Lakeview Geothermal Heating District Feasibility Study

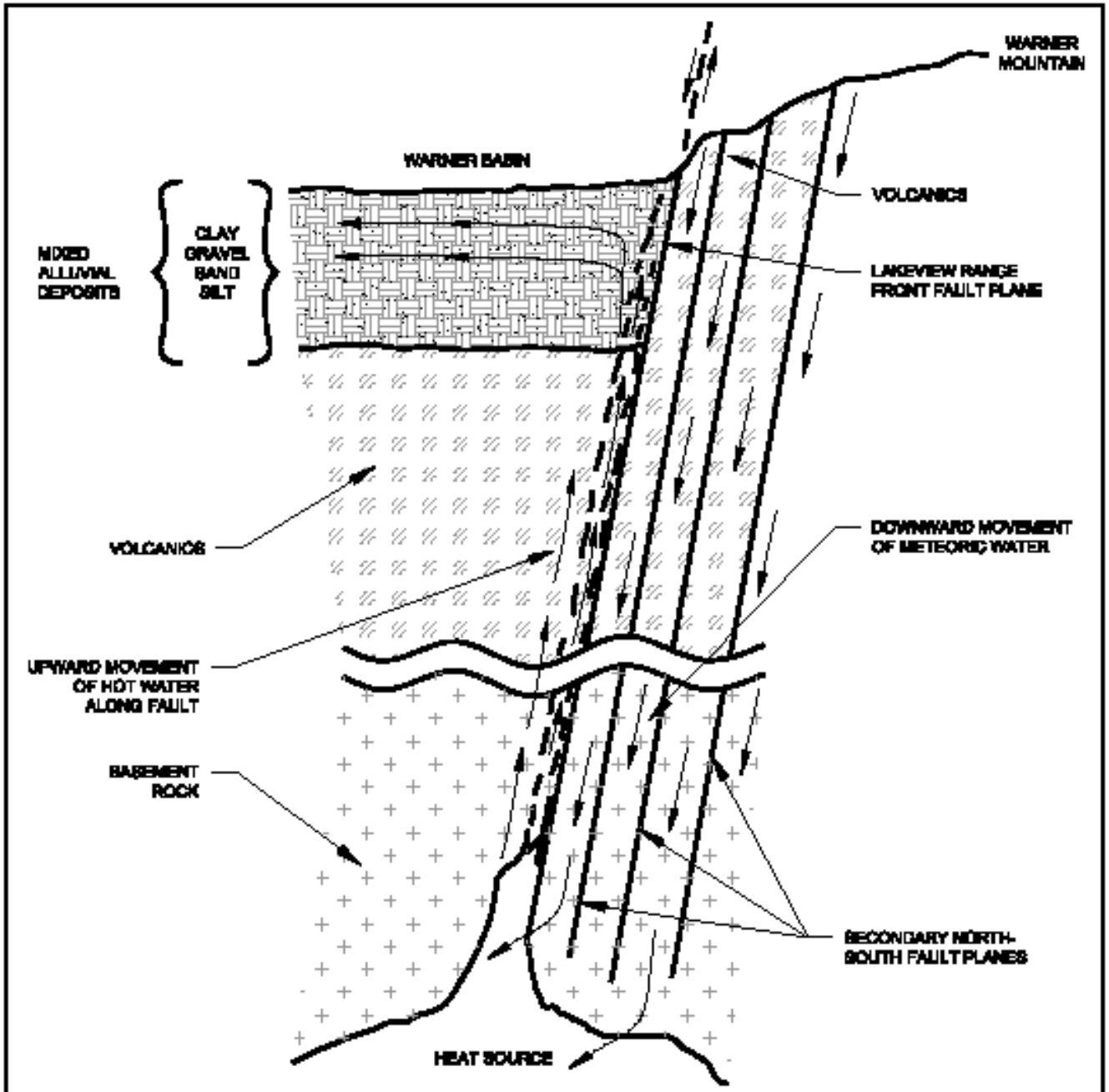
Anderson Engineering & Surveying, Inc.

Project Team

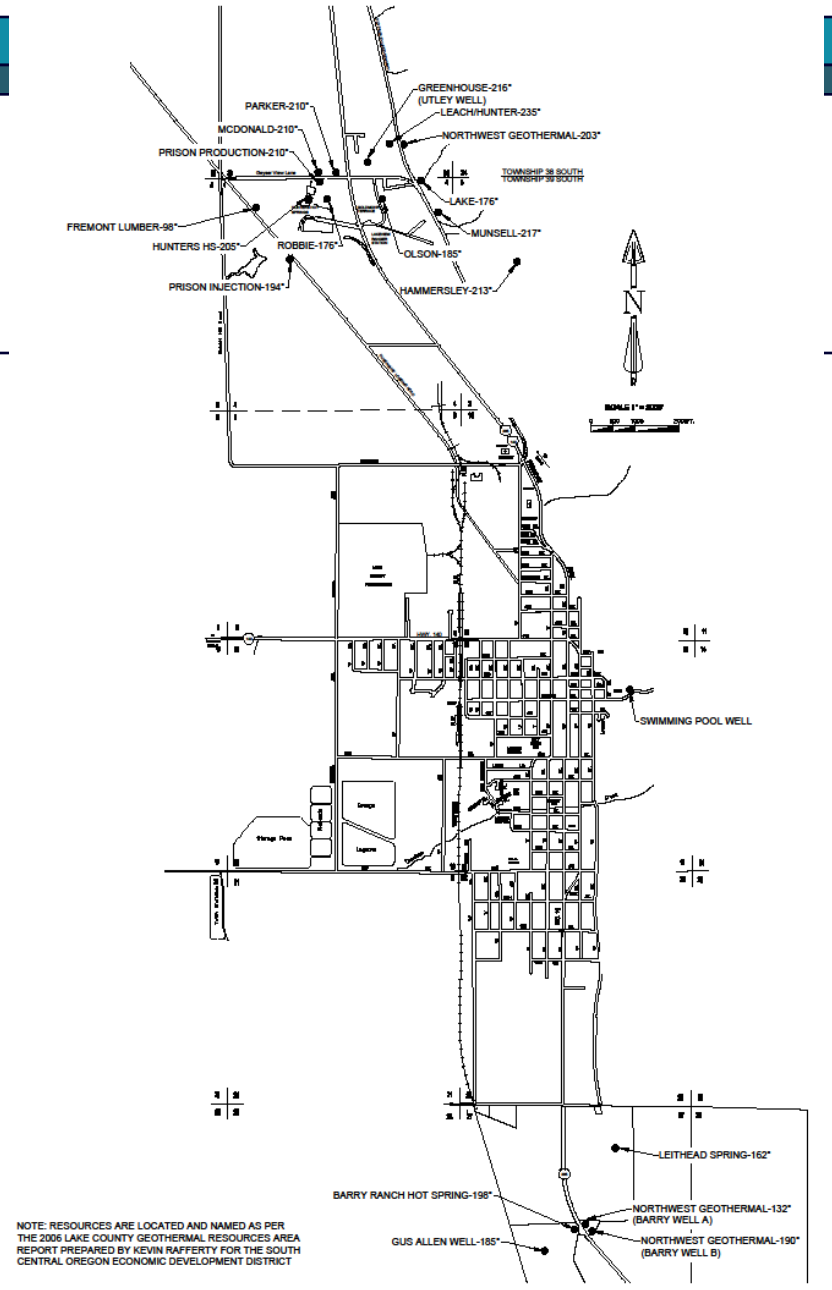
- Anderson Engineering & Surveying, Inc.
- Dale C. Bugenig, Consulting Hydrogelogist
- Kevin Rafferty, PE
- Ray Simms, Town of Lakeview

Existing Geothermal Resources

- Lakeview's Geothermal Resource is located along the base of the Warner Mountains extending to Highway 140 on the north and the California border on the south
- Hot water originates deep within the volcanic rocks and migrates upward along permeable zones associated with faults until it discharges to the alluvial deposits

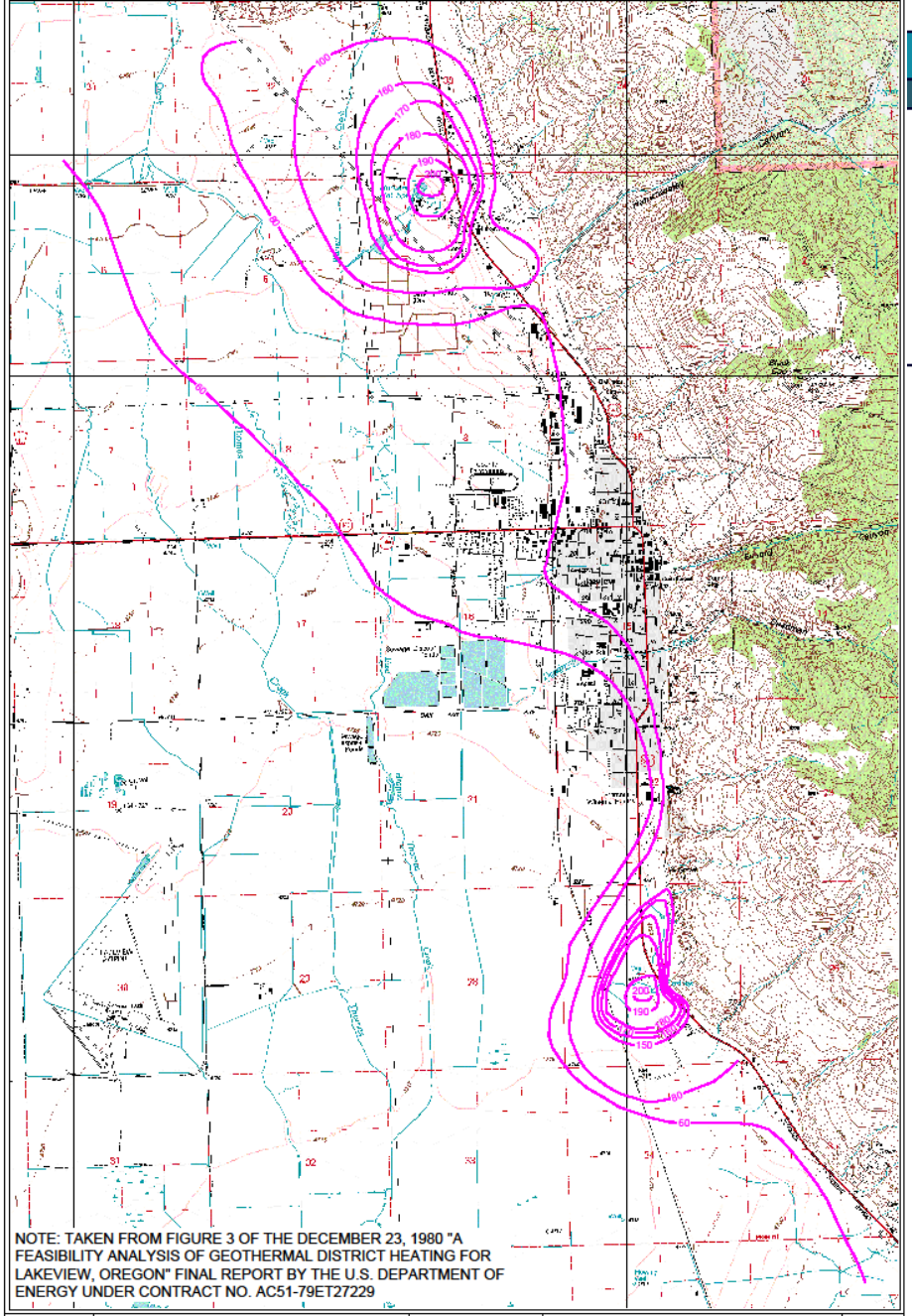


CONCEPTUAL THERMAL CONVECTIVE SYSTEM



NOTE: RESOURCES ARE LOCATED AND NAMED AS PER THE 2006 LAKE COUNTY GEOTHERMAL RESOURCES AREA REPORT PREPARED BY KEVIN RAFFERTY FOR THE SOUTH CENTRAL OREGON ECONOMIC DEVELOPMENT DISTRICT

DATE: 2/22/2011 SCALE: 1"=2000' DWG. BY: B.C. JOB: 2010-009 FILE: 2010-009	EXISTING RESOURCES - GEOTHERMAL HEATING DISTRICT FEASIBILITY STUDY LAKEVIEW, OREGON	FOR: TOWN OF LAKEVIEW 525 NORTH 1ST ST. LAKEVIEW OR. 97630 (541) 947-2029	ANDERSON ENGINEERING AND SURVEYING, INC. P.O. BOX 28 LAKEVIEW, OREGON 97630 (541) 947-4407 FAX: 947-2321


NOTE: TAKEN FROM FIGURE 3 OF THE DECEMBER 23, 1980 "A FEASIBILITY ANALYSIS OF GEOTHERMAL DISTRICT HEATING FOR LAKEVIEW, OREGON" FINAL REPORT BY THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. AC51-79ET27229
TEMP. CONTOURS - GEOTHERMAL
HEATING DISTRICT FEASIBILITY STUDY
LAKEVIEW, OREGON
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JOB: 2010-008
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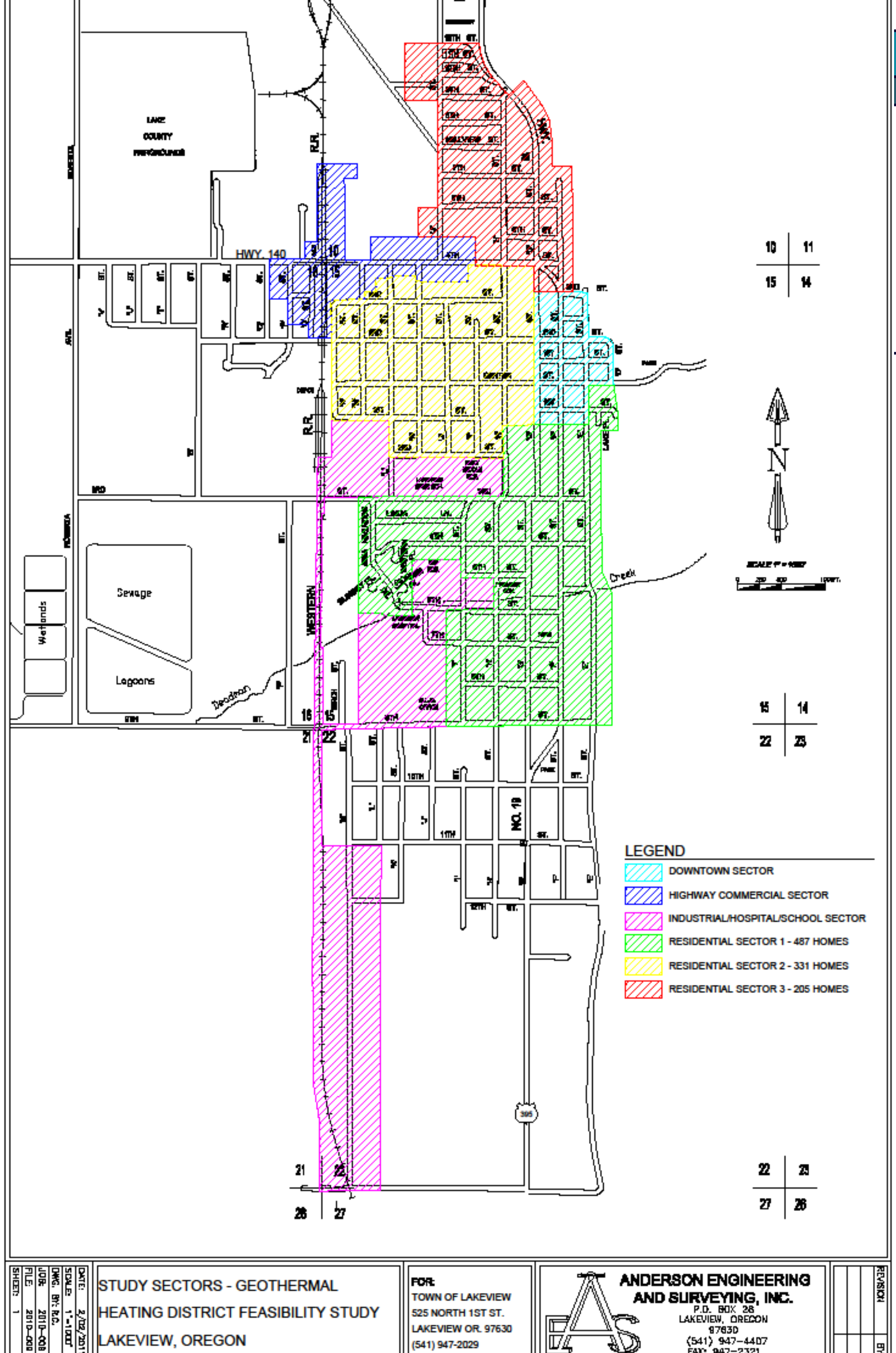
Existing Resources Currently Available to the Town of Lakeview

- Barry Well
  - Covered under existing lease
  - Permitted for 250 gpm – Permit #G-16806
  - 180 to 190 water
- Utley Well (Greenhouse Well)
  - Covered under existing lease
  - Permitted for 500 gpm – Permit #G-16836
  - 200 water
- Department of Corrections Well
  - Owned by the Town
  - Permitted for 300 gpm – Permit #G-15557
  - 208 water

Heating Area Needs

Lakeview was divided into 6 study sector areas:

- Downtown Sector (main focus of report)
- Highway Commercial Sector (adjacent to supply and return lines)
- Industrial/Hospital/School Sector (covered in 2009 Geothermal Heating Facility Study)
- Residential Sector 1 – 487 Homes
- Residential Sector 2 – 331 Homes
- Residential Sector 3 – 205 Homes


HWY. 140
Sewage
Lagoons
Wetlands
Creek
WESTERN
NO. 19
LEGEND
DOWNTOWN SECTOR
HIGHWAY COMMERCIAL SECTOR
INDUSTRIAL/HOSPITAL/SCHOOL SECTOR
RESIDENTIAL SECTOR 1 - 487 HOMES
RESIDENTIAL SECTOR 2 - 331 HOMES
RESIDENTIAL SECTOR 3 - 205 HOMES
STUDY SECTORS - GEOTHERMAL
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Heating Area Needs – Downtown Sector

- Sector consists of 44 private and public buildings in the downtown commercial core
- Buildings were inspected and data was collected including square footage, existing heating systems, and current heating costs
- Retrofit costs to upgrade each building were developed
- Total Btu needs for this sector = 7,770,136 Btu's/Hour

Heating Area Needs – Highway Commercial Sector

- Sector includes 5 businesses that abut proposed pipeline locations
- These buildings were inspected and data was collected including square footage, current heating system, and current heating costs
- Retrofit costs to upgrade the systems were developed
- Total Btu needs for this sector = 2,695,000 Btu's/Hour

Heating Area Needs – Residential Sectors

- Residential homes were not inspected for this study
- Estimated Btu requirements were developed based on a 1,500 square foot home with a peak heating load of 30 Btu's per square foot

Residential Areas				
Sector/ Area	#Homes	BTU'S Needed Av per hour	GPM Required Av GPM	Total BTU Per year
Sector One	487	15,340,500	613	23,010,750,000
Sector Two	331	10,426,500	417	15,639,750,000
Sector Three	205	6,457,500	258	9,686,250,000
Totals	1,023		1,288	48,336,750,000

Residential Costs

- Historically Residential systems are Marginal

Table 4: Residential Area Preliminary Cost Estimate

Sector/ Area	#Homes	Lineal feet Of piping	Cost per foot	Total Piping Cost
Sector One	487	29900	$ 60.00	$ 1,794,000.00
Sector Two	331	17150	$ 60.00	$ 1,029,000.00
Sector Three	205	15600	$ 60.00	$ 936,000.00
Piping from well		22000	$ 65.00	$ 1,430,000.00
Service Connections all areas				$ 2,046,000.00
Pumping and Controls				$ 600,000.00
Well Development/ permits				$ 500,000.00
Engineering/ Administration				$ 1,000,200.00
Total estimated costs				**$ 9,335,200.00**

Annual Payback over 40 years at 4.5%		$507,304.14
Operation	$	250,000.00
Cost per Million BTU	$	15.67
Cost per Million BTU / With a 65% hookup	$	21.15
Current Cost of Electricity per Mil BTU	$	29.31

Well Requirements & Capabilities

- The Utley Well was test pumped and showed only 3 feet of drawdown and maintained steady temperatures at Average Rate
  - The well is in disrepair at the surface
  - The well is over 50 years old and no records exist on casing condition
  - It is our recommendation that a new well be drilled at the source directly next to the existing well

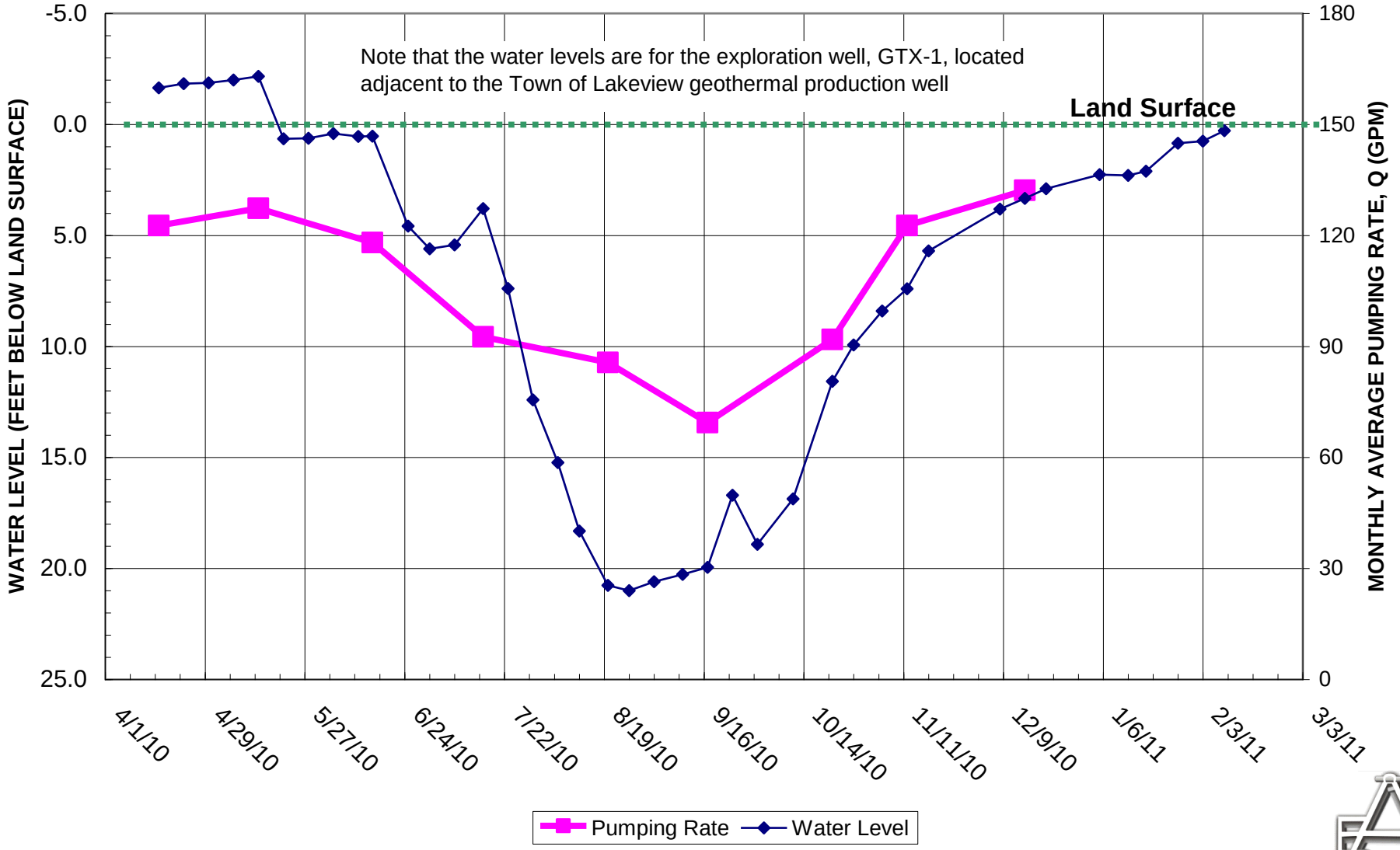
Well Requirements & Capabilities

- DOC Well
  - The Town's DOC well is newly constructed with an adequate deep seal and no changes are needed.
  - The well would require only minor modification of the existing pumping equipment

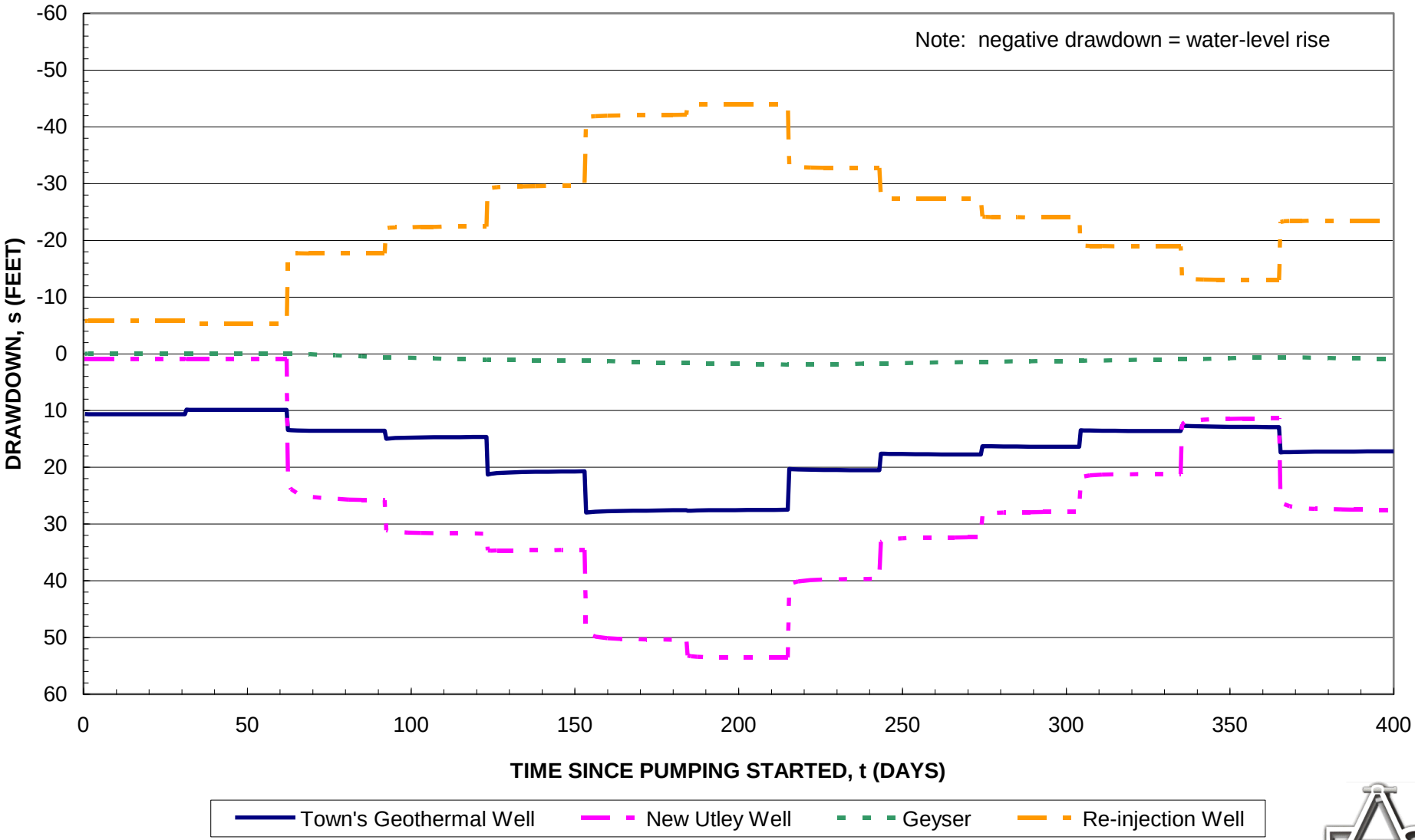
Hydraulic Analysis

- Using Existing Utley Well
- Reconditioning or Re-drilling Utley Well
- Additional Re-injection Well
- Reviewing Existing Water Level Data at Town's DOC Well

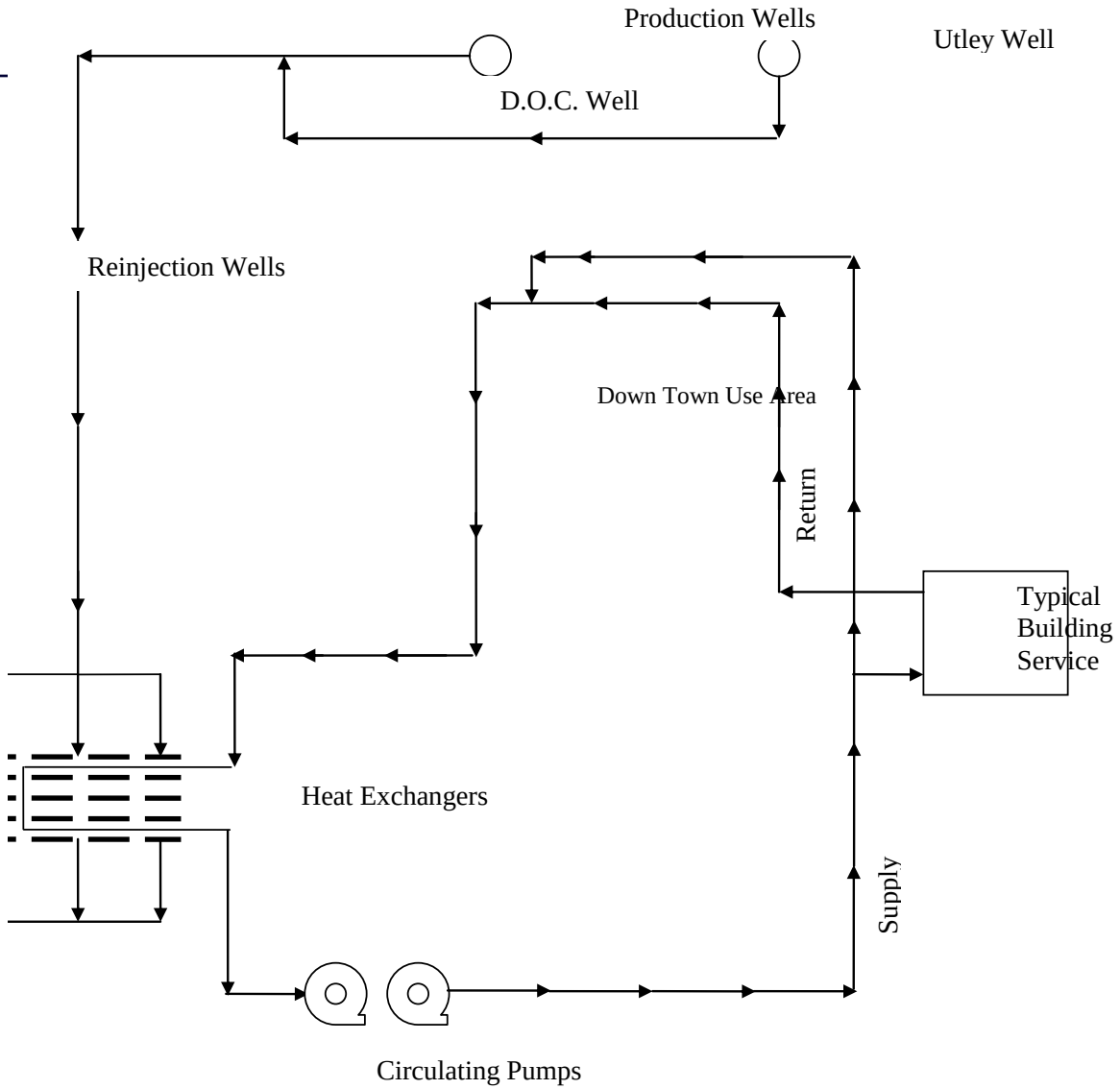
TOWN OF LAKEVIEW GEOTHERMAL WELL
WATER LEVELS For 2010-2011

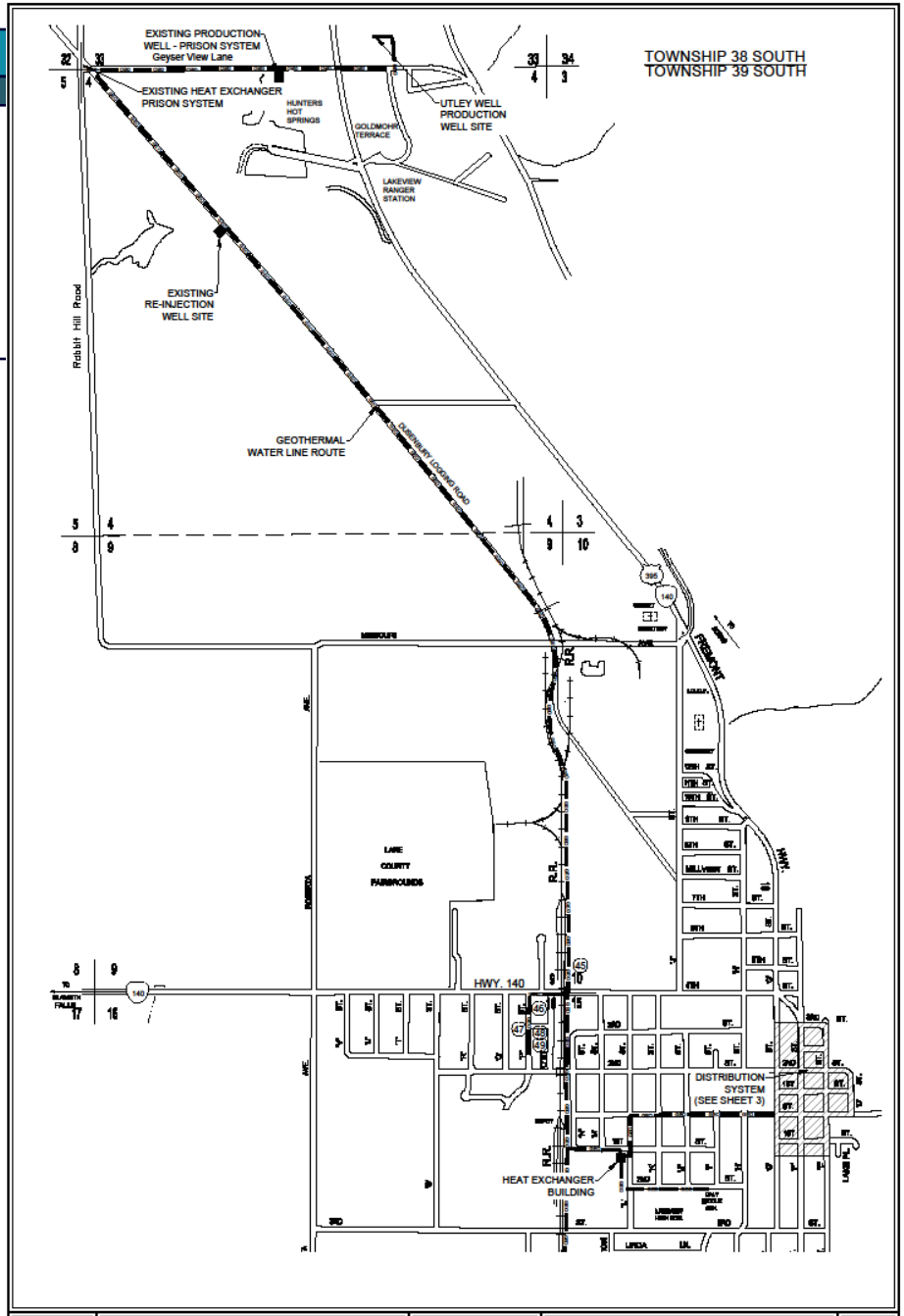


Simulated Response of the Geothermal Aquifer to Increased Usage by the Town of Lakevies, OR



Geothermal Water System Design





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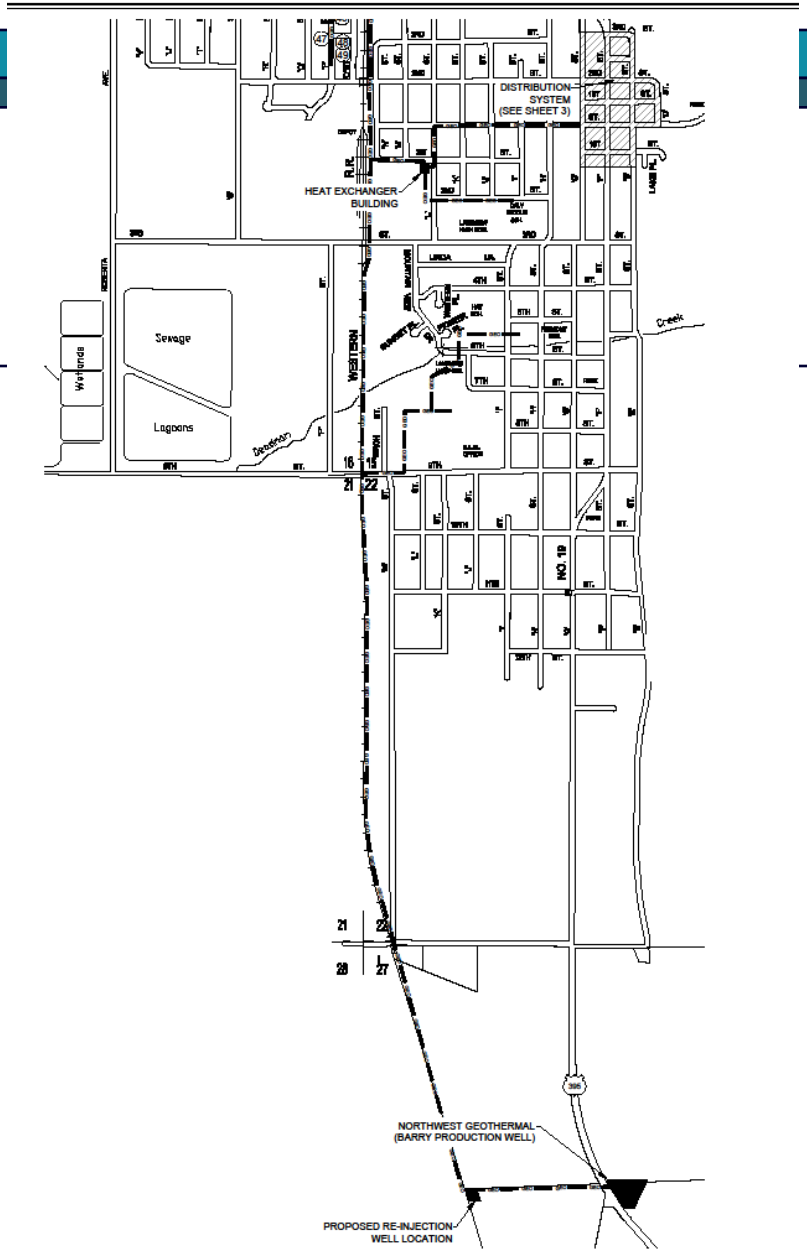

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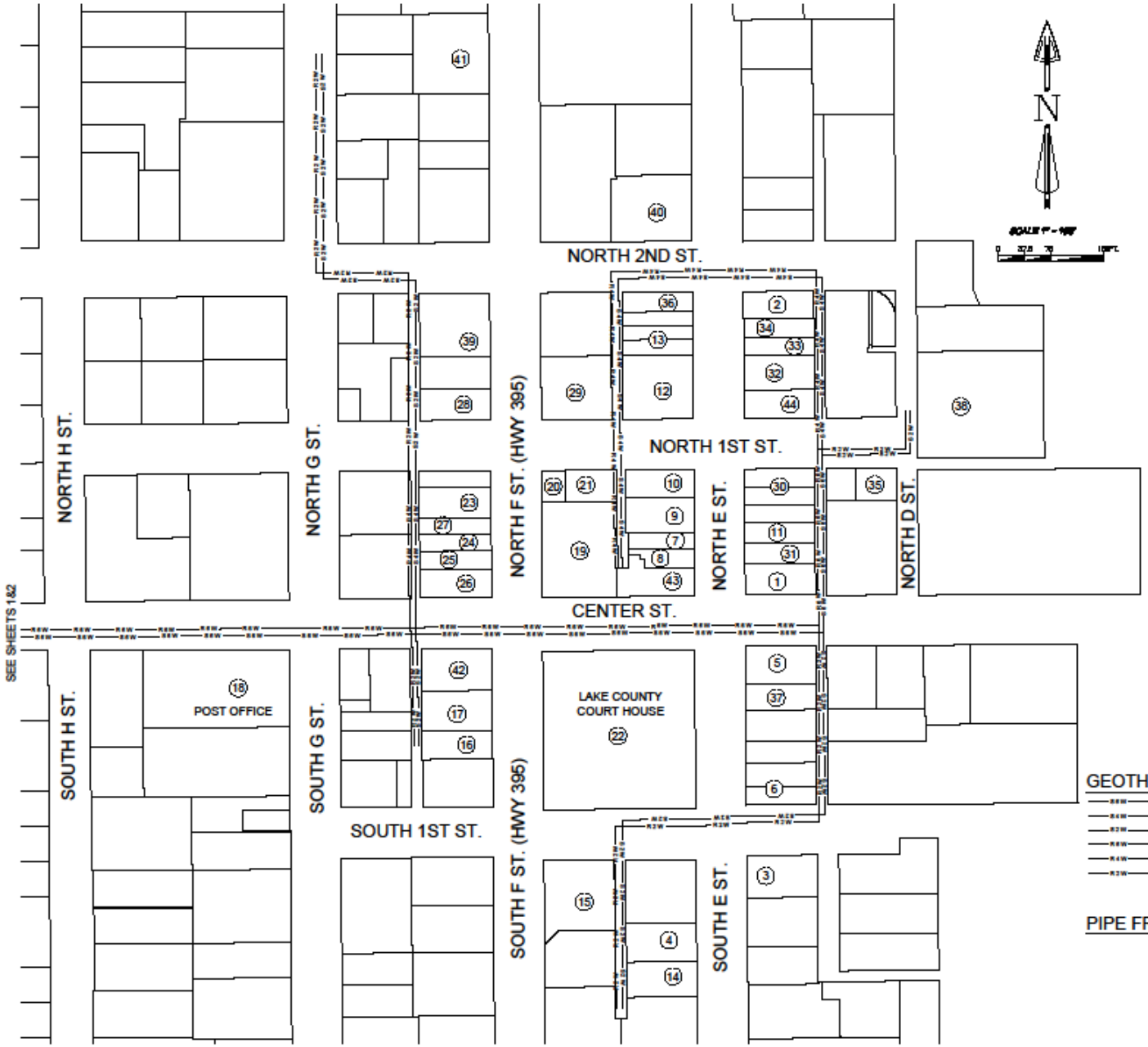

LEGEND

1 TRUE VALUE HARDWARE
2 LAKE COUNTY CHAMBER OF COMMERCE
3 OSU EXTENSION SERVICE
4 LAKE COUNTY MUSEUM
5 STERLING SAVINGS BANK
6 EAGLES LODGE
7 HOLLOWAY PHOTOGRAPHY
8 FORMER ROUND-UP TAVERN
9 39ER STORE
10 CORNER STORE
11 GOODWILL
12 INDIAN VILLAGE RESTAURANT
13 EAGLES NEST RESTAURANT
14 SCHMINK MUSEUM
15 BURGER QUEEN
16 ALGER THEATRE
17 KLAMATH BASIN EQUIPMENT
18 POST OFFICE
19 HERYFORD BUILDING
20 NICHE BOUTIQUE
21 TOWN HALL AND ANNEX
22 LAKE COUNTY COURTHOUSE
23 FLYNN'S FURNITURE & APPLIANCE/RADIO SHACK
24 BACK YARD FLORAL
25 MARIO'S RESTAURANT
26 LAKEVIEW MINISTRIES
27 CHARTER COMMUNICATIONS
28 HOWARD'S DRUG STORE
29 US BANK
30 THORNTON'S
31 GOLDEN GEM JEWELRY STORE
32 STATE OFFICE BUILDING - 108 NORTH E STREET
33 SHEAR EXPERIENCE HAIR SALON
34 FAVELL UTLEY BUILDING
35 AMERITITLE
36 SOUTH VALLEY BANK
37 AFFORDABLE FITNESS
38 MARIUS BUILDING
39 STEWARTS MARKETERIA
40 JERRY'S RESTAURANT
41 EMERGENCY SERVICES BUILDING
42 ARROW REAL ESTATE
43 WILCOX BUILDING
44 FURTADO BUILDING
45 MCFARLAND DOOR (SHEET 1)
46 FORD DEALERSHIP (SHEET 1)
47 AG AND AUTO STORE (SHEET 1)
48 NEW HOLLAND SHOP (SHEET 1)
49 MACHINE SHOP (SHEET 1)

GEOTHERMAL DISTRIBUTION SYSTEM

6" GEOTHERMAL SUPPLY LINE - 3150 FEET
4" GEOTHERMAL SUPPLY LINE - 1200 FEET
2" GEOTHERMAL SUPPLY LINE - 3050 FEET
6" GEOTHERMAL RETURN LINE - 3150 FEET
4" GEOTHERMAL RETURN LINE - 1200 FEET
2" GEOTHERMAL RETURN LINE - 3050 FEET

PIPE FROM HEAT EXCHANGER BUILDING TO WELLS

6" GEOTHERMAL SUPPLY LINE - 37,005 FEET
6" GEOTHERMAL RETURN LINE - 29,323 FEET

Table 8: Projected Pumping Rates

ACTUAL DELTA t	TEMP	HRS/YR	% TIME	BTU/SF	GPM	Utley Well %	DOC Well %	GPM Utley	GPM DOC	Total Gals Utley	Total Gals DOC	Percent Gallons Utley	Percent Gallons DOC
27	62	528	7.20%	0	0.0	100%	0%	0.00	0.0	0	0	0%	0
28	57	652	8.89%	6.5	101.2	100%	0%	101.21	0.0	3,959,503	0	4%	0%
29	52	790	10.78%	9	140.1	100%	0%	140.14	0.0	6,642,771	0	7%	0%
31	47	851	11.61%	11.5	179.1	95%	5%	170.12	9.0	8,686,218	457,169	9%	0%
32	42	963	13.14%	14	218.0	95%	5%	207.10	10.9	11,966,238	629,802	12%	1%
33	37	1067	14.56%	16.5	256.9	90%	10%	231.24	25.7	14,803,710	1,644,857	15%	2%
34	32	1147	15.65%	19	295.9	84%	16%	248.52	47.3	17,103,146	3,257,742	17%	3%
35	27	683	9.32%	21.5	334.8	79%	21%	264.48	70.3	10,838,420	2,881,099	11%	3%
36	22	354	4.83%	24	373.7	78%	22%	291.50	82.2	6,191,399	1,746,292	6%	2%
37	17	150	2.05%	26.5	412.6	73%	27%	301.23	111.4	2,711,064	1,002,722	3%	1%
37	12	82	1.12%	29	451.6	74%	26%	334.16	117.4	1,644,081	577,650	2%	1%
38	7	39	0.53%	31.5	490.5	75%	25%	367.88	122.6	860,828	286,943	1%	0%
38	2	16	0.22%	34	545.0	76%	24%	414.20	130.8	397,632	125,568	0%	0%
39	-3	6	0.08%	36.5	568.4	76%	24%	431.95	136.4	155,503	49,106	0%	0%
40	-8	2	0.03%	39	607.3	78%	22%	473.68	133.6	56,842	16,032	0%	0%

Temp Diff.	Total Hrs	Max BTU/F	Total Gallons	86,017,355	12,674,982	98,692,337
70	7,330	35				

Average pumping Rate	**195.58**	**28.82**

Average BTU per S.F.	21

Table 9: Monthly Pumping Values

	Department of Corrections Well					Utley Well (greenhouse)		
	DOC use Monthly MGD	DOC use Percent	DOC use Monthly GPM	Supplement Use GPM	Total GPM	Percent	Utley Well Monthly MG	Utley Well Monthly GPM
January	5.5	10%	123	77.0	200	18%	15,483,123.9	347
February	4.8	9%	119	31.0	150	11%	9,461,909.1	235
March	5.1	10%	114	16.0	130	10%	8,601,735.5	193
April	4.9	9%	113	7.0	120	8%	6,881,388.4	159
May	4.5	9%	101	0.0	101	6%	5,161,041.3	116
June	4.1	8%	95	0.0	95	3%	2,580,520.7	60
July	3.5	7%	78	0.0	78	0%	0.0	0
August	3.2	6%	72	0.0	72	0%	0.0	0
September	3	6%	69	21.0	90	7%	6,021,214.9	139
October	3.8	7%	85	15.0	100	9%	7,741,562.0	173
November	4.5	9%	104	46.0	150	11%	9,461,909.1	219
December	5.6	11%	125	75.0	200	17%	14,622,950.4	328
Totals	52.5	100%	100	12,615,840		100%	86,017,355.0	
				Average	124		Average	164

Utley well Total Yearly MG	86,017,355

System Ownership

- Town of Lakeview Owned – Best Option
  - Town eligible for more funding
  - Track record in geothermal heating
  - Reliable entity for the life of the system
  - Can guarantee some cost control
- Separate District
  - Funding harder to obtain
  - Benefits to Town small
- Private Development
  - Not eligible for many funding options
  - No guarantee of cost control

System Costs

Summary of System Costs

Utley Well/DOC Well Pipe Costs	$	1,047,415
Barry Well Pipe Costs	$	913,063
Downtown Distribution Piping	$	648,969
Trenching Costs	$	377,363
Pumping System	$	150,000
Well Building	$	40,000
Production Well	$	300,000
Re-injection Well	$	300,000
Heat Exchanger Building/Controls	$	500,000
Road Bores	$	85,000
Mobilization	$	20,000
Building Services	$	49,000
Engineering/Administration	$	531,697
Contingency	$	496,251
Total	**$**	**5,458,758**
Payment Amount - 40 yrs at 4.5%	$	296,646
Yearly Operation Costs	$	190,000
Pumping Costs	$	20,000
Total Yearly Costs	**$**	**506,646**

Financial Analysis

The financial analysis examined the financial feasibility of heating the downtown and highway commercial sectors by analyzing current heating costs, determining proposed geothermal costs, and projecting future heating costs.

Financial Analysis – Conclusions

- Heating the downtown and highway commercial sectors is financially feasible
- Net present value of future savings to the downtown area is $3,071,504 over the next 40 years
- Analysis assumed 50% of retrofit costs would be funded through tax credits or other sources

Rate Analysis

Rate Comparision

Geothermal heating	**$21.05**	per 1 Million BTUs	(BTUs / Geothermal Cost) * 1,000,000
Electric Heating	**$29.26**	per 1 Million BTUs	(BTUs / Electric Cost) * 1,000,000
Fuel Oil	**$31.26**	per 1 Million BTUs	(BTUs / Fuel Oil Cost) * 1,000,000
Propane	**$32.18**	per 1 Million BTUs	(BTUs / Propane Cost) * 1,000,000

Geothermal is	**71.94%**	the cost of equivalent electric heating
Geothermal is	**67.34%**	the cost of equivalent fuel oil heating
Geothermal is	**65.40%**	the cost of equivalent propane heating

Calculation Values

BTU/Year	24,068,627,954
Geothermal Cost/Year	$506,646.20
Electric Cost/Year	$704,251.71
Fuel Oil Cost/Year	$752,372.44
Propane Cost/Year	$774,647.65

Funding Options

- USDA Rural Development
- Oregon Business Development Department
- Business Energy Tax Credits
- Energy Loan Program
- Energy Trust of Oregon
- Climate Trust
- Revenue Bonds – not a good option
- General Obligation Bonds – not a good option
- Local Improvement District – not a good option
- Congressional Appropriation - unlikely

Conclusion

- Heating the downtown and highway commercial sectors is feasible
- The downtown business area will save approximately $5,000,000 over the life of the system
- Project will provide revenue for the Town
- Project has potential to reduce carbon emissions and improve Lakeview's air quality
- Challenges
  - Funding
  - Permits