

Technical Memorandum

To: Dominion Water and Sanitation District
From: Kevin O'Connell, P.E. Acuity, LLC
Date: May 8, 2019
Project: Thunderbird Water and Sanitation District – Potable Water Tie-in
Subject: Infrastructure Feasibility

SUMMARY

Four route alternatives were evaluated in this memorandum. Generally, the shortest route with the least potential conflicts presents the most favorable outcome.

The evaluation indicates that Alternative 3 (tying into the ERPP at approximate Station 528+00 running directly south from the tie-in point along the east boundary of the Lambert Ranch Subdivision, then to TWSD) presents the most favorable alignment, as it is the shortest length and lowest cost option. One risk factor must be considered in Alternative 3: there is no planned tee planned on the ERPP at the location. Therefore, Dominion must agree to have one installed during construction, or the pipeline must be tapped at a later date.

Operational and treatment challenges presented by the different chlorination systems used by the two districts must be addressed, most likely by switching Thunderbird to chloramines.

I. PURPOSE AND BACKGROUND

The Thunderbird Water and Sanitation District (TWSD or District)) is performing diligence to examine the feasibility of a tie-in to the Dominion Water and Sanitation District (DOM) Eastern Regional Pipeline Project (ERPP).

The TWSD is located approximately three miles west of the Town of Sedalia and consists of 178 single-family homes. The District has relied on four wells for its potable water (only one is currently in operation) but is interested a transition to a renewable water supply. The water from the wells is treated with hypochlorite and fed into an existing potable water distribution system consisting of 6" schedule 40 PVC that was installed in the mid 1970's. The distribution system is the source of unquantified losses.

Potable water is stored in three tanks: a 0.5 MG tank and an 80,000 gallon tank located on the west side of the subdivision; and an 80,000 gallon tank located on the east side of the subdivision. Current water demand varies seasonally and ranges between 0.33 and 0.5 AF/YR/Home. For purposes of the memo, we have assumed a delivery of 0.3 AF/YR/Home to TWSD in a 6" diameter pipeline.

See Appendix A for a list of the assumed tie-in parameters and existing conditions.

This Technical Memorandum is conceptual in nature and is not intended to provide detailed designs, hydraulic calculations, construction drawings, documents, or cost data beyond a Class 4 level.

See Exhibit 1 (Appendix B) for a location map of the ERPP and the TWSD.

II. ALTERNATIVES

We have examined four route alternatives for a pipeline to supply water from the ERPP to the TWSD. See (Appendix B) for route locations.

Beginning in the north at Station 405+70 of the ERPP, Alternatives 1A and 1B run along the eastside of the Douglas County Sharptail Ridge Open Space. Both routes follow the eastern property for approximately 1.1 miles south until turning east onto private property. At this point the routes diverge: Route 1A follows the grade of a private road in a southeast direction for approximately 1.0 mile, while Route 1B continues directly east for 0.5 mile then turns south for 0.6 mile, where it rejoins Route 1A. From this point, both routes run directly south for approximately 0.9 mile where they tie-in to the TWSD distribution system. An additional 0.3 - 0.4 miles of pipe could tie the pipeline into the TWSD High Tanks.

Alternative 2 ties into the ERPP on Rio Grande Ave (County Rd. 20) approximately 1.3 miles west of Sedalia at ERPP Station 581+08. The route runs west, staying in the right-of-way of Rio Grande Ave, for 0.75 mile until it reaches the eastern boundary of the Lambert Ranch subdivision, at which point it turns directly south, continuing for 0.70 mile until it reaches the south side of a rock outcrop. The route then turns west for approximately 0.25 mile before turning south for 0.15 mile where it ties into the TWSD distribution system.

Alternative 3 ties into the ERPP at approximate Station 528+00. This route runs directly south from the tie-in point for approximately 0.75 mile where it joins Alternative 2.

Alternatives 2 and 3 pass through two potential future well sites in the Lambert Ranch Subdivision.

III. EVALUATION CRITERIA

A. ENGINEERING AND DESIGN

1. Profiles

Exhibit 3 (Appendix B) shows the approximate profile of each route.

Table 1 summarizes the characteristics of each route:

Table 1				
Alternative Route Characteristics	Alternative 1A	Alternative 1B	Alternative 2	Alternative 3
Length	15,800 LF	16,900 LF	10,200 LF	10,100 LF
High Point Elevation*	6200	6195	6109	6100
Low Point Elevation*	6030	5970	5784	5903
Relative High Pressure	75 psi	100 psi	139 psi	85 psi
Tie-in Elevation	6070	6070	5784	5930
High Pressure based on Elevation of TWSD Tanks**	117 psi	145 psi	219 psi	172 psi

* NAVD 88

** Controlling Static Pressure: not including head loss (TWSD Tanks ~ 6300)

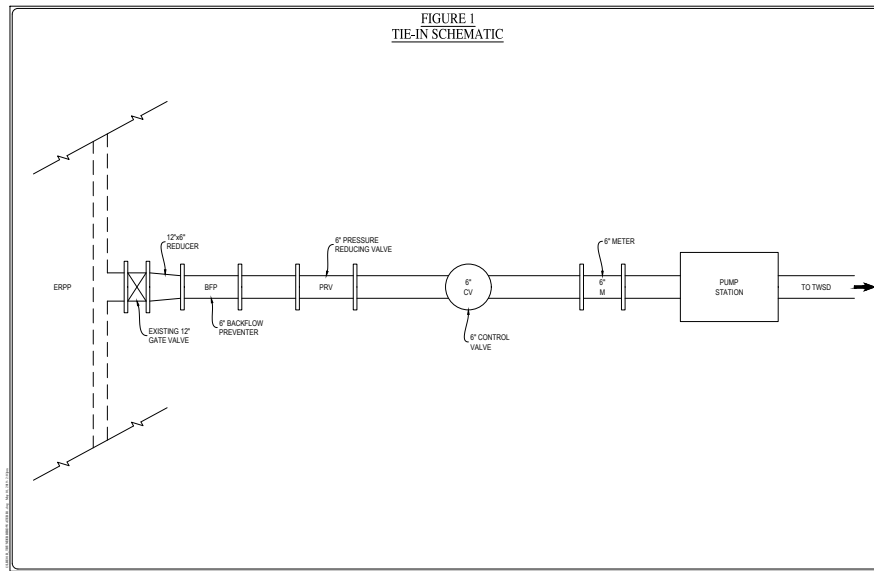
NOTE: Castle Rock Tank ~6330 (= Static Pressure in ERRP). Break pressure at tie-in per DWSD requirements.

2. Capacity

We assume a 6-inch diameter pipeline will be installed by TWSD to supply water under a master meter arrangement. Fire flow is to be provided by existing storage at the TWSD (fire requirements are beyond the scope of this Technical Memorandum). The intermediate-term maximum flow rate in the pipeline is expected to be 100 gpm. However, the theoretical carrying capacity of 6" C-900 is approximately 500 gpm. Because there is an air break at the tie-in points, the water will have to be pumped to TWSD.

3. Delivery Points

We have considered three delivery points along the ERRP. The tie-in locations have been (or will be) fitted with 12-inch tees during construction of the ERRP. DOM requires an air break at tie-in points to prevent backflow from reentering the ERRP. We have anticipated the following tie-in schematic:



A conceptual control narrative may read as follows: DOM will control the water supply to TWSD through on/off operation of the master valve. The flow rate will be regulated by the control valve, which will be operated as specified in a service agreement. The water level in wet well of the pump station will be set by the use of the pressure reducing valve (PRV) and a pressure transducer in the wet well. The pressure gradient between the ERPP and the TWSD (greater pressure on the ERPP side) will prevent potential cross-contamination that could result from water returning into the DOM system once it is delivered to TWSD. The air break in the wet well and the back flow preventer will act as redundancy.

4. Chlorination/Operations

TWSD and DOM use different chlorination systems. Chloramines (DOM system) are formed by the addition of ammonium sulfate to hypochlorite (TWSD system). The balance of ammonia and hypochlorite is critical to the efficacy of disinfection; an imbalance of the constituents leads to formation of undesirable byproducts such as di and trichloramines. Therefore, TWSD must either change its disinfection system to chloramines or flush the entire supply and distribution system each time it changes supply source.

TWSD could switch to chloramines by installing liquid ammonium sulfate (LAS) injectors at each wellhead. It should be noted that the CDPHE typically requires a minimum contact time for hypochlorite prior to the addition of LAS, which may

require additional infrastructure such as a contact chamber. The cost for a LAS injector, monitoring, and instrumentation could range from \$40,000 to \$60,000 each.

Table 2 outlines the basic hydraulic conditions for each alternative. The chlorine residual for TWSD must be managed based on the residual in the ERRP and re-chlorination by TWSD. Variables for residual chlorine include water temperature, pH, pipe material, and time. A detailed chlorine study, performed by and expert in potable water treatment processes, should be completed once the operational details of a tie-in are clearly understood.

Table 2				
Hydraulics 6" C900 (C=120)	Alternative 1A	Alternative 1B	Alternative 2	Alternative 3
25 gpm				
Velocity	0.28 fps	0.28 fps	0.28 fps	0.28 fps
Total Head loss	2'	2'	1'	1'
Travel Time	15.7 hours	16.5 hours	9.6 hours	9.6 hours
100 gpm				
Velocity	1.14 fps	1.14 fps	1.14 fps	1.14 fps
Total Head loss	17'	18'	11'	11'
Travel Time	3.8 hours	4.1 hours	2.3 hours	2.3 hours

Part time use of the pipeline will also create operational challenges. During periods of non-use the chlorine residual will decrease in Thunderbird pipeline, eventually to zero. Therefore, the pipeline will have to be flushed and disinfected prior to each use. A specific plan should be developed for draining and filling the pipeline. If water from the pipeline is drained into natural areas, a discharge permit and testing plan will most likely need to be filed with the CDPHE. Alternatives 1A, 1B, 2, and 3 contain approximately 23,000, 24,000, 14,000 and 14,250 gallons of water when full, respectively.

5. Fitting/Equipment Count

Table 3 contains tally of the fittings required for each alternate route:

Table 3				
Fixtures	Alternative 1A	Alternative 1B	Alternative 2	Alternative 3
Blow Off Valves	13	15	10	12
Air Vac Valves	13	15	10	13
Isolation Valves	8	8	3	4
Meters	1	1	1	1
Pump Stations	1	1	1	1
Check Valves	1	1	1	1
PRV's	1	1	1	1
Backflow Preventer	1	1	1	1
Control Valve	1	1	1	1

6. Electrical Service and Controls

Table 4 illustrates the approximate horsepower necessary to deliver water from each tie-in/alternate route. It should be noted that we were unable to obtain an estimated cost to install electric service from IREA. However, IREA allows a maximum 10 horsepower motor for 110 V service. This is significant as TWSD may be able to implement a phasing plan to defer the cost of installing three-phase power.

Table 4				
Approximate Horsepower Requirements	Alternative 1A	Alternative 1B	Alternative 2	Alternative 3
TWSD Tank Elevation	6300	6300	6300	6300
Low Point Elevation	6030	5970	5784	5903
Static Head	270	330	516	397
Dynamic Head @ 100 gpm	17	18	11	11
Total Head	287	348	527	408
HP Required @ 60% eff	8	9	14	10
Dynamic Head @ 25 gpm	2	2	1	1
Total Head	272	332	517	398
HP Required @ 60% eff	2	3	4	3

7. Road Crossings

Alternatives 2 and 3 require construction in Rio Grande Avenue. Alternative 2 will, at a minimum, require one traffic lane to be closed intermittently during construction. Alternative 3 will require one crossing, which should only cause minimal disruption.

B. ENVIRONMENTAL

Alt 1A and Alt 1B

Clean Water Act Section 404 Considerations

The southern terminus of both Alternative 1A and 1B is north of the Indian Creek stream channel and adjacent riparian zone. Indian Creek at this location is an intermittent stream and is subject to regulation under the provisions of Section 404 of the Clean Water Act.

The first step needed in the permitting process is to complete a pedestrian survey of the areas where the proposed pipeline alignment(s) crosses the unnamed stream channels. If the stream channels appear to be dry draws, no further evaluation will be needed. **If the stream channel crossings appear to be jurisdictional, the U.S. Army Corps of Engineers (USACE) should be requested to complete a formal jurisdictional determination (JD).**

If the streams are determined to be jurisdictional, impacts to waters of the United States could be avoided by directional drilling under stream channels. If directional drilling is infeasible, Nationwide Permit No. 12 (Utility Line Activities) could also be used to permit the project. A complete description of the requirements for Nationwide Permit No. 12 (NW-12) can be found at:

<https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/6725>. A Nationwide Permit No. 12 would likely require:

- a. Section 7 Consultation between the USACE and the FWS with a 135-day time frame to complete the Consultation,
- b. Section 106 Cultural Resource with an Area of Potential Effect limited to the dam and other construction areas including borrow areas and other appurtenance structures. (a records review (Class 1 Survey) may be adequate),
- c. two-parameter wetland delineation,
- d. depletion analysis for the South Platte Endangered Species.

If directional drilling under streams or wetlands the U.S. Army Corps of Engineers determines to be jurisdictional is feasible, Endangered Species Act Section 10 Consultation with the U.S. Fish and Wildlife Service (FWS) for the Preble's meadow jumping mouse (PMJM) may still be required. **It is important to not that timeframe for completing Section 10 Consultation is indeterminate (i.e. there is no statutory limit for the length of time the FWS can take to complete their analysis and issue a finding of 1) "no effect", 2) "may effect", or 3) "will effect"). Until the FWS completes their evaluation, avoidance or mitigation measures cannot be determined.**

Alternatives 1A and 1B occupy a common corridor and proceed north from the southern terminus for approximately 1.0 mile then cross one unnamed drainage that may be a water body subject to regulation under the provisions of Section 404 of the Clean Water Act.

At this point, Alternative 1B deviates from Alternative 1A alignment and proceeds north for approximately ½ mile where it crosses two small unnamed intermittent drainages that may be subject to regulation under the provisions of Section 404 of the Clean Water Act before turning west for approximately ½ mile where there appears to be no water bodies that are potentially jurisdictional. From here, both Alternatives then follow a route that trends north for approximately 1 mile where no water bodies were observed.

The proposed Alternative 1A follows a county road and three intermittent drainages that may be subject to regulation under the provisions of Section 404 of the Clean Water Act.

NOTE: If the project permanently affects less than 1/10 of an acre of wetlands, mitigation is not required. Generally, projects permitted under NW-12 have only temporary impacts.

Endangered Species Act (PMJM Considerations)

All stream channels and riparian corridors may be PMJM habitat. Known PMJM are located in the Indian Creek drainage approximately 1.0 mile east of the project site. Potential PMJM habitat should be confirmed with Cheryl Matthews, Director; Douglas County Open Space and Natural Resources, 100 Third Street, Castle Rock, CO 80104 (303-660-7495; cmatthew@douglas.co.us). Other PMJM

contacts in the FWS include Allison Michael, Leslie Elwood or Drue DeBerry (Telephone: (303) 236-4773; Email: coloradoes@fws.gov) could also provide assistance in this matter.

Migratory Bird Treaty Act (Nests)

Consideration should be given to avoiding construction during the nesting season for ground and tree nesting birds.

Permitting Schedule

Schedule: A reasonable schedule for completing permitting for both Alt 1A and Alt 1B is 180 days.

Alternative 2

Clean Water Act Section 404 Considerations

The Alternative 2 route crosses upland habitats. There appear to be no wetlands or stream channels crossed by this alternative.

Endangered Species Act (PMJM Considerations)

There appears to be no PMJM habitat affected by Option 2.

Migratory Bird Treaty Act (Nests)

There are extensive shrub lands in the southern one quarter to one third of the proposed corridor. This habitat likely provides nesting cover for several species protected under the provisions of the Migratory Bird Treaty Act. Consideration should be given to avoiding construction during the nesting season for ground and tree nesting birds.

Alternative 3

As in the case of Alternative 2, the proposed route for Alternative 3 crosses upland habitat and the discussions of Clean Water Act Section 404 Considerations, Endangered Species Act (PMJM Considerations), and Migratory Bird Treaty Act (Nests) also apply to Alternative 3.

Where the alignment of Alternative 3 branches off Alternative 2 and proceeds due north, the route traverses a high bench that is the hydrologic divide between Plum Creek and Indian Creek. The proposed alignment of Alternative 3 from the point where it branches from Alternative 2 appears to be vegetated only with grasses, forbs and small shrubs. Alternative 3 appears to be even more environmentally benign than Alternative 2.

Permitting Schedule

Schedule: A reasonable schedule for completing permitting for both Alternative 2 and Alternative 3 is 75 days assuming there is no Federal regulatory involvement. Correspondence and perhaps meetings with the USACE, FWS and Douglas County will likely be needed.

Other State and local permits will be required (some will be the responsibility of the construction contractor). These may include but are not limited to:

- 1) Douglas County Floodplain Development Permit
- 2) Douglas County 1041 Permit
- 3) Stormwater Discharge Associated with Construction Activities
- 4) Colorado Discharge Permit System Construction Dewatering General Permit
- 5) Air Pollutant Emission Notice (APEN)
- 6) Spill Prevention Containment and Countermeasures (SPCC) Plan
- 7) County Construction/Access and ROW Permits
- 8) Building permit

C. LAND ACQUISITION

Temporary and permanent easements will be required to install the pipeline. The number of landowners each route crosses is represented in Table 5, below. We have assigned acquisition cost of \$15,000/AC for permanent easements.

Table 5

Option	Alternative 1A	Alternative 1B	Alternative 2	Alternative 3
Easements Required (To TWSD Boundary)	2	6	1	2
Easement Acreage	9	10	4	7

IV. CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

Thunderbird Water and Sanitation					
Tie-In Alternative 1A					
Opinion of Probable Construction Cost					
April-19					
Item No.	Item Description	Units	Unit Cost	Estimated Quantity	Cost
1	General Conditions	LS	\$200,000.00	1	\$200,000.00
2	Clear/Topsoil/Prep/Access Road	LF	\$20.00	15800	\$316,000.00
3	6" C-900 PVC Pipe	LF	\$65.00	15800	\$1,027,000.00
4	Blow-off Assembly	EA	\$10,000.00	13	\$130,000.00
5	Air Vac	EA	\$12,000.00	13	\$156,000.00
6	Tie-in to Dominion Eastside Pipeline/TB system	EA	\$10,000.00	2	\$20,000.00
7	6" Meter Vault	EA	\$30,000.00	2	\$60,000.00
8	6" Gate Valve	EA	\$3,000.00	15	\$45,000.00
9	Pump Station/Wet Well	LS	\$200,000.00	1	\$200,000.00
10	Backflow Preventer/Vault/6" Control Valve	LS	\$100,000.00	1	\$100,000.00
11	Remove and Replace Asphalt	SY	\$50.00	1600	\$80,000.00
12	Erosion Control	LF	\$6.00	15800	\$94,800.00
13	Revegetation	LF	\$15.00	15800	\$237,000.00
14	Permit Fees	LS	\$20,000.00	1	\$20,000.00
15	Construction Testing	LS	\$50,000.00	1	\$50,000.00
16	Construction Staking	LS	\$40,000.00	1	\$40,000.00
17	Traffic Control	LS	\$35,000.00	1	\$35,000.00
18	Site Electrical Service (3-phase)	LS	\$50,000.00	1	\$50,000.00
19	Permanent Easement Acquisition (@ 15,500 LF)	AC	\$15,000.00	9	\$135,000.00
20	Rock Excavation	LS	\$50,000.00	1	\$50,000.00
	Subtotal				\$3,045,800.00
21	Construction Mobilization/Demobilization	5%			\$152,290.00
22	Engineering	9%			\$274,122.00
23	Permitting	5%			\$152,290.00
	Subtotal				\$3,624,502.00
24	Contingency	30%			\$913,740.00
Total in 2019 Construction Costs					\$4,538,242.00

Thunderbird Water and Sanitation					
Tie-In Alternative 1B					
Opinion of Probable Construction Cost					
April-19					
Item No.	Item Description	Units	Unit Cost	Estimated Quantity	Cost
1	General Conditions	LS	\$200,000.00	1	\$200,000.00
2	Clear/Topsoil/Prep/Access Road	LF	\$20.00	16900	\$338,000.00
3	6" C-900 PVC Pipe	LF	\$65.00	16900	\$1,098,500.00
4	Blow-off Assembly	EA	\$10,000.00	15	\$150,000.00
5	Air Vac	EA	\$12,000.00	15	\$180,000.00
6	Tie-in to Dominion Eastside Pipeline/TB system	EA	\$10,000.00	2	\$20,000.00
7	6" Meter Vault	EA	\$30,000.00	2	\$60,000.00
8	6" Gate Valve	EA	\$3,000.00	16	\$48,000.00
9	Pump Station/Wet Well	LS	\$200,000.00	1	\$200,000.00
10	Backflow Preventer/Vault/6" Control Valve	LS	\$100,000.00	1	\$100,000.00
11	Remove and Replace Asphalt	SY	\$50.00	250	\$12,500.00
12	Erosion Control	LF	\$6.00	16900	\$101,400.00
13	Revegetation	LF	\$15.00	16900	\$253,500.00
14	Permit Fees	LS	\$20,000.00	1	\$20,000.00
15	Construction Testing	LS	\$50,000.00	1	\$50,000.00
16	Construction Staking	LS	\$40,000.00	1	\$40,000.00
17	Traffic Control	LS	\$35,000.00	1	\$35,000.00
18	Site Electrical Service (3-phase)	LS	\$50,000.00	1	\$50,000.00
19	Permanent Easement Acquisition (@ 16,500 LF)	AC	\$15,000.00	10	\$150,000.00
20	Rock Excavation	LS	\$36,000.00	1	\$36,000.00
	Subtotal				\$3,142,900.00
21	Construction Mobilization/Demobilization	5%			\$157,145.00
22	Engineering	9%			\$282,861.00
23	Permitting	5%			\$157,145.00
	Subtotal				\$3,740,051.00
24	Contingency	30%			\$942,870.00
Total in 2019 Construction Costs					\$4,682,921.00

Thunderbird Water and Sanitation					
Tie-In Alternative 2					
Opinion of Probable Cost					
April-19					
Item No.	Item Description	Units	Unit Cost	Estimated Quantity	Cost
1	General Conditions	LS	\$200,000.00	1	\$200,000.00
2	Clear/Topsoil/Prep/Access Road	LF	\$20.00	10,200	\$204,000.00
3	6" C-900 PVC Pipe	LF	\$70.00	10,200	\$714,000.00
4	Blow-off Assembly	EA	\$10,000.00	10	\$100,000.00
5	Air Vac	EA	\$12,000.00	10	\$120,000.00
6	Tie-in to Dominion Eastside Pipeline/TB system	EA	\$10,000.00	2	\$20,000.00
7	6" Meter Vault	EA	\$30,000.00	2	\$60,000.00
8	6" Gate Valve	EA	\$3,000.00	9	\$27,000.00
9	Pump Station/Wet Well	LS	\$200,000.00	1	\$200,000.00
10	Backflow Preventer/Vault/6" Control Valve	LS	\$100,000.00	1	\$100,000.00
11	Remove and Replace Asphalt (@ 20' width)	SY	\$60.00	6500	\$390,000.00
12	Erosion Control	LF	\$6.00	9700	\$58,200.00
13	Revegetation	LF	\$15.00	9700	\$145,500.00
14	Permit Fees	LS	\$20,000.00	1	\$20,000.00
15	Construction Testing	LS	\$30,000.00	1	\$30,000.00
16	Construction Staking	LS	\$30,000.00	1	\$30,000.00
17	Traffic Control	LS	\$70,000.00	1	\$70,000.00
18	Site Electrical Service (3-phase)	LS	\$50,000.00	1	\$50,000.00
19	Permanent Easement Acquisition (@5700 LF)	AC	\$15,000.00	4	\$60,000.00
20	Rock Excavation	LS	\$36,000.00	1	\$36,000.00
	Subtotal				\$2,634,700.00
21	Construction Mobilization/Demobilization	5%			\$131,735.00
22	Engineering	9%			\$237,123.00
23	Permitting	3%			\$79,041.00
	Subtotal				\$3,082,599.00
24	Contingency	30%			\$790,410.00
Total in 2019 Construction Costs					\$3,873,009.00

Thunderbird Water and Sanitation					
Tie-In Alternative 3					
Opinion of Probable Cost					
April-19					
Item No.	Item Description	Units	Unit Cost	Estimated Quantity	Cost
1	General Conditions	LS	\$200,000.00	1	\$200,000.00
2	Clear/Topsoil/Prep/Access Road	LF	\$20.00	10,100	\$202,000.00
3	6" C-900 PVC Pipe	LF	\$65.00	10,100	\$656,500.00
4	Blow-off Assembly	EA	\$10,000.00	12	\$120,000.00
5	Air Vac	EA	\$12,000.00	13	\$156,000.00
6	Tie-in to Dominion Eastside Pipeline/TB system	EA	\$60,000.00	1	\$60,000.00
7	6" Meter Vault	EA	\$30,000.00	2	\$60,000.00
8	6" Gate Valve	EA	\$3,000.00	9	\$27,000.00
9	Pump Station/Wet Well	LS	\$200,000.00	1	\$200,000.00
10	Backflow Preventer/Vault/6" Control Valve	LS	\$100,000.00	1	\$100,000.00
11	Remove and Replace Asphalt (crossing)	SY	\$50.00	250	\$12,500.00
12	Erosion Control	LF	\$6.00	9600	\$57,600.00
13	Revegetation	LF	\$15.00	9600	\$144,000.00
14	Permit Fees	LS	\$20,000.00	1	\$20,000.00
15	Construction Testing	LS	\$30,000.00	1	\$30,000.00
16	Construction Staking	LS	\$30,000.00	1	\$30,000.00
17	Traffic Control	LS	\$35,000.00	1	\$35,000.00
18	Site Electrical Service (3-phase)	LS	\$50,000.00	1	\$50,000.00
19	Permanent Easement Acquisition (@ 9500 LF)	AC	\$15,000.00	7	\$105,000.00
20	Rock Excavation	LS	\$36,000.00	1	\$36,000.00
	Subtotal				\$2,301,600.00
21	Construction Mobilization/Demobilization	5%			\$115,080.00
22	Engineering	9%			\$207,144.00
23	Permitting	3%			\$69,048.00
	Subtotal				\$2,692,872.00
24	Contingency	30%			\$690,480.00
Total in 2019 Construction Costs					\$3,383,352.00

These Conceptual Opinions of Probable Costs are based on our qualifications and experience with similar projects and have undergone peer review. In addition, we have based our opinion on past experience, information from other similar projects, material suppliers, and general contractors. However, Acuity, LLC is not a construction contractor and has no control over costs or the price of labor, equipment or materials, or over a Contractor's method of pricing. Acuity, LLC makes no warranty, expressed or implied, as to the accuracy of Opinions of Cost as compared to actual costs.

V. CONCLUSION

Thunderbird Water and Sanitation District Alternative Summary 19-Apr-19				
Option	Alternative 1A	Alternative 1B	Alternative 2	Alternative 3
Pipe Length	15,800	16,900	9,700	9,600
Air Vacuum Valves	13	15	10	12
Blow-off Valves	13	15	10	13
Isolation Valves	15	16	9	9
Length in Road ROW	0	0	4000	100
Easements Required (To TWSD Boundary)	2	6	1	2
Electric Service Access	Yes	Yes	Yes	Yes
Environmental Permitting	Potential Waters of US and PMJM Habitat (3)	Potential Waters of US and PMJM Habitat (3)	No Known	No Known
Tie-in	Existing Tee	Existing Tee	Existing Tee	No Tee
Cost	High Cost	Highest Cost	Moderate Cost	Lowest Cost

The table above presents a matrix of comparison each alternative as evaluated by ten variables. A green shaded box represents a positive evaluation relative to the potential for favorable project

outcome, as defined by cost and schedule. Yellow and Red shaded boxes represent moderate and high risk to a favorable outcome based on cost and schedule.

A review of the matrix suggests that Alternatives 1A and 1B present moderate and high risk in the categories of: length, fittings, appurtenances, permitting and cost. Alt 1B, the least favorable alternative, presents additional risk due to the number of easements required.

Alternative 2, while generally favorable, presents high risk due to the work that must be performed in the right-of-way of Rio Grande Ave. Working in the right-of-way will require present higher risk due to traffic control/mitigation and possible utility conflicts (phone, cable, electric, gas).

Alternative 3 presents the most favorable alignment as it presents the shortest length and lowest cost option. One risk factor must be considered in Alternative 3: there is no planned tee planned on the ERRP at the location. Therefore, Dominion must agree to have one installed during construction, or the pipeline must be tapped at a later date.

Appendix A

Thunderbird Water and Sanitation District (TWSD)
 Dominion Tie-In Design Parameters/Assumptions
 April 2019

Objective: To provide a Technical Memorandum and Conceptual Opinion of Probable Cost evaluating the delivery of treated water by Dominion to TWSD serving as a back-up water supply to TWSD's existing wells.

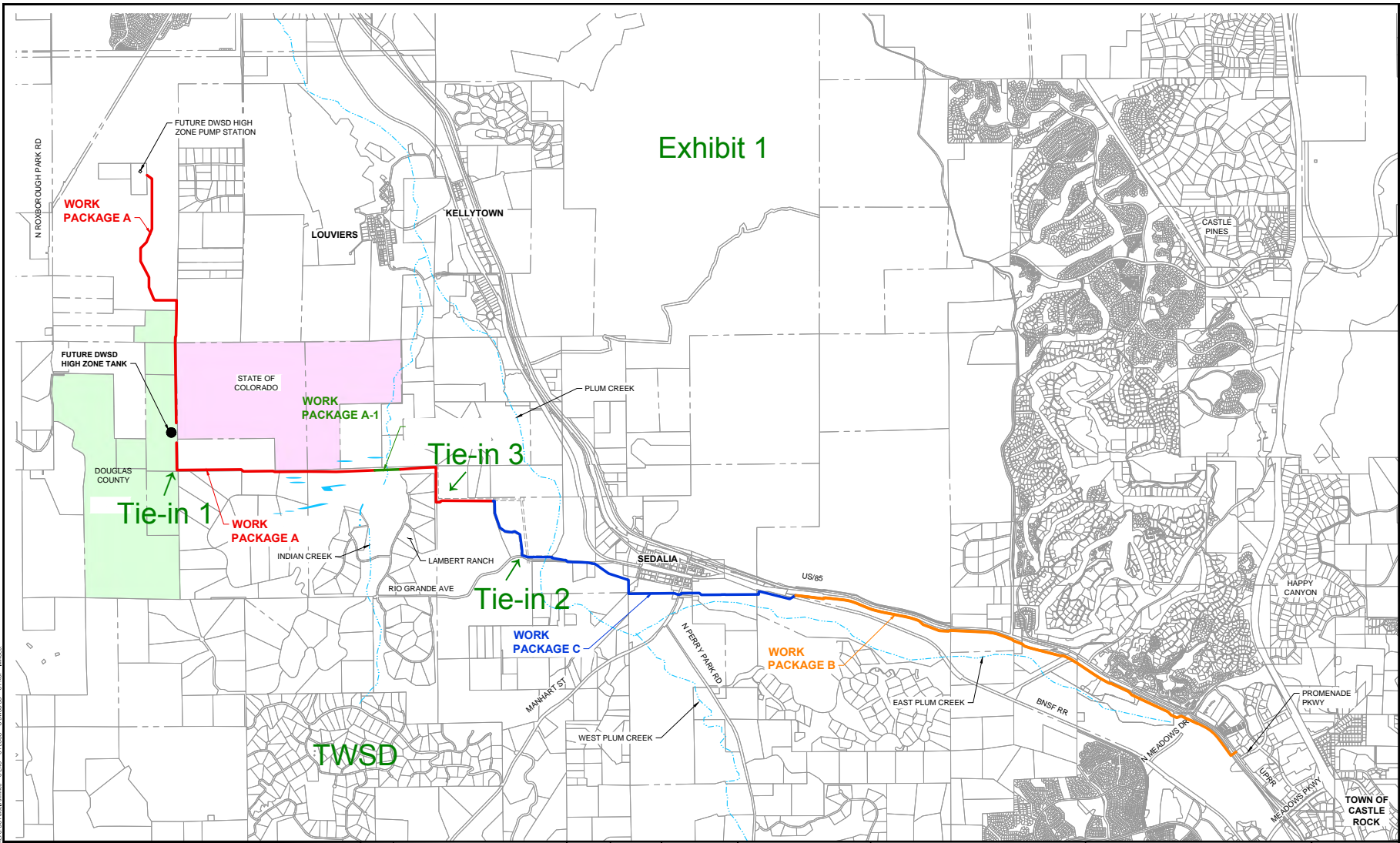
Parameter		Preliminary Value
Supply Source	Dominion East Side Pipeline	15.5 gpm average flow Annual losses unknown
Demand/capacity	.3 AF/home/Year 178 homes. Specified in purchase agreement	
Expandability	Additional build out limited to ~5%	
Existing Infrastructure	6" Schedule 40 PVC with losses	
Delivery point(s)	1. High zone tank 2. Raw water system @ Lambert Ranch 3. Treated distribution system	Need to pump ~200 - 500 vertical feet* + head loss 11,000 - 18,000 LF
Relative Elevations	Castle Rock Tank ~6352 Thunderbird High Tank ~6300 Dominion Tank ~6100 East Route Tie-in ~5800	
Pipeline Horizontal Distance	1. Tank to Tank ~18,000 LF 2. Eastern Route to SE Lambert ~8000 LF 3. SE Lambert to W. Rainbow Creek Rd. ~3000 LF	
Fire Flow	Not considered in purchase agreement	
Peak Flow	Defined in agreement as 100gpm	Fire Flow provided by storage 100gpm
Pump Station(s)	At least one required	
Surge Protection	Yes	
Pump Controls/Tie-in	Remote control and monitoring telemetry required. Structures sized to accommodate actuators. Use VFD's. Wet wells constructed of poured in place concrete. Tie-in will require air-break/wet well to prevent backflow.	
Easements	Will be required/evaluated	5-7 FPS
Max Velocity in Pipes		5-7 FPS


Operating Time Period	Year round (frost protection required)
Exiting chlorination system used by TWSD	Sodium Hypochlorite
Chlorination system used by Dominion for delivered water	Chloramines
Chlorine Management	Is issue due to incompatibility of chlorine compounds
Operation Frequency	Part time – during high demand periods
Flushing required after idle periods	Yes
Consider Chlorine/Water Aging?	May be issue
Pump Redundancy	Leave space for additional pump
Backup Electrical	Leave connection
Pipeline Material	C-900 PVC, DI, Steel
Flow Measurement	Magmeter with Totalizer
Flow measurement telemetry	Yes
Pump Station building type and structure	No known architectural requirements
Backflow Prevention	DOM requires air break between systems

* Provided by Providence Engineering


Appendix B

Exhibit 1





PROVIDENCE INFRASTRUCTURE CONSULTANTS
4901 EAST DRY CREEK ROAD, SUITE 210
CENTENNIAL, CO 80122
TEL: (303) 997-5035
www.providenceinc.com



REVISION	DESCRIPTION OF ISSUE / REVISION	REVISED BY

VERIFY SCALE
FOR ALL WORK
FOR ALL WORK
FOR ALL WORK
FOR ALL WORK

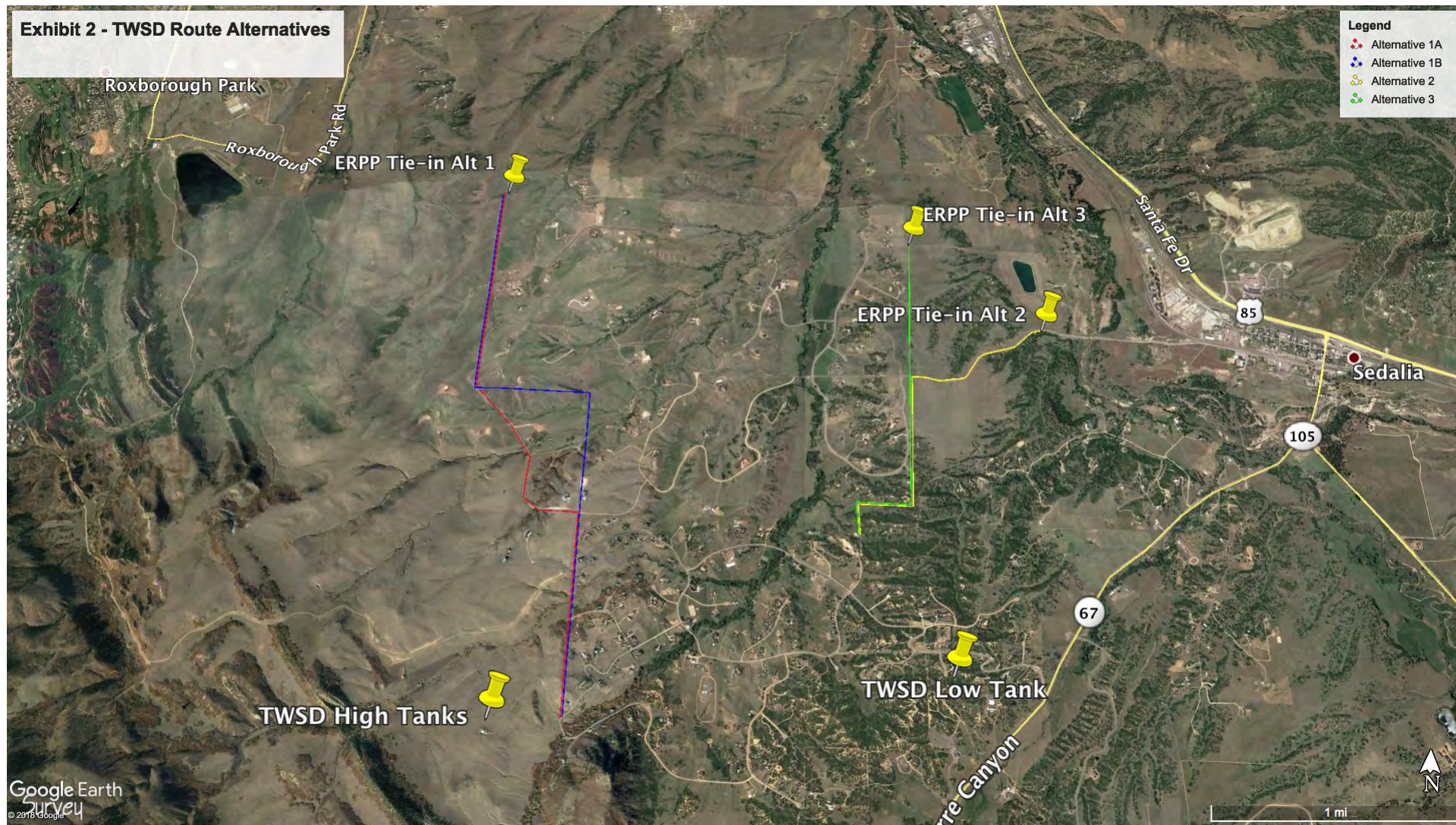
DOMINION WATER AND
SANITATION DISTRICT

EASTERN REGIONAL
PIPELINE PROJECT

WORK PACKAGE
PROJECT OVERVIEW MAP

PROJECT: 171022
DRAWN BY: M. PITTMAN
DESIGNED BY: G. BISH
APPROVED BY: L. LUNDEN
SHEET: 1 OF 1
DRAWING: WP-1

Exhibit 2 - TWSD Route Alternatives



NOTES:

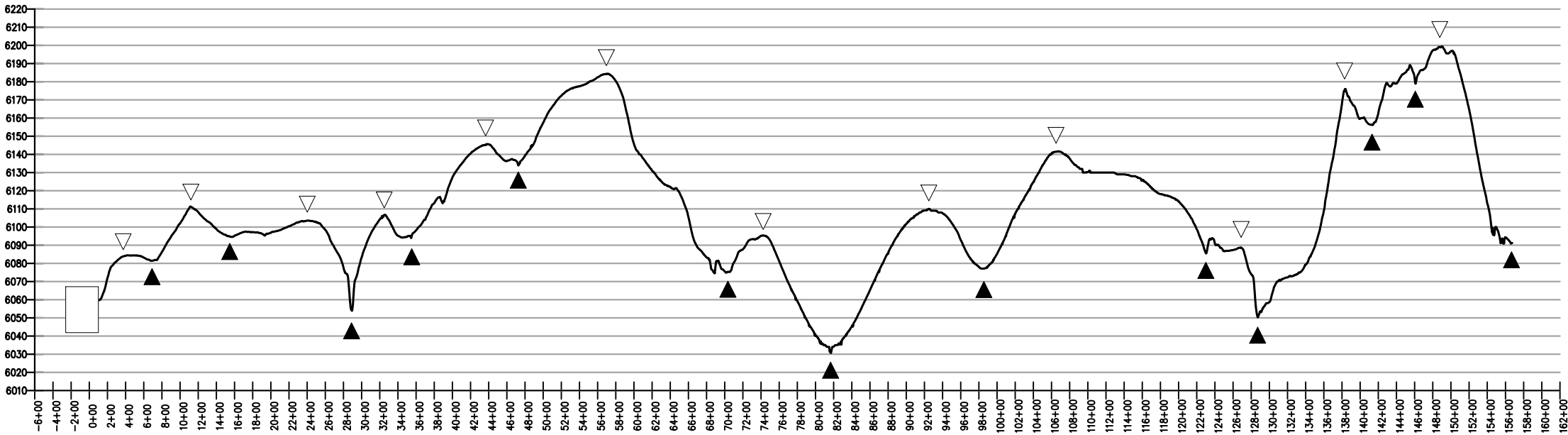
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- 2. DATASETS USED IN THE CREATION OF THIS EXHIBIT WERE:
CONTOURS SEDALIA 2013
CONTOURS ROXBOROUGH PARK NE 2013
CONTOURS ROXBOROUGH PARK SE 2013

ALTERNATIVE 1A



LEGEND:

- ▽ AIR VAC
- ▲ BLOW OFF VALVE
- PUMP STATION



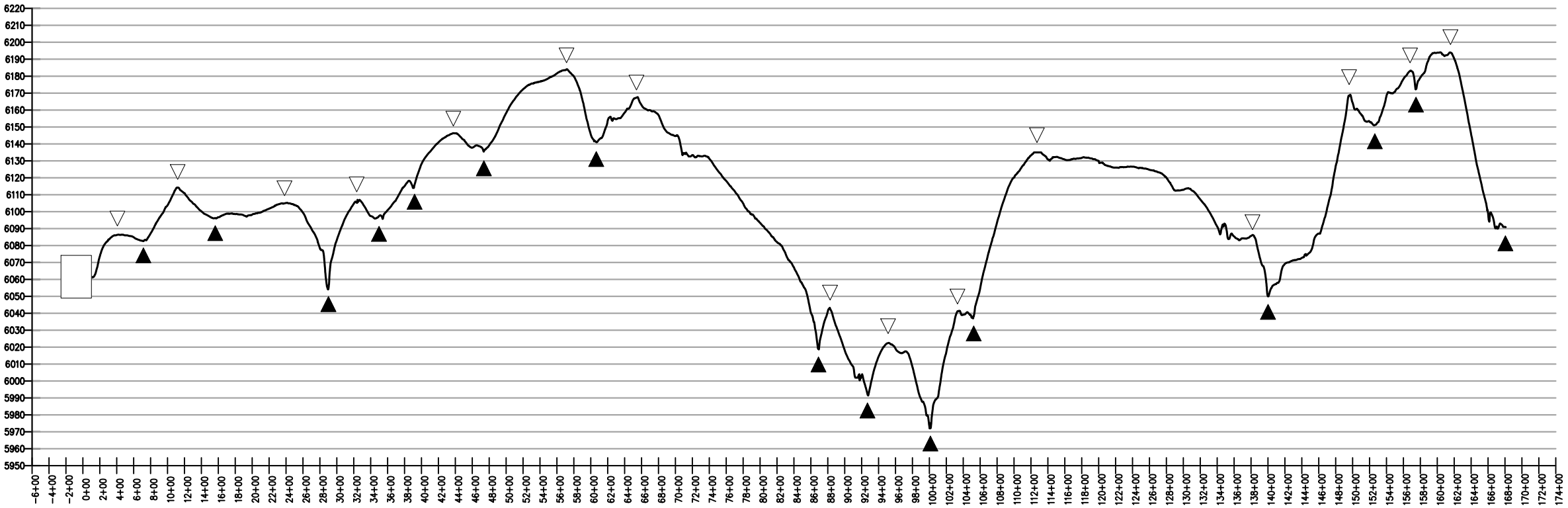
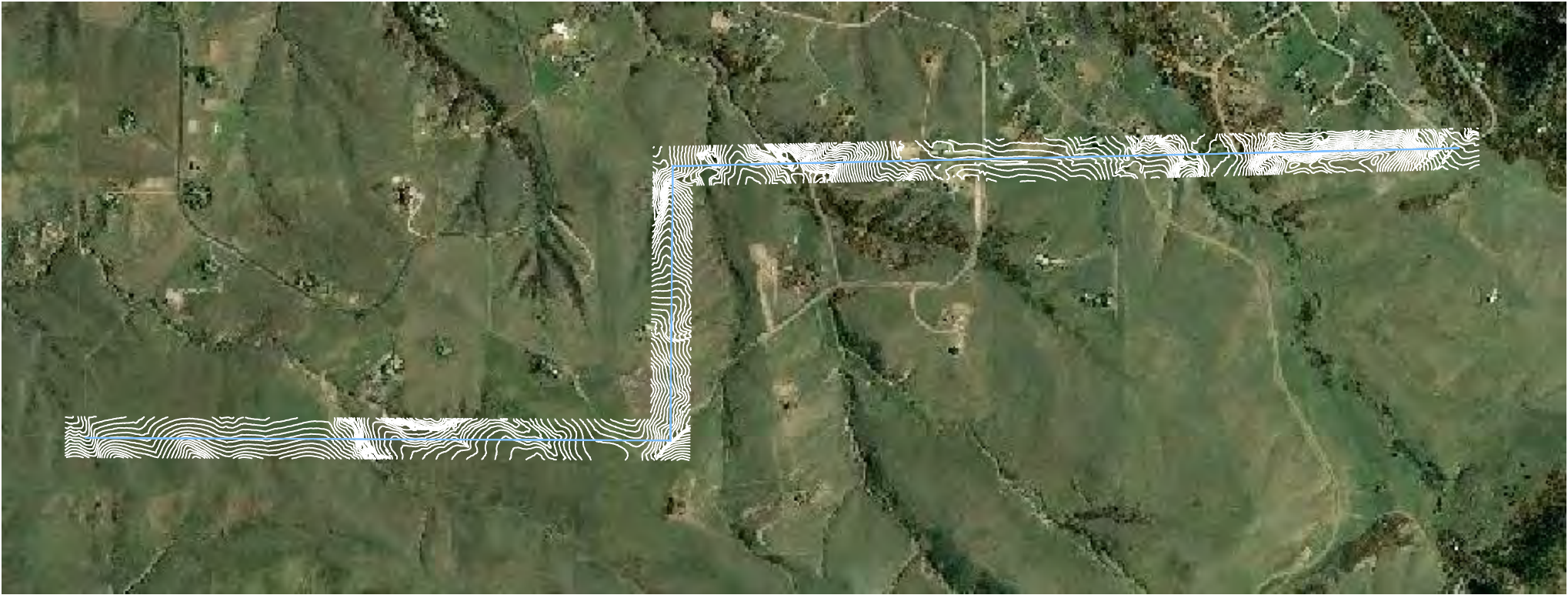
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2. DATASETS USED IN THE CREATION OF THIS EXHIBIT WERE:
CONTOURS SEDALIA 2013
CONTOURS ROXBOROUGH PARK NE 2013
CONTOURS ROXBOROUGH PARK SE 2013

LEGEND:

- ▽ AIR VAC
- ▲ BLOW OFF VALVE
- PUMP STATION

ALTERNATIVE 1B



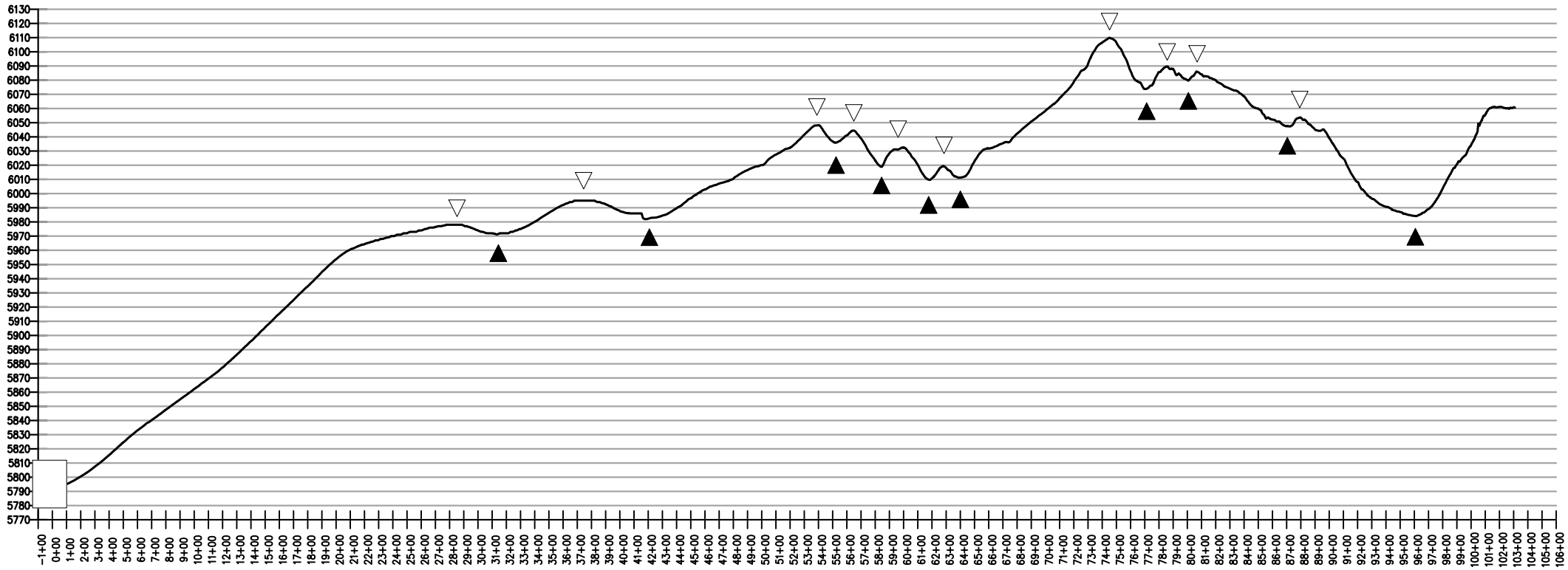
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- 2. DATASETS USED IN THE CREATION OF THIS EXHIBIT WERE:
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LEGEND:

- ▽ AIR VAC
- ▲ BLOW OFF VALVE
- PUMP STATION

ALTERNATIVE 2



NOTES:

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2. DATASETS USED IN THE CREATION OF THIS EXHIBIT WERE:
CONTOURS SEDALIA 2013

LEGEND:

- ▽ AIR VAC
- ▲ BLOW OFF VALVE
- PUMP STATION

ALTERNATIVE 3

