DIRECT APPLICATION
of
EAST COAST GEOTHERMAL RESOURCES
in a
FROZEN FOOD PLANT

MASTER

FINAL REPORT

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Project Manager
Raymond M. Costello

Principal Investigators

BRISC
Antonius C.F. Ammerlaan
Martin E. Knebel

CS Co.
Robert J. Czarnecki

Burns and Roe Industrial Services Corporation
Paramus, New Jersey

Campbell Soup Company
Camden, New Jersey

Prepared for

United States Department of Energy

Under Contract No. DE-AC05-79ET27228

NOTICE

PORTIONS OF THIS REPORT ARE ILLEGIBLE. It has been reproduced from the best available copy to permit the broadest possible availability.

APPROVED FOR RELEASE OR
PUBLICATION - O.R. PATENT GROUP
BY *[Signature]* DATE 7-23-80

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DIRECT APPLICATION
of
EAST COAST GEOTHERMAL RESOURCES
in a
FROZEN FOOD PLANT

TABLE OF CONTENTS

<u>Section Number and Title</u>	<u>Page</u>
Table of Contents	i
List of Figures	
List of Tables	
I - Summary and Conclusions	I-1
II - Introduction	II-1
-Objectives	II-1
-Scope of Work	II-1
-Trade-Off Studies	II-3
III - Geothermal Well Design and Capital Cost Estimates	III-1
-General Approach	III-1
-Proposed Well Designs	III-1
-Well Cost Estimates	III-3
IV - Geothermal Fluid, Properties and Treatment	IV-1
-Geothermal Fluid Temperatures	IV-1
-Geothermal Fluid Composition	IV-2
-Scale Control	IV-4
V - Plant Hot Water Requirements	V-1
VI - Plant Description	VI-1
-Process Description	VI-1
-Equipment Layouts and Description	VI-15
-Instrumentation	VI-22
VII - Surface System Capital Cost	VII-1

TABLE OF CONTENTS (continued)

<u>Section Number and Title</u>	<u>Page</u>
VIII - Operating Cost Estimates and Economic Analysis	VIII-1
-General Approach	VIII-1
-Results of Analysis	VIII-11
-Sensitivity Analysis	VIII-16
-"Grass Roots" Plant vs. Retrofit	VIII-26
IX - Institutional Factors and Reservoir Confirmation Plan	IX-1
-Maryland Geothermal Resources Act	IX-1
-Tax Incentives	IX-1
-Reservoir Confirmation Plan	IX-3
X - References	X-1

LIST OF FIGURES

<u>Fig. No.</u>	<u>Title</u>	<u>Page</u>
III-1	Typical Production Well Design	III-2
V-1	Hot Water Usage Weekdays	V-2
V-2	Hot Water Usage Weekends	V-3
V-3	Hot Water Usage Weekdays	V-5
VI-1	Flow Schematic - Heat Exchangers Only	VI-2
VI-2	Flow Schematic - One Heat Pump	VI-3
VI-3	Flow Schematic - Two Heat Pumps	VI-4
VI-4	Layout - Heat Exchangers Only - Minimum Treatment	VI-16
VI-5	Layout - Heat Exchangers Only - Maximum Treatment	VI-18
VI-6	Layout - Two Heat Pumps - Maximum Treatment	VI-19
VI-7	Conceptual Site Plan	VI-21
VI-8	Control Schematic - Heat Exchangers Only	VI-23
VI-9	Control Schematic - One Heat Pump	VI-24
VI-10	Control Schematic - Two Heat Pumps	VI-25
VII-1	Cost Data - Heat Pumps	VII-2
VII-2	Cost Data - Plant Heat Exchangers	VII-3
VIII-1	Geothermal Project Capital Cost Breakdown - 4th quarter, 1980 prices	VIII-13
VIII-2	Geothermal Project After-Tax Rate of Return	VIII-15
VIII-3	After-Tax Payback Periods	VIII-17
VIII-4	Effect of Geothermal Tax Incentives on After-Tax Rate of Return	VIII-18
VIII-5	Effect of Geothermal Tax Incentives on After-Tax Payback Period	VIII-19
VIII-6	Effect of Operating Life on After-Tax Rate of Return	VIII-21
VIII-7	Sensitivity of After-Tax Rate of Return to Capital Cost - Specific Capacity = 1.0	VIII-22
VIII-8	Sensitivity of After-Tax Payback Period to Capital Cost - Specific Capacity = 1.0	VIII-23
VIII-9	Sensitivity of After-Tax Rate of Return to Capital Cost - Specific Capacity = 0.1	VIII-24
VIII-10	Sensitivity of After-Tax Payback Period to Capital Cost - Specific Capacity = 0.1	VIII-25
VIII-11	Sensitivity of Rate of Return to Fuel Oil Escalation Rate	VIII-27
VIII-12	Sensitivity of After-Tax Payback Period to Fuel Oil Escalation Rate	VIII-28

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
I-1	Operating Costs and Economic Analysis Parameters	I-12
III-1	Geothermal Well Cost Estimates	III-4
III-2	Cost Estimate Breakdown-Geothermal Production Well System	III-6
IV-1	Chemical Analysis of Water by Zone Crisfield Airport Well	IV-3
IV-2	Potential Methods of Brine Treatment	IV-7
V-1	Hot Water Usage	V-4
VI-1	Heat Pump Data - Heat Exchanger Plus One Heat Pump	VI-6
VI-2	Heat Pump Data - Heat Exchanger Plus Two Heat Pumps	VI-6
VI-3	Heat Pump Data - Heat Exchanger Plus Three Heat Pumps	VI-6
VI-4	Heat Exchanger Data - Geothermal Brine Temp 120°F	VI-7
VI-5	Heat Exchanger Data - Geothermal Brine Temp 130°F	VI-8
VI-6	Heat Exchanger Data - Geothermal Brine Temp 150°F	VI-9
VI-7	Heat Exchanger Data - Heat Exchangers Only	VI-10
VI-8	Summary Heat Exchanger and Heat Pump Cases	VI-14
VII-1	Capital Cost	VII-5
VIII-1	Geothermal System Energy Production, Fuel Oil Savings, Electric Power Consumption and Capital Costs (1st qtr., 1980 dollars) - Wellhead Temp 120°F	VIII-2
VIII-2	Geothermal System Energy Production, Fuel Oil Savings, Electric Power Consumption and Capital Costs (1st qtr., 1980 dollars) - Wellhead Temp 130°F	VIII-3
VIII-3	Geothermal System Energy Production, Fuel Oil Savings, Electric Power Consumption and Capital Costs (1st qtr., 1980 dollars) - Wellhead Temp 150°F	VIII-4
VIII-4	Estimate of Intangible Drilling Costs	VIII-12

I Summary and Conclusions

The team of Burns and Roe Industrial Services Corporation and Campbell Soup Company (Proposed Subcontractor) have evaluated, via a budgetary level design and cost estimating analysis, the technical and economic viability of retrofitting an existing frozen food plant in Salisbury, Maryland to utilize the anticipated geothermal resources in that area.

The Campbell Soup Company owns and operates a frozen food plant in Salisbury, Maryland on the Delmarva peninsula. This area along the Atlantic Coastal Plain has been identified as having the potential for warm water geothermal resources.

Consideration of the plant data resulted in four potential applications of geothermal heat which were explored in concept, namely; production of hot water, production of steam, production of chilled water and refrigeration.

The production of hot water from geothermal heat showed sufficient economic promise to justify a further detailed technical and economical analysis, which is the subject of this report. The other three alternatives were eliminated from further consideration by a preliminary analysis which is covered in Appendix H.

Geothermal Fluid, Properties and Treatment

Based in part upon the heat flow data obtained from a shallow well drilling program, a Selection Committee of the DOE Division of Geothermal Enrgy chose a site at Crisfield, Maryland for a deep test well to basement. The test well was drilled during mid 1979, and temperatures and core samples were obtained and reported.

These efforts form the primary basis for the estimation of geothermal resources applicable to the current study.

The deep test well at Crisfield produced temperatures in the order of 130-135°F at an actual basement depth of about 4200 feet.

Therefore, 130°F was selected as a likely median for this project, with a lower level of 120°F and a higher level of 150°F taken as the extremes for a matrix type approach.

The principle concern in the treatment of the geothermal brine was that of scale formation.

Calculation of the Langelier Index, ionic strength and solubility limits indicated tht the brine was saturated with calcium carbonate and barium sulfate, high in magnesium carbonate and iron and substantially under saturated with calcium sulfate, strontium sulfate and silica.

The methods of treating the geothermal brine that appear to be most practical and economical, and that were used for establishing costs are: 1) Pressurization of the geothermal fluid to keep carbon dioxide in solution; 2) Maintaining a closed system to keep oxygen out of the fluid; 3) Threshold addition of phosphonate scale inhibitor.

The possibility remains that a more severe treatment might be required than the threshold chemical treatment. Therefore, as an alternate for a worst possible case, hot lime treatment was also considered.

Hot Water Usage

Hot water requirements throughout the frozen food plant were investigated. Major hot water user points are listed in Table V 1.* Three distinct temperature levels were established, i.e. 145°F, 165°F and 175°F. Hot water requirements vary considerably during the course of a 24-hour day. Maximum and minimum flow rates are included in Table VI 1. Total hot water usage for each of the three temperature

*Tables and Figures from other sections are included in the Summary for convenience.

Table V 1

CAMPBELL SOUP CO. - Salisbury, MDHot Water Usage24-hour Average Flows (gpm)

	<u>145°F</u>	<u>165°F</u>	<u>175°F</u>	<u>Total</u>
<u>Plant Hot Water 165°F</u>	-	95	-	
Max - 170 gpm				
Min - 70 gpm				
<u>Office Hot Water 150°F</u>	2	-	-	
Max - 5 gpm				
<u>HP Cleaning System 140°F</u>	29	-	-	
Max - 80 gpm				
Min - 10 gpm				
<u>Can Washer 160°F</u>	-	8	-	
Max - 8 gpm				
<u>Feedwater Heater 175°F</u>	-	-	44	
Max - 56 gpm				
Min - 40 gpm				
<u>HP Cleaning System 140°F</u>	29	-	-	
(Seller's Jet Replacement)				
Max - 64 gpm				
Min - 16 gpm				
<u>Total Average gpm</u>	60	103	44	207
Max	149	178	70	397
Min	31	78	50	159

Table VI 1
Heat Pump Data
Heat Exchangers Plus One Heat Pump

Geothermal Temperature		120°F	130°F	140°F
Geothermal Flow Rate	gpm	304	263	235
COP Heat Pump		3.5	3.6	3.7
Power Requirements	kW	282	223	144

Table VI 2
Heat Pump Data
Heat Exchangers Plus Two Heat Pumps

Geothermal Temperature		120°F	130°F	150°F
Geothermal Flow Rate	gpm	340	295	234
COP Heat Pump 1		3.5	3.6	- *
2		5.0	5.8	3.1
Power Requirements	kW			
Heat Pump 1		341	288	- *
2		86	75	200
Total		427	363	200

*No heat pump required for producing 140°F water.

Table VI 3
Heat Pump Data
Heat Exchangers Plus Three Heat Pumps
Geothermal Brine Temperature 120°F

Geothermal Flow Rate	gpm	346
COP Heat Pump 1		3.6 (centrifugal)
2		5.0 (centrifugal)
3		3.7 (reciprocating)
Power Requirements	kW	
Heat Pump 1		349
2		87
3		17
Total		453

levels were established including the daily minimum and maximum flow rates that have to be anticipated. It should be noted that the process water is obtained from potable water wells at 55°F and is fully consumed in the process on a once through basis. This relatively low "sink" temperature makes this plant one of the more attractive candidates for the low to moderate geothermal temperatures expected on Delmarva.

Geothermal Hot Water Plant

Heat for hot process water could be extracted from the geothermal brine by means of heat exchangers. With a heat exchanger, however, the temperature of the process water leaving the heat exchanger will be limited to 110°F to 140°F. Therefore, the use of heat pumps has also been considered in order to meet more closely the plant process water temperature requirements. Process water storage tanks have been included to level out the substantial variation in hot water demand.

Part of the hot process water is used directly in the preparation of food. Any chance that the geothermal brine would get mixed into the process water has to be eliminated. Therefore, in all cases, an intermediate heat exchange loop has been included establishing a clear separation between the geothermal brine and the process water.

Plate type heat exchangers were selected because they allow the lowest approach temperatures. A realistically achievable approach temperature of 5°F was assumed in all cases.

Flow schematics for a heat exchanger-only case, a one heat pump case and a two heat pump case are shown in Figures VI 1-3.

CAMPBELL SOUP CO - SALISBURY, MD.
GEO THERMAL SYSTEM SCHEMATIC
HEAT EXCHANGERS ONLY

Flow Schematic - Heat Exchangers Only

Fig. VI 1

9-1

CAMPBELL SOUP CO. SALISBURY, MD
 GEOTHERMAL SYSTEM SCHEMATIC
 ONE HEAT PUMP

Flow Schematic - One Heat Pump

Fig. VI 2

Process design data for the different heat exchanger and heat pump cases have been summarized in Table VI 8. It shows total hot water requirement of 11 MM Btu/hr or approximately 11,000 lbs/hr of steam. If only heat exchangers are applied, between 52 and 80% of this heat demand can be satisfied with geothermal heat depending on the temperature of geothermal brine. By including heat pumps, steam requirements can be reduced to 0 to 15% of the present steam requirements for hot process water.

Economic Analysis

The total capital costs are the sum of equipment, materials and installation costs. A minimum 10% contingency has been added as well as approximate allowances for overhead and profit.

The capital costs for the project are shown on Figure VIII 1. The electrical system costs, which are not shown directly on Figure VIII 1, are a function of well specific capacity ($\text{Specific Capacity} = \text{Output, gpm/Drawdown, ft}$). Therefore, the total project costs are shown for various specific capacities. For any particular case, the electrical system cost can be obtained by subtracting the Mechanical + Civil + Well costs from the corresponding total capital cost. It should be noted that the well costs shown are based on the assumption that the reinjection well is drilled to the same depth as the production well, which is probably a conservative assumption.

All of the key operating costs and economic analysis parameters used in this study are summarized on Table I 1. The fuel oil and electricity costs are typical of those used by Campbell Soup Co. for evaluating energy projects.

Table VI 8

Summary Heat Exchanger and Heat Pump Cases

	<u>Geothermal Brine Temp. °F</u>	<u>Geothermal Flow (max) GPM</u>	<u>Process Water Temp. °F</u>	<u>Geothermal Heat MMBtu/hr</u>	<u>% of Total Load</u>
HX	120	207	110	5.7	52
HX	150	207	140	8.8	80
HX + 1 HP	120	304	145	9.3	85
HX + 2 HP	120	340	145 + 165	10.8	98
HX + 3 HP	120	346	145 + 165 + 175	11.0	100

NOTE: ELECTRICAL SYSTEM COSTS VARY WITH SPECIFIC CAPACITY AND MAY BE OBTAINED BY SUBTRACTING MECH + CIVIL + WELL COSTS FROM THE CORRESPONDING TOTAL COST CURVE

CAMPBELL SOUP CO., SALISBURY, MARYLAND
 GEOTHERMAL PROJECT CAPITAL COST BREAKDOWN
 4TH QUARTER, 1980 PRICES

FIGURE VIII-1

TABLE I 1- OPERATING COSTS AND ECONOMIC ANALYSIS PARAMETERS

<u>DATE</u>	<u>END OF PROJECT YEAR</u>	<u>FUEL OIL COST \$/GAL</u>	<u>ELECTRICITY COST \$/KWH</u>
1/1/80		0.60	0.041
6/1/81	0		
6/1/82	1	0.98	0.052
6/1/83	2	1.22	0.062
6/1/84	3	1.46	0.075
6/1/85	4	1.68	0.090

AFTER YEAR 4, THESE COSTS
WERE ESCALATED AT 10% PER YEAR

OTHER COSTS AND PARAMETERS

PROJECT LIFE	= 1 YEAR CONSTRUCTION, 20 YEARS OPERATION
OPERATING HOURS	= 6250 HRS/YR
BOILER EFFICIENCY(SALISBURY)	= 80%
GEOHERMAL PUMP EFFICIENCY	= 55% (OVERALL)
PRODUCTION AND REINJECTION WELL DEPTHS	= 5000 FT.
ANNUAL CHEMICAL COST	= 11.9¢/1000 GAL + 10%/YR ESCALATION
ANNUAL INSURANCE AND TAX COST	= 2% OF CAPITAL COST + 10%/YR ESCALATION
ANNUAL MAINTENANCE COST	= 3% OF CAPITAL COST + 10%/YR ESCALATION
INCOME TAX DEDUCTIONS	
-INTANGIBLE DRILLING COSTS	= 70% OF TOTAL WELL CAPITAL COST
-DEPRECIATION	= STRAIGHT-LINE TO ZERO SALVAGE
INCOME TAX CREDITS	
-INVESTMENT TAX CREDIT	= 10%
-ALTERNATIVE ENERGY TAX CREDIT	= 15% OF TANGIBLE WELL COST + SURFACE EQUIPMENT COST (EXCLUDE HEAT PUMPS AND BUILDINGS)
INCOME TAX RATE	= 48.6%

The data on Figures VIII 1 and Table I 1 was used to determine after-tax payback periods and discounted cash flow rate of returns (ROR) for each case. The ROR's for each case are shown on Figure VIII 2 and the payback periods are shown on Figure VIII 3. The broken portion of each curve represents the transition range between the cases without heat pumps and those with heat pumps. As indicated on the Figures, the payback periods and ROR's become less attractive at the higher flow rates, especially with lower specific capacities (i.e. higher drawdowns).

In general, the maximum payback period which industrial firms will consider for energy projects is 3-6 years. For specific capacities of 0.5 and higher, the Campbell Soup Co. geothermal project would satisfy this criteria for a range of well temperatures and flows which could be considered as reasonable expectations based on testing done to date on the Delmarva Peninsula. For wellhead temperatures of 120°F to 130°F, the project would not meet the criteria regardless of flow rate if the specific capacity were 0.1 or less, and the economics would be marginal at best for values in the range of 0.1 to 0.5.

If, hypothetically, the plant were built today as a "grass roots" project, a brief analysis has indicated that payback periods might be decreased on the order of 1/2 year due to reductions in capacity of the boiler plant.

Institutional Barriers

Several institutional constraints could seriously impede the progress of geothermal development for the East Coast geothermal resources, especially in Maryland. For instance, the existing laws do not clearly define the ownership of the geothermal resources in the state. This is a major roadblock since a user could be subject to a law suit by neighbors who claimed that the user's well was removing geothermal fluid from under the neighboring land.

AFTER-TAX RATE OF RETURN, %

WELL OUTPUT, GPM

CAMPBELL SOUP CO., SALISBURY, MARYLAND
GEOTHERMAL PROJECT AFTER-TAX
RATE OF RETURN

FIGURE VIII-2

AFTER TAX PAYBACK PERIOD, YEARS

WELL OUTPUT, GPM

CAMPBELL SOUP CO., SALISBURY, MARYLAND
AFTER-TAX PAYBACK PERIODS

FIGURE VIII-3

A second impediment is the lack of clear regulations regarding tax incentives. The analysis presented herein includes allowances for intangible drilling costs and the alternative energy tax credit. However, the Internal Revenue Services is currently contemplating regulations which would limit these incentives to resource temperatures of 140°F and above. As indicated in the sensitivity analysis presented in Section VIII, such a regulation would increase the payback periods for temperature of 130°F and less beyond the attractive range for industry. In addition to making these incentives apply to the lower temperatures, an effort should be made to produce regulations which clearly define how the depletion allowance should be applied for a user such as Campbell Soup who would not be gaining income directly from the well. No credit has been taken in this study for a depletion allowance due to the lack of such regulations.

Reservoir Confirmation Plan

Based upon review of the recent DOE solicitations for an Eastern Geothermal Drilling Project (SCA 80ID 12132) and the User Coupled Confirmation Drilling Program, programs are available to confirm the resources in the Salisbury, Maryland area. This study indicates that these programs are justified. However, the results of this study indicate that the timing of the program should be revised somewhat to permit resolution of the institutional constraints discussed earlier.

II Introduction

Objectives

The objective of the DOE Geothermal Energy Development Program is to provide the nation with an economically and environmentally acceptable energy resource to supplement present energy sources. To accomplish this, the early development of a viable and growing geothermal industry is required. Under Contract No. DE-AC05-79ET27228, the work reported herein concentrated on site specific engineering and economic studies of the moderate temperature hydrothermal resources in the Atlantic Coastal Plain of the United States. In particular, an industrial team of Burns and Roe Industrial Services Corporation (BRISC) and Campbell Soup Company (CSC) studied the conversion of the existing CSC frozen food plant in Salisbury, Maryland, to utilize the resources currently being explored by DOE in that locality. BRISC was the prime contractor and CSC participated as a subcontractor. Since definitive reservoir data for the area was not yet available for analysis, a parametric study over a reasonable range of reservoir design variables was performed. Economic factors were also varied.

The specific objective of this study was to provide a data base which could be used as soon as the specific reservoir data became available to assess the practicality of utilizing the geothermal resources by retrofitting the existing frozen food plant.

Scope of Work

The team of Burns and Roe Industrial Services Corporation and Campbell Soup Company, via a budgetary level design and cost estimating analysis, has evaluated

the technical and economic viability of retrofitting an existing frozen food plant in Salisbury, Maryland, to utilize the anticipated geothermal reserves in that area. In addition, a more approximate assessment was made of the potential savings that could be realized if the design of a similar plant were started today at the same site utilizing the geothermal resources as a substitute for some or all of the conventional energy sources used in the existing plant. The work performed is defined by the following five tasks.

Task 1.0 - Engineering and Design Studies - Based on available published data and contacts with other investigators, a prediction was made of the expected range into which the relevant geothermal reservoir data (i.e. temperature, flow capacity, depth, etc.) for the Salisbury, Maryland, area will fall. Process data, plant drawings and energy data for the existing plant were compiled. Based on this information, a design concept was developed for the entire geothermal energy system from production well through the plant to final brine disposal.

Several detailed designs were developed to cover the range of uncertainty involved in the geothermal reservoir data.

Task 2.0 - Cost Estimates and Economic Analysis - Based on the designs produced in Task 1.0, a parametric analysis of capital and operating costs was performed which covered the range of geothermal design data developed in Task 1.0. A discounted cash flow rate of return type of analysis was utilized to evaluate the economic viability of retrofitting the existing plant to incorporate the use of geothermal energy in place of all or part of the conventional energy sources currently being used. The cost of energy both when supplied in conventional form and when supplied by retrofitting the geothermal system was calculated over a

20-year life. An order of magnitude estimate was also made of the difference in energy costs that might occur if a similar plant were designed from the outset to utilize geothermal energy in lieu of conventional sources.

Task 3.0 - Analysis of Institutional Factors - Relevant social, financial, environmental, legal and regulatory institutional relationships were examined and ways to eliminate any barriers they presented against the proposed application were explored.

Task 4.0 - Development of a Reservoir Confirmation Plan - Based on results from the other tasks in this study, the existing DOE East Coast Geothermal Development Plan was evaluated and possible alterations were proposed.

Trade-Off Studies

Consideration of the plant data resulted in four potential applications of geothermal heat which were explored in concept, namely production of hot water, production of steam, production of chilled water and refrigeration.

The production of hot water from geothermal heat showed sufficient economic promise to justify a further detailed technical and economical analysis, which is the subject of this report.

The other three applications were eliminated on the basis of preliminary trade-off studies which are discussed in Appendix H.

III. Geothermal Well Design and Capital Cost Estimates

General Approach

Three contractors were contacted during this study in order to obtain the design and cost data needed for the economic analysis. The three were:

1. D'Appolonia Consulting Engineers, Inc. - Pittsburgh, PA
2. Gruy Federal, Inc. - Arlington, VA
3. A.C. Schultes & Sons, Inc., - Woodbury, NJ

Very brief and general specifications were provided to all three in order to solicit their ideas on the one hand while, at the same time, insuring that comparable cost estimates would be obtained from all three. The specification was basically as follows:

No. of Wells:	1 Production Well and 1 Reinjection Well
Well Capacity:	300 gpm
Well Depth:	5000 ft. (each well)
Well Location:	Salisbury, Maryland
Scope of Supply:	All subsurface material and labor from wellhead down on a "turnkey" basis

Proposed Well Designs

Each of the three contractors provided at least a verbal response to our specifications. Figure III 1 shows the general consensus of their opinions as to the preferred design for the production and reinjection wells. While the general arrangement of the well was the same for all three contractors, the various dimensions varied as indicated on the sketch.

CAMPBELL SOUP CO. - SALISBURY, MD.
 TYPICAL PRODUCTION WELL DESIGN
 FIGURE III-1

INJECTION WELL INNER CASING RUNS FROM
 SURFACE

NOTE : DRAWING NOT TO SCALE
 III-2

The preferred design consisted of a surface casing which had the largest diameter and was placed in the top portion of the well so that the soil could support the drilling rig without collapsing into the bore.

The outer casing is placed to provide added protection against corrosion of the inner (working) casing and against pollution of any aquifers at the higher elevations. The annular space between the protective casing and the well bore would be filled with cement grout. All casings would be carbon steel.

At the levels of the producing zones, the well was completed with a stainless steel screen designed so that ground water could be extracted at high efficiency without permitting fine particles to enter the well.

Prior to placement of the screen, the area immediately adjacent to it would be underreamed and packed with gravel to further enhance the efficiency of the well.

In addition to the preferred design just described, A.C. Schultes provided cost information on several configurations. Sketches of these have been provided in Appendix I.

Well Cost Estimates

Table III 1 shows the estimates received from the three contractors. A.C. Schultes & Sons provided cost data for about a dozen wells of varying configurations, depths and diameters. All of this data is included in Appendix I and Table III 1 indicates the range of the data they provided.

Since each of the three contractors made different assumptions regarding production well pump requirements, the costs shown on Table III 1 exclude the cost of this pump. For purposes of the economic analysis, a cost of \$53,000 was used for this pump based on estimates from submersible pump suppliers.

TABLE III 1

GEOHERMAL WELL COST ESTIMATES

	<u>GRUY</u>	<u>D'APPOLONIA</u>	<u>A.C. SCHULTES</u>
WELL DETAILS:	5000' PRODUCTION WELL 5000' INJECTION WELL 300 GPM FLOW 9 5/8" INNER CASING 200' SLOTTED LINER AND GRAVEL PACK	5000' PRODUCTION WELL 5000' INJECTION WELL 300 GPM FLOW 8" INNER CASING	4000' PRODUCTION WELL 3000' INJECTION WELL 300 GPM FLOW 6" INNER CASING 200' SCREEN AND GRAVEL PACK
WELL COSTS:			
PRODUCTION WELL*	\$471,000	\$350,000	\$600,000 - \$950,000**
INJECTION WELL	387,000	350,000	480,000 - 700,000
MISCELLANEOUS	<u>179,000</u>	<u>100,000</u>	
TOTAL	\$1,037,000	\$800,000	<u>\$1,080,000 - \$1,650,000</u>

* DOES NOT INCLUDE DOWNHOLE PUMP

** DEPENDING UPON DESIGN FLOW CAPACITY

For purposes of the economic analysis, the Gruy Federal estimate was used because it represented a reasonable intermediate value. In addition to the \$53,000 for a production well pump (in lieu of the \$129,000 shown on Table III 2), an allowance of \$35,000 was also added to the capital cost for rig standby time during flow tests (\$5000/day). This resulted in a total 1st quarter 1980 cost for a 300 gpm well of \$1,125,000. Based on verbal information received from Gruy, the cost of a 100 gpm well would be about \$130,000 less, or \$995,000. This reduction was based on the lower cost of the tubulars and the pump. Capital costs for other well outputs were obtained from a straight line drawn through these two points. The costs from this line were increased by 5% to account for escalation between the first and fourth quarters of 1980, which was the assumed drilling period. The results are shown graphically on Figure VIII 1.

Table III 2

Gruy Federal, Inc.

Cost Estimate Breakdown
Delmarva Geothermal Production System
1st QTR., 1980 Costs

	<u>\$000's</u>
Mobilization/demobilization	75
Production well	471
Injection well	387
Downhole pump	129
Engineering and supervision	42
Reports	8
Material handling and fee	54
	<u>1,166</u>

	<u>Production Well</u>	<u>Injection Well</u>
Site work	20	20
Rig time	100	100
Cementing	48	55
Bits	7	7
Mud	10	5
Fuel and Water	10	7
Logging	50	25
Wellhead	10	10
Tubulars	196	138
Miscellaneous rentals	20	20
	<u>471</u>	<u>387</u>

Basis: 5000 ft wells
400 HP pump (300 gpm) set at 4800 ft
4800 ft of 9 5/8 in. casing
200 ft of slotted liner and gravel pack

Not included: Surface injection pump
Flow lines
Water treatment facilities
Pump tests (assume \$5000/day for rig standby time)
Heat extraction equipment

IV Geothermal Fluid, Properties and Treatment

IV 1 Introduction

The identification of geothermal resources along the Atlantic Coastal Plain has evolved through the work of investigators at Virginia Polytechnic Institute and State University. (IV 1) Various geophysical, geochemical and geological techniques were used to identify areas with geothermal potential, and served as a basis for selection of sites for an exploratory drilling program. Forty nine wells were drilled to a depth of approximately 1000 feet at selected sites from New Jersey to Georgia during 1978-79. Temperature profiles, geothermal gradients and thermal conductivities were measured and reported. (IV 2)

Based in part upon the heat flow data obtained from the shallow well drilling program, a Selection Committee of the DOE Division of Geothermal Energy chose a site at Crisfield, Maryland for a deep test well to basement. The test well was drilled during mid 1979, and temperatures and core samples were obtained and reported. (IV 3)

These efforts form the primary bases for the estimation of geothermal resources in the Salisbury area applicable to the current study. A range of anticipated geothermal fluid properties may be inferred from the results of these programs. Since fluid properties are site specific, unique values cannot be ascertained until a well is actually drilled.

IV 2 Geothermal Fluid Temperature

The shallow well test program estimated a temperature of 160°F at an estimated 4200 feet basement surface depth for Crisfield. (IV 2) The deep test well at Crisfield measured a temperature in the order of 135°F at an actual basement depth of about 4200 feet. (IV 3)

The shallow well test program estimated temperatures from 135 to 151°F at estimated basement depths from 4800 feet to 5300 feet for the Salisbury area. (IV 2)

Attempting an extrapolation of data from Crisfield to Salisbury (a distance of 30 miles) is risky, at best, because of typical lack of contiguity between areas. However, a reasonable projection for Salisbury, based upon the limited data available, would be the same as for Crisfield. (IV 4, IV 5 and IV 6) Therefore, 130°F was selected as a likely value, with a lower level of 120°F and a higher level of 150°F taken as the extremes for a matrix type approach.

IV 3 Geothermal Fluid Composition

The chemical analysis for the Crisfield well water appears in Table IV 1. (IV 3) Water chemistry at Salisbury could be expected to approximate that at Crisfield. (IV 5) Therefore, lacking any more site specific data, the composition of the water for the current study will be taken as that for Crisfield. The analysis for the three zones encountered at Crisfield are essentially the same. This study will use the data for zone 1, the deepest zone, to apply to Salisbury.

IV 4 Scale Formation

The principle concern in the treatment of the geothermal brine is that of scale formation. Potential problems for the Crisfield geothermal brine relate to calcium carbonate, magnesium carbonate, barium sulfate and ferric hydroxide. Calculation of the Langelier Index, ionic strength and solubility limits confirm that the brine is saturated with calcium carbonate and barium sulfate, high in magnesium carbonate and iron and under saturated with calcium sulfate, strontium sulfate and silica.

TABLE IV 1

CHEMICAL ANALYSIS OF WATER BY ZONE
AT CRISFIELD AIRPORT WELL

Zone depth, ft	ZONE 1	ZONE 2	ZONE 3
Number of Samples	4220-4148	4032-3901	3846-3798
	6	6	5
<u>Metals (mg/l)</u>	<u>Mean</u>	<u>Mean</u>	<u>Mean</u>
Copper	0.433	0.290	0.242
Zinc	3.233	0.674	1.517
Boron	7.22	9.36	7.88
Chromium	0.583	0.3	0.242
Sodium	21,667	22,800	20,167
Potassium	268.3	280	348.8
Iron	36.67	8.64	14.50
Magnesium	631.2	636	649.5
Barium	4.05	10	10
<u>Others (ppm)</u>			
Total suspended solids	60.00	94	377.7
Total dissolved solids	71,793	71,511	72,089
Total residue	71,853	71,605	72,467
Calcium carbonate	16,598	10,443	14,377
Magnesium carbonate	3,557	2,264	2,244
Bicarbonates	121.2	71.0	72.2
Chlorides	39,422	37,360	34,772
Sulfates	575.2	634	804.2
Dissolved silicates	16	30.8	19.35
Nitrates	5.32	1.78	1.70
Total organic carbon	28.3	26.6	17.83
Density (gm/cc)	1.040	1.032	1.036
pH	6.36	6.52	6.69
Equivalent salinity(Calculated)	67,921	68,896	68,428

Components in minor amounts have been eliminated for clarity.

IV 5 Scale Control

For the components of the Crisfield brine, most likely candidate scale control methods are:

- a. Threshold Chemical Additives - Injection of scale inhibiting chemicals (typically a phosphonate compound) at the well head.
- b. Acid Injection - Treatment with sulfuric acid to prevent the formation and precipitation of calcium carbonate and magnesium hydroxide.
- c. Lime Softening - Treatment with chemical lime, in some form, to precipitate out calcium and magnesium. As used here, lime softening refers to the Hot Lime Process performed at the geothermal resource temperature.
- d. Recirculation Seeding - Precipitation of calcium carbonate from a super-saturated to a saturated state with a recirculated stream serving as a seed.

IV 6 Calcium Scale Control

The potential for calcium carbonate scale appears to be the major concern for this geothermal brine composition. In the analysis in Table IV 1, the calcium carbonate composition of 16,598 ppm is the sum of all hardness precipitated in the sample and the remainder of calcium in solution expressed as calcium carbonate. However, the amount of hardness that was precipitated and, therefore, the amount of calcium in solution, is not known. In any case, the problem of calcium carbonate scaling deposit will occur within the well bore and the surface gathering line if the pressure falls below the value required to keep carbon dioxide gas completely in solution. Scale will also deposit across valves, heat exchangers and other equipment if local pressure is reduced to the point where flashing occurs.

Possible pretreatment methods for control of carbonate scale are threshold chemical additives, acid injection and hot lime softening. Threshold treatment is

frequently used to control carbonate scale. Because of the high concentration of calcium carbonate, threshold treatment in combination with partial acid injection could be considered. Straight acidification of the brine with sulfuric acid to reduce the bicarbonate ions is another method that can prevent carbonate scale, but sulfuric acid is costly and increases the potential for sulfate scale formation. The hot lime process is one of the most positive conventional treatment for carbonate scale, but there is the added cost for the hot lime reactor and sludge disposal system. The recirculation seeding of calcium carbonate crystals could be used for control of carbonate scale, but experience with this technology is limited.

IV 7 Magnesium Scale Control

The high magnesium carbonate concentration of 3557 ppm presents another potential scale formation problem. The behavior of magnesium carbonate is roughly the same as calcium carbonate. Normally, it is about five to six times as soluble as calcium carbonate, with the total hardness in any normal natural water averaging about two-thirds from calcium hardness and one-third from magnesium hardness. When the magnesium alkalinity exceeds the solubility limit, the magnesium carbonate normally reacts with water to precipitate out as magnesium hydroxide. The pretreatment method for the control of magnesium hydroxide scale is the same as for calcium carbonate.

IV 8 Iron Scale Control

Iron scale formation is another potential problem in the Crisfield geothermal brine. Its solubility is increased by increases in the free carbon dioxide content of the brine. As in the case with calcium carbonate scale formation, if carbon dioxide escapes from the solution or air leaks into the brine system, the potential for iron scale formation becomes greater. Theoretically, 1 ppm of dissolved oxygen

will oxidize 7 ppm of ferrous iron. The solubility of oxygen in the Crisfield geothermal brine is about 4 ppm, which is enough oxygen to oxidize some 28 ppm of ferrous iron. The oxidation is very slow at pH values of 7 and higher. Applicable pretreatment methods are threshold treatment and hot lime softening.

IV 9 Barium Scale Control

The barium constituent of 4.05 ppm is another problem ion in the Crisfield geothermal brine. The barium will react with sulfate ion to precipitate out as barium sulfate. Barium sulfate has an extremely low solubility limit. The amount of barium sulfate deposit is low when compared with the other problem ions such as calcium, magnesium and iron and it may take as much as a year or two before any evidence of heat transfer problems occur. However, experience has shown that a barium deposit is as hard as a calcium sulfate deposit and normally very difficult to remove. The pretreatment methods for barium sulfate scale control are threshold treatment and hot lime softening.

IV 10 Suspended Solids

The analysis also indicates a high concentration of 60 ppm in suspended solids. However, this analysis was for fluid samples directly taken after the well had been drilled. With proper well completion, the suspended solids in the geothermal brine should only be a short lived phenomenon. Once the well hole is flushed out, the soil at the bottom of the well should act as a sand filter, effectively reducing the suspended solids concentration to essentially zero.

IV 11 Summary

Possible methods for control of potentially troublesome ions have been summarized in Table IV 2. Of these, acid injection and lime treatment are expensive.

Table IV 2

Potential Methods of Brine Treatment

<u>Component</u>	<u>Treatment</u>					
	Threshold Inhibitor	Acid Injection	Lime Softening	Seeding	Closed System	Filtration
Calcium Carbonate	X	X	X	X		
Magnesium Carbonate	X	X	X			
Iron	X		X		X	
Barium Sulfate	X		X			

The latter also requires large tanks, sludge separators and sludge disposal techniques, with the distinct possibility of degradation of the geothermal resource temperature. Relatively little experience exists with the seeding technique.

Therefore, the methods of treating the geothermal brine that appear to be most practical and economical, and that will be used for establishing costs for a number of base cases in this study, are:

- 1) Pressurization of the geothermal fluid to keep carbon dioxide in solution, and
- 2) Maintaining a closed system to keep oxygen out of the fluid, and
- 3) Threshold addition of phosphonate scale inhibitor

Because of uncertainties regarding the Crisfield fluid, the poor quality of the Crisfield geothermal fluid, and the uncertainty in extrapolating from Crisfield to Salisbury the possibility remains that a more severe treatment might be required than the threshold chemical treatment that is considered. Therefore, as an alternate brine for a worst possible case, hot lime treatment will also be considered.

In this method, a solid contact reactor provides mixing of geothermal fluid with the treating chemicals and settling all in a single vessel. The solid contact reactor is about 17 ft dia by 15 ft ht with a rise rate of 1.25 gpm/ft². Sufficient time to react with all bicarbonate alkalinity present in the geothermal fluid results in a pH of about 10.2. At this pH, the iron is oxidized to ferric hydroxide and barium to barium sulfate which precipitate because of their extreme insolubility.

The sludge is blown off at the bottom of the reactor and sent to the centrifuge for dewatering from 5% to 60% solids. The wet cake at 60% solids is trucked for landfill and the centrate at 0.5% solids is returned to the reinjection well. The overflow or effluent from the reactor is acid treated to adjust the pH from 10.2 to 8.0 to redissolve any solids carryover.

V Plant Hot Water Requirements

V 1 Figures V 1 and V 2 show the required process hot water flow rate versus time of day. These data were provided by the Campbell Soup plant in Salisbury, Maryland. A total of six hot water applications were identified for consideration for a geothermal hot water plant. These are the following:

1. Plant hot water.
2. Office hot water.
3. High pressure cleaning system.
4. Can washer.
5. Boiler feedwater make-up.
6. Additional high pressure cleaning system replacing the present Seller's Jets.

The data as presented in Figures V 1 and V 2 are idealized estimates. Actual usage neither varies as abruptly as shown at specific times, nor remains as constant as shown in the figures. However, the data in Figures V 1 and V 2 are quite useful as a basis for design.

For each of the six hot water applications, the 24-hour average flow was determined. If a 5°F deviation in temperature is allowed, the six hot water applications, can be divided in three temperature groups, namely 145, 165 and 175°F. For each of the three temperature levels, the 24-hour average flow, the maximum flow and the minimum flow were tabulated (Table V 1). The total average flow for all three temperatures together amounts to 207 gpm. This was plotted accumulatively against the instantaneous flow rates from Figure V 1 in order to determine the size of the storage tank. The results indicate, as shown in Figure V 3, that a storage tank

CAMPBELL SOUP CO.- SALISBURY, MD.
HOT WATER USAGE
WEEKDAYS

KEY:

- I.A. PLANT HOT WATER 55°F - 165°F (8 GPM IF NOT SHOWN)
- I.B. OFFICE HOT WATER 55°F - 150°F (4 GPM)
- I.C. HP CLEANING SYSTEM 55°F - 140°F (10 GPM IF NOT SHOWN)
- I.D. CAN WASHER 55°F - 160°F (8 GPM, MAY OCCUR DURING ANY THREE 8-HR SHIFTS)
- I.H. FEEDWATER HEATER 55°F - 175°F (FOR FLOWS & TEMPERATURES SHOWN. MAKEUP IS HEATED TO 175°F THEN MIXED WITH CONDENSATE)
- I.I. HP CLEANING SYSTEM 55°F - 140°F (REPLACEMENT FOR SELLER'S JET)

Fig. V 1

CAMPBELL SOUP CO. - SALISBURY, MD.
HOT WATER USAGE
WEEKENDS

SEE FIGURE OF WEEKDAY USAGE FOR KEY

Fig. V 2

Table V 1

CAMPBELL SOUP CO. - Salisbury, MDHot Water Usage24-hour Average Flows (gpm)

	<u>145°F</u>	<u>165°F</u>	<u>175°F</u>	<u>Total</u>
<u>Plant Hot Water 165°F</u>	-	95	-	
Max - 170 gpm				
Min - 70 gpm				
<u>Office Hot Water 150°F</u>	2	-	-	
Max - 5 gpm				
<u>HP Cleaning System 140°F</u>	29	-	-	
Max - 80 gpm				
Min - 10 gpm				
<u>Can Washer 160°F</u>	-	8	-	
Max - 8 gpm				
<u>Feedwater Heater 175°F</u>	-	-	44	
Max - 56 gpm				
Min - 40 gpm				
<u>HP Cleaning System 140°F</u>	29	-	-	
(Seller's Jet Replacement)				
Max - 64 gpm				
Min - 16 gpm				
<u>Total Average gpm</u>	60	103	44	207
Max	149	178	70	397
Min	31	78	50	159

CAMPBELL SOUP CO. - SALISBURY, MD.
HOT WATER USAGE
WEEKDAYS

Fig. V 3

with a minimum volume of 31,740 gallons will be required to operate without interruption while producing an average flow of 207 gpm of hot water. After including a margin of safety, a storage tank capable of holding 40,000 gallons of hot water was selected for this project.

The hot water requirement data as shown in Figure V 1, V 2 and Table V 1 were revised after the preliminary studies in order to reflect new plans to replace the Seller's Jet Cleaning System with an expanded High Pressure Cleaning System.

VI Plant Description

VI-A Process Description

VI-A, 1 Introduction

Heat for hot process water can be extracted from the geothermal brine by means of heat exchangers (see Fig. VI 1). With a heat exchanger, however, the temperature of the process water leaving the heat exchanger will be limited to the temperature of geothermal brine minus the approach temperature to the heat exchanger. This means that with a heat exchanger, process water temperatures will be limited to 110°F to 140°F. Therefore, the use of heat pumps has also been considered in order to meet the plant process water temperature requirements (see Figures VI 2-3). Process water storage tanks have been included in all cases because, as was established in the conceptual design report, they improve considerably the overall economics.

Part of the hot process water is used directly in the preparation of food. Therefore, any chance that the geothermal brine would get mixed into the process water has to be eliminated. Therefore, in all cases, an intermediate heat exchange loop has been included establishing a clear separation between the geothermal brine and the process water.

Heat exchangers are all plate type heat exchangers, because they allow the lowest approach temperatures. A realistically achievable approach temperature of approximately 50°F was assumed in cases.

Overall heat transfer coefficients (U) in plate type heat exchangers can vary easily from 600 to 1200 Btu/hr sq.ft. F depending primarily on the pressure drop over the heat exchanger that is being allowed. Although pressure drop is not of prime concern here, a relatively conservative value of 800 was used for U in all

CAMPBELL SOUP CO - SALISBURY, MD.
 GEOTHERMAL SYSTEM SCHEMATIC
 HEAT EXCHANGERS ONLY

Flow Schematic - Heat Exchangers Only

Fig. VI 1

CAN TELL OIL CO. SALISBURY, MD
GEO THERMAL SYSTEM SCHEMATIC
ONE HEAT PUMP

Flow Schematic - One Heat Pump

Fig. VI 2

CAMPBELL SOUP CO. - SALISBURY, MD.
 GEOTHERMAL SYSTEM SCHEMATIC
 TWO HEAT PUMPS

Flow Schematic - Two Heat Pumps

Fig. VI 3

calculations. The heat and mass balance calculations for the cases with one or more heat pumps were performed with the aid of a programmable calculator (TI 59) program that was developed by Westinghouse. The instructions for this program plus the basic data that were developed using this program are included in this report as Appendix A. The data on heat pumps have been summarized in Tables VI 1 through VI 3. Data for the heat exchangers outside the heat pump are shown in Tables VI 4 through VI 6. Table VI 7 presents the basic heat exchanger data for the heat exchanger only cases.

VI-A, 2 Heat Exchanger Only

Fig. VI 1

The submersible pump in the production well pumps 207 gpm geothermal brine through the geothermal heat exchanger. Threshold chemicals are added prior to the heat exchanger to avoid scaling. The maximum amount of heat is extracted from the geothermal brine by designing the heat exchanger for a brine exit temperature of 65°F. A reinjection pump puts the brine back into the ground.

The heat transferred into the intermediate loop is further transferred into the process water with the aid of a second heat exchanger. 207 gpm of 55°F process water is passing this exchangers, raising the temperature of the process water to 110°F to 140°F depending on the geothermal brine temperature. Because with the intermediate loop two heat exchangers are involved in the heat transfer, the overall temperature differential between brine and process water amounts to 10°F (see also Table VI 7). The hot process water is stored in a 40,000 gallon storage tank for use in the plant. At the points of use, additional steam injection will be required to bring the process water up to the demand temperature.

Table VI 1
Heat Pump Data
Heat Exchangers Plus One Heat Pump

Geothermal Temperature		120°F	130°F	150°F
Geothermal Flow Rate	gpm	304	263	235
COP Heat Pump		3.5	3.6	3.7
Power Requirements	kW	282	223	144

Table VI 2
Heat Pump Data
Heat Exchangers Plus Two Heat Pumps

Geothermal Temperature		120°F	130°F	150°F
Geothermal Flow Rate	gpm	340	295	234
COP Heat Pump 1		3.5	3.6	- *
2		5.0	5.8	3.1
Power Requirements	kW			
Heat Pump 1		341	288	- *
2		86	75	200
Total		427	363	200

*No heat pump required for producing 140°F water.

Table VI 3
Heat Pump Data
Heat Exchangers Plus Three Heat Pumps
Geothermal Brine Temperature 120°F

Geothermal Flow Rate	gpm	346
COP Heat Pump 1		3.6 (centrifugal)
2		5.0 (centrifugal)
3		3.7 (reciprocating)
Power Requirements	kW	
Heat Pump 1		349
2		87
3		17
Total		453

Table VI 4

<u>Heat Exchanger Data</u>				
<u>Geothermal Brine Temperature 120°F</u>				
	<u>Material</u>	<u>Load</u> <u>MMBtu/hr</u>	<u>LMTD</u> <u>°F</u>	<u>A(ft²)</u> <u>U=800</u>
<u>Two Heat Pumps</u>				
HX A	Ti	4.01	10.5	477
HX B	Ti	1.03	5	258
HX 1	SS 304	9.32	5	2330
HX 2	SS 304	1.47	5	368

One Heat Pump: Process Water Temperature 145°F

HX A	Ti	4.50	10.5	536
HX B	Ti	1.20	5	300

One Heat Pump: Process Water Temperature 130°F

HX A	Ti	4.20	8.2	640
HX B	Ti	1.55	5	388
HX 1	SS 304	7.76	5	1940

Table VI 5

Heat Exchanger Data
Geothermal Brine Temperature 130°F

	<u>Material</u>	<u>Load</u> <u>MMBtu/hr</u>	<u>LMTD</u> <u>of</u>	<u>A(ft)</u> <u>U=800</u>
<u>Two Heat Pumps</u>				
HX A	Ti	5.272	11.6	567
HX B	Ti	0.539	4.2	160
HX 1	SS 304	9.315	5	2330
HX 2	SS 304	1.470	5	368
<u>One Heat Pump</u>				
HX A	Ti	6.09	12.8	5872
HX B	Ti	0.588	4.4	168
HX 1	SS 304	9.315	5	2329

Table VI 6

Heat Exchanger Data
Geothermal Brine Temperature 150°F

One Heat Pump Plus Heat Exchanger Loop in Parallel

<u>Parallel Heat Exchangers</u>				
	<u>Material</u>	<u>Load</u> <u>MMBtu/hr</u>	<u>LMTD</u> <u>of</u>	<u>A(ft²)</u> <u>U=800</u>
HX 2A	Ti	2.55	5	638
HX 2B	SS 304	2.55	5	638
<u>Heat Pump Exchangers</u>				
HX A	Ti	5.55	13.4	518
HX B	Ti	0.447	4.5	124
HX 1	SS 304	8.085	5	2021

Table VI 7
Heat Exchanger Data

	<u>Brine Temp. OF</u>	<u>Material</u>	<u>Load MMBtu/hr</u>	<u>LMTD of</u>	<u>A(ft) U=800</u>	
		<u>Geothermal Flow Rate</u>			<u>150 gpm - 207 gpm</u>	
HX 1	120	Ti	5.69	5	1030	1422
HX 2		SS 304	5.69	5	1030	1422
HX 1	135	Ti	7.25	5	1310	1810
HX 2		SS 304	7.25	5	1310	1810
HX 1	150	Ti	8.80	5	1594	2200
HX 2		SS 304	8.80	5	1594	2200

VI-A, 3 Heat Exchangers Plus One Heat Pump

Fig. VI 2

Three hot water temperature levels are required in the plant, i.e. 145, 165 and 175° F. In a system with one heat pump, 145° F hot water is produced and stored. The 165 and 175° F water is produced on site in the plant by injecting additional steam in the 145° F water.

There are a number of factors that favor the use of the heat pump in combination with two heat exchangers in order to improve on the overall efficiency of a geothermal heat pump system.

The cost of wells is a major cost item in a geothermal heating system. Hence, the heat available in the geothermal brine should be extracted from it to the fullest possible extent in order to obtain the lowest cost per unit of heat. However, the COP of a heat pump is strongly dependent on the temperature of the geothermal brine leaving the heat pump evaporator. The lower the brine exit temperature, the lower the COP of the heat pump. As a result, a heat pump cannot economically extract all the heat that is available. Further, extraction of heat from the brine leaving the heat pump evaporator with a heat exchanger for preheating the 60° F loop water does improve overall economics considerably. However, the amount of preheating of the 60° F loop water that can be achieved in this manner is limited and the process water from this preheating heat exchanger is still considerably below the temperature of the incoming geothermal brine. Heating the process water up to the temperature of the geothermal brine with a heat exchanger is a simpler and more economical approach than to impose that duty on the heat pump. Therefore, a second heat exchanger preheating the process water some more before it enters the heat pump should be considered.

This leads to a basic flow schematic for a combination of one heat pump and heat exchangers A and B as shown in Fig. VI 2.

First the 60° F loop water is preheated in heat exchanger B with the low temperature brine leaving the heat pump. Subsequently, the process water is further preheated to a temperature close to the temperature of the incoming geothermal brine in a heat exchanger A with hot geothermal brine before it enters the heat pump where the final loop temperature of 150° F is obtained.

Electric power required for the heat pump and geothermal brine flow rate depend on the temperature of the geothermal brine. Data to that effect are shown in Table VI 1.

In case of 150° F geothermal brine, 140° F process water can be produced without the use of heat pumps. This seems close enough to the assumed requirement of 145° F, which is an approximation of various plant conditions. Therefore, a design including two heat pumps was not considered for 150°F brine.

VI-A, 4 Heat Exchangers Plus Two Heat Pumps

Fig. VI 3

In a system with two heat pumps, the first heat pump increases the process water temperature to 145°. Of the total amount of 207 gpm, 60 gpm of 145° F water is stored in a 50,000 gallon storage tank to satisfy 145° F water demands in the plant. The remaining 147 gpm is further heated by the second heat pump to the next level of 165° F and stored in a 25,000 gallon tank.

The second heat pump, because it has to operate at the higher temperature, receives the geothermal brine first. After use in the second heat pump, the brine is sent to the first heat pump and its associated heat exchangers. Data regarding power

requirements and brine flow requirements are presented in Table VI 2. In the case of 150 F brine temperature, 60 gpm of 140 F water can be produced directly with heat exchangers without the need for heat pumps. The 165 F process water is obtained separately using one heat pump according to the previous case as shown in Fig. VI 2.

VI-A, 5 Heat Exchangers Plus Three Heat Pumps

By adding a third heat pump to the plant all three plant water temperatures, 145, 165 and 175 F, can be obtained eliminating the need for further steam injection in the plant. However, the third heat pump would be a small one contributing only 2% of the total heat. Smaller heat pumps are of the reciprocating type in contrast to the centrifugal type that have been considered so far. Reciprocating heat pumps are relatively expensive and not as energy efficient as the centrifugal ones. Therefore, it did not seem to be meaningful to pursue a three heat pump system in any depth. Process design data for a three heat pump system operating on 120 F brine was presented in Table VI 3.

VI-A, 6 Summary

The results of typical heat exchanger and heat pump cases have been summarized in Table VI 8. It shows total hot water requirements of 11 MM Btu/hr or approximately 11,000 lbs/hr of steam. If only heat exchangers are applied, between 52 and 80% of this heat demand can be satisfied with geothermal heat depending on the temperature of geothermal brine. By including between 1 and 3 heat pumps which required electrical power to operate, steam requirements can be reduced to 0 to 15% of the present steam requirements for hot process water.

Table VI 8

Summary Heat Exchanger and Heat Pump Cases

	<u>Geothermal Brine Temp. °F</u>	<u>Geothermal Flow (max) GPM</u>	<u>Process Water Temp. °F</u>	<u>Geothermal Heat MMBtu/hr</u>	<u>% of Total Load</u>
HX	120	207	110	5.7	52
HX	150	207	140	8.8	80
HX + 1 HP	120	304	145	9.3	85
HX + 2 HP	120	340	145 + 165	10.8	98
HX + 3 HP	120	346	145 + 165 + 175	11.0	100

VI-B Equipment Layouts and Description

VI-B, 1 Introduction

The major pieces of equipment involved in the geothermal hot water plant are the geothermal brine treatment equipment, heat exchangers, heat pumps, storage tanks, circulation pumps and hot process water pumps. With the exception of the tanks, this equipment will be all located inside the so-called geothermal building.

The best possible site for this building seems to be an area directly North of the high rise freezer storage building. The area available there measures 70 x 120 feet and probably allows above ground piping runs from the production well and to the reinjection well.

VI-B, 2 Heat Exchangers Only

A layout for a heat exchanger only case and brine treatment with threshold chemicals has been presented in Fig. VI 4. There are two type heat exchangers involved. The geothermal brine heat exchanger has titanium plates to avoid corrosion problems, while the second process water exchanger has standard SS 304 plates. Heat is transferred between the two heat exchangers with a circulation pump. This pump pumps water around in a closed loop connecting the two exchangers. Two chemical feed systems consisting of 50 gallon day-tanks and fractional horsepower, adjustable stroke, metering pumps are included.

Geothermal brine piping is urethane insulated fiber reinforced pipe. Process water and loop piping is Yoloy pipe or equal. Valves are either bronze body or cast iron body with bronze trim.

Pumps have cast steel casings with bronze or stainless steel impellers. The 40,000 gallon hot process water storage is provided by two horizontal 20,000 gallon

CAMPBELL SOUP CO - SALISBURY, MD.
GEOTHERMAL BUILDING CONCEPTUAL LAYOUT
HEAT EXCHANGERS ONLY - MINIMUM BRINE TREATMENT

FIGURE VI.4

steel tanks. This is more economical than one 40,000 gallon tank, because a 40,000 gallon tank has to be field fabricated, while 20,000 gallon tanks can still be transported over the road and, hence, can be factory fabricated. Tanks are insulated and weatherproofed on the outside and coal tar epoxy coated on the inside. Tanks are set on concrete foundations. Tank heads penetrate the building. This way, all tank connections and all instrumentation is inside the building. Building will be 32' x 16' x 12' high of cinder block construction with a flat roof. Open webbed posts will be used, spaced at 3 feet. Finished roof will be built up with insulation and a metal deck top with a 4 ply roof. Floor will be 10" thick with wire mesh reinforcing. Metal doors will be installed for access.

If hot lime treatment of the geothermal brine would be necessary, a hot lime reactor, sludge centrifuge, brine pump, and a third chemical feed pump would have to be added. A layout for this case is shown in Fig. VI 5. Approximate dimensions for the hot lime reactor are 17' diameter by 15' high, including conical bottom. Half of the building would be 18' high; the other half of the building would remain at 12' high. Overall floor dimensions would be 32' x 36'.

VI-B, 3 Heat Exchangers Plus Two Heat Pumps

A layout for the most elaborate equipment case is presented in Fig. VI 6. The two heat pumps, four heat exchangers, two circulation pumps, two process water pumps, as well as the chemical feed systems for dosing threshold chemicals, will be fitted into a building of 32' x 35' and 12' high. Because this system produces hot process water at 145 and at 165° F and at two different flow rates, one 15,000 gallon and 25,000 gallon storage tank will be required. If hot lime treatment would be necessary, then the building would have to be expanded by another 20' with an 18' high

CAMPBELL SOUP CO. - SALISBURY, MD.
 GEOTHERMAL BUILDING CONCEPTUAL LAYOUT
 HEAT EXCHANGERS ONLY - MAXIMUM BRINE TREATMENT

FIGURE VI.5

CAMPBELL SOUP CO - ELLISBURG, MD.
 GEOTHERMAL BUILDING CONCEPTUAL LAYOUT
 TWO HEAT PUMPS - MAX. BRINE TREATMENT

VI-19

FIGURE VI G

ceiling to house the reactor and sludge centrifuge. In that case, all chem feed systems would be located in the reactor area.

VI-B, 4 Piping Layout

In Fig. VI 7 the paths are indicated for the distribution of hot process water from the geothermal building to the five user locations.

Piping carrying 165⁰ F water will go from the geothermal building to the boiler feed water demineralizers, the plant hot water system and the can washer. 145⁰F process water piping will go to the office hot water location and the HP cleaning system, following the paths of Fig. VI 7. If only a single temperature process water is produced in the geothermal building, there will be only one combined piping system going to all five user locations.

Process water piping inside the plant will also be insulated Yoloy pipe or equivalent. Geothermal brine piping is not shown in this Fig. VI 7 due to the uncertainty of where a production well and a reinjection well can be located. However, a total of 850' of 6" insulated FRP pipe has been included in the cost estimate. Heat tracing is included to prevent this pipe from freezing up when not in use during winter time.

CAMPBELL SOUP CO - SALISBURY, MD
GEOHERMAL SYSTEM
CONCEPTUAL SITE PLAN

FIGURE VI.7

0 100 200
SCALE 1" = 100'

VI-C Instrumentation

VI-C, 1 The instrumentation that is visualized for the different hot process water schemes is relatively simple. Heat pumps come equipped with their own internal controls, gauges and safety switches. This includes a thermostat that automatically maintains the high temperature of the intermediate loop water.

Auxiliary controls consist of one or two flow control valves maintaining the process water flow rate at a preset level and one or two on-off valves controlled by the levels in the corresponding storage tanks as shown in Fig. VI 8 - VI 10. Heat pumps, loop pumps and geothermal brine pumps are all interlocked and their operation is also controlled by the level in the storage tanks.

In the case of two heat pumps (Fig. VI 10) the 165°F flow control valve should be set such that the 165°F tank fills up somewhat faster than the 145°F tank. When the 165°F tank is full, heat pump 2 will stop, but heat pump 1 will continue to operate. Now the full flow leaving heat exchanger 1 will go into tank 1, accelerating the filling up of tank 1. Once that tank is also filled up, heat pump 1 will stop and with both heat pumps down both geothermal well pumps will shut down automatically.

CAMPBELL SOUP CO - SALISBURY, MD.
GEOTHERMAL SYSTEM SCHEMATIC
HEAT EXCHANGERS ONLY

Control Schematic - Heat Exchanger Only

Fig. VI 8

VI-23

CAMPBELL SOUP CO. - SALISBURY, MD
 GEOTHERMAL SYSTEM SCHEMATIC
 ONE HEAT PUMP

Control Schematic - One Heat Pump

Fig. VI 9

CAMPBELL SOUP CO. - SALISBURY, MD.
 GEOTHERMAL SYSTEM SCHEMATIC
 TWO HEAT PUMPS

Control Schematic - Two Heat Pumps

Fig. VI 10

VII Surface System Capital Costs

VII 1 Quantification

Quantity take-offs for the civil/structural piping, electrical and instrumentation were obtained from the following diagrams.

Civil/Structural	Fig. VI 4 - VI 6
Piping	Fig. VI 4 - VI 7
Instrumentation	Fig. VI 8

The electrical cost estimate was based on the availability of 800 amp service from an existing service that is 500 feet away from the projected geothermal building. A new motor control center is included. The production well was assumed 100 feet away and the reinjection well 700 feet away from the new geothermal building.

VII 2 Equipment

For all major pieces of equipment, detailed cost estimates were obtained from vendors. This included heat pumps, heat exchangers, storage tanks, hot lime reactor and sludge centrifuge. Cost data for heat pumps and heat exchangers as a function of size are presented in Fig. VII 1 and VII 2, respectively.

VII 3 Material Costs

Material costs were taken from various estimating publications such as Richardson and R.S. Means and from our "In House" cost Data Files. The costs for special items of material were solicited from vendor sources who had familiarity and experience with the product involved.

VII 4 Installations Cost

Installation manhours were estimated for each task. These hours were multiplied by the specific craft rate, including payroll burden, prevailing in the

FIGURE VII. 1

PLATE HEAT EXCHANGER COST (1980)
PLATES TITANIUM (Ti) OR STAINLESS 304 (SS)
CARBON STEEL FRAMES

Baltimore, Maryland area in accordance with the latest publication by Richardson. Costs for foremen, supervision, construction services, supplies and tools were included.

VII 5 Total Capital Cost

The total capital costs are the sum of equipment, materials and installation costs. A minimum 10% contingency has been added as well as appropriate allowances for overhead and profit.

The Capital Costs data for the 12 different cases with specific well capacity have been summarized in Table VII 1 and Fig. VII 3. For each case, both the threshold treatment and the hot lime treatment for the geothermal brine were considered.

The basis for the capital cost data are the complete detailed cost estimates that were prepared for cases 1 and 5 of Table VII 1. These detailed estimates have been included as Appendices B and C. Using the basic information contained in these two detailed cost estimates, the capital cost data for the other ten cases were developed. The capital cost data work sheets that were used in preparing Table VII 1 are included as Appendix D.

From the detailed cost estimate, it was derived that the cost of electrical equipment could be extrapolated by adding or subtracting \$40 per kW differential with the exception of well pumps.

For the well pumps, it was determined from the detailed cost estimates that each kW differential, because of the distance involved, is equivalent to approximately \$400. Hence, electrical equipment costs were estimated by adding to a base cost of \$115,000, \$400/kW for the well pumps plus \$40/kW for the remainder of the load.

Table VII 1

Capital Cost

Specific Well Capacity: 1.0

Case No.	Geothermal Brine		Heat Transfer Equipment	Process Water		Threshold Treatment						Threshold Treatment	Hot Line Treatment	
	Temp. °F	Flow gpm		Temp. °F	Flow gpm	Capital Cost in \$						Total Cost \$	Total Cost \$	
						Wells	Civil Struct.	Equipment	Piping	Brine Treatment	Instrumentation			Electrical
1	120	150	HX	110	150	1,082,000	28,100	166,900	58,700	34,800	10,100	131,200	1,511,800	1,737,800
2		207	HX	110	207	1,120,000	28,100	254,700	73,600	34,800	10,100	138,000	1,659,300	1,931,500
3		267	HX + 1 HP	130	207	1,160,000	28,100	323,800	78,300	34,800	10,100	152,700	1,787,800	2,134,400
4		304	HX + 1 HP	145	207	1,185,000	28,100	397,400	78,300	34,800	10,100	166,400	1,900,100	2,272,800
5		340	HX + 2 HP	145	60	1,210,000	52,800	484,000	138,200	34,800	15,300	179,700	2,115,300	2,490,100
				165	147									
6	130	150	HX	120	150	1,082,000	28,100	188,700	58,700	34,800	10,100	131,200	1,533,600	1,759,600
7		207	HX	120	207	1,120,000	28,100	282,600	73,600	34,800	10,100	138,000	1,687,200	1,959,400
8		263	HX + 1 HP	145	207	1,150,000	28,100	370,100	78,300	34,800	10,100	156,300	1,827,700	2,174,200
9		294	HX + 2 HP	145	60	1,178,000	52,800	474,500	138,200	34,800	15,800	168,100	2,059,200	2,403,700
				165	147									
10	150	150	HX	140	150	1,082,000	28,100	208,500	58,700	34,800	10,100	131,200	1,553,400	1,779,400
11		207	HX	140	207	1,120,000	28,100	310,500	73,600	34,800	10,100	138,000	1,715,100	1,987,300
12		234	HX + 1 HP	140	60	1,135,000	52,800	373,300	111,400	34,800	15,800	150,200	1,873,300	2,168,800
				165	165

WELL OUTPUT, GPM

CAMPBELL SOUP CO., SALISBURY, MARYLAND

TOTAL GEOTHERMAL PROJECT CAPITAL COST

4TH QUARTER, 1980 PRICES

THRESHOLD TREATMENT

FIG. VII 3

VIII. Operating Cost Estimates and Economic Analysis

General Approach

The objective of this analysis was to assess the economic viability of retrofitting the Campbell Soup Company's Salisbury, Maryland plant to utilize geothermal resources. A discounted cash flow rate of return (DCFRR) analysis technique was used to evaluate the conversion of the plant. The cash flow analysis compared the future annual expenditures required from the owner in order to convert to geothermal energy sources versus those expenditures required if he maintained the status quo (i.e., he continued to use conventional #6 oil fired boilers).

A separate DCFRR analysis was performed for a total of thirty-nine cases. Each case was defined in terms of a specific combination of wellhead temperature, flow rate and specific capacity (see Tables VIII 1-3). The analysis sheets for each case are included in Appendix E.

The reduction in annual fuel oil costs due to the use of geothermal energy was considered as a "revenue" or positive cash flow. The annual expenditures or negative cash flows as used in this study included: property taxes, insurance, maintenance (materials and labor), electric power, chemicals and annual income taxes.

The net cash income for each year was the algebraic sum of all cash flows excluding income tax. For income tax purposes, deductions were made from the net cash income for intangible drilling costs and straight-line depreciation in order to get the taxable income. The intangible drilling cost deduction applied only in the first year of the project. The annual income taxes were then determined by multiplying the taxable income by a rate of 48.6% (based on input from Campbell Soup Co.). For the first year of operation only, the tax burden was reduced by subtracting

TABLE VIII - 1 GEOTHERMAL SYSTEM ENERGY PRODUCTION, FUEL OIL SAVINGS, ELECTRIC POWER CONSUMPTION, AND CAPITAL COSTS (1st QTR, 1980 DOLLARS)

	WELLHEAD TEMPERATURE - 120°F																	
	150 GPM			207 GPM				267 GPM				304 GPM				340 GPM		
Heat to Process, MBtu/hr	4.12			5.69				7.76				9.32				10.79		
Heat from Geo., MBtu/hr	4.12			5.69				7.33				8.35				9.33		
Fuel Oil Saved, Gal/yr	214,600			296,400				404,200				485,400				562,000		
Capital Cost (Mech., Civil, Instrumentation)	\$ 284,420			\$ 382,210				\$ 452,497				\$ 522,642				\$ 691,010		
Well Specific Capacity, gpm/ft	0.1	1.0	10	0.1	0.5	1.0	10	0.1	0.5	1.0	10	0.1	0.5	1.0	10	0.1	1.0	10
Production Well Drawdown, ft	1500	150	15	2070	414	207	21	2670	534	267	27	3040	608	304	30	3400	340	34
Reinjection Well Drawdown, ft	1500	150	15	2070	414	207	21	2670	534	267	27	3040	608	304	30	3400	340	34
Surface System Head Loss, ft	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
Total Geo. Pump Head, ft	3140	440	70	4280	968	554	182	5480	1208	674	194	6220	1356	748	200	6940	820	208
kW Well=Geo. Fluid Pump Power Input	162	23	4	303	68	39	13	501	109	61	18	648	141	78	20	808	95	24
Intermediate Fluid Pump Power, kW	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Water Treatment System, Electr. Input, kW	8	8	8	11	11	11	11	14	14	14	14	15	15	15	15	17	17	17
Heat Pump Power Input, kW	0	0	0	0	0	0	0	127	127	127	127	282	282	282	282	427	427	427
Total Elect. Pwr. Input, kW	180	41	22	324	89	60	34	652	260	212	169	955	448	385	327	1262	549	478
Total Elect. Energy Consumption, MW hr/yr	1124	256.8	137.5	2026	556	379	212	4079	1625	1327	1056	5969	2800	2405	2047	7890	3435	2990
Elect. System Cap. Cost, \$1000	180.5	124.9	117.3	237.0	143.0	131.4	121.0	321.4	164.6	145.4	128.2	386.5	183.6	158.5	135.3	456.4	171.2	142.8
Total Surface Sys. Cap Cost, \$1000	464.9	409.3	401.7	619.2	525.2	513.6	503.2	773.9	617.1	597.9	580.7	909.1	706.3	681.1	657.9	1147.4	862.2	833.8

TABLE VIII - 2 GEOTHERMAL SYSTEM ENERGY PRODUCTION, FUEL OIL SAVINGS, ELECTRIC POWER CONSUMPTION, AND CAPITAL COSTS (1st QTR, 1980 DOLLARS)

	WELLHEAD TEMPERATURE - 130°F											
	150 GPM			207 GPM			263 GPM			295 GPM		
Heat to Process, MBtu/hr	4.87			6.72			9.32			10.79		
Heat from Geo., MBtu/hr	4.87			6.72			8.56			9.55		
Fuel Oil Saved, Gal/yr	253,600			350,000			485,400			562,000		
Capital Cost (Mech., Civil, Instrumentation)	\$ 304,225			\$ 408,775			\$ 496,570			\$ 681,962		
Well Specific Capacity, gpm/ft	0.1	0.5	1.0	0.1	0.5	1.0	0.1	0.5	1.0	0.1	0.5	1.0
Production Well Drawdown, ft	1500	300	150	2070	414	207	2630	526	263	2950	590	295
Reinjection Well Drawdown, ft	1500	300	150	2070	414	207	2630	526	263	2950	590	295
Surface System Head Loss, ft	140	140	140	140	140	140	140	140	140	140	140	140
Total Geo. Pump Head, ft	3140	740	440	4280	968	554	5400	1192	666	6040	1320	730
kW Well Geo. Fluid Pump Power Input	162	38	23	303	69	39	486	107	60	610	134	74
Intermediate Fl. Pump Power, kW	10	10	10	10	10	10	10	10	10	10	10	10
Water Treatment System, Electr. Input, kW	8	8	8	11	11	11	14	14	14	15	15	15
Heat Pump Power Input, kW	0	0	0	0	0	0	223	223	223	362	362	362
Total Elect. Pwr. Input, kW	180	56	41	324	90	60	733	354	307	997	521	461
Total Elect. Energy Consumption, MW hr/yr	1124	352	257	2026	562	379	4584	2213	1919	6230	3335	2881
Elect. System Cap. Cost, \$1000	180.5	130.9	124.9	237.0	143.4	131.4	319.3	167.7	148.9	374.5	184.1	160.1
Total Surface Sys. Cap Cost, \$1000	484.7	435.1	429.1	645.8	552.2	540.2	815.9	664.3	645.5	1056.5	866.1	842.1

TABLE VIII - 3 GEOTHERMAL SYSTEM ENERGY PRODUCTION, FUEL OIL SAVINGS, ELECTRIC POWER CONSUMPTION, AND CAPITAL COSTS (1st QTR, 1980 DOLLARS)

	150 GPM			WELLHEAD TEMPERATURE - 150°F			234 GPM		
	Flow Per Well			207 GPM					
Heat to Process, MBtu/hr	6.37			8.79			10.64		
Heat from Geo., MBtu/hr	6.37			8.79			9.95		
Fuel Oil Saved, Gal/yr	331,800			457,800			554,200		
Capital Cost (Mech., Civil, Instrumentation)	\$ 324,030			\$ 435,340			\$ 560,103		
Well Specific Capacity, gpm/ft	0.1	0.5	1.0	0.1	0.5	1.0	0.1	0.5	1.0
Production Well Drawdown, ft	1500	300	150	2070	414	207	2340	468	234
Reinjection Well Drawdown, ft	1500	300	150	2070	414	207	2340	468	234
Surface System Head Loss, ft	140	140	140	140	140	140	140	140	140
Total Geo. Pump Head, ft	3140	740	440	4280	968	554	4820	1076	608
kW Well Geo. Fluid Pump Power Input	162	38	23	303	69	39	386	87	48
Intermediate Fl. Pump Power, kW	10	10	10	10	10	10	10	10	10
Water Treatment System, Electr. Input, kW	8	8	8	11	11	11	12	12	12
Heat Pump Power Input, kW	0	0	0	0	0	0	200	200	200
Total Elect. Pwr. Input, kW	180	56	41	324	90	60	608	309	270
Total Elect. Energy Consumption, MW hr/yr	1124	352	257	2026	562	379	3800	1931	1688
Elect. System Cap. Cost, \$1000	180.5	130.9	124.9	237.0	143.4	131.4	278.3	158.7	143.1
Total Surface Sys. Cap Cost, \$1000	504.5	454.9	448.9	672.3	578.7	566.7	838.4	718.8	703.2

VIII-4

the investment tax credit and the alternative energy tax credit. The income tax was then added algebraically to the net cash income to obtain the annual net cash flow.

The methods and assumptions used to determine the income tax deductions and credits discussed above will be described later. It should be noted here, however, that the net result of these deductions and credits generally was a net reduction in income taxes (i.e. a positive cash flow or "revenue") for the first year of the project (see Appendix E) which, when added to the net cash income, yielded a relatively large net cash flow for that year.

The annual discounted cash flow is simply the product of the discount (or present worth) factor and the annual cash flow.

The net present value is the algebraic summation of the discounted net cash flows for all years of the project life. The discount rate for which the net present value equals zero is the equivalent rate of return. This is determined through an iterative procedure which was performed by a computer program developed at BRISC. A listing of this program is included in Appendix F.

Project Time Frame

For purposes of the DCFRR analysis, it was necessary to assume dates for project start, plant start-up, and total operating life. Therefore, it was assumed that plant start-up would be on June 1, 1981 and that well drilling and major equipment contracts would be let during the fourth quarter of 1980. A 20-year operating life was assumed for all cases.

Annual Fuel Oil Cost Savings

Tables VIII 1-3 indicate the total amount of heat energy added to the process for each of the thirty-nine cases. Information available from Campbell Soup Co.

indicated that the existing boilers have a combined operating efficiency of about 80%. Based on a higher heating value of 150,000 BTU/gal and 6250 hrs/yr of plant operating, the quantity of fuel oil saved was calculated for each case. These values are shown on Tables VIII 1-3.

The unit fuel oil costs used in the analysis were obtained from Campbell Soup Company. The future escalation rates used here are the same as those currently used by Campbell Soup for evaluating energy projects. These rates are as follows:

<u>Date</u>	<u>Escalation Rate, %/yr</u>	<u>Unit Cost, \$/gal</u>
January, 1980		0.60
January, 1981	30%	0.78
January, 1982	25%	0.98
January, 1983	25%	1.22
January, 1984	20%	1.46
January, 1985	15%	1.68
January, 1986 - End of Project	10%	

These rates are based on forecasts made by the Wharton School of the University of Pennsylvania and on information from fuel oil suppliers such as Exxon, Getty and Sun Oil.

Annual Electric Energy Costs

Geothermal system power requirements and annual electric energy consumptions for each case are also shown on Tables VIII 1-3.

The specific capacity of the geothermal well is defined as follows:

$$\text{Well Specific Capacity} = \frac{\text{Well Output, gpm}}{\text{Well Drawdown, ft.}}$$

The drawdown is a measure of the head which must be provided by the well pump to overcome the flow resistance of the aquifer and the well. In this analysis, it was assumed that the drawdowns for the production well and for the reinjection wells were equal. In addition to the drawdown head for both wells, the geothermal fluid pumps must also supply the power required to overcome the surface system head loss for which a constant design value of 140 ft. of water was set for all cases. The total head requirements for the two geothermal pumps are shown on Tables VIII 1-3 for each case. Power requirements for the geothermal fluid pumps were calculated using conventional pump power equations with an assumed overall (i.e. motor and pump) efficiency of 55%. The efficiency was based on information received from suppliers of downhole and reinjection pumps.

The power requirements for the intermediate flow loop pumps were calculated for 207 gpm, 140 ft. head and an assumed overall efficiency of 55%.

Power requirements for the water treatment system were estimated to be 0.05 kW per gpm of geothermal fluid treated.

Heat pump power requirements were obtained from the heat and mass balance calculations discussed in Section VI and Appendix A.

The total electric energy consumption for each case was calculated by multiplying the sum of the above mentioned power requirements by 6250 hours per year. The results for each case are shown on Tables VIII 1-3.

The unit costs for electricity used in this analysis were also obtained from Campbell Soup Company. The escalation rates used in this study are the same as those they currently use for evaluating energy projects. These rates are as follows:

<u>Date</u>	<u>Escalation Rate, %/yr</u>	<u>Unit Cost, \$/kWh</u>
January, 1980		.041
January, 1981	10%	.045
January, 1982	15%	.052
January, 1983	20%	.062
January, 1984	20%	.075
January, 1985	20%	.090
January, 1986 - End of Project	10%	

These rates are based on the local utility's requested rate increases to date plus Campbell Soup's estimate of future escalation.

Capital Costs

As indicated in Section VII, capital costs for the Mechanical, Civil, Electrical and Instrumentation categories varied with well flow and temperature. For a given wellhead temperature and flow rate, the Electrical system cost also varied with specific capacity.

The surface equipment capital costs for each case in the first quarter of 1980 dollars are shown on Tables VIII 1-3. These were increased by 5% to account for escalation to the fourth quarter of 1980 (i.e. 10% per year for a half year). The escalated fourth quarter values are shown on the Cash Flow Analysis Sheets in Appendix E.

Based on telephone conversations with DOE, it was assumed for this study that the alternative energy tax credit would not apply to buildings and heat pumps. In order to simplify the calculations, the reasonably conservative assumption was made that for each case, the "building" cost would include all of the Civil/Structural

costs shown on the Capital Cost Estimate Summary Sheets in Appendix D. To these "building" costs were added the heat pump equipment costs from Appendix D plus \$40 per kW (see Section VII) of heat pump power from Tables VIII 1-3 which would account for the electrical costs associated with heat pump installation. The sum of these costs was then increased by 5% to obtain fourth quarter 1980 values for use in the Cash Flow Analysis (see Appendix E).

Capital Costs for the geothermal production and reinjection wells were based on cost data obtained from Gruy Federal (see Section III). It was assumed that both wells would have to be 5000 ft. deep which is probably conservative for the reinjection well. While Gruy's written estimate was for a 300 gpm well, they also provided some verbal judgments as to how much the cost could be reduced for a 100 gpm well. A straight line between these points was used to estimate costs for other well capacities. Then 5% was added for escalation to the fourth quarter of 1980. The resulting capital cost values for the two wells are shown for each case on the Cash Flow Analysis Sheets in Appendix E.

Annual Property Tax and Insurance Cost

The annual costs for taxes and insurance for the first year of operation were estimated to be 2% of the total project capital cost for each case based on information from Campbell Soup Co. This first year cost was then escalated at 10% per year throughout the project life.

Annual Maintenance Cost

Reference VIII 1 presents service lives and maintenance frequencies for carbon steel domestic, irrigation, and municipal wells in various aquifers in 10 groundwater regions across the nation. Using an economic model based on performance data for metal pipes in corrosive fluid service, that study predicted the lives and

maintenance frequencies of geothermal wells relative to the conventional water wells. Conventional wells in the Atlantic Coastal Plain had a major maintenance frequency of 6-8 years. The model predicted that geothermal wells producing brines with a pH between 6 and 7 and temperatures less than 200°F would have a major maintenance frequency of one-half or 3-4 years. A major maintenance operation was defined in Reference VIII 1 as one whose cost would be greater than 10% of the replacement cost. An expenditure of 10% every 3-4 years is equivalent to about 3% per year for the wells.

For surface equipment of the type included in the geothermal system, annual maintenance costs are generally estimated to range from 2-5% of the capital cost.

On the basis of these figures, it was decided to use a first year annual maintenance cost (materials and labor) of 3% of the total capital cost for each case. This cost was then escalated by 10% per year to get values for the remainder of the project life.

Annual Chemical Costs

During the studies of alternative geothermal brine treatment systems described in previous sections of this report, estimates of annual chemical requirements for each system (i.e. hot lime, threshold inhibitors, etc.) were also developed. Based on these studies, it was concluded that for any of the systems, a reasonable estimate of chemical costs would be 11.9¢/1000 gal. of brine based on first quarter 1980 prices in various chemical price lists. This cost was then escalated by 10% per year to get the costs for each year of the plant operating life.

Intangible Drilling Costs

In order to estimate what percentage of the total drilling costs would be classed as intangible for income tax purposes, an analysis was made of the estimated cost breakdowns provided by Gruy and D'Appolonia. This analysis is

summarized in Table VIII 4. The basic philosophy in the analysis was to consider the costs for all materials which could theoretically be removed from the well and reused as tangible costs. All other costs were intangible. The results of this analysis showed that 70% of the total well cost could be considered as intangible drilling cost. Therefore, this figure was used to determine the intangible drilling cost deduction for the year in which the well was completed. For this analysis it was assumed that the tax reduction (i.e. positive cash flow) due to this deduction would occur in the first year of operation.

Tax Credits

This analysis also assumed that the Alternative Energy Tax credit would be applied during the first year of operation. It was assumed that this deduction would be equal to 15% of the sum of the tangible well costs plus the total surface system cost minus the costs of heat pumps and buildings.

In addition to the Alternative Energy Tax Credit, an Investment Tax Credit was also assumed during the first year of operation. This credit was 10% of the total project capital cost.

Results of Analysis

Appendix E contains a Cash Flow Analysis Sheet for each of the 39 cases defined in Tables VIII 1-3. The results of all the calculations described thus far in this section are contained on those sheets. In addition, some of the key results are presented graphically in this section.

Figure VIII 1 shows the total capital costs that were used in the analysis with a breakdown of the major cost categories. The dashed portions of these curves represent the transition region between cases with heat exchangers only and those

Table VIII 4
Estimate of Intangible Drilling Costs

<u>Tangibles</u>	<u>Gruy</u>	<u>D'Appolonia</u>
Tubulars	\$196,000 <u>138,000</u> \$334,000	\$ 85,000 <u>85,000</u> \$170,000
Pump (modified cost)	<u>53,000</u>	<u>53,000</u>
TOTAL TANGIBLES	\$387,000	\$223,000
Total Tangible and Intangible	\$1,166,000	\$ 800,000
Pump adjustment	\$129,000-53,000 = - 76,000	\$10,000+53,000 = + 43,000
Pump test adjustment	+ 35,000	—
Total adjusted	\$1,125,000	\$ 843,000
Tangible Drilling Cost/Total Cost Ratio	0.34	0.26
Intangible Drilling Cost/Total Cost Ratio	0.66	0.74
Avg. Intangible Cost/Total Cost Ratio		0.70

NOTE: ELECTRICAL SYSTEM COSTS VARY WITH SPECIFIC CAPACITY AND MAY BE OBTAINED BY SUBTRACTING MECH + CIVIL + WELL COSTS FROM THE CORRESPONDING TOTAL COST CURVE

CAMPBELL SOUP CO., SALISBURY, MARYLAND
GEOHERMAL PROJECT CAPITAL COST BREAKDOWN
4TH QUARTER, 1930 PRICES

FIGURE VIII-1

with heat pumps. For each wellhead temperature, the curves are plotted up to the flow rate at which virtually the entire hot water load is satisfied. If greater flows were available, the energy could not be utilized within the plant.

The cost of the wells ranges from 50-75% of the total project cost depending on the conditions selected. It should be noted that the well cost would likely be less since the reinjection well would not be drilled to the same 5000 ft. depth as the production well.

Figure VIII 2 shows the after-tax rate of return as a function of the various well parameters. The rate of return began to decline at the higher flow rates, especially at the lower specific capacities.

Figure VIII 3 shows the after-tax payback period for the project. As with the rate of return, the payback periods become less attractive at the higher flow rates, especially with lower specific capacities (i.e. higher drawdowns).

AFTER-TAX RATE OF RETURN, %

CAMPBELL SOUP CO., SALISBURY, MARYLAND
GEOTHERMAL PROJECT AFTER-TAX
RATE OF RETURN

FIGURE VIII-2

In general, the maximum payback period which industrial firms will consider for energy projects is 3-6 years. As indicated on Figure VIII 3, for specific capacities of 0.5 and higher, the Campbell Soup Co. geothermal project would satisfy this criteria for a range of well temperatures and flows which could be considered as reasonable expectations based on testing done to date on the Delmarva Peninsula. For wellhead temperatures of 120°F to 130°F, the project would not meet the criteria regardless of flow rate if the specific capacity were 0.1 or less, and the economics would be marginal at best for values in the range of 0.1 to 0.5.

Sensitivity Analysis

Various studies were also performed to assess the sensitivity of the economic analysis results to some of the key parameters.

One area of uncertainty for this geothermal project involved the geothermal tax incentives. For instance, BRISC was informed verbally by members of DOE that the Internal Revenue Service was considering a regulation wherein the incentives would only apply to resources with temperatures of 140°F or higher. Therefore, Figures VIII 4 and 5 were developed which show what effect removal of the intangible drilling costs deduction and the alternative energy tax credit would have on the after-tax rate of return and payback period respectively. As indicated on Figure VIII 5, without these incentives, the payback periods would be 6 years or greater for temperatures of 130°F or less and specific capacities under 1.0. Therefore, under these conditions, the geothermal project would not pass the criteria for payback discussed earlier.

Concerning the operating life of the project, the analysis in Reference VIII 1, indicates that, based on material constraints, the useful life would be 15-25 years.

AFTER TAX PAYBACK PERIOD, YEARS

WELL OUTPUT, GPM

CAMPBELL SOUP CO., SALISBURY, MARYLAND
AFTER-TAX PAYBACK PERIODS

FIGURE VIII-3

LEGEND

———— BASE CASE

..... EXCLUDES INTANGIBLE DRILLING COST DEDUCTION AND
ALTERNATIVE ENERGY TAX CREDIT

CAMPBELL SOUP CO., SALISBURY, MARYLAND
EFFECT OF GEOTHERMAL TAX INCENTIVES
ON AFTER-TAX RATE OF RETURN

FIGURE VIII-4

LEGEND

— BASE CASE
 EXCLUDES INTANGIBLE DRILLING COST DEDUCTION AND
 ALTERNATIVE ENERGY TAX CREDIT

CAMPBELL SOUP COMPANY, SALISBURY, MARYLAND

EFFECT OF GEOTHERMAL TAX INCENTIVES
 ON AFTER-TAX PAYBACK PERIOD

FIGURE VIII-5

Therefore, a base value of 20 years was selected for this analysis. Figure VIII 6 was prepared to show the effect on rate of return if the life were extended to 30 years with all escalation rates the same as the base case. These results indicated that the return would increase by less than 1 percentage point for a specific capacity of 1.0 and by 1.3 to 2.4 percentage points for a specific capacity of 0.1. Payback periods increased by 0.2 to 0.5 years for a specific capacity of 1.0, and by 0.6 to 2.2 years for a specific capacity of 0.1. Thus, a 50% increase in operating life would not alter the conclusions of this study to a great extent.

Capital Cost was another area of uncertainty within the study. Figures VIII 7, 8, 9 and 10 show how the rates of return and payback periods were affected by a change of 25% in the capital cost which was considered a reasonable range given the level of detail to which this study was carried out. In calculating values for the new curves, costs for taxes, insurance, maintenance, etc., were also increased since they were estimated as percentages of capital cost. In addition to assessing the effect of design and estimating accuracy, these curves may also be used to determine what effect the addition of more complex brine treatment might make on the economics.

As indicated by the experience of recent years, prediction of fuel oil escalation rates with any degree of certainty is virtually impossible. Also, the amount of escalation could be very high, as witnessed by the 90 to 100% increase in #6 fuel oil prices in the last year alone. The base case escalation schedule for this analysis was described earlier in this section, and was roughly equivalent to 20-25% per year through 1985 and 10% per year after that. In order to test the sensitivity of the analysis results to escalation rates, calculations

LEGEND

———— BASE CASE = 20 YEAR OPERATING LIFE
..... ALTERNATE = 30 YEAR OPERATING LIFE

CAMPBELL SOUP CO., SALISBURY, MARYLAND

EFFECT OF OPERATING LIFE ON AFTER-TAX
RATE OF RETURN

FIGURE VIII-6

LEGEND

—— BASE CASE

..... CAPITAL COST VARIED BY $\pm 25\%$

WELL OUTPUT, GPM

CAMPBELL SOUP CO., SALISBURY, MARYLAND

SENSITIVITY OF AFTER-TAX RATE OF RETURN TO CAPITAL COST
SPECIFIC CAPACITY = 1.0

FIGURE VIII-7

LEGEND

———— BASE CASE

..... CAPITAL COST VARIED BY $\pm 25\%$

WELL OUTPUT, GPM

CAMPBELL SOUP CO., SALISBURY, MARYLAND

SENSITIVITY OF AFTER-TAX PAYBACK PERIOD TO CAPITAL COST
SPECIFIC CAPACITY = 1.0

FIGURE VIII-8

LEGEND

———— BASE CASE
 CAPITAL COST VARIED BY $\pm 25\%$

CAMPBELL SOUP CO., SALISBURY, MARYLAND

SENSITIVITY OF AFTER-TAX RATE OF RETURN TO CAPITAL COST
 SPECIFIC CAPACITY = 0.1

FIGURE VIII-9

LEGEND

———— BASE CASE

..... CAPITAL COST VARIED BY $\pm 25\%$

CAMPBELL SOUP CO., SALISBURY, MARYLAND

SENSITIVITY OF AFTER-TAX PAYBACK PERIOD TO CAPITAL COST
SPECIFIC CAPACITY = 0.1

FIGURE VIII-10

were made for two additional escalation schedules. In the first, the base case escalation rate for each year was increased by 50%. In the second, the increase was 100% over the base case. The results of these calculations are shown on Figures VIII 11 and 12. As indicated, on Figure VIII 12, a significant increase in escalation would be required before wells within a specific capacity of 0.1 and a temperature of 120°F would pass the payback criteria established earlier.

Gross Roots Plant vs Retrofit

Tables VIII 1-3 indicate that the heat added to process ranges from 4-11 million Btus/hr depending on which of the 39 cases is considered. These energy inputs are equivalent to 4,000-11,000 lbs/hr of steam. The two existing boilers at the Salisbury plant are rated at 24,000 lbs/hr (700 HP) and 17,000 lbs/hr (500 HP) each for a total capacity of 41,000 lbs/hr. A rather detailed analysis of various factors such as reliability, availability, commercially available boiler sizes, etc. would be required in order to determine the amount by which the existing boiler capacity could have been reduced at the design stage if the geothermal source were available. It is quite probable that no significant reduction would have been made. However, in order to evaluate the potential improvement in economics for a "grass roots" geothermal plant versus the retrofit described in this report, the following analysis was performed.

Reference VIII 2 reported capital cost estimates (1979 dollars) for oil fired plants of various capacities as follows:

<u>Capacity</u>	<u>Capital Cost</u>
10,000 lbs/hr	\$43/lb/hr
25,000 lbs/hr	\$26/lb/hr
50,000 lbs/hr	\$19/lb/hr

LEGEND

—— BASE CASE

..... ANNUAL FUEL OIL ESCALATION RATES INCREASED BY 50% OR 100%
RELATIVE TO BASE CASE

CAMPBELL SOUP CO., SALISBURY, MARYLAND

SENSITIVITY OF RATE OF RETURN TO FUEL OIL ESCALATION RATE

FIGURE VIII-11

LEGEND

— BASE CASE

..... ANNUAL ESCALATION RATES ON FUEL OIL UNIT COSTS INCREASED BY 50% OR 100% RELATIVE TO THE BASE CASE

CAMPBELL SOUP CO., SALISBURY, MARYLAND

SENSITIVITY OF AFTER-TAX PAYBACK PERIOD TO FUEL OIL ESCALATION RATE

FIGURE VIII-12

It was assumed that the Campbell Soup Boilers were derated by 11,000 lbs/hr and the capital cost savings was estimated by plotting the above cost estimates and picking off costs for plant capacities of 41,000 lbs/hr and 30,000 lbs/hr. The values obtained were:

<u>Capacity</u>	<u>Capital Cost</u>
41,000 lbs/hr	\$820,000
30,000 lbs/hr	\$690,000

It was not felt that the cost of the geothermal system itself was significantly affected by the fact that it was retrofit. Thus, the net savings would have been \$130,000 of capital cost. The 11,000 lbs/hr savings in steam capacity requirements applies to cases whose capital costs range from \$1,900,000 to \$2,400,000 (see Tables VIII 1-3 and Figure VIII 1). The \$130,000 savings in capital cost of the oil plant could be considered as a reduction in capital cost of the geothermal system of about 5-7%. Based on Figure VIII 8, the resultant reduction in after-tax payback periods would be on the order of 1/2 year.

IX Institutional Factors and Reservoir Confirmation Plan

IX 1 Maryland Geothermal Resources Act

Maryland was the first State on the East Coast to develop legislation specifically aimed at geothermal resources. In 1978 Maryland enacted the Maryland Geothermal Resources Act (see Appendix G). In this act geothermal resources are defined as the natural heat of the earth higher than 120°F with the exception of hydrocarbon substances. As far as the ownership of the geothermal heat in the State of Maryland is concerned, the Maryland Act is ambiguous. It is not clear if the State, through the Act, is claiming or disclaiming sole ownership of the State's geothermal resources. Permits for exploratory geothermal drilling or the use of a geothermal resources have to be obtained from the Department of Natural Resources. After approval of the permit, a bond shall be filed with the Department. Detailed rules and regulations, further implementing this Act, have not been developed yet. Plans for the use of geothermal resources shall conform with all applicable State laws, including all existing environmental laws. This effectively prohibits any consideration of surface disposal of the spent geothermal brine. The environmental rules and regulations also apply during the drilling and testing of a well. Geothermal brines pumped up during testing have to be stored in a temporary pond for later reinjection. Regulations also specify the control of muddy conditions during drilling.

IX 2 Tax Incentives

The Internal Revenue Service is considering several income tax deductions and credits for geothermal applications. These are as follows:

1. Depletion Allowance

The following amounts may be deducted from the income produced by the geothermal project:

1980	22%
1981	20%
1982	18%
1983	16%
1984	15%

and all years thereafter

This deduction may be taken for as long as the project produces income. Since the product of the geothermal well is not sold directly, as in the case of oil or gas, it is not clear how the regulations will be applied to the geothermal case. However, it appears that the 15% depletion allowance would be applied to that portion of the product income (i.e. soup, tv dinners, etc.) which could be reasonably allocated to the energy cost.

2. Intangible Drilling Costs

These costs are defined in regulations for oil and gas drilling. Generally, they include costs for all non-hardware items associated with the well such as labor, rig time, consumable materials, etc. These typically amount to 60% to 70% of the total well cost. The intangible drilling costs could be taken as an expense deduction from income in the year the well is drilled. Alternatively, these costs could be capitalized over a period of years.

3. Alternative Energy Tax Credit

This tax credit is equal to 15% and may be taken in addition to the standard 10% tax credit. This credit would be taken in the year the

facility goes into operation. It applies to all capital costs for wells and equipment installed to utilize the geothermal energy except that it would not apply to heat pumps. Also, any costs expensed as intangible drilling costs would not be included for tax credit. Subject to these restrictions, the alternative energy tax credit and the standard investment tax credit would enable the tax burden for the first year of operation to be decreased by a total of 25% of the capital cost.

As was shown in Section VIII "Economic Analysis" the overall economics of a geothermal application are considerably more attractive after the different tax incentives are taken into account. However, the IRS is reportedly considering regulations wherein these incentives would only apply to wells with temperatures of 140 F or higher. As shown in Section VIII, for applications with temperatures of 120-130 F, this would result in a shift from attractive payback periods to unattractive ones from industry's viewpoint.

As indicated under Item 1 above, no clear regulations exist concerning application of the Depletion Allowance to a geothermal well at the Campbell Soup plant. Therefore, this incentive was not considered in this analysis. However, such regulations, when promulgated, could significantly advance the development of geothermal energy resources.

IX 3 Reservoir Confirmation Plan

Based upon review of the recent DOE solicitations for an Eastern Geothermal Drilling Project (SCA 80 ID 12132) and the User Coupled Confirmation Drilling Program, programs are available to confirm the resources

in the Salisbury, Maryland area. This study indicates that these programs are justified. However, the results of this study indicate that the timing of the program should be revised somewhat to permit resolution of the institutional constraints regarding property rights to Maryland geothermal resources.

X References

<u>Number</u>	<u>Title</u>
IV 1	Special Report No. 5, A Symposium on Geothermal Energy and its Direct Usage in the Eastern United States, April 1979, Geothermal Resources Council, Davis, CA.
IV 2	Evaluation and Targetting of Geothermal Energy Resources in the Southeastern United States, Progress Report, Oct. 1, 1978 - March 30, 1979, John K. Costain, et al, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.
IV 3	Completion Report, Gruy Federal, Inc., Department of Energy, Crisfield Airport No. 1 Well, Somerset County, MD, 1979.
IV 4	Private Communication with Ken Schwarz, Maryland Geological Survey, Johns Hopkins University, Baltimore, MD, Nov. 1979.
IV 5	Private Communication with Joseph Lambiase, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, Nov. 1979.
IV 6	Private Communication with Fletcher Paddison, Applied Physics Laboratory - Johns Hopkins University, Laurel, MD, Nov. 1979.
VIII 1	Gass, T.E., Purdin, W.H., Armitage, D.M., "Economic Impact of Using Nonmetallic Materials in Low to Intermediate Temperature Geothermal Well Construction - Volume I" National Water Well Association for Brookhaven National Laboratory, December 1979.
VIII 2	"Cost Comparison Study - Industrial Size Boilers 10,000 to 40,000 Pound Per Hour" by Davy McKee Corporation for the U.S. Department of Energy, DOE Contract No. ED-77-C-01-2418, October 1979.

APPENDIX A

Geothermal System Heat and Mass Balances

Ⓢ TEMPLIFIER HEAT PUMP/HEAT EXCHANGER EVALUATION

PROGRAM GEO-5 - A Ⓢ COMPUTER SERVICE

March 1979

Introduction

The GEO-5 program has been developed for making optimum selections of Templifier - heat exchangers in various system combinations. These systems are particularly useful to...

- heat feed water through a wide temperature range (example: 60°F heated to 160°F).
- make maximum use of geothermal water or waste heat in water by cooling it through a wide range.

The program can accommodate the use of a heat pump with 2, 1 or no heat exchangers in four possible system arrangements.

The program will accept two different sets of boundary conditions...

1. Geothermal or other source water flow rate as a known gpm quantity, or
2. Geothermal or other source water leaving temperature.

If the value entered for one of these two inputs is not greater than the thermodynamically required minimum, the program will automatically change the value to that required.

GEO-5 for TI-59/PC100 Calculator Printer

Operating Procedure

1. Turn on calculator (and printer).
2. Partition memories. Press: 5 2nd 9 1 7
The number 559.49 should appear in the display.
3. Press CLR and read in each side of the GEO-5 program cards (-1, -2, -3, and -4) making sure to press CLR before each card is read. After each side is read the side number should appear in the display. If not, or the number is flashing, press CLR and reread that side.
4. Input the required information:

Available user water inlet temperature, T_u , in	°F	STO	0	1
Required user water outlet temperature, T_u , out	°F	STO	0	4
Required user water flow rate, W_u	gpm	STO	0	5
Available Geothermal water inlet temperature, T_g , in	°F	STO	0	7
Heat Exchanger 1 effectiveness (0 to 1), E_1		STO	1	3
Heat Exchanger 2 effectiveness (0 to 1), E_2		STO	1	6
Heat Pump COP factor (use 0.53 for TPE; 0.465 for TPB)		STO	1	9
Heat Exchanger cost factor, $H\$$ (default = 0.0214)		STO	4	7

The program will accept any value for heat exchanger effectiveness between 0 and 1 inclusive.

A value of zero is the same as no heat exchanger at all. Thus with this program four arrangements can be handled: two exchangers, heat exchanger 1 only; heat exchanger 2 only, or no heat exchangers.

A value of one is a perfect heat exchanger, which is not realistically possible because it would require an infinite heat transfer surface area. The program will accept this value but because of the infinite surface area requirement, the heat exchanger cost will also be infinite.

2. Heat exchanger cost is assumed proportional to the product of total exchange transfer area(A) and the fluid to fluid conductance (U).

For a counterflow heat exchanger, the effectiveness can be shown to be

$$\epsilon = \frac{1 - e^{-F}}{1 - R e^{-F}}$$

where

$$R = \frac{W_{\min}}{W_{\max}}$$

and

$$F = \frac{AU}{W_{\min}} (1 - R)$$

The subscripts refer to

min = lesser flow rate of W_g and W_u

max = the greater flow rate

Solving the equation for AU.

$$AU = \frac{500 \ln \left[\frac{1 - \epsilon}{1 - R\epsilon} \right]}{\left(\frac{1}{W_{\max}} - \frac{1}{W_{\min}} \right)}$$

The 500 converts the flow rates to lb/hr from gpm.

Table 1
Storage Registers

01	Tu,in	User water temperature at inlet, °F
02	Tu1	User water temperature after heat exchanger 1, °F
03	Tu2	User water temperature after heat exchanger 2, °F
04	Tu,out	User water temperature at outlet, °F
05	Wu	User water flow rate, gpm
06	Qut	Total heat to user water, Btu/hr
07	Tg,in	Geothermal water temperature at inlet, °F
08	Tg1	Geothermal water temperature after heat exchanger 1, °F
09	Tg2	Geothermal water temperature before heat exchanger 2, °F
10	Tg,out	Geothermal water temperature at outlet, °F
11	Wg	Geothermal water flow rate, gpm
12	Qgt	Total heat from geothermal water, Btu/hr
13	E1	Heat Exchanger 1 effectiveness
14	Q1	Heat transfered in Heat Exchanger 1, Btu/hr
15	\$1	Cost of Heat Exchanger 1, \$
16	E2	Heat Exchanger 2 effectiveness
17	Q2	Heat transfered in Heat Exchanger 2, Btu/hr
18	\$2	Cost of Heat Exchanger 2, \$
19	C	Heat pump COP factor
20	Qu	Heat transfered to user water in condensor, Btu/hr
21	Qg	Heat transfered from geothermal water in evaporator, Btu/hr
22	KW	Compressor energy demand, Kw
23	COP	Heat pump coefficient of performance
24	COPT	Total system coefficient of performance
25-46	-	Internal use
47	H\$	Heat exchanger cost per unit UA, \$-°F-hr/Btu

$$Q_{ut} = Q_1 + Q_2 + Q_u$$

$$Q_{gt} = Q_1 + Q_2 + Q_g$$

$$COPT = Q_{ut}/Kw/3413$$

	ONE HP	ONE HP	TWO HP			THREE HP			
INPUT	HP	HP	HP 2	HP 1	TOTAL	HP 3	HP 2	HP 1	TOTAL
Geo Temp in °F	120	120	120	113.07	120	120	119.00	112.21	120
Loop Temp Out °F	135	150	170	150	150 + 170	180	170	150	150-170-180
In °F	60	60	150	60	60	170	150	60	60
Water Flow gpm	207	207	147	207	207 - 147	44	147	207	207-147-44
Effectiveness HxA	0.9		0	0.9		0	0	0.9	
HxB	0.9		0	0.9		0	0	0.9	
HP Cop Factor	0.53		0.53			0.53			
E:Geo Temp Out °F	65	65	-	65	65	-	-	65	65
A:Geo Flow gpm	-	-	340	-		346	346	-	346
OUTPUT									
Loop T ₂ °F	75.0	71.6	150	70.0		170	150	69.8	
T ₁ °F	115.5	115.2	150	108.8		170	150	108.0	
QT Btu/h	7,762,500	9,315,000	1,470,000	9,315,000	10,785,000	220,000	1,470,000	9,315,000	11,005,000
Geo T ₁ °F	88.5	90.3	120	89.4		120	119.00	89.3	
T ₂ °F	76.6	72.9	113.07	71.1		119.00	112.21	70.9	
T _{Out} °F	65.0	65.0	113.07	65.0		119.00	112.21	65.0	
Flow gpm	266.5	303.7	340	339.1	340	346	346	344.2	346
QT Btu/h	7,328,067	8,351,960	1,178,100	8,150,359	9,328,459	174,730	1,174,670	8,125,908	9,475,308
HX1 Q1 Btu/h	4,195,890	4,504,320	0	4,013,730	4,013,730	0	0	3,949,560	3,949,560
HX 2 Q2 Btu/h	1,547,325	1,204,740	0	1,032,930	1,032,930	0	0	1,015,335	1,015,335
HP QU Btu/h	2,018,250	3,605,940	1,470,000	4,268,340	5,738,340	220,000	1,470,000	4,350,105	6,040,105
QG Btu/h	1,584,208	2,642,747	1,177,655	3,104,067	4,281,722	174,303	1,173,912	3,160,961	4,509,176
hW	127.2	282.2	85.7	341.1	426.8	13.4	86.6	348.4	448.6
COP	4.6	3.7	5.0	3.7	3.9	4.8	5.0	3.7	3.9
COPT	17.9	9.7	5.0	8.0	7.4	4.8	5.0	7.8	7.2

INPUT	ONE HP	TWO HP			ONE HP, HX IN PARALLEL		
	HP	HP 2	HP 1	TOTAL	HP	Hx2	TOTAL
Geo Temp in °F	130	130	121.8	130	150		
Loop Temp Out °F	150	170	150	150 + 170	170		
In °F	60	150	60	60	60		
Water Flow gpm	207	147	207	207 - 147	147		
Effectiveness Hx1	0.9	0	0.9		0.9		
Hx2	0.6	0	0.6		0.6		
HP Cop Factor	0.53	0.53	0.53		0.53		
E:Geo Temp Out °F	65	-	65	65	65		
A:Geo Flow gpm	-	294.7	-	295	-		
OUTPUT							
Loop T ₂ °F	65.7	150	65.2		66.1		
T ₁ °F	123.6	150	116.1		141.6		
QT Btu/h	9,315,000	1,470,000	9,315,000	10,785,000	8,085,000	2,550,000	10,635,000
Geo T ₁ °F	84.5	130	85.9		86.3		
T ₂ °F	69.5	121.8	68.7		70.1		
T _{Out} °F	65.0	121.8	65.0		65.0		
Flow gpm	263.2	294.7	293.4	295	174.2		
QT Btu/h	8,560,000	1,220,000	8,333,645	9,553,700	7,403,814	2,550,000	9,954,000
HX1 Q1 Btu/h	6.00	0	5,272,290	5,272,290	5,551,455		
HX2 Q2 Btu/h	588,000	0	539,235	539,235	446,880		
HP QU Btu/h	2,740,000	1,470,000	3,504,510	4,974,000	2,086,665		
QG Btu/h	1,980,000	1,220,000	2,522,619	3,743,000	1,405,449		
hW	223	74.5	287.7	362.2	199.6		
COP	3.6	5.8	3.6	4.02	3.1		
COPT	12.3	5.8	9.5	8.72	11.9		

APPENDIX B

Capital Cost Estimate - Case 5

This Appendix contains the detailed cost estimating work sheets for Case 5 as defined in Section VII. These sheets provide detailed information regarding material takeoffs, etc. Note that the designation "Case I" shown on these sheets only signifies that this was the first case estimated by the Estimating Department.

Estimate Sheet

:V.O.

4861-01

Type Estimate

Client

Date: 5-1-80

Sheet

Project

Geothermal H.W. System

CAMPBELL SOUP COMPANY
Salsbury, MD

Ed. by P. Ostrosky

Ext. Chk'd. by

Location

Salsbury, MD

Discipline
Mechanical

Approved by

Description

TOTAL SUMMARY. CASE I

ESTIMATED COST

Account
No.

MATERIAL

LA 301

Total Cost	
------------	--

GENERAL CONST.

50 | 354

MECHANICAL

592 560

ELECTRICAL.

195	000
-----	-----

Instrumentation.

15|000

Total

852	914
-----	-----

CASE I FILTER ADD
\$BUILDING.

ADD	379	117
-----	-----	-----

CASE II FILTER.

ADD	28	796
-----	----	-----

SALES TAX NOT INCLUDED

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 2

Location _____

Estimate Sheet

W.O. 4861-01	Type Estimate	Client	Date 5-1-80	Sheet 1-1
Project Geothermal H.W. System		CAMPBELL SOUP COMPANY	Est. by C. P. Ostrosky	Ext. Chk'd. by
Location Salsbury, MD		Salsbury, MD	Discipline Mechanical	Approved by

Description BUILDING CONST.				ESTIMATED COST				
Account No.				MATERIAL	LABOR	TOTAL COST		
SHEET 1	EXCAVATION			2581	2429	5010		
" 2	CONCRETE			2218	2632	4850		
" 3	MASONRY			1454	2401	3855		
" 4	ROOFING			4728	1489	6217		
" 5	DOORS & FRAMES			1020	1144	1164		
" 6	EQUIP SUPPORTS			7186	2428	9614		
	Total Cost			19187	11523	30710		
	INS. & TAXES 20% LABOR				2305	2305		
	MOBILIZATION 10% "				1152	1152		
	SCAFFOLDING - frames etc 10% "				1152	1152		
	SUPERVISION 20% "				2305	2305		
	CONTINGENCY 20%			3837	2305	6162		
	Total			23024	20742	43786		
	15% O+P.					6568		
						50354		
	SALES TAX NOT INCLUDED							

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 3 of

Location
Estimate Sheet

V.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-1-80</u>	Sheet <u>1</u> of <u>1</u>
Project <u>Geothermal H.W. System</u>		Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

EXCAVATION.				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	CLEARING-GRUBING	1300	SF	.50	650			—				650
								1				
	FOUNDATION EXCAV.	100	C.Y	.80	80			1.35	135			215
	BACKFILL Compaction	40	C.Y	2.50	100			1.90	76			176
	COMPACTION	40	C.Y	.33	13			.99	40			53
	GRADING.	2200	SF	.79	1738			.99	2178			3916

*Composite Rate - Based on Type of Work

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 4 of

Location
Estimate Sheet

V.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-1-80</u>	Sheet <u>1</u> of <u>1</u>
Project <u>Geothermal H.W. System</u>		<u>Salsbury, MD</u>	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	CONCRETE.											
	VISQUEEN.	1120	SF	.05	56		1	.40	28			84
	6"x6" WIRE MESH	1120	SF	.07	78			.08	90			168
	CONCRETE	34	C.Y.	58	1972			.68	2312			4284
	FLOAT FINISH	1120	SF	-	-			.18	202			202
	CUTTING	1120	S.F	10	112		-	-				112
										</		

Page 5 of

Estimate Sheet

[illegible]

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Location _____

Estimate Sheet

Page 6 of _____

V.O. <u>4861-01</u>	Type Estimate _____	Client _____	Date <u>5-1-80</u>	Sheet <u>1</u> of <u>1</u>
Project <u>Geothermal H.W. System</u>		CAMPBELL SOUP COMPANY Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by _____
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by _____

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	OPEN WEB JOIST.	11	ea	250	2750			.50	550			3300
	METAL DECK 18g.	1160	SF	.92	1067			.14	162			1229
	INSULATION 6lb-1 1/2"	1160	SF	.16	186			.10	116			302
	BUILT-UP 4PLY	11	Sq's	29	319			.27	292			611
	FLASHINGS	340	Sf	.84	286			.85	289			575
	DOWN SPOUTS	2	ea	60	120			40	80			200

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 7 of

Location

Estimate Sheet

P.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-1-80</u>	Sheet <u>1</u> of <u>1</u>
Project <u>Geothermal H.W. System</u>		Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	Hollow metal.											
	3'x7'x1 3/4	4	ea	255	1020			36	144			1164

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 8 of

Location

Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate	Client	Date <u>5-1-80</u>	Sheet <u>1</u> of <u>1</u>
Project <u>Geothermal H.W. System</u>		CAMPBELL SOUP COMPANY Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by

Description				ESTIMATED COST						Contract Unit Cost		A
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	TANK FOUNDATIONS	123	C.V.	54	6642			18.25	2245			88
	Heat Pump ..	10	C.V.	54	544			18.25	183			7

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 9 of

Location

Estimate Sheet

V.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-1-80</u>	Sheet <u>1</u> of <u>9</u>
Project <u>Geothermal H.W. System</u>		<u>Salsbury, MD</u>	Est. by <u>P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MMH/Unit	MMHs	Rate*	Cost			
	-											
	Sheet No 2			259	800	1	710			261	510	
	" " 3			73	927	12	267			86	194	
	" " 4			21	201	5	034			26	235	
	" " 5			14	769	5	333			20	102	
	" " 6			19	452	4	493			23	945	
	" " 7			3	691	2	412			6	103	
	" " 8			9	024	2	592			11	616	
	" " 9			4	261		590			4	851	
	TOTAL COST.			406	125	34	431			440	556	
	INS. & TAXES ON LABOR?	20%		—		6	886			6	886	
	MOBILIZATION " "	10%				3	443			3	443	
	RENTALS. " "	10%				3	443			3	443	
	SUPERVISION " "	20%				6	886			6	886	
	CONTINGENCY	10%		40	613	3	443			44	056	
	TOTAL.			446	738	58	532			505	270	
	START-UP									10	000	
										515	270	
	OVERHEAD/PROFIT 15%									77	290	
										592	560	

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 10 of

Location

Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-1-80</u>	Sheet <u>2</u> of <u>9</u>
Project <u>Geothermal H.W. System</u>		Location <u>Salsbury, MD</u>	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description <u>EQUIPMENT Schedule.</u>				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	<u>HEAT PUMPS</u>											
	<u>HP-1</u>	<u>1</u>	<u>EA</u>	<u>100000</u>	<u>100000</u>		<u>25</u>	<u>18</u>	<u>450</u>			<u>100450</u>
	<u>HP-2</u>	<u>1</u>	<u>EA</u>	<u>46000</u>	<u>46000</u>		<u>10</u>	<u>18</u>	<u>180</u>			<u>46180</u>
	<u>HANDLING SETTING</u>	<u>25000</u>	<u>lbs.</u>		<u>1700</u>		<u>10</u>	<u>18</u>	<u>180</u>			<u>1880</u>
	<u>HEAT EXCHANGERS</u>											
	<u>HX-A</u>	<u>1</u>	<u>EA</u>		<u>21200</u>		<u>15</u>	<u>18</u>	<u>270</u>			<u>21470</u>
	<u>HX-B</u>	<u>1</u>	<u>"</u>		<u>14300</u>		<u>10</u>	<u>18</u>	<u>180</u>			<u>14480</u>
	<u>HX-1</u>	<u>1</u>	<u>"</u>		<u>61200</u>		<u>10</u>	<u>"</u>	<u>180</u>			<u>61380</u>
	<u>HX-2</u>	<u>1</u>	<u>"</u>		<u>13700</u>		<u>5</u>	<u>18</u>	<u>90</u>			<u>13790</u>
												<u>—</u>
												<u>—</u>
	<u>HANDLING SETTING</u>	<u>29000</u>	<u>lbs</u>		<u>1700</u>		<u>10</u>	<u>18</u>	<u>180</u>			<u>1880</u>
												<u>—</u>
	<u>Geo-Beine Filtering System</u>											<u>—</u>
					<u>259800</u>				<u>1710</u>			<u>261,510</u>

*Composite Rate - Based on Type of Work

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 11 of

Location

Estimate Sheet

V.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-1-80</u>	Sheet <u>3</u> of <u>9</u>
Project <u>Geothermal H.W. System</u>		Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	P-1 FLR. MTD CENTRIFUGAL Pump 207 GPM 40HD. 15 H.P.	1		950	950	2.0	2.0	18	36			986
	P-2 FLR MTD CENTRIFUGAL Pump 147 GPM 20HD. 3 H.P.	1		650	650	1.5	2.0		36			686
	P-3 Circulation Reinjection Pump 50 H.P.	2		1400	2800	2.0	2.0		72			2872
		1			4900				1075			5975
	STORAGE TANKS											
	T-1 CAP 25000 X	1	ea	11900	11900		5.0	18-	90			11990
	T-2 CAP 15000 X	1	ea	8275	8275		5.0		90			8365
	RIGGING IN PLACE.				1700		10		180			1880
	INSULATION										19470	
	T-1 50' FT	13840	S.F	200	27680			50	6920			34600
	T-2 " "	7536	S.F	200	15072			50	3768			18840
	4" Thick w/underlayment				73927				12267			86194

*Composite Rate - Based on Type of Work

BR5901 (2/76)

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 12 of

Location
Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-1-80</u>	Sheet <u>4</u> of <u>9</u>
Project <u>Geothermal H.W. System</u>		Location <u>Salsbury, MD</u>	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST							Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount		
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost				
	1" YELLOW PIPE T.C	740	L.F	3-	2220	.08	59	18-	1062			3282	
	2")	640	"	532	3424	.083	53		954			4378	
	3")	900	"	932	8370	.01	90		1080			9450	
	4" Y	400	"	13-	6000	.14	56		672			6672	
	1" 90° MPL ELLS	20	ea	1-	20	.65	13		156			176	
	2" " "	24	ea	332	78	.75	18		216			294	
	3" " "	20	ea	11-	220	1.20	24		288			508	
	4" " "	15	ea	18-	270	1.60	24		288			558	
												-	
	3" MPL TPO TEES	2	ea	1150	23	1.80	4		48			71	
	4" " "	1	ea	24-	24	2.40	3		36			60	
												-	
	Misc. nipples - Unions		L.S	90	90	2.0	2		36			126	
	1" B.B Gate Valves Std	2	ea	17-	34	1.20	2		36			70	
	2")	2	"	41-	82	1.50	3		54			136	
	3")	1	"	116	116	2.00	2	1	36			152	
	4" ✓	1	"	230	230	3.00	3	↓	54			284	
	TOTAL				21201				5034			26235	

*Composite Rate - Based on Type of Work

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 13 of

Location

Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-1-80</u>	Sheet <u>5</u> of <u>9</u>
Project <u>Geothermal H.W. System</u>		Salsbury, MD	Est. by <u>P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	1" CLEVIS HANGERS	74	ea	7.50	555	.120	15--	18	270			825
	2")	64	"	9.00	576	.25	16-		288			864
	3")	90	"	11.50	1035	.30	27		486			1521
	4" ✓	40	"	13.00	520	.40	10-		180			700
	1" INSULATING SADDLES.	74	ea	2.50	185	.10	7-		126			311
	2")	64	"	3.75	240	.10	6-		108			348
	3")	90	"	4.90	441	.15	14-		252			693
	4" ✓	40	"	6.00	240	.15	6-		108			348
	PIPE IDENTIFICATION		L.S	300	300		-		-			300
	INSULATION-2" Urethane											
	w/Vapor Jacket.											
15.5-454	1"	800	L.F.	2.86	2288	-	-	1-	800			3088
15.5-460	2"	700	L.F	3.34	2338	-	-	1.10	770			3108
15.5-461	3"	1100	L.F	3.85	4235	-		1.30	1430			5665
15.5-468	4"	500	L.F	4.54	1816	1.0		1.57	785			2601
					114769				5333			20102

*Composite Rate - Based on Type of Work

BR-901 (2/76)

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 14 of

Location

Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-1-80</u>	Sheet <u>6</u> of <u>9</u>
Project <u>Geothermal H.W. System</u>		Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	6" FRP PIPE	850	L.F.	7.50	6375	.5	45	18-	810			7185
	6" " 90° Ell.	16	ea	60	960	4.0	64		1152			2112
	6" FLANGES	6	ea	26	156	2.0	12		216			372
	6" B & G test sets	6	ea	600	360	1.0	6		108			144
	SOLVENT											-
	PIPE SADDLES "6"	57	ea	10	570	.5	28		504-			1217
	2 1/2" URETHANE INSULATION w/ S.S JACKET	850	L.F.	4.50	3825	1.0	85		1530			5355
	PIPE SUPPORTS	57	ea	80	4560							4560
	CONNECTION @ WELL		LS	1500	1500							1500
	CONN @ REINJECTION WELL		"	1500	1500							1500
	TEST SYSTEM											
					19452			18	4493			23945

*Composite Rate - Based on Type of Work

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 15 of

Location
Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-1-80</u>	Sheet <u>7</u> of <u>9</u>
Project <u>Geothermal H.W. System</u>		Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	CONNECTIONS to EQUIP											
	1"	2	ea	60	120	1.2	2.5	18-	45			165
	2"	2	"	90	180	1.5	3.0	18	54			234
	3"	1	"	120	120	2.5	2.5	18	45			165
	CUTTING, Patching -		L.S.	1500	1500	-	-	-	-			1500
	PIPING IN Geothermal Bldg											
	6" FRP PIPE	60'	L.F.	7.50	450	7.5	45	18-	810			1260
	6" 90° ELB	12	ea	76-	912	4.0	48	18-	864			1776
	6" Flanges	12	ea	21-	252	2.0	24	18-	432			684
						-					841	
	6" Bolt Gaskets	12	ea	6-	72	0.5	6	18	108			180
	Solvent		L.S.	60	60	-	-	-	-			60
			-			-	-	-	-			
	6 HANGERS	6	ea	4.20	25	.5	3	18	54			79
	Total.				3691				2412			6103

* Composite Rate - Based on Type of Work

BR-901 (2/76)

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 16 of

Location

Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-1-80</u>	Sheet <u>8</u> of <u>9</u>
Project <u>Geothermal H.W. System</u>		Salsbury, MD	Est. by <u>P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	6" WAFFER VALVES flg.	30	ea	125	3750	.5	15	18	270			4020
	6" FLANGES FIRD	60	ea	26	1560	.5	30		540			2100
	BOLTS Gaskets	60	ea	6-	360	.5	30		540			900
	Misc. Steel.		L.S.		350		-		-			350.
	Steel Pipe											
	2" BK YELLOW T-C	60	L.F.	535	321	.083	5		90			411
	3"	110	"	930	1073	.01	11		198			1221
	4"	110	"	13-	1430	.14	12		216			1646
	2" 90° ELB 150# M&L	10	ea	250	25	.75	8		144			169
	3" " "	8	"	680	54	1.20	7		126			180
	4" " "	10	"	910	91	1.60	16		288			379
	3" TEE	4	"	1320	53	1.80	3		54			107
	4" "	3	"	16-	7	2.140	7		126			133

*Composite Rate - Based on Type of Work

BR-901 (2/76)

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT
Location _____
Estimate Sheet

Page 17 of _____

W.O. <u>4861-01</u>	Type Estimate _____	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-1-80</u>	Sheet <u>9</u> of <u>9</u>
Project <u>Geothermal H.W. System</u>		<u>Salsbury, MD</u>	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by _____
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by _____

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	2" Gate Valves B.B. Scr'd	6	ea	46	276	.5	3.0	18	54			336
	3" "	8	"	129.-	1032	1.0	8.0	1	144			1506
	4" "	6	"	240	1440	1.0	6.0	1	108			1548
	2" Check Valves B.B. Scr'd	2	ea	68	136	.5	1.0	1	18			154
	3" "	3	ea	129	387	1.0	3.0	1	54			441
	4" "	1	ea	240	240	1.0	1.0	1	18			258
	2" Unions 150" Inal	4	ea	249	10-	.25	1.0	1	18			28
	3" "	3	ea	1280	38	.50	1.5	1	27			65
	1" "	2	ea	1690	34	1.0	2.0	1	36			70
	Misc Bushing		LS	60	60	-	-					60
	2" Clevis Hangers	6	ea	430	27	.5	3.0	1	54			81
	3" "	8	ea	575	46	.75	6.0	1	108			154
	4" "	8	ea	602	48	.75	6.0	1	108			156
	Misc.											
	Total.				4261				590			4851

*Composite Rate - Based on Type of Work

BR-901 (2/76)

**Burns and Roe
Industrial Services Corp.**

CAMPBELL

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet _____ of _____
 By _____ Checked _____ Approved _____
 Title _____

LT - (2 UNITS) @ 800	1600
LCV - (2 UNITS) @ 2040	4080
LS - (2 UNITS) TO SHUT DOWN PUMPS @ 168	336
XA - 6 UNITS MOTOR	1200
TI -	300
PJ -	350
FC VALVES - (2)	9080
POSITIONER	240
MATERIAL	12,86.00
	9,000.00
CONTROL PANEL	250.00
CONT.	approx 9,000, do 12,000. 3000 15,000.
other area - (Reactor +)	approx \$ 850.

4861-01

REVISE 7/MAY/80 → 5/MAY/80

SHH 20

GEO-THERMAL H.W. SYSTEM

ELECTRICAL ESTIMATE

ELECTRICAL ESTIMATE			1	2	3	4	5	6
SHEET		MATERIAL	LABOR	TOTAL	POSSIBLE SAVINGS (DEDUCT) *v	REVISED TOTAL		
#		I	\$ VALUE					
1, 2, 3	SERVICE EQUIPMENT	\$36000	\$18500	54500	\$18700 *v	\$35800		
4 & 5	REINJECT PUMP HOUSE	1600	4800	6400	-	6400		
6 & 7	POWER FEEDS	51200	51300	102500	2700 *v	99800		
8	MOTOR HOOK-UP	800	5400	6200	-	6200		
9	1 1/2" 200V. LGHT. & RECP.	3300	6700	10000	-	10000		
10	INSTRUMENTATION	500	4700	5200	-	5200		
11	HEAT TRACING	5200	7500	12700	-	12700		
→ 12	BRINE FILTER CASE II	2500	5400	7900	-	7900		
13	OVERTIME & START UP	-	11700	11700	7820 *v	3900		
14	ADJUST. PRIM. SERVICE	34800	16000	50800	50800 *v	-		
	TOTAL	135900	\$132000	267900	-80000 *	187900		
15 & 16	BRINE FILTER CASE I	5900	9100	15000	-	15000		
12	" " " " I DEDUCT	20000	5400	7900	-	-7900		
		139300	135700	275000	80000	195000 <		
<p>* POWER SOURCE AT EXISTING HIGH VOLTAGE SUB-STATION ROOM</p> <p>** SAVINGS POSSIBLE IF EXISTING PRIMARY SERVICE IS OF ADEQUATE CAPACITY TO ACCOMMODATE INCREASED LOAD. INFO PER 6/MAY/80 - SERVICE AVAILABLE</p> <p>*v 6/MAY/80 - PER MR. T. MAY - BY TELEPHONE 800A SPACE AVAILABLE & POWER IS AVAILABLE AT AT SUB-STATION 400 LAM. FEET AWAY - BUT ALLOW 100' FOR BENDS, UPS & PIPES, ETC.</p> <p>6/MAY/80 - RULE OF THUMB - FOR FACTORY</p> <p>- 1000 KW - 800A</p> <p>- 750 KW - 600A</p> <p>- 500 KW - 400A</p>								

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT
Location _____
Estimate Sheet

Page 18 of _____

D.O. <u>486/-01</u>	Type Estimate _____	Client CAMPBELL SOUP COMPANY	Date _____	Sheet <u>18</u> of _____
Project Geothermal H.W. System		Location Salsbury, MD	Est. by _____	Ext. Chkd. by _____
Location Salsbury, MD			Discipline _____	Approved by _____

Description <u>SUMMARY</u>				ESTIMATED COST						Contract Unit Cost		Tot. Amo.
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
3				\$	25,300		637	\$23.00	14,651			
5					1,000		163		3,749			
7					35,600		1763		40,549			
8					400		185		4,255			
9					2,100		229		5,267			
10					250		161		3,703			
11					3,500		257		5,911			
12					1,900		185		4,255			
13					-		400		9,200			
14					25,000		550		12,650			
16					420		59		1,242			
	TOTAL			\$	95,470		4,584		\$105,432			\$ 200,9
	OVERHEAD 15%											30,1
	PROFIT 10%											23,1
												\$ 254,1
	TRUCK TOOLS SCAFFOLDING.											9,6
	TEMP LIGHT & POWER.											3,2
	CONSTR. TRAILERS - OFFICE & STORAGE											2,6
	ENGINEERING.											5,4
	TOTAL			\$								\$ 275,0

*Composite Rate - Based on Type of Work

BR90C

4861-01 REVISED

1/MAY/80

GEOTHERMAL H.W. SYSTEM

SH 19

SUMMARY SHEET		1	2	3	4	5	6
IF		BASE					
1	3 SERVICE EQUIPMENT	\$52100					
2							
3	5 REJECT. PUMP HOUSE	6200					
4							
5	7 PWR. FEEDERS	98000					
6							
7	8 MOTOR HOOK UP	6000					
8							
9	9 1200 LFT DBL CKT.	9500					
10							
11	10 INSTRUMENTATION	5000					
12							
13	11 HEAT TRAILING	12100					
14							
15	12 BRIN FILTER (CASE 2)	7900					
16							
17	13 OVERTIME (START-UP)	11700					
18							
19	14 ADJUST PRIM. SERVICE	78600					
20							
21	TOTAL	\$257100					
22							
23	16 BRIN-FILTER (CASE I)	6300					
24							
25	TOTAL	263800					
26							
27	TEMP. LGT 4PWR	3100					
28							
29	CONSTR. TRAILER 13 WKS	2600					
30							
31	ENGINEERING	5400					
32							
33	TOTAL	\$275000					
34							
35							
36							
37							
38							
39							
40							

DR:

Burns & Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 41 of

Location

Estimate Sheet

Q. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>29/APRIL/80</u>	Sheet <u>1</u> of <u> </u>
Project <u>Geothermal H.W. System</u>		<u>Salsbury, MD</u>	Est. by <u>J.V.K.</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>ELECTRICAL</u>	Approved by <u> </u>

SERVICE				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	750 KVA TRANSFORMER	1	EA	10,000	10,000							
	PREPARE PAD		LOT	-	100		26					
	UNCRATE & RIG INTO PLACE			-	-		32					
	PRIMARY CONN-5KV 3 #8			-	10		6					
	SECONDARY CONN-600V-8-500M			-	50		16					
	TESTING				-		16					
	GROUND TRANSFORMATION				100		10					
	5KV STRESS CONES	3	EA	25 ⁰⁰ _{EA}	75		12					
							-					
	1" G.R.S. CONDUIT	20'	FT.	.76/FT	15	.09/FT	2					
	2 1/2" G.R.S. CONDUIT	20'	FT.	2.52 ⁰⁰ _{FT}	50	.18/FT.	4					
	CONDUIT HANGING MATERIAL	ALLOW			10	ALLOW	2					
	1' FILLED BENDS	2	-	-	-	.25/EA	1					
	2 1/2" ELBOW & WELPING	4	EA	13 ⁰⁰	52	2EA	8					
	1" UNDER LOCKNUT & BUSHINGS	2	EA	0 ²⁰	1	INC	-					
	2 1/2" " " "	2	EA	3 ⁰⁰	6	INC	-					
	5KV #8 CABLE	200'	FT	3 ⁰⁰	600	.03/FT	6					
	600V-500MCM CABLE	300'	FT.	4 ⁵⁰	1368	.05/FT	15					
	SURCHING (TAPE COILS, ETC.) MISC. MATERIAL	ALLOW			163	LOT	4					

*Composite Rate - Based on Type of Work

TOTAL \$ 12,500

160 HRS

BR-901 (2/

Burr & Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 1-23 of 2

Location _____

Estimate Sheet

W.O. 4861-01	Type Estimate _____	Client CAMPBELL SOUP COMPANY	Date 29/APRIL/80	Sheet 2 of 2
Project Geothermal H.W. System		Location Salsbury, MD	Est by J.V.K	Ext. Chk'd. by _____
Location Salsbury, MD			Discipline ELECTRICAL	Approved by _____

Description				ESTIMATED COST						Contract Unit Cost		Tot Amo
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	NICC	1		EA	\$8000							
	PREPARE BASE LOT				100	LOT	8					
	UNCRATE & INSTALL 4 SECTIONS			INC	—	2/SECT	17					
	800M MAIN SECTION MATERIALS				—	4 EA	4					
	SIZE 1- ACTIVE-STARTERS 6				—	1 EA	6					
	SIZE 1- SPARE " 2				—	1 EA	2					
	SIZE 1- SPARE " 1				—	—	—					
	SIZE 2- ACTIVE " 1				—	2 EA	2					
	SIZE 2- SPARE " 1				—	—	—					
	30' 60A-3P, 1E EXT BKR 6				—	0.70/EA	4					
	400A-3 " " 2				—	1 EA	2					
	600A-3 " " 1				—	1 EA	1					
	#12 & #14 CONNECTIONS 51			} LOT	—	0.20/EA	10					
	#10 CONNECTIONS 11				—	0.50/EA	2					
	#4 " 4				—	0.25/EA	3					
	#40 & #20 CONNECTIONS 5				—	1 EA	5					
	350 MCFT CONNECTION 6				—	1.25/EA	8					
	500 MCFT CONNECTION 11				—	2 EA	22					
	GROUNDING-SYSTEM LOT				800	LOT	112					
	FISHING LOT				—	LOT	16					

Composite Rate - Based on Type of Work

TOTAL

\$9000

224

BR-90

Burns and Roe, Inc.
COST ESTIMATING SCHEDULING DEPARTMENT

Location _____

Estimate Sheet

(24 of _____)

W.O. 4861-01	Type Estimate _____	Client	Date 1/MAY/80	Sheet SUMMARY of OF SHEET # 3
Project Geothermal H.W. System		CAMPBELL SOUP COMPANY Salsbury, MD	Est by J V K	Ext. Chk'd. by _____
Location Salsbury, MD			Discipline ELECTRICAL	Approved by _____

Description SERVICE CONTINUED				ESTIMATED COST						Contract Unit Cost	
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost		
	SHEET # 3				\$ 3800		112				
	NON PRODUCTIVE LABOR 10%				—		12				
	HANDLING MATERIAL 5%				—		6				
	FOREMAN				—		15				
	TOTAL LABOR				43800		145	23.5	3335		
	OVERHEAD 15%				570		—	—	500		
	TOTAL				4370		—	—	3835		
	PROFIT 10% ROUNDED				430		—	—	383		
	TOTAL				4800		—	—	4218		
	TRUCKS & TOOLS (ROUNDED)				200						
	75% VALUE LABOR.				4200						
	TOTAL				\$ 9200						
	SERVICE										
	SH # 1: 22,500										
	SH # 2: 20,400										
	SH # 3: 9200										
	52,100										

*Composite Rate - Based on Type of Work

SUMMARY SHEET OF SHEET # 3

Burns & Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Location _____
Estimate Sheet

No. <u>4861-01</u> Project <u>Geothermal H.W. System</u> Location <u>Salsbury, MD</u> Description <u>SEAVICO CONTINUED</u>	Type Estimate _____ Client <u>CAMPBELL SOUP COMPANY</u> <u>Salsbury, MD</u>	Date <u>1/MAY/80</u> Est by <u>J.V.K.</u> Discipline <u>ELECTRICAL</u>	Sheet <u>3</u> of <u>10</u> Ext. Chk'd. by _____ Approved by _____
---	---	--	--

Project		Location		Contract		Contract		Contract		Contract		Contract	
Geothermal H.W. System		Salsbury, MD		Salsbury, MD		ESTIMATED COST		Unit Cost		Unit Cost		Total Amount	
Description		SALVAGE CONTINUED		SALVAGE CONTINUED		SALVAGE CONTINUED		SALVAGE CONTINUED		SALVAGE CONTINUED		SALVAGE CONTINUED	
Account No.	Description	Qty.	Unit	Material	Cost	Labor	Cost	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	300AMP-460V MAIN SW.	1		EH	2,500								
	UNCRATE & HANG	LOT		-	50		16						
	500V CMT - LINE SIDE COMM.	4		SEP	20		8						
	500V CMT - LOAD " "	4		SEP	20		8						
	30 KVA TRANSFORMER 460/120/220V	1		ESD	450								
	UNCRATE & WALL MOUNT	LOT			10		32						
	4#10 PRIM. COMM.				1		2						
	4#4 SEC. COMM.				4		4						
	TESTING	LOT			100		10						
	GROUND												
	120/207 3#4W-14 POLE PHASE	1		LOT	225								
	UNCRATE & HANG	LOT			10		2						
	16AMP MLD 4#4 COMM.	1			-		3						
	20AMP 1P-2L ACTIVE	4			-		2						
	5AMP 2 " "	4			-		4						
	20AMP 1 POLE SPARE	4			-		-						
	MISC. HANGING MATERIAL	ALLOW			10	LOT	5						
TOTAL					3800		112						

*Composite Rate - Based on Type of Work

Estimate Sheet

[illegible]

Burns & Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page of

Location

Estimate Sheet

W.O. <u>4861-01</u>		Type Estimate <u> </u>		Client <u>CAMPBELL SOUP COMPANY</u>				Date <u>28/APRIL/80</u>		Sheet <u>4</u> of <u> </u>		
Project <u>Geothermal H.W. System</u>		Location <u>Salsbury, MD</u>				Est. by <u>J. V. K.</u>				Ext. Chk'd. by <u> </u>		
Location <u>Salsbury, MD</u>						Discipline <u>ELECTRICAL</u>				Approved by <u> </u>		
Description <u>REINJECTION PUMP HOUSE</u>				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
	SIZE 2-COIL STATOR	1	EA	230/ea	230							
	UNCREAT & HANG	LOT			10		6		6			
	3H4 LONG SIDE			LOT }	5		LOT		2			
	3H4 LONG SIDE				-		-		-			
	CONTRD WORK	LOT			20		LOT		5			
	30A-800V DISC. SW w/FUSES	1		LOT	95		ALLOW		-			
	UNCREAT & HANG				20		"		4			
	3H4 LONG SIDE			}	10		"		2			
	3H4 LONG SIDE			}	-		-		-			
	SPLICED #4 TO #4	6					-		2			
	5KV TRANSFORMER 460/120-10	1	EA	200/ea	200		-		12			
	3H4 PRIMARY			LOT }	10				2			
	3H4 SEC. SIDE				-				2			
							-		-			
	100A-4CKT PNL-M.L.O.	1		LOT	100				11			
					700				48			

*Composite Rate - Based on Type of Work

BR-901 (1)

Brown and Roe, Inc.
COST ESTIMATING SCHEDULING DEPARTMENT

Location _____
Estimate Sheet

28

O. 4861-01		Type Estimate		Client CAMPBELL SOUP COMPANY Salsbury, MD				Date 30/APRIL/80		Sheet SUMMARY OF SH # 5	
Project Geothermal H.W. System								Est. by J. H. K.		Ext. Chk'd. by	
Location Salsbury, MD								Discipline ELECTRICAL		Approved by	
Description REJECTION PUMP HOUSE CONTINUED				ESTIMATED COST						Contract Unit Cost	
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost		
	SHEET # 5			\$	300		80				
	NON PRODUCTIVE LABOR 10%				-		8				
	HANDLING MATERIAL 5%				-		4				
	HANDLING MATERIAL 5%				-		10				
	FOREMAN				300		102	23 ⁰⁰	2346		
	TOTAL LABOR HOURS & MATERIAL				45	INC.	-		351		
	OVER HEAD 15%				345		-		2,697		
	TOTAL				35	INC.	-		269		
	PROFIT 10% (ROUNDED)				380				\$ 2966		
	TOTAL				20						
	TRUCKS & TOOLS (ROUNDED)				3000						
	VALVE LABOR				3400						
	TOTAL										
	ROUNDED										
	REJECTION PUMP HOUSE										
	SHEET # 4 :				2,800						
	SHEET # 5 :				3,400						
	TOTAL				6,200						

Turns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 29 of 30

Location _____

Estimate Sheet

W.O. 4861-01	Type Estimate	Client	Date 1/10/80	Sheet 5
Project Geothermal H.W. System		CAMPBELL SOUP COMPANY	Est by J.V.K.	Ext. Chk'd. by
Location Salsbury, MD		Salsbury, MD	Discipline ELECTRICAL	Approved by

Description REJECTION PUMP HOUSE CONTINUED				ESTIMATED COST						Contract Unit Cost	
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost		
	25 1P 480V WATER HOSE UP	1	EA	10	10	5	5				
	PS BOX	3	EA	3	9	2	6				
	OIL TIGHT FLOX W/CONK	20'	FT	5	100	2	40				
	3/4" R.R.S. CONDUIT EXPOSED	40	FT	0.58	23	.04	3				
	1 1/4" C.A.S. EDT	20	PT	1.00	20	.13	2				
	EDT HANG: MOUNTAIN	ALLOW			16	1	5				
	3/4" TUBES	4	EA	0.40	2	INC	-				
	1 1/2" TUBES	2	EA	0.90	2	INC	-				
	3/4" BONDS FIELD	4	INC	-	-	.4	2				
	1 1/4" FIELD BONDS	4	INC	-	-	.7	3				
	HOOK UP ONLY LIGHT SW	1	2	2	2	2	2				
	MISC. CONTROL WORK	ALLOW			30		6				
	#12 THW 1/2" WIRE	300'	FT	.09	27	.007	2				
	#6 THW 1/2" "	30'	FT	.27	8	.018	1				
	#4 THW 1/2" "	100'	FT	.41	41	.020	2				
	SUBTOTALS				16		1				
					300		80				

*Composite Rate - Based on Type of Work

Page 62 of

Estimate Sheet

[illegible]

Burns Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 6 of

Location

Estimate Sheet

W.O. 4861-01	Type Estimate	Client	Date 29/APRIL/80	Sheet 6 of
Project Geothermal H.W. System		CAMPBELL SOUP COMPANY Salsbury, MD	Est by J.V.K.	Ext. Chk'd. by
Location Salsbury, MD			Discipline ELECTRICAL	Approved by

Description				ESTIMATED COST						Contract Unit Cost		Total Amour
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	3/4" G. R. S. CONDUIT EXP	230'	FT	.58	133	.08	18					
	1 1/4 G R S " "	850'	FT	1.00	850	.13	110					
	2 G R S " "	50'	FT	1.60	80	.18	9					
	2 1/2 G R S " "	1020'	FT	2.52	2570	.22	224					
	3 1/2 G R S " "	170'	FT	3.38	574	.30	51					
	CONDUIT HANGING DISTANCE	ALLOW			309	LOT	34					
	1 1/4" ELBOW & COUPLINGS	10	EA	5.00	50	1	10					
	2" " & "	70	EA	8.00	80	2	20					
	2 1/2" " & "	40	EA	13.00	520	2	80					
	3 1/2" " & "	4	EA	21.50	84	2	8					
	3/4" DOUBLE LOCKOUT/INS. BUSH	30	EA	0.40	12	INC	-					
	1" " " 7" "	2	EA	0.70	1	INC	-					
	1 1/4" " " 7" "	20	EA	0.90	18	INC	-					
	2" " " 7" "	4	EA	1.80	7	12	1					
	2 1/2" " " 7" "	30	EA	3.00	90	.4	1					
	3 1/2" " " 7" "	4	EA	5.25	22	.7	3					
	3/4" FIELD BEND	20	INC	-	-	.4	8					
	1" " "	2	INC	-	-	.7	1					
	1 1/4" " "	30	INC	-	-	1.5	30					
	LOST TIME WORK IN EXIST BLDG		-	-	-		48					

*Composite Rate - Based on Type of Work

46600

656

BR59016

Burke and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Location _____
Estimate Sheet

Page 32

NO. 4861-01	Type Estimate	Client	Date 30/APRIL/80	Sheet 1 of 3
Project Geothermal H.W. System		CAMPBELL SOUP COMPANY	Est by J.V.K.	Ext. Chk'd. by
Location Salsbury, MD		Salsbury, MD	Discipline ELECTRICAL	Approved by

Account No.	Description	Qty.	Unit	ESTIMATED COST						Contract Unit Cost	
				Material		Labor				Unit Price	Amount
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost		
	SHEET # 7			\$	29,100		672				
	NON PRODUCTIVE LABOR 10%				-		67				
	HANDLING MATERIAL 5%				-		34				
	FOREMAN				-		121				
	TOTAL LABOR HOURS & MATERIAL				29,000		894	23.00	20,562		
	OVER HEAD 15%				4,350	INC.	-		3,084		
	TOTAL				33,350		-		23,646		
	PROFIT 10% (ROUNDED)				3,350	INC.	-		2,364		
	TOTAL				36,700				26,010		
	TRUCKS, TOOLS & SCHEDULE (ROUNDED)				1,200						
	BY VALUE LABOR				26,000						
	TOTAL				63,900						
	ROUNDED										
	FEED GAS										
	SHEET # 6				34,100						
	SHEET # 7				63,900						
					98,000						

Burns & Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 3 of

Location

Estimate Sheet

V.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>29/APRIL/80</u>	Sheet <u>7</u> of <u> </u>
Project <u>Geothermal H.W. System</u>		Location <u>Salsbury, MD</u>	Est. by <u>J.V.R.</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>ELECTRICAL</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Tot. Amc.
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	2" FIELD BENDS	4		INC	—		2	8				
	2 1/2 " " "	10		INC	—		2	20				
	3 1/2 " " "	4		INC	—		2	8				
	56" X 12' X 6" ^{DEEP} PULL BOX	8	EA	20	160		8	64				
	20" X 30" X 12" " "	6	CH	2.00	12.00		16	96				
	1" 14 600V. CABLE	1000'	FT	.06	60		.007	7				
	1" 12 600V. "	3000'		.09	270		.008	24				
	1" 10 600V. "	100'		.13	13		.010	1				
	1" 6 600V. "	1000'		.27	270		.018	18				
	1" 4 600V. "	1000'		.41	41		.020	2				
	#2 600V. "	3000'		.62	1860		.022	66				
	1/0 ... 600V. "	200'		1.04	208		.028	5				
	2/0 600V. "	50'		1.27	63		.03	2				
	350 MCM 600V CABLE	110'		3.20	352		.04	4				
	100 MCM 600V CABLE	5300'	V	4.54	24,168		.05	265				
	PIPE CONN & SUNDRIES	ALLOW		—	—			26				
	LOST TIME WORK IN EXIST BLDG.				335			5'6				
					29,000			672				

*Composite Rate - Based on Type of Work

BR-00

Estimate Sheet

Page 54 of [illegible]

Page 35 of

V.O. 4861-01	Type Estimate	Client CAMPBELL SOUP COMPANY Salsbury, MD	Date 1/MAY/80	Sheet 8 of
Project Geothermal H.W. System			Est by J. V. K.	Ext. Chk'd. by
Location Salsbury, MD			Discipline ELECT.	Approved by

[illegible]

Estimate Sheet

[illegible]

Estimate Sheet

W.O. 4861-01		Type Estimate	Client		Date 30/APRIL/80	Sheet 9 of 1					
Project Geothermal H.W. System		CAMPBELL SOUP COMPANY		Est. by J.V.R.		Ext. Chk'd. by					
Location Salisbury, MD		Salsbury, MD		Discipline ELECT.		Approved by					
Description 120V/208 LIGHTING & RECEPT				ESTIMATED COST						Contract Unit Cost	
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost		
	120 V FIRT & LAMP'S BOX	20	EA	70	1400	4	80				
	120 V RECEPT. BOX & COVER	10	EA	10	100	2	20				
	3/4" RIGID EXPOSED ALUM	500	FT	0.58	290	.08	40				
	CUT HANDING MATERIAL	ALUM			60		8				
	#11 THIN	2000	FT	.09	180	.007	14				
	SUNDRIES	LOT			20		4				
	SWITCHES. WP. BOX & COVER	5	EA	10	50	2	10				
					2100		176				

*Composite Rate - Based on Type of Work

B. and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Location _____
Estimate Sheet

38 of

O. 4861-01	Type Estimate	Client	Date 30/APRIL/80	Sheet SUMMARY of OF SN # 10
Project Geothermal H.W. System		CAMPBELL SOUP COMPANY Salsbury, MD	Est by J. V. R.	Ext. Ch'd. by
Location Salsbury, MD			Discipline ELECTRICAL	Approved by

Description				ESTIMATED COST						Contract Unit Cost	
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost		
	INSTRUMENTATION										
	SHEET # 10			\$	250		120				
	NON PRODUCTIVE LABOR 10%				-		12				
	HANDLING MATERIAL 5%				-		6				
	FOREMAN				-		23				
	TOTAL LABOR HOURS & MATERIAL				250		161	23	3703		
	OVER HEAD 15%				40	INC.	-		555		
	TOTAL				290		-		4258		
	PROFIT 10% (ROUNDED)				30	INC.	-		425		
	TOTAL				320		-		4683		
	TRUCKS & TOOLS (ROUNDED)				10						
	VALVE LABEL				4683						
	TOTAL				5013						
	ROUNDED				5,000						
	1/MAY/80- ALLOW FOR										
	6-CONTROL PRINTS										
	ONLY										

SHEET 1A

Burns & Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 03

Location _____

Estimate Sheet

V.O. <u>4861-01</u>	Type Estimate _____	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>30/APRIL/80</u>	Sheet <u>10</u>
Project <u>Geothermal H.W. System</u>		<u>Salsbury, MD</u>	Est by <u>J.V.K.</u>	Ext. Chk'd. by _____
Location <u>Salsbury, MD</u>			Discipline <u>ELECTRICAL</u>	Approved by _____

DESCRIPTION				ESTIMATED COST						Contract Unit Cost	
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost		
	HOOK UP ONLY			FB0	—		16				
	CONTROL PNL				—		—				
	2# 12	1			1		8				
	2# 14	15			7		8				
					—		—				
	CONTROL POINTS ALLOW	15			30		15				
	BOXES	15			30		30				
	FLEX & 30 CONNECT.	60			120		80				
	3/4" H.C. CDT.	300'	.058		174	.08	24				
	4 DT. PANS	ALLOW			50		3				
	H 18 TAW	1000'	.06		60		7				
	H 12 IN W	100'	.09		9		9				
	SOUNDING TESTING SYSTEM				19		40				
					500		240				
	1/4 IN W/80 ALLOW FOR - G-										
	CONTROL POINTS ONLY				250		120				

*Composite Rate — Based on Type of Work

rag 40

Sheet SUMMARY of OF SH # 11
Ext. Chk'd. by
Approved by

Burns & Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 1 of 1

Location _____
Estimate Sheet

O. <u>4861-01</u>	Type Estimate _____	Client CAMPBELL SOUP COMPANY Salsbury, MD	Date <u>1/11/80</u>	Sheet <u>11</u> of _____
Project <u>Geothermal H.W. System</u>			Est. by <u>J.V.K.</u>	Ext. Chk'd. by _____
Location <u>Salsbury, MD</u>			Discipline <u>ELECT.</u>	Approved by _____

DESCRIPTION				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	4 HT VI- 50' AT	800'	FT	2 ⁷⁰	2160	.03	24					
	SILICA RITS	4	EA	12 ⁰⁰	48	4	16					
	NEHA 4 CONTACT	1	EA	100 ⁻	100	8	8					
	NEHA 4 THERMO.	1	EA	100 ⁻	100	8	8					
	VSPC-VTE RT	1	EA	16 ⁻	16	4	4					
	GT-60' TAPG	3	EA	3 ⁰⁰	9	LOT	16					
	NOTE ABOVE HAS TO BE INSTALLED		-	-	-		-					
	BEFORE INSULATION		-	-	-		-					
	3/4" CONDUIT	800	FT	0 ⁵⁸	464	.07	56					
	#8 THW	2000	FT	0 ²²	440	.015	30					
	1111 G. 1111 G. 1111 G. 1111 G.				88		16					
	JCT AIR W.P.	3	EA	5	15	2	6					
	MISC. MATERIALS			LOT	60	LOT	8					
					3500		192					

*Composite Rate - Based on Type of Work

Burns and Roe, Inc.
COST ESTIMATE SCHEDULING DEPARTMENT
Location _____
Estimate Sheet

P 42

W.O. 4861-01*	Type Estimate	Client	Date 30/APRIL/80	Sheet NUMBER OF SH # 12
Project Geothermal H.W. System		CAMPBELL SOUP COMPANY Salsbury, MD	Est by J.V.K.	Ext. Chk'd. by
Location Salsbury, MD			Discipline ELECTRICAL	Approved by

Description BRINE FILTER SECTION : CASE 2				ESTIMATED COST						Contract Unit Cost	
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost		
	SHEET # 12			\$	1900		144				
	NON PRODUCTIVE LABOR 10%				-		14				
	HANDLING MATERIAL 5%				-		7				
	FOREMAN				-		20				
	TOTAL LABOR HOURS & MATERIAL			\$	1900		185	23	4255		
	OVER HEAD 15%				285	INC.	-		638		
	TOTAL			\$	2185		-		4893		
	PROFIT 10% (ROUNDED)				215	INC.	-		489		
	TOTAL			\$	2400				5382		
	TRUCKS & TOOLS (ROUNDED)				100						
	VALUE LABOR (ROUNDED)				5400						
	TOTAL (ROUNDED)			\$	7,900						
	(SEE SHEET # 13)										

*Composite Rate - Based on Type of Work

SUMMARY OF SHEET # 12

Burns & Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 13 of

Location

Estimate Sheet

O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>1/11/80</u>	Sheet <u>13</u> of <u> </u>
Project <u>Geothermal H.W. System</u>		Location <u>Salsbury, MD</u>	Est by <u>JVR</u>	Ext. Chkd. by <u> </u>
Discipline <u>ELECT.</u>			Approved by <u> </u>	

Description WORK IN NEW EXTENSION CASE: 2				ESTIMATED COST						Contract Unit Cost		Tot. Amo.
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	BRINE FILTER SECTION											
	THROUGH	1	LOT		50	LOT	8					
	PIPES & HANGING MATERIAL	LOT			10	LOT	2					
	SIZE 1 STARTERS	3	EA	175	525	4	12					
	#12 TO #12 SPLICES	9	EA	1	9	1	9					
	ADDITIONAL WORK IN RICE	LOT			530	LOT	29					
	1/2 HP MOTORS	3	EA	2	6	1	3					
	F.S. BOXES	3	EA	3	9	2	6					
	OIL TIGHT FLEX CONNECTIONS	12	FT	5	60	2	24					
	3/4" R.G.S. CONDUIT-EXPOSED	200	FT	0.58	116	.08	16					
	3/4" DOUBLE LOCKOUT 1/2" BUSH	10	EA	0.40	4	INC	—					
	3/4" FIBER BUSHES ALLOW	10	INC	—	—	.4	4					
	CONDUIT HANGING MATERIAL ALLOW				15		3					
	#12 THW	1000	FT	.09	90	.007	7					
	SUNDRIES & MISC. MATERIAL ALLOW				6		1					
	CLG INTD. HANGER & BOX	1	EA	450	450	16	16					
	THE M. STMT w/ BOX	1		50	20	4	4					
					1900		144					

*Composite Rate - Based on Type of Work

BR593

Burns & Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 4 of

Location

Estimate Sheet

No. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>1/11/70</u>	Sheet <u>13</u> of <u> </u>
Project <u>Geothermal H.W. System</u>		Location <u>Salsbury, MD</u>	Est by <u>J.V.K.</u>	Ext. Chkd. by <u> </u>
			Discipline <u>ELECT.</u>	Approved by <u> </u>

OVERTIME & START UP				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	SLIPVICK, CHANGE OVER	16 HRS				1.5	24					
	FEEDER-INSIDE EXIST. BLDG	48 HRS				1.5	72					
	TESTING	16 HRS				1.5	24					
	START-UP - 4 HRS 5 DAYS	—				—	160					
	START-UP -	16 HRS				1.5	24					
							304	\$ 23 ⁰⁰	6,992			
	FOREMAN - START UP	—					48	23 ⁰⁰	1,104			
	FLA. H. H. H. OVERTIME	32				1.5	48	23 ⁰⁰	1,104			
							900	\$	9,200			
	OVERHEAD 15%								1,386			
									10,580			
	PROFIT 10%								1,058			
									11,638			
	ROUNDED								11,700			
		</										

*Composite Rate - Based on Type of Work

SUMMARY OF SHEET 11/13

NO. 4861-01 Project Geothermal H.W. System Location Salsbury, MD Description		Type Estimate Client CAMPBELL SOUP COMPANY Salsbury, MD		Date 30/APRIL/80 Est by J. V. K. Discipline ELECTRICAL		Sheet 1 OF 5 Ext. C Approv.	
---	--	---	--	--	--	-----------------------------------	--

ADJUST PRIMARY SUB-STATION				ESTIMATED COST						Contract Unit Cost	
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost		
	ALLOW			\$	25,000		400				
	NON PRODUCTIVE LABOR 10%				-		40				
	HANDLING MATERIAL 5%				-		20				
	FOREMAN				-		90				
	TOTAL LABOR HOURS & MATERIAL				25,000		550	23-	12,650		
	OVER HEAD 15%				3,750	INC.	-		1,897		
	TOTAL				28,750		-		14,547		
	PROFIT 10% (ROUNDED)				2,875	INC.	-		1,454		
	TOTAL				31,625				16,001		
	TRUCKS & TOOLS - (ROUNDED)				1,995						
	BY VALUE LABOR ROUNDED				16,000						
	TOTAL				48,620						
	ROUNDED				\$ 48,600						
											</

* Classification Basis - Based on Type of Work

Page 46 of

Estimate Sheet

[illegible]

COST ESTIMATING & SCHEDULING DEPARTMENT

Location _____
Estimate Sheet

Page 1 of 1

W.O. 4861-01	Type Estimate	Client CAMPBELL SOUP COMPANY Salsbury, MD	Date 1/MAY/80	Sheet 15 of									
Project Geothermal H.W. System			Est by J. VIK	Ext. Chk'd. by									
Location Salsbury, MD			Discipline ELECTRICAL	Approved by									
Description BRINE FILTER SECTION - (CASE I)			ESTIMATED COST										
Account No.	Description	Qty.	Unit	Material						Labor		Contract Unit Cost Unit Price Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost				
	ADD SOFTEN TO H.W.C.	LOT			2000	LOT	32						
	3/4" R. & S. CONDUIT EXPOSED	350'	FT	0.58	203	.08	28						
	1" " " "	100	FT	0.76	76	.10	10						
	CONDUIT HANDLING MATERIAL	ALLOW	-		47	ALLOW	1						
	3/4" DOUBLE LOCKING W/INS ADJ.	20	EA	0.40	8	INC	-						
	1" " " 7' " "	4	EA	0.70	3	INC	-						
	3/8" FIELD BANDS DIFFS	20	INC	-	-	.4	8						
	1" " " 3' "	4	INC	-	-	.5	2						
	#14 THW	1500'	FT	.06	90	.007	11						
	#12 THW	2000'	FT	.09	18	.007	14						
	#10 THW	100'	FT	.13	13	.010	1						
	#8 THW	500'	FT	.22	110	.015	8						
	SUNDRIES & MISC. MATERIAL				20		1						
	CLG. H.T.D. MTR.	1	BELOW	-	-	-	-						
	PUSH BUTTON STATION W/2.0:01	6	EA	116	696	4	24						
	P.S. BOXES	7	EA	3	21	2	14						
	6" IL IT ISHT FLK & 7 CONNECTIONS	25	FT	5	125	2	50						
	CLG. H.T.D. MTR.	1	EA	450	450	16	16						
	THETING THT 1/2" DIA	1	EA	20	20	4	4						
	TOTAL				3900		224						

*Composite Rate - Based on Type of Work

DR

Durr and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Location _____

Estimate Sheet

O. 4861-01	Type Estimate _____	Client	Date 30/APRIL/80	Sheet 1 OF 3
Project Geothermal H.W. System		CAMPBELL SOUP COMPANY Salsbury, MD	Est by J. V. K.	Ext. Chkd. by
Location Salsbury, MD			Discipline ELECTRICAL	Approved by
Description				

Account No.	Description	Qty.	Unit	ESTIMATED COST						Contract Unit Cost	
				Material		Labor				Unit Price	Amount
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost		
	SHEET # 16			\$	20		8				
	NON PRODUCTIVE LABOR 10%				-		1				
	HANDLING MATERIAL 5%				-		1				
	FOREMAN				-		-				
	TOTAL LABOR HOURS				-		10	23.	230		
	OVER HEAD 15%				3	INC.	-		34		
	TOTAL						-		264		
	PROFIT 10% (ROUNDED)				2	INC.	-		26		
	TOTAL				25				290		
	TRUCKS & TOOLS. (ROUNDED)				5						
	VALUE LABOR				240						
	TOTAL				320						
	ROUNDED THIS SHEET				300						
	SHEET # 15				13900						
	TOTAL				14200						
	DEDUCT SH # 11				7900						
					6300						

NO.	Type Estimate	Client	Date	Sheet
4861-01	CAMPBELL SOUP COMPANY Salsbury, MD		30/APRIL/80	16 of
Project Geothermal H.W. System			Est. by J. V. R.	Ext. Chk'd. by
Location Salsbury, MD			Discipline ELECTRICAL	Approved by

DESCRIPTION
DRAIN FILTER SPEC. 22. (CASE I
(CONTINUED))

ESTIMATED COST

[illegible]

*Composite Rate - Based on Type of Work

BR-201

ALLOWANCE
TO
ADJUST
PRIMARY
SERVICE

EXIST ELECT RM.

225KVA
TRANSFORMER

800A
MAIN
SW

TO CRT.
BKA.
IN MCC

THROVCH

SIZE
1
COMB

SIZE
1
COMB
STN

1/2

1/4

1/2

CASE II

2 SETS 500MCM IN EXIST BLDG
2 3/4" CDT

800A MAIN

800A BUS

SIZE
1
STN

SIZE
1
STN

SIZE
1
STN

SIZE
1
STN

SIZE
1
STN

SIZE
1
STN

SIZE
1
STN

SIZE
1
STN

SIZE
1
STN

SIZE
1
STN

SIZE
1
STN

1/2

1/2

1/2

3/4

10

25

7.5

10

7.5

10

10

OIL
TIGHT
P.B. STPT.
& LOCK OUT

CASE I

PUMP

RETURN PUMP

P-1

P-2

P-3

P-4

P-5

86 KW

34 KW

30
mm
mm

120/209
3 ϕ
PUL.

INST
CONTROL
PUL

FOUR 50 HP
GEN-DRIVE PUMPS

COMB
SIZE
2
STN

25

REINJECT
PUMP HOUSE

120/209
1 ϕ
PUL

3"
1"
2"

mm
mm

Location _____

Estimate Sheet

Page 50 of

W.O. 4867-01	Type Estimate	Client CAMPBELL SOUP COMPANY Salsbury, MD	Date 5-1-80	Sheet 1 of 1
Project Geothermal H.W. System			Est. by C. P. Ostrosky	Ext. Chk'd. by
Location Salsbury, MD			Discipline Mechanical	Approved by

Description • CASE I.

[illegible]

Page 51 of

4867-01	Type Estimate	Client CAMPBELL SOUP COMPANY Salsbury, MD	Date 5-1-80	Sheet 1 of 1
Geothermal H.W. System			Ext. by C. P. Ostrosky	Ext. Chk'd. by
Salsbury, MD			Discipline CASE I	Approved by

[illegible]

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT
Location _____
Estimate Sheet

Page 52 of _____

4861-01		Type Estimate		Client				Date <u>5-1-80</u>		Sheet <u>1</u> of <u>1</u>		
Geothermal H.W. System		CAMPBELL SOUP COMPANY Salsbury, MD		CAMPBELL SOUP COMPANY Salsbury, MD				Est. by <u>C. P. Ostrosky</u>		Ext. Chk'd. by		
Salsbury, MD								Discipline <u>CASE</u>		Approved by		
<div style="display: flex; justify-content: space-between;"> DESCRIPTION: <u>FILTER SYSTEM CASE I</u> ESTIMATED COST Contract Unit Cost Total Amount </div>												
Account No.	Description	Qty.	Unit	Material		Labor				Contract Unit Cost		Total Amount
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost	Unit Price	Amount	
	<u>ADD FOR FILTER SYSTEM.</u>											
	<u>LIME FEEDER</u>	<u>1</u>	<u>ea</u>			<u>2.0</u>	<u>2.0</u>	<u>18</u>	<u>36</u>			<u>36</u>
	<u>COAGULANT FEEDER</u>	<u>1</u>	<u>ea</u>			<u>2.0</u>	<u>2.0</u>		<u>36</u>			<u>36</u>
	<u>ACID FEEDER</u>	<u>1</u>	<u>ea</u>		<u>250,000</u>	<u>1.5</u>	<u>1.5</u>		<u>27</u>			<u>250027</u>
	<u>SLUDGE CENTRIFUGE</u>	<u>1</u>	<u>ea</u>			<u>2.5</u>	<u>2.5</u>		<u>45</u>			<u>45</u>
	<u>REACTOR W/ AGITATOR</u>	<u>1</u>	<u>ea</u>			<u>6.5</u>	<u>6.5</u>		<u>117</u>			<u>117</u>
	<u>REACTOR INSULATION.</u>	<u>14000</u>	<u>S.F</u>	<u>1.50</u>	<u>21000</u>	<u>100</u>	<u>140</u>		<u>2520</u>			<u>23520</u>
	<u>PIPING.</u>		<u>L.S.</u>		<u>2000</u>		<u>-</u>		<u>2000</u>			<u>4000</u>
	<u>BUILDING ENCLOSURE.</u>											
	<u>Per Sq Ft. 32x20</u>	<u>640</u>	<u>SF</u>	<u>35</u>	<u>22400</u>				<u>-</u>			<u>22400</u>
	<u>TOTAL.</u>				<u>295,400</u>				<u>4781</u>			<u>300,181</u>

COST ESTIMATING & SCHEDULING DEPARTMENT

Page 53 of _____

Location _____

Estimate Sheet

[illegible]

APPENDIX C

Capital Cost Estimate - Case 1

This Appendix contains the detailed capital cost estimating work sheets for Case 1 as defined in Section VII. These sheets contain a detailed breakdown of material takeoff, labor rates, etc. Note that the designation "Case II" shown on these sheets only signifies that this was the second case estimated by the Estimating Department.

COST ESTIMATING & SCHEDULING DEPARTMENT

Location _____

Estimate Sheet

Page 1 of

W.O. 4861-01	Type Estimate	Client CAMPBELL SOUP COMPANY Salsbury, MD	Date 5-8-80	Sheet 1 of 1
Project Geothermal H.W. System			Est. by C. P. Ostrosky	Ext. Chk'd. by
Location Salsbury, MD			Discipline Mechanical	Approved by

[illegible]

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 2

Location _____

Estimate Sheet

W.S. <u>4861-01</u>	Type Estimate _____	Client _____	Date <u>5-8-80</u>	Sheet <u>1-1</u>
Project <u>Geothermal H.W. System</u>		CAMPBELL SOUP COMPANY Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chkd. by _____
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by _____

Description <u>BUILDING CONST.</u>				ESTIMATED COST				
Account No.				MATERIAL	LABOR	TOTAL COST		
Sheet 1	EXCAVATION			2581	2429	5010		
" 2	CONCRETE			2218	2632	4850		
" 3	MASONRY			1454	2401	3855		
" 4	ROOFING			4728	1489	6217		
" 5	DOORS & FRAMES			1020	1144	1164		
" 6	EQUIP SUPPORTS			7186	2428	9614		
	Total Cost			19187	11523	30710		
	INS. & TAXES 20%	LABOR			2305	2305		
	MOBILIZATION 10%	"			1152	1152		
	SCAFFOLDING - frames etc 10%	"			1152	1152		
	SUPERVISION 20%	"			2305	2305		
	CONTINGENCY 20%			3837	2305	6162		
	Total			23024	20742	43786		
	15% O+P.					6568		
						50354		
	SALES TAX NOT INCLUDED							

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 3 of

Location
Estimate Sheet

V.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-8-80</u>	Sheet <u>1</u> of <u>1</u>
Project <u>Geothermal H.W. System</u>		Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	CLEAVING-GRUBBING	1300	SF	.50	650			—				650
								1				
	FOUNDATION EXCAV.	100	C.Y.	.80	80			1.35	135			215
	BACKFILL Compaction	40	C.Y.	2.50	100			1.90	76			176
	COMPACTION	40	C.Y.	.33	13			.99	40			53
	GRADING.	2200	SF.	.79	1738			.99	2178			3916

*Composite Rate -- Based on Type of Work

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Location _____

Estimate Sheet

Page 4 of _____

W.O. <u>4861-01</u>	Type Estimate _____	Client _____	Date : <u>5-8-80</u>	Sheet <u>1</u> of <u>1</u>
Project <u>Geothermal H.W. System</u>		CAMPBELL SOUP COMPANY Salsbury, MD	Est. by <u>P. Ostrosky</u>	Ext. Chk'd. by _____
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by _____

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	CONCRETE.											
	VISQUEEN.	1120	SF	.05	56		.4	.40	28			84
	6"x6" WIRE MESH	1120	SF	.07	78			.08	90			168
	CONCRETE	34	C.Y.	58	1972			.68	2312			4284
	FLOAT FINISH	1120	SF	-	-			.18	202			202
	CURING.	1120	S.F	10	112		-	-				112

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 5 of

Location

Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-8-80</u>	Sheet <u>1</u> of <u>1</u>
Project <u>Geothermal H.W. System</u>		<u>Salsbury, MD</u>	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	8" CINDER BLOCK	2000	SF	1.90	1800			1.80	3600			5400
	STEEL LINTELS		L.S	200	200			1	150			350
	1608			1.3				1.40				

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 6 of

Location
Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-8-80</u>	Sheet <u>1</u> of <u>1</u>
Project <u>Geothermal H.W. System</u>		Salsbury, MD	Est. by <u>P. Ostrosky</u>	
Location <u>Salsbury, MD</u>			Discipline <u> </u>	
Description <u>ROOFING.</u>		Ext. Chk'd. by <u> </u>		Approved by <u> </u>

Description: ROOFING.				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	OPEN WEB JOIST.	11	ea	250	2750			.50	550			3300
	METAL DECK 18g.	1160	SF	.92	1067			.14	162			1229
	INSULATION 6lb-1 1/2"	1160	SF	.16	186			.10	116			302
	BUILT-UP 4PLY	11	Sq's	29	319			.27	292			611
	FLASHINGS	340	Sf	.84	286			.85	289			575
	DOWN SPOUTS	2	ea	60	120			40	80			200

Page 7 of

Estimate Sheet

[illegible]

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 8 of

Location

Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-8-80</u>	Sheet <u>1</u> of <u>1</u>
Project <u>Geothermal H.W. System</u>		<u>Salsbury, MD</u>	Est. by <u>P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	TANK FOUNDATIONS.	123	C.V.	54	6642			18.25	2245			8887
	Heat Pump ..	10	C.V.	54	544			18.25	183			727

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT
Location _____
Estimate Sheet

Page 9 of _____

4861-01	Type Estimate	Client	Date <u>5-8-80</u>	Sheet <u>1</u> of <u>1</u>
Geothermal H.W. System		CAMPBELL SOUP COMPANY Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by _____
Salsbury, MD			Discipline <u>CASE II</u>	Approved by _____

MECHANICAL PIPING.				ESTIMATED COST						Contract Unit Cost		Total Amount	
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount		
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost				
	SHEET 1 - EQUIPMENT			394	250				8	563	402	813	
	" 2 "			71	700				13	040	84	740	
	" 3 - PIPE IN BLDG.			6	285				2	916	9	174	
	" 4 " " "			9	333				3	533	12	866	
	" 5 " " "			1	713				1	458	3	171	
	" 6 EXTERIOR PIPE			15	669				3	978	19	647	
	" 7. PIPE IN GEO-THERM. BLDG			4	298				2	139	6	437	
	" 8 " " "			3	605				1	810	5	415	
	DIRECT COST.			506	853				37	437	544	290	
	INS. TAXES - 20% LABOR								7	488	7	488	
	MOBILIZATION 10% "								3	744	3	744	
	RENTALS 10% "								3	744	3	744	
	SUPERVISION 20 "								7	488	7	488	
	Contingency 10 "			50	685				3	744	54	429	
	TOTAL			557	538				63	645	621	183	

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT
Location _____
Estimate Sheet

Page 10 of _____

4861-01		Type Estimate		Client CAMPBELL SOUP COMPANY Salsbury, MD		Date <u>5-8-80</u>		Sheet <u>1</u> of <u>8</u>				
Geothermal H.W. System						Est. by <u>C. P. Ostrosky</u>		Ext. Chk'd. by				
Salsbury, MD						Discipline <u>CASE II</u>		Approved by				
<div style="display: flex; justify-content: space-between;"> EQUIPMENT - DESIGN WATER </div>												
Account No.	Description	Qty.	Unit	ESTIMATED COST						Contract Unit Cost		Total Amount
				Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	FILTER SYSTEM				250000	15	15	18	270			250270
	W/REACTOR											
	INSULATION REACTOR	14000	S.F	1.50	21000	100	140	18	2520			23520
	RIGGING			1700	1700	-		-	-			1200
	START-UP.		L.S	300	300	2	50	18	900			1200
	REACTOR INSULATION.	14000	S.F	1.50	21000	100	140	18	2520			23520
	HEAT EXCHANGERS.											
	H X-1	1	ea	51900	51900		50	18	90			51990
	H X-2	1	ea	39200	39200		50	18	90			39290
	HANDLING SETTING		L.S.	-	-		40	18	72			72
	CENTRIFUGAL PUMPS											
	P-1 & P-3-15HP	2	ea	2300	4600		390	-	1180			5780.-
	P-2-7.5HP	1	ea	950	950		2	18	36			986.-
	P-4-30HP	1	ea	4100	4100		885	-	885			4985.-

Page 17 of

4861-01	Type Estimate	Client CAMPBELL SOUP COMPANY Salsbury, MD	Date 5-8-80	Sheet 2 of 8
Geothermal H.W. System			Ext. by C. P. Ostrosky	Ext. Chk'd. by
Salsbury, MD			Discipline CASE II	Approved by

[illegible]

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 12 of

Location

Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-8-80</u>	Sheet <u> </u> of <u> </u>
Project <u>Geothermal H.W. System</u>		Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	6" FRP PIPE	350	L.F	5.70	1995	.050	18	18	324			2319
	4 " "	200	"	3.10	620	.045	9		162			782
	3" " "	375	"	2.35	881	.040	15		270			1151
	2" " "	490	"	1.50	735	.020	10		180			915
									-			
	6" FRP 90° Elb.	4	ea	26-	104	3.60	14		252			356
	3" " "	4	"	21-	84	3.00	12		216			300
	2" " "	6	"	16-	96	2.00	12		216			312
	6" FRP Tee	1	"	91-	91	4.00	4		72			163
	4 " "	1	"	30-	30	3.50	4		72			102
	3" " "	1	"	24-	24	2.75	3		54			78
	6" " COUPLING	35	ea	21-	735	1.0	35		630			1365
	4 " "	20	"	9-	180	.75	15		270			450
	3 " "	25	"	6-	150	.50	3		54			204
	SOLVENT.	1		250	250		-		-			250
	TEST- Line.	1415		20	283	.05	8.0		144			427
	Total.				6258				2916			9174

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 13 of

Location
Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-8-80</u>	Sheet <u>13</u> of <u> </u>
Project <u>Geothermal H.W. System</u>		<u>Salsbury, MD</u>	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	1" S.S. 304 Pipe	400	L.F.	7.25	2900		2.69		1079			3979
	1" S.S. 90° Fils	11	ea	8.60	95		16.15		178			273
	1" .. Gate Valves	2	"	89.	178		12.00		24			202
	CONNECTIONS TO EQUIP							18				-
	1"	2	ea	60	120	1.2	2.5		45			165
	2"	2	"	90	180	1.5	3.0		54			234
	3"	1	"	120	120	2.5	2.5		45			165
	INSULATION 2"								-			..
	URETHANE w/Vapor Jack								-			
	1"	400	L.F.	2.86	1144			1-	400			1544
	2"	200	"	3.34	668			110	226			888
	3"	375	"	3.85	1445			134	488			1933
	4"	200	"	4.54	908			150	300			1208
	6"	350	"	4.50	1575			122	700			2275
					9333				3533			12866

*Composite Rate - Based on Type of Work

BR-001 (2/76)

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT

Page 14 of

Location

Estimate Sheet

W.O. <u>4861-01</u>	Type Estimate <u> </u>	Client <u>CAMPBELL SOUP COMPANY</u>	Date <u>5-8-80</u>	Sheet <u> </u> of <u>6</u>
Project <u>Geothermal H.W. System</u>		Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by <u> </u>
Location <u>Salsbury, MD</u>			Discipline <u>Mechanical</u>	Approved by <u> </u>

Description				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	1" Clevis Flanges	40	ea	3-	120	.20	8	18	144			264
	2")	49	"	4-	196	.25	12		216			412
	3")	37	"	5-	185	.30	11		198			383
	4")	40	"	5.50	220	.40	16		288			508
	6")	35	"	6-	216	.45	16		288			504
	1" INSULATING Saddles	40	ea	1.50	60	.10	1.0		18			78
	2")	49	"	2.00	98	.10	1.0		18			116
	3")	37	"	2.50	93	.15	5-		54			147
	4")	40	"	3.00	120	.15	6-		108			228
	6")	35	"	3.00	105	.20	7-		126			231
	PIPE IDENTIFICATION		L.S	300	300	-	-	-	-			300

*Composite Rate -- Based on Type of Work

Burns and Roe, Inc.
COST EST. & SCHEDULING DEPARTMENT
Location _____
Estimate Sheet

Page 15 of _____

4861-01	Type Estimate	Client	Date <u>5-8-80</u>	Sheet <u>6</u> of <u>6</u>
Geothermal H.W. System		CAMPBELL SOUP COMPANY Salsbury, MD	Est. by <u>P. Ostrosky</u>	Ext. Chkd. by _____
Salsbury, MD			Discipline <u>CASE II</u>	Approved by _____

EXTERIOR PIPING				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	FROM well to BLOW TO Reinsection well						—	18				
	4"FRP PIPE	850	L.F	3.10	2635	.45	38		684			3319
	4" 90° ELLS FR.P.	16	ea	26-	416	4.0	64		1152			1568
	4" COUPLINGS	43	"	9-	387	.5	22		396			783
	4" FLANGES-	6	ea	26-	156	1.0	6		108			264
	4 Bolt & G ASSETS	6	ea	5-	30	1.0	6-		108			138
	SOLVENTS		L.S.	190	190				—			190
	PIPE Saddles		ea		300				—			300
	2 1/2 URETHANE w/ S.S. JACKET	850	L.F	450	3825	.10	85		1530			5355
	PIPE SUPPORTS	57	ea	80	4560		—					4560
	TEST	850	L.F.	20.	170		—					170
	Conn. @ Well.		L.S	1500	1500		—					1500
	" @ Reinsection		L.S	1500	1500			✓				1500
	TOTAL				15669				2978			18647

Burns and Roe, Inc.
COST EST. & SCHEDULING DEPARTMENT
Location _____
Estimate Sheet

Page 16 of _____

4861-01	Type Estimate	Client	Date <u>5-8-80</u>	Sheet <u>7</u> of <u>6</u>
Geothermal H.W. System		CAMPBELL SOUP COMPANY Salsbury, MD	Est. by P. Ostrosky	Ext. Chkd. by
Salsbury, MD			Discipline <u>CASE II</u>	Approved by

PIPING IN Thermal BLDG.				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	GEO-THERMAL											
	4" FRP PIPE	80	L.F.	3.10	248	.25	20	18	360			608
	4" 90° Elbs	15	ea	26-	390	2.	30		540			930
	4" Gate Valves	4	ea	380	1520	2.0	8		144			1664
	4" Check Valves	2	ea	360	720	2.0	4		72			792
	1" Flanges	15	ea	26	390	1.5	23		414			804
	4" Bolt/gaskets	15	ea	5	75	1.0	15		270			345
	SOLVENT	LS		90	90		-		-			90
	SUPPORTS, MISC. STL.	LS		120	120		-		-			120
	4" INSULATION	130	L.F.	4.55	585	1.50	150		195			780
	TEST	80	L.F.	20	160	1.10	8-		144			304

Burns and Roe, Inc.
COST ESTIMATING & SCHEDULING DEPARTMENT
Location _____
Estimate Sheet

Page 17 of _____

4861-01	Type Estimate	Client	Date <u>5-8-80</u>	Sheet <u>8</u> of <u>8</u>
Geothermal H.W. System		CAMPBELL SOUP COMPANY Salsbury, MD	Est. by <u>C. P. Ostrosky</u>	Ext. Chk'd. by
Salsbury, MD			Discipline <u>CASE II</u>	Approved by

PIPING IN GEOTHERMAL BLDG.				ESTIMATED COST						Contract Unit Cost		Total Amount
Account No.	Description	Qty.	Unit	Material		Labor				Unit Price	Amount	
				Cost/Unit	Cost	MH/Unit	MH's	Rate*	Cost			
	POTABLE -											
	6" FRP PIPE	90	L.F	5.70	513	.050	5	18	90			603
	6" FRP 90° EL	8	ea	26	208	3.60	29		522			730
	6" " Tee	2	"	91	182	4.0	8-		144			326
	6" " FLANGES	6	ea	31	186	1.5	9		162			348
	6" B/G SET	6	ea	650	39	1.0	6		108			147
	6" Gate Valve Flg	2	ea	495	990	2.0	4		72			1062
	6" Check "	1	"	440	440	2-	2-		36			476
	6" INSULATION	130	L.F	4.50	585	2-		2-	260			845
	6" HANGERS	9	ea	4-	36	.5	5		90			126
	TEST.	130	L.F	.70	26	.05	7-		126			152
	Chemical Piping		L.S	400	400	-	-		200			600
	Total.				3605				1810			2215

4861-01

7/MAY/80

GEO-THERMAL H.W. SYSTEM - CASE IIA & B
ELECTRICAL

		1	2	3	4	5	6
		MATERIAL	LABOR	TOTAL			
1	SERVICE EQUIP	19700	9900	29600			
2	REINVERT PUMP HOUS	1600	4800	6400			
3	POWER CABLES	47200	47800	95000			
4	MOTOR HOUSING	5000	18200	21200			
5	LGK. IN PUMP HOUS	1000	2000	3000			
6	INSTRUMENTATION	500	4700	5200			
7	HEAT TAPPLINGS	5200	7500	12700			
8	OVERTIME & START-UP	—	3900	3900			
9							
10							
11	TOTAL	\$78200	\$98800	\$177000			
12							
13				180000			
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

APPENDIX D

Capital Cost Estimate Summary Sheets

These sheets provide a breakdown of the Capital Costs presented in Section VII. In general, any items not shown on a particular sheet would be the same as the corresponding item on a previous list.

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

<u>CASE. 5</u>		120°F - LINE: <u>340 gpm</u>		TOTAL
		<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
		\$	\$	\$
1	<u>CIVIL - STRUCTURAL</u>	19,187	11,523	30,710
2	<u>EQUIPMENT</u>			
	HEAT PUMP (1)	101,200	570	101,770
	(2)	46,500	240	46,740
	HEAT EXCHANGER 1	21,600	320	21,920
	2	14,700	220	14,920
	A	61,700	230	61,930
	B	14,100	130	14,230
	RECIRC PUMP 1	9,950	36	9,986
	2	650	36	686
	PROCESS WATER PUMP 1	} 2,800	72	2,872
	2			
	REINJECTION PUMP	4,900	1075	5,975
	STORAGE TANK 1	42,580	7,100	49,680
	2	24,047	3,243	27,290
	<u>SUBTOTAL</u>	333,727	13,977	347,704
3	<u>PIPING</u>			
	EXISTING PLANT	35,970	10,367	46,337
	GEO THERMAL PIPING	29,163	8,255	37,418
	GEO THERMAL BUILDING	7,265	1,832	9,097
	<u>SUBTOTAL</u>	72,400	20,454	92,854
4	<u>PRETREATMENT</u>	271,000	2,781	273,781
	EQUIPMENT	295,400		
	BUILDING	22,400		22,400
	PIPING-PUMP	2,000	2,000	4,000
	<u>SUBTOTAL</u>	295,400	4,781	300,181
5	<u>INSTRUMENTATION</u>	9,000	3,000	12,000

**Burns and Roe
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title III - ROFF - LINE

	<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
	\$	\$	\$
6 ELECTRICAL			
SERVICE EQUIPMENT	28,453	14,625	43,078
REINJECTION PUMP	1,265	3,770	5,035
POWER FEEDERS	21,500	24,530	46,030
MOTOR HOOK-UP	600	4,270	4,870
LIGHTS - RECEPTABLES	2,100	5,300	7,400
INSTRUMENTATION	400	3,715	4,115
HEAT TRACING	4,110	5,930	10,040
PRETREATMENT	4,664	7,114	11,778
OVERTIME - START UP	-	4,510	4,510
ADJUST PRIM. SERVICE	12,230	2,330	14,560
SUBTOTAL	76,914	77,234	154,150
1 CIVIL - STRUCTURAL	17,137	11,523	28,660
INS. TAX. SCAFF. HOB 60% LABOR	-	6,310	6,310
CONTINGENCY 20%	3,442	2,305	5,747
SUBTOTAL	20,579	20,138	40,717
O + P 15%			6,108
TOTAL			50,825
2-3-4 MECHANICAL + PRETREATMENT	701,530	34210	735,740
INS. TAX. HOB. RENT. 60% LABOR	-	23,526	23,526
CONTINGENCY 10%	70,153	3421	73,574
SUBTOTAL	771,683	66,660	838,343
START UP			10,000
O + P 15%			125,350
TOTAL			973,693
5 INSTRUMENTATION	9200	3000	12200
CONTINGENCY 25%			3050
TOTAL			15250
6 ELECTRICAL	74230	74210	148,440
O + P 15% + 10%			112,000
TOTAL			260,440
GRAND TOTAL			1,235,920

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE 5

120°F - THRESHOLD - 340 gpm

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

1 CIVIL - STRUCTURAL

30,710

2 EQUIPMENT

HEAT PUMP 1

2

HEAT EXCHANGER 1.

2

A

8

RECIRC. PUMP 1

2

PROCESS WATER PUMP 1

2

REINJECTION PUMP

STORAGE TANK 1

2

SUBTOTAL

333,727

13,977

347,704

3 PIPING

EXISTING PLANT

GEOTHERMAL PIPING

GEOTHERMAL BUILDING

SUBTOTAL

92,400

20,454

112,854

4 PRETREATMENT

EQUIPMENT

25600

100

25700

BUILDING

-

-

PIPING-PUMP

300

72

372

SUBTOTAL

25900

18

25918

5 INSTRUMENTATION

12,000

**Burns and Roe
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

	<u>MATERIAL</u> \$	<u>LABOR</u> \$	<u>TOTAL</u> \$
6 ELECTRICAL			
SERVICE EQUIPMENT			
REINJECTION PUMP			
POWER FEEDERS			
MOTOR HOOK-UP			
LIGHTS - RECEPTABLES			
INSTRUMENTATION			
HEAT TRACING			
PRETREATMENT	1980	4270	6250
OVERTIME - START UP			
ADJUST PRIM. SERVICE			
SUBTOTAL	74,230	74,310	148,540
1 CIVIL - STRUCTURAL			
INS. TAX. SCAFF. HOB 60% LABOR			
CONTINGENCY 20%			
SUBTOTAL			
O + P 15%			
TOTAL			50,330
2-3-4 MECHANICAL + PRETREATMENT	432,027	34,611	466,638
INS. TAX. HOB. RENT. 60% LABOR	—	20,767	20,767
CONTINGENCY 10%	43,203	3,461	46,664
SUBTOTAL	475,230	58,839	534,070
START UP			10,000
O + P 15%			81,610
TOTAL			625,680
5 INSTRUMENTATION			
CONTINGENCY			
TOTAL			15,000
6 ELECTRICAL			148,540
O + P 15% + 10%			39,360
TOTAL			187,900
GRAND TOTAL			<u>872,910</u>

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE 4

12" F - LINE - 304 gpm

		<u>MATERIAL</u> \$	<u>LABOR</u> \$	<u>TOTAL</u> \$
1	<u>CIVIL - STRUCTURAL</u>	20400	12,300	32,700
2	<u>EQUIPMENT</u>			
	HEAT PUMP (1)	97,000	570	97,570
	2			
	HEAT EXCHANGER 1	61,700	230	61,930
	2			
	A	23,000	230	23,230
	B	15,600	230	15,830
	RECIRC PUMP 1	950	36	986
	2			
	PROCESS WATER PUMP 1	2300	36	2336
	2			
	REINJECTION PUMP	4400	990	5390
	STORAGE TANK 1	64,600	11000	75,600
	2			
	<u>SUBTOTAL</u>	<u>269,550</u>	<u>13320</u>	<u>282,870</u>
3	<u>PIPING</u>			
	EXISTING PLANT	17,331	7907	25,238
	GEO THERMAL PIPING	15,662	3,978	19,640
	GEO THERMAL BUILDING	4,228	2,139	6,367
	<u>SUBTOTAL</u>	<u>37,221</u>	<u>14,024</u>	<u>51,245</u>
4	<u>PRETREATMENT</u>			
	EQUIPMENT	253,800	2780	256,580
	BUILDING	22,400	-	22,400
	PIPING - PUMP	2,000	2,000	4,000
	<u>SUBTOTAL</u>	<u>\$ 278,200</u>	<u>4780</u>	<u>282,980</u>
5	<u>INSTRUMENTATION</u>	5850	1300	7650

**Burns and Roe
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

II - 120" F - LINE - 304' x m

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL	20400	12,300	32,700
INS. TAX. SCAFF. MOB 60% LABOR	-	7,380	7,380
CONTINGENCY 20%	4080	2460	6540
SUBTOTAL	24480	22140	46,620
O + P 15%			6,973
TOTAL			53,613

2-3-4 MECHANICAL + PRETREATMENT	585,048	32,124	617,172
INS. TAX. MOB. RENT. 60% LABOR	-	19,274	19,274
CONTINGENCY 10%	58,505	3,212	61,717
SUBTOTAL	643,553	54,610	698,163
START UP			10,000
O + P 15%			106,224
TOTAL			814,387

5 INSTRUMENTATION			7650
CONTINGENCY 25%			1950
TOTAL			9600

6 ELECTRICAL			
O + P 15% + 10%			198,200
TOTAL			

GRAND TOTAL

= 1,065,900

Burns and Roe
Industrial Services Corp.

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE 4 120°F - THRESHOLD - 304 SS

	<u>MATERIAL</u> \$	<u>LABOR</u> \$	<u>TOTAL</u> \$
1 <u>CIVIL - STRUCTURAL</u>	10,200	6150	16,350
2 <u>EQUIPMENT</u>			
HEAT PUMP 1			
2			
HEAT EXCHANGER 1			
2			
A			
B			
RECIRC PUMP 1			
2			
PROCESS WATER PUMP 1			
2			
REINJECTION PUMP			
STORAGE TANK 1			
2			
<u>SUBTOTAL</u>	269,550	13,320	282,870
3 <u>PIPING</u>			
EXISTING PLANT			
GEOTHERMAL PIPING			
GEOTHERMAL BUILDING			
<u>SUBTOTAL</u>	37,208	14,024	51,232
4 <u>PRETREATMENT</u>			
EQUIPMENT	25600	108	25,708
BUILDING	-	-	-
PIPING-PUMP	300	72	372
<u>SUBTOTAL</u>	25900	180	26080
5 <u>INSTRUMENTATION</u>			7650

Burns and Roe
Industrial Services Corp.

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL	10200	6150	16350
INS. TAX. SCAFF. MOB 60% LABOR		3670	3670
CONTINGENCY 20%	2040	1230	3270
SUBTOTAL	12240	11070	23310
O + P 15%			3497
TOTAL			26807

2-3-4 MECHANICAL + PRETREATMENT	332,748	27,524	360,272
INS. TAX. MOB. RENT. 60% LABOR		16,514	16,514
CONTINGENCY 10%	33295	2752	36047
SUBTOTAL	366043	46790	412,833
START UP			10,000
O + P 15%			13,422
TOTAL			436,255

5 INSTRUMENTATION			
CONTINGENCY			9600
TOTAL			

6 ELECTRICAL			188,300
O + P 15% + 10%			
TOTAL			

GRAND TOTAL

745,792

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE 3 120°F - LINE - 267 gpm

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

1 CIVIL - STRUCTURAL

2 EQUIPMENT

HEAT PUMP (1)

46,000	570	46,570
--------	-----	--------

HEAT EXCHANGER 1

51,732	220	51,952
--------	-----	--------

2

A

26,322	210	26,532
--------	-----	--------

B

18,166	230	18,396
--------	-----	--------

RECIRC PUMP 1

950	36	986
-----	----	-----

2

PROCESS WATER PUMP 1

2300	26	2326
------	----	------

2

REINJECTION PUMP

3975	300	4,275
------	-----	-------

STORAGE TANK 1

54,500	1,000	55,500
--------	-------	--------

2

SUBTOTAL

214,235	13,332	
---------	--------	--

3 PIPING

EXISTING PLANT

GEO THERMAL PIPING

GEO THERMAL BUILDING

SUBTOTAL

37,248	14,024	
--------	--------	--

4 PRETREATMENT

EQUIPMENT

BUILDING

PIPING - PUMP

SUBTOTAL

35,500	7,000	
--------	-------	--

5 INSTRUMENTATION

**Burns and Roe
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL

INS. TAX. SCAFF. HOB 60% LABOR
 CONTINGENCY 20%
 SUBTOTAL
 O + P 15%
 TOTAL

53,617

2-3-4 MECHANICAL + PRETREATMENT

INS. TAX. HOB. RENT. 60% LABOR
 CONTINGENCY 10%
 SUBTOTAL
 START UP
 O + P 15%
 TOTAL

510,023 32036

615,477
 -10,000

605,477

5 INSTRUMENTATION

CONTINGENCY
 TOTAL

9600

6 ELECTRICAL

O + P 15% + 10%
 TOTAL

GRAND TOTAL

772,535

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE.

120°F - THERMOCO - 107 1/2" dia

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

1 CIVIL - STRUCTURAL

2 EQUIPMENT

HEAT PUMP 1

2

HEAT EXCHANGER 1

2

A

B

RECIRC PUMP 1

2

PROCESS WATER PUMP 1

2

REINJECTION PUMP

STORAGE TANK 1

2

SUBTOTAL

214,235

13,932.

3 PIPING

EXISTING PLANT

GEO THERMAL PIPING

GEO THERMAL BUILDING

SUBTOTAL

37,270

4,024.

4 PRETREATMENT

EQUIPMENT

BUILDING

PIPING-PUMP

SUBTOTAL

35,712

1,674.

5 INSTRUMENTATION

**Burns and Roe
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL

INS. TAX. SCAFF. HOB 60% LABOR
 CONTINGENCY 20%
 SUBTOTAL
 O + P 15%
 TOTAL

26,600

2-3-4 MECHANICAL + PRETREATMENT

INS. TAX. HOB. RENT. 60% LABOR
 CONTINGENCY 10%
 SUBTOTAL
 START UP
 O + P 15%
 TOTAL

277,433

27,436

351,818

10,000

416,072

5 INSTRUMENTATION

CONTINGENCY
 TOTAL

600

6 ELECTRICAL

O + P 15% + 10%

TOTAL

GRAND TOTAL

452,472

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE. 2

120°F - LIME - 207 gpm

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

1 CIVIL - STRUCTURAL

2 EQUIPMENT

HEAT PUMP 1/2

HEAT EXCHANGER

1
2

51,900

230

52,130

39,200

230

39,430

A

8

RECIRC PUMP

1

250

36

286

2

PROCESS WATER PUMP

1

2300

36

2336

2

REINJECTION PUMP

4400

270

4670

STORAGE TANK

1

64,600

14,000

78,600

2

SUBTOTAL

163,350

12,522

175,872

3 PIPING

EXISTING PLANT

17,331

7907

25,238

GEO THERMAL PIPING

15,669

3977

19,647

GEO THERMAL BUILDING

2400

6070

8,470

SUBTOTAL

35,400

17,945

53,345

4 PRETREATMENT

EQUIPMENT

200,500

2780

203,280

BUILDING

-

-

-

PIPING - PUMP

2,000

2000

4,000

SUBTOTAL

202,500

4780

207,280

5 INSTRUMENTATION

**Burns and Roe
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL

INS. TAX. SCAFF. MOB 60% LABOR
 CONTINGENCY 20%
 SUBTOTAL
 O + P 15%
 TOTAL

53,612

2-3-4 MECHANICAL + PRETREATMENT

401 250 30 247

INS. TAX. MOB. RENT. 60% LABOR
 CONTINGENCY 10%
 SUBTOTAL
 START UP
 O + P 15%
 TOTAL

422,795

10,000

572,212

5 INSTRUMENTATION

CONTINGENCY
 TOTAL

8,000

6 ELECTRICAL

O + P 15% + 10%

TOTAL

GRAND TOTAL

641,422

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE. 1 120°F - THRESHOLD - 207 gpm

		<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
		\$	\$	\$
<u>1 CIVIL - STRUCTURAL</u>				
<u>2 EQUIPMENT</u>				
HEAT PUMP	1			
	2			
HEAT EXCHANGER	1			
	2			
	A			
	B			
RECIRC PUMP	1			
	2			
PROCESS WATER PUMP	1			
	2			
REINJECTION PUMP				
STORAGE TANK	1			
	2			
	<u>SUBTOTAL</u>	163,350	12,522.	
<u>3 PIPING</u>				
EXISTING PLANT				
GEO THERMAL PIPING				
GEO THERMAL BUILDING				
	<u>SUBTOTAL</u>	35,400	12,945.	
<u>4 PRETREATMENT</u>				
EQUIPMENT				
BUILDING				
PIPING-PUMP				
	<u>SUBTOTAL</u>	25,900	180	
<u>5 INSTRUMENTATION</u>				

**Burns and Roe
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL

INS. TAX. SCAFF. HOB 60% LABOR
 CONTINGENCY 20%
 SUBTOTAL
 O + P 15%
 TOTAL

26,807.

2-3-4 MECHANICAL + PRETREATMENT

INS. TAX. HOB. RENT. 60% LABOR
 CONTINGENCY 10%

224,650 25,627.

SUBTOTAL

290,715

START UP

O + P 15%

TOTAL

345,800

5 INSTRUMENTATION

CONTINGENCY

TOTAL

2600

6 ELECTRICAL

O + P 15% + 10%

TOTAL

GRAND TOTAL

382,200

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE. 1 120°F - LIME - 150 gpm

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

1 CIVIL - STRUCTURAL

2 EQUIPMENT

HEAT PUMP ~~X~~

HEAT EXCHANGER

1
2
A
B

38,605

230

38,835

29,700

230

29,930

-

-

-

-

-

-

RECIRC PUMP

1
2

760

36

796

-

-

-

PROCESS WATER PUMP

1
2

1150

36

1186

-

-

-

REINJECTION PUMP

1

3510

790

4300

STORAGE TANK

1
2

32300

5500

37800

-

-

-

SUBTOTAL

106,025

6822

3 PIPING

EXISTING PLANT

GEO THERMAL PIPING

GEO THERMAL BUILDING

SUBTOTAL

28,255

10,330

38,585

4 PRETREATMENT

EQUIPMENT

BUILDING

PIPING - PUMP

165,700

2780

168,480

-

-

2,000

2000

4000

SUBTOTAL

167,700

4780

5 INSTRUMENTATION

**Burns and Roe
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL

INS. TAX. SCAFF. MOB 60% LABOR
 CONTINGENCY 20%
 SUBTOTAL

O + P 15%

TOTAL

53,612

2-3-4 MECHANICAL + PRETREATMENT

301,980

21,932

INS. TAX. MOB. RENT. 60% LABOR
 CONTINGENCY 10%

SUBTOTAL

369,462

START UP

10,000

O + P 15%

TOTAL

479,382

5 INSTRUMENTATION

CONTINGENCY

TOTAL

4000

6 ELECTRICAL

O + P 15% + 10%

TOTAL

GRAND TOTAL

494,505

**Burns and Roe
Industrial Services Corp.**

W.D. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE. 1

120°F - THRESHOLD - 150 gpm.

MATERIAL
\$

LABOR
\$

TOTAL
\$

1 CIVIL - STRUCTURAL

2 EQUIPMENT

HEAT PUMP ~~1~~

~~2~~

HEAT EXCHANGER

1
2

A

B

RECIRC PUMP

1

2

PROCESS WATER PUMP

1

2

REINJECTION PUMP

STORAGE TANK

1

2

SUBTOTAL

106,025

6822

3 PIPING

EXISTING PLANT

GEO THERMAL PIPING

GEO THERMAL BUILDING.

SUBTOTAL

28,255

10,330

4 PRETREATMENT

EQUIPMENT

BUILDING

PIPING-PUMP

SUBTOTAL

25,900

100

5 INSTRUMENTATION

Burns and Roe
Industrial Services Corp.

W.O. No. _____ Date _____ Book No. _____ Page No. _____
Drawing No. _____ Calc. No. _____ Sheet 2 of _____
By _____ Checked _____ Approved _____
Title _____

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
REINJECTION PUMP
POWER FEEDERS
MOTOR HOOK-UP
LIGHTS - RECEPTABLES
INSTRUMENTATION
HEAT TRACING
PRETREATMENT
OVERTIME - START UP
ADJUST PRIM. SERVICE
SUBTOTAL

1 CIVIL - STRUCTURAL

INS. TAX. SCAFF. MOB 60% LABOR
CONTINGENCY 20%
SUBTOTAL
O + P 15%
TOTAL

26,807.

2-3-4 MECHANICAL + PRETREATMENT

INS. TAX. MOB. RENT. 60% LABOR
CONTINGENCY 10%
SUBTOTAL

160,180 17,332

205,662

START UP
O + P 15%

TOTAL

245,012.

5 INSTRUMENTATION

CONTINGENCY

TOTAL

9,000

6 ELECTRICAL

O + P 15% + 10%

TOTAL

GRAND TOTAL

284,420

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE. 1

DIFF. LINE - 224 gpm

		<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
		\$	\$	\$
<u>1 CIVIL - STRUCTURAL</u>				
<u>2 EQUIPMENT</u>				
HEAT PUMP	1	97,000	570	
	2	46,000	240	
HEAT EXCHANGER	1	61,200	320	
	2	13,700	230	
	A	24,000	270	
	B	11,200	230	
RECIRC PUMP	1	450	36	
	2	650	30	
PROCESS WATER PUMP	1	2300	72	
	2			
REINJECTION PUMP		4400	710	
STORAGE TANK	1	40500	9100	
	2	24040	3223	
	<u>SUBTOTAL</u>	<u>326,540</u>	<u>14,072</u>	
<u>3 PIPING</u>				
EXISTING PLANT				
GEO THERMAL PIPING				
GEO THERMAL BUILDING				
	<u>SUBTOTAL</u>	<u>72400</u>	<u>20454</u>	
<u>4 PRETREATMENT</u>				
EQUIPMENT		253,800		
BUILDING				
PIPING-PUMP				
	<u>SUBTOTAL</u>	<u>253,800</u>	<u>4750</u>	
<u>5 INSTRUMENTATION</u>				

**Gums and Roe
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL
 INS. TAX. SCAFF. HOB 60% LABOR
 CONTINGENCY 20%
 SUBTOTAL
 O + P 15%
 TOTAL

~~677,140~~

50,330

2-3-4 MECHANICAL + PRETREATMENT
 INS. TAX. HOB. RENT. 60% LABOR
 CONTINGENCY 10%
 SUBTOTAL
 START UP
 O + P 15%
 TOTAL

677,140

79036

311,582

10,000

742,518

5 INSTRUMENTATION
 CONTINGENCY
 TOTAL

15000

6 ELECTRICAL
 O + P 15% + 10%
 TOTAL

GRAND TOTAL

1,010,118

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE. 3

20% - THRESHOLD 2/4 1/2

		<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
		\$	\$	\$
<u>1 CIVIL - STRUCTURAL</u>				
<u>2 EQUIPMENT</u>				
HEAT PUMP	1			
	2			
HEAT EXCHANGER	1			
	2			
	A			
	B			
RECIRC PUMP	1			
	2			
PROCESS WATER PUMP	1			
	2			
REINJECTION PUMP				
STORAGE TANK	1			
	2			
	<u>SUBTOTAL</u>	<u>326,540</u>	<u>14,002.</u>	
<u>3 PIPING</u>				
EXISTING PLANT				
GEO THERMAL PIPING				
GEO THERMAL BUILDING				
	<u>SUBTOTAL</u>	<u>93400</u>	<u>20,954.</u>	
<u>4 PRETREATMENT</u>				
EQUIPMENT				
BUILDING				
PIPING-PUMP				
	<u>SUBTOTAL</u>	<u>15700</u>	<u>3,700</u>	
<u>5 INSTRUMENTATION</u>				

**Burns and Roe
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

MATERIAL
\$

LABOR
\$

TOTAL
\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL

INS. TAX. SCAFF. HOB 60% LABOR
 CONTINGENCY 20%
 SUBTOTAL
 O + P 15%
 TOTAL

50,370

2-3-4 MECHANICAL + PRETREATMENT

INS. TAX. HOB. RENT. 60% LABOR
 CONTINGENCY 10%
 SUBTOTAL
 START UP
 O + P 15%
 TOTAL

424,840

34,670

515,205
 10,000

525,205

5 INSTRUMENTATION

CONTINGENCY
 TOTAL

15,000

6 ELECTRICAL

O + P 15% + 10%
 TOTAL

GRAND TOTAL

611,165

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE. 2

130°F - LIME - 263 gpm

		<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
		\$	\$	\$
<u>1 CIVIL - STRUCTURAL</u>				
<u>2 EQUIPMENT</u>				
HEAT PUMP	①	80,000	570	80,570
	2	—	—	—
HEAT EXCHANGER	1	61,135	220	61,355
	2	—	—	—
	A	24,653	230	24,883
	B	11,459	230	11,689
RECIRC PUMP	1	950	36	986
	2	—	—	—
PROCESS WATER PUMP	1	2300	36	2336
	2	—	—	—
REINJECTION PUMP		3975	900	4875
STORAGE TANK	1	64600	11000	75600
	2	—	—	—
	<u>SUBTOTAL</u>	<u>249,072</u>	<u>13,232</u>	
<u>3 PIPING</u>				
EXISTING PLANT				
GEO THERMAL PIPING				
GEO THERMAL BUILDING				
	<u>SUBTOTAL</u>	<u>37,238</u>	<u>14,024</u>	
<u>4 PRETREATMENT</u>				
EQUIPMENT		234,100	2780	236,880
BUILDING		22400	—	22400
PIPING-PUMP		2000	2000	4000
	<u>SUBTOTAL</u>	<u>258,500</u>	<u>4780</u>	
<u>5 INSTRUMENTATION</u>				

**Burns and Roe
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL

INS. TAX. SCAFF. HOB 60% LABOR
 CONTINGENCY 20%
 SUBTOTAL
 O + P 15%
 TOTAL

53 613

2-3-4 MECHANICAL + PRETREATMENT

INS. TAX. HOB. RENT. 60% LABOR
 CONTINGENCY 10%
 SUBTOTAL
 START UP
 O + P 15%
 TOTAL

544 870 32 036

653 813
 10 000

763 813

5 INSTRUMENTATION

CONTINGENCY
 TOTAL

9600

6 ELECTRICAL

O + P 15% + 10%

TOTAL

GRAND TOTAL

226 600

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE. 1

130°F - THRESHOLD - 262 gpm.

	<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
	\$	\$	\$
<u>1 CIVIL - STRUCTURAL</u>			
<u>2 EQUIPMENT</u>			
HEAT PUMP (1)			
2			
HEAT EXCHANGER 1			
2			
A			
B			
RECIRC PUMP. 1			
2			
PROCESS WATER PUMP 1			
2			
REINJECTION PUMP			
STORAGE TANK 1			
2			
<u>SUBTOTAL</u>	249072	13232.	
<u>3 PIPING</u>			
EXISTING PLANT			
GEO THERMAL PIPING			
GEO THERMAL BUILDING.			
<u>SUBTOTAL</u>	37293	1424.	
<u>4 PRETREATMENT</u>			
EQUIPMENT			
BUILDING			
PIPING-PUMP			
<u>SUBTOTAL</u>	25900	130	
<u>5 INSTRUMENTATION</u>			

**Burns and Roe
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL

INS. TAX. SCAFF. MOB 60% LABOR
 CONTINGENCY 20%
 SUBTOTAL

O + P 15%

TOTAL

26,807

2-3-4 MECHANICAL + PRETREATMENT

INS. TAX. MOB. RENT. 60% LABOR
 CONTINGENCY 10%

SUBTOTAL

START UP

O + P 15%

TOTAL

312,270

27,436

370,138

10,000

460,160

5 INSTRUMENTATION

CONTINGENCY

TOTAL

9,600

6 ELECTRICAL

O + P 15% + 10%

TOTAL

GRAND TOTAL

406,570

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP - CAPITAL COSTS

CASE. 12 150°F - LINE - 234.97m

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
<u>\$</u>	<u>\$</u>	<u>\$</u>

1 CIVIL - STRUCTURAL

2 EQUIPMENT

HEAT PUMP ①

46,000 240

X

HEAT EXCHANGER 1

53,700 320

2A+2B

46,400 460

AMB

22,500 230

B

10,100 230

RECIRC PUMP 1

650 36

2

400 36

PROCESS WATER PUMP 1

} 2800 72

2

REINJECTION PUMP

3800 900

STORAGE TANK 1

40,580 7100

2

24,647 3948

SUBTOTAL

250,977 13,572

3 PIPING

EXISTING PLANT

35,970 10,367

GEO THERMAL PIPING

15,669 3,978

GEO THERMAL BUILDING

7,265 1,332

SUBTOTAL

58,904 16,177

4 PRETREATMENT

EQUIPMENT

220,000 2,781

BUILDING

22,400 -

PIPING-PUMP

2,000 2,000

SUBTOTAL

244,400 4,781

5 INSTRUMENTATION

**BURNS AND ROE
Industrial Services Corp.**

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL

INS. TAX. SCAFF. HOB 60% LABOR
 CONTINGENCY 20%
 SUBTOTAL
 O + P 15%
 TOTAL

50,330

2-3-4 MECHANICAL + PRETREATMENT

554,281 34,530

INS. TAX. HOB. RENT. 60% LABOR
 CONTINGENCY 10%
 SUBTOTAL
 START UP
 O + P 15%
 TOTAL

664,757
 10,000

674,757

5 INSTRUMENTATION

CONTINGENCY
 TOTAL

15,000

6 ELECTRICAL

O + P 15% + 10%
 TOTAL

GRAND TOTAL

689,757

Burns and Roe
Industrial Services Corp.

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
Drawing No. _____ Calc. No. _____ Sheet 1 of _____
By _____ Checked _____ Approved _____
Title CAMPBELL SOUP - CAPITAL COSTS

CASE 12 150°F - THRESHOLD - 20% INCL.

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

1 CIVIL - STRUCTURAL

2 EQUIPMENT

HEAT PUMP 1

2

HEAT EXCHANGER 1

2

A

B

RECIRC PUMP 1

2

PROCESS WATER PUMP 1

2

REINJECTION PUMP

STORAGE TANK 1

2

SUBTOTAL

250,977

19,572

3 PIPING

EXISTING PLANT

GEO THERMAL PIPING

GEO THERMAL BUILDING

SUBTOTAL

53,904

16,077

4 PRETREATMENT

EQUIPMENT

BUILDING

PIPING-PUMP

SUBTOTAL

25,000

100

5 INSTRUMENTATION

BURNS AND ROE
Industrial Services Corp.

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title _____

<u>MATERIAL</u>	<u>LABOR</u>	<u>TOTAL</u>
\$	\$	\$

6 ELECTRICAL

SERVICE EQUIPMENT
 REINJECTION PUMP
 POWER FEEDERS
 MOTOR HOOK-UP
 LIGHTS - RECEPTABLES
 INSTRUMENTATION
 HEAT TRACING
 PRETREATMENT
 OVERTIME - START UP
 ADJUST PRIM. SERVICE
 SUBTOTAL

1 CIVIL - STRUCTURAL

INS. TAX. SCAFF. MOB 60% LABOR
 CONTINGENCY 20%
 SUBTOTAL
 O + P 15%
 TOTAL

50,320

2-3-4 MECHANICAL + PRETREATMENT

INS. TAX. MOB. RENT. 60% LABOR
 CONTINGENCY 10%
 SUBTOTAL
 START UP
 O + P 15%
 TOTAL

335,780 27,227

420,237
 10,000

434,973

5 INSTRUMENTATION

CONTINGENCY
 TOTAL

15,000

6 ELECTRICAL

O + P 15% + 10%
 TOTAL

GRAND TOTAL

560,193

APPENDIX E

Cash Flow Analysis Sheets

This Appendix contains the cash flow analysis work sheets for each of the 39 cases defined in Section VIII. These sheets are intended to indicate the methods used to calculate the various annual operating costs and cash flows.

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 1 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW -150 GPM ; SPECIFIC CAPACITY -0.1 $\frac{\text{GPM}}{\text{FE OF FLOWDOWN}}$

FUEL OIL SAVINGS = 214,600 gal/year

ELECTRICITY CONSUMPTION = 1,124,000 kWhr/year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1990):

WELL = \$1,082,000 ; SURFACE SYSTEM = 468,000 ; TOTAL PLANT = \$1,550,000

HEAT PUMP EQUIPMENTS ONLY = \$28,100

ESCALATE ALL COSTS AT 10%/YEAR EXCEPT FUEL OIL AND ELECT. POWER FOR YEARS 1-4

ALL ANNUAL COSTS ARE IN \$1000

DATE	No. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PREC- IATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX -48.6% RATE	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041														
6/1/81	0	0.78	0.045	-1570					-1570							-1570.0	
6/1/82	1	0.98	0.052		-31.4	-58.4	-42.1	-8.1	+210.3	+65.3	-757.4	-78.5	-770.6	+274.8	+649.0	+714.3	
	2	1.22	0.062		-34.5	-70.0	-51.8	-8.9	+224.8	+96.6		-78.5	+18.1		-8.8	+57.8	
	3	1.46	0.075		-38.0	-81.0	-57.0	-9.8	+217.3	+124.5		-78.5	+46.0		-22.4	+102.1	
	4	1.68	0.090		-41.8	-101.2	-62.7	-10.8	+262.8	+144.0		-78.5	+65.5		-31.8	+112.2	
	5								+186.4				+79.9		-38.4	+115.6	
	6								+174.2				+95.7		-46.5	+127.7	
	7								+191.7				+113.2		-55.0	+136.7	
	8								+210.9				+132.4		-64.7	+146.6	154.0
	9								+232.0				+153.5		-74.6	+157.4	1701.4
	10								+255.3				+176.7		-85.9	+169.3	
	11								+280.1				+201.6		-98.0	+182.1	
	12								+308.7				+230.2		-111.9	+196.8	
	13								+339.6				+261.1		-126.9	+212.7	
	14								+372.5				+295.0		-143.4	+230.1	
	15								+410.9				+332.4		-161.5	+249.4	
	16								+452.0				+373.5		-181.5	+270.5	
	17								+497.2				+418.7		-203.5	+293.7	
	18								+546.9				+468.4		-227.6	+319.3	
	19								+601.6				+523.1		-254.2	+347.4	
	20								+661.7				+583.2		-283.4	+378.3	

ROI = 13.08%

Payback = 8.15 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -126 °F ; FLOW 207 GPM ; SPECIFIC CAPACITY -0.1 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

FUEL OIL SAVINGS = 296,400 gal./year

ELECTRICITY CONSUMPTION = 2,026,500 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1950):

WELL = 1,120,000 ; SURFACE SYSTEM = 650,000 ; TOTAL PLANT = 1,770,000

HEAT PUMP & BUILDINGS ONLY = \$28,100

ALL ANNUAL COSTS ARE IN \$1000

No. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX -48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/50	PRESENT	0.60	0.041													
0	0.75	0.045	-1770.0						-1770.0						-1770.0	
6/1/52	1	0.98	0.052	-35.4	-105.4	-53.1	-11.1	+290.5	+55.9	-741.0	-88.5	-787.0	+320.1	+703.2	+788.7	
2	1.22	0.062		-38.9	-125.6	-58.4	-12.2	+361.6	+126.5		-88.5	+38.0		-18.5	+108.0	
3	1.46	0.075		-42.8	-152.0	-64.3	-13.5	+432.7	+160.1		-88.5	+71.6		-34.8	+125.3	
4	1.68	0.090		-47.1	-182.3	-70.7	-14.8	+498.0	+183.1		-88.5	+94.6		-46.0	+137.1	
5									+201.4			+112.9		-54.9	+146.5	
6									+221.6			+133.1		-64.7	+156.9	
7									+243.7			+155.3		-75.4	+168.3	+1630.8
8									+268.1			+179.6		-87.3	+180.8	+1811.6
9									+294.9			+206.4		-100.5	+194.6	
10									+324.4			+235.9		-114.6	+209.8	
11									+356.8			+268.3		-130.4	+226.4	
12									+392.5			+304.0		-147.7	+244.8	
13									+431.7			+343.2		-166.8	+264.9	
14									+474.9			+386.4		-187.8	+287.1	
15									+522.4			+433.9		-210.9	+311.5	
16									+574.6			+485.1		-236.2	+338.4	
17									+632.1			+543.6		-264.2	+367.9	
18									+695.3			+608.8		-294.9	+400.4	
19									+764.9			+676.4		-328.7	+436.2	
20									+841.3			+752.8		-365.9	+475.4	

ROI = 13.97 %

Payback = 7.77 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 3 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW -267 GPM ; SPECIFIC CAPACITY -0.1 ^{GPM}/_{FE OF DRAWDOWN}

FUEL OIL SAVINGS = 404,200 gal./year
 ELECTRICITY CONSUMPTION = 4,879,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1980):

WELL = \$1,160,000 ; SURFACE SYSTEM = \$13,000 ; TOTAL PLANT = \$1,973,000

HEAT PUMP & BUILDINGS ONLY = \$100,800

* USE \$40/kWh

HEAT PUMP

58,544 MCH
 10,700 ELECT*

69,244
 X1.05 ESCALATION

\$72,707 TOTAL HEAT PUMP
 28,100 BUILDINGS
 100,800

ALL ANNUAL COSTS ARE IN \$1000

NO. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kWh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAR- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX -48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESNT	0.60	0.041													
	0	0.78	0.045	-1973.0					-1973.0						-1973.0	
6/1/82	1	0.98	0.052		-39.5	-212.1	-57.2	-14.4	+296.1	+70.9	-512.8	-98.7	-539.8	+356.3	+764.4	+835.3
	2	1.22	0.062		-43.4	-252.9	-65.1	-15.8	+453.1	+115.9		-98.7	+172	-8.4	+107.5	
	3	1.46	0.075		-47.7	-305.9	-71.6	-17.4	+570.1	+147.5		-98.7	+488	-23.7	+123.8	
	4	1.68	0.090		-52.5	-367.1	-78.8	-19.2	+679.1	+161.5		-98.7	+628	-30.5	+171.0	
	5								+177.7				+79.0	-38.4	+139.3	
	6								+195.4				+96.7	-47.0	+148.4	
	7								+215.0				+116.3	-56.5	+158.5	
	8								+236.5				+137.8	-67.0	+169.5	+1813.3
	9								+260.1				+161.4	-78.4	+181.7	+1995.0
	10								+286.1				+187.4	-91.1	+195.0	
	11								+314.7				+216.0	-105.0	+209.7	
	12								+346.2				+247.5	-120.3	+225.9	
	13								+380.8				+282.1	-137.1	+243.7	
	14								+418.9				+320.7	-155.6	+263.7	
	15								+460.8				+362.8	-176.0	+284.8	
	16								+506.9				+406.2	-196.4	+306.5	
	17								+557.5				+456.5	-223.0	+324.5	
	18								+613.3				+514.6	-250.1	+363.2	
	19								+674.6				+575.9	-279.9	+394.7	
	20								+742.1		V		+647.4	-312.7	+429.4	

ROI = 11.72 %

Payback = 8.88 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 4 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120 °F ; FLOW-304 GPM ; SPECIFIC CAPACITY - 0.1 ^{GPM}/_{FE OF DRAWDOWN}

FUEL OIL SAVINGS = 485,400 gal./year
 ELECTRICITY CONSUMPTION = 5,962,000 kWhr./year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1980):
 WELLS \$1,185,000 ; SURFACE SYSTEM \$754,000 ; TOTAL PLANT \$2,139,000
 HEAT PUMP & BUILDINGS ONLY = \$168,400

HEAT PUMP
 \$122,300 MECH
 11,300 ELECT
 133,600
 x 1.05 ESCALATION
 140,300 TOTAL HEAT PUMP
 28,100 BUILDING + 5%
 168,400 BLOC + HEAT PUMP

ALL ANNUAL COSTS ARE IN \$1000

No. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX -48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041													
0	0.78	0.045	-2139.0					2139.0							-2139.0	
4/1/82	1	0.98	0.052	-42.8	-310.4	-64.2	-16.5	475.7	441.8	-529.5	-107.0	-554.7	38.58	+88.9	+861.7	
2	1.22	0.062		-47.1	-370.1	-70.6	-18.1	552.2	486.3		-107.0	-20.7		+10.1	+96.4	
3	1.46	0.075		-51.8	-447.7	-77.7	-19.9	708.7	411.6		-107.0	+4.6		-2.2	+109.4	
4	1.68	0.090		-57.0	-537.2	-85.5	-21.9	845.5	413.9		-107.0	+6.9		-3.4	+110.5	
5								125.3				+18.3		-8.9	+116.4	
6								177.8				+30.8		-15.0	+122.8	
7								151.6				+44.6		-21.7	+129.9	
8								166.8				+55.8		-29.1	+137.7	
9								183.4				+76.4		-37.1	+146.3	
10								201.8				+94.8		-46.1	+155.7	+1586.8
11								222.0				+115.0		-55.9	+166.1	+2152.9
12								244.2				+137.2		-66.7	+177.5	
13								268.6				+161.6		-78.5	+190.1	
14								295.4				+188.4		-91.6	+203.8	
15								325.0				+218.0		-105.5	+215.1	
16								357.5				+250.5		-121.7	+235.8	
17								393.2				+286.8		-139.1	+254.1	
18								432.5				+325.5		-158.2	+274.3	
19								475.8				+368.8		-179.2	+296.6	
20								523.3				+416.3		-202.3	+321.0	

ROI = 8.39 %

Payback = 10.97 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 5 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW-340 GPM ; SPECIFIC CAPACITY-0.1 $\frac{\text{GPM}}{\text{FEET OF DRAWDOWN}}$

* USE $\frac{1}{40}$ PER W

FUEL OIL SAVINGS = 562,000 gal./year

ELECTRICITY CONSUMPTION = 7,890,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1950):

WELL = \$1,210,000 ; SURFACE SYSTEM = \$1,204,000; TOTAL PLANT = \$2,414,000

HEAT PUMP & BUILDINGS ONLY = \$204,700

HEAT PUMP

127,600 MECH.

17,100 ELECT.*

144,700

41,05 ESCALATION

151,700 TOTAL HEAT PUMP

52,800 BLOC + 5% ESCAL

204,700 BLOC + HEAT PUMP

ALL ANNUAL COSTS ARE IN \$1000

Nr. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAR- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/50	PRESENT	0.60	0.041													
0	0.78	0.045	-2414.0						-2414.0						-2414.0	
6/1/52	1	0.98	0.052	-48.3	-410.3	-72.4	-18.4	+580.8	+1.4	-847.0	-120.7	-966.3	+445.7	+915.3	+916.7	
2	1.22	0.062		-53.1	-482.2	-79.7	-20.2	+655.8	+42.4		-130.7	-77.3		+37.6	+81.0	
3	1.46	0.075		-58.4	-518.8	-87.6	-22.3	+620.5	+60.4		-120.7	-60.3		+29.3	+59.7	
4	1.68	0.090		-64.3	-510.1	-96.4	-24.5	+744.2	+48.9		-120.7	-71.8		+34.9	+83.8	
5									+53.8			-66.9		+32.5	+86.3	
6									+55.2			-61.5		+29.9	+89.1	
7									+65.1			-55.2		+27.0	+92.1	
8									+71.6			-49.1		+23.9	+95.5	
9									+78.1			-41.9		+20.4	+99.2	
10									+86.6			-34.1		+16.2	+103.2	
11									+95.3			-25.4		+12.3	+107.6	
12									+104.8			-15.9		+7.7	+112.5	
13									+115.3			-5.4		+2.6	+117.9	
14									+126.8			+6.1		-3.0	+123.8	
15									+138.5			+16.8		-9.1	+130.4	+2335.8
16									+153.5			+32.8		-15.9	+137.6	+2466.4
17									+168.8			+46.1		-23.4	+145.4	
18									+185.7			+65.0		-31.5	+154.1	
19									+204.3			+83.6		-40.6	+163.2	
20									+224.7			+104.0		-50.5	+174.2	

K.O.I = 3.09 %

Payback = 15.62 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 6 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW -207 GPM ; SPECIFIC CAPACITY - 0.15 ^{GPM} / ^{FEET} OF DRAWDOWN

FUEL OIL SAVINGS = 296,400 gal./year
 ELECTRICITY CONSUMPTION = 556,000 kWhr./year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1960):
 WELL \$120,000 ; SURFACE SYSTEM \$551,000 ; TOTAL PLANT \$1,571,000
 HEAT PUMP & BUILDINGS ONLY \$28,100

ALL ANNUAL COSTS ARE IN \$1000

Nr. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- SIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/60 PRESENT	0.60	0.041														
0	0.78	0.045	-1671.0						-1671.0						-1671.0	
4/1/62 1	0.98	0.052		-33.4	-28.9	-50.1	-11.1	+290.5	+167.0	-78.4	-83.6	-700.6	+295.9	+636.4	+903.4	
2	1.22	0.062		-36.8	-34.5	-55.1	-12.2	+361.6	+223.0		-83.6				+155.3	
3	1.46	0.075		-40.4	-41.7	-60.6	-13.5	+432.7	+276.5		-83.6				+182.8	
4	1.68	0.090		-44.5	-50.0	-66.7	-14.8	+498.0	+322.0		-83.6				+206.1	
5									+354.2						+222.7	1570.3
6									+389.6						+240.9	1811.2
7									+425.6						+260.9	
8									+471.5							
9									+518.6							
10									+570.5							
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

5.42 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 7 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW-247GPM ; SPECIFIC CAPACITY-0.5 ^{GPM}/_{FE OF DRAWDOWN}

FUEL OIL SAVINGS = 404,200 gal./year
 ELECTRICITY CONSUMPTION = 1,625,000 kWhr./year
 CAPITAL COSTS (INCL 40% 5% ESCALATION TO 4TH QTR. 1980):
 WELL = \$1,160,000 ; SURFACE SYSTEM = \$648,000 ; TOTAL PLANT = \$1,808,000
 HEAT PUMP & BUILDINGS ONLY = \$100,000

ALL ANNUAL COSTS ARE IN \$1000

	N. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041							-1508						-1508.0	
	0	0.78	0.045	-1808.0						-1508						-1508.0	
4/1/82	1	0.98	0.052		-36.2	-84.5	-54.2	-14.4	+356.1	+206.5	-512.0	-90.4	-655.6	+315.0	+653.1	+859.9	
	2	1.22	0.062		-39.8	-100.8	-58.7	-15.8	+443.1	+277.0						+186.3	
	3	1.46	0.075		-43.8	-121.9	-65.6	-17.4	+592.1	+311.4						+219.4	
	4	1.68	0.090		-48.1	-146.7	-72.2	-19.2	+679.1	+353.3						+246.1	
	5									+432.6						+266.3	+1778.0
	6									+475.9						+288.5	+2066.5
	7									+523.5							
	8									+575.8							
	9																
	10																
	11																
	12																
	13																
	14																
	15																
	16																
	17																
	18																
	19																
	20																

5.1 years

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 8 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW -304 GPM ; SPECIFIC CAPACITY -0.5 $\frac{\text{GPM}}{\text{FE OF FLOWDOWN}}$

FUEL OIL SAVINGS = 485,400 gal/year
 ELECTRICITY CONSUMPTION = 2,800,000 kWhr/year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1950):
 WELL = \$1,195,000 ; SURFACE SYSTEM = \$742,000 ; TOTAL PLANT = \$1,927,000
 HEAT PUMP & BUILDINGS ONLY = \$168,400

ALL ANNUAL COSTS ARE IN \$1000

NO. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTA- BIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/50	PRESENT	0.60	0.041													
0	0.78	0.045	-1927.0						-1927.0						-1927.0	
4/1/52	1	0.98	0.052	-38.5	-145.6	-57.5	-16.5	+475.7	+217.3	-535.0	-96.4	-708.6	+332.1	+676.4	+893.7	
	2	1.22	0.062	-42.4	-177.6	-62.6	-18.1	+592.7	+254.5		-96.4			-96.3	+198.2	
	3	1.46	0.075	-46.6	-210.0	-70.0	-19.9	+708.7	+323.2		-96.4			-133.2	+233.0	
	4	1.68	0.090	-51.3	-252.0	-76.9	-21.9	+815.5	+413.4		-96.4			-154.0	+259.3	
	5								+454.7						+250.6	-1564.8
	6								+500.2						+204.0	2168.8
	7								+550.2							
	8								+605.3							
	9															
	10															
	11															
	12															
	13															
	14															
	15															
	16															
	17															
	18															
	19															
	20															

5.26203

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 9 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW-150 GPM ; SPECIFIC CAPACITY - 1.0 $\frac{\text{GPM}}{\text{FE OF DRAINDOWN}}$

FUEL OIL SAVINGS = 214,600 gal./year

ELECTRICITY CONSUMPTION = 256,800 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1980) :

WELL = 1,052,000 ; SURFACE SYSTEM = 430,000 ; TOTAL PLANT = \$1,512,000

HEAT PUMP & BUILDINGS ONLY = \$28,100

ALL ANNUAL COSTS ARE IN \$1000

Yr. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINTEN- ANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX -48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041													
0	0.78	0.045	-1512.0						-1512.0						-1512.0	
4/1/82	1	0.98	0.052	-30.2	-13.4	-45.4	-8.1	+210.3	+113.2	-757.4	-75.6	-719.8	+260.1	+609.9	+723.1	
2	1.22	0.062		-33.3	-15.9	-49.9	-8.9	+261.8	+153.2		-75.6	+78.2		-38.0	+115.8	
3	1.46	0.075		-36.6	-19.2	-54.9	-9.8	+313.3	+192.8		-75.6	+117.2		-57.0	+135.8	
4	1.68	0.090		-40.2	-23.1	-60.4	-10.8	+360.5	+236.0		-75.6	+150.4		-73.1	+152.9	
5									+248.6			+173.0		-84.1	+164.5	
6									+273.5			+197.9		-96.2	+177.3	+1469.4
7									+300.4			+225.2		-109.4	+191.4	+1660.8
8									+330.9			+255.7		-124.1	+206.8	
9									+364.0			+289.4		-140.1	+222.7	
10									+400.4			+324.8		-157.9	+242.5	
11									+440.4			+364.8		-177.3	+263.1	
12									+484.5			+406.9		-198.7	+285.8	
13									+532.9			+452.3		-222.2	+310.7	
14									+586.2			+502.6		-248.2	+338.0	
15									+644.8			+559.2		-276.6	+368.2	
16									+709.3			+623.7		-308.0	+401.3	
17									+780.2			+704.6		-342.4	+437.8	
18									+858.2			+792.6		-380.3	+477.9	
19									+944.1			+888.5		-422.1	+522.0	
20									+1038.5			+992.5		-465.1	+570.5	

ROI = 17.98 %

Payback = 6.22 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 10 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW -207 GPM ; SPECIFIC CAPACITY - 1.0 ^{GPM} / FEET DRAWDOWN

FUEL OIL SAVINGS = 296,400 gal./year

ELECTRICITY CONSUMPTION = 379,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1980):

WELL = 1,120,000 ; SURFACE SYSTEM = 540,000 ; TOTAL PLANT = 1,660,000

HEAT PUMP BUILDINGS ONLY = 26,150

ALL ANNUAL COSTS ARE IN \$1000

	N ^o . OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041														
	0	0.78	0.045	-1660.0					-1660.0							-1660.0	
6/1/82	1	0.98	0.052		-33.2	-19.7	-49.8	-11.1	+290.5	+176.7	-784.0	-83.0	-690.7	+293.2	+62.7	+825.4	
	2	1.22	0.062		-36.5	-23.5	-54.8	-12.2	+261.6	+234.6		-83.0	+157.6		-73.7	+160.9	
	3	1.46	0.075		-40.2	-28.4	-60.3	-13.5	+22.7	+250.3		-83.0	+297.3		-100.7	+189.6	
	4	1.68	0.090		-44.2	-34.1	-66.3	-14.8	+48.0	+358.6		-83.0	+255.6		-124.2	+214.4	
	5								+322.5				+255.6		-140.7	+231.8	+1602.1
	6								+409.7				+326.7		-158.8	+250.9	+1853.0
	7								+450.7				+367.7		-178.7	+272.0	
	8								+495.7				+412.7		-200.6	+295.1	
	9								+545.3				+463.3		-224.7	+320.6	
	10								+595.9				+516.9		-250.2	+348.7	
	11								+652.8				+576.8		-280.7	+379.5	
	12								+725.8				+642.8		-312.4	+413.4	
	13								+795.4				+715.4		-347.7	+450.7	
	14								+875.2				+795.2		-386.5	+491.7	
	15								+966.1				+882.1		-429.2	+536.9	
	16								+1062.7				+979.7		-476.1	+586.6	
	17								+1168.9				+1085.9		-527.7	+641.2	
	18								+1285.8				+1202.8		-584.6	+701.2	
	19								+1414.4				+1334.4		-647.1	+767.3	
	20								+1555.8				+1477.5		-715.8	+840.1	

ROI = 21.59 %

Payback = 5.23 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 11 of _____
 By _____ Checked _____ Approved _____
 Title CARROLL SOAP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120 °F ; FLOW-257 GPM ; SPECIFIC CAPACITY - 110 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

FUEL OIL SAVINGS = 404,200 gal./year

ELECTRICITY CONSUMPTION = 1,327,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1980):

WELL = \$1,160,000 ; SURFACE SYSTEM \$625,000 ; TOTAL PLANT = 1,785,000

HEAT PUMP & BUILDINGS ONLY = \$100,000

ALL ANNUAL COSTS ARE IN \$1000

	N. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX -48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041														
	0	0.78	0.045	-1785.0					-1785.0							-1785.0	
4/1/82	1	0.98	0.052		-35.8	-69.0	-53.6	-14.4	+396.1	+323.3	-812.0	-55.4	-678.1	+310.1	+639.7	+867.0	
	2	1.22	0.062		-39.3	-82.3	-59.0	-15.8	+493.1	+296.7		-59.4	-727.3		-100.7	+196.0	
	3	1.46	0.075		-43.3	-95.5	-64.9	-17.4	+590.1	+365.0		-59.4	-875.6		-177.9	+231.1	
	4	1.68	0.090		-47.6	-119.4	-76.4	-19.2	+679.1	+421.5		-59.4	-1032.1		-161.4	+260.1	+1550.3
	5								+463.7				+374.3		-181.9	+281.8	+1832.0
	6								+510.0				+420.6		-204.4	+305.6	
	7								+561.1				+471.6		-229.2	+321.8	
	8								+617.1				+527.7		-256.4	+340.6	
	9								+676.8				+589.4		-286.4	+352.4	
	10								+746.7				+657.3		-319.4	+367.3	
	11								+821.4				+732.0		-355.8	+385.6	
	12								+903.5				+814.1		-395.7	+407.8	
	13								+993.9				+904.5		-439.6	+454.3	
	14								+1093.3				+1003.9		-487.9	+485.4	
	15								+1202.6				+1117.2		-541.0	+546.6	
	16								+1322.9				+1233.8		-599.5	+623.4	
	17								+1455.2				+1365.7		-662.8	+711.4	
	18								+1600.7				+1516.3		-734.5	+866.2	
	19								+1759.8				+1666.4		-807.4	+943.4	
	20								+1936.8				+1847.4		-897.8	+1039.0	

ROI = 23.36 %

Payback = 4.84 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 13 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120 °F ; FLOW-304 GPM ; SPECIFIC CAPACITY-1.0 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

FUEL OIL SAVINGS = 485,400 gal./year

ELECTRICITY CONSUMPTION = 2,405,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1980):

WELL \$1,185,000 ; SURFACE SYSTEM \$715,000 ; TOTAL PLANT \$1,900,000

HEAT PUMP & BUILDINGS ONLY = \$168,400

ALL ANNUAL COSTS ARE IN \$1000

Nr. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESNT	0.60	0.041													
0	0.75	0.045	-1900.0					-1900.0							-1900.0	
6/1/82	1	0.98	0.052	-35.0	-125.1	-57.0	-16.5	+475.7	+239.1	-59.5	-95.0	-685.4	+325.3	+658.4	+897.5	
2	1.22	0.062		-41.8	-145.1	-62.7	-18.1	+552.3	+320.5		-95.0	+235.5		-109.6	+210.9	
3	1.46	0.075		-46.0	-180.4	-69.0	-19.5	+708.7	+393.4		-95.0	+258.4		-145.0	+248.4	
4	1.68	0.090		-50.6	-216.5	-75.9	-21.9	+815.5	+450.6		-95.0	+355.6		-172.8	+277.8	1634.6
5								+495.7				+400.7		-194.7	+301.0	1936.6
6								+545.2				+400.2		-218.8	+326.4	
7								+599.7				+504.7		-245.3	+354.4	
8								+655.7				+504.7		-274.4	+385.3	
9								+725.7				+630.7		-306.5	+419.2	
10								+795.5				+703.3		-341.8	+456.5	
11								+878.1				+783.1		-380.6	+497.5	
12								+965.5				+870.5		-423.3	+542.6	
13								+1062.5				+967.5		-470.2	+592.3	
14								+1165.7				+1073.7		-521.8	+646.9	
15								+1285.5				+1190.8		-578.6	+707.0	
16								+1414.2				+1319.3		-641.1	+773.1	
17								+1555.6				+1460.6		-709.9	+845.7	
18								+1711.2				+1616.2		-785.5	+925.7	
19								+1882.3				+1785.3		-867.7	+1012.6	
20								+2070.5				+1975.5		-960.1	+1110.4	

ROI = 23.26 %

Payback = 4.88 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4661-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 13 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW-340 GPM ; SPECIFIC CAPACITY-1.0 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

FUEL OIL SAVINGS = 564,000 gal./year

ELECTRICITY CONSUMPTION = 3,435,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1980):

WELL = \$1,200,000 ; SURFACE SYSTEM = \$705,000 ; TOTAL PLANT = \$2,115,000

HEAT PUMP & BUILDINGS ONLY = \$204,700

ALL ANNUAL COSTS ARE IN \$1000

NO. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX -48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80 PRESENT	0.60	0.041														
0	0.78	0.045	-2115.0					-2115.0							-2115.0	
4/1/82	1	0.98	0.052	-423	-178.6	-63.5	-18.4	+559.8	+248.0	-8470	-105.8	-704.8	+371.0	+713.5	+961.5	
	2	1.22	0.062	-46.5	-213.0	-69.8	-20.2	+655.6	+235.1		-105.8	+330.3		+111.9	+234.2	
	3	1.46	0.075	-51.2	-257.6	-76.8	-22.3	+820.5	+412.6		-105.8	+300.8		+149.1	+263.5	
	4	1.68	0.090	-56.3	-309.2	-84.5	-24.5	+944.2	+469.7		-105.8	+363.9		+176.9	+292.8	+1742.0
	5							+567				+410.9		+200.0	+316.7	+2058.7
	6							+568.3				+462.5		+224.8	+343.5	+2402.2
	7							+625.2				+579.4		+252.4	+372.8	
	8							+657.7				+581.9		+282.8	+404.9	
	9							+756.5				+650.7		+316.2	+440.3	
	10							+872.1				+726.3		+352.0	+479.1	
	11							+915.3				+809.5		+392.4	+521.9	
	12							+1006.8				+901.0		+432.9	+568.9	
	13							+1107.5				+1001.7		+466.8	+620.7	
	14							+1218.3				+1112.5		+500.7	+677.6	
	15							+1340.1				+1234.3		+535.9	+740.2	
	16							+1474.1				+1368.7		+665.0	+809.1	
	17							+1621.5				+1515.7		+736.6	+884.9	
	18							+1783.7				+1672.9		+815.5	+968.2	
	19							+1962.4				+1856.3		+902.2	+1059.9	
	20							+2158.5				+2052.5		+977.5	+1160.8	

ROI = 22.11 %

Payback = 5.16 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 14 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW -150 GPM ; SPECIFIC CAPACITY -10 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

FUEL OIL SAVINGS = 214,600 gal/year

ELECTRICITY CONSUMPTION = 137,500 kWh/year

CAPITAL COSTS (INCLUDES 5% ESCALATION TO 4th QTR. 1950):

WELL = 1,082,000 ; SURFACE SYSTEM = 422,000 ; TOTAL PLANT = 1,504,000

HEAT PUMP & BUILDINGS ONLY = \$28,400

ALL ANNUAL COSTS ARE IN \$1000

ALL ANNUAL COSTS ARE IN 1960

	Nr. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PREC- IATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/50	PRESENT	0.60	0.041														
	0	0.78	0.045	-1504.0												-1504.0	-
6/1/52	1	0.98	0.052		-30.1	-7.2	-45.1	-8.1	+210.3	+119.8	-75.2	-75.2	+255.0	+604.4	-724.2		
	2	1.22	0.062		-33.1	-8.5	-49.6	-8.9	+266.9	+166.7	-75.2	-75.2	+286.5		-42.0	+119.7	
	3	1.46	0.075		-36.4	-10.3	-54.6	-9.8	+312.3	+202.2	-75.2	-75.2	+317.0		+61.7	+140.5	
	4	1.68	0.090		-40.0	-12.4	-60.1	-10.8	+360.5	+277.3	-75.2	-75.2	+362.0		+78.7	+158.5	
	5									+260.9			+185.7		-80.3	+170.6	
	6									+287.0			+211.8		-102.9	+184.1	+1497.6
	7									+315.7			+240.5		-116.9	+198.8	+1696.4
	8									+347.3			+272.1		-132.2	+215.1	
	9									+382.0			+306.8		-149.1	+232.9	
	10									+420.2			+345.0		-167.7	+252.5	
	11									+462.2			+387.0		-189.1	+274.1	
	12									+508.5			+433.3		-210.6	+297.9	
	13									+553.3			+484.1		-235.3	+324.0	
	14									+615.2			+540.0		-262.4	+352.8	
	15									+676.8			+601.6		-292.4	+384.4	
	16									+744.4			+669.2		-325.2	+419.2	
	17									+818.9			+743.7		-361.4	+457.5	
	18									+900.8			+825.6		-401.2	+496.6	
	19									+990.8			+915.6		-445.0	+545.8	
	20									+1088.9			+1014.7		-493.1	+596.8	

ROI = 18.61 %

Payback = 3.03 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 15 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW-207 GPM ; SPECIFIC CAPACITY - 10 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

FUEL OIL SAVINGS = 296,400 gal/year

ELECTRICITY CONSUMPTION = 212,000 kWhr/year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QPR. 1980):

WELL = \$1,120,000 ; SURFACE SYSTEM = \$528,000 ; TOTAL PLANT = \$1,648,000

HEAT PUMP & BUILDINGS ONLY = \$28,100

ALL ANNUAL COSTS ARE IN \$1000

Nr. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80 PRESENT	0.60	0.041														
0	0.78	0.045	-1648.0					-1648.0							-1648.0	
6/1/82 1	0.98	0.052		33.0	-11.0	-49.4	-11.1	+290.5	+186.0	-781.0	-62.4	-680.4	+290.3	+620.9	+806.9	
2	1.22	0.062		-36.3	-12.1	-54.4	-12.2	+361.6	+245.5		-62.4	+163.2		-79.3	+166.3	
3	1.46	0.075		-39.9	-15.9	-59.8	-13.5	+431.7	+302.6		-62.4	+220.2		-107.0	+195.6	
4	1.68	0.090		-43.9	-19.1	-65.8	-14.8	+498.0	+354.4		-62.4	+278.0		-132.2	+222.2	
5								+369.8				+307.4		-149.4	+249.4	+1631.4
6								+428.8				+346.4		-168.4	+260.4	+1891.8
7								+471.7				+389.3		-189.2	+282.5	
8								+516.9				+436.5		-212.1	+306.8	
9								+560.8				+484.4		-237.4	+331.4	
10								+627.8				+545.4		-265.1	+362.7	
11								+690.6				+608.2		-295.6	+395.0	
12								+759.7				+672.3		-329.2	+430.5	
13								+835.7				+753.3		-366.1	+469.6	
14								+919.2				+836.8		-406.7	+512.5	
15								+1011.1				+928.7		-451.3	+559.8	
16								+1112.3				+1029.9		-500.5	+611.8	
17								+1223.5				+1141.1		-554.6	+668.9	
18								+1345.9				+1262.4		-614.0	+731.8	
19								+1480.4				+1395.1		-670.4	+801.0	
20								+1628.9				+1546.1		-751.4	+877.1	

ROI = 22.31%

Payback = 5.06 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 16 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW -267 GPM ; SPECIFIC CAPACITY -10.0 ^{GPM} / FE OF DRAWDOWN

FUEL OIL SAVINGS = 404,200 gal./year

ELECTRICITY CONSUMPTION = 1,056,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1960):

WELL = \$1,160,000 ; SURFACE SYSTEM = \$619,000 ; TOTAL PLANT = \$1,779,000

HEAT PUMP & BUILDINGS ONLY = \$100,800

ALL ANNUAL COSTS ARE IN \$1000

No. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
11/60	PRESNT	0.60	0.041													
0	0.78	0.045	-1770.0					-1722.0							-1770.0	
6/1/62	1	0.98	0.052	-35.4	-54.9	-53.1	-14.4	+396.1	+236.3	-512.0	-55.5	-662.2	+305.6	+62.4	+865.7	
2	1.22	0.062		-38.9	-65.5	-55.4	-15.8	+493.1	+314.5		-55.5	-626.0		-109.8	+204.7	
3	1.46	0.075		-42.8	-79.2	-64.3	-17.4	+590.1	+386.4		-55.5	-597.9		-144.8	+241.6	
4	1.68	0.090		-47.1	-95.0	-70.7	-19.2	+679.1	+472.1		-55.5	-552.6		-174.3	+272.8	+1584.8
5									+491.8			+403.3		-196.0	+295.8	+1880.6
6									+541.0			+425.5		-219.9	+321.1	
7									+555.1			+406.6		-246.2	+348.9	
8									+554.6			+386.1		-275.1	+379.5	
9									+720.1			+631.5		-307.0	+413.1	
10									+792.1			+703.6		-341.9	+450.2	
11									+871.3			+782.8		-380.4	+490.9	
12									+958.4			+869.9		-422.8	+535.6	
13									+1054.2			+965.7		-469.3	+584.9	
14									+1159.7			+1071.2		-520.6	+639.1	
15									+1275.5			+1187.1		-576.9	+695.7	
16									+1403.2			+1314.7		-638.9	+764.3	
17									+1543.5			+1455.0		-707.1	+836.4	
18									+1697.9			+1609.4		-788.2	+915.7	
19									+1867.6			+1775.1		-864.6	+1002.0	
20									+2054.4			+1965.9		-955.4	+1099.0	

ROI = 24.39%

Payback = 4.63 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 17 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW -304 GPM ; SPECIFIC CAPACITY - 10.0 ^{GPM} / OF DRAWDOWN

FUEL OIL SAVINGS = 485,400 gal./year
 ELECTRICITY CONSUMPTION = 2,047,000 kWhr./year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1980):
 WELL = \$1,185,000 ; SURFACE SYSTEM \$691,000 ; TOTAL PLANT \$1,876,000
 HEAT PUMP & BUILDINGS ONLY \$168,400

ALL ANNUAL COSTS ARE IN \$1000

	No. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX -48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041														
	0	0.78	0.045	-1876.0					-1876.0							-1876.0	
6/1/82	1	0.98	0.052		-32.5	-106.4	-56.3	-16.5	+475.7	+299.0	-929.5	-93.8	-164.3	+319.3	+642.1	+901.1	
	2	1.22	0.062		-41.3	-126.9	-61.9	-16.1	+572.2	+344.0		-93.8	-250.2		-121.6	+222.4	
	3	1.46	0.075		-45.4	-153.5	-68.1	-19.9	+705.7	+421.8		-93.8	-338.0		-159.4	+262.4	
	4	1.68	0.090		-49.9	-184.2	-74.9	-21.9	+815.5	+481.6		-93.8	-350.8		-189.9	+294.7	+1680.6
	5								+533.1				+439.3		-213.5	+719.6	+2000.2
	6								+586.8				+492.6		-239.4	+347.0	
	7								+645.0				+550.2		-262.9	+322.1	
	8								+709.5				+615.7		-299.2	+410.3	
	9								+780.5				+686.7		-333.7	+446.8	
	10								+858.5				+764.7		-371.6	+486.9	
	11								+944.3				+850.5		-413.3	+531.0	
	12								+1038.8				+945.0		-458.2	+579.5	
	13								+1142.7				+1048.9		-509.8	+632.9	
	14								+1256.9				+1163.1		-565.7	+691.6	
	15								+1382.6				+1288.8		-626.4	+756.2	
	16								+1520.9				+1427.1		-693.6	+827.3	
	17								+1673.0				+1579.2		-762.5	+895.5	
	18								+1840.3				+1746.5		-845.8	+991.5	
	19								+2024.8				+1930.8		-938.2	+1056.1	
	20								+2226.7				+2132.9		-1036.6	+1190.1	

$KOI = 24.5470$

$Payback = 4.61 \text{ yrs}$

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 18 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -120°F ; FLOW 340 GPM ; SPECIFIC CAPACITY $10.0 \frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

FUEL OIL SAVINGS = $562,000 \text{ gal./year}$
 ELECTRICITY CONSUMPTION = $2,990,000 \text{ kWhr./year}$
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1950):
 WELL = $\$1,210,000$; SURFACE SYSTEM = $\$576,000$; TOTAL PLANT = $\$2,086,000$
 HEAT PUMP & BUILDINGS ONLY = $\$204,700$

ALL ANNUAL COSTS ARE IN $\$1000$

No. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTRA- SITABLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/50	PRESENT	0.60	0.041													
0	0.78	0.045	-2086.0					-2086.0							-2086.0	-2086.0
6/1/52	1	0.98	0.052	-41.7	-15.5	-12.6	-18.4	+550.5	-372.6	-847.0	-104.3	+578.7	+363.7	+644.5	+1017.5	
2	1.22	0.062		-45.9	-18.4	-62.8	-20.2	+685.6	-365.3		-104.3	+361.0		-126.8	+235.5	
3	1.46	0.075		-50.5	-22.3	-75.7	-22.3	+820.5	-447.7		-104.3	+343.4		-166.9	+250.8	
4	1.68	0.090		-55.5	-26.1	-83.3	-24.5	+944.2	-511.8		-104.3	+307.5		-198.0	+313.8	+1850.6
5								+523.0				+455.7		-222.9	+340.1	+2190.7
6								+619.3				+515.0		-250.3	+369.0	
7								+691.2				+576.9		-280.4	+400.8	
8								+749.3				+645.0		-313.5	+436.8	
9								+824.3				+720.0		-345.9	+474.4	
10								+906.7				+802.4		-390.0	+516.7	
11								+997.4				+893.1		-434.0	+563.4	
12								+1097.4				+992.8		-482.5	+614.6	
13								+1206.8				+1102.5		-535.8	+671.0	
14								+1327.5				+1223.2		-594.5	+733.0	
15								+1460.2				+1355.7		-659.0	+801.2	
16								+1606.2				+1501.9		-729.9	+876.3	
17								+1766.9				+1662.6		-808.0	+958.9	
18								+1943.5				+1839.2		-893.9	+1049.6	
19								+2137.9				+2033.6		-988.3	+1149.6	
20								+2351.7				+2247.2		-1092.7	+1259.5	

ROI = 24.02 %
 Payback = 4.69 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 19 of _____
 By _____ Checked _____ Approved _____
 Title CARROLL SOAP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -130 °F ; FLOW -150 GPM ; SPECIFIC CAPACITY -0.1 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

FUEL OIL SAVINGS = 253,600 gal/year
 ELECTRICITY CONSUMPTION = 1,124,000 kWhr/year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1980):
 WELL = \$1,082,000 ; SURFACE SYSTEM = \$509,000 ; TOTAL PLANT = \$1,591,000
 HEAT PUMP & BUILDINGS ONLY = \$28,100

ALL ANNUAL COSTS ARE IN \$1000

	N. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041														
	0	0.75	0.045	-1591.0					-1591.0							-1591.0	
4/1/82	1	0.98	0.052		-31.8	-58.4	-47.7	-8.1	+348.5	+102.5	-757.4	-79.6	-734.5	+279.5	+636.9	+739.4	
	2	1.22	0.062		-35.0	-69.7	-52.5	-8.9	+309.4	+143.3		-79.6	+63.7		-31.0	+112.3	
	3	1.46	0.075		-38.5	-84.3	-57.8	-9.8	+370.7	+179.9		-79.6	+109.3		-48.7	+131.2	
	4	1.68	0.090		-42.4	-101.2	-63.5	-10.8	+426.0	+208.1		-79.6	+128.5		-62.5	+145.6	
	5								+228.9				+149.3		-72.6	+156.3	
	6								+251.8				+172.2		-87.7	+168.1	+1452.5
	7								+277.0				+192.4		-95.9	+181.1	+1634.0
	8								+304.7				+235.1		-108.4	+195.7	
	9								+335.1				+255.5		-124.2	+210.9	
	10								+366.2				+269.1		-140.5	+228.2	
	11								+405.5				+325.9		-158.4	+247.1	
	12								+446.1				+366.5		-175.1	+268.0	
	13								+490.7				+411.1		-199.8	+290.9	
	14								+539.8				+460.2		-223.7	+316.1	
	15								+593.7				+514.1		-249.9	+343.8	
	16								+653.1				+573.5		-278.7	+374.4	
	17								+718.4				+638.8		-310.5	+402.9	
	18								+790.3				+710.7		-345.4	+444.9	
	19								+869.3				+809.7		-383.8	+485.5	
	20								+956.2				+906.6		-426.0	+530.2	

ROI = 16.43 %

Payback = 6.76 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 20 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -130 °F ; FLOW-267 GPM ; SPECIFIC CAPACITY - 0.1 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

FUEL OIL SAVINGS = 350,000 gal./year

ELECTRICITY CONSUMPTION = 2,026,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1980):

WELL \$1,120,000 ; SURFACE SYSTEM \$678,000 ; TOTAL PLANT \$1,798,000

HEAT PUMP & BUILDINGS ONLY = \$28,100

ALL ANNUAL COSTS ARE IN \$1000

Nr. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80 PRESENT	0.60	0.041														
0	0.78	0.045	-1798.0						-1798.0						-1798.0	
6/1/82 1	0.98	0.052		-36.0	-185.4	-53.9	-1.1	+343.0	+136.6	-784.0	-85.9	-737.3	+32.71	+686.0	+822.6	
2	1.22	0.062		-39.6	-125.6	-53.3	-12.2	+422.0	+190.3		-89.9	+100.4		-48.8	+141.5	
3	1.46	0.075		-43.5	-152.0	-65.3	-13.5	+511.0	+236.7		-89.9	+146.8		-71.3	+165.4	
4	1.68	0.090		-47.9	-182.3	-71.8	-14.8	+588.0	+271.2		-89.9	+181.3		-88.1	+183.1	
5									+148.3						+197.0	
6									+288.2						+212.4	1732.0
7									+361.0						+229.2	1951.2
8									+397.1						+247.8	
9									+476.8						+268.2	
10									+490.4						+290.6	
11									+528.5						+315.3	
12									+581.3						+342.5	
13									+639.5						+372.4	
14									+703.4						+405.2	
15									+773.8						+441.4	
16									+851.1						+481.2	
17									+936.3						+524.9	
18									+1029.9						+573.1	
19									+1132.9						+626.0	
20									+1246.2						+684.2	

ROI = 17.75 %
 Payback = 6.33 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 21 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -130 °F ; FLOW 263 GPM ; SPECIFIC CAPACITY -0.1 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

* USE \$40/kW

FUEL OIL SAVINGS = 485,400 gal./year

ELECTRICITY CONSUMPTION = 4,584,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1980):

WELL \$1,150,000 ; SURFACE SYSTEM \$557,000 ; TOTAL PLANT = \$2,007,000

HEAT PUMP & BUILDINGS ONLY = \$143,600

HEAT PUMP
 \$101,100 MECH
 8,920 ELECT.*
 110,020
 x 1.05 ESCALATION
 \$115,500
 28,100 BUILDING + 5%
 143,600 BLOC + HEAT PUMP

ALL ANNUAL COSTS ARE IN \$1000

Nr. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kWh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST	MAINT. COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAR- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX -48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041													
0	0.78	0.045	-2007.0					-2007.0							-2007.0	
6/1/82	1	0.98	0.052	-40.1	-238.4	-60.2	-14.2	+475.7	+122.8	-825.3	-100.4	-782.6	+359.5	+739.8	+562.6	
2	1.22	0.062		-44.2	-254.2	-66.2	-15.6	+572.2	+182.0		-100.4	+81.6		-39.7	+142.3	
3	1.46	0.075		-48.6	-347.8	-72.9	-17.1	+708.7	+226.3		-100.4	+125.9		-61.2	+165.1	
4	1.68	0.090		-53.4	-412.6	-80.1	-18.8	+816.5	+250.6		-100.4	+150.2		-73.0	+177.6	
5								+225.7							+190.5	
6								+303.2							+204.6	
7								+373.5							+220.2	1962.9
8								+366.9							+237.4	2200.3
9								+403.6							+256.2	
10								+444.0							+277.0	
11								+488.3							+299.8	
12								+537.2							+324.9	
13								+590.9							+352.5	
14								+650.0							+382.0	
15								+715.0							+416.3	
16								+786.5							+453.1	
17								+865.1							+493.5	
18								+951.7							+538.0	
19								+1046.8							+586.4	
20								+1151.5			Y				+640.7	

ROI = 15.47 %
 Payback = 7.18 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 22 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -130°F ; FLOW -295 GPM ; SPECIFIC CAPACITY -0.1 $\frac{\text{GPM}}{\text{HP OF SHALLOW}}$

* USE \$40/kW

FUEL OIL SAVINGS = 562,000 gal./year

ELECTRICITY CONSUMPTION = 6,230,000 kWh/year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1980):

WELL = \$1,175,000 ; SURFACE SYSTEM = \$1,110,000 ; TOTAL PLANT = \$2,285,000

HEAT PUMP & BUILDINGS ONLY = \$196,400

HEAT PUMP

122,300 MECH.

14,480 ELECT.

136,780

X 1.05 ESCALATION

143,600 HEAT PUMP

52,800 BUILDING & 5%

196,400 HEAT PUMP

ALL ANNUAL COSTS ARE IN \$1000

No. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 30%	MAINT- ENANCE COST @ 30%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80 PRESENT	0.60	0.041														
0	0.75	0.045	-2285.0					-2285							-2285.0	
6/1/82 1	0.98	0.052		-45.7	-324.0	-65.6	-16.2	+552.8	+56.3	-82.5	-114.3	-540.5	+418.4	-1526.9	+923.2	
2	1.22	0.062		-50.3	-386.3	-75.4	-17.8	+485.6	+55.8		-114.3	+41.5		-20.2	+135.6	
3	1.46	0.075		-55.3	-467.3	-82.9	-19.6	+820.5	+155.4		-114.3	+81.1		-39.4	+156.0	
4	1.68	0.090		-60.8	-520.1	-91.2	-21.6	+944.2	+210.5		-114.3	+96.2		-46.8	+163.7	
5								+731.6							+174.6	
6								+254.7							+186.5	
7								+250.2							+199.6	
8								+308.2							+214.0	2153.2
9								+339.8							+225.8	2382.0
10								+372.9							+247.2	
11								+410.2							+266.4	
12								+457.2							+287.5	
13								+496.3							+310.6	
14								+546.0							+336.2	
15								+600.6							+364.3	
16								+660.6							+395.1	
17								+726.7							+429.1	
18								+799.4							+466.4	
19								+879.7							+507.5	
20								+967.2							+552.7	

ROI = 12.4 %

Payback = 8.58 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 23 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -130°F ; FLOW -150 GPM ; SPECIFIC CAPACITY $-0.5 \frac{\text{GPM}}{\text{FE. OF DRAWDOWN}}$

FUEL OIL SAVINGS = gal./year
 ELECTRICITY CONSUMPTION = kwhr./year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1950):
 WELL = \$1,082,000 ; SURFACE SYSTEM = \$457,000 ; TOTAL PLANT = \$1,539,000
 HEAT PUMP & BUILDINGS ONLY = \$28,100

ALL ANNUAL COSTS ARE IN \$1000

No. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/50	PRESENT	0.60	0.041													
0	0.75	0.045	-1539.0					-1539.0							+1539.0	
4/1/52	1	0.95	0.052	-30.8	-15.3	-46.2	-8.1	+245.5	+145.1	-757.4	-77.0	+689.3	+266.9	-601.9	+747.0	
	2	1.22	0.062	-33.9	-21.5	-50.8	-8.9	+305.4	+194.0		-77.0	+117.0		-56.9	+132.1	
	3	1.46	0.075	-37.2	-26.4	-55.9	-9.5	+370.3	+241.0		-77.0	+164.0		-74.7	+161.3	
	4	1.68	0.090	-41.0	-31.7	-61.5	-10.9	+426.0	+281.0		-77.0	+204.0		-99.1	+151.9	
	5							+351.1				+232.1		-112.8	+146.3	+1423.6
	6							+370.0				+263.0		-127.8	+212.2	+1635.6
	7							+374.0				+297.0		-144.3	+229.7	
	8							+411.4				+334.4		-162.5	+246.9	
	9							+452.6				+375.6		-182.5	+270.1	
	10							+497.5				+420.8		-204.5	+293.3	
	11							+547.6				+470.6		-228.7	+315.9	
	12							+602.3				+525.3		-255.3	+342.0	
	13							+662.6				+585.6		-284.6	+375.0	
	14							+728.2				+651.8		-316.8	+412.0	
	15							+800.7				+724.7		-352.2	+445.5	
	16							+881.9				+804.9		-391.2	+490.7	
	17							+970.1				+893.1		-434.0	+536.1	
	18							+1067.1				+990.1		-481.2	+585.9	
	19							+1173.9				+1096.8		-533.0	+640.8	
	20							+1291.7				+1214.3		-590.1	+701.1	

ROI = 20.3 %

Payback = 5.54 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 24 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -130 °F ; FLOW -287 GPM ; SPECIFIC CAPACITY -0.5 ^{GPM}/_{FE OF DRAWDOWN}

FUEL OIL SAVINGS = 350,000 gal./year

ELECTRICITY CONSUMPTION = 562,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1990):

WELL = \$1,120,000 ; SURFACE SYSTEM = \$580,000 ; TOTAL PLANT = \$1,700,000

HEAT PUMP & BUILDINGS ONLY = \$28,100

ALL ANNUAL COSTS ARE IN \$1000

No. OF YEAR AFTER START UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- NANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041													
0	0.78	0.045	-1700.0					-1700.0							-1700.0	
6/1/82	1	0.98	0.052	-34.0	-29.2	-51.0	-11.1	+343.0	+37.7	-784.0	-85.0	-651.3	+303.2	+619.7	+537.4	
2	1.22	0.062		-37.4	-34.8	-56.1	-12.2	+427.0	+266.5		-85.0	-206.5		-97.9	+188.6	
3	1.46	0.075		-41.1	-42.2	-61.7	-13.5	+511.0	+352.5		-85.0	-267.5		-130.0	+222.5	
4	1.68	0.090		-45.3	-50.6	-67.9	-14.8	+555.0	+409.1		-85.0	-324.4		-157.7	+251.7	1500.2
5								+450.3							+272.8	1773.0
6								+495.4							+295.9	
7								+544.9							+321.4	
8								+599.4							+345.4	
9								+659.7							+380.2	
10								+725.7							+414.1	
11								+797.8							+451.4	
12								+872.8							+492.4	
13								+965.3							+537.5	
14								+1061.9							+587.1	
15								+1168.1							+641.7	
16								+1284.9							+701.7	
17								+1413.4							+767.8	
18								+1554.9							+840.4	
19								+1710.2							+920.4	
20								+1881.2							+1008.2	

ROI = 23.82 %
 Payback = 4.73 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 2 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -130 °F ; FLOW -263 GPM ; SPECIFIC CAPACITY -0.5 ^{GPM}/_{FE OF DRAWDOWN}

FUEL OIL SAVINGS = 485,400 gal./year

ELECTRICITY CONSUMPTION = 2,213,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1980):

WELL = \$1,150,000 ; SURFACE SYSTEM \$697,000 ; TOTAL PLANT = \$1,847,000

HEAT PUMP & BUILDINGS ONLY = \$142,600

ALL ANNUAL COSTS ARE IN \$1000

N. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- NANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX -48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESNT	0.60	0.041													
0	0.78	0.045	-1847.0					-1847							-1847	
4/1/82	1	0.98	0.052	-36.9	-115.1	-55.4	-14.2	+475.7	+254.1	-805.0	-92.4	-643.3	+319.5	+632.1	+846.2	
2	1.22	0.062		-40.6	-137.2	-61.0	-15.6	+592.2	+332.8		-92.4	-643.3		-119.3	+218.5	
3	1.46	0.075		-44.7	-166.0	-67.0	-17.1	+708.7	+413.9		-92.4	-643.3		-156.2	+252.7	
4	1.68	0.090		-49.2	-199.2	-73.8	-18.8	+815.5	+474.5		-92.4	-643.3		-185.7	+288.8	1651.2
5								+522.0							+312.2	1964.4
6								+574.1							+340.0	
7								+634.6							+369.5	
8								+694.7							+402.0	
9								+764.2							+437.7	
10								+840.6							+477.0	
11								+924.7							+520.2	
12								+1017.1							+567.7	
13								+1116.8							+620.0	
14								+1230.7							+677.5	
15								+1353.8							+740.8	
16								+1485.2							+810.4	
17								+1628.1							+886.9	
18								+1801.9							+971.1	
19								+1982.4							+1063.7	
20								+2180.3			Y				+1165.6	

ROI = 24.46 %
 Payback = 4.52 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 26 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -130°F ; FLOW -295 GPM ; SPECIFIC CAPACITY -0.5 ^{GPM}/_{FE OF DRAWDOWN}

FUEL OIL SAVINGS = \$562,000 ^{gal./year}

ELECTRICITY CONSUMPTION = 3,335,000 ^{kwh./year}

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1990):

WELL \$1,175,000 ; SURFACE SYSTEM \$909,000 ; TOTAL PLANT \$2,084,000

HEAT PUMP & BUILDINGS ONLY = \$196,400

ALL ANNUAL COSTS ARE IN \$1000

No. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTRA- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESNT	0.60	0.041													
0	0.78	0.045	-2084.0						-2084.0						-2084.0	
6/1/82	1	0.98	0.052	-41.7	-173.4	-62.5	-16.2	+550.9	+257.0	-52.5	-104.2	-669.7	+368.2	+693.7	+950.7	
2	1.22	0.062		-45.8	-206.8	-68.8	-17.8	+685.6	+346.4		-104.2	-342.2		-117.7	+228.7	
3	1.46	0.075		-50.4	-250.1	-75.6	-19.6	+820.5	+424.8		-104.2	-320.6		-155.8	+269.0	
4	1.68	0.090		-55.5	-300.2	-83.2	-21.6	+944.2	+493.7		-104.2	-379.5		-184.4	+299.3	1747.4
5									+532.1						+324.1	2071.5
6									+555.3						+371.5	2423.0
7									+643.8						+381.6	
8									+708.2						+414.7	
9									+779.0						+451.0	
10									+856.9						+491.1	
11									+942.6						+535.1	
12									+1036.9						+582.6	
13									+1140.5						+636.9	
14									+1254.6						+695.5	
15									+1380.1						+760.0	
16									+1516.1						+830.9	
17									+1669.9						+909.0	
18									+1826.8						+994.8	
19									+2000.5						+1089.2	
20									+2222.0						+1193.1	

ROI = 22.69%

Payback = 5.04 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 27 of _____
 By _____ Checked _____ Approved _____
 Title CARROLL SOUR CO - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -130°F ; FLOW -150 GPM ; SPECIFIC CAPACITY -1.0 ^{GPM} / FE OF DRAWDOWN

FUEL OIL SAVINGS = 253,600 gal./year

ELECTRICITY CONSUMPTION = 257,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1990) :

WELL = \$1,082,000 ; SURFACE SYSTEM = \$450,000 ; TOTAL PLANT = \$1,532,000

HEAT PUMP & BUILDINGS ONLY = \$28,100

ALL ANNUAL COSTS ARE IN \$1000

	Nr. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041														
	0	0.78	0.045	-1532.0					-1532.0							-1532.0	
6/1/82	1	0.98	0.052		-30.6	-13.4	-46.0	-6.1	424.5	+150.4	-75.4	-76.1	-683.6	+265.2	+597.4	+747.8	
	2	1.22	0.062		-33.7	-15.9	-50.6	-8.9	309.4	+200.3		-76.1	+133.7		+60.1	+140.2	
	3	1.46	0.075		-37.1	-19.3	-55.6	-9.8	370.3	+248.5		-76.6	+171.9		+83.5	+165.0	
	4	1.68	0.090		-40.4	-23.1	-61.2	-10.8	436.0	+290.1		-76.6	+213.5		+103.8	+186.3	
	5									+319.1						+201.2	1440.5
	6									+357.0						+217.6	1658.1
	7									+386.1						+235.7	
	8									+424.7						+255.5	
	9									+467.2						+277.4	
	10									+513.9						+301.4	
	11									+565.3						+327.8	
	12									+621.9						+356.9	
	13									+684.0						+388.8	
	14									+752.4						+424.0	
	15									+827.7						+462.7	
	16									+910.5						+505.2	
	17									+1000.5						+552.0	
	18									+1101.7						+603.5	
	19									+1211.8						+660.1	
	20									+1333.0						+723.4	

RDI = 20.76 %

Payback = 5.42 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 28 of _____
 By _____ Checked _____ Approved _____
 Title CAMPFELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -130 °F ; FLOW-207 GPM ; SPECIFIC CAPACITY-1.0 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

FUEL OIL SAVINGS = 354,000 gal/year
 ELECTRICITY CONSUMPTION = 379,000 kWhr/year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1950):
 WELLS \$1,120,000 ; SURFACE SYSTEM \$327,000 ; TOTAL PLANT \$1,667,000
 HEAT PUMP & BUILDINGS ONLY \$28,100

ALL ANNUAL COSTS ARE IN \$1000

Yr. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/50	PRESENT	0.60	0.041													
0	0.78	0.045	-1687.0						-1687.0						-1687.0	
4/1/52	1	0.98	0.052	-33.7	-19.7	-50.6	-16.1	+343.5	+227.9	-784.0	-84.3	-610.4	+299.9	+611.1	+839.0	
2	1.22	0.062		-37.1	-23.5	-55.7	-12.2	+427.0	+299.5		-64.3	+214.2		-104.1	+194.4	
3	1.46	0.075		-40.8	-28.4	-61.2	-13.5	+571.0	+367.1		-84.3	+252.8		-132.4	+229.7	
4	1.68	0.090		-44.9	-34.1	-67.4	-14.8	+588.2	+426.8		-84.3	+342.5		-166.5	+260.0	1533.1
5									+469.5						+252.3	1805.4
6									+516.4						+306.4	
7									+568.1						+333.0	
8									+624.9						+362.2	
9									+687.4						+394.3	
10									+756.1						+429.6	
11									+831.7						+468.5	
12									+914.9						+511.2	
13									+1006.4						+558.3	
14									+1107.0						+610.0	
15									+1217.7						+666.9	
16									+1339.5						+729.5	
17									+1473.4						+798.3	
18									+1620.8						+874.1	
19									+1782.8						+957.3	
20									+1961.1						+1049.0	

KOI = 24.56 %
 Payback = 4.58 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 29 of _____
 By _____ Checked _____ Approved _____
 Title CARROLL SOAP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -130°F ; FLOW -263 GPM ; SPECIFIC CAPACITY -1.0 ^{GPM} / ^{FEET} DRAWDOWN

FUEL OIL SAVINGS = 465,400 gal./year
 ELECTRICITY CONSUMPTION = 1,919,000 kWhr./year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1980):
 WELL \$1,150,000 ; SURFACE SYSTEM \$678,000 TOTAL PLANT = \$1,828,000
 HEAT PUMP & BUILDINGS ONLY = \$143,600

ALL ANNUAL COSTS ARE IN \$1000

	N.O. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041														
	0	0.78	0.045	-1828.0					-1828							-1828.0	
6/1/82	1	0.98	0.052		-36.6	-99.8	-54.8	-14.2	475.7	+20.3	-505.0	-91.4	-626.1	+214.7	+619.0	+559.7	
	2	1.22	0.062		-40.2	-119.0	-60.3	-15.6	582.3	+357.1		-91.4	-265.3		-129.1	+228.0	
	3	1.46	0.075		-44.2	-143.9	-66.4	-17.1	698.7	+437.1		-91.4	-345.7		-165.0	+269.1	
	4	1.68	0.090		-48.7	-172.7	-73.0	-18.8	815.5	+502.3		-91.4	-410.9		-199.7	+302.6	1655.0
	5								+526.5							+328.4	2017.4
	6								+607.8							+356.8	
	7								+668.6							+388.1	
	8								+735.4							+422.4	
	9								+809.0							+460.2	
	10								+889.9							+501.8	
	11								+976.8							+547.5	
	12								+1076.3							+597.8	
	13								+1184.4							+653.2	
	14								+1302.8							+714.1	
	15								+1433.1							+781.0	
	16								+1576.8							+854.7	
	17								+1734.1							+935.7	
	18								+1902.5							+1024.9	
	19								+2098.3							+1122.9	
	20								+2308.1							+1230.8	

ROI = 25.51%

Payback = 4.43 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 30 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. 430°F ; FLOW-295 GPM ; SPECIFIC CAPACITY-110 $\frac{\text{GPM}}{\text{FE OF FLOWDOWN}}$

FUEL OIL SAVINGS = 562,400 gal./year
 ELECTRICITY CONSUMPTION = 2,861,000 kWhr./year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1980):
 WELL \$1,175,000 ; SURFACE SYSTEM \$864,000 ; TOTAL PLANT = \$2,059,000
 HEAT PUMP & BUILDINGS ONLY = \$196,400

ALL ANNUAL COSTS ARE IN \$1000

	Nr. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041														
	0	0.78	0.045	-2059.0					-2059							-2059.0	
4/1/82	1	0.98	0.052		-41.2	-149.8	-61.8	-16.2	580.8	+281.5	-522.5	-103.0	-643.7	+361.9	-174.7	+956.5	
	2	1.22	0.062		-45.3	-176.6	-67.9	-17.8	655.6	+376.0		-103.0	-273.4		-132.7	+243.3	
	3	1.46	0.075		-49.8	-216.1	-74.7	-19.6	720.5	+450.3		-103.0	-357.2		-173.6	+286.7	
	4	1.68	0.090		-54.8	-259.3	-82.2	-21.6	794.2	+526.2		-103.0	-423.3		-205.7	+320.6	+1807.1
	5									+575.9						+347.6	+2154.7
	6									+636.8						+377.4	
	7									+700.5						+410.1	
	8									+770.6						+446.1	
	9									+847.1						+485.7	
	10									+932.4						+529.3	
	11									+1015.6						+577.2	
	12									+1125.2						+630.0	
	13									+1241.0						+687.9	
	14									+1365.1						+751.7	
	15									+1501.6						+821.9	
	16									+1651.8						+899.1	
	17									+1816.9						+983.9	
	18									+1996.6						+1072.2	
	19									+2196.5						+1160.1	
	20									+2418.3						+1253.1	

ROI = 24.1 %

Payback = 4.73 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 31 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -150 °F ; FLOW -150GPM ; SPECIFIC CAPACITY - 0.1 ^{GPM} / FE OF DRAWDOWN

FUEL OIL SAVINGS = 331,800 gal./year
 ELECTRICITY CONSUMPTION = 1,124,000 kWhr./year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1980):
 WELL \$1,082,000 ; SURFACE SYSTEM \$539,000 ; TOTAL PLANT \$1,621,000
 HEAT PUMP & BUILDINGS ONLY = 28,100

ALL ANNUAL COSTS ARE IN \$1000

	No. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041														
	0	0.78	0.045	-1612.0					-1612.0							-1612.0	
6/1/82	1	0.98	0.052		-32.2	-55.4	-48.4	-8.1	+325.2	+178.1	-757.4	-80.6	-659.9	-285.2	+605.9	+784.0	
	2	1.22	0.062		-35.5	-69.7	-53.2	-8.9	+404.8	+237.5		-80.6	-156.9		-76.3	+161.2	
	3	1.46	0.075		-39.0	-84.3	-58.5	-9.8	+484.4	+352.8		-80.6	-212.2		-103.1	+189.7	
	4	1.68	0.090		-42.9	-101.2	-64.4	-10.8	+557.4	+338.1		-80.6	-257.5		-125.1	+213.0	
	5								+371.9							+230.3	+1578.2
	6								+409.1							+249.4	+1827.6
	7								+450.0							+270.5	
	8								+495.0							+293.6	
	9								+544.5							+319.0	
	10								+599.0							+347.1	
	11								+658.9							+377.8	
	12								+724.7							+411.7	
	13								+797.2							+448.9	
	14								+876.7							+489.9	
	15								+964.6							+535.0	
	16								+1061.1							+584.6	
	17								+1167.2							+639.1	
	18								+1283.9							+699.1	
	19								+1412.3							+765.1	
	20								+1553.6			Y				+837.7	

ROI = 21.97 %

Payback = 5.14 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 32 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -150°F ; FLOW -207 GPM ; SPECIFIC CAPACITY - 0.1 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

FUEL OIL SAVINGS = 457,800 gal./year

ELECTRICITY CONSUMPTION = 2,026,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1980):

WELL \$1,120,000 ; SURFACE SYSTEM \$706,000 ; TOTAL PLANT \$1,826,000

HEAT PUMP & BUILDINGS ONLY \$28,100

ALL ANNUAL COSTS ARE IN \$1000

N. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041													
0	0.78	0.045	-1826.0					-1826							-1826.0	
6/1/82	1	0.98	0.052	-36.5	-105.7	-54.8	-11.1	+448.6	-240.9	-784.0	-91.3	-634.4	+334.7	+647.0	+883.9	
2	1.22	0.062		-40.2	-125.6	-60.3	-12.2	+558.5	+320.2		-91.3	+228.9		-111.2	+209.0	
3	1.46	0.075		-44.2	-152.0	-66.3	-13.5	+668.4	+392.4		-91.3	+301.1		-146.7	+246.1	
4	1.68	0.090		-48.6	-182.7	-72.9	-14.8	+769.1	+450.5		-91.3	+359.2		-174.6	+275.9	+1644.9
5								+495.6							+299.1	+1914.0
6								+545.2							+324.6	
7								+599.7							+352.6	
8								+659.6							+383.4	
9								+725.6							+417.3	
10								+798.2							+454.6	
11								+878.0							+495.7	
12								+965.8							+540.8	
13								+1062.4							+590.4	
14								+1168.6							+645.0	
15								+1285.8							+705.1	
16								+1414.0							+771.2	
17								+1553.4							+843.8	
18								+1710.9							+923.7	
19								+1882.0							+1011.7	
20								+2070.2							+1108.5	

ROI = 24.0 %
 Payback = 4.70 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 33 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -150°F ; FLOW-234 GPM ; SPECIFIC CAPACITY-0.1 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

* USE \$40/KW

FUEL OIL SAVINGS = 554,200 gal./year
 ELECTRICITY CONSUMPTION = 3,809,000 KWH/yr
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1950):
 WELL = \$1,135,000 ; SURFACE SYSTEM = \$880,000 ; TOTAL PLANT = \$2,015,000
 HEAT PUMP & BUILDINGS ONLY = \$122,000

HEAT PUMPS
 57,900 MECH
 8,000 ELECT. *
 65,900
 x 1.05 ESCALATION
 69,200 TOT. HEAT PUMP
 52,500 BUILDING + 5%
 122,000 HEAT PUMP + BLDG.

ALL ANNUAL COSTS ARE IN \$1000

	No. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAR- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/50	PRESENT	0.60	0.041														
	0	0.78	0.045	-2015.0						-2015.0						-2015.0	
6/1/52	1	0.98	0.052		-40.3	-157.6	-60.5	-12.6	+543.1	+232.1	-754.5	-100.8	-663.7	+366.3	+888.6	+920.7	
	2	1.22	0.062		-44.3	-235.6	-66.5	-13.8	+676.1	+355.9		-100.8	+215.1		-104.5	+211.4	
	3	1.46	0.075		-48.8	-285.0	-73.1	-15.2	+809.1	+387.0		-100.8				+247.9	
	4	1.68	0.090		-53.6	-342.0	-80.5	-16.7	+931.1	+438.3		-100.8				+274.3	
	5									+452.1						+296.8	1951.1
	6									+530.3						+321.6	2272.7
	7									+583.4						+348.9	
	8									+641.7						+378.8	
	9									+705.9						+411.8	
	10									+776.5						+448.1	
	11									+854.1						+488.0	
	12									+939.5						+531.9	
	13									+1023.5						+580.2	
	14									+1106.8						+633.3	
	15									+1250.5						+691.7	
	16									+1375.6						+756.0	
	17									+1511.1						+826.7	
	18									+1664.4						+904.5	
	19									+1830.9						+990.1	
	20									+2014.0						+1084.2	

ROI = 21.91 %
 payback = 5.20 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 34 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -150°F ; FLOW -150 GPM ; SPECIFIC CAPACITY -0.5 ^{GPM}/_{FE OF DRAWDOWN}

FUEL OIL SAVINGS = 331,800 gal/year

ELECTRICITY CONSUMPTION = 352,000 kWhr/year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1980):

WELL = \$1,082,000 ; SURFACE SYSTEM = \$475,000 ; TOTAL PLANT = \$1,560,000

HEAT PUMP & BUILDINGS ONLY = \$28,100

ALL ANNUAL COSTS ARE IN \$1000

N. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES INSUR- ANCE @ 2%	ELECT. POWER COST	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PREC- IATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80 PRESENT	0.60	0.041														
0	0.78	0.045	-1560.0					-1560.0							-1560.0	
6/1/82 1	0.98	0.052		-31.2	-18.3	-46.8	-8.1	+325.2	+220.9	-75.4	-78.0	-614.6	+222.2	+570.9	+791.7	
2	1.22	0.062		-34.3	-21.8	-51.5	-8.9	+404.9	+288.3		-78.0	+210.3		-102.2	+186.1	
3	1.46	0.075		-37.8	-26.4	-56.6	-9.8	+484.4	+353.8		-78.0	+275.8		-134.0	+219.8	
4	1.68	0.090		-41.5	-31.7	-62.3	-10.8	+557.4	+411.1		-78.0	+333.1		-161.9	+249.3	+1446.8
5								+152.2							+270.3	+1717.1
6								+197.4							+293.6	
7								+247.2							+319.2	
8								+301.9							+347.3	
9								+362.1							+378.2	
10								+428.3							+412.3	
11								+501.1							+449.7	
12								+581.2							+490.8	
13								+669.4							+536.2	
14								+766.3							+586.0	
15								+872.9							+640.8	
16								+990.2							+701.1	
17								+1119.2							+767.4	
18								+1261.2							+840.4	
19								+1417.3							+920.6	
20								+1589.0							+1008.9	

ROI = 25.33 %

Payback = 4. + 2 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4661-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 35 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. - 150°F ; FLOW - 267 GPM ; SPECIFIC CAPACITY - 0.5 ^{GPM}/_{FE OF DRAWDOWN}

FUEL OIL SAVINGS = 457,600 gal./year
 ELECTRICITY CONSUMPTION = 562,000 kWhr./year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1950):
 WELL \$1,120,000 ; SURFACE SYSTEM \$608,000 ; TOTAL PLANT \$1,728,000
 HEAT PUMP & BUILDINGS ONLY \$28,100

ALL ANNUAL COSTS ARE IN \$1000

	No. of YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINTEN- ANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 46.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/50	PRESENT	0.60	0.041														
	0	0.78	0.045	-1728.0						-1728.0						-1728.0	
4/1/52	1	0.98	0.052		-34.6	-29.2	-51.8	-11.1	4445.6	4321.9	-784.0	-86.4	-548.5	4310.2	-1576.8	+998.7	
	2	1.22	0.062		-38.0	-34.8	-57.0	-12.2	4558.5	4416.5		-86.4	-330.1		-160.4	+256.1	
	3	1.46	0.075		-41.8	-42.1	-62.7	-13.5	4668.4	4508.3		-86.4	-421.9		-205.0	+307.3	+1458.1
	4	1.68	0.090		-46.0	-50.6	-69.0	-14.8	4769.1	4588.7		-86.4	-502.3		-244.1	+344.6	+1802.7
	5								4647.6							+374.9	
	6								4712.3							+408.1	
	7								4783.6							+444.8	
	8								4861.9							+485.0	
	9								4948.1							+529.7	
	10								41042.9							+578.0	
	11								41147.2							+631.7	
	12								41261.9							+690.6	
	13								41388.1							+755.5	
	14								41526.9							+826.8	
	15								41679.6							+905.3	
	16								41847.6							+991.2	
	17								42032.4							+1086.6	
	18								42235.6							+1191.1	
	19								42458.1							+1306.0	
	20								42705.1							+1432.4	

ROI = 29.38%

Payback = 3.78 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 36 of _____
 By _____ Checked _____ Approved _____
 Title CAMPFILL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. - 150°F ; FLOW - 234 GPM ; SPECIFIC CAPACITY - 0.5 ^{GPM} / FEET DRAWDOWN

FUEL OIL SAVINGS = 554,200 gal./year
 ELECTRICITY CONSUMPTION = 1,931,000 kWhr./year
 CAPITAL COSTS (INCLUDES 5% ESCALATION TO 4TH QTR. 1980):
 WELL \$1,135,000 ; SURFACE SYSTEM \$755,000 ; TOTAL PLANT \$1,890,000
 HEAT PUMP & BUILDINGS ONLY = \$122,000

ALL ANNUAL COSTS ARE IN \$1000

	No. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041														
	0	0.75	0.045	-1890.0					-1890							-1890.0	
6/1/82	1	0.98	0.052		-37.8	-100.4	-56.7	-12.6	+543.1	+335.0	-74.5	-94.5	-553.4	+335.0	+604.0	+939.6	
	2	1.22	0.062		-41.6	-119.7	-63.4	-13.8	+626.1	+438.6		-94.5	+344.1		-167.2	+271.4	
	3	1.46	0.075		-45.7	-144.1	-68.6	-15.2	+809.1	+535.5		-94.5	+441.0		-214.3	+321.2	1532.2
	4	1.68	0.090		-50.3	-173.8	-75.5	-16.7	+931.1	+644.8		-94.5	+520.3		-252.9	+361.9	1894.1
	5								+670.3							+393.5	
	6								+743.9							+428.3	
	7								+818.3							+466.5	
	8								+900.1							+508.6	
	9								+990.1							+554.8	
	10								+1089.2							+605.8	
	11								+1198.1							+661.8	
	12								+1317.9							+723.3	
	13								+1449.7							+791.1	
	14								+1594.6							+865.6	
	15								+1754.1							+947.5	
	16								+1929.5							+1037.7	
	17								+2122.5							+1136.9	
	18								+2344.7							+1246.0	
	19								+2598.2							+1366.0	
	20								+2885.0			7				+1495.0	

ROI = 28.19%

Payback = 3.99 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 37 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -150°F ; FLOW -150 GPM ; SPECIFIC CAPACITY -1.0 $\frac{\text{GPM}}{\text{FE of Blowdown}}$

FUEL OIL SAVINGS = 331,800 gal./year
 ELECTRICITY CONSUMPTION = 257,000 kWhr./year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1950):
 WELL = \$1,082,000 ; SURFACE SYSTEM = \$471,000 ; TOTAL PLANT = \$1,553,000
 HEAT PUMP & BUILDINGS ONLY = \$28,100

ALL ANNUAL COSTS ARE IN \$1000

Nr. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/50 PRESENT	0.60	0.041														
0	0.78	0.045	-1553.0						-1553.0						-1553.0	
6/1/52 1	0.98	0.052		-31.1	-13.4	-46.6	-8.1	325.2	226.0	-757.4	-77.7	-609.1	270.4	566.4	+792.0	
2	1.22	0.062		-34.3	-15.5	-51.2	-8.9	404.8	294.6		-77.7	-216.9		-105.4	+189.2	
3	1.46	0.075		-37.6	-19.7	-56.4	-9.8	484.4	361.7		-77.7	-253.6		-137.8	+223.5	
4	1.68	0.090		-41.3	-23.1	-62.0	-10.8	557.4	426.2		-77.7	-292.5		-166.5	+253.7	1456.4
5									462.2						+275.3	1732.7
6									508.4						+299.1	
7									559.3						+325.2	
8									615.2						+354.0	
9									676.7						+385.6	
10									744.4						+420.7	
11									818.9						+458.7	
12									900.7						+500.7	
13									990.8						+547.0	
14									1089.9						+598.0	
15									1198.9						+654.0	
16									1318.8						+715.6	
17									1450.6						+783.4	
18									1595.7						+858.0	
19									1755.3						+940.0	
20									1930.8		1				+1030.2	

ROI = 25.74 %
 Payback = 4.34 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 38 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHEMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. - 150°F ; FLOW - 207 GPM ; SPECIFIC CAPACITY - 1.10 $\frac{\text{GPM}}{\text{FE OF DRAWDOWN}}$

FUEL OIL SAVINGS = 457,800 gal./year
 ELECTRICITY CONSUMPTION = 379,000 kWhr./year
 CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4TH QTR. 1980):
 WELL = \$1,120,000 ; SURFACE SYSTEM = \$555,000 ; TOTAL PLANT = \$1,715,000
 HEAT PUMP & BUILDINGS ONLY = \$28,100

ALL ANNUAL COSTS ARE IN \$1000

	N. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/kwh	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST @ 3%	MAINT- ENANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041														
	0	0.78	0.045	-1715.0					-1715.0							-1715.0	
4/1/82	1	0.98	0.052		-34.3	-19.7	-56.5	-11.1	+446.6	+332.0	-784.0	-85.6	-537.6	+306.9	+565.2	+900.2	
	2	1.22	0.062		-77.7	-23.5	-56.6	-12.2	+588.5	+425.5		-85.6	+345.9		-168.1	+260.4	
	3	1.46	0.075		-91.5	-28.4	-62.3	-13.5	+668.4	+522.7		-85.6				+310.3	+1470.5
	4	1.68	0.090		-45.7	-74.1	-68.5	-14.8	+769.1	+606.0		-85.6				+357.1	+1824.0
	5								+665.6							+384.2	
	6								+733.3							+418.5	
	7								+806.6							+456.2	
	8								+887.2							+497.6	
	9								+976.0							+543.3	
	10								+1073.6							+593.4	
	11								+1180.9							+648.6	
	12								+1299.0							+709.3	
	13								+1428.9							+776.1	
	14								+1571.9							+849.5	
	15								+1729.0							+930.3	
	16								+1901.9							+1019.2	
	17								+2092.1							+1116.9	
	18								+2304.3							+1224.5	
	19								+2531.4							+1342.7	
	20								+2784.6			Y				+1472.9	

ROI = 30.04 %

Payback = 3.69 yrs

**Burns and Roe
Industrial Services Corp.**

W.O. No. 4861-01 Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Calc. No. _____ Sheet 39 of _____
 By _____ Checked _____ Approved _____
 Title CAMPBELL SOUP CO. - GEOTHERMAL STUDY

CASH FLOW ANALYSIS

CASE : WELLHEAD TEMP. -150°F ; FLOW-234 GPM ; SPECIFIC CAPACITY -1.0 $\frac{GPM}{FE \text{ OF DRAINDOWN}}$

FUEL OIL SAVINGS = 554,200 gal./year

ELECTRICITY CONSUMPTION = 1,688,000 kWhr./year

CAPITAL COSTS (INCLUDE 5% ESCALATION TO 4th QTR. 1980):

WELL = \$1,135,000 ; SURFACE SYSTEM = \$738,000 ; TOTAL PLANT = \$1,873,000

HEAT PUMP & BUILDINGS ONLY = \$122,000

ALL ANNUAL COSTS ARE IN \$1000

	NO. OF YEAR AFTER START- UP	UNIT FUEL OIL COST, \$/GAL	UNIT ELECT. COST, \$/KWH	CAPITAL COST	TAXES & INSUR- ANCE @ 2%	ELECT. POWER COST	MAINTEN- ANCE COST @ 3%	CHEM- ICAL COST	FUEL OIL SAV- INGS	NET CASH INCOME	INTAN- GIBLE DRILL- ING COST	DE- PRECI- ATION	TAX- ABLE INCOME	TAX CREDIT	INCOME TAX 48.6%	NET CASH FLOW	CUMUL- ATIVE CASH FLOW
1/1/80	PRESENT	0.60	0.041														
	0	0.78	0.045	-1873.0					-1873							-1873.0	
6/1/82	1	0.98	0.052		-37.5	-87.9	-56.2	-12.6	543.1	349.0	-794.5	-93.7	-539.2	330.8	-572.9	+941.9	
	2	1.22	0.062		-41.2	-104.7	-61.9	-13.8	676.1	454.6		-93.7	336.9		-175.4	+279.3	
	3	1.46	0.075		-45.3	-126.6	-68.0	-15.2	809.1	554.0		-93.7	446.3		-223.7	+330.3	1551.4
	4	1.68	0.090		-49.9	-151.9	-74.8	-16.7	931.1	637.8		-93.7	554.1		-264.4	+373.4	1924.8
	5									701.6						+406.2	
	6									776.7						+442.2	
	7									848.9						+481.9	
	8									933.8						+525.5	
	9									1027.2						+573.5	
	10									1129.9						+626.3	
	11									1242.9						+684.4	
	12									1367.2						+748.3	
	13									1503.9						+818.5	
	14									1654.3						+895.8	
	15									1819.7						+980.9	
	16									2001.7						+1074.4	
	17									2204.9						+1177.3	
	18									2422.8						+1290.4	
	19									2664.2						+1414.9	
	20									2930.7						+1551.9	

ROI = 29.01 %

Payback = 3.86 yrs

APPENDIX F

Economic Analysis Computer Program Listing

This Appendix contains a listing of the computer program used to calculate rates of return and payback periods for this study. The program was written in BASIC language for a Wang 2200 computer. Input data was obtained from Appendix E.

```

10 COM P(4),S(4,40),R(5),C(40),N1(2,40)
20 COM F,E,T,M,X,L,O,B1,B2,B3,M1,Q1(2),Q2(2)
30 COM B$
40 SELECT PRINT 005
50 PRINT "ENTER COMMON IDENTIFIER FOR ALL RUNS"
60 INPUT B$
70 PRINT "ENTER FIRST YEAR FUEL OIL COST, $/GAL"
80 INPUT F
90 PRINT "ENTER FIRST YEAR ELECTRICITY COST, $/KWH"
100 INPUT E
110 PRINT "ENTER TAX & INSURANCE, % OF CAPITAL COST"
120 INPUT T
130 PRINT "ENTER MAINTENANCE, % OF CAPITAL COST"
140 INPUT M
150 PRINT "ENTER INCOME TAX, % OF TAXABLE INCOME"
160 INPUT X
170 PRINT "ENTER NO. OF PLANT LIFE CASES (4 MAX)"
180 INPUT L
190 IF L 1 4 THEN 170
200 IF L !1 THEN 170
210 PRINT USING 220, L
220 %ENTER## PLANT LIVES
230 FOR I= 1 TO L
240 INPUT P(I)
250 NEXT I
260 PRINT "ENTER NO. OF FUEL OIL COST CASES (4 MAX)"
270 INPUT O
280 IF O ! 1 THEN 270
290 IF O 1 4 THEN 270
300 PRINT "FOR EACH FUEL OIL COST CASE ENTER ESCALATION"
310 PRINT " RATE, IN PERCENT, STARTING WITH YEAR 2."
320 PRINT "WHEN ESCALATION RATE IS TO REMAIN CONSTANT,"
330 PRINT " ENTER 999 FOR THAT YEAR'S RATE."
340 FOR I= 1 TO O
350 PRINT USING 360, I
360 %ENTER DATA FOR CASE##
370 S(I,1)=0
380 FOR J= 2 TO 40
390 INPUT S(I,J)
400 IF S(I,J) = 999 THEN 430
410 NEXT J
420 GOTO 480
430 R(I)=J-1
440 A=J-1
450 FOR K= J TO 40
460 S(I,K)=S(I,A)
470 NEXT K
480 NEXT I
490 PRINT "ENTER ELECTRICITY ESCALATION, IN PERCENT,"
500 PRINT " STARTING WITH YEAR 2."
510 PRINT "WHEN ESCALATION RATE IS TO REMAIN CONSTANT,"
520 PRINT " ENTER 999 FOR THAT YEAR'S RATE."
530 C(1)=0
540 FOR I=2 TO 40
550 INPUT C(I)
560 IF C(I) = 999 THEN 590
570 NEXT I
580 GOTO 640
590 R(5)=I-1
600 A=I-1

```

```

610 FOR K=I TO 40
620 C(K)=C(A)
630 NEXT K
640 PRINT "ENTER ANNUAL ESCALATION RATES, IN PERCENT, FOR..."
650 PRINT "      TAXES AND INSURANCE"
660 INPUT B1
670 PRINT "      MAINTENANCE"
680 INPUT B2
690 PRINT "      CHEMICAL COST"
700 INPUT B3
710 STOP "POSITION PAPER"
720 SELECT PRINT 211(80)
730 PRINT "  GENERAL DATA APPLICABLE TO ALL CASES          ";B$
740 PRINT
750 PRINT USING 760,F
760 %FIRST YEAR FUEL OIL COST, $/GAL          ###
770 PRINT USING 780, E
780 %FIRST YEAR ELECTRICITY COST, $/KWH       ###
790 PRINT USING 800, T
800 %TAX & INSURANCE, % OF CAPITAL COST      ##.
810 PRINT USING 820, M
820 %MAINTENANCE, % OF CAPITAL COST          ##.
830 PRINT USING 840,X
840 %INCOME TAX, % OF TAXABLE INCOME         ##.
850 PRINT USING 860,L
860 %NUMBER OF PLANT LIFE CASES              #
870 PRINT "PLANT LIFE, YEARS"
880 FOR I=1 TO L
890 PRINT P(I)
900 NEXT I
910 PRINT
920 PRINT USING 930, O
930 %NUMBER OF FUEL OIL COST CASES = #
940 PRINT "FUEL OIL ESCALATION BY YEAR, IN PERCENT"
950 PRINT "YEAR";
960 FOR J = 1 TO O
970 PRINT USING 980, J;
980 %      CASE #
990 NEXT J
1000 PRINT
1010 I=0
1020 FOR J=1 TO 4
1030 IF R(J) ! I THEN 1050
1040 I=R(J)
1050 NEXT J
1060 FOR J=2 TO I
1070 PRINT J;
1080 FOR J1=1 TO O
1090 PRINT USING 1100, S(J1,J);
1100 %      ##
1110 NEXT J1
1120 PRINT
1130 NEXT J
1140 PRINT "ESCALATION RATE IS CONSTANT THEREAFTER"
1150 PRINT
1160 PRINT "ELECTRICITY ESCALATION BY YEAR, IN PERCENT"
1170 PRINT "YEAR", "RATE"
1180 J=R(5)
1190 FOR I= 2 TO J
1200 PRINT I,C(I)

```

```

1210 NEXT I
1220 PRINT "ESCALATION RATE IS CONSTANT THEREAFTER"
1230 PRINT
1240 PRINT "ANNUAL ESCALATION RATES, IN PERCENT, FOR..."
1250 PRINT "    TAXES AND INSURANCE = ",B1
1260 PRINT "    MAINTENANCE = ",B2
1270 PRINT "    CHEMICAL COST = ",B3
1280 STOP "POSITION PAPER"
1290 LOAD
1300 END

```

```

10  COM P(4),S(4,40),R(5),C(40),M1(2,40)
20  COM F,E,T,M,X,L,O,B1,B2,B3,M1,Q1(2),Q2(2)
30  COM B$
40  DIM Z1$(5),Z2(5),Z3(5),Z4(5),Z5(5),Z6(5),Z7(5)
50  SELECT PRINT 005
60  K9=0
70  K9=K9+1
80  PRINT "ENTER CASE DESCRIPTION"
90  INPUT A$
100 PRINT "ENTER ALL THE FOLLOWING IN THOUSANDS..."
110 PRINT
120 PRINT "ENTER FUEL OIL SAVINGS, GAL/YR"
130 INPUT D1
140 PRINT "ENTER ELECTRIC CONSUMPTION, KWH/YR"
150 INPUT D2
160 PRINT "ENTER CHEMICAL COST, $"
170 INPUT M1
180 PRINT "ENTER CAPITAL COST, $"
190 INPUT D3
200 PRINT "ENTER INTANGIBLE DRILLING COST, $"
210 INPUT D4
220 PRINT "ENTER TAX CREDIT, $"
230 INPUT D5
240 Z1$(K9)=A$
250 Z2(K9)=D1
260 Z3(K9)=D2
270 Z4(K9)=M1
280 Z5(K9)=D3
290 Z6(K9)=D4
300 Z7(K9)=D5
310 IF K9 = 5 THEN 350
320 PRINT "IF ADDITIONAL CASES, ENTER    YES    "
330 INPUT A1$
340 IF A1$ = "YES" THEN 70
350 SELECT PRINT 211(80)
360 K8=K9
370 FOR K9= 1 TO K8
380 A$=Z1$(K9)
390 D1=Z2(K9)
400 D2=Z3(K9)
410 M1=Z4(K9)
420 D3=Z5(K9)
430 D4=Z6(K9)
440 D5=Z7(K9)
450 K=0

```

```

460 FOR I=1 TO 0
470 FOR J=1 TO L
480 K=K+1
490 PRINT "CASE ";A$, "RUN NO. ";K;"          ";B$
500 PRINT
510 PRINT "FUEL OIL ESCALATION CASE NO. ";I
520 N=P(J)
530 PRINT "PLANT LIFE, YRS = ";N
540 PRINT
550 PRINT "FOLLOWING ARE IN THOUSANDS..."
560 PRINT "FUEL OIL SAVINGS, GAL/YR          ";D1
570 PRINT "ELECTRIC CONSUMPTION, KWH/YR      ";D2
580 PRINT "CHEMICAL COST (YR 1), $          ";M1
590 PRINT "CAPITAL COST, $                  ";D3
600 PRINT "INTANGIBLE DRILLING COST, $      ";D4
610 PRINT "TAX CREDIT, $                    ";D5
620 PRINT
630 L1=N
640 REM L1=PLANT LIFE, YEARS
650 REM SETUP FIRST LINE
660 REM G1 IS FIRST COLUMN OF OUTPUT SHEET
670 REM G9 IS NINTH COLUMN
680 REM H1 IS TENTH COLUMN
690 REM ETC
700 G1=1
710 G2=F
720 G3=E
730 G5=-D3*T/100
740 G6=-G3*D2
750 G7=-D3*M/100
760 G8=-M1
770 G9=G2*D1
780 H1=G5+G6+G7+G8+G9
790 H2=-D4
800 H3=-D3/L1
810 H4=H1+H2+H3
820 H5=D5
830 H6=-H4*X/100
840 H7=H1+H5+H6
850 PRINT "FIRST YEAR COSTS FOLLOW (IN THOUSANDS OF DOLLARS, UNL
ESS OTHERWISE NOTED)"
860 PRINT USING 870,G2,G3
870 %FUEL OIL, $/GAL      -####.###          ELECTRICITY, $/KWH  -
####.###
880 PRINT USING 890, G5,G6
890 %TAXES & INSURANCE    -####.#           ELECTRICITY      -
####.#
900 PRINT USING 910, G7,G8
910 %MAINTENANCE          -####.#           CHEMICALS        -
####.#
920 PRINT USING 930, G9,H1
930 %OIL SAVINGS          -####.#           NET CASH INCOME  -
####.#
940 PRINT USING 950, H2,H3
950 %INTANG DRILL COST    -####.#           DEPRECIATION     -
####.#
960 PRINT USING 970, H4,H5
970 %TAXABLE INCOME       -####.#           TAX CREDIT       -
####.#

```

```

980 PRINT USING 990, H6, H7
990 %INCOME TAX      -####.#          NET CASH FLOW      -
####.#
1000 PRINT
1010 PRINT USING 1030
1020 PRINT USING 1040
1030 %YEAR          NET CASH INCOME      NET CASH FLOW
1040 %-----      -----
1050 I2=1
1060 PRINT USING 1070, I2, H1, H7
1070 % ##          #####.#          #####.#
1080 REM NOW FOR REMAINING YEARS
1090 N1(1,1)=H1
1100 N1(2,1)=H7
1110 FOR I2 = 2 TO L1
1120 G2=G2*(1+S(I,I2)/100)
1130 G3=G3*(1+C(I2)/100)
1140 G5=G5*(1+B1/100)
1150 G6=-G3*D2
1160 G7=G7*(1+B2/100)
1170 G8=G8*(1+B3/100)
1180 G9=G2*D1
1190 H1=G5+G6+G7+G8+G9
1200 H4=H1+H3
1210 H6=-H4*X/100
1220 H7=H1+H6
1230 N1(1,I2)=H1
1240 N1(2,I2)=H7
1250 PRINT USING 1070, I2, H1, H7
1260 NEXT I2
1270 PRINT
1280 REM CALC ROI
1290 FOR I1 = 1 TO 2
1300 I2=1
1310 I8=5
1320 T1=0
1330 FOR I3 = 1 TO L1
1340 T1=T1+N1(I1,I3)/((1+I8/100)1/2I3)
1350 NEXT I3
1360 IF I2 = 2 THEN 1420
1370 T7=T1
1380 I7=I8
1390 I2=2
1400 I8=10
1410 GOTO 1320
1420 T8=T1
1430 I9=I7+(D3-T7)*(I8-I7)/(T8-T7)
1440 IF ABS(I9-I8) ! 0.001 THEN 1490
1450 T7=T8
1460 I7=I8
1470 I8=I9
1480 GOTO 1320
1490 Q1(I1)=I8
1500 NEXT I1
1510 REM NOW CALC PAYBACK
1520 FOR I1=1 TO 2
1530 T1=0
1540 I2=1
1550 T1=T1+N1(I1,I2)
1560 IF T1 1 = D3 THEN 1590

```



```

1570 I2=I2+1
1580 GOTO 1550
1590 Q2(I1)=(I2-1)+(D3-(T1-N1(I1,I2)))/N1(I1,I2)
1600 NEXT I1
1610 PRINT " ";
1620 PRINT "ON NET CASH INCOME      ON NET CASH FLOW"
1630 PRINT " ";
1640 PRINT USING 1650, Q1(1),Q1(2)
1650      %      ROI= ##.## %      ROI= ##.## %
1660 PRINT " ";
1670 PRINT USING 1680, Q2(1),Q2(2)
1680      %PAYBACK= ##.## YEARS      PAYBACK= ##.## YEARS
1690 I1=66-28-N
1700 FOR I3= 1 TO I1
1710 PRINT
1720 NEXT I3
1730 NEXT J
1740 NEXT I
1750 NEXT K9
1760 GOTO 50
1770 END

```

APPENDIX G

Maryland Geothermal Resources Act

Subtitle 8A. Maryland Geothermal Resources Act.

§ 8-8A-01. Definitions.

(a) *In general.* — In this subtitle the following words have the meanings indicated.

(b) *"Construction"* means any clearing, grading, excavation, building, or the commencement of any of these activities.

(c) *"Department"* means the Department of Natural Resources.

(d) *"Exploratory activities"* means any activity involving the drilling of test wells for geothermal resources.

(e) *"Geothermal resources"* means the natural heat of the earth higher than 120 degrees Fahrenheit or 49 degrees centigrade, or the energy, in whatever form, below the surface of the earth present in, resulting from, or created by, or which may be extracted from, this natural heat, the natural or artificial medium containing that heat, and all minerals in solution or other products obtained from naturally heated fluids, brines, associated gases, and steam, in whatever form, found below the surface of the earth, but excluding oil, hydrocarbon gas, and other hydrocarbon substances.

(f) *"Person"* includes corporations, companies, associations, firms, partnerships, joint stock companies, individuals, and government agencies.

(g) *"Well"* means any excavation or other alteration of the earth's surface or crust by means of which geothermal resource may be obtained. (1978, ch. 549.)

Editor's note. — Section 2, ch. 549, Acts 1978, provides that the act shall take effect July 1, 1978.

§ 8-8A-02. Legislative findings and intent.

(a) Geothermal resources are a natural resource in the State which possess great potential value for the State and the nation as a whole.

(b) In exploring and developing geothermal resources maximum possible consideration shall be afforded to avoiding waste and unreasonable use of natural resources and to protecting the environment, and to optimizing the productive use of the resource. (1978, ch. 549.)

§ 8-8A-03. Powers and duties of Department.

(a) The Department shall be responsible for the management and regulation of the geothermal resources in the State.

(b) The Department may contract for research and scientific investigation in order to determine the potential of the geothermal resources in the State.

(c) The Department may conduct and participate in development projects designed to demonstrate the feasibility of utilizing the State's geothermal resources.

(d) The Department may use any funds made available for the purpose of exploring, analyzing, developing and using geothermal resources.

(e) The Department may establish reasonable fees to cover the cost of processing permit applications.

(f) The Department may promulgate rules and regulations necessary to implement this subtitle. (1978, ch. 549.)

§ 8-8A-04. Exploratory permits.

(a) Every person is required to obtain a permit from the Department before conducting any geothermal resource exploratory activities. The applicant for this permit must have the legal right to use the surface. The permit is obtained upon written application to the Department.

(b) The application shall state the intended location of exploration, give assurance of the applicant's right to use the surface for exploration, provide an exploratory work program, and provide any information requested by the Department.

(c) The Department may approve an application if it determines that the applicant is qualified to conduct exploratory work, that the applicant will comply with all applicable laws, and that the applicant's work program provides adequate protection for the natural resources of the State.

(d) The permit required by this section shall be in lieu of any permit required by Title 8, Subtitles 6 and 8. (1978, ch. 549.)

§ 8-8A-05. Permit to appropriate or use geothermal resources.

(a) Every person is required to obtain a permit from the Department to appropriate or use, or to construct any well, plant, building, or structure which may appropriate or use geothermal resources of the State. The permit is obtained upon written application to the Department. The applicant for the permit must have the legal right to use the surface and give assurance of this right.

(b) The application shall be accompanied by the following information and any other information as required by the Department.

(1) A project description specifying:

(i) What is planned to be constructed, its purpose, use, location, estimated cost, and size; and

(ii) The methods of construction, construction schedule, and operation procedure.

(2) A list of licenses, permits, or other approvals required by any government unit.

(3) Detailed information as to the need for the use and facts concerning alternate site locations as may be requested by the Department.

(4) Information providing proof of the discovery of a geothermal resource and an evaluation of the resource.

(c) After public notice and opportunity for public hearing, the Department may issue a permit for the appropriation or use of geothermal resources if it finds that the applicant has demonstrated that the use:

(1) Conforms with and meets all applicable air, water, and noise laws of the State.

(2) Conforms with all applicable State and local plans.

(3) Would have no material adverse effect upon the natural environment of the area, its scenic or natural beauty, rare or irreplaceable resources, or unique historic site.

(4) Would not be so located, constructed, or operated as to have a material adverse effect upon the public health, safety, or welfare.

(5) Would not be a potential or immediate undue burden on the water supply of the site or region.

(6) Would not cause an unreasonable rate of resource exhaustion.

(d) The permit required by this section shall be in lieu of any permit required by Title 8, Subtitles 6 and 8. (1978, ch. 549.)

§ 8-8A-06. Bonds.

After receiving notification from the Department that an application for an exploratory or appropriation permit has been approved, but prior to commencing any construction, the applicant shall file a bond with the Department. The amount of the bond shall be determined by the Department. The bond shall be conditioned that the applicant will faithfully perform every requirement of this subtitle and rules and regulations issued pursuant to this subtitle. The bond shall be executed by the applicant and a corporate surety licensed to do business in this State. The provisions of this section do not apply to the State, political subdivisions, or municipalities. (1978, ch. 549.)

§ 8-8A-07. Judicial review of action on application.

A request for judicial review of the Secretary's action on any application shall be made within 30 days after the decision has been rendered. Proceedings shall be filed in the circuit court or in the Baltimore City Court having jurisdiction in which the facility or any part of it is to be situated. (1978, ch. 549.)

§ 8-8A-08. Violations.

(a) *Injunctions.* — Any person who violates any provision of this subtitle may be enjoined by a court of competent jurisdiction upon application of the Department acting through the Attorney General.

(b) *Penalty.* — Any person who violates any provision of this subtitle or any permit, or order issued thereunder, is liable to a penalty not exceeding \$10,000, as well as being subject to being enjoined as provided in subsection (a). The monetary penalty thus provided may be recovered in a civil action by the Department through the Attorney General. (1978, ch. 549.)

§ 8-8A-09. Construction of subtitle.

(a) This subtitle shall be liberally construed to effectuate its intents and purposes.

(b) This subtitle may not be construed to be in derogation of any powers or State laws, but shall be regarded as supplemental and in addition to powers conferred by other laws. (1978, ch. 549.)

*from the
1978 Cumulative Supplement
of the
Annotated Code of the Public General Laws of Maryland*

APPENDIX H
Preliminary Studies

Heat Pump for Geothermal Steam Generation

Introduction

During the last few years Westinghouse, under the sponsorship of DOE, has developed a heat pump capable of generating 30 psia (250° F) steam. Although primarily designed to operate from a 200° to 220° F heat source, this heat pump can generate steam from a source that is as low as 120° to 150° F. However, the COP of the heat pump will fall below 3 under these conditions. In order to establish the applicability of a steam generating heat pump in the Campbell Soup plant, some preliminary economic data were developed.

6.2 Basic Data

For the evaluation, a heat pump capable of generating 10,000 lb/hr of 30 psia steam from a 135° F geothermal brine was considered. A temperature drop of 25° F was assumed for the geothermal brine passing through the heat pump evaporator, requiring 400 gpm of geothermal brine. Under these conditions, a COP of approximately 2.4 can be anticipated, requiring 1220 kW of electric power to drive the heat pump. It was further assumed that hot feed water would be provided by the hot water system as previously discussed and that essentially only the heat of evaporation of water at 30 psia would have to be provided. Large quantities of steam are primarily required during the two production shifts or 16 hours per day. Therefore, we based our evaluation of the heat pump on a total of 4500 operating hours per year.

Otherwise, the same basic economic assumptions were applied as were for the hot process water application.

6.3 Economic Analysis

The results of the economic analysis are presented in Table

The total investment excluding wells is estimated at \$139,600. Annual operating cost excluding wells amount to approximately \$315,820. More than 85% of this total is for electric power consumption.

The cost for one to three wells is added

The total annual operating cost varies from \$380,000 to \$461,000 depending on the number of wells.

This compares to a total annual cost of \$225,000 if the present use of steam from oil fired boilers is continued.

6.4 Conclusions

It is evident from Table that at a COP of 2.4 the cost of electric power required by the heat pump already exceeds the cost of steam by a considerable margin. It re-confirms that a COP of at least 3 should be obtained before favorable fuel economics can be expected. In order to achieve a COP of 3 or more, the user temperature, be it steam or water, should not exceed the geothermal brine temperature by more than 80° to 100° F

However, to obtain an economical break even point, taking into account well and equipment costs as well, the COP of the heat pump should be more in the order of 5. It is obvious that under the present conditions, we should not consider generating steam with a heat pump using 120° - 150° F geothermal brine as a heat source. Also, in the near future, conditions for the application of a steam heat pump cannot be expected to improve favorably. The COP is determined by the thermodynamic conditions, i.e. highest and lowest temperature in the

system and the efficiency of compressor and working fluid combined. The thermodynamic conditions are determined by the application and cannot be changed. As far as the efficiency of the combination of compressors and working fluids are concerned, no real improvements are anticipated in the near future.

Table

Steam Heat Pump Economics*

Heat Pump		\$125,000
Well Pump		14,600
Total excluding well(s)		139,600
Capital Depreciation	\$/yr	20,940
Electric Power Consumption		
Well Pumps		5,450
Heat Pumps		329,625
Chemicals		<u>14,740</u>
		370,755
GRAND TOTAL, including 1 Prod.		
	Well \$/yr	435,255
	2	475,755
	3	516,255
Annual Cost Steam	\$/yr	\$225,000

*Based upon 10,000 lb/hr steam at 30 psia (250° F) with 135° F heat source.

Geothermal Chilled Water Production

Introduction

The predominant method used for chilling or refrigeration is an electric motor driven vapor compression cycle. However, when there is a heat source of sufficient temperature, like geothermal brine, chilled water can be produced with an absorption process eliminating the compressor, thereby sharply reducing the amount of electric power that is required.

Initially, ammonia was the refrigerant most frequently used in the absorption process. However, after the lithium bromide - water absorption process was developed, some twenty years ago, the ammonia absorption process was replaced with almost no exception by the lithium bromide system. The advantage of a lithium bromide unit is that it is much more compact. Hence, it can be sold as a completely factory-assembled package, shipped and installed at much less expense, resulting in a considerably lower total cost than for the ammonia units. Also, the ammonia odor emanating from the ammonia units was, in many cases, a problem.

Traditionally, lithium bromide units have been designed for 230° to 270° F heat source temperatures. However, in the last few years, a demand has developed because of the recent interest in solar and geothermal energy, for an absorption unit operating at lower temperatures. As a result, Arkla Industries has developed lithium bromide units that are specifically designed for operation at relatively low temperatures. Based on information for the Arkla low temperature unit, the possibility of producing chilled water from geothermal heat at the Campbell Soup plant was explored. Since water is the refrigerant in a lithium bromide system, temperatures attained are, necessarily, above the freezing point of water.

Basic Data

The basic performance that can be expected from a low temperature lithium bromide unit is shown in Fig. . . . It shows good performance over a relatively wide temperature range of 165° to 210° F. However, below 165° F, the COP drops off very sharply, reaching a COP of zero at approximately 157° F. The lowest design temperature that can be realistically assumed is approximately 170° F.

In Fig. . . . a basic flow schematic is shown based on a 170° F design temperature, assuming a hot water temperature drop of between 10° and 30° F in the generator.

The hot water leaving the generator will have a temperature of between 140° and 160° F and after reheating in a heater to 170° F, can be sent again to the evaporator. One way to reheat the recirculating hot water would be injection of steam. However, because it does not involve the use of any geothermal heat, the consideration of such a system is beyond the scope of this project.

The direct use of geothermal brine for reheating the circulating hot water is not possible, because the temperatures in the generator loop exceed that of the geothermal brine.

However, if a heat pump is included, operating on geothermal brine, thus increasing heat source temperature to 170° F, a chilled water system could be designed that, in essence, would derive a major portion of its energy requirements from a geothermal brine source. In the next paragraph, the technical aspects of the economics of such a system are discussed.

Technical and Economic Evaluation

The economic evaluation involves comparing the annual operating cost of a geothermal chiller, consisting of a heat pump and absorption unit versus the more conventional vapor compression unit. The size of each unit was arbitrarily set at 100 tons or 1.2 MM Btu/hr of chilling capacity, operable during 6500 hours per year.

The design point for the geothermal chiller was selected at 170° F with a COP of 0.7. This means a heat input of 1.71 MM Btu/hr is required. The temperature of the geothermal brine was assumed at 135° F. Values between 5° and 45° F were assumed for the temperature drop of the brine in the heat pump evaporator.

For determining the cost of the geothermal brine, a relatively high output of 450 gpm per well was used. It was further assumed that if only a fraction of the well flow was required for the geothermal chiller, the remainder of the well output would be used in the geothermal hot water system, thus limiting the charges for well cost of the geothermal chiller to its share of geothermal brine usage. The annual cost of one well was taken at \$64,500

According to Westinghouse data , the energy consumption for a 100 ton single compressor centrifugal chiller can be expected to range from 0.7 to 0.9 kW/ton. This is equivalent to a COP varying from 5 to 3.9. In the evaluation, a value of 0.9 kW/ton was applied. The cost of electric power was assumed at \$0.05/kWh as before.

A summary of the results based on the previous assumptions has been presented in Table . It is evident that because of the necessary inclusion of a heat pump on the geothermal chiller system, the electric power requirements of the geothermal chiller system are, after all, more or less the same as for the electric driven vapor compression chiller. Only when the heat pump is designed for a small evaporator temperature differential are there any electrical power savings, but then the quantities of geothermal brine required and the well costs associated with it are very high.

The total cost for electric power and wells clearly indicate that a conventional vapor compression chiller would be a better choice under all circumstances.

Table further lists additional cost items for each system that were not included in the economic evaluation.

It is reasonable to assume that a compression chiller will not cost more than an absorption chiller and that the cooling water cost for both systems will not differ greatly. The fact then that a geothermal chiller system will be further burdened with the cost of a heat pump, the cost of a well pump, brine pumping costs and chemical brine additive costs further confirms that a geothermal chiller system does not appear justifiable. Even when the most optimistic case would be considered, that is 150° F geothermal brine temperature, which would result in energy savings of approximately 25%, the economics continue to favor the conventional vapor compression chiller.

Table

		<u>Chilling System Costs</u>				
		<u>Vapor Compression Chiller</u>	<u>Geothermal Heat Pump Chiller</u>			<u>Steam</u>
Evaporator Temperature differential °F			5	10	20	45
Temperature brine evaporator exit °F			130	125	115	90
Heat transferred MM Btu/hr	1.20	1.71	1.71	1.71	1.71	1.71
COP	3.9	6.4	5.8	4.9	3.5	
COP absorption unit		0.7	0.7	0.7	0.7	
Combined COP	3.9	4.5	4.1	3.4	2.45	
Electric Power input kW	90	78	86	102	145	
Required brine flow, gpm		577	273	135	54	
Wells required @450 gpm/well		1.28	0.61	0.30	0.12	
<u>Annual Cost</u>	<u>\$/Yr</u>					
Electric Power	\$29,250	25,350	27,950	33,150	47,125	55,575
Well Cost		80,000	38,125	19,350	7,740	
TOTAL	29,250	105,350	66,075	52,500	54,865	55,575
Additional Cost Items	Chiller Cooling Water	Chiller Cooling Water Heat Pump Well Pump Electric Power Well Pump Chemicals				

Geothermal Refrigeration

Introduction

Because of the recent interest in geothermal energy, the Aerojet Energy Conversion Co. in close cooperation with Lewis Refrigeration Co.

investigated the possibilities of applying geothermally driven absorption refrigeration equipment in the food industry. Based on the information that was developed by these companies, the possibilities of geothermal refrigeration at the Campbell Soup plant were explored since the Salisbury plant has high refrigeration loads.

Basic Data and Assumptions

The basic data regarding performance of geothermal absorption refrigeration as they were developed by Aerojet and Lewis are presented in The theoretical performance, expressed as COP, as a function of evaporator temperature and brine temperature, are presented in the graph on the left. The efficiencies of a two stage system with organic working fluid for -4° and -40° F evaporator temperatures are shown in the graph on the right.

Although ammonia absorption systems show better heat transfer rates, organic absorption systems are preferred because they are more efficient in extracting the heat from the geothermal brine.

It is obvious that the minimum heat source temperatures of 160° F for -4° F and 235° F for -40° F exceed the anticipated maximum temperature of the geothermal brine at the Campbell Soup plant.

Therefore, it will be necessary to include a heat pump. As the temperature of the heat source to the absorption refrigeration unit increases, the performance of the refrigeration unit also increases, but at the same time, the performance of the heat pump that has to produce these higher

temperatures decreases. Therefore, for the -4°F application, three refrigeration heat source temperatures (170° , 200° and 250°F) were explored. For the -40°F application a 250°F heat source temperature seemed to be the only realistic possibility, because heat pumps capable of operating above 250°F do not exist. A brine temperature of 135°F was assumed. For the brine temperature drop in the heat pump evaporator, a relatively low value of only 10°F was applied.

Performance Evaluation

The performance data for a combined absorption refrigeration and heat pump system are shown in Table

Refrigeration COP data were taken from Fig. Heat pump COP was calculated Total system COP was determined by multiplying refrigeration COP by heat pump COP.

It shows that for the -4°F application, the best results are obtained at the highest possible heat source temperature of 250°F . At this temperature at overall COP of approximately 1.3 seems possible. This is equivalent to an energy requirement of 2.7 kW per ton of refrigeration. If -40°F is required, the COP drop sharply to 0.55 or 6.4 kW/ton of refrigeration.

Table includes COP values that are typical for a vapor compression refrigerator system According to data from Carrier , a COP of 2.8 or 1.25 kW/ton for -4°F and a COP of 1.8 or 1.95 kW/ton can be anticipated.

These values are two and three times better than the performance data projected for a combined absorption - heat pump system.

Therefore, energy requirements alone indicate that a geothermal absorption refrigeration system does not appear justifiable.

Table

Geothermal Absorption Refrigeration System Performance

Refrigeration to	-4° F	-4° F	-4° F	-40° F
Heat Source Temperature, °F	170	200	250	250
Maximum COP	0.78	0.99	1.30	1.30
Efficiency	0.08(est)	0.26	0.38	0.16
Actual COP refrigeration	0.062	0.26	0.49	0.21
Actual COP heat pump	5.77	3.91	2.64	2.64
Total System COP	0.36	1.02	1.29	0.55
COP Vapor Compression Refrigeration, approx.	2.8	2.8	2.8	1.8

REFERENCES

Templifier Heat Pump. Westinghouse Bulletin TP-1. September, 1979.

Verbal Communication, J. Eustis, DOE and R.C. Niess, Westinghouse.

Direct Heat Activated Cooling Adapted to Geothermal Energy. Geothermal Resources Council. Special Report No. 5, page 81.

Single Compressor Packaged Centrifugal Chillers. Westinghouse Product Catalog. PE-A1.

Geothermal Absorption Refrigeration for Food Processing Industries. ASHRAE Transactions, 1979, Vol. 85, Part 1.

Industrial Centrifugal Compressors. Carrier Bulletin 17, M, P, S. Page 15.

APPENDIX I

Design sketches for several designs of geothermal production and injection wells of various capacities to various depths, with cost estimates.

FIGURE 1

12"x6"x4" Production Well

4000' Deep 100 gpm

Estimated Cost = \$250,000

FIGURE 2

12"x6"x4" Injection Well

2900' Deep

Estimated Cost = \$230,000

FIGURE 3

16"x8"x6" Production Well

3000' Deep 300 gpm

Estimated Cost = \$480,000

FIGURE 4

20"x12"x8" Production/Injection Well
(Injection well 8" casing run to
surface)
3000' Deep 1000 gpm

Estimated Cost = \$700,000

FIGURE 5

Estimated Cost

1. Mobilization/Demobilization	\$150,000.
2. Construct Production Well	550,000.
3. Develop Well (200 hours)	45,000.
4. Testing/Report (5 days)	25,000.
5. Logging	15,000.
Total:	<u>\$785,000.</u>
6. Standby Time	\$ 200./hr.

FIGURE 6

20"x12"x8" Production Well

5000' Deep

Estimated Cost

1. Mobilization/Demobilization	\$150,000.
2. Construct Production Well	350,000.
3. Develop Well (200 hours)	45,000.
4. Testing/Report (5 days)	25,000.
5. Logging Well	15,000.
	<u>585,000.</u>
6. Standby Time	\$ 200./hr.
	Total: \$585,000.

16"x6" Production Well

5000' Deep

FIGURE 8

Estimated Cost

FIGURE 9