

Fulton Ditch Company

Irrigation Efficiency Alternatives Analysis

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Prepared for:

Trout Unlimited and Fulton Ditch Company

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1.0 EXECUTIVE SUMMARY

The Fulton Ditch Company (FDC) has served its shareholders for over 100 years. The original infrastructure has more than adequately met the needs of its users. However, in recent years water usage needs and circumstances have changed motivating the FDC to evaluate potential improvements making use of the latest technology which will improve water usage efficiency and have a positive economic benefit for the company. This effort identifies improvements that will ensure the ditch will continue to effectively serve its shareholders for the coming years.

Forsgren Associates has completed an assessment of three alternatives for improving Fulton Ditch service and operation. These alternatives include the following:

- Gravity Pipeline
- Pressurized Pipeline with Pump Station
- Pressurized Pipeline Pump Station and Well System

Each of these alternatives provides the approximately 9.0 cfs demand for the Fulton Ditch while reducing the volume diverted from the Chewuch River by as much as 13 cfs. This analysis developed conceptual designs for each of the alternatives as well as estimated costs. Operational and lifecycle costs were also estimated. General results are presented below.

Alternative	Estimated Capital Cost
Alt 1 - Gravity Pipeline	\$8,776,000
Alt 2 - Pressurized Pipeline Pump Station (2 psi min)	\$6,151,000
Alt 2a - Pressurized Pipeline Pump Station (50 psi min)	\$6,872,000
Alt 3 - Pressurized Pipeline Pump Station And Well System (700 gpm, 2psi min)	\$6,855,000
Alt 3a - Pressurized Pipeline Pump Station And Well System (700 gpm; 50 psi min)	\$7,456,000

Alternative	Annual Equipment Replacement Fund Estimate
Alt 1 - Gravity Pipeline	\$37,900
Alt 2 - Pressurized Pipeline Pump Station (2 psi min)	\$68,000
Alt 2a - Pressurized Pipeline Pump Station (50 psi min)	\$77,300
Alt 3 - Pressurized Pipeline Pump Station And Well System (700 gpm, 2psi min)	\$98,800
Alt 3a - Pressurized Pipeline Pump Station And Well System (700 gpm; 50 psi min)	\$114,600

Alternative	Estimated Annual Power Costs
Alt 1 - Gravity Pipeline	\$1,200
Alt 2 - Pressurized Pipeline Pump Station (2 psi min)	\$19,012
Alt 2a - Pressurized Pipeline Pump Station (50 psi min)	\$24,750
Alt 3 - Pressurized Pipeline Pump Station And Well System (700 gpm, 2psi min)	\$22,865
Alt 3a - Pressurized Pipeline Pump Station And Well System (700 gpm; 50 psi min)	\$26,585

Alternative	Estimated 40-yr Life-Cycle Cost
Alt 1 - Gravity Pipeline	\$10,340,000
Alt 2 - Pressurized Pipeline Pump Station (2 psi min)	\$9,631,480
Alt 2a - Pressurized Pipeline Pump Station (50 psi min)	\$10,954,000
Alt 3 - Pressurized Pipeline Pump Station And Well System (700 gpm, 2psi min)	\$11,721,600
Alt 3a - Pressurized Pipeline Pump Station And Well System (700 gpm; 50 psi min)	\$13,103,400

2.0 BACKGROUND

The Fulton Ditch Company (FDC) has served its shareholders for over 100 years. The original infrastructure has more than adequately met the needs of its users. However, in recent years water usage needs and circumstances have changed motivating the FDC to evaluate potential improvements making use of the latest technology which will improve water usage efficiency and have a positive economic benefit for the company. This alternative analysis will identify improvements that will ensure the ditch will continue to effectively serve its shareholders for the coming years.

Review of historical data shows that FDC diverts an average of 15 cfs with a peak of 22 cfs to supply shares totaling approximately 9.0 cfs. The remainder of the water is consumed by seepage, transportation water, and operational spills.

In 2010 the FDC in cooperation with the Bureau of Reclamation and the Methow Salmon Recovery Foundation evaluated potential projects for improving water usage efficiency for the Fulton Ditch. Four alternatives were presented including pipe the entire ditch, pipe in Winthrop area and line the rest of the ditch and develop ground water wells. The 2010 study also considered a no action alternative.

The alternatives presented in the 2010 study were not implemented due to funding limitations and lack of support from shareholders. Since 2010 circumstances have continued to change and in 2024 Trout Unlimited in cooperation with FDC authorized Forsgren Associates to reevaluate potential alternatives for improving water usage efficiency for the Fulton Ditch. This study presents the alternatives evaluated and provides a recommendation for implementation of an irrigation efficiency alternative for the ditch.

3.0 EXISTING FACILITIES

According to historical records, Fulton Ditch has diverted up to 22 cfs to deliver approximately 9.0 cfs used by its 29 shareholders. A summary of shareholders and the associated demands are provided in Appendix A. Seepage tests performed in past years have showed that approximately 3 cfs is lost due to seepage from the ditch, with another 1 cfs lost due to leakage in the pipe crossing under the Chewuch River. Total seepage losses are estimated at approximately 4 cfs. The leakage in the Chewuch River crossing is of concern as it implies the pipe is failing.

Transportation water and operational spills that are required to keep water levels in the ditch sufficient for extraction by shareholders at various points along the ditch account for another approximately 2.0 cfs. The operational spills at several strategic locations along the ditch are used to keep water from overflowing the ditch and leaves approximately 7.1 cfs as transportation and spill water that could be recovered. Table 1 provides a summary of water use and potential savings for the Fulton Ditch.

Table 1- Water Usage and Loss Summary

Water Element	Water Use (cfs)	Potential Water Savings (cfs)
Irrigation Shares	9.0	
Transportation Water and Controlled Spills	9.0	9.0
Seepage	3.0	3.0
Chewuch Crossing Loss	1.0	1.0
Totals	22.0	13.0

Figure 1 shows a layout of the existing Fulton Ditch system. The Fulton Ditch diversion occurs approximately a half mile up stream of the Chewuch River's convergence with the Methow River. A BOR fish screen is located approximately 940 feet downstream of the diversion. The ditch begins on the west side of the Chewuch River and runs 1,200 L.F. through a park to the Chewuch River crossing. This first section of the ditch is considered historical. The water then enters a concrete pipe, approximately sixty years old, crossing under the Chewuch River. The pipe rises on the other side and empties into an open ditch. The ditch then continues through Winthrop, behind or under some businesses, and through residents' back yards before leaving Winthrop City limits. This first section is approximately 6,330 L.F. The ditch then proceeds east of and parallel to the Methow River for approximately 12,470 feet until it ultimately empties into the Methow River.

4.0 ALTERNATIVE DESCRIPTIONS

Each of the alternatives described below provides the full water demand allotted for each of the 29 Fulton Ditch shareholders. Each alternative is described and the estimated cost for each alternative is provided below.

4.1 Alternative 1 – Gravity Pipeline

This alternative includes the installation of a gravity pipeline along the current alignment of the Fulton Ditch. This alternative would maintain the existing irrigation diversion along the Chewuch River as well as the existing BOR fish screen.

This alternative will require replacement of the existing siphon running under the Chewuch River. The existing siphon would be abandoned in place with a new inlet structure and outlet structure constructed at either end of the new siphon. Additional investigation would be done as part of preliminary design to verify a specific location for the siphon, but for the purposes of this study it is assumed the siphon will run approximately 20 feet upstream of the current siphon alignment.

Forsgren performed a hydraulic analysis of a gravity pipeline system for the Fulton Ditch based on existing water demands and service locations. Hydraulic modeling output for this alternative is provided in Appendix B. Assuming HDPE pipe and based on this analysis the following pipeline diameters and lengths were determined.

Table 2- Gravity Pipeline Sizes and Lengths

Station	Pipe Size (in)	Lenth (ft)
26+39.43 to 43+46.30	12	1707
43+46.30 to 53+88.57	18	1042
53+88.57 to 70+63.78	20	1675
70+63.78 to 109+23.00	24	3859
109+23.00 to 153+21.03	26	4398
153+21.03 to 226+60.23	28	7339

Typical irrigation pipeline construction is assumed. The system was modeled assuming a hydraulic grade line 2 to 4 feet above the top of pipe. This provides for positive pressure at each service tap. Each service would be sized according to the demand with a service saddle on the transmission pipeline and a shutoff/isolation valve. A layout of Alternative 1 is provided in Figure 2. An estimated cost for Alternative 1 is provided in Table 3.

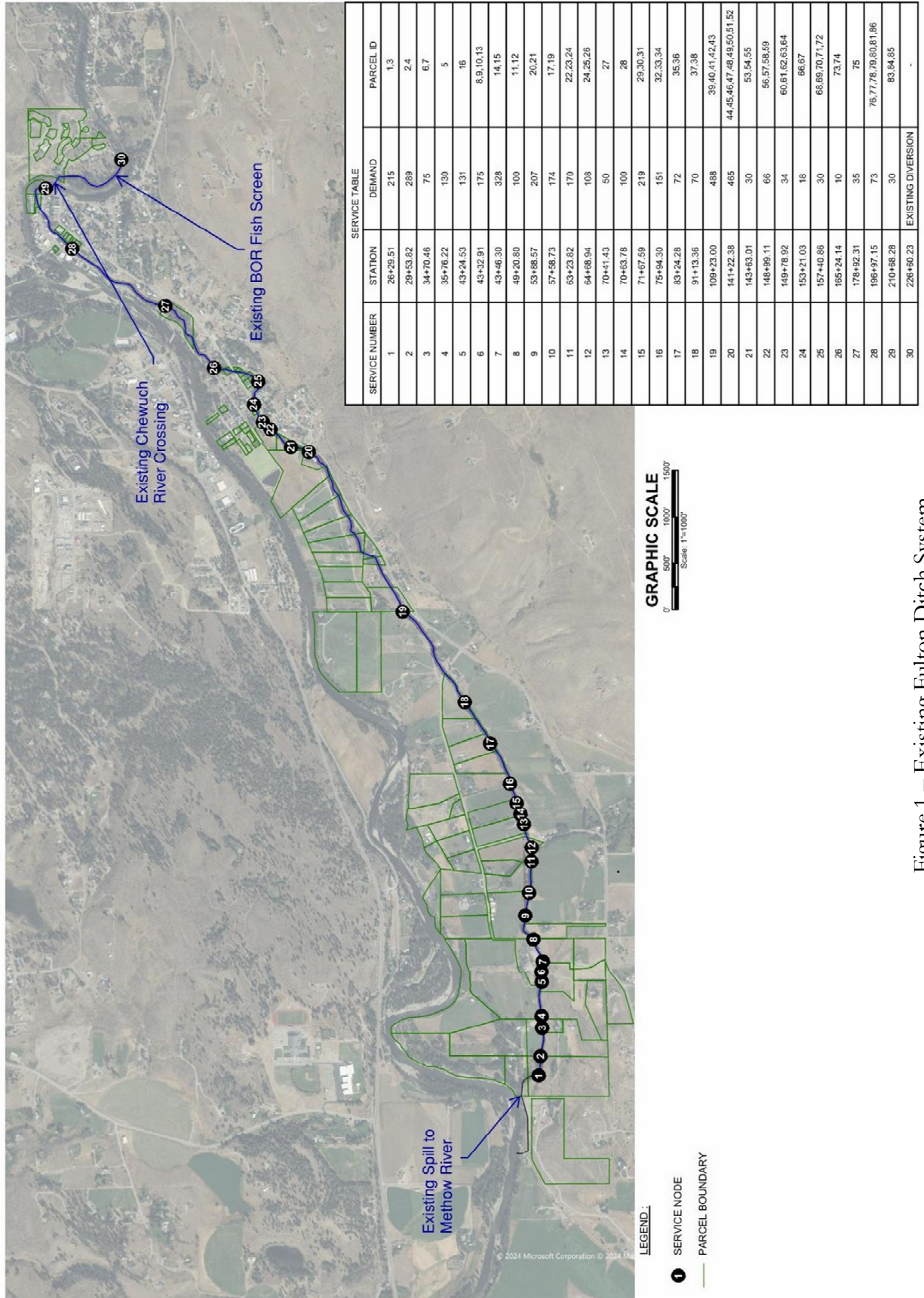


Figure 1 – Existing Fulton Ditch System

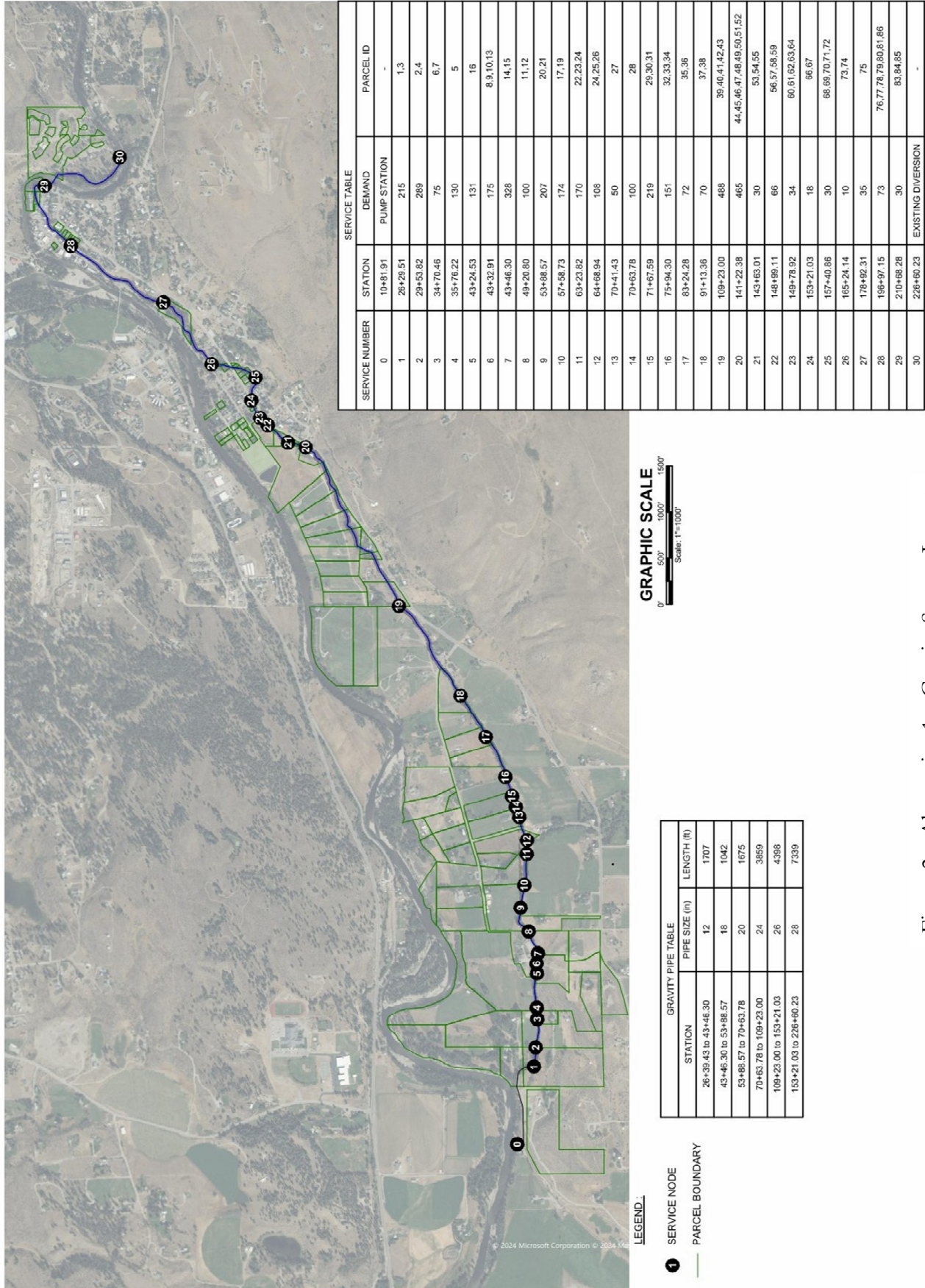


Figure 2 – Alternative 1 – Gravity System Layout

Table 3- Alternative 1 Estimated Cost

Description	Unit of Measure	Quantity	Unit Costs	Total Cost
Transmission Pipeline				
28-Inch IPS DR 11 HDPE	LF	7,500	\$ 221	\$ 1,659,375
26-Inch IPS DR 11 HDPE	LF	4,500	\$ 191	\$ 857,813
24-Inch IPS DR 11 HDPE	LF	4,000	\$ 130	\$ 520,000
20-Inch IPS DR 11 HDPE	LF	1,700	\$ 91	\$ 153,850
18-Inch IPS DR 11 HDPE	LF	1,500	\$ 74	\$ 110,250
12-Inch IPS DR 11 HDPE	LF	1,800	\$ 37	\$ 66,600
Appurtenances (valving, vents, etc.)	LS	1	\$ 165,938	\$ 165,938
Temporary Water Pollution/Erosion Control	LS	1	\$ 50,000	\$ 50,000
Clearing and Grubbing	LF	18,806	\$ 3.00	\$ 56,418
Turnout Connections	EA	29	\$ 4,000	\$ 116,000
Site Work	LS	1	\$ 225,000	\$ 225,000
			Subtotal	\$ 3,981,243
Chewuch River Crossing				
Inlet Structure	LS	1	\$ 110,000	\$ 110,000
Outlet Structure	LS	1	\$ 110,000	\$ 110,000
Cofferdams / Unwatering	LS	1	\$ 650,000	\$ 650,000
28-Inch IPS DR 11 HDPE	LF	230	\$ 1,100	\$ 253,000
Water Control and Construction Dewatering	LS	1	\$ 500,000	\$ 500,000
Site Work	LS	1	\$ 110,000	\$ 110,000
Inlet/Outlet Structure Upgrades				
Earthwork	LS	1	\$ 25,000	\$ 25,000
Control Structure	LS	1	\$ 45,000	\$ 45,000
Inlet Structure Upgrades	LS	1	\$ 80,000	\$ 80,000
Dewatering	LS	1	\$ 10,000	\$ 10,000
			Subtotal	\$ 1,893,000
			Mobilization (12%)	\$ 704,909
			Construction Subtotal	\$ 6,579,152
			Contingency (25%)	\$ 1,644,788
			Tax (8.4%)	\$ 552,649
			Total Construction	\$ 8,776,589

4.2 Alternative 2 – Pressurized Pipeline with Pump Station

This alternative includes the installation of a pressurized pipeline running along the existing alignment of the Fulton Ditch. Irrigation water would be supplied from an on-demand pump station located as shown in Figure 3 below. This location is currently controlled by Trout Unlimited and would be available for construction of the pump station.

Water would be diverted to the pump station through a screening structure located adjacent to the Methow River. The screening structure would be either a cone or flat plate self-cleaning screen.

The pumping system would include a 30 horsepower jockey pump for low flow service with a flow range from approximately 100 gpm to 600 gpm. Three 60 horsepower duty pumps would be included with each having a flow range from approximately 500 gpm to 1200 gpm. The total system would have a flow range from approximately 100 gpm to approximately 4200 gpm. Each pump would be controlled by a variable frequency drive motor allowing flows to be delivered to the system at the rate necessary to maintain a set pressure. The hydraulic analysis for the system indicates that a minimum pressure of 2 psi would be maintained throughout the system ensuring a positive pressure at each service node. An additional scenario for this alternative providing a minimum of 50 psi throughout the system was also analyzed. This scenario essentially includes larger pumps providing additional pressure throughout the system. The larger pumps are estimated to be approximately 45 horsepower for the jockey pump and approximately 75 horsepower for the duty pumps.

The pumping system would be housed in a CMU building placed over an open wet well. This configuration was determined based on the need to settle sediment in Methow River water prior to running through the pumping system.

The hydraulic modeling performed for this alternative was also based on existing water demands and service locations. Modeling output is provided in Appendix C. Assuming HDPE pipe the following pipe sizes and lengths were determined for this alternative.

Table 4- Pressure Pipeline Sizes and Lengths

Station	Pipe Size (in)	Lenth (ft)
10+00.00 to 29+53.81	22	1954
29+53.81 to 39+16.44	20	963
39+16.44 to 53+88.57	18	1472
53+88.57 to 70+63.78	16	1675
70+63.78 to 109+23.00	12	3859
109+23.00 to 141+22.38	10	3199
141+22.38 to 210+68.28	6	6946

As with Alternative 1, typical irrigation pipeline construction is assumed and each service would be sized according to the demand with a service saddle on the transmission pipeline and a shutoff/isolation valve. A layout of Alternative 2 is shown in Figure 3. An estimated cost for Alternative 2 is provided in Table 5. An estimated cost for Alternative 2a (50 psi throughout the system) is provided in Table 6.

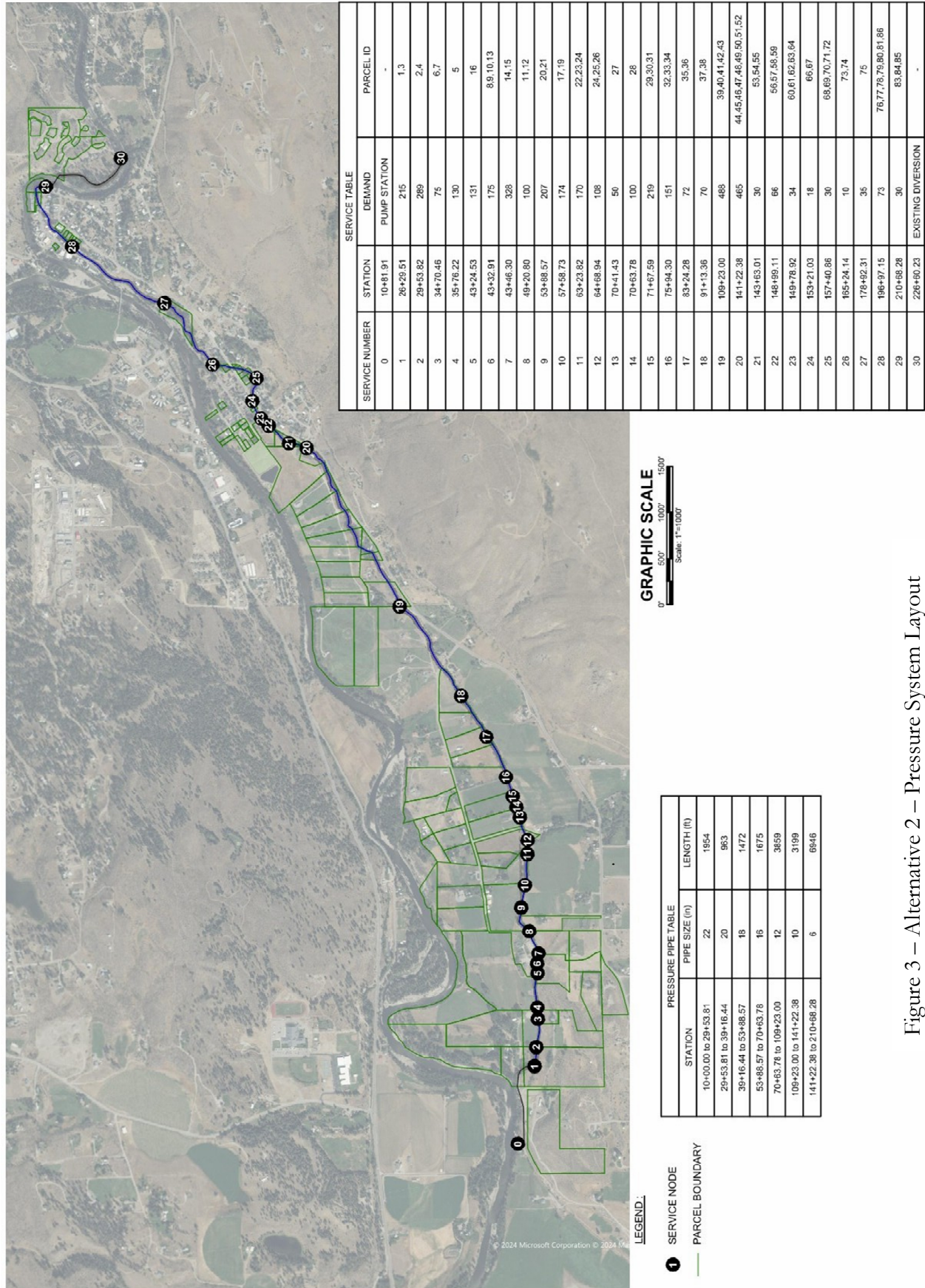


Figure 3 – Alternative 2 – Pressure System Layout

Table 5- Alternative 2 (2psi minimum) Estimated Cost

Description	Unit of Measure	Quantity	Unit Costs	Total Cost
Transmission Pipeline				
22-Inch IPS DR 11 HDPE	LF	2,000	\$ 196	\$ 392,000
20-Inch IPS DR 11 HDPE	LF	1,000	\$ 164	\$ 164,000
18-Inch IPS DR 11 HDPE	LF	1,500	\$ 133	\$ 199,500
16-Inch IPS DR 11 HDPE	LF	1,700	\$ 105	\$ 178,500
12-Inch IPS DR 11 HDPE	LF	4,000	\$ 67	\$ 266,000
10-Inch IPS DR 11 HDPE	LF	3,200	\$ 48	\$ 152,000
6-Inch IPS DR 11 HDPE	LF	7,000	\$ 18	\$ 126,000
Appurtenances (valving, vents, etc.)	LS	1	\$ 147,800	\$ 147,800
Clearing and Grubbing	LF	18,806	\$ 3.00	\$ 56,418
Turnout Connections	EA	29	\$ 4,000	\$ 116,000
Site Work	LS	1	\$ 100,000	\$ 100,000
			Subtotal	\$ 1,898,218
Pump Station				
Earthwork	CY	1,000	\$ 85	\$ 85,000
Dewatering	LS	1	\$ 65,000	\$ 65,000
Building	SF	1,100	\$ 180.00	\$ 198,000
Wet Well	CY	200	\$ 500	\$ 100,000
Interior Equipment	LS	1	\$ 36,000	\$ 36,000
Pipe Header	LS	1	\$ 80,000	\$ 80,000
Duty Pumps	EA	3	\$ 135,000	\$ 405,000
Jockey Pump	EA	1	\$ 110,000	\$ 110,000
Electrical, Controls & HVAC	LS	1	\$ 450,000	\$ 450,000
Programming	LS	1	\$ 200,000	\$ 200,000
Gravel Access Road	LS	1	\$ 10,000	\$ 10,000
Yard Piping	LS	1	\$ 45,000	\$ 45,000
Flow Metering	LS	1	\$ 15,000	\$ 15,000
Inlet Structure		1		
Earthwork	LS	1	\$ 80,000	\$ 80,000
Diversion Structure	LS	1	\$ 150,000	\$ 150,000
Screening Equipment	LS	1	\$ 100,000	\$ 100,000
Dewatering	LS	1	\$ 50,000	\$ 50,000
Electrical & Controls	LS	1	\$ 40,000	\$ 40,000
			Subtotal	\$ 2,219,000
			Mobilization (12%)	\$ 494,066
			Construction Subtotal	\$ 4,611,284
			Contingency (25%)	\$ 1,152,821
			Tax (8.4%)	\$ 387,348
			Total Construction	\$ 6,151,453

Table 6- Alternative 2a (50psi minimum) Estimated Cost

Description	Unit of Measure	Quantity	Unit Costs	Total Cost
Transmission Pipeline				
22-Inch IPS DR 11 HDPE	LF	2,000	\$ 196	\$ 392,000
20-Inch IPS DR 11 HDPE	LF	1,000	\$ 164	\$ 164,000
18-Inch IPS DR 11 HDPE	LF	1,500	\$ 133	\$ 199,500
16-Inch IPS DR 11 HDPE	LF	1,700	\$ 105	\$ 178,500
12-Inch IPS DR 11 HDPE	LF	4,000	\$ 67	\$ 266,000
10-Inch IPS DR 11 HDPE	LF	3,200	\$ 48	\$ 152,000
6-Inch IPS DR 11 HDPE	LF	7,000	\$ 18	\$ 126,000
Appurtenances (valving, vents, etc.)	LS	1	\$ 147,800	\$ 147,800
Clearing and Grubbing	LF	18,806	\$ 3.00	\$ 56,418
Turnout Connections	EA	29	\$ 4,000	\$ 116,000
Site Work	LS	1	\$ 100,000	\$ 100,000
			Subtotal	\$ 1,898,218
Pump Station				
Earthwork	CY	1,000	\$ 85	\$ 85,000
Dewatering	LS	1	\$ 65,000	\$ 65,000
Building	SF	1,100	\$ 180.00	\$ 198,000
Wet Well	CY	200	\$ 500	\$ 100,000
Interior Equipment	LS	1	\$ 36,000	\$ 36,000
Pipe Header	LS	1	\$ 80,000	\$ 80,000
Duty Pumps	EA	3	\$ 202,500	\$ 607,500
Jockey Pump	EA	1	\$ 165,000	\$ 165,000
Electrical, Controls & HVAC	LS	1	\$ 675,000	\$ 675,000
Programming	LS	1	\$ 200,000	\$ 200,000
Gravel Access Road	LS	1	\$ 10,000	\$ 10,000
Yard Piping	LS	1	\$ 45,000	\$ 45,000
Flow Metering	LS	1	\$ 15,000	\$ 15,000
Inlet Structure		1		
Earthwork	LS	1	\$ 80,000	\$ 80,000
Diversion Structure	LS	1	\$ 150,000	\$ 150,000
Screening Equipment	LS	1	\$ 100,000	\$ 100,000
Dewatering	LS	1	\$ 50,000	\$ 50,000
Electrical & Controls	LS	1	\$ 40,000	\$ 40,000
			Subtotal	\$ 2,701,500
			Mobilization (12%)	\$ 551,966
			Construction Subtotal	\$ 5,151,684
			Contingency (25%)	\$ 1,287,921
			Tax (8.4%)	\$ 432,741
			Total Construction	\$ 6,872,347

4.3 Alternative 3 – Pressurized Pipeline with Well System

The development of this alternative included a hydrogeologic analysis of the potential for water to be supplied by ground water wells. The section below provides a summary of the hydrogeologic study with the full report provided in Appendix D.

4.3.1 Alternative 3 – Hydrogeologic Study

As part of the analysis for this alternative a hydrogeologic study report was completed by American Land and Water to evaluate feasibility of replacing some or all surface water requirements with one or more wells. A conceptual hydrogeologic model characterizing groundwater conditions in the Study Area was developed based on information contained in well logs, geologic mapping, and geologic/hydrogeologic reports completed by others for the upper Methow Valley.

The principal aquifer in the Study Area is a shallow unconsolidated aquifer occupying the lower elevations of the Methow River valley floor to depths over 100 feet below ground surface (bgs). The unconsolidated aquifer is comprised of glacial and alluvial sediments characterized by layers of water bearing coarse-grained sediments (sand, gravel, cobbles) interbedded within layers of fine-grained silt and clay. The unconsolidated aquifer is bounded laterally and below by Mesozoic Era metamorphosed marine sediment and volcanic bedrock comprising a minor groundwater source in the Study Area. The unconsolidated aquifer is present nearly everywhere in the Study Area except where shallow bedrock is present.

A total of 64 domestic water wells were identified in the Study Area from Department of Ecology records. Most of these wells are 6-inch diameter domestic wells (irrigation water is supplied by Fulton Ditch or private river diversions). Approximately half of the wells are completed in the unconsolidated aquifer at depths between 30 and 110 feet bgs. Well yields in the unconsolidated aquifer recorded at the time of drilling are moderate, ranging from 5 to 50 gallons per minute (gpm) and averaging 25 gpm. Water levels elevations in the unconsolidated aquifer wells decrease down-valley and are consistent with the elevation of the Methow River indicating that groundwater within the unconsolidated aquifer generally flows southerly in the downstream direction of the river. Groundwater conditions are unconfined based on water levels in wells that are consistent with depths where water bearing units were encountered during drilling and absence of confining layers.

The unconsolidated aquifer is recharged primarily by the Methow River and down-valley flow of groundwater in unconsolidated sediments connected to the river based on water level elevations that are consistent with the river. Other sources of recharge include infiltration of precipitation, infiltration and ditch seepage of irrigation water, groundwater flow associated with the westerly-flowing Bear Creek drainage and mountain-front recharge at the interface with bedrock comprising the foothills to the east.

Drilling one or more new supply wells completed in the unconsolidated aquifer is expected to meet criteria for the Department of Ecology approval of a request to change the existing water right source to from surface water to groundwater. These include tapping an aquifer in direct hydraulic continuity with the authorized source (Chewuch River via Methow River), sufficient water availability in the aquifer, and non-impairment to existing surface and groundwater rights and wells.

Based on the hydrogeologic conceptual model and aquifer properties, American identified the area providing the best opportunity for drilling one or more new wells up to 100 feet deep meeting project objectives for well yield and hydraulic continuity with the Methow River. This ~100-acre area is located between the Fulton Ditch alignment and Methow River south from the Town of Winthrop sewer lagoons to the northern extent of Lower Bear Creek Road. Successful wells could also be located further to the south between the Fulton Ditch alignment and Methow River; however, the risk of encountering shallow bedrock is higher as indicated by bedrock present cropping out at land surface and in well logs. The westerly protruding meander bend near the downstream extent of Fulton Ditch might also provide an opportunity for siting new wells.

Based on this hydrogeologic analysis it was determined that using wells to supply a portion of the service demand should be investigated further. The description of Alternative 3 in the sections below is based in part on this hydrogeologic analysis.

4.3.1 Alternative 3 Development

This alternative includes construction of a pump station / pressurized pipeline system serving the lower portion of the Fulton Ditch with three well / pressurized pipeline systems providing water to the upper portions of the ditch. This is based on the findings of the hydrogeologic analysis suggesting that the locations with the greatest potential for successfully producing adequate well water are around and just south of the Town of Winthrop sewer lagoon area.

The proposed breakdown of the water delivery method for each service for this alternative is summarized in Table 7. Figure 4 shows how water service demands will be provided with each system.

Table 7- Alternative 3 Water Delivery Method Summary

Service No	Delivery Method	Delivery Flow (gpm)
1 through 18	Pump Station / Pipeline	2764
19	Well / Pipeline	488
20 through 27	Well / Pipeline	688
28 and 29	Well / Pipeline	103

A description of how each portion of the Fulton Ditch will be served is presented in the sections below.

4.3.2 Alternative 3 – Pump Station / Pressurized Pipeline

As with Alternative 2, the pressurized pipeline system for Alternative 3 water would be supplied from an on-demand pump station located as shown in Figure 4. The pump station configuration would be similar to that in Alternative 2 but sized to meet the demand required for the portion of the Fulton Ditch served or approximately 2760 gallons per minute. This pump station would also utilize either a flat plate or cone screening system sized for the 2760 gpm.

This pumping system would include a 25 horsepower jockey pump for low flow service with a flow range from approximately 100 gpm to 600 gpm. Two 50 horsepower duty pumps would be included with each having a flow range from approximately 500 gpm to 1200 gpm. The total system would

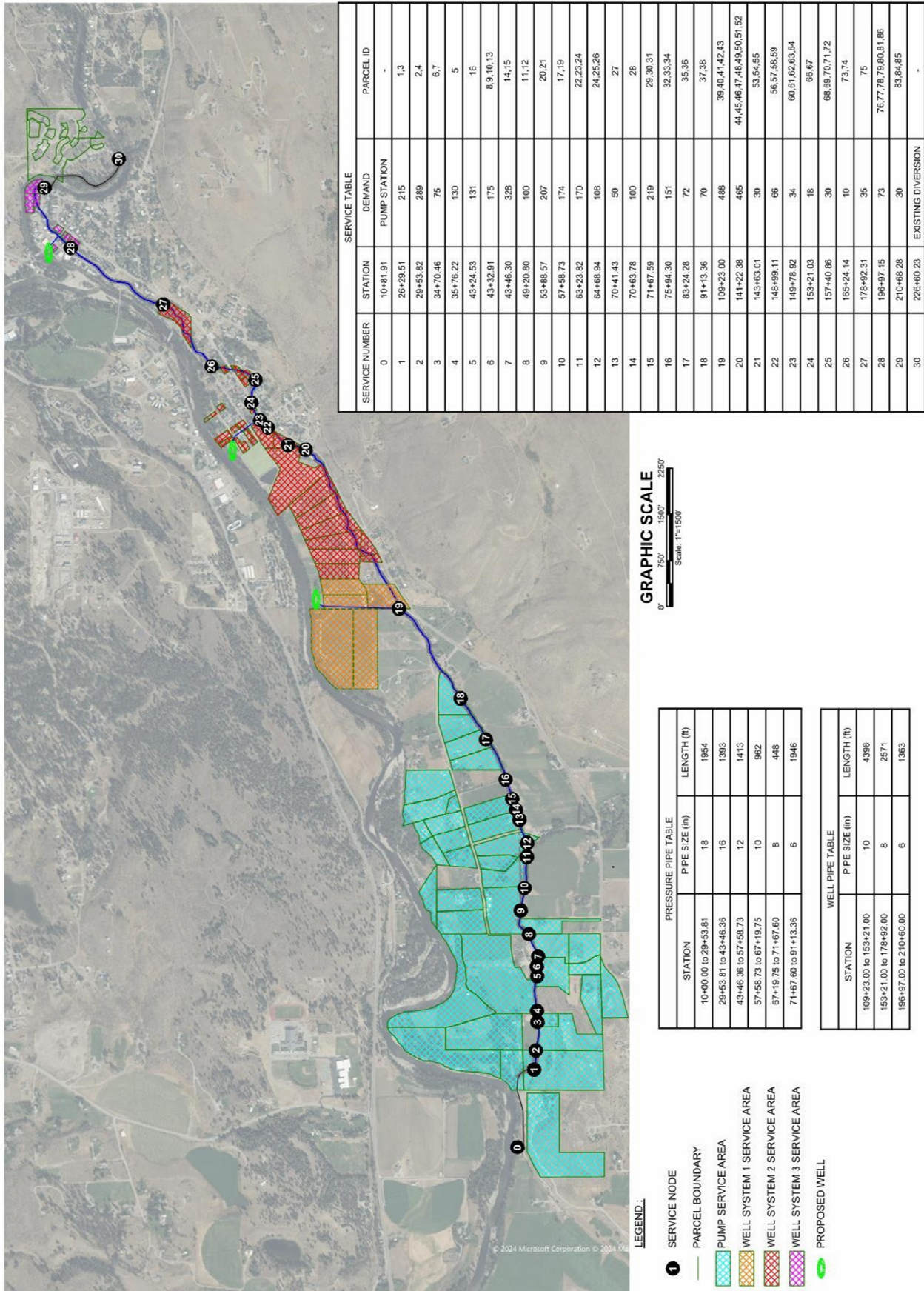


Figure 4 – Alternative 3 – Pressure / Well System Layout

have a flow range from approximately 100 gpm to approximately 3000 gpm. Each pump would be controlled by a variable frequency drive motor allowing flows to be delivered to the system at the rate necessary to maintain a set pressure. The hydraulic analysis for the system indicates that a minimum pressure of 2 psi would be maintained throughout the system ensuring a positive pressure at each service node. An additional scenario for this alternative providing a minimum of 50 psi throughout the system was also analyzed. This scenario essentially includes larger pumps providing additional pressure throughout the system. The larger pumps are estimated to be approximately 35 horsepower for the jockey pump and approximately 60 horsepower for the duty pumps.

The pumping system would be housed in a CMU building placed over an open wet well. This configuration was determined based on the need to settle sediment in Methow River water prior to running through the pumping system.

The hydraulic modeling performed for this alternative was also based on existing water demands and service locations. Modeling output is provided in Appendix E. Assuming HDPE pipe the following pipe sizes and lengths were determined for this alternative.

Table 8- Alternative 3 Pressure Pipeline Sizes and Lengths

Station	Pipe Size (in)	Length (ft)
10+00.00 to 29+53.81	18	1954
29+53.81 to 43+46.36	16	1393
43+46.36 to 57+58.73	12	1413
57+58.73 to 67+19.75	10	962
67+19.75 to 71+67.60	8	448
71+67.60 to 91+13.36	6	1946

As with Alternative 1 and 2, typical irrigation pipeline construction is assumed, and each service would be sized according to the demand with a service saddle on the transmission pipeline and a shutoff/isolation valve.

4.3.3 Alternative 3 – Well System No 1

Well System 1 would provide water to Service No 19 which has a demand of 488 gpm. It is estimated that two wells will be needed to adequately produce the 488 gpm needed. Specifics of the well system will be developed during preliminary design. For the purposes of this study, it is assumed the wells will be placed relatively close to each other. Water delivery will be provided through a 10-inch pipeline approximately 4398 feet in length (See Table 8). It is assumed the wells will be 10-inch diameter approximately 100-feet deep. Each well would be equipped with 15 hp vertical turbine well pump with variable frequency drive motor and controls.

4.3.4 Alternative 3 – Well System No 2

Well System 2 would provide water to Service No 20 through 27 with a total demand of 688 gpm. It is estimated that three wells will be needed to adequately produce the 688 gpm needed. Specifics of the well system will be developed during preliminary design. For the purposes of this study, it is assumed the wells will be placed relatively close to each other and connected to a transmission pipeline to the water service locations that is 8 inch in diameter and approximately 2571 feet in length (See

Table 8). It is assumed the wells will be 10-inch diameter approximately 100-feet deep. Each well would be equipped with 15 hp vertical turbine well pump with variable frequency drive motor and controls.

4.3.5 Alternative 3 – Well System No 3

Well System 3 would provide water to Service No 28 through 29 with a total demand of 103 gpm. It is estimated that one well will adequately produce the 103 gpm needed. Specifics of the well system will be developed during preliminary design. For the purposes of this study, it is assumed the well will be located relatively close to service No 28 with a transmission pipeline to service No 29. It is assumed the wells will be 8-inch diameter approximately 100-feet deep. The well would be equipped with 10 hp vertical turbine well pump with variable frequency drive motor and controls. A preliminary hydraulic analysis indicates the following transmission pipeline would be approximately 6-inch and approximately 1363 feet long (See Table 9).

An estimated Cost for Alternative 3 is provided in Table 10. Table 11 provides an estimated cost for the additional scenario of this alternative that provides 50 psi throughout the system.

Table 9- Well Delivery Pipeline Sizes and Lengths

Station	Pipe Size (in)	Length (ft)
109+23.00 to 153+21.00	10	4398
153+21.00 to 178+92.00	8	2571
196+97.00 to 210+60.00	6	1363

Table 10- Estimated Cost for Alternative 3 – 2 psi minimum

Description	Unit of Measure	Quantity	Unit Costs	Total Cost
Transmission Pipeline				
18-Inch IPS DR 11 HDPE	LF	1,954	\$ 133	\$ 259,882
16-Inch IPS DR 11 HDPE	LF	1,393	\$ 105	\$ 146,265
12-Inch IPS DR 11 HDPE	LF	1,413	\$ 67	\$ 94,671
10-Inch IPS DR 11 HDPE	LF	962	\$ 48	\$ 46,176
8-Inch IPS DR 11 HDPE	LF	448	\$ 30	\$ 13,440
6-Inch IPS DR 11 HDPE	LF	1,946	\$ 18	\$ 35,028
Appurtenances (valving, vents, etc.)	LS	1	\$ 59,546	\$ 59,546
Clearing and Grubbing	LF	18,806	\$ 3.00	\$ 56,418
Turnout Connections	EA	29	\$ 4,000	\$ 116,000
Site Work	LS	1	\$ 100,000	\$ 100,000
			Subtotal	\$ 927,426
Pump Station				
Earthwork	CY	1,000	\$ 85	\$ 85,000
Dewatering	LS	1	\$ 65,000	\$ 65,000
Building	SF	1,000	\$ 180.00	\$ 180,000
Wet Well	CY	190	\$ 500	\$ 95,000
Interior Equipment	LS	1	\$ 36,000	\$ 36,000
Pipe Header	LS	1	\$ 80,000	\$ 80,000
Duty Pumps	EA	2	\$ 120,000	\$ 240,000
Jockey Pump	EA	1	\$ 95,000	\$ 95,000
Electrical, Controls & HVAC	LS	1	\$ 440,000	\$ 440,000
Programming	LS	1	\$ 200,000	\$ 200,000
Gravel Access Road	LS	1	\$ 10,000	\$ 10,000
Yard Piping	LS	1	\$ 45,000	\$ 45,000
Flow Metering	LS	1	\$ 15,000	\$ 15,000
			Subtotal	\$ 1,986,000
Inlet Structure				
Earthwork	LS	1	\$ 80,000	\$ 80,000
Diversion Structure	LS	1	\$ 140,000	\$ 140,000
Screening Equipment	LS	1	\$ 90,000	\$ 90,000
Dewatering	LS	1	\$ 50,000	\$ 50,000
Electrical & Controls	LS	1	\$ 40,000	\$ 40,000
			Subtotal	\$ 1,986,000
Wells				
Well Drilling and Testing - 700gpm	EA	2	\$ 165,000	\$ 330,000
Well Pump and Controls - 700gpm	EA	2	\$ 202,500	\$ 405,000
Well Drilling and Testing - 100gpm	EA	2	\$ 80,000	\$ 160,000
Well Pump and Controls - 100gpm	EA	2	\$ 75,000	\$ 150,000
Land Acquisition and Power Supply	EA	4	\$ 75,000	\$ 300,000
10-Inch IPS DR 11 HDPE	LF	4,398	\$ 48	\$ 211,104
8-Inch IPS DR 11 HDPE	LF	2,571	\$ 25	\$ 64,275
6-Inch IPS DR 11 HDPE	LF	1,363	\$ 18	\$ 24,534
Appurtenances (valving, vents, etc.)	LS	1	\$ 29,991	\$ 29,991
			Subtotal	\$ 1,674,904
			Mobilization (12%)	\$ 550,600
			Construction Subtotal	\$ 5,138,930
			Contingency (25%)	\$ 1,284,733
			Tax (8.4%)	\$ 431,670
			Total Construction	\$ 6,855,333

Table 11- Estimated Cost for Alternative 3a – 50psi minimum

Description	Unit of Measure	Quantity	Unit Costs	Total Cost
Transmission Pipeline				
18-Inch IPS DR 11 HDPE	LF	1,954	\$ 133	\$ 259,882
16-Inch IPS DR 11 HDPE	LF	1,393	\$ 105	\$ 146,265
12-Inch IPS DR 11 HDPE	LF	1,413	\$ 67	\$ 94,671
10-Inch IPS DR 11 HDPE	LF	962	\$ 48	\$ 46,176
8-Inch IPS DR 11 HDPE	LF	448	\$ 30	\$ 13,440
6-Inch IPS DR 11 HDPE	LF	1,946	\$ 18	\$ 35,028
Appurtenances (valving, vents, etc.)	LS	1	\$ 59,546	\$ 59,546
Clearing and Grubbing	LF	18,806	\$ 3.00	\$ 56,418
Turnout Connections	EA	29	\$ 4,000	\$ 116,000
Site Work	LS	1	\$ 100,000	\$ 100,000
			Subtotal	\$ 927,426
Pump Station				
Earthwork	CY	1,000	\$ 85	\$ 85,000
Dewatering	LS	1	\$ 65,000	\$ 65,000
Building	SF	1,000	\$ 180.00	\$ 180,000
Wet Well	CY	190	\$ 500	\$ 95,000
Interior Equipment	LS	1	\$ 36,000	\$ 36,000
Pipe Header	LS	1	\$ 80,000	\$ 80,000
Duty Pumps	EA	2	\$ 180,000	\$ 360,000
Jockey Pump	EA	1	\$ 142,500	\$ 142,500
Electrical, Controls & HVAC	LS	1	\$ 440,000	\$ 440,000
Programming	LS	1	\$ 200,000	\$ 200,000
Gravel Access Road	LS	1	\$ 10,000	\$ 10,000
Yard Piping	LS	1	\$ 45,000	\$ 45,000
Flow Metering	LS	1	\$ 15,000	\$ 15,000
Inlet Structure				
Earthwork	LS	1	\$ 80,000	\$ 80,000
Diversion Structure	LS	1	\$ 140,000	\$ 140,000
Screening Equipment	LS	1	\$ 90,000	\$ 90,000
Dewatering	LS	1	\$ 50,000	\$ 50,000
Electrical & Controls	LS	1	\$ 40,000	\$ 40,000
			Subtotal	\$ 2,153,500
Wells				
Well Drilling and Testing - 700gpm	EA	2	\$ 165,000	\$ 330,000
Well Pump and Controls - 700gpm	EA	2	\$ 270,000	\$ 540,000
Well Drilling and Testing - 100gpm	EA	2	\$ 80,000	\$ 160,000
Well Pump and Controls - 100gpm	EA	2	\$ 75,000	\$ 150,000
Land Acquisition and Power Supply	EA	4	\$ 100,000	\$ 400,000
10-Inch IPS DR 11 HDPE	LF	4,398	\$ 48	\$ 211,104
8-Inch IPS DR 11 HDPE	LF	2,571	\$ 25	\$ 64,275
6-Inch IPS DR 11 HDPE	LF	1,363	\$ 18	\$ 24,534
Appurtenances (valving, vents, etc.)	LS	1	\$ 29,991	\$ 29,991
			Subtotal	\$ 1,909,904
			Mobilization (12%)	\$ 598,900
			Construction Subtotal	\$ 5,589,730
			Contingency (25%)	\$ 1,397,433
			Tax (8.4%)	\$ 469,537
			Total Construction	\$ 7,456,700

5.0 ECONOMIC ASSESSMENT

Estimated costs for each of the alternatives considered in this study have been presented above. These estimates are summarized in Table 12 below.

Table 12 - Alternative Cost Estimate Summary

Alternative	Estimated Capital Cost
Alt 1 - Gravity Pipeline	\$8,776,000
Alt 2 - Pressurized Pipeline Pump Station (2 psi min)	\$6,151,000
Alt 2a - Pressurized Pipeline Pump Station (50 psi min)	\$6,872,000
Alt 3 - Pressurized Pipeline Pump Station And Well System (700 gpm, 2psi min)	\$6,855,000
Alt 3a - Pressurized Pipeline Pump Station And Well System (700 gpm; 50 psi min)	\$7,456,000

Additional economic assessment was performed as part of this study including assessing equipment replacement fund estimates to provide for ongoing maintenance and operation of each alternative. These funds provide for the replacement of major equipment for alternatives 2 and 3 including pumping equipment, electrical equipment, and major piping equipment for the pump stations included in these alternatives. Estimates for pipeline replacement were not included in this analysis as it is assumed the pipeline will not require replacement for the period analyzed by this study. This analysis did consider pipeline appurtenances such as valving and connections that would require maintenance and likely replacement during the period analyzed. The results of the equipment replacement fund estimates are presented in Table 13.

Table 13- Equipment Replacement Fund Estimates

Alternative	Annual Equipment Replacement Fund Estimate
Alt 1 - Gravity Pipeline	\$37,900
Alt 2 - Pressurized Pipeline Pump Station (2 psi min)	\$68,000
Alt 2a - Pressurized Pipeline Pump Station (50 psi min)	\$77,300
Alt 3 - Pressurized Pipeline Pump Station And Well System (700 gpm, 2psi min)	\$98,800
Alt 3a - Pressurized Pipeline Pump Station And Well System (700 gpm; 50 psi min)	\$114,600

This analysis also included estimates of power costs for each alternative. These estimates are summarized in Table 14.

Table 14- Estimated Power Costs

Alternative	Estimated Annual Power Costs
Alt 1 - Gravity Pipeline	\$1,200
Alt 2 - Pressurized Pipeline Pump Station (2 psi min)	\$19,012
Alt 2a - Pressurized Pipeline Pump Station (50 psi min)	\$24,750
Alt 3 - Pressurized Pipeline Pump Station And Well System (700 gpm, 2psi min)	\$22,865
Alt 3a - Pressurized Pipeline Pump Station And Well System (700 gpm; 50 psi min)	\$26,585

Combining these costs allows an estimate of the life-cycle cost for each of the alternatives. These life-cycle costs were developed assuming a 40-year life for the pump stations and wells. As described

above, it is assumed the pipelines will have a longer life than 40 years so only appurtenant equipment and replacement was included in the analysis. A summary of the life-cycle costs is presented in Table 15. These costs were developed by multiplying the annual equipment replacement costs and annual power costs by 40 years and adding those totals to the capital cost for each alternative.

Table 15- Estimated Life-Cycle Costs

Alternative	Estimated 40-yr Life-Cycle Cost
Alt 1 - Gravity Pipeline	\$10,340,000
Alt 2 - Pressurized Pipeline Pump Station (2 psi min)	\$9,631,480
Alt 2a - Pressurized Pipeline Pump Station (50 psi min)	\$10,954,000
Alt 3 - Pressurized Pipeline Pump Station And Well System (700 gpm, 2psi min)	\$11,721,600
Alt 3a - Pressurized Pipeline Pump Station And Well System (700 gpm; 50 psi min)	\$13,103,400

As shown in Table 15, Alternative 2 – Pressurized Pipeline Pump Station has the lowest life-cycle cost. Equipment replacement calculations and power cost calculations are provided in Appendix F.

Appendix A – Summary of Shareholders and Demands

Name	Physical	Parcel	Shares
Abdallah, Heidi	115 Riverside Ave.	3421020496 2780021306	10
Allen, Mark and Bree Dillon	815 Main Street	6100030000	7
Ash, Barbara	55 Lower Bear Creek	6100030000	123
Baker, Jonathan and Margaret	35 LBC Road	8815000030	36
Bogaard, Amy	103B Perry	8806960400	5
Bolante, Anthony and Clarissa	#30 Durango Dr.	8814000100	52
Borgersen, Rolf and Kathy	58 B LBC Road	8812400020	45
Domenichini, Cathy (Broussard)	713 Riverside St.	2820110401	3
Callahan, Evelyn and William	#42 Durango Dr.	8814000300	52
Carlson, Marc and Brenda	50 LBC Road	6100100001	10
Chase, David and Rachel	#36 Durango Dr.	8814000200	53
Clark, Hugh and Lauran	89 LBC Road	53421130094 3421130093	328
Clark, Ina		3421020178	5
Craven, William and Justin Huff		889220200	50
Dettinger, Lynn and Eric	815 Riverside St.	3421020469	15
DeNiro, Katherine Benjamin Perin	86 Wilson Road	3421130076	130
Dillon, Karl (Manford LLC)	106 Wilson Road	3421130077	131
Dominguez, Carlos and Vicki			4
Doyle, Liam		2780041600	10
Dym, Andrew		8892200300	60
Ebenger, David		3421130101	90

Eckmann Peter and Anne		2820131402	5/62
Fulcher, Jay and Kim		3421110040 3421123004	364
Gilbertsen, Jane	77 Wilson Road	3421130075	200
Gregg, Brian and Caitlin	Castle Ave.	2780031802	16
Hall, Megan and Sohier	70A Wilson Road	3421130079	89
Heckendorn, Thomas D. Robert	101 Perry Street	3421020043	10
Heckendorn C. Henry (Geraldine Poor) Heckendorn Family Trust		3421020283 3421020004	20
Herrst, Verne	704 Castle Ave.	2820081100	20
Holbrook, Monte and Bobbie	#8 Durango Dr.	8872610100	53
Hodgins, Liza (from Ensor)		2780032101 2780032000	13
Honsinger, Bruce and Diane	27 LBC Road	8815000020	35
Kirkmire, Dan Wild Hearts Nursery	809 T-W Eastside	3421120059 3421120044	10
Larson, Lawrence and Patricia	655 T-W Eastside	8892200100	50
Layfield, Ken (deceased)		3421130080 3421130081	75
McKinney, Chris (Alan)	37 LBC Road	8815000040	36
McKittrick, Thomas and Bethann	#26 Durango Dr.	8872610400	52
Meyers, Laurie	73 LBC Road	6100050001 6100050002	108
Miller, Jake and Phoebe Ruud		3421130052	100
Mohre, Doug and Sheri	207 Riverside Ave.	2780013006	10
Monteverde, Marisa Michael Mc Mahon	108 Perry St.	2820131000	4

Mosley, Mary (Lyle)	80 LBC Road	5300050000 5300040000	92
Mudge, Garth and Barri Bernier	845 T-W Eastside Rd	342110034	12
Patterson, (Karen) Chad	54 Wilson Rd.	3421240076	15
Peterson, Dale and Sue	#20 Durango Dr.	8872610300	53
Pilkinton, Gail and Lee	11 LBC Access Rd.	6100040000	100
Pilkinton, Mike		2820050400 2820050601 2820050800 2820050900	10
Porter, Peggy	58C LBC Rd.	8812400030	58
Rhodes, Juliet	27 LBC Rd.	8815000010	35
Riley, Jack and Ronanne	78 LBC Rd	980743503	82
Robinson, Craig and Jessica	Sold to Callahan		
Rowatt, Roger		3421020425	46
Sabold, David	17 Bean Road	3421120077	20
Sigler, Pat	925 Castle Ave.	3421020131	10
<i>Silberstein, Uri Jackie Fradkin</i>			16
Smotherman, Paul	209 Castle Ave	2780032300 2780032203	12
Sunderland, John and Libby		2820101500	5
Strulic, Mike and Tracy McCabe		2820010100 2820040100	10
Tyson, Thor/Paige Embry	40 LBC Rd.	6100090001	91
Taggart, Bobbie	#18 Durango Dr.	8872610200	52
Tannehill, Brent Mary Beth Brown	60 LBC Rd.	6100120001	50

Tomlinson, Craig and Kathy	#46 Durango Dr.	8614000400	52
Van bueren, Kevin	58A LBC Rd.	8512400010	51
van Haelst, Carol Dr. Richard Pisani	102 Bluff Street	342102008	10
Vracin, Wylie		2870110301	3
Webber, Gil and Claudia	100 Bluff Street	3421020055	20
Whittaker, Sophie Will Neilson	48 LBC Rd.	6100090002	50
Wildman, Larry (Greg/Becky Caswell)	821 Riverside St.	3421020227	3
Williams, Kathy	66 LBC Rd.	6100120002	50
Wilson, Gary	81 LBC Rd.	5300020001	107
Wilson Mike	77 LBC Rd.	5300010003	62
Wood, Doug and Stephanie	645 T-W Eastside	6050100000 3421130035	25
Wrangel, Cheryl James Matheson	811 Castle Ave.	2820140301	10
Winthrop Village North Laura Grignon		9100500000	50
Town of Winthrop	4 Durango Dr.	3421110143	140
Methow Conservancy	414 Riverside Ave.	3421020264	35
Total Shareholders 75			3,935

Appendix B – Gravity Pipeline Modeling Output

Gravity Output Table

Pipe #	Length (ft)	Start Node	Stop Node	Pipe Dia (in)	Pipe Material	Hazen-Williams C	Flow (GPM)	Velocity (ft/s)	Head Loss Gradiant (ft/ft)	Headloss (ft)	Pressure Start (Psi)
55	1,618	55	Reservoir	28	HDPE	140	-4,043	2.11	0	0.77	1
54	266	54	55	28	HDPE	140	-4,013	2.09	0	0.12	1
53	675	53	54	28	HDPE	140	-4,013	2.09	0	0.32	1
52	202	52	53	28	HDPE	140	-4,013	2.09	0	0.09	1
51	116	51	52	28	HDPE	140	-4,013	2.09	0	0.05	1
50	113	50	51	28	HDPE	140	-4,013	2.09	0	0.05	2
49	1,805	49	50	28	HDPE	140	-3,940	2.05	0	0.82	2
48	1,368	48	49	28	HDPE	140	-3,905	2.03	0	0.61	2
47	345	47	48	28	HDPE	140	-3,895	2.03	0	0.15	1
46	241	46	47	28	HDPE	140	-3,895	2.03	0	0.11	1
45	197	45	46	28	HDPE	140	-3,895	2.03	0	0.09	1
44	420	44	45	28	HDPE	140	-3,865	2.01	0	0.18	1
43	117	43	44	26	HDPE	140	-3,847	2.32	0.001	0.07	2
42	225	42	43	26	HDPE	140	-3,847	2.32	0.001	0.14	2
41	10	41	42	26	HDPE	140	-3,813	2.3	0.001	0.01	2
40	70	40	41	26	HDPE	140	-3,813	2.3	0.001	0.04	2
39	234	39	40	26	HDPE	140	-3,747	2.26	0.001	0.14	2
38	302	38	39	26	HDPE	140	-3,747	2.26	0.001	0.18	2
37	241	37	38	26	HDPE	140	-3,717	2.25	0.001	0.14	2
36	577	36	37	26	HDPE	140	-3,252	1.97	0	0.26	2
35	368	35	36	26	HDPE	140	-3,252	1.97	0	0.17	2
34	424	34	35	26	HDPE	140	-3,252	1.97	0	0.19	2
33	279	33	34	26	HDPE	140	-3,252	1.97	0	0.13	2
32	24	32	33	26	HDPE	140	-3,252	1.97	0	0.01	2
31	332	31	32	26	HDPE	140	-3,252	1.97	0	0.15	2
30	746	30	31	26	HDPE	140	-3,252	1.97	0	0.34	2
29	423	29	30	26	HDPE	140	-3,252	1.97	0	0.19	2
28	26	28	29	26	HDPE	140	-3,252	1.97	0	0.01	2
27	40	27	28	24	HDPE	140	-2,764	1.96	0	0.02	2
26	1,249	26	27	24	HDPE	140	-2,764	1.96	0	0.62	2
25	520	25	26	24	HDPE	140	-2,764	1.96	0	0.26	2
24	779	24	25	24	HDPE	140	-2,694	1.91	0	0.37	2
23	575	23	24	24	HDPE	140	-2,622	1.86	0	0.26	2
22	165	22	23	24	HDPE	140	-2,622	1.86	0	0.07	2
21	427	21	22	24	HDPE	140	-2,471	1.75	0	0.17	2
20	104	20	21	24	HDPE	140	-2,252	1.6	0	0.04	2
19	22	19	20	20	HDPE	140	-2,152	2.2	0.001	0.02	2
18	322	18	19	20	HDPE	140	-2,102	2.15	0.001	0.23	2
17	251	17	18	20	HDPE	140	-2,102	2.15	0.001	0.18	2
16	145	16	17	20	HDPE	140	-1,994	2.04	0.001	0.1	2
15	565	15	16	20	HDPE	140	-1,824	1.86	0.001	0.32	2
14	370	14	15	20	HDPE	140	-1,650	1.69	0	0.17	2
13	147	13	14	18	HDPE	140	-1,443	1.82	0.001	0.09	2

12	321	12	13	18	HDPE	140	-1,443	1.82	0.001	0.19	2
11	9	11	12	18	HDPE	140	-1,343	1.69	0.001	0	2
10	566	10	11	18	HDPE	140	-1,343	1.69	0.001	0.3	2
9	13	9	10	12	HDPE	140	-1,015	2.88	0.002	0.03	2
8	8	8	9	12	HDPE	140	-840	2.38	0.002	0.01	2
7	408	7	8	12	HDPE	140	-709	2.01	0.001	0.48	2
6	340	6	7	12	HDPE	140	-709	2.01	0.001	0.4	2
5	21	5	6	12	HDPE	140	-579	1.64	0.001	0.02	2
4	84	4	5	12	HDPE	140	-579	1.64	0.001	0.07	2
3	517	3	4	12	HDPE	140	-504	1.43	0.001	0.32	2
2	324	2	3	12	HDPE	140	-215	0.61	0	0.04	3
1	593	1	2	12	HDPE	140	0	0	0	0	3

Appendix C – Pressure Pipeline Modeling Output

Pump Output Table

Pipe #	Length (ft)	Start Node	Stop Node	Pipe Dia (in)	Pipe Material	Hazen-Williams C	Flow (GPM)	Velocity (ft/s)	Head Loss Gradient (ft/ft)	Headloss (ft)	Pressure Start (Psi)
1	266	1	2	6	HDPE	140	30	0.34	0	0.03	2
2	675	2	3	6	HDPE	140	30	0.34	0	0.07	2
3	202	3	4	6	HDPE	140	30	0.34	0	0.02	2
4	116	4	5	6	HDPE	140	30	0.34	0	0.01	2
5	113	5	6	6	HDPE	140	30	0.34	0	0.01	3
6	1,805	6	7	6	HDPE	140	103	1.17	0.001	1.73	4
7	1,368	7	8	6	HDPE	140	138	1.57	0.002	2.26	5
8	345	8	9	6	HDPE	140	148	1.68	0.002	0.65	5
9	241	9	10	6	HDPE	140	148	1.68	0.002	0.45	5
10	197	10	11	6	HDPE	140	148	1.68	0.002	0.37	6
11	420	11	12	6	HDPE	140	178	2.02	0.003	1.11	6
12	117	12	13	6	HDPE	140	196	2.22	0.003	0.37	7
13	225	13	14	6	HDPE	140	196	2.22	0.003	0.71	7
14	10	14	15	6	HDPE	140	230	2.61	0.004	0.04	7
15	70	15	16	6	HDPE	140	230	2.61	0.004	0.3	7
16	234	16	17	6	HDPE	140	296	3.36	0.007	1.59	8
17	302	17	18	6	HDPE	140	296	3.36	0.007	2.05	9
18	241	18	19	6	HDPE	140	326	3.7	0.008	1.95	10
19	577	19	20	10	HDPE	140	791	3.23	0.003	2.01	11
20	368	20	21	10	HDPE	140	791	3.23	0.003	1.28	12
21	424	21	22	10	HDPE	140	791	3.23	0.003	1.48	12
22	279	22	23	10	HDPE	140	791	3.23	0.003	0.97	13
23	24	23	24	10	HDPE	140	791	3.23	0.003	0.08	13
24	332	24	25	10	HDPE	140	791	3.23	0.003	1.16	14
25	746	25	26	10	HDPE	140	791	3.23	0.003	2.6	15
26	423	26	27	10	HDPE	140	791	3.23	0.003	1.47	16
27	26	27	28	10	HDPE	140	791	3.23	0.003	0.09	16
28	40	28	29	12	HDPE	140	1,279	3.63	0.003	0.14	16
29	1,249	29	30	12	HDPE	140	1,279	3.63	0.003	4.35	18
30	520	30	31	12	HDPE	140	1,279	3.63	0.003	1.81	18
31	779	31	32	12	HDPE	140	1,349	3.83	0.004	3	20
32	575	32	33	12	HDPE	140	1,421	4.03	0.004	2.44	21
33	165	33	34	12	HDPE	140	1,421	4.03	0.004	0.7	22
34	427	34	35	12	HDPE	140	1,572	4.46	0.005	2.18	22
35	104	35	36	12	HDPE	140	1,791	5.08	0.007	0.67	23
36	22	36	37	16	HDPE	140	1,891	3.02	0.002	0.04	23
37	322	37	38	16	HDPE	140	1,941	3.1	0.002	0.6	23
38	251	38	39	16	HDPE	140	1,941	3.1	0.002	0.47	23
39	145	39	40	16	HDPE	140	2,049	3.27	0.002	0.3	24
40	565	40	41	16	HDPE	140	2,219	3.54	0.002	1.35	24
41	370	41	42	16	HDPE	140	2,393	3.82	0.003	1.01	25
42	147	42	43	18	HDPE	140	2,600	3.28	0.002	0.26	25
43	321	43	44	18	HDPE	140	2,600	3.28	0.002	0.58	25
44	9	44	45	18	HDPE	140	2,700	3.4	0.002	0.02	25
45	566	45	46	18	HDPE	140	2,700	3.4	0.002	1.09	26

46	13	46	47	18	HDPE	140	3,028	3.82	0.002	0.03	26
47	8	47	48	18	HDPE	140	3,203	4.04	0.003	0.02	26
48	408	48	49	18	HDPE	140	3,334	4.2	0.003	1.16	27
49	340	49	50	20	HDPE	140	3,334	3.4	0.002	0.58	28
50	21	50	51	20	HDPE	140	3,464	3.54	0.002	0.04	28
51	84	51	52	20	HDPE	140	3,464	3.54	0.002	0.15	27
52	517	52	53	20	HDPE	140	3,539	3.61	0.002	0.98	28
53	324	53	54	22	HDPE	140	3,828	3.23	0.001	0.45	29
54	593	54	55	22	HDPE	140	4,043	3.41	0.002	0.91	30
55	953	55	56	22	HDPE	140	4,043	3.41	0.002	1.46	57
56	34	Pump	57	22	HDPE	140	4,043	3.41	0.002	0.05	63
57	51	Reservoir	Pump	22	HDPE	140	4,043	3.41	0.002	0.08	-

Appendix D – Hydrogeologic Study

Appendix E – Pressure Pipeline Well System Modeling Output

Pump Output Table (Serves 1-18)

Pipe #	Length (ft)	Start Node	Stop Node	Pipe Dia (in)	Pipe Material	Hazen-Williams C	Flow (GPM)	Velocity (ft/s)	Head Loss Gradient (ft/ft)	Headloss (ft)	Pressure Start (Psi)
1	779	1	2	6	HDPE	140	70	0.79	0	0.37	3
2	575	2	3	6	HDPE	140	142	1.61	0.002	1	4
3	165	3	4	6	HDPE	140	142	1.61	0.002	0.29	4
4	427	4	5	6	HDPE	140	293	3.32	0.007	2.84	5
5	104	5	6	8	HDPE	140	512	3.27	0.005	0.48	5
6	22	6	7	8	HDPE	140	612	3.91	0.006	0.14	5
7	322	7	8	8	HDPE	140	662	4.23	0.007	2.39	7
8	251	8	9	10	HDPE	140	662	2.7	0.003	0.63	7
9	145	9	10	10	HDPE	140	770	3.15	0.003	0.48	7
10	565	10	11	10	HDPE	140	940	3.84	0.005	2.71	9
11	370	11	12	12	HDPE	140	1,114	3.16	0.003	1	9
12	147	12	13	12	HDPE	140	1,321	3.75	0.004	0.54	9
13	321	13	14	12	HDPE	140	1,321	3.75	0.004	1.19	10
14	9	14	15	12	HDPE	140	1,421	4.03	0.004	0.04	10
15	566	15	16	12	HDPE	140	1,421	4.03	0.004	2.4	11
16	13	16	17	16	HDPE	140	1,749	2.79	0.002	0.02	11
17	8	17	18	16	HDPE	140	1,924	3.07	0.002	0.02	11
18	408	18	19	16	HDPE	140	2,055	3.28	0.002	0.84	12
19	340	19	20	16	HDPE	140	2,055	3.28	0.002	0.7	13
20	21	20	21	16	HDPE	140	2,185	3.49	0.002	0.05	13
21	84	21	22	16	HDPE	140	2,185	3.49	0.002	0.2	12
22	517	22	23	16	HDPE	140	2,260	3.61	0.002	1.27	14
23	324	23	24	18	HDPE	140	2,549	3.21	0.002	0.56	14
24	593	24	25	18	HDPE	140	2,764	3.48	0.002	1.19	15
25	953	25	26	18	HDPE	140	2,764	3.48	0.002	1.92	43
26	34	Pump	27	18	HDPE	140	2,764	3.48	0.002	0.07	49
27	51	Reservoir	Pump	18	HDPE	140	2,764	3.48	0.002	0.1	0

Appendix F – Equipment Replacement and Power Cost Calculations

Pressure Pipeline (2psi min) Equipment Replacement

P = Present Value
 F = Future Value
 A = Annualized Value
 i = Interest or Inflation rate
 n = number of years

Assumed Inflation = 3.0%
 Assume Interest = 3.0%

1. Replacement costs in Today's Dollars

Item	Year of Replacement																					
	5 Year 2030	10 Year 2035	15 Year 2040	20 Year 2045	25 Year 2050	30 Year 2055	35 Year 2060	40 Year 2065	45 Year 2070	50 Year 2075	55 Year 2080	60 Year 2085	65 Year 2090	70 Year 2095	75 Year 2100	80 Year 2105	85 Year 2110	90 Year 2115	95 Year 2120	100 Year 2125		
Pumps ¹		\$	75,000	\$25,000		\$	90,000	\$	25,000	\$75,000		\$	515,000		\$	75,000		\$	515,000			
Discharge Piping and Valves								\$	80,000							\$	37,000					
Pump Station Flow Meter				\$	10,000				\$	25,000		\$	8,000			\$	10,000			\$	8,000	
Electrical / Pump Controls				\$	100,000				\$	200,000		\$	100,000			\$	100,000			\$	100,000	
Diversion Screen Mechanical									\$	45,000						\$	45,000					
Pipeline Appurtenances				\$	150,000				\$	150,000		\$	150,000			\$	150,000			\$	150,000	
Miscellaneous Equipment	\$	5,000	\$	5,000	\$	5,000	\$	5,000	\$	5,000	\$	5,000	\$	5,000	\$	5,000	\$	5,000	\$	5,000	\$	5,000
Total (2015 costs)	\$	5,000	\$	5,000	\$	80,000	\$	290,000	\$	5,000	\$	95,000	\$	5,000	\$	530,000	\$	80,000	\$	5,000	\$	778,000

2. Future Replacement Cost

F = P(F/P,i,n)

	Year 2020	Year 2025	Year 2030	Year 2035	Year 2040	Year 2045	Year 2050	Year 2055	Year 2060	Year 2065	Year 2070	Year 2075	Year 2080	Year 2085	Year 2090	Year 2095	Year 2100	Year 2105	Year 2110	Year 2115																				
Inflated costs	\$	5,796	\$	6,720	\$	124,637	\$	523,772	\$	10,469	\$	230,590	\$	14,069	\$	1,728,880	\$	302,528	\$	21,920	\$	25,411	\$	4,583,667	\$	34,150	\$	39,589	\$	734,314	\$	3,692,389	\$	61,679	\$	7,436,243	\$	82,891	\$	5,054,500

Notes:

¹ Assumed service / replacement schedule.

Year 15 Rebuild 3 duty pumps at \$25,000 per pump. \$25,000 includes \$10,000 for shaft and bearing rebuild, \$7,500 for motor rebuild, and \$7,500 for pump pulling and reinstallation.
 Year 20 Rebuild jockey pump at \$25,000. \$25,000 includes \$10,000 for shaft and bearing rebuild, \$7,500 for motor rebuild, and \$7,500 for pump pulling and reinstallation.
 Year 30 Rebuild 3 duty pumps at \$25,000 per pump. \$25,000 includes \$10,000 for shaft and bearing rebuild, \$7,500 for motor rebuild, and \$7,500 for pump pulling and reinstallation. Replace impellor for 5 duty pumps at \$5,000 per pump.
 Year 40 Rebuild jockey pump at \$25,000. \$25,000 includes \$10,000 for shaft and bearing rebuild, \$7,500 for motor rebuild, and \$7,500 for pump pulling and reinstallation.
 Year 45 Rebuild 3 duty pumps at \$25,000 per pump. \$25,000 includes \$10,000 for shaft and bearing rebuild, \$7,500 for motor rebuild, and \$7,500 for pump pulling and reinstallation.
 Year 60 Replace 3 duty pumps at \$135,000 each and jockey pump at \$110,000

3. Annual installment required to finance;

A = F(A/F,i,n)

Year 2030 Equipment Replacement Costs =	\$	1,092
Year 2035 Equipment Replacement Costs =	\$	586
Year 2040 Equipment Replacement Costs =	\$	6,701
Year 2045 Equipment Replacement Costs =	\$	19,493
Year 2050 Equipment Replacement Costs =	\$	287
Year 2055 Equipment Replacement Costs =	\$	4,847
Year 2060 Equipment Replacement Costs =	\$	233
Year 2065 Equipment Replacement Costs =	\$	22,929
Year 2070 Equipment Replacement Costs =	\$	3,263
Year 2075 Equipment Replacement Costs =	\$	194
Year 2080 Equipment Replacement Costs =	\$	187
Year 2085 Equipment Replacement Costs =	\$	28,111

4. Present (2025) value of installments for;

P = A(P/A,i,n)

Year 2030 Equipment Replacement Costs =	\$	5,000
Year 2035 Equipment Replacement Costs =	\$	5,000
Year 2040 Equipment Replacement Costs =	\$	80,000
Year 2045 Equipment Replacement Costs =	\$	290,000
Year 2050 Equipment Replacement Costs =	\$	5,000
Year 2055 Equipment Replacement Costs =	\$	95,000
Year 2060 Equipment Replacement Costs =	\$	5,000
Year 2065 Equipment Replacement Costs =	\$	530,000
Year 2070 Equipment Replacement Costs =	\$	80,000
Year 2075 Equipment Replacement Costs =	\$	5,000
Year 2080 Equipment Replacement Costs =	\$	5,000
Year 2085 Equipment Replacement Costs =	\$	778,000

5. Total Present (2025) value of annual equipment replacement installments = \$ 1,883,000

6. Annual installment required to finance equipment replacement over the next 100 years =

A = P(A/P,i,n)

\$ 68,038

7. Use \$ 68,000

Pumping Capacity

Pressurized Pipeline Pump Station - 2 psi

Flow	4043
TDH	255
Horsepower	325.4
Input H.P.	325.43 HP
Input KW	242.64 kW
Est. Hours operation	2000 hours

485,283 kWh
0.051 dollars/kWh
 \$ 24,749.41

Pressurized Pipeline With Wells - 2 psi

Flow	2760
TDH	250
Horsepower Pump Station	205.0
Input H.P.	204.99 HP
Input KW	152.84 kW
Est. Hours operation	2000 hours

305,683 kWh
0.051 dollars/kWh
 \$ 15,589.82

Flow	700 Assume two wells
TDH	230
Horsepower per well	47.8
Total H.P. (two wells)	95.66 HP
Input KW	71.33 kW
Est. Hours operation	2000 hours

142,652 kWh
0.051 dollars/kWh
 \$ 7,275.25

Total Power Cost \$ 22,865.07

Pumping Capacity (2)

Pressurized Pipeline Pump Station - 50 psi

Flow	4043
TDH	255
Horsepower	325.4
Input H.P.	325.43 HP
Input KW	242.64 kW
Est. Hours operation	2000 hours

485,283 kWh
0.051 dollars/kWh
 \$ 24,749.41

Pressurized Pipeline With Wells - 50 psi

Flow	2760
TDH	250
Horsepower Pump Station	205.0
Input H.P.	204.99 HP
Input KW	152.84 kW
Est. Hours operation	2000 hours

305,683 kWh
0.051 dollars/kWh
 \$ 15,589.82

Flow	700 Assume two wells
TDH	275
Horsepower per well	57.3
Total H.P. (two wells)	144.58 HP
Input KW	107.80 kW
Est. Hours operation	2000 hours

215,592 kWh
0.051 dollars/kWh
 \$ 10,995.18

Total Power Cost \$ 26,585.00

Pumping Capacity (2)

Pressurized Pipeline Pump Station - 50 psi								
	Flow		4043					
	TDH		255					
	Horsepower		325.4					
	Input H.P.		325.43 HP					
	Input KW		242.64 kW					
	Est. Hours operation		2000 hours					
			485,283 kWh					
			0.051 dollars/kWh					
			<u>24,749.41</u>					
			\$					
Pressurized Pipeline With Wells - 50 psi								
	Flow		2760					
	TDH		220					
	Horsepower Pump Station		180.4					
	Input H.P.		180.39 HP					
	Input KW		134.50 kW					
	Est. Hours operation		2000 hours					
			269,001 kWh					
			0.051 dollars/kWh					
			<u>13,719.04</u>					
			\$					
	Flow		700		Assume two wells			
	TDH		275					
	Horsepower per well		57.3					
	Total H.P. (two wells)		114.58 HP					
	Input KW		85.43 kW					
	Est. Hours operation		2000 hours					
			170,856 kWh					
			0.051 dollars/kWh					
			<u>8,713.64</u>					
			\$					