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THE WINE VALLEY INN :

A MINERAL WATER SPA IN
CALISTOGA, CALIFORNIA.

GEOHERMAL-ENERGY-SYSTEM CONCEPTUAL
DESIGN AND ECONOMIC FEASIBILITY
OCTOBER 26, 1981

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WINE VALLEY INN
Calistoga, CA

ALLAN NICHOL
Architect

The Wine Valley Inn

a mineral water spa
in Calistoga, California

This new 55 unit resort will feature complete exercise and health facilities including two large 18' canopied spas with cold plunge and a large swimming pool. Massage and steam will be a part of custom tailored exercise programs.

A juice bar/deli serving natural foods and both a lounge and conference areas shall cater to the individual, family or large groups.

The Wine Valley Inn is a contemporary pioneer in energy management using the most up-to-date techniques for the utilization of Direct Use Geothermal Energy for all heating and cooling requirements.

1.0 GENERAL

1.1 INTRODUCTION

The purpose of this study is to determine the engineering and economic feasibility for utilizing geothermal energy for air conditioning and service water heating at the Wine Valley Inn, a mineral water spa in Calistoga California.

1.2 SCOPE

The study evaluates heating, ventilating, air conditioning and water heating systems suitable for direct heat geothermal application. Due to the excellent geothermal temperatures available at this site, the mechanics and economics of a geothermally powered chilled water cooling system are evaluated. The Wine Valley Inn has the resource potential to have one of the few totally geothermal powered air conditioning and water heating systems in the world. This total concept is completely developed.

The project site has limited fresh water supplies available at present. Therefore, a water plan was prepared to determine the quantity of water required for fresh water well development based on the special requirements of the project.

An economic evaluation of the system is included to justify the added capital investment needed to build the geothermally powered mineral spa. Energy payback calculations are presented.

Direct heat utilization of geothermal power is an application for Energy Management (EM) planning, methods and equipment. A thermal cascade system is proposed to direct the geothermal water through the energy system to first power the chiller, then the space heating system, domestic hot water, the two spas and finally to heat the swimming pool. This report describes the Energy Management strategy required to automatically control this cascade process using industrial quality micro-processor equipment. Energy Management controls are selected to keep equipment sizing at a minimum, pump only the amount of geothermal water needed and be self balancing. The system is proposed to run automatically and to complement the primary purpose of the Inn, which is to be efficient and keep the guests comfortable.

2.0 ANALYSIS OF GEOTHERMAL POTENTIAL

The Geysers-Calistoga Known Geothermal Resource Area (KGRA) lies in the northern part of the California Coast Ranges, in Lake, Mendocino, Napa, and Sonoma Counties. The area is typified by northwest mountain ridges and valleys made up of geologically recent volcanoes and lava flows. The Wine Valley Inn is in the town of Calistoga which is located in the southern part of the KGRA at the end of the Napa valley which runs southeasterly into the San Francisco bay area. It is a one and one-half hour drive from San Francisco on one of the most heavily traveled tourist and holiday routes in California.

Calistoga has been well known for its abundant natural hot springs from early times. Other wells in the immediate area have geothermal water available at temperatures up to 270° F (132° C). See Site Map 1 and Site Specific Table 1. The undeveloped pilot well on the site indicates temperatures of 182° F (83° C) at 330 Ft. The developed well is to be drilled deeper into the primary geothermal aquifer expected at a depth of 500 to 600 FT. Geotechnical surveys conducted by the California Division of Oil and Gas and U.S. Department of Energy (DOE) indicate that the production well should deliver temperatures to 200° F and flows of approximately 100 GPM.

The real factor limiting the development of the geothermal resource in the Calistoga area is related to environmental issues regulating the disposal of the geothermal water rather than its availability. The issue at Calistoga is that the geothermal water is typically somewhat high in total dissolved solids of which boron is of particular concern.

Boron encroachment into agricultural lands in this Napa location has been a problem. The Napa Valley vineyards are premium world class grape producing lands and are limited. The interests of the grape producers will prevail over any environmental problems caused by geothermal activities. Influenced by this, the City of Calistoga has established a Sanitary Code (Calistoga City Ordinance No. 322) that restricts the physical, chemical and biological characteristics of the discharge into the city sewer system. Boron is restricted to 1 Milligram/liter. The geothermal water contains 10 times that amount of boron and cannot be discharged unless treated (See, Exhibit 1). Treating the water would itself produce a brine waste that would have to be disposed of or transported which is too costly to consider.

Site map Calistoga, Calif.

SITE SPECIFIC RESOURCE DATA

CODE NO.	NAME	LOCATION				TEMP. °C	FLOW LITERS PER MIN.	TDS* MG/L	DEPTH METERS	PH**	DATA SOURCES
		Lat.	Long.								
S-4	Mark West Springs	38 32.93N	122 43.20W			31	1	330	-	-	(C)
S-6	Mark West Warm Springs	38 32.95N	122 43.25W			30.6	-	-	-	-	(A)
N-3	Calistoga Power Company Well	38 35.73N	122 36.02W			137	-	-	350	-	(C)
N-4	Pacheteau's Well	38 34.93N	122 34.43W			99	1976	660	46	-	(C)
N-5	Calistoga Hot Springs	38 34.93N	122 34.37W			75	-	710	-	-	(C)
N-6	Well 8N/6W-4F1m	38 34.45N	122 31.90W			81.1-82	-	690	63	-	(A) (C)
N-15	Calistoga Hot Springs	38 34.56N	122 34.22W			50	-	713	-	-	(A)
N-16	Calistoga Power Company #2	38 35.46N	122 36.00W			31.7	-	-	290	-	(A)
N-17	Calistoga Power Company #1	38 35.45N	122 36.02W			137.8	-	-	351	-	(A)
N-18	Calistoga Power Company Pacheteau 1	38 34.57N	122 34.23W			137.8	-	-	610	-	(A)
N-20	Pacheteau Well	38 34.56N	122 34.26W			98.9-100	1968	644-663	46	8.3-9.0	(A)
N-22	Unnamed Well	38 34.57N	122 36.12W			31.1	-	-	-	-	(A)
N-23	Well 8N/6W-7F1m	38 33.83N	122 34.05W			25	-	-	75	7.3	(A)
N-24	Well 9N/7W-25N1m	38 35.67N	122 35.47W			29.5	-	551	45	7.7	(A)
N-25	Well 9N/7W-26R2m	38 35.70N	122 35.77W			43.3	-	470	63	-	(A)
N-37	Capped Geyser, Calistoga Hot Springs	38 36.00N	122 36.00W			100	80	-	-	8.4	(B)
N-40	Calistoga Well	38 35.00N	122 34.40W			99	-	-	-	-	(D)
N-41	Pritchard	38 35.40N	122 35.20W			66	-	-	72	-	(D)
N-42	Pritchard	38 35.40N	122 35.20W			27	-	-	17	-	(D)

This information was prepared by the GRIPS Commission as part of a U.S. Department of Energy Cooperative Agreement DE-FC-03-79ET27194.

LABORATORIES

CHEMICAL ANALYSIS

FOR: A & K DRILLINGSAMPLE SOURCE WELL ATADDRESS P.O. Box 645Wine Valley InnCITY & STATE Petaluma, California 94953DATE-TIME COLLECTED 11-4 80COLLECTED BY A & K Drilling

MAJOR ANIONS	MG/L*	ME/L**	DETERMINATION	MG/L*	DETERMINATION	MG/L*
SO ₄ - Sulfate	9.2		Alkalinity - Total	195.	F-Fluoride	6.2*
Cl - Chloride	130.		Calcium Hardness CaCO ₃	26.	B-Boron	10.
HCO ₃ - Bicarbonate	240		Magnesium Hardness CaCO ₃	9.9	Al-Aluminum	
CO ₃ - Carbonate	< 1.		Total Hardness CaCO ₃	36.	Mn-Manganese	0.15**
NO ₃ - Nitrate-N	0.3		Total Dissolved Solids 180°C	400	Fe-Iron	14.***
			Ag-Silver	< 0.02	Cr-Chromium	0.12***
TOTAL ME/L**			As-Arsenic	0.01	Phenol	
MAJOR CATIONS			Ba-Barium	< 0.5	Grease & Oil	
Ca - Calcium	10.		Cd-Cadmium	< 0.01	Cu-Copper	< 0.05
Mg - Magnesium	2.4		Odor TO # @ 40°C		Heavy Metals (As Group)	
			Color Units		Hg-Mercury	< 0.002
			Turbidity (Turbidity Units)		MBAS	.39
Na - Sodium	140				Pb-Lead	< 0.05
K - Potassium			Hydrogen Ion Concentrate (pH)	7.81	Se-Selenium	< 0.01
					Zn-Zinc	< 0.05
TOTAL ME/L**			Sp. Cond.-Micromhos 25°C	820	SiO ₂	13.

Milligrams Per Liter

Milliequivalents Per Liter

REMARKS: * Concentration over required limits for Fluoride .8-2.0 mg/l

** Recommended limit for Manganese .05 mg/l.

*** Recommended limit for Iron .3 mg/l.

**** Required limit for Chromium .05 mg/l.

APPROVED BY _____

ANALYSIS NO. 1180-11644, 11645, 11646

PROPERTY OWNED BY _____

DATE COMPLETED 11-14-80ANALYST [Signature]

Two environmentally viable alternatives are available to utilize the resource for this project. They are; downhole heat exchangers and pumped re-injection methods. Downhole heat exchangers eliminate the problem of disposal of the geothermal water, since only the heat is taken from the well. The disadvantage of using downhole exchangers in this system is that the crossflow characteristics in the well are unknown making its heat production limits and depletion rate uncertain. Equipment specified for this project require high water flows and dependable inlet temperatures approaching those in the current well. Downhole exchangers do not meet this requirement.

Pumped re-injection methods using compact, easy to clean, efficient surface plate heat exchangers, best meet the requirements for this project. The geothermal water will be re-injected directly after it leaves the plate heat exchanger.

Any economic study of the potential for utilization of this geothermal resource must consider that energy costs charged by the local utility (Pacific Gas and Electric) have consistently been increased at a rate of 20 to 30% per year. The short term prospect indicates that this will continue. Recreational luxury activities such as a spa requiring natural gas energy sources for water heating are certain to be limited by cost, taxation, or may be outright banned by legislation in the future.

This geothermal project will not only avoid energy expenses and produce mineral water, but as an added value, the 'Geothermal Alternate Energy Concept' will be a significant promotional feature of this mineral spa business.

3.00 ECONOMIC FEASIBILITY

The economic feasibility analysis for the proposed Wine Valley Inn geothermal energy system considered both air conditioning and water heating loads. The added investment required to install geothermally powered air conditioning was evaluated against the lower first cost and higher energy expenses of operating a conventional electric/gas system. Service water heating costs for domestic hot water, spa and pool heating were derived directly from the displaced cost of natural gas. (See section 5.01-.04)

3.01 CONCLUSIONS

The geothermal energy system for the Wine Valley Inn will cost more than twice as much as a conventional motel energy system. The system will produce the equivalent of about \$33,000/yr worth of energy at 1982 projected costs. Considering these energy costs avoided, the added investment will be paid back in 7 to 8 years. The geothermal system is economically feasible on this point alone. **However, The economic feasibility of the geothermally powered energy system is academic to the opportunity of the primary business venture proposed here.**

Consider that the Wine Valley Inn will be the contemporary pioneer in bringing up-to-date energy recovery and management techniques to this huge dormant natural Calistoga resource. The total value of the geothermal energy system must consider the added revenue from the business attracted because of its unique alternate energy concept. The American public has become very interested in demonstrations of alternate energy sources. It is expected that this current wave of awareness and the energy display planned for the geothermal mechanical equipment room will provide an attraction that will help create high occupancy levels at the Wine Valley Inn.

The Wine Valley Inn is located on Highway 29 which is a very popular holiday wine country trip from the San Francisco and Sacramento population centers. Occupancy rates for other area inns have typically averaged in the 80 to 90% range. Week-ends and holidays must be booked months in advance. This would indicate that yearly revenues in the \$750,000 to 1,000,000 range can be expected from a modern inn at this site. Competition from remodeled mineral spas or other new inns in Calistoga can be expected.

If we assume that the mineral spa facilities combined with the unique geothermal power theme produces a 10% cash flow advantage (\$75,000 to 100,000/yr increased revenue) for The Wine Valley Inn it is clear that the promotional and advertising value of the geothermal energy system can be several times more valuable than the energy produced.

Therefore, it is concluded that a geothermal energy system is economically attractive for the Wine Valley Inn particularly if the value of the geothermal power demonstration aspect of the project is considered. As years pass and the demonstration value diminishes, the value of the low energy operating expenses will continue to increase the property's value. The primary design goal of the energy system should be directed towards the construction of a quality system of high reliability and long life that can be used as a technically correct show case for marketing and guest information. First and foremost the system must provide for the comfort, convenience, and health spa interests of the paying guests and be an energy production and conservation system second.

3.02 CENTRAL THERMAL ENERGY SYSTEM COST ESTIMATES *

If the Wine Valley Inn is to have a geothermal system it will require a central four pipe hydronic air conditioning system. Conventional slap-in packaged through the wall electric/gas heat air conditioning units and boilers would cost approximately \$200,000 but would exclude the geothermal power possibilities. Therefore the following cost estimates are listed to compare a central system with and without geothermal production equipment:

1. Central plant mechanical room hydronic air conditioning system suitable for utilizing geothermal water including:
 - a) Base estimate for all electric chillers, pumps, and cooling tower.
 - b) Control valves inside piping.
 - c) Central plant micro-processor cascade control, panel, display, & sensors.
 - d) Lobby micro-processor occupancy control of guest room A/C fan coil units. \$138,300
2. Zone fan coil air conditioning units, ventilation and four pipe hydronic distribution system:
 - a) 68 Fan coil delivery units.
 - b) Ventilation fans and ducts.
 - c) Chilled water pre-insul. piping.
 - d) Heating water pre-insul. piping.
 - e) Misc fittings and insulaton \$142,300

Central Thermal Energy System Cost \$280,600

3. Geothermal Energy Production System equipment including:	
a) Geothermal wells with vari-speed control (1 production, 1 injection)	
b) Geothermal vertical turbine pump	
c) Addition for 1 Absorption chiller	
d) Plate exchanger.	
e) Radiant slab piping & controls	
f) Misc Piping and fittings	
Total Geothermal Energy Production System	<u>\$186,650</u>
TOTAL GEOTHERMAL ENERGY SYSTEM COST	\$447,250
COST WITHOUT GEOTHERMAL SYSTEM	<u>\$280,600</u>
ADDED INVESTMENT REQUIRED FOR GEOTHERMAL POWER	<u>\$185,650</u>

* Pool and spa pumps and filters not included in comparison since they would be required for any system.

3.03 LIFE CYCLE ENERGY CASH FLOW ANALYSIS

The following energy economic computer studies (See data file GEO1) are based on complete cash flow projections which consider alternate energy cost avoidance, operating expenses, depreciation, before and after tax considerations, finance costs, inflation and fuel cost escalations. The method of analysis is based on the present value (present worth) concept of comparing discounted income and discounted expense cash flows. The internal rate of return (IRR) is defined as the ratio of these discounted cash flows. The payback is the date at which the IRR becomes positive which or is in other words when the present value of accumulated energy savings income exceeds the present value of accumulated expenses.

The most important consideration for a financial analysis of an energy system concerns the estimates for inflation and for fuel cost escalation rates above the inflation. These cash flow studies assume inflation at 8% per annum. Combined energy (gas/electric) escalation rates are assumed to be 25% the first year (already approved by the California Public Utilities Commission), 6% until the 8th year then 1.5% thereafter. Maintenance costs are increased with inflation. Operation costs, which include geothermal pumping costs, are escalated with the fuel rate increases. These are conservative estimates.

NOV 10 1981

SYLVESTER ASSOCIATES — GEOTHERMAL ENERGY
CASH FLOW ANALYSIS FOR... 15 YEARS FINANCIAL PLAN

GEOTHERMAL ENERGY SYSTEM

CAPITAL INVESTMENT JUSTIFICATION FOR

WINE VALLEY INN,

DATA FILE NAME, GEO1

FINANCIAL DECLARATIONS:

TOTAL CAPITAL INVESTMENT ANALYZED	\$ 186650
GEOTHERMAL ENERGY EQUIPMENT COST	\$ 186650
INITIAL PAYMENT	\$ 0
STANDARD COOLING ENERGY COST	\$ 35664
GEOTHERMAL ENERGY CONTRIBUTION	92.0 %
FIRST YEAR FUEL COST ESCALATION	25.0 %
EIGHT YEAR FUEL COST ESCALATION	6.0 %
LAST YEAR FUEL COST ESCALATION	1.5 %
INFLATION RATE	8.0 %
PRIME RATE	18.0 %
CURRENT INTEREST RATE	12.0 %
EQUIPMENT LIFE	25 YEARS
OPERATION AND MAINT EXPENSE RATE PER YR	3.5 %
INCOME TAX RATE	50.0 %
INVESTMENT TAX CREDIT RATE	25.0 %
INVESTMENT TAX CREDIT	\$ 46663
DEPRECIATION CONSTANT	2

TABLE 1

YEARLY CASH FLOW ITEM	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1996
1. STANDARD ENERGY COST	47433	54074	61644	70274	80113	91328	104114	118690	129966	142313	224034
2. GEOTHERMAL ENERG COST	3795	4326	4932	5622	6409	7306	8329	9495	10397	11385	17923
3. ENERGY COST SAVINGS	43638	49748	56713	64652	73704	84022	95785	109195	119569	130928	206112
4. ACCUML TOTAL SAVINGS	43638	93386	150099	214751	288455	372477	468262	577457	697026	827954	1694546
5. OPER - MAINT EXPENSE	6533	7055	7620	8229	8888	9599	10367	11196	12092	13059	19188
6. DEPRECIATION EXPENSE	24887	21568	18693	16200	14040	12168	10546	9140	7921	6865	3357
7. ACCUMULATED PAYMENTS	26881	53763	80644	107525	134407	161288	188170	215051	241932	268814	403220
8. ACCUML TOTAL EXPENSES	58301	92238	126739	161849	197619	234099	271347	309424	348397	388337	605485
9. DISCOUNTED EXPENSES	52054	27054	24557	22314	20296	18482	16849	15379	14054	12860	8417
10. ACCUML DISCOUNTED EXP	52054	73531	90210	102858	112134	118602	122743	124971	125635	125034	110620
11. RATE OF RETURN (INT)%								0.02	0.12	0.20	0.47
12. IMPROVED NET CASHFLOW	32000	15811	22211	29542	37935	47542	58537	71118	80596	90987	160042
13. ACCUMULATED CASH FLOW	32000	47811	70023	99564	137499	185041	243578	314696	395292	486279	1135723
14. ACCUML DIS CASH FLOW (PRESENT WORTH)	28572	38115	49841	63275	78021	93747	110182	127100	142546	156569	207492
INTERNAL PAYBACK IN	7.90 YEARS										

FILE GEO1

4.0 FRESH WATER SUPPLY ASSESSMENT

Hotel/motel lodging businesses in the U.S. can generally be classified as either; 'interstate lodging' or 'destination hotels'. These lodging facilities vary from providing only basic overnight services to a full complement of services and luxury provisions. The Wine Valley Inn is a 'destination hotel' in the luxury provision class requiring surprising quantities of fresh water. This study was made to determine the amount of fresh water needed to maintain guest comfort and to sustain Inn activities in an efficient uninterrupted manner.

The present Calistoga city water system is inadequate to support growth. As a result, fresh water supplies for this project are limited by a Calistoga moratorium on new city water connections enforced by a very high connection charge. The geothermal water cannot be used directly for potable water due to the Calistoga City Ordinance which prohibits its disposal into the sewer system as discussed in Section 2.0. This situation provides only two practical alternatives for obtaining fresh water; on site fresh water wells and/or geothermal water conversion treatment methods.

4.1 ASSUMPTIONS

Room occupancy of the Wine Valley Inn will average 80%. Each occupied room will have an average of 1.7 guests per room (1). Given 55 rooms, total guest occupancy at the assumed occupancy level shall be approximately 100 guests per day. Water design requirements shall be based on peak daily usage. Storage tanks will be specified to handle hourly peak water demands. All water outlets will be flow regulated. Landscape or exterior water use will be completely controlled. All pool and mineral pool water estimates shall be considered as fresh water demands.

4.2 STATISTICS

Water use in hotels and motels has been carefully studied by the American Hotel & Motel Association (AHMA). These statistics were compiled because both water and energy costs are now a significant part of a hotel or motel's operating expense (see Appendix, Section 7.2). They are the basis of water quantity and water energy use estimates included herein. These statistics included many types and sizes of lodging businesses. The American Society of Heating, Refrigeration, and Air Conditioning applications handbook, The California Title 24 Energy regulations, and the Association of Energy Engineers Guide (11.1-3) were also used as a statistical reference source.

4.3 WATER SUPPLY DEMAND ESTIMATES

According to the AHMA, 'destination hotels' such as Wine Valley have a history of higher water and energy use than interstate hotel/motels given equal occupancy percentages because the time spent at the site and activity levels are higher. The spa, pool and other luxury amenities will also demand higher than average water and energy use patterns. The Wine Valley Inn water quantity estimates were compiled by taking the basic average AHMA statistics for 46 interstate hotel/motels and weighed them to consider the destination nature of the Inn and the extra water demand requirements for the luxury facilities.

The standard basic hotel/motel water consuming features of the Inn include:

- Bathroom facilities for 50 regular guest units
- Bathroom facilities for 5 deluxe guest suites
- Swimming pool including daily make-up water
- Laundry facilities
- Landscape watering (low maintenance)

Two kinds of water use statistics are available for these basic needs. One statistic is the yearly average gallons per day per guest value. The second and most important statistic is peak guest use which will determine the design capacity for the water supply system. Refer to Exhibit 2, in the Appendix, "A General Survey of Water Use for 46 Hotel/motel Properties" located in 13 states. The 'average property' served interstate travelers, had 223 guest rooms, a restaurant/kitchen, laundry and swimming pool. Water used within these properties ranged from a low of 76 gal/guest to a high of 177 gal/guest. No peak month values were given.

Refer to Exhibit 3, which displays water use data for 42 small "Econo-Travel Guest Motel Properties" more in the size range of the Wine Valley Inn. Flow regulation and water management methods are standard policy in these properties. The daily gallon per guest water use ranged from a low of 79 gal/guest to a high of 334 gal/guest. The average and monthly peak water use statistics were:

1. Average for year ----- 140 gal/guest/day
2. Average peak month ----- 165 gal/guest/day
with peaks ranging from 79 to 298 gal/guest/day
excluding highest and lowest records.

These statistics were primarily from interstate hotel-/motels. AGMA information indicates that destination hotels use an average of 15% more water than an interstate lodging. Therefore the adjusted water estimates suitable for basic Wine Valley Inn services would be:

3. Average for year---168 gal/guest/day x 100 =16800 gal/day
4. Estimated Peak use-198 gal/guest/day x 100 =19800 gal/day

The project will also require extra fresh water supplies for the unique water consuming recreational and luxury features of the Wine Valley Inn. The following features were not typical of the hotels and motels from which the previous statistics were derived and therefore need to be added to these basic averages to provide an accurate water supply estimate:

1. Warm and hot mineral water pool daily make-up water
 2. Spa exercise, massage, steam room, shower & toilet
 3. Cooling tower condensate make-up water and supply
 4. Mansion house bar, restrooms, kitchen, & living quarters
 5. Geothermal pump bearing lubrication
- Estimated total extra daily water requirements; 4000 gal/day

Therefore:

The total Wine Valley Inn water use will average-----22800 gal/day and require maximum peak delivery design capacity of 24800 gal/day

The on site well will have to provide 18 gallons per minute on a continuous basis to supply the approximately 25000 gal per day maximum needed. Since demand will vary significantly throughout the day, storage will be required. The following chart based on ASHRAE standards indicates the demand use profile expected for fresh water.

Figure 4.4, Water Use Profile

Based on this profile, a 12000 gallon storage system with provisions for future expansion is planned. A domestic water system pump feeding a 360 gallon accumulator system will be installed to provide a 40 to 80 GPM demand supply.

4.5 WATER TREATMENT

As previously addressed, the geothermal water is not suitable for use directly. However it is desired and necessary to provide limited amounts of geothermal water to mix with or fill the mineral spas. Geothermal water could also provide a source of lubricating water to the geothermal vertical turbine pump. This pump will require about 1 GPM continuously. Oil lubrication of this pump cannot be used because this would pollute the the aquifer into which the geothermal water will be injected.

Both of these limited uses of geothermal water may require treatment to remove the iron which the chemical analysis indicates is in relatively high concentrations (14mg/l, see water analysis, Section 2.3, Exhibit 1). The iron will stain spa tiles and would certainly scale the shaft bearings and enclosure tube if not treated. Greensand filtration will be required to remove the soluble iron and manganese. Greensand filtration will reduce any trivalent or oxidized iron to acceptable levels for introduction to the lubrication lines or spas.

Water disposal from the mineral bath spas will still have to be managed because of the boron. The simplest method would be to regulate mineral spa water discharge to 10% of total daily freshwater input. This would dilute the boron to levels acceptable for the sewer code. If 100% mineral water is used in the spas, each 8500 gallon spa will require four days to completely drain by bleeding it in with the sewer water. This schedule could be accelerated by reducing the mineral mix percent. Since there are two spas, complete draining of one for occasional maintenance will not totally interrupt the spa activities. Perhaps a more suitable arrangement would be to provide a continual mineral water flush to both spas of 2000 gals per day.

The geothermal water could be treated using reverse osmosis equipment to remove the boron and produce potable water in accordance with the California State Drinking Water Standards. This process requires a considerable electric power input to the equipment and requires membrane changeout every three years. The cost, including equipment amortization would be approximately 4 mills/gallon or about \$90/day. This cost cannot be justified. Also the process recovers only 50% of the water leaving a brine which would present the same basic disposal problem.

4.6 WATER HEATING ENERGY REQUIREMENTS

a) DOMESTIC HOT WATER SERVICE HEATING

1. Guest Rooms for 55 units in (BTUH)
both buildings (140 ° F water temp
and an 80 ° F temp. rise)
Peak hourly load @ 350 gal/hr
Max gal/unit = 65 gal/day
Max gal/day = 3575 gal/day
Average gal/unit = 45 gal/day
Average Motel gal = 2475 gal/day
Annual Load @ 903,000 gal/year = 602×10^6 BTU/YR

2. Public Spa/Massage/Showers
in main section (140° F water)
includes 6 showers and 5 basins
Peak hourly load @ 450 gal/hr
Max gal/day = 3600 gal/day
Average gallons = 2880 gal/day
Annual Load @ 1,051,000 gal/year = 701×10^6 BTU/YR
3. Laundry (140 ° F water)
Peak hourly load @ 150 gal/hr
Max gal/day = 1000 gal/day
Average gal/day = 800 gal/day
Annual Load @ 292,000 gal/year = 195×10^6 BTU/YR
4. Kitchens/bar/ and misc (140° F)
Peak hourly load @ 100 gal/hr
Max gal/day = 800 gal/day
Average gal/day = 600 gal/day
Annual Load @ 219,000 gal/year = 146×10^6 BTU/YR
5. Total Domestic Hot Water Heating Summary
Peak hourly flow @ 1050 gal/hr x 1.25 = 1,313 gal/hour
From ASHRAE: Demand Factor = 0.25
Probable demand @ 1313 gal/hr x 0.25 = 328 gal/hr
Average hourly heating load = 219,000 BTUH
Peak hourly heating load = 650,000 BTUH
Total gallons per year = 2.5×10^6 Gal/YR
Total design heat load:
 $\frac{650,000 \text{ BTUH}}{80 \text{ degrees} \times 8.33 \text{ lbs} \times 60 \text{ min}} = 16.2 \text{ Gal/min}$
Annual hot water heating load = 1.64×10^9 BTU
Annual Hot Water Heating Energy Requirements:
at 80 % efficiency = 20,500 Therms/YR
Equivalent natural gas displaced at \$0.42/therm
= \$8610 per year.

(1) See Appendix Section 7.3 for AHMA statistics

5.0 BUILDING DESCRIPTION AND THERMAL LOADS SUMMARY

The Wine Valley Inn will have 55 guest units. Fifty of these units will be in the main motel section. Five delux units will be in the guest mansion house. Construction shall be frame construction on a slab floor. All windows except those in doors shall be double pane glass. Walls shall be insulated with R-11 mineral fiber insulation. Roof insulation shall be R-19. In general the building thermal envelope shall substantially comply and exceed the minimum prescriptive standards set forth in the California (Title 24) Energy Code.

The largest thermal loads at Wine Valley will be related to heating the spas, pool, and for general hot water service required to support the spa activities. The two large outdoor spas and the bathing facilities associated with these activities plus the exercise rooms will require large amounts of energy. In general, guests at Wine Valley will be taking energy baths. This type of business is perfectly suited to the natural hot geothermal waters in Calistoga.

A summary of all the thermal load calculations follows:

a) AIR CONDITIONING LOADS

1. Space heating for motel and mansion house 525,695 BTU
Annual equivalent natural gas displacement* 12,522 Therms/Y
2. Cooling for motel and mansion house 60.3 TON
Annual equivalent elect power displacement 110,605 KWHr

b) OUTDOOR SPA HEATING

1. Peak maintenance load 300,000 BTU
2. Annual load requirements 1.17×10^9 BTU/Y
3. Annual equivalent natural gas displacement* 14,560 Therms/Y

c) POOL HEATING

1. Peak maintenance load 300,000 BTU
2. Annual load requirements 1.06×10^9 BTU/Y
3. Annual equivalent natural gas displacement* 13,400 Therms/Y

d) HOT WATER SERVICE HEATING

1. Guest room annual load	602 x 10 ⁶ BTU/YI
2. Public spa/massage/showers annual load	701 x 10 ⁶ BTU/YI
3. Laundry annual load	195 x 10 ⁶ BTU/YI
4. Kitchens/bar and misc annual load	146 x 10 ⁶ BTU/YI
5. Total Domestic Hot Water Heating	1.64 x 10 ⁹ BTU/YI
Annual equivalent natural gas displacement	20,500 Therms/YI

e) TOTAL WINE VALLEY INN GEOTHERMAL ENERGY SUMMARY

ITEM	DEMAND		HEAT SUPPLY		ANNUAL LOAD BTU/YR X 10 ⁶	UTIL IZAT ION FACTOR
	PEAK	LOAD	GEO-	GEO-WTR		
	BTUH X 10 ³	CLEAN GPM	WATER DELTA T	CASCADE T INLET		
1. Space Heating	526	88	15-20	190	967	.21
2. Absorption Cooling	550	110	8-10	200	722	.15
3. Outdoor Spa Heating	300	5-50	3-20	150-170	1170	.45
4. Swimming Pool Heat	300	5-50	3-20	130-145	1060	.40
5. Domestic Hot Water	650	6	5-15	170-180	1640	.29

* 80% conversion efficiency assumed

5.01 BUILDING HEAT LOSSES

The buildings have extensive window shading provided by the walkway overhangs. Computerized load calculations included a shading analysis for this feature. The results of this analysis showed that this architectural feature is the most significant energy conservation treatment of the structure. It reduces cooling tonnage by 22%.

Total building heat losses were determined by making a complete take-off of the buildings wall, window, roof and floor areas from the drawings. Loads were prepared by zone or zone groups based on the activities and orientation of the zone. These loads as follows were calculated in compliance with California Title 24 standards and the American Society of Heating, Refrigeration and Air conditioning Engineers (ASHRAE) 90-75 standard methods:

- (BTUH)
- a) Main motel section public areas
including; spa, exercise room,
massage, lockers, baths and lobby.
Forced air and radiant slab heat.
Subtotal 135,453
 - b) Main motel guest rooms
includes 50 rooms
Zone hot water fan coil units.
Subtotal 255,693
 - c) Mansion house; including bar,
living quarters and 5 guest rooms
Forced air and radiant slab heat.
Subtotal 134,549
- TOTAL SPACE HEATING LOAD 525,695 BTUH
- d) Total peak design heat load:

$$\frac{588,742 \text{ BTUH}}{12 \text{ degrees} \times 8.33 \text{ lbs} \times 60 \text{ min}} = 87.65 \text{ Gal/min @ } 160^{\circ} \text{ F}$$
 - e) Annual equivalent gas heating energy requirements;

$$\frac{525695 \text{ BTUH} \times (24 \text{ Hr/day}) \times (2918 \text{ degree F Day/Yr})}{(42^{\circ} \text{ F delta Temp}) \times 100000 \text{ BTH/therm} \times .70 \text{ effy}} = 12,522 \text{ therms (equivalent natural as) } \times 1.15 \text{ S.F.}$$
 - f) Annual equivalent natural gas replacement cost @\$.42/
therm =\$ 5259/yr

5.02 BUILDING COOLING LOADS

(TONS)

- a) Main motel section public area
including; spa, exercise room,
massage, lockers, baths and lobby.
Forced air ventilation and cooling.
Subtotal 12.0
 - b) Main motel guest rooms
Includes 50 rooms
Zone chilled water fan coil units.
Subtotal 34.5
 - c) Mansion house, including bar,
living quarters and 5 guest rooms
Forced air ventilation and cooling.
Subtotal 13.8
- TOTAL SPACE COOLING REQUIRED 60.3 TONS
- d) Geothermal water at 205 degrees 110 gal/min
to replace tons (75%) of conventional cooling
would extract 550×10^3 BTUH of Geothermal Energy.
 - e) Annual equivalent electric cooling energy requirements;
 $60.3 \text{ tons} \times 1.1 \text{ KW/ton} \times 1450 \text{ M.F.L.C.H.} \times 1.15 \text{ S.F.}$
 $= 110605 \text{ KWhrs}$
 - f) Annual equivalent electric cooling costs at @
 $\$0.067/\text{KWhr} = \$ 7410$

5.03 POOLS AND SPAS

Heating for spas and pools will be cascaded from the last sections of the primary plate heat exchanger. Loads for both the spas and pool can be separated into two types; peak loading (bringing the water to temperature) and maintenance loads (keeping the water at temperature due to losses). Of these the peak warm-up loadings far exceed the maintenance loads and define the heat exchanger size and performance. These peak loads are also deferrable. The energy management controls will schedule these peak loads during times when other loads are at a minimum. This energy management strategy will keep equipment sizing and cost down.

Maintenance loads, on the other hand, define the energy consumption and operating cost for the systems. While these loads represent a smaller porportion of the total BTU/Hr demand of the system, their utilization factors (percent of time required) accumulate the majority of the annual energy required.

a) OUTDOOR SPA HEATING

- 1) Peak maintenance load for two 18x18 FT
8760 Gal, 292 SQ-FT Spa Pools,
at 100 & 105°F. = 133,000 BTUH
- 2) Initial warm up load
for 3 to 5 hours = 1.20×10^6 BTUH
- 3) Annual load requirements = 1.17×10^9 BTU
- 4) Equivalent natural gas = 11,650 therms/YR
- 5) Equivalent displaced natural gas
cost at 80% efficiency = \$6116/YR

c) POOL HEATING

- 1) Peak maintenance load for one 20 x 40 FT
768 SQ-FT Swimming Pool at 80°F. = 250,000 BTUH
- 2) Average daily load = 2.9×10^6 BTU
- 3) Annual load requirements = 1.06×10^9 BTU
- 4) Equivalent natural gas = 10,718 Therms/YR
- 5) Equivalent displaced natural gas
cost at 80% efficiency = \$5627/YR

6.0 MECHANICAL ENERGY SYSTEMS

The Wine Valley Inn will have a central heating, ventilating and cooling system. All heating and a significant portion of the cooling energy needs will be derived from the geothermal resource as well as the domestic hot water heating system, spa heating, and swimming pool heating. Space heating to public areas will be through a combination of radiant slab floors and fan coil air systems. Heating and cooling space conditioning to individual guest rooms will be through a four pipe hot water and chilled water fan coil units. A microprocessor energy management system will control and optimize the equipment.

6.01 CHILLERS AND ABSORPTION COOLING CONSIDERATIONS

The chilled water cooling system shall be a two stage arrangement using an absorption chiller with an electric reciprocating second stage. Cooling will be provided from geothermal water from the hottest first stage of the plate heat exchanger cascade process. The Arkla 'Solair 300' absorption chiller has been selected as the primary first stage cold generator (See appendix section 7.1). Chiller number 2 shall be a Trane Model CGWA040M Water cooled reciprocating dual compressor unit. Condenser cooling for both chillers will be provided with a packaged 75 ton evaporative cooling tower.

The absorption chiller performance is rated at the geothermal water temperature minus 5 degrees which is the heat exchanger temperature approach that will transfer the energy to clean geo-heated water which will drive the chiller. This product was developed for low temperature solar applications and performs in the 165 to 195 degree F temperature range at flows of about 90 GPM. The geothermally heated water is expected meet these input flow requirements.

The simplest and most commonly used method of estimating building cooling energy requirements is the 'equivalent full load cooling hour method'. With this method, the equipment is sized to meet 97.5% (peak load) of all weather conditions. Total energy is estimated by taking the peak load calculated (see Section 5) and multiplying it by an equivalent full load hour value taken for the Calistoga area from an ASHRAE manual or code book. This energy estimation method is fine except it does not tell us when the cooling system is used at partial load or how to manage it.

The cooling energy yearly load profile (Figure 6.01) was derived from Saint Helena weather histories to estimate the percent of the total yearly energy consumption that can be provided at partial loading. This profile shows that peak loads occur only a small percent of the year and that geothermal power can supply 73% of the total cooling energy while operating at 1/2 of its peak design load.

Figure 6.01, Total cooling load profile

Total yearly energy costs for the buildings, based on the equivalent full load cooling hour method and American Hotel Motel Association statistics estimate that the electric cooling cost will be \$ 7410/year based on a \$0.067 KWhr electric rate which includes fuel cost adjustments and a demand charge estimate. (See Section 5.02 (f))

Two computer cash flow analysis were made to compare the added cost to provide partial cooling (See Data Case 1) with total absorption cooling (See Data Case 2) to a conventional electric compressor system. A summary of these results is found in Table 1:

T A B L E 1

ABSORPTION COOLING INVESTMENT COMPARISON

	Case 1	Case 2
1. Absorption added cost differential	\$ 20650	30900
2. Geothermal cooling contribution, percent	73 %	99 %
3. Payback based on internal rate of return	4.9yr	6.6yr
4. Present worth of free cooling over 15 years	\$ 36057	46798

This economic analysis indicated that little is gained from designing for 100% geothermal cooling since the second absorption chiller would only be needed 27% of the time. It was determined that the most economical and practical situation would be to provide the absorption chiller to handle up to the first 25 to 30 tons of cooling in conjunction with an auxiliary conventional reciprocating type chiller which would provide peak load and would also provide an auxiliary standby system.

NOV 4 1981

SYLVESTER ASSOCIATES—GEOTHERMAL ENERGY
CASH FLOW ANALYSIS FOR... 15 YEARS FINANCIAL PLAN

GEOTHERMAL ENERGY SYSTEM
CAPITAL INVESTMENT JUSTIFICATION FOR
WINE VALLEY INN, DATA FILE NAME, CASE1

FINANCIAL DECLARATIONS:

TOTAL CAPITAL INVESTMENT ANALYZED \$ 20650
ABSORPTION COOLING EQUIPMENT COST \$ 20650
INITIAL PAYMENT \$ 0
STANDARD COOLING ENERGY COST \$ 7410
GEOTHERMAL ENERGY CONTRIBUTION 73.0 %
FIRST YEAR FUEL COST ESCALATION 25.0 %
EIGHT YEAR FUEL COST ESCALATION 6.0 %
LAST YEAR FUEL COST ESCALATION 1.5 %
INFLATION RATE 8.0 %
PRIME RATE 18.0 %
CURRENT INTEREST RATE 12.0 %
EQUIPMENT LIFE 25 YEARS
OPERATION AND MAINT EXPENSE RATE PER YR 7.1 %
INCOME TAX RATE 50.0 %
INVESTMENT TAX CREDIT RATE 25.0 %
INVESTMENT TAX CREDIT \$ 5163
DEPRECIATION CONSTANT 2

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YEARLY CASH FLOW ITEM	TABLE 1									
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1. STANDARD ENERGY COST	9855	11235	12808	14601	16645	18976	21632	24661	27003	29569
2. GEOTHERMAL ENERG COST	2661	3033	3458	3942	4494	5123	5841	6658	7291	7984
3. ACCUML TOTAL SAVINGS	7194	15396	24746	35405	47556	61408	77199	95201	114914	136499
4. OPER - MAINT EXPENSE	1466	1583	1710	1847	1995	2154	2327	2513	2714	2931
5. DEPRECIATION EXPENSE	2753	2386	2068	1792	1553	1346	1167	1011	876	759
6. ACCUMULATED PAYMENTS	2974	5948	8922	11896	14870	17844	20818	23792	26766	29740
7. ACCUML TOTAL EXPENSES	7193	11751	16435	21256	26225	31353	36654	42140	47828	53733
8. ACCUML DISCOUNTED EXP	6423	9368	11698	13509	14881	15884	16580	17020	17247	17301
9. RATE OF RETURN (INT)%					0.01	0.11	0.20	0.28	0.34	0.39
10. ACCUMULATED CASH FLOW	5163	8807	13473	19311	26493	35217	45708	58224	72248	87928
11. ACCUML DIS CASH FLOW (PRESENT WORTH)	4610	7021	9590	12272	15033	17842	20676	23515	26053	28311
INTERNAL PAYBACK IN 4.90 YEARS										

FILE CASE1

NOV 4 1981

SYLVESTER ASSOCIATES-----GEOTHERMAL ENERGY
CASH FLOW ANALYSIS FOR... 15 YEARS FINANCIAL PLAN

GEOTHERMAL ENERGY SYSTEM
CAPITAL INVESTMENT JUSTIFICATION FOR
WINE VALLEY INN, DATA FILE NAME, CASE2

FINANCIAL DECLARATIONS:

TOTAL CAPITAL INVESTMENT ANALYZED \$ 30900
ABSORPTION COOLING EQUIPMENT COST \$ 30900
INITIAL PAYMENT \$ 0
STANDARD COOLING ENERGY COST \$ 7410
GEOTHERMAL ENERGY CONTRIBUTION 99.0 %
FIRST YEAR FUEL COST ESCALATION 25.0 %
EIGHT YEAR FUEL COST ESCALATION 6.0 %
LAST YEAR FUEL COST ESCALATION 1.5 %
INFLATION RATE 8.0 %
PRIME RATE 18.0 %
CURRENT INTEREST RATE 12.0 %
EQUIPMENT LIFE 25 YEARS
OPERATION AND MAINT EXPENSE RATE PER YR 7.1 %
INCOME TAX RATE 50.0 %
INVESTMENT TAX CREDIT RATE 25.0 %
INVESTMENT TAX CREDIT \$ 7725
DEPRECIATION CONSTANT 2

TABLE 1

YEARLY CASH FLOW ITEM	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1996
1. STANDARD ENERGY COST	9855	11235	12808	14601	16645	18976	21632	24661	27003	29569	46548
2. GEOTHERMAL ENERG COST	99	112	128	146	166	190	216	247	270	296	465
3. ACCUML TOTAL SAVINGS	9757	20879	33559	48014	64493	83279	104695	129109	155842	185115	378869
4. OPER - MAINT EXPENSE	2194	2369	2559	2764	2985	3224	3481	3760	4061	4386	6444
5. DEPRECIATION EXPENSE	4120	3571	3095	2682	2324	2014	1746	1513	1311	1136	556
6. ACCUMULATED PAYMENTS	4450	8900	13351	17801	22251	26701	31152	35602	40052	44502	66753
7. ACCUML TOTAL EXPENSES	10764	17584	24593	31807	39242	46916	54847	63057	71568	80404	130442
8. ACCUML DISCOUNTED EXP	9611	14018	17505	20214	22267	23769	24810	25468	25808	25888	23831
9. RATE OF RETURN (INT)%							0.05	0.15	0.22	0.28	0.49
10. ACCUMULATED CASH FLOW	6718	11021	16691	23933	32976	44088	57572	73776	91999	112436	256151
11. ACCUML DIS CASH FLOW (PRESENT WORTH)	5998	8786	11881	15210	18712	22336	26043	29797	33176	36201	46798
INTERNAL PAYBACK IN	6.60 YEARS										

FILE CASE2

6.02 PLATE HEAT EXCHANGER

The primary geothermal heat exchanger shall be a multi-plate "Paraflo" unit manufactured by APV Company Inc. or approved equal. The exchanger shall be multi-circuited for 5 separate cascaded water heating services. Water temperatures needed to operate the heating and cooling systems will require a 5 degree approach to the current well temperatures. Plate heat exchangers meet this specification. Other advantages of the plate exchangers are; they use less space than tube and shell systems, they are easy to clean, they are expandable and adjustable. Exchanger shall be performance rated for all water service as follows:

A. Materials of construction:

1. Plates Type 316 stainless steel.
2. Gaskets Neoprene
3. Nozzles Type 316L
4. Frame & bars. . Carbon stl. epoxy painted or chrome plated

B. Performance:

1. Hot water supply flow side 60 to 90 GPM Max
(195 °F supply inlet temp) 60 GPM Min
2. Heated water circuit 1 HVAC
a. Inlet temp. 178 °F (5 degree approach in 1st
b. Outlet temp. 190 °F circuit)
c. Flow 60 to 100 GPM Max
3. Heated water circuit 2 DHW
a. Inlet temp. 60 °F
b. Outlet temp. 140 °F
c. Flow 10 to 33 GPM Max
4. Heated water circuit 3 SPA1
a. Inlet temp. 75 °F
b. Outlet temp. 115 °F
c. Flow 20 to 95 GPM Max
5. Heated water circuit 4 SPA2
a. Inlet temp. 70 °F
b. Outlet temp. 110 °F
c. Flow 20 to 95 GPM Max
6. Heated water circuit 5 POOL
a. Inlet temp. 70 °F
b. Outlet temp. 80 °F
c. Flow 20 to 95 GPM Max

6.03 HVAC AIR CONDITIONING COILS AND SERVICE WATER PIPING

The Wine Valley Inn's primary heating delivery system shall consist of multiple fan coil units in all zones. Geo-heated water shall be pumped to these locations in pre-insulated pipe. Pipe from the mechanical rooms to all buildings and locations shall be buried and stubbed out through the slab floors at designated locations. All heating pipe shall be pre-insulated metal core Johns-Mansville Copper Core Temp-Tite pipe or approved equal.

The Wine Valley primary cooling delivery system shall consist of multiple fan coil units at all zone locations. Chilled water shall be pumped to these locations in pre-insulated pipe. Pipe from the mechanical rooms to all buildings and locations shall be buried and stubbed out through the slab floors at designated locations. All underground insulated pipe shall be Johns-Manville Kool Kore PVC Pressure Pipe with Ring Tite joints or approved equal. Underslab pre-insulated pipe shall be Copper Core Temp-Tite pipe to contract specifications.

6.04 POOL AND SPA HEATING SYSTEM AND SERVICE PIPING

The Wine Valley pool and spa water to be heated shall be pumped to the primary central heat exchanger in the mechanical room in pre-insulated pipes. Pipe from the mechanical rooms and to the pool shall be buried or contained in underfloor enclosures. All underground insulated pipe 1-1/2" to 4" shall be Johns-Manville Kool Kore Pressure Pipe.

6.05 GEOTHERMAL WATER SYSTEM AND PIPING

The Wine Valley Inn's thermal energy systems (heating and cooling) shall be 91% powered by geothermal power. The geothermal water shall be pumped from the geothermal aquifer, passed through the primary plate heat exchanger and then be immediately re-injected back into the ground without being exposed to air, other service water or pollutants.

Pipe from the geothermal well to the primary heat exchanger shall be ASTM A120-69 Schedule 40 black steel welded flange insulated pipe. Pipe from the primary heat exchanger to the injection well shall be ASTM PB2110, IPS size Polybutylene pipe, Shell Series 160 (SDR 13.5) or approved equal.

6.06 FIELD INSTALLED PIPING INSULATION

All hot water, chilled water, and condenser coolant pipe above ground exposed and interwall pipe shall be insulated with 1" of foam insulation with an overall equivalent minimum R value of 3.7. All insulated geothermal, geo-heated, HVAC service and domestic hot water pipe shall be protected with American Standards Institute color coded PVC jackets and fitting covers

6.07 RADIANT SLAB AND FLOOR PIPING

For guest comfort, heating efficiency and as a part of the geothermal energy theme of the Wine Valley Inn slab floors in the public areas shall have continuous lengths of Shell "Duraflex" polybutylene heating pipe in the concrete. This will include the first floor lobby and spas of the main section and the first floor lobby, bar, meeting rooms and living quarters of the mansion house building.

Geo-heated water from the central system shall be circulated through various zones. Each zone will have thermostat control of its slab. Radiant slab heat shall be the first heating stage with second stage heating being available from the fan coil units.

6.08 MICRO-PROCESSOR ENERGY MANAGEMENT CONTROL SYSTEM

The microprocessor central plan energy management controller shall provide the necessary control program to operate the hydronic system as a variable volume system. It shall read the temperatures in the primary plate heat exchanger and increase or decrease the speed of the geo-well water pump to meet the demand. It shall monitor the performance of the geothermally driven absorption chiller and activate the necessary stages of the auxiliary electric compressive chillers to meet demand.

The EM program shall perform the necessary computations on a continuous basis to provide BTU accounting information for display and guest promotional information of natural geothermal energy. This information shall be retrievable either on a continuous or data memory report basis.

One panel (wall) mounted ASCII 19" video monitor with detached keyboard shall be permanently mounted at the center control station in the mechanical room. One desk type ASCII 12" video monitor CRT to be placed in the lobby to serve the guest room control and overall Wine Valley Inn energy system status and control needs. The program will have a monitoring program than will sample pressures and temperature and activate an alarm to call for maintenance.

Performance specifications shall be based on microprocessor control equipment by Andover Control Co. and control components by Johnson Control Penn Division. The system shall basically provide the following features, functions and capabilities:

1. The controller shall provide adaptive control of 48 drivers.
2. Uninterruptable Real Time Clock. Rechargeable battery backup included shall provide a four-day power loss capability. The system shall be programmed to automatically correct the clock for day light savings time and leap years.
3. Provide power failure program protection and start-up management of drivers. The system shall without human intervention upon restoration of power; update all functions, resume operation on current time and status and implement special building start-up strategies as required.
4. The controller shall sense all inputs, test for multiple input programmed conditions, and execute the appropriate action or adaption on valves, pumps, fans, actuators and/or motors of the energy systems.
5. The controller shall have the capability of being programmed to examine its inputs for emergency condition for alarm and to be capable of automatically initiating the actuation of the appropriate mode. The operator through a terminal shall be capable of overriding the programmed control sequence to manually operate the equipment.
6. The controller shall have the capacity to log operational, environmental and product temperature data for equipment as percent time of input/output activity, average temperatures, average pressures, flow rates analogs and display BTU calculations.
7. The controller status shall be accessible through a ASCII telephone communications channel to provide remote status, operation and maintenance and/or trouble shooting of the system.

APPENDIX 7.1

WATER USE - 46 Properties/1978

46 properties located in 13 states and D.C.

A total of 10,250 guest rooms (37,400,000 available rooms/yr)

The 46 properties had 2,514,000 occupied rooms in 1978 and consumed a total of 601.6 million gallons of water, or an average of 239.2 gallons of water per occupied room.

(140.71 Gal/day

The average size property was 223 guest rooms and had a restaurant/kitchen, laundry and swimming pool. Water use within the 46 properties ranged from a low of 129 gallons per occupied room to a high of 301 gallons per occupied room.

76 gal/guest

177 gal/guest

(From data on file at the Energy Technical Center) 12/17/79

Exhibit 2-1

Water Use - 1978
46 Hotel/Motel Properties

<u>Property Location</u>	<u>No of Rooms</u>	<u>No of Occupied Rooms</u>	<u>Water Use (Gals)</u>	<u>Water Use Per Occupied Room (Gals)</u>
Illinois	500	129,948	28,298,731	217.8
Illinois	526	125,217	24,711,831	197.4
Illinois	586	158,271	34,101,355	215.5
California	405	124,911	27,815,491	222.7
Hawaii	635	92,720	50,410,341	543.7
Hawaii	311	29,706	8,384,892	282.3
Hawaii	247	81,007	12,446,803	153.7
West Virginia	208	54,976	26,127,142	475.2
Illinois	249	64,623	18,188,835	281.4
Missouri	200	52,925	8,040,041	151.9
Kansas	167	42,855	10,156,274	237.0
Missouri	237	49,172	13,790,301	280.4
Missouri	243	61,651	14,420,907	233.9
Indiana	155	44,646	6,223,776	139.4
Indiana	209	52,405	9,687,995	184.9
Missouri	162	45,995	10,744,990	233.6
Missouri	166	40,423	5,611,123	138.8
Oklahoma	223	54,953	10,042,571	182.7
Indiana	161	38,209	6,736,938	176.3
Illinois	213	62,568	11,470,598	183.3
Missouri	262	38,519	12,028,644	312.3
Missouri	156	68,194	18,344,430	269.0
Ohio	169	46,383	7,600,188	163.9
Michigan	216	25,631	9,219,716	359.7
Michigan	153	47,227	7,469,279	158.1
Michigan	212	59,615	10,119,620	169.7
Ohio	249	64,261	15,741,216	245.0
Michigan	149	44,636	8,613,795	193.0
Michigan	199	27,761	7,013,717	252.6
Ohio	148	40,080	7,802,161	194.6
Michigan	153	44,554	9,317,710	209.1
Ohio	197	52,592	6,792,294	129.1
Ohio	248	62,405	16,314,970	261.4
Ohio	149	44,202	7,278,526	164.7
Ohio	140	36,182	4,971,540	137.4
Michigan	155	47,844	9,685,003	202.4

Water Use - 1978
46 Hotel/Motel Properties
 (Cont'd)

<u>Property Location</u>	<u>No of Rooms</u>	<u>No of Occupied Rooms</u>	<u>Water Use (Gals)</u>	<u>Water Use Per Occupied Room (Gals)</u>
Michigan	107	32,897	5,386,108	163.7
Virginia	130	34,638	7,873,226	227.3
North Carolina	132	37,477	7,474,515	199.4
South Carolina	177	56,484	13,555,414	240.0
District of Columbia	145	45,391	13,667,621	301.0
North Carolina	168	32,594	9,383,539	287.9
South Carolina	265	81,605	20,872,839	255.8
South Carolina	122	47,743	9,143,415	219.0
New Hampshire	135	36,658	10,413,604	284.1
North Carolina	110	37,717	11,202,048	297.0
46 Properties	10,249	2,514,383	601,553,384	239.2 gal/room

Based on 1.7 guests room, Average = 141 gal/guest

Note: All of the above listed hotels/motels have kitchens, laundries and swimming pools.

The above data is based on records on file at the

Energy Technical Center
 Hospitality, Lodging & Travel
 Research Foundation, Inc.
 Ste 169W, 84 N. E. Loop 410
 San Antonio, TX 78216

Exhibit 2-3

Small (48 guest room) Motel.
 - laundry, but no kitchen.
 Representative of guest room was only.

	CULPEPER	TAMPA	LEXINGTON	RICHMOND	GAINES	DANVILLE	MELDON	JARVIS	HARRIS	CHLOTT	COLCHAS	COLMORN	WOLF865	VABCHBO	CHSHONT	CHSVAN	MYRTCH	GREENSC	GREENBO	FINLAY
JAN	56	84	125	117	71	56	147	121		334	104	99	128		222	63	155	171	293	69
FEB	79	78			63	75	122	131	77	152	76	106		114	206	67	299	165		
MAR	58	92	83	99	66	58	49	133		156	96	98	92	125	152	60		119		68
APR	64	123			77	47	70	123	75	186	80	106			139	66	221	97	92	
MAY	55	250	81	59	98	62	87	187		185	82	73		133	154	55		95		82
JUN	55	220			101	49	91	199		217	87	93	86		130	74	81	121		
JUL	55	160	58	60	106	65	103	209		135	112	88		128	104	69		177	135	55
AUG	54	117			94	48	153	182	183	169	154	93	74		112	76	130	156		
SEP	62	123	66	77	139	56	139	199		147	84	74		151	126	79		284		81
OCT	63	121			105	60	86	132		176	108	77			152	70	278	260	101	
NOV	61	111	94	128	94	64	126	112	134	119	176	92	163	165	179	106		98		81
DEC	56	158	113	34	110	48	116	99		106	53	116		104	110	115	269	98	95	135
AVERAGE FOR YEAR	60	128	77	77	89	57	102	145	111	169	99	92	98	138	144	73	159	150	117	72
GUESTS PER ROOM	1.67	1.56	2.00	2.06	1.86	1.75	1.99	1.55	1.66	1.44	1.57	1.45	1.55	1.82	1.80	1.72	2.01	1.45	1.57	1.66
COST W/S PER 1000 GALLONS **	\$ 5.05	\$ 1.66	\$ 2.77	\$ 1.90	\$ 2.38	\$ 1.07	\$.93	\$ 1.53	\$ 1.71	\$ 1.16	\$ 1.21	\$ 1.25	\$ 1.38	\$ 1.91	\$.48	\$ 1.04	\$ 1.09	\$ 1.11	\$.95	\$.77

NOTES: * Have a Swimming Pool
 ** W/S - Cost of water & Sewage Combined

GALLONS PER GUEST ECONO-TRAVEL WATER USAGE EVALUATION GUIDE

60 - 69	OUTSTANDING
70 - 79	EXCELLENT
80 - 90	ACCEPTABLE
90 - 120	Unusual Local Circumstances or some wastage may be responsible.
121 - UP	Something is Definitely Wrong!! Needs Attention.

WATER USAGE 1979

(GALLONS PER GUEST)

3/80

	CULPEPR.	TAMPA	LEXTON	RICHMIL	GAINES	DANVILLE	MELDON	JARVIS	HARRISPA	CHLOTTE *	COLCHAS	COLMORW	NORF865	VABCHBO	CHSHANT	CHSVAN	FINLAY	YOUNGTN	MYRTCH *	GREENSC	GREENBO	FREDDY
JAN	78	136	105	33	124	56	124	80		91	150	76		107	101	87	133	44	263	126	218	
FEB	60	81		64	72	56	95	108	115	161	89	130	166		95	96			207		168	94
MAR	60	80	105		114	62	56	105		69	112	113		95	95	79	74	28	142	71	153	
APR	59	82		59	97	59	117	91		104	84	109	78		81	93			298		131	79
MAY	50	103	79		106	78	91	144	72	92	88	114		91	93	64	69		166		127	
JUN	69	165		72	77	74	106	93		109	76	139	68		71	79		81	74	71	138	
JUL	83	140	75		106	73	135	104		99	78	107		175	59	65	73		119		146	
AUG	123	92		72	93	67	75	89	82	135	75	140			63	70			140		59	57
SEP	105	98	71		99	87	126	132		163	116	119		161	72	92	71	52	206	77	63	
OCT	105	94		77	77	108	146	101		166	127	130	76		83	111			145		62	58
NOV	61	106	83		75	185	141	99	87	113	118	203		69	81	119	87		128	67	63	
DEC	59	108	115	79	48	114	174	104		181	102	105	138	117	72	123		56	188		68	93
AVERAGE FOR YEAR	79	103	84	67	86	81	113	104	89	123	99	126	93	132	79	89	78	59	154	74	99	70
GUESTS PER ROOM	1.71	1.71	1.86	1.97	1.81	1.66	1.96	1.61	1.68	1.60	1.53	1.67	1.58	1.80	1.74	1.65	1.61	1.76	1.91	1.80	1.36	1.85
COST W/S PER 1000 GALLONS	\$5.18	\$ 1.68	\$ 2.77	\$ 1.94	\$ 2.58	\$ 1.19	\$ 1.21	\$ 1.52	\$ 1.60	\$ 1.18	\$ 1.17	\$ 1.08	\$ 1.18	\$ 2.00	\$.80	\$ 1.22	\$.93	\$ 1.75	\$ 1.66	\$ 1.00	\$ 1.22	\$ 1.73

NOTES: * Have a Swimming Pool
 ** W/S - Cost of Water & Sewage Combined
 *** Does not have a laundry

ECONO-TRAVEL WATER USAGE EVALUATION GUIDE

60 - 69	OUTSTANDING
70 - 79	EXCELLENT
80 - 90	ACCEPTABLE
91 - 120	Unusual Local Circumstances or some wastage may be responsible
121 - UP	Something is Definitely Wrong!! Needs Attention.

APPENDIX 7.2

LEGEND

	STAMPED CONCRETE GDS DETAIL # 30
	ASPHALT PAVING 4" RND HBR 6000 GDS DETAIL #
	ASPHALT PAVING 4" CONC CURB BOARD GDS DETAIL #
	BLACK WALL GDS DETAIL # 14
	PICNIC TABLE MODEL # 600 GDS DETAIL # 14
	POST MOUNT - MODEL # 955/D/20' HIGH RAIL & WCL FORM (G B, 231157)
	SPLIT LIGHT - MODEL # 9055N RAIL & RAIL LIGHTING (G B) 2579339
	WALKWAY LIGHT - MODEL # 9555/D/20' HIGH RAIL & WCL FORM (G B) 2251157

GEOTHERMAL ROOM & WELL

MULTIPLE ACCESS WAY
PER ARCH DRWG

EXISTING EXISTING EXISTING

Lake St.

Road

VIEW

CITY 600/400
PER ARCH DRWG

Mansion House

Rec. Area

REFER TO GDS # 1-5
PER REC AREA DETAIL

SPR 1

SPR 2

NOTES

1. REFER TO ARCH DRWG - GDS # 1-5 PER SITE GDS NO.
2. REFER TO ARCH DRWG FOR ROADWAY AND SIDEWALK IMPROVEMENTS.
3. CONTRACTOR SHALL NOTIFY ADEQUATE SURFACE DRAINAGE MAY FROM BLDG, WALKS, HALLS PER ARCH DRWG.

State Route 29

SITE

PLAN

PLAN- MECHANICAL ROOM & HVAC SERVICE PIPING

C ELEVATION C-C MECHANICAL ROOM EAST ELEVATION VIEW OF DRIVE THRU SECTION

NOTES: MECHANICAL ROOM DISPLAY AREA

1. THE MECHANICAL ROOM SHALL BE A GEOTHERMAL DISPLAY AREA CONSTRUCTED TO INFORM AND PROMOTE THE DIRECT HEAT GEOTHERMAL RESOURCE FOR ENERGY AND RECREATIONAL PURPOSES.
2. ALL GEOTHERMAL, GEOTHERMAL, HVAC SERVICE AND DOMESTIC HOT WATER PIPE SHALL BE INSULATED WITH CORAL-CELL 300 INSULATION WITH AMERICAN STANDARDS INSTITUTE COI CODED PVC JACKETS AND FITTINGS PER THE FOLLOWING SCHEDULE:
 GEOTHERMAL SUPPLY WATER RED
 GEOTHERMAL RETURN WATER YELLOW
 GEOTHERMAL HVAC SERVICE WATER GREEN
 CHILLED HVAC SERVICE WATER BLUE
 POOL WATER HEATED SERVICE BLUE
 SPA HEATING AND DOMESTIC HOT WATER WHITE
3. ALL PIPING WILL BE SUPPORTED AND ORIENTED TO 1 INCHES PER FOOT SLOPE POSSIBLE AND BE PER CODE MARKED WITH A PERMANENT PRINTED LABEL FOR PIPE CONTENT, FUNCTION, SOURCE, DIRECTION, DIRECTION FOR DISPLAY AND INSTRUCTIONAL PURPOSES.
4. THE PRIMARY PLATE HEAT EXCHANGER SHALL BE INSTALLED MAINTENANCE OF PLATES CAN BE EASILY ACCOMPLISHED FROM THE FRONT BY GULLY PLATES, PLATE AND GULLY REMOVAL.
5. METAL PAINTED OUTSIDE 12\"/>

4/10/81

A SECTION A-A DIRECT HEAT GEOTHERMAL MECHANICAL SYSTEMS AND DISPLAY AREA

SCALE 1/2\"/>

SYLVESTER & ASSOCIATE
 P. O. Box 1327
 SANTA ROSA, CALIFORNIA 95406
 (707) 523-3228

Plate heat exchanger (source: APV Co., Inc.).

ARKLA[®] solaire[®] 300 WATER CHILLER

SUN POWERED AIR CONDITIONING

CYCLE OF OPERATION

The Arkla SOLAIRE[®] 300 Water Chiller operates on the absorption principle. Solar heated water is the energy source, circulating in a closed loop between the unit's generator and the solar collectors. In a second closed loop, the refrigeration tonnage is delivered by chilled water which circulates between the unit's evaporator coil and a refrigeration load. In a third water circuit, condensing water flows through the unit's absorber and condenser coils, carrying away the waste heat.

To begin the cycle, solar heated water enters the generator tubes. Its heat vaporizes part of the water refrigerant in solution, separating it from the lithium bromide absorbent.

The vaporized refrigerant passes to the condenser where it gives up its latent heat to the condensing water and is liquefied. It then flows through a "U" tube and through the flash chamber into the evaporator, wetting the outer surfaces of the evaporator coil tubes. There it is again vaporized as it absorbs the heat of the refrigeration load from the chilled water. The vapor then flows to the absorber where it is again liquefied as it combines with the absorbent in the process that gives the cycle its name.

The hot absorbent passes from the generator to the liquid heat exchanger where it gives up some of its heat. The pre-cooled absorbent then enters the absorber where it wets the outer surfaces of the absorber coil tubes and combines with the vapor refrigerant. It then gives up the remainder of its heat to the condensing water flowing inside the absorber coil tubes.

After the absorption process, the reunited refrigerant-absorbent solution drains into the solution sump. From there, it flows to the solution pump which moves it through the liquid heat exchanger where it is pre-heated before continuing on to the generator to repeat the cycle.

Refinements, in addition to the liquid heat exchanger, include:

1. The Concentration Chamber and Dump Valve. The chamber, by collecting and storing a portion of the liquid refrigerant, provides the optimum solution concentration for best unit performance when entering condensing water temperatures are in the normal range of from 75°F to 90°F. If condensing water temperature drops below 75°F, the dump valve opens and empties any stored refrigerant into the solution sump, diluting the solution. This dilution allows stable and continuous unit operation at the lower condensing water temperatures.
2. The Solution By-Pass Valve. This valve is opened for a timed interval during the initial minutes of any start, by-passing solution around the absorber coil directly back to the solution sump. This allows time for the evaporator coil to be fully wetted with liquid refrigerant before the absorber becomes active.
3. The Hot Water Control Valve. This valve, in addition to acting as an on-off device, modulates the flow of hot water (input energy) to the generator according to the entering and leaving chilled water temperatures. If either or both temperatures drop below preselected points, the valve reduces hot water flow through the generator by diverting some hot water into its by-pass. Thus, input energy is adjusted to match the refrigeration load.