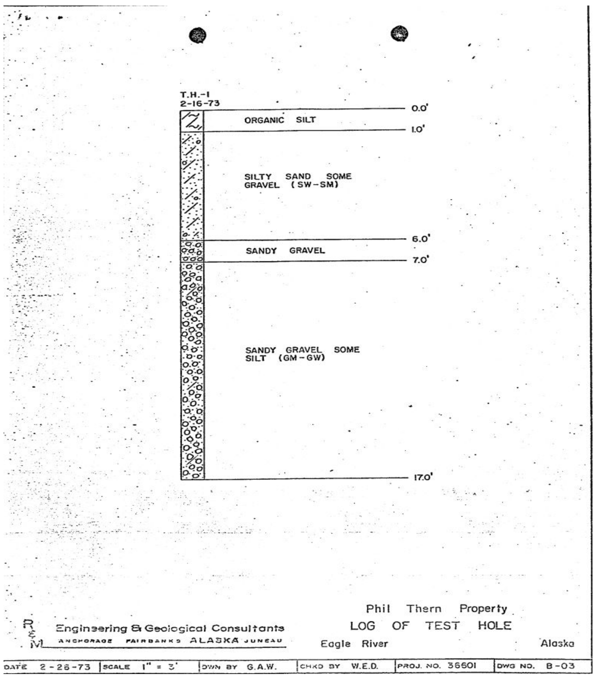
Appendix C
Wetland Map

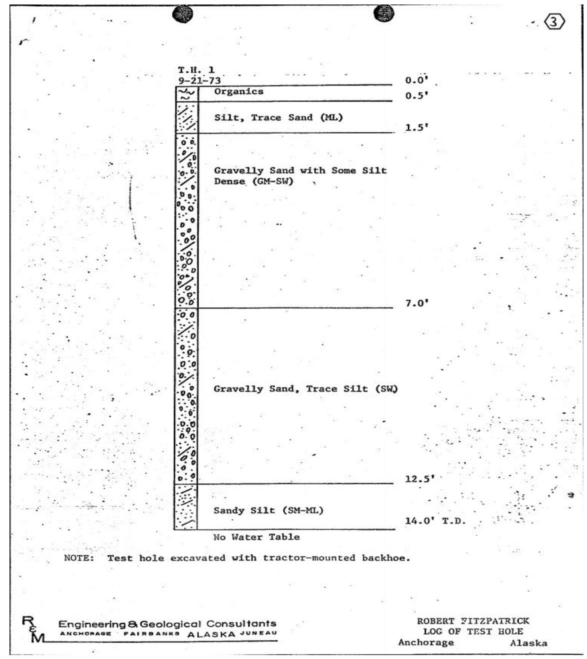


Appendix D
Boring Logs









Appendix E

Appendix E contains values and technical drawings in reference to the pipe material decisions.

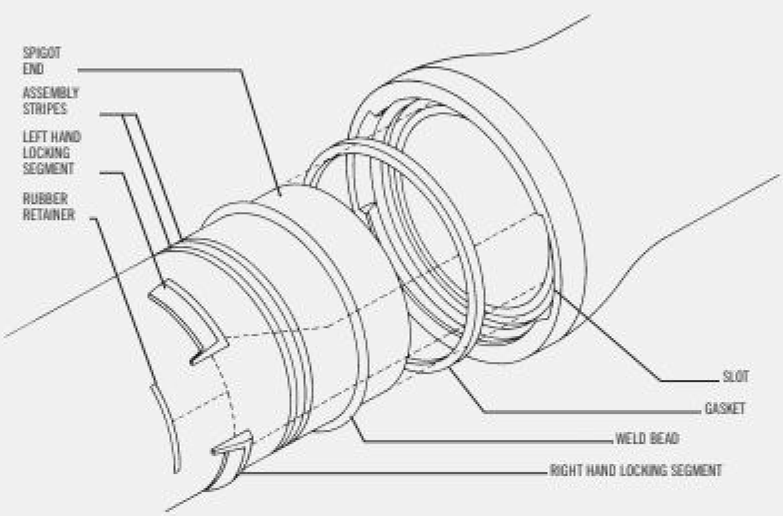
Tensile Strength	3600 psi, minimum—ASTM D882
Elongation	800%, minimum—ASTM D882
Dielectric Strength	800 V/mil, minimum—ASTM D149
Impact Resistance	600 g, minimum—ASTM D1709-B
Propagation Tear Resistance	2550 gf, minimum—ASTM D1922

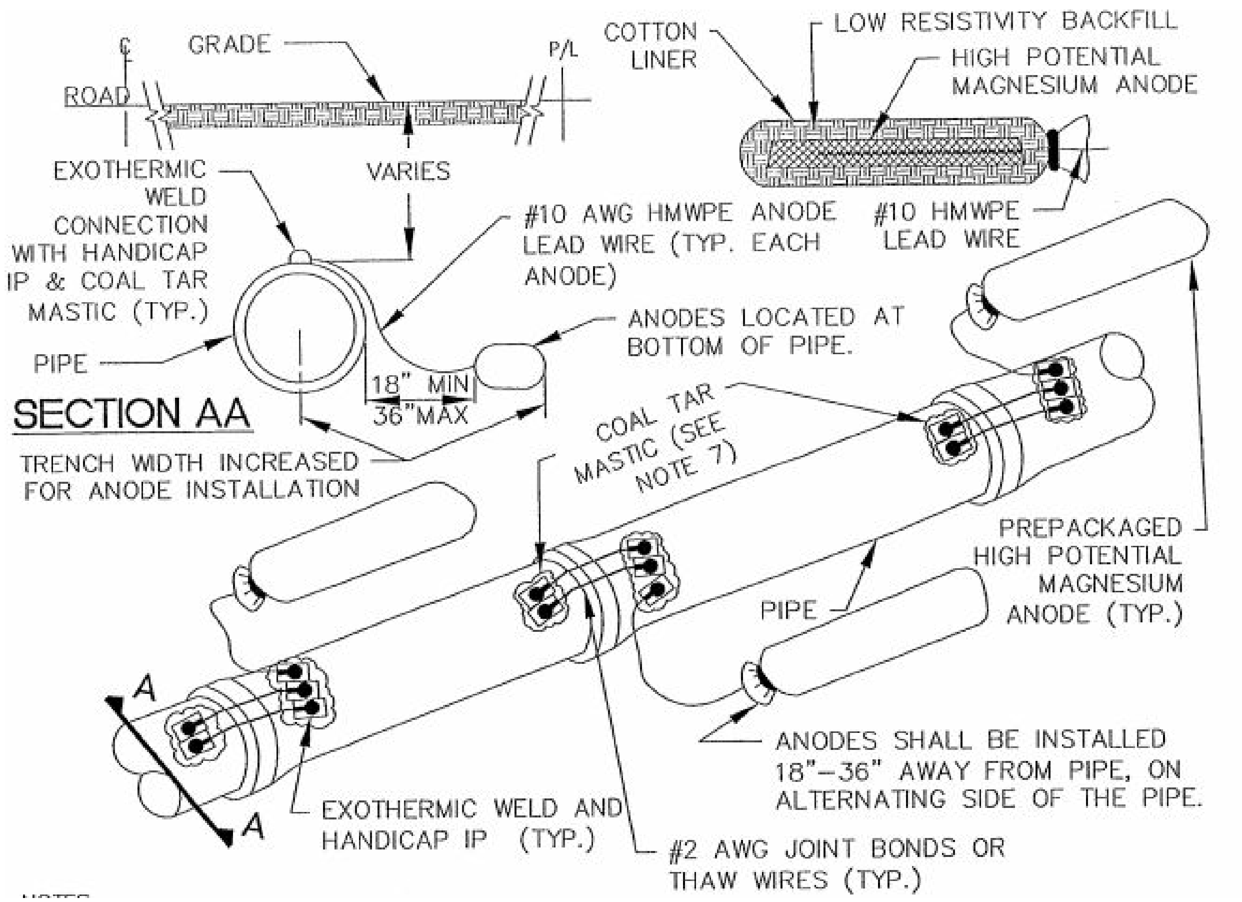
Polyurethane encasement

Assembly Instructions for Pipe and Fittings 12"-20"

Two Bell Slots

1. Lay pipe or fitting such that both of the bell slots are accessible (in the horizontal position if possible).
2. Clean the socket and insert a TYTON® Gasket.
3. Clean the pipe spigot end back to the assembly stripes.
4. Lubricate the exposed surface of the gasket and the pipe spigot end back to the weld bead.
5. Make a conventional push-on joint assembly, fully homing the pipe until the first assembly stripe is in the bell socket. Keep the joint in straight alignment during assembly.
6. Insert lower locking segment into a bell slot and slide the segment around the pipe.
7. Insert upper locking segment into the same bell slot and rotate around the pipe.
8. Hold the upper segment in place and wedge the rubber retainer into the slot between the two locking segments.
9. Repeat steps 6-8 for other slot. Make sure that all 4 locking segments and 2 rubber retainers are securely in place.
10. Extend the joint to remove the slack in the locking segment cavity. Joint extension is necessary to attain the marked laying length on the pipe and to minimize growth or extension of the line as it is pressurized. (Refer to the Table on page 22.)
11. Set the joint deflection as required. (See Table on page 22.)





ROAD
GRADE
P/L
VARIES
EXOTHERMIC WELD CONNECTION WITH HANDICAP IP & COAL TAR MASTIC (TYP.)
PIPE
SECTION AA
18" MIN
36"MAX
TRENCH WIDTH INCREASED FOR ANODE INSTALLATION
#10 AWG HMWPE ANODE LEAD WIRE (TYP. EACH ANODE)
ANODES LOCATED AT BOTTOM OF PIPE.
COTTON LINER
LOW RESISTIVITY BACKFILL
HIGH POTENTIAL MAGNESIUM ANODE
#10 HMWPE LEAD WIRE
COAL TAR MASTIC (SEE NOTE 7)
PREPACKAGED HIGH POTENTIAL MAGNESIUM ANODE (TYP.)
PIPE
A
A
EXOTHERMIC WELD AND HANDICAP IP (TYP.)
#2 AWG JOINT BONDS OR THAW WIRES (TYP.)
ANODES SHALL BE INSTALLED 18"–36" AWAY FROM PIPE, ON ALTERNATING SIDE OF THE PIPE.

Seq#	Qty	Description	Units	Price	Ext Price
10		**16" TR FLEX ITEM SECTION:**			
30	3762	16 TR FLEX CL52 DI PIPE	FT	121.82	458,286.84
40	1	16 TR FLEX 90 C110 USA	EA	2,636.37	2,636.37
50	209	NORTHTOW 20# MAGNESIUM ANODE W /#10 WIRE LEAD CP-A-M 20#-10- 10HMW	EA	125.00	26,125.00
60	22	THERMOWELD M-161-16 16"-24" MOLD	EA	72.57	1,596.54
70	1060	THERMOWELD CI 32 SHOT	EA	3.55	3,763.00
80	500	WIRE HMWPE 2 BLK 7STR CU 500FT	FT	2.50	1,250.00
90	1060	ROYSTON HANDY CAP IP/PRIMERLES	EA	4.66	4,939.60
100	3900	14-16 VBIO POLYWRAP 34 LAYFLAT 8 MIL 300' ROLL WHITE	FT	1.62	6,318.00
110	1	16" TF2 TIDEFLEX CK VALVE	EA	8,545.46	8,545.46
130		**12" TR FLEX ITEM SECTION:**			
150	3762	12 TR FLEX CL52 DI PIPE	FT	89.10	335,194.20
160	1	12 TR FLEX 90 C110 USA	EA	1,363.64	1,363.64
170	209	NORTHTOW 20# MAGNESIUM ANODE W /#10 WIRE LEAD CP-A-M 20#-10- 10HMW	EA	125.00	26,125.00
180	22	THERMOWELD M-115 10"-14" MOLD	EA	72.57	1,596.54
190	1060	THERMOWELD CI 32 SHOT	EA	3.55	3,763.00
200	500	WIRE HMWPE 2 BLK 7STR CU 500FT	FT	2.50	1,250.00
210	1060	ROYSTON HANDY CAP IP/PRIMERLES	EA	4.66	4,939.60
220	3800	10-12 VBIO POLYWRAP 27 LAYFLAT 8 MIL 380' ROLL WHITE	FT	1.28	4,864.00
230	1	12" TF-2 TIDEFLEX CHECK VALVE	EA	3,454.55	3,454.55
250		**8" TR FLEX ITEM SECTION:**			
270	3762	8 TR FLEX CL52 DI PIPE	FT	52.73	198,370.26
280	1	8 TR FLEX 90 C110 USA	EA	818.19	818.19
290	209	NORTHTOW 20# MAGNESIUM ANODE W /#10 WIRE LEAD CP-A-M 20#-10- 10HMW	EA	125.00	26,125.00
300	22	THERMOWELD M-114 MOLD 4"-8"	EA	58.31	1,282.82
310	1060	THERMOWELD CI 32 SHOT	EA	3.55	3,763.00
320	500	WIRE HMWPE 2 BLK 7STR CU 500FT	FT	2.50	1,250.00
330	1060	ROYSTON HANDY CAP IP/PRIMERLES	EA	4.66	4,939.60
340	4000	3-8 VBIO POLYWRAP 20 LAYFLAT 8 MIL 500' ROLL WHITE	FT	1.06	4,240.00
350	1	8" TF-2 TIDEFLEX CHECK VALVE	EA	1,636.37	1,636.37

Appendix F

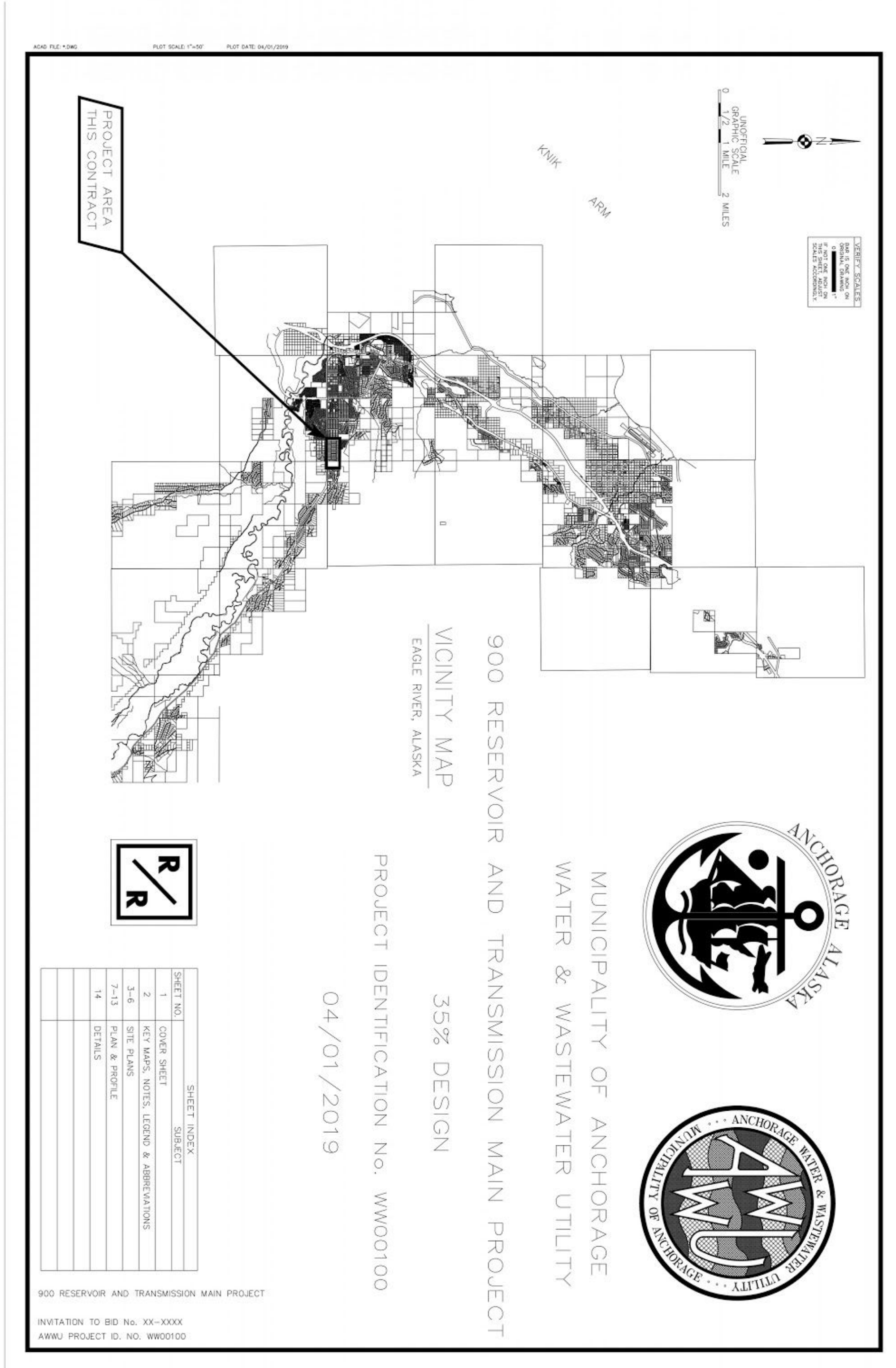
Reservoir Material Alternatives and Life Cycles

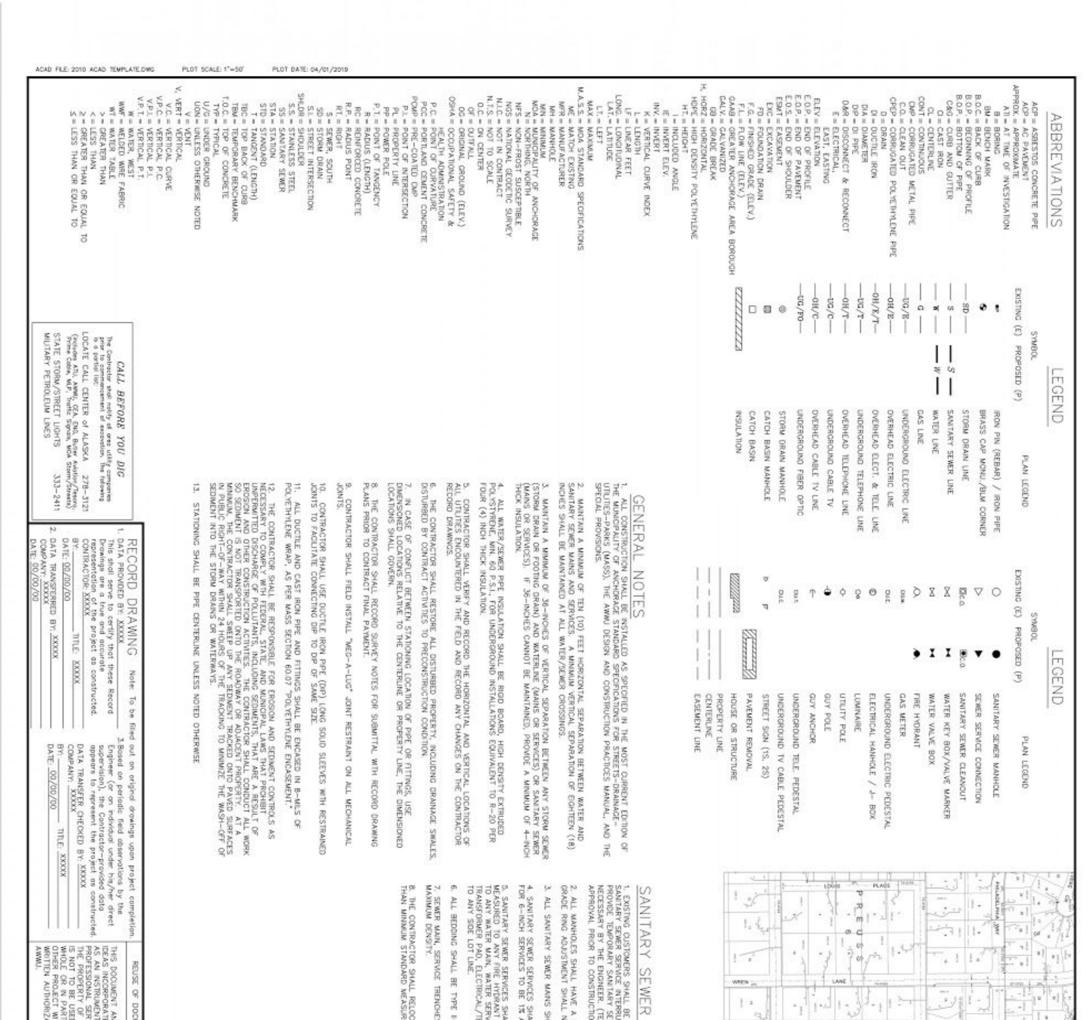
Reservoir Materials	Initial Material Costs	Comments
Bolted Steel	**$350,000.00**	**Lowest Initial Cost**
Welded Steel	**$850,000.00**	**Longest Life Cycle**
Concrete	**$1,100,000.00**	**Strongest Design**
Glass Fused to Steel Bolted	**$640,000.00**	**Lowest Life Cycle Cost**

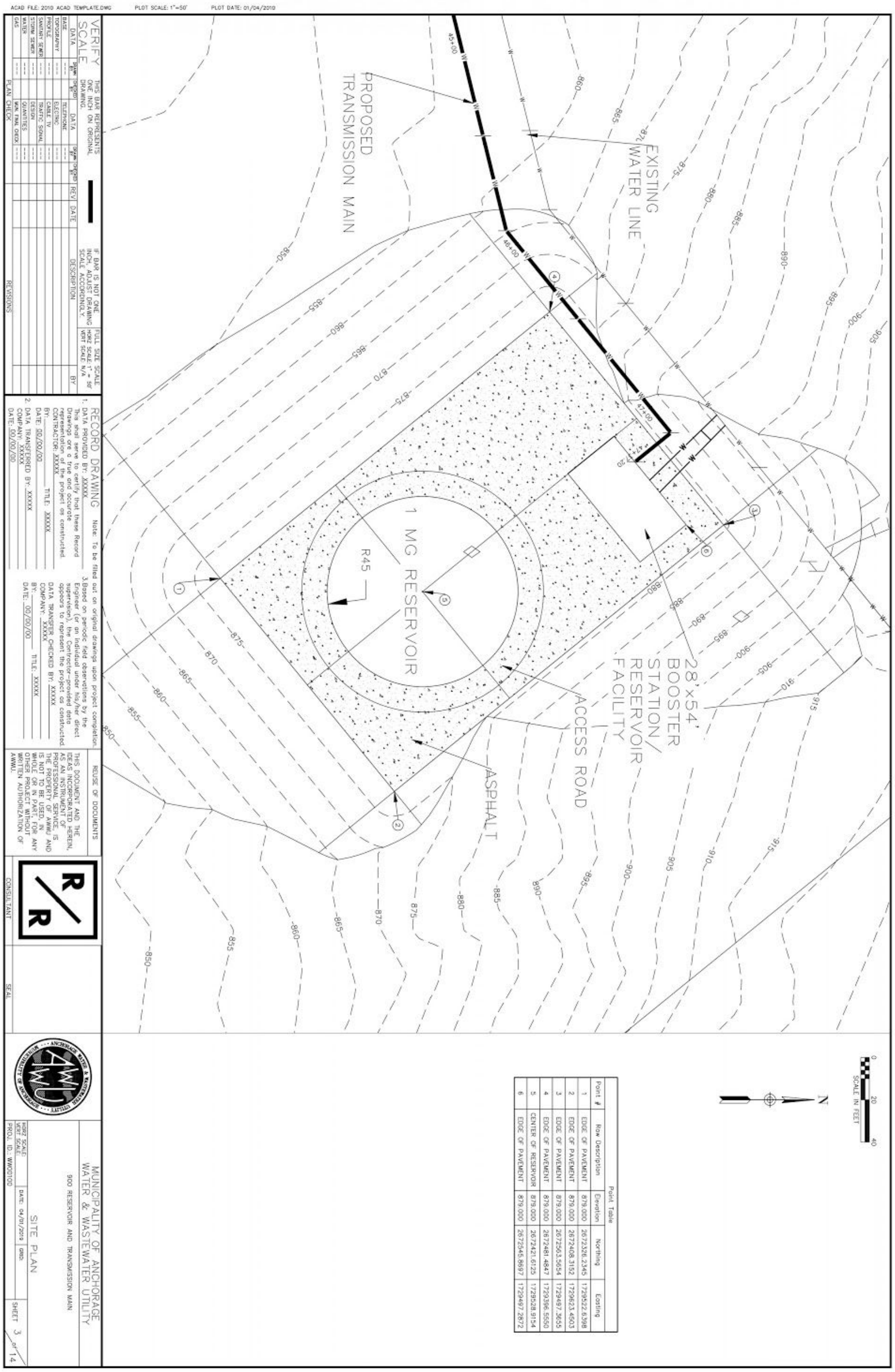
Reservoir Material	5 Year Routine Maintenance Cost	Life Cycle (Years)	Life Cycle Cumulative Cost
Bolted Steel	**$9,000.00**	**60**	**$808,000.00**
Welded Steel	**$118,000.00**	**60**	**$2,266,000.00**
Concrete	**$10,000.00**	**60**	**$1,220,000.00**
Glass Fused to Steel Bolted	**$8,500.00**	**60**	**$720,000.00**

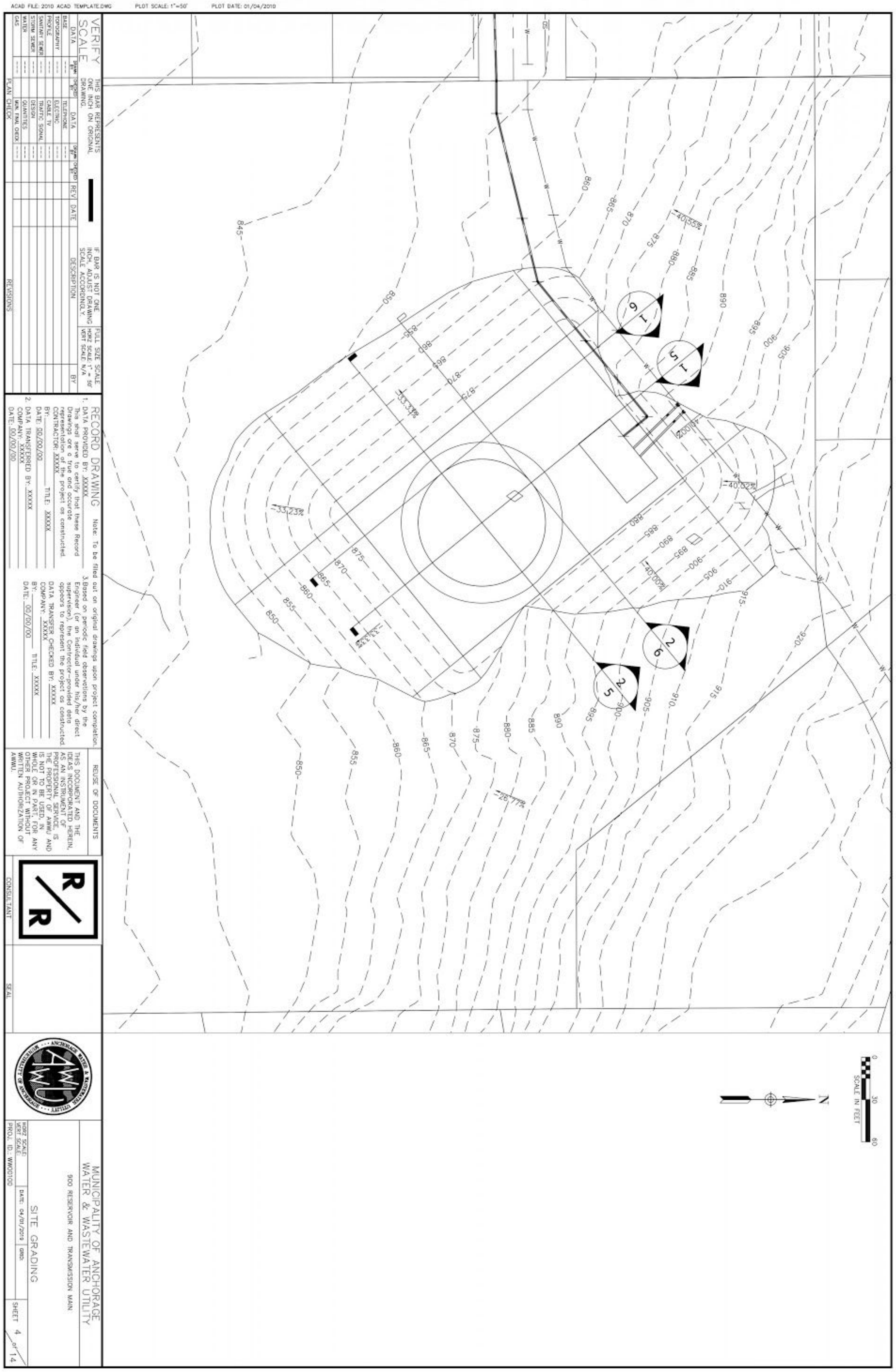
Appendix G

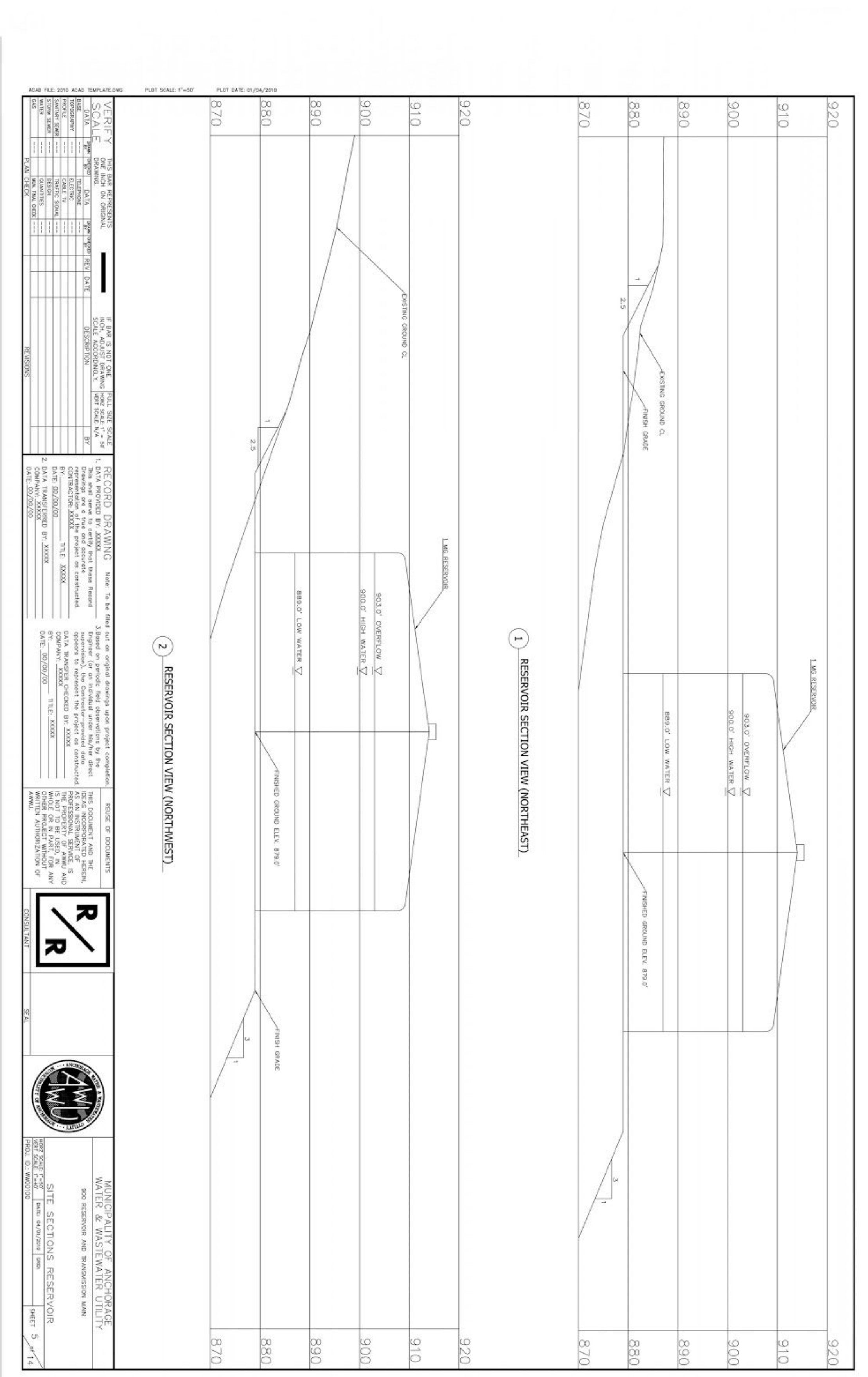
Drawing Set

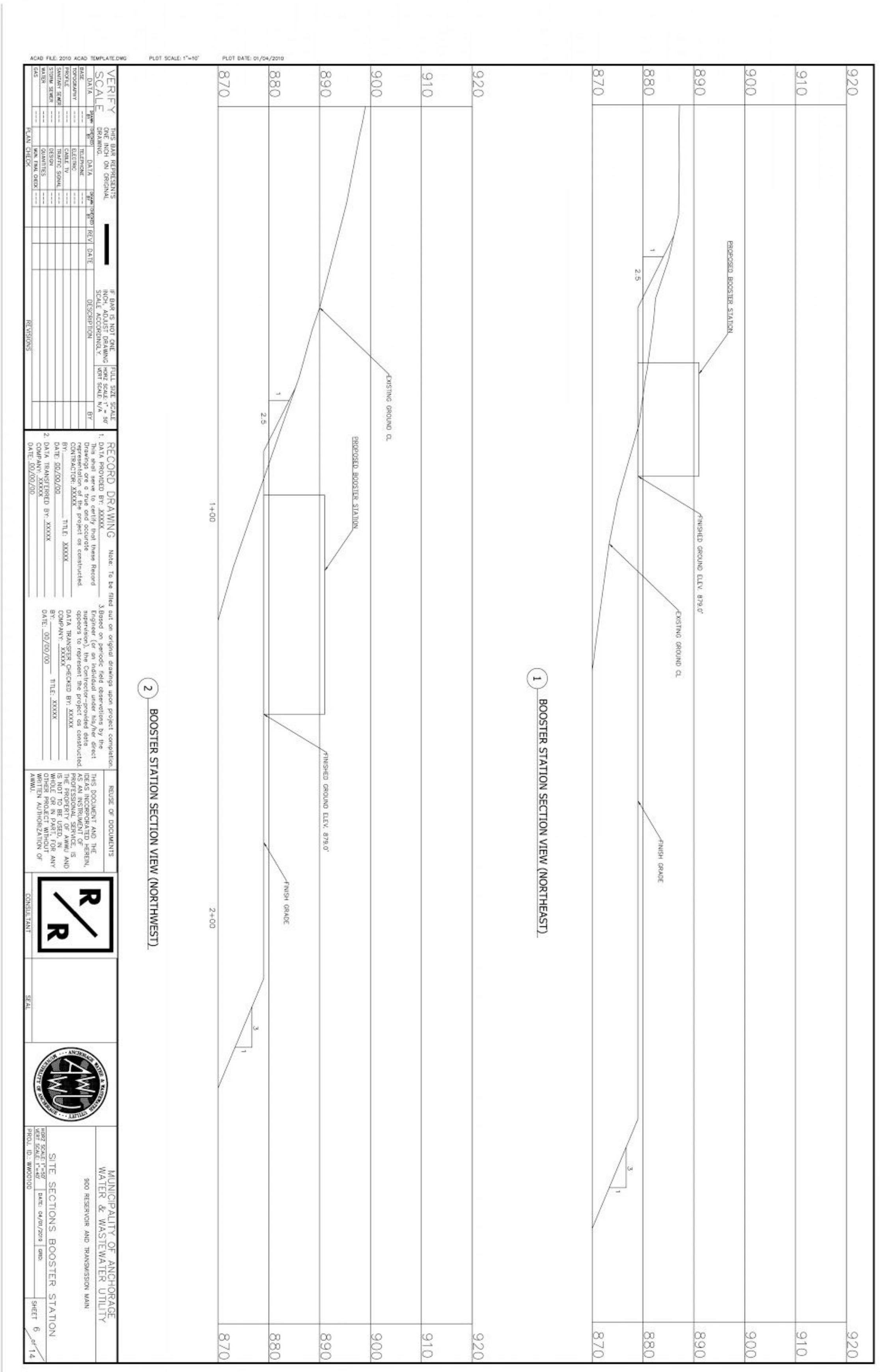


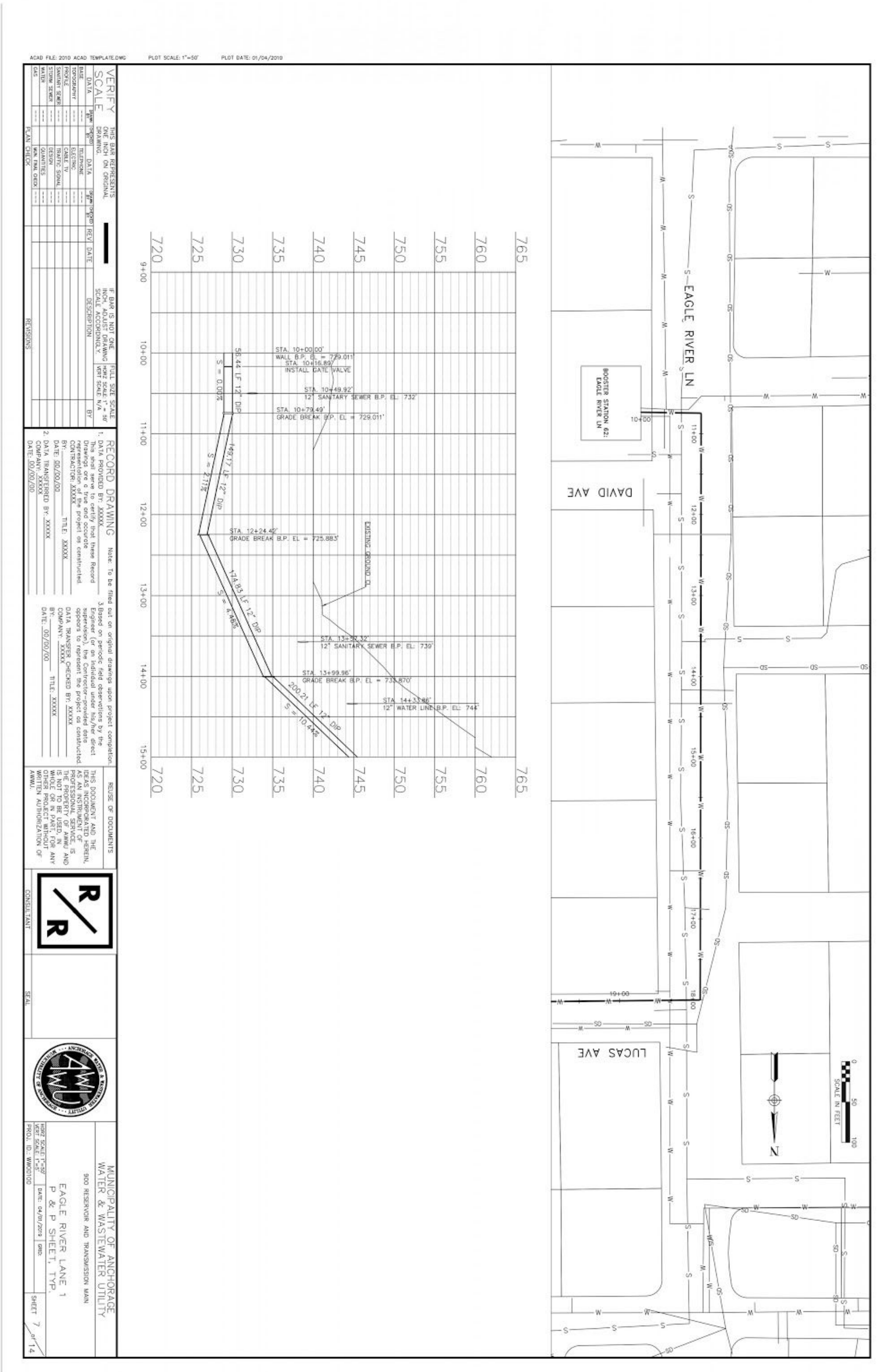

ABBREVIATIONS
LEGEND
GENERAL NOTES
SANITARY SEWER NOTES
WATER NOTES
WATER KEY MAP
N.T.S.
RECORD DRAWING
MUNICIPALITY OF ANCHORAGE
WATER & WASTEWATER UTILITY
KEY MAP, NOTES, LEGEND, & ABBREVIATIONS

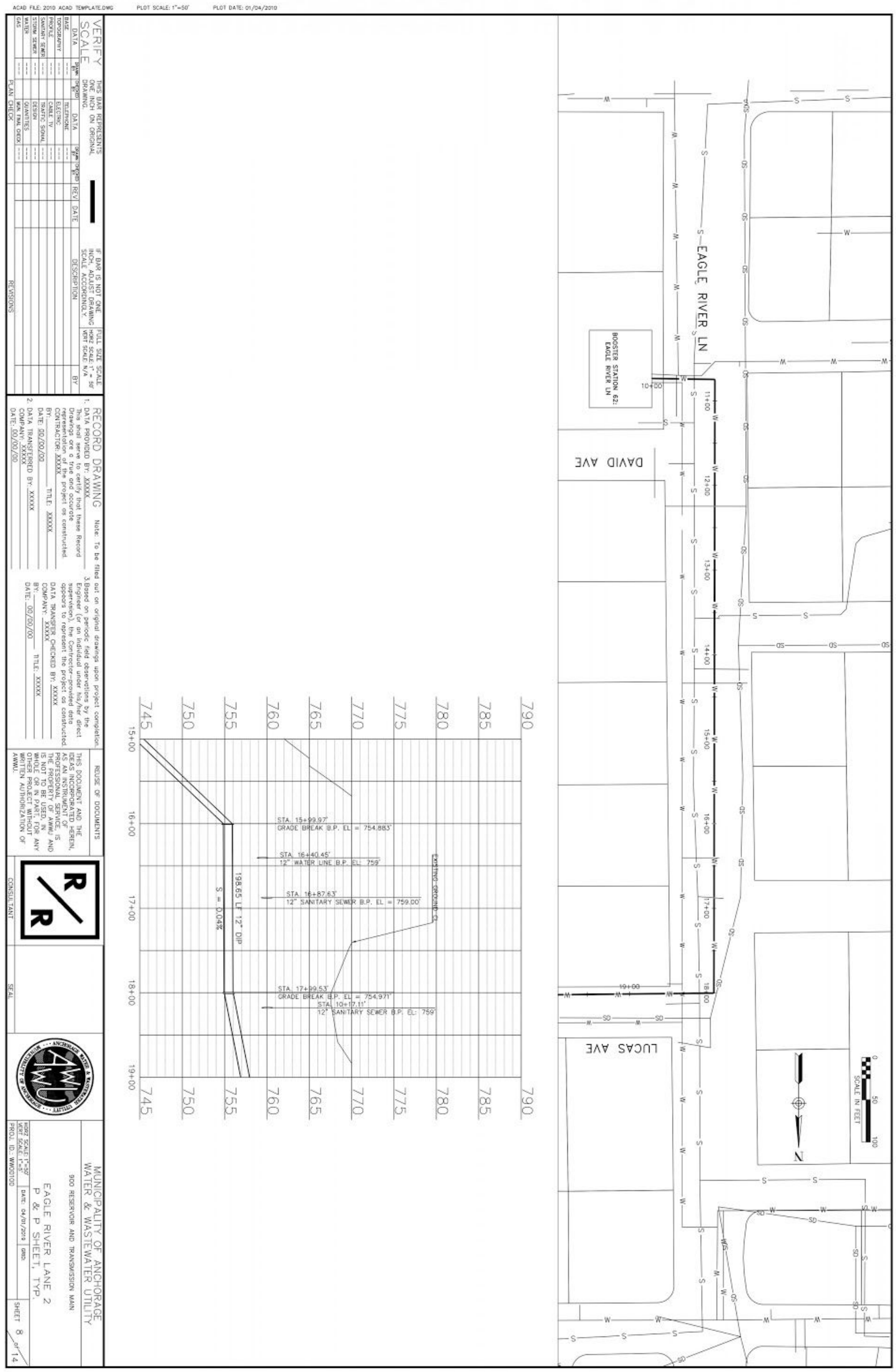

PROPOSED TRANSMISSION MAIN
EXISTING WATER LINE
1 MG RESERVOIR
R45
28'x54' BOOSTER STATION/ RESERVOIR FACILITY
ACCESS ROAD
ASPHALT
MUNICIPALITY OF ANCHORAGE WATER & WASTEWATER UTILITY
900 RESERVOIR AND TRANSMISSION MAIN
SITE PLAN

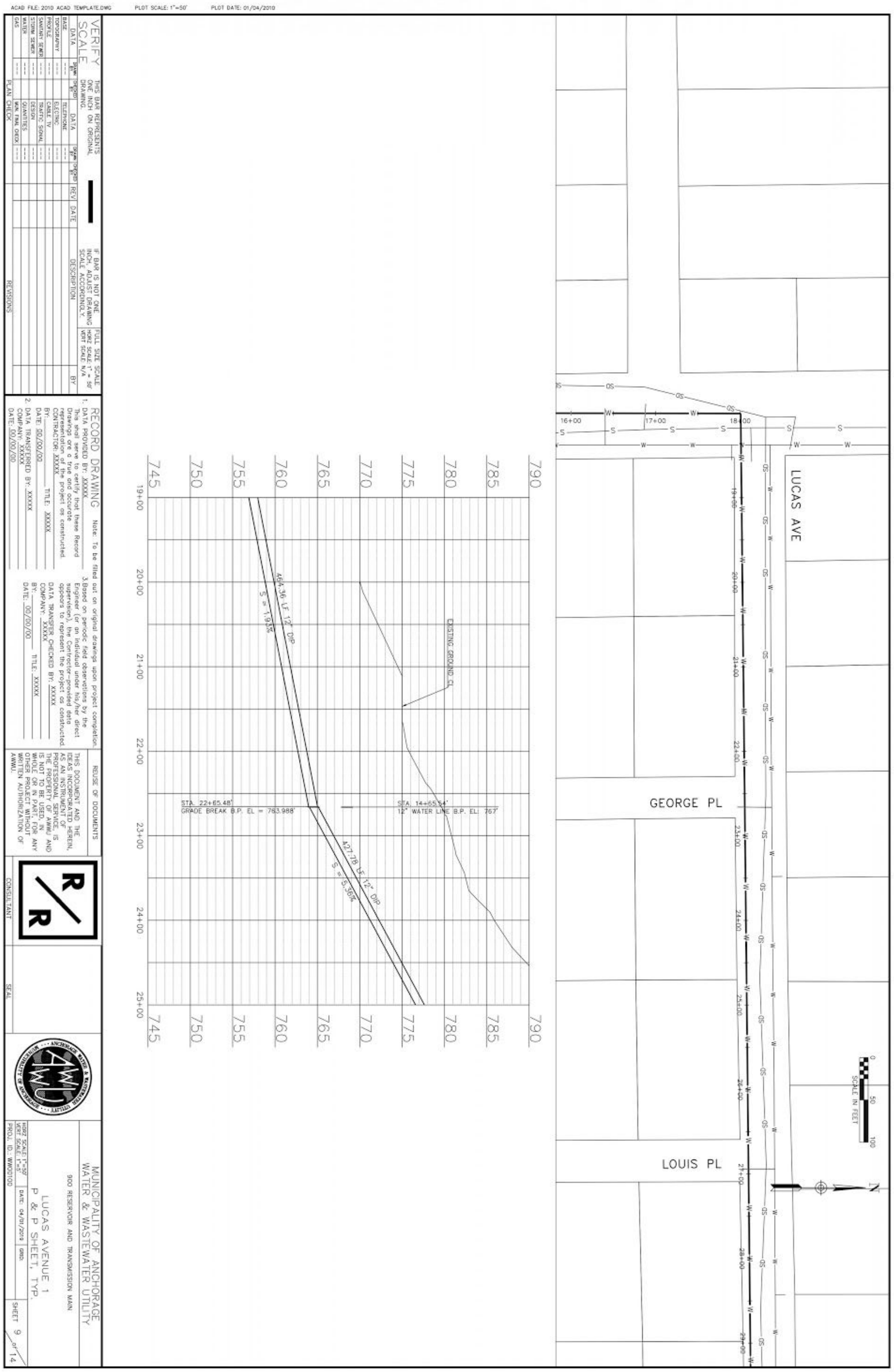

MUNICIPALITY OF ANCHORAGE
WATER & WASTEWATER UTILITY
900 RESERVOIR AND TRANSMISSION MAIN
SITE GRADING
RECORD DRAWING
SCALE IN FEET

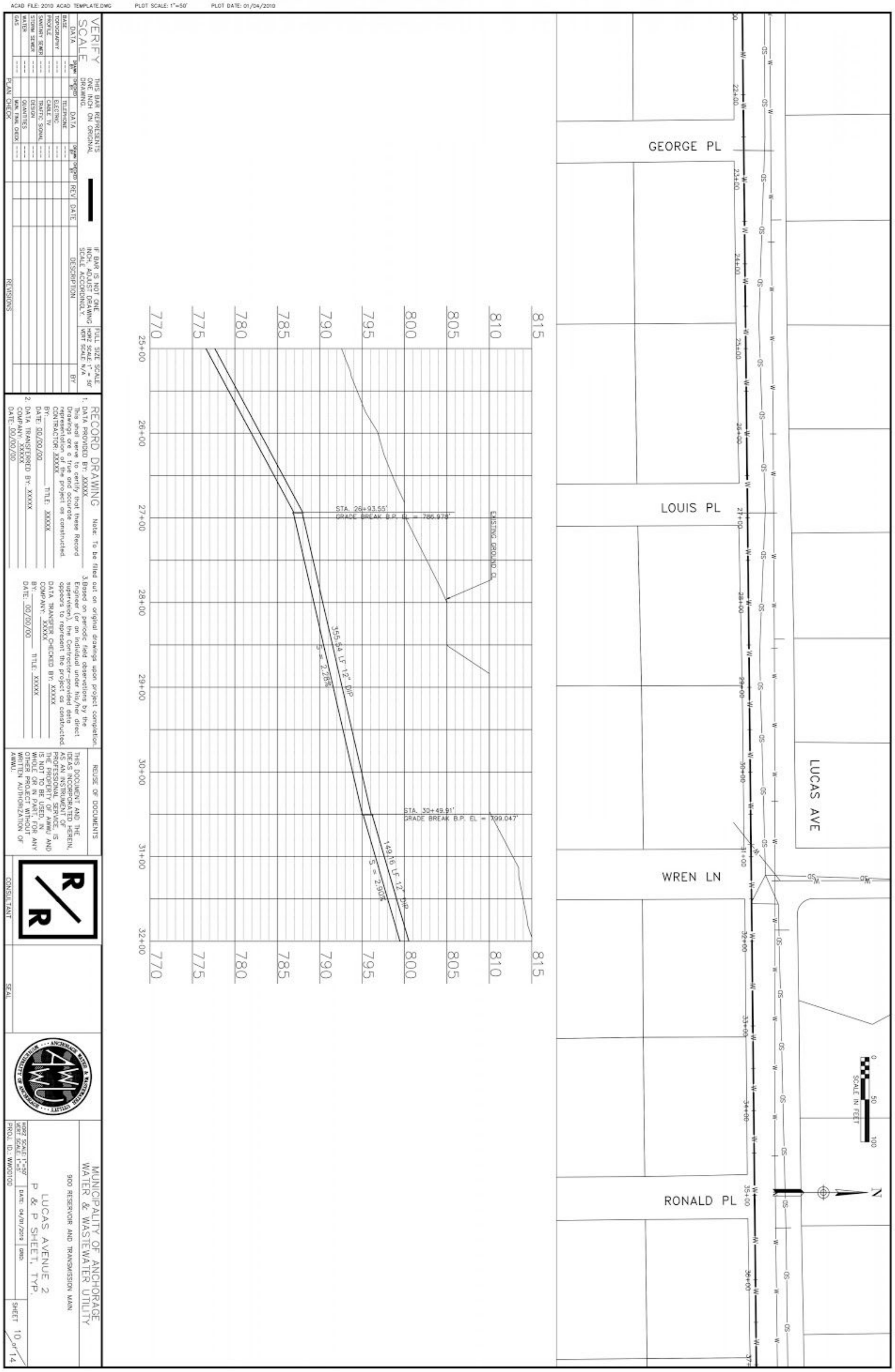

RESERVOIR SECTION VIEW (NORTHEAST)
RESERVOIR SECTION VIEW (NORTHWEST)
1 MG RESERVOIR
903.0' OVERFLOW
900.0' HIGH WATER
889.0' LOW WATER
FINISHED GROUND ELEV. 879.0'
EXISTING GROUND CL
FINISH GRADE
MUNICIPALITY OF ANCHORAGE
WATER & WASTEWATER UTILITY
900 RESERVOIR AND TRANSMISSION MAIN
SITE SECTIONS RESERVOIR
RECORD DRAWING
REUSE OF DOCUMENTS
REVISIONS

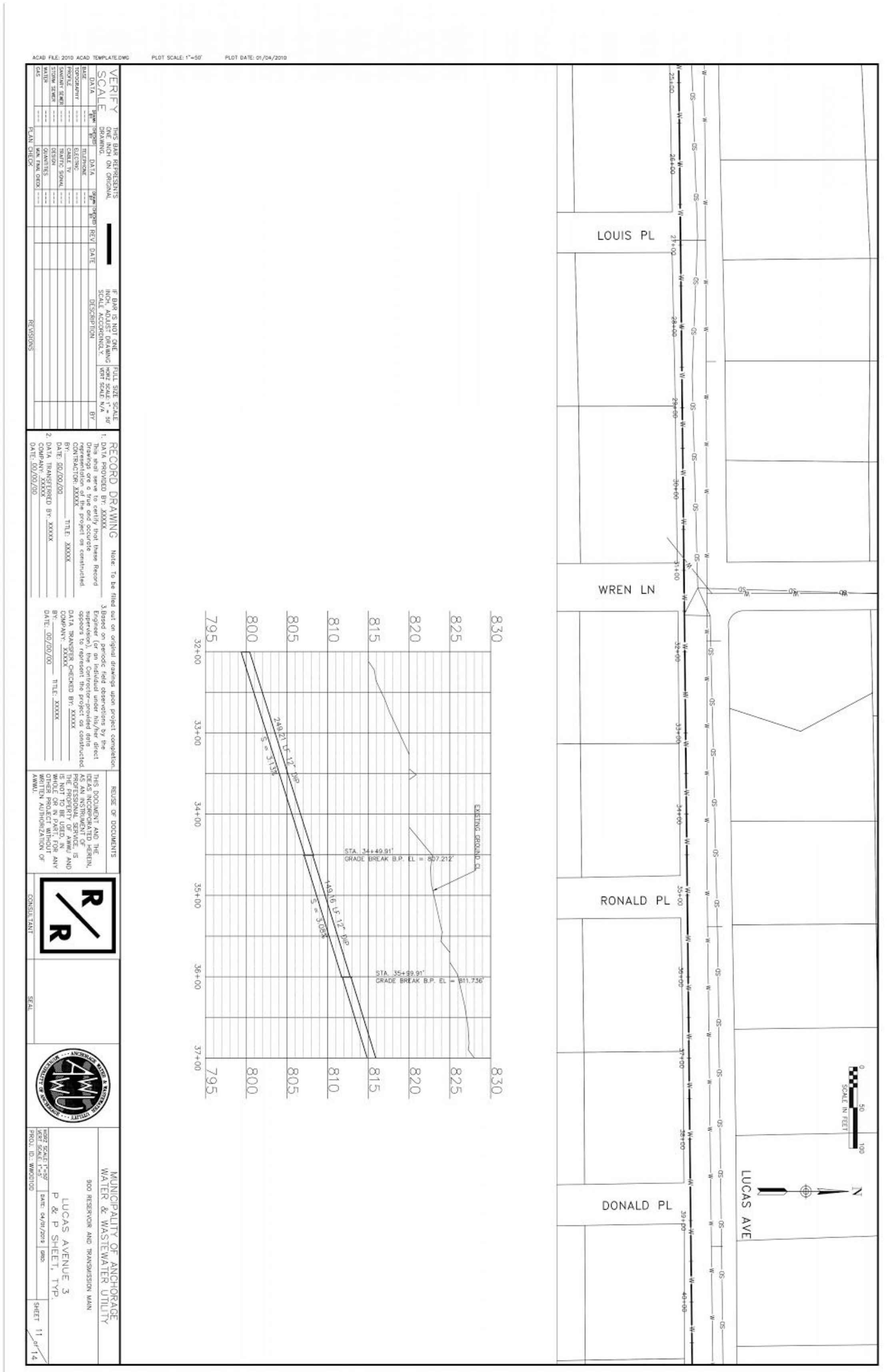

BOOSTER STATION SECTION VIEW (NORTHEAST)
BOOSTER STATION SECTION VIEW (NORTHWEST)
PROPOSED BOOSTER STATION
EXISTING GROUND CL
FINISHED GROUND ELEV. 879.0'
FINISH GRADE
RECORD DRAWING
VERIFY SCALE
REUSE OF DOCUMENTS
CONSULTANT
SEAL
MUNICIPALITY OF ANCHORAGE WATER & WASTEWATER UTILITY
900 RESERVOIR AND TRANSMISSION MAIN
SITE SECTIONS BOOSTER STATION

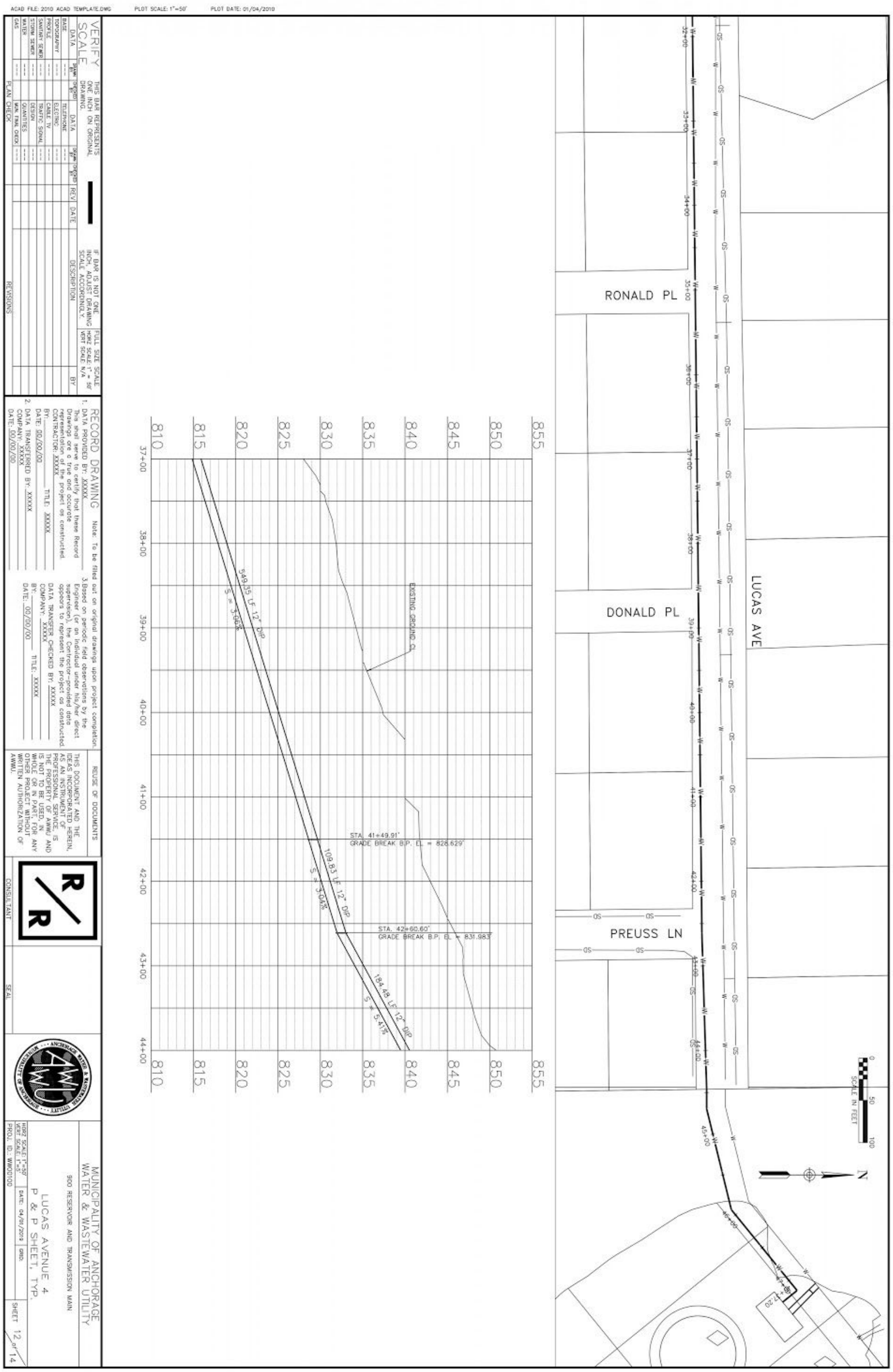

EAGLE RIVER LN
DAVID AVE
LUCAS AVE
BOOSTER STATION 62: EAGLE RIVER LN
RECORD DRAWING
MUNICIPALITY OF ANCHORAGE WATER & WASTEWATER UTILITY
EAGLE RIVER LANE 1
P & P SHEET, TYP.

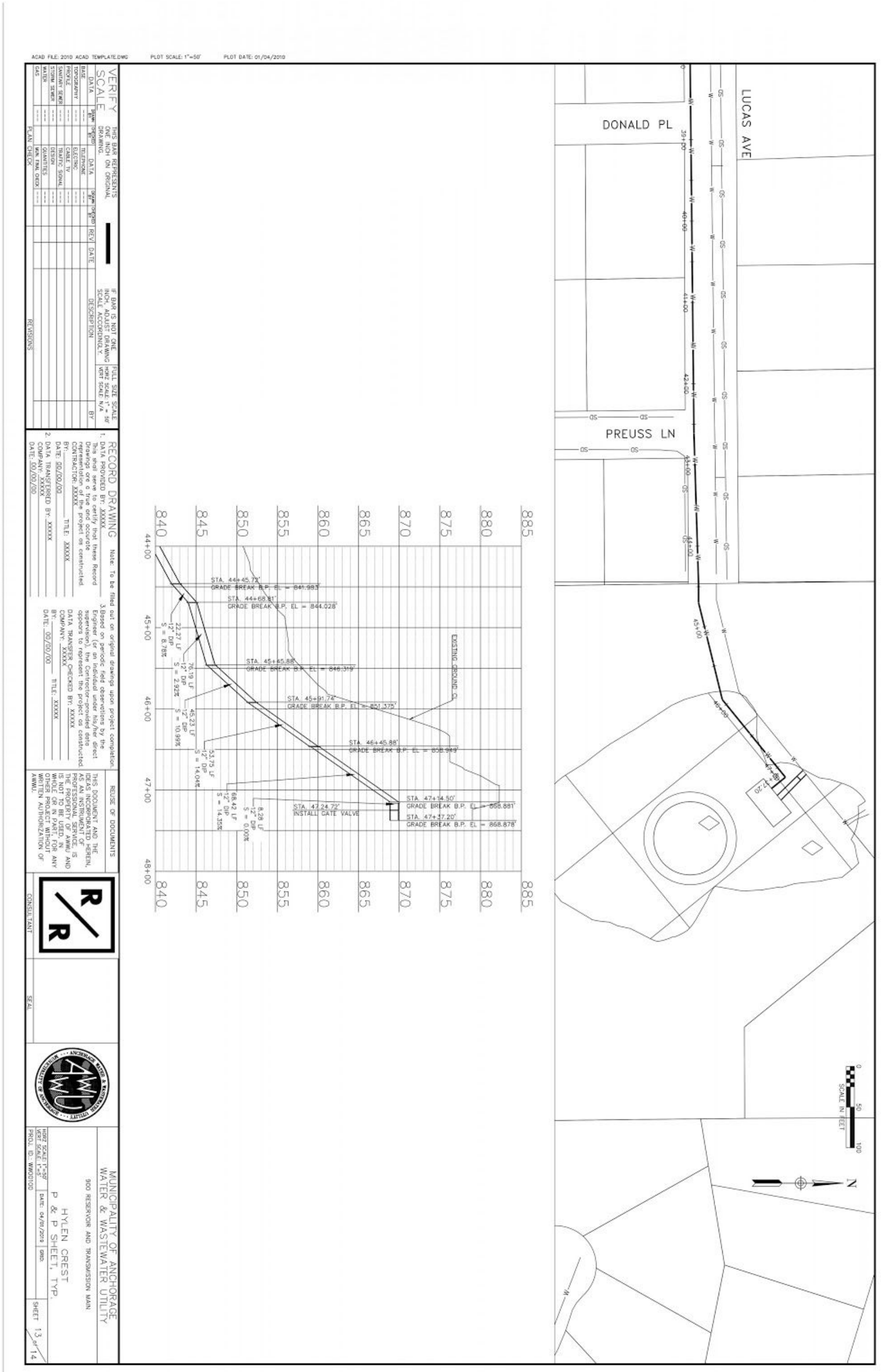

EAGLE RIVER LN
DAVID AVE
LUCAS AVE
BOOSTER STATION 62: EAGLE RIVER LN
MUNICIPALITY OF ANCHORAGE
WATER & WASTEWATER UTILITY
EAGLE RIVER LANE 2
P & P SHEET, TYP.
RECORD DRAWING
REUSE OF DOCUMENTS

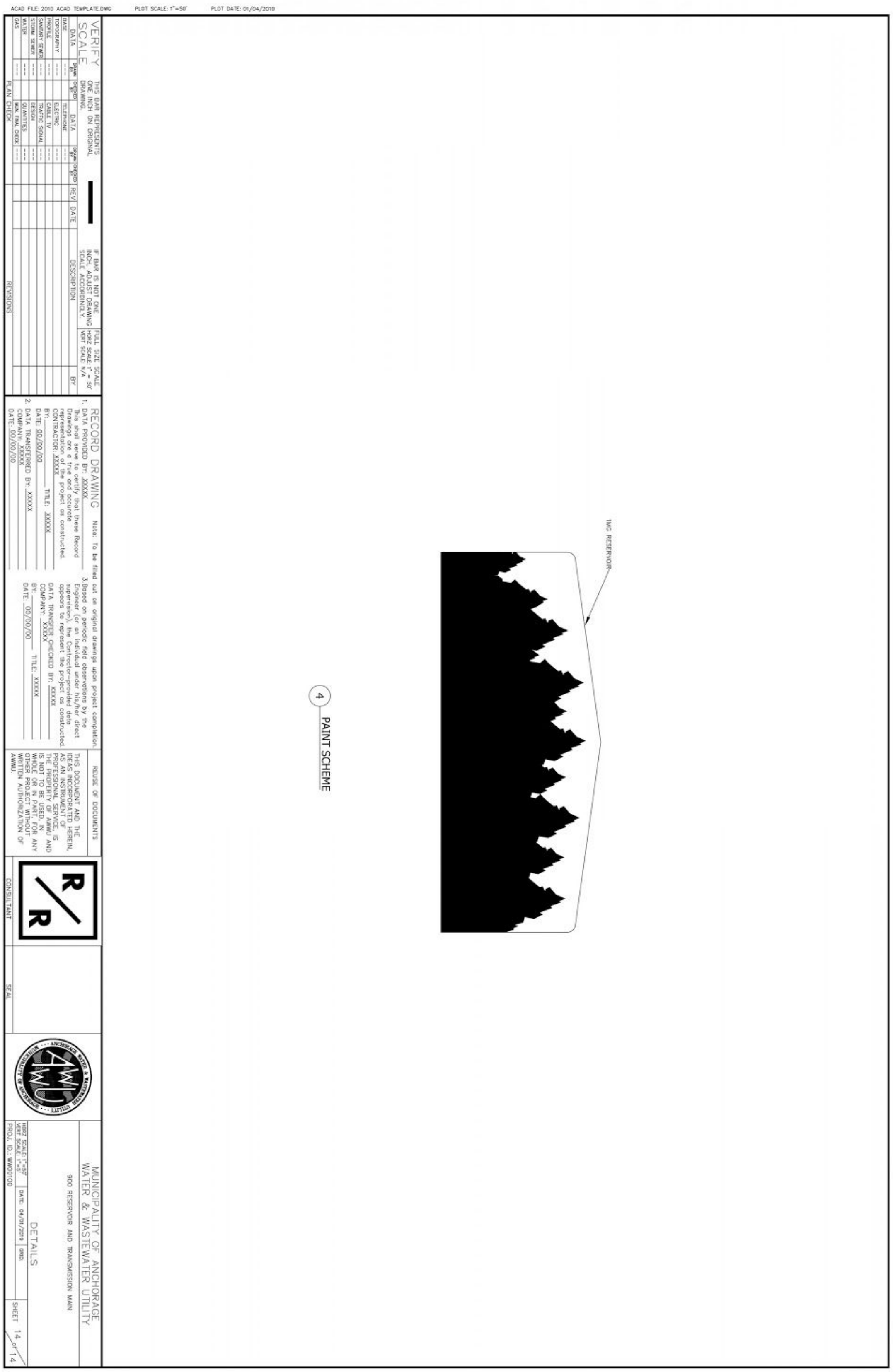

LUCAS AVE
GEORGE PL
LOUIS PL
EXISTING GROUND CL
STA. 22+65.48' GRADE BREAK B.P. EL = 763.988'
STA. 14+65.54' 12" WATER LINE B.P. EL. 767'
464.36 LF 12" DIP
427.78 LF 12" DIP
RECORD DRAWING
REUSE OF DOCUMENTS
MUNICIPALITY OF ANCHORAGE WATER & WASTEWATER UTILITY
900 RESERVOIR AND TRANSMISSION MAIN
LUCAS AVENUE 1
P & P SHEET, TYP.
SHEET 9 of 14


GEORGE PL
LOUIS PL
WREN LN
RONALD PL
LUCAS AVE
RECORD DRAWING
MUNICIPALITY OF ANCHORAGE
WATER & WASTEWATER UTILITY
LUCAS AVENUE 2
P & P SHEET, TYP.


LOUIS PL
WREN LN
RONALD PL
DONALD PL
LUCAS AVE
EXISTING GROUND CL
STA. 34+49.91'
GRADE BREAK B.P. EL = 807.212'
STA. 35+99.91'
GRADE BREAK B.P. EL = 811.736'
RECORD DRAWING
REVISIONS
CONSULTANT
SEAL
MUNICIPALITY OF ANCHORAGE
WATER & WASTEWATER UTILITY
LUCAS AVENUE 3
P & P SHEET, TYP


RONALD PL
DONALD PL
PREUSS LN
LUCAS AVE


LUCAS AVE
DONALD PL
PREUSS LN
EXISTING GROUND
RECORD DRAWING
MUNICIPALITY OF ANCHORAGE
WATER & WASTEWATER UTILITY
HYLEN CREST
P & P SHEET, TYP.


PAINT SCHEME
VERIFY SCALE
REVISIONS
RECORD DRAWING
REUSE OF DOCUMENTS
CONSULTANT
SEAL
MUNICIPALITY OF ANCHORAGE
WATER & WASTEWATER UTILITY
DETAILS