12 Appendix C – Technical Memoranda

12.3 Preliminary Groundwater Supply Wells, Pipeline, and Operating Costs

Eagle Mountain Pumped Storage Project – Preliminary Groundwater Supply Wells, Pipeline, and Operating Costs

Prepared by: Nick Miller, P.E., and Richard Westmore, P.E., GEI Consultants, Inc.

April 9, 2009

Eagle Crest Energy Company (ECEC) is proposing to use groundwater wells in the Desert Center area as water supply for its Pumped Storage Project (Project). ECEC will need water to initially fill the Project reservoirs and provide annual make-up water from evaporation and seepage. Based on preliminary analysis, three groundwater wells will be used to provide water for filling the Project reservoirs. This technical memorandum presents the analysis to estimate pipe and pump sizes, construction costs, and power costs. Additional information regarding seepage from the Project reservoirs and groundwater supply pumping effects can be found in the technical memorandums listed in the references.

The locations of the three groundwater wells is uncertain at this time, however, six potential properties have been identified. The potential properties have been separated into Primary and Alternate Well Properties, which are shown on Figure 1. Based on the water supply pipeline alignments shown on Figure 1, we have evaluated several alternatives and developed estimates of pipe material, pipe sizes, pumping head, pumping costs, and construction costs for each. After review of several alternate system configurations a preferred system design was selected to minimize construction costs and power requirements.

Using the Primary Well Properties the preferred groundwater supply well system would consist of the following main components:

- 3 – 2,000 gpm; 1,000 horsepower Vertical Turbine Pumps
- 3.9 miles of 12” diameter steel pipe
- 0.7 miles of 18” diameter steel pipe
- 10.7 miles of 24” diameter steel pipe

The total construction cost opinions for the groundwater supply well system are based on preliminary designs and current Project understandings. The construction cost estimates are based on our evaluation of significant construction items, materials and installation unit prices. No allowances have been made for easement and property acquisition, construction contingencies, mobilization, bonds, insurance, design, or legal and administrative costs. These additional costs can be significant and should be included in the total cost for budgeting purposes. The total construction cost opinion for the groundwater supply well system was estimated to be about $19.9 million.

Pump sizing and power estimates for the groundwater supply well system are based on preliminary designs and current Project understandings. Pipe friction losses were estimated using the Swamee-Jain equation. Minor losses were assumed to be 20 percent of the total pipe friction losses. The pump sizes were limited to a maximum total dynamic head (TDH) of 1,500 feet. Pump efficiency was assumed to be 80 percent. Pumping power costs were estimated using $0.08 per kilowatt hour. The total estimated power required for initially filling the Project reservoirs was estimated to be about 61.4 GW-hrs, costing approximately $4.9 million.

The total construction costs opinions for the groundwater supply well system and pumping power costs to initially fill the Project reservoirs was estimated to be about $24.8 million. Additionally, the annual pumping costs required to replace evaporation losses after the initial filling were developed assuming the two wells furthest from the Project would be decommissioned. Based on this assumption, the annual cost for pumping the water lost to evaporation was estimated to be approximately $173,000.

Using the Alternate Well Properties the preferred groundwater supply well system would consist of the following main components:

- 3 – 2,000 gpm; 1,000 horsepower Vertical Turbine Pumps
- 2.6 miles of 12” diameter steel pipe
- 5.6 miles of 18” diameter steel pipe
- 10.7 miles of 24” diameter steel pipe

Based on the same assumptions listed above, the total construction cost opinion for the groundwater supply well system was estimated to be about $22.2 million or about $2.3 million more than the Primary Well Properties alignments. The total estimated power required for initially filling the Project reservoirs and for annual evaporation replacement did not change considerably. Based on the Alternate Well Properties alignments, the total construction costs opinions for the groundwater supply well system and pumping power costs to initially fill the Project reservoirs was estimated to be about $27.1 million.

Detailed calculations and alternate system configurations are presented in Attachment 1.

References

GEI, 2009. Eagle Mountain Pumped Storage Project: Seepage Analyses for Upper and Lower Reservoirs. Produced for ECEC.

GEI 2009. Groundwater Supply Pumping Effects: Eagle Mountain Pumped Storage Project. Produced for ECEC.

Eagle Mountain

Kaiser

Distance to Reservoir:
Approximately 16 miles

807172003

177

Distance to Reservoir:
Approximately 10 miles

811121002

808240007

Distance to Reservoir:
Approximately 12 miles

808240008

811180014

811180015

Distance to Reservoir:
Approximately 14 miles

Eagle Mountain

Desert
Center

10

Legend

- Primary Well Property
- Alternate Well Property
- Parcel2007
- Potential Water Supply Wells
- Alternate Water Supply Wells
- Water Line
- Lower Reservoir
- Highways

0 0.75 1.5 Miles

N

NO.	DATE	ISSUE/REVISION	DES	DRN	CHK	APP

Eagle Crest Energy Company

EAGLE CREST
ENERGY COMPANY

GEI PROJECT 080473

EAGLE MOUNTAIN PUMPED
STORAGE PROJECT
EAGLE MOUNTAIN, CALIFORNIA

POTENTIAL WATER
SUPPLY WELLS

FIGURE
1

March 2009

O:\Gis\Projects\080470 072610 Eagle Mountain\Final License MXDs\Pipeline_Parcels.mxd 030309

ATTACHMENT 1

EAGLE MOUNTAIN
PUMPED STORAGE PROJECT

GROUNDWATER SUPPLY WELL SYSTEM DESIGN

GEI Consultants, Inc.
080470 Eagle Mountain Pumped Storage Project
Water Supply Pipeline Design
1/6/2009
NDM

= Recommended Design

RESULTS

Pipe Section	Pipe Material	Discharge (gpm)	Pipe Diameter (in)	Total Dynamic Pumping Head (ft)	Required Power (GW-hrs)
1A	Steel	2,000	12	1,470	21.8
2A	Steel	4,000	18		
3A	Steel	6,000	24		
1B	Steel	2,000	12	1,184	21.0
1C	Steel	2,000	12	1,049	18.6
				TOTAL FILLING PUMPING COST =	**$ 4,915,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 24,777,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 173,000**
1A	Steel	2,000	18	1,247	18.5
2A	Steel	4,000	18		
3A	Steel	6,000	24		
1B	Steel	2,000	12	1,186	21.1
1C	Steel	2,000	12	1,049	18.6
				TOTAL FILLING PUMPING COST =	**$ 4,654,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 24,907,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 173,000**
1A	Steel	2,000	18	1,223	18.1
2A	Steel	4,000	24		
3A	Steel	6,000	24		
1B	Steel	2,000	12	1,175	20.9
1C	Steel	2,000	12	1,052	18.7
				TOTAL FILLING PUMPING COST =	**$ 4,614,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 25,480,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 173,000**
1A	Steel	2,000	24	1,197	17.7
2A	Steel	4,000	24		
3A	Steel	6,000	24		
1B	Steel	2,000	12	1,175	20.9
1C	Steel	2,000	12	1,052	18.7
				TOTAL FILLING PUMPING COST =	**$ 4,584,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 27,659,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 173,000**
1A	Steel	2,000	18	1,072	15.9
2A	Steel	4,000	18		
3A	Steel	6,000	30		
1B	Steel	2,000	12	1,100	19.5
1C	Steel	2,000	12	963	17.1
				TOTAL FILLING PUMPING COST =	**$ 4,203,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 28,010,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 169,000**

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	= Recommended Design				
1A	Steel	2,000	18	1,048	15.5
2A	Steel	4,000	24		
3A	Steel	6,000	30		
1B	Steel	2,000	12	1,089	19.3
1C	Steel	2,000	12	966	17.2
				TOTAL FILLING PUMPING COST =	**$ 4,162,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 28,592,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 169,000**
1A	Steel	2,000	24	1,022	15.1
2A	Steel	4,000	24		
3A	Steel	6,000	30		
1B	Steel	2,000	12	1,089	19.3
1C	Steel	2,000	12	966	17.2
				TOTAL FILLING PUMPING COST =	**$ 4,132,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 30,771,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 169,000**
1A	Steel	2,000	24	1,017	15.0
2A	Steel	4,000	30		
3A	Steel	6,000	30		
1B	Steel	2,000	12	1,087	19.3
1C	Steel	2,000	12	967	17.2
				TOTAL FILLING PUMPING COST =	**$ 4,123,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 31,013,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 169,000**
1A	Steel	2,000	30	1,011	15.0
2A	Steel	4,000	30		
3A	Steel	6,000	30		
1B	Steel	2,000	12	1,087	19.3
1C	Steel	2,000	12	967	17.2
				TOTAL FILLING PUMPING COST =	**$ 4,117,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 31,895,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 169,000**
1A	Steel	2,000	12	1,463	21.7
2A	Steel	4,000	12		
3A	Steel	6,000	36		
1B	Steel	2,000	12	1,172	20.8
1C	Steel	2,000	12	911	16.2
				TOTAL FILLING PUMPING COST =	**$ 4,695,000**
				TOTAL CONSTRUCTION & FILLING COST =	**$ 35,169,400**
				ANNUAL EVAPORATION PUMPING COST =	**$ 168,000**

Note:
All system designs assume a maximum pumping total dynamic head (TDH) of 1,500 feet.

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080470 Eagle Mountain Pumped Storage Project
Water Supply Pipeline Design
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Purpose: Determine required pipe size for the Eagle Mountain Pumped Storage Project water supply pipeline.

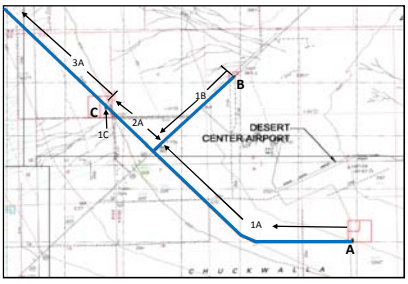
Reference: Civil Engineering Reference Manual, 11th Ed., Lindenburg, 2008.

Assumptions: 1. Swamee-Jain Equation for pipe friction loss calculations.
2. Assume minor loss are equal to 20% of friction head.

$$f = \frac{0.25}{\left(\log_{10}\left(\frac{\frac{\varepsilon}{D}}{3.7} + \frac{5.74}{\mathrm{Re}^{0.9}}\right)\right)^2} \qquad h_f = \frac{fLv^2}{D2g}$$

Pipe Material: Steel
Specific Roughness, e, ft: 0.0002
Kinematic Viscosity, v = 0.0000121 @ 60 degrees
Target Discharge, gpm = 6,000 13.37 cfs

SKETCH:



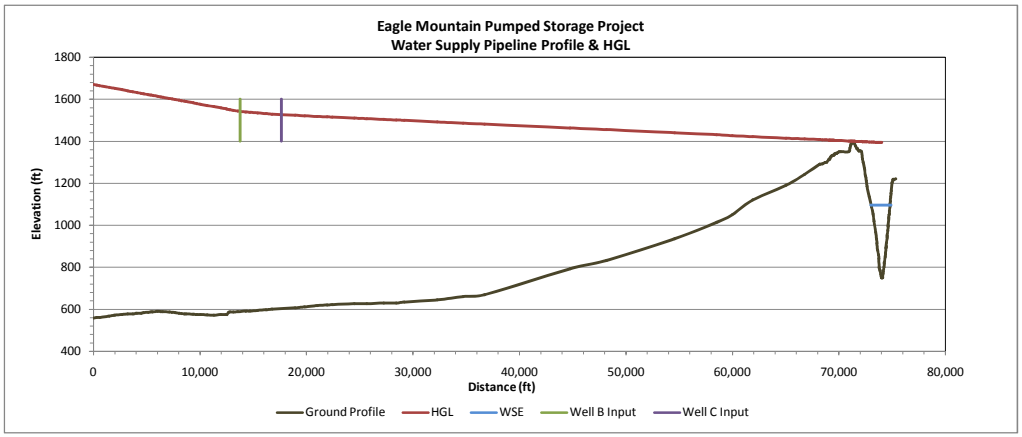
Pipe Section Number	Starting Station	Ending Station	Length (ft)	Discharge (gpm)	Discharge (cfs)	Pipe Diameter (in)	Area (ft^2)	Velocity (ft/s)	Reynolds #	Friction Factor *f*	Friction Losses (ft)	Fitting Losses (ft)	Total Head Loss (ft)	Head Loss Per Foot (ft/ft)
1A	0	13775	13775	2,000	4.46	12	0.79	5.674	4.7E+05	0.0156	107.4	21.5	128.9	0.0094
2A	13775	17637	3862	4,000	8.91	18	1.77	5.044	6.3E+05	0.0145	14.8	3.0	17.7	0.0046
3A	17637	74020	56383	6,000	13.37	24	3.14	4.255	7.0E+05	0.0139	110.6	22.1	132.7	0.0024
1B	0	6555	6555	2,000	4.46	12	0.79	5.674	4.7E+05	0.0156	51.1	10.2	61.3	0.0094
1C	0	200	200	2,000	4.46	12	0.79	5.674	4.7E+05	0.0156	1.6	0.3	1.9	0.0094

Avg. Daily Pump Time, hrs: 20
Cost Per Kilowatt, $: 0.08
Pump Efficiency, N, %: 80

Pump Label:	A	B	C
Pump Elevation, ft:	560	550	605
Assumed Ground Water Elevation, ft:	480	480	480

Pipe Section Number	Initial Pumping Head Above Ground (ft)	Total Dynamic Pumping Head (ft)	Required Pump Horse Power (HP)	Minimum Continuous Pumping Time (days)	Required Power (GW-hrs)	Total Initial Fill Pumping Costs ($)	Installed Pipe Unit Cost ($/ft)	Total Pipe Cost ($)	Pump Cost (assume $500/HP) ($)	Well Installation ($)	TOTAL COST ($)
1A	1,110	1,470	929	1,568	21.76	1,741,000	78	1,080,000	470,000	413,800	**3,704,800**
2A							112	432,000			**432,000**
3A							273	15,389,000			**15,389,000**
1B	1,052	1,184	748	1,568	21.03	1,683,000	78	514,000	380,000	413,800	**2,990,800**
1C	921	1,049	663	1,568	18.63	1,491,000	78	16,000	340,000	413,800	**2,260,800**
				TOTAL =	**61.42**	**4,915,000**				**TOTAL COST =**	**24,777,400**

PROFILE PLOT:



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080470 Eagle Mountain Pumped Storage Project
Water Supply Pipeline Design
1/6/2009
NDM

Purpose: Determine required pipe size for the Eagle Mountain Pumped Storage Project water supply pipeline.

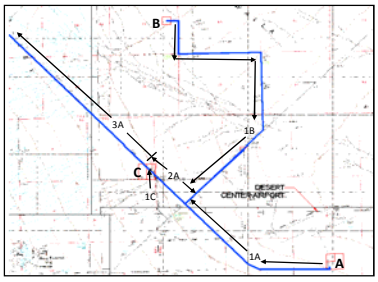
Reference: Civil Engineering Reference Manual, 11th Ed., Lindenburg, 2008.

Assumptions: 1. Swamee-Jain Equation for pipe friction loss calculations.
2. Assume minor loss are equal to 20% of friction head.

$$f = \frac{0.25}{\left(\log_{10}\left(\frac{\frac{\varepsilon}{D}}{3.7} + \frac{5.74}{\mathrm{Re}^{0.9}}\right)\right)^2} \qquad h_f = \frac{fLv^2}{D2g}$$

Pipe Material: Steel
Specific Roughness, e, ft: 0.0002
Kinematic Viscosity, v = 0.0000121 @ 60 degrees
Target Discharge, gpm = 6,000 13.37 cfs

SKETCH:



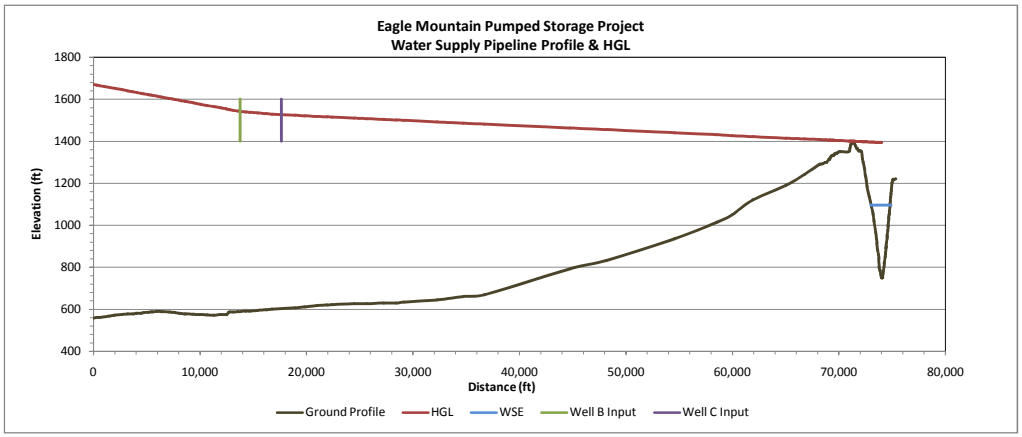
Pipe Section Number	Starting Station	Ending Station	Length (ft)	Discharge (gpm)	Discharge (cfs)	Pipe Diameter (in)	Area (ft^2)	Velocity (ft/s)	Reynolds #	Friction Factor *f*	Friction Losses (ft)	Fitting Losses (ft)	Total Head Loss (ft)	Head Loss Per Foot (ft/ft)
1A	0	13775	13775	2,000	4.46	12	0.79	5.674	4.7E+05	0.0156	107.4	21.5	128.9	0.0094
2A	13775	17637	3862	4,000	8.91	18	1.77	5.044	6.3E+05	0.0145	14.8	3.0	17.7	0.0046
3A	17637	74020	56383	6,000	13.37	24	3.14	4.255	7.0E+05	0.0139	110.6	22.1	132.7	0.0024
1B	0	25530	25530	2,000	4.46	18	1.77	2.522	3.1E+05	0.0157	26.3	5.3	31.6	0.0012
1C	0	200	200	2,000	4.46	12	0.79	5.674	4.7E+05	0.0156	1.6	0.3	1.9	0.0094

Avg. Daily Pump Time, hrs: 20
Cost Per Kilowatt, $: 0.08
Pump Efficiency, N, %: 80

Pump Label:	A	B	C
Pump Elevation, ft:	560	550	605
Assumed Ground Water Elevation, ft:	480	480	480

Pipe Section Number	Initial Pumping Head Above Ground (ft)	Total Dynamic Pumping Head (ft)	Required Pump Horse Power (HP)	Minimum Continuous Pumping Time (days)	Required Power (GW-hrs)	Total Initial Fill Pumping Costs ($)	Installed Pipe Unit Cost ($/ft)	Total Pipe Cost ($)	Pump Cost (assume $500/HP) ($)	Well Installation ($)	TOTAL COST ($)
1A	1,110	1,470	929	1,568	21.76	1,741,000	78	1,080,000	470,000	413,800	**3,704,800**
2A							112	432,000			**432,000**
3A							273	15,389,000			**15,389,000**
1B	1,023	1,124	710	1,568	19.97	1,598,000	112	2,856,000	360,000	413,800	**5,227,800**
1C	989	1,117	706	1,568	19.84	1,588,000	78	16,000	360,000	413,800	**2,377,800**
				TOTAL =	**61.57**	**4,927,000**				**TOTAL COST =**	**27,131,400**

PROFILE PLOT:



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Water Supply Pipeline Design
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EVAPORATION REPLACEMENT WATER PUMPING CALCULATIONS ONLY

Purpose: Determine required pipe size for the Eagle Mountain Pumped Storage Project water supply pipeline.

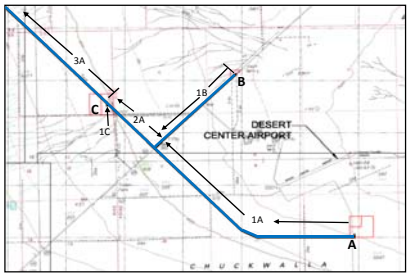
Reference: Civil Engineering Reference Manual, 11th Ed., Lindenburg, 2008.

Assumptions: 1. Swamee-Jain Equation for pipe friction loss calculations.
2. Assume minor loss are equal to 20% of friction head.

$$f = \frac{0.25}{\left(\log_{10}\left(\frac{\frac{\varepsilon}{D}}{3.7} + \frac{5.74}{\mathrm{Re}^{0.9}}\right)\right)^2} \qquad h_f = \frac{fLv^2}{D2g}$$

Pipe Material: Steel
Specific Roughness, e, ft: 0.0002
Kinematic Viscosity, v = 0.0000121 @ 60 degrees
Target Discharge, gpm = 2,000 4.46 cfs

SKETCH:



Pipe Section Number	Starting Station	Ending Station	Length (ft)	Discharge (gpm)	Discharge (cfs)	Pipe Diameter (in)	Area (ft^2)	Velocity (ft/s)	Reynolds #	Friction Factor *f*	Friction Losses (ft)	Fitting Losses (ft)	Total Head Loss (ft)	Head Loss Per Foot (ft/ft)
1C	0	200	200	2,000	4.46	12	0.79	5.674	4.7E+05	0.0156	1.6	0.3	1.9	0.0094
3A	200	56578	56378	2,000	4.46	24	3.14	1.418	2.3E+05	0.0160	14.1	2.8	16.9	0.0003

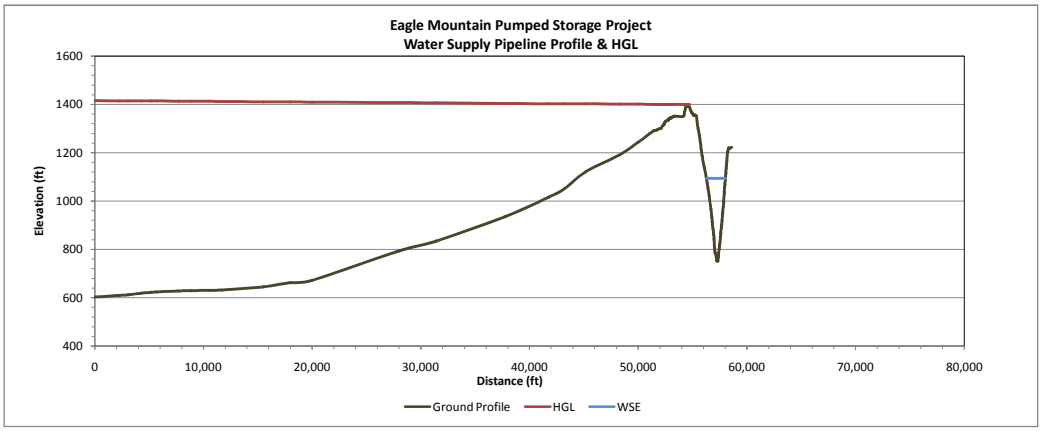
Avg. Daily Pump Time, hrs: 20
Cost Per Kilowatt, $: 0.08
Pump Efficiency, N, %: 80

Evaporation Volume: 1763 ac-ft

Pump Label: C
Pump Elevation, ft: 605
Assumed Ground Water Elevation, ft: 480

Pipe Section Number	Initial Pumping Head Above Ground (ft)	Total Dynamic Pumping Head (ft)	Required Pump Horse Power (HP)	Minimum Continuous Pumping Time (days)	Required Power (GW-hrs)	Total Evaporation Pumping Costs ($)					
1C	811	956	604	239	2.16	173,000					
	0										
	0										
				TOTAL =	2.16	173,000				TOTAL COST =	0

PROFILE PLOT:



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Daily Pumping Duration, t:	20	hrs
Pumping Rate, Q:	6,000	gpm
Pumping Rate, Q:	13.37	cfs
Pumping Rate, Q:	8066	AF/yr
Annual Seepage:	1628	AF/yr
Annual Evaporation:	1763	AF/yr

Year	Water Pumped (AF)	Losses (AF)	Volume in Reservoir (AF)	Days
1	8066	3391	4675	365
2	8066	1763	10977	365
3	8066	1763	17280	365
4	8066	1763	23582	365
5	2381	1763	24200	108

Days for Fill to Full Operating Capacity =	**1568**	Days
	4.3	Years
	224	Weeks

Notes:

1.) First year pumping assumes fillling reservoirs, evaporation, and seepage. In subsequent years, seeped water will be returned to reservoirs by seepage recovery wells.

2.) Seepage estimates from Miller and Westmore Seepage Memo, 2009. Assuming a 5-foot thick line is installed.

3.) Evaporation estimates from ECEC Draft License Application 2008. Assuming 7.5 feet per year evaporation rate.

4.) Pumping duration is estimated assuming 24 hours/day during Oct-May, and 12 hours/day during Jun-Sept.

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Pipe Installed Cost Table

Pipe Costs $/foot										
	Diameter (in)	**12**	**18**	**24**	**30**	**36**	**42**	**48**	**54**	**60**
1	**Plastic (PVC, ABS)**	$ 33.85	$ 59.85	$ 99.43	$ 153.08	$ 220.31	$ 294.62	$ 372.00	$ 458.96	$ 555.00
2	**Steel**	$ 78.35	$ 111.85	$ 272.93	$ 338.08	$ 464.31	$ 535.62	$ 607.00	$ 673.46	$ 740.00
3	**Concrete**	$ 120.85	$ 138.85	$ 156.93	$ 178.58	$ 200.31	$ 255.12	$ 310.00	$ 364.96	$ 420.00

RS Means 2009

Excavation, trench, common earth, 1.0 CY excavator 31 23 16.13 0090 (4' to 6' deep) & 0510 (6' to 10' deep)
Bedding, no compaction, 50' haul sand & gravel, 200 HP F.E. Loader 31 23 23.14 4000
Backfill, no compaction, 50' haul common earth, 200 HP F.E. loader, 31 23 23.14 4020
Compaction, sheepsfoot roller, 12" lifts, 2 passes 31 23 23.23 5680

Trench size estimate:

Trench width is 4' wider than the pipe diameter
Bedding is 1' below the pipe + up to spring line
Backfill is 3' deep

Plastic 33 11 13.25 3010 - 3200

	material & install	trench size		excavation			bedding			backfill			TOTAL	TOTAL
DIA (in)	unit rate ($/LF)	depth (ft)	width (ft)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	cost ($/LF)	cost ($/in dia)
12	$29.00	5.0	5.0	0.9	$4.10	$3.80	0.25	$0.76	$0.19	0.7	$1.22	$0.87	$33.85	$2.82
18	$54.00	5.5	5.5	1.1	$4.10	$4.59	0.29	$0.76	$0.22	0.9	$1.22	$1.04	$59.85	$3.33
24	$92.50	6.0	6.0	1.3	$4.10	$5.47	0.33	$0.76	$0.25	1.0	$1.22	$1.21	$99.43	$4.14
30	$145.00	6.5	6.5	1.6	$4.10	$6.42	0.36	$0.76	$0.27	1.1	$1.22	$1.39	$153.08	$5.10
36	$211.00	7.0	7.0	1.8	$4.10	$7.44	0.39	$0.76	$0.29	1.3	$1.22	$1.58	$220.31	$6.12
42	$284.00	7.5	7.5	2.1	$4.10	$8.54	0.41	$0.76	$0.31	1.4	$1.22	$1.77	$294.62	$7.01
48	$360.00	8.0	8.0	2.4	$4.10	$9.72	0.42	$0.76	$0.32	1.6	$1.22	$1.96	$372.00	$7.75
54	$445.50	8.5	8.5	2.7	$4.10	$10.97	0.43	$0.76	$0.33	1.8	$1.22	$2.16	$458.96	$8.50
60	$540.00	9.0	9.0	3.0	$4.10	$12.30	0.44	$0.76	$0.33	1.9	$1.22	$2.37	$555.00	$9.25

Black Steel Pipe 33 11 13.40 1010-1140

	material & install	trench size		excavation			bedding			backfill			TOTAL	TOTAL
DIA (in)	unit rate ($/LF)	depth (ft)	width (ft)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	volume (CY/LF)	unit rate ($/CY)	cost ($/LF)	cost ($/LF)	cost ($/in dia)
12	$73.50	5.0	5.0	0.9	$4.10	$3.80	0.25	$0.76	$0.19	0.7	$1.22	$0.87	$78.35	$6.53
18	$106.00	5.5	5.5	1.1	$4.10	$4.59	0.29	$0.76	$0.22	0.9	$1.22	$1.04	$111.85	$6.21
24	$266.00	6.0	6.0	1.3	$4.10	$5.47	0.33	$0.76	$0.25	1.0	$1.22	$1.21	$272.93	$11.37
30	$330.00	6.5	6.5	1.6	$4.10	$6.42	0.36	$0.76	$0.27	1.1	$1.22	$1.39	$338.08	$11.27
36	$455.00	7.0	7.0	1.8	$4.10	$7.44	0.39	$0.76	$0.29	1.3	$1.22	$1.58	$464.31	$12.90
42	$525.00	7.5	7.5	2.1	$4.10	$8.54	0.41	$0.76	$0.31	1.4	$1.22	$1.77	$535.62	$12.75
48	$595.00	8.0	8.0	2.4	$4.10	$9.72	0.42	$0.76	$0.32	1.6	$1.22	$1.96	$607.00	$12.65
54	$660.00	8.5	8.5	2.7	$4.10	$10.97	0.43	$0.76	$0.33	1.8	$1.22	$2.16	$673.46	$12.47
60	$725.00	9.0	9.0	3.0	$4.10	$12.30	0.44	$0.76	$0.33	1.9	$1.22	$2.37	$740.00	$12.33

GEI Consultants, Inc.
080470 Eagle Mountain Pumped Storage Project
Water Supply Pipeline Design
1/6/2009
NDM

Pipe Installed Cost Table

Pipe Costs $/foot										
	Diameter (in)	**12**	**18**	**24**	**30**	**36**	**42**	**48**	**54**	**60**
1	**Plastic (PVC, ABS)**	$ 33.85	$ 59.85	$ 99.43	$ 153.08	$ 220.31	$ 294.62	$ 372.00	$ 458.96	$ 555.00
2	**Steel**	$ 78.35	$ 111.85	$ 272.93	$ 338.08	$ 464.31	$ 535.62	$ 607.00	$ 673.46	$ 740.00
3	**Concrete**	$ 120.85	$ 138.85	$ 156.93	$ 178.58	$ 200.31	$ 255.12	$ 310.00	$ 364.96	$ 420.00

Concrete 33 11 13.10 3000 - 3060

	material & install	trench size		excavation			bedding			backfill			TOTAL	TOTAL
DIA	unit rate	depth	width	volume	unit rate	cost	volume	unit rate	cost	volume	unit rate	cost	cost	cost
(in)	($/LF)	(ft)	(ft)	(CY/LF)	($/CY)	($/LF)	(CY/LF)	($/CY)	($/LF)	(CY/LF)	($/CY)	($/LF)	($/LF)	($/in dia)
12	$116.00	5.0	5.0	0.9	$4.10	$3.80	0.25	$0.76	$0.19	0.7	$1.22	$0.87	$120.85	$10.07
18	$133.00	5.5	5.5	1.1	$4.10	$4.59	0.29	$0.76	$0.22	0.9	$1.22	$1.04	$138.85	$7.71
24	$150.00	6.0	6.0	1.3	$4.10	$5.47	0.33	$0.76	$0.25	1.0	$1.22	$1.21	$156.93	$6.54
30	$170.50	6.5	6.5	1.6	$4.10	$6.42	0.36	$0.76	$0.27	1.1	$1.22	$1.39	$178.58	$5.95
36	$191.00	7.0	7.0	1.8	$4.10	$7.44	0.39	$0.76	$0.29	1.3	$1.22	$1.58	$200.31	$5.56
42	$244.50	7.5	7.5	2.1	$4.10	$8.54	0.41	$0.76	$0.31	1.4	$1.22	$1.77	$255.12	$6.07
48	$298.00	8.0	8.0	2.4	$4.10	$9.72	0.42	$0.76	$0.32	1.6	$1.22	$1.96	$310.00	$6.46
54	$351.50	8.5	8.5	2.7	$4.10	$10.97	0.43	$0.76	$0.33	1.8	$1.22	$2.16	$364.96	$6.76
60	$405.00	9.0	9.0	3.0	$4.10	$12.30	0.44	$0.76	$0.33	1.9	$1.22	$2.37	$420.00	$7.00

Water Supply Wells 33 21 13.10 0500

40' deep, incl. gravel & casing, complete, 24" diameter casing x 18" diameter screen = $72,500

Unit Cost/ft =	1800	$/ft
Depth Multiplier =	2.0	
Total Unit Cost =	**3600**	**$/ft**

GEI Consultants, Inc.

Client: Eagle Crest Energy

Project: Eagle Mountain Pumped Storage Project

Purpose: Estimate Construction Costs for Water Supply Line Extraction Wells

Project Manager: G. Gillin/R. Shatz

Cost for **THREE** wells

Item No.	Item	Unit	Quantity	Unit Cost	Item Cost
1	Mobilization/Demobilization	LS	1	$35,000	$35,000
2	Mobalization/Demobalization Site-to-Stie	LS	2	$20,000	$40,000
3	Site Work	LS	3	$20,000	$60,000
4	Electrical Connection	LS	3	$50,000	$150,000
5	Conductor Casing and Sanitary Seal	LF	150	$500	$75,000
6	18" Borehole Drilling	LF	2400	$80	$192,000
7	Geophysical (E-Logs & Gamma-Logs)	LS	3	$2,500	$7,500
8	34" Borehole Drilling	LF	2400	$40	$96,000
9	X-Y Caliper Survey	LS	6	$2,000	$12,000
10	20" Dia. (Nominal) x 3/8-inch Wall Blank Steel Well Casing or 20" Dia. (Nominal) x 5/16-inch Wall Blank 0.2% Copper Bearing Steel Well Casing	LF	1170	$80	$93,600
11	20" Dia. (Nominal) carbon steel wire wrapped screen, 0.070 slot	LF	1197	$190	$227,430
12	Gravel Feed Pipe	LF	645	$10	$6,450
13	Gravel Envelop	LF	1770	$50	$88,500
14	Install Annular and Transition Seals	LF	630	$45	$28,350
15	Preliminary Development	HR	201	$260	$52,260
16	Furnish and install Test Pump	LF	750	$25	$18,750
17	Pump Development	HR	72	$200	$14,400
18	Step-Drawdown and Constant Rate Aquifer Testing	HR	108	$200	$21,600
19	Plmbness and Alignment Tests	LS	3	$2,500	$7,500
20	Well Disinfection	LS	3	$1,000	$3,000
21	Video Camera Surveys	LS	6	$1,500	$9,000
22	Borehole Abandomnent	LF	300	$5	$1,500
23	Stand-by Time	HR	12	$130	$1,560

Estimate (3) wells **$1,241,400**

Estimate (1) well **$413,800**

GEI Consultants, Inc.
EM Pumped Storage Project
Well Materials Estimate

Item #	Description	Unit	Quantity	Well 1	Well 2	Well 3
				Unit Quantity	Unit Quantity	Unit Quantity
1	Mobilization/Demobilization	LS	1	1		
2	Mobalization/Demobalization Site-to-Stie	LS	2		1	1
3	Conductor Casing and Sanitary Seal	LF	150	50	50	50
4	18" Borehole Drilling	LF	2400	800	800	800
5	Geophysical (E-Logs & Gamma-Logs)	LS	3	1	1	1
6	34" Borehole Drilling	LF	2400	800	800	800
7	X-Y Caliper Survey	LS	6	2	2	2
8	20" Dia. (Nominal) x 3/8-inch Wall Blank Steel Well Casing or 20" Dia. (Nominal) x 5/16-inch Wall Blank 0.2% Copper Bearing Steel Well Casing	LF	1170	390	390	390
9	20" Dia. (Nominal) carbon steel wire wrapped screen, 0.070 slot	LF	1197	399	399	399
10	Gravel Feed Pipe	LF	645	215	215	215
11	Gravel Envelop	LF	1770	590	590	590
12	Install Annular and Transition Seals	LF	630	210	210	210
13	Preliminary Development	HR	201	67	67	67
14	Furnish and install Test Pump	LF	750	250	250	250
15	Pump Development	HR	72	24	24	24
16	Step-Drawdown and Constant Rate Aquifer Testing	HR	108	36	36	36
17	Plmbness and Alignment Tests	LS	3	1	1	1
18	Well Disinfection	LS	3	1	1	1
19	Video Camera Surveys	LS	6	2	2	2
20	Borehole Abandomnent	LF	300	100	100	100
21	Stand-by Time	HR	12	4	4	4

Pump Data Sheet - National Pump Company

Company:
Name:
Date: 4/7/2009

NATIONAL PUMP COMPANY, LLC

Pump:

Size: M14XXHC (14 stage)

Type: VERT.TURBINE
Synch speed: 1800 rpm

Speed: 1770 rpm
Dia: 11.4075 in

Curve: CVM14XXH4P6C

Impeller:

Specific Speeds:

Ns: 2315
Nss: 5172

Dimensions:

Suction: 10 in
Discharge: 12 in

Pump Limits:

Temperature: 180 °F
Pressure: 321 psi g
Sphere size: 0.64 in

Power: ---
Eye area: 25.4 in²

Search Criteria:

Flow: 2000 US gpm

Head: 1500 ft

Fluid:

Water
SG: 1
Viscosity: 1.105 cP

Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

NPSHa: ---

Motor:

Standard: NEMA
Enclosure: WP-1

Speed: ---
Frame: ---

Sizing criteria: Max Power on Design Curve

Pump Selection Warnings:

Pump shutoff dP exceeds limit for the pump.

---- Data Point ----

Flow:	2000 US gpm
Head:	1500 ft
Eff:	85%
Power:	890 hp
NPSHr:	22 ft

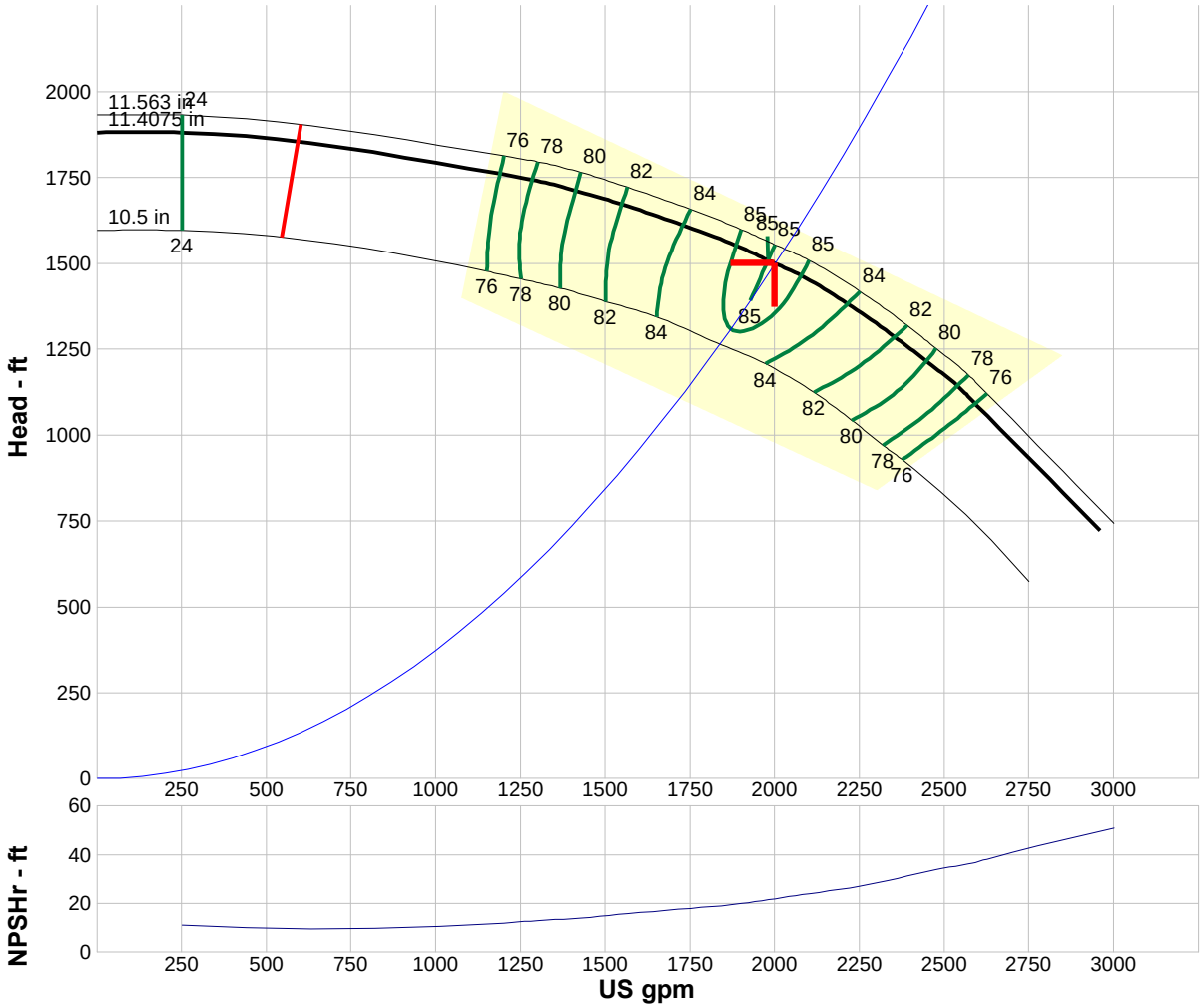
---- Design Curve ----

Shutoff head:	1882 ft
Shutoff dP:	813 psi
Min flow:	594 US gpm
BEP:	85% @ 1979 US gpm

NOL power:
939 hp @ 2538 US gpm

-- Max Curve --

Max power:
978 hp @ 2475 US gpm



Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
2400	1770	1250	81	935	31.5
2000	1770	1500	85	890	22
1600	1770	1654	83	809	16.3
1200	1770	1759	76	699	12
800	1770	1811	54	612	11.6

Selected from catalog: National Pump Company.60 Vers: 60cy0331