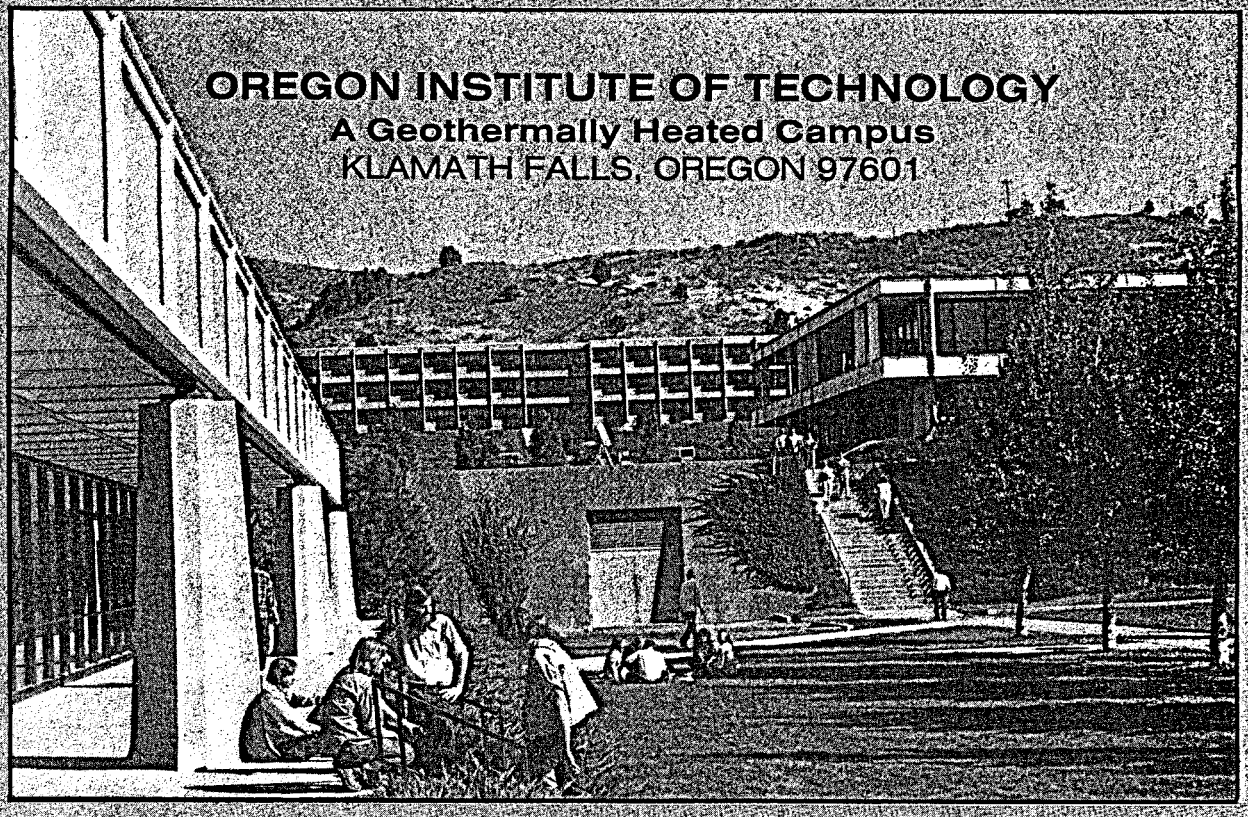
GEO-HEAT CENTER



DISCLAIMER

HEATING FACILITIES

KLAMATH COUNTY ROAD DEPARTMENT SHOPS
Klamath Falls, Oregon

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

Introduction

The Klamath County road department shop complex is located on the east side of Washburn Way about a quarter of a mile south of South Sixth Street. Directly across the street on the west side of Washburn Way, Maywood Industries is presently utilizing 118°F water pumped from a geothermal well about 1500 feet deep. Being aware of this, County personnel have asked if it is practical to heat the shop complex geothermally. The complex presently heats about 13,000 square feet of space using electric and natural gas heaters. Plans are under consideration that would increase the total heated area to nearly 24,000 square feet. This study is based on eliminating the existing electrical and natural gas heaters and heating the entire 24,000 square feet geothermally.

Summary of Conclusions

It is practical and economically feasible to heat the road department shop complex geothermally. Capital cost, is estimated to be $170,000. Annual energy savings for the enlarged facility would be 56,720 KWH of electricity and 36,924 therms of natural gas, with a first year value of $18,175. This savings, less operating costs, when applied with escalation considerations over a period of twenty years, result in a present worth of $382,385 when discounted at 8%. Thus, with 8% bonds financing of this project is economically attractive.

Description of Geothermal System

Figure #1, Flow Diagram of Geothermal System shows the basic plan for the proposed system. Included are heating duties, flow rates and key temperatures and pressures. Figure #2, Piping Scheme for Geothermal System, gives pipe routing, as well as pipe size and type, proposed to accomplish the system as outlined in Figure #1.

The geothermal production well will be located midway and just inside the west boundary of the property. A 12" well bore with 10" casing to 500 feet and 10" well bore with 8" casing for the remaining 1,000 feet to the total well depth of 1,500 feet is anticipated. This well should produce the required peak demand of about 113 gallons per minute of 118°F geothermal water. A deep well turbine pump with variable speed drive will need a 15 HP electric motor drive to pump the geothermal water through the 3" fiberglass reinforced discharge piping. A 200 foot pumping level is assumed. To minimize fouling a two loop system is proposed. Geothermal water passing through a plate heat exchanger

will transfer 1.562 million BTU per hour of heat to the secondary loop. The plate heat exchanger is located in a 10'x10' steel building about 500 feet east of the production well. Also located in this building is the circulating pump and spare pump, and the suction drum. A 3" fiberglass reinforced pipe (FRP) carrys the 90°F geothermal water from the plate heat exchanger to the injection well about 500 feet to the east and next to the north property boundary. Geothermal FRP pipe is buried, with insulation only on the line to the heat exchanger. The secondary loop piping uses FRP for 3" and 2" sizes with the smaller pipe being steel. Only the supply lines are insulated. Lines between the exchanger, and paint and pesticide shop are buried, as are the lines between the buildings. (See Figure #2). The bulk of the heating is accomplished by forced air convectors utilizing finned heating coils. Potable water in the secondary loop enters the coils at 113°F and leaves at 75°F. Figure #1 shows the location and size of coils.

Slightly less than one half the heat to the overhaul area is supplied by floor coils. The coils are 1 1/4" plastic pipe, 8 passes, with 25 lengths per pass. Each length is about 45 feet long with 6" spacing between lengths. Water leaving the coils is 100°F, bringing the return water temperature to 85°F at the suction drum. The circulating pump requires a 5 HP electric motor drive to circulate about 112 gallons per minute with a discharge pressure of 40 psig. Water makeup of potable water is made into the suction drum. There is normally no flow.

Energy Balance

Table #2, Estimated Peak Heating Requirements, shows that the peak heating requirement for the existing heated areas is about 1.136 million BTU per hour and will be about 1.930 million BTU per hour for the expanded facilities. This assumes that the added areas to be heated will be reasonably well insulated. Total area to be heated will be increased from about 13,000 square feet to about 24,000 square feet. This added heated area includes the existing battery room, enclosing the existing wash rack, a new welding shop addition, and heating the two buildings that now house the sign/survey operations and the paint/ pesticide storage.

Table #3 tabulates the actual gas and electricity consumption for the fiscal year 1978-1979. Gas consumption was 16,699 therms and electricity consumed was 165,440 kilowatt hours.

Table #4 is an energy balance matching the heat source to the heating requirements as presented in Table #2. To meet the total peak requirements of about 1.930 million BTU per hour for the expanded facilities, 1.562 million will be furnished by the geothermal and the remainder from electric lighting. The calculated annual gas consumption for the existing system is 21,220 therms per year, as shown in the footnote on Table #4. This is about 12.8% greater than actual annual consumption of 165,440 therms as shown on Table #3. The most likely explanation is that during the coldest months the existing gas system was unable to provide enough gas to maintain the 65°F interior temperature used in the heating calculations.

Table #5 presents the development of the first year annual savings of $18,175 for the expanded facilities. Assumptions are, that without geothermal,

heating would be supplied by the existing electrical and gas heaters plus additional gas heaters for the added heated areas. Natural gas heating is less expensive than electricity at the current rates if the gas heaters selected have a thermal efficiency greater than 75%. Annual savings amount to 56,720 KWH of electricity and 36,924 therms of natural gas.

Capital and Operating Costs

Table #1 summarizes capital and operating costs. Total capital is estimated at $170,000. However, for the economic analysis a credit of $20,000 was deducted for gas heaters that would otherwise be necessary if the expanded facilities were not heated geothermally. The $170,000 cost does not include any costs for building or insulating the expanded facilities. It does not include cost of removing and replacing the existing concrete floor in the overhaul area. Also excluded are any engineering or contractor's fees, permits or licenses, or cost escalation. Operating cost for the first year is estimated to be $4,389. Of this, $1,221 is for electric power to operate the geothermal system. This cost does not include the power for existing or additional lighting.

Cost Analysis

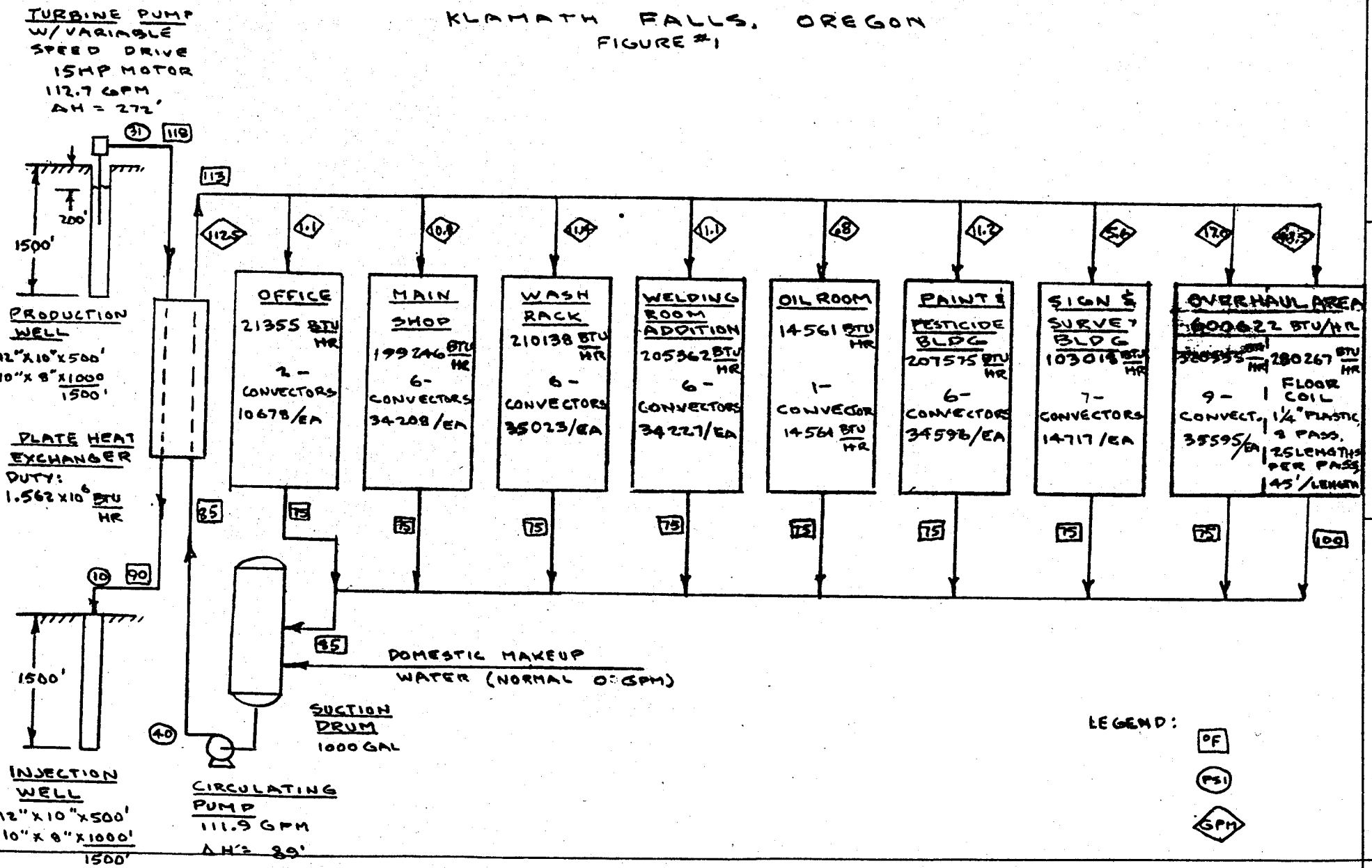
Table #6 details the cost analysis over the 20-year project life. As previously indicated the first year savings of $18,175 results from electricity and natural gas not used for heating. This savings, less operating costs, when applied with escalation over the project life results in a present worth of $382,385 when discounted at 8%. Therefore, if the project was financed with 8% bonds a considerable surplus, in excess of the estimated capital investment, is generated over the project life. The project is economical, and would continue to be so even if the geothermal system cost more than the estimated $170,000.

The following rates of inflation were used in the 20-year projected cash flow:

	1980-1987	1988-2001
Natural gas	12.2%	8.5%
Electricity	9.5%	8.58%
Maintenance	7.0%	7.0%
Insurance	2.0%	2.0%

FLOW DIAGRAM OF GEOTHERMAL SYSTEM

KLAMATH COUNTY ROAD DEPARTMENT SHOPS
KLAMATH FALLS, OREGON
FIGURE #1



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SUMMARY OF CAPITAL & OPERATING COSTS

TABLE #1

CAPITAL COSTS

GEOTHERMAL & INJECTION WELLS	50000
TURBINE PUMP	20000
PLATE HEAT EXCHANGER	4000
FORCE AIR FINNED TUBE CONVECTORS	10000
GEOTHERMAL & SECONDARY PIPING	50000
CIRCULATING PUMP & SPARE	7000
WELL HEAD & EXCHANGER BUILDINGS	6000
MISCELLANEOUS ELECTRICAL & MECHANICAL	10000
SUBTOTAL	157000
CONTINGENCY	13000
(1) TOTAL CAPITAL	#170000
CREDIT FOR GAS HEATERS NOT INSTALLED	20000
NET CAPITAL FOR ECONOMIC ANALYSIS	#150,000

OPERATING COSTS

MAINTENANCE & INSURANCE	
PIPING	276
PUMPS, EXCHANGER, CONVECTORS, BUILDINGS	2318
INSURANCE	574
	3168
ELECTRIC POWER FOR SYSTEM	1221
TOTAL ANNUAL OPERATING COST (1ST YEAR)	#4389

(1) EXCLUDES ANY ENGINEERING OR CONTRACTORS FEES, PERMITS OR LICENSES, OR COST ESCALATION.

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ESTIMATED PEAK HEATING REQUIREMENTS

KLAMATH COUNTY ROAD DEPT. SHOP COMPLEX

KLAMATH FALLS, OREGON

TABLE #2

BUILDING NAME	EXISTING		PROPOSED	
	AREA (FT^2)	PEAK HEAT (BTU/HR)	AREA (FT^2)	PEAK HEAT (BTU/HR)
OFFICE	600	26400	600	26400
MAINTENANCE SHOP				
OVERHAUL AREA	4500	742500	4500	742500
MAIN. SHOP	4465	235752	4665	246312
OIL ROOM	600	18000	600	18000
PAINT & PESTICIDE STORAGE	2000	79200	6480	256608
SIGN & SURVEY	864	34214	3216	127354
WASH RACK	UNHEATED		2112	259776
WELDING SHOP ADDITION	—	—	2064	253872
TOTAL	13,029	1,136,066	24,237	1,930,822

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KLAMATH COUNTY ROAD DEPARTMENT

GAS & ELECTRIC CONSUMPTION

FISCAL YEAR 1978-79

TABLE #3

Gas Consumption

Year		Therms
1978	6/1-6/30.....	84
	6/30-8/1.....	9
	8/1-8/30.....	74
	8/30-9/29.....	396
	9/29-10/30.....	345
	10/30-11/30.....2278	
	11/30-1/2/79.....3990	
1979	1/2-1/31.....3073	
	1/31-3/2.....2476	
	3/2-4/3.....1654	
	4/3-5/1.....1531	
	5/1-5/31.....	789
	TOTAL FISCAL YEAR	16699

Power Consumption

Year		Kilowatt-HR
1978	6/20-7/20.....	10160
	7/20-8/21.....	11120
	8/21-9/20.....	11760
	9/20-10/19.....	11120
	10/19-11/18.....	11280
	11/18-12/20.....	19360
	12/20-1/22/79.....	212 00
1979	1/22-2/20.....	16080
	2/20-3/21.....	15200
	3/21-4/20.....	14240
	4/20-5/21.....	12880
	5/21-6/20.....	11040
	TOTAL FISCAL YEAR	165440

ENERGY BALANCE

KLAMATH COUNTY ROAD DEPT. SHOP COMPLEX
TABLE #4

HEAT SOURCE	EXISTING PEAK HEAT (KW)	EXISTING PEAK HEAT (BTU/HR)	PROPOSED PEAK HEAT (KW)	PROPOSED PEAK HEAT (BTU/HR)
ELECTRIC HEATERS	29.9	—	0	—
ELECTRIC LIGHTS & OTHER	57.3	—	108.1	—
TOTAL ELECTRIC	87.2	297652	108.1	368945
NATURAL GAS (@75% EFFICIENCY)		(1) 838414		0
GEOTHERMAL		0		1,561,877
TOTAL PEAK HEATING (FROM TABLE #2)		1,136,066		1,930,822

(1) $838414 \frac{BTU}{HR} \times 1897 \frac{HR}{YR} \times \frac{1}{.75} = 21220$ THERMS/YR

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(1) ANNUAL SAVINGS PROPOSED SYSTEM

KLAMATH COUNTY ROAD DEPT. SHOP COMPLEX
TABLE #5

HEAT SOURCE	PEAK		ANNUAL (5)				
	HEAT (KW)	LOAD (BTU/HR 10^6)	HEAT LOAD (BTU/HR 10^9)	PURCHASED ENERGY GAS (THERMS/YR)	ELECTR. (KW/YR)	UNIT COST (¢/UNIT)	ANNUAL COST ($/YEAR)
EXIST. ELECT. HEATERS	29.9	.102049	.1936	—	56720	.021	1191
EXIST. GAS HEATERS	—	.660299	(3) 1.2524	(4) 16699	—	.460	
ADDITIONAL GAS HEATERS	—	.799529	1.5169	(3) 20225	—	.460	
TOTAL		1.561877 (2)	2.9629				18,175

(1) BASIS:
HEAT REQUIRED IN EXCESS OF THAT SUPPLIED BY LIGHTING TO BE FURNISHED BY GAS & ELECTRIC HEATER.

(2) EQUIVALENT TO HEAT SUPPLIED BY GEOTHERMAL SYSTEM (SEE TABLE 4)

(3) @ 75% EFFICIENCY

(4) FROM TABLE #3

(5) @ 1997 HOURS PER YEAR

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KLAMATH COUNTY ROAD DEPARTMENT SHOPS

Table #6

YEARS	NATURAL GAS CURRENT COST	ELECTRIC HEAT CURRENT COST	GEOTHERMAL ESTIMATED PUMPING COST	GEOTHERMAL MAINTENANCE SYSTEM COST	GEOTHERMAL ESTIMATED INSURANCE COST	SAVINGS PER YEAR	PRESENT WORTH AT 8%
Present Cost	16985	1191	1231	2594	574		
1	19057	1304	1337	2775	585	15663	14503
2	21382	1428	1464	2969	597	17779	15242
3	23990	1563	1603	3177	609	20164	16007
4	26917	1712	1755	3400	621	22852	16797
5	30201	1874	1922	3638	633	25882	17615
6	33886	2053	2104	3892	646	29295	18460
7	38020	2248	2304	4165	659	33138	19336
8	41252	2440	2502	4456	672	36061	19482
9	44758	2650	2717	4768	685	39236	19628
10	48562	2877	2950	5102	699	42687	19772
11	52690	3124	3203	5459	713	46438	19916
12	57169	3392	3478	5841	727	50513	20059
13	62028	3683	3775	6250	742	54943	20202
14	67301	4000	4100	6688	757	59754	20344
15	73021	4343	4453	7156	772	64983	20485
16	79228	4715	4834	7659	787	70664	20626
17	85963	5120	5249	8199	803	76835	20766
18	93270	5559	5699	8776	819	83542	20905
19	101196	6036	6188	9394	836	90828	21043
20	109789	6554	6719	10057	852	98743	21180
						980010	382385