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ENVIRONMENTAL CONSIDERATIONS OF A GUAM WIND ENERGY CONVERSION SYSTEM ALONG THE COTAL - WINDWARD HILL SAVANNA

by

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For

The Guam Energy Office
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OVERVIEW:

This paper describes the present physical, biological and human environment which might be affected by any proposed wind-electric project, and also reviews current environmental research concerning Wind Energy Conversion Systems (WECS) applicable to such a project.

The area borders the Cotal Conservation Reserve and Ylig Drainage System (Tarzan River area). No houses exist in the immediate area. The closest communities are the Windward Hills Golf Course housing area to the east and a few widely scattered road side homes to the south. Results of geological and biological surveys indicate the region consists of a clay substrate underlying a savanna ecosystem. No endangered biota were recorded from site surveys.

In general, WECS are benign. There are three main environmental considerations, all of which are of concern to nearby residents. First, some turbines can create television interference. Cable television eliminates the problem. Second, there is some noise associated with the motion of the blades. The effect of noise is a function of distance, up-wind or down-wind home composition, etc. A third environmental consideration is land use and potential visual affects.

Current land use by off-road vehicles has affected the area's drainage and erosional patterns. Precautionary measures during construction are needed to control sedimentation in the Ylig River Drainage System and to stabilize the sensitive geomorphological conditions that presently exist.

A complete environmental impact assessment would be needed when engineering and logistical parameters are worked out. All ecological affects from construction of access roads and fencing, to the impact of building electrical transmission and distribution systems, general on-site utilities, and support structures would need to be addressed.

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INTRODUCTION:

Civilization has harnessed the wind for centuries to pump, grind and sail. In recent years, people have been using wind to produce electricity. Growing energy requirements, increasing fossil fuel costs, and the dependence on foreign sources, all have directed governments and individuals, especially those of the emerging island nations of Oceania, toward the utilization of windpower. The completion of a wind project in Windward Hills would place Guam at the forefront of island energy technology. On the local level, a proposed project would provide job opportunities, displace thousand of barrels of imported oil per year, and increase the energy self-sufficiency of the territory.

Among the attractive aspects of Wind Energy Conversion Systems (WECS) ---also called WTG (Wind Turbine Generators) or just "Windfarms" ---is that they are considered environmentally benign. They use an inexhaustible source, and have relatively little affect on air and water quality, on biota in the area, or on solid waste disposal requirements. Resource commitments include the land and air space occupied by the system, and an economic commitment to dispose of the power generated.

The recent explosion of windfarm activity in California, Hawaii and other areas, has identified several possible environmental issues that could impede the development of windfarm technology. Unfortunately, few environmental data or discussions relating to a tropical island wind-electric installation have been published.

Many environmental parameters would have to be considered when engineering the installation and maintenance of a tropical island windfarm.

Factors such as corrosion from salt spray, lightning protection, typhoons, high humidity, etc., must be addressed by the design engineer. National Aeronautics and Space Administration (NASA) and the U.S. Department of Energy (DOE) have identified three environmental considerations in the siting of wind turbine generators. The first is possible television interference. In areas where wind turbine generators are placed near communities that use antennas for reception, a zone of interference can be defined. Cable television reception is not affected by WECS.

Another important environmental impact is the noise associated with the motion of the blades. Although modest and of low frequency, the noise can have an adverse effect on the public. New blade designs and site considerations are possible solutions.

The third possible environmental problem is land use and the associated potential visual pollution that may become an issue when large numbers of machines are deployed in an area. As a result, aesthetics, community attitudes, and limited land intrusion are considerations in the Guam WECS design efforts.

This paper addresses the above environmental issues and provides, from on-site surveys, baseline biological and geological information for the target area.

GENERAL SITE DESCRIPTION:

One possible site for a WECS project is the Windward Hills - Cotal Reserve area adjacent to Route 17 (see Figure 1). The target area is part of a high plateau savanna, 400 to 500 ft. above sea level overlooking the Ylig River Drainage System and the Pacific Ocean (Plates 1 and 2). Geographically, the 15° to 20° slope below the area provides conditions for good laminar wind flow for the NE prevailing winds. Geomorphologically, the area has a weathered volcanic substratum similar to the Nimitz Hill area. Soils consist of semi-permeable clays. Many badland areas are found in the proposed project area.

Current land use by off-road vehicles has formed much of the present drainage and erosion patterns. A Eucalyptus planting program has helped stabilize the soil along the popular Tarzan Falls Trail on the Cotal Reserve. Some meteorlogical data are available from the Guam Energy Office (rainfall and wind regimes).

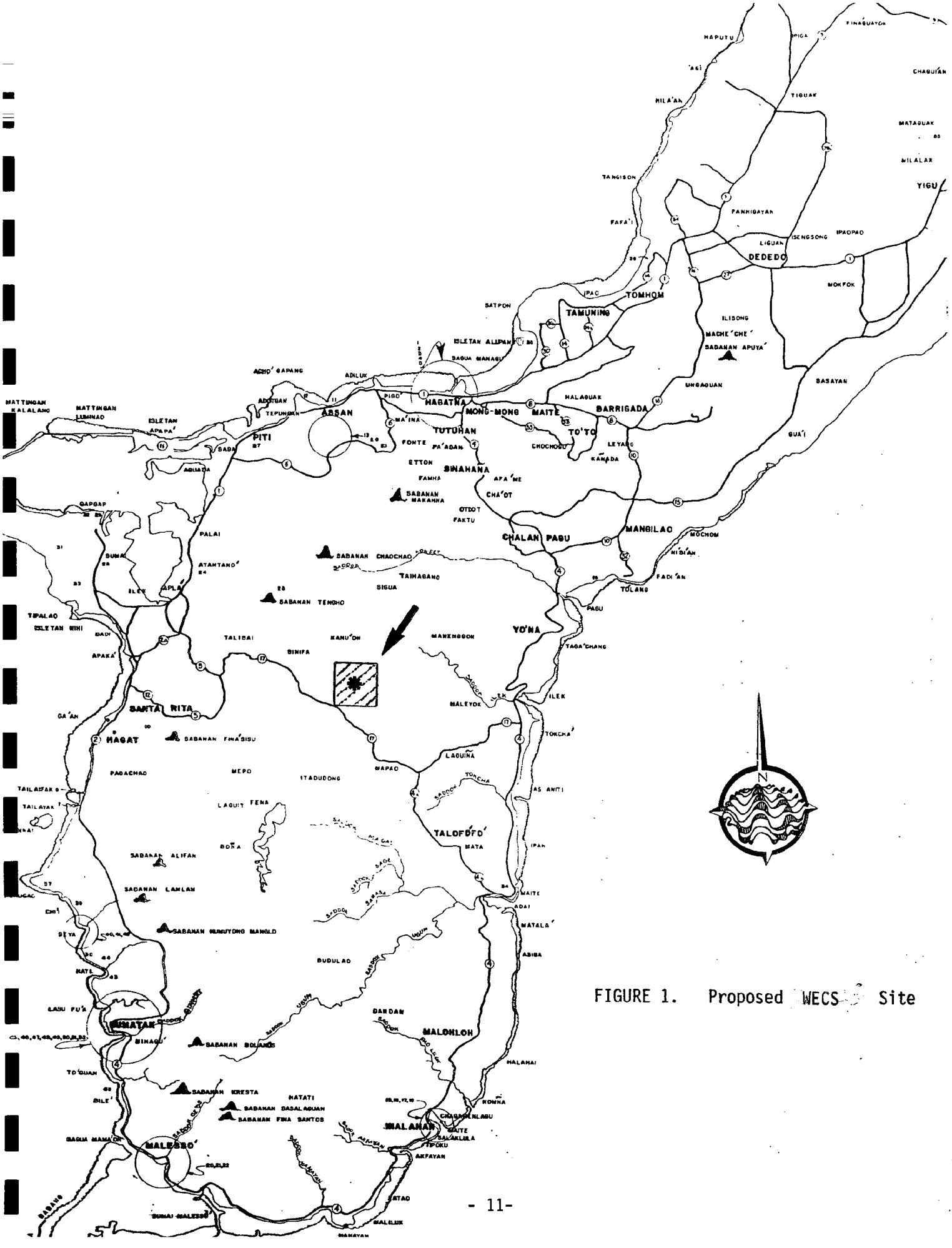

FIGURE 1. Proposed WECS Site

PLATE 1. Proposed Site; Looking East

PLATE 2. Proposed Site; Looking Northwest

GEOLOGIC ENVIRONMENTAL ASSESSMENT:

The area is situated north and east of the Cross Island Road (Route 17), on the east-central half of the U.S.G.S., Talofofo 7½' Quadrangle. It is entirely underlain by deeply weathered and dissected volcaniclastic and stratified lava flows of the Alutom formation. Severe gullying and sedimentation are on-going and even minimal construction will exacerbate the situation unless very careful planning is carried out. A cross sectional view is diagramed in Figure 2.

Geologic problems fall generally into the following overlapping categories.

1. Slope Instability: Gravitational-rotational slumping of weathered bedrock blocks is currently a major concern wherever the Alutom formation is encountered. The volcanics weather to depths exceeding 50 ft. and the upper 30 ft. are essentially all clays and oxides (saprolite). Aligned clay minerals provide excellent slip planes along which hillside slopes move, especially during very wet seasons.

   A second form of slope instability that is currently active in the targeted area are mud slides and flows that are triggered by torrential rains following dry seasons. Both types of instability are severe because of the combination of steep slopes; highly weathered rock; scant vegetation; and wet-dry season patterns.

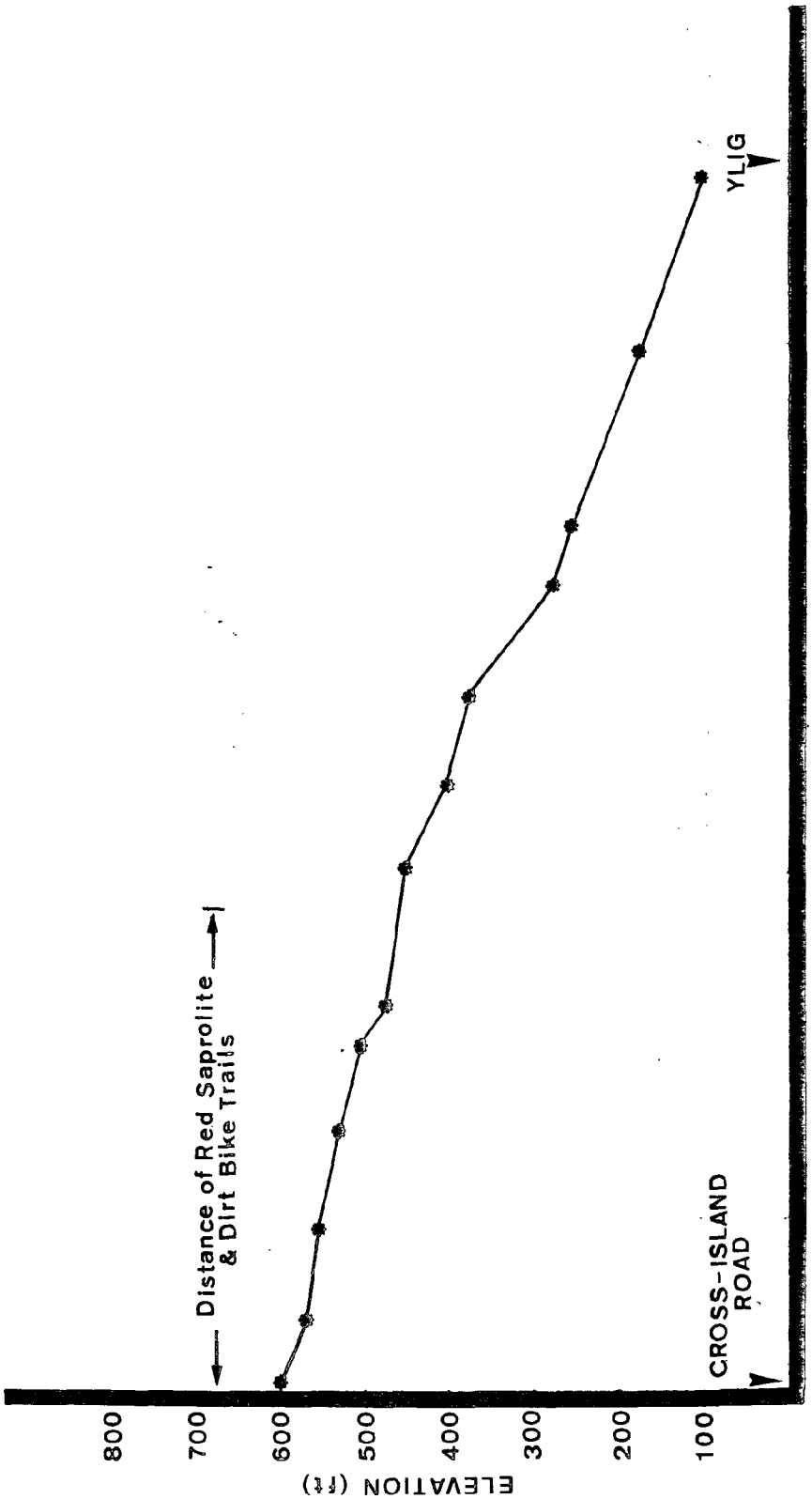

FIGURE 2. Cross-sectional view of the N 60°E Trail on U.S.G.S. Quadrangle.

2. Drainage: Surface drainage in the targeted area is both variable and seemingly random. The location and importance of gullys appear to be determined by off-road vehicle use. Construction will obviously affect the downslope surface drainage pattern in unpredictable ways, unless serious planning is carried out. Furthermore, renewed downslope gullying and headwater erosion will undercut the toe of many slopes helping to trigger gravitational slumping and mud flows.

3. Sedimentation: Because of the steep slopes and volcanic bedrock, off-road vehicles have accelerated soil erosion and sedimentation. Unless well-planned, construction will worsen the situation. A potential problem will be the relationship of hillside construction in intensifying Ylig River siltation, especially in regard to the water supply pumping station 2 - 3 miles downstream.

4. Soil Properties: Site soil composition, consists of light colored (sandy) to dark (more limestone) volcanic - saprolitic clays. Before any construction is undertaken sampling and testing of the clay-oxide soil should be run for the following engineering properties.

   (a) Shrink-swell; or expansion-contraction
   (b) Cohesion, strength, and Atterberg Limits
   (c) Compactability
   (d) Permeability
   (e) Liquification

These tests would be best run as part of a soil survey of the site, that would include soil description, maps showing vertical and horizontal extent of soils, and grain size and moisture contents.

In view of the above geological considerations, extreme care in planning the windfarm installation is vital. Ground cover plantings; defined drainage areas and possible siltation basins; and restrictions on off-road vehicles should be instituted before excavations are initiated. The need for a dry season construction timetable is obvious.

BIOLOGICAL ENVIRONMENTAL ASSESSMENT:

The ecosystem in the project area is often disturbed by brush fires, off-road vehicle traffic and general public usage of the Tarzan Falls Trail. Typical savanna flora covers the proposed project area. Casuarina littoralis and scattered Pandanus and Cycas seem to survive the savanna fires each year. The swordgrass, Micanthus floridulus, is common. Other grasses (Dimeria chloridiformis) and ferns (Dicranopteris linearis) along with Morinda citrifolin and Dianella ensifolia tenaciously hold on to the clay soil through the rainy season. Existing vegetation consists mostly of introduced species. Because of the ephemeral nature of the area, the ridge-top stands of Casuarina are rapidly lossing their hold (Plates 3, 4, 5, and 6). No endangered flora was found.

Because of heavy foot and off-road vehicle traffic, wildlife is scarce in the area. No endemic avian fauna (all of which are endangered) were seen. No mammals were observed, but rats, mice, and occasionally, pigs and deer are expected to be found in the area. Piles of Achatina fulica (snail) shells were observed in the project zone.

The well-visited Tarzan Falls area is part of the Ylig River Drainage System. (Figure 3). Some physical parameters of the drainage system are compiled in Table 1. On-site surveys of the Tarzan River revealed a rich fish and shrimp fauna. Stocks of Macrobrachium lar, Kuhlia rupestris, and Tilapia sp. are present. Table 2 and Appendix I list the observed and reported biota from the Ylig System and some hydrological physiochemical characteristics. Obvious precautions should be observed when excavating the project site as to minimally disturb the Ylig River Drainage System and adjoining marine ecosystem.

PLATE 3. Ridge Erosional Patterns

PLATE 4. Ridge Erosional Patterns

PLATE 5. Ridge Erosional Patterns

PLATE 6. Ridge Erosional Patterns

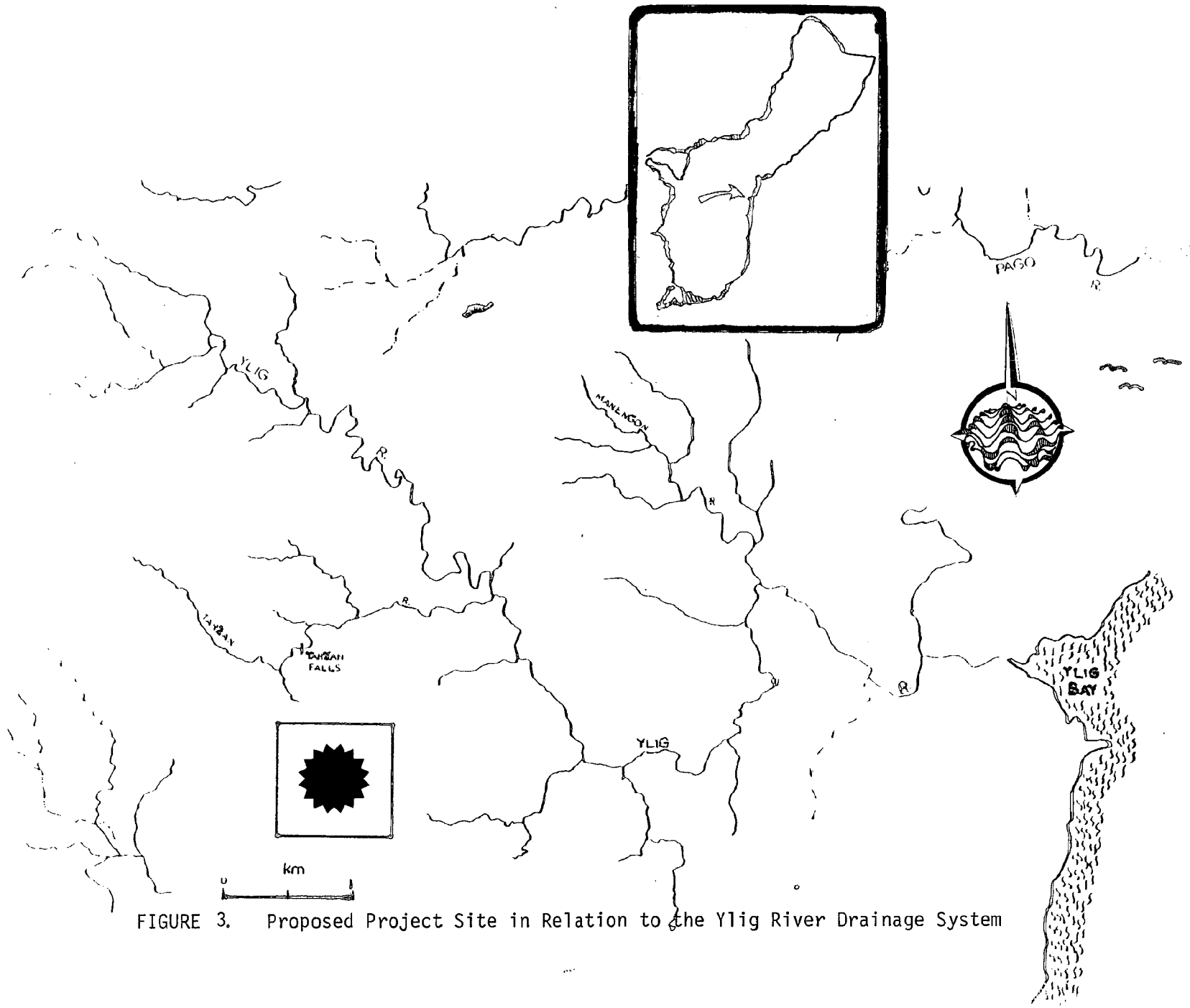

FIGURE 3. Proposed Project Site in Relation to the Ylig River Drainage System

TABLE 1. Some Physical Parameter of the Ylig Drainage System.

Ylig River, Guam

COORDINATES: Lat. 13° 23' 33" N
Long. 144° 46' 08" E

ELEVATION: 137 m

TOTAL RIVER SYSTEM DATA:

1) Length of longest continuous perennial channel: 11,994 m
2) Combined perennial channel lengths: 16,734 m
3) Approximate drainage area: 3,007 ha

Addiditonal Information:

1) Gaging Station:
   Lat. 13° 23' 28" N
   Long. 144° 45' 06" E
   Elev. 6 m
   Average (28 yrs.) discharge: 0.81 m3/s
2. The Ylig has 2 major tributaries: The Tarzan and Manengon.
3. Ylig system supplies Yona Village with drinking water.

TABLE 1. (Cont'd.)

Tarzan River, Guam

CORDINATES:

Lat. 13° 23' 51" N

Long. 144° 43' 54" E

LENGTH OF PERENNIAL TURBUTARIES AND MAIN CHANNEL: 5,182 m

ELEVATION: 119 m

Additonal Information:

1) The Tarzan drains into the Ylig.

2) Tarzan Falls:

Lat. 13° 23' 39" N

Long. 144° 43' 09" E

Elev. 64 m

Manengon River, Guam

COORDINATES: Lat. 13° 23' 52" N

Long. 144° 45' 03" E

LENGTH OF PERENNIAL TRIBUTARIES AND MAIN CHANNEL: 7.727 m

LENGTH OF MAIN CHANNEL: 2,240 m

ELEVATION: 61 m

Additional Information:

1) The Manengon drains into the Ylig.

TABLE 2. Reported and Observed Aquatic Flora and Fauna from the Tarzan---Ylig River Drainage System.

Animals	
Invertebrates:	
Ostracod	Cypretta ef. tenuicauda Varra
Sponges	Spongillidae, unidentified spp.
Shrimps	Atya serrate Bate
	Atya spinipes Newport
	Caridina nilotica (P. Roux)
	Caridina typus H. Milne Edwards
	Macrobrachium lar (Fabr.
Crabs	Varuna sp.
Snails	Melanid spp.
	Neritina pulligera (Linneaus)
	Neritina sp.
	Thiarid sp.
Vertebrates:	
Fish	Awaous guamensis (Valenciennes)
	Kuhlia rupestris (Lacepede)
	Sicyopterus macrostetholepis (Bleeker)
	Stiphodon elegans (Steindachner)
	Tilapia mossambica (Peters)

TABLE 2. (cont'd.)

Eel	Anguilla marmorator
Plants:	
Non Vascular (Algae)	Chara sp
	Cladophora cf. crispata
	Cladophora glomerata L. Kuetz.
	Closterium moniliferum Bory Enrenb.
	Closterium parvurum Nag.
	Cosmarium repandum Nords.
	Mougeotia sp.
	Oedogonium sp.
	Pleurotaenium trabecula var. Vectum
	Roya sp.
	Scenedesmus arcuatus
	Scenedesmus ovalternus Chod.
	Spirogyra sp.
	Thorea gaudichaudii C. Agardh
Vascular (Flowering)	Hydrilla verticillata (L.F.) Royle

HUMAN ENVIRONMENTAL CONSIDERATION:

Aside from recreational use, the project site is uninhabited. A few homes lie along the south side of Route 17 and a deep swordgrass-lined gorge separates the target area from the Windward Hills Country Club Community to the east. In general, the housing in the area is very good, with families living well within middle to upper income brackets. To provide a forum for public input, households in these areas were given survey forms (sample and replies are in Appendix II). Of the twenty-five homes in the area, 24% of the households completed and return the questionniare for statistical analysis. Results are compiled in Table 3. It is interesting to note that none of the households were air conditioned, most had visited or used wind-electric systems and they were split down the middle, and emphatically so, when asked if they would be agreeable to a WECS in their area.

As discussed in the introduction and survey cover letter (Appendix II), three environmental considerations, all of which can affect nearby residents, are of concern to WECS engineers. The first: possible television interference, is minimized by cable television. As noted in Table 3, 83.3% of those that replied to the survey are cable connected.

The second environmental consideration to nearby humans is system associated noise. Kelley (1982) reports that an investigation into the extent and causes of acoustic noise associated with the operation of WECS has been undertaken by the Solar Energy Research Institute (SERI). Noise problems were not a major concern before 1979. Earlier sound measurements indicated little chance for community annoyance at distances much beyond 6 or 8 rotor diameters. With the installation of the MOD-1 (2 million watt) turbine in North Carolina, General Electric

TABLE 3

Results from the Residental Survey

		% YES	% NO
1.	Do you have Cable TV?	83.3	16.0
2.	Is your house air conditioned most of the time?	0	100
3.	Have you ever visited (or used) a Wind Powered Generator System?	66.6	33.3
4.	Politics and economics aside, would you be agreeable to establishment of a Wind Powered Generation System in the Tarzan area?	50.0	50.0

NOTE: See Appendix II for actual data and residents reasons for or against a WECS.

Company (builder of the MOD-1) received sporadic noise complaints from a few residents living within 2-5 km. Since then, considerable effort has been expended by NASA, SERI and other organizations to determine the characteristics of the noise, its origin and production mechanisms, its propagation path, and what can be done to eliminate or reduce it (Figure 4 and Table 4).

The studies conclude the impulsive sounds are a result of the turbine blades passing through intense, viscous wakes downstream of the tower's vertical support members. The radiated pressure pulse is in the sub-audible range (below 20 Hz). The pulse then interacts with structures thereby causing vibrations and vibration-induced audible thumping. Kelley reports SERI has recommended the installation of a specific type or aerodynamic spoiling device on the support tower to break up air flow into chaotic turbulence thereby substantially reducing the acoustical radiation from large (megawatt) turbines.

To date, there have been no major complaints or noise associated with turbines under 200 kilowatt capacity.

The third possible environmental problem is land use and associated visual pollution that may become an issue with nearby residents. Future land use would probably have to be restricted to the Cotal Reserve. Aesthetics, community attitudes and limited land intrusion would have to be major considerations in any Guam WECS.

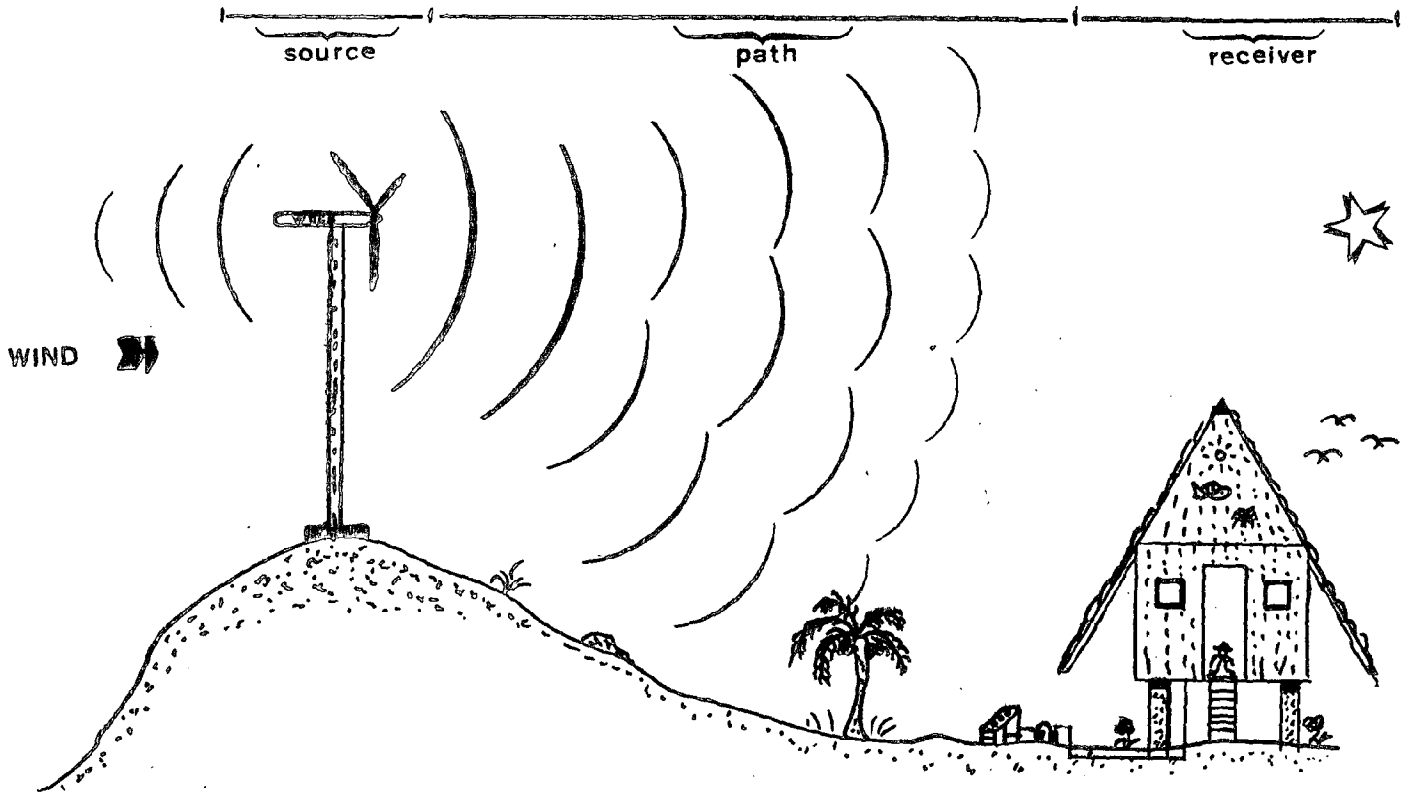

FIGURE 4. Physical parameters responsible for generation, propagation, and perception of WECS noise. See Table 2.

TABLE 4. Physical Parameters Responsible for Generation, Propagation, and Perception of WECS Noise. (Modified from Kelley 1982) see Figure 4.

Source: Generation Parameters

(a) RPM
(b) Windspeed
(c) Inflow turbulence
(d) Wind shear

Path: Propagation of Turbine Noise

(a) Geometric spreading
(b) Atmospheric refraction
(c) Ground reflection

Receiver: Dynamic Coupling to House Structure

(a) Vibration
(b) Vibration - induced noise

RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS, POLICIES AND CONTROLS FOR THE AFFECTED AREA.

Presently, although visitors and hikers unobtrusively visit and leave the area, many off-road vehicles traverse the Cotal Reserve and adjacent private area to the extent of creating or accelerating a semi-badlands condition.

Research at the Bureau of Planning revealed that the Cotal Conservation Reserve is under the jurisdiction of the Department of Parks and Recreation. The adjacent private land is designated as "open space - conservation" by the Bureau in their projected Year 2000 Community Design Plan (Map 8, see Appendix III). The Territorial Planning Commission could designate the area "A" Rural Zone thereby allowing "Utilities and public facilities" (Appendix IV).

No record has been found of any archaeological finds in the area. The territorial archaeologist suggests a reconnaissance survey be conducted to check the probability of disturbing any historical sites.

PROPOSED MITIGATION MEASURES TO REDUCE CONSTRUCTION IMPACT:

The following standard measures should be considered and monitored.

Erosion:	-	Minimize earthwork and disturbing activities.
	-	Employ helicopters for tower raising. (They are cost-effective and don't need roads or cranes.)
	-	Follow a prompt re-vegetation program.
Siltation:	-	Stabilize excavations
	-	Limit activities during rainy seasons
	-	Define and avoid disturbing the existing drainage patterns
Topographic Alteration:	-	Return the environment to its natural state where possible.

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APPENDIX I

Physiochemical Characteristics of the Ylig Drainage System. Analyses conducted in the laboratory of Layne International, Inc., Guam, and is condensed from the report: Austin, Smith & Associates, Inc. 1968. A report covering the surface water survey of the Island of Guam. Prep. for Public Utility Agency of Guam. 78p.

pH	7.7
Methol - Alk $CaCO_3$	156
Turbidity	3.6
Calcium Hardness	13.0
F (ppm)	0.1
Total dissolved solids	240
Clorides (ppm)	16
Total Hardness	15.3
Fe (ppm)	0.072
B (ppm)	0.105
NO_3 (ppm)	0.1
SO_4 (ppm)	2.8
Dissolved O_2 (ppm)	8.0
CO_2 (ppm)	3.5
Micromhos	330
SiO_2 (ppm)	21
Mn (ppm)	0.005
PO_4 (ppm)	0.051
NH_3 (ppm)	0.01
CrO_4 (ppm)	0.05
Ag (ppm)	0.05
CO (ppm)	0.10

APPENDIX II

Bruce Best Tropical Systems
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PHONE 789-2304

August 30, 1984

Hafa Friends,

This is non political.

Please take a few moments to answer the enclosed questionnaire.

My firm is active in research and development of alternate energy and biological systems for tropical islands. Recently, I was asked to assess the impact of a proposed wind power generation system on the physical and natural environment around the Tarzan-Windward Hills area. This area has been suggested as a possible site for a future windfarm.

Environmentally, all politics aside, windfarms are benign. After installation, wind-powered generators do not pollute the air, land or water. There are three environmental considerations, all of which are of concern nearby residents.

First, some turbines can create television interference. Cable television eliminates the problem. Second, there is some noise associated with the motion of the blades. The effect of noise is less with distance, up-wind location, insulation, etc. A third environmental consideration is land use and any potential visual affects. Aesthetics, community impacts and anticipated land use are factors that I will stress in my report.

I would like to include as much community input as possible so please take a couple of minutes to complete and mail the following short questionnaire.

Thank you very much for your time. An analysis of the results of questionnaires received prior to September 10th will be included in my report.

Thank you.

Sincerely,

Bruce Best

BRUCE BEST

Environmental consideration of a proposed Wind Power Generation System along the Cotal-Windward Hills area.

-R E S I D E N T I A L S U R V E Y-

		YES	NO
1.	Do you have Cable TV? I CAN STAND WITHOUT CABLE	(✓)	( )
2.	Is your house air conditioned most of the time? NO AIR CON	( )	(X)
3.	Have you ever visited (or used) a Wind Powered Generator System?	( )	(X)
4.	Politics and economics aside, would you be agreeable to establishment of a Wind Powered Generation System in the Tarzan area?	(✓)	( )

5. Concerning the environment, what are your feelings on a proposed Wind Power Generation System in your area?

IVE BEEN WORKING ON THIS MYSELF TO BUILD ONE FOR ME, FOR THE REASON THAT ONE MORE POWER INCREASE MAY BE I'LL ASK GOVT OF GUAM POWER TO CUT MY POWER. SO KEEP IT UP.

Environmental consideration of a proposed Wind Power Generation System along the Cotal-Windward Hills area.

-R E S I D E N T I A L S U R V E Y-

		YES	NO
1.	Do you have Cable TV?	(X)	( )
2.	Is your house air conditioned most of the time?	( )	(X)
3.	Have you ever visited (or used) a Wind Powered Generator System?	( )	(X)
4.	Politics and economics aside, would you be agreeable to establishment of a Wind Powered Generation System in the Tarzan area?	(X)	( )

5. Concerning the environment, what are your feelings on a proposed Wind Power Generation System in your area?

No Problem.

Environmental consideration of a proposed Wind Power Generation System along the Cotal-Windward Hills area.

-R E S I D E N T I A L S U R V E Y-

		YES	NO
1.	Do you have Cable TV?	(✓)	( )
2.	Is your house air conditioned most of the time?	( )	(✓)
3.	Have you ever visited (or used) a Wind Powered Generator System?	(✓)	( )
4.	Politics and economics aside, would you be agreeable to establishment of a Wind Powered Generation System in the Tarzan area?	( )	NO!!

5. Concerning the environment, what are your feelings on a proposed Wind Power Generation System in your area?

We moved out here for Quiet, the View unobstructed by poles & Wires, and privacy.

I can do without power, except where it is necessary to bring water up from wells.

We have the ocean on all sides.... why don't we use it!

Evelyn Kilgore

Environmental consideration of a proposed Wind Power Generation System along the Cotal-Windward Hills area.

-R E S I D E N T I A L S U R V E Y-

		YES	NO
1.	Do you have Cable TV?	(X)	( )
2.	Is your house air conditioned most of the time?	( )	(X)
3.	Have you ever visited (or used) a Wind Powered Generator System?	(X)	( )
4.	Politics and economics aside, would you be agreeable to establishment of a Wind Powered Generation System in the Tarzan area?	( )	(X)

5. Concerning the environment, what are your feelings on a proposed Wind Power Generation System in your area?

You do not have at the present Time anywhere in "world" That would work on Guam Your right It's non-political It's just another way around for our dear governor To get his commission

Environmental consideration of a proposed Wind Power Generation System along the Cotal-Windward Hills area.

-R E S I D E N T I A L S U R V E Y-

		YES	NO
1.	Do you have Cable TV?	X	( )
2.	Is your house air conditioned most of the time?	( )	(X
3.	Have you ever visited (or used) a Wind Powered Generator System?	X	( )
4.	Politics and economics aside, would you be agreeable to establishment of a Wind Powered Generation System in the Tarzan area?	( )	X

5. Concerning the environment, what are your feelings on a proposed Wind Power Generation System in your area?

ENVIRONMENTALLY UGLY — ALSO RUINS SCENERY. ECONOMICALLY SINCE MOST FORECASTERS EXPECT LOWER REAL ENERGY PRICES NEXT 6 TO 10 YEARS, WINDPOWER WOULD HAVE TO COME IN AT HALF OR LESS OF CURRENT POWER RATES.

Environmental consideration of a proposed Wind Power Generation System along the Cotal-Windward Hills area.

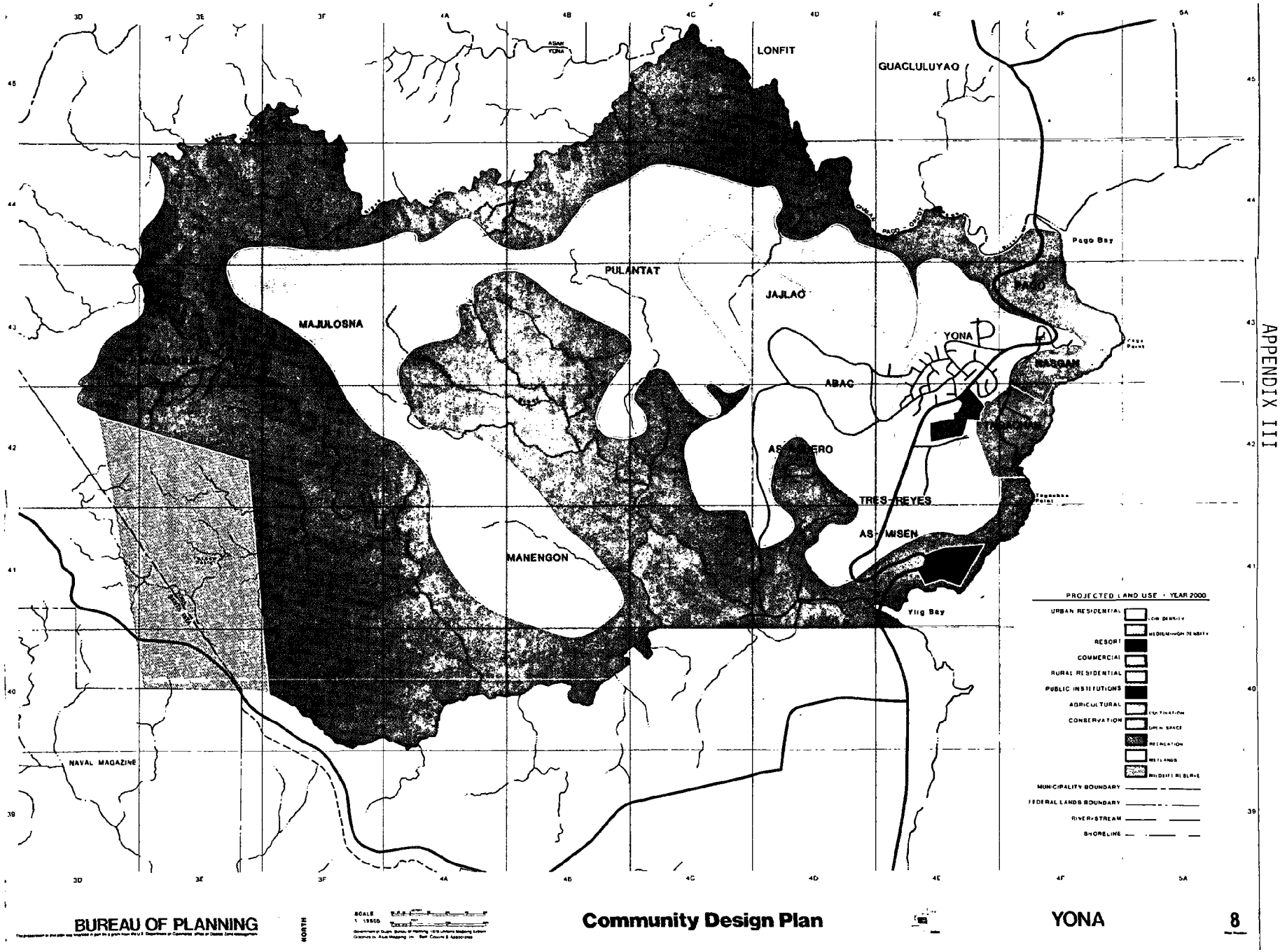
-R E S I D E N T I A L S U R V E Y-

		YES	NO
1.	Do you have Cable TV?	( )	(X)
2.	Is your house air conditioned most of the time?	( )	(X)
3.	Have you ever visited (or used) a Wind Powered Generator System?	(X)	( )
4.	Politics and economics aside, would you be agreeable to establishment of a Wind Powered Generation System in the Tarzan area?	(X)	( )

5. Concerning the environment, what are your feelings on a proposed Wind Power Generation System in your area?

Aesthetics are important. A system utilizing less oil or coal is more important.

Good luck
We all need it.



BUREAU OF PLANNING

NORTH

SCALE 1 : 15000

Community Design Plan

YONA

8

G10-10.206 b

Volume 2 of 2

C10-10.206

APPENDIX IV

Guam Coastal Management Program and Draft Environmental Impact Statement

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Office of Coastal Zone Management

§ 17103. "A" rural zone.
(a) Use Permitted
1. One-family dwellings and duplexes.
2. Farming and fisheries, including all types of activities and pursuits customarily carried on in the field of agriculture and fisheries, including the raising of crops and fruits, poultry and livestock, grazing and dairying, tree and other vegetative production, whether for commercial or personal uses.
3. Uses customarily accessory to any of the above uses including home occupations, and private automobile parking areas as well as accessory buildings and structures such as private garages, warehouses, barns, corrals, or other similar structures.

(b) Conditional Use
1. Parks, playgrounds and community centers.
2. Biological gardens.
3. Schools and churches.
4. Hospitals, sanitariums, and institutional uses.
5. Cemeteries.
6. Recreational use including golf courses, cockpits, marinas, beaches, swimming pools, and accessory residential and commercial use.
7. Extractive industry.
8. Utilities and public facilities.
9. Wholesale and retail stores, shops and businesses.
10. Automobile service stations, including service shops.
11. Accessory uses and structures for the above.

§ 17104. "R1" one-family dwelling zone.
(a) Use Permitted
1. One-family dwellings.
2. Gardening and the keeping of pets for noncommercial purposes.
3. Use customarily accessory to any of the above uses including home occupations and private parking areas with accessory buildings and structures.

(b) Conditional Use
1. Duplexes.
2. Schools and churches.
3. Parks, playgrounds and community centers.
4. Health service office, outpatient with laboratory.
5. Utilities and public facilities.

§ 17105. "R2" multiple dwelling zone.
(a) Use Permitted
1. One-family dwellings.
2. Duplexes.
3. Multi-family dwellings.
4. Hotels, private groups and institutions.
5. Accessory uses and structures for the above.

(b) Conditional Uses
1. Any conditional use permitted in the "R1" zone.
2. Health clinics.
3. Utilities and public facilities.
4. Air, bus, taxi, auto, rental terminals.
5. Accessory uses and structures for the above.

§ 17106. "C" commercial zone.
(a) Use Permitted
1. One-family dwellings.
2. Duplexes.
3. Wholesale and retail stores, shops and businesses.
4. Amusement enterprises.
5. Automobile service station, including minor repairs.
6. Bakeries.
7. Mortuaries.
8. Offices, business or professional, and banks.
9. Personal service shops, including barber shops, beauty parlors, laundromats, and the like.
10. Repair shops and service shops, including shoe repair shops, plumbing shops, dressmaking shops, and the like, but not including, automobile repair shops for major work.
11. Restaurants and cafes.
12. Studios.
13. Other uses which in the judgment of the Commission, as evidenced by resolution in writing, are similar to those listed herein.

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