Draft

Green River Pipeline

Cost Analysis

Utah Division of Water Resources
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(Subject to Revision)

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Section 1 – Introduction

As water demand in Utah continues to increase, especially along the Wasatch Front, the water supplies made available through the various water development projects of the past are reaching full utilization. Since the pioneers first entered the Salt Lake Valley in 1847, water development has played an integral role in the growth and prosperity of Utah. Water development will continue to play an important role in Utah's future.

While modest amounts of water are still available for development in most areas of the state, Utah's most significant sources of remaining water supply exist in the Bear River and Colorado River drainages. In 1992, the Utah Legislature allocated most of the remaining developable water supply of the Bear River (220,000 acre-feet per year) among various counties in northern Utah and the Wasatch Front, and directed the Utah Division of Water Resources to develop these water supplies as needed. This water is expected to be needed sometime between 2020 and 2025 and will only meet a portion of the increasing demand.

Allocation of the Colorado River dates back to 1922, when the Colorado River Compact was approved by Congress. Subsequent agreements among the basin states refined these allocations such that Utah is entitled to approximately 1.4 million acre-feet per year. Current uses amount to just under 1 million acre-feet per year, leaving approximately 400,000 acre-feet per year available for use.

This report looks at various alternatives to import water from the Green River drainage, a major tributary to the Colorado River, for use along the Wasatch Front. In particular, it investigates the feasibility of importing water from either Fontenelle Reservoir in western Wyoming or Flaming Gorge Reservoir, near the Utah Wyoming border, into the Bear River or Weber River drainage.

Section 2 – Basic Design Parameters & Assumptions

For the sake of simplicity, the cost analysis presented in this report uses similar design parameters and assumptions as those found in a detailed study performed on another Utah project with similar characteristics, namely the Lake Powell Pipeline.[1] The Lake Powell Pipeline is a project located along the Utah/Arizona border that proposes to transport water from Lake Powell 120 miles overland to the St. George area. Similar to this project, the Lake Powell Pipeline would develop a portion of Utah's remaining Colorado River allocation.

Although useful for comparative purposes, this report should not be construed as comparable to the study prepared for the Lake Powell Pipeline. While significant resources have been spent to investigate the proposed alignments and alternatives of the Lake Powell Pipeline, no comparable investigations have been performed for the Green River Pipeline. Subsequently, this report should be viewed as a preliminary analysis only.

Table 1 lists basic design parameters and unit costs used in the Lake Powell Pipeline study and this report. For the most part, the unit costs used and other assumptions made are very similar. Notable differences include the interest rate of 3.9% (instead of 4.13%) and the design life of 50 years (instead of 40 years). Also, the level of detail and field reconnaissance contained in each pipeline reach for this report is much rougher than that for the Lake Powell Pipeline.

[1] Boyle Engineering Corp. & Alpha Engineering, Inc., *Lake Powell Pipeline Feasibility Study*, 1995. This study was conducted with help from and in cooperation with the Washington County Water Conservancy District and the Utah Division of Water Resources.

TABLE 1
Basic Design Parameters and Other Assumptions

Parameter	Lake Powell Pipeline Feasibility Study	This Report
Design Flow	60,000 acre-feet/yr.	60,000 acre-feet/yr.
Manning's Roughness coefficient	0.011	0.011
Base Pipe Costs:		
45"	$3.00/lf/in	$3.60/lf/in*
48"	$3.10/lf/in	$3.72/lf/in*
51"	$3.20/lf/in	$3.84/lf/in*
54"	$3.30/lf/in	$3.96/lf/in*
Adverse Condition Costs:		
High Pressure	Accelerating cost formula for pressures above 150 psi	Modeled fit of formula used for Lake Powell Pipeline
Rock	$0.30 to 0.80/lf/in	$0.10 to 0.50/lf/in**
Ground Water	Not Encountered	$0.10 to 0.30/lf/in
Slope	1.00 to 1.22 multiplier	1.00 to 1.22 multiplier
Appurtenances	1.05 multiplier	1.05 to 1.07 multiplier†
Right-of-Way Acquisition	100' wide corridor at $2,000 per acre	100' wide corridor at $500 per acre^
Pumping Plant (85% efficient):		
Low Lift (under 800 feet)	$7,750,000	$7,000,000‡
High Lift (over 800 feet)	$11,800,000	$9,100,000‡
Hydropower Station (82% efficient)	$4,100,000	$3,500,000 (low head) $4,100,000 (high head)
Contingencies	15% design & administration 10% additional contingency	15% design & administration 10% addition contingency
Interest Rate	4.13%	3.90%§
Design Life	40 years	50 years§
Energy Costs	$0.030/kwh off-peak $0.045/kwh on-peak $0.035/kwh average	$0.035/kwh off-peak~ $0.052/kwh on-peak~ $0.041/kwh average~

* Values used in the 1995 Lake Powell Pipeline Study indexed to 2002 construction prices using ENR's construction cost index (1.20).
** Lower costs per foot were used in this report because pipe reaches in this analysis were not broken up into as small of segments, thus tending to overestimate the impacts of adverse conditions.
† Multiplier of 1.07 used along I-80 corridor where greater costs are expected during construction.
^ Used for the entire length of each alignment.
‡ This report assumed slightly lower costs because pump lifts were lower in nearly every instance.
§ Economic variables used by the Division of Water Resources during the summer of 2002.
~ Values used in the 1995 Lake Powell Pipeline Study indexed to 2002 prices using the Bureau of Labor's index for finished energy goods (1.16).

Section 3 – Pipeline Alternatives

Pipeline Alignments

Four alignments were selected for this preliminary analysis (see Figure 1). Two of these alignments originate high on the Green River at Fontenelle Reservoir (elev. 6506), located approximately 35 miles northeast of Kemmerer, Wyoming. The other two alignments originate lower on the Green River at Flaming Gorge Reservoir (elev. 6040), located approximately six miles east of Manila, Utah.

Both alignments from Fontenelle Reservoir follow U.S. Highway 189 to a point about three miles east of Kemmerer, where they diverge and take a different course to their ultimate destinations on the Bear and Weber rivers. Alignment A goes through Kemmerer and continues in a westerly direction until it terminates at the Bear River, near Randolph, Utah. Alignment B turns south, crosses about 14 miles of rangeland, and eventually joins U.S. Highway 89, south of Kemmerer. Alignment C follows U.S. Highway 89 to Interstate 80, then parallels it west through Evanston to Echo Reservoir, and to its eventual terminus at Rockport Lake, near Wanship.

Alignments C and D originate from separate locations on Flaming Gorge Reservoir. Alignment C begins in Wyoming at a point about 15 miles north of Manila, Utah. This alignment crosses about 36 miles of rangeland before it joins Alignment D, near Mountain View, Wyoming. From this point alignment C continues west, joins Interstate 80, and parallels it west through Evanston to Echo Reservoir, and to their eventual terminus at Rockport Lake, near Wanship. Alignment D begins in Utah at a point approximately four miles east of Manila. This alignment crosses some rangeland until it reaches a local road near Manila. This road eventually joins state route 46 to Manila. At Manila, the alignment continues west along route 46, crosses into Wyoming where it becomes state route 414, and eventually joins alignment C near Mountain View. From there this alignment follows the same course as alignment C all the way to Rockport Lake.

Project Alternatives

Two alternatives were analyzed for Alignment A, the only difference being that alternative 1 has one pump station while alternative 2 has two pump stations. Alignments B and D have four alternatives each: two that terminate lower on the Weber River at Echo Reservoir and two that terminate higher on the Weber River at Rockport Lake. Alignment C has six alternatives: two terminate at the Bear River near Evanston; two terminate at Echo Reservoir; and two terminate at Rockport Reservoir. Single pump station and dual pump station alternatives were analyzed for each pipe run (all odd numbered alternatives have a single pump station; even numbered alternatives have dual pump station.).

Table 2 summarizes the essential differences of the 16 alternatives.

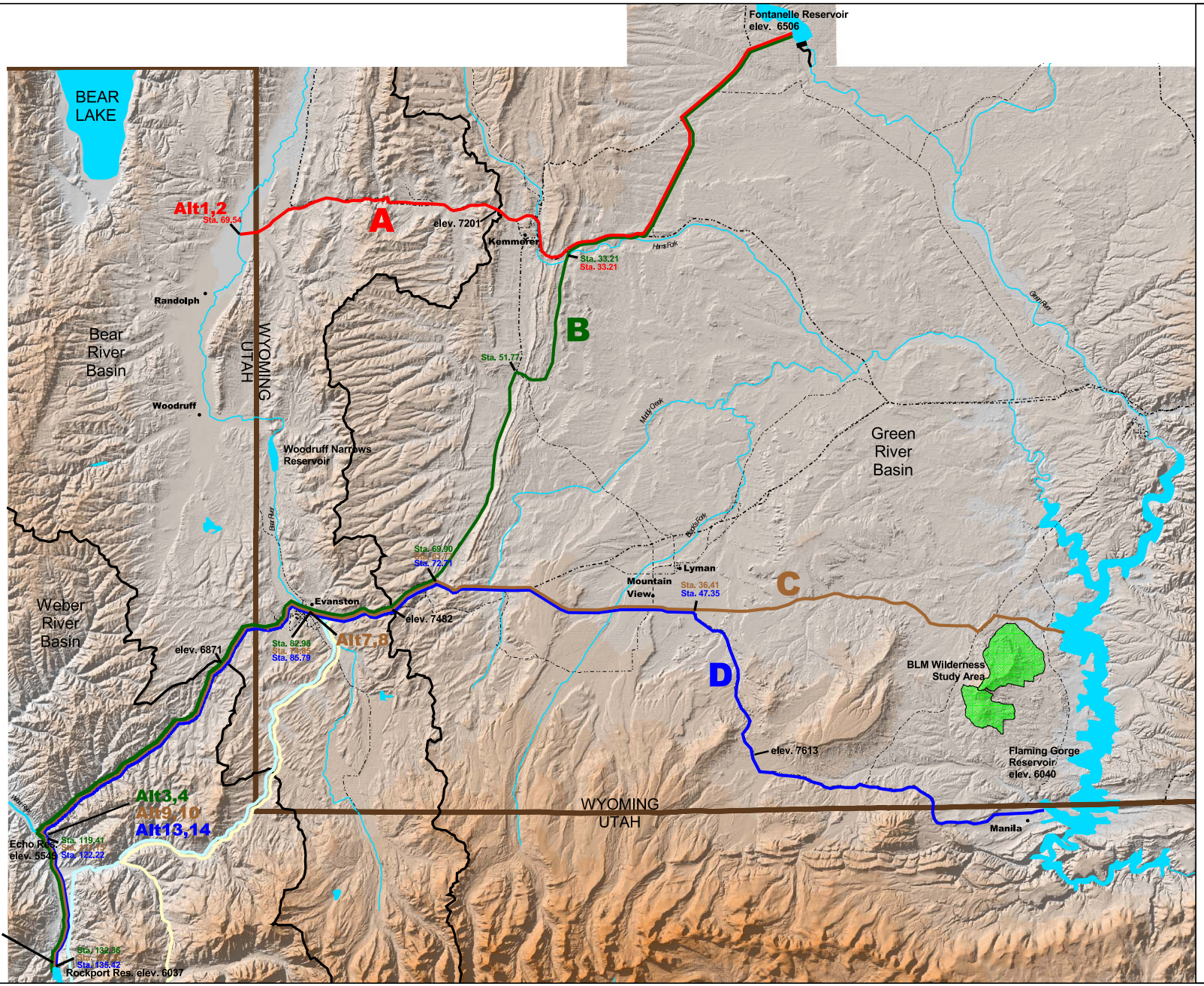

Figure 1

Green River Pipeline

Alignments and Alternatives

Legend

- Alignment A
- Alignment B
- Alignment C
- Alignment D

5 0 5 10 Miles

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NATURAL RESOURCES
Division of Water Resources

TABLE 2
Comparison of Alternatives

Alternatives	Destination			Number of Pump Stations	
	Bear River near Evanston	Weber River at Echo Reservoir	Weber River at Rockport Lake	1	2
1,7	X			X	
2,8	X				X
3,9,13		X		X	
4,10,14		X			X
5,11,15			X	X	
6,12,16			X		X

Alternatives 1 & 2 (Fontenelle Reservoir to the Bear River, below Woodruff Narrows Reservoir) have the shortest pipeline length, 69.4 miles. Alternatives 15 & 16 (Flaming Gorge Reservoir to the Weber River, Rockport Lake) have the longest pipeline length, 135.4 miles. All other alternatives have pipelines that range in length from 74.9 to 132.9 miles, depending upon the point of origin and destination.

(Note: The favored alignment for the Lake Powell Pipeline is 119.4 miles.)

Section 4 – Cost Estimates

A detailed cost estimate was prepared for each of the 16 alternatives (see Appendix B). Table 3 summarizes the alternatives that terminate on the Bear River. Tables 4 and 5 summarize the alternatives that terminate on the Weber River at Echo Reservoir and Rockport Lake, respectively.

Bear River Alternatives

Table 3 summarizes the costs of the four Bear River alternatives analyzed.

TABLE 3
Cost Estimate Summary for Bear River Alternatives

Alternative	Total Project Cost	Total Annualized Cost	Yearly O&M Cost*	Unit Cost†
1	$144,110,000	$8,622,000	$2,028,000	$144
2	$144,856,000	$8,726,000	$2,098,000	$145
7	$176,480,000	$13,219,000	$5,144,000	$220
8	$162,340,000	$12,697,000	$5,269,000	$212

* Includes regular operation and maintenance costs and net energy purchase costs.
† Cost per acre-foot assumes full utilization of 60,000 acre-feet per year.

As shown, the unit cost of water at the point of discharge (under full use conditions) ranges from a low of $144 to a high of $220 per acre-foot. The $144 per acre-foot unit cost is for Alternative 1, which is the shortest pipeline of all the alternatives and has one pump station. The unit cost for Alternative 2, which is the same as Alternative 1 with two pump stations, is $145 per acre-foot. This is one of only instance where the two pump station alternative was not less than its one pump station counterpart.

While importing water into the Bear River Drainage is the cheapest of all the alternatives analyzed, it has its disadvantages. The largest disadvantage being that there is no existing infrastructure that would allow the water to be put to use along the Wasatch Front where it is most needed. The latest cost estimates for bringing Bear River water to the Wasatch Front are in the neighborhood of $300 per acre-foot. In addition to this, importation of water into the Bear River would require a possible revision of the Bear River Compact, and would require not only Utah's approval, but that of Idaho and Wyoming.

Weber River Alternatives

Six alternatives were studied that terminate on the Weber River at Echo Reservoir. Alternatives 3 & 4 follow Alignment B from Fontenelle Reservoir. Alternatives 9 & 10 follow Alignment C and Alternatives 13 & 14 follow Alignment D; all four of these alternatives originate from Flaming Gorge Reservoir. Table 4 summarizes the costs of these six alternatives.

TABLE 4
Cost Estimate Summary for Weber River at Echo Reservoir Alternatives

Alternative	Total Project Cost	Total Annualized Cost	Yearly O&M Cost*	Unit Cost†
3	$279,387,000	$14,859,000	$2,075,000	$248
4	$260,094,000	$14,061,000	$2,160,000	$234
9	$261,707,000	$15,263,000	$3,288,000	$254
10	$229,227,000	$13,902,000	$3,413,000	$232
13	$273,463,000	$16,251,000	$3,738,000	$271
14	$264,701,000	$15,990,000	$3,878,000	$266

* Includes regular operation and maintenance costs and net energy purchase costs.
† Cost per acre-foot assumes full utilization of 60,000 acre-feet per year.

As shown, the unit cost of water at the point of discharge (under full use conditions) ranges from a low of $232 to a high of $271 per acre-foot. The $232 per acre-foot unit cost is for Alternative 10, which is the shortest pipeline of all the Weber River alternatives and has two pump stations. The unit cost for Alternative 9, which is the same as Alternative 10 with only one pump station, is significantly more at $254 per acre-foot.

The next lowest Weber River alternative is Alternative 4, with a unit cost at $234 per acre-foot. This alternative also contains two pump stations.

Six alternatives were also studied that terminate higher up on the Weber River at Rockport Lake. Alternatives 5 & 6 follow Alignment B from Fontenelle Reservoir. Alternatives 11 & 12 follow Alignment C from a location high up on Flaming Gorge Reservoir. Alternatives 15 & 16 follow Alignment D which originates from a location on Flaming Gorge Reservoir near Manila, Utah. Table 5 summarizes the costs of these six alternatives.

TABLE 5
Cost Estimate Summary for Weber River at Rockport Lake Alternatives

Alternative	Total Project Cost	Total Annualized Cost	Yearly O&M Cost*	Unit Cost†
5	$307,037,000	$17,439,000	$3,391,000	$291
6	$287,744,000	$16,641,000	$3,476,000	$277
11	$290,926,000	$17,919,000	$4,608,000	$299
12	$258,618,000	$16,566,000	$4,733,000	$276
15	$305,596,000	$19,040,000	$5,058,000	$317
16	$296,834,000	$18,779,000	$5,198,000	$313

* Includes regular operation and maintenance costs and net energy purchase costs.
† Cost per acre-foot assumes full utilization of 60,000 acre-feet per year.

As shown, the unit cost of water at the point of discharge (under full use conditions) ranges from a low of $276 to a high of $313 per acre-foot. This is $45 to $82 per acre-foot more than those alternatives that terminate lower on the Weber River, at Echo Reservoir. The $276 per acre-foot unit cost is for Alternative 12, which follows Alignment C and originates at Flaming Gorge

Reservoir. The unit cost for Alternative 11, which is the same as Alternative 12 with only one pump station, is significantly more at $299 per acre-foot.

The next lowest Weber River alternative is Alternative 6, with a unit cost at $234 per acre-foot. This alternative originates at Fontenelle Reservoir and also contains two pump stations.

Section 5 – Areas for Further Study

The presentation to this point could easily be considered a "quick and dirty" analysis. Generally speaking, assumptions that have been made are conservative, so as to not underestimate actual costs. Certainly, refinements can and should be made if a better idea of actual costs is desired. Areas of weakness in this report include the following:

- Design parameters remained constant and were not optimized (i.e. 60,000 acre-feet and 51 in. pipe diameter).[2]
- No field reconnaissance was performed to observe and pinpoint potential problem areas and refine individual reach costs.
- Acquisition of rights-of-way was assumed to cost $500 per acre along the entire path of the pipeline ($2,000/acre in locations where alignment did not follow a major highway).
- Pipe costs were assumed to be the same as those shown in the Lake Powell Pipeline study (1995) indexed to 2002 prices using ENR's construction cost index. Actual pipe construction costs may vary and could have a large impact on project costs.
- Energy costs were assumed to be the same as those shown in the Lake Powell Pipeline study (1995) indexed to 2002 prices using the Bureau of Labor's finished energy goods index. Actual costs of energy may vary and could have an impact on actual project costs.
- Reservoir pump station costs were assumed to be similar (approx. $18 million) to the Bureau of Reclamation's estimates for the Lake Powell Pump Station.[3]
- None of the alternatives investigate the potential for a peaking reservoir that would maximize the economic benefits of a hydropower station. (For instance, the Lake Powell Pipeline study found that a peaking reservoir and enlarged hydropower station would significantly reduce the unit cost of the project.)
- Interstate water rights issues associated with the project were not investigated.
- Additional costs associated with storing, treating and delivering the project water to the end consumer was not investigated.

[2] Although not included in this report, a few test runs were made at a flow rate of 80,000 acre-feet per year, instead of 60,000 acre-feet. These test runs indicated that a unit cost of approximately $110 per acre-foot could be obtained for Alternative 1 using the same 51 in. pipe diameter. This represents more than a 13 percent reduction in unit costs (Alternative 1 at 60,000 acre-feet has a unit cost of $127).

[3] See Bureau of Reclamation, *Preliminary Design and Cost Estimate for Lone Rock Pump Station*, (Provo: 2002).

Appendix A – Pipeline Alignment Profiles

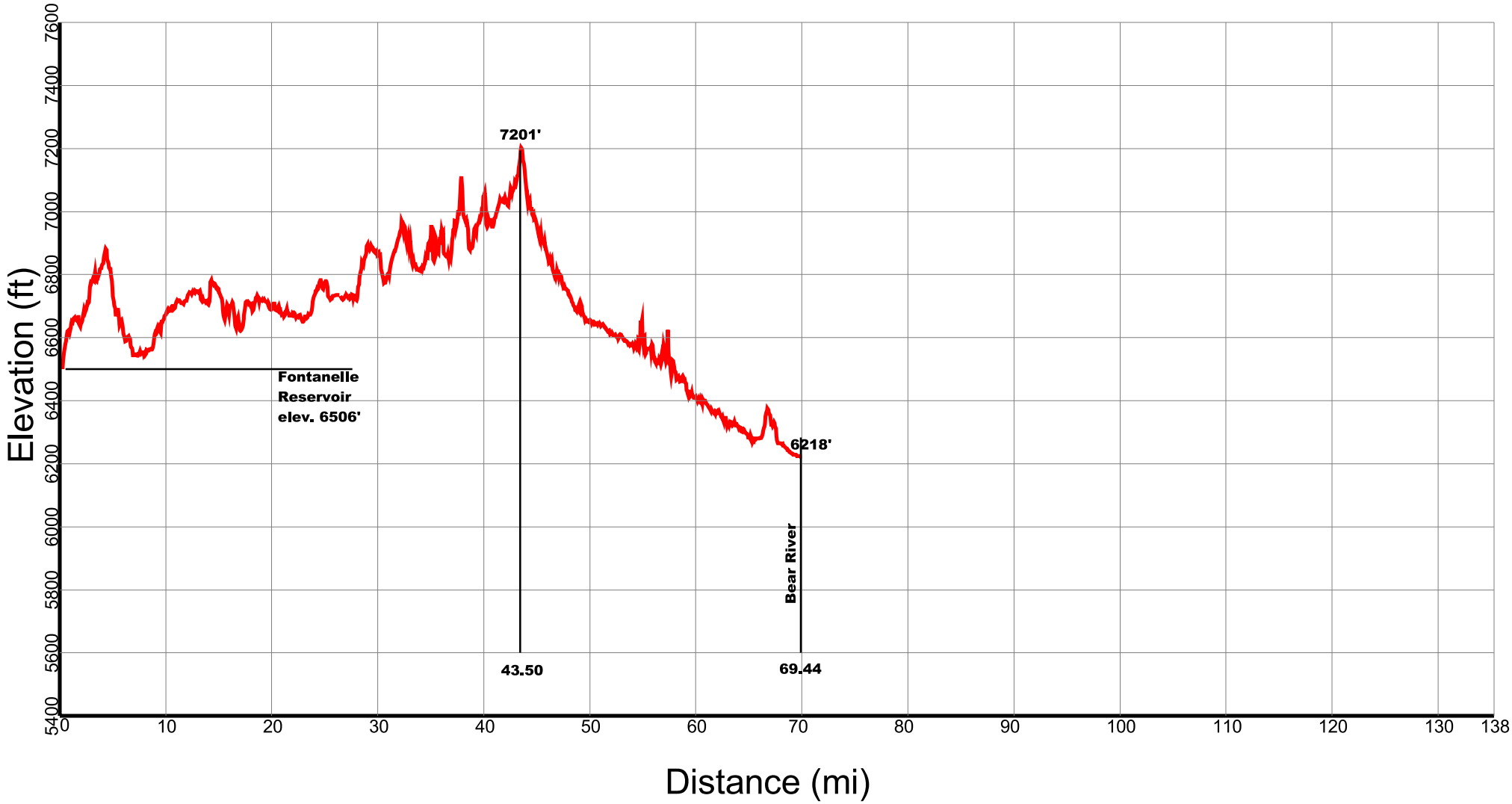
This appendix contains pipeline profiles for each of the four alignments analyzed in this report. The general description of each alignment from the report is repeated below:

Alignments A, B, and C all originate at Fontenelle Reservoir and follow U.S. Highway 189 to the vicinity of Kemmerer, where they diverge. Alignment A goes through Kemmerer and continues in a westerly direction until it crosses the Bear River in Utah. The alignment then turns south along state route 16 until it reaches Interstate 80, where it continues to its Weber River destination, Echo Reservoir.

Alignments B and C are essentially the same, with only a slight difference in their path near Kemmerer. Both alignments eventually join again on U.S. Highway 89, south of Kemmerer, and continue until they join Interstate 80. They then follow Interstate 80 west through Evanston to Echo Reservoir.

Alignment D originates from Flaming Gorge Reservoir. This alignment goes west until it reaches a local road near Manila. This road eventually joins state route 46 to Manila. At Manila, the alignment continues west along route 46, crosses into Wyoming where it becomes state route 414, and eventually joins Interstate 80 near Mountain View. From there it follows Interstate 80 through Evanston to its Weber River destination, Echo Reservoir.

Alignment A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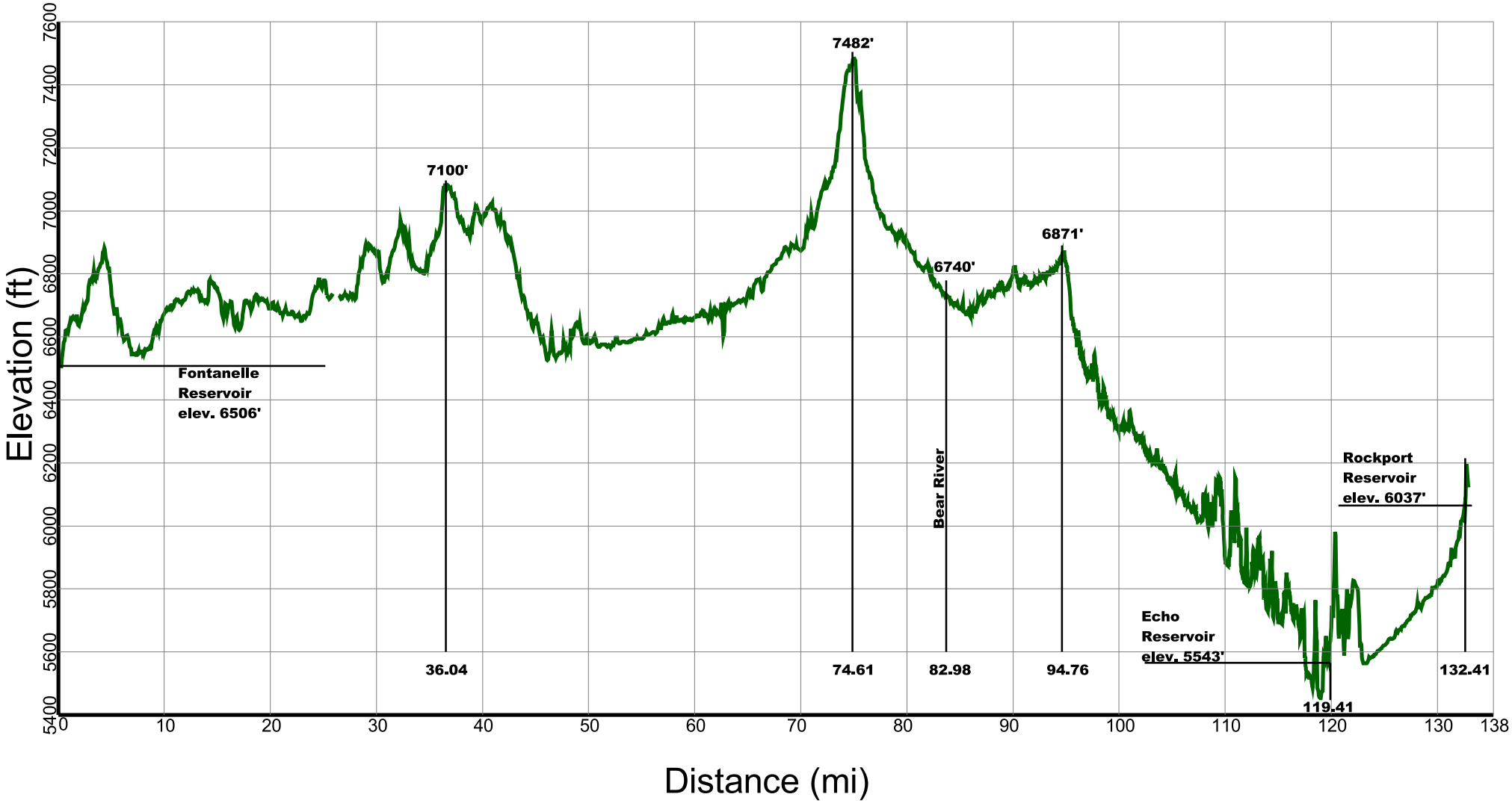
7400
7200
7000
6800
6600
6400
6200
6000
5800
5600
5400
0
10
20
30
40
50
60
70
80
90
100
110
120
130
138
Distance (mi)
7201'
Fontanelle
Reservoir
elev. 6506'
6218'
Bear River
43.50
69.44

Alignment B


Elevation (ft)
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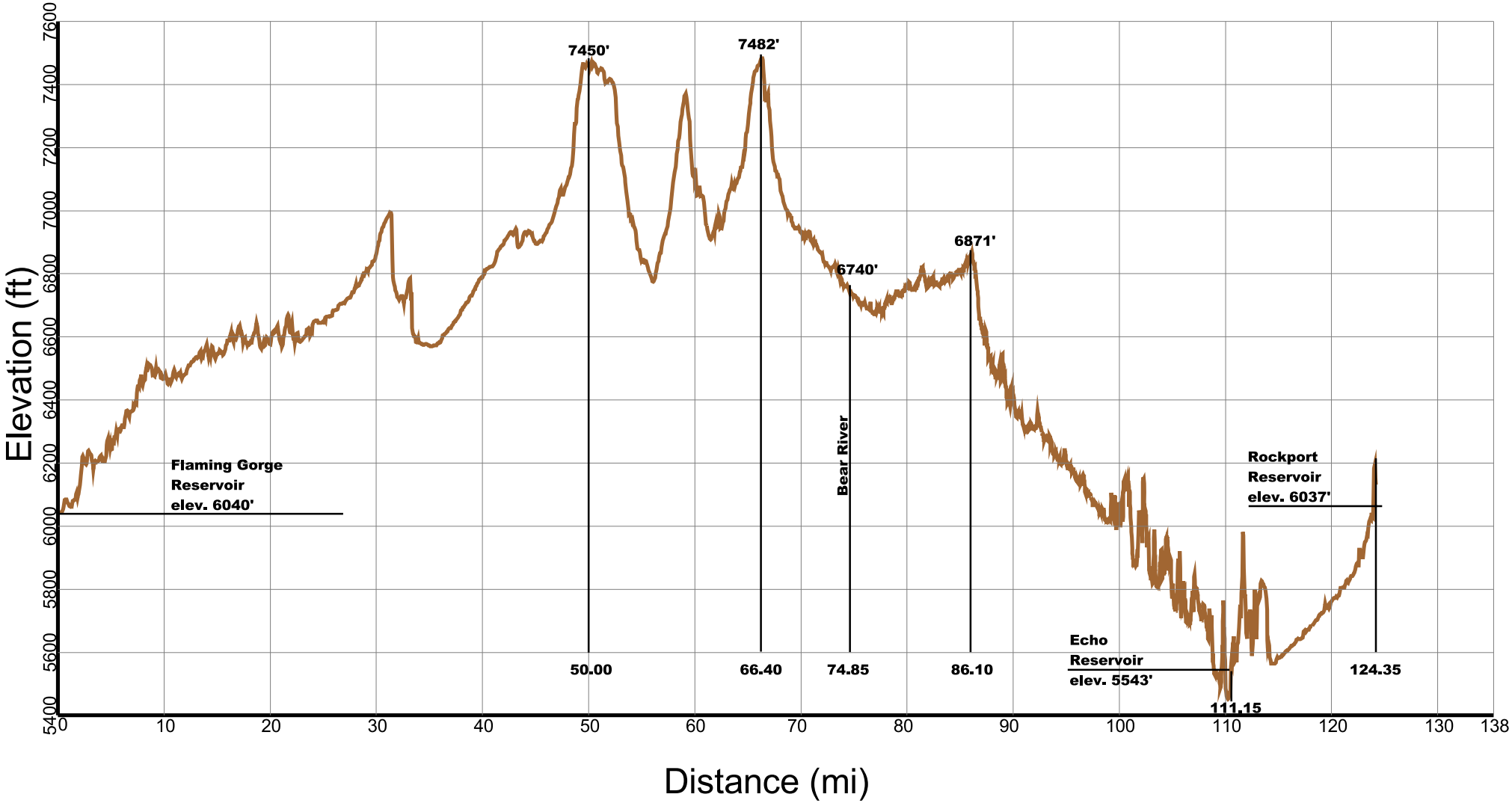
6800
6600
6400
6200
6000
5800
5600
5400
0
10
20
30
40
50
60
70
80
90
100
110
120
130
138
Distance (mi)
Fontanelle
Reservoir
elev. 6506'
7100'
36.04
7482'
74.61
6740'
Bear River
82.98
6871'
94.76
Echo
Reservoir
elev. 5543'
119.41
Rockport
Reservoir
elev. 6037'
132.41

Alignment C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7000
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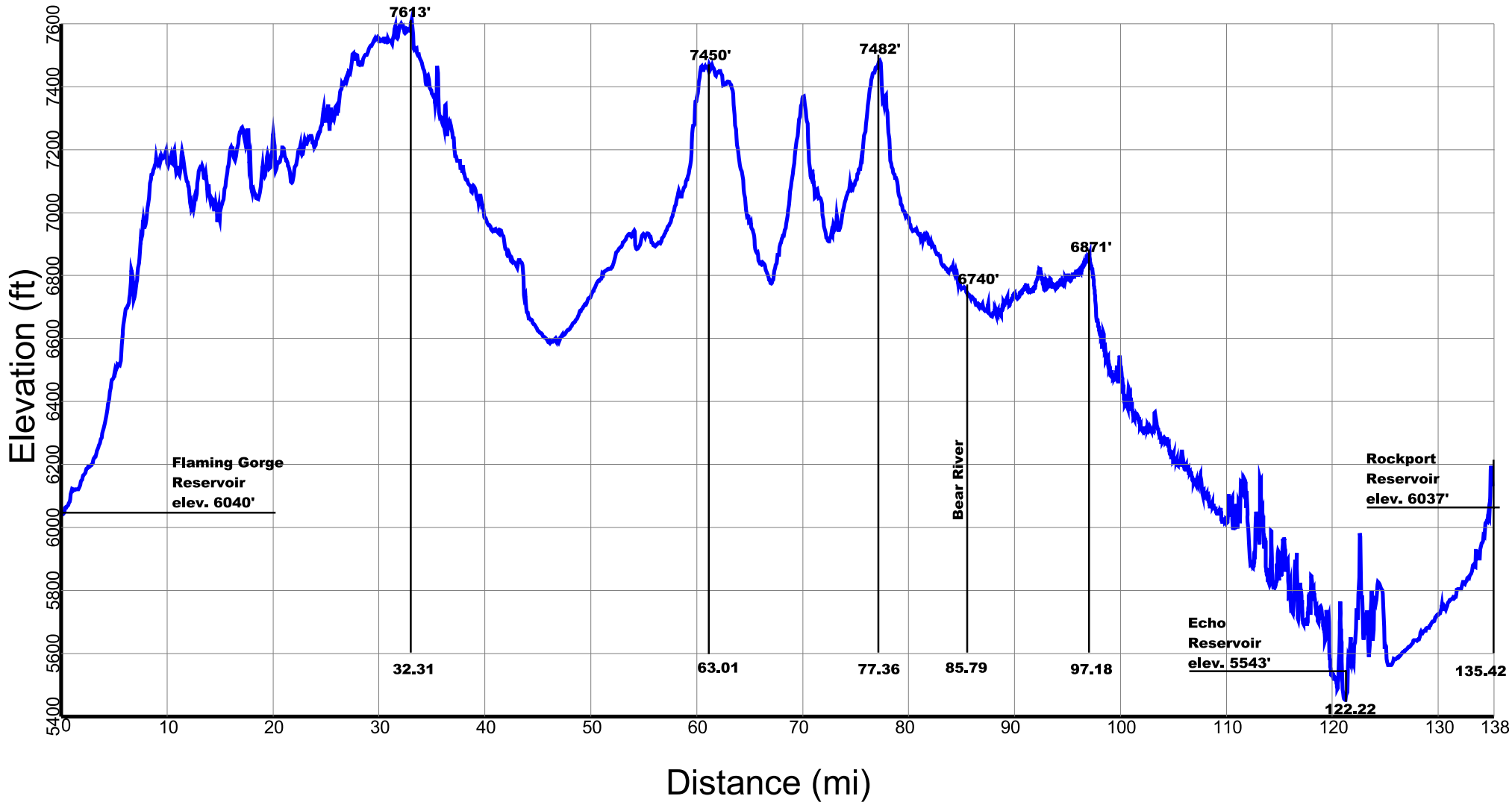
6200
6000
5800
5600
5400
0
10
20
30
40
50
60
70
80
90
100
110
120
130
138
Distance (mi)
7450'
7482'
6740'
6871'
Flaming Gorge
Reservoir
elev. 6040'
Bear River
50.00
66.40
74.85
86.10
Echo
Reservoir
elev. 5543'
111.15
Rockport
Reservoir
elev. 6037'
124.35

Alignment D


Elevation (ft)
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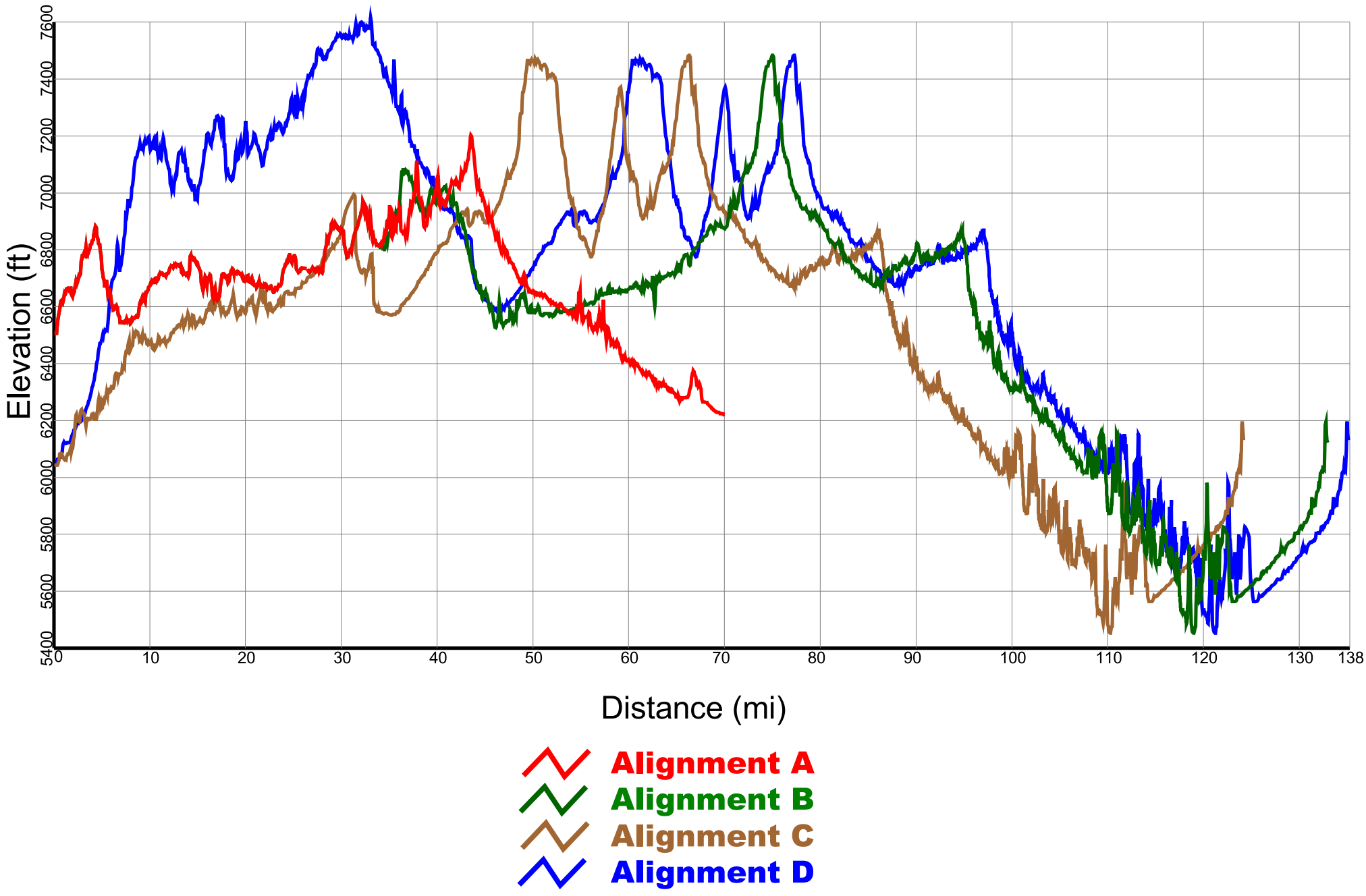
7400
7200
7000
6800
6600
6400
6200
6000
5800
5600
5400
7613'
7450'
7482'
6871'
6740'
Flaming Gorge
Reservoir
elev. 6040'
Bear River
Rockport
Reservoir
elev. 6037'
Echo
Reservoir
elev. 5543'
32.31
63.01
77.36
85.79
97.18
122.22
135.42
0
10
20
30
40
50
60
70
80
90
100
110
120
130
138
Distance (mi)

All Alignments



Appendix B – Cost Estimate Sheets

This appendix contains detailed cost estimate sheets for each of the 18 alternatives. A description of various items on each sheet is provided below:[4]

Station (miles)	The pipeline station in miles from its point of origin.
Pipe Diam. (in.)	The inside diameter of the pipeline.
Velocity (ft/sec)	The flow velocity in the pipeline.
HGL Slope	The slope of the hydraulic grade line (head loss per unit length of pipe).
Base Pipe Cost ($/lf/in)	The basic cost of fabricating and installing the pipe in dollars per linear foot of pipe divided by pipe diameter in inches. This includes a 10% contingency.[5]
Ground Elev.	The ground elevation at the station indicated.
HGL Elev.	The elevation (in feet) of the hydraulic grade line at the station indicated. It generally includes the HGL elevation at control points, including high points, pump stations, etc.
Avg. Press. (psi)	The average pipe pressure between the current station and the previous station.
Add for High Press. ($/lf/in)	The unit cost (in dollars per linear foot per inch diameter) added for high pressure.
Add for Rock ($/lf/in)	The unit cost (in dollars per linear foot per inch diameter) added for rock or marginally rippable soils.
Add for Grndwter ($/lf/in)	The unit cost (in dollars per linear foot per inch diameter) added for anticipated high groundwater conditions (at major stream crossings and along Alignment A in the Bear River Valley).
Slope Factor	A multiplier that increases estimated construction costs for steep slopes.
Appurt. Factor	A multiplier that increases estimated construction costs to account for valving, traffic control, mobilization, paving, dust control, reseeding, etc.
Unit Pipeline Cost ($/lf/in)	The unit cost (in dollars per linear foot per inch diameter) for the pipeline which includes all construction costs.
R/W Cost ($/lf)	The unit cost per linear foot of right-of-way purchased. This assumes a 100' wide easement and acquisition costs of $2,000 per acre.
Reach Cost ($)	The total construction and right-of-way cost between the current station and the previous station.
Annualized Cost ($)	The amortized payment amount at the interest rate and period indicated in the project data section. Annualized costs are included for the pipeline, pump station and hydropower station construction cost totals, and for energy and O&M costs.

[4] Boyle Engineering Corp. & Alpha Engineering, Inc., *Lake Powell Pipeline Feasibility Study*, 1995, 49.
[5] Ibid, 14.

Alternative 1 - Alignment A, Fontenelle Reservoir to Bear River, below Woodruff Narrows (one pump station)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	= 82.85	cfs	
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Fontenelle Reservoir Elevation =				6506										
		Fontenelle Pump Station, lift (ft) =				1150							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6506	7656	498	2.09			1.00	1.05	6.23	1.15	0	
10.00	51	5.84	0.001724	3.84	6703	7565	373	1.19			1.00	1.05	5.28	1.15	14,269,261	
20.00	51	5.84	0.001724	3.84	6715	7474	329	0.90			1.00	1.05	4.98	1.15	13,460,029	
30.00	51	5.84	0.001724	3.84	6868	7383	223	0.30			1.00	1.05	4.35	1.15	11,768,078	
33.21	51	5.84	0.001724	3.84	6848	7354	219	0.28			1.00	1.05	4.33	1.15	3,759,022	
36.79	51	5.84	0.001724	3.84	6860	7321	200	0.18	0.40		1.00	1.05	4.64	1.15	4,499,528	
37.90	51	5.84	0.001724	3.84	7018	7311	127	0.00		0.30	1.22	1.05	5.30	1.15	1,591,900	
39.43	51	5.84	0.001724	3.84	7058	7297	104	0.00		0.30	1.10	1.05	4.78	1.15	1,979,325	
43.50	51	5.84	0.001724	3.84	7201	7260	26	0.00	0.10		1.22	1.05	5.05	1.15	5,556,179	
50.00	51	5.84	0.001724	3.84	6658	7201	235	0.36	0.40		1.00	1.05	4.83	1.15	8,499,906	
60.00	51	5.84	0.001724	3.84	6368	7110	321	0.85	0.40		1.00	1.05	5.35	1.15	14,462,059	
67.79	51	5.84	0.001724	3.84	6235	7039	348	1.02	0.10		1.00	1.05	5.21	1.15	10,975,426	
69.44	51	5.84	0.001724	3.84	6218	7024	349	1.03	0.10	0.30	1.00	1.05	5.53	1.15	2,467,220	
		Hydropower Station, head (ft) =				806							1 River Crossing		500,000	
														Total Cost of Pipeline =	**93,787,932**	**4,291,328**

PUMP STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1150	0.85	9,484			3,544,659
Capital Costs									18,000,000	823,602
O&M Costs										180,000
								Total Cost of Pump Station(s) =	**18,000,000**	**4,548,261**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	806	0.82	4,632			-1,731,378
Capital Costs									3,500,000	160,145
O&M Costs										35,000
								Total Cost of Hydrostation =	**3,500,000**	**-1,536,233**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	115,287,932	
15% Design & Administration	17,293,190	791,261
10% Contingency	11,528,793	527,507
TOTAL PROJECT COST	**144,109,915**	**8,622,125**
UNIT WATER COST, FULL USE ($/af)		**144**
YEARLY OPERATING COST (Energy+O&M)		**2,028,281**

Alternative 2 - Alignment A, Fontenelle Reservoir to Bear River, below Woodruff Narrows (two pump stations)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	=	82.85	cfs
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Fontenelle Reservoir Elevation =				6506										
		Fontenelle Pump Station, lift (ft) =				550							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6506	7056	238	0.38			1.00	1.05	4.43	1.15	0	
10.00	51	5.84	0.001724	3.84	6703	6965	114	0.00			1.00	1.05	4.03	1.15	10,917,976	
20.00	51	5.84	0.001724	3.84	6715	6874	69	0.00			1.00	1.05	4.03	1.15	10,917,976	
26.00	51	5.84	0.001724	3.84	6770	6819	21	0.00			1.00	1.05	4.03	1.15	6,550,785	
		Second Pump Station, lift (ft) =				600										
26.00	51	5.84	0.001724	3.84	6770	7419	281	0.62			1.00	1.05	4.68	1.15	0	
30.00	51	5.84	0.001724	3.84	6868	7383	223	0.30			1.00	1.05	4.35	1.15	4,707,231	
33.21	51	5.84	0.001724	3.84	6848	7354	219	0.28			1.00	1.05	4.33	1.15	3,759,022	
36.79	51	5.84	0.001724	3.84	6860	7321	200	0.18	0.40		1.00	1.05	4.64	1.15	4,499,528	
37.90	51	5.84	0.001724	3.84	7018	7311	127	0.00		0.30	1.22	1.05	5.30	1.15	1,591,900	
39.43	51	5.84	0.001724	3.84	7058	7297	104	0.00		0.30	1.10	1.05	4.78	1.15	1,979,325	
43.50	51	5.84	0.001724	3.84	7201	7260	26	0.00	0.10		1.22	1.05	5.05	1.15	5,556,179	
50.00	51	5.84	0.001724	3.84	6658	7201	235	0.36	0.40		1.00	1.05	4.83	1.15	8,499,906	
60.00	51	5.84	0.001724	3.84	6368	7110	321	0.85	0.40		1.00	1.05	5.35	1.15	14,462,059	
67.79	51	5.84	0.001724	3.84	6235	7039	348	1.02	0.10		1.00	1.05	5.21	1.15	10,975,426	
69.44	51	5.84	0.001724	3.84	6218	7024	349	1.03	0.10	0.30	1.00	1.05	5.53	1.15	2,467,220	
		Hydropower Station, head (ft) =				806							1 River Crossing		500,000	
														Total Cost of Pipeline =	**87,384,532**	**3,998,336**

PUMP STATION(S)

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1150	0.85	9,484			3,544,659
Capital Costs									25,000,000	1,143,891
O&M Costs										250,000
								Total Cost of Pump Station(s) =	**25,000,000**	**4,938,551**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	806	0.82	4,632			-1,731,378
Capital Costs									3,500,000	160,145
O&M Costs										35,000
								Total Cost of Hydrostation =	**3,500,000**	**-1,536,233**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	115,884,532	
15% Design & Administration	17,382,680	795,356
10% Contingency	11,588,453	530,237
TOTAL PROJECT COST	**144,855,665**	**8,726,247**
UNIT WATER COST, FULL USE ($/af)		**145**
YEARLY OPERATING COST (Energy+O&M)		**2,098,281**

Alternative 3 - Alignment B, Fontenelle Reservoir to Weber River, Echo Reservoir (one pump station)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	=	82.85	cfs
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Fontenelle Reservoir Elevation =				6506										
		Fontenelle Pump Station, lift (ft) =				1700							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6506	8206	737	4.25			1.00	1.05	8.50	1.15	0	
10.00	51	5.84	0.001724	3.84	6688	8115	618	3.11			1.00	1.05	7.30	1.15	19,708,745	
20.00	51	5.84	0.001724	3.84	6650	8024	595	2.90			1.00	1.05	7.08	1.15	19,126,173	
30.00	51	5.84	0.001724	3.84	6868	7933	461	1.81			1.00	1.05	5.93	1.15	16,028,083	
33.21	51	5.84	0.001724	3.84	6848	7904	457	1.78			1.00	1.05	5.90	1.15	5,117,844	
34.08	51	5.84	0.001724	3.84	6796	7896	477	1.92		0.30	1.00	1.05	6.37	4.59	1,512,250	
36.04	51	5.84	0.001724	3.84	7100	7878	337	0.95			1.00	1.05	5.03	4.59	2,702,194	
40.00	51	5.84	0.001724	3.84	7000	7842	365	1.13	0.10		1.00	1.05	5.32	4.59	5,770,347	
48.38	51	5.84	0.001724	3.84	6630	7766	492	2.04	0.10		1.00	1.05	6.28	4.59	14,377,192	
50.00	51	5.84	0.001724	3.84	6596	7751	500	2.11			1.00	1.05	6.25	1.15	2,734,155	
60.00	51	5.84	0.001724	3.84	6655	7660	435	1.62			1.00	1.05	5.73	1.15	15,484,587	
69.90	51	5.84	0.001724	3.84	6870	7570	303	0.74			1.00	1.05	4.81	1.15	12,890,116	
74.61	51	5.84	0.001724	3.84	7482	7527	19	0.00			1.20	1.07	4.93	1.15	6,282,018	
77.18	51	5.84	0.001724	3.84	6950	7503	240	0.39	0.30		1.10	1.07	5.33	1.15	3,703,591	
80.00	51	5.84	0.001724	3.84	6875	7478	261	0.50			1.00	1.07	4.65	1.15	3,546,079	
82.98	51	5.84	0.001724	3.84	6740	7451	308	0.77		0.20	1.00	1.07	5.15	1.15	4,149,570	
85.14	51	5.84	0.001724	3.84	6670	7431	330	0.90		0.30	1.00	1.07	5.40	1.15	3,152,617	
90.00	51	5.84	0.001724	3.84	6800	7387	254	0.47			1.00	1.07	4.61	1.15	6,058,067	
94.76	51	5.84	0.001724	3.84	6871	7343	205	0.21			1.00	1.07	4.33	1.15	5,580,505	
95.49	51	5.84	0.001724	3.84	6630	7337	306	0.76	0.30		1.00	1.07	5.24	1.15	1,035,430	
100.00	51	5.84	0.001724	3.84	6280	7296	440	1.65	0.30		1.00	1.07	6.19	1.15	7,550,501	
110.00	51	5.84	0.001724	3.84	6000	7205	522	2.28	0.30		1.10	1.07	7.56	1.15	20,410,631	
119.41	51	5.84	0.001724	3.84	5543	7119	683	3.72	0.30		1.10	1.07	9.25	1.15	23,488,676	
		Hydropower Station, head (ft) =				1576							2 River Crossings		1,000,000	
														Total Cost of Pipeline =	**201,409,373**	**9,215,618**

PUMP STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1700	0.85	14,020			5,239,931
Capital Costs									18,000,000	823,602
O&M Costs										180,000
								Total Cost of Pump Station(s) =	**18,000,000**	**6,243,533**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1576	0.82	9,059			-3,385,912
Capital Costs									4,100,000	187,598
O&M Costs										41,000
								Total Cost of Hydrostation =	**4,100,000**	**-3,157,314**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	223,509,373	
15% Design & Administration	33,526,406	1,534,023
10% Contingency	22,350,937	1,022,682
TOTAL PROJECT COST	**279,386,716**	**14,858,541**
UNIT WATER COST, FULL USE ($/af)		**248**
YEARLY OPERATING COST (Energy+O&M)		**2,075,019**

Alternative 4 - Alignment B, Fontenelle Reservoir to Weber River, Echo Reservoir (two pump stations)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	= 82.85	cfs	
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Fontenelle Reservoir Elevation =				6506										
		Fontenelle Pump Station, lift (ft) =				700							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6506	7206	303	0.74			1.00	1.05	4.81	1.15	0	
10.00	51	5.84	0.001724	3.84	6688	7115	185	0.11			1.00	1.05	4.15	1.15	11,235,805	
20.00	51	5.84	0.001724	3.84	6650	7024	162	0.01			1.00	1.05	4.04	1.15	10,934,699	
30.00	51	5.84	0.001724	3.84	6868	6933	28	0.00			1.00	1.05	4.03	1.15	10,917,976	
33.21	51	5.84	0.001724	3.84	6848	6904	24	0.00			1.00	1.05	4.03	1.15	3,504,670	
34.08	51	5.84	0.001724	3.84	6796	6896	43	0.00			1.00	1.05	4.03	4.59	965,676	
		Second Pump Station, lift (ft) =				1000										
34.08	51	5.84	0.001724	3.84	6796	7896	477	1.92		0.30	1.00	1.05	6.37	4.59	0	
36.04	51	5.84	0.001724	3.84	7100	7878	337	0.95			1.00	1.05	5.03	4.59	2,702,194	
40.00	51	5.84	0.001724	3.84	7000	7842	365	1.13	0.10		1.00	1.05	5.32	4.59	5,770,347	
48.38	51	5.84	0.001724	3.84	6630	7766	492	2.04	0.10		1.00	1.05	6.28	4.59	14,377,192	
50.00	51	5.84	0.001724	3.84	6596	7751	500	2.11			1.00	1.05	6.25	1.15	2,734,155	
60.00	51	5.84	0.001724	3.84	6655	7660	435	1.62			1.00	1.05	5.73	1.15	15,484,587	
69.90	51	5.84	0.001724	3.84	6870	7570	303	0.74			1.00	1.05	4.81	1.15	12,890,116	
74.61	51	5.84	0.001724	3.84	7482	7527	19	0.00			1.20	1.07	4.93	1.15	6,282,018	
77.18	51	5.84	0.001724	3.84	6950	7503	240	0.39	0.30		1.10	1.07	5.33	1.15	3,703,591	
80.00	51	5.84	0.001724	3.84	6875	7478	261	0.50			1.00	1.07	4.65	1.15	3,546,079	
82.98	51	5.84	0.001724	3.84	6740	7451	308	0.77		0.20	1.00	1.07	5.15	1.15	4,149,570	
85.14	51	5.84	0.001724	3.84	6670	7431	330	0.90		0.30	1.00	1.07	5.40	1.15	3,152,617	
90.00	51	5.84	0.001724	3.84	6800	7387	254	0.47			1.00	1.07	4.61	1.15	6,058,067	
94.76	51	5.84	0.001724	3.84	6871	7343	205	0.21			1.00	1.07	4.33	1.15	5,580,505	
95.49	51	5.84	0.001724	3.84	6630	7337	306	0.76	0.30		1.00	1.07	5.24	1.15	1,035,430	
100.00	51	5.84	0.001724	3.84	6280	7296	440	1.65	0.30		1.00	1.07	6.19	1.15	7,550,501	
110.00	51	5.84	0.001724	3.84	6000	7205	522	2.28	0.30		1.10	1.07	7.56	1.15	20,410,631	
119.41	51	5.84	0.001724	3.84	5543	7119	683	3.72	0.30		1.10	1.07	9.25	1.15	23,488,676	
		Hydropower Station, head (ft) =				1576							2 River Crossings		1,000,000	
														Total Cost of Pipeline =	**177,475,102**	**8,120,489**

PUMP STATION(S)

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1700	0.85	14,020			5,239,931
Capital Costs									27,100,000	1,239,978
O&M Costs										271,000
								Total Cost of Pump Station(s) =	**27,100,000**	**6,750,909**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1576	0.82	9,059			-3,385,912
Capital Costs								Should be 4,100,000	3,500,000	160,145
O&M Costs										35,000
								Total Cost of Hydrostation =	**3,500,000**	**-3,190,767**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	208,075,102	
15% Design & Administration	31,211,265	1,428,092
10% Contingency	20,807,510	952,061
TOTAL PROJECT COST	**260,093,878**	**14,060,785**
UNIT WATER COST, FULL USE ($/af)		**234**
YEARLY OPERATING COST (Energy+O&M)		**2,160,019**

Alternative 5 - Alignment B, Fontenelle Reservoir to Weber River, Rockport Lake (one pump station)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	= 82.85	cfs	
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Fontenelle Reservoir Elevation =				6506										
		Fontenelle Pump Station, lift (ft) =				1700							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6506	8206	737	4.25			1.00	1.05	8.50	1.15	0	
10.00	51	5.84	0.001724	3.84	6688	8115	618	3.11			1.00	1.05	7.30	1.15	19,708,745	
20.00	51	5.84	0.001724	3.84	6650	8024	595	2.90			1.00	1.05	7.08	1.15	19,126,173	
30.00	51	5.84	0.001724	3.84	6868	7933	461	1.81			1.00	1.05	5.93	1.15	16,028,083	
33.21	51	5.84	0.001724	3.84	6848	7904	457	1.78			1.00	1.05	5.90	1.15	5,117,844	
34.08	51	5.84	0.001724	3.84	6796	7896	477	1.92		0.30	1.00	1.05	6.37	4.59	1,512,250	
36.04	51	5.84	0.001724	3.84	7100	7878	337	0.95			1.00	1.05	5.03	4.59	2,702,194	
40.00	51	5.84	0.001724	3.84	7000	7842	365	1.13	0.10		1.00	1.05	5.32	4.59	5,770,347	
48.38	51	5.84	0.001724	3.84	6630	7766	492	2.04	0.10		1.00	1.05	6.28	4.59	14,377,192	
50.00	51	5.84	0.001724	3.84	6596	7751	500	2.11			1.00	1.05	6.25	1.15	2,734,155	
60.00	51	5.84	0.001724	3.84	6655	7660	435	1.62			1.00	1.05	5.73	1.15	15,484,587	
69.90	51	5.84	0.001724	3.84	6870	7570	303	0.74			1.00	1.05	4.81	1.15	12,890,116	
74.61	51	5.84	0.001724	3.84	7482	7527	19	0.00			1.20	1.07	4.93	1.15	6,282,018	
77.18	51	5.84	0.001724	3.84	6950	7503	240	0.39	0.30		1.10	1.07	5.33	1.15	3,703,591	
80.00	51	5.84	0.001724	3.84	6875	7478	261	0.50			1.00	1.07	4.65	1.15	3,546,079	
82.98	51	5.84	0.001724	3.84	6740	7451	308	0.77		0.20	1.00	1.07	5.15	1.15	4,149,570	
85.14	51	5.84	0.001724	3.84	6670	7431	330	0.90		0.30	1.00	1.07	5.40	1.15	3,152,617	
90.00	51	5.84	0.001724	3.84	6800	7387	254	0.47			1.00	1.07	4.61	1.15	6,058,067	
94.76	51	5.84	0.001724	3.84	6871	7343	205	0.21			1.00	1.07	4.33	1.15	5,580,505	
95.49	51	5.84	0.001724	3.84	6630	7337	306	0.76	0.30		1.00	1.07	5.24	1.15	1,035,430	
100.00	51	5.84	0.001724	3.84	6280	7296	440	1.65	0.30		1.00	1.07	6.19	1.15	7,550,501	
110.00	51	5.84	0.001724	3.84	6000	7205	522	2.28	0.30		1.10	1.07	7.56	1.15	20,410,631	
119.41	51	5.84	0.001724	3.84	5543	7119	683	3.72	0.30		1.10	1.07	9.25	1.15	23,488,676	
130.00	51	5.84	0.001724	3.84	5810	7023	525	2.31			1.00	1.05	6.46	1.15	18,475,093	
132.41	51	5.84	0.001724	3.84	6037	7001	418	1.49			1.00	1.05	5.59	1.15	3,644,778	
		Hydropower Station, head (ft) =				964							2 River Crossings		1,000,000	
															Total Cost of Pipeline =	**223,529,244**	**10,227,727**

PUMP STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1700	0.85	14,020			5,239,931
Capital Costs									18,000,000	823,602
O&M Costs										180,000
								Total Cost of Pump Station(s) =	**18,000,000**	**6,243,533**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	964	0.82	5,539			-2,070,386
Capital Costs								Should be 3,500,000	4,100,000	187,598
O&M Costs										41,000
								Total Cost of Hydrostation =	**4,100,000**	**-1,841,788**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	245,629,244	
15% Design & Administration	36,844,387	1,685,839
10% Contingency	24,562,924	1,123,893
TOTAL PROJECT COST	**307,036,555**	**17,439,204**
UNIT WATER COST, FULL USE ($/af)		**291**
YEARLY OPERATING COST (Energy+O&M)		**3,390,545**

Alternative 6 - Alignment B, Fontenelle Reservoir to Weber River, Rockport Lake (two pump stations)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	=	82.85	cfs
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Fontenelle Reservoir Elevation =				6506										
		Fontenelle Pump Station, lift (ft) =				700							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6506	7206	303	0.74			1.00	1.05	4.81	1.15	0	
10.00	51	5.84	0.001724	3.84	6688	7115	185	0.11			1.00	1.05	4.15	1.15	11,235,805	
20.00	51	5.84	0.001724	3.84	6650	7024	162	0.01			1.00	1.05	4.04	1.15	10,934,699	
30.00	51	5.84	0.001724	3.84	6868	6933	28	0.00			1.00	1.05	4.03	1.15	10,917,976	
33.21	51	5.84	0.001724	3.84	6848	6904	24	0.00			1.00	1.05	4.03	1.15	3,504,670	
34.08	51	5.84	0.001724	3.84	6796	6896	43	0.00			1.00	1.05	4.03	4.59	965,676	
		Second Pump Station, lift (ft) =				1000										
34.08	51	5.84	0.001724	3.84	6796	7896	477	1.92		0.30	1.00	1.05	6.37	4.59	0	
36.04	51	5.84	0.001724	3.84	7100	7878	337	0.95			1.00	1.05	5.03	4.59	2,702,194	
40.00	51	5.84	0.001724	3.84	7000	7842	365	1.13	0.10		1.00	1.05	5.32	4.59	5,770,347	
48.38	51	5.84	0.001724	3.84	6630	7766	492	2.04	0.10		1.00	1.05	6.28	4.59	14,377,192	
50.00	51	5.84	0.001724	3.84	6596	7751	500	2.11			1.00	1.05	6.25	1.15	2,734,155	
60.00	51	5.84	0.001724	3.84	6655	7660	435	1.62			1.00	1.05	5.73	1.15	15,484,587	
69.90	51	5.84	0.001724	3.84	6870	7570	303	0.74			1.00	1.05	4.81	1.15	12,890,116	
74.61	51	5.84	0.001724	3.84	7482	7527	19	0.00			1.20	1.07	4.93	1.15	6,282,018	
77.18	51	5.84	0.001724	3.84	6950	7503	240	0.39	0.30		1.10	1.07	5.33	1.15	3,703,591	
80.00	51	5.84	0.001724	3.84	6875	7478	261	0.50			1.00	1.07	4.65	1.15	3,546,079	
82.98	51	5.84	0.001724	3.84	6740	7451	308	0.77		0.20	1.00	1.07	5.15	1.15	4,149,570	
85.14	51	5.84	0.001724	3.84	6670	7431	330	0.90		0.30	1.00	1.07	5.40	1.15	3,152,617	
90.00	51	5.84	0.001724	3.84	6800	7387	254	0.47			1.00	1.07	4.61	1.15	6,058,067	
94.76	51	5.84	0.001724	3.84	6871	7343	205	0.21			1.00	1.07	4.33	1.15	5,580,505	
95.49	51	5.84	0.001724	3.84	6630	7337	306	0.76	0.30		1.00	1.07	5.24	1.15	1,035,430	
100.00	51	5.84	0.001724	3.84	6280	7296	440	1.65	0.30		1.00	1.07	6.19	1.15	7,550,501	
110.00	51	5.84	0.001724	3.84	6000	7205	522	2.28	0.30		1.10	1.07	7.56	1.15	20,410,631	
119.41	51	5.84	0.001724	3.84	5543	7119	683	3.72	0.30		1.10	1.07	9.25	1.15	23,488,676	
130.00	51	5.84	0.001724	3.84	5810	7023	525	2.31			1.00	1.05	6.46	1.15	18,475,093	
132.41	51	5.84	0.001724	3.84	6037	7001	418	1.49			1.00	1.05	5.59	1.15	3,644,778	
		Hydropower Station, head (ft) =				964				Should be 3			2 River Crossings		1,000,000	
															Total Cost of Pipeline =	**199,594,973**	**9,132,599**

PUMP STATION(S)

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1700	0.85	14,020			5,239,931
Capital Costs									27,100,000	1,239,978
O&M Costs										271,000
								Total Cost of Pump Station(s) =	**27,100,000**	**6,750,909**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	964	0.82	5,539			-2,070,386
Capital Costs									3,500,000	160,145
O&M Costs										35,000
								Total Cost of Hydrostation =	**3,500,000**	**-1,875,241**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	230,194,973	
15% Design & Administration	34,529,246	1,579,908
10% Contingency	23,019,497	1,053,272
TOTAL PROJECT COST	**287,743,717**	**16,641,447**
UNIT WATER COST, FULL USE ($/af)		**277**
YEARLY OPERATING COST (Energy+O&M)		**3,475,545**

Alternative 7 - Alignment C, Flaming Gorge Reservoir to Bear River, near Evanston (one pump station)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	= 82.85	cfs	
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Flaming Gorge Reservoir Elevation =				6040										
		Flaming Gorge Pump Station, lift (ft) =				2100							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6040	8140	910	6.18			1.00	1.05	10.52	4.59	0	
10.00	51	5.84	0.001724	3.84	6460	8049	688	3.77			1.00	1.05	7.99	4.59	21,762,697	
20.00	51	5.84	0.001724	3.84	6595	7958	591	2.86			1.00	1.05	7.04	4.59	19,188,941	
30.00	51	5.84	0.001724	3.84	6860	7867	436	1.62			1.00	1.05	5.73	4.59	15,684,860	
36.41	51	5.84	0.001724	3.84	6590	7809	528	2.33			1.00	1.05	6.48	4.59	11,337,280	
43.99	51	5.84	0.001724	3.84	6930	7740	351	1.04		0.10	1.00	1.05	5.23	1.15	10,713,086	
50.00	51	5.84	0.001724	3.84	7450	7685	102	0.00			1.00	1.05	4.03	1.15	6,561,703	
55.43	51	5.84	0.001724	3.84	6840	7635	345	1.00	0.10		1.00	1.07	5.28	1.15	7,758,859	
60.00	51	5.84	0.001724	3.84	7100	7594	214	0.25			1.00	1.07	4.38	1.15	5,418,753	
61.77	51	5.84	0.001724	3.84	6946	7578	274	0.57			1.22	1.07	5.76	1.15	2,756,526	
69.05	51	5.84	0.001724	3.84	7482	7511	13	0.00	0.30		1.10	1.07	4.87	1.15	9,596,516	
70.00	51	5.84	0.001724	3.84	6940	7503	244	0.41			1.20	1.07	5.46	1.15	1,401,508	
74.85	51	5.84	0.001724	3.84	6740	7459	311	0.79			1.00	1.07	4.96	1.15	6,503,075	
		Hydropower Station, head (ft) =				719							2 River Crossings		1,000,000	
															Total Cost of Pipeline =	**119,683,805**	**5,476,211**

PUMP STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	2100	0.85	17,318			6,472,856
Capital Costs									18,000,000	823,602
O&M Costs										180,000
								Total Cost of Pump Station(s) =	**18,000,000**	**7,476,458**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	719	0.82	4,131			-1,543,941
Capital Costs									3,500,000	160,145
O&M Costs										35,000
								Total Cost of Hydrostation =	**3,500,000**	**-1,348,796**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	141,183,805	
15% Design & Administration	21,177,571	968,994
10% Contingency	14,118,381	645,996
TOTAL PROJECT COST	**176,479,757**	**13,218,862**
UNIT WATER COST, FULL USE ($/af)		**220**
YEARLY OPERATING COST (Energy+O&M)		**5,143,915**

Alternative 8 - Alignment C, Flaming Gorge Reservoir to Bear River, near Evanston (two pump stations)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	=	82.85	cfs
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Flaming Gorge Reservoir Elevation =				6040										
		Flaming Gorge Pump Station, lift (ft) =				1400							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6040	7440	607	3.00			1.00	1.05	7.19	4.59	0	
10.00	51	5.84	0.001724	3.84	6460	7349	385	1.26			1.00	1.05	5.36	4.59	14,672,396	
20.00	51	5.84	0.001724	3.84	6595	7258	287	0.65			1.00	1.05	4.71	4.59	12,938,451	
30.00	51	5.84	0.001724	3.84	6860	7167	133	0.00			1.00	1.05	4.03	4.59	11,099,722	
36.41	51	5.84	0.001724	3.84	6590	7109	225	0.31			1.00	1.05	4.36	4.59	7,674,571	
43.99	51	5.84	0.001724	3.84	6930	7040	47	0.00		0.10	1.00	1.05	4.14	1.15	8,490,146	
		Second Pump Station, lift (ft) =				700										
43.99	51	5.84	0.001724	3.84	6930	7740	351	1.04		0.10	1.00	1.05	5.23	1.15	0	
50.00	51	5.84	0.001724	3.84	7450	7685	102	0.00			1.00	1.05	4.03	1.15	6,561,703	
55.43	51	5.84	0.001724	3.84	6840	7635	345	1.00	0.10		1.00	1.07	5.28	1.15	7,758,859	
60.00	51	5.84	0.001724	3.84	7100	7594	214	0.25			1.00	1.07	4.38	1.15	5,418,753	
61.77	51	5.84	0.001724	3.84	6946	7578	274	0.57			1.22	1.07	5.76	1.15	2,756,526	
69.05	51	5.84	0.001724	3.84	7482	7511	13	0.00	0.30		1.10	1.07	4.87	1.15	9,596,516	
70.00	51	5.84	0.001724	3.84	6940	7503	244	0.41			1.20	1.07	5.46	1.15	1,401,508	
74.85	51	5.84	0.001724	3.84	6740	7459	311	0.79			1.00	1.07	4.96	1.15	6,503,075	
		Hydropower Station, head (ft) =				719							2 River Crossings		1,000,000	
														Total Cost of Pipeline =	**95,872,226**	**4,386,696**

PUMP STATION(S)

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	2100	0.85	17,318			6,472,856
Capital Costs									30,500,000	1,395,547
O&M Costs										305,000
								Total Cost of Pump Station(s) =	**30,500,000**	**8,173,404**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	719	0.82	4,131			-1,543,941
Capital Costs									3,500,000	160,145
O&M Costs										35,000
								Total Cost of Hydrostation =	**3,500,000**	**-1,348,796**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	129,872,226	
15% Design & Administration	19,480,834	891,358
10% Contingency	12,987,223	594,239
TOTAL PROJECT COST	**162,340,283**	**12,696,901**
UNIT WATER COST, FULL USE ($/af)		**212**
YEARLY OPERATING COST (Energy+O&M)		**5,268,915**

Alternative 9 - Alignment C, Flaming Gorge Reservoir to Weber River, Echo Reservoir (one pump station)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	=	82.85	cfs
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Flaming Gorge Reservoir Elevation =				6040										
		Flaming Gorge Pump Station, lift (ft) =				2100							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6040	8140	910	6.18			1.00	1.05	10.52	4.59	0	
10.00	51	5.84	0.001724	3.84	6460	8049	688	3.77			1.00	1.05	7.99	4.59	21,762,697	
20.00	51	5.84	0.001724	3.84	6595	7958	591	2.86			1.00	1.05	7.04	4.59	19,188,941	
30.00	51	5.84	0.001724	3.84	6860	7867	436	1.62			1.00	1.05	5.73	4.59	15,684,860	
36.41	51	5.84	0.001724	3.84	6590	7809	528	2.33			1.00	1.05	6.48	4.59	11,337,280	
43.99	51	5.84	0.001724	3.84	6930	7740	351	1.04		0.10	1.00	1.05	5.23	1.15	10,713,086	
50.00	51	5.84	0.001724	3.84	7450	7685	102	0.00			1.00	1.05	4.03	1.15	6,561,703	
55.43	51	5.84	0.001724	3.84	6840	7635	345	1.00	0.10		1.00	1.07	5.28	1.15	7,758,859	
60.00	51	5.84	0.001724	3.84	7100	7594	214	0.25			1.00	1.07	4.38	1.15	5,418,753	
61.77	51	5.84	0.001724	3.84	6946	7578	274	0.57			1.22	1.07	5.76	1.15	2,756,526	
69.05	51	5.84	0.001724	3.84	7482	7511	13	0.00	0.30		1.10	1.07	4.87	1.15	9,596,516	
70.00	51	5.84	0.001724	3.84	6940	7503	244	0.41			1.20	1.07	5.46	1.15	1,401,508	
74.85	51	5.84	0.001724	3.84	6740	7459	311	0.79			1.00	1.07	4.96	1.15	6,503,075	
77.01	51	5.84	0.001724	3.84	6672	7439	332	0.92		0.30	1.00	1.07	5.41	1.15	3,162,674	
80.00	51	5.84	0.001724	3.84	6775	7412	276	0.59			1.00	1.07	4.74	1.15	3,830,734	
87.36	51	5.84	0.001724	3.84	6871	7345	205	0.21			1.00	1.07	4.33	1.15	8,634,868	
90.00	51	5.84	0.001724	3.84	6400	7321	399	1.36	0.30		1.00	1.07	5.88	1.15	4,197,724	
100.00	51	5.84	0.001724	3.84	6025	7230	522	2.28	0.30		1.00	1.07	6.87	1.15	18,560,911	
110.00	51	5.84	0.001724	3.84	5500	7139	710	3.98	0.30		1.10	1.07	9.56	1.15	25,810,155	
111.15	51	5.84	0.001724	3.84	5543	7128	687	3.76	0.30		1.10	1.07	9.29	1.15	2,884,707	
		Hydropower Station, head (ft) =				1585							3 River Crossings		1,500,000	
														Total Cost of Pipeline =	**187,265,579**	**8,568,459**

PUMP STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	2100	0.85	17,318			6,472,856
Capital Costs									18,000,000	823,602
O&M Costs										180,000
								Total Cost of Pump Station(s) =	**18,000,000**	**7,476,458**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1585	0.82	9,112			-3,405,653
Capital Costs									4,100,000	187,598
O&M Costs										41,000
								Total Cost of Hydrostation =	**4,100,000**	**-3,177,055**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	209,365,579	
15% Design & Administration	31,404,837	1,436,949
10% Contingency	20,936,558	957,966
TOTAL PROJECT COST	**261,706,974**	**15,262,777**
UNIT WATER COST, FULL USE ($/af)		**254**
YEARLY OPERATING COST (Energy+O&M)		**3,288,203**

Alternative 10 - Alignment C, Flaming Gorge Reservoir to Weber River, Echo Reservoir (two pump stations)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	=	82.85	cfs
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

$2000/acre in roadless areas

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Flaming Gorge Reservoir Elevation =				6040										
		Flaming Gorge Pump Station, lift (ft) =				1400							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6040	7440	607	3.00			1.00	1.05	7.19	4.59	0	
10.00	51	5.84	0.001724	3.84	6460	7349	385	1.26			1.00	1.05	5.36	4.59	14,672,396	
20.00	51	5.84	0.001724	3.84	6595	7258	287	0.65			1.00	1.05	4.71	4.59	12,938,451	
30.00	51	5.84	0.001724	3.84	6860	7167	133	0.00			1.00	1.05	4.03	4.59	11,099,722	
36.41	51	5.84	0.001724	3.84	6590	7109	225	0.31			1.00	1.05	4.36	4.59	7,674,571	
43.99	51	5.84	0.001724	3.84	6930	7040	47	0.00		0.10	1.00	1.05	4.14	1.15	8,490,146	
		Second Pump Station, lift (ft) =				700										
43.99	51	5.84	0.001724	3.84	6930	7740	351	1.04		0.10	1.00	1.05	5.23	1.15	0	
50.00	51	5.84	0.001724	3.84	7450	7685	102	0.00			1.00	1.05	4.03	1.15	6,561,703	
55.43	51	5.84	0.001724	3.84	6840	7635	345	1.00	0.10		1.00	1.07	5.28	1.15	7,758,859	
60.00	51	5.84	0.001724	3.84	7100	7594	214	0.25			1.00	1.07	4.38	1.15	5,418,753	
61.77	51	5.84	0.001724	3.84	6946	7578	274	0.57			1.22	1.07	5.76	1.15	2,756,526	
69.05	51	5.84	0.001724	3.84	7482	7511	13	0.00	0.30		1.10	1.07	4.87	1.15	9,596,516	
70.00	51	5.84	0.001724	3.84	6940	7503	244	0.41			1.20	1.07	5.46	1.15	1,401,508	
74.85	51	5.84	0.001724	3.84	6740	7459	311	0.79			1.00	1.07	4.96	1.15	6,503,075	
77.01	51	5.84	0.001724	3.84	6672	7439	332	0.92		0.30	1.00	1.07	5.41	1.15	3,162,674	
80.00	51	5.84	0.001724	3.84	6775	7412	276	0.59			1.00	1.07	4.74	1.15	3,830,734	
87.36	51	5.84	0.001724	3.84	6871	7345	205	0.21			1.00	1.07	4.33	1.15	8,634,868	
90.00	51	5.84	0.001724	3.84	6400	7321	399	1.36	0.30		1.00	1.07	5.88	1.15	4,197,724	
100.00	51	5.84	0.001724	3.84	6025	7230	522	2.28	0.30		1.00	1.07	6.87	1.15	18,560,911	
110.00	51	5.84	0.001724	3.84	5500	7139	710	3.98	0.30		1.10	1.07	9.56	1.15	25,810,155	
111.15	51	5.84	0.001724	3.84	5543	7128	687	3.76	0.30		1.10	1.07	9.29	1.15	2,884,707	
		Hydropower Station, head (ft) =				1585							3 River Crossings		1,500,000	
														Total Cost of Pipeline =	**148,781,605**	**6,807,600**

PUMP STATION(S)

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	2100	0.85	17,318			6,472,856
Capital Costs									30,500,000	1,395,547
O&M Costs										305,000
								Total Cost of Pump Station(s) =	**30,500,000**	**8,173,404**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1585	0.82	9,112			-3,405,653
Capital Costs									4,100,000	187,598
O&M Costs										41,000
								Total Cost of Hydrostation =	**4,100,000**	**-3,177,055**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	183,381,605	
15% Design & Administration	27,507,241	1,258,612
10% Contingency	18,338,160	839,075
TOTAL PROJECT COST	**229,227,006**	**13,901,634**
UNIT WATER COST, FULL USE ($/af)		**232**
YEARLY OPERATING COST (Energy+O&M)		**3,413,203**

Alternative 11 - Alignment C, Flaming Gorge Reservoir to Weber River, Rockport Lake (one pump station)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	=	82.85	cfs
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Flaming Gorge Reservoir Elevation =				6040										
		Flaming Gorge Pump Station, lift (ft) =				2100							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6040	8140	910	6.18			1.00	1.05	10.52	4.59	0	
10.00	51	5.84	0.001724	3.84	6460	8049	688	3.77			1.00	1.05	7.99	4.59	21,762,697	
20.00	51	5.84	0.001724	3.84	6595	7958	591	2.86			1.00	1.05	7.04	4.59	19,188,941	
30.00	51	5.84	0.001724	3.84	6860	7867	436	1.62			1.00	1.05	5.73	4.59	15,684,860	
36.41	51	5.84	0.001724	3.84	6590	7809	528	2.33			1.00	1.05	6.48	4.59	11,337,280	
43.99	51	5.84	0.001724	3.84	6930	7740	351	1.04		0.10	1.00	1.05	5.23	1.15	10,713,086	
50.00	51	5.84	0.001724	3.84	7450	7685	102	0.00			1.00	1.05	4.03	1.15	6,561,703	
55.43	51	5.84	0.001724	3.84	6840	7635	345	1.00	0.10		1.00	1.07	5.28	1.15	7,758,859	
60.00	51	5.84	0.001724	3.84	7100	7594	214	0.25			1.00	1.07	4.38	1.15	5,418,753	
61.77	51	5.84	0.001724	3.84	6946	7578	274	0.57			1.22	1.07	5.76	1.15	2,756,526	
69.05	51	5.84	0.001724	3.84	7482	7511	13	0.00	0.30		1.10	1.07	4.87	1.15	9,596,516	
70.00	51	5.84	0.001724	3.84	6940	7503	244	0.41			1.20	1.07	5.46	1.15	1,401,508	
74.85	51	5.84	0.001724	3.84	6740	7459	311	0.79			1.00	1.07	4.96	1.15	6,503,075	
77.01	51	5.84	0.001724	3.84	6672	7439	332	0.92		0.30	1.00	1.07	5.41	1.15	3,162,674	
80.00	51	5.84	0.001724	3.84	6775	7412	276	0.59			1.00	1.07	4.74	1.15	3,830,734	
87.36	51	5.84	0.001724	3.84	6871	7345	205	0.21			1.00	1.07	4.33	1.15	8,634,868	
90.00	51	5.84	0.001724	3.84	6400	7321	399	1.36	0.30		1.00	1.07	5.88	1.15	4,197,724	
100.00	51	5.84	0.001724	3.84	6025	7230	522	2.28	0.30		1.00	1.07	6.87	1.15	18,560,911	
110.00	51	5.84	0.001724	3.84	5500	7139	710	3.98	0.30		1.10	1.07	9.56	1.15	25,810,155	
111.15	51	5.84	0.001724	3.84	5543	7128	687	3.76	0.30		1.10	1.07	9.29	1.15	2,884,707	
120.00	51	5.84	0.001724	3.84	5790	7048	545	2.47			1.00	1.07	6.75	1.15	16,143,092	
124.35	51	5.84	0.001724	3.84	6037	7008	421	1.51			1.00	1.07	5.72	1.15	6,731,933	
		Hydropower Station, head (ft) =				971							4 River Crossings		2,000,000	
														Total Cost of Pipeline =	**210,640,604**	**9,637,999**

PUMP STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	2100	0.85	17,318			6,472,856
Capital Costs									18,000,000	823,602
O&M Costs										180,000
								Total Cost of Pump Station(s) =	**18,000,000**	**7,476,458**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	971	0.82	5,582			-2,086,216
Capital Costs								Should be 3,500,000	4,100,000	187,598
O&M Costs										41,000
								Total Cost of Hydrostation =	**4,100,000**	**-1,857,618**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	232,740,604	
15% Design & Administration	34,911,091	1,597,380
10% Contingency	23,274,060	1,064,920
TOTAL PROJECT COST	**290,925,755**	**17,919,138**
UNIT WATER COST, FULL USE ($/af)		**299**
YEARLY OPERATING COST (Energy+O&M)		**4,607,640**

Alternative 12 - Alignment C, Flaming Gorge Reservoir to Weber River, Rockport Lake (two pump stations)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	= 82.85	cfs	
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

$2000/acre in roadless areas

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Flaming Gorge Reservoir Elevation =				6040										
		Flaming Gorge Pump Station, lift (ft) =				1400							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6040	7440	607	3.00			1.00	1.05	7.19	4.59	0	
10.00	51	5.84	0.001724	3.84	6460	7349	385	1.26			1.00	1.05	5.36	4.59	14,672,396	
20.00	51	5.84	0.001724	3.84	6595	7258	287	0.65			1.00	1.05	4.71	4.59	12,938,451	
30.00	51	5.84	0.001724	3.84	6860	7167	133	0.00			1.00	1.05	4.03	4.59	11,099,722	
36.41	51	5.84	0.001724	3.84	6590	7109	225	0.31			1.00	1.05	4.36	4.59	7,674,571	
43.99	51	5.84	0.001724	3.84	6930	7040	47	0.00		0.10	1.00	1.05	4.14	4.59	8,627,909	
		Second Pump Station, lift (ft) =				700										
43.99	51	5.84	0.001724	3.84	6930	7740	351	1.04		0.10	1.00	1.05	5.23	1.15	0	
50.00	51	5.84	0.001724	3.84	7450	7685	102	0.00			1.00	1.05	4.03	1.15	6,561,703	
55.43	51	5.84	0.001724	3.84	6840	7635	345	1.00	0.10		1.00	1.07	5.28	1.15	7,758,859	
60.00	51	5.84	0.001724	3.84	7100	7594	214	0.25			1.00	1.07	4.38	1.15	5,418,753	
61.77	51	5.84	0.001724	3.84	6946	7578	274	0.57			1.22	1.07	5.76	1.15	2,756,526	
69.05	51	5.84	0.001724	3.84	7482	7511	13	0.00	0.30		1.10	1.07	4.87	1.15	9,596,516	
70.00	51	5.84	0.001724	3.84	6940	7503	244	0.41			1.20	1.07	5.46	1.15	1,401,508	
74.85	51	5.84	0.001724	3.84	6740	7459	311	0.79			1.00	1.07	4.96	1.15	6,503,075	
77.01	51	5.84	0.001724	3.84	6672	7439	332	0.92		0.30	1.00	1.07	5.41	1.15	3,162,674	
80.00	51	5.84	0.001724	3.84	6775	7412	276	0.59			1.00	1.07	4.74	1.15	3,830,734	
87.36	51	5.84	0.001724	3.84	6871	7345	205	0.21			1.00	1.07	4.33	1.15	8,634,868	
90.00	51	5.84	0.001724	3.84	6400	7321	399	1.36	0.30		1.00	1.07	5.88	1.15	4,197,724	
100.00	51	5.84	0.001724	3.84	6025	7230	522	2.28	0.30		1.00	1.07	6.87	1.15	18,560,911	
110.00	51	5.84	0.001724	3.84	5500	7139	710	3.98	0.30		1.10	1.07	9.56	1.15	25,810,155	
111.15	51	5.84	0.001724	3.84	5543	7128	687	3.76	0.30		1.10	1.07	9.29	1.15	2,884,707	
120.00	51	5.84	0.001724	3.84	5790	7048	545	2.47			1.00	1.07	6.75	1.15	16,143,092	
124.35	51	5.84	0.001724	3.84	6037	7008	421	1.51			1.00	1.07	5.72	1.15	6,731,933	
		Hydropower Station, head (ft) =				971							4 River Crossings		2,000,000	
														Total Cost of Pipeline =	**172,294,393**	**7,883,443**

PUMP STATION(S)

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	2100	0.85	17,318			6,472,856
Capital Costs									30,500,000	1,395,547
O&M Costs										305,000
								Total Cost of Pump Station(s) =	**30,500,000**	**8,173,404**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	971	0.82	5,582			-2,086,216
Capital Costs								Should be 3,500,000	4,100,000	187,598
O&M Costs										41,000
								Total Cost of Hydrostation =	**4,100,000**	**-1,857,618**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	206,894,393	
15% Design & Administration	31,034,159	1,419,988
10% Contingency	20,689,439	946,659
TOTAL PROJECT COST	**258,617,991**	**16,565,875**
UNIT WATER COST, FULL USE ($/af)		**276**
YEARLY OPERATING COST (Energy+O&M)		**4,732,640**

Alternative 13 - Alignment D, Flaming Gorge Reservoir to Weber River, Echo Reservoir (one pump station)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	=	82.85	cfs
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Flaming Gorge Reservoir Elevation =				6040										
		Flaming Gorge Pump Station, lift (ft) =				2350							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6040	8390	1018	7.54			1.00	1.05	11.95	1.15	0	
9.94	51	5.84	0.001724	3.84	7200	8300	476	1.92			1.00	1.05	6.05	4.59	16,432,333	
20.00	51	5.84	0.001724	3.84	7205	8208	435	1.61			1.00	1.05	5.72	1.15	15,560,621	
30.00	51	5.84	0.001724	3.84	7588	8117	229	0.33			1.00	1.05	4.38	1.15	11,856,600	
32.31	51	5.84	0.001724	3.84	7613	8096	209	0.23			1.00	1.05	4.27	1.15	2,672,550	
40.00	51	5.84	0.001724	3.84	7960	8026	29	0.00	0.10		1.00	1.05	4.14	1.15	8,613,353	
50.00	51	5.84	0.001724	3.84	6745	7935	516	2.23			1.00	1.05	6.37	1.15	17,219,643	
54.93	51	5.84	0.001724	3.84	6930	7890	416	1.48		0.10	1.00	1.05	5.69	1.15	7,579,447	
60.00	51	5.84	0.001724	3.84	7365	7844	207	0.22			1.00	1.05	4.26	1.15	5,853,173	
63.01	51	5.84	0.001724	3.84	7458	7816	155	0.00			1.00	1.05	4.03	1.15	3,286,311	
66.37	51	5.84	0.001724	3.84	6840	7786	410	1.43	0.10		1.00	1.07	5.75	1.15	5,222,038	
70.00	51	5.84	0.001724	3.84	7326	7753	185	0.11			1.22	1.07	5.16	1.15	5,064,877	
72.71	51	5.84	0.001724	3.84	6946	7728	339	0.96			1.10	1.07	5.65	1.15	4,140,719	
77.36	51	5.84	0.001724	3.84	7482	7686	88	0.00			1.20	1.07	4.93	1.15	6,201,992	
80.00	51	5.84	0.001724	3.84	6946	7662	310	0.79	0.30		1.00	1.07	5.27	1.15	3,762,316	
85.79	51	5.84	0.001724	3.84	6740	7609	377	1.21			1.00	1.07	5.40	1.15	8,452,731	
87.95	51	5.84	0.001724	3.84	6672	7589	397	1.35		0.30	1.00	1.07	5.87	1.15	3,428,304	
90.00	51	5.84	0.001724	3.84	6750	7571	356	1.07			1.00	1.07	5.25	1.15	2,911,627	
97.18	51	5.84	0.001724	3.84	6871	7505	275	0.58			1.00	1.07	4.73	1.15	9,186,796	
98.30	51	5.84	0.001724	3.84	6600	7495	388	1.28			1.00	1.07	5.48	1.15	1,659,624	
100.00	51	5.84	0.001724	3.84	6496	7480	426	1.55	0.30		1.00	1.07	6.09	1.15	2,796,975	
110.00	51	5.84	0.001724	3.84	6090	7389	563	2.62	0.30		1.00	1.07	7.23	1.15	19,537,358	
120.00	51	5.84	0.001724	3.84	5525	7298	768	4.58	0.30		1.10	1.07	10.27	1.15	27,703,313	
122.22	51	5.84	0.001724	3.84	5543	7277	751	4.41	0.30		1.10	1.07	10.06	1.15	6,027,857	
		Hydropower Station, head (ft) =				1734							3 River Crossings		1,500,000	
														Total Cost of Pipeline =	**196,670,561**	**8,998,790**

PUMP STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	2350	0.85	19,380			7,243,434
Capital Costs									18,000,000	823,602
O&M Costs										180,000
								Total Cost of Pump Station(s) =	**18,000,000**	**8,247,036**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1734	0.82	9,970			-3,726,259
Capital Costs									4,100,000	187,598
O&M Costs										41,000
								Total Cost of Hydrostation =	**4,100,000**	**-3,497,661**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	218,770,561	
15% Design & Administration	32,815,584	1,501,499
10% Contingency	21,877,056	1,000,999
TOTAL PROJECT COST	**273,463,201**	**16,250,663**
UNIT WATER COST, FULL USE ($/af)		**271**
YEARLY OPERATING COST (Energy+O&M)		**3,738,175**

Alternative 14 - Alignment D, Flaming Gorge Reservoir to Weber River, Echo Reservoir (two pump stations)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	=	82.85	cfs
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

$2000/acre in roadless areas

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Flaming Gorge Reservoir Elevation =				6040										
		Flaming Gorge Pump Station, lift (ft) =				1400							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6040	7440	607	3.00			1.00	1.05	7.19	1.15	0	
9.94	51	5.84	0.001724	3.84	7200	7350	65	0.00			1.00	1.05	4.03	4.59	11,033,123	
20.00	51	5.84	0.001724	3.84	7205	7258	23	0.00			1.00	1.05	4.03	1.15	10,983,484	
		Second Pump Station, lift (ft) =				950										
20.00	51	5.84	0.001724	3.84	7205	8208	435	1.61			1.00	1.05	5.72	1.15	0	
30.00	51	5.84	0.001724	3.84	7588	8117	229	0.33			1.00	1.05	4.38	1.15	11,856,600	
32.31	51	5.84	0.001724	3.84	7613	8096	209	0.23			1.00	1.05	4.27	1.15	2,672,550	
40.00	51	5.84	0.001724	3.84	7960	8026	29	0.00	0.10		1.00	1.05	4.14	1.15	8,613,353	
50.00	51	5.84	0.001724	3.84	6745	7935	516	2.23			1.00	1.05	6.37	1.15	17,219,643	
54.93	51	5.84	0.001724	3.84	6930	7890	416	1.48		0.10	1.00	1.05	5.69	1.15	7,579,447	
60.00	51	5.84	0.001724	3.84	7365	7844	207	0.22			1.00	1.05	4.26	1.15	5,853,173	
63.01	51	5.84	0.001724	3.84	7458	7816	155	0.00			1.00	1.05	4.03	1.15	3,286,311	
66.37	51	5.84	0.001724	3.84	6840	7786	410	1.43	0.10		1.00	1.07	5.75	1.15	5,222,038	
70.00	51	5.84	0.001724	3.84	7326	7753	185	0.11			1.22	1.07	5.16	1.15	5,064,877	
72.71	51	5.84	0.001724	3.84	6946	7728	339	0.96			1.10	1.07	5.65	1.15	4,140,719	
77.36	51	5.84	0.001724	3.84	7482	7686	88	0.00			1.20	1.07	4.93	1.15	6,201,992	
80.00	51	5.84	0.001724	3.84	6946	7662	310	0.79	0.30		1.00	1.07	5.27	1.15	3,762,316	
85.79	51	5.84	0.001724	3.84	6740	7609	377	1.21			1.00	1.07	5.40	1.15	8,452,731	
87.95	51	5.84	0.001724	3.84	6672	7589	397	1.35		0.30	1.00	1.07	5.87	1.15	3,428,304	
90.00	51	5.84	0.001724	3.84	6750	7571	356	1.07			1.00	1.07	5.25	1.15	2,911,627	
97.18	51	5.84	0.001724	3.84	6871	7505	275	0.58			1.00	1.07	4.73	1.15	9,186,796	
98.30	51	5.84	0.001724	3.84	6600	7495	388	1.28			1.00	1.07	5.48	1.15	1,659,624	
100.00	51	5.84	0.001724	3.84	6496	7480	426	1.55	0.30		1.00	1.07	6.09	1.15	2,796,975	
110.00	51	5.84	0.001724	3.84	6090	7389	563	2.62	0.30		1.00	1.07	7.23	1.15	19,537,358	
120.00	51	5.84	0.001724	3.84	5525	7298	768	4.58	0.30		1.10	1.07	10.27	1.15	27,703,313	
122.22	51	5.84	0.001724	3.84	5543	7277	751	4.41	0.30		1.10	1.07	10.06	1.15	6,027,857	
		Hydropower Station, head (ft) =				1734							3 River Crossings		1,500,000	
														Total Cost of Pipeline =	**175,661,090**	**8,037,488**

PUMP STATION(S)

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	2350	0.85	19,380			7,243,434
Capital Costs									32,000,000	1,464,181
O&M Costs										320,000
								Total Cost of Pump Station(s) =	**32,000,000**	**9,027,615**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1734	0.82	9,970			-3,726,259
Capital Costs									4,100,000	187,598
O&M Costs										41,000
								Total Cost of Hydrostation =	**4,100,000**	**-3,497,661**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	211,761,090	
15% Design & Administration	31,764,164	1,453,390
10% Contingency	21,176,109	968,927
TOTAL PROJECT COST	**264,701,363**	**15,989,759**
UNIT WATER COST, FULL USE ($/af)		**266**
YEARLY OPERATING COST (Energy+O&M)		**3,878,175**

Alternative 15 - Alignment D, Flaming Gorge Reservoir to Weber River, Rockport Lake (one pump station)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	=	82.85	cfs
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Flaming Gorge Reservoir Elevation =				6040										
		Flaming Gorge Pump Station, lift (ft) =				2350							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6040	8390	1018	7.54			1.00	1.05	11.95	1.15	0	
9.94	51	5.84	0.001724	3.84	7200	8300	476	1.92			1.00	1.05	6.05	4.59	16,432,333	
20.00	51	5.84	0.001724	3.84	7205	8208	435	1.61			1.00	1.05	5.72	1.15	15,560,621	
30.00	51	5.84	0.001724	3.84	7588	8117	229	0.33			1.00	1.05	4.38	1.15	11,856,600	
32.31	51	5.84	0.001724	3.84	7613	8096	209	0.23			1.00	1.05	4.27	1.15	2,672,550	
40.00	51	5.84	0.001724	3.84	7960	8026	29	0.00	0.10		1.00	1.05	4.14	1.15	8,613,353	
50.00	51	5.84	0.001724	3.84	6745	7935	516	2.23			1.00	1.05	6.37	1.15	17,219,643	
54.93	51	5.84	0.001724	3.84	6930	7890	416	1.48		0.10	1.00	1.05	5.69	1.15	7,579,447	
60.00	51	5.84	0.001724	3.84	7365	7844	207	0.22			1.00	1.05	4.26	1.15	5,853,173	
63.01	51	5.84	0.001724	3.84	7458	7816	155	0.00			1.00	1.05	4.03	1.15	3,286,311	
66.37	51	5.84	0.001724	3.84	6840	7786	410	1.43	0.10		1.00	1.07	5.75	1.15	5,222,038	
70.00	51	5.84	0.001724	3.84	7326	7753	185	0.11			1.22	1.07	5.16	1.15	5,064,877	
72.71	51	5.84	0.001724	3.84	6946	7728	339	0.96			1.10	1.07	5.65	1.15	4,140,719	
77.36	51	5.84	0.001724	3.84	7482	7686	88	0.00			1.20	1.07	4.93	1.15	6,201,992	
80.00	51	5.84	0.001724	3.84	6946	7662	310	0.79	0.30		1.00	1.07	5.27	1.15	3,762,316	
85.79	51	5.84	0.001724	3.84	6740	7609	377	1.21			1.00	1.07	5.40	1.15	8,452,731	
87.95	51	5.84	0.001724	3.84	6672	7589	397	1.35		0.30	1.00	1.07	5.87	1.15	3,428,304	
90.00	51	5.84	0.001724	3.84	6750	7571	356	1.07			1.00	1.07	5.25	1.15	2,911,627	
97.18	51	5.84	0.001724	3.84	6871	7505	275	0.58			1.00	1.07	4.73	1.15	9,186,796	
98.30	51	5.84	0.001724	3.84	6600	7495	388	1.28			1.00	1.07	5.48	1.15	1,659,624	
100.00	51	5.84	0.001724	3.84	6496	7480	426	1.55	0.30		1.00	1.07	6.09	1.15	2,796,975	
110.00	51	5.84	0.001724	3.84	6090	7389	563	2.62	0.30		1.00	1.07	7.23	1.15	19,537,358	
120.00	51	5.84	0.001724	3.84	5525	7298	768	4.58	0.30		1.10	1.07	10.27	1.15	27,703,313	
122.22	51	5.84	0.001724	3.84	5543	7277	751	4.41	0.30		1.10	1.07	10.06	1.15	6,027,857	
130.00	51	5.84	0.001724	3.84	5730	7207	640	3.31			1.00	1.07	7.65	1.15	16,067,891	
135.42	51	5.84	0.001724	3.84	6037	7157	485	1.99			1.00	1.07	6.24	1.15	9,138,148	
		Hydropower Station, head (ft) =				1120							4 River Crossings		2,000,000	
														Total Cost of Pipeline =	**222,376,600**	**10,174,987**

PUMP STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	2350	0.85	19,380			7,243,434
Capital Costs									18,000,000	823,602
O&M Costs										180,000
								Total Cost of Pump Station(s) =	**18,000,000**	**8,247,036**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1120	0.82	6,439			-2,406,822
Capital Costs									4,100,000	187,598
O&M Costs										41,000
								Total Cost of Hydrostation =	**4,100,000**	**-2,178,224**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	244,476,600	
15% Design & Administration	36,671,490	1,677,928
10% Contingency	24,447,660	1,118,619
TOTAL PROJECT COST	**305,595,750**	**19,040,345**
UNIT WATER COST, FULL USE ($/af)		**317**
YEARLY OPERATING COST (Energy+O&M)		**5,057,612**

Alternative 16 - Alignment D, Flaming Gorge Reservoir to Weber River, Rockport Lake (two pump stations)

PROJECT DATA

Design Flow (Q) =	60,000	af/yr	= 82.85	cfs	
Manning's Roughness Coefficient (n) =	0.011				
Pipe Diameter (D) =	51	inches	Interest Rate =	3.90%	
Area (A) =	14.1863	ft^2	Period =	50	yrs.
Wetted Perimeter (Wp)	13.3518	ft			
Velocity (V) =	5.84049	ft/sec	Base Pipe Cost =	$3.84	/lf/in
Energy Gradient (S) =	0.00172		Right-of-Way Cost =	$500	/acre

$2000/acre in roadless areas

PIPELINE

Station (miles)	Pipe Diam. (in.)	Velocity (ft/sec)	HGL Slope	Base Pipe Cost ($/ft/in)	Ground Elev.	HGL Elev.	Avg. Press. (psi)	Add for High Press. ($/ft/in)	Add for Rock ($/ft/in)	Add for Grndwtr ($/ft/in)	Slope Factor	Appurt. Factor	Unit Pipeline Cost ($/ft/in)	R/W Cost ($/lf)	Reach Cost ($)	Annualized Costs ($)
		Flaming Gorge Reservoir Elevation =				6040										
		Flaming Gorge Pump Station, lift (ft) =				1400							Right-of-Way Width (ft) =		100	
0.00	51	5.84	0.001724	3.84	6040	7440	607	3.00			1.00	1.05	7.19	1.15	0	
9.94	51	5.84	0.001724	3.84	7200	7350	65	0.00			1.00	1.05	4.03	4.59	11,033,123	
20.00	51	5.84	0.001724	3.84	7205	7258	23	0.00			1.00	1.05	4.03	1.15	10,983,484	
		Second Pump Station, lift (ft) =				950										
20.00	51	5.84	0.001724	3.84	7205	8208	435	1.61			1.00	1.05	5.72	1.15	0	
30.00	51	5.84	0.001724	3.84	7588	8117	229	0.33			1.00	1.05	4.38	1.15	11,856,600	
32.31	51	5.84	0.001724	3.84	7613	8096	209	0.23			1.00	1.05	4.27	1.15	2,672,550	
40.00	51	5.84	0.001724	3.84	7960	8026	29	0.00	0.10		1.00	1.05	4.14	1.15	8,613,353	
50.00	51	5.84	0.001724	3.84	6745	7935	516	2.23			1.00	1.05	6.37	1.15	17,219,643	
54.93	51	5.84	0.001724	3.84	6930	7890	416	1.48		0.10	1.00	1.05	5.69	1.15	7,579,447	
60.00	51	5.84	0.001724	3.84	7365	7844	207	0.22			1.00	1.05	4.26	1.15	5,853,173	
63.01	51	5.84	0.001724	3.84	7458	7816	155	0.00			1.00	1.05	4.03	1.15	3,286,311	
66.37	51	5.84	0.001724	3.84	6840	7786	410	1.43	0.10		1.00	1.07	5.75	1.15	5,222,038	
70.00	51	5.84	0.001724	3.84	7326	7753	185	0.11			1.22	1.07	5.16	1.15	5,064,877	
72.71	51	5.84	0.001724	3.84	6946	7728	339	0.96			1.10	1.07	5.65	1.15	4,140,719	
77.36	51	5.84	0.001724	3.84	7482	7686	88	0.00			1.20	1.07	4.93	1.15	6,201,992	
80.00	51	5.84	0.001724	3.84	6946	7662	310	0.79	0.30		1.00	1.07	5.27	1.15	3,762,316	
85.79	51	5.84	0.001724	3.84	6740	7609	377	1.21			1.00	1.07	5.40	1.15	8,452,731	
87.95	51	5.84	0.001724	3.84	6672	7589	397	1.35		0.30	1.00	1.07	5.87	1.15	3,428,304	
90.00	51	5.84	0.001724	3.84	6750	7571	356	1.07			1.00	1.07	5.25	1.15	2,911,627	
97.18	51	5.84	0.001724	3.84	6871	7505	275	0.58			1.00	1.07	4.73	1.15	9,186,796	
98.30	51	5.84	0.001724	3.84	6600	7495	388	1.28			1.00	1.07	5.48	1.15	1,659,624	
100.00	51	5.84	0.001724	3.84	6496	7480	426	1.55	0.30		1.00	1.07	6.09	1.15	2,796,975	
110.00	51	5.84	0.001724	3.84	6090	7389	563	2.62	0.30		1.00	1.07	7.23	1.15	19,537,358	
120.00	51	5.84	0.001724	3.84	5525	7298	768	4.58	0.30		1.10	1.07	10.27	1.15	27,703,313	
122.22	51	5.84	0.001724	3.84	5543	7277	751	4.41	0.30		1.10	1.07	10.06	1.15	6,027,857	
130.00	51	5.84	0.001724	3.84	5730	7207	640	3.31			1.00	1.07	7.65	1.15	16,067,891	
135.42	51	5.84	0.001724	3.84	6037	7157	485	1.99			1.00	1.07	6.24	1.15	9,138,148	
		Hydropower Station, head (ft) =				1120							4 River Crossings		2,000,000	
														Total Cost of Pipeline =	**201,367,129**	**9,213,685**

PUMP STATION(S)

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Total Lift (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	2350	0.85	19,380			7,243,434
Capital Costs									32,000,000	1,464,181
O&M Costs										320,000
								Total Cost of Pump Station(s) =	**32,000,000**	**9,027,615**

HYDROPOWER STATION

Item	Avg. ($/kwh)	Off Peak ($/kwh)	On Peak ($/kwh)	Flow (cfs)	Head (ft)	Effic.	Power (kW)		Cost ($)	Annualized Costs ($)
Energy Cost	0.041	0.035	0.052	82.85	1120	0.82	6,439			-2,406,822
Capital Costs									4,100,000	187,598
O&M Costs										41,000
								Total Cost of Hydrostation =	**4,100,000**	**-2,178,224**

PROJECT SUMMARY

Item	Cost ($)	Annualized Costs ($)
Total Construction Cost	237,467,129	
15% Design & Administration	35,620,069	1,629,820
10% Contingency	23,746,713	1,086,546
TOTAL PROJECT COST	**296,833,912**	**18,779,442**
UNIT WATER COST, FULL USE ($/af)		**313**
YEARLY OPERATING COST (Energy+O&M)		**5,197,612**