PD-ABP-014
93770

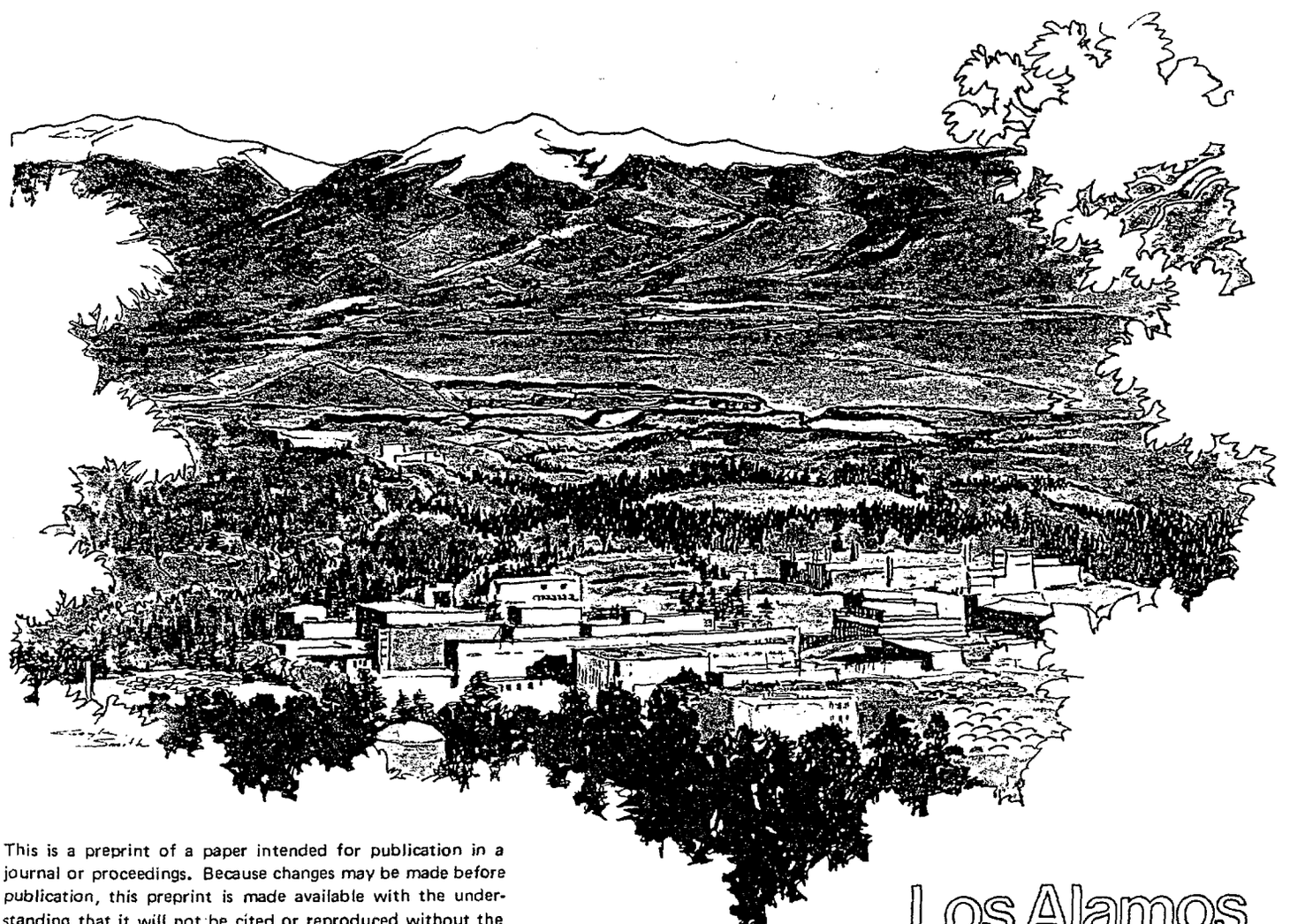
CENTRAL AMERICA ENERGY RESOURCES PROJECT

FINAL ADDENDUM TO THE PROJECT PAPER

submitted to the

Regional Office for Central America and Panama

April 1986



This is a preprint of a paper intended for publication in a journal or proceedings. Because changes may be made before publication, this preprint is made available with the understanding that it will not be cited or reproduced without the permission of the author.

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

INTRODUCTION

This document contains the final addenda to the approved Project Paper entitled "Central America Energy Resources Project: Plan for Concurrent Phases I and II" revised March 1985. The original Project Paper contained detailed work plans and budgets for a total of $5.2 million of activities. A previous addendum to the Project Paper entitled "Mineral Reconnaissance Program for Costa Rica" was submitted and approved for implementation. This final addendum covers activities with total budgets of $2.5 million, bringing the total of Phase I and II activities to $10.2 million, the sum approved in the original PASA Agreement between the Agency for International Development and the US Department of Energy.

All of the Project components contained in this Addendum involve continuation and extension of Components begun under Phase I with the exception of the Geothermal Support to El Salvador and Panama which is a new component. For clarity we have employed the same sequence of topics. Also, for the sake of brevity, we have avoided repeating problem statements and other information contained in the original Project Paper unless there has been a change. Thus, the section entitled, Status at the End of the Project in this document should be interpreted as a list of the additional items to be delivered with the increased funding. For each Component, the Status at the End of the Project from the original Project Paper and the current document are additive.

I. PROJECT COMPONENT

A. Energy Situation Analysis

1. Problem Statement. The energy situation update which was prepared in Phase I of this project component allowed us to establish working relationships with energy planners in the region. Through these contacts, a number of important energy planning needs were identified. Guatemala and Panama require assistance in development of a national energy plan, which is critical to the energy future of these two countries. El Salvador and Costa Rica both need assistance in energy demand estimation so that they can make optimal investments in supply to meet expected demand. Honduras has yet to develop a strong, centralized energy planning organization and will benefit from the energy/economic database transferred under this project. A national energy plan and institutional strengthening is a critical need in Belize.

A second problem in the region is the lack of a means to communicate energy information to potential investors in industry in the region. The abundant hydroelectric and geothermal resources of the region, coupled with reasonable electricity prices in some countries, could serve to attract some private investment in new industries.

Although some coordinated planning efforts have fostered an awareness of common energy problems, communications could be improved among planners in the region. An integration of planning efforts and a sharing of experiences could benefit all of the planning organizations in the region.

2. Project Component Description.

a. Activities. This project component will address needs in the region by focusing on three activities: (1) energy planning

assistance in each country; (2) preparation and publication of an energy atlas for the Central American countries; and (3) maintenance and support for the computerized database that was transferred during Phase I of this project.

The long-term goals of this project were specified in the Project Paper for Phase I: (1) development of sound national energy policies; (2) efficient energy use; and (3) provision of an analytical framework to measure the benefit of indigenous resource development.

b. Task Statement.

1) Energy Planning Assistance. This task will provide technical assistance and training that has been requested by the countries in the region. Assistance activities will be tailored to the needs of each country and will consist of visits or prolonged stays by Los Alamos or contract economists to train counterparts in various methods necessary to energy planning. Costa Rica has requested assistance in construction of a macroeconomic model to link with their energy planning model. Panama, Guatemala, and Belize will receive assistance in formulation and implementation of their national energy plans. El Salvador has requested assistance in developing a plan of action for future planning activities and also would like assistance in energy demand estimation. Strengthening of the energy data computerization process will take place in Guatemala, Honduras, and, possibly, Belize. In addition to training through work with counterparts, one or two seminars will be held at INCAE on national energy plans and energy demand estimation, topics which will benefit all countries.

2) Energy Atlas. Preparation of an energy atlas was begun under Phase I of this project when base maps of the Central American countries were digitized. These maps will be used to project a variety of energy and infrastructure data such as resources, electricity generation and distribution systems, rivers,

transportation networks, forest cover, etc. It will also contain text explaining major energy issues as well as the tables and graphs of relevant energy information, and photographs of important energy resources or exploitation in the region. The purpose of the document is to disseminate information about the Central American energy situation to a broad audience, including possible investors, students, government officials and policy makers.

3) Maintenance of the Sistema de Informacion Centroamericano para Planificacion Energetica (SICAPE). This energy/economic database was constructed and transferred during Phase I of this project component. We will take the responsibility to enter new data, such as national energy balances, as they become available and will provide support to individual countries to expand the database, where requested.

c. Coordination and Implementation Plan. Energy assistance activities by the World Bank and the Inter-American Development Bank (IDB) were described in the Phase I document. We will complement activities of the IDB in El Salvador by providing follow-on assistance to a project that is being discontinued. Work in Guatemala will be designed jointly by Los Alamos and the Ministerio de Energia y Minas to complement the UNDP energy planning project in that country. Costa Rica is receiving follow-on assistance to an AID project that has recently ended. Panama specifically requested special assistance from Los Alamos to supplement assistance from the Economic Commission of Latin America in the preparation of its national energy plan. Belize is expected to receive a loan from the World Bank to evaluate and select new means of generating electricity in the country. Our assistance, aimed at the broader energy situation, is intended to provide a context and institutional strengthening for the activities to be carried out under the World Bank loan.

The project component will be directed by Dr. Linda Trocki

and will be performed by the following personnel as needed: Dr. Steven Booth, Dr. Anthony Burris, Robert Drake, Dr. Fred Roach, Dr. Ronald Sutherland, Flavio Gurule, and Patricia Aragon of Los Alamos, and Dr. Alvaro Umana, Guillermo Selva, and Milton Fonseca of INCAE. Outside consultants from universities, private firms, and government organizations will be sought when necessary.

The main counterpart organizations in each country are the following: Direccion Sectorial de Energia in Costa Rica (DSE); Comision Ejecutiva Hidroelectrica del Rio Lempa (CEL) in El Salvador; Ministerio de Energia y Minas (MEM) in Guatemala; Consejo Superior de Planificacion Economica (CONSUPLANE) in Honduras; Comision Nacional de Energia (CONADE) in Panama; the Belize Electricity Board (BEB) and the Secretary of Energy in Belize.

Subtask 1) is expected to be an ongoing activity throughout the life of the Central America Energy Resources Project. Expected products at the end of the Project are listed below. Subtask 2) will be completed in draft form by December, 1986. Subtask 3) is another ongoing activity.

d. Status at End of Project.

- o Macroeconomic model specified for Costa Rica.
- o Energy demand models specified for El Salvador and Panama.
- o Status of energy planning at CEL evaluated and report completed.
- o Policy paper on energy in Honduras completed.
- o Database and energy planning capabilities strengthened in Guatemala.
- o National energy plan outlined for Belize and counterparts trained in necessary steps.
- o Regional seminar held on national energy planning or energy demand estimation.
- o Draft of energy atlas completed.

o Database updated to contain most recent energy balance data available and delivered to counterparts.

e. Project Component Budget

		$K
Projected Budget for Energy Planning Assistance		
Economist base salary ($50K/FTE/Yr) 1.13 FTE	57	
Fringe @ 25% of base salary	14	
Burden @ 77% of base plus fringe	54	125
INCAE Contract		
Personnel	20	
Seminar	25	45
Travel		
Air fare (8 R/T, Albuquerque to Central American Capital City)	8	
Per diem (average $75/person-day x 224 person-days)	16	
Local and field expense	1	25
Consultants (20 days @ $250/day)		5
General Materials and Services		
Group and Division Office overhead	31	
Other administrative expenses	19	50
		250
Energy Atlas		
Economist and statistician average base salary ($50K/FTE/Yr) x .80)	40	
Fringe @ 25% of base salary	10	
Burden @ 77% of base salary plus fringe	39	89

Translation and publication cost		20
Travel		
Air fare (2 R/T to Central American Capital City @ $1,000/trip)	2	
Per diem for 28 days @ $75/day	2	
Local and field expense	1	5
General Materials and Services		
Group and Division Office overhead	20	
Other administrative expenses	16	36
Subtotal		150
SICAPE Database Maintenance and Support		
Economist base salary ($50K/FTE/Yr) x .1 FTE	5	
Fringe @ 25% of base salary	1	
Burden @ 77% of base salary plus fringe	5	11
Data analyst base salary ($25K/FTE/Yr) x .2 FTE	5	
Fringe @ 25% of base salary	1	
Burden @ 77%	5	11
INCAE Contract		8
Travel		
Air fare (1 R/T to Central American Capital City)	1	
Per diem (14 days @ $75/day)	1	2
General Materials and Services		
Group and Division Office overhead	5	
Other administrative expenses	3	8
Subtotal		40
TOTAL		440

f. Activity Schedule and Milestones. The schedule for the tasks described is shown on the accompanying milestone chart.

B. Analysis and Assessment of Non-Traditional Energy Resources

1. Regional Geothermal Energy Resources.

a. Honduras Geothermal Reconnaissance.

1) Problem Statement. See CAERP: Plan for Concurrent Phases I and II, revised March 1985.

2) Project Component Description.

a) Activities. See Project Paper revised, March 1985.

b) Task Statement.

(1) Evaluation of Prior Work. See Project Paper revised, March 1985.

(2) Acquire Existing Oil Well Data. See Project Paper revised, March 1985.

(3) Field Investigations. Reconnaissance-scale geological and geochemical investigations were completed at the six originally identified geothermal areas: Azacualpa, San Ignacio, Platanares, Pavana, El Olivar, and Sambo Creek. The results were summarized in a reconnaissance report. Evaluation of these results led to the selection of four sites (Azacualpa, San Ignacio, Platanares, and Pavana) for detailed geological and geochemical investigations. Complete results from these investigations are being published as separate geologic reports on each site and a detailed geochemistry report on all sites. All reports are being published in both Spanish and English.

PROJECT COMPONENT TITLE: ENERGY SITUATION ANALYSIS (ENERGY PLANNING ASSISTANCE)

ACTIVITY SCHEDULE AND MILESTONES

Fiscal Year 1986 Quarters

SUBTASK	3	4	1	
Energy Planning Assistance				
Costa Rica		Specification of macroeconomic model		Estimation and analysis
Belize	Outline process toward national plan	Train counterparts	Draft of preliminary plan	Consult on energy planning
El Salvador		Advise CEL on planning		Consult on energy demand models
Guatemala		Data base strenghtened	Report on energy policy alternative	Assist with planning
Honduras		Draft concept paper		Assist in survey design
Panama		Assist on draft of national energy plan		
Energy Atlas		Preliminary maps completed	Compilation Draft	Final publication
Energy/Economic Data Base	Seminar			Updating and maintenance

Evaluation of the results of the detailed investigations indicates that Platanares, San Ignacio, and Azacualpa have high potential for geothermal development. To further evaluate this potential, geophysical surveys (detailed gravity and self-potential) have been designed for the Platanares and San Ignacio sites and a 500-m thermal gradient hole has been planned for the Platanares site. Additional detailed fluid geochemical studies were also made at Platanares, San Ignacio, and Azacualpa to examine recharge and seasonal chemical and isotopic variations at these sites.

Country-wide geothermal reconnaissance efforts have been increased with additional geochemical and geophysical work. Existing gravity and aeromagnetic data are being compiled and reprocessed to generate a gravity map of Honduras, an aeromagnetic map of Honduras, and a depth-to-Curie-point map of Honduras. The gravity and aeromagnetic maps will aid in interpreting the regional structure and tectonics of Honduras, important factors in understanding basin-and-range-type geothermal resources. The depth-to-Curie-point map basically shows the depth to the 550°C isotherm and thus is useful for reconnaissance-scale exploration.

Approximately 20 water samples not related to the six initial geothermal sites have been collected in Honduras. These samples are now being analyzed. When completed the results will provide background hydrologic data for the country.

(4) Sample Analyses. See Project Paper, revised March 1985.

(5) Coordination with Proposed Italian Study. With joint funding from the United Nations Development Program, the Government of Italy, and the Government of Honduras, the Italians have proposed a geothermal study for the central region of Honduras. Work on the project began in February, 1986.

Los Alamos is currently investigating the technical details

of the proposed Italian effort. The region of coverage is limited to the central part of the country and does not include identified geothermal manifestations in the northern, western, and southern regions of Honduras (Platanares is not included in the region).

Two Italian geothermal companies, "dal in. te. sa." and "Geotermica Italiana srl" have been identified as active participants in the Honduras work. An initial meeting was held between the Italians, ENEE, the USGS, and Los Alamos on February 7, 1986 to ensure that duplication of effort is avoided. Preliminary drafts of all Los Alamos reports have been given to the Italians. A free exchange of gravity data between Los Alamos and the Italians was also agreed upon. The Italians and Los Alamos have jointly scheduled a meeting with ENEE for late April, 1986 to encourage data exchange.

(6) Generation of a "Geothermal Development and Management Guide." To assist ENEE in the future development and management of any geothermal resources identified in Honduras, Los Alamos will write and publish a "Geothermal Development and Management Guide." This handbook will outline all steps in development from initial reconnaissance through electricity generation.

3) Coordination and Implementation Plan. Personnel changes only.

4) Status at End of Project. By December 31, 1986 the following deliverables will have been produced jointly by Los Alamos and ENEE and transmitted to AID:

o Medium depth thermal gradient will drilled, data obtained, and analysis performed

o Recommendations for additional work to evaluate the feasibility of the development of geothermal resources in Honduras.

o Aeromagnetic map of Honduras.

o Gravity map of Honduras.

o Geothermal Development and Management Guide.

*Deliverables attributable to extended funding.

5) Project Component Budget		$K
Equipment Development	100	
Personnel		
Base salary for geologist ($52K/FTE/Yr)	30	
Base salary for technician ($28K/FTE/Yr)	5	
Fringe @ 25% of salary	9	
Burden @ 77% of base salary plus fringe	34	78
Travel		
Air fare	8	
Per diem	8	
Rental car and local expense	4	20
General Materials and Services		42
Geophysical Contract (Aeromag and gravity maps of Honduras)		100
TOTAL		340

6) Activity Schedules and Milestones. The schedule for the tasks described is shown on the accompanying chart.

PROJECT COMPONENT TITLE: HONDURAS GEOTHERMAL RECONNAISSANCE

ACTIVITY SCHEDULE AND MILESTONES

Fiscal Year 1986 Quarters

SUBTASK	3	4	1
Six Site Reconnaissance Report			
Field Work			
Report Writing			
Edit and Publish			
Aeromagnetic Map of Honduras			
Process Data			
Generate and Publish			
Gravity Map of Honduras			
Process Data			
Generate and Publish			
Geothermal Management Guide			
Writing			
Edit and Publish			

b. Miravalles Geothermal Development.

1) Problem Statement. See Project Paper, revised March 1985.

2) Project Component Description.

a) Activities. See Project Paper, revised March 1985.

b) Task Statement.

(1) Well Logging Rig and High-Temperature Cable. See Project Paper, revised March 1985.

(2) High-Temperature Downhole Logging Tools. Los Alamos will provide a selection of high-temperature instrumentation packages for use in the Miravalles wells. These logging tools, developed by Los Alamos in cooperation with private sector organizations, represent a unique capability that cannot be supplied by commercial logging service companies. Los Alamos engineers will work with ICE representatives to define a Miravalles logging program. ICE has requested that the following logs be given the highest priority for Miravalles:

- Temperature
- Pressure
- Fluid Velocity Spinner
- Multi-Arm Caliper
- Downhole Fluid Sampler
- Casing Collar Locator

To perform temperature, pressure, and fluid velocity measurements in a flowing geothermal well normally requires two logging tools and separate logging operations. Because of the high temperatures, pressures, and flow rates observed in Miravalles wells,

each tool entry into a well will be a complex operation. Los Alamos will combine the functions of these two tools into a single instrumentation package to minimize the number of well entries required.

The very high flow velocities encountered in Miravalles well PGM-10 subjected the downhole tools to severe vibrations during the limited logging operations carried out during the summer of 1985. These vibrations were of a sufficient intensity to loosen logging tool assembly joints resulting in premature failure of the tools. Los Alamos will rebuild the logging tools used in PGM-10 and will design and fabricate a locking mechanism for each assembly joint.

(3) Well Logging at Miravalles and Training of ICE Personnel. Los Alamos engineers and technicians, working in cooperation with ICE personnel, will perform downhole logging measurements in Miravalles production wells. Los Alamos will provide on-site training to appropriate ICE personnel on the operation of the well logging rig, automatic data acquisition system, the operation of the downhole logging tools, and the interpretation of the data from the tools. At the request of ICE, additional logging runs will be performed with the downhole fluid sampler tool to obtain samples of reservoir brine for analysis by both ICE and Los Alamos chemists. These investigations will be directed at understanding the characteristics of the reservoir brine and its tendency to produce calcite scale in the wellbores.

The high-temperature well flows at Miravalles required cooling of the logging cable prior to respooling on the logging rig cable drum. Although a temporary water spraying system was used during initial field operations, a more efficient cooling system is required to protect both the logging cable and the pressure lock from thermal damage. Los Alamos will modify the wellhead pressure lock to incorporate an efficient water cooling system for protection of the cable and lock assembly and to increase logging rates during tool retrieval operations.

Los Alamos will provide a state-of-the-art automatic data acquisition system for the temporary logging rig by using the components ordered for the self-contained logging truck under the Support Equipment for Central America Project Component (see section d. following).

3) Coordination and Implementation Plan. See Project Paper, revised March 1985.

4) Status at End of Project. By December 31, 1986 the significant accomplishments listed below will be completed in addition to those specified in the Project Paper, revised March 1985.

o A new logging tool, combining the features of two previous tools, will be developed and used at Miravalles to minimize the number of high-pressure well entries required.

o The mechanical design of the logging tools will be improved to provide greater resistance to flow induced vibrations that can occur in high flow rate wells such as those at Miravalles.

o Downhole fluid samples will be obtained from the Miravalles reservoir for initial brine chemistry investigations. Brine samples will be provided to ICE for chemical analysis.

o A state-of-the-art automatic data acquisition system will be provided for the temporary logging rig by using the components ordered for the logging truck under the support equipment project component.

5) Project Component Budget.

a) Well Logging Rig and High-Temperature Cable. No change from previous budget.

b) High-Temperature Downhole Logging Tools.		$K
Base salary for mechanical and electrical technicians (28K/FTE/Yr)	0.2 FTE	5.6

Base salary for mechanical and electrical engineers (52K/FTE/Yr) 0.2 FTE	10.4	
Fringe @ 25% of base salary	4.0	
Burden @ 77% of base salary plus fringe	15.4	35.4

c) Well Logging at Miravalles and Training of ICE Personnel

Base salary for mechanical and electrical technicians (23K/FTE/Yr) 0.2 FTE	5.6	
Base salary for mechanical, chemical and electrical engineers (52K/FTE/Yr)	10.4	
Fringe @ 25% of base salary	4.0	
Burden @ 77% of base salary plus fringe	15.4	35.4
General materials and services		10.0
Data acquisition supplies		(23.0)
ICE and University of Costa Rica counter-part efforts		(10.0)
Travel		
Air fare (6 R/T, Los Alamos to San Jose @ $700/trip)	4.2	
Per diem (43 person nights @ $60/night)	2.6	
Rental cars and local expense	.4	7.2
TOTAL		45.0

6) Activity Schedule and Milestones. The schedule for the tasks described is shown on the accompanying milestone chart.

d. Support Equipment for Central America.

1) Problem Statement. See Project Paper, revised March 1985.

2) Project Component Description.

PROJECT COMPONENT TITLE: MIRAVALLES GEOTHERMAL DEVELOPMENT

SUBTASK	MONTH: APRIL - JUNE	JULY - SEPTEMBER	OCTOBER - DECEMBER
DOWNHOLE LOGGING DATA			
Technical memorandum on wells PGM-3 and PGM-10.			
Technical memorandum on brine chemistry.			
DOWNHOLE LOGGING TOOLS			
Complete modifications and ship to Miravalles.			
WELL LOGGING AND TRAINING			
Well logging at Miravalles and ICE training.	Miravalles		
Review Phase II plans with ICE.	Miravalles and San Jose		
DOWNHOLE LOGGING DATA			
Technical memorandum on wells PGM-5 and PGM-11.			
Technical memorandum on brine chemistry.			
Final Miravalles Report.			(completed)

a) Activities. See Project Paper, revised March 1985.

b) Task Statement.

(1) Self-Contained Logging Truck. No change from existing project paper with the following exceptions:

o Upon completion the logging truck will be shipped to El Salvador for use at Ahuachapan rather than Costa Rica for use at Miravalles. The temporary well logging rig is currently stationed at Miravalles and is being used for logging operations at that site.

o Los Alamos has recommended that the logging truck be owned by US AID (rather than Los Alamos) but assigned to Central America. Responsibility for the truck will reside with the organization to which it is assigned for logging according to the terms and conditions of the management plan for geothermal well logging operations in Central America that is being prepared by Los Alamos.

(2) High-Temperature Downhole Logging Tools. No change from existing project paper with the following exceptions:

o The measurement functions of the fluid velocity spinner/temperature tool and the pressure/temperature tool have been combined into a single logging tool. This will result in four different downhole instrument sondes for well logging although the originally proposed five different measurement functions are still retained. Use of this new tool will streamline field logging operations and improve the consistency of the data.

o Because of host country requests for a downhole fluid sampler tool, the proposed natural gamma detector will be replaced by a fluid sampler tool.

(3) DC Resistivity System. No change from the existing project paper with the following exception:

o To provide increased operational reliability and operator safety while conducting field measurements in the hostile climatic extremes of Central America, the design specifications for the system were upgraded. These upgrades include an improved cooling system for the transmitter, high-stability switches in the electrical circuits that operate under high current loads, greater operator protection through improved grounding and shielding of the high-voltage circuits, and mounting trailers designed for rough road conditions.

(4) Audiomagnetotelluric (AMT) System. See Project Paper revised March 1985.

3) Coordination and Implementation Plan. No change from existing project paper with the following exception:

o ICAITI is no longer proposed as the counterpart organization for this effort. Operation of the logging truck and tools will be in accordance with the management plan for geothermal well logging operations in Central America. Counterpart organizations for the logging and geophysical measurements will be the same organizations already designated for geothermal energy activities in each of the countries.

4) Status at End of Project. Upon termination of the project, the significant accomplishments listed below will be completed in addition to (or in place of) those specified in the existing project paper:

o A new logging tool, combining the features of two previous tools, will be provided to minimize the number of high-pressure well entries required and improve the consistency of the data.

o The mechanical design of the logging tools will be improved to provide greater resistance to flow induced vibrations that can occur in high flow rate wells such as those in Central America.

o A downhole fluid sampler tool will be provided in place of

the proposed natural gamma detector to conform to the requests of the counterpart organizations.

o Design improvements will be implemented in the DC resistivity system to provide increased operational reliability and operator safety.

5) Project Component Budget.		$K
a) Self-Contained Logging Truck.		
Diesel-powered logging truck		38
b) High-Temperature Downhole Logging Tools:		
Fluid Velocity/Pressure/Temperature Probe (2 ea.)	36	
Natural Gamma Detector (1 with spare electronics)	(32)	
Downhole Fluid Sampler (1 ea.)	40	
Multi-Arm Caliper Tool (1 ea.)	2	
Pressure and Temperature Probe	(36)	
		10
c) DC Resistivity System.		47
d) Audiomagnetotelluric (AMT) System.		—
TOTAL		95

Cost estimate is based on fabrication of a similar system for Los Alamos and includes shipping cost to Central America.

6) Activity Schedule and Milestones. The schedule for the tasks described is shown on the accompanying milestone chart.

e. Direct Heat Applications in Central America.

PROJECT COMPONENT TITLE: SUPPORT EQUIPMENT FOR CENTRAL AMERICA

SUBTASK	MONTH: APRIL - JUNE	JULY - SEPTEMBER	OCTOBER - DECEMBER
SELF-CONTAINED LOGGING TRUCK			
Truck delivered to Los Alamos.			
Installation of data acquisition system and logging cable.			
Testing and shipping to Ahuachapan.		(completed)	
DOWNHOLE LOGGING TOOLS			
Downhole logging tools completed.			
Testing and shipping to Ahuachapan.		(completed)	
DC RESISTIVITY SYSTEM			
(Completed and tested.)			
AUDIO MAGNETOTELLURIC SYSTEM			
Technical decision on prototype system performance.			
Fabricate system for Central America.			(completed)

1) Problem Statement. See Project Paper revised March 1985.

2) Project Component Description.

a) Activities. The first objective of this effort is to identify, assess, and recommend agricultural (particularly isolated rural agricultural), industrial, or commercial applications for process heat or steam from known geothermal reservoirs in Guatemala. The applications will be selected to increase development and/or decrease dependence on imported fuel and will serve as examples to the other countries of Central America. Guatemala has been chosen because (1) its known geothermal resources and its relatively substantial industrial base are favorable to demonstrating process heat applications. Guatemala contains known geothermal reservoirs that have been drilled and geothermal process heat may become available without incurring substantial additional drilling costs; and (2) although promising geothermal resources are known and their development has gone as far as drilling wells, the nation has not yet exploited them.

The second objective is to promote the development of the most promising applications. This development will begin with a demonstration project.

b) Task Statement.

(1) Survey of Existing Process Heat Requirements. A senior engineer affiliated with Los Alamos will collaborate with a consulting firm or university to conduct a survey of process heat use in existing industries in Guatemala. The location, amount of heat, temperature requirements, and power-to-heat ratios will be collected for the major operations. Data on the location and characteristics of the geothermal resources will also be compiled. The study on energy conservation in industry currently funded by AID may provide useful results for our survey. When the data from the survey have been assimilated, we will identify existing industries that could benefit

from near-term conversion to a geothermal heat source. Special attention will be given to possible applications to benefit the agroindustry. The schedule is also designed to provide data for the energy situation analysis. A report summarizing the results of the survey will be prepared.

(2) Identification of the Most Promising Applications of Geothermal Heat Use. In addition to our consideration of existing industries, we will identify the potential of direct heat use and/or cogeneration from geothermal resources in new industries in Central America. After several applications of direct heat use and/or cogeneration have been identified for existing and new industries, we will hold three technical exchange meetings in Guatemala for participants from government, university, and private sectors to ascertain which applications are most favored, what other applications should be considered, and what is the support in Guatemala for the proposed projects. Based upon the input from these meetings and after collaboration with our Guatemalan counterparts, several applications that are deemed most promising will be recommended for demonstration in Guatemala. The resource base, technological capability, and market for new products will be considered in our recommendations. It is expected that geothermal process heat applications to agroindustry will have high priority.

(3) Feasibility Studies of Selected Applications. With the concurrence of both AID and our Guatemalan counterparts, one or more applications for detailed prefeasibility studies will be selected. Feasibility studies will then be made of the selected projects, including a description of the future commercial developments that might occur as a result of the demonstrations, a determination of any impediments to the achievement of a successful demonstration with recommendations for removal of the impediments, and conceptual designs of the demonstration systems.

(4) Design of the Demonstration System(s) by Guatemala. With the assistance of Los Alamos, MEM and INDE will design and make

working drawings of the demonstration systems. This task will allow MEM and INDE to become thoroughly familiar with the system's design and operational characteristics. Besides the design work, other preparations will be made by MEM and INDE to assure that the feedstocks and products will flow smoothly through the demonstration system when it is operational. The design will incorporate locally available materials. The facility will be operated by crews provided by MEM and INDE. If some materials or components must be procured in the US, Los Alamos will provide them within the limitations of the funds available to the project.

The above work plan assumes that Guatemala Government personnel will perform the design work. If not, the project schedule will have to be delayed until funds become available to cover the costs of a design subcontractor.

(5) Construction of the Demonstration Facility by Guatemala. Los Alamos will provide technical assistance during the construction period and also procure materials or components as was noted above in Item (4).

The construction plan assumes that Guatemala will do the work with government labor. If not, the project schedule will have to be delayed until funds become available to cover the construction costs.

(6) Operation of the Demonstration Systems by Guatemala. Los Alamos, as in above tasks 4 and 5 will continue to provide the technical assistance to help achieve successful demonstrations. MEM and INDE will conduct the demonstration of the use of geothermal heat.

It is expected that the initial demonstrations will occur near the end of the 1986 calendar year but enough experience or information should be acquired to allow plans to be made for the demonstration of additional heat applications in the same facilities or modifications of the facilities.

(7) Report on the Feasibility Studies and the Demonstrations. A report on the feasibility studies and the demonstrations performed by the end of 1986 will be prepared by Los Alamos.

c). Coordination and Implementation Plan. This work will be coordinated with IDB, who is funding geothermal resource development in Guatemala. The demonstrations will be planned to use existing production wells at Zunil in such a way as to improve the overall utilization of the geothermal energy that is available at Zunil. The project will be designed so it does not interfere with development of the 15-MWe electricity generating facilities.

This project will be managed by a senior engineer at Los Alamos with knowledge of process heat applications from geothermal energy, either John Altseimer or Frederick Edeskuty. It will be the main task for John Altseimer and Frederick Edeskuty or equivalently trained personnel, as well as other Los Alamos engineers assisted by members of the private sector and universities. We plan to conduct our analysis jointly with MEM, who will have the strong support of INDE. ICAITI (Ludwig Ingram, Deputy Director) will be subcontracted to perform the initial surveys of existing and potential heat applications. Our primary contact at MEM will be Ing. Carlos Avalos O., Chief of the Department for the Development of New Energy Sources, who reports directly to Rolando Yon Siu, Director of the General Directorate of New Energy Sources. Engineers from the Ministry of Energy and Mines will be trained to evaluate projects and make technology comparisons. Members of the private sector will be acquainted with direct heat applications through technical exchange meetings and workshops. Engineers from such organizations as Stone and Webster, the University of Miami, the University of Oregon, the Oregon Institute of Technology, the University of Costa Rica, the University of Puerto Rico, the New Mexico State University, and/or the University of New Mexico who have relevant experience will be sought to collaborate on the project as required and as time and funds are available.

d). Status at End of 1986.

o Three technical exchange meetings held to disseminate information about direct heat applications and to solicit comments from the private sector.

o Initial systems designed, constructed, and placed into operation by Guatemala with Los Alamos assistance.

e). Project Component Budget.

		$K
Base salary for engineer $50K/FTE/Yr (0.88 FTE)	43.8	
Fringe @ 27% of base salary	11.8	
Burden @ 77% of base salary plus fringe	42.9	98.5
Subcontractors and collaborators		
1 person @ $250 for 31 days and		12.8
2 persons @ $250/day for 10 days		
Travel		
Air fare (Los Alamos - Guatemala City)	13.2	
3 R/T at $1067 plus 10 @ $1000		
Per diem (3 five day trips and 10 six day trips)	6.0	
Local miscellaneous and transportation	1.5	20.7
Report and miscellaneous support services		18.0
General Materials and Services		20.0
TOTAL		170.0

f). Activity Schedule and Milestones.

PROJECT COMPONENT TITLE: Direct Heat Applications in Guatemala

ACTIVITY SCHEDULE AND MILESTONES

Fiscal Year 1986 Quarters

SUBTASK	3	4	1
Survey of existing process heat requirements	▽ draft report		
Identification of new applications	▽ completed		
feasibility studies of demonstrations	▽ letter report		
Design of demonstration systems	▽ complete		
Construction of demonstration systems	———	▽ complete	
Operation of demonstration systems		start-up	▽ ——— ▽ operation ———
Demonstration Status Report			——— ▽ draft report

f. Geothermal Support to El Salvador and Panama.

1) Problem Statement. The power plant at Ahuachapan, El Salvador, is a clean and efficient power station operating from a localized, high-quality hydrothermal geothermal resource. Current power production is 42 MW although the installed electrical capacity of the plant is 95 MW. During the early 1980's, Ahuchapan generated approximately 42% of the electrical power required in El Salvador. Because of increasing demand and declining well productivities, it now provides only approximately 25% of the nation's electrical power. This plant plays a key role in providing secure electrical power for the country because many of the hydroelectric plants and their associated power lines cross territory that is subject to attack.

The El Salvador Geothermal Support Project component responds to direct requests from the local AID Mission office and the Comision Ejecutiva Hidroelectrica del Rio Lempa (CEL) for assistance at the Ahuachapan geothermal field. Production at this field is steadily declining and a well logging program is desired to investigate the characteristics of the reservoir and wells responsible for this decline. At the present time, almost no high-temperature well logging capabilities exist in Central America.

Downhole logging tools can be effectively used to identify the formation horizons that are producing geothermal brines, locate damaged zones in production wells, identify chemical scale formations in wellbores, obtain downhole fluid samples or detailed brine chemistry studies, and to accurately measure the reservoir pressure under flowing and shut-in well conditions. At Ahuachapan, results from a well logging program could be used to support the following production enhancement strategies:

a) Because of damaged wells or damaged production horizons in the reservoir formations, the flow of geothermal fluids to the surface is being restricted. Logging data can be used to identify

such wells or production horizons and remedial actions can be implemented.

b) Because of sustained production from the central portion of the field, reservoir pressures are no longer sufficient to maintain the desired flow rates. Logging data can be used to upgrade the models of the Ahuachapan reservoir to assist in the development of a spent brine reinjection plan that could stabilize the pressure decline in the field.

The Panama Geothermal Support Project component responds to direct requests from the Instituto de Recursos Hidraulicos y Electrificacion (IRHE) for assistance in the reconnaissance and prefeasibility efforts in Panama. This includes participation in the Advisory Panel meetings for geothermal development in Panama and laboratory analysis and interpretation of data from fluid samples that have been collected by IRHE. Geothermal manifestations in Panama are less obvious than in other Central American countries. The volcanic sequence responsible for geothermal resources in Costa Rica extends into western Panama, however, and exploitable resources could be present. In regions of the country where chemical geothermometer temperature estimates are sufficiently high, further exploration and development could be pursued.

2) Project Component Description.

a) Activities. Within the geothermal support to El Salvador project component, activities will be focused on the immediate need at Ahuachapan to arrest the declining well production flow rates. The approach will be to make detailed downhole measurements in selected production wells using Los Alamos developed high-temperature logging tools. These measurements will be made in production wells located in the highly-explored central part of the field and also in wells located to the south, the direction in which the reservoir is thought to extend.

The objective of these measurements will be to determine whether production declines can be attributed to individual well damage, the reduction in the central reservoir pressure, or a combination of the above. If damaged wells (or damaged producing formations adjacent to the wells) are located, remedial actions can be recommended to CEL for near-term production improvements. If reservoir pressure decline is the principal consideration, the well logging data will be available to improve the existing reservoir model of the Ahuachapan field. In follow-on studies, this well logging data would provide critical input for an integrated reservoir engineering investigation that would culminate in the design and implementation of an effective spent brine reinjection program.

Los Alamos would perform the necessary logging measurements using the new self-contained logging truck being fabricated under the "Support Equipment for Central America" project component. The necessary logging tools for the Ahuachapan wells are also being fabricated under this project component.

Within the geothermal support to Panama project component, activities will be focused on the chemical analysis of water samples collected in Panama by IRHE and shipped to Los Alamos. This will include the calculation of geothermometer temperatures, interpretation of the chemistry data, and recommendations for further work in the most promising areas. Los ALamos will continue to provide technical support to the advisory panel for geothermal development in Panama and will present the results of the chemical analyses to this panel.

b) Task Statement.

(1) Self-Contained Logging Truck. The new self-contained logging truck being fabricated under the "Support Equipment for Central America" project component will be shipped to El Salvador for use at Ahuachapan. The unit will be shipped complete with a high-temperature 7-conductor geothermal logging cable, self-contained

automatic data acquisition system including mini-computer, hydraulically powered draw works, diesel engine powered auxiliary electrical generator, required logging accessories and spare parts. Los Alamos designed high-temperature cablehead assemblies for interfacing with the downhole tools will also be provided. This equipment will be made available to CEL for use at Ahuachapan under the terms and conditions specified in the management plan for geothermal well logging operations in Central America.

(2) High-Temperature Downhole Logging Tools. The new high-temperature downhole logging tools being fabricated under the "Support Equipment for Central America" project component will be shipped to El Salvador for use at Ahuachapan. These logging tools, developed by Los Alamos in cooperation with private sector organizations, represent a unique capability that cannot be supplied by commercial logging service companies. Los Alamos engineers will work with CEL representatives to define the Ahuachapan logging program. The following downhole tools have been identified by CEL as having the highest priority for the Ahuachapan logging program:

- Temperature probe with casing collar locator and gage ring to assure that wellbore is sufficiently open for safe tool penetration.
- Spinner/Temperature/Pressure tool to determine what formation horizons are producing geothermal fluids. Combination of these three functions into a single tool allows measurement of the essential flowing parameters of a well during a single logging operation.
- Multi-Arm Caliper tool for accurate measurement of casing and production slotted liner inside diameters. This tool effectively measures any scale accumulations in the wellbore and can detect casing damage and regions with excessive wear or roughness.
- Fluid-Sampler tool for capturing reservoir brine samples at depth. These samples, collected at reservoir pressure, contain the noncondensible gases and are used for detailed brine chemistry investigations.

(3) Well Logging at Ahuachapan and Training of CEL Personnel. Los Alamos and CEL personnel will conduct flowing and static logging operations in production wells at Ahuachapan. Candidate wells for logging will be selected from the following group: Wells 22, 24, and 27 from the central part of the field, and wells 31 and 32 to the south of the main exploitation area. Los Alamos will provide on-site training to appropriate CEL personnel on the operation of the logging truck, the operation of the automatic data acquisition system, the operation of the downhole tools, and the interpretation of the data from the tools. Los Alamos engineers and technicians will be on-site during all logging runs in the Ahuachapan wells.

(4) Geochemistry Support for Panama. Los Alamos will provide major and minor element analyses and water stable isotope analyses of samples collected by IRHE. These analyses will be used in calculating mixing or thermal fluids with groundwaters as well as in calculating underground temperatures using chemical geothermometers. Based on the results of these calculations, Los Alamos will identify promising areas that should be further investigated by extensive sampling involving both Los Alamos and IRHE personnel.

c) Coordination and Implementation Plan. CEL has been identified as the counterpart organization for the Ahuachapan well logging effort. During the logging of the wells with the logging truck, CEL and Los Alamos engineers and technicians will cooperatively accomplish the necessary tasks. During a recent visit to Ahuachapan to inspect the candidate well sites, CEL personnel agreed to provide the following technical support:

- Fuel supply for logging rig while on location.
- Personnel skilled in geothermal wellhead rigging and operation of all valves above the wellhead's existing master valve. This includes assembly, operation, and relocation as necessary to allow use of Los Alamos furnished pressure lock at each wellhead.
- Cooling water and water supply tank with pump, hose, and nozzle for use by Los Alamos staff for necessary water spray cooling

of wireline and pressure lock during removal of equipment from well.

o Accomodations in CEL visitor housing units for Los Alamos personnel during period of continuous operations at the Ahuachapan location plus transportation to and from accomodations and wellheads.

o Movement of all Los Alamos logging equipment in El Salvador from and to port of entry as well as between wellheads at Ahuachapan and assistance in clearing El Salvadoran Customs requirements into and out of the country.

o Access to the CEL power plant shops at Ahuachapan for repair of tools or instruments if need arises, or at other CEL repair shops.

o Crane for use during logging operations.

o CEL staff as necessary to throttle wellhead flow as needed to protect instruments during flowing log measurements (to minimize instrument damage).

o Relocation of fence sections around wellheads, where necessary, to provide adequate clearance for logging truck and support equipment.

Because of CEL's ten years of experience with an operating geothermal power plant, most of the equipment required to support the logging operations is available a Ahuachapan. The management plan for geothermal well logging operations in Central America has been reviewed by CEL and found to be satisfactory.

The well logging at Ahuachapan and training of CEL personnel will be performed under the direction of Dr. R. J. Hanold. He will dedicate almost all of his time to planning, training, participating in field activities, and meeting reporting requirements for Central American initiatives.

Principal investigator for the equipment, logging, and training activities will be B. R. Dennis, electrical engineer and group leader of the earth sciences instrumentation group. Additional

support will be provided by S. P. Koczan (mechanical engineer), C. O. Grigsby (chemical engineer), P. J. Chavez (mechanical technician), J. D. Kolar (electronics technician), R. A. Maestas (electronics technician), P. R. Gutierrez (logging equipment operator), and R. M. Potter (well logging specialist).

IRHE has been identified as the counterpart organization for the geochemistry support for Panama. Results will also be provided to members of the Panama Geothermal Advisory Panel. The geothermal support to Panama will be performed under the direction of Dr. R. J. Hanold who is also a member of the Panama Advisory Panel.

Principal Investigator for the water sampling and analysis activities will be Dr. F. E. Goff, lead scientist for geochemistry investigations. Additional support will be provided by C. O. Grigsby (chemical engineer), L. A. Schevenell (geologist), P. E. Trujillo (chemist), and D. A. Coune (chemical technician).

d) Status at End of Project. Upon termination of the project, the significant accomplishments listed below will be completed:

- The self-contained logging truck, complete with necessary accessories, will be tested and shipped to the Ahuachapan geothermal field in El Salvador.
- Working with CEL scientists and engineers, an Ahuachapan well logging program will be developed.
- A selection of high-temperature geothermal well logging tools, consistent with the requirements of the Ahuachapan well logging program, will be tested and shipped to Ahuachapan.
- A well logging program will be conducted in the Ahuachapan wells. It is anticipated that three wells will be logged and that six different logs will be obtained for each well.
- During the cooperative logging effort, Los Alamos engineers and technicians will work with CEL personnel to explain the

operation of the logging truck, data acquisition system, and the downhole tools. Los Alamos will participate with CEL personnel in the field interpretation of the data being obtained from the Ahuachapan wells.

o Data from the Ahuachapan wells will be critically reviewed at Los Alamos and compared with existing data from other geothermal wells. A technical report summarizing the logging results and presenting recommendations for future field activities at Ahuachapan will be prepared and presented to CEL. Emphasis will be directed at the declining field production and any remedial actions that can be taken by CEL to stabilize this decline.

o Chemical and water stable isotope analyses will be performed on water samples collected in Panama by IRHE.

o Geothermometer and mixing calculations will be performed and the various thermal sites in Panama will be evaluated for their geothermal potential.

o The results of the chemical analyses will be analyzed in detail and will be reported to IRHE and the advisory panel. Emphasis will be on the geothermal potential of the promising site(s) and on recommendations for further work needed to continue geothermal development in Panama.

e. Project Component Budget.

(3) Well Logging at Ahuachapan and Training of CEL Personnel.

		$K
Base salary for mechanical and electrical technicians (29K/FTE/Yr) 1.3 FTE	37.7	
Base salary for mechanical and electrical engineers (52K/FTE/Yr)	36.4	
Fringe @ 26% of base salary	19.3	
Burden @ 79.5% of base salary plus fringe	74.3	
		167.7

General Materials and Services		14.3
Replacement electrical and mechanical components for logging truck and logging tools		13.0
Laboratory analyses of well samples		20.0
Travel		
Air fare (18 R/T, Los Alamos to San Salvador @ $1000/trip)	18.0	
Per diem (240 person nights @ $60/night)	14.4	
Rental cars and local expenses	2.6	35.0
Total for El Salvador		250.0

(4) Geochemistry Support for Panama.

Base salary for chemical technicians (29K/FTE/Yr) 0.3 FTE	8.7	
Base salry for geochemists (52K/FTE/Yr) 0.2 FTE	10.4	
Fringe @ 26% of base salary	5.0	
Burden @ 79.5% of base salary plus fringe	19.2	43.3
Laboratory analyses of well samples		3.0
General Materials and Services		3.7
TOTAL		50.0

f) Activity Schedule and Milestones. The schedule for the tasks described is shown on the accompanying milestone chart.

PROJECT COMPONENT TITLE: GEOTHERMAL SUPPORT TO EL SALVADOR AND PANAMA

SUBTASK	MONTH: APRIL - JUNE	JULY - SEPTEMBER	OCTOBER - DECEMBER
WELL LOGGING AND TRAINING AT AHUACHAPAN			
Review logging plans with CEL.	San Salvador		
Logging truck and tools arrive in Ahuachapan.			
Well logging and CEL training.			Ahuachapan
DOWNHOLE LOGGING DATA			
Final Ahuachapan Report.			
PANAMA GEOTHERMAL RECONNAISSANCE			
Draft report on chemical analyses of fluid samples.			
Participate in Geothermal Advisory Panel meeting.	Panama City		
Final report on chemical analyses and recommendations.		(completed)	

2. Peat Resource Assessment and End-Use Study.

a. Problem Statement. During preliminary reconnaissance resource assessment work, peat deposits were located in Panama and Costa Rica. Analysis of samples from several of the deposits indicates each country has large quantities of good quality peat. Both countries need technical assistance to evaluate their peat resources because there is presently little published information about and experience with peat in Central America. Refinadora Costarricense de Petroleo (RECOPE) in Costa Rica and Instituto de Recursos Hidraulicos y Electrification (IRHE) in Panama have requested assistance to initiate and carry out resource assessments, mining studies and experimental programs to demonstrate end-use feasibility. In Costa Rica two deposits are in the process of being surveyed and characterized for their potential for economic development. Work is also being initiated in Panama to characterize and develop a very large low-ash deposit in northwestern Panama with the objective of generating electricity using peat.

Available data indicate Belize and Guatemala also have sizeable peat resources. If this is true, the need for petroleum products in those countries could be alleviated by burning peat to generate electricity or for process heat.

b. Project Component Description.

1) Activities. The activities to be performed in Costa Rica and Panama include: 1) train appropriate in-country personnel; 2) assistance with peat resource evaluation; 3) demonstrate end-use feasibility. Because the technical base exists in Central America to enable the countries to do the required work, the approach for this project is to provide enough expertise and training so that in-country geologists, engineers, economists and technicians can eventually conduct peat resource assessments and do end-use development on their own.

In the early phases of the project, this learning experience will be more intensive, involving: 1) cooperative work in the field and laboratory between Los Alamos National Laboratory and host country personnel; 2) training courses; and 3) exchanges of scientists and technicians between Los Alamos National Laboratory and the host institutions. After Central American personnel have learned more about the resources and capabilities of the host institution as well as the logistics required to conduct these studies, Los Alamos personnel will act as consultants to the host organizations in such areas as characterizing the resources, recommending new approaches or additional studies, and evaluating analytical results. We may also help to advise the host institution as well as those participating in the peat end-use program, regarding site selection for demonstration projects, mining, or end-use testing.

2. Task Statement.

a. Training

Training of RECOPE and IRHE personnel for field work (i.e., use of coring equipment, description of peat samples, description of site characteristics, sample collection procedures, etc.) was begun during the initial collecting trips that Los Alamos personnel made to Costa Rica and Panama. Additional training will include completion of field techniques, basic information relative to the composition of peat, the classification of peat, types of analyses to be done on peat and their significance, methods of resource calculations, mining methods, environmental impacts, and various end-uses.

To accomplish this training in the fundamentals of peat resource assessment, a training short-course will be held in San Jose, Costa Rica. This short-course will be run in July 1986 by Dr. Arthur Cohen, Los Alamos National Laboratory and Dr. William Spackman, Pennsylvania State University. It will be designed specifically to meet the needs of those people in Central America who are already

working on the development of peat resources or who might have an interest in doing so in the future.

Key geologists and technicians will also receive training by visiting two or three different peat research laboratories in the US. Certain engineers will receive additional training by visiting project site in Jamaica where peat deposits will be used to generate electrical power.

b) Peat Resource Evaluation

(1) Country-Wide Exploration Program - Costa Rica. Based on previous advice from Los Alamos peat experts, RECOPE has already begun a country-wide exploration to find additional peat deposits in Costa Rica. This work will be continued by RECOPE with Los Alamos personnel acting only in an advisory capacity and/or as a source of technical expertise.

The field methods employed in doing this kind of reconnaissance involve gaining access to an area in which peat may occur and then taking a small number of representative samples from the area with a Macaulay peat sampler. With proper training, a good judgement can be made in the field as to whether the samples may be peat and whether they should be analyzed. Laboratory analysis is required to determine if the material is good quality peat. If good quality peat is found in an area and geomorphic (or vegetational) evidence suggests that the deposit may be of reasonable size, plans will be made for more detailed sampling.

(2) Detailed Studies of Specific Sites - Costa Rica. When evidence from the Costa Rica country-wide assessment suggests that a reasonably large deposit has been found, plans will be made for more systematic sampling of the deposit. This usually involves sampling to the bottom of the deposit using a grid sampling plan or equally-spaced transects.

The purpose of this sampling will be to determine the vertical and lateral extent of the deposit and its "quality." Since "quality" is somewhat a function of the desired end-use, a specific deposit may be of high quality for certain uses but low quality for others. Fortunately, various laboratory tests can be used to predict the behavior of peat for industrial or agricultural uses (see methodology).

Based upon previous discoveries by Los Alamos and RECOPE personnel, RECOPE has already begun detailed studies on two sites (one near Siquirres and one near Los Chiles). Sampling and analyses have been nearly completed for the Siquirres site and have begun on the Los Chiles site. RECOPE has sufficient people (and now has suitable laboratory facilities) to do all of the field work and most of the laboratory tests necessary for this task. Los Alamos peat specialists will provide additional technical assistance or advice, where needed, and will conduct a limited number of selected analytical tests to help in assessment of the quality of the resource. Los Alamos personnel will also assist RECOPE in planning future studies, in analyzing test results, and in obtaining qualified consultants to assist in these studies.

In order to accomplish the tasks described above, it is expected that 3-4 trips for about three days each by two Los Alamos peat specialists (and/or consultants to Los Alamos) will be required before the end of 1986.

(3) Regional Reconnaissance of Northwestern Panama. During our previous trip to Panama, our mission was to determine if any peat deposits were present in this country (since none had ever been reported). One deposit of large size (about 40 km_2) and potentially great economic potential was discovered near the town of Changuinola in the northwestern part of the country. Subsequent laboratory tests conducted at Los Alamos established that many samples from this deposit had very high organic matter content (98%) and some

had heating values as high as 10,800 BTU/lb. dry. This would be approximately equivalent to the heating value of a subbituminous coal. Thus, this depost could have great potential for many uses, and certainly for electrical power generation. Furthermore, geomorphological and ecological evidence suggests that 2 or 3 other deposits of this same type may also occur in this area and extending east to Chiriqui Grande. It is on the basis of this information, (plus indications from the Panamanians that they are interested in developing this region) that we propose herein to concentrate our efforts on reconnaissance exploration of northwestern Panama. This should involve 3 to 4 weeks of field work, using a heliocopter, two field vehicles, a boat, and about 6 field assistants. With proper training, a good judgement can be made in the field as to whether any samples collected might be peat and whether they should be retained for additional laboratory analysis. Laboratory analysis is required to determine if the material is good quality peat. This task should result in between 100 and 200 samples to be analyzed for the entire northwestern Panama region.

(4) Detailed Study of Chanquinola Site - Northwest Panama. Because we have already discovered a potentially significant deposit near the town of Cahnquinola (as previously described) and since there is strong in-country interest in this area, we are proposing that this deposit be the first to be investigated in detail. Using Macaulay samplers, a helicopter, two field vehicles, and about the same size crew as used in task 2, systematic sampling of the entire deposit (including an adjacent deposit near Amirante) will be initiated. This will involve about 150 sample sites and as many as 550 samples collected for laboratory analysis. Analyses to be conducted will include "proximate" analysis (moisture, ash, fixed carbon, volatile matter), calorific value (BTU/lb.), "ultimate analysis" (C, H, O, and S), bulk density, pH, petrographic/botanical composition (including fiber content and plant types), mineralogical analysis of the ash, and ash fusion temperature. These analyses will have use both in calculating the total quantity of the resource and in establishing the

industrial behavior of the peat (e.g. electrical power applications, agricultural uses, etc.).

It is expected that sample collection at this site will be done entirely by IRHE (with Los Alamos assistance and advice where required) and that it will take approximately one month to complete the sample collection (with helicopter assistance). Without helicopter support, this sampling task will probably take several months.

For this detailed study, it is also expected that Los Alamos will be responsible for conducting or contracting out most of the analyses. Completion of these analyses will take approximately three months.

c) End-Use Studies and Experimental Program. Having identified potential end-uses for the peat resources, plans will be made and implemented to carry out experimental programs to demonstrate end-use feasibility and to obtain realistic cost data. Several tasks are envisioned. These include test burns of peat in a cement plant in Costa Rica, test burns of peat in an existing work gasifier in Costa Rica (if technically reasonable), stove combustion and environmental tests using peat from Costa Rica at ICAITI's facility in Guatemala City, feasibility and cost studies for fluidized bed boilers and gasifiers, a viability study for a peat-fueled power plant in Panama and peat mining studies for both Panama and Costa Rica.

At the conclusion of these studies, reports will be written summarizing the findings. Draft reports should be available at the end of FY86.

3. Coordination and Implementation

Program management for this component is the responsibility of Mr. Joseph Frank. Dr. James Aldrich is the Project Leader of the

peat resource assessment and Dr. Arthur Cohen, the technical lead. Dr. Kenneth Williamson is the Project Leader of the end-use development and Dr. Gary Thayer, the technical lead. All work will be planned and coordinated through the counterpart organizations by Mr. Arturo Ramariz of IRHE in Panama and Mr. Oldemar Ramirez of RECOPE in Costa Rica. Dr. William Spackman and Thomas Malterer, well-known consultants on peat and coal, are being employed by Los Alamos to aid in its training tasks, and also to give advice on technical management, planning, and data analysis.

In addition, a well known authority on end-uses of peat, Dr. M. Kopstein of Peat Systems International and Mr. A. Allen of A. D. Allen Company will participate in the program. The schedule of implementation is shown on the accompanying milestone chart.

Both RECOPE and IRHE are making significant economic contributions to this project in their respective countries. Both organizations are contributing all of the personnel required to do the field work, two or more field vehicles and gas, and many geologists and other experts to help in analyzing data and performing some of the laboratory work. RECOPE has expended a significant amount of its own funds to build and equip a peat analysis laboratory to conduct tests for this project.

4. Status of End of Phase 2 - FY86

- Training of in-country personnel should be to the point where they can continue studies of peat on their own.
- Regional assessment of peat resources of northwestern Panama will be completed.
- Country-wide assessment of peat resources of Costa Rica will be one-half completed.
- Detailed analysis of the quantity and quality of the peat resource at Changuinola in Panama will be completed.
- Detailed analysis of the quantity and quality of peat resources at Siguirres and Los Chiles sites in Costa Rica will be completed.

o Test burn of peat at cement plant in Costa Rica will have been carried out.

o Half of the stove combusting and environmental tests using Costa Rican peat at ICAITI'S facility in Guatemala Cty will be completed.

o Planning for test burn of peat in existing work gasifier in Costa Rica will be continuing.

o Feasibility and cost studes for fluidized bed boilers and gasifiers will be in progress.

o Viability study for a peat-fueled power plant near Changuinaola, Panama will be in progress.

o Peat mining studies for Costa Rica and Panama will be in progress.

5. Project Component Budget. See following pages.

6. Activity Schedules and milestones. See following pages.

Previous Page Blank

PEAT RESOURCE ASSESSMENT AND END-USE STUDY

PROJECT COMPONENT BUDGET

	$K	$K
Projected Budget for Resource Assessment		
Geologist base salary ($48.1K/FTE/Yr) 1.6 FTE	77.0	
Fringe @ 25.5% of base salary	19.6	
Burden @ 79% of base salary plus fringe	76.3	172.9
Technical and secretarial base salary ($22.7K/FTE/Yr) 1.0 FTE	22.7	
Fringe @ 25.5% of base salary	5.8	
Burden @ 79% of base salary plus fringe	22.5	51.0
Travel		
Air fare (12 R/T Albuquerque to Central American capital city)	12.0	
Per diem (average $75/person-day x 64 person-days)	4.8	
Helicopter for field work	20.0	36.8
Consultants (24 days @ $250/day)	6.0	6.0
Chemical analysis (contract)	38.0	38.0
SUBTOTAL		304.7
Projected Budget for Training		
Geologist or engineer base salary ($50.0K/FTE/Yr) 0.2 FTE	10.0	
Fringe @ 25.5% of base salary	2.6	
Burden @ 79% of base salary plus fringe	9.9	21.7

Projected Budget for Training (Cont'd)

Technical and secretarial base salary ($22.7K/FTE/Yr) 0.2 FTE	4.5	
Fringe @ 25.5% of base salary	1.2	
Burden @ 79% of base salary plus fringe	4.5	10.2
Travel		
Air fare (6 R/T Albuquerque to Central American capital city)	6.0	
Airfare (2 R/T: Albuquerque to Colorado and Albuquerque to Pennsylvania)	1.0	
Airfare (3 R/T Panama to Jamaica)	2.5	
Per diem (average $75/person-day x 30 person-days)	2.3	
Local and field expenses	2.8	14.6
Consultants (8 days @ $250/day)	2.0	2.0
SUBTOTAL		48.5

Projected Budget for End Use Study

Engineer base salary ($50.0K/FTE/Yr) 1.0 FTE	50.0	
Fringe @ 25.5% of base salary	12.8	
Burden @ 79% of base salary plus fringe	49.6	112.4
Technical and secretarial base salary ($22.7K/FTE/Yr) 0.4 FTE	9.1	
Fringe @ 25.5% of base salary	2.3	
Burden @ 79% of base salary plus fringe	9.0	20.4

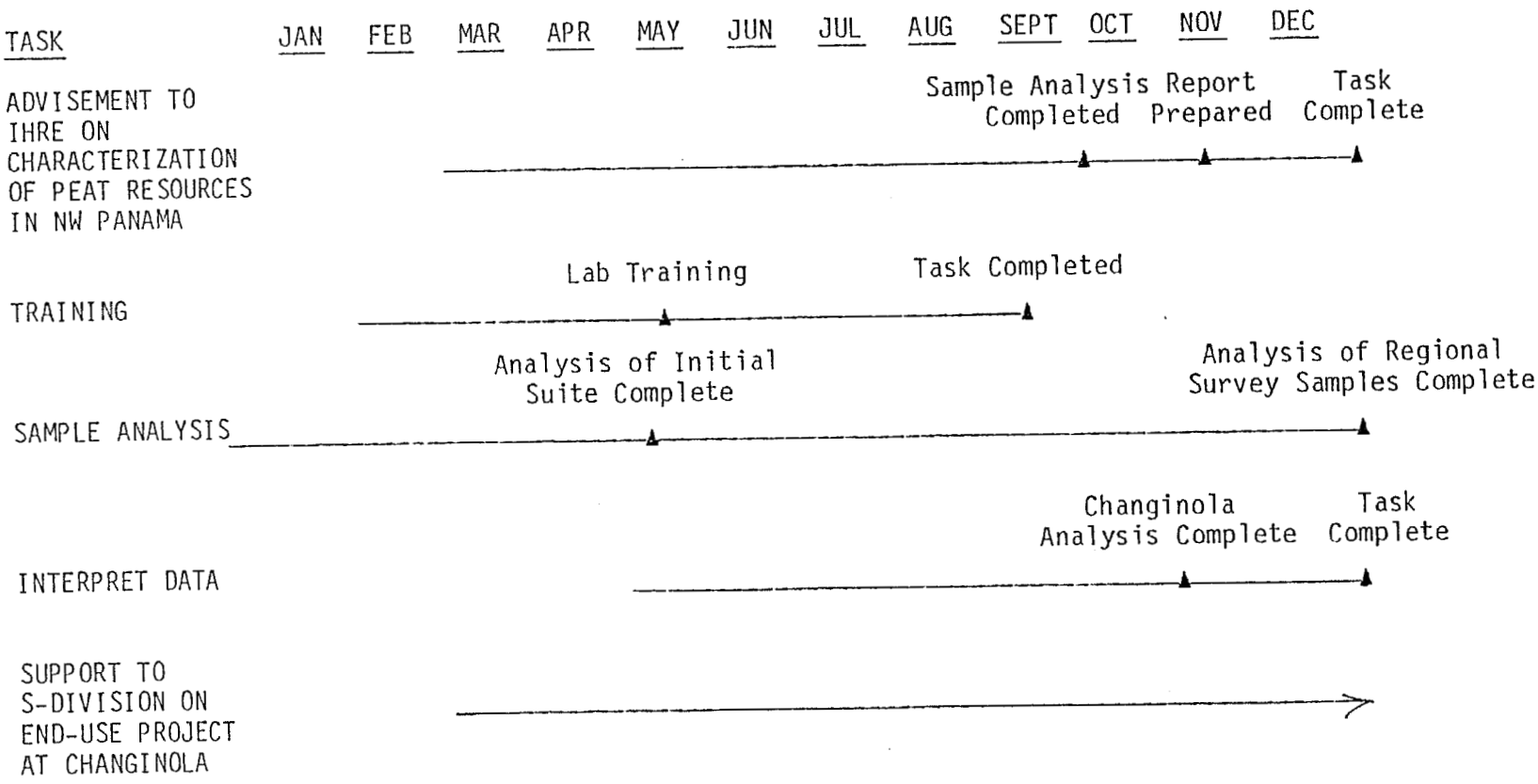
Projected Budget for End Use Study (Cont'd)

Travel		
Air fare (8 R/T Albuquerque to Central American capital city)	8.0	
Per diem (average $75/person-day x 40 person-days)	3.0	
Local and field expenses	8.0	19.0
Consultants (220 days @ $250/day)	55.0	55.0
ICAITI stove contract	40.0	40.0
SUBTOTAL		246.8
PROJECT COMPONENT TOTAL		600.0

PANAMANIAN PEAT RESOURCE ASSESSMENT

ACTIVITY SCHEDULE AND MILESTONES

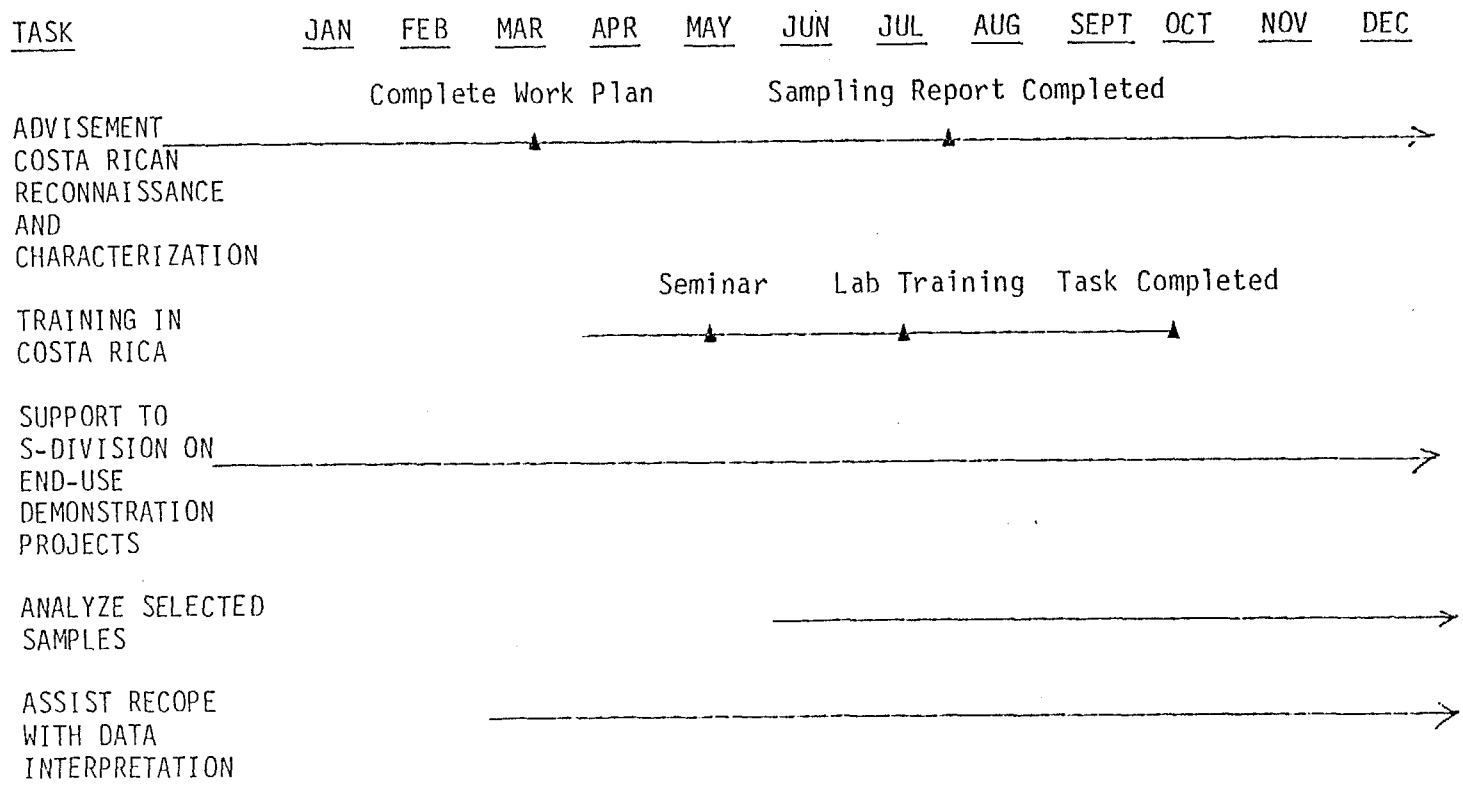
1986



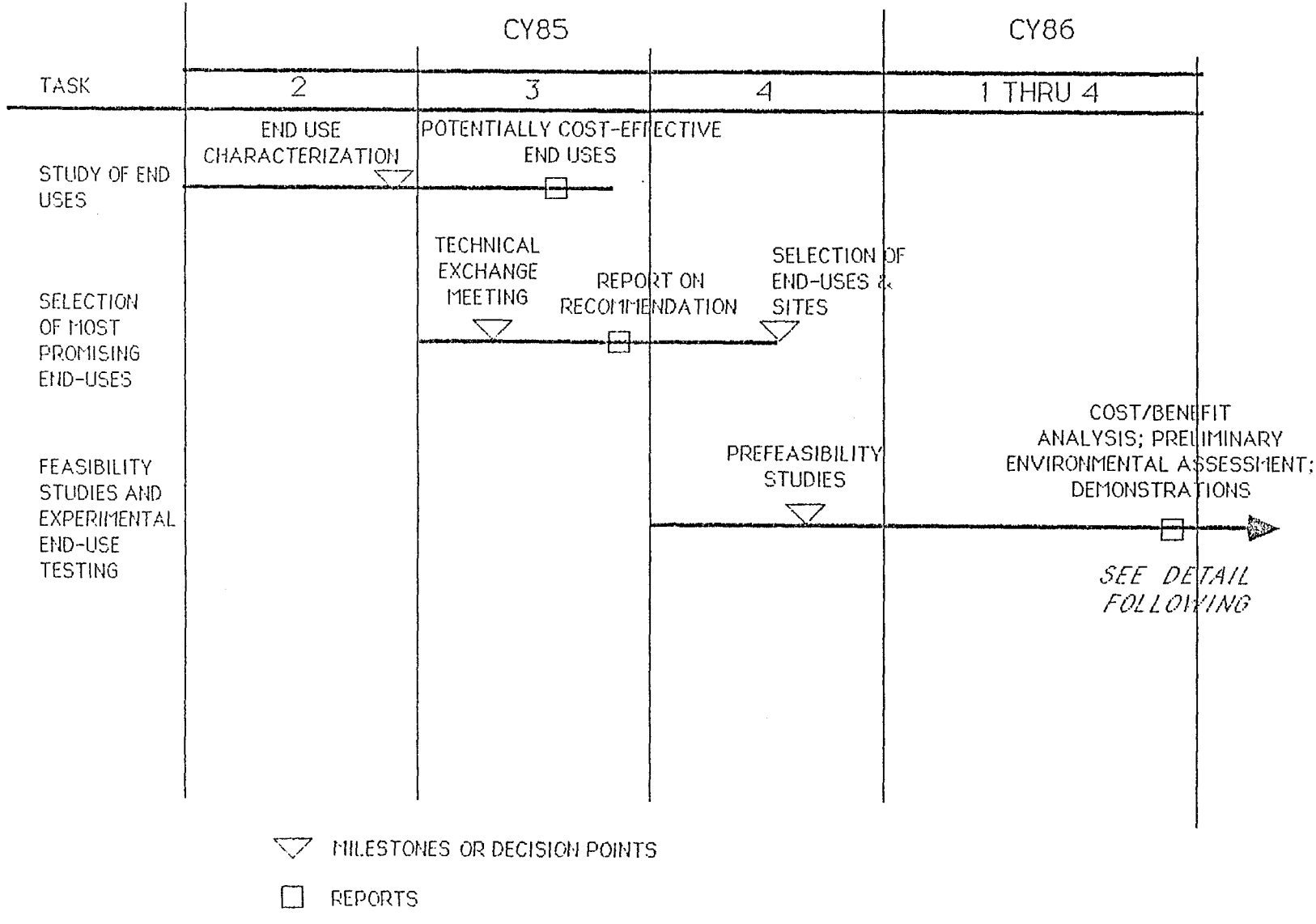
COSTA RICAN PEAT RESOURCE ASSESSMENT

ACTIVITY SCHEDULE AND MILESTONES

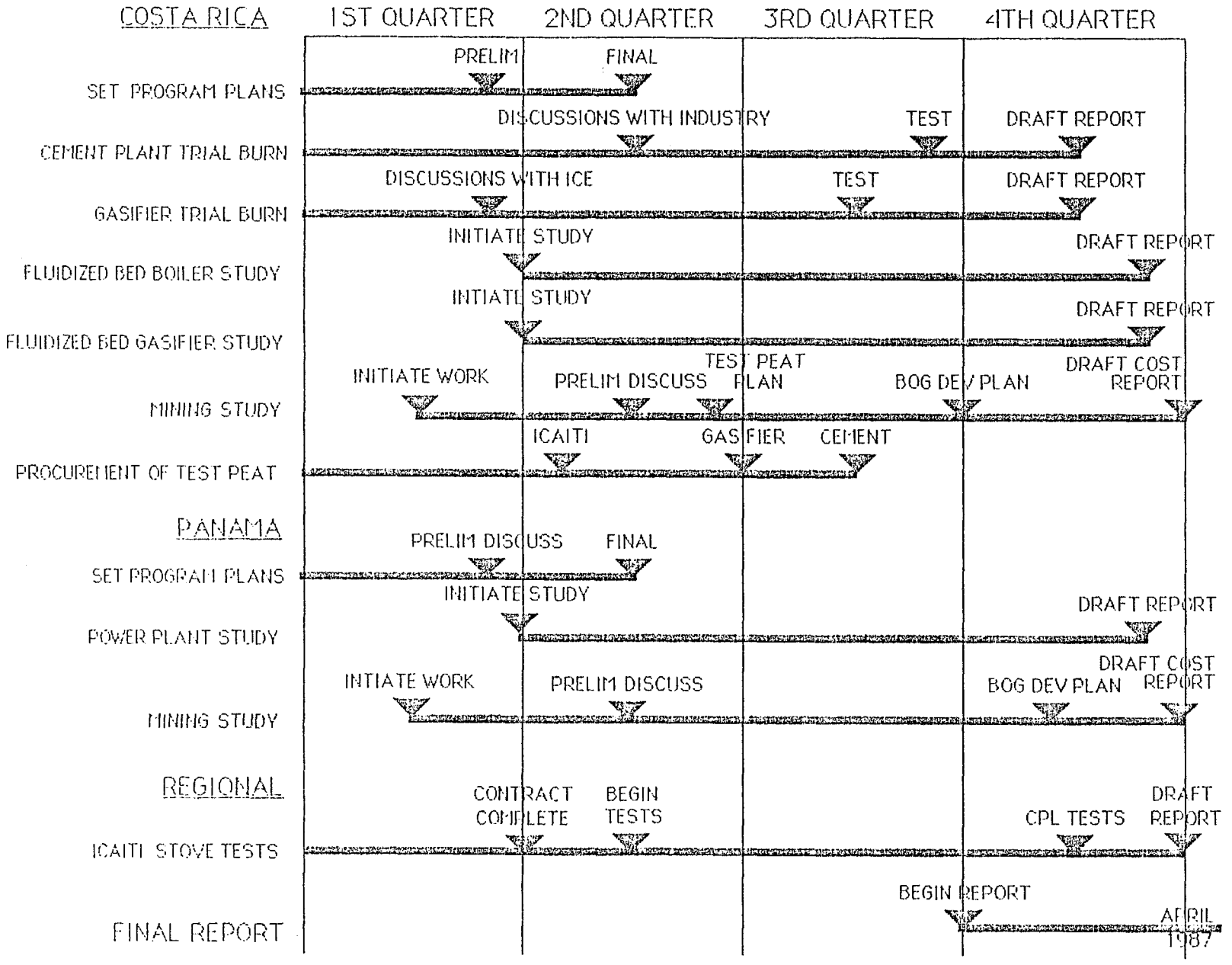
1986



COSTA RICAN PEAT END USES
ACTIVITY SCHEDULE AND MILESTONES



DETAILS OF CY1986 EFFORT



C. Management

Funds are required to support project management at Los Alamos and for the regional project coordinator and the regional geothermal coordinator. A portion of these funds will be used for the development of the monitoring system for the Zunil Direct Heat Project and for the development of the logical frameworks for each of the components.

D. Contingency

Funds are required to cover unanticipated increases in the estimated cost of items or services required for the projects. Also, the independent evaluation of the Central American Energy Resources Project will be funded from this source.

E. Summary Budget

Component	$K
Energy Situation Analysis	440.0
Honduras Geothermal Reconnaissance	340.0
Miravalles Geothermal Development	45.0
Support Equipment for Central America	95.0
Direct Heat Applications of Geothermal Energy	170.0
Geothermal Support to Panama and El Salvador	300.0
Peat End Use Assessment and Reconnaissance	600.0
Management	250.0
Contingency	269.7
	2,509.7