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HEATING FACILITIES

**Virginia Lake Townhouses & Apartments
Reno, Nevada**

3-80

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HEATING FACILITIES

Virginia Lake Townhouses & Apartments Reno, Nevada

The following study is the result of a request to the Geo-Heat Utilization Center for Technical Assistance.

Introduction

The Virginia Lake Townhouses and Apartments are located in a 12 acre parcel in the geographic center of Reno, Nevada. There are 148 apartments, consisting of 70 single story garden apartments in 10 buildings, 40 two story townhouses in six buildings, and 38 two story apartments in five buildings. All apartments are presently heated with individual natural gas fired forced air furnaces. Hot water is provided by gas fired water heaters, except for the 40 older townhouses which are using water directly from a geothermal source. This water has now been found to be unsuitable for potable use. Located on the property are two geothermal wells, complete with pumps. The larger well can deliver 500 gallons per min., and the smaller well 65 gallons per min., of the 135°F geothermal water. The Geo-Heat Utilization Center has been asked to determine a scheme for using the geothermal water from these wells to provide the needed space and hot water heating for the 148 apartments. An outdoor swimming pool also requires heating.

Space Heating

Space heating in all three types of apartments will be accomplished through the installation of finned water coils in existing ductwork or furnaces. Geothermal water will be pumped from Well #2 through a main distribution system and used directly in the coils. Piping system specifics are available in the Appendix.

New Townhouses

In the new townhouses the coils will be installed at the return air inlet on the furnace. It is possible that some enlarging of this opening will be necessary or the coil may have to be installed just ahead of the opening in the return air cavity (under closet behind return air grille). A location in the supply air on these furnaces would be more advantageous but the air conditioning coil and available space in the utility room precludes this possibility. Control of water flow will be accomplished through the use of a modulating water valve maintaining 87° water off the coil. Room thermostat on call for heat will energize a fan relay initiating air flow. Water valve will be interfaced with control system in such a manner as to prevent water flow unless fan is operating (call for heat). No fan or motor modifications are necessary as the furnace is air conditioning equipped and thus able to generate the required air flow (at high speed).

Old Townhouses

Furnaces in these units are downflow type and installed in such a fashion as to preclude a supply air side installation. Coils are to be placed in the return air duct just above the furnace. In order to satisfy design heat loss requirements at the available temperature and a reasonable air side pressure drop, required coil surface areas somewhat exceed present duct cross-sectional area. To accommodate the installation a duct transition will be required as per Figure 2 in Appendix. For uniform air flow an entering air side transition angle of 8° is recommended but up to 30° is permissible. Furnace room dimensions will be the determining factor. The control sequences will be the same as that used in the new Townhouses.

For 32 of these units (inside apartments) the present fan and motor are capable of supplying the required air flow. The apartments located on the outside, however, do not have sufficient capacity for the new air flows. Two options are available here. First the furnace can be utilized as is, with no modifications to the fan and motor this unit in conjunction with the geothermal water should be capable of delivering 84% of the design loss, yielding a balance point of 16°F outside air temperature. Below the balance point the gas burner could be employed as a booster. Two control schemes are available to accomplish this (see Appendix). A second approach would be to modify the fan and motor to achieve the required air flow.

For this particular apartment a larger horsepower and high RPM motor would be required (see Appendix). Several items bear consideration here. First, obtaining a motor which embodies the necessary characteristics of frame, size, horsepower, speed and voltage may be difficult. Second, major modifications to a furnace of this age may not prove to be economically feasible. Third, and possibly most important, is the significant noise level output which would result from the higher air flows in the new design (primarily around the furnace).

Garden Apartments

Furnaces in these apartments are of the downflow variety and again require a return air coil installation. As in the old townhouses a duct transition will be required to accommodate the coil. The smaller ductwork dimensions in these units will necessitate a somewhat more complicated 4-way transition. The same method of control will be employed as in the townhouses.

In order to satisfy the full design heat loss, some modification is necessary to all of the furnaces. Using existing furnace blowers without modification, between 51% - 69% of the design heat load can be delivered depending on the type of apartment (see Appendix). To achieve the necessary air flow at a reasonable motor RPM some size increase of the blower will be necessary. This presents a problem not encountered in the old townhouses. It is probable that the blower housing will be unable to accommodate a larger blower wheel. 55 of the apartments require either a 14% or 25% size increase. This compounds the question of economic feasibility mentioned in the old townhouses section. These furnaces would also be subject to the same noise and motor selection considerations as the above.

One advantage of the two stage operation (geo-heat to balance point, gas burner below balance point) is that it allows the gas burner to operate in a manner that more closely approximates steady state. That is to say that the "on" cycles would be longer during operation in the colder weather, eliminating much of the dynamic efficiency loss that would otherwise result.

Domestic Hot Water Heating

Each of the three types of apartments requires a distinct approach to domestic water heating.

In the garden apartments the existing distribution network will be retained. Cold potable water entering the system will pass through a plate heat exchanger in which it will be heated to 125° by the geothermal water. The heated water will then enter the storage tank from which it will pass into the distribution system. In view of the lower temperature water and decreased recovery rate, a larger storage volume is required. A 300 gallon storage tank yields approximately 18 gallons of usable storage per apartment. This in addition to a heat exchanger capacity of approximately 16 gal/hr apartment (recovery) should satisfy any expected demand. It is possible that a small heating element at each tank may be needed to compensate for stand-by losses from storage. Five 300-gallon tanks and five plate heat exchangers are needed. See Figure #3.

The 40 older townhouses will continue to be served by Well #1, although indirectly. The recent contaminant problems have necessitated certain pumping changes. Well water will be pumped through a plate heat exchanger raising city water up to 125°F. The heated water will then pass through a booster boiler (gas fired) in which its temperature will be raised to 140°, thus satisfying dishwasher requirements. A storage capacity of approximately 880 gal. will yield a usable storage volume of 16.5 gal/apt., coupled with a recovery rate of 17.7 gal/hr-apt., the system should provide the expected demand. As in the above case, some stand-by compensation may be required. It is proposed that all the above components (heat exchanger, storage, booster boiler) be located in an enlarged well head structure at Well #1. A city water line and gas line will have to be supplied to the well head. See Figure 4.

The new townhouses will retain the existing 30 gal. gas fired hot water heaters in each unit. Cold water will be routed through a shell and tube heat exchanger before entering the hot water heater tank. A control valve will supply geothermal water to the heat exchanger when flow exists in the cold water line. Incoming water will be heated to 110°F in the heat exchanger. The gas burner will provide additional temperature increase and stand-by compensation. See Figure 5.

Pool water will be heated by a heat exchanger placed in parallel with the existing filter. A slip stream will be drawn from the main body of water which would normally pass through the filter. Balancing valves will be employed to roughly regulate the flow. When sensor on inlet side of pump calls for heat, a detent action valve is opened initiating pool water flow through heat exchanger. This valve will be interfaced with the geothermal water valve in such a way as to prevent geothermal water flow unless detent valve is open. Modulating geothermal water valve will maintain constant pool water temperature out of heat exchanger. A heat exchanger capacity of 200,000 BTU/hr

will provide for normal heat loss (peak of 100,000 BTU/hr for the months of June, July and August) and initial heat-up at the beginning of the season. See Figure 6.

Pumps

No information is available on the pump presently operating at Well #1 but it is assumed that it can be integrated into the new design.

The pumping requirements at a peak flow of 323 gpm at Well #2 are approximately 25 HP at a total head of 200 feet. The present pump significantly exceeds this requirement (60 HP). A second consideration concerns the fact that the existing model is a single speed model. Since flow would vary widely in this particular kind of system, it is common practice to employ a speed reducing coupling between the motor and pump (hydraulic torque converter). Since there are only two ways to control water flow - speed of pump or head control, the available options are limited. While it is possible to completely replace the existing motor or add a speed control between the pump and motor, either of these options would be expensive. The best initial approach seems to be head control through the use of a throttling valve. This solution could involve sizable electrical energy waste depending upon pump characteristics.

Energy Savings

If the geothermal heating system is installed as outlined it is estimated that the purchase of about 140,000 therms per year of natural gas can be eliminated. A breakdown of the source of these savings is shown on Table 1.

Finned Tube Coils

A total of 148 finned coils will be needed to meet the space heating requirements of the project. They were selected on the basis of a 50°F temperature rise (70- 120°F) and a water ΔT of 43°F (130- 87°F). Due to the low temperature of the geothermal water available, 6 rows of coils were employed in all cases. The depth of these coils in conjunction with the increased air flows will necessitate some fan and motor modifications in order to meet 100% of design heating load in some instances. Details of selected coils are shown on Table 2.

Design Heating Loads

Design heating loads for the various apartments are tabulated on Table 3. Loads vary from 28,040 BTU/hr to 51,800 BTU/hr. These are peak loads based on a 70°F inside temperature and a 6°F outside temperature.

Geothermal Water Requirements

Total geothermal water required during peak conditions is calculated to be 323 gallons per minute, assuming all heat requirements are met geothermally. Since some boost heat will be supplied by natural gas, the actual peak would be somewhat less. Table #4 shows the flow required to the various uses.

ENERGY SAVINGS

Table 1

GAS - Annual

Domestic Hot Water Heating - Basis 37 gal/day/apt for townhouses, 30 gal/apt/day for Garden Apts. 125° to Garden Apts, 130° to old Townhouses, 60° ΔT rise to new Townhouses.

	Therms/Apt/yr.	Total
70 Garden apts.	91.2	6,385
40 Old Townhouses	- 7.03	- 281
38 New Townhouses	84.4	<u>3,206</u>
		9,310 therms/yr.

Space Heating - Basis 6,022 degree day heating season, 70°F inside design, 6°F outside design, full heating load carried by geothermal.

Garden Apts.	Therms/Apt/yr.	Total
2 bedroom outside 15	1,096	16,450
2 bedroom inside 35	965	33,790
1 bedroom outside 5	976	4,880
1 bedroom inside 15	823	12,350

Old Townhouses

Outside Apt.	8	895	7,164
Inside Apt.	32	742	23,740

New Townhouses

Outside Apt.	10	996	9,960
Inside Apt.	28	791	<u>22,160</u>

Total space heating	130,500
Total water heating	<u>9,310</u>

Total Projected Gas Savings	139,800 Therms/yr
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Should the two stage approach be implemented (no airflow modification to furnaces) a total savings of 131,100 therms would be realized.

COIL SELECTION - SPACE HEATING

Table 2

	Garden Apartments			Old Townhouses		New Townhouses	
	1 Bedrm (inside)	1 Bedrm (outside) 2 Bedrm (inside)	2 Bedrm (outside)	Outside	Inside	Outside	Inside
Entering Air	70						▽
Leaving Air	120						▽
Entering Water	130						▽
Leaving Water	87						▽
ACFM	927	1087	1234	1010	836	843	670
Coil Size	16½x27"	19½x27	19½x27	19½x21	19½x21	19½x21	19½x21
Number Feeds	1						▽
Code	3						▽
E1	4493						▽
Rows	6						▽
Air ΔP In. H ₂ O	.29	.19	.30	.29	.20	.20	.12
Water ΔP Ft. H ₂ O	8.31	13.14	15.14	10.12	7.24	7.35	4.89
	11	10	12	12	11	11	9
GPM	1.82	2.13	2.42	1.98	1.64	1.66	1.32
BTU/hr	89,140	45,900	52,100	42,648	35,300	35,600	28,300
	300	296	365	355	294	303	241
Tubes	10	12	11	12	12	12	12
Passes	60	72	66	72	72	72	72
Number req'd	15	40	15	8	32	10	28

DESIGN HEATING LOADS

Table 3

	Garden Apts.		Old Townhouses		New Townhouses
	1 Bedroom	2 Bedroom	1 Bedroom	2 Bedroom	
Inside	38,900	45,600	35,040	35,040	28,040
Outside	46,100	51,800	42,300	42,300	35,300

Basis - 60°F Outside design, 70°F inside
Figures in BTU/hr

Note - "outside" refers to apartments located on the end
of a building. See Piping Scheme

"inside" refers to an apartment having two party walls

WATER FLOWS (Geothermal) AT PEAK 100% of DESIGN LOAD

Table 4

Garden Apartments	Number	GPM/Unit	GPM	
DHW Heaters	5	4.3	21.5	
1 Bedroom inside	15	1.82	27.75	
1 Bedroom outside	5	2.13	10.65	170.75
2 Bedroom inside	35	2.13	74.55	
2 Bedroom outside	15	2.42	36.3	
Pool heater	1	667	6.67	6.67
Old Townhouses				
1 Bedroom inside	15	1.64	24.6	
1 Bedroom outside	5	1.98	9.9	
2 Bedroom inside	3	1.64	4.92	73.1
2 Bedroom outside	17	1.98	33.66	
New Townhouses				
Water heaters	38	.5	19	
Outside Apartment	10	1.66	16.6	72.6
Inside Apartment	28	1.32	37.0	
				<hr/> 323 GPM

Appendix

HEATING CAPABILITIES OF FURNACES BASED
ON PRESENT AIR FLOW CAPABILITIES

Garden Apartments - Below calculations assume gas burner heating below balance point.

1 Bedroom inside apt - Design heat loss 38,900 BTU/hr
capacity @ present air flow - 26,811 BTU/hr
69% of design loss. Balance point @ 26°F

2 Bedroom inside apt

1 Bedroom outside apt - Design loss 45,600 BTU/hr
capacity @ present air flow - 26,811 BTU/hr
59% of design loss. Balance point @ 32.4°F

2 Bedroom outside apt - Design loss 52,100 BTU/hr
capacity @ present air flow - 26,811 BTU/hr
51% of design loss. Balance point @ 37.4°F

Old Townhouses

1 Bedroom outside

2 Bedroom outside - Design heat loss - 42,300 BTU/hr
capacity @ present air flow - 35,467 BTU/hr
84% of design loss. Balance point @ 16.2°F

1 Bedroom inside

2 Bedroom inside - Design heat loss - 35,041 BTU/hr
capacity @ present air flow is sufficient.

REQUIRED MODIFICATIONS TO FURNACES TO
ACHIEVE GEO-DESIGN AIR FLOWS

(1) 75,000 BTU/hr furnace - Garden Apts.

Present air flow capacity 1/8 HP, 1500 RPM
635 CFM @ .5" static

Required capacity:

Inside 1 Bedroom apt - 927 CFM (15 units)

Associated Modifications - 8% increase in fan dia.
Replace existing motor with 1/3 HP 1725 RPM motor

Outside 1 Bedroom apt. (40 units)

Inside 2 Bedroom apt. - 1087 CFM

Modifications - 14% increase in fan dia.,
Replace existing motor with 1/3 HP 1725 RPM motor

Outside 2 Bedroom apt - 1234 CFM (15 units)

Modifications - 25% increase in fan dia.
Replace existing motor with 1/2 HP 1725 RPM motor

(2) 100,000 BTU/hr Furnace - Old Townhouses

Present air flow capacity 1/5 HP 1075 RPM
840 CFM @ .5" static

Required capacity:

Inside 1 Bedroom apt (32 units)

Inside 2 Bedroom apt - 836 CFM

No Modifications Necessary

Outside 1 Bedroom (8 units)

Outside 2 Bedroom - 1010 CFM

Modifications - Replace motor with 1/3 HP 1725 RPM

(3) 80,000 BTU/hr Furnace - New Townhouses

A/C equipped furnaces exceeds air flow requirements
for both inside and outside model townhouse.

Fig. 1
TYPICAL INSTALLATION OF GEO-WATER PUMP - GARDEN APPTS

FIG 2
TYPICAL WATER COIL INSTALLATION - GARDEN APTS AND OLD TOWNHOUSES

FIG 3

SCHEME FOR DOMESTIC HOT WATER HEATING - GARDEN APARTMENTS
TO REPLACE PRESENT HOT WATER HEATERS IN UNITS
2501A, 2518A, 87, 73, 25519.

Fig 4

SCHEME FOR DOMESTIC HOT WATER HEATING - OLD TOWNHOUSES

COMPONENTS TO BE LOCATED IN AN ENLARGED WELL-HEAD STRUCTURE
 @ Well #1

Fig 5

UTILITY ROOM DETAIL (SPACE AND DOMESTIC WATER HEATING) - NEW TOWNHOUSES

FIG 6

POOL HEATING PIPING SCHEME

DETENT CONTROL VALVE TO MAINTAIN 75° POOL CONTROL SYSTEM TO BE DESIGNED IN SUCH A WAY AS TO PREVENT OPERATION OF GED WTE VALVE UNLESS HEAT IS REQUIRED BY POOL

SCHEMATIC FOR 2 STAGE OPERATION OF FURNACE
1ST STAGE - GEO HT. 2ND STAGE - GAS BURNER

METHOD #1 - ASSUMES A RETURN AIR GEO-WATER COIL INSTALLATION.
THIS METHOD REQUIRES THE ADDITION OF A 2-STAGE TROOM T-STAT,
3-CONDUCTED WIRE FROM FURNACE TO SAME, A FAN RELAY
AND POSSIBLY A CONTROL CIRCUIT TRANSFORMER IF PRESENT
ONE IS NOT OF SUFFICIENT CAPACITY.

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SCHEMATIC FOR 2 STAGE OPERATION OF FURNACE 1ST STAGE GEO HT 2ND STAGE GAS BURNER

METHOD #2 - SAME COIL INSTALLATION CONSIDERATIONS AS IN METHOD #1. THIS APPROACH REQUIRES THE ADDITION OF AN OUTDOOR T-STAT AND FAN RELAY BUT ELIMINATES THE 3 CONDUCTION WIRE AND 2 STAGE THERMO STAT OF #1. EXISTING CONTROL CIRCUIT TRANSFORMER WOULD AGAIN HAVE TO EVALUATED FOR SUFFICIENT CAPACITY. THIS METHOD IS ESPECIALLY ADVANTAGEOUS WHERE FURNACES ARE LOCATED NEAR AN OUTSIDE WALL.

NOTE: ODT APPROACH ELIMINATES UNNECESSARY USAGE OF GAS BURNER DUE TO RAPID THERMOSTAT SET-UP.

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TABLE 3

VIRGINIA LAKES WITHOUT DOMESTIC HOT WATER

<u>NATURAL GAS</u>	<u>GEOHERMAL PUMPING COSTS</u>	<u>GEOHERMAL OPERATION & MAINTENANCE COSTS</u>	<u>GEOHERMAL SYSTEM INSURANCE</u>	<u>LOAN PAYMENT</u>	<u>NET INCOME BEFORE TAXES</u>	<u>PRESENT VALUE AT 15%</u>	<u>TOTAL NEGATIVE CASH FLOW</u>
<u>COST</u>	<u>COST</u>	<u>COST</u>	<u>COST</u>	<u>COST</u>			
57415.60	4209.66	9697.55	4155.10	66382.49			
64420.	4610.	10376.	4197.	66382.	-21145.	-18387.	-21145.
72280.	5047.	11103.	4239.	66382.	-14492.	-10958.	-14492.
81098.	5527.	11880.	4281.	66382.	-6973.	-4585.	-6973.
90992.	6052.	12712.	4324.	66382.	1522.	870.	
102093.	6627.	13601.	4367.	66382.	11115.	5526.	
114548.	7257.	14553.	4411.	66382.	21945.	9487.	
128523.	7946.	15572.	4455.	66382.	34167.	12845.	-42609.
139447.	8628.	16662.	4499.	66382.	43275.	14147.	
151300.	9368.	17829.	4544.	66382.	53177.	15116.	
164161.	10172.	19077.	4590.	66382.	63940.	15805.	
178114.	11044.	20412.	4636.	66382.	75640.	16258.	
193254.	11992.	21841.	4682.	66382.	88357.	16514.	
209681.	13021.	23370.	4729.	66382.	102179.	16607.	
227503.	14138.	25005.	4776.	66382.	117201.	16564.	
246841.	15351.	26756.	4824.	66382.	133528.	16410.	
267823.	16668.	28629.	4872.	66382.	151271.	16166.	
290588.	18099.	30633.	4921.	66382.	170553.	15849.	
315288.	19651.	32777.	4970.	66382.	191507.	15475.	
342087.	21338.	35071.	5020.	66382.	214276.	15056.	
371165.	23168.	37526.	5070.	66382.	239017.	14604.	

199369.

COST ANALYSIS

Table 1 provides a 20-year cash flow using the following assumptions:

1. That the developer will charge the same rate for geothermal space heating and domestic hot water as the projected costs for natural gas.
2. That the geothermal developer has other income and other profitable geothermal projects such that he can take full advantage of percentage depletion allowances and investment tax credits.

The percentage depletion allowance is 22% for 1980, declining 2% per year through 1983 and stability at 15% thereafter. Straight-line depreciation was taken assuming a 10-year taxable life for the project and a 10% salvage value. All costs, tangible and intangible, were capitalized. Based on the first year net income before taxes, the project would probably be depreciated using a 20-year life in order to generate more income in the early years of the project so that full advantage could be taken of the 25% investment tax credit and the 22% depletion allowance. The loan payment is based on a 15% annual cost of capital. These payments could be reduced drastically if a low interest guaranteed loan was obtained. The project operates at a loss through the first 10 years. However, the after tax cash flow indicates considerable income provided full advantage can be taken of available tax credits and deductions.

The following rates of inflation were used in all tables. The economic inflation rate was assumed to be 7% per year.

	<u>1980-1986</u>	<u>1987-2000</u>
Natural Gas	12.2%	8.5%
Electricity	9.5%	8.58%
Maintenance	7.0%	7.0%
Insurance	1.0%	1.0%

These inflation rates were obtained from projections by the Oregon Department of Energy. Although these rates are ultraconservative, the incremental inflation rate for natural gas and electricity has proven to be relatively accurate over the past three years. The fact that the economic inflation rate may be much higher than 7% is not significant in that rents, operating expenses, etc., are assumed to increase in keeping with the economic inflation rate.

Table 2 makes the same assumptions as Table 1 except that no tax credits, depletion allowances, or depreciation were calculated. Depreciation and depletion would only be used to decrease the net income before taxes and then be added back to arrive at an after tax cash flow. Therefore, the last column on this table indicates the actual cash flow for the project ignoring taxes. Note that without the ability to take available tax write-offs, considerable additional working capital would be required to sustain the project through the first six years of operation.

Table 3 eliminates the capital investment and operating costs for the domestic hot water system. Based on engineering cost estimates, the cost of the domestic hot system is not justified by the savings over the existing system. However, it is highly possible that this system would be feasible in the early years of the project due to rising prices for natural gas. Cost of the project was reduced from \$515,000 to \$415,000. Pumping costs, operation and maintenance costs, etc., were reduced proportionally. Once again, tax deductions and tax credits were ignored. As the last column indicates, only \$42,600 of additional working capital would be needed to sustain the project through the first three years. If capital could be borrowed at 9% instead of 15%, the project could provide a positive cash flow in the first year.

TABLE 1

VIRGINIA LAKES WITH DOMESTIC HOT WATER
ASSUMING ALL TAX WRITE-OFFS ARE AVAILABLE

NATURAL GAS	DEPLETION ALLOWANCE	STRAIGHT- LINE DEPRECIATION	GEOHERMAL PUMPING COSTS	GEOHERMAL OPERATION & MAINTENANCE COSTS	GEOHERMAL SYSTEM INSURANCE	LOAN PAYMENT	NET INCOME BEFORE TAXES	48% FEDERAL INCOME TAXES	NET INCOME AFTER TAXES	PLUS INV. TAX CREDIT, DEPRCN. & DEPLETION	AFTER TAX CASH FLOW
COST			COST	COST	COST	COST					
61512.00			4510.00	11872.00	5155.10	82358.64					
69016.	15184.	46396.	4938.	12703.	5207.	82359.	-97770.	-46930.	-50840.	61580.	139617.
77436.	15487.	46396.	5408.	13592.	5259.	82359.	-91064.	-43711.	-47353.	61883.	14530.
86884.	15639.	46396.	5921.	14544.	5311.	82359.	-83286.	-39977.	-43309.	62035.	18726.
97484.	15597.	46396.	6484.	15562.	5364.	82359.	-74278.	-35654.	-38625.	61993.	23368.
109377.	16406.	46396.	7100.	16651.	5418.	82359.	-64953.	-31178.	-33776.	62802.	29027.
122720.	18408.	46396.	7774.	17817.	5472.	82359.	-55505.	-26643.	-28863.	64804.	35941.
137692.	20654.	46396.	8513.	19064.	5527.	82359.	-44820.	-21513.	-23306.	67050.	43744.
149396.	22409.	46396.	9243.	20398.	5582.	82359.	-36992.	-17756.	-19236.	68805.	49570.
162095.	24314.	46396.	10036.	21826.	5638.	82359.	-28474.	-13668.	-14807.	70710.	55903.
175873.	26381.	46396.	10897.	23354.	5694.	82359.	-19208.	-9220.	-9988.	72777.	62788.
190822.	28623.		11832.	24989.	5751.	82359.	37268.	17888.	19379.	28623.	48002.
207042.	31056.		12848.	26738.	5809.	82359.	48233.	23152.	25081.	31056.	56137.
224641.	33696.		13950.	28610.	5867.	82359.	60159.	28876.	31283.	33696.	64979.
243735.	36560.		15147.	30612.	5926.	82359.	73131.	35103.	38028.	36560.	74589.
264453.	39668.		16447.	32755.	5985.	82359.	87239.	41875.	45364.	39668.	85032.
286931.	43040.		17858.	35048.	6045.	82359.	102582.	49239.	53343.	43040.	96382.
311320.	46698.		19390.	37501.	6105.	82359.	119267.	57248.	62019.	46698.	108717.
337782.	50667.		21053.	40127.	6166.	82359.	137410.	65957.	71453.	50667.	122121.
366494.	54974.		22860.	42935.	6228.	82359.	157138.	75426.	81712.	54974.	136686.
397646.	59647.		24821.	45941.	6290.	82359.	178588.	85722.	92866.	59647.	152513.

TABLE 2

VIRGINIA LAKES WITH DOMESTIC HOT WATER

<u>NATURAL GAS</u>	<u>GEOHERMAL PUMPING COSTS</u>	<u>GEOHERMAL OPERATION & MAINTENANCE COSTS</u>	<u>GEOHERMAL SYSTEM INSURANCE</u>	<u>LOAN PAYMENT</u>	<u>NET INCOME BEFORE TAXES</u>
<u>COST</u> 61512.00	<u>COST</u> 4510.00	<u>COST</u> 11872.00	<u>COST</u> 5155.10	<u>COST</u> 82358.64	
69016.	4938.	12703.	5207.	82359.	-36190.
77436.	5408.	13592.	5259.	82359.	-29181.
86884.	5921.	14544.	5311.	82359.	-21251.
97484.	6484.	15562.	5364.	82359.	-12285.
109377.	7100.	16651.	5418.	82359.	-2151.
122720.	7774.	17817.	5472.	82359.	9299.
137692.	8513.	19064.	5527.	82359.	22230.
149396.	9243.	20398.	5582.	82359.	31814.
162095.	10036.	21826.	5638.	82359.	42236.
175873.	10897.	23354.	5694.	82359.	53568.
190822.	11832.	24989.	5751.	82359.	65891.
207042.	12848.	26738.	5809.	82359.	79289.
224641.	13950.	28610.	5867.	82359.	93855.
243735.	15147.	30612.	5926.	82359.	109691.
264453.	16447.	32755.	5985.	82359.	126907.
286931.	17858.	35048.	6045.	82359.	145622.
311320.	19390.	37501.	6105.	82359.	165965.
337782.	21053.	40127.	6166.	82359.	188077.
366494.	22860.	42935.	6228.	82359.	212112.
397646.	24821.	45941.	6290.	82359.	238235.

ADDENDUM

Virginia Lakes Apartment Complex

3-80

ADDENDUM

Virginia Lakes Apartment Complex

GEO-HEAT UTILIZATION CENTER

OREGON INSTITUTE OF TECHNOLOGY -- KLAMATH FALLS, OREGON 97601

(503) 882-6321 Ext. 267

Paul J. Lienau, Director

April 1, 1980

Jerry Cruitt
Cruitt & Galli
3394 Lakeside Drive
Reno, Nevada 89509

Dear Mr. Cruitt:

This is in reply to your letter of March 17 regarding the economic feasibility of converting the Virginia Lakes apartment complex from natural gas to geothermal heating.

We have not made a detailed review of the \$515,510 cost estimate for the conversion made by Pete Peterson of JBA Consulting Engineers. However, this amounts to an average cost of \$3,483 for each of the 148 apartments. This does not seem out of line for a retrofit to provide geothermal water for space heating and domestic hot water. However, a savings of approximately \$100,000 in capital expenditure would result if facilities to produce domestic hot water were eliminated.

We have made an economic evaluation of the geothermal system with and without domestic hot water heating facilities. Basis for this evaluation is the following:

	<u>Space & Water Heating</u>	<u>Space Heating Only</u>
Capital Investment	\$515,000	\$415,000
Annual Natural Gas Savings	139,800 Therms \$ 61,512/year	130,490 Therms \$ 57,415/year
Operating Cost (Start of 1st year)		
Maintenance	11,872	9,697
Electrical power	4,510	4,209
Taxes and insurance	5,155	4,155
Total operating costs	\$ 21,537/year	\$18,061/year

Jerry Cruitt - 2
April 1, 1980

Three cases were considered:

- Case 1 - Capital investment \$515,000, project qualifies for, and advantage taken of, all investment tax credits and depletion allowances
- Case 2 - Capital investment \$515,000, no investment tax credits or depletion allowances.
- Case 3 - Capital investment \$415,000, no investment tax credits or depletion allowances.

The results can be summarized as follows:

- Case 1 - Economically feasible if tax and depletion allowance can be applied.
- Case 2 - Economically feasible if \$101,058 in equity capital is available to carry the project through the first five years of deficit operation.
- Case 3 - Economically feasible if \$42,609 in equity capital is available to carry the project through the first three years of deficit operation.

Attached is a write up of the three cases for which evaluations were made. If you have any questions, please contact Charles Higbee or myself.

Yours truly,

Gene P. Ryan, Research Associate

GPR:cf

Attachments

COST ANALYSIS

Table 1 provides a 20-year cash flow using the following assumptions:

1. That the developer will charge the same rate for geothermal space heating and domestic hot water as the projected costs for natural gas.
2. That the geothermal developer has other income and other profitable geothermal projects such that he can take full advantage of percentage depletion allowances and investment tax credits.

The percentage depletion allowance is 22% for 1980, declining 2% per year through 1983 and stability at 15% thereafter. Straight-line depreciation was taken assuming a 10-year taxable life for the project and a 10% salvage value. All costs, tangible and intangible, were capitalized. Based on the first year net income before taxes, the project would probably be depreciated using a 20-year life in order to generate more income in the early years of the project so that full advantage could be taken of the 25% investment tax credit and the 22% depletion allowance. The loan payment is based on a 15% annual cost of capital. These payments could be reduced drastically if a low interest guaranteed loan was obtained. The project operates at a loss through the first 10 years. However, the after tax cash flow indicates considerable income provided full advantage can be taken of available tax credits and deductions.

The following rates of inflation were used in all tables. The economic inflation rate was assumed to be 7% per year.

	<u>1980-1986</u>	<u>1987-2000</u>
Natural Gas	12.2%	8.5%
Electricity	9.5%	8.58%
Maintenance	7.0%	7.0%
Insurance	1.0%	1.0%

These inflation rates were obtained from projections by the Oregon Department of Energy. Although these rates are ultraconservative, the incremental inflation rate for natural gas and electricity has proven to be relatively accurate over the past three years. The fact that the economic inflation rate may be much higher than 7% is not significant in that rents, operating expenses, etc., are assumed to increase in keeping with the economic inflation rate.

Table 2 makes the same assumptions as Table 1 except that no tax credits, depletion allowances, or depreciation were calculated. Depreciation and depletion would only be used to decrease the net income before taxes and then be added back to arrive at an after tax cash flow. Therefore, the last column on this table indicates the actual cash flow for the project ignoring taxes. Note that without the ability to take available tax write-offs, considerable additional working capital would be required to sustain the project through the first six years of operation.

Table 3 eliminates the capital investment and operating costs for the domestic hot water system. Based on engineering cost estimates, the cost of the domestic hot system is not justified by the savings over the existing system. However, its highly possible that this system would be feasible in the early years of the project due to rising prices for natural gas. Cost of the project was reduced from \$515,000 to \$415,000. Pumping costs, operation and maintenance costs, etc., were reduced proportionally. Once again, tax deductions and tax credits were ignored. As the last column indicates, only \$42,600 of additional working capital would be needed to sustain the project through the first three years. If capital could be borrowed at 9% instead of 15%, the project could provide a positive cash flow in the first year.

TABLE 1

VIRGINIA LAKES WITH DOMESTIC HOT WATER
ASSUMING ALL TAX WRITE-OFFS ARE AVAILABLE

NATURAL GAS	DEPLETION ALLOWANCE	STRAIGHT- LINE DEPRECIATION	GEOHERMAL PUMPING COSTS	GEOHERMAL OPERATION & MAINTENANCE COSTS	GEOHERMAL SYSTEM INSURANCE	LOAN PAYMENT	NET INCOME BEFORE TAXES	48% FEDERAL INCOME TAXES	NET INCOME AFTER TAXES	PLUS INV. TAX CREDIT, DEPRCH. & DEPLETION	AFTER TAX CASH FLOW
CDST			CDST	CDST	CDST	CDST					
512.00			4510.00	11872.00	5155.10	82358.64					
69016.	15184.	46398.	4938.	12703.	5207.	82359.	-97770.	-46930.	-50840.	61580.	139617.
77436.	15487.	46398.	5408.	13592.	5259.	82359.	-91064.	-43711.	-47353.	61883.	14530.
86884.	15638.	46398.	5921.	14544.	5311.	82359.	-83286.	-39977.	-43309.	62035.	18726.
97484.	15597.	46398.	6484.	15562.	5364.	82359.	-74278.	-35654.	-38625.	61993.	23368.
09377.	16408.	46398.	7100.	16651.	5419.	82359.	-64953.	-31178.	-33776.	62802.	29027.
22720.	18408.	46398.	7774.	17817.	5472.	82359.	-55505.	-26643.	-28863.	64804.	35941.
37692.	20654.	46398.	8513.	19064.	5527.	82359.	-44820.	-21513.	-23306.	67050.	43744.
49396.	22409.	46398.	9243.	20398.	5582.	82359.	-36992.	-17756.	-19236.	68805.	49570.
63095.	24314.	46398.	10036.	21826.	5638.	82359.	-28474.	-13668.	-14807.	70710.	55903.
75873.	26381.	46398.	10897.	23354.	5694.	82359.	-19208.	-9220.	-9988.	72777.	62788.
90822.	28623.		11632.	24989.	5751.	82359.	37268.	17888.	19379.	88623.	48002.
107042.	31056.		12848.	26738.	5809.	82359.	48233.	23152.	25081.	91056.	56137.
124641.	33696.		13950.	28610.	5867.	82359.	60159.	28876.	31283.	93696.	64979.
143735.	36560.		15147.	30612.	5926.	82359.	73131.	35103.	38028.	96560.	74589.
164453.	39668.		16447.	32755.	5985.	82359.	87239.	41875.	45364.	99668.	85032.
186931.	43040.		17858.	35048.	6045.	82359.	102582.	49239.	53343.	43040.	96382.
211320.	46698.		19390.	37501.	6105.	82359.	119267.	57248.	62019.	46698.	108717.
237782.	50667.		21053.	40127.	6166.	82359.	137410.	65957.	71453.	50667.	122121.
266494.	54974.		22860.	42935.	6228.	82359.	157138.	75426.	81712.	54974.	136686.
297646.	59647.		24921.	45941.	6290.	82359.	178588.	85722.	92866.	59647.	152513.

TABLE 2

VIRGINIA LAKES WITH DOMESTIC HOT WATER

<u>NATURAL GAS</u>	<u>GEOHERMAL PUMPING COSTS</u>	<u>GEOHERMAL OPERATION & MAINTENANCE COSTS</u>	<u>GEOHERMAL SYSTEM INSURANCE</u>	<u>LOAN PAYMENT</u>	<u>NET INCOME BEFORE TAXES</u>
COST 61512.00	COST 4510.00	COST 11872.00	COST 5155.10	COST 82358.64	
69016.	4938.	12703.	5207.	82359.	-36190.
77436.	5408.	13592.	5259.	82359.	-29181.
86884.	5921.	14544.	5311.	82359.	-21251.
97484.	6484.	15562.	5364.	82359.	-12285.
109377.	7100.	16651.	5418.	82359.	-2151.
122720.	7774.	17817.	5472.	82359.	9299.
137692.	8513.	19064.	5527.	82359.	22230.
149396.	9243.	20398.	5582.	82359.	31814.
162095.	10036.	21826.	5638.	82359.	42236.
175873.	10897.	23354.	5694.	82359.	53568.
190822.	11832.	24989.	5751.	82359.	65891.
207042.	12848.	26738.	5809.	82359.	79289.
224641.	13950.	28610.	5867.	82359.	93855.
243735.	15147.	30612.	5926.	82359.	109691.
264453.	16447.	32755.	5985.	82359.	126907.
286931.	17858.	35048.	6045.	82359.	145622.
311320.	19390.	37501.	6105.	82359.	165965.
337782.	21053.	40127.	6166.	82359.	188077.
366494.	22860.	42935.	6228.	82359.	212112.
397646.	24821.	45941.	6290.	82359.	238235.

TABLE 3

VIRGINIA LAKES WITHOUT DOMESTIC HOT WATER

<u>NATURAL GAS</u>	<u>GEOHERMAL PUMPING COSTS</u>	<u>GEOHERMAL OPERATION & MAINTENANCE COSTS</u>	<u>GEOHERMAL SYSTEM INSURANCE</u>	<u>LOAN PAYMENT</u>	<u>NET INCOME BEFORE TAXES</u>	<u>PRESENT VALUE AT 15%</u>	<u>TOTAL NEGATIVE CASH FLOW</u>
COST	COST	COST	COST	COST			
415.60	4209.66	9697.55	4155.10	66382.49			
64420.	4610.	10376.	4197.	66382.	-21145.	-18387.	-2114
72280.	5047.	11103.	4239.	66382.	-14492.	-10958.	-1449
31098.	5527.	11880.	4281.	66382.	-6973.	-4585.	-697
30992.	6052.	12712.	4324.	66382.	1522.	870.	
32093.	6627.	13601.	4367.	66382.	11115.	5526.	
14548.	7257.	14553.	4411.	66382.	21945.	9487.	
28523.	7946.	15572.	4455.	66382.	34167.	12845.	-4260
39447.	8628.	16662.	4499.	66382.	43275.	14147.	
51300.	9368.	17829.	4544.	66382.	53177.	15116.	
64161.	10172.	19077.	4590.	66382.	63940.	15805.	
78114.	11044.	20412.	4636.	66382.	75640.	16258.	
93254.	11992.	21841.	4682.	66382.	88357.	16514.	
109681.	13021.	23370.	4729.	66382.	102179.	16607.	
27503.	14138.	25005.	4776.	66382.	117201.	16564.	
46841.	15351.	26756.	4824.	66382.	133528.	16410.	
67823.	16668.	28629.	4872.	66382.	151271.	16166.	
90588.	18099.	30633.	4921.	66382.	170553.	15849.	
15288.	19651.	32777.	4970.	66382.	191507.	15475.	
42087.	21338.	35071.	5020.	66382.	214276.	15058.	
71165.	23168.	37526.	5070.	66382.	239017.	14604.	

199369.