

PLANNING FOR THE PREVENTION OF
ENVIRONMENTAL AND RECREATIONAL LOSSES
DUE TO OCEAN THERMAL ENERGY CONVERSION
DEVELOPMENT ON CABRAS ISLAND, GUAM

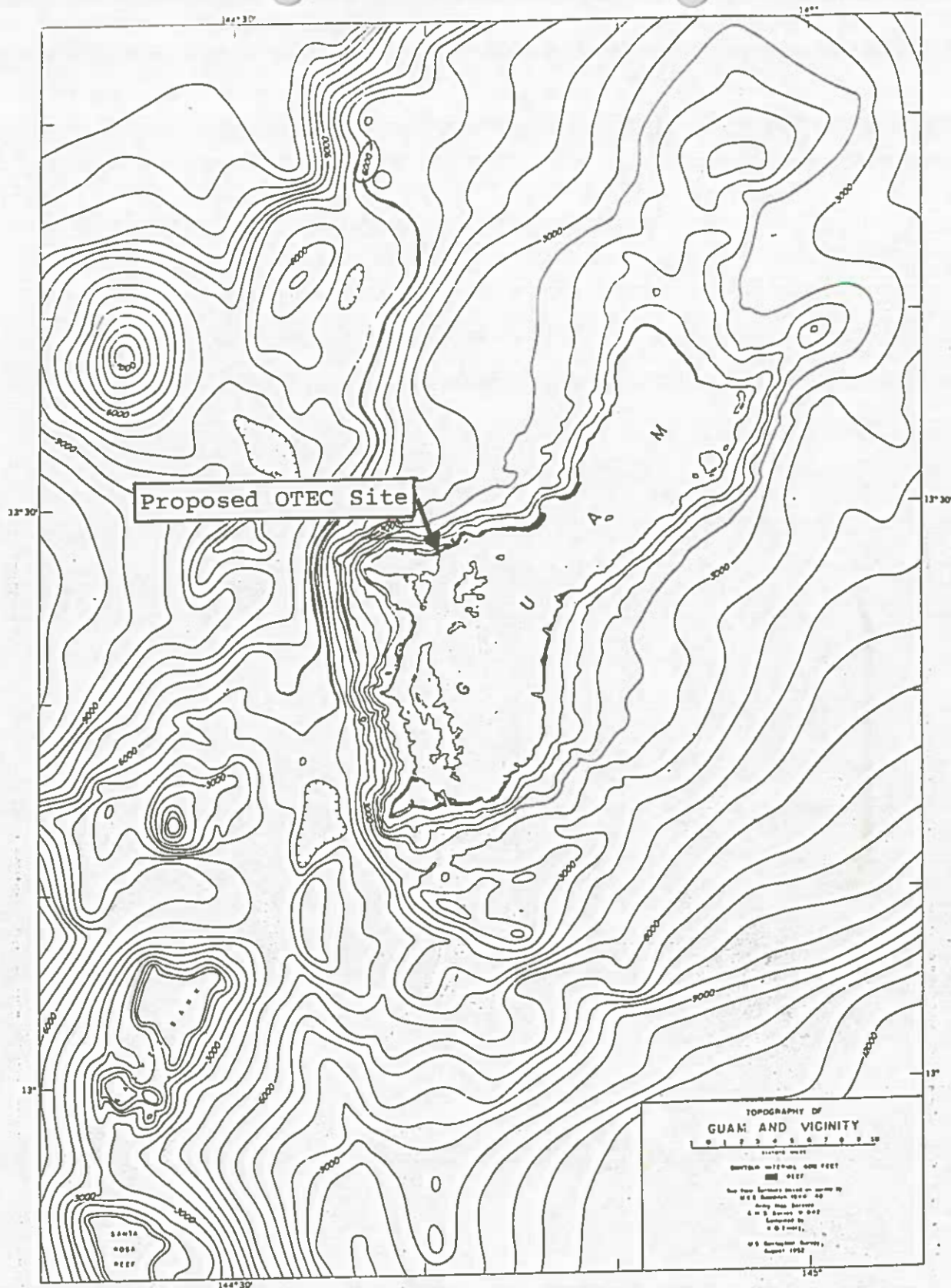
A Grant Application to the
COASTAL ENERGY IMPACT PROGRAM
NATIONAL OCEANIC AND ATMOSPHERE ADMINISTRATION

Submitted by the

GOVERNMENT OF GUAM
GUAM ENERGY OFFICE
in conjunction with the
BUREAU OF PLANNING, OCZM

JUNE 1, 1980

Funds Requested: \$81,000
Program: CEIP 308(d)(4)
Allocation: FY 1980

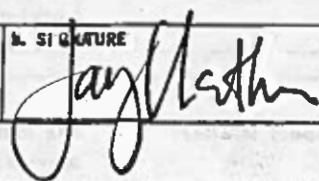


BATHYMETRIC CHART OF GUAM AND VICINITY, showing site of proposed land-based OTEC development. Contour interval is 600 feet (100 fathoms) on both land and sea floor.

SECTION I—APPLICANT/RECIPIENT DATA

SECTION II—CERTIFICATION

SECTION III—FEDERAL AGENCY ACTION

FEDERAL ASSISTANCE			2. APPLICANT'S APPLICATION	3. STATE APPLICATION IDENTIFIER	4. NUMBER
1. TYPE OF ACTION ☐ PREAPPLICATION ☒ APPLICATION (Mark appropriate box) ☐ NOTIFICATION OF INTENT (Opt.) ☐ REPORT OF FEDERAL ACTION			b. DATE 19 80 May 23	b. DATE Year month day 19	a. NUMBER 1 1 • 4 2 4
4. LEGAL APPLICANT/RECIPIENT a. Applicant Name : Guam Energy Office b. Organization Unit : c. Street/P.O. Box : Box 2950 d. City : Agana f. State : Guam h. Contact Person (Name & telephone No.) : Jay Lather 472-8711			a. County : g. ZIP Code : 96910	5. FEDERAL EMPLOYER IDENTIFICATION NO. 6. PROGRAM (From Federal Catalog) a. TITLE Environmental/Recreational Grants	
7. TITLE AND DESCRIPTION OF APPLICANT'S PROJECT Planning for the Prevention of Environmental and Recreational Losses Due to Ocean Thermal Energy Conversion Development on Cabras Island, Guam			8. TYPE OF APPLICANT/RECIPIENT A-State B-Interstate C-Substate District D-County E-City F-School District G-Special Purpose District H-Community Action Agency I-Higher Educational Institution J-Indian Tribe K-Other (Specify): Enter appropriate letter ☐ A		
10. AREA OF PROJECT IMPACT (Names of cities, counties, States, etc.) Territory of Guam			12. TYPE OF APPLICATION A-New B-Renewal C-Revision D-Continuation E-Augmentation Enter appropriate letter ☐ A		
13. PROPOSED FUNDING a. FEDERAL \$ 81,000 .00 b. APPLICANT .00 c. STATE .00 d. LOCAL .00 e. OTHER .00 f. TOTAL \$ 81,000 .00			14. CONGRESSIONAL DISTRICTS OF: a. APPLICANT Guam b. PROJECT Guam 16. PROJECT START DATE Year month day 19 80 Oct 1 17. PROJECT DURATION 18 Months 18. ESTIMATED DATE TO BE SUBMITTED TO FEDERAL AGENCY Year month day 19 80 June 1		
15. TYPE OF CHANGE (For 15a or 15b) A-Increase Dollars B-Decrease Dollars C-Increase Duration D-Decrease Duration E-Cancellation F-Other (Specify): Enter appropriate letter(s) ☐ ☐ ☐			19. EXISTING FEDERAL IDENTIFICATION NUMBER		
20. FEDERAL AGENCY TO RECEIVE REQUEST (Name, City, State, ZIP code) Coastal Energy Impact Program, 2001 Wisc Ave, Washington, D.C.			21. REMARKS ADDED ☐ Yes ☐ No		
22. THE APPLICANT CERTIFIES THAT a. To the best of my knowledge and belief, data in this preapplication/application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved. b. If required by OMB Circular A-95 this application was submitted, pursuant to instructions therein, to appropriate clearinghouses and all responses are attached: (1) ☐ (2) ☐ (3) ☐			No response ☐ Responses attached ☐		
23. CERTIFYING REPRESENTATIVE a. TYPED NAME AND TITLE Jay L. Lather Director			b. SIGNATURE 		
24. AGENCY NAME			c. DATE SIGNED Year month day 1980 05 28		
25. ORGANIZATIONAL UNIT			26. FEDERAL APPLICATION IDENTIFICATION		
27. ADDRESS			28. FEDERAL GRANT IDENTIFICATION		
29. ACTION TAKEN ☐ a. AWARDED ☐ b. REJECTED ☐ c. RETURNED FOR AMENDMENT ☐ d. DEFERRED ☐ e. WITHDRAWN			30. FUNDING a. FEDERAL \$.00 b. APPLICANT .00 c. STATE .00 d. LOCAL .00 e. OTHER .00 f. TOTAL \$.00		
31. ACTION DATE Year month day 19			32. CONTACT FOR ADDITIONAL INFORMATION (Name and telephone number)		
33. STARTING DATE Year month day 19			34. ENDING DATE Year month day 19		
35. REMARKS ADDED ☐ Yes ☐ No			36. FEDERAL AGENCY A-95 ACTION a. In taking above action, any comments received from clearinghouses were considered. If agency response is due under provisions of Part 1, OMB Circular A-95, it has been or is being made. b. FEDERAL AGENCY A-95 OFFICIAL (Name and telephone no.)		

Do Not Complete

PART II

OMB NO. 60-RO 186

PROJECT APPROVAL INFORMATION

Item 1.
Does this assistance request require State, local, regional, or other priority rating? _____ Yes _____ No
Name of Governing Body _____
Priority Rating _____

Item 2.
Does this assistance request require State, or local advisory, educational or health clearances? _____ Yes _____ No (Attach Documentation)
Name of Agency or Board _____

Item 3.
Does this assistance request require clearinghouse review in accordance with OMB Circular A-95? _____ Yes _____ No (Attach Comments)

Item 4.
Does this assistance request require State, local, regional or other planning approval? _____ Yes _____ No
Name of Approving Agency _____
Date _____

Item 5.
Is the proposed project covered by an approved comprehensive plan? _____ Yes _____ No
Check one: State ☐
Local ☐
Regional ☐
Location of Plan _____

Item 6.
Will the assistance requested serve a Federal installation? _____ Yes _____ No
Name of Federal Installation _____
Federal Population benefiting from Project _____

Item 7.
Will the assistance requested be on Federal land or installation? _____ Yes _____ No
Name of Federal Installation _____
Location of Federal Land _____
Percent of Project _____

Item 8.
Will the assistance requested have an impact or effect on the environment? _____ Yes _____ No
See instructions for additional information to be provided.

Item 9.
Will the assistance requested cause the displacement of individuals, families, businesses, or farms? _____ Yes _____ No
Number of:
Individuals _____
Families _____
Businesses _____
Farms _____

Item 10.
Is there other related assistance on this project previous, pending, or anticipated? _____ Yes _____ No
See instructions for additional information to be provided.

PART III - BUDGET INFORMATION

SECTION A - BUDGET SUMMARY

Grant Program, Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Rec. Grants	11.424	\$	\$	\$ 81,000	\$ -0-	\$ 81,000
2.						
3.						
4.						
5. TOTALS		\$	\$	\$	\$	\$

SECTION B - BUDGET CATEGORIES

Do Not Complete

Object Class Categories	- Grant Program, Function or Activity					Total (5)
	(1)	(2)	(3)	(4)	(5)	
a. Personnel	\$	\$	\$	\$	\$	\$
b. Fringe Benefits						
c. Travel						
d. Equipment						
e. Supplies						
f. Contractual						
g. Construction						
h. Other						
i. Total Direct Charges						
j. Indirect Charges						
k. TOTALS	\$	\$	\$	\$	\$	\$
7. Program Income	\$	\$	\$	\$	\$	\$

SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) APPLICANT	(c) STATE	(d) OTHER SOURCES	(e) TOTALS
8. Recreational/Environmental Grants	\$ -0-	\$ -0-	\$ -0-	\$ -0-
9.				
10.				
11.				
12. TOTALS	\$	\$	\$	\$

SECTION D - FORECASTED CASH NEEDS
Do Not Complete

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	\$	\$	\$	\$	\$
14. Non-Federal					
15. TOTAL	\$	\$	\$	\$	\$

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT
Do Not Complete

(a) Grant Program	FUTURE FUNDING PERIODS (YEARS)			
	(b) FIRST	(c) SECOND	(d) THIRD	(e) FOURTH
16.	\$	\$	\$	\$
17.				
18.				
19.				
20. TOTALS	\$	\$	\$	\$

SECTION F - OTHER BUDGET INFORMATION

(Attach additional Sheets if Necessary)

21. Direct Charges:

22. Indirect Charges:

23. Remarks:

PART IV - ASSURANCES

The Applicant hereby assures and certifies that it will comply with the regulations, policies, guidelines, and requirements including OMB Circulars No. A-95 and A-102 and Federal Management Circular 74-4, as they relate to the application, acceptance and use of Federal funds for this Federally assisted project. Also the Applicant assures and certifies with respect to the grant that:

1. It possesses legal authority to apply for the grant; that a resolution, motion or similar action has been duly adopted or passed as an official act of the applicant's governing body, authorizing the filing of the application, including all understandings and assurances contained therein, and directing and authorizing the person identified as the official representative of the applicant to act in connection with the application and to provide such additional information as may be required.
2. It will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352) and in accordance with Title VI of that Act, no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the applicant receives Federal financial assistance and will immediately take any measures necessary to effectuate this agreement.
3. It will comply with Title VI of the Civil Rights Act of 1964 (42 USC 2000d) prohibiting employment discrimination where (1) the primary purpose of a grant is to provide employment or (2) discriminatory employment practices will result in unequal treatment of persons who are or should be benefiting from the grant-aided activity.
4. It will comply with requirements of Title II and Title III of the Uniform Relocation Assistance and Real Property Acquisitions Act of 1970 (P.L. 91-646) which provides for fair and equitable treatment of persons displaced as a result of Federal and federally assisted programs.
5. It will comply with the provisions of the Hatch Act which limit the political activity of employees.
6. It will comply with the minimum wage and maximum hours provisions of the Federal Fair Labor Standards Act, as they apply to hospital and educational institution employees of State and local governments.
7. It will establish safeguards to prohibit employees from using their positions for a purpose that is or gives the appearance of being motivated by a desire for private gain for themselves or others, particularly those with whom they have family, business, or other ties.
8. It will give the grantor agency or the Comptroller General through any authorized representative the access to and the right to examine all records, books, papers, or documents related to the grant.
9. It will comply with all requirements imposed by the Federal grantor agency concerning special requirements of law, program requirements, and other administrative requirements approved in accordance with OMB Circular A-102.
10. It will insure that the facilities under its ownership, lease or supervision which shall be utilized in the accomplishment of the project are not listed on the Environmental Protection Agency's (EPA) list of Violating Facilities and that it will notify the federal grantor agency of the receipt of any communication from the Director of the EPA Office of Federal Activities indicating that a facility to be utilized in the project is under consideration for listing on the EPA.
11. It will comply with the flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973, P.L. 93-234, 87 Stat. 975, approved December 31, 1976. Section 102(a) requires, on and after March 2, 1975, the purchase of flood insurance in communities where such insurance is available as a condition for the receipt of any federal financial assistance for construction or acquisition purposes for use in any area that has been identified by the Secretary of the Department of Housing and Urban Development as an area having special flood hazards. The phrase "federal financial assistance" includes any form of loan, grant, guarantee, insurance payment, rebate, subsidy, disaster assistance loan or grant, or any other form of direct or indirect federal assistance.
12. It will assist the federal grantor agency in its compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. 470), E.O. 11593, and the Archeological and Historic Preservation Act of 1974 (16 U.S.C. 469a-1 et seq.) by (a) consulting with the State Historic Preservation Officer on the conduct of investigations as necessary to identify properties listed in or eligible for inclusion in the National Register of Historic Places that are subject to effect (see 36 CFR Part 800.8) by the activity, and notifying the federal grantor agency of the existence of any such properties, and by (b) complying with all requirements established by the Federal grantor agency to avoid or mitigate adverse effects upon such properties.

PART V - ASSURANCES (Continued)

(Signed copies of the following additional assurances must accompany the application.)

The Guam Energy Office hereby assures
(Name of Designated State Agency)

and certifies that assistance has been allocated within the State in accord with the State's intrastate allocation process required under Section 308(g)(2) and as described in Subpart J of the CEIP Rules and Regulations, 15 CFR, Section 931.110.

Jay L. Lather, Director, Guam Energy Office May 28, 1980
(Signature and Title of Authorized Official) (Date)

The Bureau of Planning hereby assures
(Name of Designated State Agency)

and certifies that the funds will be used in a manner that is compatible with the State's developing, or consistent with the State's approved, coastal zone management program.

Betty S. Guerrero, Director, Bureau of Planning May 28, 1980
(Signature and Title of Authorized Official) (Date)

COMPLETE ONLY IF 308(b) FUNDS ARE REQUESTED

The requisitioner hereby assures and certifies that:

1. It will repay to the United States the amount of any grant which is determined by NOAA not to have been expended for those purposes stipulated in the CEIP Rules and Regulations, 15 CFR 931.33(b) or 931.73(b)(2).
2. It will repay to the United States any amounts which NOAA determines were not expended or obligated by the close of the fiscal year immediately following the fiscal year in which this grant was awarded.

(Signature and Title of Authorized Official) (Date)

Task #1

Employ a full-time professional consultant with a marine/environmental background for a twelve-month period to perform the following:

- A. Review all environmental studies made on the proposed OTEC.
- B. Represent the Government of Guam and the Guam Energy Office in administering current grants under the Guam CEIP.
- C. Work as liaison with the Guam Coastal Zone Management office at the Bureau of Planning and ensure supportive activities.
- D. Prepare a master document based on the above tasks identifying all negative potential environmental and recreational impacts and proposing a strategy to accomplish the mitigation or avoidance of that damage.

Task #2

Complete topographical assesment of the proposed OTEC site at Cabras Island.

This study would require surveying of the coastal area site reef flat, and approximately 4,000 feet of inclined sub-surface area on which the underwater coldwater pipe will be laid. Soil, reef and underwater floor analyses must be performed to determine surface and foundation composition.

Task #3

Study the ocean water currents directly off-shore from the proposed OTEC site at Cabras Island.

In order to analyze the impacts of potential thermal and toxic pollution from the proposed OTEC site, it is necessary to accurately plot off-shore currents on the surface and at regular interval depths (5M) to a final depth of 500M.

V. BUDGET AND WORK SCOPES.

Task #1

a.	Contractual (Salary)	\$27,000
	NOTE: Office space and overhead expenses will be provided at no cost	
b.	Office furniture	800
c.	Printing	3,300
	TOTAL	<u>\$31,100</u>

Task #2

a.	Contractual	\$30,500
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Task #3

a.	Contractual	\$18,500
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Administrative Costs

a.	Overseas Telephone	\$ 480
b.	Postage	120
c.	Office Supplies	300
	TOTAL	<u>\$ 900</u>

TOTAL APPLICATION	\$81,000
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A detailed scope of work for each of these tasks follows:

PLANNING FOR THE PREVENTION OF ENVIRONMENTAL
AND RECREATIONAL LOSSES DUE TO OTEC DEVELOPMENT
ON CABRAS ISLAND, GUAM

THE GUAM ENERGY OFFICE (CEIP)

SCOPE OF WORK, TASK NO. 1

Comprehensive Strategy for Avoiding Environmental Damage
Due to OTEC Development on Cabras Island, Guam

I. WORK OBJECTIVE:

The major objective of this task is the preparation of a master document identifying all negative potential environmental and recreational effects of the proposed OTEC development on Cabras Island, Guam and presenting a strategy to avoid those effects.

II. WORK PURPOSE:

Since 1976, the University of Guam Marine Lab and other interested parties have studied various parts of the marine environment adjacent to the proposed OTEC development. A number of these studies have been funded through the Guam CEIP with 308 (c)(1) funds and dealt with coastal problems associated with major energy facility siting in the coastal zone, including the OTEC site at Cabras Island. None of these studies focused on a comprehensive strategy to plan for the mitigation of the anticipated environmental damage and almost certain recreational losses that will result from the proposed OTEC development. Within the framework of 308(d)(4)

funding under the CEIP, it is desirable to prepare that strategy by completing the remaining environmental studies and actually preparing the master plan.

This study will be conducted in accordance with the federal guidelines applicable under the CEIP and will utilize the work product of past studies funded under this program.

III. WORK TASKS:

The significance of the proposed OTEC development to the economy of Guam requires that the Guam Energy Office employ a full-time professional consultant to work in-house on the preparation of this strategy. The successful candidate will possess at least a Master of Science degree in a marine-related field and will have work experience supportive of the study, preferably in environmental problems associated with major coastal energy facilities. The consultant will be contracted for a twelve-month period to perform the work tasks A through E as described below.

- A. Review all environmental, marine, engineering and related studies which include or reference the proposed OTEC site on Cabras Island. Where necessary, obtain written permission to use these works in the preparation of the final document. Extract from this material all necessary data to prepare a strategy for the mitigation or avoidance of environmental and recreational loss or damage

resulting from the proposed OTEC development. The studies to be considered shall include, but are not limited to the following:

- (1) Power plants and the Marine Environment, Additional Observation in Piti Bay and Piti Channel, Guam (1975)
- (2) The Influence of Power Plant Operations on the Marine Environment in Piti Channel, Guam (1976)
- (3) Power plants and the Marine Environment in Piti Bay and Piti Channel, Guam: 1976-1977 Observations and General Summary (1977)
- (4) Nearshore Currents and Coral Reef Ecology of the West Coast of Guam, Marianas Islands (1974)
- (5) Planning for the Impacts of Guam Energy Facility Expansion (1978)
- (6) Environmental Development Plan (1979)
- (7) Three Methods of Coral Transplantation for the Purpose of Re-establishing a coral community in the Thermal Effluent Area of the Tanguissan Power Plant (1979)
- (8) Oceanographic Conditions in the Vicinity of Cabras Island and Glass Breakwater for the Potential Development of Ocean Thermal Energy Conversion for Guam (1979)
- (9) Suitability of Guam from an Environmental Aspect as a Potential Site for Ocean Thermal Energy Conversion Plants (1975)
- (10) Economic and Land-Use Plan for Cabras Island and Surrounding Area (1979)
- (11) Marine Environmental Survey of the GORCO Deballast Discharge, Cabras Island, Guam (1978)
- (12) Environmental Impact Report, Projected OTEC Development for the Territory of Guam (1979)

B. The consultant shall be prepared to represent the Government of Guam and the Guam Energy Office in an official capacity in the administration of current CEIP grants and those anticipated under this application. These include:

- (1) An Environmental Study of Luminao Reef in Relation to Proposed OTEC Development on Guam
- (2) Economic Utilization of Coldwater Effluent from a proposed land-based OTEC plant
- (3) Economic and Environmental impacts of the Development of a Low-Head Hydroelectric Power System in Southern Guam
- (4) An assessment of the Marine Terminal Facilities at Apra Harbor with Respect to the Movement of Large Quantities of Ammonia and Chlorine
- (5) Other grants funded under this application.

The consultant shall be expected to possess a working knowledge of the technology and methods used in all CEIP projects and shall be prepared to work with the grantees in furthering the successful completion of the grants.

C. The consultant shall be the liaison between the Guam Energy Office, CEIP, and the Bureau of Planning, Coastal Zone Management Office and shall ensure that all CEIP programs are closely related and supportive of the CZM objectives.

D. The consultant shall review all relevant federal guidelines and be charged with ensuring compliance by the Government of Guam.

E. The consultant shall, during the course of this contract, prepare a written document detailing a comprehensive strategy for the mitigation or avoidance of environmental and recreational damage or loss due to the proposed OTEC development. This document shall:

- (1) include appropriate references to the studies identified in Tasks A through D of this Scope of Work;
- (2) clearly identify all potential environmental and recreational losses or damage resulting from the OTEC development;
- (3) assess these losses in terms of both economic and social impact on the people of Guam;
- (4) present a detailed and comprehensive strategy and plan of action to mitigate or, where possible, to fully avoid these losses; and
- (5) shall be presented in draft form 30 days before the termination of this contract with the final approved document presented to the Director of the Guam Energy Office on or before the last day of this contract.

IV. REPORT SUBMITTAL

The final document shall be submitted to the Director of the Guam Energy Office 30 days prior to the expiration of this contract.

PLANNING FOR THE PREVENTION OF ENVIRONMENTAL
AND RECREATIONAL LOSSES DUE TO THE OTEC DEVELOPMENT
ON CABRAS ISLAND, GUAM

THE GUAM ENERGY OFFICE (CEIP)

SCOPE OF WORK, TASK NO. 2

A Complete Topographical Assessment of the Proposed
OTEC Site and Adjacent Marine Area at Cabras Island, Guam

I. WORK OBJECTIVE:

The major objective of this task is the preparation of a detailed topography of the OTEC site and adjacent areas in order to assist the Government of Guam in evaluating potential environmental and recreational damages that may result from the proposed OTEC development at the Cabras Island site.

II. WORK PURPOSE:

A number of significant environmental studies have been performed on much of the Cabras Island area, especially the marine environment affected by the Cabras Island Power Plant but none of these have fully considered the environmental effects of the area's topography. In order to evaluate the potential environmental and recreational damages that may result from the proposed OTEC development it is necessary to assess the land contours and elevation relevant to wind, current flows, tidal action, wave impact, secondary effects of earthquakes and soil or foundation composition.

III. WORK TASKS:

- A. Using available topographical data and the services of a qualified surveying team, prepare a complete topographical composition of the area of the proposed OTEC site. This area includes the Cabras Island Power Plant and Piti Power Plant land areas, the upper and lower Piti Channels in Apra Harbor, the Cabras OTEC site and the Cabras Island areas extending 1,000 meters to the west-southwest, the Cabras Island and reef flat areas extending 500 meters to the east-northeast of the OTEC site including the Tepungan Channel, all inclusive submerged area, and a cold water pipe access strip extending from the Cabras Power Plant cooling channel intake, at an approximate right angle to the reef, extending down the submerged slope to a depth of 500 meters and the area within 15 meters of both sides of that line. As described, this total area is outlined in Exhibit 2-A. Contour lines shall be in intervals of five feet.

- B. Based on the results of Task A, prepare a three dimensional model of the area using styrofoam, plaster, or other professionally accepted material. The model shall be to scale and constructed on a board approximately one meter square. The model shall be suitably colored and labeled to allow the general public and appropriate regulatory agencies to fully understand the topography of the OTEC site and related areas. The model shall have a removable plexiglass cover for protection during movement to public presentations.

- C. The contour maps and model shall be submitted to the Director of the Guam Energy Office within six months of the award of contract and shall include the originals and 10 copies of each map.

IV. PROJECT PREPARATION

A. Topography Maps

- (1) The topographic maps shall be submitted within six (6) months following the award of this contract.
- (2) The topographic maps shall consist of one (1) original mylar reproducible for each section and two (2) reproducible mylar prints for each section.
- (3) The topographic maps shall be drawn at 1"=200' scale.

B. Model

- (1) The relief model shall be formed to scale and constructed on a suitable base material. The model should measure an area of one (1) meter square at an appropriate scale to include the proposed OTEC site, extending 1000M to the Southwest, 500M to the Northeast, 750M to the southeast and extending outward towards the sea to a depth not less than 500M (See Exhibit 2-A). Appropriate colors shall be selected and legends provided to distinguish land area above and below sea levels as well as corresponding color intensities to distinguish varying elevations. The model should have a removable plexiglass cover for protection during movement to public presentations.
- (2) The model shall be completed and submitted within nine (9) months following the award of this contract.

PLANNING FOR THE PREVENTION OF ENVIRONMENTAL
AND RECREATIONAL LOSSES DUE TO OTEC DEVELOPMENT
ON CABRAS ISLAND, GUAM

THE GUAM ENERGY OFFICE (CEIP)

SCOPE OF WORK, TASK NO. 3

Study of Ocean Water Currents Directly Off-Shore from the
Proposed OTEC Site at Cabras Island, Guam

I. WORK OBJECTIVE:

The major objective of this study is analyze and report by written and graphical documentation the direction, strength and variations of ocean water currents off-shore from the proposed OTEC site.

II. WORK PURPOSE:

A number of significant environmental and marine studies have been performed on the areas adjacent to the proposed OTEC site by the Marine Laboratory at the University of Guam and other interested parties. In order to fully assess the potential environmental and recreational losses of the proposed OTEC facility and to plan for the mitigation of those losses, it is necessary to compliment those studies with a basic current flow study of the affected waters.

III. WORK TASKS:

- A. Using appropriate instrumentation, measure, record, and graph with vectors or acceptable notation, the direction and relative strength of currents at various times of day and high, low and mean tides, found on the reef flat and ocean areas directly off-shore from the proposed OTEC site. These waters include all flow on the reef flat from the Tepungan Channel area southeast of Cabras Island extending around the north of Cabras Island approximately 1,000 meters along the beach southwest of the Cabras Power Plant cooling channel intake. Ocean surface currents must be presented from the reef to a distance of one kilometer on a line extending directly from the Cabras Power Plant cooling channel intake. Bottom currents must be presented from the reef along the same line described above to a depth of 500 meters. These areas are outlined in Exhibit 3-A.
- B. The presentation must include a projection of the direction and force of currents anticipated during a major typhoon.

IV. REPORT SUBMITTAL:

- A. The final report of this study including maps and drawings must be presented to the Director of the Guam Energy Office within twelve months of the date of contract for this award.

B. Ten (10) copies of the draft report shall be provided for review by the Guam Energy Office and Guam Coastal Zone Management Program, three weeks prior to finalization.

C. The final report will consist of an original and 10 copies.

IV. OTHER SPECIFICATIONS:

A. During the course of the study, monthly meetings will be held with the Director to report the progress of the research.

B. A subsequent meeting will be held after submittal of the draft to discuss possible corrections and/or revisions.

PART IV: PROGRAM NARRATIVE

1. Objectives and Need for Assistance

Energy consumption on Guam is presently supported by the burning of fossil fuel, 100% of which is imported from foreign sources. Apparent worldwide shortages of fossil fuels and climbing cost of purchase and transshipment to Guam suggest a need for the development of locally available alternate energy sources of a renewable nature. One such alternative is the production of power by a system known as Ocean Thermal Energy Conversion (OTEC).

The need for OTEC development on Guam is due to the present dependence on imported foreign petroleum to generate electricity. Lacking natural resources supportive of heavy industry, Guam relies fully upon tourism and federal assistance to maintain its fragile economy. During the Pacific Basin Development conference held in February of 1980 at Hawaii, representatives of the Departments of the Interior and Commerce clearly stated their intentions that the territories develop stronger economic bases rather than depend on annual federal assistance. In this regard, OTEC offers potential to provide a relatively cheap source of electricity that will encourage economic development.

Residential consumers now pay almost 9¢ per KWH for electricity and that rate is expected to reach or exceed 10¢ by the end of this calendar year. The high cost considered with the unstable supply situation

precludes active economic development and further supports OTEC planning.

The OTEC system utilizes the temperature gradient between warm surface waters and cold deep waters as its energy source. Assuming the use of a closed system, it operates by continuously recycling a liquid with low vaporization pressure (e.g., ammonia, propane, or freon). The liquid is heated by the warm water, and its vapor then drives a turbine which in turn produces electrical power. In order to complete the system and to obviate the loss of medium, the vapor is then condensed with the cold water and re-used. A larger temperature difference between the warm surface water and the cold deep water, results in greater efficiency of the system. The ocean's surface waters have a high heat capacity and thus an OTEC system can operate on a continuous 24-hour basis, regardless of weather conditions or time of day. Ocean Thermal Energy Conversion represents a relatively non-polluting, consistent, and reliable system run by a virtually inexhaustable energy source.

A high, consistent temperature gradient resulting from the warm tropical ocean surface and steep submarine slopes, minimizing the distance from shore to sufficiently cold deep water, make the OTEC system a viable alternative for Guam. In order to proceed with planning for the development of such a system and in order to secure the help of concerned federal agencies, it is necessary to fully consider the potential social, economic and environmental impacts of such an energy system. Because Guam offers a uniquely appropriate site for a land-based OTEC system,

the coastal development site meets criteria for funding under the Coastal Energy Impact Program (CEIP). Specifically, it is necessary to design a program to ameliorate unavoidable losses to valuable environmental and recreational resources in the Guam Coastal Zone resulting from land-based OTEC development affecting the Luminao Barrier reef and the Apra Harbor estuary. For this reason, the Territory of Guam, through the designated CEIP agency, the Guam Energy Office, seeks federal assistance in the amount of \$81,000 in 308 (d)(4) funds under the FY-80 CEIP allocation.

2. Geographic Location

Guam, lying 800 miles north of the equator in the Western Pacific; Latitude 13°30'N - Longitude 144°45'E, is a large island of old weathered volcanoes and raised limestones. The southwesternmost of a volcanic chain, the Mariana Islands, it rises to an altitude of 1290 feet, with rolling terrain to sea level. The island possesses a good range of vegetation types: mangrove swamps, strand vegetation, and wooded uplands.

Much of the coastline is sheer or reef bound although the eastern coast has many small bays, particularly in the southern portion, which are partially reefbound and suitable only for small craft. The only natural bay of commercial importance is Apra Harbor on the western coast. Although Agat Bay has potential, and Umatac Bay was utilized during the colonial rule by the Spaniards, tides and heavy swells make anchorage hazardous in these locations.

The North Pacific Equatorial current sweeps westward around and below Guam into the Phillipine Sea. The total volume transport of the North Pacific Equatorial Current has been estimated to be 45 million m^3/sec on the low side to 106 million m^3/sec on the high side, with the most recent estimate of 85 million m^3/sec being intermediate. The maximum velocities at latitude 10°N in 1955 and latitude 13.5°N in 1966 were 100 cm/sec and 40 cm/sec, respectively. At a depth of 500 m the maximum westward current is about 10 cm/sec.

The annual extremes of temperature in the surface waters of the area are 76°F to 94°F ($28-29^\circ\text{C}$). The thermocline is shallowest at Lat. 7.5°N and the vertical temperature gradient is greatest there. The boundary between the North Equatorial Current and the Equatorial Countercurrent is normally located around Lat. 7°N and is an area of natural upwelling of colder water. Northward across the current, the thermocline becomes less pronounced as the 10°C isotherm slopes downward faster than the 20°C isotherm, particularly north of Lat. 15°N . Below the 6°C isotherm no pronounced slope of isotherms occurs in the North Pacific Equatorial Current.

The site of the proposed 40 MW land-based OTEC development is on the northeast end of Cabras Island adjacent to the existing Cabras and Piti conventional power plants as identified in Figure 1.

The land is currently controlled by the U.S. Department of Defense and has had no commercial activity or development in the post-war period.

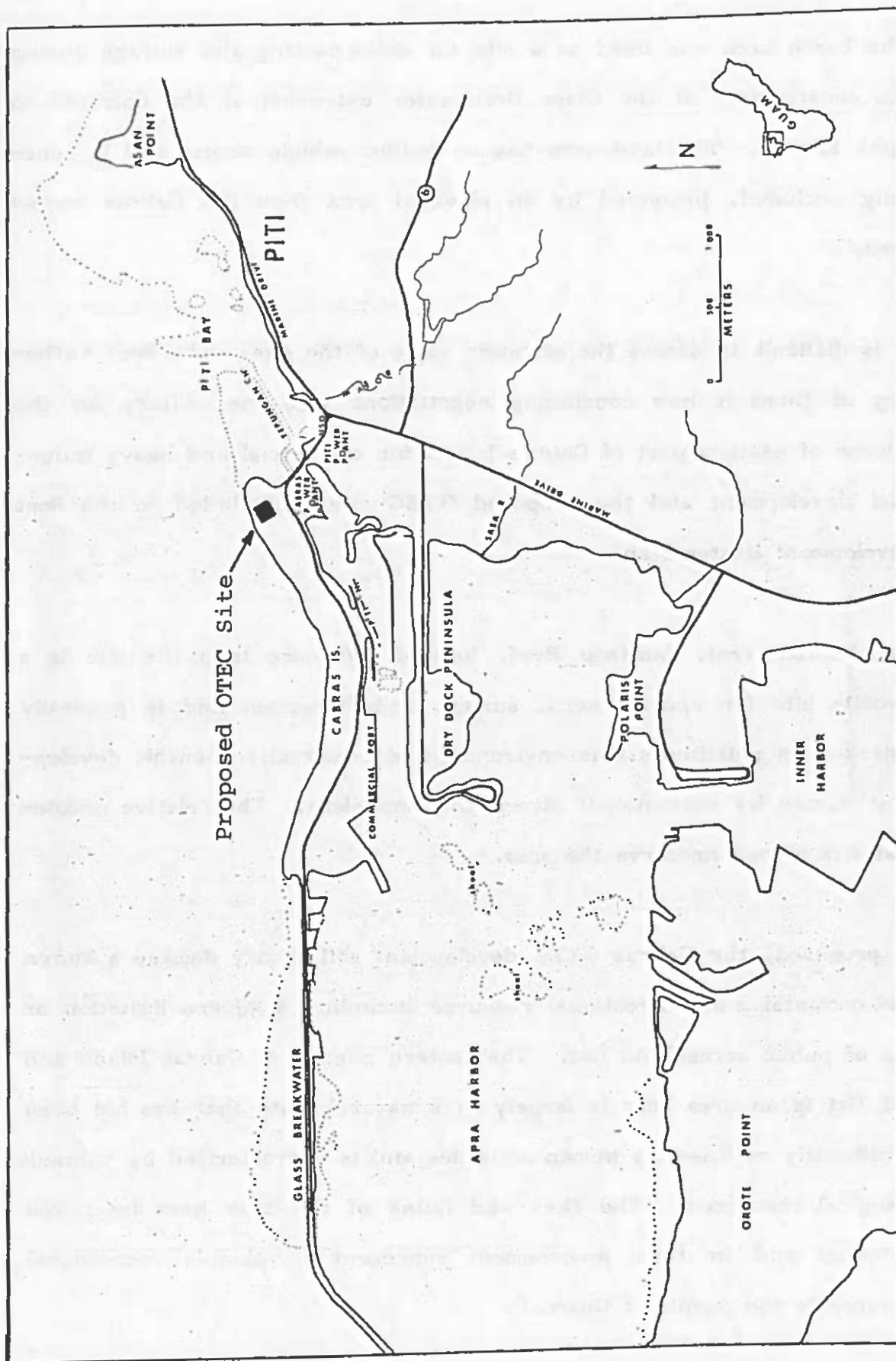


FIGURE 1. Geographic setting of the proposed OTEC site near Piti Village on Cabras Island on the western shore of Guam.

The beach area was used as a site for d d o s casting and storage during the construction of the Glass Breakwater extension at the entrance to Apra Harbor. The land area has no public vehicle access and is generally secluded, protected by an elevated area from the Cabras access road.

It is difficult to assess the economic value of the site. The Port Authority of Guam is now concluding negotiations with the military for the release of eastern part of Cabras Island for commercial and heavy industrial development and the proposed OTEC site is included in the Port Development Master Plan.

The barrier reef, Luminao Reef, located off-shore from the site is a favorite site for sport divers, surfers and fishermen and is generally regarded as pristine marine environment with attractive benthic development valued by recreational divers and snorklers. The relative remoteness has helped preserve the area.

As proposed, the Cabras OTEC development will clearly damage a known environmental and recreational resource including a severe limitation or loss of public access and use. The eastern portion of Cabras Island and reef flat is an area that is largely in a natural state that has not been significantly modified by human activities and is characterized by valuable ecological resources. The flora and fauna of the area have been well protected and in their environment represent a valuable recreational resource to the people of Guam.

3. Results or Benefits Expected

The current U.S. Department of Energy (DOE) OTEC program is rapidly reaching the demonstration phase and DOE officials have stated their intentions to release the first program opportunity notices early this summer. The Guam Energy Office is optimistic that the territory will be included in this DOE program at least through the design phase. For this reason it is important that immediate efforts be undertaken to collect and review all existing environmental research relative to the proposed OTEC development and complete the final studies leading to the design of programs that identify, measure, and ultimately avoid large scale environmental and recreational losses. If approved, this grant will provide the Government of Guam with a meaningful plan for the mitigation of damages to valuable marine environmental and recreational resources.

4. Approach

The proposed Guam OTEC development is a large scale energy facility which will produce 40 megawatts (MW) of electricity. The system will require intake pipes for cold and warm water that will measure approximately 18 feet in diameter and will conduct seawater under high pressure flow of about 30,000 cubic feet per second. Because this development will be sited on a barrier reef frequented by fishermen, divers and swimmers, the government anticipates recreational losses and certain environmental damage.

A variety of environmental studies have been performed on the area due to the development of a large, 132 MW conventional Cabras Power Plant on adjacent interior land (see Figure 1). The University of Guam Marine Laboratory has studied the waters offshore of the Glass Breakwater for a potential OTEC facility. From their brief investigation, the area studied appears suitable for ocean thermal energy conversion.

Briefly, the off-shore area is characterized by steep slopes (26-52%) dropping quickly to 2,000-2,400 feet deep. Surface temperatures are generally above 80°F, and begin to drop markedly at depths below 300 feet. Salinity and density decrease slightly with the temperature change (Figure 2). At 1,500 feet, the temperature is about 45°F; and at 2,800-3,000 feet, it is consistently about 41°F (Figure 3). The nutrients, phosphorus and nitrogen, increase dramatically with depth. Oxygen shows a reverse trend, with dissolved oxygen decreasing from about 6.25 to about 2.5 parts per million from the surface to the 2,800-foot depth. These patterns are similar to those of other OTEC sites, notably Hawaii.

While no site-specific primary productivity (phytoplankton) studies have been done at different depths, the waters off Guam can be expected to follow tropical ocean trends for total biomass (productivity). This trend is for the largest amount of primary productivity (phytoplankton) to occur in the Photic zone, or zone in which light intensity is 99% of the incident surface radiation. This zone is about 300 feet deep in the tropical Pacific.

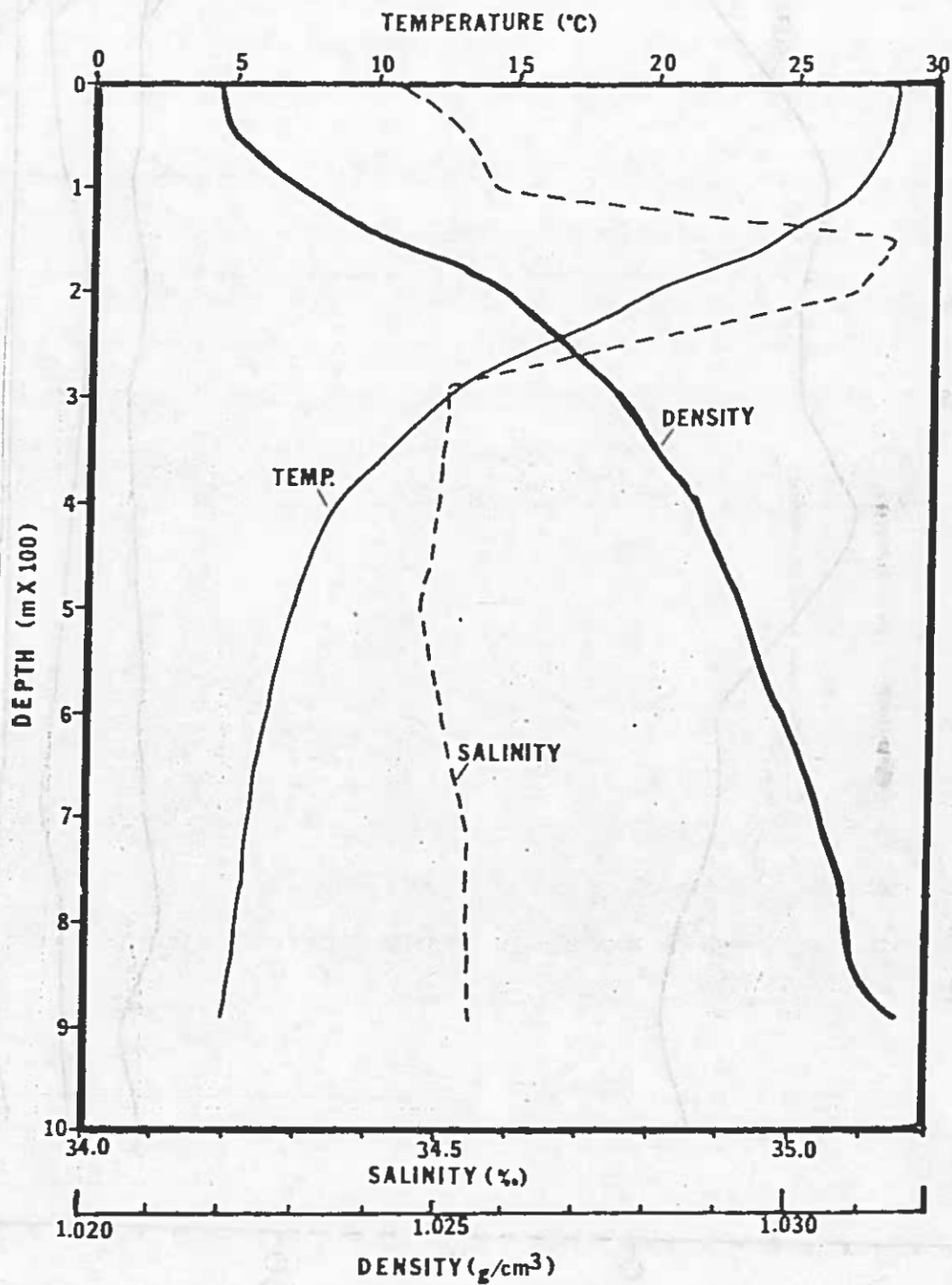


FIGURE 2. Mean temperature, salinity and density profiles in the vicinity of Cabras Island, Luminao Reef and Glass Breakwater, Guam (February 1978-February 1979.)

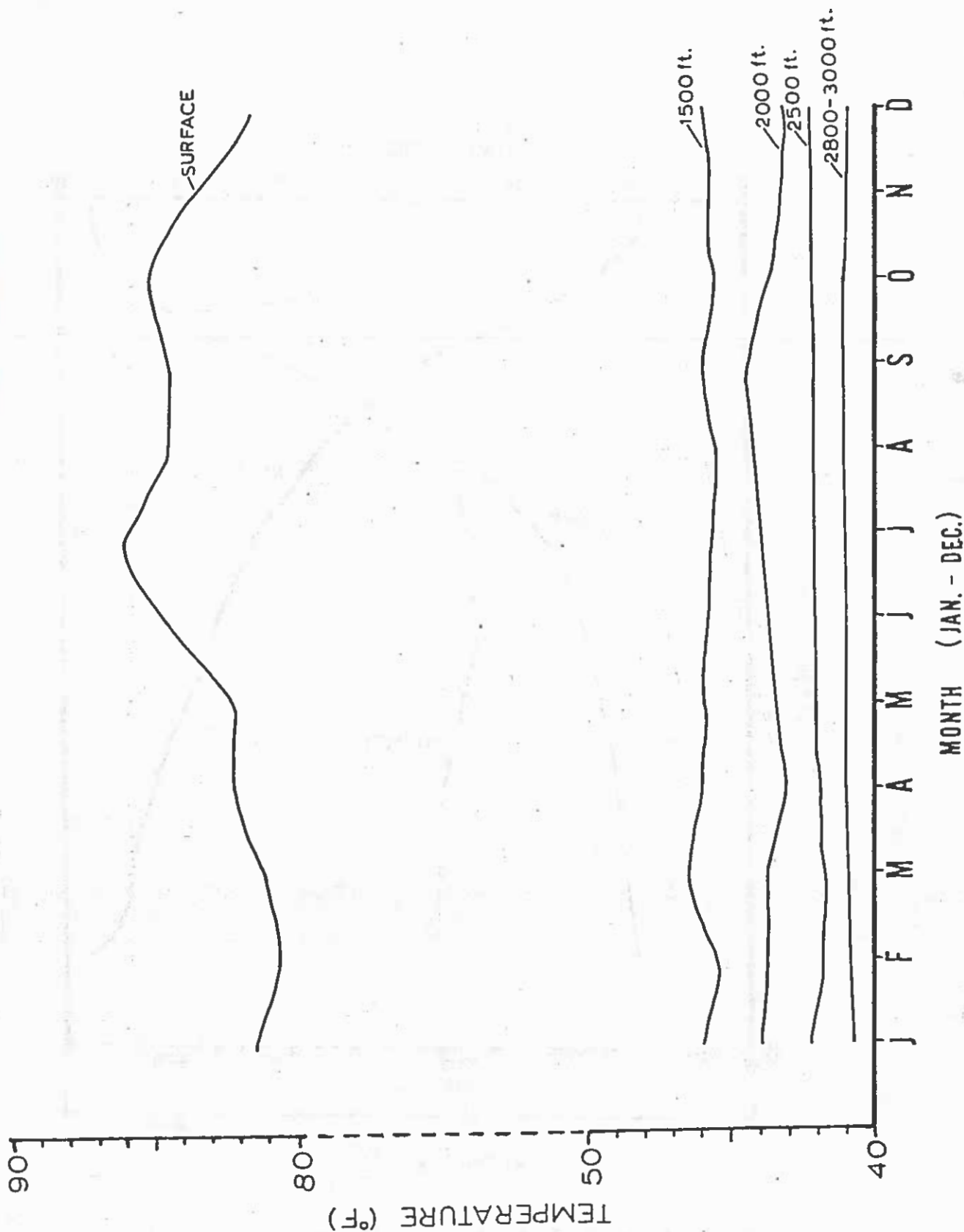


FIGURE 3. Mean monthly temperatures for surface, 1500, 2000, 2500 and 2800-3000 feet in the vicinity of Cabras Island, Luminao Reef and Glass Breakwater, Guam.

Zooplankton species that could be anticipated include Chaetognatha, Euphausiacea, decapod crustacea, Pteropoda, as well as invertebrate larvae. Vertical distribution of zooplankton would parallel phytoplankton, with the majority living in the upper, mixed layer. The thermal and density changes form a barrier through which they are unable to pass. Other offshore marine biota include albacore and skipjack tuna, mahimahi, jack, swordfish, marlin, and several species of sharks. The quantification of primary production with depth, and qualitative and quantitative plankton and nekton studies, are research areas which will require a thorough examination prior to further quantification of OTEC impact on Guam.

To date, only one limited study by Dames and Moore (1979) has been performed on the environmental impacts of an OTEC facility on Guam. That study identified a number of potential impacts based upon engineering experience with shore-based power stations, and through extrapolation of existing data. The successful deployment and operation, in July, 1979, of the first sea-based 50 kilowatt (KW) OTEC plant off the coast of the Island of Hawaii began to quantify the magnitude of the impacts identified in this section.

The environmental impacts of constructing a 40 MW, land-based OTEC plant on Cabras would include noise, traffic and, perhaps, dust (from site preparation). These impacts would be similar in magnitude to the construction of a conventional power plant of similar size. In addition, there would be marine impacts, such as sedimentation, pressure changes

with resultant fish mortality, and noise from the enlarging of the intake and discharge channels and placing of the cold water pipe (CWP). The benthic communities in these areas (predominantly corals), would be covered and probably destroyed. Prior to any construction, the benthic community along the final CWP alignment should be examined and identified. Special attention should be given to precious corals which might be found, at depth, in the corridor, as well as threatened or endangered species whose presence has not been currently detected. Recreational activities would be severely limited or terminated during construction.

The operational impact on water quality would be associated with the following:

- o Toxicity effects (lethal and sublethal due to chemical changes)
- o Mixing effects
- o Intake/discharge mortality effects

However, further review of currents, winds, waves and other oceanographic conditions at the proposed site is necessary to thoroughly quantify the magnitude of these impacts.

Biocides must be introduced at times into the intake streams to reduce biological growth (bio-fouling) in the heating and cooling systems. These fluids, and the use of growth-resistant (anti-fouling) paints, are intended to be toxic to life forms whose presence could restrict the water flow, or compromise heat transfer in the heat exchangers. While

chlorine addition will necessarily be limited to an allowable concentration of 1.67 pounds per million gallons for two hours per day, circulation of extremely large volumes of water will result in large total discharges of chlorine.

For the near-shore discharge from the facility, the effects of chronic low-level discharge in the marine communities of Apra Harbor need to be researched. Results of a recent UOG study indicate that biofouling is not as extensive on Guam as on other proposed U.S. mainland OTEC sites. If so, chlorine use could be reduced accordingly. University of Guam ongoing studies and U.S. Department of Energy studies on smaller OTEC plants are designed to further research biofouling and the impacts of chlorine control methods. These studies will be considered in Guam's mitigation strategy.

The ammonia working fluid that is utilized in the closed cycle engine will be contained to the greatest extent possible. However, because the heat exchanger surfaces will be exposed to constant physical and chemical stresses, some leakage is possible, as are accidental spills. The environmental effects of such leaks will depend greatly on amounts leaked, and weather and sea conditions at the time of spill.

The proposed land-based facility could be surrounded by berms to contain, or direct, the flow of the ammonia to the safest and least damaging location. The amount would be small, but contact with the rich coral communities on the seaward side of Cabras Island, or the

upper reaches of Apra Harbor, would probably result in nearly total destruction of marine life and would affect recreational activities. This problem will be studied in detail under a current 308 (c)(1) grant from CEIP.

Losses from the piping, pumps and heat exchanger surfaces of an OTEC plant will represent a continuing low-level source of aluminum. The erosion/corrosion rate for aluminum under OTEC conditions is estimated at 0.1 mil per year. While the erosion rate may be small, the extremely large surface areas anticipated on an OTEC plant will result in substantial total amounts of ionic aluminum being discharged. Aluminum is ubiquitous, and very little is known of its toxicity to marine organisms.

In addition to metals from heat exchangers, OTEC systems are anticipated to use protective coatings to retard growth on the CWP. These paint coatings generally consist of salts of heavy metals (primarily copper, mercury, zinc) and arsenic, all of which are toxic to marine life. The metals slowly diffuse out of the paint matrix.

Another environmental concern, with respect to OTEC operation, is that of nutrient enrichment of euphotic waters in the vicinity of the effluent discharge. Pumping of cold, nutrient-rich water from depth and discharging into the sun-lit upper layers may stimulate increases in local primary production. Characteristically, the near surface water off Guam are oligotrophic, supporting low amounts of phytoplankton production despite availability of abundant solar energy for photosynthesis. This

limited productivity occurs because no mechanism exists for mixing of nutrient-rich deeper water into the sun-lit upper strata, where the nutrients would stimulate more vigorous primary production. The OTEC systems will create artificial upwelling conditions, thus promoting eutrophication of local waters.

Entrainment refers to the incorporation of smaller pelagic organisms (plankton and micronekton) into the condensor or evaporator water flow. Impingement refers to the physical blockage of larger organisms from joining this entrainment through placement of barrier screens on the intake ports. Entrainment effects will be among the more important aspects of OTEC operation, from an environmental standpoint. Organisms entrained into OTEC heat exchangers will experience a variety of stresses, including thermal stresses (inside the heat exchangers, and as the discharge water equilibrates with ambient receiving water), mechanical stresses (turbulence, abrasion and pressure changes), chemical stresses (biocides, corrosion products), and ecological stresses (altered light and trophic conditions attending vertical water mass displacement). Organisms in discharge receiving waters will also be subjected to some of these adversities. These stresses will manifest lethal and sublethal effects which may bear upon the population dynamics of certain species, but may be well below detectability in the case of some species.

Studies at coastal generating stations with heat exchangers in operation indicate that pump entrainment effects (mechanical or hydraulic stresses) may account for a significant portion of total plankton mortalities. The

40°F thermal changes over approximately ten seconds, which may characterize OTEC entrainment conditions, would be relatively benign by comparison to the more radical temperature changes normally associated with heat exchangers in coastal generating stations. The pumping systems used to circulate sea water through the OTEC plants may impose mechanical stresses similar to those in coastal power plants and will have an environmental impact.

Implications of evaporator (upper ocean levels) entrainment may be more important than for condensor (deep water) entrainment, since early life history stages of most species of pelagic fish of commercial resource value reside the upper (mixed) ocean layer. Although they normally comprise only a small portion of the zooplankton community from a numerical standpoint, their numbers may figure importantly in maintenance of stable, reproducing populations. This would be especially true in the land-based facility which would be obtaining warm water from Apra Harbor.

Impingement effects are of significant concern at many coastal power plants, where traveling screens and trash racks account for high levels of mortality among fishes attracted to and drawn into intake structures. Velocity caps, improved well screen designs with a mesh size of about ½-inch, effective barriers and fish return systems are mitigating these effects in many locations. Similar technological innovation should be incorporated into both the shore-based and sea-based OTEC final designs. None of these hazards have yet been considered relative to recreational users of the site.

The major air quality impact associated with a shore-based OTEC plant is the accidental release of the ammonia working fluid. This could occur for several reasons. A vehicle collision with the land-based plant could damage the working fluid containment system. Human error or accident might also cause a release of the working fluid, as might an act of terrorism. U.S. Coast Guard studies indicate that approximately 60 percent of a major ammonia spill would go into solution, with the remaining 40 percent vaporizing to be dispersed in the atmosphere. Atmospheric dispersion would be a function of winds and atmospheric stability. Proper design and operational procedures can minimize these events, but a strategy must be designed to accomodate them.

The possibility of a typhoon damaging the proposed OTEC plant and causing a release of the working fluid must also be considered. In spite of design modifications that might minimize damage and reduce the possibility of ammonia release, storm damage is probably the largest threat to the ammonia working fluid piping system.

The proposed land-based facility would be similar in external appearance to a warehouse, like those at the Guam Commercial Port facilities. The visual appearance would be more pleasing than the Cabras or Piti power plants, and there would be no exhaust stacks or emissions associated with the OTEC operation. The large water pipes would be below grade in the intake channel and, therefore, not particularly obtrusive on the landscape. From the shore near Piti Village, the OTEC plant would appear as an additional 2 to 3-story building, depending on the heat exchanger design.

The environmental considerations are summarized as follows:

- o the potentially toxic effect on marine life of metallic elements eroded or corroded from heat exchangers;
- o the adverse effect of mixing natural thermocline and salinity gradients;
- o the potentially toxic effects of working fluid seepage into the seawater or seawater into the working fluid;
- o the ecological impacts of concentrations of biocides (such as chlorine) used to prevent biofouling;
- o the safety of workers faced with exposure to chemicals;
- o the effect on the microclimate of slightly lower air and surface temperatures around the plant.

It should, however, be noted that any inquiry into the potentially adverse environmental impact of OTEC activities is speculative. Nonetheless, it is necessary that these issues be addressed at this preliminary stage of OTEC development.

Potential environmental impacts from OTEC facilities bordering on coastal waters include those from construction and operation of such facilities, cables and transmission lines, and services and support facilities. The existing U.S. legislation relevant to OTEC activities both during its research and development phase and during the commercial phase includes the OCS Lands Act, CZMA, DPA and the National Environmental Policy Act of 1969 (NEPA). The implications of these acts have not been fully evaluated relative to OTEC development on Guam.

NEPA requires federal agencies to prepare records on environmental effects of and alternatives to "every recommendation or report on proposals for legislation and other major federal actions significantly affecting the quality of the human environment". Since federal involvement in OTEC development is expected to be substantial, at least during the initial stages, preparation of programmatic Environmental Impact Statements (EIS) will be required during the final phase of OTEC development. Additionally, while the OTEC facility will be subject to a site-specific EIS, it is also possible that a regional EIS will be needed because of the cumulative effect of a number of OTEC facilities on the island.

Since so little is yet known about OTEC activities and operations, it seems desirable that environmental assessments be conducted during the research phase. The same applies in the commercial phase, whether the OTEC plant is to operate in a U.S. coastal zone, in the coastal zone of another state, or on the high seas.

Guam also has international responsibilities to avoid environmental damage or loss due to OTEC development. Part XII of the Informal Composite Negotiating Text (ICNT), produced at the ongoing Law of the Sea Conference (LOS III), contains 46 articles dealing with the protection and preservation of the marine environment. As a territorial state, Guam is obliged to protect and preserve the marine environment to refrain from polluting the environment of other states or areas beyond their national jurisdiction, and to take measures to prevent, reduce, and control marine pollution. Among specific measures, states are to minimize release

of toxic, harmful, or noxious substances from dumping, pollution from vessels, and "from all other installations and devices operating in the marine environment, in particular for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea, and regulating the design, construction, equipment, operation and manning of such installations or devices".

In another article, ICNT calls upon states "[i]n taking measures to prevent, reduce, and control pollution of the marine environment....not to transfer, directly or indirectly, damage or hazards from one area to another or transform one type of pollution into another". States would also assume positive legal responsibility to cooperate in international monitoring programs and to assess the environmental impacts of their activities on the marine environment. Article 210 deals specifically with activities in the Area:

International rules, standards and recommended practices, and procedures shall be establishedto prevent, reduce, and control pollution of the marine environment from activity relating to the exploration and exploitation of the Area. Such rules, standards, and recommended practices and procedures shall be reexamined from time to time as necessary.

Fully recognizing the existing research, the Guam Energy Office proposes that the following tasks be performed to produce a strategy to avoid or mitigate environmental and recreational damage or loss resulting from the planned OTEC development: