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**STUDY OF PRIVATE ENTERPRISE DEVELOPMENT
OF THE RAFT RIVER KGRA**

Final Report

By
Sidney J. Green
Wayne S. Brown
Peter D. Meldrum

MASTER

July 1977

Work Performed Under Contract No. EY-76-C-07-1623

Terra Tek
Salt Lake City, Utah

**U. S. DEPARTMENT OF ENERGY
Geothermal Energy**

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PROGRESS REPORT

STUDY OF PRIVATE ENTERPRISE DEVELOPMENT
OF THE RAFT RIVER KGRA

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Wayne S. Brown
Peter D. Meldrum

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Submitted to
ERDA/Division of Geothermal Energy
Contract E(10-1)-1623

TR77-64
July, 1977

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SUMMARY

This report presents information, analysis, and conclusions made to date by Terra Tek on the ERDA/DGE contract, "Private Enterprise Development of the Raft River KGRA". Terra Tek has been concentrating primarily on the small for-profit venture business model; and hence, conclusions to date are made primarily for this model. Small ventures are defined here as being those that can reasonably project total sales of one-to-ten million dollars in the near-term of five years or less.

- The largest uncertainty at Raft River has to do with availability of consumptive water; i.e. water rights. If the reservoir water can be used for irrigation, and if the "reservoir" is defined as disconnected from surface water aquifers, this problem would primarily disappear. The answer to these questions is critical.
- The possibility of electric generation from the Raft River KGRA creates a great deal of uncertainty, particularly for a small venture. Reservoir capacity and life become a serious question if electric generation is developed.
- The well costs, and even the certainty of obtaining a producing well, are a deterrent to a small venture. The small venture simply cannot afford to drill one (or maybe two) deep wells, and the risks of ill-defined drilling and completion costs are too high.

- The usual environmental concerns of seismic disturbance, subsidence, animal and plant life adjustments, air quality, and the like are not considered significant problems. This is a big advantage for the Raft River KGRA.
- The private enterprise small venture development of the Raft River KGRA does not look very attractive, because the small venture cannot afford the large costs involved with the items given above. It should be noted that this should not be construed to mean that all ventures at Raft River appear unattractive; only the small venture has been addressed. Models for large ventures will be addressed next in this program.
- The Raft River Electric Cooperative, Inc., appears very interested in development of the Raft River Basin. This support and cooperation is very important to any venture; and their participation possibly even in an equity position, would substantially enhance the success of any venture.
- Promoters of any venture need rather detailed, current, and accurate cost data for the particular Industrial-Agricultural system involved, like greenhouse operations, potato processing, or the like. This information can best be obtained by experts in the respective operations; such expert analysis will additionally add much "credibility" to any conclusions drawn. This program will generate such data on greenhouse operations, and will begin on potato processing.
- If the INEL number two well were made available for direct-heat private enterprise applications, small venture development (as

well as larger venture developments) would look much more attractive. The INEL well plus cooperation of the Co-op would leave only one unsolved problem -- the availability of consumptive water.

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PROGRAM REVIEW

OBJECTIVE

In response to ERDA/DGE PRDA DGE-76-1, "Engineering and Economic Studies of Non-Electric Applications of Geothermal Heat", Terra Tek submitted a proposal aimed at commercializing direct-heat geothermal resources. The proposed effort was for private enterprise development, aimed primarily at the Raft River KGRA.

Terra Tek's primary interest is successful commercialization with the intent that a successful venture would serve as a business model for further commercialization efforts. In simple language, Terra Tek believes that a profitable commercialization venture at Raft River will lead to other attempts at direct-heat geothermal recovery through other private enterprise ventures.

**TASK 1 - REVIEW OF INDUSTRY-AGRICULTURE COMPLEX AND DEFINITION OF
PRIVATE ENTERPRISE MODELS**

Substantial background information regarding different direct-heat uses of geothermal energy at Raft River were made available to Terra Tek during the preparation of this proposal. This information was obtained through detailed, well organized INEL programs. Additionally, much more information has been made available, and INEL programs continue to provide technical information regarding the geothermal reservoir, the use of reservoir water for irrigation, the growing of fish, direct space heating, and the like.

Little review was required by Terra Tek for this task, since one of the staff for this contract, Dr. Wayne Brown, had been directly involved in the previous INEL programs, and very close communication existed with Dr. Jay Kunze, who also serves as Adjunct Professor at the University of Utah. Furthermore, the complete INEL staff have been extremely cooperative and available for direct contact at any time.

Terra Tek has judged it necessary to conduct additional financial analysis of Industrial-Agriculture systems. The objective of these studies will be to obtain detailed, current financial information, and in some cases a complete cost-benefit analysis will be conducted.

Terra Tek has devoted effort to understanding and considering different business models. Most of the information obtained to date regarding business models is presented in the Task 4 review. To date, Terra Tek study has concentrated primarily on the development of small for-profit ventures. The reason for placing first priority on such a business model is because of Terra Tek's familiarity with such a model; and hence, the higher probability of including a complete study leading to successful commercialization.

From information obtained to date, the viability of a small for-profit venture business model appears questionable for the Raft River KGRA. This is further discussed in Task 4. Terra Tek proposes to conduct additional studies aimed at evaluating other business models, as is discussed in the next section.

TASK 2 - NON-TECHNICAL PROBLEM AREAS

In this task, Terra Tek has put priority on investigating

- (a) the availability of land,
- (b) the availability of water for consumptive purposes,
- (c) the legal, environmental, and sociological problems,
- (d) interaction with local groups.

(a) Since any business venture will require land, Terra Tek undertook an analysis to assess the availability of land in the Raft River area and the likely terms for leasing and/or purchasing land. Mr. Guy Alder, an experienced Salt Lake City land appraiser, real estate broker, and recently retired head appraiser for the U.S. Post Office, has served as consultant to this effort. He has investigated the Raft River area to determine land prices and availability, and his report to Terra Tek is enclosed as Attachment 1. (It should be noted that Terra Tek did not intend to lease or purchase land through Mr. Alder's efforts, i.e. there was no attempt to use this R & D contract to obtain information so that Terra Tek might purchase land or acquire land rights.)

Land, particularly adjacent to the INEL number two well, appears to be available and could probably be obtained by a private enterprise. Land acquisition does not appear to be a limitation, however the costs will be very much dependent upon the local attitude that exists at the time the land is sought. The preliminary analysis also suggests that leasing is a more attractive alternative than direct purchase of the land. A minimal amount of added effort is proposed for this subtask.

(b) The major obstacle associated with the development of direct-heat geothermal resources in the Raft River area is the availability of water for consumptive use. Presuming a lack of communication between fresh water aquifers and the geothermal reservoir, there should be no major legal conflict with fresh-water users. If technological assessment indicates otherwise, the geothermal developer runs a substantial risk that production will be severely limited or even stopped to the extent necessary to protect prior appropriations. In any event, consumptive water rights must be obtained for the day-to-day operation of the Industrial-Agricultural complex. This poses a serious problem since the Raft River area is believed to be subject to a moratorium in water permit applications, as current consumption may exceed the recharging of the aquifers.

Mr. Peter Meldrum personally confirmed this situation with the Director of the Department of Water Resources during his trip to Boise last March. The Director stressed that he was issuing no new "water rights". Due to the low water table, the Raft River Basin is closed to all consumptive wells except for domestic wells (single households with a maximum usage of 1,300 gallons per day). Mr. Meldrum also reviewed the regulations in the Idaho Safe Drinking Act as they may pertain to geothermal development.

Additional investigations are planned under this subtask to assess the possibility of using the geothermal reservoir water for crop production, fish farming, or other consumptive uses. It may be possible to "mine" the water from the geothermal reservoir for consumptive use in addition to using the water as an energy source. While such a concept is obviously highly desirable, its technical possibility has not been fully established; current INEL programs are providing valuable data.

(c) Terra Tek has not reviewed the environmental and sociological problems associated with the Raft River site in detail, however, Terra Tek is aware of other studies concerning these subjects. The water problem has been addressed and Terra Tek representatives attended the Geothermal Resources Development Institute program conducted in Salt Lake City in January, 1977. The Idaho code, as it pertains to the characterization of geothermal resources, has been reviewed in detail. A summary of that review is presented in Attachment 2. It is clear that the legal problems pose a serious limitation to a small private venture designed to utilize the Raft River water for direct-heat applications. A small venture may not be able to afford the legal costs to make their project viable. Terra Tek proposes additional effort in this subtask.

The major environmental considerations have to do with the quality of the geothermal fluid and the method of discharge. Dissolved solids and gases and temperature of the discharge water are environmental concerns. Some precautions will be required to prevent contamination of ground waters and soils. Re-injection is the most environmentally suitable method of disposal, unless the quality of the geothermal fluid permits irrigation. The majority of the environmental concerns, such as induced seismicity, ground subsidence, distribution of wild-life habitats, and decreased air quality from the release of dissolved gases, will result in minimal or no impact to the environment in the Raft River area. And, since the use of geothermal energy for space heating is generally regarded by environmental groups as a positive alternative provided care is taken in planning, added support is provided for the feeling that environmental problems will not be of major concern. In fact. Mr. Schlender, past Executive Director of the Raft River Electric Cooperative, Inc.,

stated that he believes that the geothermal development of Raft River has the full support of the Sierra Club.

Sociological considerations also appear to pose no serious restrictions on the development of the Raft River geothermal reserves. Terra Tek proposes to review the Battelle Northwest Research Laboratories' recent studies, but no significant contract effort is proposed.

(d) With the assistance of Dr. Jay Kunze, Terra Tek visited the Raft River Electric Cooperative, Inc., at Malta, in November, 1976. Dr. Wayne Brown and Mr. Sidney Green gave an informal presentation on Terra Tek, the ERDA contract objectives, and Terra Tek's Raft River interests. The meeting was most cordial, and the Co-op members expressed strong interest in the development of the Raft River Basin and a very cooperative and open-minded attitude. The communication of Dr. Kunze and other INEL staff with the Co-op appears excellent, therefore leading to the belief that any geothermal development project would receive very fair consideration. The support (and possibly participation) of the Co-op is believed to be absolutely essential for any Raft River geothermal development. This is particularly true since the Co-op has asked its members (practically all of the citizens of the area) to assign whatever geothermal rights they may be entitled to to the Co-op. This has resulted in an acquisition of geothermal rights to more than 90,000 acres of private land. Further interaction with the Co-op is proposed as part of this subtask.

The "Logistics" and the "Labor" aspects of this task appear at this date to be only business (cost) considerations, and they are incorporated into the business analysis. "Sociological" aspects were discussed in Item (c) above, and "Water Distribution System" and "Re-injection Problems" are to be covered in Task 3.

TASK 3 - TECHNICAL PROBLEMS

To date it appears that the primary technical problems have to do with the specific Industry-Agriculture complex being considered; i.e. requirements for greenhouses, or for potato processing, for example. They are not directly "geothermal" problems except to the extent that scaling and/or corrosion may pose cost uncertainty -- dependent upon the specific complex being considered. The usual "uncertainty-of-the-reservoir" is not believed to be a serious problem (except as noted below) at Raft River since the hot water requirements are relatively small. Even a rather large direct-heat complex will simply not demand very large reservoir capacities as compared to electric generation.

Relative to this task, several uncertainties of a technical nature have major impact on costs, and hence the business models. The uncertainty of costs associated with developing a new producing well appears to be a very serious deterrent for the small "for-profit" venture business model, and undoubtedly has a very large input on any business model. It is not clear if water re-injection will be required, and if so at what depth. This presents a major cost uncertainty. The impact of long-term reservoir production for electric generation, if that should develop at Raft River, brings the "uncertainty-of-the-reservoir" problem into consideration. The distinction between deep geothermal reservoir water and shallow irrigation [consumptive] water will require a definitive answer before any venture could proceed. This is further complicated if electric generation is developed utilizing the same reservoir.

Terra Tek proposes that the problems above that are technical in nature be addressed in Task 2. A substantial effort is needed, and this effort should draw directly on the current INEL programs that are helping to answer those technical-in-nature problems.

TASK 4 - BUSINESS ANALYSIS

The business analysis has concentrated principally on two aspects:

- (a) the return on investment, and
- (b) the mechanics for getting a venture underway.

In both, the principal concern has been to bridge the gap between the previous INEL cost data which suggest that several Industrial-Agricultural complex ventures would be profitable, and the realization that no private enterprise ventures are underway. (An exception might be the greenhouse operations at Raft River; however, because of its small-scale operation, it is not considered further.)

(a) Return on Investment - As stated previously, the Terra Tek effort to date has been mainly to analyze the small for-profit business ventures. Other models are proposed for investigation, and will be considered in the future; however, the analysis and conclusions presented here relate mainly to the one model. The "return-on-investment" considerations are almost totally "risk" related; i.e. if everything were to go well, a reasonable return might be expected. The problem is one of accessing the real situation where everything does not go well.

- Economic analysis suggest that a private enterprise direct-heat geothermal energy venture is a relatively low-margin, relatively long-payout venture. Expenses and revenues, available to date, using energy cost projects, simply do not show the high margins that would attract very high-risk investment. Since a low-margin, long-payout venture appears certain, detailed, current, and accurate cost data are required in order for future additional considerations.

- Water availability poses a severe uncertainty. Any small venture would need to spend relatively large amounts of resources to adequately answer this question. This is a major cost limitation (particularly the start-up costs) for the small venture.
- At Raft River, the plans for possible electric power generation create considerable uncertainty. Electric power generation requirements would quite possibly pre-empt small venture direct-heat utilization. Reservoir uncertainty problems become paramount if large demands are placed on the reservoir for electric power generation.
- Well-drilling and completion costs are a major uncertainty. Even with the significant advances that INEL is making in establishing drilling and completion requirements, and even with the most recent observations by INEL that rather shallow wells may be possible (1800 feet), the unknown drilling and completion costs are a very significant deterrent to a small venture. (As a note, shallow wells offer lower costs for drilling and completion, but create more severe water-rights uncertainties.)

With the above observations, Terra Tek at this date has concluded that without some major yet unknown contribution - - like making the INEL number two well available - - the small venture model for Raft River is not very attractive. (This should not be inferred to mean that all ventures appear unattractive; only small ventures have been considered.) The remoteness of the area, and the possibility of obtaining wells with known temperature/flow conditions essentially free ("unsuccessful" high-production geothermal exploration wells) will cause the new venture

promoters to investigate other sites for less small direct-heat ventures.

(b) Mechanics of Venture Initiation - Just as there are different private enterprise business models, there are different possibilities for initiation of the venture. The most straight-forward for direct-heat utilization is the promotion of the venture by interests directly in the energy source. The intent would be to commercialize [profitability] the geothermal heat, with the greenhouses, potato processing plant, fish farm, or the like, as the user - not promotor. This offers the advantage that the promoter's first priority interest is geothermal energy commercialization, and this should lead to the highest probability for success.

A second candidate for initiation of a venture is through interests of an energy user, where geothermal direct-heat may serve. Here the promoter's first interest is his main-line business, and therefore, he will likely seriously consider geothermal energy only as he can accommodate such interests with his main business. Terra Tek has pursued the investigation of the former approach.

- To have a well with proven temperature/flow characteristics available, essentially free or to be drilled to very shallow depths (100's of feet) offers the most promise for attracting promoters of private enterprise direct-heat ventures. At present, neither of these exist at Raft River.
- While some cost data are available on several Industrial-Agricultural systems, a very detailed, current analysis by experts in the industry involved is required for any promotor to proceed. At this date, greenhouse operations appear to be the best near-term candidates for the Idaho Raft River development. Potato processing appears to be the second choice.

- It is essential that any study thoroughly investigate a system, such as greenhouse operation, potato processing plant, or the like, in order to be helpful to commercialize direct-heat geothermal energy. An incomplete analysis of several systems will offer little information for promoters, since this will not answer questions critical to their evaluations. No such detailed analysis exists yet, but is proposed to be conducted in this effort.

As a note, the INEL number two well appears to be an excellent candidate for direct-heat utilization. The well is not on BLM property, and hence the problems and uncertainties of getting rights to public lands does not exist. And, land appears available nearby for Industrial-Agricultural complex development. The well has proven temperature/flow characteristics to handle a very large Industrial-Agricultural complex or a number of small venture operations.

PROPOSED EFFORT TO COMPLETE CONTRACT

TASK 1

To date Terra Tek has concentrated primarily on "small for-profit ventures" as a business model. And, as indicated in the previous sections, without some significant contribution such a model does not look attractive for the Raft River KGRA. Other business models with much larger scale ventures should be considered. Larger-scale models as indicated in the Terra Tek proposal will be considered.

TASK 2

The assessment of consumptive water availability problems needs much more analysis. Emphasis should be placed on:

- Availability of water for consumptive use such as irrigation and process water;
- Water rights and reservoir (depth and recharge) uncertainties;
- Well costs and probabilities of drilling a successful producing well;
- Water injection depths and overall requirements;
- The impact of possible electric generation at Raft River.

This task will not include "reservoir engineering" for example, but will provide data for the business models and the business analysis.

TASK 3

Technical problems analysis has been primarily combined with Task 2. Some small effort may be needed to consider cost uncertainties that

scaling and corrosion would have on a specific Industrial-Agricultural complex.

TASK 4

The data from Task 1 on business models will be utilized in this task for final business analysis. This task will draw conclusions, and present overall guidelines for private enterprise development.

As part of this Task, greenhouse operations will be evaluated in the greatest detail, since this is believed the most likely near-term candidate for the Raft River KGRA. This will be accomplished by utilizing Mr. Mike Alder and Dr. Hugh Bollinger of Native Plants, Inc., in Salt Lake City as consultant-subcontractors. Potato processing will be given second priority.

ATTACHMENT 1

LETTER OF FINDINGS
AVAILABILITY OF LAND

by Guy Alder*

Presented as Part of
ERDA Contract E(10-1)-1623
"Study of Private Enterprise Development of
the Raft River KGRA"

TR 77-64
January, 1977

*Consultant to Terra Tek

January 28, 1977

LETTER OF FINDINGS

Mr. P. (Pete) Meldrum
Consultant to the President
Terra Tek Inc.
420 Wakara Way
Salt Lake City, Utah

Dear Mr. Meldrum:

In accordance with the request made by Wayne Brown and confirmed by you on January 14, 1977, I have personally inspected the properties near the deep test geothermal wells located near Bridge, Idaho, on January 19, 1977, for the purpose of providing counsel on the advisability of leasing or purchasing such abutting properties for experimental purposes.

Market value, as defined for this report, is the highest price, as of the date of this appraisal, estimated in terms of money that a willing, prudent, and well-informed purchaser would be warranted in paying and an equally well-informed seller justified in accepting for a property if placed in the open market for a reasonable period of time, with both parties acting free of compulsion or duress, and with all rights and benefits inherent or attributable to the property included in said value.

Appraisal is on a "fee-simple" basis.

Regardless of the route selected it will require an experienced negotiator to acquire a lease or purchase of any parcel of ground at an economic amount. Under any circumstances, the negotiated amounts will be well above market value. Ownerships, due to the existence of the deep test wells are of the opinion they share an amenity of unlimited value and are afraid they are about to be "conned" from their monetary benefits. They are fully aware they have captive buyers or interests in the use of the land.

If the land is leased and experiments produce low cost energy complexes having a high market demand, their concerns could be warranted. Under these circumstances they would benefit from the investment, time and expertise of others without being involved with the risks. Conceivably, they could ask and receive considerations equal to, or even in excess of urban land prices.

From my contacts they are asking a yearly lease amount in excess of the market value of raw acreage. The Raft River Electric Power Co-op is currently leasing from Ivan Darrington undeveloped range land for \$200 per

Guy D. Alder, Appraiser

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year consideration. Land in this instance could not be developed into crop land because of the high saline content in the ground, the shallow top soil, and the presence of gravel. Mr. Darrington is willing to lease, but not sell, other similar land for the same yearly rental consideration.

Typically, undeveloped range land, without water, is selling in the Malta-Raft River Belt for \$75 to \$150 per acre. Dry farm land that has been prepared for crops is selling from \$200 to \$350 per acre. Irrigated crop land is selling from \$600 to \$1,000 per acre. As would be expected, most ownerships are asking for prices in excess of these amounts.

According to John Gray, Director, Federal Land Bank at Burley, Idaho, his organization would lend from \$250 to \$260 per acre for irrigated crop land in the Bridge, Idaho area. This would represent a sixty per cent value assignment for the appraised value and worth of the land due to the short growing season of ninety frost free days per year. Terms would be at 8½% for twenty years.

Ivan Darrington first considered the sale of some of his land if his two high school sons could be assured of some gainful employment at the project. Otherwise, he wanted to retain ownership for their future farming interests. He did not confirm it in writing. The lease asking price for the irrigated cropland to the west and south of deep test well #2 would be at \$300 per year with the obligation to remove any capital improvements located thereon and to replant the alfalfa fields upon the expiration of the lease. This land has a new shallow well located after he purchased the property from Harriett Crank in 1970. It has a depth of 280 feet cased to 260 feet, tested 50 miners inches of water at 80 feet. Pump set at 110 feet. He purchased the 120 acres from Harriett Crank in 1970 for \$166.67 per acre which included a well in the center of the parcel.

Lance Udy has signified an interest in leasing or possibly selling some of the acreage immediately to the east of well #2. He has not, as yet, confirmed any amounts for consideration. They will undoubtedly be in the same thinking bracket of Ivan Darrington. Mr. Udy's property is dry farm land, except the portions which may be irrigated from the tailings of the well.

Harriett Crank stipulated she still had land that was available for lease near well #1. Consideration was not discussed and would not be disclosed until she "personally sat down with the parties interested in leasing the property." If her land became a viable alternative, she would probably sell. She did sell the ten acres with her greenhouses during 1976 that were utilizing the energy for heating and irrigation water from well #1.

All of the above are residents within Bridge-Almo, Idaho communities.

Guy D. Alder, Appraiser

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For further consideration the 100 acres of undeveloped range land to the east of well #1 which could be developed into dry farm land or crop land owned by Paul Pewitt could be leased, or possibly purchased. He is an absentee owner living in Texas.

My recommendation would be to acquire the ownership of a sufficient sized parcel to accomodate your needs for the next ten years. The land, if purchased at a reasonable amount, could be sold at some future date at an amount somewhat commensurate to the purchase price, with the involvement during the period of holding being limited to the interest on the investment. This would assume the purchase could be negotiated at a price near market value, not to exceed \$1,000 per acre for forty acres or less. This could be accomplished through a knowledgeable resident of the area who would serve as a broker or through a reputable brokerage firm.

As an alternative, if such a purchase becomes unrealistic, then a lease should then be negotiated following the same recommended procedure. It is important not to get the abutting property owners upset or to question the trust of your intentions.

Ivan Darrington
Almo, Idaho 83312
(202) 824-2112

Lance Udy
Bridge, Idaho 83312
(208) 645-2254

Harriett P. Crank
Bridge, Idaho 83312
(208) 645-2996

Paul P. Pewitt
P. O. Box 696
Glen Rose, Texas 76403
Hm. (817) 897-2264
Off. (817) 897-4624

John Gray, Director
Federal Land Bank
Burley, Idaho
(208) 678-3516

I trust this report is sufficiently complete for the purposes intended. If any additional information is desired, please feel free to call on me. I appreciate being able to be of service to you on this occasion.

Respectfully submitted,

Guy D. Alder, SRPA

Guy D. Alder, Appraiser

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Well #2 taken from southeast corner
looking northwest.

water tailings from Well #2 taken from
easterly bank looking
west.

Older well near center of
Ivan Darrington's property
looking northwest.

View of newer well near north central
property line looking west.

View of the alfalfa field taken near
center of Darrington property looking
southeast.

View of the Darrington property at the
southwesterly corner looking northeast.

View of the Lance Udy property as taken from the southwesterly corner looking northeast.

View of the Lance Udy property showing leased strip to Utah State Agricultural College on left and westerly property line.

**View of the Harriett Crank property
as taken from the southwesterly corner
looking northeast near Well #1.**

**View of Paul P. Pewitt property as taken
from the northeasterly corner looking
southeast near Well #1.**

**View of Well #1 as taken from the
northwesterly corner looking southeast
showing baffle boards in tailing pond.**

Name: Guy D. Alder

Address: 1047 Eastgate Road
Salt Lake City, Utah 84117

Date of Birth: November 8, 1915

Education: Received basic education under the Salt Lake City Public School system, including two years of post-graduate work. Attended George Washington University at Washington D. C., and the University of Maryland at College Park, Maryland. Have not received college degree.

Appraisal Training:	Course	Sponsor	Location	Date Completed
	8-week course	VA	Wash. D. C.	Aug. 25, 1955
	Course I	AIREA	Univ. of Utah	July 1, 1958
	Course II	AIREA	Univ. of Calif.	Sept. 10, 1958
	Course III	AIREA	Univ. of Ill.	July 29, 1960
	Course V	AIREA	Utah State Univ.	Aug. 16, 1968
	Course I	CPM	Hotel Utah, S.L.C.	Nov., 1963
	Course II	CPM	Sheraton Hotel, Denver	June, 1964

Completed instructor's training courses for American Institute of Real Estate Appraisers and Society of Real Estate Appraisers. Taught appraisal courses seven times at university level. Past president of Utah Chapter #28 AIREA. Past president of Utah Chapter #41 SREA. Served three years as a regional representative for SREA. Served three years at national level on Rural Properties Committee of AIREA.

Appraisal Experience: Staff appraiser for the Veterans Administration, Salt Lake City, Utah, from July 1, 1955, until December 1, 1957. Effective that date I became the appraiser for Zions First National Bank. Since July 1, 1955, my full-time employment activity has been devoted to appraisal problems, now on an independent fee basis. I have done fee appraising for the Veterans Administration, Federal Housing Administration, State Road Commission of Utah, State Savings & Loan Association, Deseret Federal Savings & Loan Association, Church of Jesus Christ of Latter-day Saints, Surety Life Insurance Company, Salt Lake County, etc. I have appeared in court on many occasions as an expert witness. Also, co-author in preparing the Residential Cost Manual for Utah, as published by Salt Lake Chapter #41, SREA. Assumed responsibility of revised second edition. For the period 1974 through 1977 I was employed as the Chief Appraiser for the United States Postal Service in their headquarters at Washington, D. C. This governmental agency is the largest owner and lessee of commercial property in the world. Some of the major appraisals completed are:

Wheeler Machinery Company Buildings
 Strevell-Patterson Hardware Co. Warehouse
 Salt Lake Hardware Company Warehouse
 Salt Lake Clinic Company Buildings
 Budge Clinic
 Alta Rose Lodge
 Four Ski Lodges
 Solitude Ski Resort
 Trevelodge
 Ramada Inn
 Perry's Lodge
 S. E. Brady Estate
 Rulon Knell Estate (Six Motels)
 H. H. Peery Estate, Inc.
 Enoch Smith & Sons Interests
 Wherry Housing Project
 Roy Shopping Center
 Cottonwood Plaza Regional Shopping Center
 Valley Fair Regional Shopping Center
 South Plains Mall Regional Shopping Center
 Utah Central Airport
 Bridal Veil Falls Aerial Tramway
 Samuel Clark Farm
 Bartholomae Ranch
 Double Arrow Ranch
 Harold Calder Farm
 Little America
 Magnum Trusts 7-Eleven Markets and
 Artic Circles
 Gulf Oil Service Station Sites
 Rodway Inns
 U. S. Postal Properties
 Synergetics
 European Health Spas

Salt Lake City, Utah
 Salt Lake City, Utah
 Grand Junction, Colorado
 Salt Lake City, Utah
 Logan, Utah
 Alta, Utah
 Teton Village, Wyoming
 Brighton, Utah
 Salt Lake City, Utah
 Salt Lake City, Provo, Utah
 Kanab, Utah
 Pocatello, Idaho
 Phoenix, Ariz., Cedar City, Ut.
 Ogden, Utah
 Salt Lake City, Utah
 Hill Field, Utah
 Roy, Utah
 Salt Lake City, Utah
 Granger, Utah
 Lubbock, Texas
 Salt Lake City, Utah
 Provo Canyon, Utah
 Mill Pond, Utah
 Ely, Nevada
 Seeley Lake, Montana
 Burley, Idaho
 Granger Junction, Wyoming
 Utah, Illinois, Washington,
 Colorado and California
 Utah, Idaho and Nevada
 Utah, Nevada and Colorado
 Entire United States
 Entire United States
 Entire United States

CONTINGENCIES AND LIMITING CONDITIONS

The legal description in this report was received or abstracted from a reliable source and is assumed to be correct, but your appraiser takes no responsibility as to its correctness.

No title opinion is rendered herewith and the property is appraised free and clear of all liens and encumbrances, and on the basis of a marketable title, with all rights of ownership in "fee simple," unless otherwise noted.

The improvements, if any, are assumed to be within the lot boundaries and in accordance with the requirements of zoning and building ordinances, but no representation is made in regard thereto, unless noted.

The appraiser shall not be required to give testimony or appear in court as an expert witness in connection with this report, or the property values arrived at therein, unless prior arrangements are made.

The value estimate is based on the market and monetary conditions prevailing as of the valuation date and cannot be applied to the other dates in the past or future.

The content of this report is for the general use and benefit of the client, but the value conclusions nor any other part of the report shall not be conveyed to the public through advertising, public offerings, news, or other media, nor shall the name of the appraiser or reference to the professional affiliations of the appraiser, be used or exploited without the written consent of the appraiser.

All market data and other information contained in this report is assumed to be correct but is not guaranteed. All sources of reliable information have been investigated with none being withheld which would tend to distort the final estimate of value.

CERTIFICATE OF APPRAISAL

I hereby certify:

1. That I have personally inspected and examined the property described in this appraisal;
2. That my employment and the compensation for rendering this report are not contingent upon the value found;
3. That I have no past, present, or contemplated future interest in the property, unless otherwise noted;
4. That to the best of my knowledge and beliefs, the statements and opinions contained in this appraisal, subject to the contingencies and limiting conditions set forth above, are correct; and,
5. That the appraisal has been completed in accordance with standards of practice and code of ethics of the Society of Real Estate Appraisers.

Re: Properties near deep test geothermal wells
located near Bridge, Idaho

Effective Date: January 19, 1977

Date Completed: January 28, 1977

Appraiser

SRPA

ATTACHMENT 2

**CHARACTERIZATION OF
GEOTHERMAL RESOURCES UNDER IDAHO LAW**

**by John Davis*
Peter Meldrum****

**Presented as Part of
ERDA Contract E(10-1)-1623
"Study of Private Enterprise Development of
the Raft River KGRA"**

**TR 77-63
May 1977**

*** Utah Attorney specializing in Resources Law, serving
as Consultant to Terra Tek**

**** Terra Tek**

CHARACTERIZATION OF GEOTHERMAL RESOURCES
UNDER IDAHO LAW

In 1972, Idaho passed laws to specifically deal with geothermal resources in that state. Idaho has characterized geothermal resources as a unique resource:

"Geothermal resources are found and hereby declared to be sui generis, being neither a mineral resource nor a water resource, but they are also found and hereby declared to be closely related and possibly affecting and effected by water and mineral resources in many instances." (Idaho Code 42-4002(c) (Supp. 1975).

Idaho defines geothermal resources as:

"...the natural heat energy of the earth, the energy, in whatever form, which may be found in any position and at any depth below the surface of the earth present in, resulting from, or created by, or which may be extracted from such natural heat, and all minerals in solution or other products obtained from the material medium of any geothermal resource." (Idaho Code 42-4002 (c) (Supp. 1975).

Material medium is further defined as:

"...any substance, including, but not limited to naturally heated fluids, brines, associated gases, and steam, in whatever form, found at any depth and in any position below the surface of the earth, which contains or transmits the natural heat energy of the earth, but excluding petroleum, oil, hydrocarbon gas, or other hydrocarbon substances." (Idaho Code 42-4002 (e) (Supp. 1975).

Thus, an inference can be drawn that Idaho recognizes a legal as well as conceptual difference between the energy produced and the matter from which the energy is extracted. Presumably the "material medium" may be characterized as property of the state and Idaho claims full power to regulate its use, whether on private or state land. In this regard, it is treated somewhat similarly to water. On the other hand when the "fluids, brines,

associated gases, and steam" are used to produce energy that are not subject to water laws in the sense that a permit for an appropriation is required. The statute provides that an application to appropriate water is required only when the water extracted in a geothermal operation is expected to be used for any beneficial use other than as "a mineral source, an energy source, or otherwise as a material medium." (Idaho Code 42-4003 (b) (Supp. 1975)). Thus, appropriation requirements may hinge on the use to which the fluids are put. A technological assessment must be made for all non-electric uses of geothermal fluids to determine if the material medium (hot water) is put to any use other than for the extraction of heat. Presumably, such uses as free farming or fish farming would require an appropriation to vest rights in the material medium, whereas power production or space heating would not.

Although there is definite statutory authority for the proposition that geothermal resources are not to be treated as water, there remains the problem that may exist when geothermal production interferes with the use of water by prior appropriators. Idaho Code 42-4005(e) attempts to answer this problem at the application stage. It provides:

"The director shall not issue a permit if he finds that operation of any well under a proposed permit will unreasonably decrease ground water available for prior water rights to any aquifer or other groundwater source for beneficial uses other than uses as a mineral source, an energy source, or otherwise as a material medium, unless and until the applicant has also obtained a permit for the appropriation of groundwaters under Chapter 2, Title 42, Idaho Code."

A reasonable interpretation of this statute would be that the

Director (Department of Water Resources) must disapprove a permit for a geothermal well if the operation will decrease the groundwater supply to the detriment of prior appropriators when the geothermal operator is putting the water to use other than as a "material medium" and the operator has not obtained a permit for appropriation. This leads to the conclusion that a geothermal operator does not need a water appropriation for extraction of energy from a "material medium."

Nevertheless, the Director has discretionary authority to refuse to issue a geothermal permit if he finds:

"Any possible interdependence between any geothermal resource reservoir, pool, or other source expected to be affected under the permit and any aquifers or other sources of groundwaters used for beneficial uses other than uses as a material medium or a mineral source, and the probability that such interdependence may cause such groundwater sources to be inadequate to meet demands on them under the existing water rights."

Although a water appropriation may not be necessary, it does not mean that courts will not protect existing water rights once a geothermal permit has been granted. It only means that a geothermal operator's rights are not dependent on filing for a water permit for purposes of priority in these circumstances. Assuming, however, that many non-electrical applications of geothermal resources would result in a consumptive use of water other than as a mere energy source, a water appropriation permit application must be filed.

As a practical matter, a prospective geothermal developer should, at the earliest opportunity, make an assessment of the resource to determine the effect of exploitation on groundwater

supplies. The Raft River area is now subject to a moratorium on water permit applications as current consumption exceeds the recharging of aquifers. Nevertheless, permits were granted on the three production wells in the area, presumably indicating a lack of communication between fresh water aquifers and the geothermal reservoirs. As long as this holds true, there should be no conflict with fresh water users. If technological assessment indicates otherwise, a geothermal operator runs the risk that production may be limited to the extent necessary to protect prior appropriators.

An additional potential conflict exists between multiple users of the geothermal reservoir. Again, technological facts may be determinative of the outcome of a dispute. The current ERDA Project to develop power from the medium temperature resource could be jeopardized by independent drilling for non-electric purposes. Idaho law gives the Director authority to require unitization of a resource to avoid waste (Idaho Code 42-4013(b)). As geothermal resources are sui generis, water law concepts of "first in time, first in right" have no application. Traditional oil and gas law may be used to settle disputes of this nature. The "rule of capture" gives the resource to whomever develops it, subject to statutory compulsory unitization authority to prevent waste. As the geothermal industry is still in its infancy, the law will develop as the situations arise and predictions as to outcomes may be little more than guesswork.

As may be inferred from the foregoing discussion, Idaho law requires a permit for any geothermal well. The general permit requirements are summarized in Section III. In addition, copies of Idaho statutes and regulations will be furnished.

ACQUISITION OF GEOTHERMAL RESOURCES

Despite the concept mentioned above that the "material medium" through which geothermal energy may be extracted may be characterized as property of the state, it appears certain that the right to extract the resource is dependent upon obtaining authority from the landowner, whether state, federal, or private. In addition, many estates in land have been severed into a mineral and surface estate. Where in fact lands have been so severed, a difficult problem exists to determine whether rights to production should be obtained from the surface owner or the mineral owner. If the instrument creating the severance makes no mention as to how the parties agree to deal with geothermal resources, geothermal developers may have to wait for judicial determination of ownership of the resource. A background of existing case law is presented on page 20 of my paper and will not be repeated here. What I do attempt to cover here are potential methods to deal with a very uncertain area of the law. I will break this topic into a discussion of private, state, and federal lands.

A. Private lands. Two alternatives are available: Leasing and purchase. In developing a non-electric industry complex, one must consider obtaining both rights to extract the geothermal resource as well as sites upon which to locate the structures necessary to exploit the resource. Depending on the number of wells needed and the extent of land necessary for contemplated uses, outright purchase of land may be an attractive alternative. All risks in geothermal development would then be

born by the developer/landowner. Realistically, potential vendors may inflate prices to reflect the potential gain for a profitable energy source. Assessment of the potential gain and risk involved may be extremely speculative, especially in an area where the resource has not been thoroughly evaluated. Appraisal of land values must be measured against the developer's certainty of resource utilization in a very new industry.

An alternative to purchase is leasing. Leasing has the effect of greatly reducing capital expenditures while allowing the lessor to share in the potential gain of geothermal exploitation. Typically, a geothermal operator pays, in addition to rental, royalties to the owner an amount of 10 - 15 percent of the market value of steam produced. The only experience of which I have knowledge is the sale of steam to a power producer where market values are determined from the agreed sale price to the utility. Negotiating a royalty where the developer is the same business entity as the ultimate user would present more difficult problems of negotiation. Perhaps a satisfactory solution to the problems of purchase and leasing in this situation may be a partnership-type arrangement between the developer/user and the landowner.

In negotiating a lease with a landowner, the following is a checklist of items of negotiation that should be consulted during negotiation:

1. Grant: Definition of resource (should comply with state definition), mineral extraction; disclaimer of interest in state or federal government; right to enter land and erect structures for development including transmission lines.

2. Primary term: Normally fifteen years with extension upon discovery and production should provide for rentals, for delays due to environmental approvals, acts of God, war, and the like.
3. Royalties: Right to fractional part of minerals, 10 - 15 percent of steam (hot water) value.
4. Miscellaneous: Duty of lessor to cooperate in obtaining necessary permits, licenses, etc.
5. Pooling and Unitization: Authority should be granted to unitize or pool for efficient exploitation of resource. Several formulas are in current use, most commonly, an acreage allocation of royalties to adjoining landowners.

These lease provisions are but a smattering of the details to be worked out in negotiating lease terms. There are a couple of articles that cover this area. One by Gerald J. Kitchen is contained in Geothermal Resources Development Institute materials from the January Salt Lake Conference.

Where the mineral and surface estates have been severed, problems exist in determining from whom one should lease. A suggested solution to this problem is the establishment of an escrow account from which payment could be made after resolution of the dispute. It has been suggested that this approach may even work when the Federal government is a claimant although the Federal government has yet to approve leases in such disputed lands.

B. Federal lands. The only method available for acquiring geothermal resources on Federal land is through leasing under the Geothermal Steam Act of 1970 and regulations promulgated under the Act. Requirements under the Act have been discussed by other

law commentators and I have attached what I believe to be the best treatment

Perhaps worth clarifying at this point is the issue presented in the Union Oil Company case where there is private ownership of the surface with a reservation of mineral interest in the Federal Government. If higher courts should overturn the District Court case, the Federal Government may become the owner of much more geothermal resources. Regulations for their disposition have not yet been promulgated. Presumably, they would be leased in much the same manner as under current law. The lessee of these interests would acquire a right to the reasonable use of the surface as is required to exploit the resource, despite the private ownership of the surface. (This theory is derived from current mining law practice under severed lands.) The use of the surface, however, would very likely be limited to the extraction of the resource and not to industrial siting for its use. Industrial siting would have to be negotiated with the landowner.

C. State lands. Idaho statutes govern the leasing of state lands.

A summary of those laws follows:

Leasing of state lands are administered through the state board of land commissioners. Leases on state lands are issued for a primary term of ten years and "so long thereafter as geothermal resources are produced in paying quantities, or as much longer thereafter as the lessee in good faith shall conduct geothermal well drilling or construction operation..." The lease carries with it the right to use and occupy the surface

for purposes reasonably incident to geothermal operations. Geothermal resources are defined as in the permit statutes and Idaho has expressly declared that prior mineral leases do not carry with them geothermal interests. This comports with Idaho's characterization of geothermal resources as being sui generis.

Leases are limited to one section of land but a person may hold more than one lease.

Annual rental for leased lands are set by statute at not less than 25 cents per acre per year and/or a royalty of not less than 10 percent of the geothermal resources produced or the value thereof. The rentals and/or royalties may be fixed in any manner, including, but not limited to, competitive bidding as the state board of land commissioners may deem as in the best interests of the state.

Idaho allows multiple use of state lands and may issue other leases such as grazing or agricultural leases provided that the geothermal lessee has the right to a reasonable surface use of the land as well as the right to ingress and egress.

Approval of the commission is required for transfer or assignment of a lease. A bond of \$1,000 per lease before commencement of operations is required for purposes of assuring restoration of the land. After commencement of operations the minimum bond requirement is \$6,000 per lease. Leases may be cancelled by the commission upon a finding of lack of due diligence in commencing operations.

In addition, the commission is authorized to cooperate in

unit plans with state lands in conjunction with adjoining geothermal development to the extent the state is not required to share in any drilling costs.

There may be severed mineral and surface estates on state lands much the same as the federal lands and ownership claims may well have to be litigated to be determined. Idaho courts may likely follow the federal example. There is currently a pending case in California under California law and may be helpful in forecasting an Idaho result.

DEVELOPMENT OF GEOTHERMAL RESOURCES

The principal law that governs geothermal development is the statutes and regulations promulgated by the State of Idaho. However, there may be a wide variety of federal and state laws that must be considered. I have included at this point a previously written summary of Regulations for Drilling for Geothermal Resources.

A. Idaho Permit Procedures: Geothermal permits are handled by the Department of Water Resources through its director although the geothermal resources are not characterized as water for appropriation purposes. The following requirements are taken from Idaho Code 42-4991 - 42-4015 (Supp. 1975).

(1) The applicant's name. (More detailed information is required if the applicant is a partnership, association, or corporation).

(2) The location of the proposed well.

(3) The length, size, type and thickness of the casing and any other devices to conserve the geothermal resource, avoiding waste and protection of other subsurface natural resources.

(4) The character and composition of the material expected to be derived from such well.

(5) The means proposed to contain the material to prevent damage to life, property, or surface and atmospheric natural resources.

(6) The relationship of the proposed well to any overall program.

(7) Any other information the Director may require.

If the applicant requires water for his operations or water is expected to be used other than for the extraction of minerals or energy, the applicant must also apply for an appropriation of water. Filing fees are also required.

The statute exempts from permit requirements any vested rights in substances that may be valuable as geothermal resources that were in existence prior to January 1, 1972. There are also some restrictions on any drilling below 3,000 feet in a geothermal area.

Upon receipt of a properly completed application, the Director of the Department of Water Resources is required to ascertain whether the granting of the permit is within the public interest. Among the relevant considerations are:

- (1) The financial resources of the applicant.
- (2) The adequacy of measures to prevent damage to other resources, including the quality of groundwaters.
- (3) The possibility that the proposed operation may cause waste or damage to other geothermal resources.
- (4) Measures proposed to safeguard the environment.
- (5) Any possible interdependence of groundwater uses under existing water rights and geothermal development.

The applicant and the director are entitled to have a public hearing to determine the propriety of granting a permit.

If the director does not find the well is against the public interest, he may grant the permit either as applied for, or with further restrictions or conditions. If the director finds the well is against the public interest, he may deny the

permit. In no case in which the director may find that the geothermal operation will unreasonably reduce the quality of groundwater may he issue a permit. If the director fails to issue a permit, he/she is required to state the reasons therefor with particularity.

If an applicant is denied or modified, the applicant is entitled to a full evidentiary hearing before the Water Resources Board. The results of the hearing may be appealed to the district court which will consider the matter without receiving new evidence. The decision of the board will be affirmed except when the decision is not supported by substantial evidence. The decision of the district court is appealable to the Supreme Court.

The director may refuse to issue a permit if the geothermal operation may unreasonably deplete groundwater levels that may endanger other valid water rights in absence of an appropriation by the geothermal operator. (The statute is unclear as to whether the appropriation requirement attaches only when the geothermal operator uses the water other than as a material medium or when the other water users use their water other than as a material medium. In either case, however, the director may refuse a permit if not in the public interest which may well involve the protection of other users' rights.)

The director shall require the posting of performance bonds of a least \$10,000 per well.

The director also has the authority to require consolidation of permit applications for several wells in an operator's program. Approval is require for the abandonment of any well and has the

authority to issue orders to prevent abandonment in any manner that may cause waste or endanger life, property, or other resources.

The statute gives the following powers to the Water Resources Board:

(1) The ability to promulgate reasonable rules and regulations to carry out the provisions of the act.

(2) The power to impose logging and other record keeping requirements on geothermal operators.

(3) The power to enter onto land to inspect wells and other operations.

(4) The power to issue orders to prevent unsafe practices of prevent environmental damages.

(5) The power to enforce actions through the district courts.

(6) The district court is authorized to assess fines and jail terms upon willful voilations of valid orders.

(7) The director is authorized to institute investigations and studies to determine the best manner of exploiting geothermal resources.

(8) The director may enter into cooperative agreements with other states to administer geothermal areas which are partially in Idaho and partially in other states.

In addition to the requirements above, the applicant may not transfer the operation of an approved well without securing an amendment to the permit application. The applicant must also provide for the designation of an agent for service of

orders, notices, or permits issued by the director.

Voluntary unit agreements must be approved by the water resources board and, to prevent waste, the board may require unitization of geothermal operations.

(Regulations and statutes may be found in Appendices and respectively.

B. Miscellaneous Provisions: Of course drilling is but a minor aspect of full-scale non-electric geothermal utilization. There are other aspects that require consideration. Under this subsection, I will attempt to deal with the possible laws that may be encountered in geothermal operations. At this point, a study of the laws has not been made to determine their precise applicability and the procedures to be followed in obtaining appropriate permits. (These subject areas should be considered along with the laws dealt with in Section IV dealing with the impacts of development).

(1) Building permits. Local and state laws must be considered to insure compliance with building codes and ordinances.

(2) Zoning laws. Local zoning laws will have to be complied with and variances or amendments may have to be obtained prior to construction of industrial facilities.

(3) Easements and rights-of-way. It is likely that federal or state procedures must be examined to acquire legal right to land for ingress and egress to property. For private land, this must be separately negotiated. Rights-of-way may also be required for steam transmission lines.

(4) Employment laws. There are a considerable number of state and federal laws relating to employee protection. Some or all must be complied with during construction and production. Although I have not yet researched these laws, they should be thoroughly examined prior to engaging in geothermal development. Some of these laws are: Occupational Safety and Health Act, Employment Discrimination Laws, Affirmative Action Programs, and Special Laws governing Federally Funded Construction.

(5) Caveat. For all laws respecting energy development, it would be well for the potential geothermal developer to follow closely re-organization efforts of the Executive Branch of the Federal Government. Many priorities may change over the coming months. I believe that geothermal resource development will rise in priority in comparison with nuclear research and I expect that federal support for geothermal development will not be curtailed.

IMPACTS OF GEOTHERMAL DEVELOPMENT

Environmental, economic, and social impacts of development are important considerations in assessing feasibility of development.

A. Environmental impacts.

Environmental impacts are required to be assessed, and in some cases, social impacts are studied as an environmental effect. The National Environmental Policy Act requires filing statements for "major Federal actions significantly affecting the quality of the human environment." (42 U.S.C. 4321 et seq.) Environmental studies are currently being undertaken in the Raft River area by ERDA. It is possible that separate environmental studies may not be required at Raft River. According to a telephone conversation with Mr. Schlender, the Executive Director of the Raft River Geothermal Coop, the development at Raft River has the support of the Sierra Club. If this is true, it would appear that there would be no significant risk to development as long as reasonable steps are taken to protect the environment.

On particular environmental concern that does require study is the disposal of waste fluids. The Federal Water Pollution Control Act requires permits from the Environmental Protection Agency for reinjection into the "navigable" waters of the United States. "Navigable" waters have been construed as any source which may reach navigable waters, including dry gulches.

There is a good argument that all groundwaters may be under the jurisdiction of the Act. If the geothermal reservoirs are

effectively cutoff from other groundwaters, a permit may not be required. A similar result may be reached with jurisdiction under the State Drinking Water Act.

Another potential federal environmental law that should be considered is the Clean Air Act. The Clean Air Act is primarily concerned with restricting atmospheric pollution of sulfur dioxide and particulates from stationary sources. High sulfur content in geothermal steam may require abatement procedure to avoid law.

B. Socio-Economic Considerations.

Social and economic effects are, like environmental effects, difficult to assess without site specific information. A class at the University of Utah College of Law is currently working on a rather comprehensive analysis of rural industrialization and the ability of law to solve problems of development of this kind. The project is expected to be completed in early May and I have been promised a copy of the report. Information provided may be useful in analyzing the following areas:

(1) Migration and training of labor required for production and necessary support services.

(2) Taxing of industry at local and state level to provide necessary services, i.e., fire and police protection, utilities, sewage treatment, schools, parks, etc. (Providing support for electricity and water for a population base may be a severe economic hurdle to overcome as the area is under a water and power deficit).

(3) City planning for reducing impacts of rapid growth. "Boom" towns are notorious for poor environments

(4) Alternatives to "boom" towns. A study should be made of use of mass transportation for site workers with city support at other locations. Costs of development may be reduced by this method but impacts at alternate population centers must still be assessed.

ATTACHMENT 3

**GREENHOUSE ANALYSIS
AND GEOTHERMAL APPLICATIONS**

by Wayne S. Brown*

**Presented as Part of
ERDA Contract E(10-1)-1623
"Study of Private Enterprise Development of
the Raft River KGRA"**

**TR 77-64
December, 1976**

*** Consultant to Terra Tek**

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20 December 1976

TO: Sidney J. Green

FROM: Wayne S. Brown

SUBJECT: Greenhouse Analysis and Geothermal Applications

FOR REFERENCE ONLY

Attached is a financial analysis of a greenhouse operation designed to grow seedlings for use in reforesting regions which have been damaged by mining and civil works operations. This analysis is based on two previous efforts prepared by Mike Alder, president of Native Plants, Inc. and Kendell Huseby of Montana State University. The analysis is presented in some detail to provide a clear basis for considering the advantages of geothermal heating over conventional fuels.

The seedling greenhouse uses a smaller work force than most greenhouse operations, partially due to automation and, in part, due to the nature of the project. For this reason, it is an appropriate operation for a remote region, such as Raft River. While the greenhouse considered here is much too small to make an impact at Raft River, it can be scaled to a much larger operation. A larger-scale facility with multiple bays would permit a cost decrease in the greenhouse construction with the internal bays costing approximately 11% less per ft² than those on the perimeter. Otherwise, the facilities would scale in an approximate linear fashion. Thus, it appears that the unit under consideration will be adequate for comparing the geothermal heating possibilities with conventional heating.

Fuel cost for heating the greenhouse was the single largest uncertainty of any of the variables considered. Cost estimates varied by a factor of two between Alder and Huseby, and a separate estimate by Ralph Wright of Miller Floral was lower than either of them. This area needs considerably more refinement. I intend to interview more greenhouse operators and request actual operating data on annual fuel costs.

My present analysis indicates that present fuel costs are only about six percent of the operating costs and five percent of the total annual costs. While this is still significant, it is somewhat less than I had been led to believe.

The heating apparatus required for geothermal heating will use a hot water coil similar to that used by many greenhouses in this area. Others use gas heaters which exhaust combustion products from burning

Sidney J. Green
20 December 1976
Page Two

natural gas and air into the houses. In either case the capital costs for heating equipment will probably not differ greatly for geothermal heating and conventional fuels.

As a final note, I have considered construction of an entirely new greenhouse in this analysis, since new greenhouses would be required at Raft River. If a geothermal well could be located on property adjacent to an existing greenhouse, such as 20th Century Farms or Hydro Tech near Hurricane, it would be appropriate to consider only the retrofit costs.

I will keep you informed of my progress as this analysis proceeds.

WSB/ml
Encl.

ANALYSIS OF GREENHOUSE OPERATION FOR RAISING SEEDLINGS

Reforestation of lands ravished by mining operations and associated mineral processing has become important to mining companies. Freeway side and center strips also need landscaping to break up the monotony of long stretches of roads. Several companies have sought to develop strains of trees, shrubs, grasses and groundcovers which would be satisfactory for growth in an arid climate. This is particularly important in much of the western and southwestern parts of the United States where vegetation generally grows slowly. A local company, Native Plants, Inc., is focusing its entire business strategy on developing, growing and marketing strains of drought-resistant plant life which can be used to reforest mine dumps, strip mines, freeway side and center strips, sanitary land fills and regions where the countryside has been left barren by natural means.

Mr. Mike Alder, president of Native Plants, has prepared a pro forma for a greenhouse operation in which plantlife is grown in greenhouses. His investigation shows sufficient promise to warrant further study. He based his analysis on a report prepared by Kendell Huseby of Montana State University entitled, "A Tree Seedling Greenhouse: Design and Costs," which analyzed a model greenhouse for a forestry application. This analysis utilizes the results of both Huseby and Alder as a base point.

The operation is centered around an 11,000 ft² greenhouse (approximately 1/4 acre) designed to accommodate 580,000 seedlings a year by harvesting two crops annually. The seedlings are containerized and placed in uniform pallets mounted on rollers. Rails located throughout the greenhouse service building, lathhouse and loading area permit transport of the pallets with minimum difficulty. By careful design, the greenhouse

can utilize 80% of the available floor space for growing.

The principal buildings required in the facility are the greenhouse, a service building and a lathhouse. In the service area the seeds are planted in the growing media which is packed loosely into containers with a separate compartment for each plant. Native Plants has developed a special two-part plastic container, called Tubepak, which separates easily when it is time to remove the plant. The containers, which hold five plants each, are assembled into flats and 25 flats can be loaded on each pallet for ease in handling. Each pallet will contain 1,250 seedlings.

The greenhouses are equipped with automatic sprinkling systems for irrigation, temperature control equipment and devices to control humidity and inject CO₂ into the atmosphere. The pallets are transported into the greenhouse and stored during the growth period on rocks. At the completion of the growing cycle the seedlings are transported to the lathhouse for storage, hardening and as inventory awaiting delivery.

An economic analysis has been prepared to estimate the financial feasibility of the project. A Summary of the analysis is tabulated below. Details of the analysis follow the summary.

Facilities and Equipment

Site preparation	\$ 3,674
Water storage	1,600
Greenhouse (11,136 ft ²)	61,541
Service building (3,000 ft ²)	22,220
Lathhouse (20,000 ft ²)	6,932
Materials handling equipment	10,924
Contingency @ 5%	<u>5,345</u>
Total facilities and equipment	\$112,236

Annual Fixed Costs

Depreciation	11,565
Insurance	1,122
Taxes	1,300
Interest	5,612
Land lease	250

Total annual fixed costs	\$19,849
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Operating Costs

Labor	27,000
Growing materials	4,000
Fertilizer	5,250
Containers	21,600
Fuel for CO ₂ generator	1,200
Electricity	1,200
Maintenance	700
Heating costs	4,000

Total annual operating costs	\$64,950
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Annual Fixed Costs	\$19,849
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Annual Operating Costs	<u>64,950</u>
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Total Annual Costs	\$84,799
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Estimate of Cost to Produce Seedling

$$\frac{\text{Annual costs}}{\text{Number of seedlings per year}} = \frac{\$84,799}{580,000} = 14.6\text{¢/seedling}$$

This assumes all seeds live. Alder estimates from previous studies and experience it is likely that 90% of the seeds will mature. This is equivalent to a cost of 16.2¢/seedling. Seedlings of the type being considered have been sold in small quantities for as high as 50¢ per plant, though in large quantities the price will likely be somewhat lower.

Details of Cost AnalysisSite preparation

Assuming the site is reasonably level and only minimal grading is required, Stoker Asphalt Co. has quoted Alder \$3,674 to provide 5,280 ft² of 2-inch blacktop surface for the greenhouse aisles, service building

and limited parking space, plus 20,700 ft² of four-inch deep gravel for the lathhouse and walkways.

Water facilities

Assuming the site is remote to local water facilities, an irrigation storage tank will be required. Alder planned on a 500 gallon pressurized tank which was estimated at \$1,600 by Ted R. Brown Assoc. No allowance is made for drilling a well to provide irrigation water.

Greenhouse

A number of greenhouse manufacturers were contacted for prices. A wide variety of greenhouse types is commercially available. Prices range from approximately \$1 per ft² for a double polyethylene film house to \$4 per ft² for a solid frame house glazed with glass or fiberglass. The poly houses have a lifespan of one or two years, whereas the glass houses have a lifetime in excess of 40 years, if they are protected from vandalism and not subjected to severe hailstorms. Fiberglass glazing has the advantage over glass of high strength, resistance to damage and better light diffusion qualities.

A Roper IBG Arch II type house with fiberglass covering was selected for this application. This is a first-class facility with long life provided by a manufacturer with a long reputation for quality. A price of \$44,969 was quoted for two Arch II type houses. The price included structure, fiberglass, freight, heating and cooling equipment, controls and erection.

Greenhouse apparatus

Sprinkling system. The Huseby report estimated a cost for an automatic sprinkling system for irrigation at \$8,035. This figure appears adequate.

Cyclic lighting equipment. Cyclic lighting can significantly increase plant growth for a large variety of species of plant life. Huseby estimates \$2,159 for components, assembly and installation.

Monitoring and alarm system. Since the greenhouse is designed for minimal labor, a monitoring and alarm system is provided to detect malfunctions in any of the operating systems. Huseby estimates \$850 for an adequate system.

Standby electric generator. A 30 KW standby electric generator is provided for emergency power shortages. The price of a generator system with a fuel supply tank adequate for 36 hours is estimated by Huseby at \$5,128.

CO₂ generators. A CO₂ generator of adequate size can be obtained for \$400, according to Alder.

Cost of greenhouse and ancillary equipment

Greenhouse	\$44,969
Sprinkling System	8,035
Lighting system	2,159
Monitor and alarm system	850
Standby electric supply	5,128
CO ₂ generator	<u>400</u>
Total greenhouse cost	\$61,541

Service Building

Roper IBG has quoted \$15,601 for a 3,000 ft² metal building erected on site. This is a price of \$5.20 per ft² which is comparable to other metal buildings.

Lathhouse

Lathhouses are designed to provide shade cover and have been built in a variety of configurations. The design chosen here is that of Huseby, who investigated several types and selected a wood structure with strips of woven polypropylene fabric as a shade cover. The cost for a 20,000 ft²

structure is \$6,932, or about 35¢ per ft².

Materials Handling System

Pallet assembly

Huseby designed special pallets to transport and store the seedlings in his system. He required 336 pallets at a cost of \$29.50 each, for a total cost of \$9,912. The Alder pallets will be of a different design but the cost will probably be about the same.

Track installation

Huseby estimated the installed price of the track at \$1,012. Re-design will be required to accommodate the Alder system, but the price is probably reasonable. The total materials handling system is estimated at $\$9,912 + \$1,012 = \$10,924$.

Depreciation

The depreciation period of all of the capital facilities is taken as ten years, except the lathhouse cover which is assumed good for five years. It is clear that the life of many of the items is longer than ten years, but for consideration of a new venture of this type, a life of more than ten years is not warranted. Zero salvage value is assumed. Since the lathhouse cover cost was estimated at \$3,432, the annual depreciation for the facility is \$11,565.

Insurance

Huseby received quotes from insurers which averaged approximately 2% of the average investment. This yields an estimate of \$1122/yr. for this facility. This is surely on the safe side compared to other insurance rates.

Taxes

Alder estimated \$1,300 for a 2-1/2 acre agriculture site approximately 25 miles south of Salt Lake City. This is probably a reasonable estimate for a western agriculture area.

Interest

Assuming 10% interest over ten years, the interest on the \$112,236 investment is \$5,612/yr.

Land Cost

Land costs vary widely. A land lease cost of \$100 per acre was deemed reasonable. For a 2.5 acre plot the annual lease would be \$250.

Labor

Alder analyzed his labor costs on the basis of past operating experience and used a figure of \$27,000 which is approximately 25% higher than Huseby's estimates. Inflation could account for part of the difference but more is attributable to the type of operation.

Growing Materials

Alder has good historical data for his operation and a cost of \$4,000 was projected for materials associated with 600,000 seedlings.

Fertilizer

Based on historical costs, Alder projects fertilizer at \$5,250. This is triple the estimate of Huseby but based on different growing techniques.

Containers

The patented Tubepak containers used by Native Plants cost 15¢ each

in quantity and each holds 5 seedlings. For 600,000 seedlings a year the number of Tubepak containers required is 120,000 at a cost of \$18,000

Fuel for CO₂ Generator

Huseby estimates \$615, Alder \$1,200. This analysis used the conservative estimate.

Electricity

Huseby estimates \$825, Alder \$1,200. \$1,200 was used as a safe figure.

Maintenance

The Alder estimate of \$700 based on his experience was used for maintenance costs. This will likely increase in later years, but should be adequate during the first five years.

Heating Costs

Huseby estimates heating costs at \$2,950/yr. Ralph Wright of Miller Floral reports historical heating costs at 10 to 15¢ per ft² for a northern Utah climate with an abbreviated growing cycle. Alder estimates heating costs at \$6,000. The estimate used here was \$4,000. This is about 6% of the operating cost and somewhat lower than rough estimates quoted earlier to the author by greenhouse operators.

Conclusions

This cost analysis for constructing and operating a seedling type greenhouse provides instructive information on a greenhouse operation with a little more automation than usual in the greenhouse industry. It is possible to operate such a facility with minimal manpower and it is, therefore, suitable for a location such as Raft River. The potential profit

margin in this type product is sufficiently high to make investment of commercial funds attractive. Furthermore, there is a large market for the product. The primary risk is in the unproven ability for the seedlings to survive in an arid climate. It will be several months before Native Plants will be able to evaluate a crucial experiment in which seedlings were planted along Utah freeway sidestrips. If the seedlings survive the winter in reasonable numbers, this will give added impetus to Native Plants' willingness to embark on a new expansion and a venture at Raft River could be attractive.

Heating equipment costs for conventional fuel will likely be similar to those for a geothermal system. If geothermal water can be provided to greenhouses at Raft River at a very low cost, it could be sufficiently attractive to offset the disadvantage of the remote location.

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