PANAMA
EL VALLE DE ANTÓN GEOTHERMAL FIELD
ADVANCED PREFEASIBILITY STUDIES - PHASE II

(TC-95-73-62)

EXECUTIVE SUMMARY

REQUESTER:	Ministry of Planning and Economic Policy	
EXECUTING AGENCY:	Instituto de Recursos Hidráulicos y Electrificación [Water Resources and Electrification Administration] (IRHE) and the Inter-American Development Bank (IDB)	
BENEFICIARY:	Instituto de Recursos Hidráulicos y Electrificación	
FINANCING:	IDB:	US$1,400,000 (Nonreimbursable funding from the Japan Special Fund)
	Local counterpart funding:	US$ 678,000
	Total:	US$2,078,000
TERMS:	Execution period:	2 years
	Disbursement period:	2.5 years

ENVIRONMENTAL CLASSIFICATION: The Environment Committee, at its meeting of August 22, 1995, classified this as a Category III operation.

OBJECTIVES: Incorporate geothermal energy into the country's primary energy supply by contracting for consultancy and drilling services to conduct advanced prefeasibility studies for this geothermal field. These studies will yield a preliminary evaluation of the field's energy potential, making it possible to offer the private sector the opportunity to undertake commercial exploitation of the geothermal field for generation of electricity.

DESCRIPTION: To achieve this objective, the first step will be to consolidate the geoscientific studies carried out in the course of the earlier program. This will be followed by drilling 3,000 meters of exploratory geothermal wells. Roughly 2,000 meters will be drilled in the first two wells with the aim of penetrating the permeable resistive formation and, at a depth of approximately 800 to 1,000 meters, entering the electrically conductive layer which (on the basis of geophysical surveys) is interpreted as being the sealing layer protecting the geothermal aquifer. When this formation is reached, tests will be

conducted to verify that it is indeed impermeable and thermal-gradient measurements will be taken.

The remaining 1,000 meters of drilling will deepen the first two wells with a view to intercepting the geothermal deposit, which is expected to be found at a depth of 1,500 meters.

Rock samples will be taken during the drilling operations and these will be the subject of geoscientific studies. When drilling is completed the wells will be tested; if they are capable of maintaining production for a reasonable length of time, studies will then be conducted on the geothermal reservoir. The findings from the various disciplines will be analyzed and interpreted in order to prepare the prefeasibility report in accordance with the terms of reference.

BENEFITS: The operation will result in geothermal energy being incorporated into the country's primary energy supply. In the case of Panama, geothermal power would replace conventional thermally generated power, thereby reducing a source of pollution and improving average unit production costs. Furthermore, given the geographical location of the geothermal fields relative to the topology of Panama's power system, the geothermal projects would feed electricity into key nodes in the power system, thereby improving reliability and cutting power losses.

RISKS: Those inherent in a geothermal exploration project.

THE BANK'S COUNTRY STRATEGY: The Bank's strategy for the sector supports the government's decision to implement reforms in the energy sector designed to improve its operational efficiency through a number of actions; these would include creating an appropriate framework to enable and encourage the private sector to participate in energy sector investments. In compliance with one of the mandates of the Eighth Replenishment, the Bank is supporting actions by countries seeking to develop their renewable energy resources in pursuit of sustainable growth strategies and plans. The technical-cooperation project put forward in this document meets the criteria indicated above.

SPECIAL CONTRACTUAL CONDITIONS: None. The technical cooperation agreement would contain the Bank's standard conditions as to hiring of consulting services, progress reports, procurement of goods and services, disbursements, and dispute settlement, among others.

I. BACKGROUND

1.1 In order to expand exploitation of Panama's natural resources, the Instituto de Recursos Hidráulicos y Electrificación [Water Resources and Electrification Administration] (IRHE) has adopted a development strategy based on least-cost expansion plans which take account of power generation projects with feasibility studies for initiatives that make use of renewable energy resources. It is also in the national interest to create conditions that will attract private-sector investors to the development of priority projects.

1.2 In order to explore the country's geothermal resources, IRHE asked the Bank (in 1983) to finance the following studies: (i) a national geothermal reconnaissance survey, and (ii) a prefeasibility study in the priority geothermal field (to be defined in the aforementioned study). The Bank approved two technical-cooperation projects for the purposes indicated: ATN/SF-2228 PN (A) and ATC/SF-2228 PN (B), respectively.

1.3 The national reconnaissance survey was satisfactorily completed in 1987, coming to the conclusion that Panama possesses two geothermal fields with characteristics favorable for commercial exploitation, one located in the area of El Valle de Antón, and the other in Chitre-Calobre. The survey identified El Valle de Antón as the priority area.

1.4 Based on the reconnaissance survey results, the prefeasibility studies were taken in hand, with partial use of ATC/SF-2228 PN (B) technical-cooperation resources. However, as a result of the difficult political and financial situation in Panama in 1988, the government failed to meet its financial obligations to the Bank, and the Bank was in turn obliged to suspend disbursements on all loans and technical-cooperation projects in course of implementation.

1.5 Suspension of disbursements on the geothermal program occurred at a time when bids had been invited for well drilling in El Valle de Antón and a geomagnetic measurement survey was under way in Chitre-Calobre. Work already begun remained uncompleted, and obviously the activities planned next in sequence did not take place. In short, although some of the work relating to the prefeasibility studies was carried out, the most important tasks remained in abeyance.

1.6 Once the conditions that had compelled suspension of disbursements had been remedied, the Bank systemically set about reactivating its operations in Panama. Approval was given for technical-cooperation program ATC/SF-2228-PN (B) to be reactivated in 1993, but it did not become effective until this year (1995), because the national

budget did not include the necessary items appropriations for the project.

1.7 Before resuming activities, IRHE asked the Bank to send a special mission to Panama to carry out two assignments: (i) evaluate the status of the studies, and (ii) update the program of activities and its cost. In addition, having regard to the desire of IRHE authorities to expand the program objective 1/ so as to intercept the geothermal deposit and ascertain its characteristics, the mission was also charged with defining the activities and costs of a new technical-cooperation operation to be negotiated under the Bank's trust-funds program.

1.8 The IDB mission reached the following conclusions: (i) the resources currently available under the ATC/SF-2228-PN (B) technical-cooperation project (US$784,000 from the IDB and US$424,000 from IRHE) were insufficient to complete the program even as initially defined, and obviously far from adequate to cover the program's expanded objectives, and (ii) the supplementary technical-cooperation funds required to implement the expanded program would be US$1.4 million, while IRHE would have to contribute an additional US$1,176,000 in counterpart funds.

1.9 In its letter DPEvs-DPI-No. 14 of May 19 the Ministry of Planning asked the Bank to approve the technical-cooperation project described above.

1.10 In compliance with the Panamanian government's request, the Bank prepared a Profile for the new technical-cooperation project in order to carry out the mandatory consultation with the authorities of the trust funds in question. After those authorities had studied the project, the Japan Special Fund informed the Bank that it had accepted the operation in principle. For its part, IRHE also informed the Bank that arrangements had been made for the local counterpart funds.

1/ The initial objective of the study was to demonstrate that the geothermal field at El Valle de Antón was suitable for commercial operation, viz. existence of a demonstrable heat source, and presence of the following formations at depth: (i) an impermeable formation protecting the geothermal deposit, and (ii) a second, deeper formation capable of containing the deposit. The initial objective did not include financial resources to intercept the geothermal deposit through deep wells.

II. FRAME OF REFERENCE

2.1 Under the law which established it, IRHE is the public electricity enterprise charged with planning, building and operating the country's power system.

2.2 IRHE has an installed capacity of 991 MW (86% of the country's total installed capacity); of the remaining 14%, the Panama Canal Commission accounts for 142 MW and the Chiriquí Land Co. for 10 MW. IRHE's installed capacity is derived largely from hydroelectric plants (550 MW) and conventional thermal power plants (362 MW). Panama has attained 73% electrification coverage.

2.3 A total of 3,400 GWh was generated to meet power demand in 1994. Operation of the thermal power plants in 1994 required the use of 2 million barrels of oil-based fuels at a cost of US$39.3 million. Under the most recent IRHE expansion plan, covering the period 1995-2007, additional generation capacity is to be split evenly between hydroelectric plants and thermal power plants. If this expansion plan is implemented as it stands, yearly consumption of oil-based fuels will rise to an average of 2.2 million barrels, at a cost of US$44 million (1995 dollars). 2/

2.4 Based on experience with the 250 geothermal power units installed throughout the world, development of geothermal power generation has proved to be one of the best nonpolluting ways to generate electricity. Most of these plants operate at a load factor of roughly 85%, which makes the unit cost of electricity generated in this way lower than that of alternative methods of base load power generation. 3/ This has been verified in IDB-conducted project analyses for approval of loans to geothermal projects in various countries in the region. In the specific case of Panama, geothermal power would replace conventional thermal energy, reducing a source of pollution and improving average unit production costs. Furthermore, given the geographical location of the geothermal fields relative to the topology of Panama's power system, the geothermal projects would feed electricity into key nodes in the power system, thereby improving reliability and cutting power losses.

2/ However, because of the difficulties inherent in hydropower development, the capacity to be installed in thermal generating plants is expected to be larger than provided in the plan.

3/ This is not, however, the case in countries or regions with abundant cheap natural gas, as currently in the United States and Bolivia. None of the other geothermal countries have natural gas, so that geothermal projects only have to compete with (oil-fired) thermal and hydropower projects.

2.5 The Bank's strategy for the sector supports the government's decision to implement reforms in the power sector designed to improve its operational efficiency through a number of actions; these would include creating an appropriate framework to encourage the private sector to participate in energy sector investments. In compliance with one of the mandates of the Eighth Replenishment, the Bank is supporting actions by countries seeking to develop their renewable energy resources in pursuit of sustainable growth strategies and plans. The technical cooperation proposed in this document meets the criteria indicated above.

III. OBJECTIVES

3.1 The purpose of the advanced prefeasibility study of the El Valle de Antón geothermal field is to obtain the information required to verify and make a preliminary evaluation of the field's energy resources. A further objective of the studies is to compile reliable information to attract private investors for development of the geothermal power project, a process which will make it possible to adjust policies, rules and regulations for the exploration, investigation and development of other geothermal fields in the country.

IV. DESCRIPTION OF THE PROJECT

4.1 The El Valle de Antón geothermal reservoir is located some 75 km S and 57°W of Panama City, inside the El Valle caldera, in the province of Coclé and district of Antón. It is reached by taking the Pan American Highway as far as La Unión and then Highway 71 (which is paved and passable year-round) to El Valle. The reservoir lies at an elevation of approximately 570 meters above sea level, and the drilling sites have easy access to sources of water, electricity, telephones and hotels.

4.2 Geological, volcanological and geophysical studies show that El Valle consists of two calderas, a smaller one to the north known as La Mesa, and the El Valle caldera to the south. The two depressions are separated by three post-caldera domes aligned along an E-W axis, known respectively as Pajita, Gaital and Caracoral. Petrographic analyses have shown that the collapse that gave rise to the El Valle caldera and the emplacement of the domes in the major ring fault in the field took place around one million years ago. However, volcanic activity has occurred more recently (between 35,000 and 50,000 years ago), with Plinian eruptions producing significant deposits of volcanic ejecta. Analysis of these pyroclastic materials has confirmed the existence of a large magma chamber (minimum 27 km^3). Petrographic reconstruction of the

magma crystallization process indicates that the chamber lies at a relatively shallow depth, making it a significant heat source for the siting of a geothermal resource beneath the El Valle caldera.

4.3 Interpretation of the geophysical survey data indicates that the area south of the domes, i.e. the El Valle caldera proper, is characterized by the presence of a permeable surface layer between 400 and 500 meters thick, followed by a low-permeability formation with a maximum thickness of 1,000 meters, and that the roof of the resistive basement rock lies at a depth of approximately 1,500 meters.

4.4 To accomplish the objectives listed in the preceding section, the findings of existing geoscientific studies will first be consolidated, and a preliminary conceptual geothermal model will then be prepared; lastly, some 3,000 meters of small-diameter deep wells will be drilled. The first 2,000 meters will seek to penetrate the initial surface layers, which are both resistive and permeable, in order to enter, at a depth of 800 to 1,000 meters, the conductive layer which is inferred to be the formation sealing the reservoir, where thermal-gradient and heat-flow measurements will be taken.

4.5 The first well will be drilled in the south-central part of the El Valle caldera and the second in the southwestern part of the same depression: this is a zone with numerous thermal manifestations and a relatively shallow resistive basement. The 1,000 meters of additional drilling will seek to intercept the geothermal deposit at a depth of close to 1,500 meters. Geophysical surveys will be conducted in all the boreholes, samples of geothermal fluids will be taken at the bottom of the hole for the required chemical analyses, together with bottom-hole temperature measurements, and injectability tests will be carried out in the wells that have intercepted the deposit.

4.6 With the information thus obtained, it is hoped to be able to characterize the geothermal deposit using indirect methods (i.e., methods which do not require bringing the wells into production), and to predict its production and behavior, together with the field's theoretical potential. If the wells can be induced to flow, short-term tests will be conducted which should further refine the results obtained from the indirect methods outlined above.

4.7 In the event the wells are able to maintain their production for a relatively extended period of time, consideration could be given to advancing reservoir engineering studies. The following conditions would also have to be met: (i) existence of a permeable zone at relatively shallow depth (not more than 700 meters) capable of absorbing the residual fluids to be reinjected into it; (ii) IRHE's Longyear 44 drilling rig and drilling crew would have to be capable of drilling a reinjection well in the area in question to the depth

indicated; and (iii) IRHE would have to be able to procure, with the necessary despatch, the silencer and the piping leading from the production wells to the reinjection wells, together with other essential materials. IRHE has proposed that it defray the cost of this part of the program (reservoir studies) using its own funds.

4.8 The technology to be used would be traditional in relation to the drilling of exploratory deep geothermal wells and the conducting of geoscientific surveys.

V. COST AND BUDGET

A. Cost estimates and financing plans

5.1 As indicated earlier, the technical cooperation proposed in this document is an essential complement to ATC/SF-2228-PN (B), which has just been reactivated, and thus it is important that this complementarity be taken into account in defining the activities and costs to be covered by each of these projects.

5.2 In light of the above, a CPM was prepared for the complete project (i.e. technical-cooperation project ATC/SF-2228-PN (B) plus technical-cooperation funds from the Japan Special Fund). To this end, the time needed for each activity was calculated, together with the resources required and unit costs (cost of the various specialists, cost of wells, plus cost of travel, publications and communications).

5.3 The results of this exercise were as follows: (a) the updated implementation program for the project (Annex 1), which shows that approximately 2-1/2 years will be required for implementation of the complete project, 4/ and (b) the project cost estimate (Table 1).

5.4 Table 1 which follows shows that, with the resources currently available from technical-cooperation project ATC/SF-2228-PN (B) plus local counterpart funds, which add up to approximately US$1.21 million (US$785,000 from the IDB and US$424,000 from IRHE), only the following items can be financed: (i) the cost of the advisory group; (ii) the individual experts needed to consolidate the previous studies and adjust the bidding documents, and (iii) the cost of drilling one well (including associated geoscientific studies). These activities are obviously insufficient to achieve the program objectives.

4/ To cover contingencies that might arise during the implementation period, it was decided to take 1997 as the year of project completion for purposes of use of financial resources.

TABLE 1
PANAMA. ADVANCED PREFEASIBILITY STUDIES FOR THE VALLE DE ANTÓN GEOTHERMAL FIELD (PHASE II)
COST ESTIMATE AND FINANCING PLAN
(in thousands of U.S. dollars)

COST ITEMS	ATC/SF-2228-PN (B)			TC-95-73-62			GRAN
	IDB-SF	IRHE	TOTAL	JSF	IRHE	TOTAL	TOTA
INDIVIDUAL CONSULTANTS	193	0	193	0	0	0	19
Updating of specifications and bidding documents for well drilling	9	0	9	0	0	0	
Consolidated reports on Chitre-Calobre and El Valle de Antón	32	0	32	0	0	0	3
Expert advisory group	152	0	152	0	0	0	15
CONSULTING FIRM	129	0	129	409	140	549	67
Focus mission	37	0	37	0	0	0	3
Geoscientific studies of wells	92	0	92	177	0	177	26
Reservoir studies	0	0	0	0	140	140	14
Advanced prefeasibility report	0	0	0	232	0	232	23
DRILLING	463	429	892	925	458	1,383	2,27
Site acquisition and preparation	0	15	15	0	0	0	1
Drilling of well No. 1	371	414	785	0	0	0	78
Drilling of well No. 2	92	0	92	390	298	688	78
Additional deep drilling	0	0	0	535	0	535	53
Drilling of reinjection well using IRHE equipment	0	0	0	0	160	160	16
CONTINGENCIES	0	0	0	66	80	146	14
TOTALS	785	429	1,214	1,400	678	2,078	3,29

5.5 Program TC-95-73-62, the new technical-cooperation operation proposed to be funded from the Japan Special Fund, could finance the remainder of the drilling program and all the costs of the consulting firm which would be in charge of all the studies.

5.6 The amount to be financed under the new technical-cooperation project would be US$1.4 million. The Japan Special Fund has been asked to provide these resources as a nonreimbursable contribution. The local counterpart contribution would amount to US$678,000.

5.7 The cost of engaging a consulting firm to carry out the studies will be US$678,000. This cost represents 212 person-weeks of actual work, so that the average cost used in the estimate is US$2,570 per person-week. The same consulting firm will be responsible for contracting and supervising the drilling of the wells. When the cost of well drilling is included, the total cost of the contract with the consulting firm will be US$2,778,000.

B. Schedule of disbursements

5.8 The schedule of disbursements from the various sources of financing is shown in Table 2 below.

TABLE 2
DISBURSEMENT SCHEDULE
(in thousands of U.S. dollars)

SOURCE	1995	1996	1997	TOTAL
1. JSF-Technical-cooperation project TC-95-73-62	0	910	490	1,400
2. Technical-cooperation project ATC/SF-2228-PN (B)	115	670	0	785
3. Local counterpart – IRHE (for the entire program)	75	843	189	1,107
TOTALS	190	2,423	679	3,292

5.9 As this table shows, disbursements under technical-cooperation project TC-95-73-62 would take place in the years 1996 and 1997. However, as there will undoubtedly be some final adjustments and other payments to be made in 1998, it is recommended that the disbursement period be set at 2-1/2 years.

VI. POTENTIAL ENVIRONMENTAL IMPACT

A. General

6.1 The use of geothermal energy is one of the cleanest ways to generate electricity, as it taps natural heat, which is abundantly available in tectonically active areas (such as the Latin American countries located along the "Ring of Fire" circling the Pacific),

and as it releases only small quantities of pollutants into the environment. Geothermal energy can avoid or replace power generated using fossil fuels that contaminate the environment. Geothermal power projects have limited spatial requirements compared with what is needed for hydropower or thermal power projects (taking into account, for the latter, the land required from the mine downstream). Gas discharges from geothermal power plants into the atmosphere are between 5% and 8% of the combustion gases discharged from thermal power plants. This means that, when geothermal power generation replaces thermal generation, there is a positive effect on global warming; this factor led to a geothermal power project in the Philippines being declared eligible for a grant from the Global Environment Facility, which is administered by the World Bank.

6.2 The possible environmental impact of a geothermal project relates mainly to drilling operations (particularly those in the later stage of the project, when the field is being developed and the power plant is being built); construction of civil works; discharge of geothermal fluids during testing of new wells (these well-characterization tests are of short duration), and later during operation of the plant. The liquid effluents from large-diameter drilling require drilling-waste storage ponds; liquid wastes from long-term testing and plant operation, which may contain contaminants, are eliminated by reinjecting them into deep permeable layers in the geothermal field.

6.3 Noncondensable gases are discharged through stack ejectors. The noncondensable gases from geothermal projects in the region typically represent 0.5% (by volume) of the steam produced; their composition is typically carbon dioxide (93.3%), hydrogen sulfide (0.74%) and the remainder made up of other nonpolluting gases such as nitrogen, hydrogen and methane. No significant concentrations of hydrogen sulfide are expected to build up, as the constant winds in the area disperse noncondensable gases rapidly (the area is being considered for a wind-power project). It will be evident from the above that geothermal projects do not produce sulfur oxide emissions (the main source of acid rain) or nitrogen oxide emissions (which raise surface ozone levels), while carbon dioxide emissions (the cause of the greenhouse effect) are minimal.

6.4 The project area is inhabited, albeit not densely. Accordingly, land use in the project that is being designed for El Valle de Antón should be kept to a minimum, leaving a large percentage of the area available for pre-existing activities. Because of this feature of the project area, it will be necessary to limit the number of drilling platforms during the development phase, but this can be done using directional drilling, a technique that has already been successfully applied in other Bank-financed projects.

For the plant proper, double closed-cycle designs 5/ are being considered, which would eliminate any effluent emissions into the environment.

B. Environmental classification

6.5 Having studied the situation as outlined above, the Bank's Environment Committee (CMA) classified the project in **Category III**. The CMA's main recommendation was that the terms of reference for the consulting firm to be engaged for the advanced prefeasibility studies should include terms of reference for environmental feasibility studies; if the geothermal project is deemed feasible, these environmental feasibility studies should conclude with a definition of the terms of reference for the environmental studies to be carried out as part of the project. This CMA requirement has been met in the terms of reference drawn up for the consultancy contract, which are appended to this document as Annex 2.

6.6 Safety and environmental protection standards will be observed during the field work carried out as part of the advanced prefeasibility studies. The consulting firm, with support from an expert advisory group, will as part of the focus mission assess the environmental impact of this advanced prefeasibility phase, with a view to: (i) identifying and describing the natural resources that could be affected by study activities, notably drilling operations; and (ii) identifying the specific requirements that should be included as an environmental plan during implementation of the studies so as to minimize adverse effects.

VII. STATUS OF THE PROJECT WITHIN THE BANK

7.1 The project has received approval in principle from the Japan Special Fund which the Bank administers in trust, and the CMA has approved the project's environmental brief. The present document is the plan of operations on the basis of which the Bank will be

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5/ In the first cycle, the geothermal fluid (a combination of vapor and hot water) is brought to the surface through the production wells. The steam is separated from the water and is conducted and expanded through a steam turbine to produce electricity; the steam is condensed after passing through the turbine. The condensed water is added to the residual water from the wells, passed to a second-cycle heat exchanger and then led back to the reinjection wells. In the second cycle, the (still hot) water separated in the first cycle is passed to a heat exchanger where an organic liquid is evaporated off which is subsequently expanded through a binary turbine for later condensation and return to the heat exchanger where it receives additional thermal energy.

asked to approve the technical-cooperation project. The terms of reference for requesting bids from consulting firms are complete (Annex 2-A to this document). It is hoped to conclude negotiations with the Government of Panama and IRHE before the project is submitted to the Bank's Board of Executive Directors for formal approval.

VIII. IMPLEMENTATION

A. Project implementation schedule

8.1 The execution timetable (Gantt chart) for the studies is presented in Annex 1. As can be seen from this diagram, activities will initially be carried out in coordination with implementation of technical-cooperation project ATC/SF-2228-PN (B), which in essence will cover the individual experts needed to reactivate the program, the cost of the consulting firm's focus mission, and the cost of the first well. Once the funds from the old technical-cooperation project have been exhausted, the new project funds would begin to be drawn down. The program will require two years for implementation, and 2-1/2 years for disbursement.

B. Contracting and negotiations

8.2 In selecting the consultant, the Bank will ask a shortlist of firms to submit bids; this list of firms will be agreed with IRHE and the authorities of the technical-cooperation fund in question. Bids will be requested once the plan of operations has been approved by the Loan Committee. The firms will be given one month to submit their proposals (two-envelope method). Negotiation of the contract with the firm selected will begin immediately after the Bank has completed its evaluation of the bids.

8.3 In accordance with the terms of reference, the consulting firm will be responsible for engaging a competent drilling contractor, through an open call for tenders. It is also specified that the consulting firm will add no charge for the drilling contractor's invoices, and will bill only the time spent by its technical and administrative staff administering the contract and supervising the work of the contractor.

8.4 As explained earlier, part of the cost of the contract with the consulting firm (including the cost of the first well) will be covered by funds from technical-cooperation project ATC/SF-2228-PN (B). This will require the government, acting through the Ministry of Planning, to authorize the Bank to assume this responsibility. The Ministry has already authorized the Bank to engage the advisory group experts and the two individual consultants needed to initiate the program. The government's

agreement to delegate this responsibility would need to be included in the new technical-cooperation agreement.

8.5 For implementation of the studies, IRHE is required to contribute counterpart funds to defray the costs incurred by the consulting firm in preparing the reservoir studies, and part of the drilling costs. Consequently, the agreement to be concluded between the Bank and IRHE will need to establish that IRHE will make the payments in question direct to the consultant when so requested by the Bank in accordance with project needs.

8.6 In addition to providing counterpart funds, IRHE will be responsible for providing logistical support required for project execution. Such support will be required particularly during the mobilization phase for the consulting firm and the drilling contractor, and during visits by consultants and experts. IRHE will exercise technical supervision of the work jointly with the Bank. IRHE will be totally responsible for drilling the reinjection well(s) using its own equipment and drilling crew; this is required for long-term tests on the wells in order to undertake the reservoir engineering studies. This work will be carried out only if the deep wells can be induced to produce, and if production can be maintained for the time required for testing.

C. Reports

8.7 The individual consultants and experts to be engaged and the consulting firm will present a report upon completion of their work indicating the results of the activities. Upon completing the focus mission, the consulting firm will submit a report specifying in greater detail the activities it is to carry out. At each milestone specified for the successive stages of the studies, reports will be submitted on that stage. All of the reports will be discussed in Panama in formal meetings of the advisory group for the project, which will include not only the experts making up the group but also the individual consultants, professionals from the consulting firm, and professionals from the Bank and IRHE charged with supervising the studies.

D. Disbursements and payments

8.8 Disbursements and payments will be made in conformity with the contracts.

8.9 The technical cooperation agreement will contain the Bank's standard conditions as to hiring of consulting services, progress reports, procurement of goods and services, disbursements, and dispute settlement, among others.

E. Responsibility within the Bank

8.10 Basic and technical responsibility for this operation will lie with Regional Operations Department 2 (RE2), through its Finance and Basic Infrastructure Division (RE2/FI2), and the Bank's Country Office in Panama, with technical support from the Environment Division of the Social Programs and Sustainable Development Department (SDS/ENV).

PANAMA

VALLE DE ANTÓN. GEOTHERMAL FIELD. ADVANCED FEASIBILITY STUDIES

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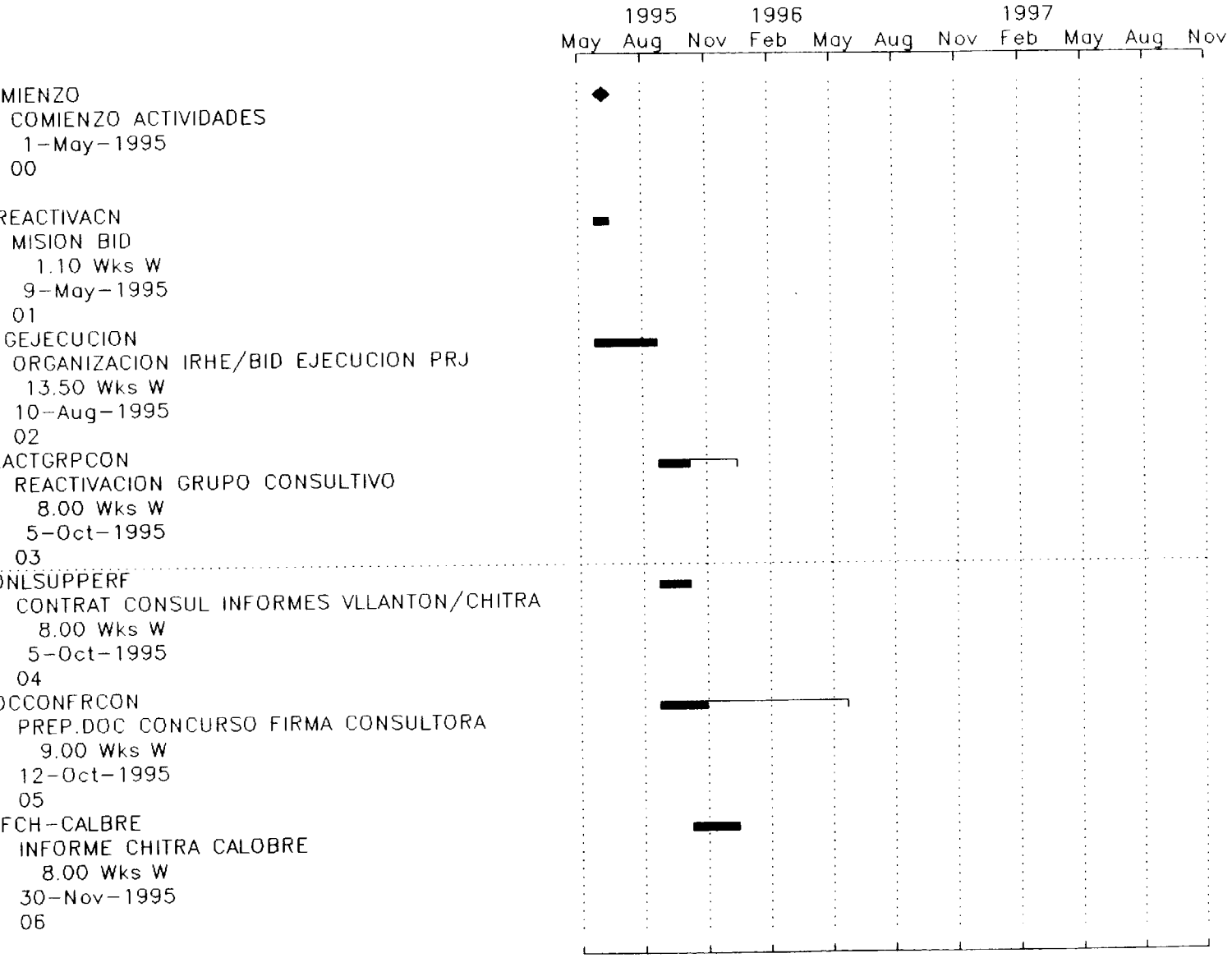

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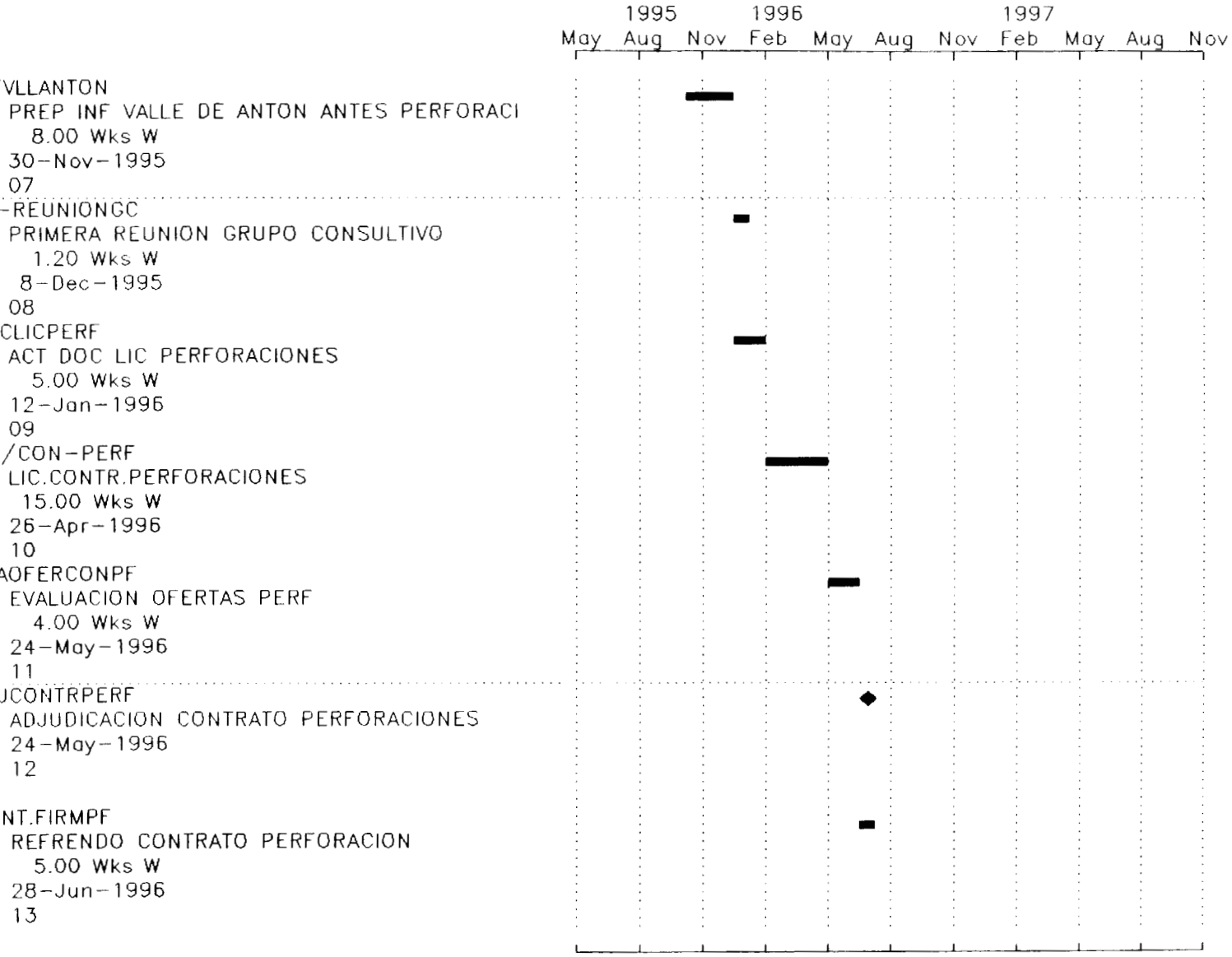

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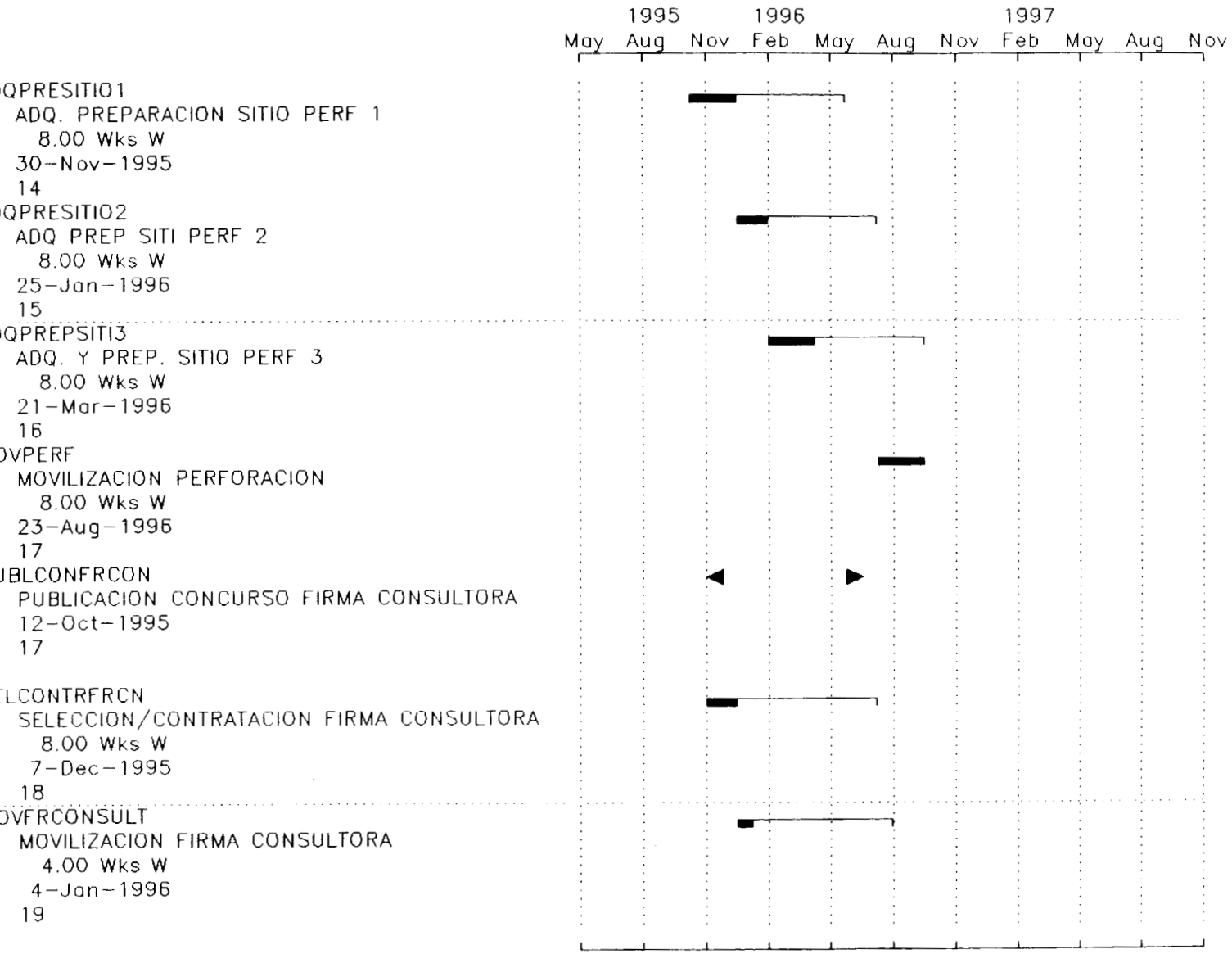

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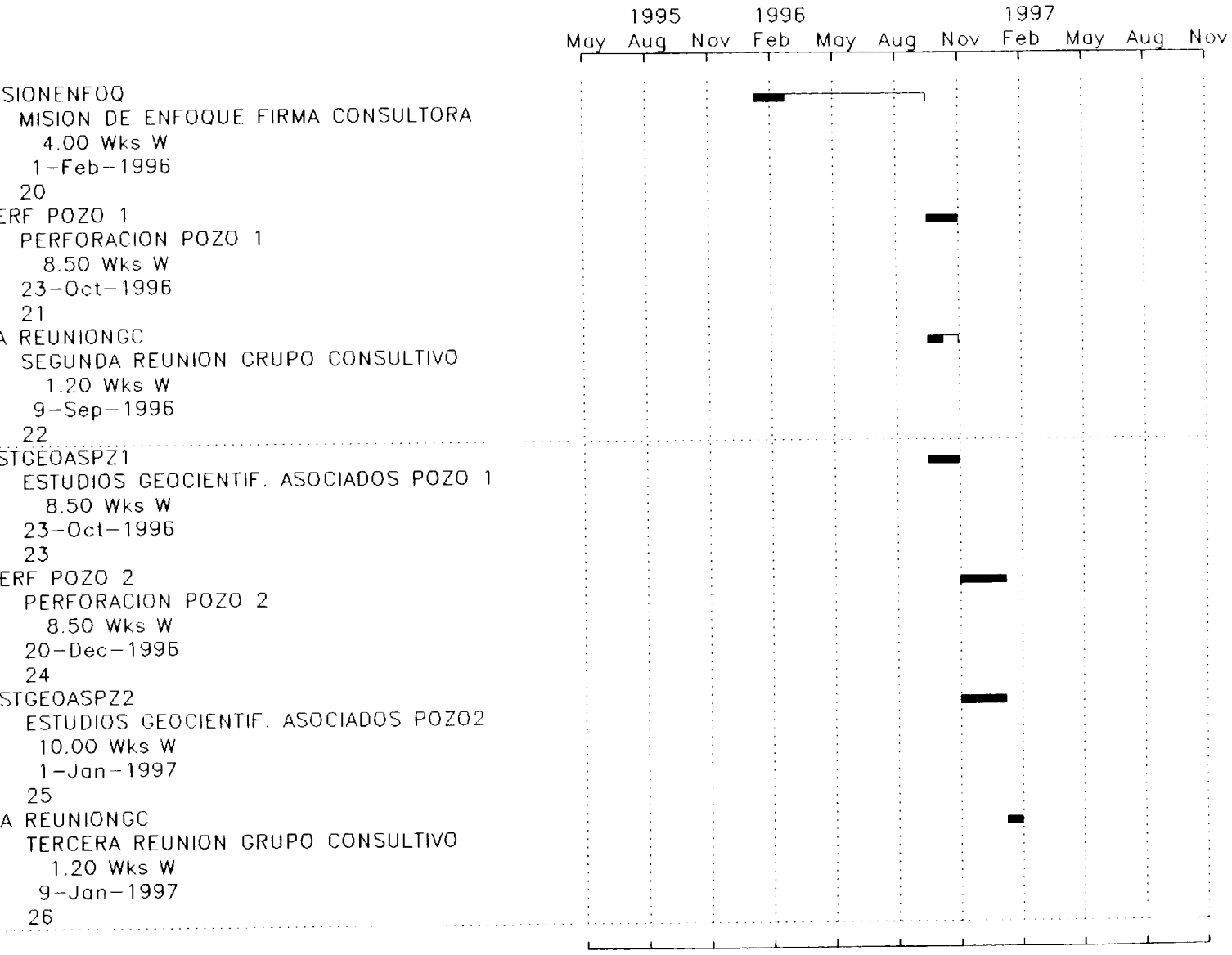

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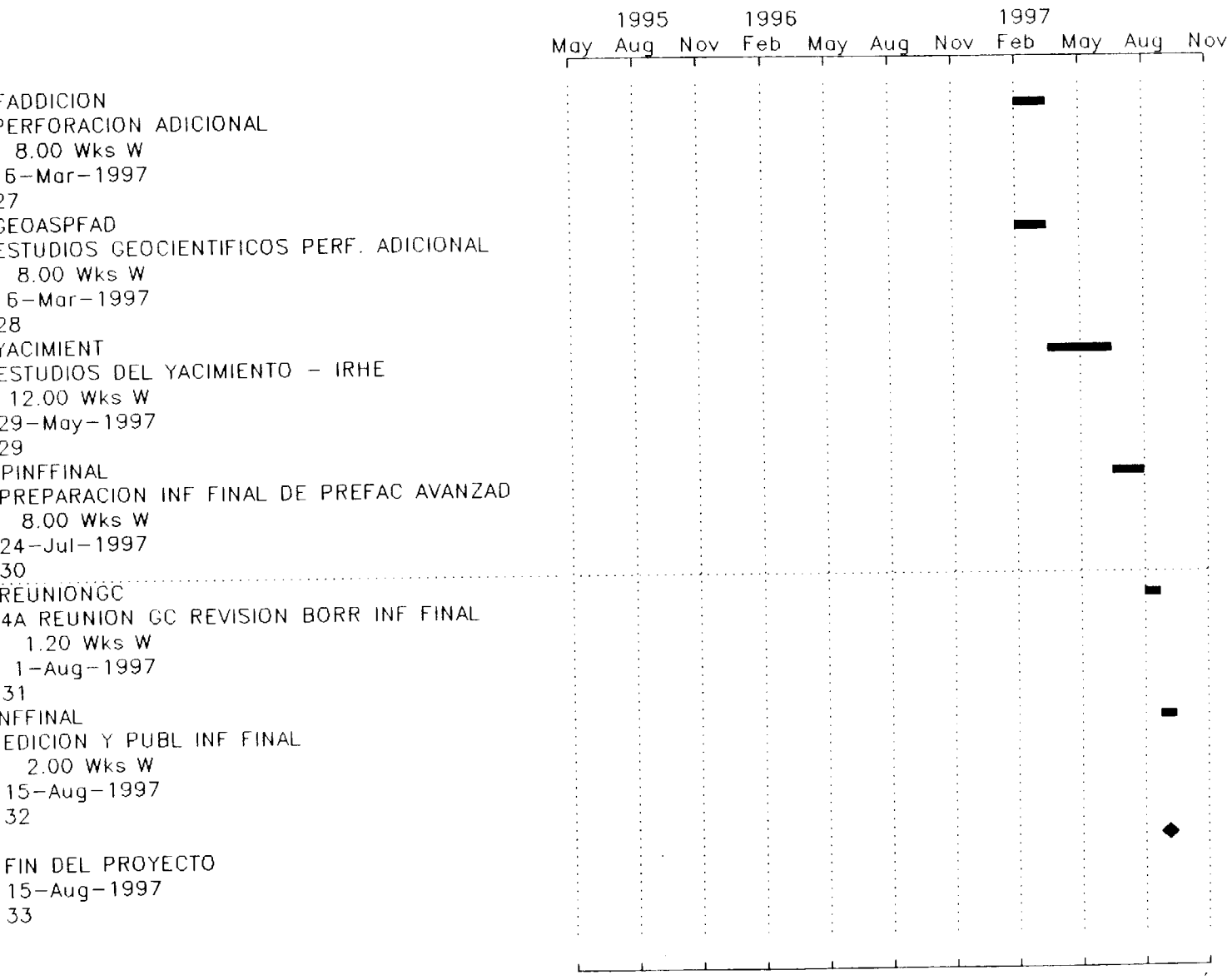
VALLE DE ANTÓN. GEOTHERMAL FIELD. ADVANCED FEASIBILITY STUDIES

11-Oct-19



PANAMA
EL VALLE DE ANTÓN GEOTHERMAL FIELD
ADVANCED PREFEASIBILITY STUDIES - PHASE II

Terms of Reference for the Consulting Firm

I. BACKGROUND

1. In order to expand exploitation of Panama's natural resources, the Instituto de Recursos Hidráulicos y Electrificación [Water Resources and Electrification Administration] (IRHE) has adopted a development strategy based on least-cost expansion plans which take account of power generation projects with feasibility studies for initiatives that make use of renewable energy resources. It is also in the national interest to create conditions that will attract private-sector investors to the development of priority projects.

2. Geothermal energy is one of Panama's renewable energy resources. The national geothermal reconnaissance survey confirmed that the country possesses two geothermal fields which can probably be developed to generate electricity at competitive rates: El Valle de Antón and Chitre-Calobre.

3. The aforementioned reconnaissance studies assigned priority to the El Valle de Antón geothermal field, which is why geoscientific studies there advanced further after the reconnaissance than in the Chitre-Calobre area (without totally neglecting the latter). The partial prefeasibility studies conducted in the El Valle de Antón geothermal area yielded favorable results (geophysical and geochemical anomalies of geothermal interest).

4. Now it is desired to expand upon these studies with the exploratory drilling of small-diameter deep wells and associated geoscientific studies. Through this program it is hoped to overcome the main risks in geothermal exploration, viz. (i) verification of the existence of an impermeable formation overlying the geothermal reservoir, and (ii) if possible intercept and expose the geothermal deposit.

II. DESCRIPTION OF THE STUDY

5. The El Valle de Antón geothermal reservoir is located some 75 km S and 57°W of Panama City, inside the El Valle caldera, in the province of Coclé and district of Antón. It is reached by taking the Pan American Highway as far as La Unión and then Highway 71

(which is paved and passable year-round) to El Valle. The reservoir lies at an elevation of approximately 570 meters above sea level, and the drilling sites have easy access to sources of water, electricity, telephones and hotels.

6. Geological, volcanological and geophysical studies show that El Valle consists of two calderas, a smaller one to the north known as La Mesa, and the El Valle caldera to the south. The two depressions are separated by three post-caldera domes aligned along an E-W axis, known respectively as Pajita, Gaital and Caracoral. Petrographic analyses have shown that the collapse that gave rise to the El Valle caldera and the emplacement of the domes in the major circular fault in the field took place around one million years ago. However, volcanic activity has occurred more recently (between 35,000 and 50,000 years ago), with Plinian eruptions producing significant deposits of volcanic ejecta. Analysis of these pyroclastic materials has confirmed the existence of a large magma chamber (minimum 27 km^3). Petrographic reconstruction of the magma crystallization process indicates that the chamber lies at a relatively shallow depth, making it a significant heat source for the siting of a geothermal resource beneath the El Valle caldera.

7. Interpretation of the geophysical survey data indicates that the area south of the domes, i.e. the El Valle caldera proper, is characterized by the presence of a permeable surface layer between 400 and 500 meters thick, followed by a low-permeability formation with a maximum thickness of 1,000 meters, and that the roof of the resistive basement rock lies at a depth of approximately 1,500 meters.

8. To accomplish the objectives listed in the preceding section, the findings of existing geoscientific studies will first be consolidated, and a preliminary conceptual geothermal model will then be prepared; lastly, some 3,000 meters of small-diameter deep wells will be drilled. The first 2,000 meters will seek to penetrate the initial surface layers, which are both resistive and permeable, in order to enter, at a depth of 800 to 1,000 meters, the conductive layer which is inferred to be the formation sealing the reservoir, where thermal-gradient and heat-flow measurements will be taken.

9. The first well will be drilled in the south-central part of the El Valle caldera and the second in the southwestern part of the same depression: this is a zone with numerous thermal manifestations and a relatively shallow resistive basement. The 1,000 meters of additional drilling will seek to intercept the geothermal deposit at a depth of close to 1,500 meters. Geophysical surveys will be conducted in all the wells, samples of geothermal fluids will be taken at the bottom of the hole for the required chemical analyses, together with bottom-hole temperature measurements, and

injectability tests will be carried out in the wells that have intercepted the deposit.

10. With the information obtained from the activities listed above, it is hoped to be able to characterize the geothermal deposit using indirect methods (i.e., methods which do not require bringing the wells into production), and to predict its production and behavior, together with the field's theoretical potential. If the wells can be induced to flow, brief tests will be conducted which should further refine the results obtained from the indirect methods outlined above.

11. In the event the wells are able to maintain their production for a relatively extended period of time, consideration could be given to advancing reservoir engineering studies. The following conditions would also have to be met: (i) existence of a permeable zone at relatively shallow depth (not more than 700 meters) capable of absorbing the residual fluids to be reinjected into it; (ii) IRHE's Longyear 44 drilling rig and drilling crew would have to be capable of drilling a reinjection well in the area in question to the depth indicated; and (iii) IRHE would have to be able to procure, with the necessary despatch, the silencer and the piping leading from the production wells to the reinjection wells, together with other essential materials. IRHE has proposed that it defray the cost of this part of the program (reservoir studies) using its own funds.

12. With the project, the possible characteristics of a future investment project for exploitation of the geothermal resources at El Valle de Antón will be examined. In light of the level of information to be yielded by the studies, it should be possible, if the results are positive, to interest private investors in developing a power generation project, which would improve the reliability and lower the cost of providing electricity in Panama.

III. OBJECTIVES

13. The purpose of the advanced prefeasibility stage for the El Valle de Antón geothermal field is to obtain the information required to verify and make a preliminary evaluation of the field's energy resources. A further objective of the studies is to compile reliable information to attract private investors for the development of a geothermal power project, which would also make it possible to adopt policies for the exploration, examination and development of the other geothermal fields identified in Panama.

IV. IDB/IRHE/CONSULTANT INTERFACE

14. The IDB will be the body in charge of the contract for consultancy services specified in these terms of reference, and consequently will be responsible for coordinating the study, with the assistance of a group of experts (the Advisory Group). IRHE will assist the Bank by providing logistical and technical support to the consultant and its subcontractors.

15. IRHE will participate actively in the field work, and to this end will appoint the professional staff who are to work with the consultants and are to be actively involved with the Bank in the conduct and oversight of the study at all decision levels.

16. The consulting firm is to submit to the IDB for its consideration, and through the IDB to the Advisory Group, all key issues which it feels require approval at that level. The Advisory Group will be made up of five experts of international stature. Representatives of the Bank and of IRHE will participate in the Advisory Group's discussions.

17. IRHE will provide the consulting firm with all available relevant information and will cooperate in gathering any additional data or information that may be required and is available, within IRHE itself or in any other institution in Panama.

18. Wherever possible, the consultant should carry out its work at the drilling sites and in such offices or other premises as IRHE may assign to it during the execution of the project. Survey analyses and laboratory tests may be processed outside Panama, whether at the consulting firm's headquarters or at properly qualified laboratories.

19. IRHE staff will use IRHE computer programs for analyses of expansion of the country's power generation system (Model SUPER OLADE/BID) and will perform the economic and financial studies. The consulting firm will cooperate solely in the technical aspects of the geothermal alternative.

20. The consultants are to explain the methodology they propose to use for each of the activities and place at IRHE's disposal all that is required to complete the study in a way that will serve to train the staff of the institution.

21. For implementation of this project, IRHE will be responsible for site purchase and preparation, for the construction of certain civil works, such as access roads and drilling rigs, and for water and power supply to the drilling rigs. The consulting firm will award

the contracts for well drilling on the basis of competitive bidding among drilling companies.

V. SCOPE OF SERVICES

a. Focus mission

22. IRHE will make available to the consulting firm all the scientific and physical data available on the geothermal field, derived from surface studies. It will also provide the reports of past meetings of the Advisory Group for the project and the report of an individual consultant commissioned to consolidate geoscientific surveys, overview maps and the geothermal conceptual model.

23. Notwithstanding the foregoing, the consultant will be responsible for furthering the geoscientific interpretation in the course of preparing its proposal, and for doing so in greater detail during the focus mission. The process to be followed should enable the consulting firm to accept the geothermal conceptual model proposed by the individual consultant or to propose a reformulation or refinement of that model (with arguments supporting its proposal).

24. The consulting firm must demonstrate to the Advisory Group, IRHE and the Bank that the model it proposes as a result of its focus mission incorporates the essential physical characteristics of the hydrogeothermal system in the best possible manner and consequently explains the behavior and characteristics recorded during the geoscientific studies.

25. The consulting firm will, during the preparation of the final prefeasibility report, refine the conceptual model to incorporate the drilling findings.

26. In addition to the foregoing, the consultant is to cover the following items in its report on the focus mission:

- The size, availability and quality of the geothermal resources in the El Valle de Antón field, and recommendations for activities needed to complete the advanced prefeasibility studies.

- Identify and analyze possible physical restrictions on use of the geothermal resource and propose a set of measures to mitigate these restrictions.

- Discuss and analyze the drilling program to reach the deep deposit in accordance with the interpretations of the findings of the geophysical and volcanological surveys.

- Propose in detail how it plans to supervise the drilling and associated geological, geochemical and geophysical surveys. With due regard to the financial resources available, the consultant is also to indicate how it proposes to log lithological information, fracturing indexes and data on porosity and permeability, and which computer models it intends to use to generate quantitative lithological interpretation sections.

- During the focus mission, the consultant must define the reference environmental framework prior to implementation of the project, in terms of the area's geology and hydrogeology, water environment, air quality, vegetation, flora and fauna, morphological and cultural features of the landscape, and socioeconomic conditions. The consultant will also verify that all negative impacts will remain within acceptable levels, and will suggest corrective measures, with an estimate of associated costs and benefits.

- Discuss and analyze other geoscientific studies in order to improve the final results, such as:

  - Clarification of the area's tectonic features and their relative evolution over time, and establish a correlation with the regional structural framework

  - Calculate absolute (potassium-argon whole-rock) and complementary datings

  - Microseismic studies

  - Establish correlations between the volcanic materials that will be encountered in the boreholes and the various volcanological units recognized on the surface.

- Discuss the process to be used to induce the deep wells for purposes of characterization and to ascertain whether or not appropriate conditions exist for conducting long-term and interference tests, and when and how the consultant would recommend the drilling of reinjection wells using IRHE's equipment and drilling crew.

- Discuss the content and the studies it plans to conduct for the final advanced prefeasibility report, which it is to prepare on the basis of the drilling campaign.

b. Drilling contract and supervision

(i) Drilling contract

27. The consulting firm will place the contract for well drilling with a competent firm, selected through an open call for bids, using

specifications and bidding documents to be prepared by an individual expert. The drilling services will include supply of the drilling materials and other required services (cementing, etc.). The drilling contractor will thus be a subcontractor to the consultant.

28. The technical specifications to be used in soliciting bids for drilling will incorporate recommendations from the Advisory Group for the project. The consulting firm will review the document and specifications and indicate its agreement therewith before proceeding to issue the call for bids. If the consultant finds that certain aspects of the specifications and bidding documents need to be amended, it must make recommendations to this effect, together with a statement of reasons. The Bank will give timely notice of its decision on whether or not to incorporate the consultant's recommendations, having first consulted with the Advisory Group and with IRHE.

29. The consulting firm will add no charge for the drilling contractor's invoices. Time spent by the consultant's technical and administrative staff administering the contract and supervising the work of the contractor must be billed separately from other consultancy services.

30. The consulting firm is to submit the following to the Bank for its approval: (i) the notice to be used to invite bids; (ii) the evaluation of bids; (iii) the results of the negotiations with the successful bidder; and (iv) the draft contract as negotiated.

(ii) Drilling supervision

31. As part of its assignment to supervise the well drilling operations, the consulting firm is required to provide the following specialized services: (i) supervision of all phases of the drilling operation (technical and administrative monitoring) including any reinjection operations that may be carried out using IRHE's equipment and drilling crew; (ii) supervision of compliance with safety and environmental regulations on the part of the drilling contractor; (iii) geological logs and analyses during the drilling operation, including services of subcontractors for geophysical surveys and laboratory services; (iv) decision-making in the course of drilling operations in consultation with the IDB's and IRHE's project chiefs and, in complex cases, with the Advisory Group; (v) oversight of the injectability and well-production tests; (vi) preparation of consolidated drilling reports; (vii) preparation of a report interpreting the geoscientific studies associated with the drilling; and (viii) preparation and presentation of reports to meetings of the Advisory Group with concrete proposals for specific items on the agenda for Advisory Group meetings.

c. Final advanced prefeasibility report

32. To permit full evaluation of the results obtained from the project, the consulting firm will include the following items in the final prefeasibility report:

a. Project frame of reference:

- Owner; address
- Geographic location
- Overall objective of the project
- Project justification (social, economic, regional, national, technical and environmental)
- Relationship of the project to existing land-use plans and regional and local development policies for the area
- Other

b. Findings and interpretation of geoscientific studies by discipline and consolidated with the overview map and conceptual model of the geothermal field.

c. Preliminary assessment of the field's energy potential, including detailed explanation of the methodology employed, with a clear indication of margins of uncertainty.

d. Evaluation of physical restrictions, in particular the tendency to incrustation, which can be controlled by the separation pressure and the fluid reinjection method; corrosive potential, which can affect the selection of materials; and the content and assumed changes in noncondensable gases over time, which could influence the selection of equipment.

e. If it proves possible to carry out long-term tests and study interference between the deep wells, the findings and evaluation of the reservoir engineering studies must be presented.

f. Alternative development schemes and the costs of each (including those relating to environmental measures for each alternative); selection of the optimum scheme for development of the field.

g. Description of the proposed development: describe the geothermal project, emphasizing the following aspects:

- Design, construction and operation of the geothermal wells: drilling, well testing and evaluation of reservoir, steam production system

- Design, construction and operation of the geothermal plant: construction and site characteristics, collection of fluids and system of injection or disposal, turbine generator system, basic design criteria (quantity and quality of geothermal fluids to be used, volumes of waste matter to be produced, chemicals to be used in cooling towers, etc.), typical construction activities, system for reducing noncondensable gases, system for disposing of liquid and solid wastes, power transmission system

- Ancillary works: roads, utilities, etc.

Maps, diagrams and basic engineering designs should be appended, together with other documents illustrating details of the project.

h. An environmental impact study, with the following objectives: (i) Assess the environmental impact of the various activities involved in drilling and operating geothermal wells, constructing and operating the power plant, and other ancillary project activities, such as construction of roads, potable water supply systems, disposal of waste water, domestic waste, etc.; and (ii) determine and propose actions, works or measures of various types required to mitigate or control any environmental impacts deemed to be significant.

To comply with the aforesaid objectives, the study must determine which project activities are liable to have an impact on the environment, natural resources or sensitive environmental values, and to identify, predict and evaluate their potential impact and suggest appropriate mitigating measures.

The environmental impact study must comply with the provisions of existing national, regional and local legislation, and take account of the expectations of the local population and local representative bodies.

The detailed terms of reference for preparation of the environmental impact study are attached as Annex 2-B.

i. The economic and financial study for the project, using guidelines and methodologies acceptable to the IDB.

j. The bases for offering the project to the private sector, in accordance with legislation currently in effect in Panama.

VI. OPERATIONAL ASPECTS

33. The consulting firms that participate in the call for bids must present their proposals in two separate packages, one containing the technical proposal and the other the financial proposal. The evaluation will be based on the technical proposal, using the methodology set forth below in section c. (Evaluation of proposals).

a. Technical proposals

34. Bidders must include the following in their technical proposals:

- The manner in which the firm intends and proposes to carry out the tasks specified in these terms of reference, breaking down and detailing activities that have been presented as a whole. The bidding firms may recommend elements which they feel should be implemented within the project budget, which would improve the quality of the results, and which have not been expressly mentioned in this document.

- Operational organization they will employ to carry out the study, with the relevant organization charts attached.

- The personnel they will employ to carry out each of the activities making up the study, with indications of time required in person-months or person-hours and a tabular breakdown of professionals and nonprofessionals. Curricula will be attached for professional personnel.

- Duration of the study and schedule of activities, indicating the duration and operational sequencing of each activity.

- The bidder's experience with similar studies, attaching the relevant attestations.

b. Financial proposal

35. In the financial proposal, the bidder must show personnel costs and direct costs separately.

36. Personnel costs will consist of salaries and benefits for the staff needed to carry out the study, multiplied by a factor covering administrative costs and the contractor's profit.

37. Direct costs will consist of other costs incurred in carrying out the study, such as per diems, transportation costs, laboratory analyses, aerial photography, procurement of maps, photocopying, cost of printing the report, etc.

38. Based on the total cost and the schedule of activities, the bidder will suggest a payment or disbursement schedule and a form of payment for the study.

39. The bidder will also offer bid security in the form of a bid guarantee from a surety company recognized in Panama, which conforms to Panamanian regulations in this regard.

c. Evaluation of proposals

40. Bids will be evaluated on the basis of the technical proposal using the factors indicated in the table below.

Bid Evaluation Factors and Scores

No.	FACTORS	PARTIAL SCORE	MAXIMUM TOTAL SCORE
1	**Technical presentation**		
	Clarity of detail in presentation of tasks to be carried out	0 - 15	
	Reasonable plan of action	0 - 5	30
	Proposals employing state-of-the-art methodologies	0 - 5	
	Efficient implementation program	0 - 5	
2	**Firm's experience**		
	Has carried out similar projects in the past	0 - 10	
	Appropriate computer models available	0 - 5	25
	Laboratories for geochemical and petrographic analyses	0 - 5	
	Geophysical survey equipment	0 - 5	
3	**Qualifications of experts to be assigned to the project**		
	Geoscientists specializing in geology, volcanology, hydrogeology and geophysics	0 - 10	
	Environmentalists	0 - 10	35
	Reservoir engineers and electrical, mechanical and civil engineers	0 - 10	
	Economists and planners	0 - 5	
4	**References presented with the proposal**	0 - 5	5
5	**Knowledge of Spanish language**	0 - 5	5
	Total score		100

41. The proposals received will be scored using the factors listed above, then ranked from highest to lowest total score. The Bank will invite the highest-ranked firm to enter into negotiations, whereupon the second-envelope (containing the financial proposal) will be opened in the bidder's presence. In the event that

agreement cannot be reached with the first firm, the second ranked proposal will be considered, and so on in succession until an agreement is concluded. The second envelopes of firms not invited to negotiate will be returned to them unopened.

PANAMA
EL VALLE DE ANTÓN GEOTHERMAL FIELD
ADVANCED PREFEASIBILITY STUDIES - PHASE II

Terms of Reference for the
Environmental Impact Study

1. The following aspects are to be covered in the environmental impact study.

   A. **Description of the area's environmental characteristics**

2. The following characteristics of the area of influence are to be clearly described:

3. • **Criteria for definition of area of influence**

4. • **Physical environment:**

   Water: hydrology and quality of surface and ground water

   Air: local meteorology, with an emphasis on wind direction and velocity, temperature, relative humidity, atmospheric pressure and solar radiation; air quality; noise levels

   Land: geology, seismology, geomorphology and soils.

5. Wherever possible, this characterization is to be based on secondary or available information. If sampling campaigns are required, they should be limited to what is strictly necessary to ascertain current levels of pollution.

6. • **Biotic environment**

   Aquatic resources: pisciculture, aquatic biology and benthos of watercourses or surface water deposits that might be affected by the project.

   Land resources: existing biological systems, with an indication of their general flora and fauna composition. If the presence of endangered species is suspected, or if the environmental authority so demands, this description may be supplemented by some field sampling.

7. If existing information is not sufficient for this purpose, some field sampling may be justified.

8. • **Human environment**

Sociodemographic aspects: population, levels of health and education, endemic diseases, level of employment and income patterns

Services, infrastructure and water supply

Economic aspects: current land use, bases of the local economy (significance of different branches of activity)

Sociocultural aspects: historical or archeological resources, attitudes and concerns of human groups likely to be affected

Esthetics: Landscapes and scenery of special note.

9. In general, this characterization can be prepared using existing information, underpinned by a number of surveys and interviews, the latter aimed particularly at defining sociodemographic and sociocultural conditions.

• **Legal and institutional aspects**

National, regional and local standards applicable to the project in regard to soil, water and air

Entities at various levels that will be involved with the project and the procedures each of them require

Representative groups in the region interested in the project and their respective positions.

10. The representative groups' positions are to be ascertained through interviews with their leaders.

B. **Identification, prediction and evaluation of environmental impacts**

11. The environmental impact assessment will cover the following stages:

- Identification of direct and indirect impacts, both positive and negative, temporary and permanent, and those that are cumulative in nature. Matrixes, checklists or other methods may be used for this purpose.

- Prediction or quantification of impacts using mathematical or empirical models, mapping systems, opinions from experts or others.

- Evaluation or determination of the significance of the impacts (in light of legislation, health criteria, etc.).

- Identification, evaluation and selection of alternative methods for preventing, mitigating and/or offsetting significant impacts, having regard to their efficacy, cost and other criteria.

12. The analysis should take particular account of the following impacts:

    - Impacts on water resources: pollution through discharge of geothermal liquids, purging or other surface actions

    - Impacts on air quality: pollution from noncondensable gases, especially hydrogen sulfide

    - Impacts on noise levels: noise pollution caused by construction and operation of wells and the geothermal plant

    - Impacts on land resources: seismicity, including subsidence, and disposal of solid waste materials

    - Impacts on ecological resources: direct loss of habitat, invasion of cleared areas by weeds, long-term effects on biota (positive or negative)

    - Socioeconomic impacts: appropriation of land and changes in use, modifications in water use, changes in the economy and in social conditions (levels of morbidity, education, employment, etc.)

    - Impact on the landscape.

13. A special discussion is to be included on impacts deemed to be inevitable and on irreversible and irrecoverable damage expected to be caused to environmental resources and values as a result of execution of the project.

C. **Environmental management plan**

14. Based on the evaluation of impacts and alternative mitigation methods, an environmental management plan will be drawn up aimed at mitigating or controlling impacts deemed to be significant.

15. The plan will be organized into programs, projects and activities, depending on the nature of the impact to be mitigated and the scale of intervention proposed. A cost calculation will be made for each of these activities, projects and programs and an implementation schedule put forward, tied in with the schedule for development and operation of the geothermal project.

16. An essential component of the environmental management plan will be an "Environmental Monitoring Program," which will seek to track the behavior of environmental parameters through the various stages of development and operation of the project.

17. This monitoring effort should focus especially on water and air quality. With regard to water quality, the emphasis will be on concentrations of boron, arsenic, chromium, mercury and other highly toxic elements. With regard to air quality, the emphasis will be on measuring hydrogen sulfide and sulfur dioxide emissions and concentrations.

D. **Contingency plan**

18. As part of the environmental management procedures for the project, a contingency plan will be prepared to deal with possible blowouts from the geothermal wells and acute air pollution events, involving in particular hydrogen sulfide. This plan will include the following aspects:

- Analysis of risk of accidents
- Definition of objectives and scope of the plan
- Determination of the roles of the various levels, bodies and groups involved
- Formulation of a plan of action to be followed in the event of an accident
- Determination of the control techniques and equipment to be used
- Formulation of a system for monitoring and evaluation of the plan
- Proposal for a training and simulation program
- Design of the logistic information needed to execute the plan
- Types of report to be provided: basic, manual of operations, and instruction manual
- Compilation of a database for the plan.

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PROPOSED RESOLUTION

PANAMA. NONREIMBURSABLE TECHNICAL COOPERATION FOR THE VALLE DE ANTON GEOTHERMAL FIELD PROGRAM ADVANCED PREFEASIBILITY STUDIES, PHASE II

The Board of Executive Directors

RESOLVES:

1. That the President of the Bank, or such representative as he shall designate, is authorized, in the name and on behalf of the Bank, as Administrator of the Japan Special Fund, under the Agreement dated April 26, 1988, to enter into such agreements as may be necessary and to take such additional measures as may be pertinent for the execution of the plan of operations referred to in Document AT- , with respect to a technical cooperation with the República de Panamá, hereinafter referred to as the "Beneficiary", for the Valle de Anton Geothermal Field Program, Advanced Prefeasibility Studies, Phase II.

2. That up to the sum of US$1,400,000, or its equivalent, is authorized for the purpose of this resolution, chargeable to the above-mentioned funds.

3. That the above-mentioned sum is to be provided on a nonreimbursable basis.