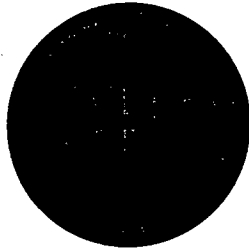


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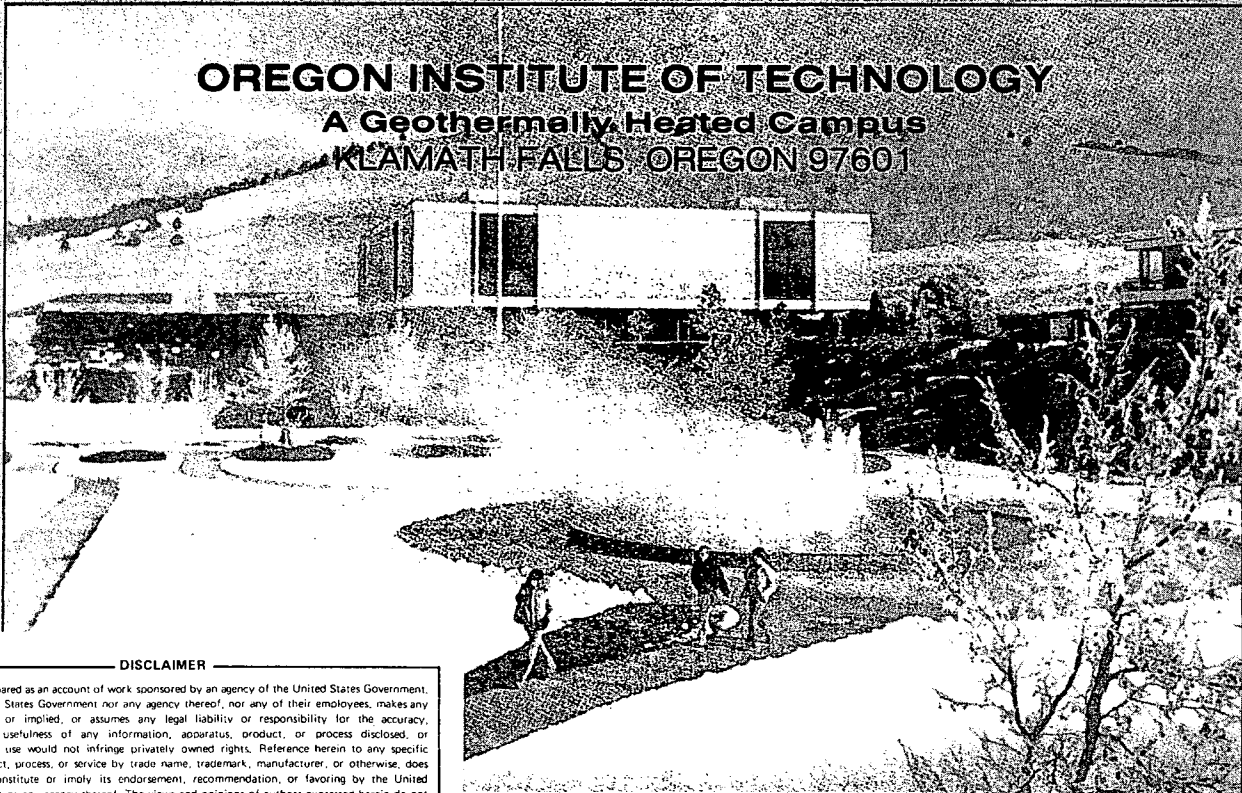
# GEO-HEAT CENTER

# MASTER

GEOHERMAL-HEATING FACILITIES  
FOR  
CARSON ELEMENTARY SCHOOL AND WIND RIVER  
MIDDLE SCHOOL

February 1982

**OREGON INSTITUTE OF TECHNOLOGY**  
A Geothermally Heated Campus  
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GEOHERMAL-HEATING FACILITIES  
FOR  
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GEOTHERMAL HEATING FACILITIES FOR  
CARSON ELEMENTARY SCHOOL AND WIND RIVER MIDDLE SCHOOL

The following report is the result of a request for technical assistance.

INTRODUCTION

Carson Elementary School and Wind River Middle School are located in Carson, Washington, adjacent to the Wind River. Both schools are operated by the Stevenson-Carson School District.

Carson Elementary, comprised of 49,000 square feet, was constructed in several phases beginning in 1951. The construction is variable, but is characterized by large expanses of single glass and uninsulated masonry areas. An oil fired steam boiler supplies a variety of terminal equipment.

Wind River Middle School was built in 1972 and, as a result, exhibits much greater insulation levels. The 38,000 square foot structure is heated entirely by an electric resistance terminal reheat system.

Carson Hot Springs Resort, located approximately one half mile from the schools, exhibits temperatures of 124°F. In addition, geological work is in progress to better define the local geothermal resource.

This report examines the feasibility of geothermal use at the school for space heating purposes.

SUMMARY OF CONCLUSIONS

The feasibility of a geothermal heating system for Carson Elementary

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and Wind River Middle Schools is dependent upon the cost of well drilling to access the geothermal resource. However, due to a lack of information regarding the local geology, accurate estimates of well costs could not be made. As a result, all economic analyses were constructed in such a way as to indicate the amount of capital available for well development (see Tables 1-5). Five different economic runs were made and are summarized as follows:

1. Existing buildings with wells at school site - Table 1.
2. Master plan buildings with wells at school site - Table 2.
3. Existing buildings with pipeline to hot springs - Table 3.
4. Master plan buildings with pipeline to hot springs - Table 4.
5. Master plan buildings with pipeline to hot springs and accelerated electrical rates - Table 5.

An explanation of each of these tables is contained in the Economic Analysis section. A summary of the cost input data for each is shown in Table 7 with more detailed costs shown in Table 6.

The most attractive approach for use of geothermal at the schools is Table 2. This system is based upon the additions to each school found in the master plan and on production and injection wells at the school site. The capital cost for this system is \$194,296 and a Net Present Value of \$438,772 is generated after 20 years (discounted at 12%). This sum is the amount of capital which would be available for well development if a 20 year payback was desired.

The cost of piping water from the existing hot springs, based on the existing temperature, is not economically feasible. However, if a resource of higher than 124°F could be found, both the flow rate and

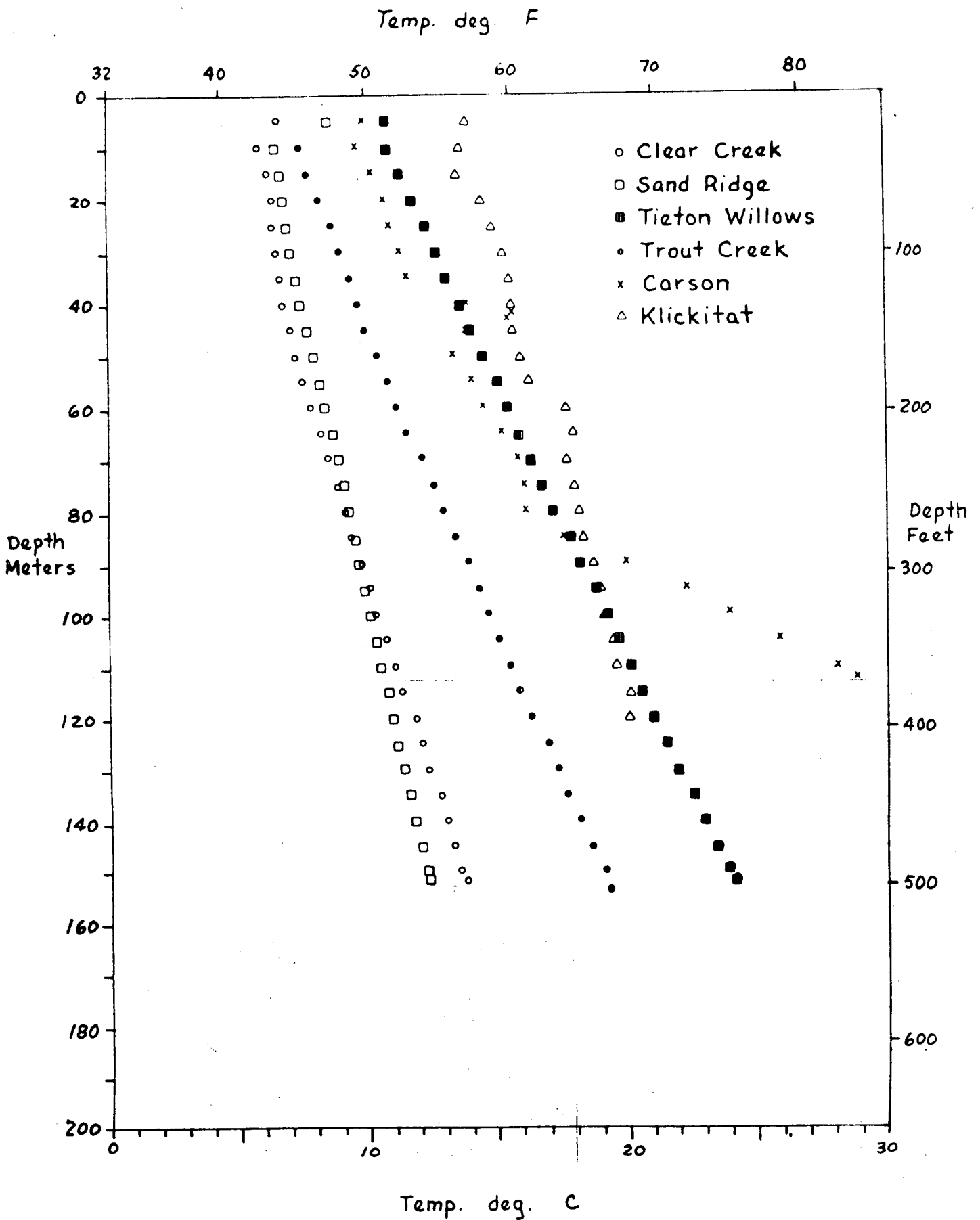


FIGURE 1.—Composite temperature-depth plots for Clear Creek (DNR-4), Sand Ridge (DNR-5), Tieton Willows (DNR-6A), Trout Creek (DNR-7), Carson (DNR-8), and Klickitat (DNR-9) drill holes.

need for piping insulation could be eliminated resulting in a large reduction in capital costs.

It is strongly recommended that the district pursue the possibility of a test well at the site of the schools.

#### AVAILABILITY OF GEOTHERMAL

The most definitive evidence of the geothermal resource in the area of the schools is the Carson Hot Springs. The Hot Springs has been used as a resort for many years. The existing flow rate is 50 gpm at approximately 127°F. This water is used for bathing purposes and subsequently disposed of in the Wind River.

In late 1981, the Washington Department of Natural Resources, Division of Geology and Earth Resources, released the results of test drilling in the Carson area. A test hole was drilled north of Carson Hot Springs which resulted in a temperature gradient (in the lower portion of the hole) of approximately 340°C/km. Figure 1 indicates the size of the gradient at Carson in comparison to the rest of the region. If this gradient continues and adequate water flows are available, the conditions for a production well would be very attractive.

Unfortunately, the test hole was drilled at the sight of the hot springs. The schools are located some 2,000 feet west of this location and approximately 370 feet higher in elevation. State geology personnel feel that the hot water in the area is associated with an igneous rock body known informally as the Buck Mountain intrusive. At this point, the extent of this unit is not well defined. As a result, it is impossible to predict the potential for a successful well at the school site. There

is a possibility of further test drilling by the Department of Geology and Earth Resources during the summer of 1982. The school district should pursue the possibility of a test hole at the school. If access to the geothermal resource could be gained at the school site, the requirement for pipelines to the existing hot springs and royalty to the resource owner could be eliminated.

#### GEOHERMAL SYSTEM

Two options are available for geothermal access at the schools. The first is to pipe geothermal water from the existing hot springs area to the schools. In this case, production and injection wells would be located at the hot springs. The second option would be to drill the wells at the school site. This would eliminate the requirement for a pipeline from the hot springs to the school. In either case, the retrofit necessary for the existing mechanical system at the schools would be the same. The following paragraphs describe the details of the individual building retrofits and the methods of geothermal access.

Figure 2 shows the topographic features of the area around Carson. An inset details the cross section between the springs and the school. If the existing springs were used as the geothermal resource, a production well and an injection well would be required at the hot springs site. In view of the flow rate required (~500 gpm at peak), injection would probably be necessary as opposed to the present method of river disposal. As indicated in Figure 2, there is a large elevation difference between the two sites. In order to avoid excessive pumping requirements



and satisfy the wishes of the resource owner (for return of the water) a closed loop type system would be required. Figure 3 shows the flow scheme of such an arrangement. Due to the elevation difference, a high static pressure ( $\sim 160$  psi) would exist at the lower end of the system requiring the use of steel piping for that section of the system. Fiber-glass reinforced plastic could be used for the balance of the piping. In addition to the two wells and piping loop, the system would require a plate heat exchanger and circulating pump.

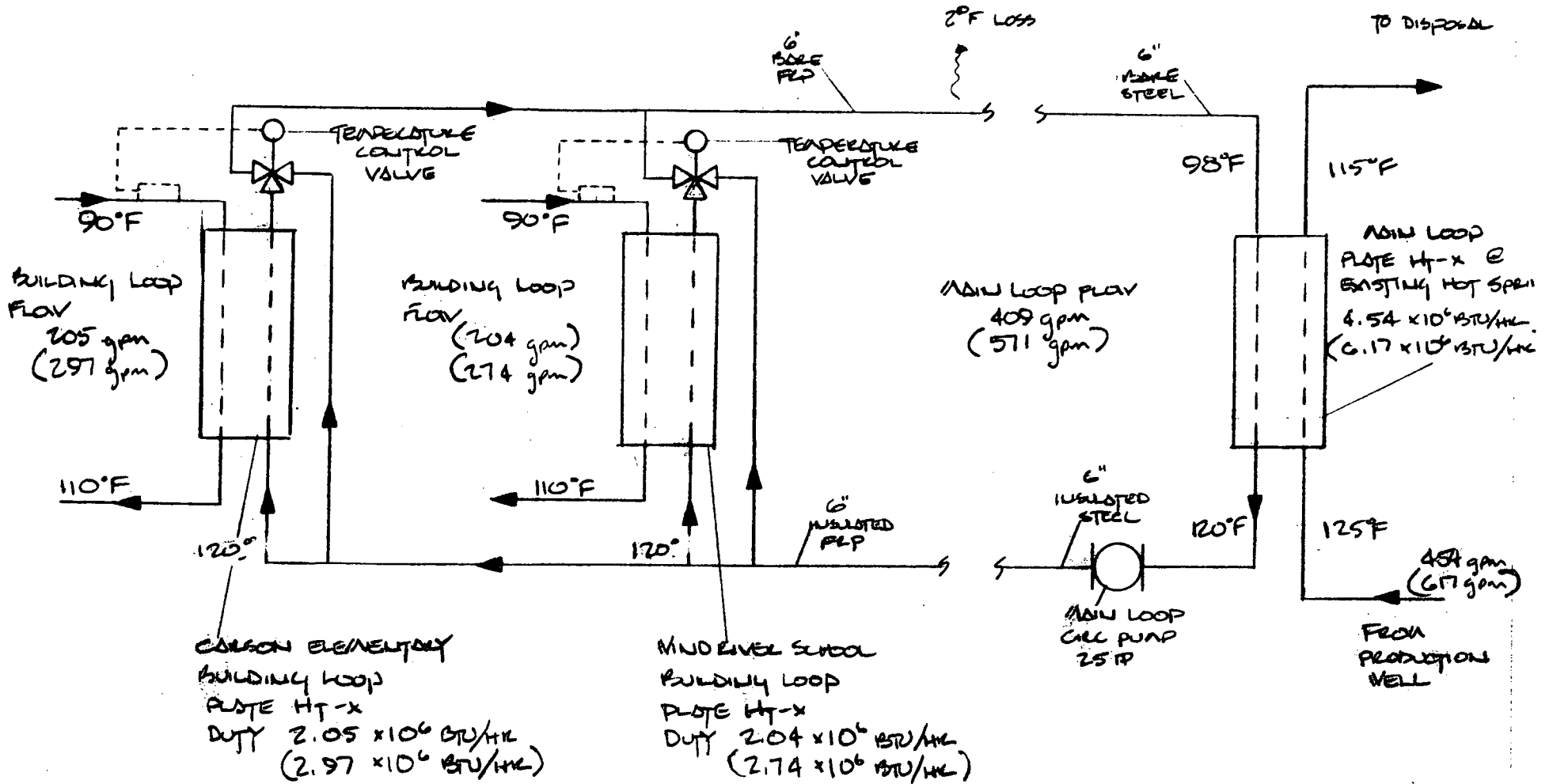
Geothermal water from the production well would pass through the heat exchanger giving up heat to the closed loop water. The cooled geothermal would then be directed to disposal (injection or river). Closed loop water would then pass through a plate heat exchanger at each school, heating the building loop water. Flows indicated in Figure 3 are peak flows for the existing buildings. Flow requirements for the master plan addition are shown in parentheses. The resource temperature was taken to be  $125^{\circ}\text{F}$ . If warmer temperatures were available, some reduction in flow rates would result. In view of the low water temperature available, little additional heat loss can be tolerated between the springs and the schools. As a result, the supply line would have to be insulated. The return line could be uninsulated to reduce capital cost.

Table 6 shows the capital costs for the pipeline and associated equipment. Capital costs for wells were not estimated due to the lack of geological information on the area.

#### Wells at School Site

In view of the lack of information concerning a potential well at

FIGURE 3  
 FLOW DIAGRAM - STEVENSON-CARSON SCHOOLS  
 ALL VALUES @ PEAK CONDITIONS



KL 223-02

this site, economics were run with only retrofit costs for this system. A cash flow column was generated in Tables 1 & 2 showing the amount of money available for resource development based on savings.

#### Carson Elementary School Retrofit

In order to determine the required capacity of the geothermal system at the school, a block heat load calculation was done. In addition, existing ventilation rates were evaluated for potential reduction. Based on this, a peak capacity of 2,050,000 Btu/hour was determined. Using a supply water temperature of 110°F (building side of the heat exchanger) and a 20°  $\Delta t$ , this results in a flow rate of 205 gpm. The 20°  $\Delta t$  was determined as a result of available coil area in existing unit ventilators. A larger  $\Delta t$  at this supply temperature would have resulted in a surface area requirement of greater than three rows. This could not be accommodated in the present unit ventilator cabinets.

The building is currently heated with an oil fired steam boiler supplying a variety of steam terminal equipment. Steam and condensate piping is run primarily in perimeter trenches.

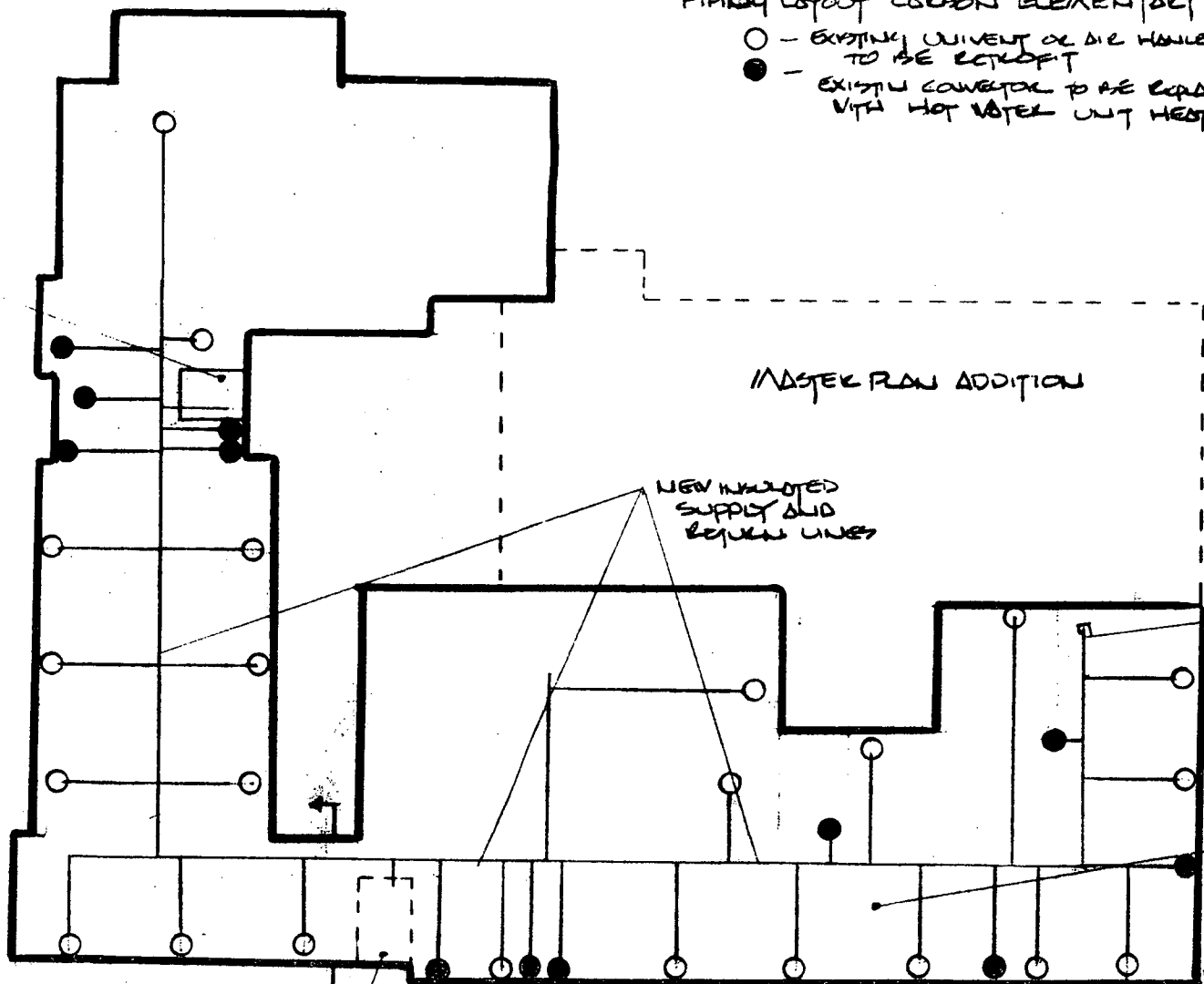
In order to accommodate the use of geothermal at the schools, some major system modification would be necessary. New insulated hot water piping would be installed in the attic space above the corridors. In the older portion of the building, branches would be run through the attic to the individual terminal equipment. In the newer portion of the building, these branches would be exposed along the ceiling in classroom areas. The condensate side of the existing steam piping is

FIGURE 4

PIPING LAYOUT COLLISION ELEMENTARY

- - EXISTING UNIT OR AIR HANDLER TO BE RETROFIT
- - EXISTING CONVERTER TO BE REPLACED WITH HOT WATER UNIT HEATER

EXISTING POILER RM. HT-X AND CIRC. PUMP. LOCATED HERE.



MASTER PLAN ADDITION

NEW INSULATED SUPPLY AND RETURN LINES

STUPS TO ADDITION

ADDS PIPING IN SPACE OVER COLLIDOR BRANCHES EXPOSED ABOVE CEILING.

ALL MAIN PIPING AND BRANCHES IN ATTIC BRES. - OLD SECTION

POILER RM FOR MASTER PLAN HT-X AND CIRC. PUMP. LOCATED HERE

KL 2-23-87

too small for proposed water flows. In addition, there is not sufficient access to the existing pipe trenches for the installation of new piping. As a result, it was felt to be more economical to install the new water piping in the ceiling area.

Most forced air terminal equipment could be re-used. However, the existing steam distribution coils and control valves would be replaced with new three row hot water coils and control valves. This configuration is capable of 95°F supply air temperatures. In conjunction with the existing air flow capabilities, this is more than sufficient to meet building heat losses.

Existing natural convection equipment would be replaced with new forced air hot water unit heaters. The present equipment would be unable to supply sufficient heat to meet losses. If higher geothermal temperatures become available, this equipment replacement should be re-evaluated.

Capital costs for the retrofit of the existing building and for the proposed master plan changes are shown in Table 6. Capital costs for the additions (master plan) were calculated to be the difference between a new hot water system compared to a new steam system. Heat losses and energy consumption for the addition were based on the Wind River School.

#### Wind River School

Based on the recent construction of the Wind River School, it is felt that the installed capacity of the existing equipment agreed more

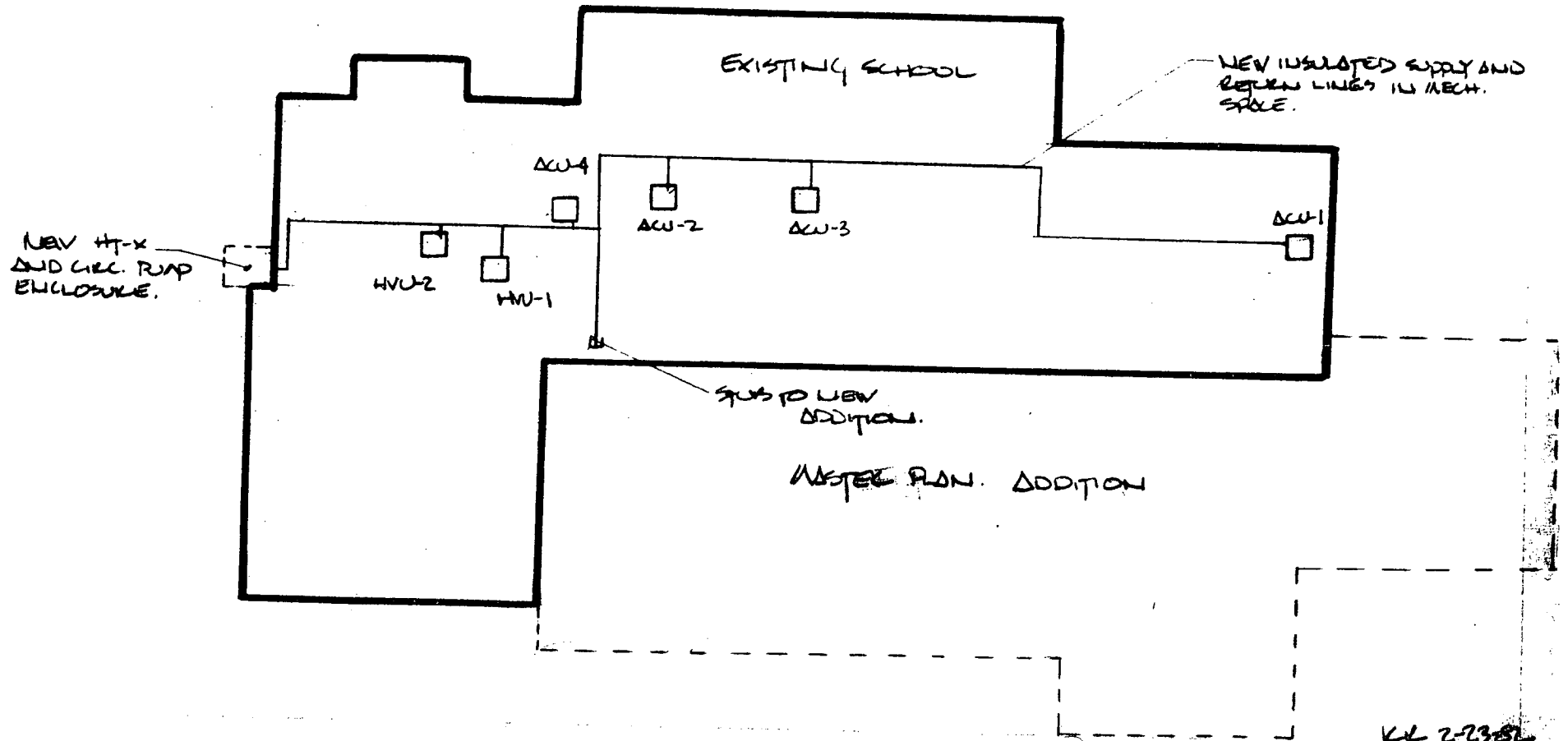
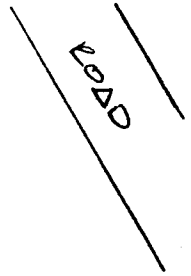
closely with the structure heat loss. As a result, installed capacity was used as the capacity of the geothermal heating system. Construction drawings indicate this figure to be 2,040,000 Btu/hour.

The existing system at the school is an air distribution terminal reheat arrangement with electric resistance duct heaters. Six main air handlers supply air flow for the building. Air is then heated to individual space demands by the terminal units.

Retrofit of this system for geothermal would consist of installing hot water coils in each of the existing air handlers. Since these units were originally designed to accommodate cooling coils, which were not installed, there is sufficient space for the four row hot water coils. The required capacity of the new hot water coils was calculated to be the sum of the existing terminal reheat units capacities. Supply air temperature was then calculated from present mix air temperature and air flow. This results in supply air temperatures to some spaces which are lower than present design. As a result, some air side balancing will be necessary to assure that all areas are satisfied. Hot water coils were based on 600 fpm face velocities which corresponds to original cooling coil design. In addition to the coils, new hot water control valves and supply and return piping would be installed in the existing mechanical space.

Due to the lack of mechanical area space at the school, a new enclosure would be constructed to house the building heat exchanger and circulating pump. For purposes of cost estimation this was assumed to be located at the west end of the building as shown in Figure 5.

FIGURE 5  
WIND RIVER MIDDLE SCHOOL  
PICKING LAYOUT



Capital costs for this system are shown in Table 6. Costs for the new addition were assumed to be the difference between that of an electric resistance and hot water systems. Energy use and heating load for the addition was based on the existing Wind River School.

LIFE CYCLE COST ANALYSIS  
FOR  
WIND RIVER MIDDLE SCHOOL AND CARSON ELEMENTARY SCHOOL

Life cycle cost analysis for the conceptual geothermal heating system at the Wind River Middle and Carson Elementary schools appears in tables one through five.

It was assumed that the system would come on line in 1983. The twenty year forecasts assume a 7% economic inflation rate over the project life, and additional inflation rates for conventional fuels as forecast by the Oregon Department of Energy "Fifth Annual Report" as follows:

Heating Oil

8.9% 1983 through 1994  
8.8% 1995 through 2001

Electrical Power

7.9% through 1987  
9.1% through 2001

The columns in tables one through five provide twenty year life cycle costs as follows:

Columns one and two forecast the costs of heating the schools with conventional fuels; specifically oil and electricity.

Column three forecasts the twenty year cost of electricity for the geothermal heating system. Column four indicates the maintenance costs for the geothermal system inflating at the economic inflation rate of seven percent per annum. Column five projects the insurance costs associated with the geothermal system, inflation at two percent per annum.

Column six, net energy savings, is the result of adding columns one and two and subtracting columns three, four and five.

Column seven assumes 100% debt financing and shows the twenty year loan payment that would be required at 12% per year.

Column eight shows the twenty year cash flows after all costs of the geothermal system are subtracted from projected costs of the present heating system. Column nine is a summation of the cash flows from column eight.

Due to the fact that no well drilling costs were considered in any of the life cycle cost analysis tables, column ten and eleven were calculated to provide projections of the amount of money that could be spent to drill production and injection wells for the geothermal system. As an example, in table one, column eleven shows that \$160,000 could be spent on well development if an eight year payback is required. These two columns have little significance other than providing this information. Since the project was assumed to be 100% financed at twelve percent, and the loan payments have been subtracted out prior to column eight. The net present values shown for years one through twenty have no bearing on the capital investment required for the geothermal system except as relates to resource development costs.

TABLE 6

## SYSTEM COST FIGURES

Carson School

## Costs for Retrofit of Existing Building

## Capital Costs:

Main piping	10,000
Branches with controls	42,600
Replace coils in UV's	11,500
New hot water unit heaters	5,500
Replace coils in HVU and ACU units	17,100
Heat exchanger	11,000
Circulating pump	3,500
DHW retrofit	4,000
Mechanical room piping allowance	2,000
Miscellaneous mechanical & electric	5,800

122,000

15% engineering & contingency 18,000TOTAL 140,000

## Operating Costs:

Maintenance - no increase

Increased electrical usage 243

## Savings:

$$3925.7 \times 10^6 \text{ Btu/yr} \div 140,000 \text{ Btu/gal}$$

$$\times \$1.10/\text{gal} =$$
30,845

Table 6 cont'd:

Costs for Retrofit of Master Plan Building

Capital Costs:

Branch piping with controls	24,000
Main piping	10,700
Replace coils in UV's	5,500
New hot water unit heaters	4,000
Replace coils in HVU units	11,000
Heat exchanger	9,500
Controls	2,500
Circulating pumps	3,000
Mechanical room piping allowance	2,000
Miscellaneous mechanical & electric (@ .05)	3,600
Premium on equipment in new addition (to accommodate low temp HW design)	<u>11,210</u>
	87,000
15% engineering & contingency	<u>13,100</u>
TOTAL	<u><u>100,100</u></u>

Operating Costs:

Maintenance	-	no increase	
Increased electrical usage (from above)			<u>243</u>

Savings:

$2209.3 \times 10^6$ Btu/yr + 140,000 X 1.1 =	17,360
$964.1 \times 10^6$ Btu/yr + 140,000 X 1.1 =	<u>7,575</u>
	<u><u>24,935</u></u>

Table 6 cont'd:

Wind River School

Costs for Retrofit of Existing Building

Capital Costs:

Replace coils in ACU and HVU units	23,500
Heat exchanger	11,000
Controls	2,500
Enclosure	4,000
Circulating pump	3,500
Piping	21,500
Miscellaneous mechanical and electric	<u>6,600</u>
	72,600
15% engineering & contingency	<u>11,000</u>
TOTAL	<u><u>83,600</u></u>

Operating Costs:

Maintenance -		
piping	124	
equipment	<u>700</u>	
		<u>824</u>
Increased electrical usage		<u>188</u>
Insurance		<u>418</u>

Savings:

$1815.8 \times 10^6 \text{ Btu/yr} + 3413 \times .028 =$	<u><u>14,897</u></u>
--	----------------------

Table 6 cont'd:

Costs for Retrofit of Master Plan Building

Capital Costs:

Costs from previous page	72,600
Premium on equipment for addition (incremental difference between electricity, forced air, and hot water systems)	8,500
	<u>81,100</u>
15% engineering & contingency	<u>12,300</u>
TOTAL	93,400

Operating Costs:

Maintenance	<u>824</u>
Increased electrical usage	<u>188</u>
Insurance	<u>418</u>

Savings:

$1815.8 \times 10^6 \text{ Btu/yr} + 3413 \times 1.10 =$	14,897
$744.2 \times 10^6 \text{ Btu/yr} + 3413 \times 1.10 =$	<u>6,105</u>
TOTAL	<u>21,002</u>

Pipeline from Existing Springs:

Capital Costs:

Steel piping	96,800
FRP piping	109,800
Circulating pump	68,00
Heat exchanger	14,500
Hook-ups	<u>5,000</u>
	232,900
15% engineering & contingency	<u>35,000</u>
TOTAL	267,900

Table 6 cont'd:

Operating Costs:

Maintenance		
piping	1212	
equipment	<u>463</u>	
		<u>1,675</u>
Increased electrical usage		<u>940</u>
Insurance		<u>1,340</u>

TABLE 7

Run #1	Existing Buildings - no pipeline	
	Capital cost	223,600
	Maintenance	824
	Electricity	431
	Insurance	418
	Savings	
	Oil	30,845 (per year)
	Electricity	14,897
Run #2	Master Plan Buildings with no pipeline	
	Capital cost	194,296
	Maintenance	824
	Electricity	431
	Insurance	418
	Savings	
	Oil	24,934 (per year)
	Electricity	21,002
Run #3	Existing Buildings with pipeline	
	Capital cost	491,500
	Maintenance	2,499
	Electricity	1,371
	Insurance	1,758
	Savings	
	Oil	30,845 (per year)
	Electricity	14,897
Run #4	Master Plan with pipeline	
	Capital cost	462,196
	Maintenance	2,499
	Electricity	1,371
	Insurance	1,758
	Savings	
	Oil	24,934 (per year)
	Electricity	21,002
Run #5	Master Plan with pipeline and high electric rate	
	Capital cost	462,196
	Maintenance	2,499
	Electricity	1,371
	Insurance	1,758
	Savings	
	Oil	24,934 (per year)
	Electricity	37,804

TABLE I

LIFE CYCLE COST ANALYSIS  
FOR

Date: Feb. 24, 1982

WIND RIVER MIDDLE SCHOOL AND CARSON ELEMENTARY SCHOOL

	1	2	3	4	5	6	7	8	9	10	11
	HEATING OIL CURRENT SYSTEM	ELECTRICITY CURRENT SYSTEM	ELECTRICITY GEOTHERMAL SYSTEM	MAINTENANCE GEOTHERMAL SYSTEM	INSURANCE GEOTHERMAL SYSTEM	NET ENERGY SAVINGS	DEBT SERVICE ANNUAL CASH FLOW	TWENTY YEAR ANNUAL CASH FLOW	CUMULATIVE CASH FLOW	DISCOUNTED CASH FLOW	CUMULATIVE DISCOUNTED CASH FLOW
PRESENT COST	30845	14897	431	824	418						
YEAR											
1983	33590	16074	465	882	426	47891	29935	17956	17956	16032	16032
1984	36580	17344	502	943	435	52043	29935	22108	40064	17624	33656
1985	39835	18714	541	1009	444	56555	29935	26619	66683	18947	52603
1986	43381	20192	584	1080	452	61456	29935	31521	98204	20032	72636
1987	47242	21787	630	1156	462	66781	29935	36846	135050	20907	93543
1988	51446	23770	688	1237	471	72821	29935	42886	177936	21727	115270
1989	56025	25933	750	1323	480	79404	29935	49469	227405	22377	137648
1990	61011	28293	819	1416	490	86580	29935	56645	284050	22878	160525
1991	66441	30868	893	1515	500	94401	29935	64466	348515	23247	183772
1992	72354	33677	974	1621	510	102926	29935	72991	421506	23501	207274
1993	78794	36741	1063	1734	520	112218	29935	82283	503789	23654	230928
1994	85806	40085	1160	1856	530	122345	29935	92410	596199	23719	254647
1995	93357	43732	1265	1986	541	133298	29935	103363	699562	23688	278335
1996	101573	47712	1380	2125	552	145228	29935	115293	814855	23591	301926
1997	110511	52054	1506	2273	563	158223	29935	128288	943142	23438	325364
1998	120236	56791	1643	2433	574	172377	29935	142442	1085585	23235	348600
1999	130817	61959	1793	2603	585	187795	29935	157860	1243444	22991	371591
2000	142329	67597	1956	2785	597	204588	29935	174653	1418097	22712	394303
2001	154854	73748	2134	2980	609	222879	29935	192944	1611041	22402	416705
2002	168481	80459	2328	3189	621	242803	29935	212867	1823909	22067	438772
TOTAL	1694662	797531	23074	36145	10359	2422614		1823909		438772	

Simple Payback

7 Years

TABLE 2

LIFE CYCLE COST ANALYSIS  
FOR  
WIND RIVER MIDDLE SCHOOL AND CARSON ELEMENTARY SCHOOL

Date: Feb. 24, 1982

	COST OF CAPITAL 12%										
	TOTAL CAPITAL COST 194296										
	NET PRESENT VALUE 468332										
	1	2	3	4	5	6	7	8	9	10	11
	HEATING OIL CURRENT SYSTEM	ELECTRICITY CURRENT SYSTEM	ELECTRICITY GEOTHERMAL SYSTEM	MAINTENANCE GEOTHERMAL SYSTEM	INSURANCE GEOTHERMAL SYSTEM	NET ENERGY SAVINGS	DEBT SERVICE ANNUAL CASH FLOW	TWENTY YEAR ANNUAL CASH FLOW	CUMULATIVE CASH FLOW	DISCOUNTED CASH FLOW	CUMULATIVE DISCOUNTED CASH FLOW
PRESENT COST	24934	21002	431	824	418						
YEAR											
1983	27153	22661	465	882	426	48041	26012	22029	22029	19669	19669
1984	29570	24451	502	943	435	52141	26012	26129	48158	20830	40499
1985	32201	26383	541	1009	444	56590	26012	30578	78736	21765	62263
1986	35067	28467	584	1080	452	61418	26012	35406	114142	22501	84765
1987	38188	30716	630	1156	462	66657	26012	40645	154787	23063	107828
1988	41587	33511	688	1237	471	72704	26012	46691	201478	23655	131483
1989	45288	36561	750	1323	480	79296	26012	53284	254762	24103	155586
1990	49319	39888	819	1416	490	86483	26012	60471	315233	24423	180009
1991	53708	43518	893	1515	500	94319	26012	68307	383539	24632	204641
1992	58489	47478	974	1621	510	102862	26012	76850	460389	24743	229384
1993	63694	51798	1063	1734	520	112175	26012	86163	546552	24770	254154
1994	69363	56512	1160	1856	530	122329	26012	96317	642869	24722	278876
1995	75467	61655	1265	1986	541	133330	26012	107318	750187	24594	303471
1996	82108	67265	1380	2125	552	145316	26012	119304	869491	24412	327883
1997	89333	73386	1506	2273	563	158378	26012	132365	1001856	24183	352066
1998	97195	80065	1643	2433	574	172610	26012	146598	1148454	23913	375979
1999	105748	87350	1793	2603	585	188117	26012	162105	1310559	23610	399588
2000	115054	95299	1956	2785	597	205015	26012	179003	1489562	23277	422866
2001	125178	103972	2134	2980	609	223427	26012	197415	1686977	22921	445787
2002	136194	113433	2328	3189	621	243489	26012	217477	1904454	22545	468332
TOTAL	1369904	1124371	23074	36145	10359	2424696		1904454		468332	

Simple Payback

6 Years

TABLE 3

LIFE CYCLE COST ANALYSIS  
FOR  
WIND RIVER MIDDLE SCHOOL AND CARSON ELEMENTARY SCHOOL

Date: Feb. 24, 1982

		COST OF CAPITAL						12%			
		TOTAL CAPITAL COST						491500			
		NET PRESENT VALUE						124088			
	1	2	3	4	5	6	7	8	9	10	11
	HEATING OIL CURRENT SYSTEM	ELECTRICITY CURRENT SYSTEM	ELECTRICITY GEOTHERMAL SYSTEM	MAINTENANCE GEOTHERMAL SYSTEM	INSURANCE GEOTHERMAL SYSTEM	NET ENERGY SAVINGS	DEBT SERVICE ANNUAL CASH FLOW	TWENTY YEAR ANNUAL CASH FLOW	CUMULATIVE CASH FLOW	DISCOUNTED CASH FLOW	CUMULATIVE DISCOUNTED CASH FLOW
PRESENT COST	30845	14897	1371	2499	1758						
YEAR											
1983	33590	16074	1479	2674	1793	43718	65801	-22084	-22084	-19718	-19718
1984	36580	17344	1596	2861	1829	47637	65801	-18164	-40248	-14480	-34198
1985	39835	18714	1722	3061	1866	51900	65801	-13901	-54150	-9895	-44093
1986	43381	20192	1858	3276	1903	56536	65801	-9265	-63415	-5888	-49981
1987	47242	21787	2005	3505	1941	61578	65801	-4224	-67638	-2397	-52378
1988	51446	23770	2188	3750	1980	67298	65801	1497	-66142	758	-51619
1989	56025	25933	2387	4013	2019	73539	65801	7738	-58404	3500	-48119
1990	61011	28293	2604	4294	2060	80347	65801	14545	-43859	5875	-42245
1991	66441	30868	2841	4594	2101	87773	65801	21971	-21888	7923	-34322
1992	72354	33677	3099	4916	2143	95873	65801	30071	8184	9682	-24640
1993	78794	36741	3381	5260	2186	104708	65801	38906	47090	11185	-13455
1994	85806	40085	3689	5628	2230	114344	65801	48543	95633	12460	-995
1995	93357	43732	4025	6022	2274	124769	65801	58967	154600	13514	12519
1996	101573	47712	4391	6444	2320	136130	65801	70329	224929	14391	26909
1997	110511	52054	4791	6895	2366	148514	65801	82712	307641	15111	42020
1998	120236	56791	5227	7377	2413	162010	65801	96208	403849	15694	57714
1999	130817	61959	5702	7894	2462	176718	65801	110917	514766	16154	73868
2000	142329	67597	6221	8446	2511	192747	65801	126946	641712	16508	90376
2001	154854	73748	6787	9038	2561	210216	65801	144415	786127	16768	107144
2002	168481	80459	7405	9670	2612	229253	65801	163451	949578	16944	124088
											0
TOTAL	1694662	797531	73398	109619	43569	2265606		949578		124088	

Simple Payback

17 Years

TABLE 4

LIFE CYCLE COST ANALYSIS  
FOR  
WIND RIVER MIDDLE SCHOOL AND CARSON ELEMENTARY SCHOOL

Date: Feb. 24, 1982

		COST OF CAPITAL									
		TOTAL CAPITAL COST									
		NET PRESENT VALUE									
		12%									
	1	2	3	4	5	6	7	8	9	10	11
	HEATING OIL CURRENT SYSTEM	ELECTRICITY CURRENT SYSTEM	ELECTRICITY GEOTHERMAL SYSTEM	MAINTENANCE GEOTHERMAL SYSTEM	INSURANCE GEOTHERMAL SYSTEM	NET ENERGY SAVINGS	DEBT SERVICE ANNUAL CASH FLOW	TWENTY YEAR ANNUAL CASH FLOW	CUMULATIVE CASH FLOW	DISCOUNTED CASH FLOW	CUMULATIVE DISCOUNTED CASH FLOW
PRESENT COST	24934	21002	1371	2499	1758						
YEAR											
1983	27153	22661	1479	2674	1793	43868	61878	-18010	-18010	-16081	-16081
1984	29570	24451	1596	2861	1829	47735	61878	-14143	-32154	-11275	-27356
1985	32201	26383	1722	3061	1866	51935	61878	-9943	-42097	-7077	-34433
1986	35067	28467	1858	3276	1903	56498	61878	-5380	-47477	-3419	-37852
1987	38188	30716	2005	3505	1941	61454	61878	-425	-47902	-241	-38093
1988	41587	33511	2188	3750	1980	67181	61878	5303	-42599	2686	-35407
1989	45288	36561	2387	4013	2019	73430	61878	11552	-31047	5226	-30181
1990	49319	39888	2604	4294	2060	80250	61878	18371	-12676	7420	-22761
1991	53708	43518	2841	4594	2101	87690	61878	25812	13136	9308	-13453
1992	58489	47478	3099	4916	2143	95808	61878	33930	47066	10925	-2529
1993	63694	51798	3381	5260	2186	104665	61878	42787	89853	12300	9772
1994	69363	56512	3689	5628	2230	114328	61878	52450	142303	13463	23234
1995	75467	61655	4025	6022	2274	124800	61878	62922	205225	14420	37654
1996	82108	67265	4391	6444	2320	136219	61878	74340	279565	15212	52866
1997	89333	73386	4791	6895	2366	148668	61878	86790	366355	15856	68722
1998	97195	80065	5227	7377	2413	162242	61878	100363	466719	16371	85093
1999	105748	87350	5702	7894	2462	177040	61878	115162	581881	16773	101866
2000	115054	95299	6221	8446	2511	193174	61878	131296	713177	17074	118940
2001	125178	103972	6787	9038	2561	210764	61878	148886	862062	17287	136226
2002	136194	113433	7405	9670	2612	229939	61878	168061	1030124	17422	153649
TOTAL	1369904	1124371	73398	109619	43569	2267688		1030124		153649	0

Simple Payback

16 Years

TABLE 5

LIFE CYCLE COST ANALYSIS  
FOR  
WIND RIVER MIDDLE SCHOOL AND CARSON ELEMENTARY SCHOOL

Date: Feb. 24, 1982

	1	2	3	4	5	6	7	8	9	10	11
	HEATING OIL CURRENT SYSTEM	ELECTRICITY CURRENT SYSTEM	ELECTRICITY GEOTHERMAL SYSTEM	MAINTENANCE GEOTHERMAL SYSTEM	INSURANCE GEOTHERMAL SYSTEM	NET ENERGY SAVINGS	DEBT SERVICE ANNUAL CASH FLOW	TWENTY YEAR ANNUAL CASH FLOW	CUMULATIVE CASH FLOW	DISCOUNTED CASH FLOW	CUMULATIVE DISCOUNTED CASH FLOW
	24934	37804	2468	2499	1758						
PRESENT COST											
YEAR											
1983	27153	40791	2663	2674	1793	60814	61878	-1065	-1065	-951	-951
1984	29570	44013	2873	2861	1829	66019	61878	4141	3076	3301	2351
1985	32201	47490	3100	3061	1866	71664	61878	9786	12862	6965	9316
1986	35067	51242	3345	3276	1903	77785	61878	15907	28769	10109	19425
1987	38188	55290	3610	3505	1941	84423	61878	22544	51314	12792	32218
1988	41587	60321	3938	3750	1980	92240	61878	30362	81676	15382	47600
1989	45288	65810	4296	4013	2019	100770	61878	38892	120568	17593	65193
1990	49319	71799	4687	4294	2060	110077	61878	48199	168767	19467	84659
1991	53708	78333	5114	4594	2101	120232	61878	58354	227121	21043	105702
1992	58489	85461	5579	4916	2143	131312	61878	69433	296554	22356	128058
1993	63694	93238	6087	5260	2186	143399	61878	81521	378075	23435	151493
1994	69363	101723	6641	5628	2230	156587	61878	94709	472784	24309	175803
1995	75467	110980	7245	6022	2274	170905	61878	109026	581810	24986	200789
1996	82108	121079	7905	6444	2320	186519	61878	124640	706450	25504	226293
1997	89333	132097	8624	6895	2366	203545	61878	141667	848118	25882	252175
1998	97195	144118	9409	7377	2413	222113	61878	160235	1008352	26138	278313
1999	105748	157232	10265	7894	2462	242360	61878	180482	1188834	26286	304599
2000	115054	171541	11199	8446	2511	264438	61878	202560	1391393	26341	330939
2001	125178	187151	12218	9038	2561	288512	61878	226634	1618027	26314	357253
2002	136194	204181	13330	9670	2612	314763	61878	252885	1870912	26216	383469
TOTAL	1369904	2023888	132128	109619	43569	3108477		1870912		383469	0

Simple Payback

12 Years