GEO-HEAT CENTER

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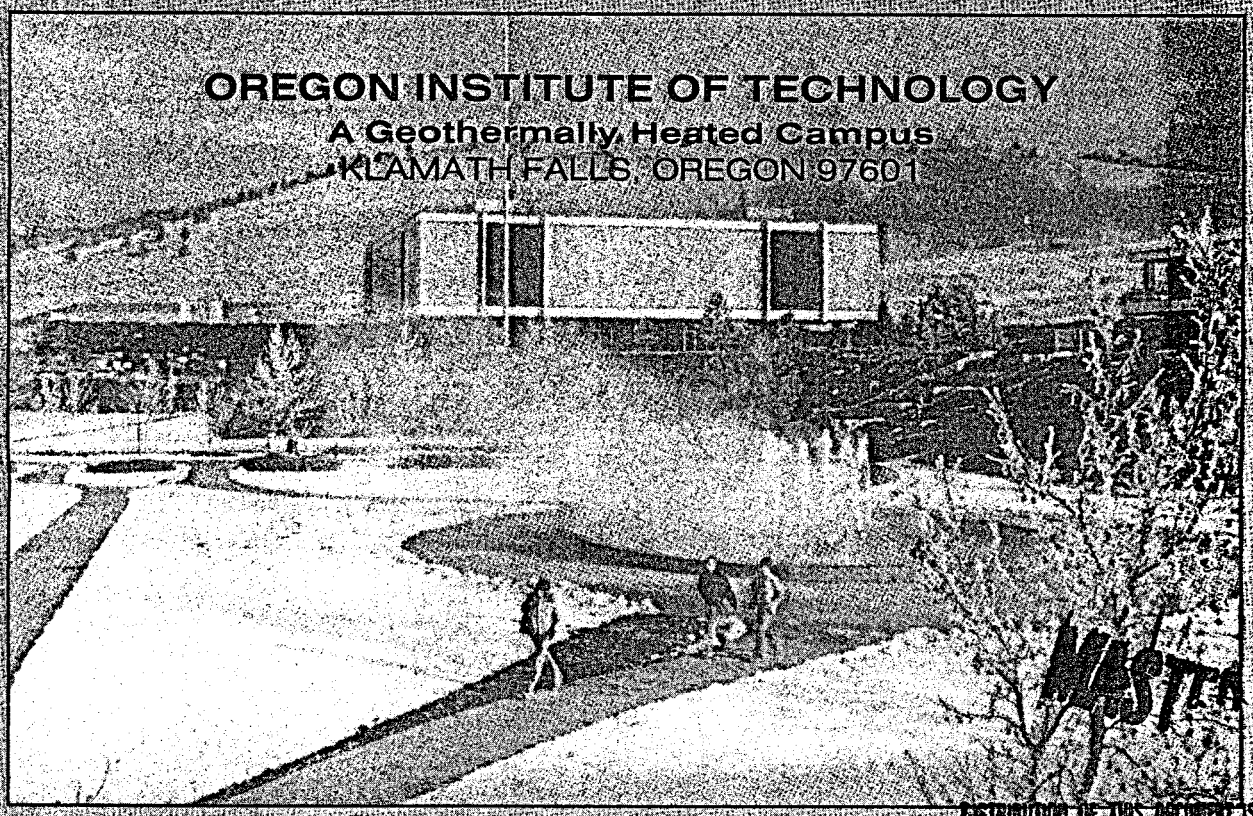

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GEOTHERMAL DISTRICT HEATING AND COOLING SYSTEM for The City of Calistoga, California

January 1982

By

Jack Frederick
Aurora Electrical & Mechanical Co.

For

Geo-Heat Center
Oregon Institute of Technology
Klamath Falls, Oregon 97601

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GEOTHERMAL DISTRICT
HEATING AND COOLING SYSTEM
For the City of
CALISTOGA, CALIFORNIA

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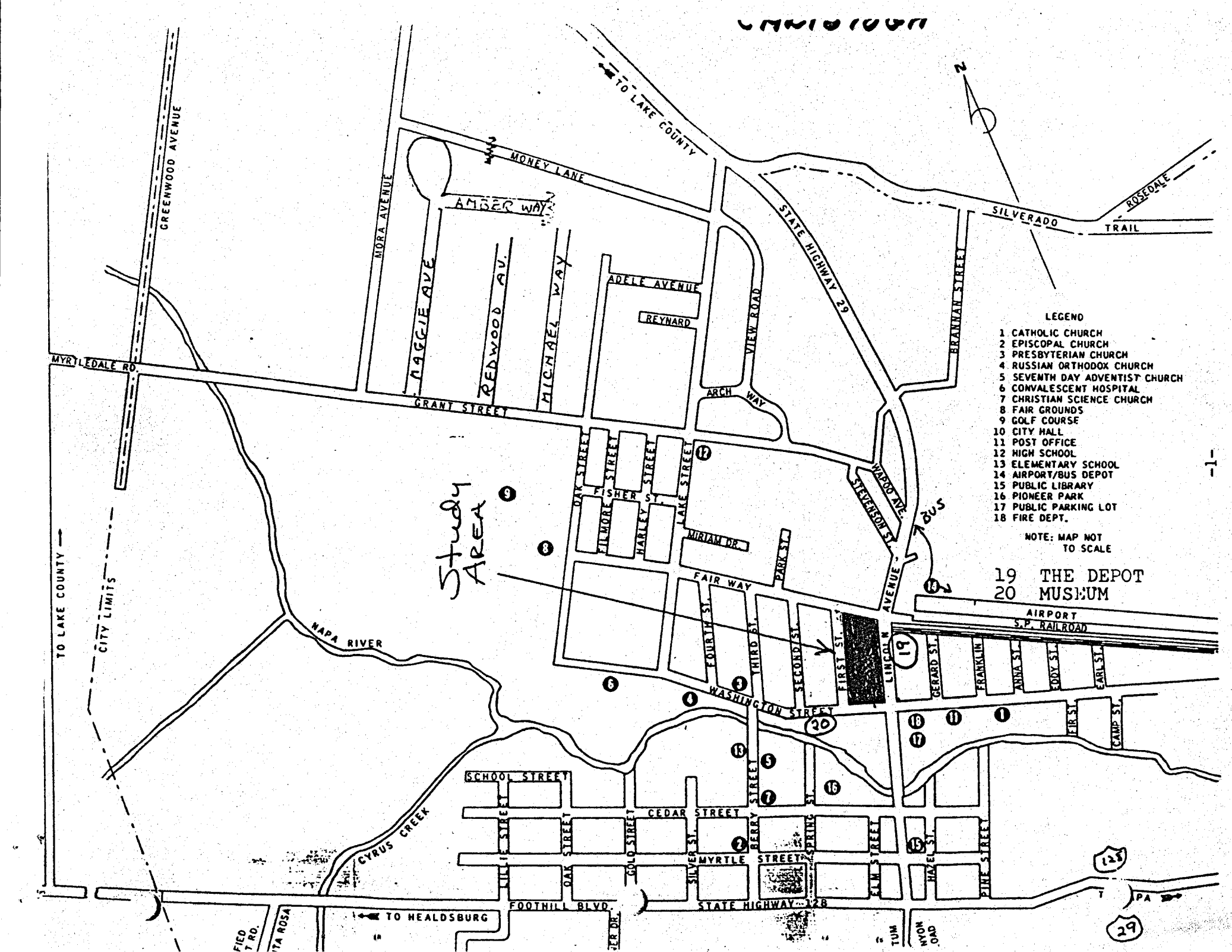
TO LAKE COUNTY
GREENWOOD AVENUE
MONEY LANE
MORA AVENUE
AMBER WAY
MAGGIE AVE
REDWOOD AV.
MICHAEL WAY
ADELE AVENUE
REYNARD
VIEW ROAD
STATE HIGHWAY 29
SILVERADO TRAIL
ROSEDALE
BRANNAN STREET
MYRTLEDALE RD.
GRANT STREET
ARCH WAY
OAK STREET
FILLMORE STREET
HARLEY STREET
LAKE STREET
WARDO AVE.
STEVENSON ST.
BUS
MIRIAM DR.
PARK ST.
FAIR WAY
FOURTH ST.
THIRD ST.
SECOND ST.
FIRST ST.
LINCOLN AVENUE
AIRPORT
S.P. RAILROAD
GERARD ST.
FRANKLIN
ANNA ST.
ODY ST.
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CAMP ST.
Study Area
NAPA RIVER
CITY LIMITS
TO LAKE COUNTY
WASHINGTON STREET
SCHOOL STREET
CEDAR STREET
MYRTLE STREET
LILLIE STREET
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BERRY STREET
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PINE STREET
CYRUS CREEK
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TO HEALDSBURG
LEGEND
1 CATHOLIC CHURCH
2 EPISCOPAL CHURCH
3 PRESBYTERIAN CHURCH
4 RUSSIAN ORTHODOX CHURCH
5 SEVENTH DAY ADVENTIST CHURCH
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9 GOLF COURSE
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11 POST OFFICE
12 HIGH SCHOOL
13 ELEMENTARY SCHOOL
14 AIRPORT/BUS DEPOT
15 PUBLIC LIBRARY
16 PIONEER PARK
17 PUBLIC PARKING LOT
18 FIRE DEPT.
NOTE: MAP NOT TO SCALE
19 THE DEPOT
20 MUSEUM

Introduction:

Calistoga has long been known for having moderate (270°F. maximum) hydrothermal deposits. City officials requested that this study be done to determine the economic feasibility of a geothermal heating and cooling district for a portion of the downtown commercial area and city-owned building. This project will also provide the City of Calistoga with a model to set necessary guidelines for future geothermal development.

The area being studied is bordered by Washington Street, Lincoln Avenue, Fairway Avenue and First Street; also to be included are the Calistoga Community Center and Sharpsteen Museum.

Descriptions of existing and proposed systems for each building in the block are on the following pages.

Heating and cooling loads for each building are shown in Table 1 and retrofit costs in Table 2. Detailed cost estimates, system schematics and energy consumption data for each building are shown in Appendix A, B, and C respectively.

In order to give each individual property owner an approximation of required equipment and capital for a privately owned system, cost estimates have been done on the basis of each building having its own independent heating and cooling system. This method, while providing a necessary reference point for the property owners shows a high total installed system cost. This high cost is due primarily to the number of chillers necessary and the limitation in sizes available (3 ton and 25 ton) of currently manufactured chillers. Final engineering for this project will address the cost effectiveness of each building having its own system, compared to a system where multiple buildings would be served by a central system.

For example, the Bank of America has a 15 ton cooling load and would require a derated 25 ton Arkla chiller to cool the building. Funke's Clothing Store is adjacent to the B of A and has a 10 ton cooling load which will require manifolding three 3 ton Arkla units together. One 25 ton unit at full rating can satisfy the needs of both buildings. This would eliminate the need for the 3-ton units, thereby showing a substantial cost reduction. Centralizing equipment for cooling will add to the administrative problems of the district.

Summary

The well is to be located at the northeast corner of the Calistoga Mineral Water Bottling Company's property on a narrow strip of open ground between the Calistoga Pharmacy and the parking lot of the Cal Mart.

Analysis of existing wells in the area, by the California Department of Mines and Geology (Appendix D), clearly shows that the hottest geothermal deposits, within the study area, are on the northern end of the block.

Current proposals are for the bottling company to own and finance the well costs, including the downhole heat exchanger. The City of Calistoga would own and operate the pipeline distribution system from the wellhead to the individual building sites. The bottling company will sell the heat from the well to the City of Calistoga, which will in turn sell the heat to the individual consumers.

The advantages of this proposal are:

1) The City of Calistoga would not have to add to its fiscal burden the costs of the well and downhole heat exchanger.

2) The bottling company would have a back-up, production well (assuming suitable water quality) for bottling purposes.

3) The well will produce income for the bottling company from selling heat as well as the bottled mineral water.

4) The bottling company has the facilities to maintain close scrutiny of the water quality in the well to determine the affect of the downhole heat exchanger on the chemical composition of the water.

Preliminary design of this system has centered around the concept of the downhole heat exchanger. The Calistoga area while having vast hydrothermal deposits has a severe shortage of potable water. The geothermal water often has unacceptable levels of boron, arsenic and other chemicals. If a downhole heat exchanger can be used successfully in this area, the tremendous advantages of the geothermal resource can be utilized by the people of Calistoga, while eliminating the problems associated with pumping and reinjecting the water into another well.

If, however, upon completion and testing of the well, a downhole heat exchanger cannot be utilized, a reinjection system will be considered with an existing well owned by the City being used as the injection well. This well is approximately 200' south of the Sharpsteen Museum and is not being used.

The proposed geothermal well will be 24" diameter and cased with 18" pipe. The downhole heat exchanger will be made of 810' of 6" schedule 40 steel pipe. With a static water level of 7' - 10', approximately 790' of the pipe will be submerged. The sizing of the downhole heat exchanger was done by the Oregon Institute of Technology, Geo-Heat Center staff based on past experience and water temperatures of 235°F. or greater.

TABLE I

HEATING AND COOLING LOADS

Bldg. #	Name	Heating BTU/H	Cooling (tons)
1	Cal Mart	304,551	33
2	Calistoga Water	54,558	3
3	Calistoga Pharmacy	123,637	6
4	White Swan	49,775	3
5	Mt. View Hotel	512,720	60
6	Attorney's offices	29,176	3
7	Game Room	29,176	3
8	Alex' Restaurant	83,095	9
9	Bank of America	168,337	15
10	Funke's Clothing	110,669	10
11	Village Cafe	87,418	6
12	S.F. Federal Savings	36,094	3
13	Stone's Jewelry	18,050	2
14	Ceceo's Restaurant & offices	101,427	9
15	Calistoga City Hall	74,629	8
16	Sharpsteen Museum	132,112	11
17	Calistoga Community Center	61,921	5
	Total	1,977,345	189

Annual Heating Load 3.62×10^9 BTU

Annual Cooling Load 3.28×10^9 BTU

TABLE II

APPROXIMATE RETROFIT COSTS

Bldg.	Name	Heating & Cooling	Heating
1	Cal Mart	$ 60,721	$ 7,012
2	Calistoga Mineral Water	21,680	4,818
3	Calistoga Pharmacy	28,655	2,441
4	White Swan	17,462	2,441
5	Mount View Hotel	159,766	45,787
6	Attorney's offices	19,343	2,865
7	Game Room	19,343	2,865
8	Alex's Restaurant	41,003	5,622
9	Bank of America	56,054	11,570
10	Funke's Clothing	46,080	11,162
11	Village Cafe	28,655	2,441
12	S.F. Federal Savings	19,343	2,865
13	Stone's Jewelry	19,343	2,865
14	Ceceo's Restaurant & offices	42,815	6,604
15	Calistoga City Hall	43,706	8,171
16	Sharpsteen Museum	52,269	7,479
17	Calistoga Community Center	29,424	3,749
		$ 705,662	$130,757

Well Costs

24" Bore with 18" casing	
85' Blow-out preventer	
420' deep	
Permits and Bonds	
Installed cost	$50,000
Downhole heat exchanger	
810' 6" Sch.40 Black Iron Pipe Installed Cost	8,400
	$58,400

Operating Costs

These figures are based upon current electrical rates of 9.7¢ kilowatt.

20 H.P. Circ. Pump
1 - Horsepower = 746 watts
20 HP x 746 = 14,920 watts
14,920 ÷ 1,000 = 14.92 kilowatts
14.92 KW x 9.7¢/KWH - $1.45/KWH
$1.45 KWH/24 hr. day = $34.80/day
$34.80 x 365 days = $12,702/year

WF-36 Arkla Chiller 250 watt draw
250W ÷ 1,000 = .25 HW
.25 KW x 9.7¢/KWH - 2.5¢/KWH
2.5¢ x 8 hrs. = 20¢/day
20¢ x 150 days = $30.00/cooling season

WFB 300 Arkla Chiller 150 watt draw
150W ÷ 1,000 = .15 KW
.15 KW x 9.7¢/KWH = 1.5¢/KWH
1.5¢ x 8 hrs. = 12¢/day
12¢ x 150 days = $18.00/cooling season

Grundfos VMS - 65-80 Circ. Pump .75 HP
Condensing and chilled water
.75 HP x 746 = 559.5 W
559.5 ÷ 1,000 = .5595 KW
.56 KW x 9.7¢/KWH - 5.5¢/KWH
5.5¢ x 8 hrs. = 44¢/day
44¢ x 150 days = $66.00/cooling season (150 days)

Two pumps required so....

$66.00 x 2 = $132.00 per cooling season

Sta-Rite Circulating Pump .5 HP
Condensing and chilled water
.5 x 746 = 373 watts
373W ÷ 1,000 = .373 KW
.373 x 9.7¢/KWH = 3.6¢/KWH
3.6¢ x 8 hrs. = 28.8¢/day
28.8¢ x 150 days = $43.20/cooling season (150 days)

Two pumps required so....

$43.20 x 2 = $86.40/cooling season

Lanco Fan Coils 115V 1 60

Models LH02, 03, 04, 06, average draw 2 amps (high)
P = IE Watts = Amps x volts 230 = 2 x 115
230 W ÷ 1,000 = .23KW
.23KW x 9.7¢ = 2.2¢/KWH
2.2¢ x 8 hrs. = 17.6¢/day
17.6¢ x 365 days = $64.24/year

Models LH & HH - 08, 10, 12 average draw 5 amps (high)
P = IE 575 = 5 x 115
575W ÷ 1,000 = .575 KW
.575KW x 9.7¢ = 5.6¢/KWH
5.6¢ x 8 hrs. = 44.6¢/day
44.6¢ x 365 days = $162.80/year

Models HH 15, 18, 22 average draw 9.5 amps (high)
P = IE 1092.5 = 9.5 x 115
1092.5W ÷ 1,000 = 1.093KW
1.093KW x 9.7¢ = 10.6¢/KWH
10.6¢ x 8 hrs. = 84.8¢/day
84.8¢ x 365 days = $309.52/year

MAINTENANCE SCHEDULE

Maintenance costs on a system of this type should be low. The City-owned pipeline, if correctly installed, should be virtually maintenance free. The circulating pump will require periodic inspection, which can be done during the twice annual oiling of the pump.

Maintenance of the individual buildings' systems will also be quite low. The cooling towers must be examined periodically for scaling. The fan coils and pumps must be oiled annually and of course air filters changed.

The chillers should have a complete check every spring prior to the cooling season. Monthly inspections should include checking and recording of the temperature readings. If problems are indicated, service personnel should be called.

Maintenance cost:

Monthly inspection -- $75/call x 12	=	$ 900
Spring start-up -- $300/ yr.	=	300
		$1,200/yr.

Typical Retrofit System

The basic Heating and Cooling system design is the same for each building in this study.

A maximum temperature of 205°F will be supplied to each building through the central piping system. The main pipeline is designed to supply the correct amount of water to power the chillers.

The flow rate required for maximum chiller output is in all cases larger than required to meet the design heating load.

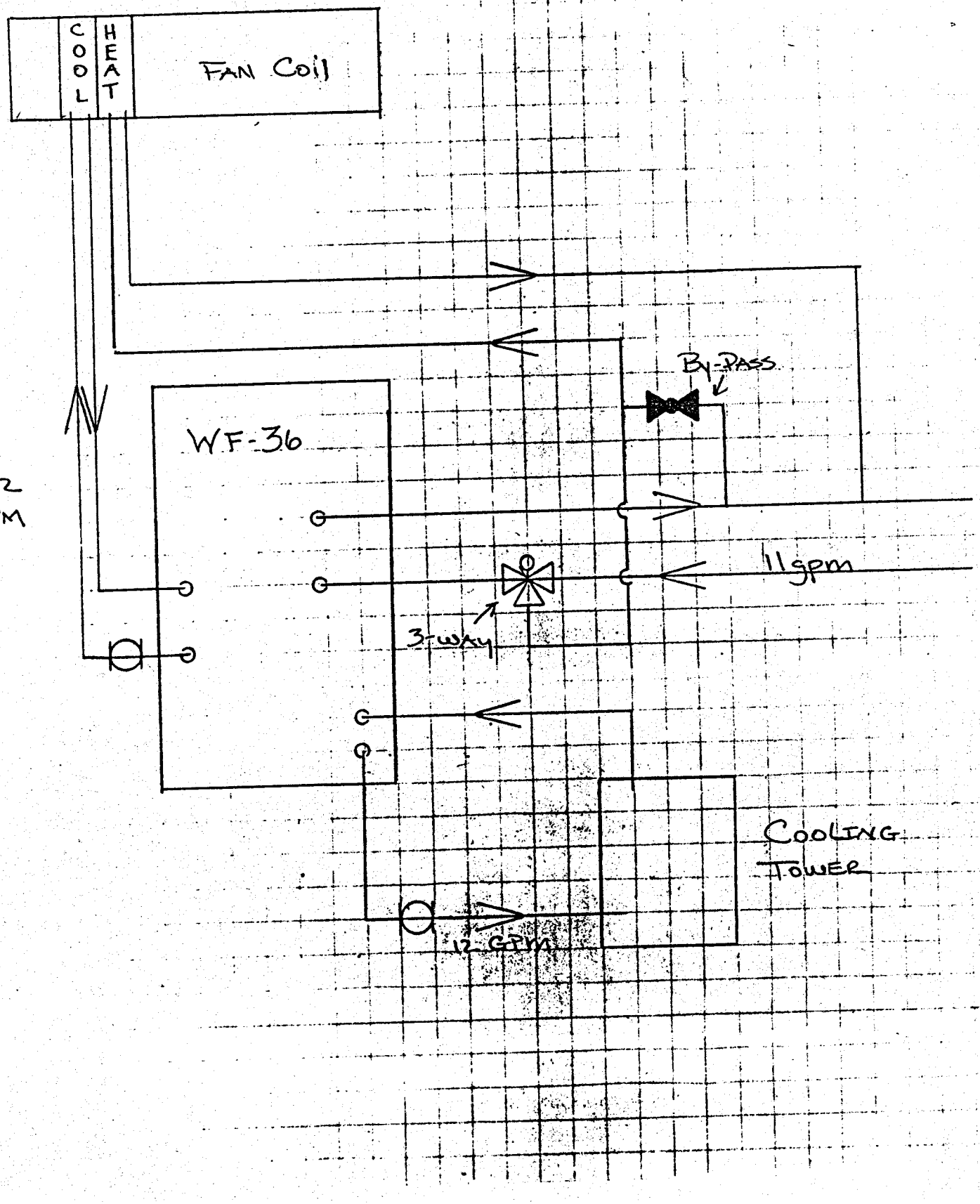
A Johnson Controls 3-way valve will be installed ahead of the chiller on the supply main. In the cooling mode this electrically operated valve will divert water to the chiller which will extract 10°F from the hot water and then return the cooled water to the main. Chilled water will then be pumped to the fan coils.

All fan coils will have a heating and a cooling coil. Therefore each building's retrofit will be a four pipe system.

In the heating mode hot water from the main will be through the 3-way valve direct to the heating coil. A bypass will be located just past the 3-way valve to short circuit a portion of the hot water to ensure correct flow to the fan coils.

Domestic hot water will be supplied continuously from the return pipe to a tube and shell heat exchanger. An aquastat located on the lower portion of the domestic hot water tank will start a circulating pump when the temperature drops to 120°F. As some of the buildings do not require domestic hot water, its inclusion in the system is optional.

Typical System Schematic



CAL MART

Heating Load: 304,551 BTUH

Cooling Load: 396,000 BTUH (33 tons)

Fuel consumption figures are included in the attached graph.

Existing System: 4 Rooftop mounted York Model # YB125AW48N-24, natural gas heating -- electric coolinb.

Proposed System:

The existing York units are to be replaced with four Lanco fan coils. The existing duct work will be adapted to fit the replacement units.

An Arkla WFB 300 chiller will be located at the southwest corner of the building. The 25 ton delivered capacity of the WFB 300 is at an inlet water temperature of 195°F. By raising the supply water to 200°-205°F the units delivered capacity rises to 30 tons. Because of the large amount of refrigeration equipment in the food market, the 30 ton figure should be adequate to meet the building's cooling load.

The cooling tower will be located on the roof of the building. Its operating weight of 3600 lbs. will require additional structural support.

Flow Rate:

Cooling

Main - chiller	90 gpm @ 200°-205°F
Chilled water to fan coil	60 gpm @ 50°F
Condensing water	90 gpm @ 103°F

Heating

Main - heating coil	14 gpm/coil x 4 = 56 gpm

CALISTOGA MINERAL WATER BOTTLING COMPANY

Heating Load:

Main Offices (second flr.)	28,557	BTUH
Production office(first flr.)	21,000	"
Lab.	5,000	"
	54,558	

Cooling Load:

Main offices	28,800	BTUH =	2.4 tons
Production office	4,800	"	.4 "
Lab.	2,400	"	.2 "
	36,000	BTUH	3. tons

Fuel consumption figures are listed on attached graph

Existing System

Main offices: Carrier Mod. #585A036100YAC natural gas heating and electric cooling

Production office: Electric heat and cooling - window unit

Lab.: Electric heating and cooling - window unit

Proposed System:

A WF-36 Arkla chiller will be located in the southwest corner of the building.

The Halstead Mitchell cooling tower will be located just above the chiller on the roof. This location will require structural support for the unit.

The Carrier Gas-Pak servicing the main offices will be replaced with a Lanco fan coil which will require sheet metal adapters to accommodate it.

The Lab and Production offices will have fan coils located above the ceilings. There is plenty of space to accommodate them. The existing units may be left in place.

Flow Rate:

Cooling

Main - chiller	11 gpm @ 200°-205°F
Chilled water	7.2 gpm @ 50°F
Condensing water	12 gpm @ 103°F

Heating

Main - fan coil	9.5 gpm @ 200°F

CALISTOGA PHARMACY

Heating Load	123,637	BTUH
Cooling Load	72,000	BTUH (6 tons)

Fuel consumption figures on existing graph.

Existing System: A roof mounted Carrier Gas Pak currently provides natural gas heating and electric cooling.

Proposed System

The only space available for equipment location is the back portion of the roof, approximately 20 ft. from the main supply and return.

Two WF-36 Arkla Chillers will be manifolded together to provide cooling. The cooling tower will be located within 15 ft. of the chillers, also on the roof. Structural supports will be necessary for both the chillers and the cooling tower.

The existing duct system will require modification to accept the new fan coil.

Flow Rate:

Cooling

Main - chiller	22 gpm @ 200°-205°F
Chilled water	14.4 gpm @ 50°F
Condensing water	24 gpm @ 103°F

Heating

Main - fan coil	12 gpm @ 200°F

WHITE SWAN

Heating Load	49,775 BTUH
Cooling Load	36,000 BTUH (3 tons)

Fuel consumption: The building is currently unoccupied and past bills are not available.

Existing System: A roof mounted Carrier Gas-Pak provides electric cooling and natural gas space heating.

Proposed System

The existing Gas-Pak will be removed. In its place an Arkla WFB-36 and the Halstead Mitchell cooling tower will be placed on the roof. A new fan coil will also be installed.

Flow Rate:

Cooling	
Main - chiller	11 gpm @ 200°-205°F
Chilled water	7.2 gpm @ 50°F
Condensing water	12 gpm @ 103°F
Heating	
Main - fan coil	8 gpm @ 200°F

MOUNT VIEW HOTEL

Heating Load: 512,760 BTUH

Cooling Load: 720,000 BTUH (60 tons)

Fuel consumption: The Mount View Hotel changed hands in May of 1981. Consumption figures are available from that time forward.

The amounts listed on the graph under gas consumption were incorrect. One bill for the restaurant was not included. The corrections have been made by assuming 50% of the gas from that meter was used for cooking purposes, the other 50% was used for domestic hot water heating. Therefore, the entire amount listed on the graph was used for DHW, Spa and Pool heating.

Existing System: The Hotel was remodeled in 1979. The old steam boiler was removed and at present the entire hotel has window units providing electric heating and cooling. Natural gas is used for cooking in the restaurant, domdstic hot water heating and heating the pool and spa.

Proposed System:

The Mount View Hotel is currently heated and cooled with window units. Therefore, the retrofit will require a completely new 4-pipe distribution system.

The first floor has a crawl space that can be utilized for this sytem. This crawl space runs under most of the building. In the portion of the first floor lacking the crawl space the pipe will have to be run outside the building or run inside and be trimmed out.

The second floor has a 4'-6' attic over it and can easily accommodate the piping for the second floor fan coils.

The fan coils for the first floor rooms will be mounted either over the door or in the top of the closet. The same approach may be used on the second floor or the fan coils may be located in the attic space.

The chillers (2 WFB-300 Arklas) and the cooling towers (2 Frick ICT-50's) must be roof mounted as there is no other space to accommodate them. Structural supports will be necessary.

The 6" FRP supply and return main will be piped up the East wall of the hotel, across the roof and down the west side of the building. A 4" FRP line will come off the main and tee into 2 - 3" lines which will supply the chiller and the heating coils in the fan coils.

The hotel has been split into two zones. The eastern side (Zone #2) will have a higher load early in the day and not as high a load as the Western side (Zone #1) in the afternoon and evening. Each zone will have its own chiller and cooling tower.

MOUNT VIEW HOTEL (cont'd.)

In addition to the heating and cooling load, the Mount View has a large domestic hot water load. A tube and shell heat exchanger (Taco model #B4412-4L) has been selected to meet the domestic hot water requirements. The shell side of the hat exchanger will be supplied continuously from the return side of the Mount View's 4" FRP line.

The swimming pool and spa are heated year around by a Teledyne Lacus boiler. Unfortunately, the gas consumption figures for the water of 1980-81 are not available. Assuming a heat loss of 10°F/day for the swimming pool and 25°F/day for the spa, a load of 3.35×10^6 BTU/day must be met. Since this design load will occur only in the winter months and the flow in the main system is excessive to meet the building heat load, the pool-spa load will not have a deleterious effect on the overall systems performance.

Flow Rates:

Main - chillers (2)	180 gpm @ 200°-205°F
Chilled water	120 gpm @ 50°F
Condensing water	180 gpm @ 103°F

Zone #1	50 gpm
Zone #2	44 gpm

ATTORNEY'S OFFICE

Heating Load	29,000 BTUH
Cooling Load	36,000 BTUH (3 ton)

Fuel consumption figures are not available.

Existing System: Day and night #568CJ042 combination gas heating and electric cooling.

Proposed System

A WF-36 Arkla chiller is to be placed behind the building. The Halstead-Mitchell cooling tower is also to be placed behind the building. Chilled water from the Arkla unit will be pumped to a Lanco fan coil which will replace the existing equipment on the roof.

Flow Rate:

Cooling	
Main - chiller	11 gpm @ 200°-205°F
Chilled water	7.2 gpm @ 50°F
Condensing water	12 gpm @ 103°F
Heating	
Main - fan coil	4 gpm @ 200°F

GAME ROOM

Heating Load	29,000	BTUH
Cooling Load	36,000	BTUH (3 ton)

Fuel consumption figures are not available.

Existing System: Day and Night #568CJ042 combination gas heating and electric cooling.

Proposed System

A WF-36 Arkla chiller is to be placed behind the building. The Halstead-Mitchell cooling tower is also to be placed behind the building. Chilled water from the Arkla unit will be pumped to a Lanco fan coil which will replace the existing equipment on the roof.

Flow Rate:

Cooling	
Main - chiller	11 gpm @ 200°-205°F
Chilled water	7.2 gpm @ 50°F
Condensing water	12 gpm @ 103°F
Heating	
Main - fan coil	4 gpm @ 200°F

ALEX'S RESTAURANT

Heating Load: 83,095 BTUH

Cooling Load: 108,000 BTUH (9 tons)

Fuel consumption figures are not available.

Existing system:

Restaurant and Bar: Rooftop unit
1 - BDP Co. (Div. of Carrier) Model #585B060125 YACR
1 - Swamp Cooler

Kitchen: 1 - BDP Co. (Div. of Carrier) Model #585CJ036075
Rooftop mount

Proposed System:

The three WF 36 Arkla chillers are to be mounted on the roof as is the Halstead-Mitchell GCKA 30 cooling tower. Structural supports will be necessary. Three Lanco fan coils will be replacing the existing units. A branch of the 2" return line will provide continuous flow to a tube and shell heat exchanger for domestic hot water purposes.

Flow Rate:

Cooling	
Main - chillers	33 gpm @ 200-205°F
Chilled water	21.6 gpm @ 50°F
Condensing water	36 gpm @ 103°F
Heating	
Main - fan coil	23 gpm @ 200°F

Bank of America

Heating Load	168,337 BTUH
Cooling Load	180,000 BTUH (15 tons)

Energy consumption figures are shown on the attached graph.

Existing System:

Heating - 2 Hayes gas fired SED Duct Furnaces Model #SED-E-12
Serial #10760, Input 120,000 BTUH; Bonnet Cap. 90,000 BTUH

Cooling - Baltimore Aircoil Co. Inc., Model #20 CMA, serial #60-8518
Worthington Compressor, Mod. #2VHJ8, 2PZW, serial #39H60P105

Proposed System:

The existing equipment in the Bank of America is 22 yrs. old. The space will accommodate the chiller and fan coil necessary for a retrofit. Therefore, the existing equipment should be removed.

A 3" supply main will power the WFB-300 Arkla chiller.

The Frick ICT-50 cooling tower will be located outside the mechanical room wall on the roof over a bearing wall and will not require structural supports.

Flow Rate:

Cooling:	
Main - chiller	90 gpm @ 200°-205°F
Chilled water	60 gpm @ 50°F
Condensing water	90 gpm @ 103°F
Heating	
Main - fan coil	20 gpm @ 205°F

FUNKE'S CLOTHING STORE

Heating Load	110,669 BTUH
Cooling Load	120,000 BTUH (10tons)

Fuel consumption figures are as listed on attached graph.

Existing System - The store is divided into two rooms. The mens' section comprises approximately 40% of the store and the ladies section 60%.

Each section has one gas fired unit heater. The cooling is done by window units located over the front door.

Proposed System

The 3 WF 36 Arkla chillers will be located on the ground behind the building. The Halstead-Mitchell GCKA 30 cooling tower will be placed on the roof over a bearing wall and will not require structural support.

The building has approximately 14' ceiling currently and no existing duct system. A trunk main should be installed. The existing equipment can be left in place.

There is no existing domestic hot water system and the owner does not require it.

Flow Rate

Cooling	
Main - chillers	33 gpm @ 220°-205°F
Chilled water	21.6 gpm @ 50°F
Condensing water	36 gpm @ 103°F
Heating	
Main to fan coils HH-15	10 gpm @ 200°F
HH-22	14 gpm @ 200°F

VILLAGE CAFE

Heating Load	87,418 BTUH
Cooling Load	72,000 BTUH (6 tons)

Consumption figures are not available.

Existing System - There is no central heating system in the building. It is heated by the gas stoves and ovens used for cooking. There is one window unit located over the front door and an evaporative cooler on the roof.

Proposed System

The 3 chillers will be located behind the restaurant and the cooling tower will be roof-mounted. Structural supports for the cooling tower will be necessary.

The new fan coil will be roof-mounted where the evaporative cooler is currently located.

Flow Rate

Cooling	
Main - chiller	33 gpm @ 200°-205°F
Chilled water	21.6 gpm @ 50°F
Condensing water	36 gpm @ 103°F
Heating	
Main - fan coils	16 gpm @ 200°F

SAN FRANCISCO FEDERAL SAVINGS

Heating Load	36,094 BTUH
Cooling Load	36,000 BTUH (3 tons)

Consumption figures for the bank are not available.

Existing System - Day and Night Duopac Model #60/140 YAC-102 AT

Proposed System

The chiller for the bank will be located behind the building with the cooling tower on the roof above. Structural support will be necessary. The existing Day & Night unit should be replaced with a new fan coil. Adapters will be necessary to accommodate the new fan coils.

Flow Rate

Cooling	
Main - chiller	11 gpm @200°-205°F
Chilled water	7.2 gpm @ 50°F
Condensing water	12 gpm @ 103°F
Heating	
Main - fan coil	8 gpm @ 200°F

STONE'S JEWELRY

Heating Load	18,050 BTUH
Cooling Load	24,000 BTUH (2 ton)

Consumption figures are not available.

Existing System:
Heating: 1 - Reznor gas fired unit heater
Cooling: 1 - Window unit

Proposed System

The chiller will be located behind the shop on the ground and the cooling tower will be located above on the roof. No duct system will be required.

Flow Rate

Cooling	
Main - chiller	11 gpm @ 200°-205°F
Chilled water	7.2 gpm @ 50°F
Condensing water	12 gpm @ 103°F
Heating	
Main - fan coil	4 gpm @ 200°F

CECEO'S RESTAURANT AND OFFICES

Heating Load	101,427 BTUH
Cooling Load	108,000 BTUH (9 ton)

Consumption figures are not available

Existing System:

Offices - Fraser-Johnson Gas-Pac, Model #140WR60GI
serial #F14230031016, gas heating, electric cooling

Restaurant - 1 Fraser-Johnson Gas-Pac, Model #60WR24GINA,
serial #E143100310218, gas heat, electric cooling
1 Fraser Johnson Gas-Pac, Model #80WR36GINA

Proposed System

The chillers and cooling tower will be roof mounted and will require structural support.

The Gas-Paks should be replaced with new fan coils. One coil will heat and cool the office area. The other will heat and cool the restaurant area. Sheet metal work will be required to accommodate the new fan coils.

Flow Rate

Cooling	
Main - chiller	33 gpm @ 200°-205°F
Chilled water	21.6 gpm @ 50°F
Condensing water	36 gpm @ 103°F
Heating	
Main - fan coil #1	6
Main - fan coil #2	14
	20 gpm @ 200°F

CALISTOGA CITY HALL

Heating Load	74,629 BTUH
Cooling Load	96,000 BTUH (8 tons)

Fuel consumption is listed on the attached graph.

Existing System

Cooling - 6 electric window units

Heating - 4 wall mounted gas furnaces, 1 Reznor unit heater

There is no duct system in the building.

Proposed System

The chillers for the Calistoga City Hall will be ground mounted, as will the cooling tower.

Three new fan coils will be installed to condition the space. There is no duct system in the building at present. Careful location of the new fan coils will minimize the amount of duct required.

Flow Rate

Cooling	
Main - chiller	33 gpm @ 200°-205°F
Chilled water	21.6 gpm @ 50°F
Condensing water	36 gpm @ 103°F
Heating	
Main-fan coils - 3 LH-12 fan coils	24 gpm @ 200°F

SHARPSTEEN MUSEUM

Heating Load	132,112 BTUH
Cooling Load	132,000 BTUH (11 tons)

Fuel consumption figures are listed on the attached graph.

Existing System: The existing system is a gas fired heating and electrically operated cooling Coleman, Model #CSC 60

Proposed System

The chillers and cooling tower will be located on the ground at the southwest corner of the building.

The existing Coleman unit, which is located outside over a door will be replaced with a new fan coil. Duct modifications will be necessary.

Flow Rate

Cooling	
Main - chiller	22 gpm @ 200°-205°F
Chilled water	14.4 gpm @50°F
Condensing water	24 gpm @ 103°F
Heating	
Main-fan coil	14 gpm @ 200°F

COMMUNITY CENTER

Heating Load	61,921 BTUH
Cooling Load	60,000 BTUH (5 tons)

Fuel consumption figures are shown in the attached graph.

Existing System: A combination gas heating and electric cooling Coleman Model #CSC-60 unit is mounted outside on the end of the building over a door.

Proposed System

The chillers and the cooling tower will be ground mounted at the southwestern corner of the building.

A new fan coil will replace the Coleman unit. Sheet metal adapters will be necessary to accommodate the fan coil.

Flow Rate

Cooling	
Main - chiller	22 gpm
Chilled water	14.4 gpm
Condensing water	24 gpm
Heating	
Main - fan coil	14 gpm

Conclusion

In order to determine the viability of the overall project it was first necessary to ascertain its attractiveness to individual end users. This was accomplished by calculating the existing annual energy consumption which would be displaced by geothermal. This figure was then compared to the cost of retrofit to arrive at simple payback.

Actual billing figures were available for a number of the buildings. The results of these buildings were then extrapolated to the balance of the structures for which no actual data was available. Table 1 summarizes the results of these calculations.

It is important to note that the simple payback figures shown in the table relate only to building specific costs. That is, no consideration for branch costs to the main pipeline, main pipeline costs, maintenance costs, financing costs, or costs for geothermal energy. As a result, actual payback figures would be far in excess of those shown in the table. In view of the long payback periods, especially for the total system, life cycle cost analysis was not felt to be necessary.

As a result of the long paybacks for the individual users, the district system would not be economically feasible at this time.

There are two primary factors contributing to this situation. The first is the high cost and low availability of absorption cooling equipment. As mentioned in the introduction, the size of the cooling load for a number of the buildings falls between the available equipment capacities. The condition necessitates manifolding together several smaller units resulting in high installation costs. For example, Funke's Clothing Store has a cooling load of 10 tons, requiring three 3-ton absorption chillers at a cost of $24,600. By comparison, a new rooftop air cooled electric air conditioning unit would cost only $6,675 installed. As a result, a large annual savings in operating costs must be obtained to justify such a first cost difference. However, based upon existing electrical consumption this potential does not exist.

A second factor which reduced the attractiveness of the heating only system is the lack of large heating requirements, especially on an annual basis. The relatively mild winter season (2918 Degree Days) results in natural gas usage which is insufficient to justify the cost of the equipment retrofit.

The key to an economically successful geothermal project is the potential for a large conventional energy displacement. This is highlighted by the relatively low payback figures for the larger end users, especially Cal Mart and the Mount View Hotel. These two loads should be examined further for the potential of individual projects.

TABLE 1

Simple Payback Results

	Electricity Savings ($/yr)	Nat. Gas Savings ($/yr)	Heating & Cooling Payback (yrs)	Heating only Payback (yrs)
Cal Mart	2501	3463	11.35	2.02
Calistoga Water	136	628	35.00	7.00
Calistoga Pharmacy	420	948	22.7	2.60
White Swan	136	373	39.2	6.50
Mt. View Hotel	6598	9101	10.2	3.80
Attorney's Offices	136	217	62.9	13.20
Game Room	136	217	62.9	13.20
Alex's Restaraunt	408	619	45.3	9.10
Bank of America	681	1257	35.00	9.20
Funke's Clothing	453	829	44.6	13.50
Village Cafe	272	651	33.7	3.70
S.F. Savings	136	270	55.0	10.60
Stone's Jewelry	90	135	98.7	21.20
Ceceo's Restaraunt	408	759	42.5	8.70
Museum	786	1221	29.8	6.10
Community Center	340	453	41.8	8.30
Calistoga City Hall	377	412	65.7	19.80