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To: Mr. Gerald O. Lesperance
Energy Division
DBED
Fax: (808) 586-2536

Date: December 11, 1991

Page: 1 of 1

From: Murray C. Gardner
Executive Vice President

In reply to your request, we think that the tasks additional to those discussed/costed by HIG that should be considered for State funding include:

1. Any useful new proposals from HIG; Don Thomas indicated in the November 5, 1991, memorandum; "Cost Estimates for Geothermal Program" that some geophysics proposals may be forthcoming.
2. Future SOH site selection by the program team. This was recommended in GeothermEx's October 11, 1991, memorandum to you. For this, personnel time for photo/map analysis, travel and field examination, and reporting should be included. Direct costs for ground/air travel should also be considered. I estimate the total cost for this to be about \$12,000. If the professional time is already in staff budgets, then it is just a matter of getting the work done; direct costs may be \$2,000.
3. Site specific environmental work for future SOHs once the locations are picked. Harry Olson apparently has some ideas about contractors for this. I estimate \$60,000.
4. Additional temperature and pressure runs and hole instrumentation in the original SOHs. I estimate \$15,000 for the initial installation work by contractors, \$8,000 for data interpretation and reporting, and \$60,000 for continued monitoring, periodic equipment inspection, maintenance, replacement of tubing and chambers as required, data interpretation and reporting.

We already added \$15,000 to the geophysical task for initial gravity work under the Cooper-Moore proposal. This may be increased depending upon results. It would be worthwhile to reserve an additional \$20,000 for expansion of gravity work in the KFD7 or summer of next

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To: Mr. Gerald O. Lesperance
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Date: December 9, 1991

Page: 1 of 15

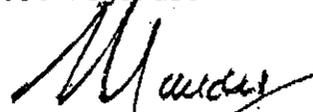
From: Murray C. Gardner
Executive Vice President

Subject: Transmission of review of HIG proposals

Herewith are our comments on the submission by HIG of proposals and budgets for scientific work to be funded by DBED. The detailed analyses of the proposed tasks have been prepared by me with assistance from senior specialists for each of the disciplines. Please review the comments in confidence as you indicated would be done. I look forward to discussing the issue with you. I anticipate being in Honolulu late Tuesday afternoon, December 17 and Wednesday morning, in the event you want to meet prior to the TAC meeting on Wednesday.

I feel competent to address the issues of the HIG proposal, but it would be preferable to have others (Sanyal, Greensfelder) take a more active roll, including on-island appearances in the future. Some discussions and explanations of interpretations are not easily put into memoranda and reports and would make memoranda to burdensome for readers. We can talk further about this issue at your convenience.

Best regards.



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Drilling design and direction is a matter for expert drilling engineers, not for GTAC or Geoscience program personnel. The drilling program should not be overburdened with projects that interfere with the principal objectives of determining downhole temperature, pressure, deliverability of wells and reservoir conditions. The selection of locations of SOHs may be usefully guided by knowledgeable members of GTAC, but extraneous input may be counterproductive. A future memorandum and report by GeothermEx will propose and explain drilling methods for new SOHs under Task 2 of our contract.

The integrated DBED program is understood to have the objectives of encouraging geothermal exploration and development, while protecting the fresh groundwater system and the environment, and assuring resource development with minimal impact on the continued productivity of wells drilled into the geothermal reservoir. DBED is less concerned with subsidizing the growth of staff functions and research at HIG and other agencies which conduct idealized scientific investigations. The rationale by HIG that some percentage of a total DBED budget should be expended to support scientific research is not defensible. Each scientific investigation should justify its own funding. If scientific programs cannot clearly be applied to identifying and confirming the extent of the geothermal reserves, or methods of conservation and economical development, they should be funded elsewhere.

The State has undertaken its geothermal program to ultimately obtain the acceptance by and funding from financial institutions for the continued development of geothermal resources in the State. We agree that resource identification, reservoir assessment, resource management and environmental documentation all contribute to the acceptance of geothermal resources by such institutions. However, some of the programs submitted by HIG are impractical and/or have been proven to have little value to operators and financial institutions at geothermal fields elsewhere. Some of the Geoscience proposals may be professionally endorsed and represent worthwhile investigations which should be supported, perhaps by the University of Hawaii or the National Science Foundation, but not by DBED. Programs which are not appropriate for support by DBED include those which: 1) conserve great amounts of core for possible use of future generations; 2) analyze 300 samples to store and compare data when 50 analyses would be sufficient for interpretation by a trained investigator; and 3) conduct surveys which have already been tried and shown to have no useful application to mapping geothermal reservoirs in Hawaii.

It is acknowledged that drilling as an alternative to laboratory investigations is comparatively expensive; for example, one

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month of rig standby may consume more than \$100,000. However, this should not be a reason to expend similar amounts of money for unnecessary scientific programs. The following sections of this memorandum objectively discuss the merits of the several subtask proposals of the Geosciences program.

2. Comments on the Geology Program

The principles of the geology program appear well-founded. The aspects of core "curation" presented by Dr. Thomas were discussed in detail in our recommendations in the memorandum of November 6, 1991 entitled Review of Core Data from State of Hawaii Scientific Observation Holes, SOH-1, SOH-2 and SOH-4. The core curator (Ms. R. Evans?) should be primarily responsible for this recommended work; "student help" should only be involved for fetch-and-carry assistance. This is work for professional staff. Ms. Evans should have access to senior geologic staff for confirmation of her interpretations and discussions of sample intervals selected for geochemical and XRD investigations.

The concept of total core splitting remains controversial. The cost-benefit to geothermal development of core splitting is questionable at best. Our opinion is that only the footage which is identified as meaningful to a study of reservoir conditions during the preparation of the core summary should be split and preserved for archive. It is simply not necessary to split every part of every flow of the repetitive sequence of eruptive rocks, especially the upper several thousand feet of each hole. As we have recommended before (October 11, 1991) in a memorandum entitled Recommendations for SOH and Geothermal Assessment Programs, one hole may be selected for splitting and archiving for future scientific investigation. The costs should then be assessed against those of alternative tasks if arguments are presented for any further splitting. In any case, the core curator should not be distracted from urgent technical tasks to split core at this time.

The budgeted cost for technical curation of \$57,824 is appropriate if it is for the scientific aspects of this work, not for core splitting and preparation. If the costs of the wages of graduate students (\$12,720, plus fringes) and materials and supplies (\$8,000) is partly for core splitting, it should be reduced to \$6,360 for wages plus fringes for general assistance and \$3,000 for supplies, inclusive of any core splitting and preserving. This would reduce the total budget from \$57,824 to about \$47,000.

Two specific geological proposals are presented: Whole Rock Chemical Analysis and Study of Secondary Mineralization. Both are

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important studies, although both are less applied to the development of geothermal resources than to academic interest. It is unlikely that the rocks from Mauna Loa volcano will have meaningful differences in reservoir characteristics than those from Kilauea. There may be small difference in initial structure, thickness of individual flows, silica content, gas inclusions and so forth that affect alteration and permeability.

It also remains to be proven that the work could lead to the ability to map the areal extent of fresh and saline water alteration episodes, and the impact of such alteration on reservoir permeability. The salinity of fluids circulating in the KERZ are best determined by sampling during flow tests of wells. Although salinity affects development practices, it has already been shown (in geothermal fields in the Imperial Valley and elsewhere) that highly saline geothermal fluids can be economically developed for power production.

The cost of the proposal for Chemical and Mineralogical Characterization of SOH Cores (Sinton and Hulsebosch) is determined by sub-sampling and preparation. The number of samples should be reduced to that number necessary to fulfill the goal of confirmation of description of cores. Every flow unit need not be examined. We have recommended an initial selection of 60 samples rather than 300. The proposer has stated that he wants this study to be precursor to later proposals to outside funding agencies. This should not be viewed as a valid reason for expending DBED budget to obtain detailed volcanic stratigraphy. We recommend that \$12,000 be initially budgeted for this task, including a complete report. The work should be closely coordinated with core curation.

The budget of the specific proposal for Mineralogic Assessment of Reservoir Fluid Conditions, SOH Geothermal Drill Holes (Sykes) is also determined by sample preparation and laboratory analyses. There may be some redundancy in preparation of sections for petrography with the Sinton proposal. With reduction to about 60 additional samples for XRD, microprobe and SEM analyses, plus the fluid inclusion work on 15 samples, and commensurate reduction of personnel time, the budget should be \$10,000, including a complete report to confirm the existing (binocular) descriptions, and discussion of relations of alteration to permeable zones, fluid rock ratios, fluid composition and paragenesis.

The total budget for the geological subtask as presented here is:

Curation	\$47,000
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Chemical/Mineralogical Characterization	12,000
Mineralogical Assessment of Reservoir Fluids	<u>10,000</u>
Total	\$69,000

This contrasts with the estimation in HIG's proposal of \$133,479.

3. Comments on the Geochemical Subtask

GeothermEx has generally supported the principles and program of the geochemical subtask in a previous memorandum (October 11, 1991). We recognize that the work may be redundant with U.S Geological Survey programs in the KERZ; however, the program appears necessary to contribute in a timely way to a State EIS, to evaluate and forecast contamination possibilities, and to guide any future exploration in Hawaii and other countries.

There are some details of the program presented which are of questionable technical value and therefore questionable cost-benefit value. The principal criticism of the geochemical subtask proposal is of the attempt to marry the publicly funded geochemical program to a geothermal reservoir modeling and engineering program that is the responsibility of private operators and their consultants under the regulation of DLNR. In other words, analytical data and interpretations resulting from geochemical surveys should be obtained by operators at their cost in the course of their reservoir management programs and sent to DLNR for State review and use for regulatory purposes. Furthermore, we think that the personnel classifications and costs in the proposal are not realistic for this work. It is clear that this work would extend for more than one year. The following specific comments relate to the geochemical subtask.

I. With respect to the relationship between the subtask and the four stated program objectives:

A. ASSESSMENT OF RESOURCE POTENTIAL OUTSIDE OF THE KERZ

To the extent that data are not already available for Maui and other counties, and Hawaii County outside the KERZ, this appears to be a reasonable program objective. It is also consistent with general geothermal exploration practice.

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Continuous monitoring of "shallow" groundwater wells throughout the rift for temperature, water level and conductivity, combined with monthly sampling for chemical and isotopic analysis is likely to produce a tremendous volume of data. Based on our experience reviewing similar data collected at projects elsewhere, there is considerable likelihood that the volume of data will greatly exceed the reasonable needs of a modeling subtask or any questions about the groundwater system. It is possible, for example, that little or no variation in temperature, conductivity or chemical composition will be seen for months or even years at many or even all of the data collection sites.

As an alternative, we suggest that the "shallow" groundwater sources be sampled once every six weeks for one year, with temperature, water level and conductivity measured at the time of sample collection, and isotopes analyzed initially and after twelve weeks only if there are changes in chemical composition. If the chemistry at a given site shows significant variation during the year, more frequent data collection at that site can be considered. If there is no significant variation during the year, the data collection interval should be increased to 3 or 6 months during the second year. A shorter interval might continue at sites known to be close to geothermal injection locations and thought (from a conceptual hydrogeologic model) to be susceptible to injection effects.

The subtask description would be clearer if the approximate number and locations of "shallow" wells available for sample collection were included.

It is not clear why the State should fund or conduct the sampling and analysis of "deep" fluids and gases from new and existing private geothermal exploration holes and geothermal monitoring holes, unless as a paid service for the private operators. Private operators involved in exploration and field development are likely to be collecting geochemical data from well tests and downhole sampling. If they are not, they are missing opportunities for obtaining valuable information needed to meet their own program objectives.

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It is possible that some operators may be poorly funded or using geochemical programs and methods which are poorly designed. Perhaps the State should consider: 1) setting up guidelines for mandatory geochemical methods and data collection, based on standard industry practices; 2) requiring that all operators follow these methods; and 3) requiring that copies of essential laboratory results be filed immediately with the State.

Included in the data to be generated are radioactive isotopes C¹⁴, T, and Rn. Although we agree that selected analyses of T may be warranted, the need for data on C¹⁴ and Rn is questionable. In our experience, these isotopes have been of little use in resource assessment, even though they may be of scientific interest.

C. RESERVOIR MANAGEMENT SUPPORT

As stated above, it is not clear why the State should fund or carry out routine analyses of production and reinjection fluids on a long term basis, unless as a service paid for by the private operators. All responsible operators collect these data.

However, individual operators may not be very concerned with the integration of their data with those from other parts of the KERZ, or with modeling the KERZ as a whole. Therefore, it appears appropriate that a private operator's chemical data, collected according to standard industry practices and formatted in standard fashion, should routinely be made available for modeling by an appropriate party as discussed below in our comments on reservoir engineering.

D. ENVIRONMENTAL DOCUMENTATION

This documentation should be considered an integral part and objective of the shallow groundwater data collection program discussed under program objective B, above. All chemical analyses, water levels, temperatures, flow rates and well locations should be carefully and systematically compiled into a computer database.

II. With respect to the budget:

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We are concerned about the proposed team of one lab analyst, one lab/field technician and a graduate student. This team structure is less than optimal in terms of seniority and continuity of personnel.

It is unlikely that the analyst will be able to perform an adequate and quality job of determining dissolved species, gases, stable isotopes and radioactive isotopes. It is stated that some analytical support costs for the use of equipment not available in Puna will be needed, but no detail is given. Realistically, the Puna analyst should be able to perform high-quality analyses of dissolved species. All of the remaining analyses should be performed by outside labs specializing in gases or isotopes. The projected costs of this outside work should be documented; the budget of \$8,000.00 for analytical services seems low.

If it has been established that the Puna lab analyst can produce high quality, reproducible data on dissolved species, then gas analyses may be considered for addition, but only with back-up from outside sources to confirm data quality. We are very cautious about this because we have seen too often that labs attempting to provide too many services experience problems with data quality.

Another major concern is continuity of lab personnel. The use of a graduate student to assist with data compilation and interpretation needs to be controlled carefully. The lab analyst should not be involved in compilation and interpretation because the analyst needs to concentrate his/her efforts on analytical methods and data quality. A few analysts are also capable of data reduction and interpretation, but not many and probably not someone funded at the proposed \$28,800/yr.

The graduate student will need to work closely with the analyst to monitor results, and both need to be monitored by someone with experience in geothermal geochemistry to assure that attention is focussed on appropriate tasks. Is this senior person Dr. Donald Thomas? If so, this should be discussed even if funded from other sources. In other words, a serious full-time activity is proposed under the geochemistry program. Timely and accurate results must be produced, and continuity from one graduate student to the next must be ensured. The budget may be adequate if sampling and analyses of deep geothermal fluids from operators' wells and equipment for continuous monitoring is excluded. If this is the case, a budget of about \$160,000 is not excessive.

4. Comments on Geophysical Subtasks

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The passive seismic and gravity surveys addressed in the introductory section are appropriate and potentially useful in furthering our understanding of the geologic structure and seismicity of the KERZ. However, the vertical seismic profiling (VSP) has doubtful utility, as discussed below, in the discussion of that proposal.

Concerning passive seismic studies, the letter (and the proposal by Drs. Cooper and Moore) does not describe priorities or phasing of the five tasks comprising this report. In our view, this omission represents a potential for inefficient use of resources. Most of the stated research objectives are reasonable, with one exception. We believe that the data which are proposed to be gathered to evaluate the possible movement of reinjection fluid and contamination of groundwater are unlikely to have the resolving power to answer such a question.

Gravity surveys should be confined to one or a few traverses of closely spaced stations, perpendicular to the trend of the KERZ, and located near and west of Puulena Crater, and should be tied to the previous regional survey. Although no budget request has been made, a minimum task as described above could be supported.

1. Comments on the Proposal to Conduct an Analysis of Seismic Activity on the Kilauea East Rift Zone (KERZ)

A. GENERAL COMMENTS

The scope of work proposed is reasonable and potentially useful in defining the structure and seismicity of the KERZ in ways that may illuminate hydrothermal systems and potential geothermal drilling targets. As it stands, however, the proposal does not set forth priorities and relative levels of effort for the five elements or task included. While each of the tasks (excepting the use of VSP) is likely to be worthwhile, the proposers do not explain how the data, analyses, and resulting models are to be integrated.

It is important that the scientists and students undertaking this work have sufficient (that is to say, advanced) skills in geophysical forward and inverse modeling. Qualifications of the principal investigators have not been stated. The time allocated to the principal investigators (7 person months) may be insufficient for satisfactory completion of the HVO seismic data analysis. The duration of such a project would need to be at least one year, and two years is a more reasonable duration for the ambitious effort; adequate time to plan, conduct, modify, and repeat modeling procedures is vital. Rushed research is not a good investment. The proposed budget, appropriately

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reallocated according to the priorities described below, may be adequate and is certainly not excessive.

We feel that an incremental approach, in which successive phases of work build upon preceding ones, is required to achieve maximum benefit for the dollar resources expended. Too many elements are included in this proposal; VSP and microearthquake portable arrays should be omitted.

A large amount of high quality data has been collected by the HVO array of permanent seismographic stations over the past 22 years, and little work appears to have been done to analyze and interpret these data in relationship to hydrothermal activity and geothermal targets in the KERZ. Klein and Koyanagi (1989) have presented a comprehensive, brief summary of the seismicity of the Kilauea region, as observed by the HVO network. They point out that, since 1985, virtually all shocks with $M > 1$ have been detected and located. The maps and cross sections presented in this article suggest that swarms of shocks have occurred around Puulena Crater and some geothermal wells, especially HGP-A.

We believe that the first step in any research program on seismicity of the KERZ should be a truly thorough analysis of the HVO seismic data set, at least for the period since 1985. This work should precede collection of new seismic data with portable equipment, but might well be accompanied by conduct and interpretation of one or a few densely spaced gravity traverses transverse to the KERZ, in the general vicinity of Puulena Crater and perhaps to the west. The analysis and interpretation should include a variety of procedures for analysis of P- and S-wave travel times in order to interpret seismic velocity structure. Geophysical inverse modeling should include models which incorporate constraints based on other geophysical (e.g., gravity and aeromagnetic) and surface geologic data (e.g., dike occurrence). Source mechanism studies are addressed below, with spatial-temporal analyses of hypocentral locations.

Short-term microearthquake surveys with state-of-the-art equipment (PASSCAL portable seismographs) may be appropriate following thorough analysis and interpretation of available data. In this way, structural and earthquake source features developed out of the HVO data may be methodically selected and investigated.

Spatial-temporal windowing of hypocentral locations should be an important part of the program to analyze and interpret the HVO seismographic data. This would serve to isolate swarms and possible relationships among swarms, which may illuminate hydrothermal systems.

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In addition, these analyses should attempt to isolate and interpret source mechanisms (from first-motions) characteristic of various swarms and of structural features identified in the project, and of their interrelationships.

No consideration is given to the use of "calibration shots" to establish first-order receiver delays for observing epicentral areas of interest. This may be more useful than microearthquake surveys, and would certainly be more valuable than the VSP work described in the companion proposal. However, it is recognized that a variety of logistical and institutional problems may be encountered in conducting this kind of work.

B. COMMENTS ON THE FIVE LISTED RESEARCH TASKS**1. Analysis of P-Wave Travel Times to USGS Stations**

Research procedures for this task are not defined. It might be assumed that forward (ray tracing) and inverse modeling (two- or three-dimensional?) of travel time residuals would be employed, and both ought to be, as well as hypocentral relocation procedures. Use of "master-event" methods is not mentioned but is likely to be beneficial. None of these techniques, nor their probable resolving power, are discussed, nor are specific objectives described.

2. Construction of Initial Velocity Model

Use of zero-offset VSP profile data is proposed. However, the accompanying proposal on that subject states that the maximum depth of exploration is to be 2,000 feet. How useful can such shallow data be? It is said that published velocity models for "deeper" (deeper than 2,000 feet?) structure will be used. The comments above, under task 1, indicate the types of analyses that are appropriate and which will serve to model seismic velocity structure to depths of at least 20 km. This work, together with task 1, may be expected to engage skilled seismologists for at least one year.

There is little advantage in investigating travel times if deep structure (to depths of at least 10 km) is not to be modeled. VSP profiling is not necessary, and would be of little help unless carried to depths of at least 10,000 feet in many wells, in the basic structural modeling that needs to be done. This is discussed in our comments on the VSP proposal.

3. Microearthquake Array Study

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This is potentially valuable as presented. However, it should not be part of the same proposal as task 1 and 2 above. Rather, it should follow satisfactory completion of that work.

4. Calculate P- and S-wave Slowness (etc.)

This properly belongs to tasks 1 and 2, and, as commented, needs to be discussed in detail. Vp/Vs ratio mapping is potentially useful, but should not be attempted before very thorough modeling or velocity structure, forward and inverse, is completed.

5. Earthquake Locations and Source Parameters

This task has not been defined, but important objectives and methods are noted above (under "General Comments").

6. Suggestions for Further Exploration

These should not be considered at this time, but may become important in the future, following completion of tasks 1, 2 and 5, if those tasks are thoroughly done as described in the comments above.

2. Comments on the Proposal for Acquiring a Zero-Offset Vertical Seismic Profile (VSP) in SOH

In the discussion of the first proposal, it was explained why this work would be of little use. The least attractive aspect of this proposal is its small maximum depth of exploration, just 2,000 feet. We fail to see how such shallow structural information can be an important part of the kind of work needed to illuminate the structure of the KERZ and its hydrothermal systems. VSP to depths of 10,000 feet in many wells might be useful, but that should not receive consideration until much other work has been completed, *i.e.*, for some years.

From these comments, it follows that the budget for geophysics is recommended to be about \$115,000.00, including gravity surveys, for the proposal to Conduct Analysis of Seismic Activity on the Kilauea East Rift Zone by Cooper and Moore, as redefined by our technical advice. This contrasts with the \$140,887.00 proposed for the work.

5. Comments on the Reservoir Engineering Subtask (including Hydrological Modeling)

We have maintained that numerical modeling of the geothermal reservoir is not an appropriate effort and expense for the State of

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Hawaii, and particularly for the DBED (see memoranda of October 11, 1991 and October 23, 1991, by Gardner and Sanyal respectively). Workovers, additional measurements and tests of SOH-1, -2, and -4 are, however, appropriate works to be continued under the SOH program supported by DBED. Specifically, temperature and pressure measurements and monitoring should be implemented as soon as possible in the SOHs and perhaps HGP-A. This work should be conducted as before, by experienced professional scientists and technicians. The work should not be used as a reason to augment or train inexperienced staff. This is work that must be accomplished routinely and continually if data are to be accurate and useful, and should be conducted in its entirety by contractors and consultants with proper equipment. The State would also be exposed to general liability if its personnel perform this work.

1. Comments on the Proposal for Reservoir Engineering

We agree with the proposal that high priority should be given to monitoring downhole pressures in wells HGP-A, SOH-1 and possibly Lanipuna 6, if it is available. (Lanipuna 6 is not likely to be made available as long as the operator is liable for damages.) Long-term monitoring of the reservoir response to future production/injection at the PGV plant will provide important data on reservoir properties. This monitoring should have priority over possible tidal monitoring in wells SOH-2 and SOH-4, particularly in view of the limited number of data loggers acquired for the SOH project.

Running of downhole temperature surveys should also be undertaken, as suggested by the proposal, but should not be conducted if significant pressure responses are occurring. Removal and reinstallation of capillary tubing to conduct temperature surveys generally causes a displacement of the pressure data, as it is very difficult to return the tubing to exactly the same depth in the observation wells.

However, it will be necessary during such a long-term pressure monitoring program to remove the tubing periodically for inspection and possibly replacement. The inspections and temperature surveys could be conducted at the same time. The cost of removing and reinstalling the tubing in the three wells on a periodic basis and possible replacement has not been considered in the budget. We would suggest that inspections should initially be done on a three monthly basis; the frequency can then be changed depending on the condition of the tubing.

2. Comments on the Proposal for Hydrologic Modeling

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We agree with the proposal that modeling is an important part of reservoir management for the KERZ. However, in order to accomplish the objectives described in the first paragraph of the proposal regarding the interaction of the shallow and deep systems, it will be necessary to construct a single model of both systems rather than the two separate models discussed. In addition to this overall model, it will also be necessary to construct a separate, more detailed model of the area that is presently being exploited to thoroughly evaluate geothermal reservoir productivity issues. Both of these models should be based on a detailed conceptual model, as mentioned in the proposal.

The proposed budget also suggests the modeling will be done as a research project by a graduate student and that the principal investigators will have only a minimal role in the work. This is not realistic. The State will be left with neither a useful product nor an expert staff. Consultants will not be able to simply continue the work from a graduate thesis product. Although the principal investigators have considerable reputation in theoretical (rather than practical) aspects of groundwater modeling, this experience will be unlikely to suffice for geothermal reservoir modeling. GeothermEx is currently working with an experienced groundwater analyst on a project involving dewatering of a shallow geothermal system; much of his work is not applicable to geothermal reservoir modeling by integrated finite difference methodology. We cannot recommend any funding for this proposal as it is presented. The task should be assigned to practical, experienced professionals. The difference in budget is the total amount of \$167,000.00.

6. Conclusions

On the basis of the proposals as written, GeothermEx advises that DBED accept certain scientific studies and budget funds as follows:

Geology	\$ 69,000
Geophysics	115,000
Geochemistry	158,026
Reservoir Engineering	0
Reservoir Modeling	<u>0</u>
Total	\$342,026

Additional budget may be committed elsewhere in the case of use-it-or-lose-it funding. This should be done based on the merit of alternative proposals, several of which have been suggested herein.