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GEOTHERMAL DISTRICT-HEATING POTENTIAL FOR CASINOS/HOTELS IN RENO, NEVADA

November 30, 1981

PRELIMINARY FEASIBILITY STUDY

Prepared for:
OREGON INSTITUTE OF TECHNOLOGY
Geo-Heat Center
Contract # TA 1-81

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SUMMARY

This report combines results from the pre-feasibility study of a geothermal district heating system for greater Reno and the pre-feasibility study of providing geothermal heat to casinos/hotels located in downtown Reno by connection to the proposed district heating system (DHS).

Geothermal sources were selected from published data. Potential users were selected from aerial and City planning maps, and published building and demographic information. Energy consumption data from the electric and gas utility was matched with consumption information from surveys of representative buildings by category and climatic data. As an example, a written survey was mailed to the casino/hotels and two on-site visits were made.

Retrofit methodology and cost were examined for the casino/hotels and representative buildings.

The configuration of the district heating system was derived from dividing the City into segments - South Virginia Street, downtown Reno and north of downtown - and using geographic areas within those segments which had the highest peak demand density.

The system was designed by dividing the project into the following subsystems:

1. Heat Source
2. Distribution
3. Building Connection and Heating System Retrofit

To determine the system economics, the investment costs for the subsystems were totaled. Then assuming a given construction schedule and current economic conditions, a cash flow analysis was performed.

Based on the pre-feasibility studies, a geothermal district heating system for Reno appears technically and economically feasible. Furthermore, additional economic savings are achieved when the Reno casinos/hotels are connected to the DHS.

Steamboat Hot Springs and a geothermal area east of downtown are the most promising geothermal sources for the DHS. The City of Reno has a large yearly heat load with an average heating degree days per year of 6,022°F days and a heating season greater than eight months.

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The peak demand of the proposed city district heating system is 589 million Btu/hr.

Twenty percent of the hotel/casino complexes have steam or individual heating systems which are expensive to retrofit. Therefore, only thirteen casino/hotel complexes are connected to the DHS which contain 3,743 rooms with a peak demand of 150 million Btu/hr and yearly consumption of 310,700 million Btu. The thirteen selected casino/hotel complexes contain 75 percent of the total casino/hotel rooms in the downtown area.

The DHS design incorporates a closed loop piping network for the geothermal source and another closed loop piping network for transmission subsystems. The transmission network uses hot water as a medium and indirect connections with the users. With a temperature drop at the source heat exchanger of 150°F (350°F to 200°F), the transmission water will be approximately 250°F which will heat the user water to as much as 220°F. The temperature drop at the user heat exchanger will vary from 20°F to 100°F depending on the heating system configuration.

A total of 199 buildings are connected to the proposed DHS. The buildings are connected to permit continued operation of existing heating systems. The estimated total capital costs for construction of the system is $55,403,600 in $1981. To encourage hook-up to the proposed DHS, retrofit costs will be included in the DHS capital costs and energy sales will vary from 65 percent to 80 percent the cost of natural gas for the same heat demand. The system will take five years to construct, with initial hook-ups in the third year of construction. Over the first twenty years of system operation the average heating cost of the district heating system was found to be only 40 to 50 percent of the cost of heating using conventional natural gas equipment.

Because of the positive results of the pre-feasibility study, this report contains an implementation plan, Section 7.0, which outlines the steps to bring the DHS to the construction stage.

1.0 INTRODUCTION

Trans Energy Systems, Inc., Bellevue, Washington, was contracted by the Oregon Institute of Technology to conduct pre-feasibility studies of a geothermal district heating system (DHS) for greater Reno and of supplying geothermal heating to the casinos/hotels in downtown Reno. The purpose of these brief studies was to determine if a geothermal district heating system is technically feasible and to conduct a "first-cut" economic analysis.

Trans Energy Systems' European parent, Compagnie Generale de Chauffe, currently operates five geothermal hot water district heating systems in France. A substantial amount of the system performance data and estimated capital costs for the Reno system are based on these operation's systems.

In these projects, geothermal heat sources are selected from published data. Potential heat users are selected in three distinct areas of the City. The heat loads are calculated from building characteristics from published data, on-site surveys and climatic data. In some cases, building and heating system blueprints are reviewed on site to make heat load and retrofit cost calculations. The peak demand and average yearly consumption are calculated for the connected users by building category and area of the City.

The DHS is designed to fully utilize the selected geothermal heat source and City areas of greatest heat demand density. The expense of retrofitting heating systems is reflected in market penetration by building category.

The economic analysis assumes current economic conditions and financing with tax-exempt revenue bond issues.

The conclusion of the combined studies supports initiation of the detailed engineering economic and market analyses described in the implementation plan.

2.0 GEOTHERMAL HEAT SOURCES

Published data are available on three potential geothermal heat sources near Reno. The areas of known thermal ground water occurrence in the Truckee Meadows geothermal area, between Carson and Virginia Range on the west and east, respectively, and from Peavine Mountain to the north to Steamboat Hills on the south are shown in the map in Figure 1. Furthermore, the entire Truckee Meadow area has a prospective value. The potential sources are listed in Table 1.

Table 1

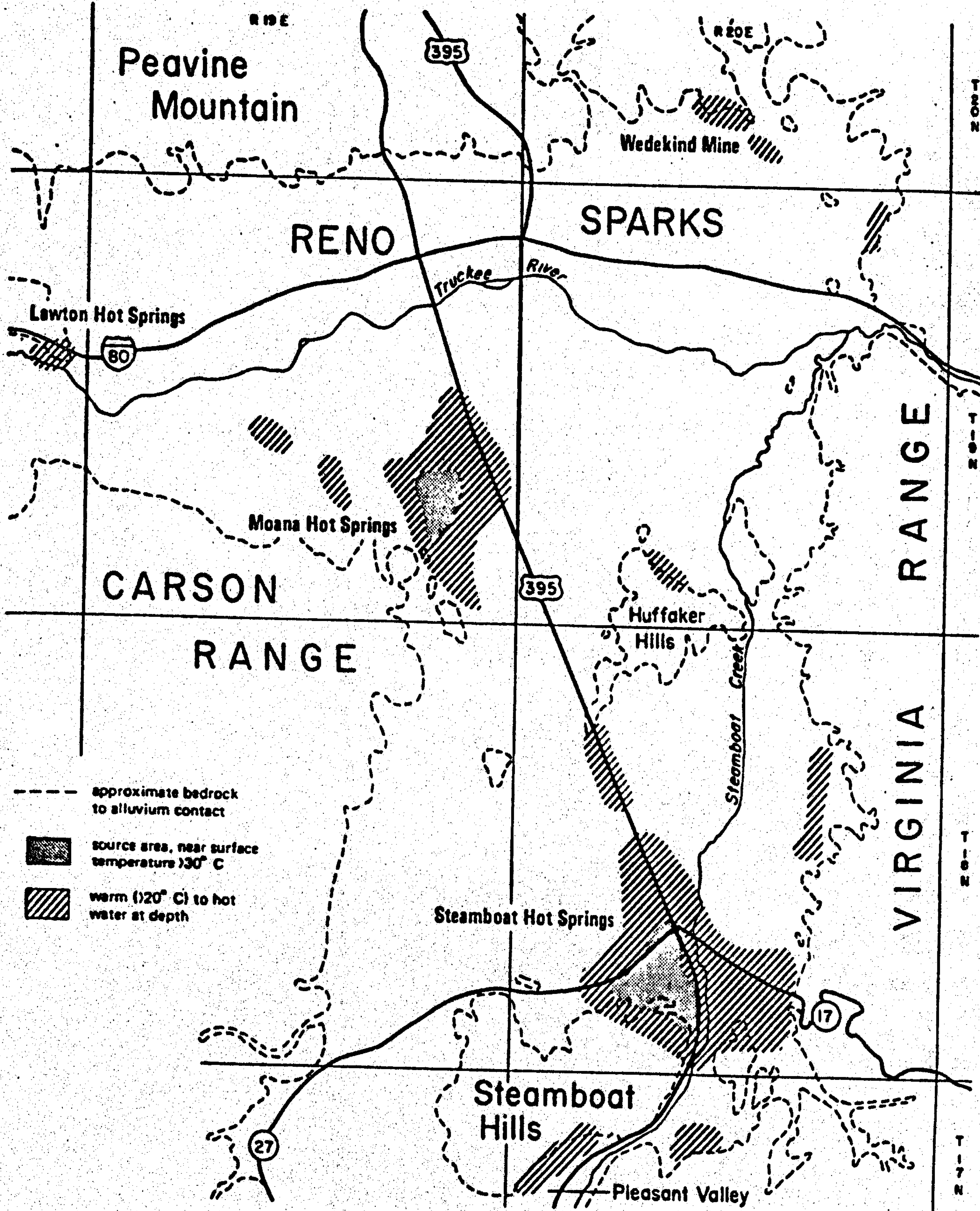
POTENTIAL GEOTHERMAL HEAT SOURCES

NAME	DIRECTION FROM RENO
Wedekind Mining District	Northeast
Lawton Hot Springs	West
Moana Hot Springs	Southwest
Steamboat Hot Springs	South
Potential Unnamed Source	East

The Wedekind Mining District is located six miles northeast of downtown Reno. During mining, hot water, heavily charged with sulfurous gas, has been encountered, but no other significant data is available. Water from the Lawton Hot Springs, six miles west of downtown Reno, has a temperature of 120°F and an artesian well was reported having water at 140°F.

Located in southwestern Reno, the Moana Hot Springs area has many shallow wells. Hot water temperatures range from 167°F to 205°F at a depth of 100 feet with no additional increase for deeper wells. More than thirty-three wells have already been drilled in this area. Preliminary results from testing by the University of Nevada indicate that additional wells could possibly jeopardize the current uses.

Steamboat Hot Springs is located nine miles south of downtown Reno. The springs used as resort and health spa, are near boiling temperature. Steam wells encountered temperatures of 280°F at 160 feet and 369°F in deeper wells.



Map indicating thermal ground-water occurrence in the Truckee Meadows area. (Bulletin 91, Thermal Waters of Nevada, Nevada Bureau of Mines and Geology, 1979)

Figure 1

Steamboat Hot Springs is the best known geothermal area in Nevada, and many geologic studies are still currently pursued at this site; new lease agreements were signed in 1980.

Recent wells were drilled at Steamboat Springs by Phillips Petroleum Company in 1979 and 1981 to depths of 3,000 feet which provided maximum water temperatures in excess of 400°F (ref. Bulletin 91, Appendix 2, August 20, 1981 update). An assessment by the U.S. Geologic Survey, Geologic Survey Circular 790-1978, measures the available wellhead thermal energy as 3.4×10^{15} Btu. As discussed below, the thermal energy demand of the proposed district heating system is 11×10^{12} Btu/year. Theoretically, there is sufficient energy to serve the district heating system for over 300 years.

The Steamboat Hot Springs is the most promising heat source because it is the largest resource, and there is currently no interference with existing geothermal applications. Furthermore, the temperature of the springs is high with good fluid flow. The detail characteristics of the fluids quality (i.e., corrosive properties) have not been investigated.

The prospect for a good geothermal source within five miles east of downtown Reno is also promising. Data on this location remains proprietary but this source should be very suitable for district heating.

Wedekind, Lawton and Moana Springs are either currently tapped or have limited resource which reduces their potential application. The possible resource east of downtown could be economical, but test wells are required to further characterize its potential. Steamboat Hot Springs has sufficient resource at useful temperatures. For purposes of this report, Steamboat Hot Springs is the selected heat source. The technical/economic analysis conducted for this site is sufficiently conservative so that any other sites will prove even more feasible.

3.0 POTENTIAL HEAT USERS

The heating demand of Reno makes district heating very economical. This report examines only heating for space and domestic water heating. However, future efforts should examine the impact of providing cooling with absorption chillers.

Climatic data from the National Oceanic & Atmospheric Administration for the 1941-1980 period and heating and cooling degree days are indicated in Tables 2 and 3.

Table 2

CLIMATIC DATA FOR RENO
TEMPERATURES (1941-1980)

	January	July
Normal daily mean temperature:	31.9°F	69.3°F
Normal daily minimum temperature:	18.3°F	47.4°F
Normal daily maximum temperature:	45.4°F	91.1°F

The extremes in temperature as recorded through 1977 are:
Lowest: -16°F Highest: 104°F

Table 3

HEATING AND COOLING DEGREE DAYS

Average heating degree days per year	6,022°F days
Maximum degree days per month (Jan.)	1,026°F days
Monthly degree days > 500	8 months
Total cooling degree days	329°F days
Cooling degree days in July & August	259°F days

The City of Reno has a large yearly heat load and a heating season longer than eight months. To calculate thermal demand densities for designing the district heating network, geographic zones and building categories in Reno were characterized as working units. Thermal demand density was then calculated using building energy consumption data and climatic conditions. Areas south of downtown Reno were examined first. A map of the potential service areas along South

Virginia Street is shown in Figure 2. The diameters of the circles denote the size of the user heat load. The proposed Reno district heating system has been segmented into three districts:

South Virginia Street
Downtown Reno
North of Downtown Reno

Details on each area are discussed below.

3.1 SOUTH VIRGINIA STREET

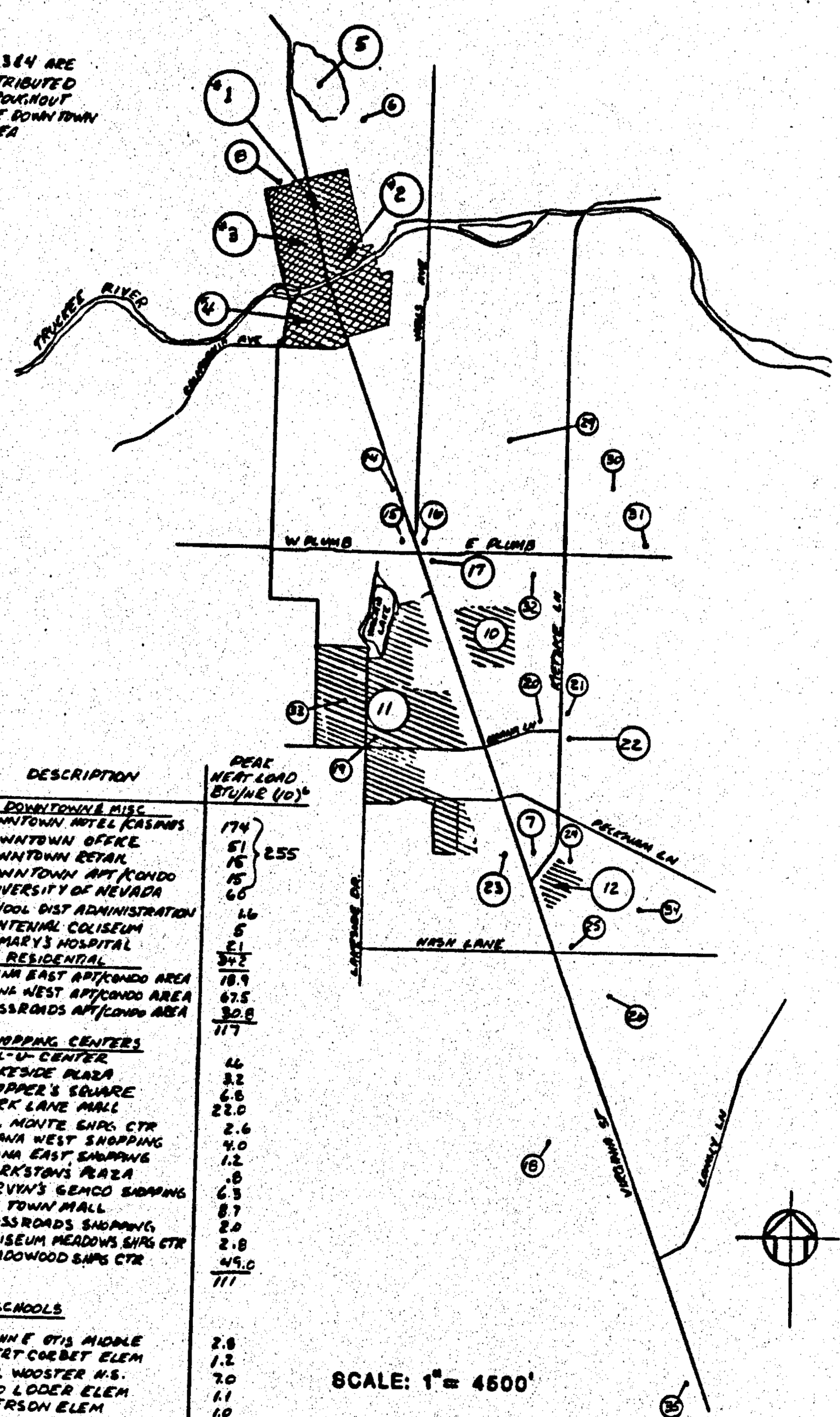
The selection of Steamboat Hot Springs as a potential heat source makes Virginia Street, which runs from Steamboat Springs to downtown, a major physical feature. Because Virginia Street is the most likely main transmission route, building proximity to this street was considered in user selection. To calculate building densities and to identify geographical zones, aerial photographs, surveys from the Community Development Department, data from the Census Bureau, and Polk Maps showing the family dwelling units by zone in the city were used.

3.1.1 Single Family Housing

Single family residential units dominate the area south of downtown Reno and north of Plumb Street. Based on data in the Reno City Profile a "State of the City" Report, Reno Department of Planning, 1981 (City Profile); the Home Energy Survey II, Report 1, August, 1981, Sierra Pacific Power Company (Home Energy Survey); and the above references, the peak load density for this area is .25 - .30 X 10^6 Btu per hour per acre assuming 100 percent hookup of buildings. Because of this low demand density and therefore questionable economics, single family housing was eliminated from further consideration.

3.1.2 Multi-Family Housing

A survey was conducted in September, 1981 of Reno apartment buildings (Apartment Survey) by Trans Energy Systems' engineers to supplement the City Profile data base. Apartments are concentrated in the southwest and southeast sectors of Reno, particularly in three locations designated 10, 11 and 12 on Figure 2. Based on the City Profile and home energy and apartment surveys, the average apartment size is assumed to be 900 ft^2. The number of units served in areas 10, 11 and 12 are 700, 2,500 and 1,140 units, respectively. Assuming the peak



I.D NO.	DESCRIPTION	PEAK HEAT LOAD BTU/HR (10)⁶	
	DOWNTOWN & MISC		
1	DOWNTOWN HOTEL/CASINOS	174	255
2	DOWNTOWN OFFICE	51	
3	DOWNTOWN RETAIL	15	
4	DOWNTOWN APT/CONDO	15	
5	UNIVERSITY OF NEVADA	66	
6	SCHOOL DIST ADMINISTRATION	1.6	
7	CENTENNIAL COLISEUM	5	
8	ST MARY'S HOSPITAL	21	
		342	
	RESIDENTIAL		
10	MOANA EAST APT/CONDO AREA	18.9	
11	MOANA WEST APT/CONDO AREA	67.5	
12	CROSSROADS APT/CONDO AREA	30.8	
		117	
	SHOPPING CENTERS		
14	VAL-U-CENTER	4.6	
15	LAKESIDE PLAZA	3.2	
16	SHOPPER'S SQUARE	6.8	
17	PARK LANE MALL	22.0	
18	DEL MONTE SHPG CTR	2.6	
19	MOANA WEST SHOPPING	4.0	
20	MOANA EAST SHOPPING	1.2	
21	CLARKSTON'S PLAZA	.8	
22	MERVYN'S GEMCO SHOPPING	6.3	
23	OLD TOWN MALL	8.7	
24	CROSSROADS SHOPPING	2.0	
25	COLISEUM MEADOWS SHPG CTR	2.8	
26	MEADOWOOD SHPG CTR	49.0	
		111	
	SCHOOLS		
29	VAUGHN E OTIS MIDDLE	2.8	
30	ROBERT CORBET ELEM	1.2	
31	EARL WOOSTER H.S.	7.0	
32	ECHO LODER ELEM	1.1	
33	ANDERSON ELEM	1.0	
34	SMITH RIDGE & EDWARD PINE ELEM.	4.7	
35	HUFFAKER ELEM	.5	
		19.0	
	TOTAL	689	

POTENTIAL SERVICE AREA

Figure 2

demand for apartment units is 30 Btu/hr/ft^2, the combination of apartment houses and multiplexes in the area from Plumb Street South to Moana Lane gives an approximate peak demand of 117 X 10^6 Btu/hr. The yearly energy consumption is estimated to be 233,600 X 10^6 Btu.

3.1.3 Schools

The Reno School District provided accurate information on the location, heat consumption and floor space for schools. Seven schools have existing hot water space heating systems and two have steam systems; only the seven schools with hot water systems are considered for district heating. The locations of the schools are shown in Figure 2, and the heat demand by school in Table 4. Based on consumption and degree day information, the Schools have a peak demand of 33 to 40 Btu/hr ft^2. With an approximate total floor area for the schools of 500,000 ft^2, the peak demand is 19 X 10^6 Btu/hr.

3.1.4 Shopping Centers

Shopping centers are predominately located along Virginia Street south of the downtown area. The name and peak demand for each area are shown in Table 5. The floor space of the shopping centers is 3.03 X 10^6 ft^2 with individual shopping centers varying from 20 X 10^3 to 1.4 X 10^6 ft^2. The peak demand range is assumed to be 35 to 40 Btu/hr/ft^2. The total peak demand for the shopping centers is 111 X 10^6 Btu/hr. The design of the district heating system assumes that 100 percent of the shopping centers in Table 5 will subscribe to the system.

A site survey of several shopping centers showed typical roof-top units providing the current space heating and cooling needs for the shopping centers. Based on these observations, it is assumed that the majority of shopping centers use forced air and unit heating systems.

3.1.5 Centennial Coliseum

The Centennial Coliseum location shown in Figure 2 is near the southern most multi-family residential area along Virginia Street. The Coliseum has approximately 200 X 10^3 ft^2 and a peak demand of 5 X 10^6 Btu/hr.

3.2 DOWNTOWN RENO

Downtown Reno has been the core area for major development in the last five years in Reno. All the hotels, motels and casino complexes included in the user survey are located within this area.

Table 4

SCHOOLS

PEAK HEAT DEMAND

Schools	Total $\times 10^6$ Btu/hr
E. Otis Vaughn Middle School	2.8
Roger Corbett Elementary School	1.2
Earl Wooster High School	7.0
Echo Loder Elementary School	1.1
Anderson Elementary School	1.0
Edward L. Pine Middle School & Smithridge Elementary School	4.7
Huffaker Elementary School	.5
Total	$\approx 19 \times 10^6$ Btu/hr

Table 5

SHOPPING CENTERS
PEAK HEAT DEMAND

Shopping Centers	Total X 10^6 Btu/hr
Val-U-Center	1.6
Lakeside Plaza	3.2
Shoppers Square	6.8
Park Lane Mall	22.0
Del Monte Shopping Center	2.6
Moana West Shopping Center	4.0
Moana East Shopping Center	1.2
Clarkson's Plaza	.8
Mervyn's/Gemco	6.3
Old Town Mall	8.7
Crossroads	2.0
Coliseum Meadows Shopping Center	2.8
Meadowood Shopping Center	49.0
Total	≈ 111 X 10^6 Btu/hr

3.2.1 Hotels/Casinos/Motels

Information on the hotels/casinos/motels in the downtown area was obtained from a recent city development survey of buildings, the Reno Tour Listing, questionnaires sent to the Gaming Industry Association, field surveys of two hotels and one casino, phone conferences with six hotels for additional information on square footage and heating system characterization and the Reno assessor's office. The hotels have from 25 to 590 rooms. The two hotels which were surveyed on-site contained in excess of 500 rooms and less than 200 rooms, respectively.

3.2.1.1 Hotel/Casino Complexes

Data from all sources show a total of 4,991 rooms in the hotel/casino complexes. The heating systems are predominantly total or partial hot water systems with approximately 20 percent of the complexes having steam or individual unit heating systems. Because of the expense of retrofitting existing steam or individual unit systems, it was assumed that only 75 percent of the total rooms would be connected for a total of 3,743 rooms located in thirteen buildings, with a peak demand of 150 X 10^6 Btu/hr.

3.2.1.2 Motels

Information on the motels was obtained from the Tourist Listing. The number of rooms in the motels varied from 25 to 170. The total number of rooms in the 38 motels is 2,007. Assuming a connection rate of 50 percent in 20 buildings, a total peak demand of 20 X 10^6 Btu/hr will occur.

3.2.1.3 Independent Casinos

The two largest casinos were surveyed and both have hot water heating systems. Assuming that three casinos are connected to the district heating system, the total square footage would be 130,000 square feet with a total peak demand of 4 X 10^6 Btu/hr.

3.2.2 Office and Financial Buildings

Information from the recent development survey and the Assessor's office show a floor space of 2.8 million square feet for office and financial buildings. Assuming the connection of 50 percent of the total square footage, a peak hourly demand of 51 X 10^6 Btu/hr exists for seventeen buildings ranging from 20 X 10^3

to 200 X 10^3 ft^2. No information was collected on the existing heating systems in the office and financial institution buildings.

3.2.3 Retail Buildings

From the recent development survey, a total of .73 X 10^6 ft^2 of floor space is devoted to retail establishments. Assuming that 50 percent of the total floor area is located in thirteen buildings which subscribe to the system, the retail buildings will have a peak demand of 15 X 10^6 Btu/hr. No information on the types of heating systems was collected.

3.2.4 Residential Structures

In the downtown area there are 743 apartments. The floor area, obtained from the Assessor's office, for two large high rise apartment buildings is 421 X 10^3 ft^2. These apartments use hot water heating systems. Assuming a floor area of 600 X 10^3 ft^2 located in four buildings, there is a total peak demand of 50 X 10^6 Btu/hr.

3.3 NORTH OF DOWNTOWN RENO

Three large users north of downtown Reno are included in the district heating system. The University of Nevada has approximately 28 campus buildings which are served by a high temperature hot water district heating system. There is approximately 1.5 X 10^6 ft^2 of floor area in the University and the peak demand for the University buildings is 60 X 10^6 Btu/hr.

The School District Administration Building has 44 X 10^3 ft^2 and a peak demand of 1.6 X 10^6 Btu/hr. St. Mary's Hospital has an area of 351 X 10^3 ft^2 and a peak demand of 21 X 10^6 Btu/hr. In each of these cases the yearly consumption data was used with degree day information to obtain the peak demand. All the large users are located in Figure 2.

3.4 HEAT LOAD SUMMARY

The peak hourly design demand and estimated yearly consumption for each type of user above are summarized in Table 6. The total peak demand, without a diversity factor, is 589 X 10^6 Btu.

The yearly consumption was calculated for an average heating load in Reno of 6,022 °F days. For some buildings such as schools, the University and St. Mary's Hospital, yearly consumption data was available. This consumption was

Table 6

HEAT LOAD SUMMARY

South Virginia Street	PEAK DEMAND X 10^6 Btu/hr	YEARLY CONSUMPTION X 10^6 Btu
Multi-Family Housing	117	233,600
Shopping Center	111	150,800
Schools	19	28,500
Coliseum	5	2,400
Downtown		
Hotels/Casinos	150	310,700
Motels	20	33,000
Casinos	4	5,800
Offices	51	77,000
Retail	15	22,200
Apartments	15	33,000
North Downtown		
St. Mary's Hospital	21	40,500
University of Nevada	60	116,000
School District Administration Bldg.	1.6	2,500
TOTAL	589	1,056,000

based on degree days for a particular year. The consumption was adjusted to represent a year with the average number of degree days.

From data collected from some hotels and casino complexes, an average energy consumption per ft^2 was calculated and applied to other hotel and casino complexes. These consumption figures were compared with consumption data provided by Sierra Pacific Power Company for thirteen large hotels/motels. For the other buildings, approximate values per square foot were used.

Results, including heat for domestic hot water consumption, are tabulated in the second part of Table 6 per each category of user. The total yearly consumption is 1,056,000 million Btu.

$1,056,000 \times \frac{.40}{10^6} =$

4.0 DISTRICT HEATING SYSTEM DESIGN CONCEPT

The general concept for the Reno District Heating System is represented in the schematic drawing in Figure 3 and is divided into three parts as follows:

1. A closed loop system at the geothermal source is used to isolate the high temperature corrosive geothermal water. The heat exchanger at each well is designed to take geothermal water at 350°F, provide for a 150°F temperature drop and return water for reinjection at 200°F.
2. The transmission network conveying heat from the well heat exchangers to the buildings is also a closed loop system.
3. An indirect connection is used for each building.

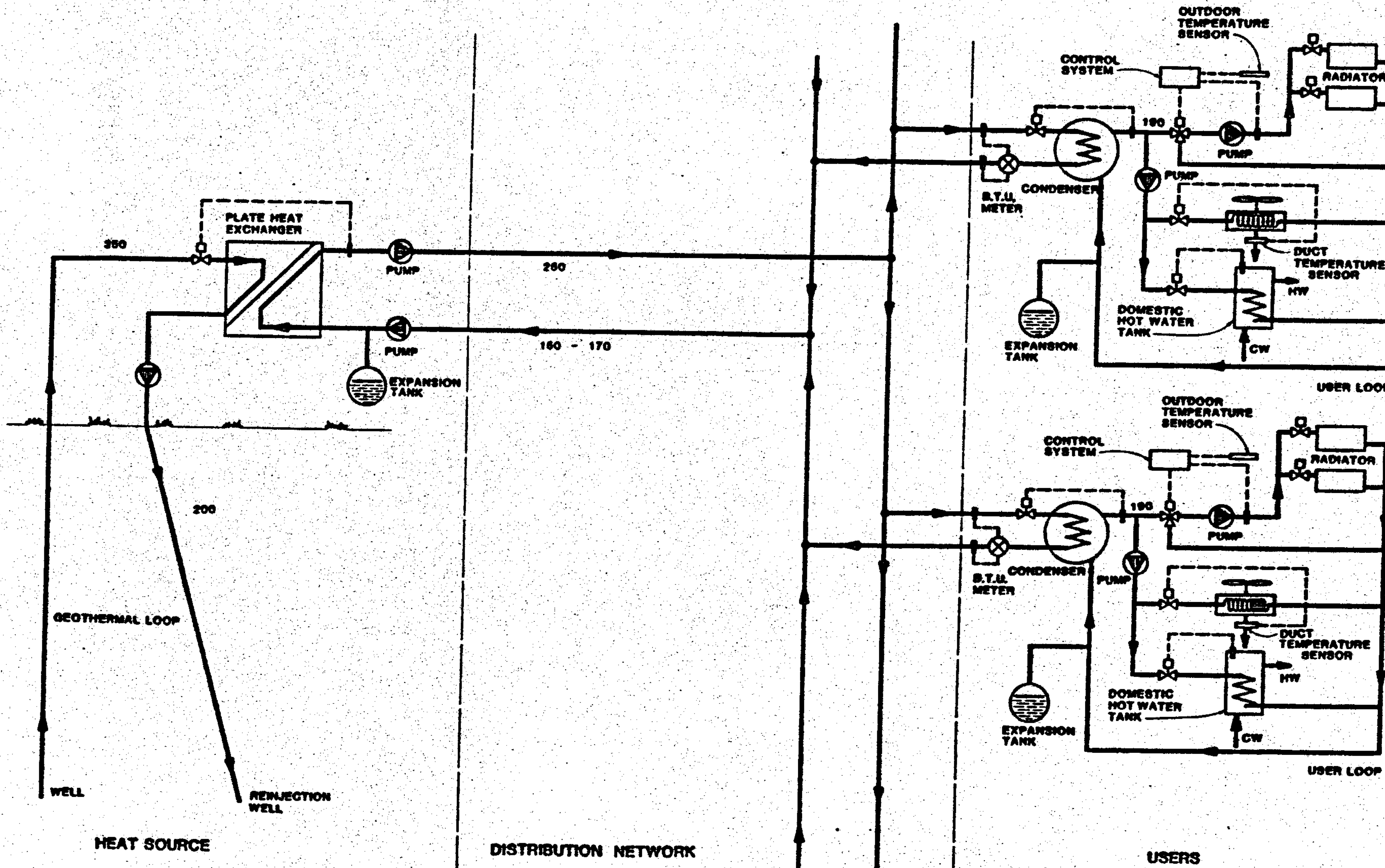
This design isolates the transmission medium from each user's system. The design also takes advantage of the high percentage of existing hydronic space heating systems and permits the retention of existing user heat sources.

With a temperature drop at the source heat exchanger of 150°F, the transmission water will be approximately 250°F which will heat the user water to as much as 220°F. The temperature drop at the user heat exchanger will vary from 20°F to 100°F depending on the configuration.

4.1 HEAT SOURCE

The potential service area has a peak demand of 589 million Btu/hr or 172 megawatts thermal. Using a diversity factor of 80 percent, the system is designed to meet a peak demand of 475 X 10^6 Btu/hr. Hot water has been chosen as the transmission medium because it matches the character of the heat source, minimizes heat losses, and enables an economical system design.

In order to satisfy the design demand of 475 X 10^6 Btu/hr, with a temperature drop at the geothermal wells of 150°F, the source must be capable of furnishing a flow in excess of 6,000 gallons per minute. This is achieved by using six wells each having a flow of 1,000 GPM. Because of the water volume needed, six reinjection wells will also be used. As shown in Figure 3, each well will have a plate and frame heat exchanger, a control valve to adjust the flow according to the temperature of the distribution medium, 2 pumps (one on the supply line, the other on the return line of the distribution network) connected to the main headers of the distribution line which has a total flow of 10,000 GPM at a 100°F temperature drop.



RENO DISTRICT HEATING SYSTEM
GENERAL CONCEPT

FIGURE 8

A centralized control system will monitor the six groups of heat exchangers, control valves and pumps to: 1) maintain the maximum temperature drop between the supply well and the reinjection well, and 2) adjust the flow in the distribution system to meet the load. A step controller will be used for this purpose.

4.2 DISTRIBUTION SYSTEM

The transmission piping network will be two direct-buried pipes 24" in diameter, with polyurethane insulation and fiberglass jackets. The distribution system branching from this transmission line will vary from 2" to 24" in diameter (see general layout, Figure 4, and downtown layout, Figure 5).

4.3 BUILDING HOOKUP AND RETROFIT

The distribution network is designed to favor existing hydronic heating systems. Significant retrofitting is only required for forced air systems or domestic water production for non-hydronic systems.

4.3.1 Building Hookup

Each building has a heat exchanger, control system to adjust the heat supply to the load of the user system and an energy Btu meter. A typical connection for an existing hot water system is shown in Figure 3. Design will be done to permit retention of the existing boiler or furnance.

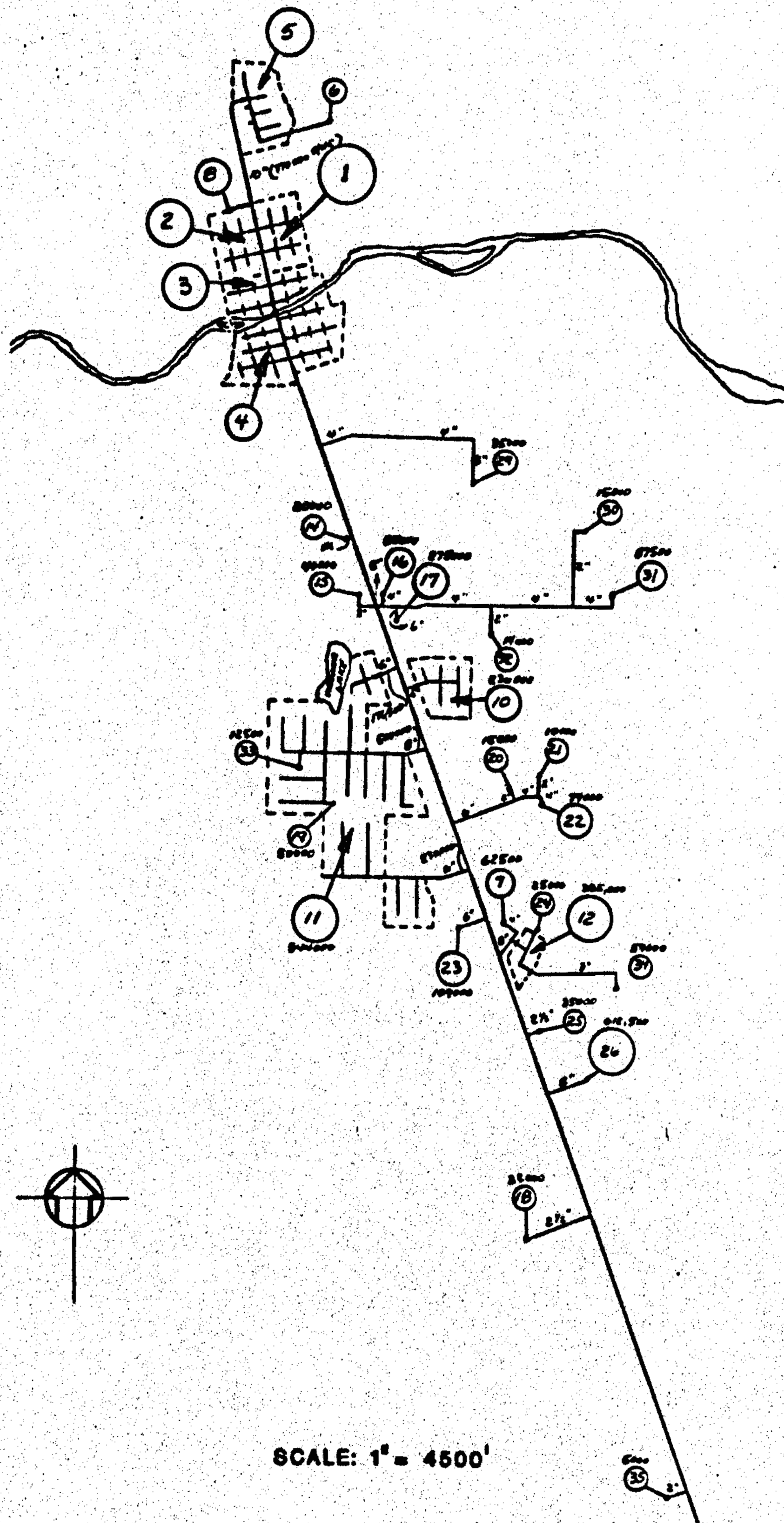
The total number of buildings by category which are connected to the district heating system are listed in Table 7.

4.3.2 Heating System Retrofit

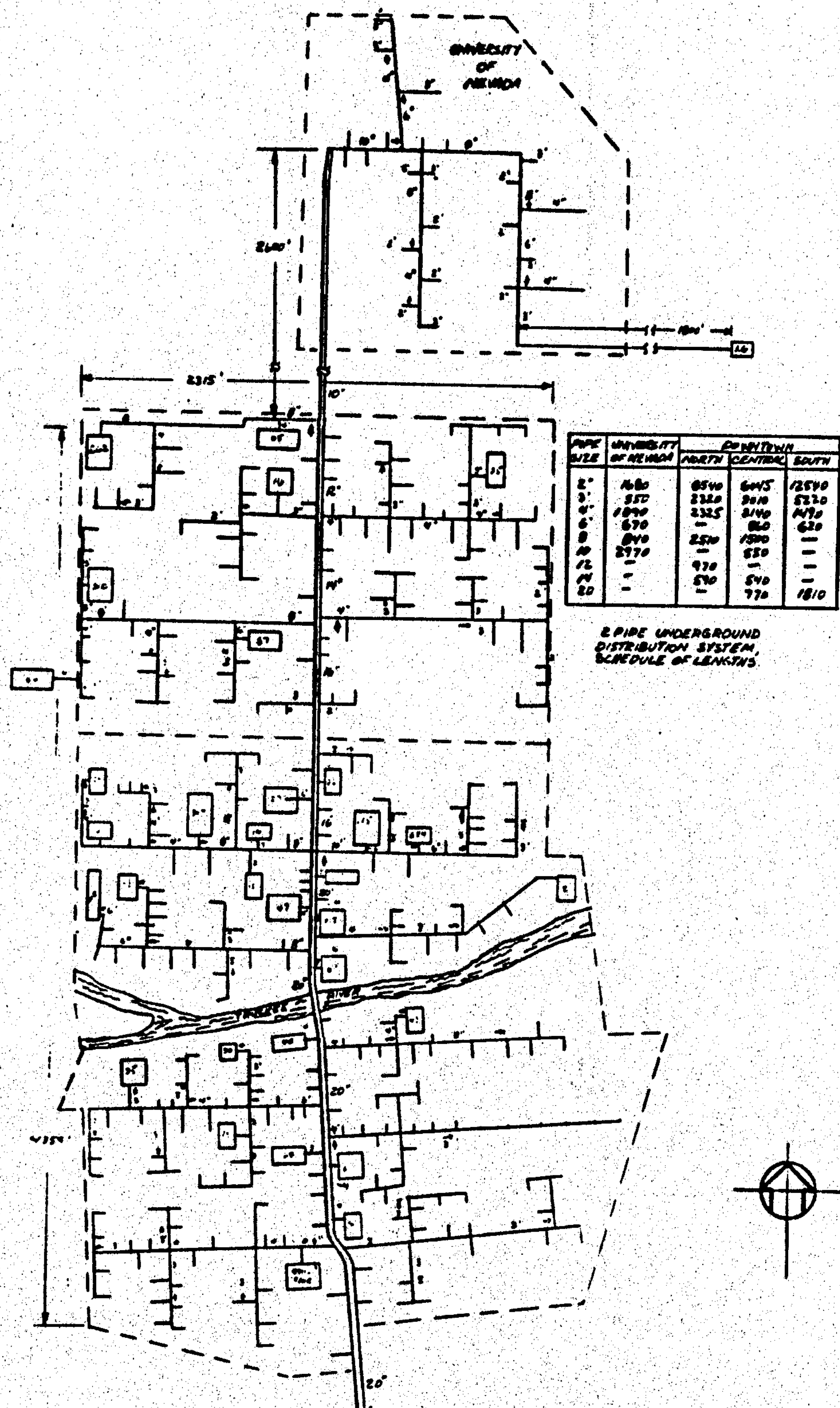
4.3.2.1 Multi-Family Residential

Space Heating

In the South Virginia Street area, the apartment survey of 3,383 apartments with hot water or forced air heating systems showed that 35 percent of the space heating systems are hot water systems and 65 percent are forced air systems. For estimating the retrofit costs, it was assumed that 30 percent of the 4,340 apartments connected as described in paragraph 3.1.2 are connected to a centralized system, hot water or forced air, and 70 percent have to be retrofitted.



DISTRIBUTION SYSTEM – GENERAL LAYOUT



PIPE SIZE	UNIVERSITY OF NEVADA	DOWNTOWN NORTH	DOWNTOWN CENTRAL	DOWNTOWN SOUTH
2"	1680	8540	6445	12540
3"	550	2320	3010	5220
4"	1890	2325	2140	1490
6"	670	—	860	620
8	840	2510	1590	—
10	2970	—	550	—
12	—	970	—	—
14	—	590	540	—
20	—	—	770	1810

2 PIPE UNDERGROUND DISTRIBUTION SYSTEM, SCHEDULE OF LENGTHS

SCALE: 1" = 840'

DOWNTOWN RENO

Figure 5

Table 7

CONNECTED BUILDINGS

Virginia Street Area		
Apartments	69	
Shopping Centers	44	
Schools	7	
Centennial Coliseum	1	
		121

Downtown Reno		
Hotel/Casino	13	
Motel	20	
Casino	3	
Office/Finance	17	
Retail	13	
High Rise	4	
		70

North of Downtown		
St. Mary's Hosiptal	1	
School District Administration Bldg.	1	
University of Nevada	6	
		8
TOTAL		199

Out of the buildings which are connected, a certain percentage in each category requires additional labor and equipment for retrofitting.

The retrofit cost was estimated by using a typical three-story building with 50 apartments, and included the replacement of natural gas furnaces by unit heaters with hot water coils connected to the existing air duct and a new piping distribution system through the building to each coil.

Domestic Hot Water

The apartment survey also showed that 42 percent of the domestic hot water systems are centralized systems with either a "hot water to domestic hot water" heat exchanger (20 percent) or direct, natural gas or electric, heaters (22 percent) as opposed to individual apartment water heaters. Only the centralized systems will be supplied by the district heating system, and the retrofit cost includes only the replacement of direct heaters with hot water to domestic hot water heat exchangers.

4.3.2.2 Shopping Centers

Retrofitting of shopping center heating systems requires replacement of furnaces with hot water coils or replacing the heating component of rooftop units. Unlike residential structures, shopping centers have mechanical rooms which have sufficient space to insert a hot water coil. Domestic hot water systems were not considered.

4.3.2.3 Schools and Coliseum

All the schools to be connected have hot water systems and, therefore, require only the connection interface equipment previously described. The Coliseum has forced air and can be retrofitted in a manner similar to the shopping centers.

4.3.2.4 St. Mary's Hospital

St. Mary's Hospital has hot water heated by a steam boiler for space and domestic water heating. The only retrofit required is connecting the domestic hot water to the hot water system.

4.3.2.5 University of Nevada

The University of Nevada has a central boiler plant which distributes high temperature water to each building. New distribution lines and heat exchangers are required for the connection of building systems because of the higher temperature

(375°F instead of 250°F). This retrofit is treated as a connection cost rather than a retrofit expense. The economics of connecting the University requires additional review prior to establishing feasibility.

4.3.2.6 Hotels/Casinos/Motels

According to the development survey results (see 3.2.1.1), seven hotels out of the thirteen identified are totally hot water heated and represent about 67 percent of the connected rooms. The other hotels require partial retrofit. The existing installation for a typical hotel and casino with steam boilers is shown in Figure 6. The designated boilers produce steam. For space heating of casinos and restaurants, preheat coils are steam heated, but reheat coils are hot water heated with hot water produced from steam/hot water converters. The space heating of the rooms is provided by a hot water system. Domestic hot water is produced from instant steam/domestic hot water heat exchangers:

Figure 7 shows a schematic of the retrofit as follows:

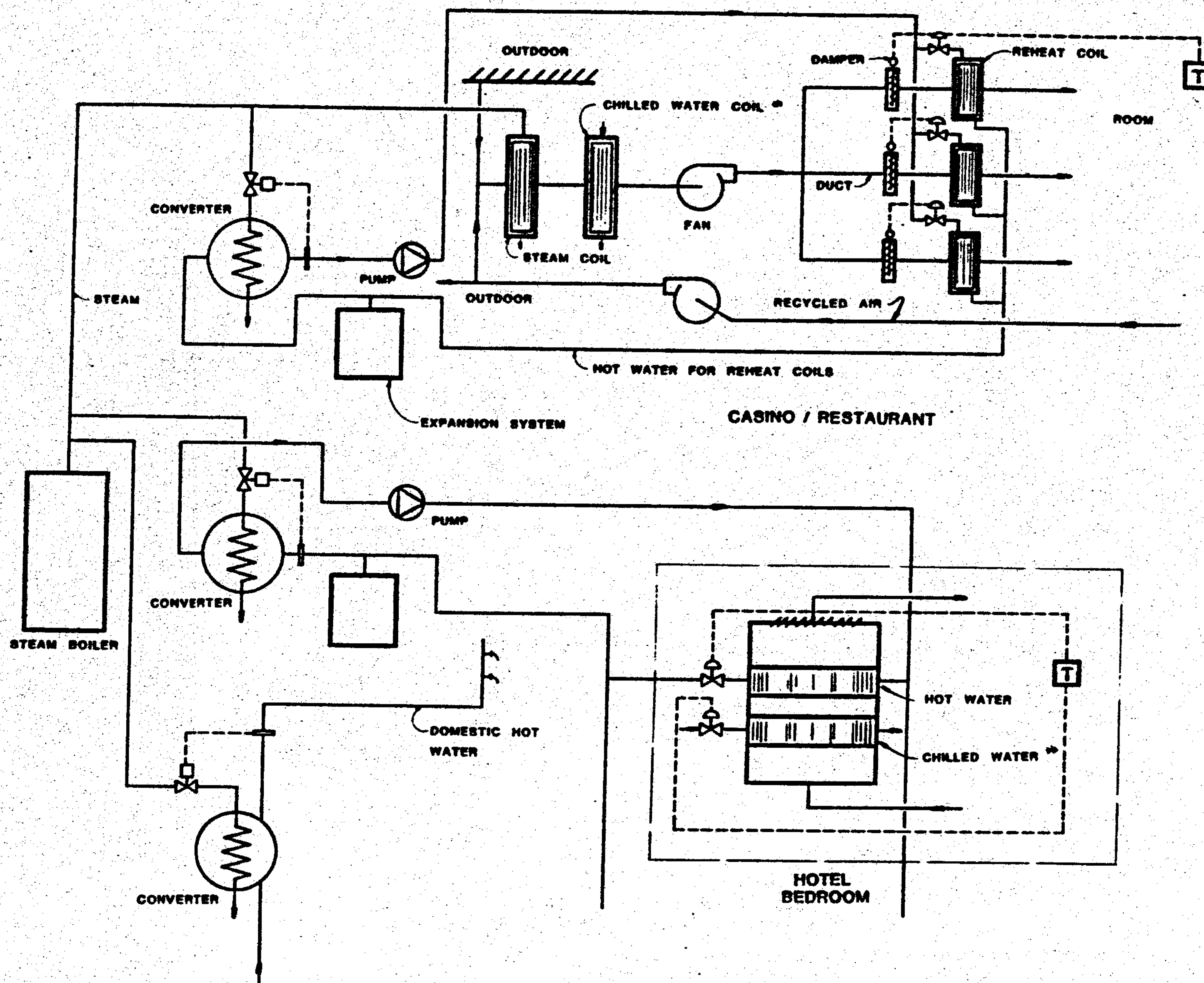
1. The hot water space heating systems connected to the main heat exchanger which obtains heat from the district heating system, and
2. Installation of a new hot water/domestic hot water heat exchanger.

The system is designed to permit operation of the existing installation as a backup. The retrofit costs were calculated in detail for two large hotels. This data was the basis for estimating the retrofit costs for the other hotels.

4.3.2.7 Office, Retail and High Rise Apartments

Approximately 60 percent of the motels (or 600 rooms) were assumed to require retrofitting. Seventy percent of the office and financial buildings and retail establishments and two of the four apartment buildings were assumed to require retrofitting. An approximate retrofit cost per square foot was used to estimate the total retrofit costs for these buildings.

FIGURE 6



TYPICAL EXISTING HOTEL/CASINO WITH STEAM BOILER PLANT

* DETAILS OF CHILLED WATER SYSTEM ARE NOT SHOWN

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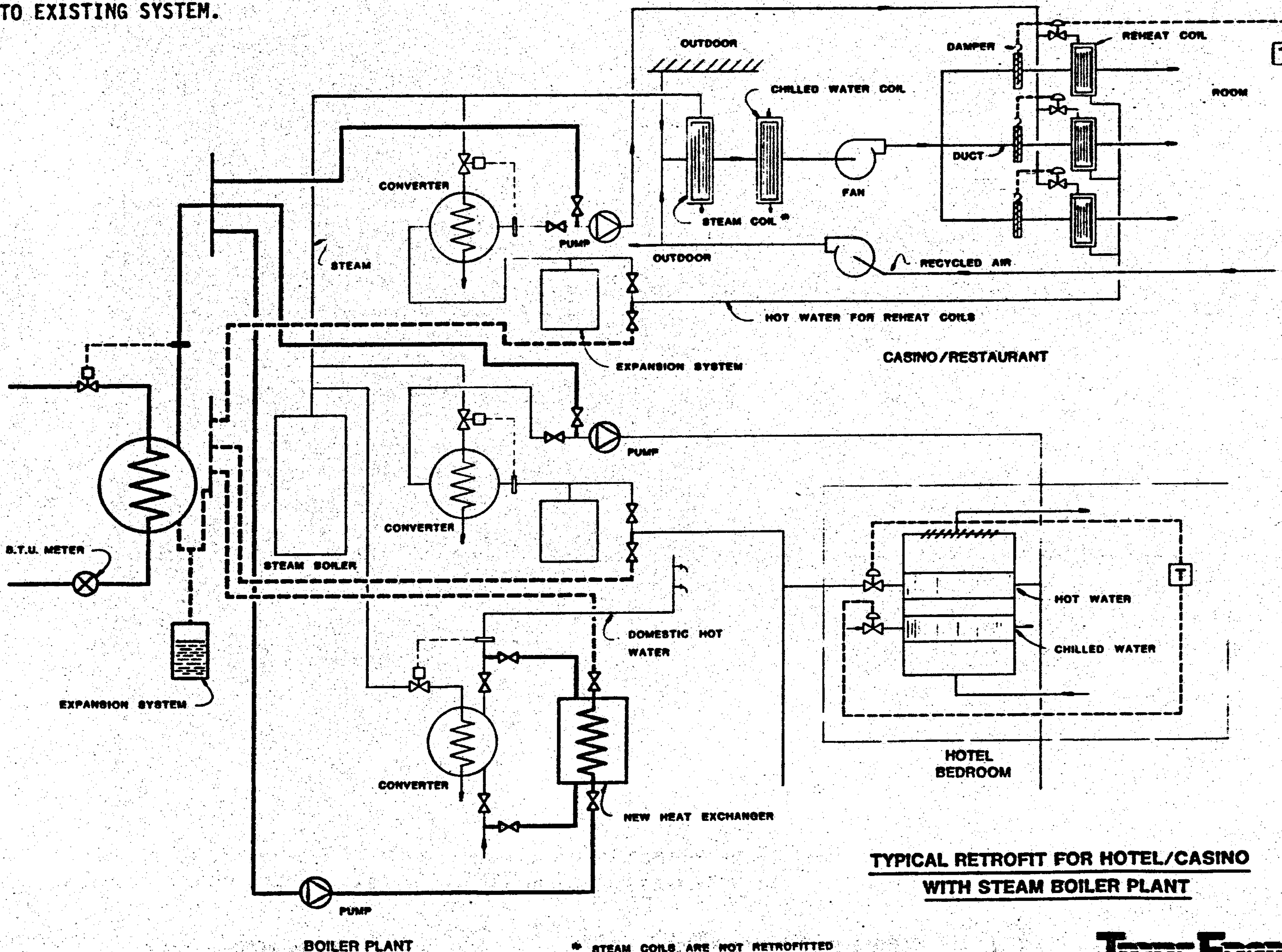
HEAVY LINES INDICATE ADDITIONS
TO EXISTING SYSTEM.



TYPICAL RETROFIT FOR HOTEL/CASINO
WITH STEAM BOILER PLANT

* STEAM COILS ARE NOT RETROFITTED

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FIGURE 7

5.0 ECONOMIC ANALYSIS

5.1 INVESTMENT COSTS

To determine the district heating system capital costs, the system has been divided into components. The geothermal source subsystem cost includes six resource and six reinjection wells, six heat exchangers, 12 pumps, valves and various piping and instrumentation. Housing for the pumps and heat exchangers is also included.

The transmission line is ten miles long and includes two direct buried 20" to 24" diameter pipes with polyurethane insulation and fiberglass jackets. The distribution network includes 30 miles of two pipes varying from 1-1/2" to 20" in diameter. The cost is based on the assumption that the pipe runs to the entrance of the user buildings. Figure 4 shows a piping diagram of the Virginia Street area and Figure 5 shows the piping network for downtown Reno. The piping costs include all labor and material charges.

The retrofit costs include the connection and retrofit requirements as discussed in Section 4.3. A breakdown of the connection and retrofit costs by building category is shown in Table 8. A connection cost for each building in the system is included in the substation costs for each building. Buildings with existing hot water heating systems have no retrofit costs.

The capital costs are summarized in Table 9; the total in $1981 is $55,403,600.

5.2 ECONOMICS

This preliminary economic study considers only financing with tax-exempt revenue bonds. The principal assumptions are discussed below.

5.2.1 Implementation Schedule

The schedule in Figure 8 assumes initiation of engineering in late 1982, construction startup in 1984, shakedown and operation of the first part of the system in early 1987, with total operation in 1990.

5.2.2 Operating and Maintenance Costs

Using data from similar size hot water district heat systems in Europe, the operating and maintenance staff will require 25 people including management and clerical personnel. The yearly labor cost in $1981 is $1,080,000. For

Table 8

CONNECTION AND RETROFIT COSTS

	CONNECTION (Substation)	RETROFIT	TOTAL
VIRGINIA STREET AREA			
Multi-Family Housing	$ 536,000	$2,380,000	$2,916,000
Shopping Centers	363,000	787,000	1,150,000
Schools	64,000	-	64,000
Centennial Coliseum	12,000	42,000	52,000
DOWNTOWN			
Hotel	$ 257,000	$1,319,000	$1,576,000
Motel	130,000	329,000	459,000
Casinos	22,000	-	22,000
Office & Financial Buildings	171,000	570,000	741,000
Retail	89,000	195,000	284,000
Downtown Housing	43,000	88,000	131,000
NORTH OF DOWNTOWN			
St. Mary's Hospital	31,000	32,000	63,000
University of Nevada	102,000	-	102,000
School District Administration Bldg.	8,000	-	8,000
	$1,828,000	$5,742,000	$7,570,000

Table 9

CAPITAL COSTS ($1981)

1. Geothermal Source		
1.1 Geothermal Wells	$ 9,000,000	
1.2 Heat Exchangers, Pumps, Valves, Piping, Etc.	2,050,000	
Subtotal		$ 11,050,000
2. Distribution Network		
2.1 Transmission Line - Wells to South Limit of Downtown (10 mi., 10-24")	17,482,400	
2.2 Distribution Lines		
2.2.1 Shopping Center, Schools & Coliseum along Virginia Street	2,090,600	
2.2.2 Apartment Areas Along Virginia Street	4,268,000	
2.2.3 Downtown	3,700,900	
2.2.4 North of Downtown (University and School Dist. Admin. Bldg, St. Mary's Hospital	790,300	
Subtotal		28,332,200
3. Retrofit (Connection & Retrofit)		7,570,000
		$ 46,952,200
A & E Fee (8%)		3,756,200
Contingency (10%)		4,695,200
Grand Total ($1981)		$ 55,403,600

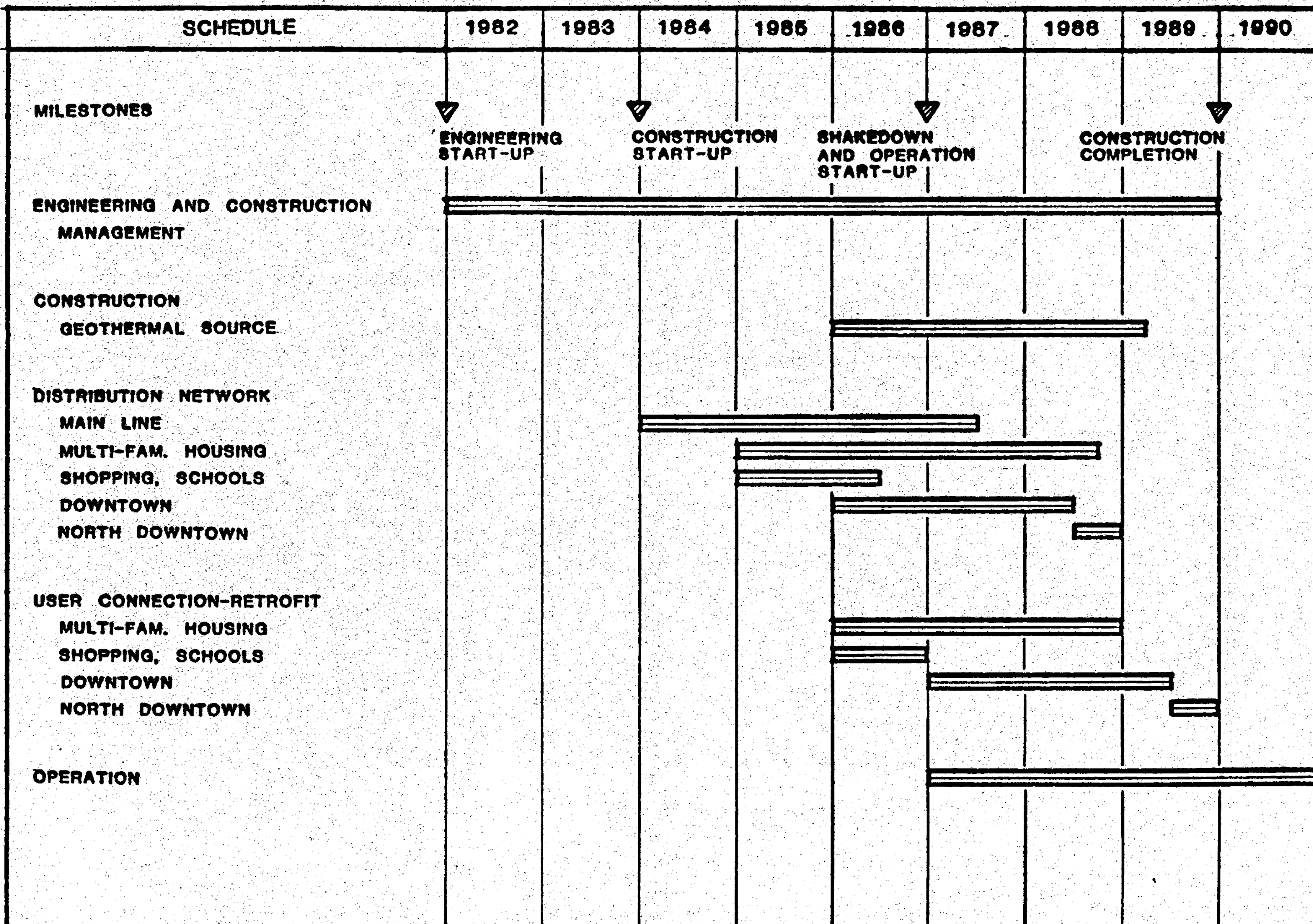

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Figure 8

the first two years of operation (prior to full scale operation) 75 percent of this cost was included, and for the third year of operation 85 percent of this cost was included.

Yearly electricity consumption, with full load, was estimated at 9,800,000 kWh. Assuming an average first year electricity cost of 5¢/kWh, the yearly cost in $1981 is $490,000. During the first three years of operation this consumption, based on the buildings connected, was 3,000,000 kWh in 1987, 5,300,000 kWh in 1988 and 7,600,000 kWh in 1989.

5.2.3 Escalation Assumptions

Different costs were escalated each year as shown in Table 10.

Table 10

PRICE ESCALATION ASSUMPTIONS*

Labor:	7% through 1989 5% from 1990
Supplies, Parts:	8% through 1989 6% from 1990
Electricity:	15% through 1983 10% from 1984 through 1989 5% from 1990

*Escalation Includes Inflation Rate

5.2.4 Financing

The financing assumes that engineering expenses for 1982 and 1983 are covered by short term loans at an interest rate of 15 percent, and that other expenses are covered by two revenue bond issues for terms of 20 years at 13 percent. A financial calendar was established from the schedule for the expenses, including inflation, from 1984 through 1989.

The first revenue bond covers the engineering and construction expenses for 1984 through 1986 for $41,660,000 and the shakedown and operation costs for 1987 for $1,660,000. The second revenue bond covers the engineering and construction expenses for 1987 through 1989 for $40,810,000. Assumptions for these bonds appear in Table 11 which shows the calculations for the first bond.

Debt service will start in 1988 for the first bond issues, and in 1990 for the second bond issue. The yearly capital cost for this first bond is $6,253,000 and $6,605,000 for the second bond issue.

Table 11

FINANCING

FIRST BOND

Engineering and Construction Cost (1984-1985-1986)	$ 41,660,000
Shake Down and Operating Cost (1987)	1,660,000
	$ 43,320,000
Indirect Cost	
Bond Issuance Cost 3.5%	$ 1,943,550
Capitalized Interest (4 years 13%)	28,875,600
Debt Service Fund (1 year)	7,904,690
Reserve Contingency Fund (1 year 25%)	1,976,170
Operating Fund (3 months year 1990)	1,125,000
Total Plus	+$ 41,825,010
Interest Earned (15%)	
Construction Fund	$ 12,268,000
Capitalized Interest	10,828,350
Debt Service Fund	4,742,820
Reserve Contingency Fund	1,185,700
Operating Fund	590,620
Total Minus	-$ 29,615,490
Total Financing Required:	$ 55,529,520
Yearly Debt Service (20 years 13%)	7,904,690
Less Interest on Debt Service Fund (15%)	-1,185,700
Interest on Reserve Congingency Fund (15%)	- 296,420
Interest on Operating Fund (15%)	- 168,750
Yearly Capital Cost	$ 6,253,820

5.2.5 District Heating System Cost Savings

The primary heating fuel that will be offset by the district heating system is natural gas. The following discussion is therefore based upon conversion of natural gas-fired equipment.

Figure 9 shows the projected natural gas prices in the Reno area. The price projections are upon an average 1981 natural gas price of $0.47122/therm (Sierra Pacific Power Company Schedule issued 2/1/81) and U.S. Department of Energy projected price escalations (DOE/PE-0029).

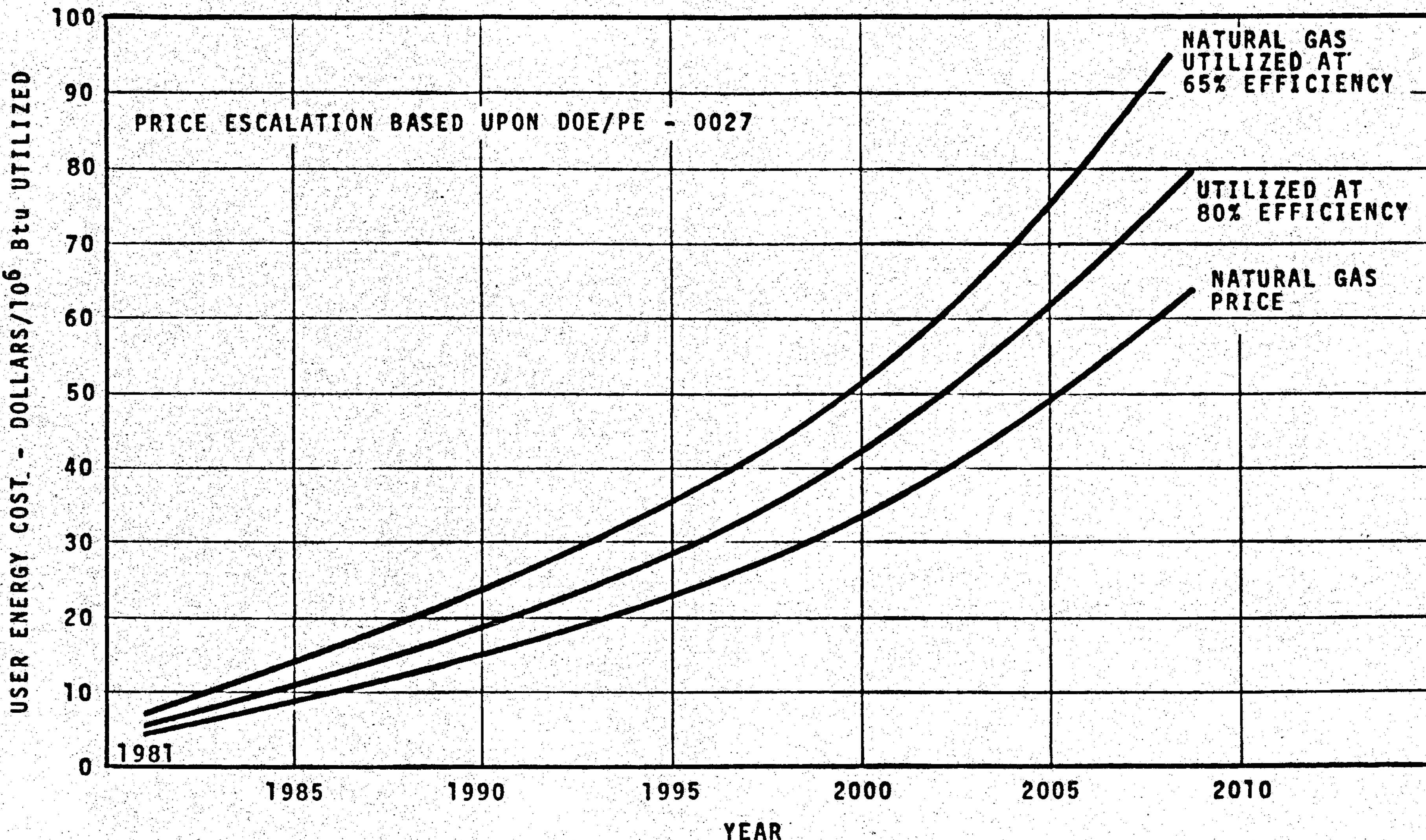
When comparing alternative energy systems, a convenient and tangible evaluation parameter is the cost of the energy supplied to the user ($/Btu). The difference between the cost of natural gas and the cost of the energy supplied by the district heating system represents the cost savings in $/Btu. To put these two costs on the same basis, the energy costs must be based upon the energy usefully utilized by the user, i.e., corrected for the efficiency of the user space and water heating equipment.

Depending upon the size and type of equipment, the annual average heating efficiency of natural gas-fired equipment will range from 65 to 80 percent with the higher efficiencies typically only found in very large building heating systems. The effects of heating system efficiencies of 65 and 80 percent on the effective cost of natural gas ($/Btu utilized) are shown in Figure 9.

By comparison, the energy supplied to a user by the district heating system as measured by the user's Btu meter, is utilized at an efficiency of 100 percent.

In order to be economically viable, the Reno district heating system must provide energy at a price below the price of conventional systems. For purposes of the system economic analysis, the maximum price of the energy supplied by the district heating system was assumed to be equal to the price of natural gas. Due to the difference in efficiency between natural gas-fired heating equipment and the district heating system user equipment, this represents a cost savings of 20 to 35 percent for natural gas equipment with efficiencies of 80 to 65 percent respectively.

Figure 10 shows the projected energy costs of conventional natural gas heating systems compared to the cost of energy from the district heating system. As



PROJECTED NATURAL GAS ENERGY COSTS

Figure 9

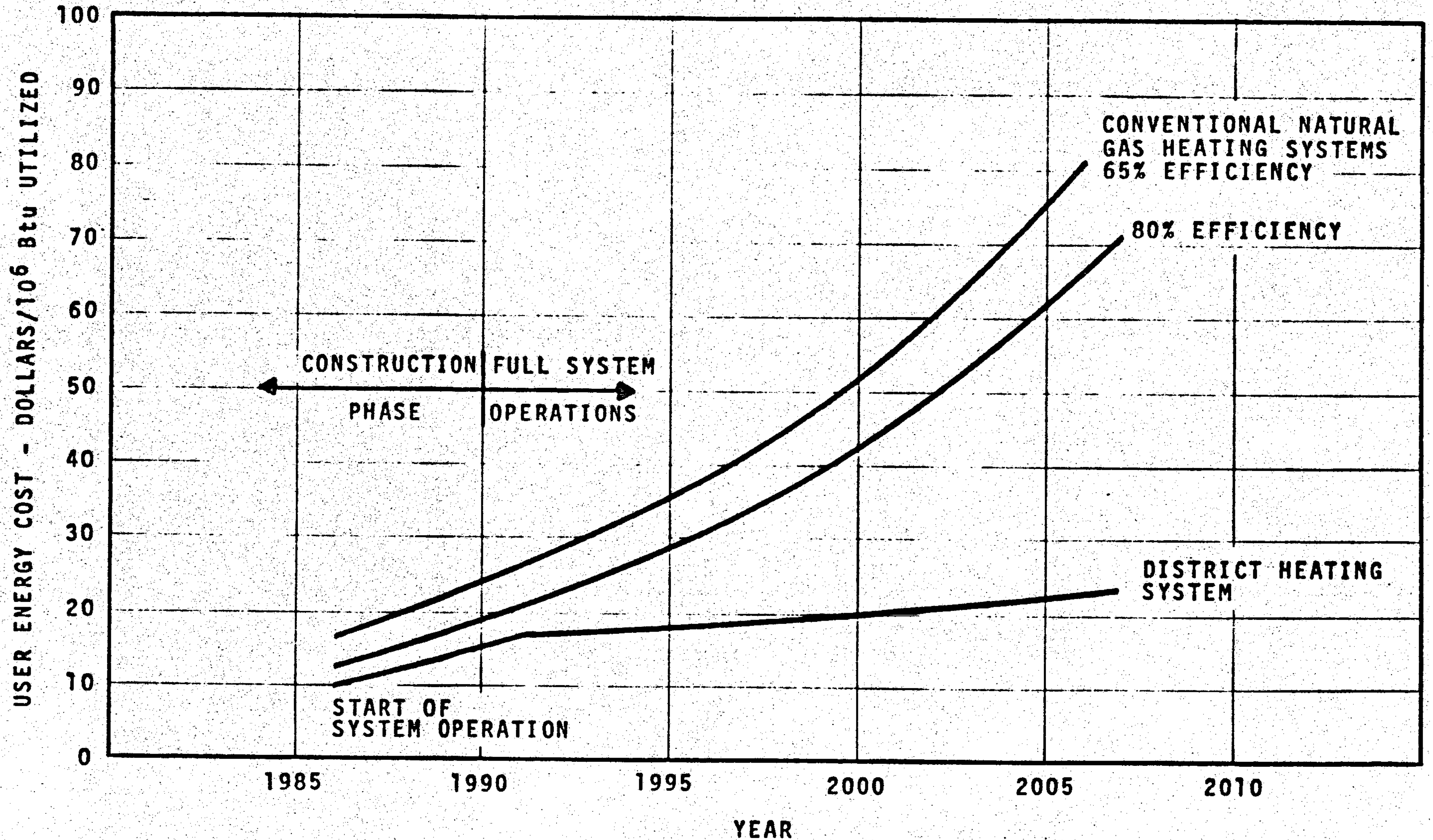


Figure 10

CONVENTIONAL AND DISTRICT HEATING SYSTEMS
USER ENERGY COST COMPARISON

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shown, the district heating system offers a very substantial cost savings compared to conventional natural gas heating equipment. For the period from 1987 (the first year of operation) through 2007, the average cost of heating using the district heating system is only 40 to 50 percent of the cost of heating using a conventinal natural gas heating system.

5.2.6 Geothermal Royalty Effects

The district heating system costs shown in Figure 10 assume that all equipment costs associated with the geothermal source including the wells, pumps, heat exchangers, etc. are paid for by the district heating system. Unless the owner/operator of the district heating system also owns the geothermal source, a royalty will have to be paid for the right to remove energy from the site. While the exact amount of any royalty can only be determined based upon negotiations with the geothermal source owner, the amount of any royalty is anticipated to be in the range of 5 to 10 percent of the cost ($/Btu) of an equivalent amount of fossil fuel.

Figure 11 shows the effect of royalties equivalent to 5 and 10 percent of the cost of natural gas on the cost of the district heating system. As shown, the effect of the royalties are relatively limited. Even the 10 percent royalty only reduces the 20 year average cost of heating with the district heating system to only 47 to 58 percent of the cost of conventional natural gas heating systems with efficiencies ranging from 65 to 85 percent.

5.2.7 Alternative Heat Sources and Service Areas

The district heating system economics described in the preceeding paragraphs of this section were based upon an arbitrarily selected service area and the use of a well defined heat source (Steamboat Hot Springs). While the economics of this district heating system looks very promising, it is very likely that as additional work is performed as discussed in Section 7.0 to optimize the system design, the overall district heating system economics will be significantly improved.

For example, as noted in Section 2.0, there are some potentially suitable geothermal resources nearer to Reno than Steamboat Hot Springs. If additional analysis of these resources showed that they would be suitable as the thermal source for the district heating, the transmission line could be shorter with significant cost savings. Similarly, the district heating system service

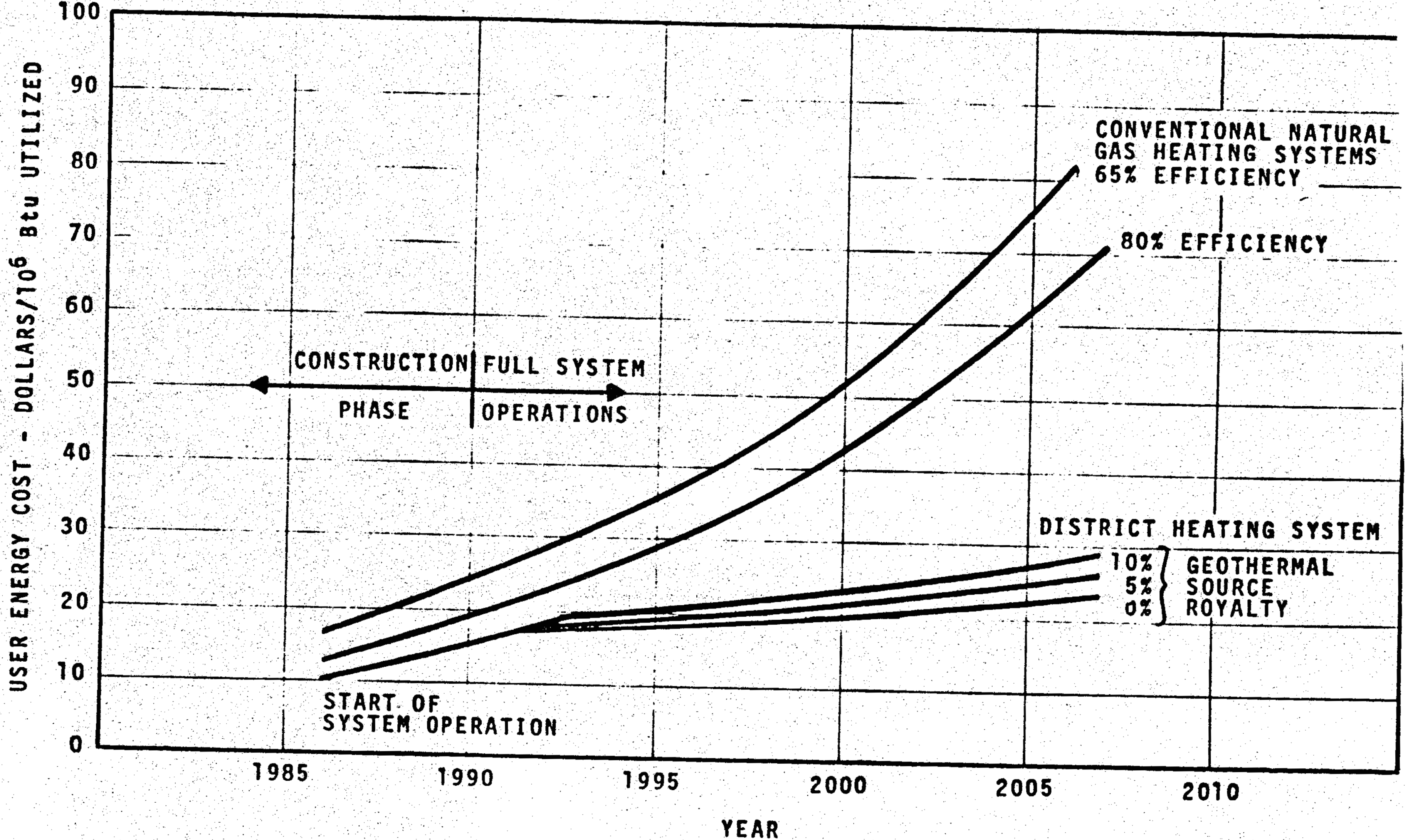

Figure 11

EFFECT OF GEOTHERMAL SOURCE ROYALTIES ON USER ENERGY COST

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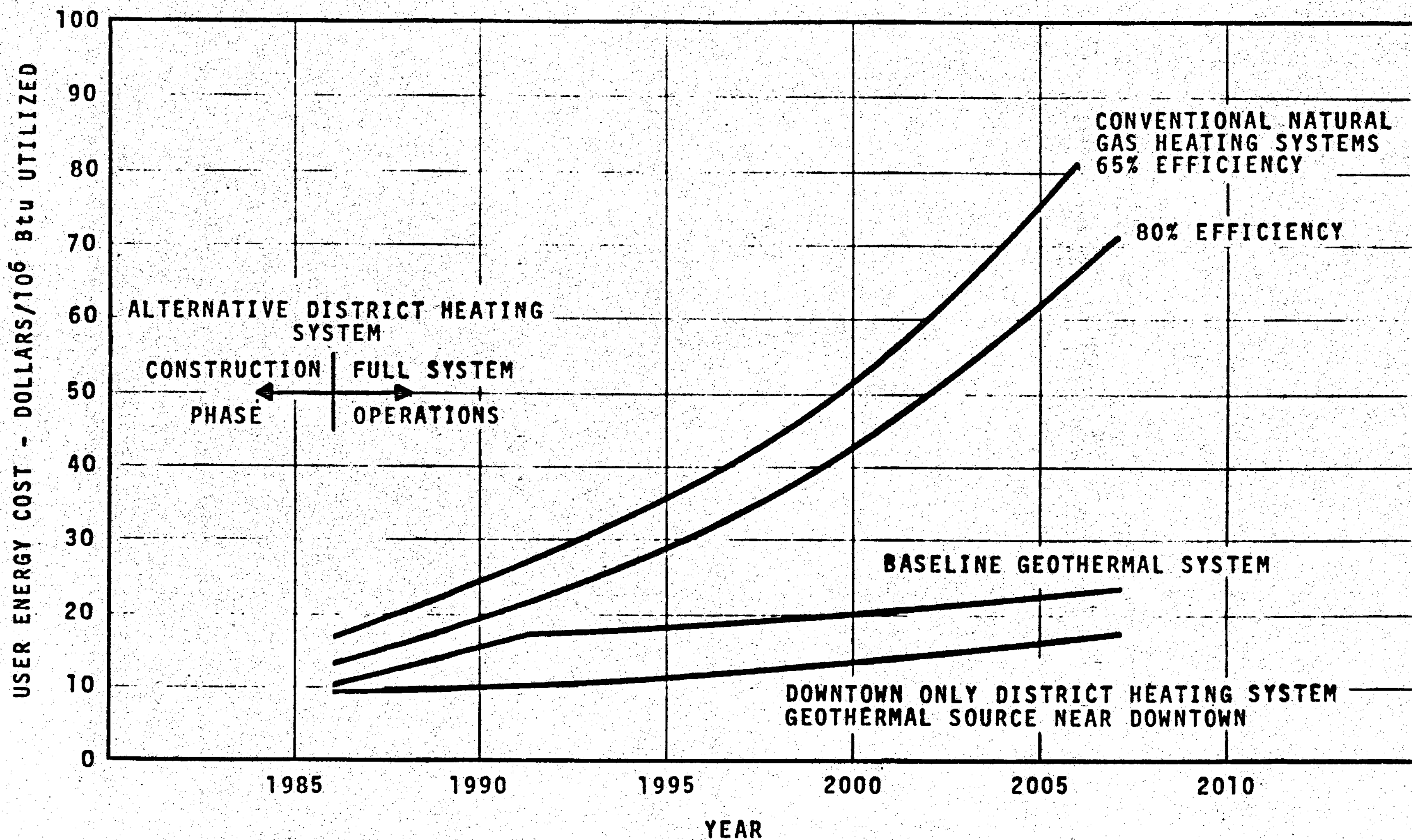
area could be optimized to service only the more cost effective sections of Reno such as the downtown area.

Assuming that a suitable geothermal source could be found near the downtown and the district heating system were limited to downtown Reno, the total capital cost of the alternative district heating system would be approximately $18,000,000. This alternative district heating system would have an annual thermal load of approximately 50 percent of the baseline district heating system. Due to the smaller size of its service area and the elimination of a long transmission line, the construction period of the alternative district heating system would be shortened to approximately two years. Assuming construction started in 1984, the alternative system could be operating in 1987.

Figure 12 presents the cost of energy from the alternative district heating system compared to the baseline district heating system. As shown, the alternative district heating system offers significant advantages over the baseline system. The 20 year average cost of energy supplied by the alternative system is reduced to only 26 to 32 percent of conventional natural gas heating systems (heating system efficiencies of 65 and 80 percent respectively).



ALTERNATIVE DISTRICT HEATING SYSTEM AND SERVICE AREA
EFFECT ON USER ENERGY COST

Figure 12

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6.0 CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations from the pre-feasibility studies of geothermal heating for hotels/casinos and geothermal district heating for Reno were combined to achieve maximum benefits from the individual projects.

6.1 CONCLUSIONS

1) Geothermal Heat Source

Steamboat Hot Springs, 10 miles south of Reno, was selected as the heat source for the district heating system (DHS). Another geothermal area east and within five miles of downtown Reno is a potential source; however, existing data on the location and characterization of the source are proprietary.

2) Potential Heat Users

The service area for the proposed DHS is divided into the densely constructed areas along South Virginia Street, downtown and north of downtown Reno. The penetration of the space heating market varies by building category and existing type of heating system. A total of 199 buildings are connected to the system to give a total peak demand of 589×10^6 Btu/hr and a predicted yearly consumption of 1.06×10^6 Btu.

3) District Heating System Design

The DHS design incorporates a closed loop piping network for the geothermal sources and for the hot water transmission subsystem with an indirect connection for each user. Based on an 80 percent diversity factor, the peak design demand is 475×10^6 Btu/hr. Six production wells with six reinjection wells will generate a total source flow of 6,000 gallons per minute and transmission line flow of 10,000 gallons per minute.

Buildings with existing hydronic space and hot water heating systems were favored for connection to the system. For other heating systems, retrofit methodologies were selected and costs calculated for each category of buildings. Seventy percent of the apartment units connected to the DHS are retrofitted, but only centralized domestic water heaters are retrofitted. In contrast, only 33 percent of the hotel/casino/motel rooms required a partial retrofit. The total retrofit costs for all buildings in $1981 is $5,742,000.

4) Economic Analysis

The total investment cost for the DHS to include the geothermal energy recovery equipment, distribution network, connection and retrofit is $55,403,600 in $1981.

Economic analysis of the district heating system shows very substantial savings of conventional natural gas-fired district heating systems. During the first twenty years of operation the district heating system, the average heating costs of the district heating system will be only 40 to 50 percent of the costs of heating with natural gas.

Based on the results of the pre-feasibility study, a geothermal district heating system for Reno to include the downtown hotel/casinos is technically and economically feasible.

6.2 RECOMMENDATIONS

Because of the time and financial limitations on the pre-feasibility study, additional data collection and engineering and economic analyses are required before detail design can commence. The following actions are recommended.

1. Investigate the two potential geothermal heat areas with test wells to characterize the sources.

2. Survey the potential users to include more detail and a greater number of buildings in each category.

3. Assess the feasibility of providing cooling.

4. Examine other methodologies and more detailed costs for retrofitting all types of existing systems in each building category.

5. Assess the impact of adding proposed Double Diamond Development along the planned DHS transmission route to the system.

6. Optimize the DHS design by examining the sensitivity of the system economics to various configurations and assumptions. As an example, the analysis in the pre-feasibility study assumed that retrofit costs were included in the capital costs; therefore, there should be a scenario which excludes retrofit costs from capital costs. Other scenarios should include a system design which meets 40 percent of the system peak demand and assumption of various inflation and other economic factors.

A suggested plan to implement the above recommendations is detailed in Section 7.0. Also included is a description of efforts to investigate and address the environmental, legal and institutional issues necessary to support the project through detail design, construction and operation.

7.0 IMPLEMENTATION PLAN

As presented in Section 5.0, the results of this preliminary feasibility study show that Reno district heating system offers significant potential cost savings over conventional Reno heating systems. The implementation plan presented in the following section was established to develop the Reno district heating system and bring the benefits of district heating to Reno.

The implementation plan for the Reno district heating system is shown schematically in Figure 12. The overall implementation plan consists of three phases which are each broken into separate tasks. The three implementation plan phases are:

Phase I - Economic, Regulatory and Engineering Assessments
Phase II - System Financial Development
Phase III - System Design and Construction

Each of these are discussed below.

7.1 PHASE I - ECONOMIC, REGULATORY AND ENGINEERING ASSESSMENT

The pre-feasibility study has shown that a geothermal district heating system in Reno, Nevada will provide significant savings. Phase I (as described below) is necessary to quantify the total savings and develop an approach to overcome institutional barriers such as financing, regulations and billing procedures. During this phase additional data on the geothermal heat resource, user thermal demands, service area, market penetration, etc. will be obtained so that detailed cost estimates can be developed.

During this phase additional engineering and economic studies will be performed to better define (1) the quantities, temperatures and costs of energy available from the area geothermal heat sources, (2) the thermal demands (for both heating and cooling) of potential system customers, (3) preliminary system design and cost and (4) system economics. In addition to the above work, Phase I will also involve an assessment of applicable regulatory requirements, and the development of a financial plan. The efforts to accomplish the above Phase I work are organized into four tasks:

RENO DISTRICT HEATING SYSTEM
IMPLEMENTATION PLAN

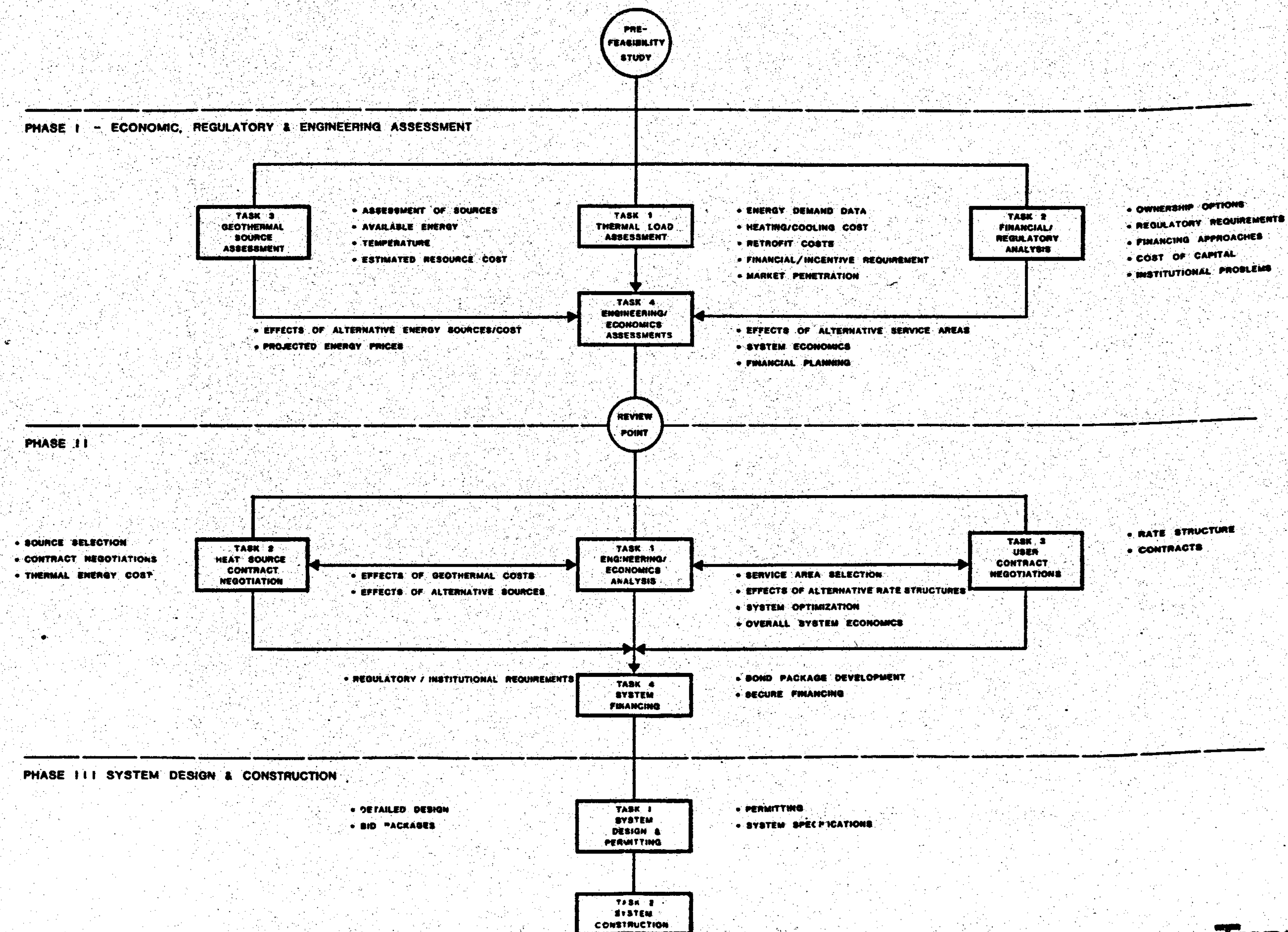

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FIGURE 13

Task 1 - Thermal Load Assessment
Task 2 - Financial/Regulatory Assessments
Task 3 - Geothermal Source Assessment
Task 4 - Engineering/Economic Assessments

Each of these tasks are presented below.

7.1.1 Task 1 - Thermal Load Assessment

The heating data used as the basis of the pre-feasibility thermal demand requirements were based upon consumption data from a limited number of representative building types. To improve the accuracy of the heating demand forecasts, more buildings in each category, e.g., apartments, schools, shopping centers, residences, will be surveyed. In addition, the cooling loads and costs will be determined for the surveyed buildings. The cooling load and cost data will be used during Task 4 to determine the economics of providing space cooling as well as spece heating. Task 1 will also include a more detailed examination of heating system retrofit technology and the costs of retrofitting each type of existing space and domestic water heating system. Based on the pre-feasibility study, the costs for retrofitting multi-family structures which do not have hydronic heating systems are very high. An analysis of the economic tradeoffs between connecting these structures to the district heating system versus the structures continuing to use their existing heat systems will be performed.

In the pre-feasibility study, all retrofit costs were included in the capital cost of the DHC system. The inequities of this approach are demonstrated when the retrofit of large apartments and hotels are considered. Both have large heat demands, but the nominal cost for retrofitting the heating system is much greater for apartment buildings than in hotels. To assess the impact of removing the retrofit expenses from system cost, other scenarios will be considered which assume that the user pays retrofit costs, where applicable. To predict market penetration by the DHC system in those cases, it will be important to know the sensitivity of the penetration rate to the retrofit costs and length of payback with savings.

The penetration of the heating and cooling market by the DHC system is crucial to the system's economic feasibility. Research will be performed with key individuals and groups to identify perceptions of potential users and the community at large about the DHC system. Results from this process will provide the basis for determining the required incentives to obtain user hookup as well as the restraints which must be removed. Furthermore, the market sensitivity to private versus public ownership, individual versus utility payment of hookup costs and rate variation will be evaluated.

7.1.2 Task 2 - Financial/Regulatory Assessment

Due to the capital intensive nature of the district heating/cooling system, in-depth financial planning is a necessity. During this task, discussions will be initiated with a wide variety of financial institutions, including bond underwriters, bond counsel, banks and leasing firms. The intent of these discussions will be to establish the best funding sources for the project, define institutional barriers that may have to be overcome before financing can be arranged for the project, and develop alternative ownership forms.

The financial planning efforts include the selection of a financial advisory firm. The selected firm will provide financial advice on the project as it develops through the latter implementation phases. During Phase III, the financial advisor will develop a financing package for the system. The exact nature of this financial package will depend upon system ownership and the requirements of the Nevada Public Service Commission.

During this portion of Task 2, discussions will be held with the Nevada Public Service Commission and others to establish the policies and regulations that may affect the project, and the effects of alternative forms of system ownership and the policies and regulations affecting the project. These discussions will include extension of service into Reno, system capitalization requirements, issuance of securities, ownership alternatives, as well as rates and profit margins. If any regulatory or legislative problems are identified, a plan will be developed to take the necessary legislative or other corrective actions. Regulatory assessment efforts will continue as necessary throughout each of the remaining phases as the system design, service areas, financing, ownership, etc., become finalized.

7.1.3 Task 3 - Geothermal Source Assessment

During Task 3, the owners of the various potential geothermal resources will be contacted and discussions held to better identify the estimated quantities of energy available, source temperatures and any special corrosion or fouling problems of the heat source. These discussions will include preliminary assessments of the costs of utilizing these resources.

In addition, Trans Energy Systems will assist the Reno City Attorney's office in reviewing applicable Federal and State geothermal regulations and evaluating their impact on the availability and cost of the geothermal resources.

7.1.4 Task 4 - Engineering/Economic Assessments

Based upon the results of Tasks 1, 2 and 3, detailed system schematics will be defined identifying load demand, pipe network, substations, etc. A series of sensitivity studies will be conducted to develop alternate system configurations and construction schedules. Each configuration will be analyzed and specific operational conditions established.

The sensitivity analysis will be used to test the impact of having a geothermal energy source east of downtown. Other scenarios will test the economic sensitivity of the system to various financing methods, ownership options and inflation and energy escalation rates.

The potential cost savings of the district heating/cooling system are dependent upon the escalation rate of electricity, natural gas and oil prices in the Reno area. An important part of the system economic tradeoff efforts will be to develop realistic long-term energy and fuel price escalation rates for the area. To establish these rates, discussion will be held with the staff of the Nevada Public Service Commission, Sierra Pacific Power Company and oil distributors.

7.1.5 Phase I Program Review

At the conclusion of this phase, a program review will be held summarizing project results to date. Specific recommendations on the following will be made:

1. Project Definition/Feasibility
2. System Ownership
3. Financing Approach
4. Regulatory Actions Required
5. Implementation Steps to be Followed

7.2 PHASE II - SYSTEM FINANCIAL DEVELOPMENT

During Phase II, the Reno district heating system will be taken through to the point of securing system financing and the start of system design. Phase II consists of four tasks:

Task 1 - Engineering/Economic Analysis
Task 2 - Heat Source Contract Negotiations
Task 3 - User Contract Negotiations
Task 4 - System Financing

Task 1, 2 and 3 will be conducted concurrently. Each of these tasks are described below.

7.2.1 Task 1 - Engineering/Economic Analysis

The Task 1 efforts are oriented to provide the technical and economic support required for both the user and heat source negotiations (Tasks 2 and 3), and to finalize the overall system design and service area based upon the results of Tasks 2 and 3.

The results of the Task 2 and 3 negotiations may have significant effects on the final district heating system design and economics. During the Task 2 and 3 negotiations, Task 1 analysis will be used to determine the economic and system implications of alternative proposals. The Task 1 support will insure that the best possible terms and conditions from an overall system standpoint are reached.

Based upon the results of Task 2 and 3, final optimization studies will be performed, the system service area selected, and the final system economic analysis performed.

In addition, all engineering support required for bond package development will be provided.

7.2.2 Task 2 - Heat Source Negotiations

During Task 2, contract negotiations will be started with each owner of the alternative geothermal energy sources. These negotiations will lead the final selection of a thermal energy source and contract covering the utilization and cost of energy from the source.

7.2.3 Task 3 - User Contract Negotiations

During Task 3, contracts will be negotiated with major system users. These contracts will be a part of the basis of the system financing. These negotiations will include discussions as to interface equipment ownership, retrofit costs, connection costs and overall rate structure.

7.2.4 Task 4 - System Financing

During Task 4, the regulatory and institutional requirements for financing the system will be reviewed. Working in conjunction with the bond underwriters and bond counsel, the system owner/operator will develop the bond package (bond prospectus, etc.). Funding will be secured through the bond underwriters.

7.3 PHASE III - SYSTEM DESIGN AND CONSTRUCTION

7.3.1 Task 1 - System Design

During the system design phase, the detailed engineering design of the district heating/cooling system will be completed, all permit approvals acquired and the bid packages prepared. The detailed engineering system design will include the geothermal well heat exchangers, transmission, trunk and distribution lines, pumping stations, water treatment equipment, chiller/storage subsystems and architectural/system interface. A partial list of the end-items of this phase is presented below:

1. Engineering drawing of equipment installation and layout.
2. System engineering specifications.
3. Equipment and material specifications.
4. Architectural and construction specifications.
5. Engineering drawing of equipment installations and system layout.
6. Engineering, crafts, labor and supervision cost details.
7. Construction expense estimates.

A detailed construction schedule and PERT network will be prepared to provide a smooth integration of the system construction.

7.3.2 Task 2 - System Construction

As shown in the schedule presented in Figure 9, the start of construction is anticipated in the Spring of 1984, with the first system cusom ers coming on line in the Spring of 1987.