Environmental Impact Assessment
Of
The Balam Jungle Estate Development

Corozal District, Belize Central America

To Be Undertaken By:

Balam Investments LLC

Dr. h. c. Hartmut Porsch, Managing Member

September 2007






Prepared By:

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[1]Team References Are Shown In **Addendum 1**.

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LIST OF ABBREVIATIONS

Ac	Acres (area)
AIA	Archaeological Impact Assessment
BEL	Belize Electricity Limited
BERT	Belize Emergency Response Team
BJE	Balam Jungle Estate
BP	Before Present
BRL	Barrier Reef Lagoon
BTU	British Thermal Units
COD	Chemical Oxygen Demand
CG	Confluent Growth
DOE	Department of the Environment
EIA	Environmental Impact Assessment
Ft, ft	Feet, Foot
Gal, gal	Gallon(s)
GPM	Gallons per Minute
Ha, ha	Hectares (area)
In, in	Inches
Kg, kg	Kilograms
Km, km	Kilometers
kW	Kilowatt
M	Millions, Meters
mg	Milligram
mm	Millimeters
M M^3	Million Cubic Meters
mph	Miles per Hour
MSW	Municipal Solid Waste
MT, mt	Metric Ton
mW	Megawatts
NEMO	National Emergency Management Organization (BZ)
NICH	National Institute of Culture and History
NOAA	National Oceanic and Atmospheric Administration (US)
ppm	parts per million
RDZ	Residential Tourism Zone
REA	Rapid Ecological Assessment
TDZ	Timber Development Zone
TNTC	Too Numerous To Count
TSS	Total Suspended Solids

EXECUTIVE SUMMARY

DEVELOPMENT PROFILE

The project planned for development is being proposed by Dr. h. c. Hartmut Porsch of Miami Florida in the United States, sole managing member of Balam Investments LLC, which is a limited liability company registered in Nevada in the United Sates (see **Addendum 2**). The company is proposing to undertake a timber export and residential tourism development on approximately 85,000 acres of land comprising the Balam Jungle Estate (BJE), near to Shipstern village, in the Corozal District of Belize (see **Illustrations 1** - **3**).

Commercial timber operations will entail selective cutting of hardwoods from approximately 44,345 acres of upland broadleaf forest, in 5 sequential stages over a period of 25 years. The first and subsequent (5-year) stages of timber operations will entail the selective harvest, milling and export of approximately 3.7 M Bd/Ft of hardwoods from 8,869 acres of broadleaf forest in accordance with a timber management plan that has been approved by the Belize Forestry Department.

The residential tourism development will entail placement of 25,000 domicile units on 25,784 acres of coastal scrub (Glady) forest & savanna in 5 sequential stages over a period of 25 years. The first (5-year) stage of domicile development will entail the establishment of 5,000 units, a golf course, 2 marinas and other amenities on approximately 7,480 acres of land & 2,020 acres of coastal lagoon (see **Illustrations 4** & **5**). The 5,000 units will include 1,470 apartment/condominiums; 1,189 town homes; and residences for 2,073 1/5th acre lots; 571 half acre lots; 83 one acre lots, and 114 two acre lots. The apportionment of units and amenities in subsequent stages of the residential tourism development will be determined by prevailing market conditions at the time of commencement.

Stage-1 roof space area at capacity development will be on the order of 10.9 M square feet, or approximately 250 acres, which represents 18% of the 1,383 acres of land allocated for roof space development (i.e. including units & amenities), or < 3% of the total 9,500 acres of land allocated for Stage-1 development. All structures will be accessible from public carriageways extending throughout the proposed development site. Land allocation for carriageway and canal placements will be on the order of 917 acres, for a combined infrastructure footprint of approximately 2,297 acres, or 24% of the entire Stage-1 land allocation. Consequently, residual green (and wet) space will be on the order of 7,203 acres, or approximately 76 % of the entire 9,500 acre Stage-1 development site.

Power supply for the development will be obtained from Belize Electricity, with diesel self-generation for backup electricity supply in the short term. Long term power supply however, will be derived from a combination of Belize-based hydroelectricity, onsite development and use of bio-fuels, and sequestration-positive timber management, which will go a long way toward making the development carbon-neutral. Potable water supply for the development will be processed from canal and/or sea water abstracted from Chetumal Bay. Effluent discharge from the development will be treated by a matrix of batch plants with grey water used to irrigate the golf course and effluent from swimming pools settled in ponds before discharge. Solid waste will be source separated on site, and the fraction that cannot be either safely reduced or stored on site, will be transported and stored at the nearest designated regional solid waste storage facility, in keeping with the national solid waste management plan. The environmental impact assessment described herein addresses all 10 phases of development, for which the proponent has been referred to seek environmental clearance (see **Addendum 3**). The primary characteristics of the development are summarized in **Table 1**.

ILLUSTRATION 1:

LOCATION MAP OF THE PROPOSED DEVELOPMENT IN BELIZE

ILLUSTRATION 2:

1990 LANDSAT 5 TM IMAGE (BANDS 453) OF THE BALAM JUNGLE ESTATE

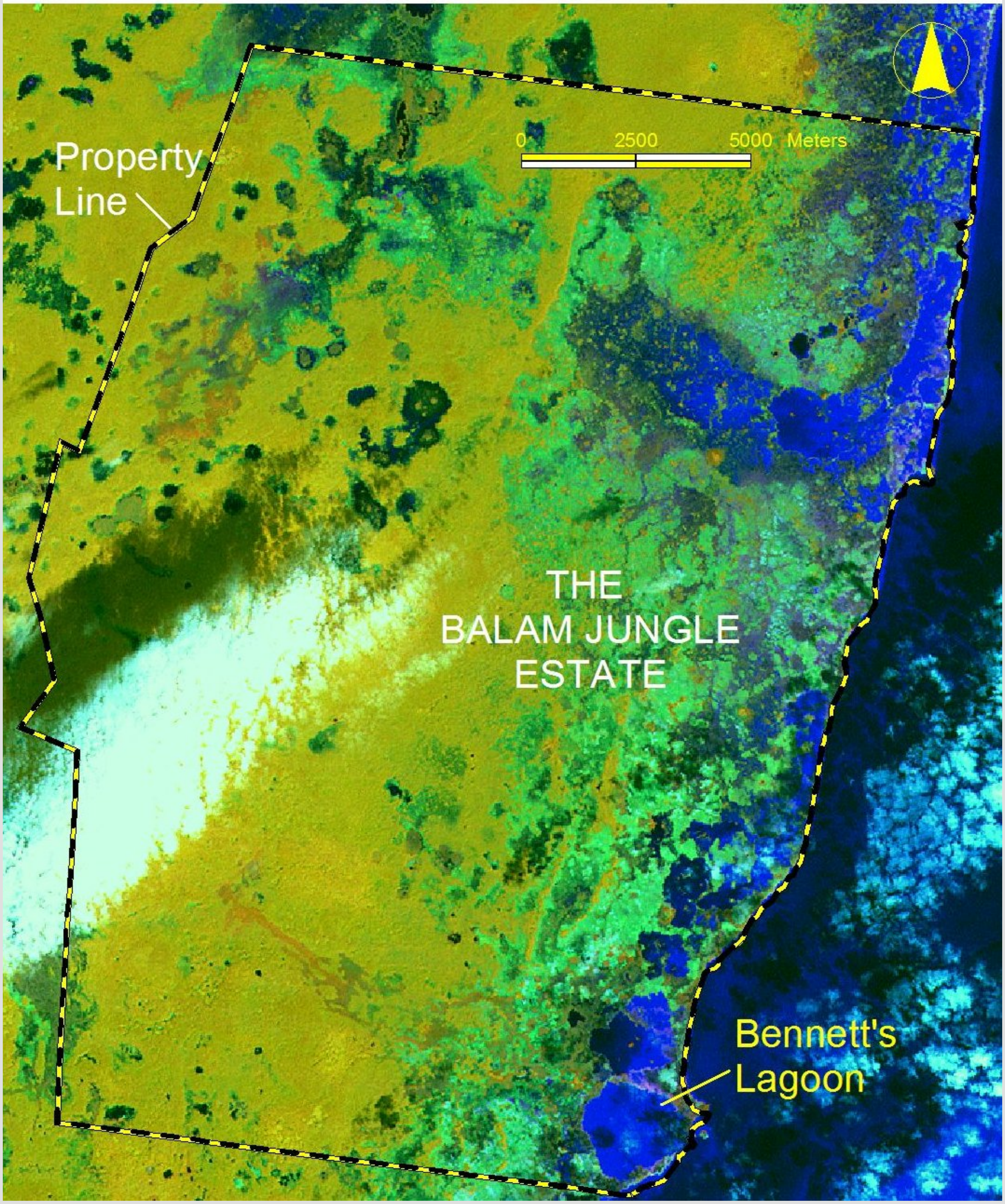


ILLUSTRATION 3:

THE 10 STAGES OF DEVELOPMENT PLANED FOR THE BALAM JUNGLE ESTATE

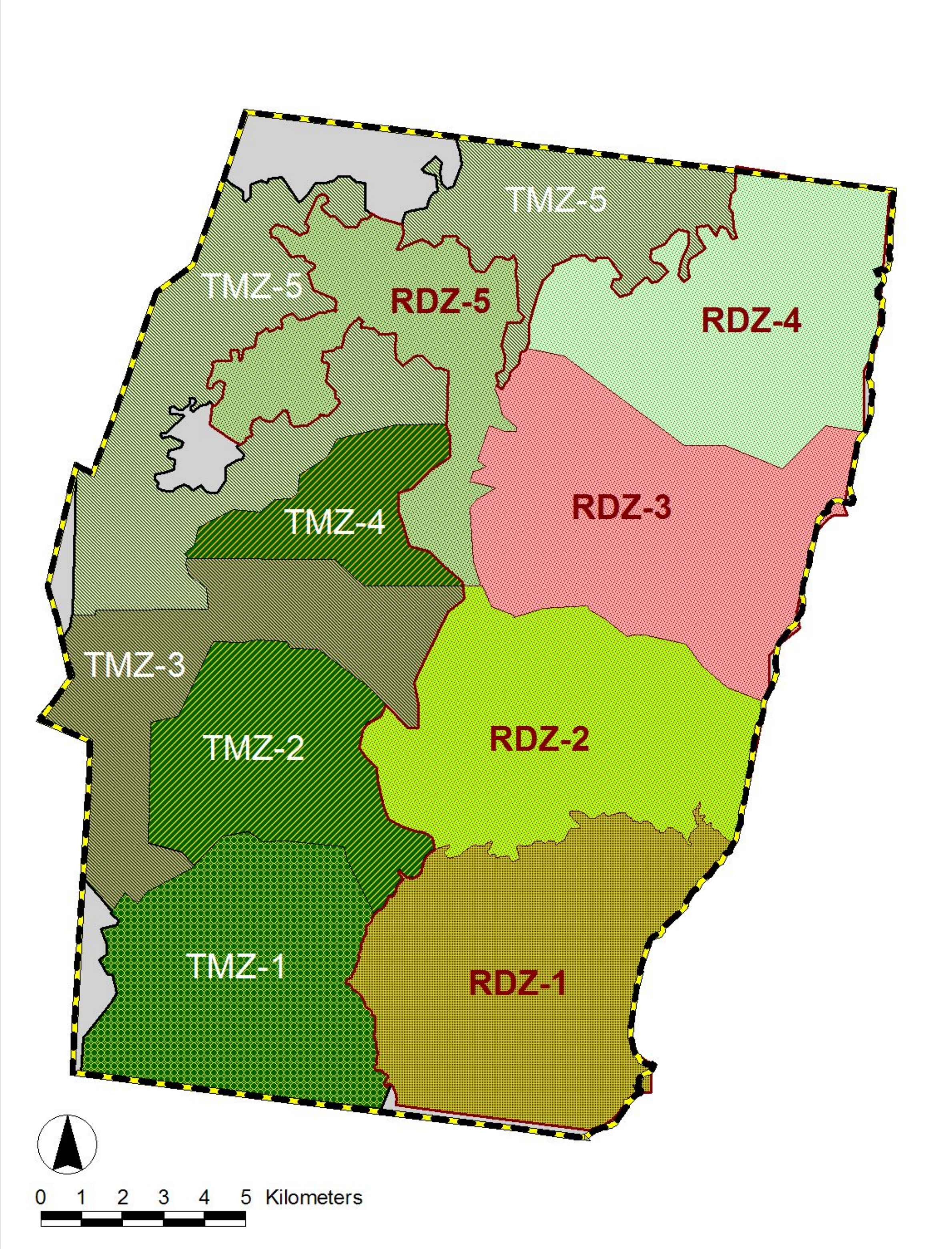


ILLUSTRATION 4:

MASTER PLAN FOR THE SECTION 1 DEVELOPMENT

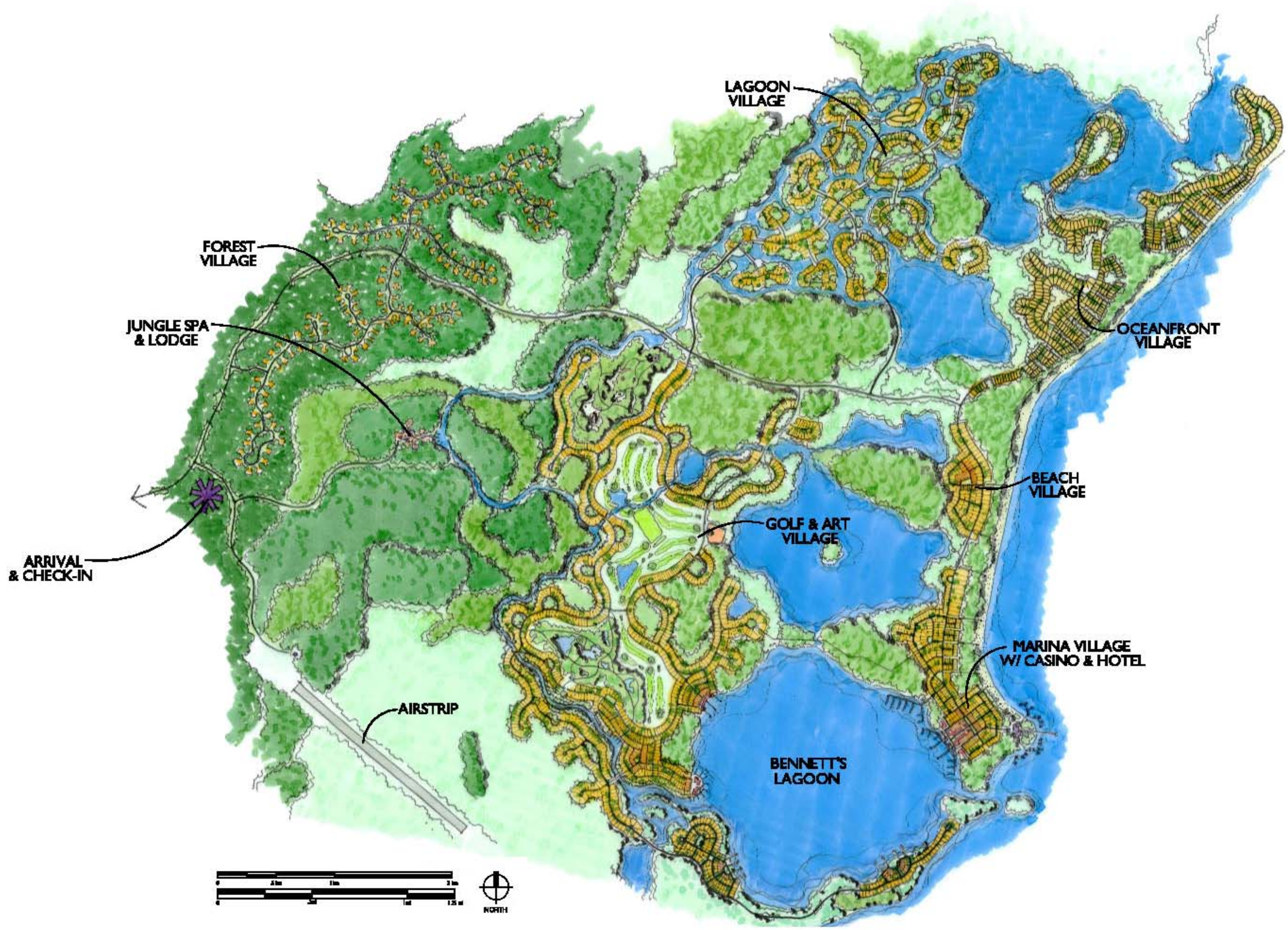


ILLUSTRATION 5:

PHASES OF THE SECTION 1 DEVELOPMENT

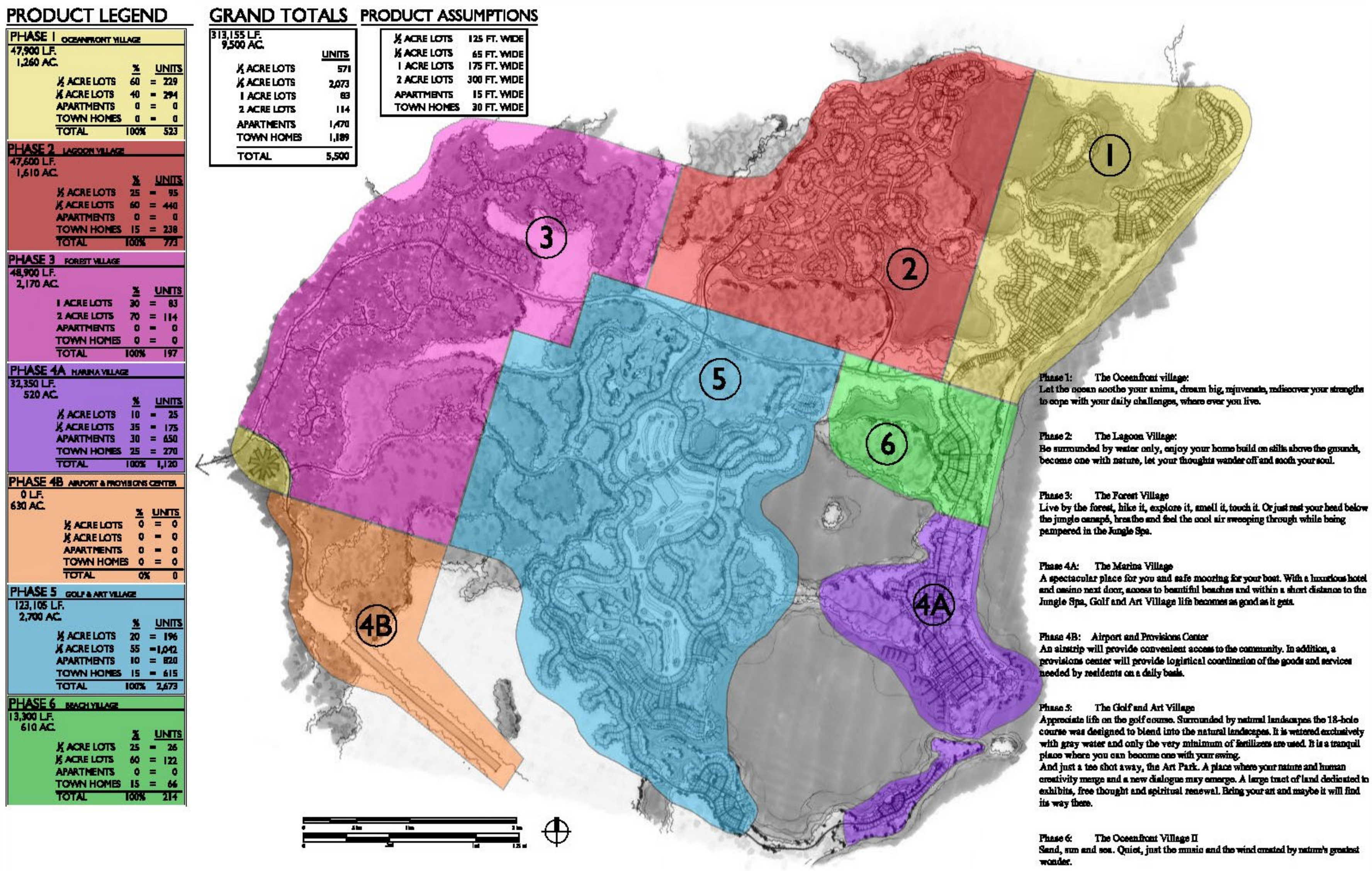


TABLE 1

PRIMARY CHARACTERISTICS OF THE PROPOSED DEVELOPMENT

FEATURE	PARAMETER
Subject Request:	Environmental Clearance For Development
Type of Development:	700 Unit Hotel Space; 5,500 Residential Units; Marina & Commercial Space
Total Capital Investment:	≥ US $ 100 m
Labor and Management:	Local, with limited expatriate management support
Land Characteristics	
Total Property Area	85,000 Acres
Workable Land Unit	72,725 Acres
Development Plan	70,000 Acres
Development Plan as Percent of Workable Land Unit (Per Stage)	22%
Design Capacity	
Maximum Human Occupation (Guests & Staff)	< 30,000
Employment	
Construction Phase	≥ 500
Operating Phase	≥ 2,500
Wildlife	
Number of Dependent Species:	> 500
Endangered, Threatened or Vulnerable Species	
Ecosystems / Plants:	Lowland Broadleaf Forest
Anurans & Reptiles:	Numerous
Birds:	Double-Crested Cormorant & Black Catbird
Mammals:	Predator Cats, Game & Manatee

ECOSYSTEM AND WILDLIFE CONSERVATION PLAN

A rapid ecological assessment (REA) of the 95,723-acre Balam Jungle Estate was conducted during two field visits spanning a total of 8 field days during May and June 2007. Previously published reports specific to the Balam Jungle Estate produced by Wildtracks (2003) and Mendoza (2006) were reviewed and consulted during the project. The land cover classification completed by Wildtracks (2003) and utilized in the Sustainable Forest Management Plan (Mendoza 2006) identified 12 vegetation types within the BJE using both satellite imagery and ground-truthing techniques (see **Illustration 6**). These vegetation types follow the nomenclatural designations outlined in the Central American Ecosystems Map for Belize (Meerman and Sabido, 2001). The vegetation types identified within the BJE include:

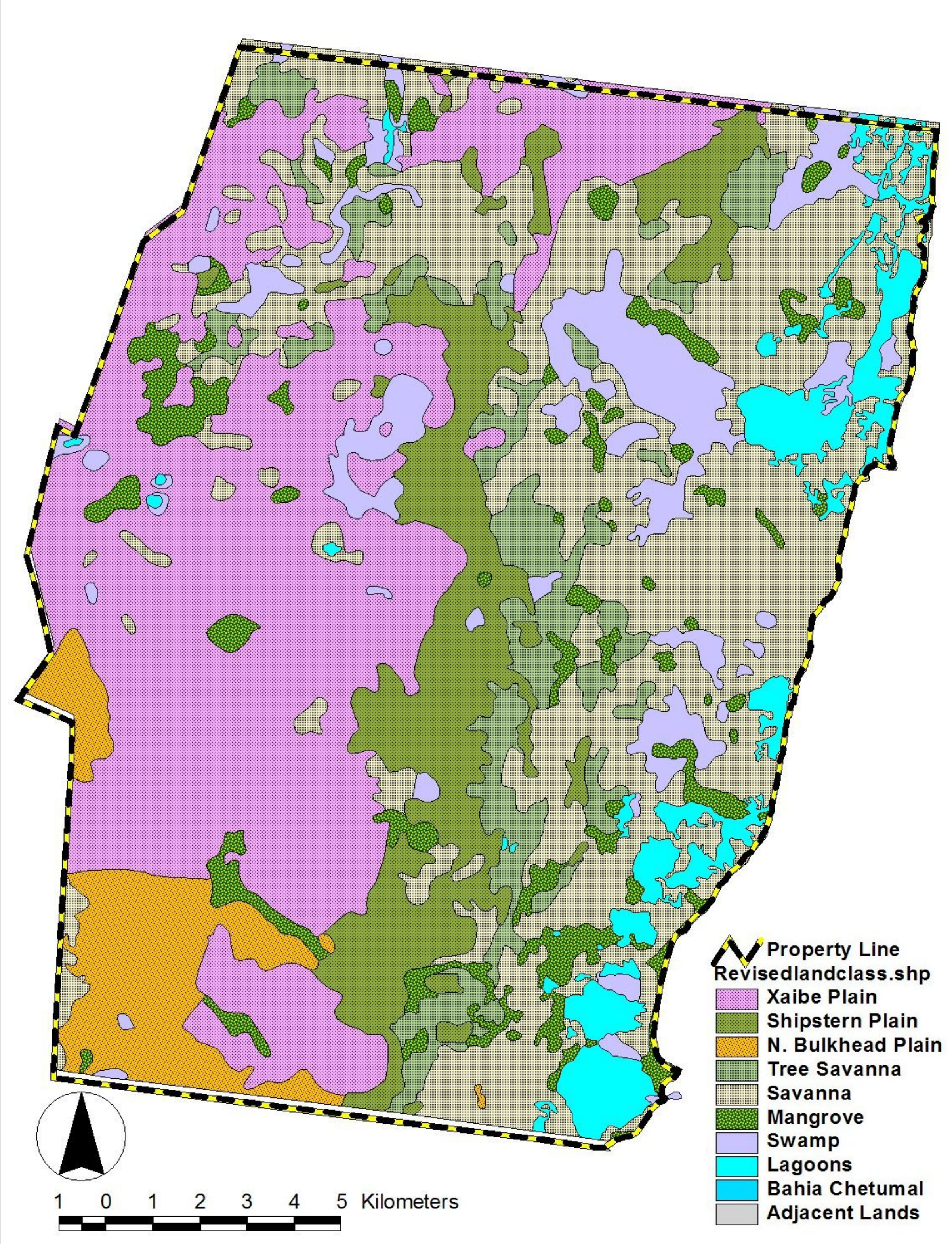
- *Tropical Evergreen Seasonal Broadleaf Lowland Forest Over Calcareous Soils: NE Variant;*
- *Tropical Evergreen Seasonal Swamp Forest Of Northern Belize (High Variant);*
- *Tropical Evergreen Seasonal Swamp Forest Of N Belize (Low Variant);*
- *Tropical Semi-Deciduous Broadleaf Lowland Forests;*
- *Broadleaved Lowland Shrubland: Leguminous Variant;*
- *Tropical Lowland Tall Herbaceous Swamp;*
- *Permanently Waterlogged Freshwater Mangrove Scrub;*
- *Basin Mangrove Forests;*
- *Mixed Mangrove Scrub;*
- *Dwarf Mangrove Scrub;*
- *Marine Salt Marsh With Many Succulent Plants;*
- *Tropical Littoral Forest And Beach Communities ;*
- *Coastal Fringe Rhizophora Mangle –Dominated Forests;*

Of these 13 vegetation types, five comprised greater than 90% of the land area within BJE while the remaining eight ecosystem types comprise ca. 6.8% of land area (Wildtracks 2003:22). As such, the systematic sampling of vegetation and birds occurred primarily in the five largest land cover; these include: *Tropical Evergreen Seasonal Broadleaf Forest Over Calcareous Soils: Northeastern Variant* (31.4%), *Marine Salt Marsh With Many Succulent Species* (21.1%), *Dwarf Mangrove Scrub* (13.6%), *Tropical Evergreen Seasonal Swamp Forest Of Northern Belize: High Variant* (12.9%), And *Permanently Waterlogged Freshwater Mangrove Scrub* (10.6%).

The timber management zone, which has been previously disturbed by ongoing logging operations, encompasses approximately 44,345 acres (42%) of the BJE and forms the flat plain subunits belonging to the Xaibe and Northern Bulkhead Plain land systems described by King *et al* (1992). These land systems are primarily composed of *Tropical Evergreen Seasonal Broadleaf Lowland Forest Over Calcareous Soils: NE Variant* habitat (which is perhaps the most species rich, and highly disturbed ecosystem within the BJE), and the *Tropical Evergreen Seasonal Swamp Forest Of Northern Belize: High Variant* habitat, respectively (see **Illustration 6**).

ILLUSTRATION 6:

LAND COVER CLASSIFICATION OF THE BJE DEVELOPMENT SITE



The residential tourism zone, which has not been previously disturbed to any significant extent, will eventually encompass 37,400 acres (39%) of the BJE and form the Glady Forest Plain within the Shipstern Plain land system, along with the tree savanna & savanna subunits of the Corozal Saline Swamps land system described by King *et al* (1992). The Glady Forest Plain is primarily composed of *Tropical Evergreen Seasonal Swamp Forest Of Northern Belize: High Variant* habitat; and the tree savanna & savanna land units are primarily composed of *Marine Salt Marsh With Many Succulent Plants*; *Tropical Littoral Forest And Beach Communities*; and *Coastal Rhizophora mangle Forest* habitats (see **Illustration 6**).

While the *Tropical Evergreen Seasonal Broadleaf Lowland Forest Over Calcareous Soils: NE Variant,* habitat of the timber management zone is of particular conservation interest for the level of disturbance to which it is presently being exposed, the latter three coastal habitats of the residential tourism zone are also of particular conservation interest because they were reported to be under protected in the last comprehensive assessment of Belize ecosystems (Iremonger & Brokaw, 1995), and will be likely to be disturbed in part by the proposed development activities. The 1995 assessment recommended a minimum conservation area of 10% of any given ecosystems extent, and subsequently established that the conservation shortfall for *Marine Salt Marsh With Many Succulent Plants*; *Tropical Littoral Forest And Beach Communities*; and *Coastal Rhizophora mangle Forest* habitats in Belize was 302/8,778-acres (3.7%); 182/1,821-acres (10%), and 815/1,851-acres (5.6%), respectively. The 9,500-acre Stage 1 residential development will result in disturbance of approximately 4,178 acres of *Marine Salt Marsh*; 100 acres of *Littoral Forest*; and removal of 100 acres of *Coastal Rhizophora mange Forest*; or all of their present extent within the Stage 1 development through canal excavation, landfill and beach revetment activities.

Terrestrial and marine wildlife of the project site encompasses a wide range of plants, anurans, reptiles, birds and mammals (see **Illustration 7**), those species of which having particular conservation interest are itemized in **Table 2**. The overall ecosystem and wildlife conservation plan for the proposed development is based on the developer's intent to (1) minimize impacts on resident wildlife within the timber management zone by improving stem yield per unit measure of new logging road construction; (2) observe design measures that exclude species-rich wetlands and cultural sites from the overall foot print of the development; (3) defend the prevailing extent of littoral / beach forest communities important to migrant birds by undertaking beach revetment in seaward direction; and (4) observe Manatee conservation guidelines, and improve near-shore sea grass and Manatee habitat above prevailing conditions by creating offshore channels from dredging activities that are more favorable to sea grass growth and Manatee movement through the area.

LEGAL, POLICY AND ADMINISTRATIVE FRAMEWORK

The legal, policy and administrative framework relevant to the proposed development delineate the obligations and responsibilities of the project proponent as well as those of the Government of Belize with respect to conservation practice. This framework is loosely embodied by international conventions and treaties, the laws of Belize (revised 2000), and policy guidelines developed by national institutions from time to time.

ILLUSTRATION 7:

ENVIRONMENTAL FEATURES OF THE PROPOSED DEVELOPMENT SITE

Key:

Top Row, (left to right): Aerial photo of the *Tropical Evergreen Seasonal Broadleaf Lowland Forest Over Calcareous Soils: NE Variant* habitat within the forest management zone; Colorful forest grasshopper; and the well known Wood Stork (*Mycteria americana*) colony. **Bottom Row** (left to right): Landscape mosaic typical of coastal savanna hummocks; fruit of the Laurel (*Cordia dodecandra*); Surface scatter of ancient Maya pottery shards found within the savanna hummock.

TABLE 2

KEY WILDLIFE SPECIES OF CONSERVATION INTEREST

Common Name	Scientific Name	Status	Comments
Mahogany	*Swietenia macrophylla*	Endangered (IUCN)	Many Saplings Within BJE
Fiddlewood	*Vitex gaumeri*	Endangered (IUCN)	Very Common Within BJE
Casque-Headed Tree Frog	*Triprion pentasatus*	Indicator Of Disturbed Habitats	Not Seen Within BJE
American Crocodile	*Crocodylus acutus*	CITES I Endangered Specie	Rare Within BJE
Morelet's Crocodile	*Crocodylus moreletii*	CITES I Endangered Specie	Common Within BJE
Black Catbird	*Melanoptila glabrirostris*	CITES I Endangered Specie	Common Within BJE
Great Curassow	*Crax rubra*	CITES I Endangered Specie	Common Within BJE
Jaguar	*Panthera onca*	CITES I Endangered Specie	Common Within BJE
Ocelot	*Leopardus pardalis*	CITES I Endangered Specie	Common Within BJE
Margay	*Leopardus wiedii*	CITES I Endangered Specie	Common Within BJE
Kinkajou*	*Potos flavus*	CITES I Endangered Specie	Common Within BJE
Collared Peccary	*Pacari tajacu*	CITES I Endangered Specie	Common Within BJE
White-Lipped Peccary	*Tayassu pecari*	CITES I Endangered Specie	Common Within BJE
Baird's Tapir*	*Tapirus bairdii*	CITES I Endangered Specie	Common Within BJE
West Indian Manatee	*Trichechus manatus*	CITES I Endangered Specie	Common Within BJE

International Conventions and Treaties

There are a number of international conventions and treaties that Belize has enjoined which are principally concerned with conservation practices and compliance at the national level (see **Table 3**). The key conventions of particular relevance to the proposed development concern the *International Convention on Biological Diversity*, and the *Central American Biodiversity Convention,* which specifically address conservation of biodiversity, sustainable use and sharing the benefits of biodiversity.

The proposed development serves to reinforce these conventions through (1) allocation of lands (green space) for exclusive conservation use; and preservation of native species and wildlife corridors through exclusion of fencing in general; and (2) recognition of Conservation efforts for Manatee by development of a overall conservation and navigational regulatory plan based on the Belize Coastal Zone Management Authority & Institute and Manatee Specialist Nicole Auil recommendations for Manatee conservation (see **Addendum 5**)

CITES (Convention on International Trade in Endangered Species) guidelines for conservation of rare, threatened and endangered species will also be adhered to by the proposed development as no ranked or protected species will be captured, traded or eliminated by the proposed development. Consequently none of the proposed development's activities are anticipated to present any unmitigated conflict(s) with Belize's existing framework of conservation conventions and treaties.

Laws of Belize

The governing component of the legal framework is provided by the Substantive Laws of Belize, revised in 2000, the principle acts of which that are likely to be relevant to the proposed development being itemized in **Table 3**. Key points of contact between Belize's national legislation and the proposed development include the following:

- *The Forestry Act (Chapter 213)* provides for the collection of fees for the removal of mangrove forest based on a rate of \$ 0.40 per tree removed. The harvest of several other tree species requires payment of such royalties to the Forestry Department. Although the Act applies to forest reserves and public lands generally, forest products removed from private land appear to be subject to such charges under specific declaration by the Ministry, only.

- *The Environmental Protection Act (Chapter 328)* confers authority to the Department of the Environment for the regulation of pollution, effluent discharge limitations and environmental impact assessments. In particular, effluent regulations under this act define select parametric limits for effluent discharge as being $\leq$ 50 ppm BOD_5 (at 20 °C), $\leq$ 100 ppm COD, $\leq$ 100 ppm total suspended solids (TSS), $\leq$ 3 ppm for nitrates (NO_3^-), $\leq$ 1 ppm for total ammonium (NH_4^+), $\leq$ 5 ppm for phosphate (PO_4^{3-}), and 0-10 MPN/100 ml for total Coloform and total fecal Coloform bacteria.

TABLE 3

LEGISLATION RELEVANT TO THE DEVELOPMENT

(For a complete listing of the substantive laws of Belize, revised 2000, see **Addendum 4**)

INTERNATIONAL CONVENTIONS AND TREATIES:

- Convention on Biological Diversity
- Protocol Concerning Specially Protected Areas and Wildlife
- Land-Based Sources of Pollution Protocol
- Convention for the Conservation of Biodiversity and Protection of Priority Areas in Central America
- Central American Biodiversity Convention
- Agreement on Co-Operation for the Protection and the Improvement of the Environment and the Conservation of Natural Resources in the Border Zone
- The Convention On International Trade Of Endangered Species (CITES)

LAWS OF BELIZE:

TITLE V Social Services, Health and Education:

- The Social Security Act Chapter 44

TITLE VI Revenue and Currency:

- The Customs Regulation Act Chapter 49
- The Income and Business Tax Act Chapter 55
- The Land Tax Act Chapter 58
- The Sales Tax Act Chapter 63

TITLE XVI Property and Land Law:

- The Belize Land Development Authority Act Chapter 181
- The Lands Utilization Act Chapter 188
- The Landlord and Tenant Act Chapter 189
- The Law of Property Act Chapter 190
- The Strata Titles Act Chapter 196

Continued…

TABLE 3

LEGISLATION RELEVANT TO THE DEVELOPMENT

(*Continued*)

TITLE XVIII Forests, Agriculture, Livestock and Fisheries:

- The Forest Act, Chapter 213
- The Pesticides Control Act Chapter 216
- The Wildlife Protection Act Chapter 220

TITLE XIX Resources and Utilities:

- The Water and Sewerage Act Chapter 222
- The Solid Waste Management Authority Act Chapter 224

TITLE XXIII Commercial Law:

- The Companies Act Chapter 250
- The Limited Liability Partnerships Act Chapter 258

TITLE XXVI Trade and Commerce:

- The Belize Tourism Board Act Chapter 275
- The Belize National Tourism Council Act Chapter 276
- The Hotels and Tourist Accommodations Act Chapter 285

TITLE XXVIII Labor and Trade Unions:

- The Labor Act Chapter 297
- The Wages Council Act Chapter 302
- The Workmen's Compensation Act Chapter 303

TITLE XXXII Environmental Regulation and Control, Culture and History:

- The Environmental Protection Act Chapter 328

  Statutory Instrument No. 94 of 1995 (Effluent Limitations)

  Statutory Instrument No. 107 of 1995 (Environmental Impact Assessments)

  Statutory Instrument No. 56 of 1996 (Pollution Regulations)
- The Coastal Zone Management Act Chapter 329

TITLE XXXIII Regulation and Control of Miscellaneous Matters:

- The Private Works Construction Act Chapter 337

…End

Background (pre-existing) values for these parameters were 1.1 – 4.4 ppm for H_2S; 0.8 – 1.5 ntu for TSS, 0.3 – 1.8 for Nitrate; 0 - 1 ppm for total Ammonium, 0 – 425 Total Coloform /100 mls; and 0 – 421 Fecal Coloform /100 mls; suggesting that background levels for H_2S, Ammonium and Total Coloform exceed regulatory standards. The batch plant treatment scheme planned for use have effluent specifications that surpass background values at 20:30:30 (i.e. 20 ppm BOD_5, 30 ppm TSS and 20 ppm Ammonium Nitrogen) but independent tests of the batch plants planned for use have reported effluent values of 8:13:3.3 the former two of which are superior to regulatory standards.

- *The Private Works Construction Act (Chapter 337)* requires the proponent to obtain a license from the Minister (unspecified) "….to construct any …pier, …, or fill up any land on the shore of the sea or bank of any river in any part of Belize other than Belize City". The proposed development plans to establish two piers but fill no land along the shore of the sea or bank of any river, and therefore must seek permission from the Minister (unspecified) for pier placement.

- *The Land Utilization Act (Chapter 188)* empowers the Land Utilization Authority and delineates the application procedures for the subdivision of land.

- *The Mines and Minerals Act (Chapter 226)* states under PART IV, SECTION 79 (2) in respect of a *Quarry Permit* that "…no permit shall be required in the following cases- … (b) the owner or occupier of private land taking construction minerals from such land for the construction of buildings, dams roads and similar works on such land for his own use or that of his employees…". This section of the Act implies that the private land excavation for canals and lagoons and replacement of the material within the property as fill is not subject to royalty charges, fees or permitting requirements as would be the case were the materials in question were removed from the sea or public lands.

National Development Guidelines

The planning jurisdiction of the proposed development site falls within unregistered areas, and otherwise does not fall within the planning jurisdiction of Orange Walk or Corozal. However, generalized development guidelines have been embodied within common practices and policy guidelines of the Land Utilization Authority and Department of the Environment, which generally require roof coverage to be $\leq$ 30 % of any given entitlement; and batch plant level technology use for any residential system not incorporated into an urban sewage system.

IMPACTS AND MITIGATION

The only unavoidable, negative impacts posed by the proposed development concern the reduction of native land cover from creation of conveyances within both the forest management and residential tourism zones; and from increased use of exterior land and sea conveyances to access the Balam Jungle Estate itself. These impacts can only be *fully* mitigated by non-development. Aside from these unavoidable impacts, the development's overall design plan and the mitigation measures identified herein will considerably limit the potential for otherwise avoidable negative impacts to result from the proposed development's placement (see **Table 4**).

Potential avoidable negative impacts that will be of key importance to observe the stated mitigation measures for include: (1) forest edge increase and further aggravated fractionation from capricious logging trail development within the forest management zone; (2) colloid, chemical, petroleum and nutrient-based contamination of ground water and/or newly created canals, existing coastal lagoons and near shore waters within the residential tourism zone; (3) incremental fire risk to the savanna and broadleaf forest habitats within both the forest management and residential tourism zones; (4) increased risk of rookery abandonment by Woodstorks and other wading birds, along with degradation of found cultural sites with the BJE from unmanaged tourism visitation; and (5) increased risk of manatee Mortality from pollution and/or boating related injuries.

The positive social impacts of the project include the creation of jobs and foreign exchange earnings for Belize. Stage-1 of the proposed development *alone* is anticipated to require USD $ 100 M in investment, create more than 500 construction jobs, and earn in excess of US $ 50 M in foreign exchange per year from construction and operating activities at capacity development. The company is presently seeking environmental clearance for the proposed development, which is the subject of the environmental impact assessment presented herein. The project is scheduled to commence development in early 2008 on referral for clearance.

TABLE 4

KEY DEVELOPMENT IMPACTS AND MITIGATION MEASURES

POSITIVE IMPACT OPPORTUNITIES	AVOIDABLE NEGATIVE IMPACT RISKS	RECOMMENDED MITIGATION MEASURES
Jobs & Foreign Exchange Revenues	Increased Risk Of Pollution In Coastal Marine Habitats ~~~~~ Increased Fire Risk To Broadleaf Forests & Coastal Savanna Habitats ~~~~~ Increased Risk Of Wildlife Emigration In Response To Tourism Visitation & Boat Use	Use Practical Design, Construction & Operation Measures To Manage Or Prevent Release Of Toxic Compounds ~~~~~ Manage Fire Risks Through Training, Equipment Outfitting & Maintaining Fire Breaks ~~~~~ Implement Measures To Manage Tourism Access & Boating Practices Within And Approaching The Development Site

1. THE PROJECT DESCRIPTION

1.01 Give the exact location of the project and provide proof of ownership of the parcel of land comprising the project site. Include a copy of a lease document or land title.

1.02 Describe the following characteristics of the proposed development:

a. The layout plan for the overall development, including siting of all facilities such as residential buildings, condominiums, hotel/resort facilities, water treatment facilities, sewage treatment facilities, canal network, power generation/fuel storage facilities, marina/docking facilities, feeder roads, drainage/canal facilities, carriageway, storage facilities, administrative buildings/complexes.

b. The physical plan for development, including the siting and rationale of all facilities and infrastructure, such as feeder roads.

1.03 Describe briefly the facilities provided in the plans above (1.02 a and 1.02 b)

1.04 Provide specifications and detailed designs for the following:

a. Collection and disposal systems for solid waste;
b. Sewage collection, disposal and treatment systems;
c. Water source, treatment and distribution systems;
d. Marinas, piers, docking facilities and related infrastructure;
e. Canal Network; and
f. Carriageway.

1.05 Give detailed information on any water sports activities that will be carried out in the area (if applicable).

1.06 Give detailed information on management and disposal of wastewater originating from the swimming pools (include information on water quality monitoring).

1.07 Provide a list of all chemicals to be employed in the maintenance of the swimming pools.

1.08 Give detailed information about the proposed marina (i.e. fueling for boats, mechanic services).

1.09 Provide an outline of the overall management structure anticipated for the proposed development.

1.10 Describe the implementation of the project in phases (if applicable).

1.11 Provide detailed and adequately labeled maps at appropriate scales to illustrate the general settings of project-related development sites, as well as surrounding areas likely to be environmentally affected. These maps shall include topographic contours, where available, appropriate buffer zones along all permanent water bodies on site, the location of major surface waters, roads, parks or reserves, political boundaries and existing land use and a photo-geologic/geomorphic map of the project area showing geomorphic features (by use of aerial photographs, if available).

PROJECT LOCATION AND OWNERSHIP

The project site is located on lands which are known locally as the Balam Jungle Estate (BJE), which spans approximately 95,000 contiguous acres of land which adjoin some 17 miles of frontage on Chetumal Bay in northeastern Belize (see **Illustration 8**); east of the areas known as Fireburn and Little Belize, east of the Freshwater Creek Wildlife Sanctuary, and south of the Shipstern Wildlife Reserve, in the Corozal District of Belize (see **Illustrations 9** & **10**).

The BJE is presently titled to the Corozal Timber Land Company Limited (CTC), which is comprised of 5 parcels, including parcel 256 (Vol 28, Folio 107), parcel 257 (Vol 28, Folio 105), parcel 258 (Vol 28, Folio 109), parcel 259 (Vol 28, Folio 108), and parcel 260 (Vol 28, Folio 106), together comprising 85,852 acres of land, the certificates of title for which are shown in **Addendum 6**. The company's holdings are presently held in receivership by Castillo, Sanchez & Burrell LLP of Belize City, Mr. Julian Castillo receiver. The proponent of the proposed development described herein, is Balam Investments, LLC, Hart Porsch, sole Managing Member. Balam Investments LLC has entered into a purchase agreement with the Corozal Timber Land Company receivers that comes into effect on award of environmental clearance for the proposed development.

DEVELOPMENT CONCEPT

The project concept is for the creation of two tiered development, the first entailing enhancement of timber management and export activities already in progress at the BJE, and the second entailing establishment of an amenity-based, residential tourism product designed to attract European-based eco-tourism visitation and residence. Enhancement of existing timber operations will entail implementation of a 25-year timber management program designed to achieve stand improvement through selective cutting rotation. The overall residential tourism product calls for the build-out of five stages of development on the 25,784-acre coastal forest and savanna habitat of the BJE.

DEVELOPMENT CHARACTERISTICS

The Timber Management Component

A sustainable forest management plan (SFMP) was developed for the CTC in February 2006 by Fundacion Naturaleza Para La Vida based in Peten, Guatemala (Mendoza, 2006), based on systematic ground survey of more than 90 sampling stations within the BJE (see **Illustrations 11 - 13**).

The findings of the ground survey resulted in itemization of the standing volume of 130 species of timber within the 16,000 hectare canopy forest of the BJE (see **Addendum 7**), 32 species of which were recognized by the Belize Forestry Department as having either known or reasonably sure commercial potential (Percival Cho, personal communication); and standing volume for 26 of these species was deemed to be sufficient for commercial harvesting (see **Table 5**).

ILLUSTRATION 8:

ORIENTATION OF LAND GRANTS FORMING THE BALAM JUNGLE ESTATE

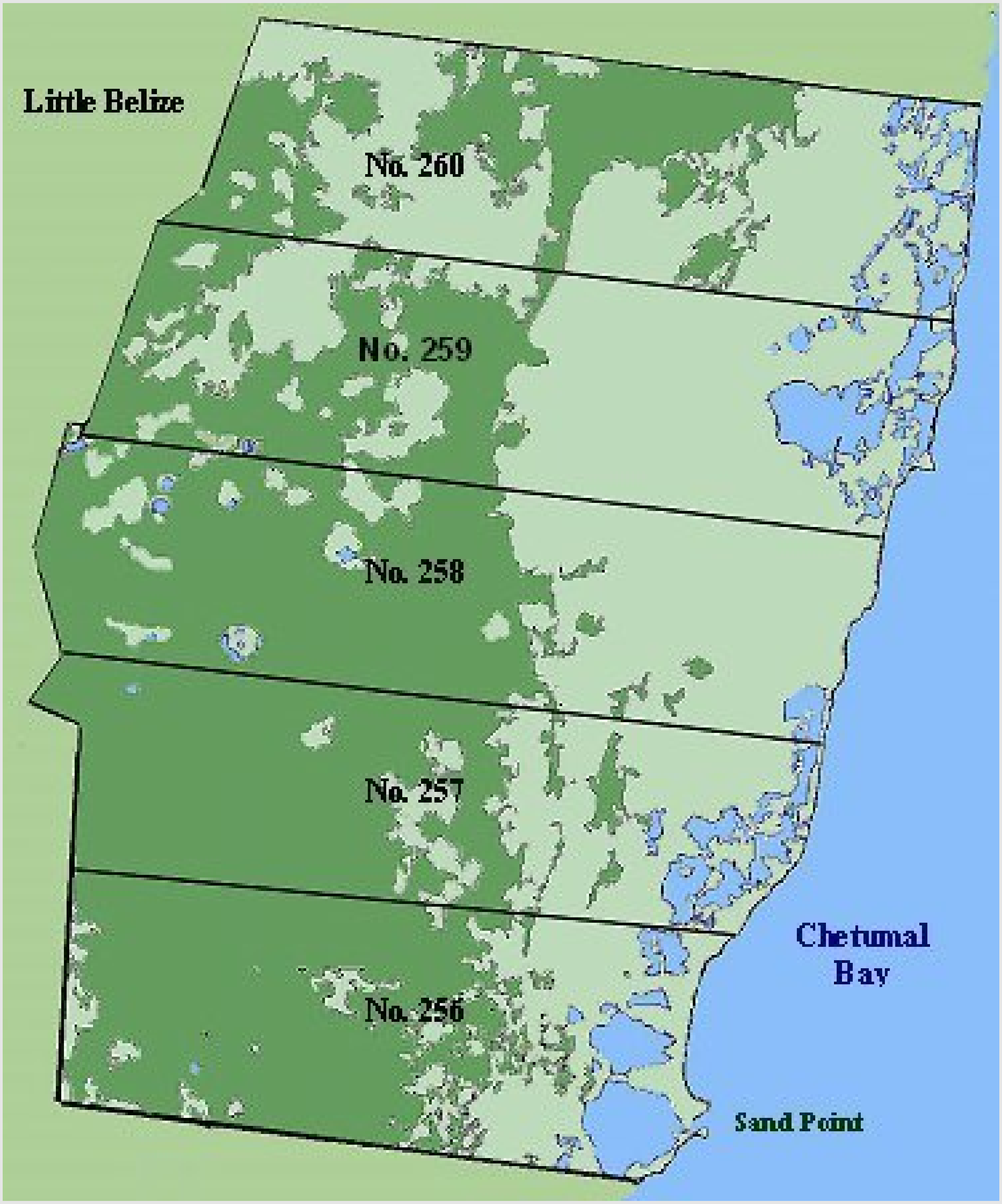


ILLUSTRATION 9:

1990 LANDSAT 5 TM IMAGE (BANDS 453) OF THE BALAM JUNGLE ESTATE

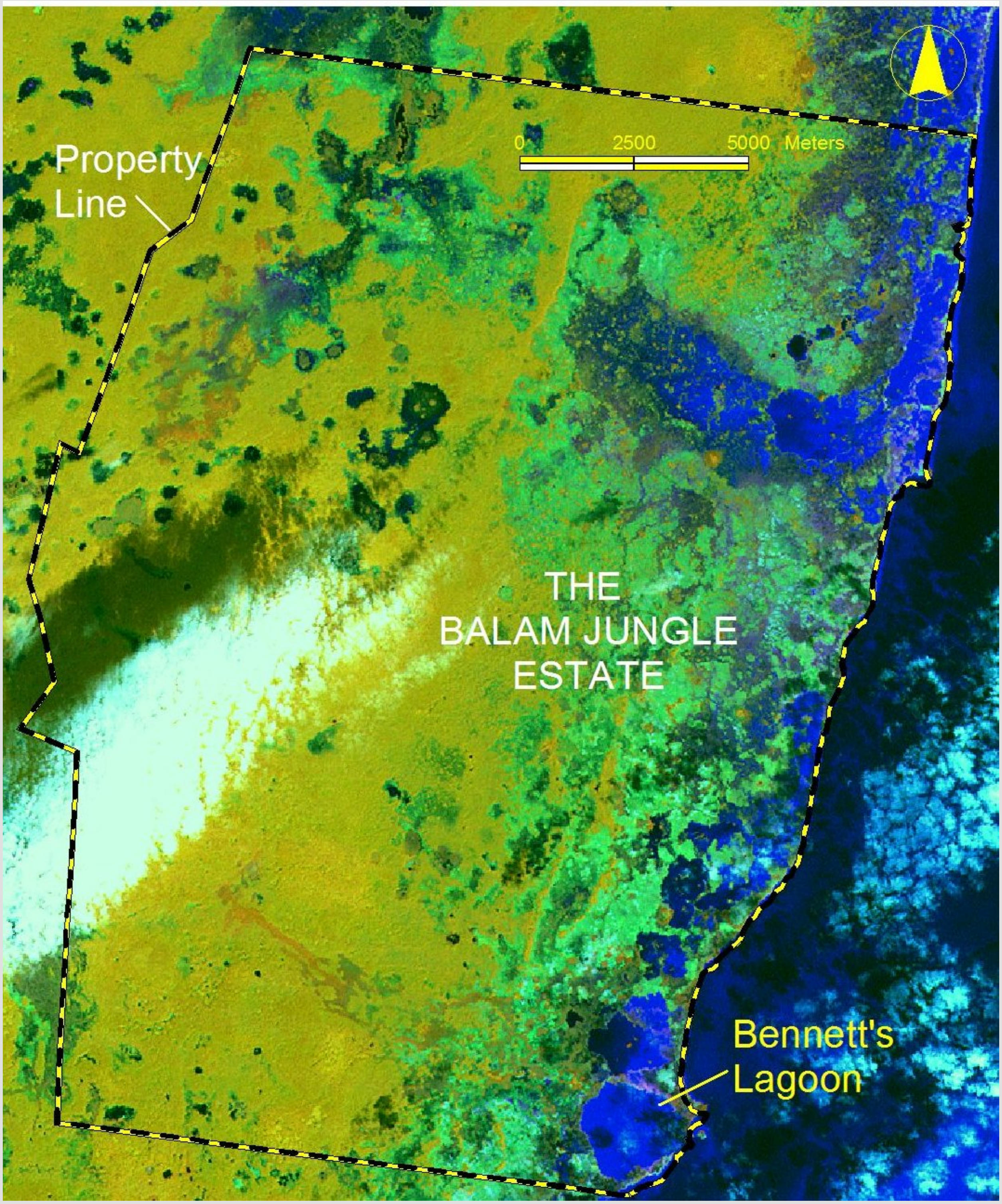


ILLUSTRATION 10:

AERIAL PHOTOS OF BROADLEAF FOREST AND COASTAL HAMMOCK WITHIN BJE

ILLUSTRATION 11:

EXTENT OF BROADLEAF FOREST AND SAVANNA HABITATS PLANNED FOR DEVELOPMENT WITHIN THE BALAM JUNGLE ESTATE

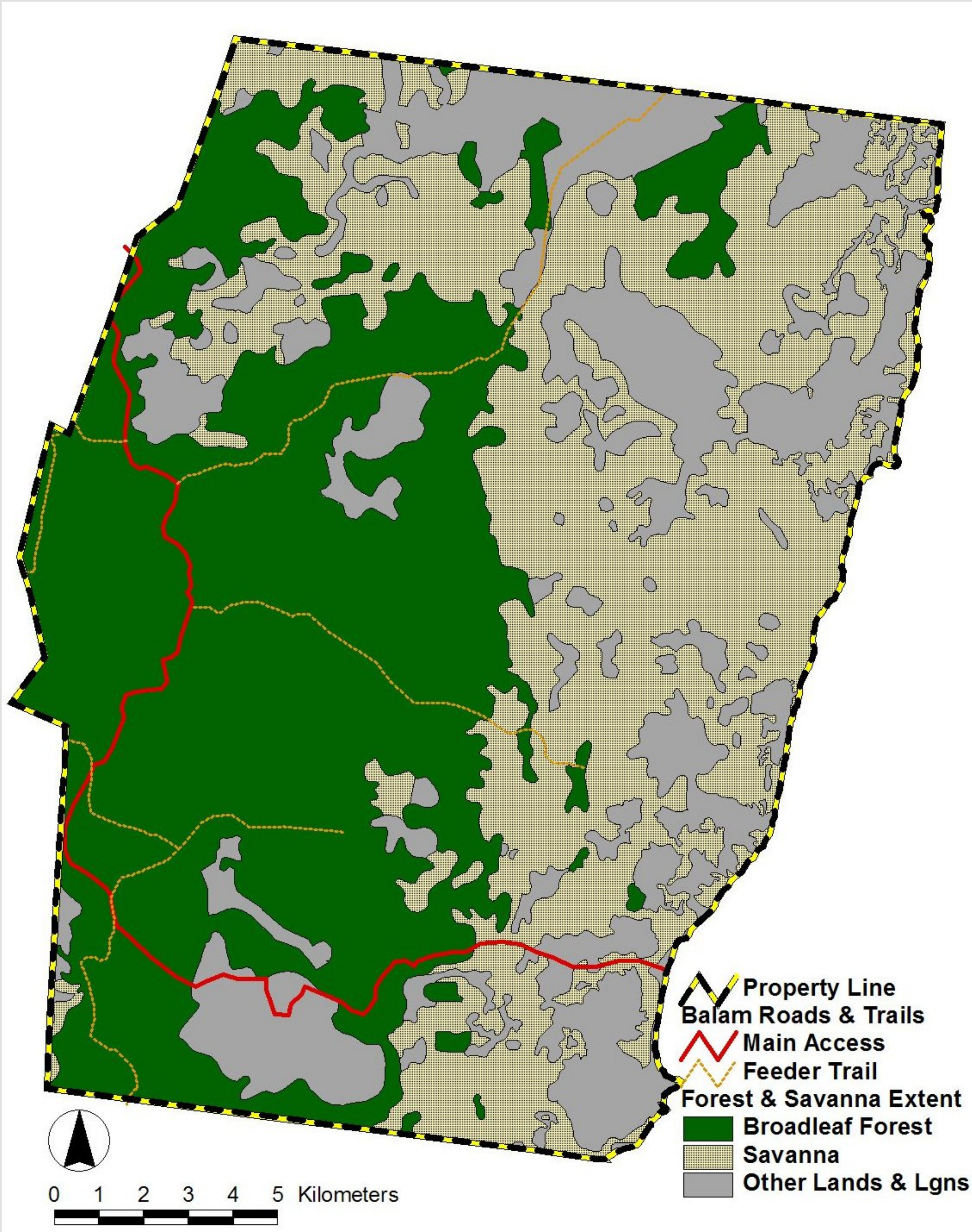


ILLUSTRATION 12:

LOCATION MAP OF TIMBER LANDS PROPOSED FOR MANAGEMENT

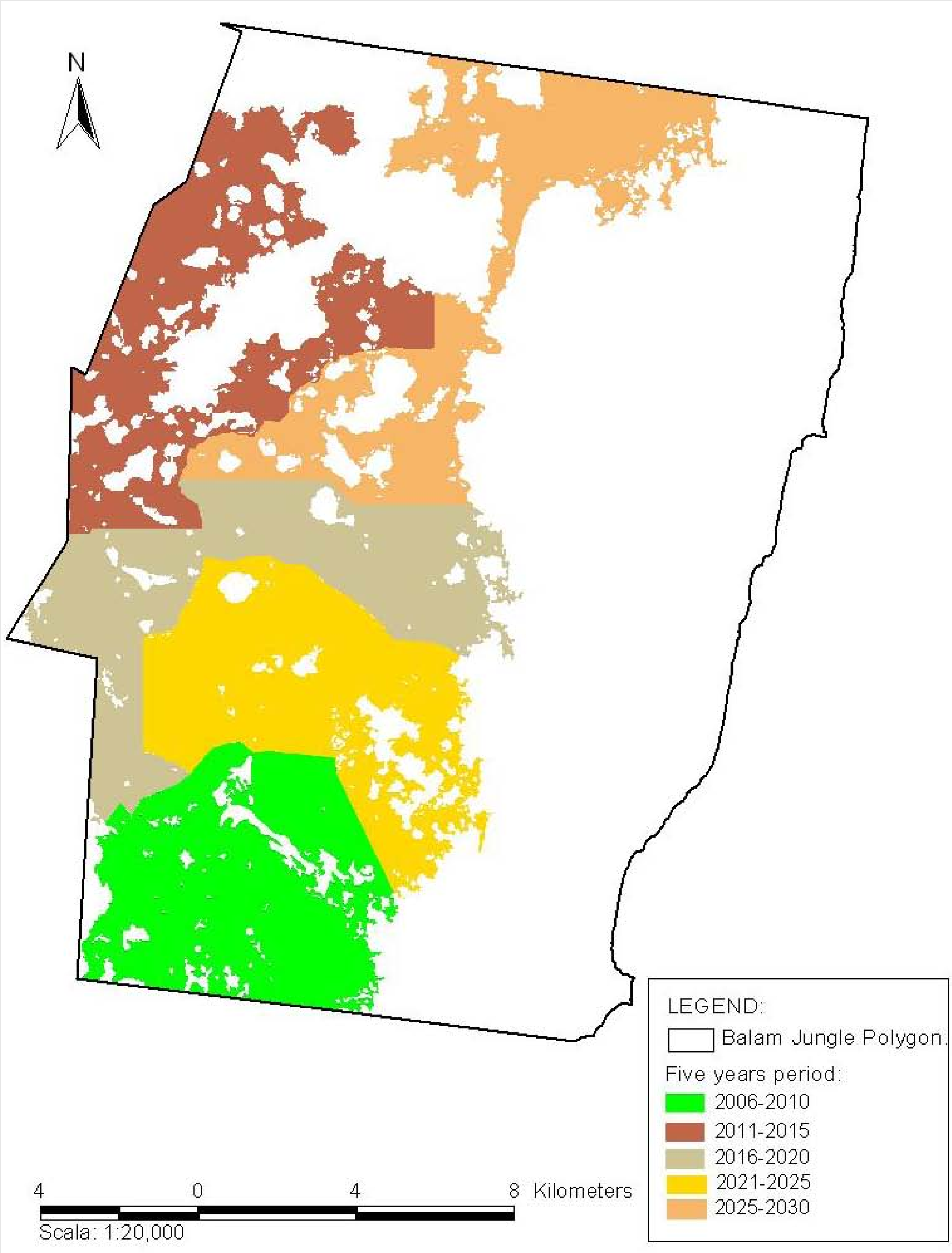


ILLUSTRATION 13:

FOREST SAMPLING STATIONS WITHIN THE BALAM JUNGLE ESTATE

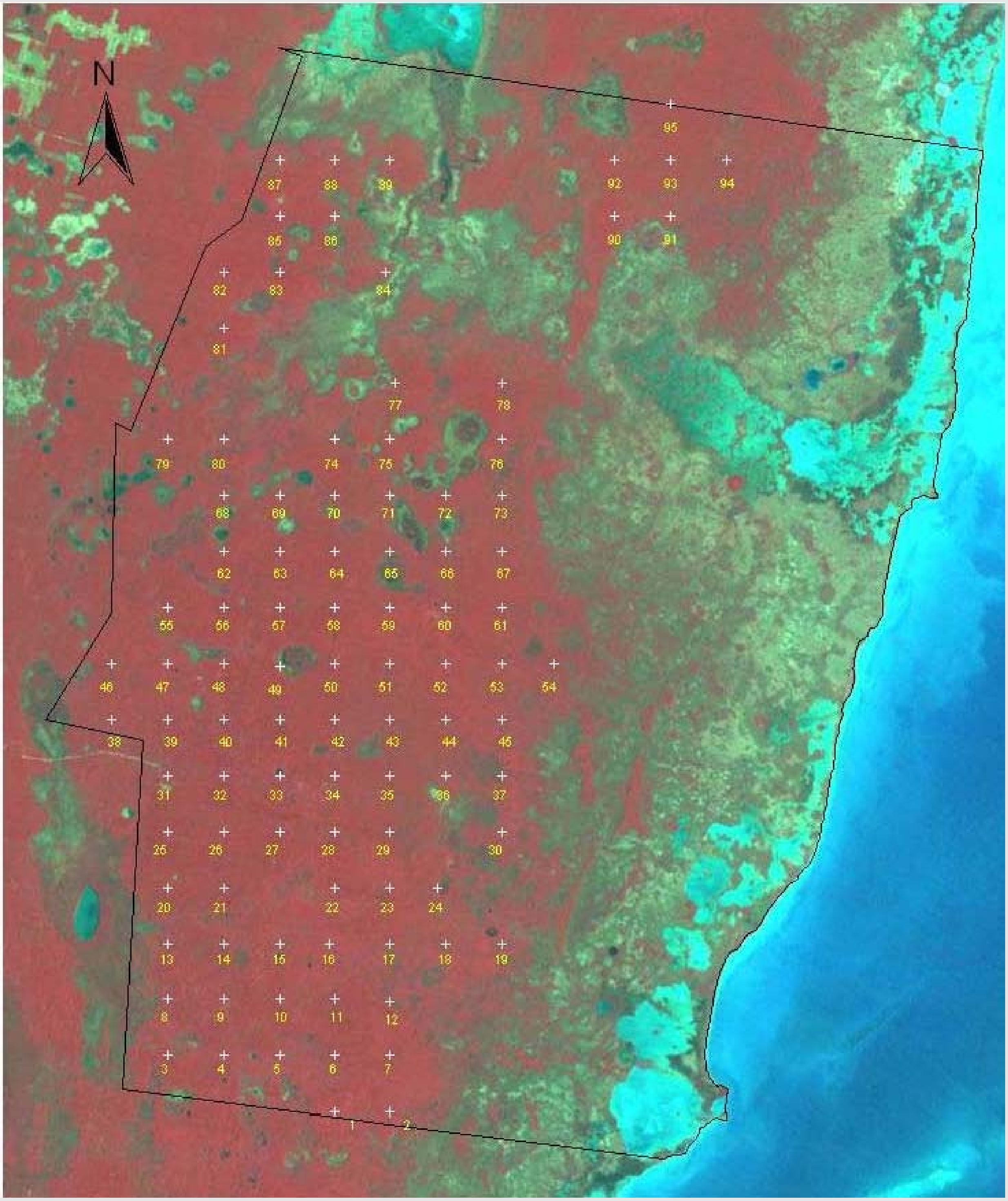


TABLE 5

2007 HARDWOOD TIMBER INVENTORY OF TREES HAVING > 45 CM DBH

Scientific Name	Common Name (Belize)	Utility / Comment	Export Quality	Standing M^3 > 40 CM DBH / HA	Conversion Factor: M^3 To BF	No Of Hectares In Survey Area:	Standing BF > 40 CM DBH	[A]: Sawn BF At 47 % Yield
Aspidosperma megalocarpon	My Lady	Timber, Beams	Prime	0.017	423.5	16,000	115,179	54,847
Brosimum alicastrum	Breadnut	Flooring Material	Select	0.175	423.5	16,000	1,185,662	564,600
Bucida buceras	Bullet Tree	Timber - House Posts & Bridge		0.169	423.5	16,000	1,145,010	545,243
Calophyllum brasiliense	Santa Maria		Prime	0.839	423.5	16,000	5,684,401	2,706,855
Ceiba pentandra	Cotton			0.034	423.5	16,000	230,357	109,694
Cordia alliodora	Salmwood		Prime	0.058	423.5	16,000	392,962	187,125
Cordia dodecandra	Zericote		Elite	0.021	423.5	16,000	142,279	67,752
Cordia sp.				0.011	423.5	16,000	74,527	35,489
Dendropanax arboreus	White Gombolimbo	Timber - Secondary Plywood		0.567	423.5	16,000	3,841,544	1,829,305
Ficus glabrata				0.117	423.5	16,000	792,700	377,476
Ficus sp.	Fig			0.020	423.5	16,000	135,504	64,526
Lonchocarpus castilloi	Black Cabbage Bark		Prime	0.228	423.5	16,000	1,544,748	735,593
Lysiloma sp.	Salam		Select	0.019	423.5	16,000	128,729	61,299
Manilkara zapota	Sapodilla			1.045	423.5	16,000	7,080,094	3,371,470
Metopium brownei	Black Poisonwood		Elite	0.753	423.5	16,000	5,101,733	2,429,394
Platymiscium dimorphandrum	Hormigo	Timber - Valuable	Elite	0.024	423.5	16,000	162,605	77,431
Pouteria amygdalina	Sillion			0.219	423.5	16,000	1,483,771	706,557
Pouteria reticulata				0.018	423.5	16,000	121,954	58,073
Pouteria sapota				0.128	423.5	16,000	867,227	412,965
Pseudobombax ellipticum	Mapola			0.237	423.5	16,000	1,605,725	764,630
Simarouba glauca	Negrito		Select	0.063	423.5	16,000	426,838	203,256
Spondias mombin	Hogplum	Plywood & Matchsticks		0.292	423.5	16,000	1,978,361	942,076
Swartzia cubensis	Bastard Rosewood	Timber	Prime	0.167	423.5	16,000	1,131,460	538,790
Swietenia macrophylla	Mahogany		Elite	0.316	423.5	16,000	2,140,966	1,019,507
Tabebuia ochracea	Cortez	Timber - Very Valuable	Elite	0.006	423.5	16,000	40,651	19,358
Tabebuia rosea		Timber - Secondary		0.008	423.5	16,000	54,202	25,810
Vitex gaumeri	Fiddlewood	Timber - Secondary	Select	0.551	423.5	16,000	3,733,141	1,777,684
26 Species							**41,342,331**	**19,686,805**

Moreover, the study went on to point out that board wood volume of commonly recognized commercial hardwoods such as Mahogany (*Swietenia macrophylla*) and Cedar (*Cedrela odorata*), was more often than not restricted by soil depth, such that many stems would be unlikely to exceed 45 cm in diameter, or only 75% of BFD approved cutting diameter for Mahogany used elsewhere. Hence the Belize Forestry Department was petitioned for, and granted am mean cutting diameter of 45 cm for the BJE timber operations in 2006.

The Residential Tourism Component

The project is envisioned to consist of approximately 5,500 residential units arranged in a river-delta-like layout encompassing 8 village developments, 2 hotel-casino-marina complexes, one or more 18-hole golf courses, and an assortment of activity-based amenities, including tennis courts, and an artists' commercial village (see **Illustrations 14** - **16**; **Tables 6** & **7**). Actual roof space planned for development will be on the order of 10.9 M square feet, or approximately 250 acres, which represents 2.6% of the 9,500 acres of land allocated for the Stage-1 residential tourism product development, or less than 1% of the savanna habitat planned for development.

Apartment & Condominiums

A total of 1,470 apartment/condominium units are planned to be established on a total of 123 acres of land. The apartment/cadmium units are tentatively planned to be arranged in 10-unit, 3-floor complexes having a maximum roof area of 4,800 Ft Sq, and each being established on a half-acre land parcel. Individual units will be configured with 1 or 2 bedrooms and have a average area of 1,200 Sq Ft (110 M^2) each, and a maximum occupancy of 2 persons. Each apartment/condominium unit will be sold ready for occupancy, inclusive of utility connection, managed green space and sewage treatment, contracted solid waste collection service, furniture and golf course membership.

Town Homes

A total of 1,189 town home units are planned to be established on a total of 149 acres of land. The town homes are tentatively planned to be arranged as single units established on a half-acre land parcels and each having a maximum occupancy of 4 persons. Individual units will be configured with 1 or 2 bedrooms and have a average area of 1,400 Sq Ft (130 M^2). Each town home unit will be sold ready for occupancy, inclusive of utility connection, managed green space and sewage treatment, contracted solid waste collection service, furniture and golf course membership.

Fifth & Half-Acre Residential Lots

A total of 2,073 fifth-acre lots are planned to be established on 415 acres of land. These lots are tentatively planned to be developed with single residential units, each having a maximum roof space of 2,400 Sq Ft (225 M^2) and maximum occupancy of 6 persons each. Individual units will be configured with 2 or 3 bedrooms, and each will be sold ready for occupancy, inclusive of utility connection, managed green space and sewage treatment, contracted solid waste collection service, furniture and golf course membership.

ILLUSTRATION 14:

MASTER PLAN FOR THE STAGE-1 DEVELOPMENT SITE

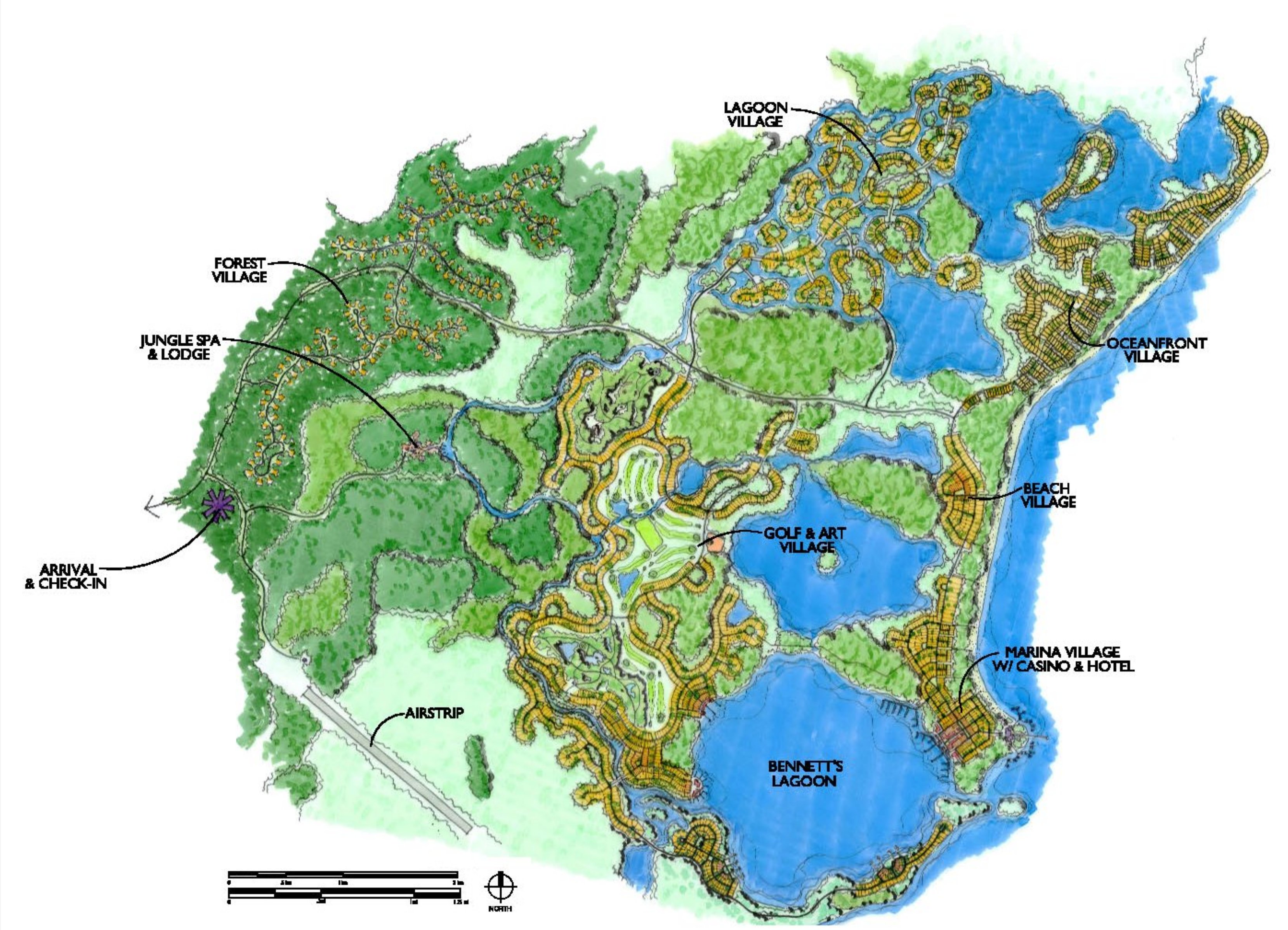


ILLUSTRATION 15:

ORIENTATION OF THE STAGE-1 DEVELOPMENT SITE WITH RESPECT TO THE SAVANNA HABITAT

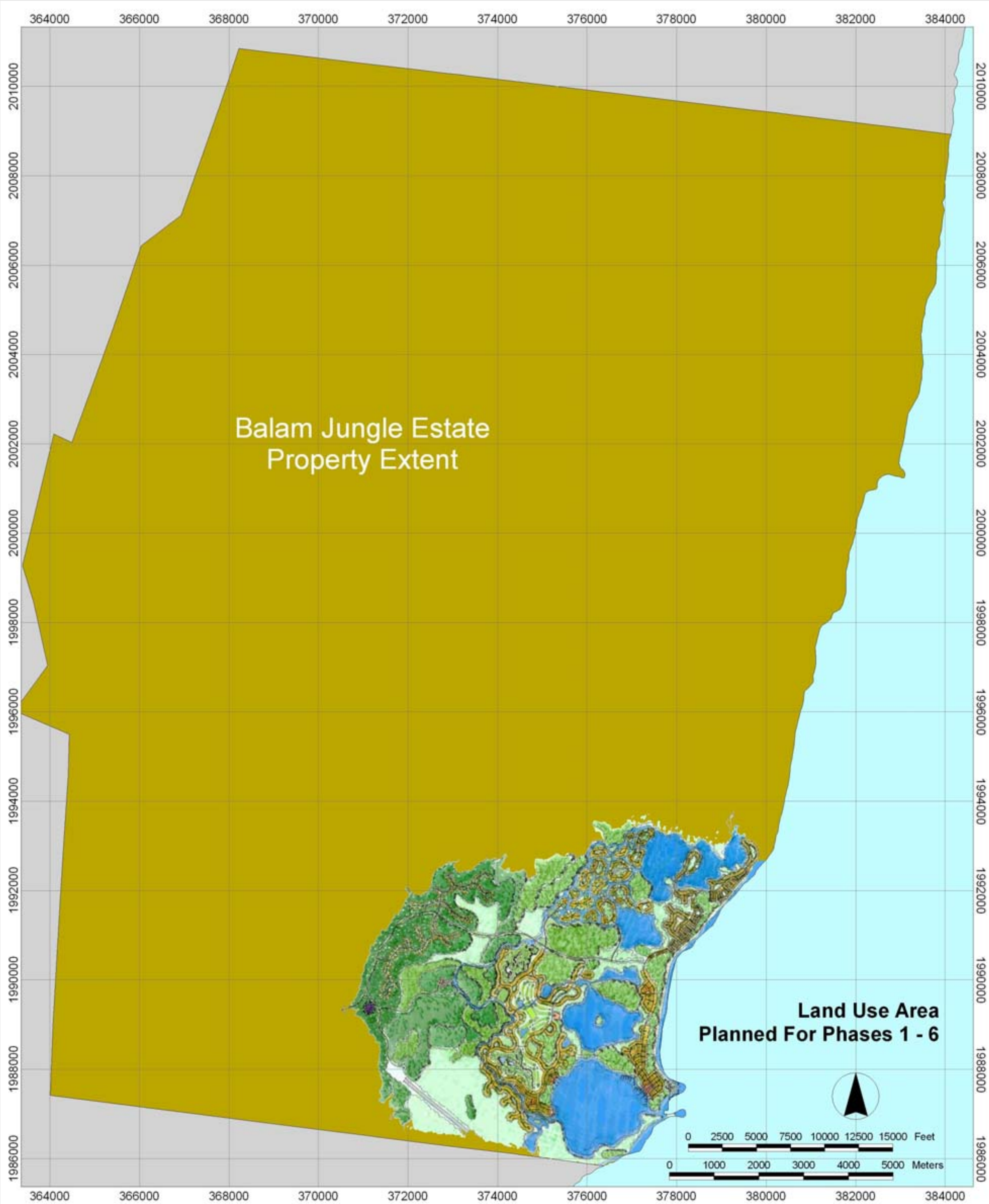


ILLUSTRATION 16:

SIX PHASES OF THE STAGE-1 RESIDENTIAL TOURISM DEVELOPMENT PLAN

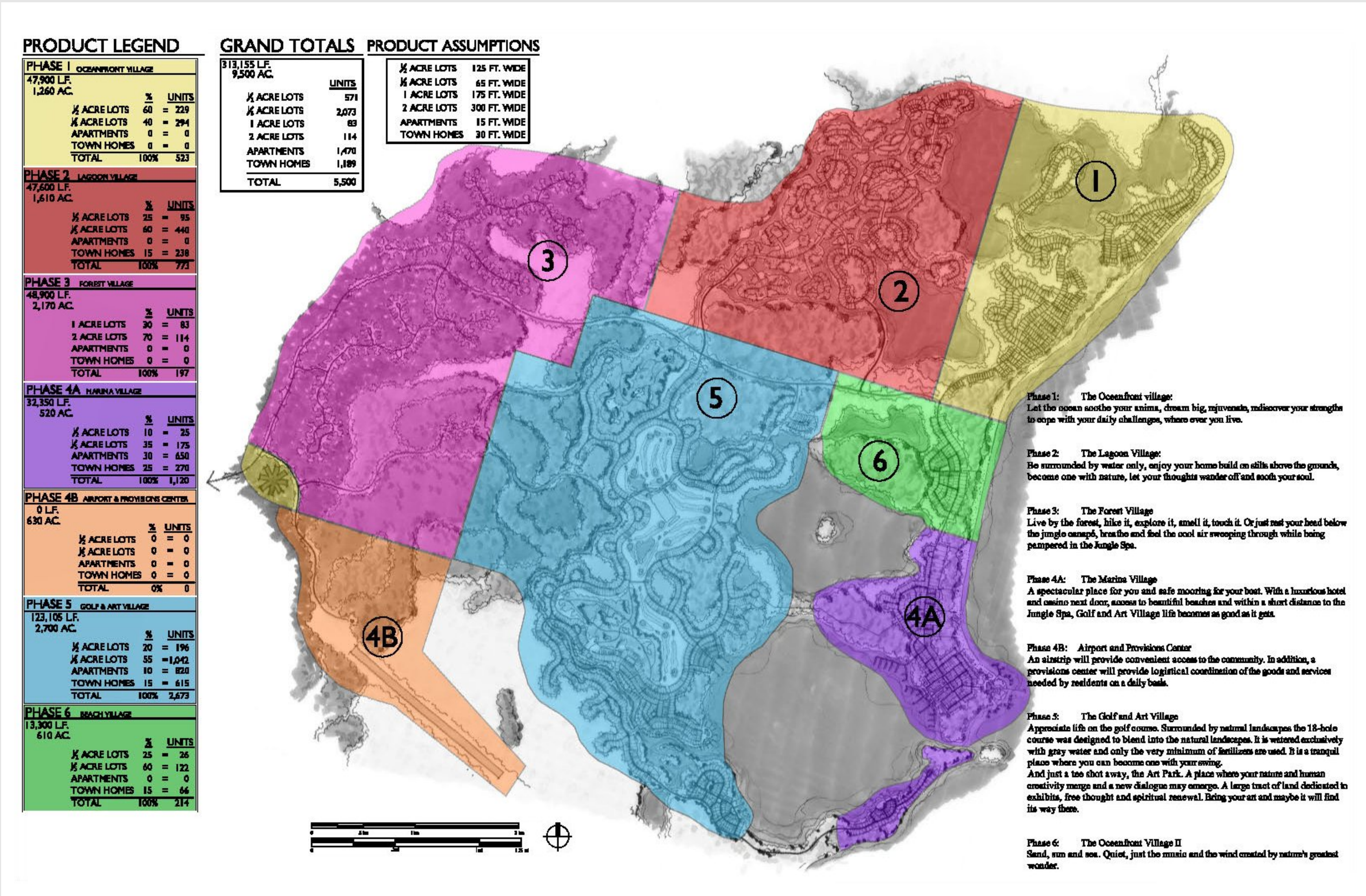


TABLE 6

PROPOSED LAND USE ALLOCATION FOR THE STAGE-1 DEVELOPMENT

STAGE-1 DEVELOPMENT COMPONENTS	**No Units**	**Ac**	**Ha**	**%**	**Resi-dential**	**Com-mercial**	**Admin**	**Green Space**
Phase I Components								
Residential Units								
Homes On 1/5-Ac Lots	294.0	58.8	23.7	4.7%	4.7%			
Homes On 1/2-Ac Lots	229.0	114.5	46.2	9.1%	9.1%			
Employee Housing	4.0	20.0	8.1	1.6%			1.6%	
Infrastructure								
Roads (Km)	10.0	13.5	5.4	1.1%			1.1%	
Utility & Maintenance Complex	1.0	5.0	2.0	0.4%			0.4%	
Green Space	1.0	1,048.2	422.7	83.2%				83.2%
Subtotal, Phase-I Components	***539.0***	***1,260.0***	***508.1***	***100.0%***	***13.8%***	***0.0%***	***3.1%***	***83.2%***
Phase II Components								
Residential Units								
Town Houses	238.0	29.8	12.0	1.8%	1.8%			
Homes On 1/5-Ac Lots	440.0	88.0	35.5	5.5%	5.5%			
Homes On 1/2-Ac Lots	95.0	47.5	19.2	3.0%	3.0%			
Infrastructure								
Roads (Km)	18.2	24.6	9.9	1.5%			1.5%	
Non-Navigable Canals (Km)	17.3	98.0	39.5	6.1%			6.1%	
Green Space	1.0	1,322.2	533.1	82.1%				82.1%
Subtotal, Phase-II Components	***809.4***	***1,610.0***	***649.2***	***100.0%***	***10.3%***	***0.0%***	***7.6%***	***82.1%***
Phase III Components								
Residential Units								
Villas On 1-Ac Lots	83.0	83.0	33.5	3.8%	3.8%			
Villas On 2-Ac Lots	114.0	228.0	91.9	10.5%	10.5%			
Infrastructure								
Roads (Km)	13.3	18.1	7.3	0.8%			0.8%	
Navigable Canals (Km)	0.4	2.8	1.1					
Non-Navigable Canals (Km)	0.6	3.5	1.4					
Green Space	1.0	1,834.7	739.8	84.5%				84.5%
Subtotal, Phase-III Components	***212.3***	***2,170.0***	***875.0***	***99.7%***	***14.3%***	***0.0%***	***0.8%***	***84.5%***
Phase IV-A Components								
Residential Units								
Apartment/Condominiums	650.0	32.5	13.1	6.3%	6.3%			
Town Houses	270.0	33.8	13.6	6.5%	6.5%			
Homes On 1/5-Ac Lots	175.0	35.0	14.1	6.7%	6.7%			
Homes On 1/2-Ac Lots	25.0	12.5	5.0	2.4%	2.4%			
Commercial Units								
Hotel-Marina-Casino Complex	3.0	45.0	18.1	8.7%		8.7%		
Infrastructure								
Roads (Km)	8.5	11.5	4.6	2.2%			2.2%	
Alleys (Km)	2.8	2.5	1.0	0.5%			0.5%	
Green Space	1.0	347.2	140.0	66.8%				66.8%
Subtotal, Phase-IV-A Components	***1,135.3***	***520.0***	***209.7***	***100.0%***	***21.9%***	***8.7%***	***2.7%***	***66.8%***

TABLE 6

PROPOSED LAND USE ALLOCATION FOR THE STAGE-1 DEVELOPMENT PLAN

(Continued)

STAGE-1 DEVELOPMENT COMPONENTS	No Units	Ac	Ha	%	Resi-dential	Com-mercial	Admin	Green Space
Phase IV-B Components								
Infrastructure								
Roads (Km)	1.4	1.9	0.8	0.3%			0.3%	
Green Space	1.0	628.1	253.3	99.7%				99.7%
Subtotal, Phase-IV-B Components	***2.4***	***630.0***	***254.0***	***100.0%***	***0.0%***	***0.0%***	***0.3%***	***99.7%***
Phase V Components								
Residential Units								
Apartment/Condominiums	820.0	41.0	16.5	1.5%	1.5%			
Town Houses	615.0	76.9	31.0	2.8%	2.8%			
Homes On 1/5-Ac Lots	1,042.0	208.4	84.0	7.7%	7.7%			
Homes On 1/2-Ac Lots	196.0	98.0	39.5	3.6%	3.6%			
Commercial Units								
Hotel-Marina-Casino Complex	1.0	36.2	14.6	1.3%		1.3%		
Golf Course & Club House	1.0	250.0	100.8	9.3%		9.3%		
Infrastructure								
Roads (Km)	32.2	43.6	17.6	1.6%			1.6%	
Alleys (Km)	2.0	1.8	0.7	0.1%			0.1%	
Navigable Canals (Km)	11.6	87.4	35.3	3.2%			3.2%	
Non-Navigable Canals (Km)	3.0	17.3	7.0	0.6%			0.6%	
Green Space	1.0	1,839.3	741.7	68.1%				68.1%
Subtotal, Phase-V Components	***2,724.8***	***2,700.0***	***1,088.7***	***100.0%***	***15.7%***	***10.6%***	***5.6%***	***68.1%***
Phase VI Components								
Residential Units								
Town Houses	66.0	8.3	3.3	1.4%	1.4%			
Homes On 1/5-Ac Lots	122.0	24.4	9.8	4.0%	4.0%			
Homes On 1/2-Ac Lots	26.0	13.0	5.2	2.1%	2.1%			
Infrastructure								
Roads (Km)	3.8	5.2	2.1	0.9%			0.9%	
Alleys (Km)	1.1	1.8	0.7	0.3%			0.3%	
Green Space	1.0	557.3	224.7	91.4%				91.4%
Subtotal, Phase-VI Components	***219.9***	***610.0***	***246.0***	***100.0%***	***7.5%***	***0.0%***	***1.2%***	***91.4%***
Total, Phases I - VI	**5,643.1**	**9,500.0**	**3,830.6**	**100.0%**	**11.9%**	**2.8%**	**3.0%**	**82.3%**

TABLE 7

OCCUPANCY ALLOCATION FOR THE STAGE-1 DEVELOPMENT PLAN

Development Component	Acreage	Hectares	Number Of Structures	Number Of Units / Structure	Maximum Occupancy / Unit	Total Human Occupancy	Mean Occupancy / Ac	SF Roof Space / Unit	SF Land Area / Unit	Roof Space As % Land Unit	Total SF Roof Space	Roof Space As % Land Allocation
Phase I Components												
Homes On 1/5-Ac Lots	58.8	23.7	294	1	4	1,176	20	2,400	8,716	27.5%	705,600	1.3%
Homes On 1/2-Ac Lots	114.5	46.2	229	1	6	1,374	12	3,600	21,790	16.5%	824,400	1.5%
Employee Housing	20.0	4.0	4	50	2	400	20	25,000	871,200	2.9%	100,000	0.2%
Phase II Components												
Town Houses	29.8	12.0	238	1	4	952	32	1,400	5,448	25.7%	333,200	0.5%
Homes On 1/5-Ac Lots	88.0	35.5	440	1	4	1,760	20	2,400	8,716	27.5%	1,056,000	1.5%
Homes On 1/2-Ac Lots	47.5	19.2	95	1	6	570	12	3,600	21,780	16.5%	342,000	0.5%
Phase III Components												
Villas On 1-Ac Lots	83.0	33.5	83	1	8	664	8	4,600	43,580	10.6%	381,800	0.4%
Villas On 2-Ac Lots	228.0	91.9	114	1	10	1,140	5	6,200	87,160	7.1%	706,800	0.7%
Phase IV-A+B Components												
Apartment/Condominiums	54.2	21.8	65	10	3	1,950	36	4,800	21,780	22.0%	312,000	0.6%
Town Houses	33.8	13.6	270	1	4	1,080	32	1,400	5,448	25.7%	378,000	0.8%
Homes On 1/5-Ac Lots	35.0	14.1	175	1	6	1,050	30	2,400	8,716	27.5%	420,000	0.8%
Homes On 1/2-Ac Lots	12.5	5.0	25	1	8	200	16	3,600	21,780	16.5%	90,000	0.2%
Hotel-Marina-Casino Complex	45.0	18.1	3	1	350	1,050	23	50,000	653,700	7.6%	150,000	0.3%
Phase V Components												
Apartment/Condominiums	68.3	27.6	82	10	3	2,460	36	4,800	21,780	22.0%	393,600	0.3%
Town Houses	76.9	31.0	615	1	4	2,460	32	1,400	5,448	25.7%	861,000	0.7%
Homes On 1/5-Ac Lots	208.4	84.0	1,042	1	6	6,252	30	2,400	8,716	27.5%	2,500,800	2.1%
Homes On 1/2-Ac Lots	98.0	39.5	196	1	8	1,568	16	3,600	21,780	16.5%	705,600	0.6%
Hotel-Marina-Casino Complex	36.2	14.6	3	1	350	1,050	29	50,000	653,700	7.6%	150,000	0.1%
Phase VI Components												
Town Houses	8.3	3.3	66	1	4	264	32	1,400	5,448	25.7%	92,400	0.3%
Homes On 1/5-Ac Lots	24.4	9.8	122	1	6	732	30	2,400	8,716	27.5%	292,800	1.1%
Homes On 1/2-Ac Lots	13.0	5.2	26	1	8	208	16	3,600	21,780	16.5%	93,600	0.4%
Totals, Phases I - IV	**1,383.4**	**553.8**	**4,187**	**88**	**804**	**28,360**	**20**	***8,619***	***120,342***	***7.2%***	**10,889,600**	**2.6%**

A total of 571 half-acre lots are planned to be established on 286 acres of land. These lots are tentatively planned to be developed with single residential units, each having a maximum roof space of 3,600 Sq Ft (335 M^2) and maximum occupancy of 8 persons each. Individual units will be configured with 3 or 4 bedrooms, and each will be sold ready for occupancy, inclusive of utility connection, managed green space and sewage treatment, contracted solid waste collection service, furniture and golf course membership.

One & Two-Acre Villa Lots

A total of 83 one-acre lots are planned to be established on 83 acres of land. These lots are tentatively planned to be developed with single residential units, each having a maximum roof space of 4,600 Sq Ft (430 M^2) and maximum occupancy of 10 persons each. Individual units will be configured with 3 or 4 bedrooms, and each will be sold ready for occupancy, inclusive of utility connection, managed green space and sewage treatment, contracted solid waste collection service, furniture, golf course and casino membership.

A total of 114 two-acre lots are planned to be established on 228 acres of land. These lots are tentatively planned to be developed with single residential units, each having a maximum roof space of 6,200 Sq Ft (575 M^2) and maximum occupancy of 12 persons each. Individual units will be configured with 4 or more bedrooms, and each will be sold ready for occupancy, inclusive of utility connection, managed green space and sewage treatment, contracted solid waste collection service, furniture, golf course and casino membership.

Hotel / Casino Complexes

Two hotel complexes of 350+ keys each, along with several bars & restaurants, shops, bathing pools, Riviera-like casino rooms, and combined assembly facilities for up to 250 persons are planned for development on 2 parcels having a combined area of 81 acres of land in the eastern western shores of Bennett's Lagoon. Support and adjunct amenities to be developed in association with the hotel will include a reception area, offices for administration and sales, a fitness center, a spa, a sports facility, yoga platforms and parking areas. Total occupancy for each hotel component has been estimated at 2 persons + 1 staff for each room, or a total of 3 persons x 350 rooms, or 1,050 persons per hotel at 100% occupancy. Final architectural and landscape design characteristics for each hotel site and building are presently under development, and will be submitted to the DOE for final review & comments prior to commencement of their construction.

Marina Docking & Storage Facilities

Two marina facilities are planned for development alongside of the Hotel-Casino facilities on Bennett's Lagoon, with each consisting of a 250-slip wet-dock station, a 250 boat dry-dock station, and a fuel depot located on the marina apron. Additional support facilities will include a boat ramp, a mariner’s shop, and sufficient parking area for approximately 150 vehicles. Excavation requirements will involve deepening of approximately 3 acres bottom within the natural entrance to Bennetts Lagoon, and creation of two marina basins and interconnecting canal in Bennetts Lagoon of approximately 20 acres combined area and 2.5 meters depth. Material will be excavated with a suction dredge, the spoils from which will be placed onto the hotel-casino complex and residential sites to raise mean ground elevation to 1.5 meters above sea level.

Staff Housing & Maintenance Center

Approximately 20 acres of land will be allocated to the development of 4 residential facilities for the 600+ staff anticipated to be required to operate both the timer and residential tourism projects through the Stage-1 development. A 5 acre utility & maintenance center with residential quarters will also be developed for a full time mechanic and maintenance team trained in the operational and repair needs for all structures and equipment.

Conveyance Infrastructure

Approximately 87.4 kilometers of access roads, 5.9 kilometers of alleys, 11.6 kilometers of navigable canals, and 26.3 kilometers of non-navigable canals will be constructed during Stage-1 of the development connecting the residential, commercial, amenities, attractions, staff and maintenance facilities. All road works will be lighted and constructed according to Ministry of Works guidelines for light duty roads.

A 1,525 meter (5,000 Ft) runway is planned for placement at the southwestern corner of the Stage 1 development, on approximately 200 acres of land (i.e. 3,050 x 250 meters), which has been cleared and re-landscaped for use as the approach and landing apron. The runway will be sought for private licensing by the Belize Airport Authority (BAA), and aligned to 135 / 315 degrees, or parallel to prevailing easterly winds & perpendicular to northern winds, or as otherwise may be required by the BAA.

Artists Commercial Village

An artists commercial village comprised of approximately 25 - 50 retail shops offering various cafes, theaters, art supplies, services and works to development residents and guests will be established on lands adjoining the Phase V hotel complex. Occupancy for the commercial village has been estimated at approximately 6 persons per shop, for a total of 150 - 300 persons at capacity development and occupation. Final architectural and landscape design characteristics for the commercial village are presently under development, and will be submitted to the DOE for final review & comments prior to commencement of their construction.

Outdoor Sport Facilities

An 18-hole professional golf course, practice area and 15,000 Sq Ft clubhouse are to be established on approximately 250 acres of land in Phase V of the Stage-1 development adjacent to residential and other amenities planned for development. Presently under design, the golf course is planned to be for the exclusive by development residents and guests. Several 10-court tennis, hand-ball & related activity centers will be established throughout the Stage-1 development. As with the golf amenity, the various outdoor sport centers are presently under design for the exclusive by development residents and guests.

Cultural Attractions

The BJE is presently thought to harbor two ancient Maya ceremonial sites on the order of perhaps 250 – 500 acres in area each; and a third ceremonial center, which is likely greater in area than 1,000 acres, is known to lie just a few hundred meters outside of the BJE's southwestern most boundary, along the road to Bomba Village. Although designated as protected areas by the Ancient Monuments and Antiquities Act (Chapter 330 in the Laws Of Belize, Revised 2000), and outside of the residential tourism zone planned for development along the coastal savanna of the BJE, the project proponent is interested in working with the Institute of Archaeology to research and preserve these sites, as well as engage them in passive tourism use in one or more later stages of development.

Green Space

Approximately 7,819 acres of land or 82.3% of the 9,500 acre Stage-1 development site is planned for designation as green space, ***after*** building construction, road work and amenity development. This level of green space reserve will constitute some 30% of the 25,784 acre savanna habitat proposed for development. This land unit will be imbedded with foot and golf cart trails for recreational use by residents and guests, but fencing will be prohibited from use in any stage of development, in order to promote connectivity between these otherwise infrastructure-free green areas.

Land Modification Requirements

A total of approximately 1.5 M M^3 of land excavations (~90 Ha x 1 M depth) are planned for beach revetment (325,000 M^3); marina access & basin development (201,400 M^3); and construction of canal systems (986,961 M^3). Spoil from these actions will be used to offset fill requirements for beach revetment (325,000 M^3); road and alleyway conveyances (458,000 M^3); residential lots (1,334,000 M^3); and amenities (1,334,000 M^3), leaving the balance of fill requirements to be excavated from onsite quarries at ~5,570,639 M^3, or ~708 Ha x 1 M depth.

Overlay of the development master plan shown in **Illustration 15** onto the land classification map shown in **Illustration 11**, establishes that significant levels of cut and fill will be required to achieve the intended land use objectives for the savanna habitat of the BJE (see **Page 19**). Discussions with the project proponent have established that while this level of material movement is not cost prohibitive to the development, further adjustments are likely to be imposed on the overall land use plan until material movement and fill requirements have been minimized.

Carrying Capacity

Maximum human occupancy for the entire development is estimated to be on the order of 26,890 persons at capacity development, for an overall density of 19 persons/acre (see **Table 7**), or approximately two-thirds (2/3^{rds}) the design density of suburban Belmopan (est. ~ 32 persons/acre).

Water & Power Requirements

Total *potable* water-demand estimate at maximum capacity, based on an assumed usage rate of 0.205 M^3 (54 gal) per person per day will be approximately 0.205 M^3/Person-Day x 28,360 Persons (at capacity development) = 5,800 M^3/Day before consideration of other use, such as cleaning, irrigation, and/or pool water exchange.

Routine energy requirements for the proposed development at capacity occupancy and operation are estimated at approximately 60 megawatts, the majority of which is anticipated to be supplied by BEL. Emergency/back-up energy requirements on the order of 15% will be supplied by self-generation with one or more reciprocating / turbine diesel-electric plant(s). Fuel and other petroleum products used in support of the back-up power facility will be stored in either a concrete or buried earthen bond or the manufacturers' containers as the case may apply. Spilled petroleum, spent oils and related materials will be stored in 55 gal drums also located within the above-described fuel bonds.

Waste Management Plan

Liquid waste will be treated on site using either a centralized batchplant treatment station (see **Addendum 8**), or a distributed batchplant system (see **Addendum 9**), in proportion the various loading requirements of each phase of development. Hence, large facilities such as Condominiums, the Hotel, Commercial Village, and Visitors Center will use a large scale system such as that produced by either Klargester or Besst, while single family estate sites will use low density modular treatment systems. No effluent from any sewage treatment system will be discharged into adjoining surface waters, but grey water will be recovered for use in Golf Course irrigation. Filtered effluent from swimming pools and parking lots will be settled in holding ponds for salinity reduction and chlorine oxidation prior to incorporation into the overall irrigation system for the proposed development. Domestic solid waste will be entirely stored off site at the National Waste Storage Facility being developed at Mile 25 on the Western Highway in the Belize District of Belize.

Management Structure For The Overall Development

The management entity responsible for the entire development will be Balam Investments, LLC, Dr. h.c. Hartmut Porsch, sole Managing Member. Individual development components however, are anticipated to be contracted out to professional operators who have extensive experience in timber management & export; and residential tourism developments, and who will otherwise be responsible for day to day operations.

2. THE PHYSICAL ENVIRONMENT

2.1 Describe the climate and meteorology of the project area, including rainfall average per year and prevailing wind patterns in the project area.

2.2 Provide a physical description of the effluent receiving water bodies including creeks, rivers, lagoons and sea front; and collect a minimum of three different water quality data sets, preferably three (3) separate months, on the water body to be used for effluent disposal. This data should include the following parameters:

a) Dissolved Oxygen
b) Hardness
c) PH
d) Sulfate
e) Temperature
f) Total Dissolved Solids
g) Total Nitrate (as $NO^{-}_{3,}$ N)
h) Total Phosphate
i) Total Suspended Solids

(Assays a, b, and c are to be conducted in the field and the remainder are to be conducted preferably by an independent water quality consultant. The water quality analyses should contain the official stamp of the laboratory (if any) and the signature of the technician.)

2.3 Provide details of the basic physical environment.

a) Geology of the project area. This should include the following:

- Geomorphology - Give a detailed description of the characteristics of landform, land surface including exposed rock types, types of unconsolidated materials exposed (sediments), rivers, tributaries, ridges, valleys, and geological structures — faults, folds, if they can be determined by field mapping.

- Subsurface Geology - Give a detailed description of the stratigraphy of the rocks or unconsolidated materials, within the project site, to depths allowing for maintenance of suitable impermeable layer for the protection of the water table. This must be done by core sampling (mechanical or manual) using a pre-determined borehole grid. Cross sections of the rock types or unconsolidated materials should also be presented. The engineering properties of the rocks and/or unconsolidated materials must be tested (including permeability) to determine the suitability for the proposed development.

b) The soil type(s), soil fertility and agricultural value.

c) Provide information on the specific soil type and submit the results of an analysis carried out to determine soil permeability/profile in the proposed project area. Provide typical soil profile of the property.

d) The topography of the area, including flood hazard and drainage patterns around the project site.

e) The current land use of the project site and adjacent properties.

2.4 Describe the terrestrial and aquatic fauna and flora (including rare and/or endangered species) that can be found within the project site or in adjacent areas, including the effluent receiving water bodies.

a) Estimate the acreage of vegetation to be cleared, indicating areas designated for removal and percent to be removed.

b) Identify any species of conservation significance and specify measures for their protection.

METEOROLOGICAL & HYDROLOGICAL CHARACTERISTICS

Meteorological Characteristics

Bulk rainfall at the project site is estimated to be $\geq$ 80 inches, or $\geq$ 1.5 meters, per year, based on a 30-year average developed by the National Meteorological Service (see **Illustration 17**). Hence, rainfall volume from the 10,889,600 Ft^2 (1,012,195 M^2) of roof catchment area being proposed for development would be expected to be on the order of 1.5 million M^3 of freshwater water per year, or 4,160 M^3 of freshwater water per day, which corresponds to approximately 72% of the daily potable water demand (5,800 M^3) at capacity development (see **Page 36**).

The most recent hurricane to impact the region was Hurricane Chantal (2001). A category 1 storm, Chantal impacted the region by causing some USD $4 million in damages and two deaths, all in Belize. Hurricane impact probability at the proposed development site for 2006 was estimated by the US National Weather Service to be above normal until later downgraded, however the August 2007 update has restated that 2007 will be an above average year for Atlantic hurricane development (see **Addendum 10**). Normal impact probability for the entire Caribbean region in an average year is approximately 33% (1 – 3 storms out a normal probability of 9 named storms/season), which is about half that of the US in a normal year. The 2005 hurricane risk for the Caribbean in general was considered to be average, and for Belize that year was estimated at < 4% (see **Illustration 18**). Given these considerations, the project proponent will need to insure:

1. ***All vertical structures meet a minimum level of construction integrity to withstand wind speeds in excess of 100 mph, in order to prevent damage to neighboring structures; and***
2. ***The hurricane preparedness, notification and evacuation plan, as presented herein (see Page 177) will need to be adopted & implemented by residents to minimize risk to property and life during these seasonal events.***

Bathymetry, Topography & Hydrology

Coastal Bathymetry

Bathymetric survey of water depth reported by **Wildtracks (2003a)** for the BJE ranged from 0.24 - 0.72 meters below sea level at a distance of 10 meters east the BJE shoreline, to 0.55 - 1.34 meters elevation below sea level at a distance of 150 meters east of the BJE shoreline. *Ecoworks* survey of the southern region of the BJE showed water depth to range from 0.400 meters below sea level at 90 meters from shore, to 1.28 meters at 365 meters from shore, 1.20 meters at 420 meters from shore, and 1.34 meters at 445 meters from shore (see **Illustration 19** & **Table 8**).

A series of discontinuous, shallow lagoons extend along the margin of the coastal savanna, west of the BJE's entire shoreline. These lagoons likely act as receiving water bodies for runoffs from the coastal savanna, but their relatively low surface water elevation of perhaps 0.1 meter above sea level and shallow depth of 0.400 - 0.600 meters below sea level, affords them little actual volume or head with which to store or convey runoff waters from the 25,784 acre savanna habitat.

ILLUSTRATION 17:

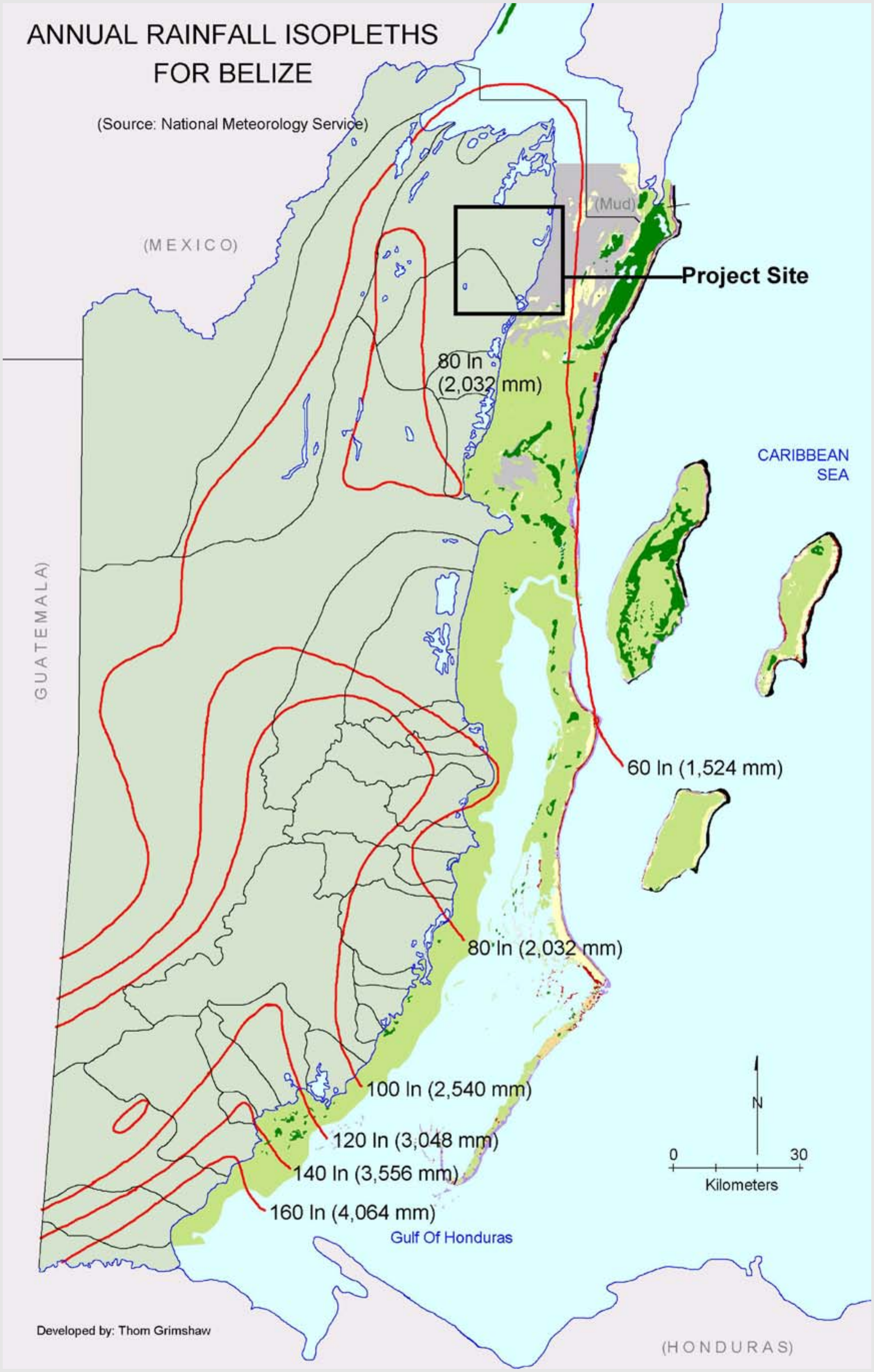
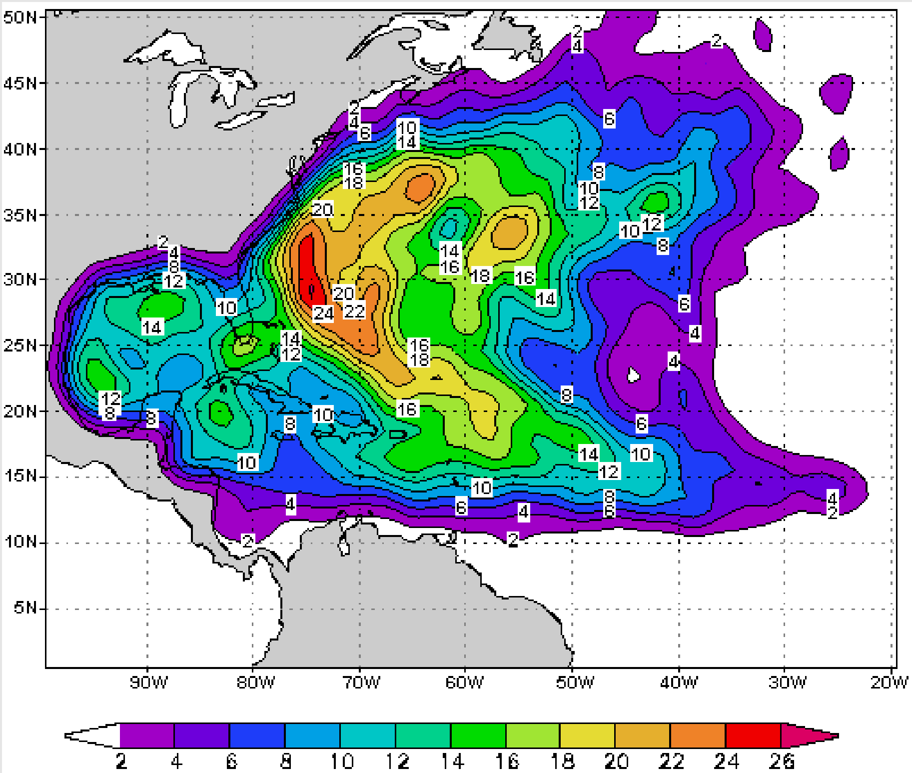
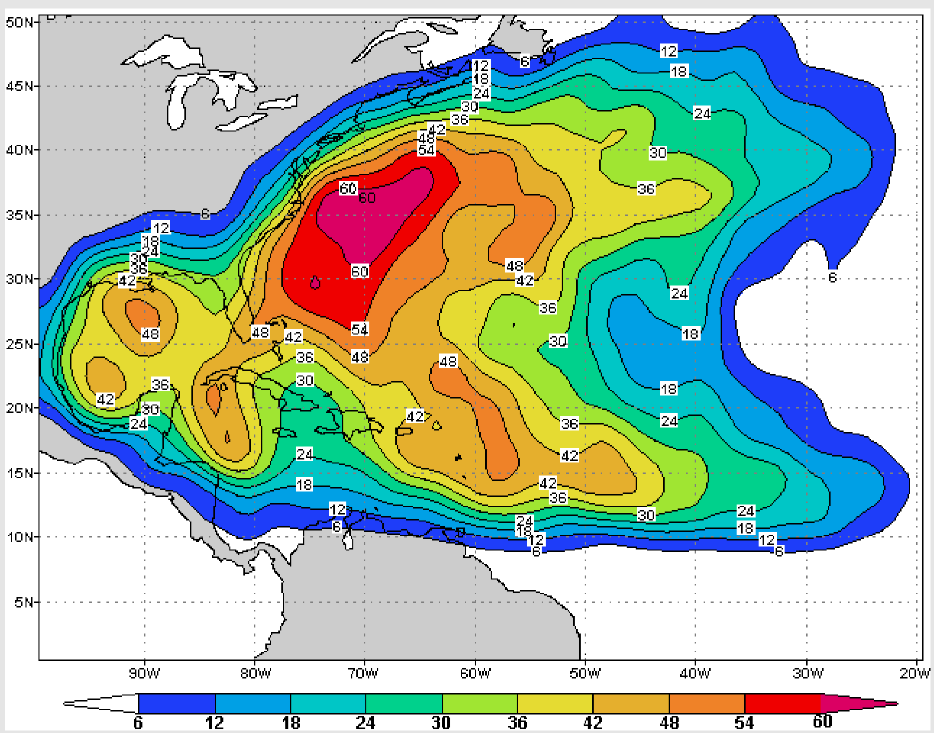


ILLUSTRATION 18:

2005 TROPICAL CYCLONE PROBABILITIES FOR THE NORTH ATLANTIC REGION





Key:

2005 Risk of a hurricane (**top**) and a named tropical storm (**bottom**) as calculated by NOAA (2005).

ILLUSTRATION 19:

BATHYMETRIC SURVEY POINTS ALONG THE COASTLINE OF THE BALAM JUNGLE ESTATE

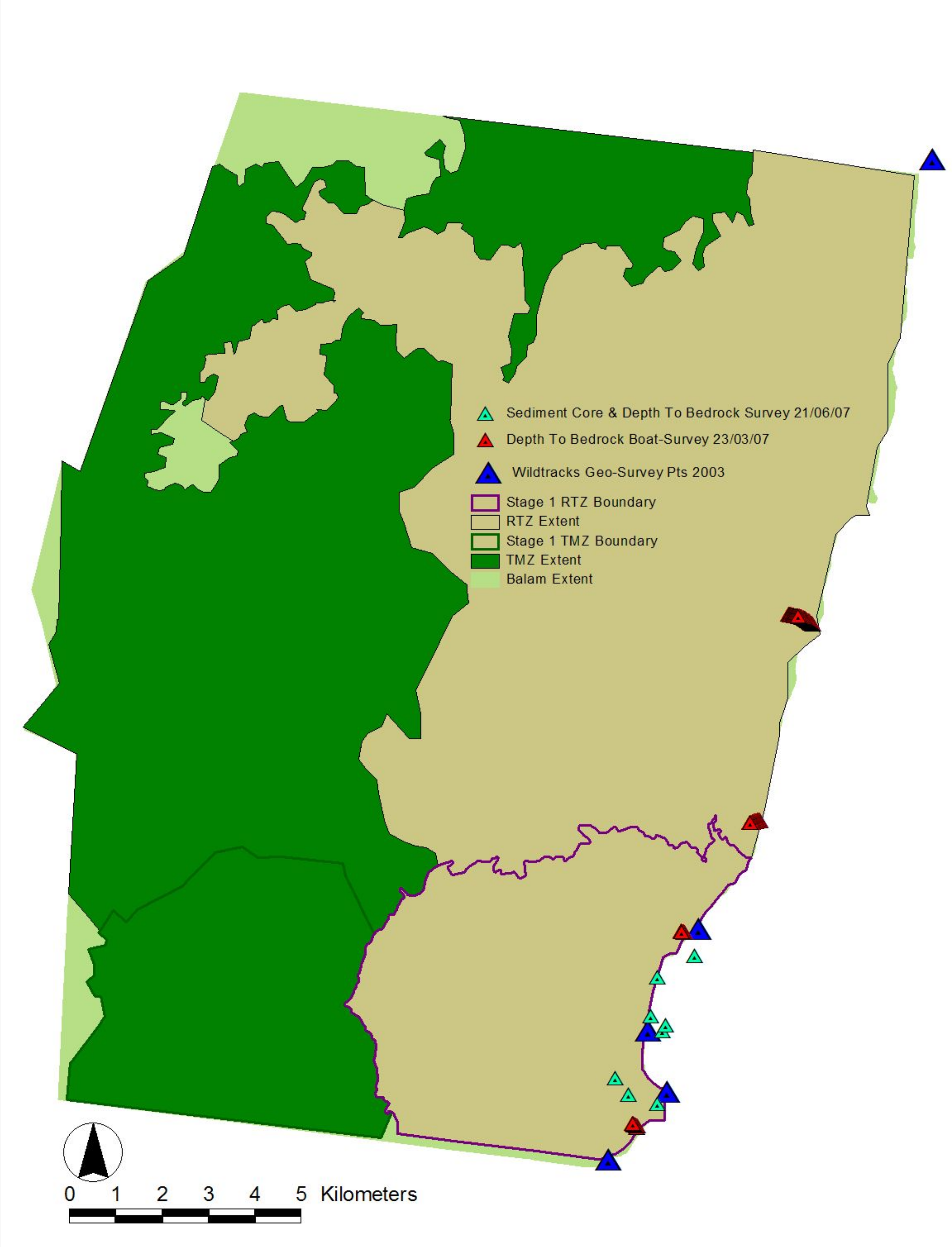


TABLE 8

COASTAL MARINE WATER DEPTH AT THE BALAM JUNGLE ESTATE

Distance From Shore (meters) / Water Depth (meters)	10	20	50	60	80	90	100	110	120	150	365	420	445
Ecoworks (2007)													
Chetumal Bay Point Set	---	---	---	---	---	0.400	---	---	---	---	1.280	1.200	1.340
Bennett's Lagoon Point Set	0.610	---	---	---	---	---	---	0.400	---	---	---	---	---
Wildtracks (2003a)													
Chetumal Bay Transect 1	0.308	0.390	0.41	0.435	0.490	---	0.490	0.480	0.540	0.568	---	---	---
Chetumal Bay Transect 2	0.305	0.790	1.350	---	---	---	---	---	---	---	---	---	---
Chetumal Bay Transect 3	0.240	0.290	0.392	0.530	1.070	---	0.820	---	---	---	---	---	---
Chetumal Bay Transect 4	0.720	0.175	0.678	0.945	1.090	---	1.165	---	---	---	---	---	---
Chetumal Bay Transect 5	---	0.244	0.178	---	0.267	---	0.270	---	---	0.545	---	---	---

Topography Of The Coastal & Upland Plains

The topographic relief of the 25,784 acre coastal savanna within the BJE, which constitutes the principal land unit being proposed for residential tourism development and approximately 27% of the BJE, was determined by onsite survey to form an eastward down-sloping plain that ranged from $\geq$ 0.2 M above sea level along the sea coast to $\leq$ 0.7 M above sea level along its western margin. Similar ranges for this habitat were also noted by King *et al* 1992 and Wildtracks (2003a).

The coastal savanna habitat within the BJE is pockmarked with *Hammocks* and *Bajos*, which together encompass some 11,595 acres, or 12% of the BJE (see **Illustration 20**). *Hammocks* include 0.5 - 5.0 acre mounded brown soils populated with sedges and black & white mangrove-dominant vegetation that were found, in about 50% of the sites examined, to have a peak elevation of 1-3 meters above the surrounding savanna, and/or be home to significant assemblages of wildlife species of particular conservation interest (see **Pages 66 - 98**). Quite unlike the *Hummock* micro-habitat, *Bajos* typically consist of black, peaty soils partially or completely covered by wetland vegetation or standing surface water, extending perhaps 0.1 - 1.0 meters below the savanna plain. In both cases however, these two micro-habitats were originally formed over the common sandy black top soils & wet marl to bedrock that is typical of the savanna habitat. Regardless of the respective importance of these habitats, however, they have been designed out of the overall development model for the BJE in order to secure the development's conservation objectives and market image.

The topographic relief of the timber management zone, which encompasses an area of 44,345 acres (42%) of the BJE, is tipped in three opposing plains, the first of which conveys runoffs to the northwest into the Shipstern watershed, the second of which conveys runoffs to the southwest into the Freshwater Creek watershed, and the third of which conveys runoffs to the southeast onto the coastal plain (see **Illustration 20**). As such, this land unit has been reported by King et al 1992 to range from $\geq$ 10 M to $\leq$ 30 M elevation above sea level. Low canopy forest lands, which lie between the timber management zone and the savanna habitat encompass an area of 6,427 acres, or 7% of the BJE, express intervening elevations and hence, serve to convey runoff flows from the timber management zone eastward to the savanna habitat (see **Illustration 20**).

Site Hydrology

The pre-existing runoff attributes of the proposed land use areas within the BJE are east, south-east (see **Illustration 21**). These attributes will not be modified by the proposed developments, and therefore are not anticipated to influence contemporary land use patterns outside of the Balam Jungle Estate.

Drilling logs from the area, particularly the Placid Oil Well Log (Shipstern 1: 1981-82), established that the limestone bedrock beneath the BJE is likely to be on the order of 1,800 meters thick. This limestone bed is extensively karstified (i.e. subject to solution on a very large scale during the Pleistocene sea level low stand), which has resulted in the formation of a vast network of subterranean cave systems and sinkholes that can be seen on satellite imagery and topographic maps of the area as round or sub-circular ponds.

ILLUSTRATION 20:

3D RELATIVE ELEVATION MODEL OF THE BALAM JUNGLE ESTATE

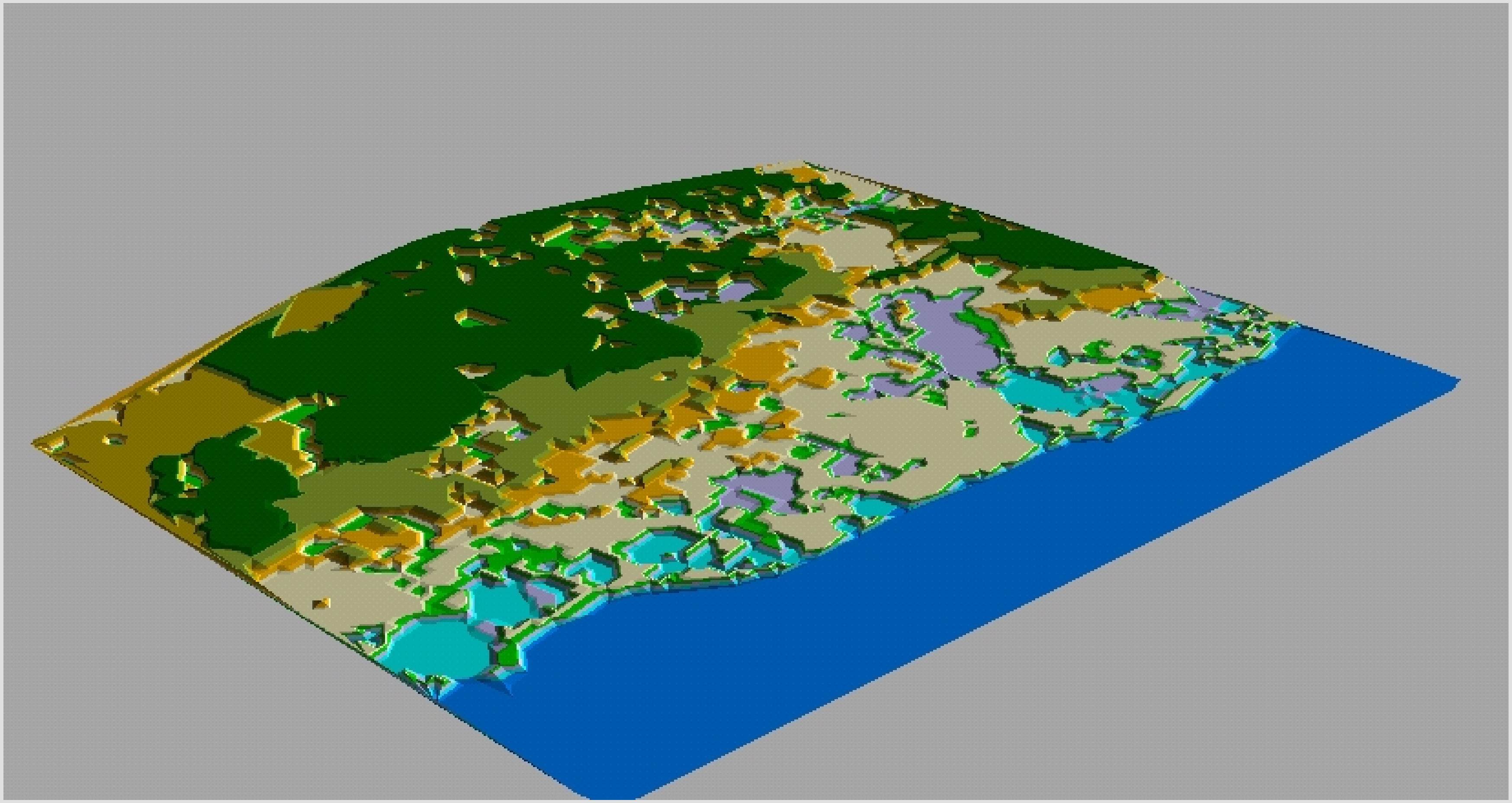
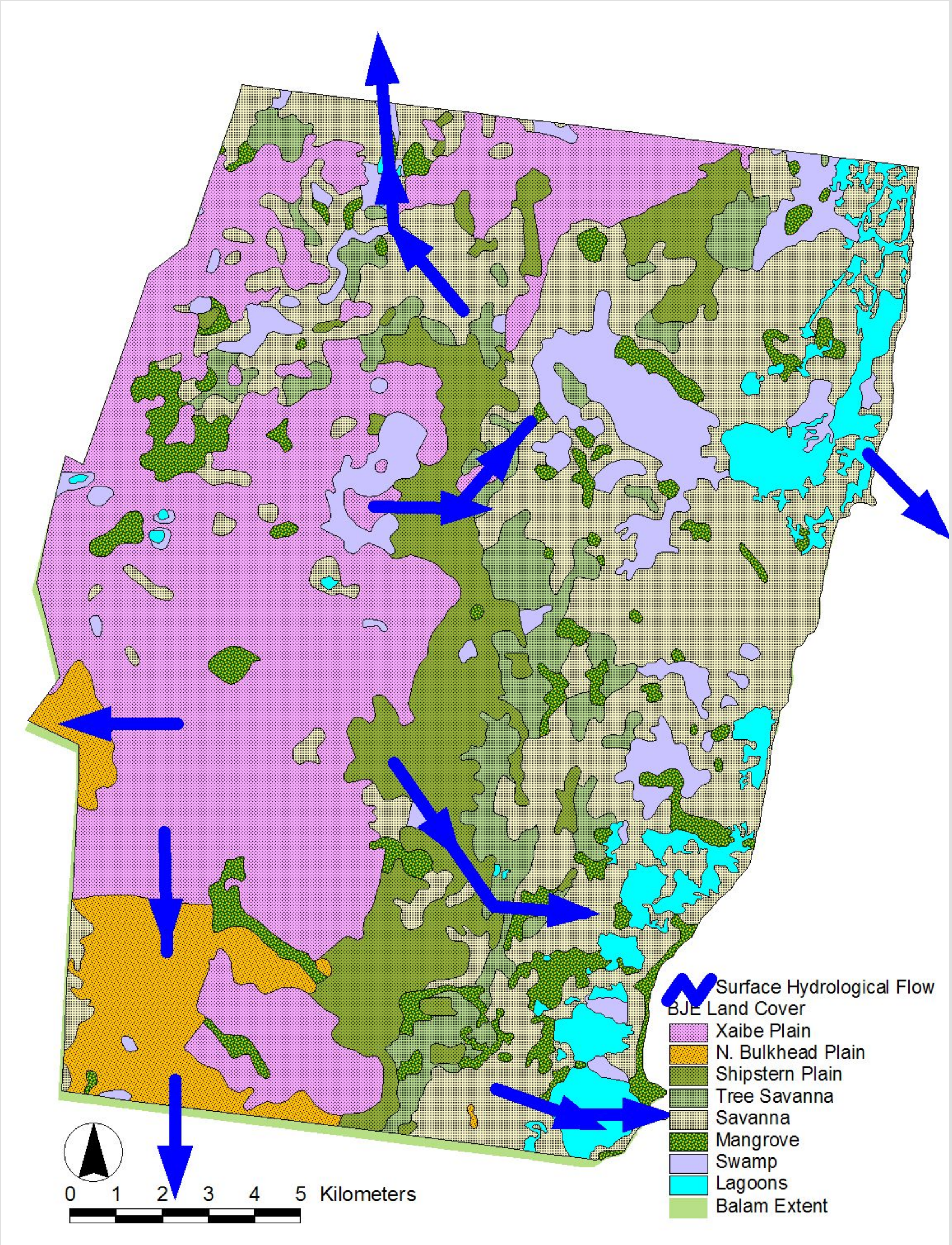


ILLUSTRATION 21:

HYDROLOGICAL CHARACTERISTICS OF THE BALAM JUNGLE ESTATE



Many of the cave systems are clearly linked to the Caribbean Sea as salt water occurs several miles inland. During one 2-day fieldwork session, Holland (2004) reported that a local guide, Nolberto Garcia, pointed out many salt and brackish water cenotes (sinkholes) and excavated ponds in the western part of the BJE, along with other fresh water cenotes that clearly were spring fed. The distribution of subsurface fresh water either as springs or within the shallow water table of the area is not readily predictable and clearly the subsurface hydrology of the BJE is very complicated due to karstification and possibly faulting. However, mapping of all cenotes, wells, and ponds might be useful for gaining an understanding of the spatial distribution of ground water quality although it will be important to remember that the distribution may also be random and not practically discernable from the exercise.

Taken together, these characteristics of the Balam Jungle Estate development site will require the proponent to:

3. ***Insure advance evacuation of the residential tourism development site in the event of direct hurricane approach, as the area will likely flood and remain impassible until pre-hurricane environmental conditions return;***

4. ***Insure that water features and drainage of the proposed development site are designed in respect of the low topographic relief of the area;***

5. ***Insure that septic systems, unless motorized, are placed above grade to support gravity-based flow & function; and***

6. ***Recognize the risks presented by the shallow nature of the water table, which is highly vulnerable to contamination from disposal of any liquid waste, particularly waste oil from equipment, and hence will require appropriate treatment or bond storage to offset.***

GEOLOGY

Geological Setting

The northern coastal plain of Belize where the project site is located forms part of the great Yucatan Carbonate Platform which extends over northern Belize, the Yucatan of Mexico and the Peten Basin in Guatemala (e.g. Viniegra, 1981). Most of the surface geology of the BJE, as shown in the geologic map of Belize by Cornec, 2003 (see **Illustration 22**), is composed of late Tertiary limestone of the Orange Walk Group, while the southernmost part is older and referred to the early Tertiary, flint bearing, Doubloon Bank Formation.

Stratigraphy

The Marine Basin Of Chetumal Bay

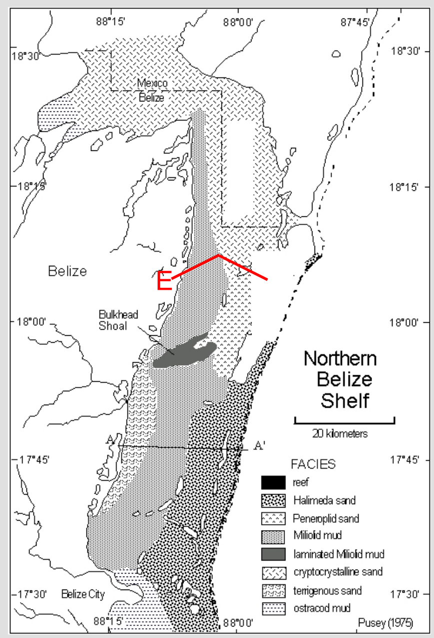
The marine sediments and underlying bedrock platform of Chetumal Bay's extension into Belize has been the subject of considerable study since the mid 1970's. Purdy (1975) mapped the material origin of sediments in the Bay and determined the shoreline region of the BJE to be composed of Miliolid Foraminifera mud (see Illustration 23, upper section), however Mazzullo (2006) determined the sediments to be comprised of a relatively uniform (well mixed) Miliolid-Mollusk sand, the depth of which varied according to the westward-sloping bedrock blocks (see Illustration 23, lower section) which were previously recognized by Cornec (2003) as being common throughout the project area, and extending to the surrounding Sarteneja-Chunox-Little Belize region of northern Belize.

This bedrock foundation is composed of horizontally layered, white/light grey to buff colored, well cemented (hard) limestone and conglomeratic marls (marl with cobbles and pebbles of hard limestone), believed to be of Pleistocene/ Pliocene age. Placid Oil Company drilled an exploration well, Shipstern 1, south of Sarteneja in 1981-1982, approximately 15 km north of BJE's northern boundary, and determined the first 5,980 feet of depth to be through limestone and dolomite rocks, followed by a granite layer extending to 6,220 feet, after which drilling was stopped.

ILLUSTRATION 23:

SEDIMENT & BEDROCK CHARACTERISTICS OF CHETUMAL BAY

Top. Sediment characteristics within Chetumal Bay adjacent to the BJE (after Purdy, 1975). **Bottom.** Cross section of sediment & bedrock characteristics within Chetumal Bay adjacent to the BJE (after Mazzullo, 2006).



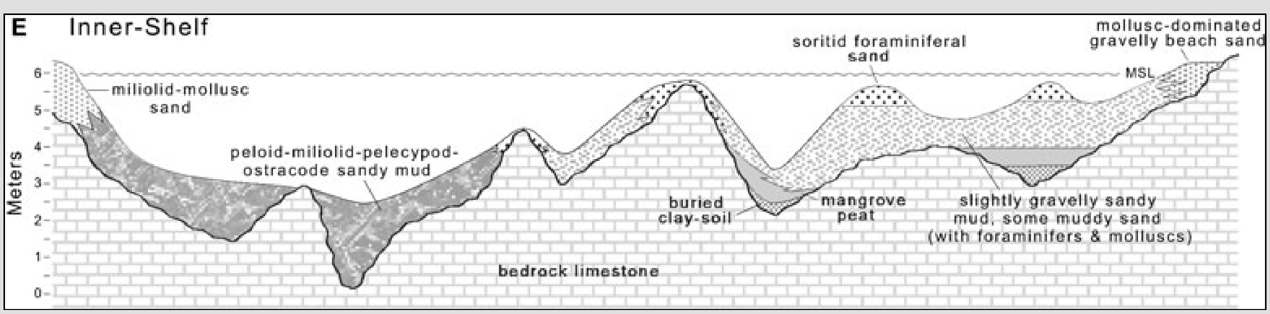
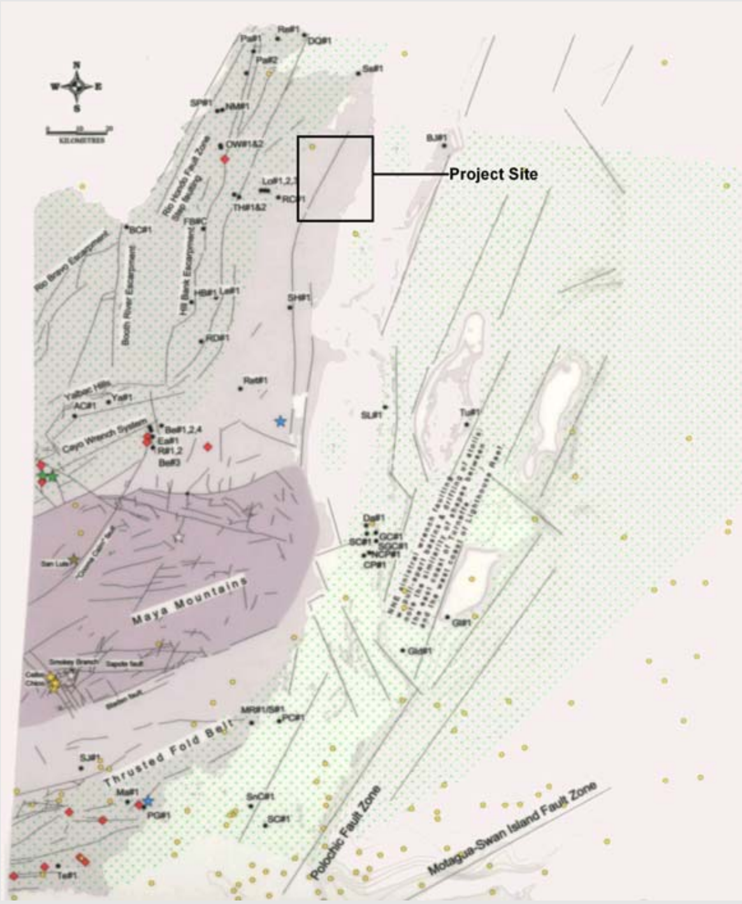
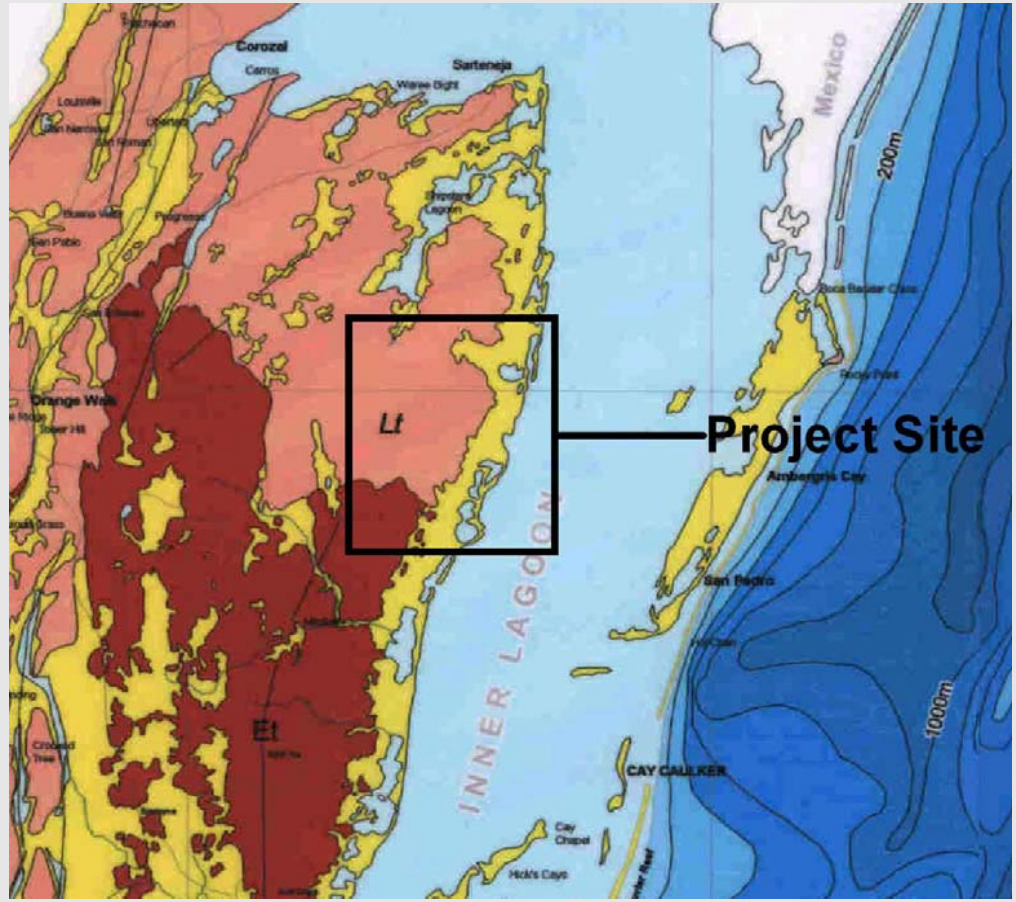


ILLUSTRATION 22:

GEOLOGY MAP FOR THE PROJECT AREA





Key

Geologic maps of Belize (Cornec 2003). Left: Mineral Potentials & Faults. Note location of fault along the western side of the project site. Right: Yellow field at the margin of the project site designates Quaternary materials, particularly Cretaceous & Lower Tertiary carbonates. Salmon field desinated later tertiary / mio -pliocene Orange Walk group marls, corals & limestones. Dark brown field spanning the interior of the project site designates early tertiary materials of the Doubloon Bank formation of limestone with huge chert nodules (>3 feet in diameter).

More recent evaluations conducted by Wildtracks (2003a) and *Ecoworks* (this study) determined near shore marine and lagoon sediments to have an average surface depth of 0.66 $\pm$ 0.42 meters below sea level; an average sediment depth of 1.99 $\pm$ 0.82 meters; and an average depth to bedrock of 2.64 $\pm$ 0.89 meters to a distance of more than 450 meters from shore (see **Illustrations 24 - 25** and **Table 9**), supporting the feasibility of constructing a deep-draft boat channel with which to access the marina facilities proposed for development (see **Page 34**). Moreover, recent analysis of these sediments established them to have a mean composition of: 70.4 $\pm$ 15.5 % sand, 15.9 $\pm$ 10.8 % silt, and 13.8 $\pm$ 5.5 % clay (see **Addendum 11**), which constitutes a mixture that is highly suited for the beach revetment planned for each Section of the proposed development.

The Coastal Savanna Land Unit

Little to no work has been directed toward understanding the geological stratigraphy of the Coastal Savanna land unit outside of the information presented in the land systems work of Wright 1959, King *et al* 1992 and that published herein. They reported the soils of this habitat to consist of a *Turneffe-Shipstern* -like subsuite, *Tintal-Ycacos* -like subsuite or a mixture of the two; with the *Shipstern* subsuite consisting of *shallow calcareous sand over coral*, and the *Ycacos* subsuite consisting of *permanently wet saline and brackish peats and gleys*. Neither Wright nor King based their classifications on direct observation of soil cores, however, with both basing their classification on of vegetation cover.

Direct observation and laboratory assay of soils collected from 4 sampling stations located within the savanna habitat of the Section 1 development zone by *Ecoworks*, established however, that subsoil strata consisted of a shallow dark brown topsoil overlying a wet to waterlogged, percolation-resistant grey to white marl matrix extending from 0.08 - 1.4 meters below grade to bedrock and as a soil profile much closer to the *Revenge-Tok* subsuite, typed by King *et al* (1992) as being comprised of mottled calcareous sandy clay-clay similar to that encountered in savanna cores (see **Illustrations 26** & **27**; and **Table 10**).

Interestingly, the coastal savanna subsoils are wettest in the lower strata along the coast, and wettest in the upper strata along the western margin of the habitat, suggesting that both fresh water and sea water contribute to the relatively high water content of the soil (up to 60% of core volume), particularly in wet weather. The material fraction of the soils is approximately 2:1 silt to sand, which in light of the relatively high water content observed, suggests the savanna soils might yield 100-300 mm (4 - 12 inches) of subsidence in their natural state since they are only marginally compressible, *unless* otherwise compromised by excavations such as the canal systems planned for development (see **Addendum 12**). Such excavations would afford lateral movement (slump) of soils under significant ground loading pressures, the remedy for which would principally rely on the deployment of retaining walls embedded into the underlying bedrock along the proposed canal systems to provide an opposing resistance. (To this end, the master plan for Section 1 would require some 140,000 feet of retaining walls to line all navigable & non-navigable canals).

ILLUSTRATION 24:

MARINE SEDIMENT CORE & BEDROCK PROBE SAMPLING SITES

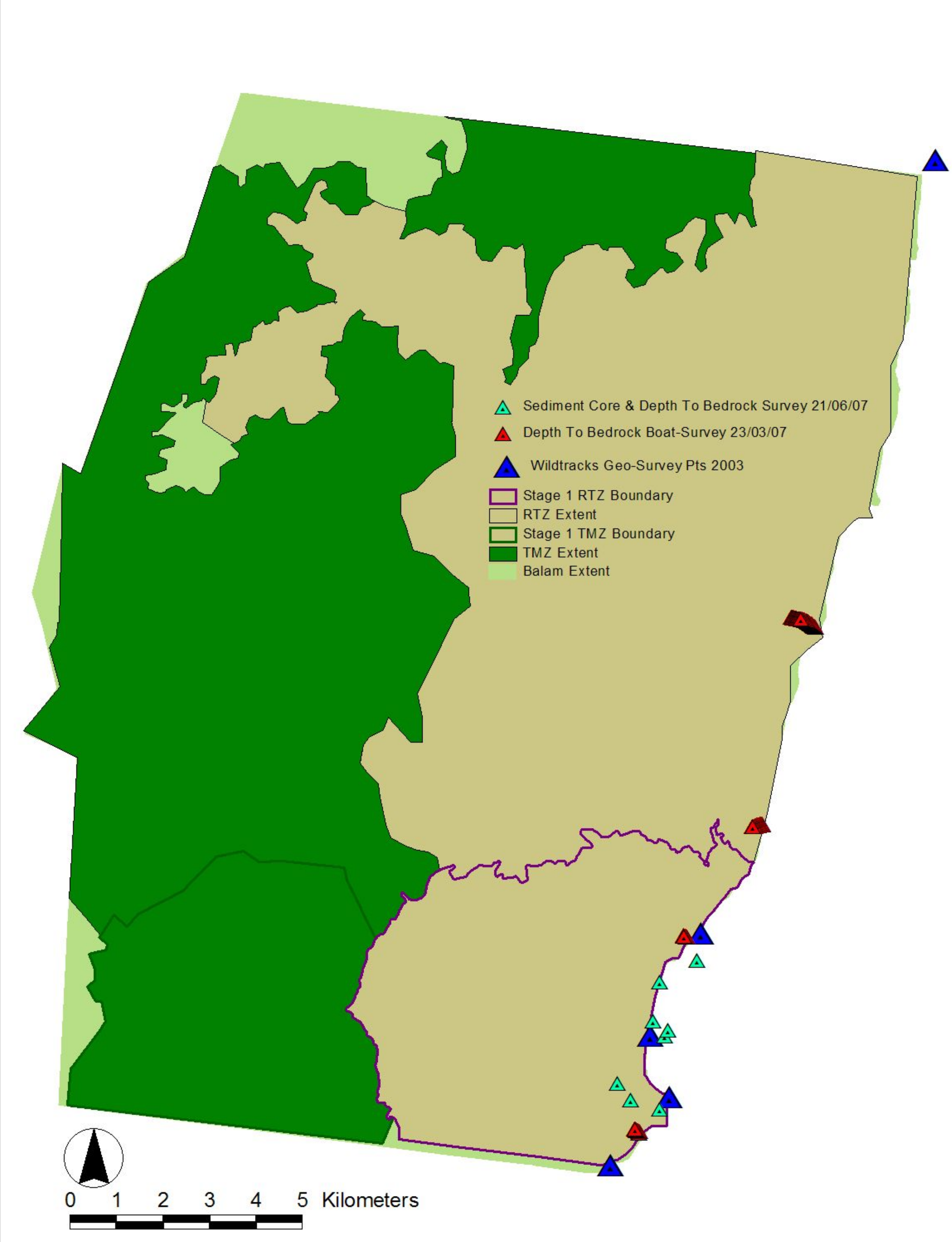


ILLUSTRATION 25:

COLLECTION OF MARINE SEDIMENT & BEDROCK DATA WITHIN THE BALAM JUNGLE ESTATE

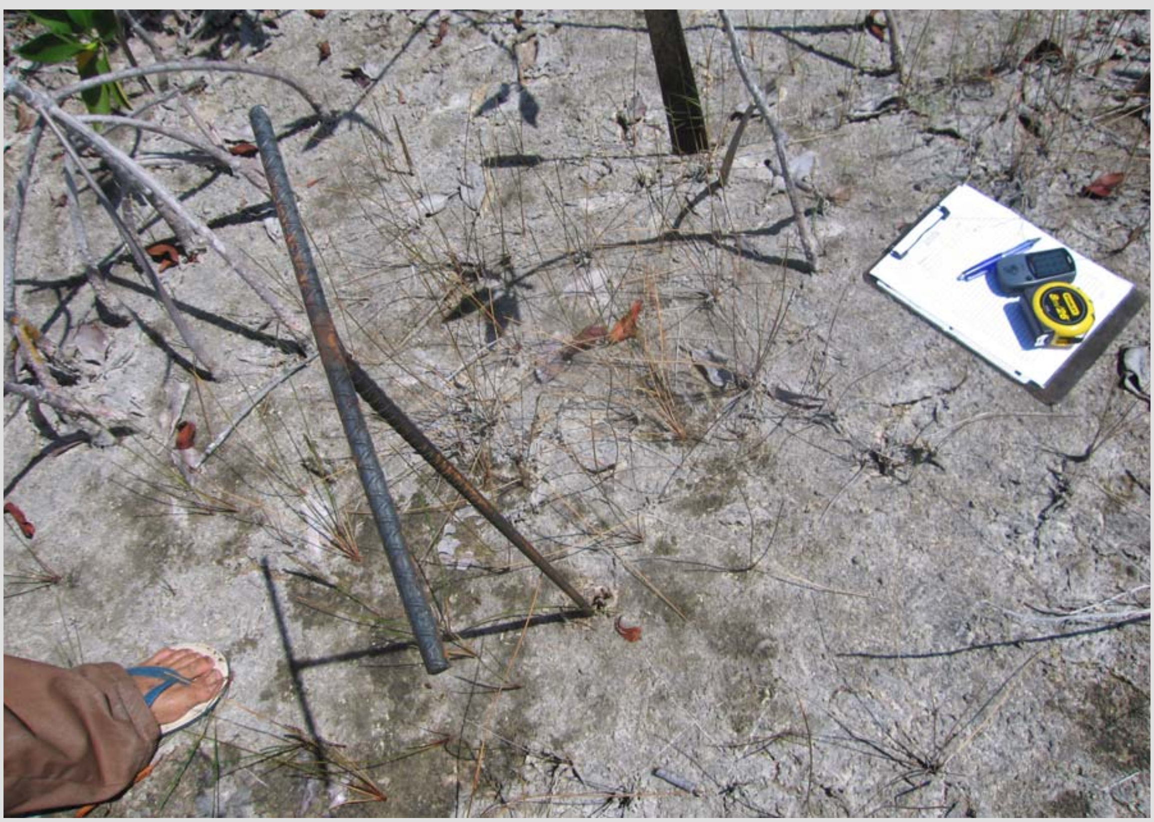


TABLE 9

MARINE SEDIMENT THICKNESS & BEDROCK DEPTH BELOW SEA LEVEL IMMEDIATELY OFFSHORE FROM THE BALAM JUNGLE ESTATE

DISTANCE FROM SHORE (M)	*10*	*20*	*50*	*60*	*80*	*90*	*100*	*110*	*120*	*150*	*365*	*420*	*445*
SEDIMENT THICKNESS/BEDROCK DEPTH BELOW SEA LEVEL (M)													
Ecoworks (this study)													
Chetumal Bay Point Set	---	---	---	---	---	1.55 /1.95	---	---	---	---	0.98 /2.26	2.13 /3.33	0.98 /2.32
Bennett's Lagoon Point Set	3.90 /4.51	---	---	---	---	---	---	3.90 /4.30	---	---	---	---	---
Wildtracks (2003a)													
Chetumal Bay Transect 1	2.40 /2.71	2.40 /2.79	2.40 /2.81	2.40 /2.84	2.40 /2.83	---	0.79 /1.28	0.46 /0.94	0.93 /1.47	1.34 /1.91	---	---	---
Chetumal Bay Transect 2	2.40 /2.71	2.40 /3.55	2.40 /3.75	---	---	---	---	---	---	---	---	---	---
Chetumal Bay Transect 3	2.40 /2.64	2.40 /2.69	1.63 /2.02	1.21 /1.74	2.40 /3.49	---	2.40 /3.22	---	---	---	---	---	---
Chetumal Bay Transect 4	---	2.00 /3.75	2.12 /2.80	---	---	---	---	---	---	---	---	---	---
Chetumal Bay Transect 5	---	1.45 /1.69	1.54 /1.72	---	---	---	---	---	---	---	---	---	---

ILLUSTRATION 26:

COASTAL CORING & BEDROCK SAMPLING SITES IN RELATION TO THE LAND SYSTEMS CLASSIFICATION OF KING ET AL 1992

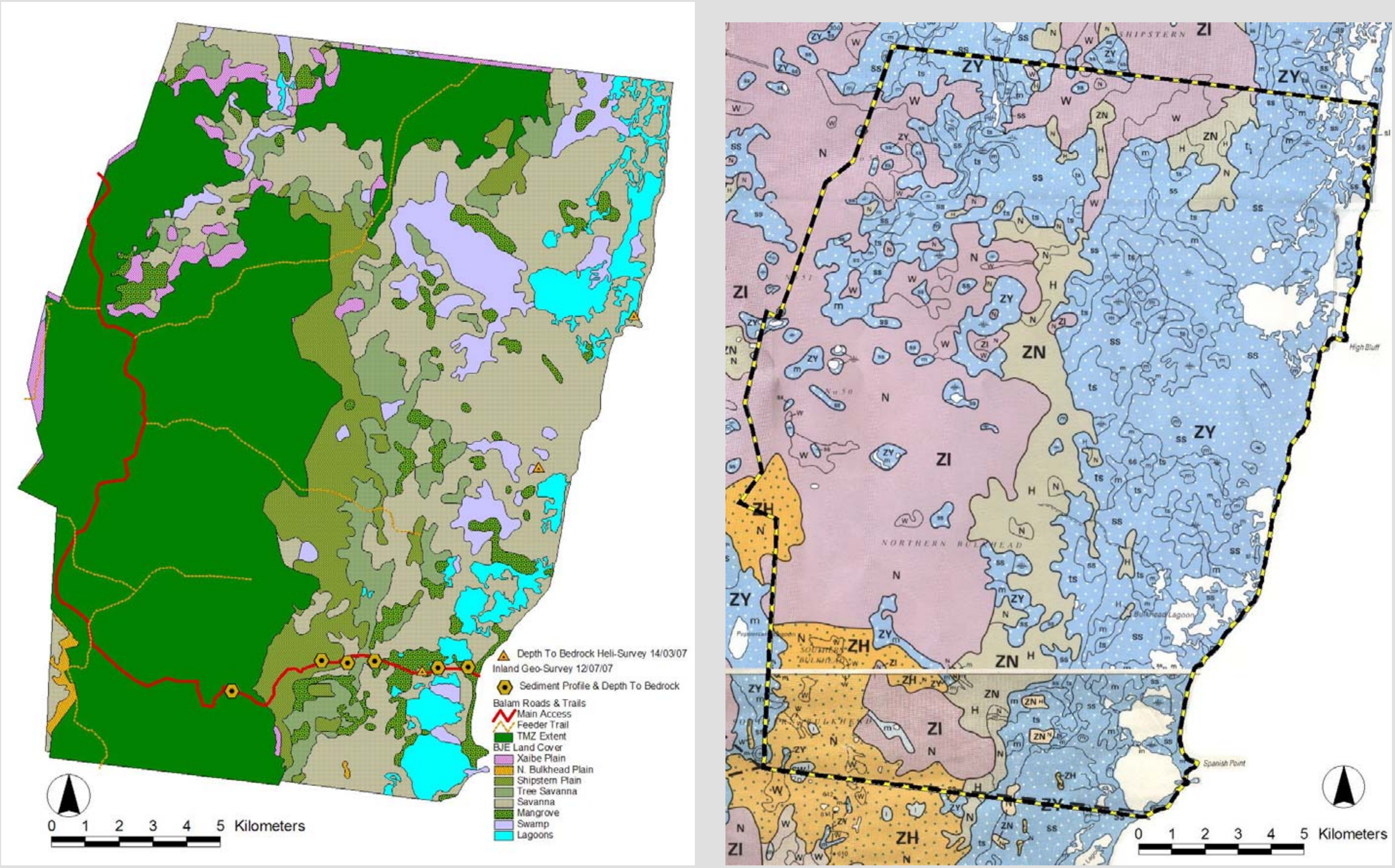


ILLUSTRATION 27:

COLLECTION OF COASTAL SOIL & BEDROCK DATA WITHIN THE BJE

TABLE 10

SOIL CHARACTERISTICS OF THE COASTAL SAVANNA

Site	**Distance Inland** (meters)	**Horizon**	**Depth** (in/ft)	**Description**
2		*0*	*28*	*Water Table*
2		1	3	Dark Brown Topsoil
2		2	69	Grey Clay
2	**400**	**2**	**6.0**	**Depth To Bedrock (Ft)**
3		*0*	*26*	*Water Table*
3		1	3	Dark Brown Topsoil
3		2	23	Light Grey Clay
3		3	44	Dark Grey Clay
3	**1,315**	**3**	**5.8**	**Depth To Bedrock (Ft)**
4		*0*	*16*	*Water Table*
4		1	4	Dark Brown Topsoil
4		2	12	Light Grey Clay
4		3	34	Dark Grey Clay
4	**3,290**	**3**	**4.2**	**Depth To Bedrock (Ft)**
5		*0*	*30*	*Water Table*
5		1	2	Dark Brown Topsoil
5		2	22	Light Grey Clay
5		3	30	White Clay
5		4	8	White Clay (very soggy)
5	**4,195**	**4**	**5.2**	**Depth To Bedrock (Ft)**
6		*0*	*?*	*Water Table*
6		1	2	Black Top Soil
6		2	8	Brown Soil
6		3	9	Orange-Yellow Soil
6		4	10	Light Orange Soil
6		5	12	White Soil
6	**4,984**	**5**	**3.4**	**Depth To Bedrock (Ft)**
1		*0*	*?*	*Water Table*
1		1	6	Black Top Soil
1		2	17	Brown Clay Soil
1		3	20	Yellow-Brown Soil
1		4	6	White Marl
1	**7,705**	**5**	**4.1**	**Depth To Bedrock (Ft)**

Conversely however, the relatively shallow bedrock foundation beneath the savanna soil can be accessed for support of high ground loading structures at relatively low expense, leaving the natural soil to carry much lighter loads of landfill, landscaping or foot paths, but requiring structural support (i.e. retaining walls) for heavier loads in the vicinity of the canal and/or marina excavations. Given the elevation of the savanna's existing grade (0.2-0.7 meters above sea level) and the supra-bedrock soil structure, approximately 0.6 - 1.0 meters of fill will be required to raise mean savanna habitat elevation to 1 meter above sea level as is currently recommended by way of accommodation for sea level rise born by climate change.

The Forest Management Zone

King *et al* 1992 reported the soils of the western portion of the Balam Jungle Estate to belong to mosaics of three principle subsuites, which include the Bahia Remate, Pembroke Xiabe and Pembroke Pulucax subsuites of the Shipstern (ZN), Xaibe (ZI) and Northern Bulkhead (ZH) Plains (see **Illustration 28**). The Bahia Remate subsuite consists of very stony and shallow black to dark grey mineral clays developed over recently emergent, massive or fragmented coral on the low areas around Chetumal Bay; usually presented in ridges, having grades of increasing stone size up to 30 cm depth.   The Xaibe and Pulucax subsuites of the Pembroke soil suite consist of calcareous clays which vary in color from red to yellow (respectively). The Xaibe subsuite is the better drained of the two, and the more likely to persist to depths exceeding 50 cm, but both are common to the Shipstern, Xaibe and Northern Bulkhead Plains.

More recently, Holland (2004) noted that the western region of the Balam Jungle Estate demonstrates a markedly different stratigraphy from that of either the offshore marine or coastal savanna habitats. One of the most striking bedrock features in this region of the BJE is the widespread occurrence of a hard, well cemented, limestone layer or bed, which can be observed along the logging roads throughout the area (see **Illustration 29** top & center). This feature is known to occur northwards to Sarteneja and westwards at least to Chunox Village, and forms a gently undulating surface of perhaps a few meters amplitude, which may be due to either weak regional folding or to karst solution of the limestone surface during a period of emergence.

The upper surface of this layer is often capped by a thin, laminated, brown (ferruginous?), 1-5 mm thick crust that is believed to represent a regional unconformity. Beneath the laminated crust the hard limestone rock is light gray to buff, fine-grained often laminated limestone, with occasional simple tube-like trace fossils. The limestone is often conglomeratic containing hard limestone clasts (fragments) up to boulder size. The clasts appear to be matrix supported (appear to be “floating” in the fine grained limestone; see **Illustration 29** bottom left & right). In the southern part of the BJE (at UTM N2001951, E16365690) flint nodules were noted to occur in the marl. North of this area flint nodules appear to be absent. Further south the abundance and size of flint nodules in the marl layer appears to increase, and the flint bearing marl still lies above the hard limestone surface. This indicates that either the marl becomes more siliceous to the south, or the flint bearing marl belongs to a different formation as suggested by Cornec (2003). Microfossils in the flint demonstrate that the flint replaces the limestone (marl) as a late stage digenetic alteration.

ILLUSTRATION 28

FOREST CORING & BEDROCK SAMPLING SITES IN RELATION TO THE LAND SYSTEMS CLASSIFICATION OF KING ET AL 1992

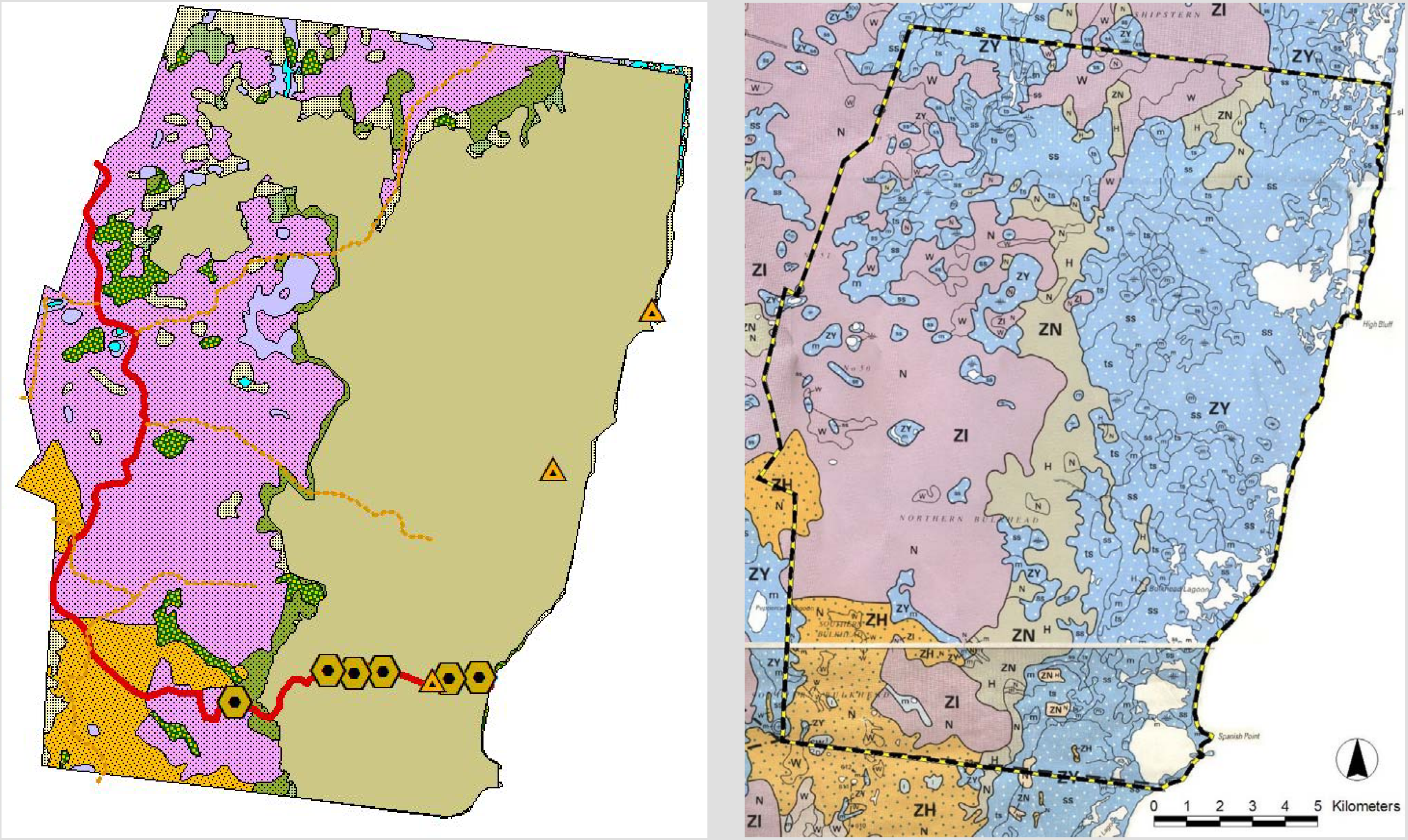


ILLUSTRATION 29

GEOLOGICAL FEATURES OF THE WESTERN BALAM JUNGLE ESTATE

Top Right. Northern part of BJE. Top of the hard limestone layer, note brown mineralized crust and solution pitted surface (right of hammer).

Center. Logging road to sawmill camp built directly on hard limestone. Note the undulating hard limestone layer.

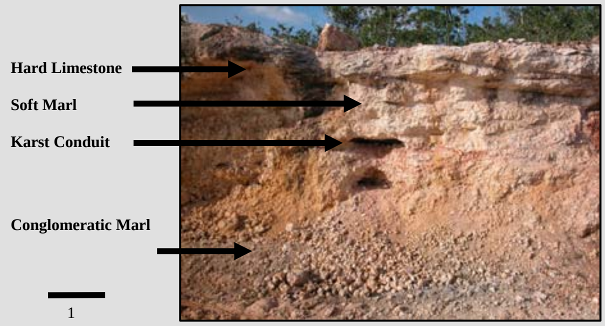
Bottom Right. Hard limestone layer (dark color) with conglomeratic clasts (light colored limestone fragments), note large clast to right of the hammer handle. Marl pit on logging road near Balam Jungle Gate.

Bottom Left. Hard limestone layer on logging road near sawmill camp. Note dark flint nodule in middle (left of pen) and fragments of limestone "floating" in the hard limestone layer (conglomerate). Black color is due to weathering and coating of fungus.

The hard limestone layer itself is between 80 cm and 1.5 m thick, forms a prominent ledge or bed at or near the top of nearly all the quarries (marl pits) in the area (see **Illustration 30** The bed is well cemented with little visible porosity, but occasional fractures which are likely related to tectonic jointing or subsidence due to collapse of underlying karst-created cavities. In the low lying (basin) areas between the ridges of the hard limestone is a bed of soft, white to light gray, sometimes conglomeratic, fine grained limestone, locally termed "marl".

ILLUSTRATION 30

TYPICAL QUARRY CROSS-SECTION



The term marl here is actually a misnomer since marl denotes an impure limestone or limey clay; these marls are very pure limestones. This soft rock unit also has regional distribution and can be several meters thick, enough to cover the ridges of the hard limestone layer above it. The thick bed of underlying conglomeratic marl is composed of hard limestone cobbles and pebbles (lithoclasts) set within a soft marl sediment matrix.

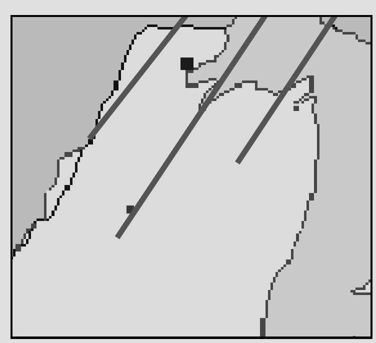
Thin clay deposits, mostly less than 1 meter thick (though the lower boundary to clay beds was not seen at all localities), occur throughout the western part of the BJE as fill in the basin like areas between the hard limestone ridges. It is likely that the clay deposits once covered the entire area but have been eroded off higher areas like the ridges. The clays vary in color from locality to locality but are mostly yellow to yellow-brown with mm size black hematite grains sometimes oxidized to yield red mottling in the southern part of the property. In the north a uniform dark gray clay was found (see ledger). No bedding or lamination was observed in any of the clays. The clays are invariably non calcareous and have very little silt. The silt seen is clear quartz. Based on literature descriptions of clays elsewhere in northern Belize (e.g. Red Bank Formation) some of these, especially those with the red weathering hematite grains, could be bentonitic clays. The various types of clays found in the BJE all occur above the marl/flint bearing marl beds and thus constitute the youngest geological strata in the BJE.

Tectonics

The northeast corner of Belize lies on a stable fault block or horst, formed as a result of the eastward sliding of the Caribbean and North American plates during the Tertiary Recent period. To the north of the Balam Jungle Estates area lies the major Shipstern Lagoon system, one of several major waterways in the north (other examples being Progresso Lagoon and the New River, Shipstern) believed to be aligned along these SW-NE trending faults downfaulted to the east (King et al, 1992; see **Illustration 31**. No evidence of tectonic activity has been seen in the Balam Jungle area, though it should be borne in mind that this coastal area of Belize remains a tectonically active area (James & Ginsburg, 1979; McCann & Pennington, 1990).

ILLUSTRATON 31

FAULT LINES OF NORTHERN BELIZE



Implications Of Site Geology On The Development

The geology of the Balam Jungle Estate development site is favorable to the forestry and residential tourism developments being proposed, albeit for the following considerations:

7. ***While the soil compactabiity of the savanna habitat is adequate for the vertical ground pressure loading of roads & buildings, easements along causeways should be established in order to set-back infrastructure loading along canal walls, and to provide maintenance access in the event of soil slump from canal wall failure; and***

8. ***Septic tanks and leach fields will of necessity need to be designed for placement into exogenous fill materials and therefore must be afforded ample percolation in these soils to maximize leach field effectiveness.***

WATER QUALITY CHARACTERISTICS

Water samples were collected from two sampling stations sited within Chetumal Bay and Bennett's Lagoon on 21 June 2007 (see **Illustration 32**). Samples were collected in one gallon jugs at 60 cm depth below water surface and assayed for chemical & biological constituents the same day at the Bowen & Bowen water quality laboratory in Ladyville and the Ecoworks laboratory in Belmopan (respectively).

Physio-Chemical Water Quality

Sampling results for physio-chemical water quality in Chetumal Bay and Bennett's Lagoon are shown in **Table 11** (see also **Addendum 13**). The relatively high temperature values observed in conjunction with, moderately brackish salinity, elevated phosphorus levels, moderately high TOC levels, and low oxygen levels, are indicative of significant levels of sediment respiration, particularly since casual observations during sampling established biodiversity to be deplete. The low *E. coli* levels observed, however, establish the site is not presently polluted with human sewage, as are many other coastal sites in Belize. Unfortunately, it remains unclear if copper values are impacting estuary biodiversity in this region since they have been reported to be more than 3 times their indicated value at the BJE (i.e. 5 ppm) over a coral reef habitat near to Placencia.

Biological Water Quality

Five-hundred meter plankton tows along the BJE frontage on Chetumal Bay returned no plankton captures, which in light of the relatively oligotropic chemical water conditions observed, is not particularly surprising. Plankton samples from Bennett's Lagoon were deplete with respect to phytoplankton, but were otherwise abundantly populated with a few species of Crustacean and either rotifer or ciliate plankters. Copepods and nauplii were observed to be deeply entwined in predator/prey relations; while the two new and as yet unidentified ciliates or rotifers, were noted to be capable of very high speed locomotion and easy evasion from Copepod predators (see **Illustration 33**).

Conclusions & Recommendations

The relatively low nutrient levels, low oxygen loads, and high sediment respiration rates anticipated in the sampling area, along with the relatively depauperate planktonic and vertebrate biodiversity in an environment that is seldom disturbed by human interventions provides a clear indication that prevailing water quality conditions set the adaptive standard for the fauna inhabiting the site, making it somewhat unique, despite its relatively low overall biodiversity. Given these considerations, the proponent will need to:

9. ***Insure that irritants & pollutants such as colloid turbidity, pool chemicals, golf course pesticides, and/or petroleum residues are not permitted to become elevated to point where they extirpate the unique planktonic marine fauna of Bennett's Lagoon; and***

10. ***Four-cycle outboard engines are promoted for use by guests and residents in order to reduce the potential for petroleum accumulation in the surface water layer of Bennett's Lagoon.***

ILLUSTRATION 32:

CHEMICAL & BIOLOGICAL WATER QUALITY SAMPLING STATIONS AT THE BALAM JUNGLE ESTATE

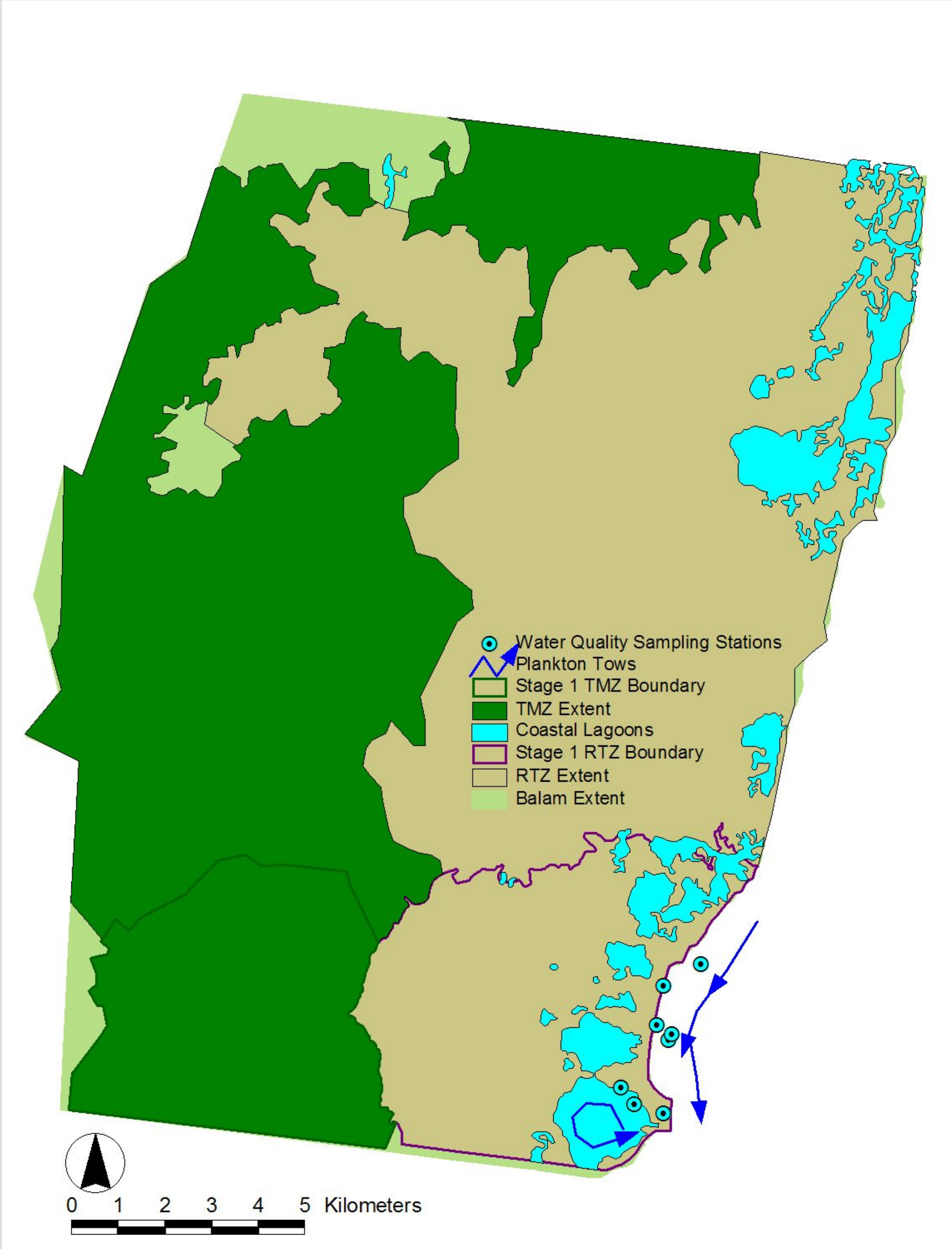


TABLE 11

WATER QUALITY PARAMETERS FOR BENNETS LAGOON AND CHETUMAL BAY

		Bahia Chetumal	Bahia Chetumal	Bennett's Lagoon	Bennett's Lagoon	Bahia Chetumal
Parameter	Unit	Wp117	Wp118	Wp119	Wp120	Wp123
Temperature	^{O}C	29.7	30.7	30.9	30.6	31
Salinity	ppt	18	21	20	23	18
Oxygen	ppm	4.49	3.75	5.24	4.83	4.57
Suspended Solids (Ss)	ppm	28	29	58	31	21
Turbidity	ntu	14.57	14.93	21.3	19.8	20.6
Copper (Cu)	ppm	1.56	1.3	1.24	1.36	1.48
Nitrogen, Total (N)	ppm	N/D	N/D	N/D	N/D	N/D
Phosphorus, Total (P)	ppm	0.07	0.04	0.09	0.03	0.09
Ammonia (NH_3)	ppm	N/D	N/D	N/D	N/D	N/D
Silica (SiO_2)	ppm	9.2	6.5	3.2	3.4	10.2
Organic Carbon, Total (TOC)	ppm	55	65	75	80	90
Total Coloform	count	58/100ml	39/100ml	104/100ml	T.N.T.C	T.N.T.C
Fecal Coloform	count	3/100ml	3/100ml	2/100ml	0/100ml	2/100ml

ILLUSTRATION 33

COMMON PLANKTERS OF BENNET'S LAGOON, BALAM JUNGLE ESTATE

Top Right. A reciprocating rotifer or ciliate that propels itself faster than striking Copepod plankters by accordion or slinky-like compression and extension of its apparently tubular body.

Center. Another unusual and unidentified plankter that spins as it moves through the water column like a slow-motion Frisbee.

Bottom Right. One of numerous nauplii larvae found in plankton tows from Bennett's Lagoon.

Bottom Left. An apex predator, this Copepod (above) prepares to launch itself across some 20 body lengths to capture its pint-sized quarry, a mite, which is perhaps 1/20th is size.

(**Note:** black lines belong to square etchings that are 0.01 mm on a side. Hence, the plankton shown are much smaller than one square.)

TERRESTRIAL FLORA & FAUNA

Ecosystem Descriptions And Plant Species Lists

Overview

A rapid ecological assessment (REA) of the 95,500-acre Balam Jungle Estate (BJE) located within the south-east Corozal District, was conducted during two field visits spanning a total of 8 field days during May and June 2007. Previously published reports specific to the Balam Jungle Estate produced by Wildtracks (2003b) and Mendoza (2006) were reviewed and consulted during the project. The land cover classification completed by Wildtracks (2003b) and utilized in the Sustainable Forest Management Plan (Mendoza 2006) identified 13 vegetation types within the BJE using both satellite imagery and ground-truthing techniques. These vegetation types follow the nomenclatural designations outlined in the Central American Ecosystems Map for Belize (Meerman and Sabido, 2001). The vegetation types identified within the BJE include:

- *Tropical Evergreen Seasonal Broadleaf Lowland Forest Over Calcareous Soils: NE Variant*
- *Tropical Evergreen Seasonal Swamp Forest Of Northern Belize (High Variant)*
- *Tropical Evergreen Seasonal Swamp Forest Of N Belize (Low Variant)*
- *Tropical Semi-Deciduous Broadleaf Lowland Forests*
- *Broadleaved Lowland Shrubland: Leguminous Variant*
- *Tropical Lowland Tall Herbaceous Swamp*
- *Permanently Waterlogged Freshwater Mangrove Scrub*
- *Basin Mangrove Forests*
- *Mixed Mangrove Scrub*
- *Dwarf Mangrove Scrub*
- *Marine Slat Mark With Many Succulent Plants*
- *Tropical Littoral Forest And Beach Communities*
- *Coastal Fringe Rhizophora Mangle –Dominated Forests.*

Of these 13 vegetation types, five comprised greater than 90% of the land area within BJE while the remaining eight ecosystem types comprise ca. 6.8% of land area (Wildtracks 2003b:22). As such, the systematic sampling of vegetation and birds occurred primarily in the five largest land cover; these include: Tropical evergreen seasonal broadleaf forest over calcareous soils: Northeastern variant (31.4%), Marine Salt Marsh with many succulent species (21.1%), Dwarf mangrove scrub (13.6%), Tropical evergreen seasonal swamp forest of N Belize: High Variant (12.9%), and Permanently waterlogged freshwater mangrove scrub (10.6%). Of these five major ecosystem types, three (Marine salt marsh, Dwarf mangrove scrub, permanently waterlogged freshwater mangrove scrub) are characterized by low plant species diversity despite covering a combined 45% of the land cover within the property. Thus, the majority of research effort was expended in two ecosystem types characterized by higher floral and faunal diversity while other ecosystem types received less sampling effort.

Due to the extremely large size of the BJE and the lack of access roads within the property (see **Illustrations 34-35**), it was extremely difficult to reach certain parts of the property. As such, ecosystem types near access roads were selected for sampling during the REA. For hard-to-access areas, a helicopter was chartered to fly over the property. Though this doesn't allow any determination of on-the-ground species diversity, it allowed a preliminary identification of the ecosystem type in the areas visited. What is important to note is that the mere size of the property and the inaccessibility of large tracks of forests limited the practical scope of this REA to a very small percentage of land area within the Balam Jungle Estate. As a result, the treatment herein is not a comprehensive treatment of the biodiversity existing within the property. Increase sampling intensity, particulary in the tropical evergreen forest will certainly add many more species to the already long list.

Methods

Ecosystem types within the BJE were identified using vegetation maps (Wildtracks 2003b) and the expertise of the Ecoworks REA specialist. Once ecosystem types were identified, five 200m^2 transects (100m X 2m) were demarcated within each habitat. Thus, the minimum sample unit for any ecosystem type was 1000m^2. All trees with a diameter at breast height (dbh) greater than 10cm that occurred within transects were identified to the species level, where possible. In addition to the species determination, the abundance of each species was recorded within transects. The abundance of species abundance and their relative abundance within an ecosystem facilitate the designation of the ecosystem type and allow the identification of species "typical" of that forest type. Although tree species diversity was the focus of sampling, an effort was made to identify, shrubs, herbs, vines, orchids and epiphytes that occurred within the sample unit. Each of the UTM co-ordinates for each transect was further recorded for designation on topographic maps for the BJE.

In addition to transects, the Ecoworks REA specialist also utilized the "walk in the woods" (Phillips and Gentry 1993; Young, 2005) approach to survey flora diversity. This methodology was used when traveling through the forest searching for a specific habitat type or Mayan Ruins. A similar effort was made to inventory those species occurring along the major roads within the property. Thus, the actual sampling area utilized for the REA is significantly larger than the area from transects alone.

Spelling of scientific names of plants followed Mabbaerly's *The Plant Book* (2000) while names not found in the Mabberley (2000) followed Balick et al. (2000) *Checklist of Vascular Plants of Belize: With common Names and Uses*. Species arrangement and classification of flowering plants followed Cronquist's *An Integrated System of Classification of Flowering Plants* (1981). Creole common names were assigned to each botanical species where possible. No effort was made to harmonize the common names of species identified by Wildtracks (2003b) and Mendoza 2006); instead the common names followed those of Young (2005).

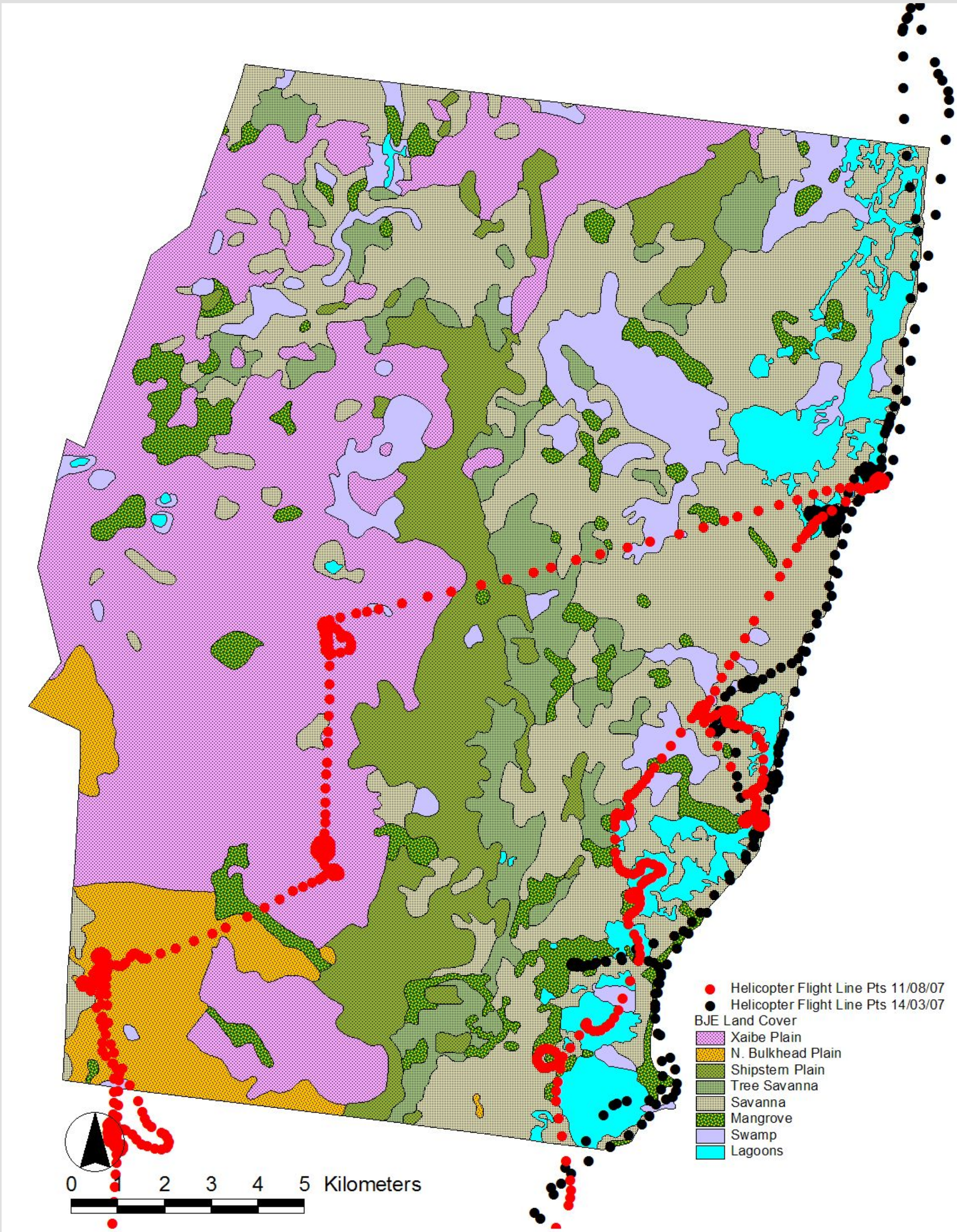
ILLUSTRATION 34:

AERIAL VIEWS OF THE BALAM JUNGLE ESTATE LAND COVER

Above: The Coastal Savanna; **Below**, The Timber Management Zone

ILLUSTRATION 35:

LAND COVER CLASSIFICATION FOR THE BJE DEVELOPMENT SITE SHOWING HELICOPTER SURVEY FLIGHT LINES



Tropical Evergreen Seasonal Broadleaf Lowland Forest Over Calcareous Soils: NE, High & Low Variants

For the purposes of this REA, the habitat description of this forest type utilized by Wildtracks (2003b:23) will be reproduced here. "This habitat is highly variable within the property in terms of height, degree of seasonality, and the relative abundance of dominant tree species. The primary causal factor behind these variations appears to be the soil depth and moisture: the deeper and more humid soils support taller, more evergreen and less seasonally stressed vegetation." However, the species composition and relative abundance reported here sometimes differ from those of listed by Wildtracks (2003b) and may be an artifact of the sampling location.

Within the BJE property, this habitat type is characterized by the present of the following species in high abundance in the canopy layer (see **Illustration 36** and **Tables 12 -14**): gombolimbo (*Bursera simarouba*), santa maria (*Callophyllum brasiliense*), Wild Grape (*Coccoloba schiedeana*), Glossywood (*Guettarda combsii*), black poison wood (*Metopium brownei*), Sapodilla (*Mailkara zapote*), fiddlewood (*Vitex gaumeri*), black mamee ciruela (*Pouteria campechiana*), sillion (*Pouteria amygdalina*), boy job (*Matayba appositifolia*), kill man (*Dendropanax arboreus*), botan (*Sabal mauritiformis*), negrito (*Simarouba glauca*), copal (*Protium copal*). Other species such as big leaf mahogany (*Swietenia macrophylla*) and cabbage bark (*Lonchocarpus castilloi*) do occur and are expected to occur within this habitat type; however, their relative abundance is low compared to other species. This is primarily as a result of the selective logging of these valuable tree species.

The understorey of this forest type is dominated primarily by palms in high abundance. These species include: bayleaf (*Sabal mauritiformis*), tiger leaf (*Sabal yapa*), give and take (*Crysophila staurocantha*) and salt water palmetto (*Thrinax radiata)*. Other species common in the understorey include many *Psychotria* spp., wild coffee (*Rinorea dexiflora*) and mahogany saplings (indicative that this species is regenerating well on its own). As reported in the biodiversity report, a few of these species (Mahogany, fiddlewood) have IUCN designation of being endangered despite the fact that the fiddlewood is extremely abundant within this forest type.

ILLUSTRATION 36:

Typical Representatives From The *Tropical Evergreen Seasonal Broadleaf Lowland Forest Over Calcareous Soils* Habitat

Breadnut
(*Brosmium alicastrum*)

Waterwood:
(*Cassipourea guianensis*)

Sapadilla:
(*Manilkara zapota*)

TABLE 12

SPECIES OCCURRING IN *TROPICAL EVERGREEN SEASONAL BROADLEAF LOWLAND FOREST OVER CALCAREOUS SOILS*: LOW VARIANT

Botanical Name	Local Name	Transect					Abundance
		T1	T2	T3	T4	T5	(% indv)
Acacia cornigera	Black cockspur	x	x		x		1
Acoelorraphe wrightii	Primenta	x	x				25
Bactris major	Poke-n-dough boy					x	6
Brosmium alicastrum	Breadnut	x	x	x		x	9
Bursera simarouba	Gombolimbo	x	x	x	x		20
Calophyllum brasilense	Santa Maria	x	x	x	x	x	18
Cassipourea guianensis	Waterwood				x	x	9
Cecropia peltata	Trumpet	x	x				2
Chrysophyllum mexicanum	Wild Star Apple				x		1
Coccoloba belizensis	Wild Grape	x	x		x		3
Coccoloba diversifolia	Wild Grape	x	x			x	13
Coccoloba sp.	Wild Grape			x	x		4
Croton schiedeanus	Wild Cinnamon				x		4
Crysophilia staurocantha	Give and Take	x	x	x	x	x	17
Cupania belizensis	Bastard Grande Betty	x	x	x			2
Dendropanax arboreus	Kill Man	x	x		x		5
Guattardia combsii	GlossyWood	x	x	x	x	x	13
Manilkara zapota	Sapodilla	x	x	x	x	x	11
Matayba appositifolia	Boy Job	x	x	x	x		22
Metopium brownei	Black Poison Wood	x	x		x		27
Nectandra sp.	Timbersweet	x		x			2
Pithecelobium sp.						x	1
Pouteria amygdalina	Mamee Ciruela; Sillion	x	x	x	x	x	20
Pouteria campechiana	Mamee Ciruela			x	x	x	17
Protium copal	Copal	x	x	x	x	x	11
Psuedomedia spuria	Wild Cherry	x	x	x	x	x	9
Rinorea dexifolra	Wild Coffee			x			31
Sabal mauritiformis	Botan	x	x		x	x	12
Simarouba glauca	Negrito	x	x	x	x	x	4
Swartzia cubensis	Bastard Rosewood					x	1
Swietenia macrophylla	Mahogany	x	x	x	x		2
Thrinax radiata	Salt Water Palmetto				x	x	45
Trophis mexicana	Ramon	x	x			x	5
Trophis racemosa	Ramon			x			2
Unknown	Fabaceae	x	x				5
Unknown	Fabaceae	x	x				8
Unknown	Sapindaceae	x	x				9
Unknown	Nink and bite	x			x		15
Vitex gaumeri	Fiddlewood	x		x	x	x	6
Zuelania guidonia	Drunken Bayman Stick				x		3
Zygia sp.	Turtlebone			x			1
TOTAL							**421**

TABLE 13

SPECIES OCCURRING IN *TROPICAL EVERGREEN SEASONAL BROADLEAF LOWLAND FOREST OVER CALCAREOUS SOILS:* HIGH VARIANT

Botanical Name	Local Name	Transect					Abundance
		1	2	3	4	5	(# indv)
Acacia cornigera	Black cockspur	x		x			4
Allophyllus cominia	Bastard Cherry	x					1
Annonna sp.	Wild Custard Apple				x		2
Bactris mexicana	Hones				x		2
Brosmium alicastrum	Breadnut	x	x				3
Bursera simarouba	Gombolimbo	x		x	x		16
Byrsonima bucidifolia	Deer Craboo			x			1
Caesalpinia gaumeri	Warree Wood		x	x			6
Cassipourea guianensis	Waterwood	x	x		x		3
Calophyllum brasiliense	Santa Maria			x	x		5
Cecropia peltata	Trumpet	x					5
Chrysophyllum mexicanum	Wild Star Apple	x					1
Coccoloba belizensis	Wild Grape		x				2
Coccoloba sp.	Wild Grape	x	x				1
Coccoloba sp.	Wild Grape	x		x	x		5
Crysophilia staurocantha	Give and Take	x			x		5
Dendropanax arboreus	Kill Man	x	x	x	x		31
Desmoncus orthacanthus	Basket Ti-tie				x		1
Guattardia combsii	GlossyWood	x		x			4
Heliocarpus mexicanus	Moho		x				5
Hirtella racemosa	Wild Pigeon Plum		x	x	x		5
Luehea seemannii	Mampola				x		1
Lonchocarpus castilloi	Cabbage Bark			x			1
Lonchocarpus rugosus	Black Cabbage Bark	x					3
Manilkara zapota	Sapodilla		x				5
Matayba appositifolia	Boy Job	x	x	x	x		14
Metopium brownei	Black Poison Wood	x	x	x	x		28
Pouteria amygdalina	Mamee Ciruela; Sillion	x		x			5
Pouteria campechiana	Mamee Ciruela	x	x	x	x		10
Pouteria reticulata	Mamee Ciruela	x	x				2
Protium copal	Copal		x	x	x		6
Psuedomedia spuria	Wild Cherry	x	x		x		2
Rinorea dexifolra	Wild Coffee			x			3
Sabal mauritiformis	Botan	x	x	x	x		15
Simarouba glauca	Negrito	x	x	x	x		13
Spondias mombin	Hogplum	x			x		5
Swartzia cubensis	Bastard Rosewood	x	x				5
Swietenia macrophylla	Mahogany	x	x				3
Trichospermum grewiifolium	Narrowleaf Moho	x					3
Trophis mexicana	Ramon		x				2
Trophis racemosa	Ramon	x		x	x		6
Vitex gaumeri	Fiddlewood	x	x		x		2
Zuelania guidonia	Drunken Bayman Stick	x		x			4
Zanthoxylum panamense	Prickly Yellow		x				1
TOTAL							**247**

TABLE 14

SPECIES OCCURRING IN *TROPICAL EVERGREEN SEASONAL BROADLEAF LOWLAND FOREST OVER CALCAREOUS SOILS*: LOW VARIANT

Botanical Name	Local Name	Transect					Abundance
		T1	T2	T3	T4	T5	(# indv)
Acacia cornigera	Cockspur	x					1
Acacia sp.	Acacia				x		1
Bactris major	Poke and dough boy	x			x	x	2
Bactris mexicana	Warrie hones	x			x		7
Brosmium alicastrum	Breadnut	x				x	7
Bursera simarouba	Gombolimbo		x	x			5
Callophylum braziliense	Santa Maria		x	x			4
Cassipourea guianensis	Water Wood	x	x			x	15
Castilla elastica	Rubber	x	x	x			8
Cecropia peltata	Trumpet	x					10
Cocoloba hondurensis	White Wild Grape		x				4
Coccoloba cozulmelensis	Wild Grape	x				x	3
Coccoloba refexiflora	Wild Grape			x	x		4
Coccoloba belizenensis	Black Wild Grape		x				3
Coccoloba sp.			x			x	6
Cojoba sp.		x					1
Crysophilia staurocantha	Give and take	x	x			x	5
Cupania belizenensis	Grande betty	x			x		1
Dendropanax arboreus	Kill Man		x				2
Drypetes brownei	Bull Hoff	x				x	2
Ficus sp.	Fig	x		x		x	1
Ficus sp.	Strangler Fig		x				2
Guazuma ulmifolia	Bay Cedar	x					2
Lonchocarpus castilloi	Cabbage bark		x	x			7
Luhea seemanii	Mampola		x				2
Manilkara sapota	Sapodilla		x		x		1
Matayba oppositifolia	Boy Job		x		x	x	4
Metopium brownei	Black Poisonwood		x				12
Pouteria campechiana	Black Mamee Ciruela	x	x	x		x	10
Pouteria amygdalina	Sillion	x	x				4
Pouteria mammea	Mamee	x					6
Pseudolmedia spuria	Wild Cherry		x		x		1
Protium copal	Copal	x	x	x			6
Randia armata	Chicken Toe		x				1
Roystonea regia	Royal Palm	x				x	5
Sabal mauritiformis	Botan; Bayleaf	x	x				22
Simira salvadorensis	Jancro Red Wood					x	
Simarouba glauca	Negrito	x	x				3
Spondias mombin	Hog Plum	x				x	5
Swartzia cubensis	Bastard Rosewood	x					1
Swietenia macrophylla	Mahogany		x				3
Tabernaemontana alba	Dog Tone	x					1
Trichilia havaensis	Wild Lime					x	2
Trophis mexicana	Ramon		x			x	3
Trophis racemosa	Ramon	x			x	x	4
Vitex gaumeri	Fiddlewood		x			x	3
Vitis tiliifolia	Water Vine	x				x	2
Zuelania guidonia	Drunken Bayman Stick		x		x	x	4
Unknown # 1(Fabaceae)?						x	1
Unknown #2 (Euphorbiaceae?)					x		1
TOTAL							**210**

Tropical Evergreen Seasonal Broadleaf Lowland Forest Over Calcareous Soils: With Predominance Of Cohune Ridge

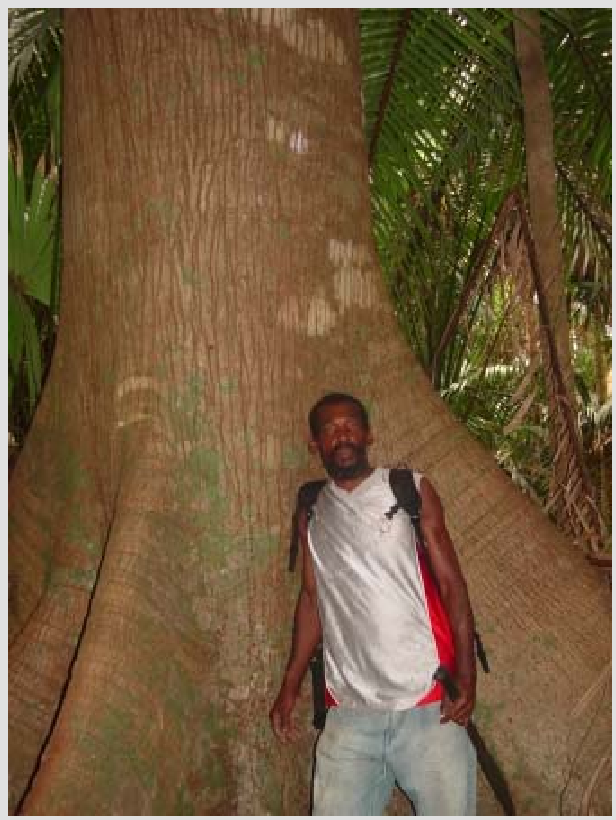
Although the *Lowland Broadleaf Forest With A Predominance Of Cohune Ridge* (*Attalea cohune*) is not separated as a distinct forest type by Iremonger and Brokaw (1995) nor Wildtracts (2003), the species of this habitat are included separately to demonstrate the distinctness in species composition characteristic of this forest type. This forest type is structurally (uneven canopy) and physiognomyically (assemblage of species) different from the above mentioned forest type.

Within the BJE, *Cohune Ridge* is characterized by the following canopy species in order of abundance (see **Illustration 37** and **Tables 15 & 16**): Cohune (*Attalea cohune*), Rubber (*Castilla elastica*), Trumpet (*Cecropia peltata*), Royal Plam (*Roystonia regia*), Narrow Leave Moho (*Trichospermum grewiifolium*) Black Mamee ciruela (*Pouteria campechiana*), and Hog Plum (*Spondias mombin*), Negrito (*Simarouba glauca*) and Botan (*Sabal mauritiformis*). In addition to these species, two species, Mamee (*Pouteria mammosa*) and Breadnut (*Brosimum alicastrum*) are extremely abundant near Mayan Ruins. Both of these species were heavily utilized by the Mayans for food. The understorey of this forest type is dominated by Bayleaf (*Sabal mauritiformis*) and Give and Take (*Crysophila staurocantha*).

ILLUSTRATION 37:

Typical Representatives From The *Tropical Evergreen Seasonal Broadleaf Lowland Forest Over Calcareous Soils With Predominance Of Cohune Ridge*

Cohune Palms:
(*Attalea cohune*)



Rubber
(*Castilla elastica*)

TABLE 15

SPECIES OCCURRING IN *LOWLAND BROADLEAF FOREST: WITH A PREDOMINANCE OF COHUNE PALM (From Southeastern BJE)*

Botanical Name	Local Name	Transect					Abundance
		T1	T2	T3	T4	T5	(# indv)
Acacia cornigera	Cockspur		x		x	x	5
Acacia dolichostachya	Jesmo					x	1
Acacia sp.	Wild Tambran	x					1
Attalea cohune	Cohune	x	x	x	x		83
Bactris major	Poke and dough boy			x	x	x	3
Brosmium alicastrum	Breadnut				x		3
Bursera simarouba	Gombolimbo	x				x	2
Cassia grandis	Bokut	x	x				2
Cassipourea guianensis	Water Wood	x	x		x	x	8
Castilla elastica	Rubber	x			x		57
Cecropia peltata	Trumpet	x		x	x	x	33
Ceiba pentandra	Cotton Tree		x			x	2
Chrysophyllum mexicana	Wild Star Apple		x				1
Citharexylum caudatum	Pigeon Berry		x				2
Coccoloba sp.	Wild Grape				x		1
Cocoloba hondurensis	White Wild Grape		x			x	2
Crysophilia staurocantha	Give and take		x				1
Cupania belizenensis	Grande betty				x	x	4
Dendropanax arboreus	Kill Man		x				1
Drypetes brownei	Bull Hoff	x		x	x		11
Enterolobium cyclocarpum	Tubroos			x			1
Ficus sp.	Hicatee Fig	x	x				4
Ficus sp.	Fig	x		x			7
Ficus sp.	Strangler Fig	x	x		x		3
Guazuma ulmifolia	Bay Cedar	x				x	2
Piper amalago	Spanish elder		x	x			3
Piscidia picipula	Jabin	x					1
Pouteria campechiana	Black Mamee Ciruela	x	x		x		10
Pouteria sp.	Mamee Ciruela			x	x	x	6
Protium copal	Copal	x	x	x		x	6
Pseudolmedia spuria	Wild Cherry					x	1
Rinorea guatemalensis	Wild Coffee	x		x		x	6
Roystonea regia	Royal Palm	x	x			x	30
Sabal mauritiformis	Botan; Bayleaf	x	x		x	x	36
Spondias mombin	Hog Plum	x		x	x	x	12
Swartzia cubensis	Bastard Rosewood		x		x	x	3
Swietenia macrophylla	Mahogany					x	1
Tabernaemontana alba	Dog Tone		x				1
Trichilia havanensis	Wild Lime		x				1
Trophis mexicana	Ramon	x			x		2
Vitex gaumeri	Fiddlewood				x	x	3
Zanthoxylum sp.	Prickly Yellow	x			x	x	4
Zuelania guidonia	Drunken Bayman Stick	x	x	x			5
TOTAL							**371**

TABLE 16

SPECIES OCCURRING IN *LOWLAND BROADLEAF FOREST: WITH A PREDOMINANCE OF COHUNE PALM (From Northwestern BJE)*

Botanical Name	Local Name	Transect					Abundance
		T1	T2	T3	T4	T5	(# indv)
Acacia cornigera	Cockspur	x					1
Acacia collinsii	Cockspur			x			1
Acacia dolichostachya	Jesmo		x				1
Acacia sp.	Wild Tambran			x			1
Allophyllus comina			x		x		2
Attalea cohune	Cohune	x			x		35
Brosmium alicastrum	Breadnut		x		x		3
Bursera simarouba	Gombolimbo			x			1
Cassia grandis	Bokut		x				2
Cassipourea guianensis	Water Wood				x		1
Cassia grandis	Bokut		x				1
Castilla elastica	Rubber	x		x			4
Cedrela mexicana			x				1
Cecropia peltata	Trumpet	x		x			23
Ceiba pentandra	Cotton Tree			x			1
Citharexylum caudatum	Pigeon Berry			x			1
Cocoloba hondurensis	Black Wild Grape	x					1
Crysophilia staurocantha	Give and take		x	x			5
Cupania belizenensis	Grande betty	x		x			2
Dendropanax arboreus	Kill Man				x		1
Drypetes brownei	Bull Hoff		x				1
Ficus maxima	Hicatee Fig	x					5
Ficus sp.	Fig	x					2
Ficus sp.	Strangler Fig	x	x				2
Hylocerus undatus	Pitahaya		x				1
Hirtella racemosa	Timbersweet		x				1
Licaria peckii	Timbersweet		x	x			2
Luehea seemannii	Mampola		x				1
Macherium keglii	Bloodti-tie		x				1
Margaritaria nobilis	Ramon macho		x				1
Metopium brownei	Black Poisonwood	x					1
Pimenta dioica	All Spice		x	x			2
Piper sp.	Spanish Elder		x	x			5
Piscidia picipula	Jabin		x	x			2
Pithecellobium sp.			x				1
Pouteria campechiana	Black Mamee Ciruela	x		x	x		3
Pouteria mammosa	Mamee	x					20
Protium copal	Copal		x				2
Pseudolmedia spuria	Wild Cherry	x	x				2
Rinorea guatemalensis	Wild Coffee	x					1
Roystonea regia	Royal Palm	x					1
Simarouba glauca	Negrito	x					2
Sabal mauritiformis	Botan; Bayleaf	x	x				3
Spondias mombin	Hog Plum		x				2
Swartzia cubensis	Bastard Rosewood	x					1
Swietenia macrophylla	Mahogany		x				1
Tabernaemontana alba	Dog Tone	x					1
Trichilia havanensis	Wild Lime		x		x		4
Trichospermum grewiifolium	Narrowleaf Moho	x					28
Trophis mexicana	Ramon	x					2
Vitex gaumeri	Fiddlewood	x					6
Zanthoxylum sp.	Prickly Yellow				x		1
Zuelania guidonia	Drunken Bayman Stick			x	x		2
TOTAL							**198**

Tropical Evergreen Seasonal Swamp Forest Of Northern Belize: High & Low Variants

Although these two ecosystem types may be differentiated based on structural characteristics (canopy height, undulating topography, water mark on tree trunks) and species composition, they often occur together and grade into each other making definite delimitations often difficult. This is especially apparent is the BJE characterized by undulating topography.

Common species that occur in these forest types in the BJE include bullet tree (*Bucida buceras*), Black Poisonwood (*Metopium brownei*), Santa Maria (*Calophyllum brasiliense*), Logwood (*Haemotoxylon campechianum*), Palmetto (*Acoelorraphe wrightii*), Savannah Poisonwood (*Cameraria latifolia*), Ridge Poisonwood (*Sebastiana tuerckheimiana*) and various Myrtaceous (*Eugenia* spp.?) species (see Tables 17 & 18). Where particular species dominate (e.g., bullet tree or logwood), those areas are referred to as *Bullet Tree Swamp* or *Logwood Swamp* (see **Illustration 38**; Note bare seasonally inundated forest floor). These never occur in the high variant but almost always occur in the low variant Swamp Forests. *Tropical Evergreen Seasonal Swamp Forests* tend to have a relatively high abundance of epiphytic species from both the Bromeliacae (Bromeliad) and Orchidaceae (Orchid) plant families.

ILLUSTRATION 38:

Typical Representatives From The *Tropical Evergreen Seasonal Swamp Forest Of Northern Belize: High & Low Variants* Habitat

Black Poisonwood In Fruit (*Metopium brownei*)

Wild Grape in foreground & Logwood in background

Laurel (*Ouratea lucens*) with brilliant yellow flowers is common in this forest type.

TABLE 17

TROPICAL EVERGREEN SEASONAL SWAMP FOREST OF N BELIZE: HIGH VARIANT

Botanical Name	Local Name	Transect					Abundance
		T1	T2	T3	T4	T5	(# indv)
Allophyllus cominia				x			
Bauhinia jennengsii	Bauhinia	x					**1**
Bursera simarouba	Gombolimbo	x		x			4
Byrsonima buccidifolia	Deer Craboo	x					1
Casearia corymbosa	Billyhop	x					1
Caesalpinia gaumeri	Waree Wood	x		x			5
Callophylum braziliense	Santa Maria		x	x			6
Cassipourea guianensis	Water Wood	x					2
Cecropia peltata	Trumpet			x			
Coccoloba belizenensis	Black Wild Grape	x		x			4
Croton schiedeanus	Wild Cinnamon	x					1
Crysophilia staurocantha	Give and take	x		x			3
Cupania belizenensis	Grande betty		x	x			4
Dendropanax arboreus	Kill Man	x		x			9
Erythroxylum guatemalense	Redwood	x		x			4
Eugenia sp.	Wild Guava	x	x	x			14
Guettarda combsii	Glossy Wood	x					2
Hampea trilobata	Broad Leaf Moho	x	x	x			5
Hirtella racemosa	Timbersweet			x			
Licaria peckii	Timbersweet	x					3
Lonchocarpus castilloi	Cabbage Bark			x			1
Lonchocarpus guatemalensis	White Cabbage bark	x	x				2
Malmmea depressa	Wild Orange	x		x			3
Manilkara sapota	Sapodilla	x					3
Matayba oppositifolia	Boy Job		x	x			5
Metopium brownei	Black Poisonwood	x	x	x			25
Pouteria campechiana	Black Mamee Ciruela	x	x				7
Pouteria amygdalina	Sillion		x	x			1
Protium copal	Copal	x	x	x			5
Sabal mauritiformis	Botan			x			
Sebastiana tuerckheimiana	Ridge Poisonwood	x	x	x			24
Simira salvadorensis	Jancro Red Wood	x	x				4
Simarouba glauca	Negrito	x		x			7
Swartzia cubensis	Bastard Rosewood	x		x			2
Swietenia macrophylla	Mahogany			x			1
Tabebuia guayacan	Cortez	x					1
Vanilla planifolia	Vanilla	x					3
Vitex gaumeri	Fiddlewood			x			8
Unknown (Myrtaceae)	Wild Guava	x					20
Zuelania guidonia	Drunken Bayman Stick			x			1
TOTAL							**192**

TABLE 18

TROPICAL EVERGREEN SEASONAL SWAMP FOREST OF N BELIZE: LOW VARIANT

Botanical Name	Local Name	Transect					Abundance
		T1	T2	T3	T4	T5	(# indv)
Acacia sp.		x					1
Acoelorraphe wrightii	Primenta	x	x		x		18
Bucida buceras	Bullet Tree	x	x	x			25
Bursera simarouba	Gombolimbo	x					3
Cameraria latifolia	Savanna Poisonwood	x	x		x		30
Clusia sp.	Clusia	x					1
Coccoloba belizenensis	Black Wild Grape	x					3
Coccoloba sp	Guavanillo	x	x				5
Coccoloba reflexifolia	Wild Grape	x			x		2
Coccoloba cozulelensis	Wild Grape		x	x			2
Coccoloba sp.	Wild Grape	x		x	x		3
Conocarpus erecta var. silveri	Buttonwood	x			x		2
Crecentia cujute	Calabash	x	x				3
Haematoxylon campechianum	Logwood	x	x	x	x		50
Hampea trilobata	Broadleaf Moho	x					1
Hyperbaena winzerlingii	Juk-mi-back	x					1
Jacquina macrocarpa	Juk-mi-back	x	x		x		3
Lonchocarpus rogosus	Black Cabbage Bark	x					2
Manilkara sapota	Sapodilla	x	x				2
Metopium brownei	Black Poisonwood	x	x		x		25
Mimosa hemiendyta	Catzim	x					1
Mouriri myrtilloides	Jug; Cacho	x					3
Myrica cerifera	Tea Box	x					1
Myrmecophila tibicinis	Horn Orchid	x	x				2
Ouratea lucens	Laurel	x	x				2
Pouteria campechiana	Mamee Ciruela	x					1
Sabal mauritiformis	Botan; Bayleaf	x	x				3
Sabal yapa	Tiger Leaf	x					1
Swartzia cubensis	Bastard Rosewood	x					5
Unknown (Calyptranthes sp.?)	Gooseberry	x	x				9
Unknown	Wild cassava	x					1
Unknown (Sapotaceae?)		x					1
TOTAL							**212**

Savannah Orchard

Bridgewater et al. (2002) description of this habitat type is quoted in this report. “This vegetation has the appearance of an ‘orchard’ with the trees evenly spaced, the majority rarely exceeding 8m, although some mature individuals of *Bucida buceras* are emergent and can attain 15m. It has a greater density of woody shrubs and small trees than other savanna subtypes, but its relatively open canopy and small stature easily distinguish Savanna Orchard from Forest and Pine Ridge (Savanna Woodland). This vegetation type has been seen only in hydrologic transitional areas from wetland to more typical savanna. Savanna Orchard is frequently seasonally waterlogged. The species composition of Savanna Orchards varies greatly, but they tend to be dominated by Bullet Tree (*Bucida buceras)*, Logwood (*Haematoxylon campechianum)* and *Cameraria latifolia (Savanna Poisonwood…*others being *Malpighia glabra* L., *Jacquinia macrocarpa* Cav., *Coccoloba* sp., *Semialarium mexicanum*, *Byrsonima crassifolia*, *Chrysobalanus icaco* L., *Myrica cerifera* and occasional clumps *of Acoelorraphe wrightii*. *Pinus caribaea* and *Quercus oleoides* are conspicuously absent. The ground layer is open, dominated by grasses and sedges, with abundant *Cassytha filiformis*, and the herbaceous flora is more depauperate than in other drier savanna areas. The strong influence of water is often reflected in the ground flora, which can be dominated by a single species of Sedge (*Eleocharis interstincta).* The trees and shrubs can support an abundant epiphytic flora of *Tillandsia* sp., ...other bromeliads, orchids and parasitic mistletoes’ *Phthirusa* spp.” (Bridgewater et al. 2002:428). This description summarizes well the vegetation type found in BJE (see **Illustration 39**). As shown in **Table 19**, the species diversity is low within this vegetation type.

ILLUSTRATION 39:

Typical Residents Of The Savannah Orchard Habitat

Savanna Orchard showing Palmeto Palm and *Cameraria latifolia* (note wet grassy layer).

Savannah Poisonwood (*Cameraria latifolia*)

Table 19
Savanna Orchard

Botanical Name	Local Name	Transect					Abundance
		T1	T2	T3	T4	T5	(# indv)
Acoelorraphe wrightii	Primenta	x	x		x		14
Cameraria latifolia	Savanna Poisonwood	x	x	x			20
Coccoloba sp.	Wild grape	x	x				10
Conocarpus erecta	Buttonwood	x				x	6
Crescentia cujute	Calabash	x			x		3
Eleocharis sp.		x	x	x	x	x	N/A
Eleocharis intersticta	Sedge	x	x	x	x	x	N/A
Haematoxylon campechianum	Logwood	x	x	x			40
Jacquina macrocarpa	Juk-mi-back	x	x			x	9
Mimosa hemiendyta	Catzim	x					1
Scleria bracteata	Razor grass	x		x	x		N/A
Unknown (Poaceae)	Grass	x	x	x			N/A
Unknown (Cyperaceae)	Grass	x	x	x			N/A
TOTAL							**212**

Mixed Mangrove Scrub

The habitat description utilized by Wildtracks (2003b) is used to describe this vegetation type within BJE. The canopy height ranges from 3-6 m (see **Illustration 40**, upper photo). At the time of this study, the area was waterlogged. Though mangrove species are the most abundance species (see **Table 20**), these occur on the fringes of freshwater lagoons. Most abundant species occurring within this vegetation type are Red Mangrove (*Rhizophora mangle*), Black Mangrove (*Laguncularia racemesa*), Buttonwood (*Conocarpus erecta*) and Spiny Bullet Tree (*Bucida buceras*).

Dwarf Mangrove Scrub

This vegetation type is found on coastal mudflat and is easily recognized by the presence of stunted red mangrove (*Rhizophora mangle*) in extremely high densities (see **Illustration 40**, center photo) that make any type of penetration difficult. The habitat contained only stunted red mangroves in what appears to be permanently waterlogged soils.

Marine Salt Marsh With Many Succulent Species

This vegetation type is comprised of dwarf red mangroves, and small succulent species such as *Batis maritime* (see **Illustration 40,** lower photo), silver stunted buttonwood (*Conocarpus erectus var. silveri*), salt grass (*Distichilis spicata*), glasswort (*Salicornia perennis*), sea oxeye (*Borrichia frutescens*) with occasional small patches of black mangrove (*Avicennia germinans*). Patches of open ground covered by a number of sedge species is common within this forest type. The soil is permanently waterlogged in the portion of habitat visited.

ILLUSTRATION 40:

Typical scenes and species of the Mixed Mangrove scrub; dwarf mangrove scrub; and Marine Salt Marsh With Many Succulent Species Habitats

Mixed Mangrove Scrub With Numerous Dwarf Buttonwood (*Conocarpus erutus var. silveri*)

Dwarf Red Mangrove (*Rhizophora mangle*)

Salicornia sp.

TABLE 20

MIXED MANGROVE SCRUB

Botanical Name	Local Name	Transect					Abundance
		T1	T2	T3	T4	T5	(# indv)
Rhizophora mangle	Dwarf Red Mangrove	x	x	x	x		>100
Borrichia frutescens	Sea Oxeye		x	x			10
Batis maxima				x	x		
Avicennia germinans	*Black Mangrove*		x				5
Concocarpus erecta var. silveri	Silver Button Wood	x	x	x			35
Concocarpus erectus	ButtonWood	x			x		7
Salicornia begelovii	Salicorna	x	x	x			>100
Bucida spinosa	Spiny Bullet Tree	x	x				3
Ipomoea sp.	Morning Glory Vine		x				1
Myrmecophilia tibicinis		x	x	x			3
Spartina spartinae	*Swordgrass*			x	x		N/A
Laguncularia racemosa	White mangrove	x	x				6
Eleocharis sp.					x		N/A
TOTALS							**>270**

Survey Results

In general, the findings of the REA concur with the ecosystem classification identified in the Biodiversity Report by Wildtracks (2003b), albeit with three exceptions and one addition. The first is the extent of the ecosystem type designated as *Tropical Semi-Deciduous Broadleaf Lowland Forest,* which is a highly specialized and therefore unique ecosystem from the standpoint that it is short stature (8-12m), and most of its resident species lose their leaves during the dry season.

Wildtracks (2003b) reported this rare habitat to occurr near the northwestern boundary of the property, and while the Ecoworks REA specialist was unable to ground-truth the area due to it's inaccessibility, a fly over by helicopter was conducted to ascertain the presence of the ecosystem type from the air on the notion that this particular habitat type should be easily recognizable for the leafless state of its canopy species. The aerial survey was unable to establish the presence of this habiat despite the survey being correctly timed at the end of the dry season, and the survey period being sufficient for a thorough examination of the region and identification of the habitat. Rather, the forest region identified by Wildtracks, from the air, appeared to closely resemble *Tropical Evergreen Seasonal Swamp Forests Of Northern Belize: Low Variant*. Nonetheless, final determination of this forest type will require ground sampling at various times throughout the annual dry season in Belize.

ILLUSTRATION 41:

NATURAL GROUND CHARACTERISTICS OF THE WESTERN BJE.

Photograph 1:
Cleared land in Little Belize, adjacent to Balam Jungle Estate, showing undulating characteristics of landscape

The second exception to the ecosystem classification by Wildtracks (2003b) concerns the homogeneity of certain forest type (e.g., *Tropical Evergreen Seasonal Lowland Broadleaf Forest*) represented on the land classification map for BJE. With the current resolution of existing satellite imagery for BJE and the huge acreage of the property, it is impossible to ground-truth every portion of the property thereby making it necessary to have coarse designations of each ecosystem type. On the ground, however, the ecosystem types exist in varying degrees of gradations sometimes over as little as 200m. This is hardly surprising considering the undulating nature of the forested area within the property (Note the ground undulation shown in **Illustration 41** above, taken from Mendoza, 2006).

These undulations follow the top surface of the limestone bedrock and range from shallow, widely spaced undulations to low, but steep, exposed limestone ridges three to 4 meters in height (Mendoza 2006:9). As a result of the undulating topography, swamp forests or 'bajos' that are seasonally flooded occur next to 'high' or 'upland' forest that are never inundated during the rainy season. In other words, the BJE property displays greater habitant heterogeneity than what appears on the land classification map.

The third exception to the ecosystem classification prepared by Wildtracks is the inclusion of *Cohune Ridge*, a lowland broadleaf forest with a predominance of the large cohune palm (*Attalea cohune*), within the *Tropical Evergreen Seasonal Broadleaf Lowland Forest Over Calcareous Soils* ecosystem type. Although the classification by Iremonger and Brokaw (1995) and Wildtracks (2003b) did not distinguish this habitat type, both the Ecoworks REA Specialist and Wildtracks recognize that this habitant type is indeed very different from the above mention forest type. Thus, for the purposes of the REA, the species occurring within this habitat type will be presented separately despite not specifically delimiting this as a 'separate' vegetation type.

During the REA, the Ecoworks REA Specialist identified a savannah ecosystem type not included within the 13 vegetation type identified by Wildtracks (2003b) as occurring with in the BJE. The species composition of this habitat type within the BJE most closely resembles the *Savanna Orchard* vegetation type described by Bridgewater *et al* (2002) and, as such, that description will be used here (see below).

Taxonomic Diversity of Balam Jungle Estate

Overall, 258 species representing 70 families and 180 genera were recorded for the BJE with greater ca. 60% (152 species) of these species being trees. In total, greater that 2,300 individuals were sampled within transects. The taxonomic diversity reported in the Biodiversity Report (Wildtracks, 2003b), recorded a total of 122 species representing 52 families from 104 genera. Thus, the sampling intensity utilized within this REA yield an additional 136 species, 18 families and 74 genera of plants not recorded in the Wildtracks Biodiversity Report. The tree species diversity recorded during this REA compares favorably (152 vs 169 tree species) with the tree species diversity recorded in the Sustainable Forest Management Plan, which utilized systematic sampling on the property (see **Illustration 13, Page 25;** and **Addendum 7**).

Forest Threats

Deforestation

It is evident from the both the Biodiversity Report (Wildtracks 2003b), the Sustinable Forest Managemnt Plan (Mendoza, 2006) and this Rapid Ecological Assessment (REA) that the Balam Jungle Estate (BJE) is an incredibly diverse property containing high floral and faunal diversity. The fact that this private property consists of nearly two percent of all of Belize's land area (85,000 acre) makes the BJE an important repository for biodiversity in Belize and if management sustainably will become increasingly important as the habitats outside the property disappear due to large-scale agriculture occurring in Little Belize. In fact, deforestation in Little Belize has almost reached the property boundary of the Balam Jungle Estate.

Logging Operations

BJE is additionally ecologically important because the property is extremely heterogenous and contains a variety of ecosystem types in large acreage, many transitional zones, and varied topography. Large tracts of habitats are important for the proper functioning of ecosystems and the maintenance of species and genetic diversity.

Large–scale logging of valuable timber species such as mahogany (S*wietenia macrophylla*), Santa Maria (*Callophylum brasilense*), Cabbage Bark (*Lonchocarpus castilloi*), Cedar (*Cedrella mexicana*) is ongoing within the property. Logging operations, by necessity, are dependent on the creation of access roads & trails to reach timber stems. Unfortunately, these roads lead to a concomitant fragmentation of the forest into smaller segments that may inhibit proper function of the ecosystem and negatively impact bird and other wildlife species. For example, habitat fragmentation reduces the size of forest patches, which reduces the total area of contiguous habitat available to birds, and increases the isolation of the habitat. As a result, edge habitat increases which may lead to higher predation of bird eggs and young (Robinson 1998). Care must be taken to minimize the creation new logging roads as well as to maximize the use of existing roads within the Balam Jungle Estate.

The creation of such roads & trails can more directly lead to distruction of seedling and sapling stems through simple operation of large scale machinery and equipment within stands of natural forest, as well as facilitate timber poaching, and hence unwanted departure from appropriate management practices through rogue harvesting of immature and seedling trees. (This may be particularly the case along the shared border between the BJE and the Freshwater Creek Forest Reserve, despite the ongoing community management of the latter facility). Consequently, if the logging operation is not well managed and best management practices are not implemented and enforced, the absence of appropriate management will have a detrimental impact of the forest of BJE and the biodiversity contained therin.

Hurricanes

Friesner (1993) reviewed the impact of 32 hurricane landfalls in Belize between 1785 and1978 on Belize's forest reserves. His findings indicated that damage to northern forests varied according to wind speed & duration, soil depth, and tree species. The year 1942 saw three hurricane landfalls in Belize one of which traversed the Freshwater Creek and Honey Camp reserves, and therefore undoubtedly passed through the Balam Jungle Estate Forests. Friesner, and other authors cited in his report concluded from post-hurricane assessments of the area that Belize's northern forests were more susceptible to storm duration than speed, and that deeply rooted trees were more inclined to experience stem breakage, whereas poorly or shallow rooted trees were more vulnerable to being blown down in their entirety.

Friesner went on to cite one study of hurricane Hattie impacts on Stann Creek District forest reserves that had ascertained hardwood forests to be, in general, more susceptible to hurricane damage that pine or other assembledges, and that Billy Webb (*Sweetia panamensia*), Cortez* (*Tabebuia guyacaban*), Quamwood (*Schizolobium parahybum*), and Banak (*Virola Koschnyi*) were less susceptible to crown damage than Mahogany* (*Swietenia macrophylla*), Carbon (*Tetragastris stevensonii*), Nargusta (*Terminalia amazonia*), Gumbolimbo* (*Bursera simatrouba*), and Prickly Yellow* (*Zanthoxylum* spp.), which tended to experience < 50% crown damage; and Santa Maria* (*Calophyllum brasiliense*), Negrito (*Simarouba glauca*), Yemeri (*Vochysia hondurensis*), and Waika Chewstick (*Symphonia globulifera*), which tended to experience > 50% crown damage from hurricanes (asterisks indicating species found with the BJE). The findings being taken to suggest that a portion of the overall management strategy for the forest be dedicated to selective advancement of resistant timber species.

Fire

Mendoza (2006) specifically addresses fire as key hazard to the Balam Jungle Estate forests in noting: *Tropical forests don't usually burn. In their natural state, fuel loads are low and not highly flammable, and the humidity is high even during drought years. Fires in broadleaf forests are often ignored and bear no resemblance to the massive blazes that can be seen in burning needle-leaf forests. The fire is usually low, and slowly creeping through the leaf litter. Often it is possible to walk close up to it and even through it without too much danger. There is usually little "media value" in such fires. Only in areas with Cohune (Attalea cohune), the effects can be more dramatic. The abundant leaf litter under these palms explodes into flames, often igniting the crown and spraying sparks over great distances. But even in the case of these slow, low fires, the damage can be profound. Trees, especially young trees may appear unharmed but still die over time. The mortality either being the result of direct damage or indirect damage such as increased pathogen access through the fire damaged bark. Tree mortality as the result of such slow fires may continue for several years after the actual fire (pers. obs.). Each fire, which leaves more dead or dying trees behind makes the forest even more prone to fire damage. Due to the increased activity relating to the ongoing management and harvesting activities on the Property, an increased danger of forest fires has become a reality. And obviously, any kind of forest fire has the potential of being extremely devastating to the conservation and management of the existing natural resources within the management area.*

Mendoza (2006) went on to note that it is the abundance of natural fuels, particularly as grasses, shrubs, logging waste and even tree trash remants from hurricanes, which can be difficult to extinguish once ignighted, that greatly exacerbate fire intensity and damage. In the case of the BJE, these raw materials are already in great abundance by virtue of on-going logging operations, and the presence of the 25,784 acre savanna habitat immediately adjacent to the forest management zone (see **Illustration 42**). Further intensification of harvesting activities and development of the savanna habitat for residential tourism use will undoubetly increase fire risk to the BJE forests if only for the increased human presence planned, and hence, the incremental fire risk likely to be imposed by the proposed development will inturn require strick adhearance to the fire aversion and management guidelines identified in Mendoza's forest management plan for the BJE, and are summarized herein on **Page 174**.

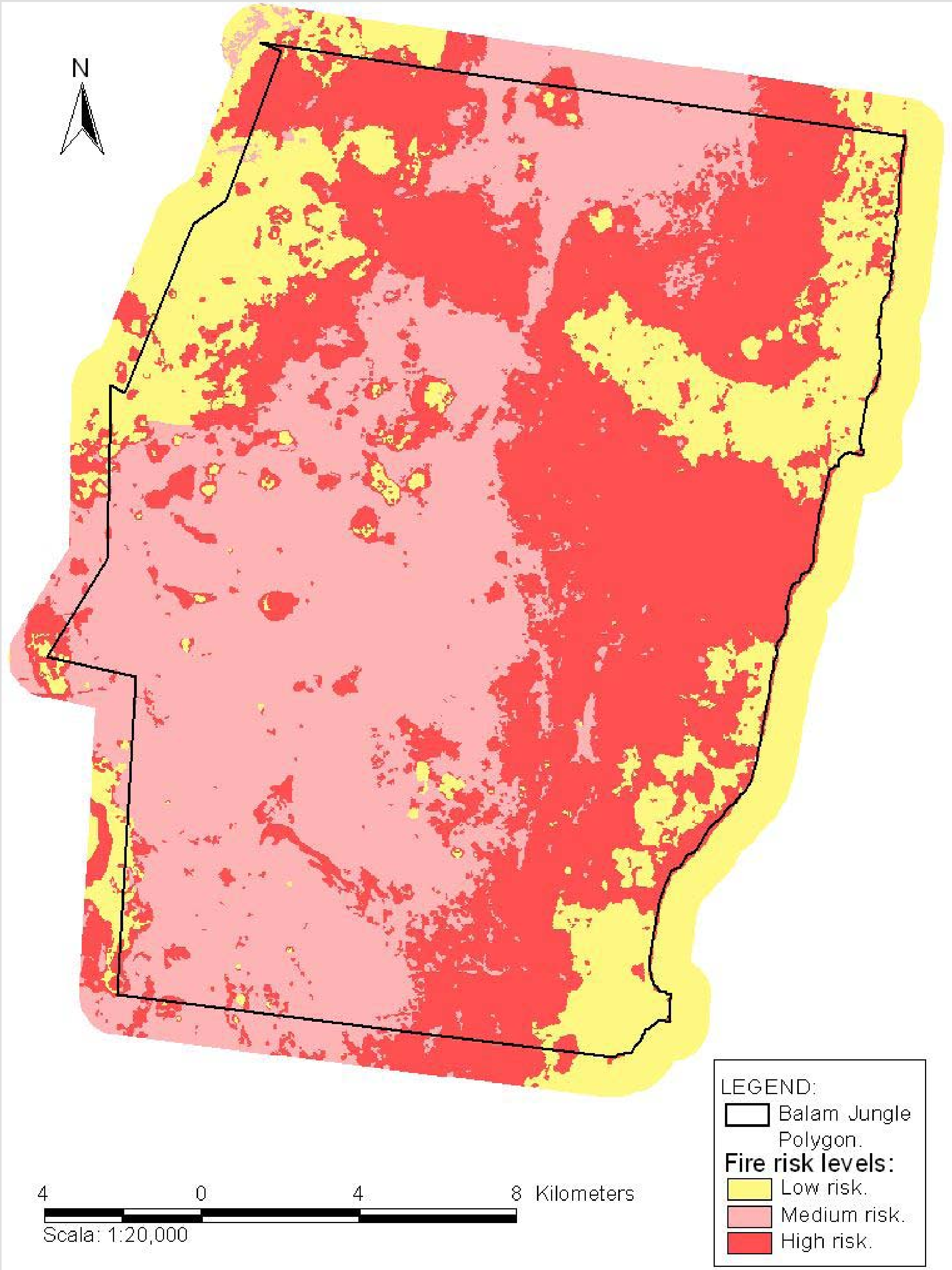
Recommendations

Given the preceding discussion, the project proponent will particularly need to:

11. ***Arboreal microhabitats within the coastal savanna habitat will require preservation through exclusion from use in order for their continued role as important coastal bird rookeries and breeding sites;***
12. ***The shoreline's savanna orchard or littoral forests must either be preserved or replaced during establishment of the proposed development in order to sustain their continued visitation and support by migrating birds; and***
13. ***Fire management practices are fully implemented in order to prevent distruction of the Balam Jungle Broadleaf Forests.***

ILLUSTRATION 42:

FIRE RISK LEVELS WITHIN THE BALAM JUNGLE ESTATE



Terrestrial Vertebrate Fauna

Amphibians Of The Balam Jungle Estate

Ten of the 19 species of amphibians reported to occur within the Balam Jungle Estate by Wildtracks (2003b) were seen during the June 2007 field survey (see **Illustration 43** & **Table 21**). Observed species included two species of toad, seven species of tree-frogs and 1 specie of salamander.

Anurans form an important group of indicator species of human interventions (Hawthorne *et al* 2003) and climate change (Gardner 2001). To date, only inventories of 19 anurans have been reported on. Conversely however, use of these species as indicators of detrimental environmental change will require long term monitoring of the population structure itself.

ILLUSTRATION 43:

ANURANS OF THE BALAM JUNGLE ESTATE

Above, The Rainforest Toad (*Bufo valliceps*) shown against 1 cm scale. **Below**, File Photo Of the Red-Eyed Tree Frog, (*Agalychnis callidryas*) which has been found within the BJE.

Reptiles Of The Balam Jungle Estate

Six of the 76 species of reptiles reported to occur within the Balam Jungle Estate by Wildtracks (2003b) were seen during the June 2007 field survey (see **Table 22**). These included the Bocotora (*Trachemys scripta*), Brown Basilisk (*Basiliscus vittatus*), Wish-Willy (*Ctenosaura similis*), Shiny Skink (*Mabuya unimarginata*), Indigo Snake (*Drymarchon corais*), and The Green Headed Tree Snake (*Leptophis mexicanus*). One new species (i.e. not previously reported by Wildtracks) was also observed, which included the Smooth Head Helmeted Basilisk (*Corytophanes cristatus*) shown in **Illustration 44** at right.

ILLUSTRATION 44:

AN UNUSUAL FOREST LIZARD FROM THE BALAM JUNGLE ESTATE: The Smooth Head Helmeted Basilisk (*Corytophanes cristatus*).

TABLE 21

ANURAN FAUNA WITH RANGES THAT ENCOMPASS THE BALAM JUNGLE ESTATE*

Common Name*	Scientific Name
Toads & Frogs	
Red-Eyed Tree Frog	*Agalychnis callidryas*
Giant Toad*	*Bufo marinus*
Rainforest Toad*	*Bufo valliceps*
Elegant Narrow-Mouth Toad	*Gastrophryne elegans*
Variegated Tree Frog*	*Hyla ebraccata*
Mahogany Tree Frog	*Hyla loquax*
Small Headed Tree Frog*	*Hyla microcephala*
Cricket Tree Frog*	*Hyla picta*
Sheep Frog	*Hypopachus variolosus*
White Lipped Frog	*Leptodactylus labialis*
Sabinal Frog	*Leptodactylus melanonotus*
Pepper Tree Frog*	*Phrynohyas venulosa*
Leopard Frog*	*Rana berlandieri*
Vaillant's Frog	*Rana vaillanti*
Burrowing Toad	*Rhinophrynas dorsalis*
Staufer's Tree Frog*	*Scinax stauferi*
Mexican Tree Frog*	*Smilisca baudini*
Yucatan Casquehead Tree Frog	*Triprion petasatus*
Salamanders	
Yucatan Mushroomtongue Salamander	*Bolitoglossa yucatana*

*Species Noted During 2007 REA

TABLE 22

REPTILE FAUNA WITH RANGES THAT ENCOMPASS THE BALAM JUNGLE ESTATE*

Common Name	Scientific Name	Common Name	Scientific Name
Crocodiles	***Crocodiles***	***Snakes***	***Snakes***
American Crocodile	*Crocodylus acutus*	Yucatan Blind Snake	*Typhlops microstomus*
Morlet's Crocodile	*Crocodylus morletii*	Boa Constrictor	*Boa constrictor*
		Two-Spotted Snake	*Coniophanes bipunctatus*
Marine Turtles	***Marine Turtles***	Black-Striped Snake	*Coniophanes imperialis*
Loggerhead Turtle	*Caretta caretta*	Schmidt's Black-Stripe Snake	*Coniophanes schmidti*
Green Turtle	*Chelonia mydas*	Snail-Eating Thirst Snake	*Dipsas brevifacies*
Hawksbill Turtle	*Eretmochelys imbricata*	Lizard Eater	*Dryadophis melanolomus*
Leatherback Turtle	*Dermochelys coriacea*	Indigo Snake*	*Drymarchon corais*
		Speckled Racer	*Drymobius margaratiferus*
Freshwater Turtles	***Freshwater Turtles***	Tropical Rat Snake	*Elaphe flavirufa*
Central American River Turtle	*Dermatemys mawii*	Blotched Hook-Nose Snake	*Ficimia publia*
Narrowbridge Musk Turtle	*Claudius angustatus*	Blunthead Tree Snake	*Imantodes cenchoa*
Mexican Giant Musk Turtle	*Staurotypus triporcatus*	Yucatan Blunt Head Snake	*Imantodes tenuissimus*
Tabasco Mud Turtle	*Kinosternon acutum*	Milk Snake	*Lampropeltis triangulum*
White Lipped Mud Turtle	*Kinosternon leucostomum*	Rainforest Cat-Eyed Snake	*Leptodeira frenata*
Scorpion Mud Turtle	*Kinosternon scorpiodes*	Northern Cat-Eyed Snake	*Leptodeira septentrionalis*
Furrowed Wood Turtle	*Rhinoclemmys areolata*	Parrot Snake	*Leptophis ahaetulla*
Bokotora / Ornate Terrapin*	*Trachemys scripta*	Mexican Parrot Snake*	*Leptophis mexicanus*
		Neotropical Whiptail	*Masticophis mentovarius*
Lizards	***Lizards***	Redback Coffie Snake	*Ninia sebae*
Yucatan Banded Gecko	*Coleonyx elegans*	Mexican Vine Snake	*Oxybelis aenus*
TuberculateLeaf-toed Gecko	*Phyllodactylus tuberculosus*	Green Vine Snake	*Oxybelis fulgidus*
Dwarf Gecko	*Sphaerodactylus glaucus*	Puffing Snake	*Pseustes poecilonotus*
Turnip Tail	*Thecadactylu rapicauda*	Guatemalan Neckband Snake	*Scaphiodontophis annulatus*
Brown Basilisk*	*Basiliscus vittatus*	Peninsula Rat Snake	*Senticolis triaspis*
Smoothhead Helmeted Basilisk	*Cortyophanes cristatus*	Cloudy Snail Sucker	*Sibon nebulata*
Serrated Casquehead Iguana	*Laemanctus serratus*	Pygmy Snail Sucker	*Sibon sanniola*
Black Iguana	*Ctenosaura similis*	Terrestrial Snail Sucker	*Sibon sartorii*
Green Iguana	*Iguana iguana*	Tiger Tree Snake	*Spilotes pullatus*
Yucatan Spiny Lizard	*Sceloporus chrysostictus*	Freminville's Scorpion-Eating Snake	*Stenorrhina freminvillei*
Lundell's Spiny Lizard	*Sceloporus lundelli*	Yucatan White Lipped Snake	*Symphimus mayae*
Rosebelly Lizard	*Sceloporus teapensis*	Red Earth Centipede Snake	*Tantilla schistosa*
Ghost Anole	*Norops lemurinus*	Yucatan Dwarf Short-Tailed Snake	*Tantillita canula*
Smooth Anole	*Norops rodriguezii*	Western Ribbon Snake	*Thamnophis proximus*
Brown Anole	*Norops sagrei*	Orangebelly Swamp Snake	*Tretanorhinus nigroluteus*
Silky Anole	*Norops sericeus*	Falsel Terciopelo	*Xenodon rabdocephalus*
Schwartze's Skink	*Eumeces schwartzi*	Coral Snake	*Micrurus diastema*
Shiny Skink*	*Mabuya unimarginata**	Central American Coral Snake	*Micrurus nigrocinctus*
Brown Forest Skink	*Sphenomorphus cherriei*	Cantil	*Agkistrodon bilineatus*
Rainbow Ameiva	*Ameiva undulata*	Fur de Lance	*Bothrops asper*
Yucata Whiptail	*Cnemidophorus angusticeps*	Neotropical Rattlesnake	*Crotalus durissus*

*Species Noted During 2007 REA

Birds Of The Balam Jungle Estate

The following report contain the bird species identified within five vegetation types (as identified within the Vegetation assessment) occurring on the Balam Jungle Estate (BJE). Although the Biodiversity Report completed by Wildtracks (2003b) listed 260 species as possibly occurring within the BJE, this was a projected number based on bird assessment from five areas surrounding the BJE; these include the Fireburn Reserve, Shipsturn Nature Reserve, Freshwater Creek Forest Reserve and Waree Bight (see **Table 23**). Of the 260 species projected in the BJE, Wildtracks (2003b:41) used a ranking system to estimate to increase the likelihood of those species occurring within the property. Based on this ranking, it was estimated that 180 species ‘can be confidently expected to occur, while a further 80 are expected to occur.” Wildtracks recommended that a full bird survey is necessary to confirm these findings.

Methods

The Balam Jungle Bird Assessment was completed during one four-day visit to the property from June 7th-11th, 2007. Species richness was assessed using both "Point Counts" and "Census" along the length of determined transects used for the vegetation analysis in addition to opportunistic sightings during the period of study. Identification of species was done visually, using a binoculars (Canon - 8 x 23A) and (Bushnell - 10 x 52). Most species were also identified by their vocalization within a span of about 50 meters radius for each transect. The method implemented initiated at day break and late in the afternoon when birds are most active.

Results

A total of 117 species within 39 families were recorded within the BJE, including 9 species not previously reported by Wildtracks (see listings with an asterisk shown in **Table 23** and **Illustration 45**). Among these, 3 species of "Austral" or "Dry Season" migrants were documented, namely, Piratic Flycatcher, Sulphur-bellied Flycatcher and Yellow-green Vireo. These three species migrate from the south and nest in Belize; some migrate further north and return south after the nesting period. It is important to note that only 2 species of migrants were recorded in the coastal area, namely, Little Blue Heron and the very rare, Snowy Plover. All other migrant species in the family Parulidae (Wood Warblers) have returned to their breeding grounds in the north. A complete list, including migrants, can be accomplished during the migration season, August - April. Such a high richness in only 4 days of sampling suggests that the BJE has a high species diversity of birds as indicated within the Biodiversity Report (Wildtracks 2003b). Of particular interest are the coastal areas of the property. Coastal areas typically contained a great number of both "transients" and "migrants" because most migrating species use landmarks like large water ways and the coastline to navigate. Species of importance or concern, for instance, Cerulean, Swainson's and Blackburnian Warblers are expected to be found in these areas.

TABLE 23

WILDTRACKS (2003b) BIRD LIST FOR THE BALAM JUNGLE ESTATE

Family / Common Name*	Scientific Name	Family / Common Name*	Scientific Name	Family / Common Name*	Scientific Name
Tinamidae		**Cathartidae**		**Heliornithidae**	
Great Tinamou*	*Tinamus major*	Black Vulture*	*Coragyps atratus*	Sungrebe*	*Heliornis fulica*
Thicket Tinamou*	*Crypturellus cinnamomeus*	Turkey Vulture*	*Cathartes aura*	**Aramidae**	
Little Tinamou	*Crypturellus soui*	Lesser Yellow-headed Vulture	*Cathartes burrovianus*	Limpkin*	*Aramus guarauna*
Podicipedidae		King Vulture	*Sarcoramphus papa*	**Charadriidae**	
Least Grebe	*Tachybaptus dominicus*	**Anatidae**		Black-bellied Plover	*Pluvialis squatarola*
Pied-billed Grebe	*Podilymbus podiceps*	Black-bellied Whistling Duck*	*Dendrocygna autumnalis*	Wilson's Plover	*Charadrius wilsonia*
Pelicanidae		Muscovy Duck	*Cairina moschata*	Semipalmated Plover	*Charadrius semipalmatus*
American White Pelican	*Pelecanus erythrorhynchos*	Blue-winged Teal	*Anas discors*	Killdeer	*Charadrius vociferus*
Brown Pelican	*Pelecanus occidentalis*	Lesser Scaup	*Aythya affinis*	**Recurvisrostridae**	
Phalocrocoracidae		**Accipitridae**		Black-necked Stilt	*Himantopus mexicanus*
Neotropic Cormorant	*Phalacrocorax brasilianus*	Osprey	*Pandion haliaetus*	**Jacanidae**	
Double-crested Cormorant	*Phalacrocorax auritus*	Gray-headed Kite	*Leptodon cayanensis*	Northern Jacana	*Jacana spinosa*
Anhingidae		White-tailed Kite	*Elanus leucurus*	**Scolopacidae**	
Anhinga	*Anhinga anhinga*	Snail Kite	*Rostrhamus sociabilis*	Greater Yellowlegs	*Tringa melanoleuca*
Fregatidae		Plumbeous Kite	*Ictinia plumbea*	Solitary Sandpiper	*Tringa solitaria*
Magnificent Frigatebird*	*Fregata magnificens*	Black-collared Hawk	*Busarellua nigricollis*	Spotted Sandpiper	*Actitis macularia*
Adeidae		Gray Hawk	*Asturina nitida*	Semipalmated Sandpiper	*Calidris pusilla*
Bare-throated Tiger Heron	*Tigrisoma mexicanum*	Common Black-Hawk*	*Buteogallus anthracinus*	Least Sandpiper	*Calidris minutilla*
Great Blue Heron	*Ardea herodius*	Great Black-Hawk	*Buteogallus urubitinga*	White-rumped Sandpiper	*Calidris fuscicollis*
Great Egret*	*Ardea alba*	Roadside Hawk*	*Buteo magnirostris*	**Laridae**	
Snowy Egret	*Egretta thula*	Broad-winged Hawk	*Buteo platypterus*	Laughing Gull	*Larus atricilla*
Little Blue Heron*	*Egretta caerulea*	Short-tailed Hawk	*Buteo brachyurus*	Royal Tern	*Sterna maxima*
Tricolored Heron	*Egretta tricolor*	Black Hawk-Eagle	*Spizaetus tyrannus*	Sandwich Tern	*Sterna sandvicensis*
Reddish Egret	*Egretta rufescens*	Ornate Hawk-Eagle	*Spizaetus ornatus*	Least Tern	*Sterna antillarum*
Cattle Egret	*Bubulcus ibis*	**Falconidae**		Black Tern	*Chlidonias niger*
Green Heron	*Butorides virescens*	Collared Forest-Falcon*	*Micrastur semitorquatus*	**Columbidae**	
Black-crowned Night Heron	*Nycticorax nycticorax*	Laughing Falcon*	*Herpetotheres cachinnans*	Pale-vented Pigeon	*Columba cayennensis*
Yellow-crowned Night Heron	*Nyctanassa violacea*	Bat Falcon	*Falco rufigularis*	Scaled Pigeon	*Columba speciosa*
Boat-billed Heron	*Cochlearius cochlearius*	Peregrine Falcon	*Falco peregrinus*	Red-billed Pigeon*	*Columba flavirostris*
Threskiornithidae		**Cracidae**		White-winged Dove*	*Zenaida asiatica*
White Ibis*	*Eudocimus albus*	Plain Chachalaca*	*Ortalis vetula*	Common Ground-Dove	*Columbina passerina*
Roseate Spoonbill*	*Ajaia ajaia*	Great Curassow	*Crax rubra*	Plain-breasted Ground-Dove*	*Columbina minuta*
Ciconiidae		**Odontophoridae**		Ruddy Ground-Dove	*Columbina talpacoti*
Jabiru	*Jabiru Mycteria*	Black-throated Bobwhite	*Colinus nigrogularis*	Blue Ground-Dove*	*Claravis pretiosa*
Wood Stork*	*Mycteria americana*	**Rallidae**		White-tipped Dove*	*Leptotila verreauxi*
		Ruddy Crake*	*Laterallus ruber*	Gray-fronted Dove*	*Leptotila rufaxilla*
		Clapper Rail	*Rallus longirostris*	Caribbean Dove	*Leptotila jamaicensis*
		Gray-necked Wood-Rail	*Aramides cajanea*	Ruddy Quail-Dove*	*Geotrygon montana*
		Common Moorhen	*Gallinula chloropus*		
		American Coot*	*Fulica americana*		

TABLE 23

WILDTRACKS (2003b) BIRD LIST FOR THE BALAM JUNGLE ESTATE, CONTINUED

Family / Common Name*	Scientific Name	Family / Common Name*	Scientific Name	Family / Common Name*	Scientific Name
Psittacidae		**Alcedinidae**		**Tyrannidae**	
Olive-throated Parakeet*	*Aratinga nana*	Ringed Kingfisher	*Ceryle torquata*	Yellow-bellied Tyrannulet*	*Ornithion semiflavum*
Brown-hooded Parrot	*Pionopsitta haematotis*	Belted Kingfisher	*Ceryle alcyon*	Northern Beardless-Tyrannulet*	*Camptostoma imberbe*
White-crowned Parrot*	*Pionus senilis*	Amazon Kingfisher	*Chloroceryle amazona*	Greenish Elaenia	*Myiopagis viridicata*
White-fronted Parrot*	*Amazona albifrons*	Green Kingfisher	*Chloroceryle americana*	Yellow-bellied Elaenia*	*Elaenia flavogaster*
Yellow-lored Parrot	*Amazona xantholora*	American Pygmy Kingfisher	*Chloroceryle aenea*	Ochre-bellied Flycatcher*	*Mionectes oleagineus*
Cuculidae		**Bucconidae**		Northern Bentbill *	*Ocostoma cinereigulare*
Yellow-billed Cuckoo	*Coccyzus americanus*	White-necked Puffbird	*Notharcus macrorhynchus*	Eye-ringed Flatbill*	*Rhynchocyclus brevirostris*
Mangrove Cuckoo*	*Coccyzus minor*	**Ramphastidae**		Yellow-olive Flycatcher*	*Tolomyias sulphurescens*
Squirrel Cuckoo*	*Tapera naevia*	Collared Aracari*	*Pteroglossus torquatus*	Stub-tailed Spadebill*	*Platyrinchus cancrominus*
Groove-billed Ani	*Crotophaga sulcirostris*	Keel-billed Toucan*	*Ramphastos sulfuratus*	Royal Flyctacher*	*Onychorhynchus coronatus*
Tytonidae		**Picidae**		Tropical Pewee	*Contopus cinereus*
Barn Owl*	*Tyto alba*	Red-vented Woodpecker*	*Melanerpes pygmaeus*	Yellow-bellied Flycatcher	*Empidonax flaviventris*
Strigidae		Golden-fronted Woodpecker*	*Melanerpes aurifrons*	Least Flycatcher	*Empidonax minimus*
Vermiculated Screech-Owl*	*Otus guatemalae*	Smoky-brown Woodpecker*	*Veniliornis fumigatus*	Bright-rumped Atilla*	*Atilla spadiceus*
Ferruginous Pygmy-Owl	*Glaucidium brasilianum*	Golden-olive Woodpecker*	*Piculus rubiginosus*	Yucatan Flycatcher*	*Myiarchus yucatanensis*
Mottled Owl*	*Ciccaba virgata*	Chestnut-colored Woodpecker	*Celeus castaneus*	Dusky-capped Flycatcher*	*Myiarchus tuberculifer*
Caprimulgidae		Linneated Woodpecker*	*Dryocopus lineatus*	Brown-crested Flycatcher	*Myiarchus tyrannulus*
Lesser Nighthawk	*Chordeiles acutipennis*	Pale-billed Woodpecker*	*Campephilus guatemalensis*	Great Kiskadee	*Pitangus sulphuratus*
Common Nighthawk	*Chordeiles minor*	**Furnariidae**		Boat-billed Flycatcher*	*Megarhynchus pitangua*
Common Paraque*	*Nyctidromus albicollis*	Plain Xenops	*Xenops minutus*	Social Flycatcher*	*Myiozetes similis*
Yucatan Poorwill	*Nyctiphynus yucatanica*	**Dendrocolaptidae**		Sulphur-bellied Flycatcher*	*Myiodynastes luteiventris*
Yucatan Nightjar	*Caprimulgus badius*	Tawny-winged Woodcreeper*	*Dendrocincla anabatina*	Tropical Kingbird*	*Tyrannus melancholicus*
Nyctibiidae		Ruddy Woodcreeper	*Dendrocincla homochroa*	Couch's Kingbird*	*Tyrannus couchii*
Northern Potoo	*Nyctibius jamaicensis*	Olivaceous Woodcreeper	*Sittasomus griseicapiilus*	Eastern Kingbird	*Tyrannus tyrannus*
Apopidae		Northern Barred-Woodcreeper*	*Dendrocolaptes sanctithomae*	**Incertae Sedis (species of uncertain affinities)**	
Chimney Swift	*Chaetura pelagica*	Ivory-billed Woodcreeper*	*Xiphorhynchus flavigaster*	Thrush-like Schiffornis*	*Schiffornis turdinus*
Vaux's Swift	*Chaeturi vauxi*	Streak-headed Woodcreeper	*Lepidocolaptes souleyetii*	Rose-throated Becard	*Pachyramphus aglaiae*
Lesser Swallow-tailed Swift*	*Panyptila cayennensis*	**Thamnophilidae**		Masked Tityra*	*Tityra semifasciata*
Trochlidae		Barred Antshrike*	*Thamnophilus doliatus*	**Pipridae**	
Green-breasted Mango	*Anthracothorax prevostii*	**Formicariidae**		White-collared Manakin*	*Manacus cadei*
Canivet's Emerald	*Chlorostilbon canivetii*	Black-faced Antthrush*	*Formicarius analis*	Red-capped Manakin*	*Pipra mentalis*
White-bellied Emerald*	*Amazilia candida*			**Vireonidae**	
Rufous-tailed Hummingbird*	*Amazilia tzacatl*			White-eyed Vireo	*Vireo griseus*
Buff-bellied Hummingbird	*Amazilia yucatanensis*			Mangrove Vireo	*Vireo pallens*
Cinnamon Hummingbird	*Amazilia rutila*			Yellow-throated Vireo	*Vireo flavifrons*
Trogonidae				Red-eyed Vireo	*Vireo olivaceous*
Black-headed Trogon*	*Trogon melanocephalus*			Yellow-green Vireo*	*Vireo flavoviridis*
Violaceous Trogon*	*Trogon violaceus*			Yucatan Vireo	*Vireo magister*
Momotidae				Tawny-crowned Greenlet*	*Hylophilus ochraceiceps*
Blue-crowned Motmot*	*Momotus momota*			Lesser Greenlet*	*Hylophilus decurtatus*
				Rufous-browed Peppershrike*	*Cyclarhis gujanensis*

TABLE 23

WILDTRACKS (2003b) BIRD LIST FOR THE BALAM JUNGLE ESTATE, CONTINUED

Family / Common Name*	Scientific Name	Family / Common Name*	Scientific Name	Family / Common Name*	Scientific Name
Corvidae		**Parulidae, Continued**		**Icteridae**	
Green Jay*	*Cyanocorax yncas*	Prothonotary Warbler	*Protnotaria citrea*	Red-winged Blackbird	*Agelaius phoeniceus*
Brown Jay*	*Cyanocorax morio*	Worm-eating Warbler	*Helmintheros vermivorus*	Melodious Blackbird*	*Dives dives*
Yucatan Jay	*Cyanocorax yucatanicus*	Ovenbird	*Seiurus aurocapillus*	Great-tailed Grackle*	*Quisicales mexicanus*
Hirundinidae		Northern Waterthrush	*Seiurus noveboracensis*	Bronzed Cowbird	*Molothrus aeneus*
Mangrove Swallow	*Tachycineta albilinea*	Louisiana Waterthrush	*Seiurus motacilla*	Black-cowled Oriole*	*Icterus prosthemelas*
Bank Swallow	*Riparia riparia*	Kentucky Warbler	*Oporornis formosus*	Hooded Oriole	*Icterus cucullatus*
Gray-breasted Martin	*Progne chalybea*	Common Yellowthroat	*Geothlypis trichas*	Yellow-backed Oriole	*Icterus chrysater*
Troglodytidae		Gray-crowned Yellowthroat*	*Geothlypis poliocephala*	Orange Oriole	*Icterus auratus*
Spot-breasted Wren*	*Thryothorus maculipectus*	Hooded Warbler	*Wilsonia citrina*	Altamira Oriole	*Icterus gularis*
White-bellied Wren*	*Uropsila leucogastra*	Yellow-breasted Chat	*Icteria virens*	Yellow-billed Cacique*	*Amblycercus holosericeus*
White-breasted Wood-Wren*	*Henichorhina leucosticta*	Gray-throated Chat	*Granatellus sallaei*	Montezuma Oropendonla*	*Psarocolius montezuma*
Sylviidae		**Thraupidae**			
Long-billed Gnatwren*	*Ramphocaenus melanurus*	Gray-headed Tanager*	*Eucometis penicillata*		
Blue-gray Gnatcatcher*	*Polioptila caerulea*	Red-throated Ant-Tanager*	*Habia fuscicauda*		
Tropical Gnatcatcher*	*Poliotila plumbea*	Rose-throated Tanager*	*Piranga roseogularis*		
Turdidae		Summer Tanager	*Piranga rubra*		
Wood Thrush	*Hylocichla mustelina*	Scarlet Tanager	*Piranga olivacea*	***2007 Species Not Previously Recorded:***	
Clay-colored Robin	*Turdus grayi*	Blue-gray Tanager	*Thraupis episcopus*		
Mimidae		Scrub Euphonia*	*Euphonia affinis*	**Falconidae**	
Gray Catbird	*Dumetella carolinensis*	Yellow-throated Euphonia	*Euphonia hirundinacea*	Barred Forest Falcon*	*Micrastur ruficollis*
Black Catbird*	*Melanoptila glabirostris*	Red-legged Honeycreeper*	*Cyanerpes cyaneus*	**Icteridae**	
Tropical Mockingbird*	*Mimus gilvus*	**Emberizidae**		Yellow-Tailed Oriole*	*Icterus mesomelas*
Bombycillidae		Blue-black Grassquit	*Volatinia jacarina*	**Parulidae**	
Cedar Waxwing	*Bombycilla cedorum*	White-collared Seedeater*	*Sporophila torqueola*	Mangrove Warbler*	*Dendroica petechia*
Parulidae		Olive Sparrow*	*Arremonops rufivirgatus*	**Thraupidae**	
Blue-winged Warbler	*Vermivora pinus*	Green-backed Sparrow*	*Arremonops chloronotus*	Red-Crowned Ant-Taniger*	*Habia fuscicauda*
Golden-winged Warbler	*Vermivora chrysoptera*	**Cardinalidae**		**Emberizidae**	
Tennessee Warbler	*Vermivora peregrina*	Grayish Saltator	*Saltator coerulescens*	Common-Tody Flycatcher*	*Todirostrum cinereum*
Northern Parula	*Parula americana*	Black-headed Saltator*	*Caryothraustes poliogaster*	Piratic Flycatcher*	*Legatus leucophalus*
Yellow Warbler	*Dendroica petechia*	Northern Cardinal*	*Cardinalis cardinalis*	**Incertae Sedis**	
Chestnut-sided Warbler	*Dendroica pensylvanica*	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Black-Crowned Tityra*	*Tityra inquisitor*
Magnolia Warbler	*Dendroica magnolia*	Blue-black Grosbeak	*Cyanocompsa cyanoides*	**Charadriidae**	
Yellow-rumped Warbler	*Dendroica coronata*	Blue Bunting*	*Cyanocompsa caerulea*	Snowy Plover*	*Charadrius alexandrinus*
Black-throated Green-Warbler	*Dendroica virens*	Blue Grosbeak	*Guiraca caerulea*	**Psittacidae**	
Blackburnian Warbler	*Dendroica fusa*	Indigo Bunting	*Passerina cyanea*	Red-Lored Parrot*	*Amazona autumnalis*
Yellow-throated Warbler	*Dendroica dominica*				
Bay-breasted Warbler	*Dendroica castanea*				
Black-and-White Warbler	*Mniotilta varia*				
American Redstart	*Setophaga ruticilla*				

*Species Noted During 2007 REA

Other resident species that possibly use this area are the elusive Pheasant Cuckoo and the Mangrove Cuckoo. Very little is known regarding the breeding habits of these two birds, (Lee Jones - Birds of Belize, 2003). Additionally, species such as ducks and hummingbirds are poorly represented in this study, though of course the property has identical habitats like The Rio Bravo Conservation Management area and Runaway Creek Nature Preserve where over 300 species of birds have reliably been identified and recorded. Raptors/birds of prey, both residents and migrants were minimal in the study, reason being, the timing of the survey. For a more detailed study, sampling should be done at different times within the migration season, possibly the months of August, December and April. Additionally sampling in hard to access areas would certainly add to the bird fauna recorded within the property.

Of great interest is a small island that apparently used as a rookery by the Wood Stork, along the coast. This can be great site of interest for avid birders and photographers alike that are enthusiastic about bird behaviors. Access was not possible to this area but it would certainly a good survey site.

Another factor contributing to species richness is the existence of many "transition zones" along broadleaf and the coastal area. For instance, several patches of secondary growth or disturbed forest were encountered within the different forest types. Secondary growth forest is known to have high species composition (Valelly & Mallory 1997). The Mangrove forest is also important as it provides space for specialist species such as the Mangrove Warbler, Black Catbird and other species that depend on aquatic habitats, such as herons, Sandpipers and Water Thrushes. Even Great Egrets that leave interior wetlands during the migration season utilize these areas. The Gray-crowned Yellowthroat, a species only known to occur in a few interior landscape of Belize was recorded during the survey. Other specie of interest is the Red-Vented Woodpecker which is uncommon in all the remaining districts but notably occurs in practically all the forest types sampled. Finally, the area is also important as the breeding ground for at least 3 species of the Seasonal Migrants (Dry Season residents), such as the Piratic Flycatcher, Sulpur-Bellied Flycatcher and Yellow Green Vireo that uses all the forest types sampled.

ILLUSTRATION 45:

Birds Of The Balam Jungle Estate

Female White Collard Seed-Eater (*Sporophila torqueola*)

Flycatcher Nest

3 Chicks In Tropical Kingbird Nest (*Tyrannus melancholicus*)

Mammals Of The Balam Jungle Estate

While no systematic surveys were undertaken to study the mammalian diversity within BJE every effort was made to record species seen during the eight day study period on the property. Species included in the list include those seen, heard or those that left tell-tale signs (e.g., tracts, scat). Three night walks were taken along the major road and logging roads in an effort to document nocturnal mammal species. As with the vegetation reports, the list produced here should compliment that of the biodiversity report by Wildtracks 2003b). Ten mammal species of the 25 species reported by Wildtracks (see **Illustration 46** & **Table 25**) were recorded as being present in the BJE (see **Illustration 46** & **Table 25**).

ILLUSTRATION 46:

Mammals Of The Balam Jungle Estate

Above: The Apex Predator, Jaguar (*Panthera onca*). **Below**: Jaguar Prey, The White Tailed Deer (*Odocoileus virginianus*).

MARINE FLORA & FAUNA

Marine Flora & Invertebrate Fauna

The Balam Jungla Estate was reported by Wildtracks (2003b) to be sparsely populated with 9 species of marine flora typically found in shallow brackish water on exposed rubble or sand, and/or in sheltered mangrove habitats (see **Illustration 47**). Noted species included the Green Algae: Mermaids Wine Glass (*Acetabularia calyculus*); *Udotea fibrosa*; *Batophora oerstedii*; Red Algae: *Laurencia caraibica*; Brown Algae: *Sargassum platycarpum*; *S. vulgare*; *Turbinaria turbinate*; and the vascular Turtle Grass (*Thalassia testudinum*) and Shoal Grass (*Halodule beaudettei*).

ILLUSTRATION 48:

Marine Flora Of The BJE

Top: Turtle Glass (*Thalassia testudinum*); **Bottom:** Shoal Grass (*Halodule beaudettei*).

Snorkel surveys conducted by Wildtracks along coastal survey transects oberserved land, swimming & hermit crabs, along with various marine snails, barnicles and shrimp where the sea floor is rocky and hence, heterogeneous. One observation of predatory cat tracks near the sea shore suggest prey species may include crabs and other marine fauna,

TABLE 24

MAMMALS OF THE BALAM JUNGLE ESTATE

Mammal Species of the Forested Areas	
Virginia Possum*	*Didielphis virginiana*
Common Opossum*	*Didelphis marsupialis* (seen)
Common Tent Making Bat*	*Uroderma bilobatum*
Northern Tamandua	*Tamandua mexicana*
Nine-banded Armadillo*	*Dasypus novemcinctus*
Yucatan Squirrel	*Sciurus yucatanensis*
Central American Agouti*	*Dasyprocta punctata*
Paca*	*Agouti paca*
Grey Fox*	*Urocyon cinereoargenteus*
Margay	*Leopardus wiedii*
Ocelot	*Leopardus pardalis*
Puma*	*Puma concolor*
Jaguar	*Panthera onca*
Striped Hog-nosed Skunk	*Conepatus semistriatus*
Tayra	*Eira barbara*
Kinkajou*	*Potos flavus*
Northern Raccoon	*Procyon lotor*
White-nosed Coati	*Nasua narica*
Collared Peccary	*Pacari tajacu*
White-lipped Peccary	*Tayassu pecari*
Red Brocket Deer	*Mazama americana*
White-tailed Deer*	*Odocoileus virginianus*
Baird’s Tapir*	*Tapirus bairdii*

Marine Vertebrate Fauna

The marine vertebrate fauna of the BJE appear to be equally selected by the harsh, high-temperature euryhaline environment of its coastal lagoons and offshore waters, and so not surprisingly perhaps, appears to be as species poor as the sites marine flora. Resident marine fauna noted by Wildtracks (2003b) included the Orange Flagfish (*Jordanilla pulchra*); Chequered Pufferfish (*Spoeroides testudines*); Redfin Needlefish (*Stronglyura notata*); Yellow Stingray (*Dasyatis americana*); American Crocodile (*C. acutus*); Bottle-nosed Dolphin (*Tursiops truncatus*); and West Indian Manatee (*Manatus trichechus*).

Wildtracks further reported that area estuaries, and an offshore geological feature known as Bulkhead Shoal, are reputed by area fishermen to be visited by spawning Bonnet Head Sharks (*Sphyrna tiburo*); and a wide range of sport fishes such as Tarpon, Snook, Bonefish, Stone Bass, and juvenile Nassau Grouper (respectively). Consequently, the close physical proximity of resident and offshore marine fauna suggests that important predator/prey and/or water quality linkages may exist between these groups.

ILLUSTRATION 48:

Marine Fauna Of The BJE

Top: The Orange Flagfish (*Jordanella pulchra*). **Bottom:** A Bonnet Head Shark (*Sphyrna tiburo*).

Recommendations

Given the preceding discussion of terrestrial and marine flora and fauna of the Balam Jungle Estate, the project proponent will need to:

14. ***Consider investment in the long term monitoring of Anuran populations with the Timber Management Zone and Residential Tourism Development areas in order to identify long term impacts that may be negatively influencing the ecology of the BJE; and***

15. ***Insure that all other vertebrate wildlife within the BJE is adequately protected from hunting, fires and other forms of mortality borne by human interventions; and that wildlife corridors are designed into the proposed development layout, in order to afford access to formerly visited green spaces within the development footprint; and***

16. ***Insure the coastal brackish water habitat is not degraded by effluent pollution inputs from the proposed development in existing linkages between resident & transient marine fauna, and area fishermen who expoit the later of these groups as an alternative tourism livelihood are to persist intact.***

HISTORICAL & CONTEMPORARY LAND USE

The land use history of the Balam Jungle Estate is likely to date back many thousands of years, possible the time of the coastal Paleo-Indian occupation ca 10,0000 bp. Although no physical evidence of Paleo-Indian occupation of the site was found during the conduct of an archaeological impact assessment of the area (see **Addendum 15**), the presence of pottery shards on numerous, previously unrecorded coastal mounds, along with previously unrecorded burial mounds and stone erections further inland suggest the ancient Maya certainly occupied the site from at least the Late Classic Period of 300 B.C. forward (see **Illustration 49**).

Institute of Archaeology (IOA) records indicate the only colonial period occupation of the BJE may have been at Spanish Point. Such colonial period explorers / settlers may have used the area for hunting, logging, fishing and agriculture, but the lack of physical evidence supporting the claim suggests the site may in the long run, only yield limited or ephemeral evidence of past use.

Contemporary use of the Balam Jungle Estate has been almost exclusively limited to licensed and unlicensed timber extraction, aside from the limited hunting by residents from nearby, but nevertheless remote villages. Regional land use practices however, have entailed extensive land clearing by the Shipyard Menonites for agricultural production on the Xaibe Plain, which extends into the Lowland Broadleaf Forests of the BJE (see **Page 163**). Consequently, while the Xaibe land system making up approximately 40% of the BJE may be significantly better suited to agricultural production than other land systems within the property, higher economic and employment returns to the national economy are likely to be realized under the proposed development plan, particularly if processed timber products enjoin one or more eco-certification programs, and unharvested timber is set aside for carbon sequestration credit.

Given these considerations, the IOA has recommended the following guidelines for development within the BJE:

- With respect to the coastal region of the property (i.e. the residential tourism zone), IOA *recommends that NEAC allow the development…to proceed but with the stipulation that the developer hires someone with past excavation experience to observe all land clearing and excavation activities*;
- In respect to the area designated as the timber management zone, *a systematic archaeological survey needs to be conducted in that area before any development can proceed. This survey should make every effort to determine site and ancient population density in that area, and it should provide a cultural resource management plan for these large sites*; and
- Land clearing and construction activities are immediately stopped for the purpose of advising the Belize Institute Of Archaeology, and affording its determination of an appropriate course of action or options available to the proponent, which invariable include either cessation or modification of the development and in the present contet, may involve slight realignment of the proposed Stage 1 subdivision components (see **Illustration 50**, right panel).

ILLUSTRATION 49:

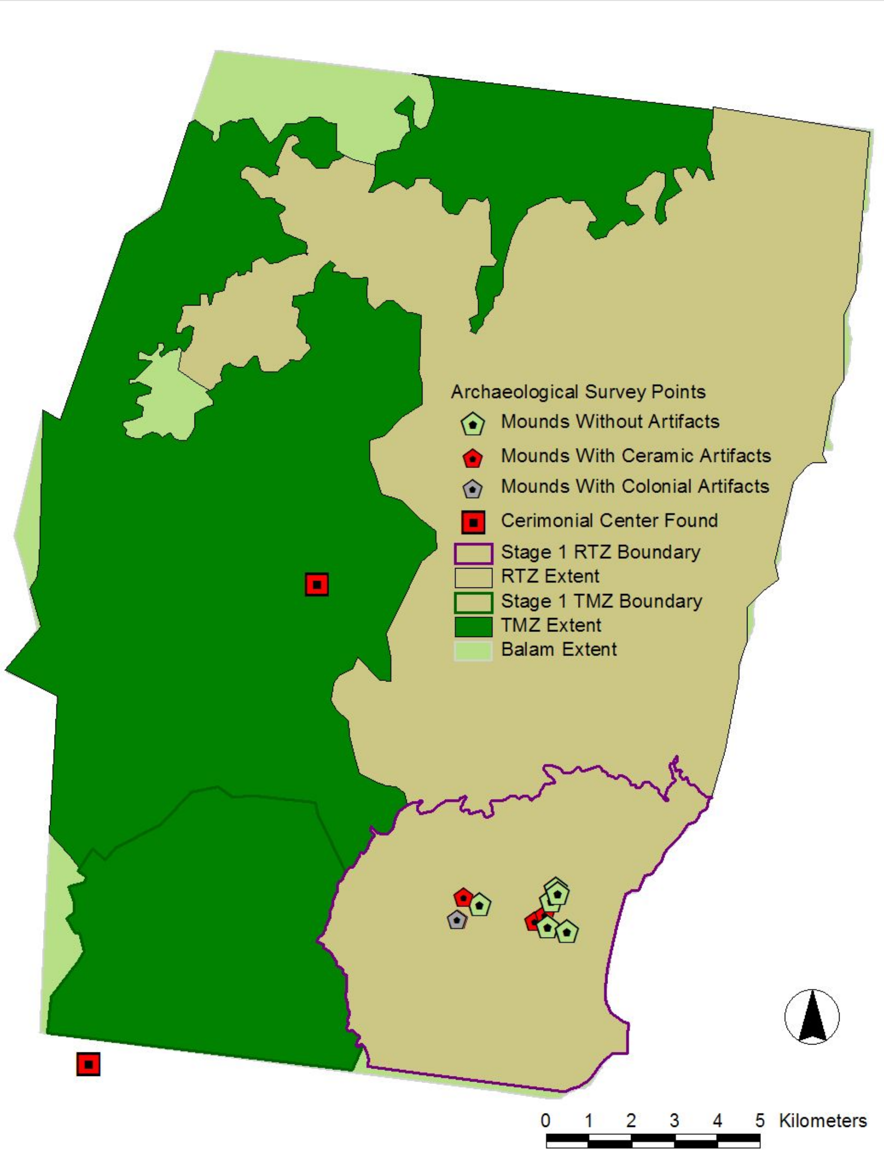
FOUND EVIDENCE OF COLONIAL & MAYA OCCUPATION

Top Left: Olive Jar Fragment Typical Of Historical Occupation, Probably By Spanish Explorers, at Site 4. **Bottom Left:** Historical Period Bottle From Site 4.

Top Right: Excavation Of A Test Pit At Site 1. **Center Right:** Pottery Shards Of Maya Origin From Upper Layer Of Site 1 Test Pit. **Bottom Right**: View Of 10 Meter High Mound Found Within Central Plaza Of Upland Site 1.

ILLUSTRATION 50:

CULTURAL SITES WITHIN THE BALAM JUNGLE ESTATE



TEXT BOX 1:

SUMMARY OF KEY RECOMMENDATIONS

- All vertical structures meet a minimum level of construction integrity to withstand wind speeds in excess of 100 mph, in order to prevent damage to neighboring structures;
- The hurricane preparedness plan, as presented herein (see **Page 177**), will need to be adopted & implemented by residents to minimize risk to property and life during these seasonal events;
- Insure advance evacuation of the residential tourism development site in the event of direct hurricane approach, as the area will likely flood and remain impassible until pre-hurricane conditions return;
- Insure that water features and drainage of the proposed development site are designed in respect of the low topographic relief of the area;
- Insure that septic systems, are placed above grade to support gravity-based flow & function;
- Recognize the risks presented by the shallow nature of the water table, which is highly vulnerable to contamination from disposal of any liquid waste, particularly waste oil from equipment, and hence will require appropriate treatment or bond storage to offset;
- While the soil compactabiity of the savanna habitat is adequate for the vertical ground pressure loading of roads & buildings, easements along causeways should be established in order to set-back infrastructure loading along canal walls, and to provide maintenance access in the event of soil slump from canal wall failure;
- Septic tanks and leach fields will of necessity need to be designed for placement into exogenous fill materials and therefore must be afforded ample percolation in these soils to maximize leach field effectiveness;
- Insure that irritants & pollutants such as colloid turbidity, pool chemicals, golf course pesticides, and/or petroleum residues are not permitted to become elevated to point where they extirpate the unique planktonic marine fauna of Bennett's Lagoon;
- Four-cycle outboard engines are promoted for use by guests and residents in order to reduce the potential for petroleum accumulation in the surface water layer of Bennett's Lagoo;
- Arboreal microhabitats within the coastal savanna habitat will require preservation through exclusion from use in order for their continued role as important coastal bird rookeries and breeding sites;
- The shoreline's savanna orchard or littoral forests must either be preserved or replaced during establishment of the proposed development in order to sustain their continued visitation and support by migrating birds;
- Fire management practices are fully implemented in order to prevent distruction of the Balam Jungle Broadleaf Forests;
- Consider investment in the long term monitoring of Anuran populations with the Timber Management Zone and Residential Tourism Development areas in order to identify long term impacts that may be negatively influencing the ecology of the BJE; and
- Insure that all other vertebrate wildlife within the BJE is adequately protected from hunting, fires and other forms of mortality borne by human interventions; and wildlife corridors are designed into the proposed development layout, in order to afford access to formery visited green spaces within the development footprint;
- Insure the coastal brackish water habitat is not degraded by effluent pollution inputs from the proposed development in existing linkages between resident & transient marine fauna, and area fishermen who expoit the later of these groups as an alternative tourism livelihood are to persist intact; and
- Land clearing and construction activities to be monitored by a designated representative of the Belize Institute of Archaeology for the purpose of determining the course of action should any find of cultural significance be unearthed during project construction.

3.1 TRANSPORTATION –

Specific to Land-Based Transportation & Road Design

3.1 Roads and Trails

3.11 Evaluate options for the provision of suitable roads/walkways (if any) for the development, taking into account proper access to lots, etc.

3.12 Select preferred option for the provision of suitable roads/walkways for the development. This will need to examine construction materials (types, sources, volumes, transportation) and methods in relation to their environmental impacts.

3.13 Recommend precise mitigation measures, based on the specific option selected, for the proper management of the vehicular/boat traffic close to and within the project area. These mitigation measures must include recommendations for protection features against siltation, erosion, and other potential pollution to the environment.

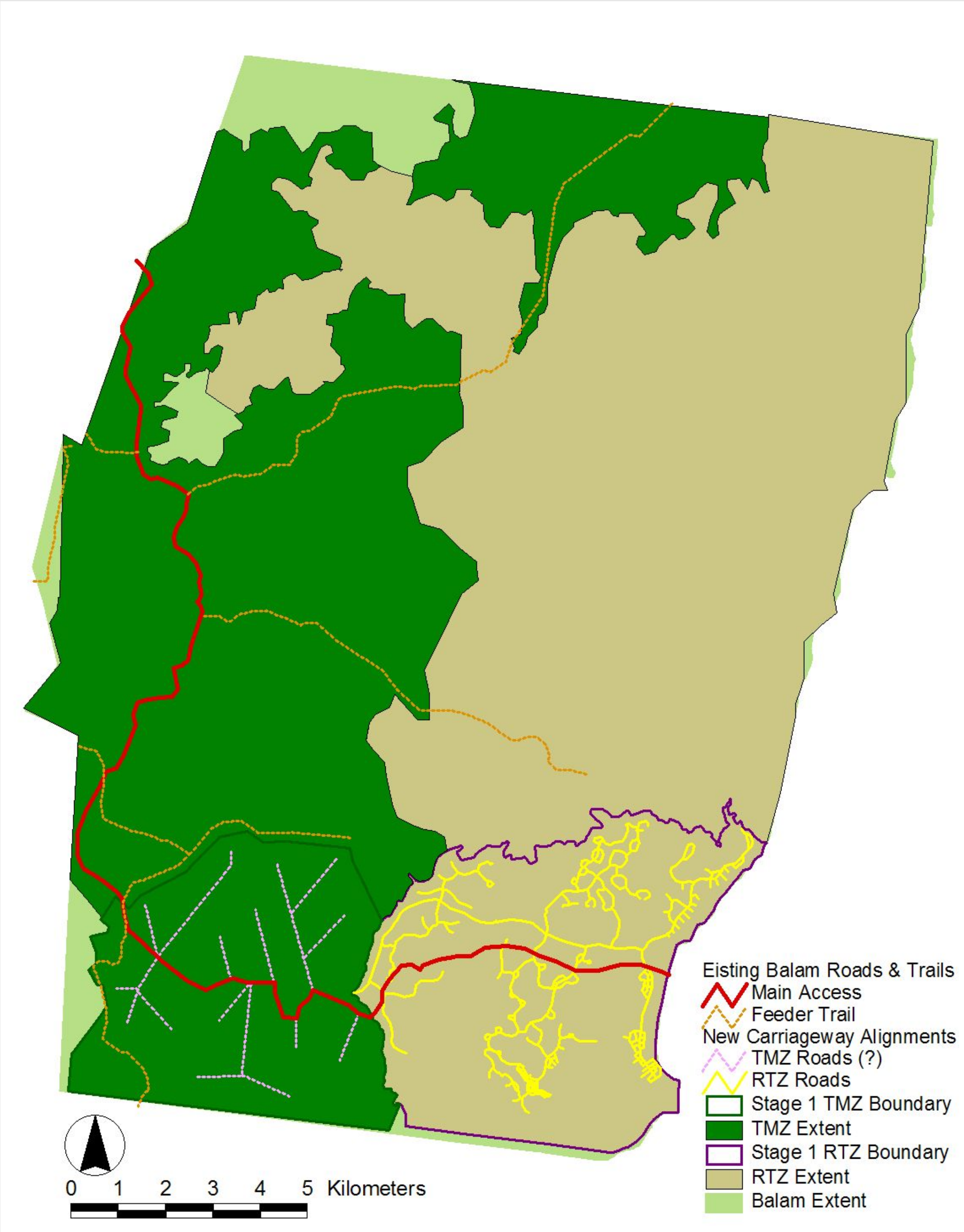
LAND-BASED TRANSPORTATION PLAN AND DESIGN OPTIONS

Land-based transportation within the Section 1 development site will entail the establishment and/or upgrade of approximately 43 Km of roads and trails within the Year 1-5 timber management zone; 87 Km of new access roads and 6 Km of alleys within the residential tourism development; and 14 Km of easement access between the Old Northern Highway at Maskall Village and the road matrix within the timber management zone, for a total of approximately 150 Km of new and/or refurbished roads, alleys and trails (see **Illustration 51**).

All roads & trails within the timber management zone will be unsurfaced and designed for use by heavy equipment, while all roads & alleys within the residential tourism development and the easement will be surfaced with tarmac and designed for light-duty vehicles (i.e. bicycles, golf carts and small pick-up trucks), as may be needed by guests, residents and/or staff to move between different parts of the development and their respective accommodations and/or places of employment. All road works will be lighted and constructed according to Ministry of Works guidelines for light duty roads, as shown in. Various pedestrian trails will also be established in green spaces for nature viewing. The land-based transportation plan for the proposed development is not anticipated to create any significant negative impact risks related to material supply, which are unaccounted for in **Chapters 4** & **9** of this assessment. No alternative land-based transportation design options are available which can suitably access all of the proposed lots and other accommodation sites, save and except for the non-development option, and so the proposed option represents the preferred option for development.

ILLUSTRATION 51:

EXISTING AND PROPOSED ROAD CARRIAGEWAYS SERVICING THE STAGE 1 DEVELOPMENT



LAND-BASED TRAFFIC TRANSPORTATION IMPACTS AND MITIGATION MEASURES

The impact potentials presented by the land-based transportation plan are summarized in **Table 25** and **Text Box 2**.

Direct negative impacts risks from construction and operation of access roads at the proposed development site concern the reduction of broadleaf forest and coastal savanna habitats, which constitute unavoidable impacts that can only be mitigated by non-development.

Indirect negative land-based transportation impact risks concern increased potential for fire starts from (human) smoking, and/or operation of poorly maintained heavy equipment within either the timber management zone or residential tourism development; and increased potential for rainwater, sediment and petroleum-based pollution runoffs to accumulate in ground and or surface waters such as local cenotes, coastal lagoons and/or Chetumal Bay; both of which constitute avoidable, but more than likely irreversible impacts. *Residual* negative land-based transportation impact risks concern increased potential for public injury risk from increased traffic loads likely to be produced by the proposed development, which also constitutes an avoidable impact. Measures available for mitigating avoidable impacts include:

- Design and Construction Measures that provide for the placement of settlement ponds into the overall landscape plan for the development, and insure all drainage from these settlement areas discharge into the inland waterway / canal system planned for development where ever possible;
- Operating Measures that achieve zero-fire starts through smoking and/or open fire restrictions; outfitting all petroleum powered vehicles with spark arresters, along with maintenance of electrical connections on all vehicles for the prevention of electrical spark generation; utility mapping of all natural surface water sources suited for use in fire control; and outfitting all work crews and/or maintenance vehicles with fire fighting equipment such as round-point shovels, chemical foam extinguishers, and water uptake, storage & dispensing equipment.
- Operating Measures that provide for slow speed (i.e. < 15 mph), sign placements along roads and trails, placement of traffic stops in residential areas, appropriate training for all development staff operating vehicles at the site, and adherence to public licensing requirements for all vehicle operators, inclusive of staff, residents and guests.

MONITORING REQUIREMENTS

Inspections of fire fighting equipment should be conducted weekly; while roadway runoff settlement areas for containment integrity should be inspected monthly; and staff operating licenses should be inspected annually for necessary renewal requirements.

TABLE 25

MITIGATION MATRIX OF LAND-BASED TRANSPORTATION IMPACTS[1]

IMPACT CATEGORY	DIRECT IMPACTS	MITIGATING MEASURES	INDIRECT IMPACTS	MITIGATING MEASURES	RESIDUAL IMPACTS	MITIGATING MEASURES
Land-Based Transportation Impacts	Reduction of broadleaf forest and coastal savanna habitat along carriageway alignments.	None, Non-Development	Increased fire risk to the broadleaf forest and/or savanna habitat from increased human presence and operation of either electric or petroleum based vehicles. Delivery of fresh water, sediment and/or petroleum-based run-offs into area ground and/or surface waters.	Achieve zero-fire starts through smoking and/or open fire restrictions; outfitting all petroleum powered vehicles with spark arresters, along with maintenance of electrical connections on all vehicles for the prevention of electrical spark generation; utility mapping of all natural surface water sources suited for use in fire control; and outfitting all work crews and/or maintenance vehicles with fire fighting equipment such as round-point shovels, chemical foam extinguishers, and water uptake, storage & dispensing equipment. Place settlement ponds into the overall landscape plan for the development, and insure all drainage from these settlement areas discharge into the inland waterway / canal system planned for development where ever possible.	Increased risk of public injury	Place signage and traffic stops to limit vehicle traffic speed through residential areas Ensure staff are properly trained to operate vehicles Adhere to public licensing requirements in regard to operation of vehicles by staff, residents or guests

[1]**Note:** Negative impacts shown in black type, yellow shading indicates unavoidable negative impacts, positive impacts shown in blue-green type.

TEXT BOX 2:

SUMMARY OF KEY LAND-BASED TRANSPORTATION IMPACTS AND MITIGATION MEASURES

I. UNAVOIDABLE IMPACTS:

- Reduction of broadleaf forest and coastal savanna habitat.

II. AVOIDABLE IMPACTS:

- Increased fire risk to the broadleaf forest and/or savanna habitats from increased human presence and operation of either electric or petroleum based vehicles;
- Delivery of fresh water, sediment and/or petroleum-based run-offs into area ground and/or surface waters; and
- Increased risk of public injury.

III. MITIGATION MEASURES:

- Achieve zero-fire starts through smoking and/or open fire restrictions; outfitting all petroleum powered vehicles with spark arresters, along with maintenance of electrical connections on all vehicles for the prevention of electrical spark generation; utility mapping of all natural surface water sources suited for use in fire control; and outfitting all work crews and/or maintenance vehicles with fire fighting equipment such as round-point shovels, chemical foam extinguishers, and water uptake, storage & dispensing equipment;
- Place settlement ponds into the overall landscape plan for the development, and insure all drainage from these settlement areas discharge into the inland waterway / canal system planned for development where ever possible;
- Ensure staff are properly trained to operate vehicles; and
- Adhere to public licensing requirements in regard to operation of vehicles by staff, residents or guests.

IV. MONITORING REQUIREMENTS:

- Inspections of fire fighting equipment should be conducted weekly; while roadway runoff settlement areas for containment integrity should be inspected monthly; and staff operating licenses should be inspected annually for necessary renewal requirements.

3.2 TRANSPORTATION –

Specific to Sea-Based Transportation & Marina Design

3.2 Boat Related Activities and Infrastructure

3.21 Determine the projected number and types of boats likely to be associated with the entire development.

3.22 Evaluate options for boat storage, i.e. parking facilities and size of facility. This will require examination of dredging/mining requirements, construction methods and transportation of materials (If applicable).

3.23 Determine the need for mining and impacts associated with the construction of the parking facility (if any).

3.24 Evaluate options for the supply of fuel to boats and identify the best method for eliminating potential spillages and maximizing health and safety. This should include options for the proper storage of the fuels.

3.25 Evaluate options for storage of water borne vessels, (if applicable). This will require examination of:

i. Dredging requirements/volume of materials to be dredged;
ii. Disposal/use of dredged materials;
iii. Physical character of materials to be dredged;
iv. Benthic substrate
v. Design of marina facility, including access channel (if applicable);
vi. Type of dredging equipment;
vii. Need for shoreline protection;
viii. Near shore and off shore current patterns;
ix. Near shore and off shore sedimentation patterns;
x. Wind conditions;
xi. Wave conditions;
xii. Transportation of construction materials;
xiii. Methods of controlling sedimentation of marina (if applicable);
xv. Requirement for maintenance dredging (frequency and volume)

3.26 Evaluate options for the construction of beach protection structures/devices and identify the preferred option (if applicable).

SEA-BASED TRANSPORTATION PLAN AND DESIGN OPTIONS

Sea-based transportation to and from the proposed development will be focused through a 12 kilometer navigable canal system for conveyance of shallow, 3-Ft draft boats to the sea via Bennett's Lagoon; and two 250-slip wet-dock / 6-Ft draft marinas and two 250-boat dry-dock stations to be established on the northern and western sides of Bennett's Lagoon. Options for the proposed development's sea-based transportation design chiefly concern: (1) the design and location of the navigable canal system planned for placement on the coastal savanna; and (2) the design and location of the marina and other boating-related facilities proposed for placement on Bennetts Lagoon.

Development Options For The Navigable Canal System

The inland waterway / navigable canal system has been designed into the residential tourism component of the overall development for the purposes of providing: (1) direct boating access between individual residences and the sea; (2) land fill resources in close physical proximity to roads & residential lots; (3) improved drainage density and buffer zone with which to accommodate rainfall runoff from the savanna habitat in the vicinity of the development; and (4) a water feature amenity with which to attract lot and home buyers.

These attributes identify the key advantages of the canal system, while others collateral benefits would include increased aquatic/marine habitat area for fish and other coastal wildlife; and improved access to surface waters for fire fighting use, to name only a few. The disadvantages of the canal system, however, include its (1) likely, long-term permanence as a landscape feature; (2) potential for eutrophication and degradation as a receiving water body of development runoffs; (3) potential for abandonment of the area by terrestrial & arboreal wildlife that are now dependent on the savanna habitat; (4) increased mortality risk to Manatee from attraction into the navigable canal system to gain freshwater access and hence, increased potential for prop-injury; and (5) increased presentation of boating accident risk and hence, personal injury; none of which are avoidable, but the latter four of which can be either wholly or partially mitigated.

Given these considerations, the options for development include: (1) acceptance of the proposed development option; (2) addition or modification of select components and/or reduction in canal system scale; or (3) rejection of the first two options altogether and acceptance of the non-development option. While the second option might seek to arbitrarily eliminate or downsize select components of the canal system to avert such avoidable risks as slumping and landscape collapse that can otherwise be readily mitigated through the implementation of appropriate engineering measures (see **Page 50**), modification of the canal systems' location, orientation, length, width, or depth would not eliminate any of the unavoidable disadvantages of the proposed inland canal system.

Rather, such modification of the master plan for the development would require its comprehensive redesign, which in turn would likely cause the proponent to abandon the development's placement in Belize, along with the substantive economic resources that would otherwise accompany its placement, and hence, result in election of the 3rd or non-development option by default. Given this consideration, and the fact that the savanna habitat in question, while supporting several species of wildlife, offers little to no economic value for agriculture or other revenue generating activities, it seems reasonable to accept the proposed option along with the caveat or requirement for (1) physical preservation of or increase in the number of the savanna habitats' adjoining microhabitats; and (2) placement of natural bridges that are unsuited to human use, in order to afford terrestrial wildlife continued access to natural or landscaped green spaces within the residential tourism development zone, which might otherwise be less accessible for the human presence being proposed for the area.

Development Options For The Marina Facilities

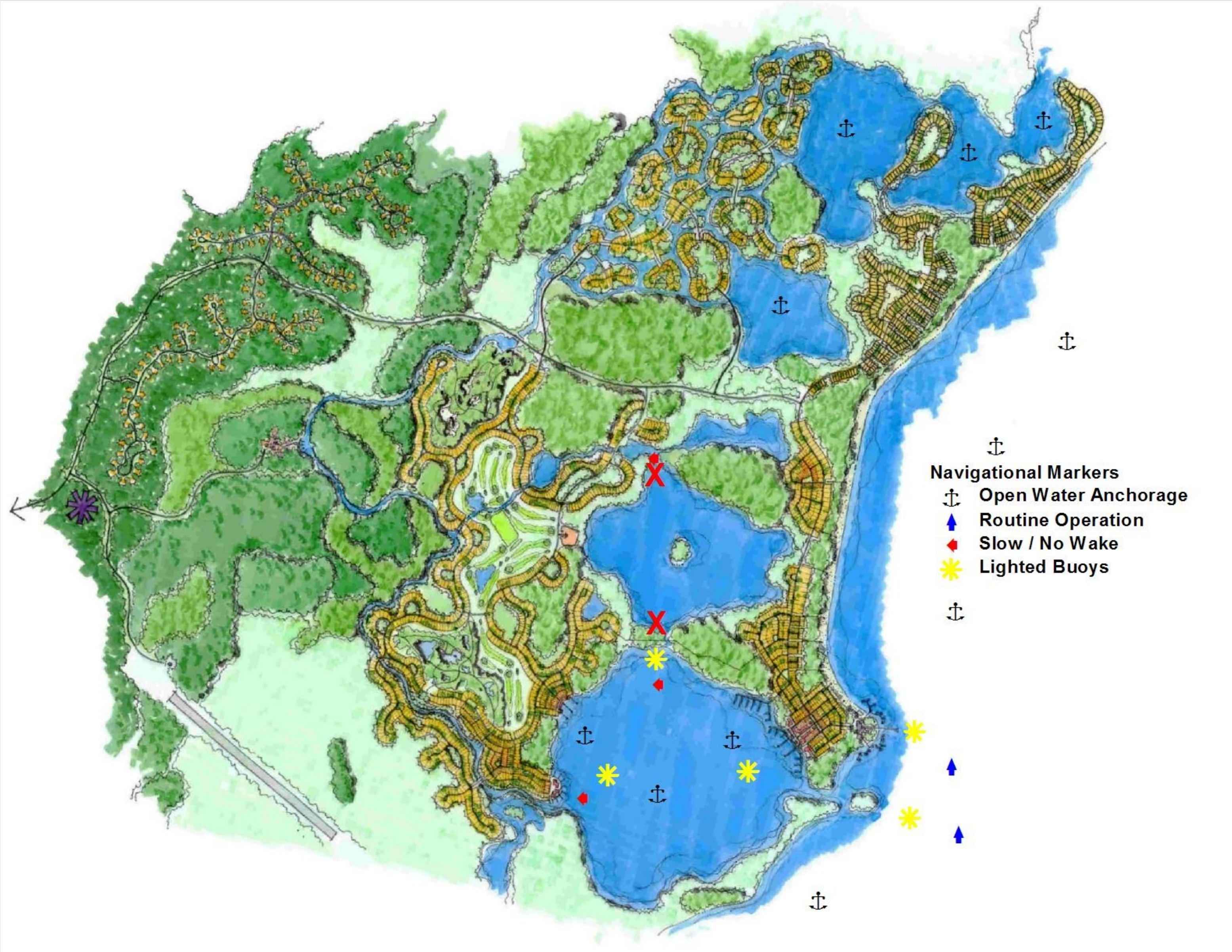
Placement of marina facilities on Bennetts Lagoon and alongside the Corozal Bay will result in a net increase in area boat traffic; the advantages of which include increased commerce in an area that otherwise is poorly disposed to significant economic development and foreign revenue accumulation; and the disadvantages of which may include incremental mortality risk to area wildlife through: (1) petroleum-based contamination of marine or aquatic prey resources for the nesting birds of Bulkhead Lagoon Caye; (2) contamination and degradation of other aquatic wildlife within Bennett's Lagoon and near shore coastal waters; and (3) prop injury to Manatees that occupy the area to feed, drink freshwater, and/or shelter. Consequently, and as with the navigable canal system, the development options available for consideration are essentially limited to the proposed option, a downsized version of the proposed option, or the non-development option, the latter two of being likely to either diminish or eliminate the anticipated economic benefits of the project, as ample marina facilities are ubiquitously regarded as an integral amenity for residential tourism developments.

The above-referenced disadvantages of the proposed development option which might potentially be conveyed to coastal wildlife can be largely ameliorated through pollution abatement actions including: (1) maintenance of all petroleum products in two or more fuel bond(s) having 110% of the stored petroleum volume in order to eliminate spill risk; (2) training of all fuel handlers in safe handling of flammable compounds; (3) offering of preferential docking rates for operators of boats powered by low or zero polluting 4-cycle engines or wind; and Manatee risk aversion actions including: (1) focused *enforcement* of national Manatee conservation guidelines as well as the those of the Corozal Bay Manatee Sanctuary; (2) boat speed control and demarcation of no wake zones and approved navigation routes with signage and lighted navigational buoys (see **Illustration 52**); (3) public education, particularly for all development residents and staff concerning Manatee tourism guidelines (see **Addenda 5**); and (4) enforcement and penalty collection in the event a Manatee is killed as a direct violation of the navigational and/or tourism guidelines for Manatee conservation, rather than development abatement. It is also important to note that placement of the two Marinas on Bennett's Lagoon is not anticipated to promote accumulation of petroleum or other contaminants in area waters owing to a combination of existing tidal flow (see **Page 39**), and the enhanced flow that will result in wet weather from drainage of the majority of the 9,500 acre Section 1 development site through the Bennett's Lagoon watershed.

Scale options for the proposed marina facilities are limited to the reduction in wet slips (assuming that increased dry dock capacity, as a trade off for fewer slips, would not constitute a material reduction in prop injury risk to Manatee). A reduction in wet slip number, while likely to proportionately reduce the above-quantified incremental risk of pollution and prop injury to Manatee, would not eliminate either risk, nor the need for enforcement of Manatee conservation, and hence would simply transfer the nominal Manatee-risk to the proponent and Belize by jeopardizing the viability of the development. Consequently, and given that no alternative sea-based transportation design options are available which can both reduce pollution and manatee risks without jeopardizing the economic viability of the proposed development, the proposed marina development plan and represents the preferred options for development.

ILLUSTRATION 52:

SEA APPROACH TO THE BJE DEVELOPMENT SITE



SEA-BASED TRANSPORTATION IMPACTS AND MITIGATION MEASURES

The impact potentials presented by the sea-based transportation plan are summarized in **Table 26** and **Text Box 3**.

Physical Impacts

Direct, Indirect and *Residual* negative physical sea-based transportation impacts posed by the proposed development not addressed under **Chapter 4**: Material Resource Use are nil.

Biological Impacts

Direct negative sea-based transportation impact risks are nil. *Indirect* negative sea-based transportation impact risks concern the increased risk of prop injury to Manatee which is an irreversible, but avoidable impact. *Residual* negative sea-based transportation impact risks concern increased potential for public injury risk, which is also an irreversible, but avoidable impact. Measures available for mitigating avoidable impacts include:

- Operational Measures involving the establishment of regulations and placement of signage in near shore waters of Bennett's Lagoon and the Corozal Bay indicating boat speed, and approved navigational corridors for boats approaching or departing from Bennett's Lagoon and the Corozal Bay (as shown in **Illustration 52**), as well as the reporting and procedural requirements in the event of prop injury to Manatee.
- Operational Measures that provide for education of all boat operators using the marina about (1) navigational regulations for the area; and (2) the importance of Manatee conservation and the need for responsible navigation practices and slow operating speeds when navigating in the vicinity of Bennett's Lagoon and/or Corozal Bay.

Water Impacts

Direct, negative sea-based transportation impacts on area water resources posed by the proposed development concern the potential for contamination of area surface waters with petroleum effluent, which is a reversible and avoidable impact. Potential *Indirect* and *Residual* negative sea-based transportation impacts on area water resources chiefly concern the reduction of marine flora & fauna in response to petroleum contamination, which is an avoidable & reversible impact. Measures for mitigating these avoidable impacts include:

- Design Measures that will insure drainage of the 9500-acre site through the Bennett's Lagoon watershed for the purpose of facilitating flushing of petroleum residues in wet weather;
- Operational Measures that will insure the responsible storage and handling of petroleum products at the marina's fuel depot, and hence prevent or eliminate the risk of petroleum spills and contamination of area waters; and
- Educational Measures that communicate the advantages of 4-cycle marine engine use.

TABLE 26

MITIGATION MATRIX OF SEA-BASED TRANSPORTATION IMPACTS[1]

IMPACT CATEGORY	DIRECT IMPACTS	MITIGATING MEASURES	INDIRECT IMPACTS	MITIGATING MEASURES	RESIDUAL IMPACTS	MITIGATING MEASURES
Physical Impacts	Nil	None	Nil	None	Nil	None
Biological Impacts	Nil	None	Increased risk to any Manatee that may frequent the site of propeller injury	Place & enforce signage on navigational regulations in vicinity of Bennett's Lagoon and the Corozal Bay, Provide education to development occupants in regard to manatee injury risk and conservation requirements Promote use of safety propellers on guest, staff and resident boats	Increased risk of public injury	Place signage to limit boat traffic speed Ensure staff are properly trained to operate boats Adhere to public licensing requirements in regard to operation of boats by staff, residents or guests
Water Impacts	Placement of marina and fuel facilities on Bennett's Lagoon , may lead to contamination of the Lagoon with petroleum effluents	Insure drainage of the 9500-acre site through the Bennett's Lagoon watershed for the purpose of facilitating flushing of petroleum residues in wet weather	Presence of petroleum point source on Bennett's Lagoon may lead to emigration of area marine life	Insure drainage of the 9500-acre site through the Bennett's Lagoon watershed for the purpose of facilitating flushing of petroleum residues in wet weather	Presence of petroleum point source on Bennett's Lagoon may lead to emigration of area marine life	Insure drainage of the 9500-acre site through the Bennett's Lagoon watershed for the purpose of facilitating flushing of petroleum residues in wet weather

[1]**Note:** Negative impacts shown in black type, yellow shading indicates unavoidable negative impacts, positive impacts shown in blue-green type.

MONITORING REQUIREMENTS

Monitoring requirements primarily concern the need to establish the degree, if any, of petroleum contamination occurring within the navigable canal system and/or Bennett's Lagoon on a quarterly basis; and for the development to support and/or participate in enforcement of Manatee conservation in the area by conducting weekly monitoring patrols to educate and enforce navigational regulations in the area, particularly as they relate to boat speed and Manatee injury. Manatee conservation education effectiveness should be assessed at least once yearly.

TEXT BOX 3:

SUMMARY OF KEY SEA-BASED TRANSPORTATION IMPACTS AND MITIGATION MEASURES

I. UNAVOIDABLE IMPACTS:

- None

II. AVOIDABLE IMPACTS:

- Increased risk of petroleum contamination in area waters and wildlife;
- Increased risk to manatees of propeller injury;
- Increased risk of public injury.

III. MITIGATION MEASURES:

- Maintenance of all petroleum products in two or more fuel bond(s) having 110% of the stored petroleum volume in order to eliminate spill risk;
- Train all fuel handlers in safe handling of flammable compounds;
- Offer preferential docking rates for operators of boats powered by low or zero polluting 4-cycle engines or wind;
- Place signage establishing designated navigational lanes, no wake zones, and reporting & procedural requirements in the event of injury to Manatee;
- Provide education to development occupants in regard to navigational regulations & Manatee injury risk, the importance of area habitats to Manatee, and the need for Manatee conservation;
- Ensure staff, guests and residents are properly trained to operate vehicles;
- Insure drainage of the 9500-acre site through the Bennett's Lagoon watershed for the purpose of facilitating flushing of Bennett's Lagoon of petroleum residues in dry weather; and
- Provide education to both wet and dry slip boat owners in regard to 4-cycle engine benefits.

IV. MONITORING REQUIREMENTS:

- Determine the level of petroleum contamination risk in the navigable canal system and Bennett's Lagoon on a quarterly basis;
- Support and/or participate in enforcement of Manatee conservation in the area by placement of a monitoring team to enforce navigational regulations in the area, particularly as they relate to boat speed and Manatee injury.
- Assess implementation of education and signage recommendations at least once annually.

4. MATERIAL RESOURCE USE

4.1 Provide information on the specific soil type and submit results of analysis carried out to determine soil permeability/profile in the proposed project area.

4.2 Provide the soil profile of at least three bores of a diagonal transect of the property.

4.3 Determine the type and volume of construction materials required for the entire development, including road construction, infrastructure needs, etc.

4.4 Evaluate options for meeting the requirements of the Geology and Petroleum Department with respect to mining/quarry licenses/permits including reviewing the sources, volume, extraction methods and transportation as well as identifying:

i. Direct and indirect biological impacts;
ii. Direct and indirect physical impacts (e.g. forest processes);
iii. Impact on water resources; and
iv. Specific mitigation measures.

4.5 Identify the preferred option for the extraction methods, source and transportation of materials, specifying the necessary mitigation measures, their residual impacts and significance.

MATERIAL VOLUME REQUIREMENTS AND SUPPLY OPTIONS

The present design plan of the proposed development calls for approximately 1.5 M M^3 of cut material and approximately 5.6 M M^3 of fill material to be relocated within the properties proposed for development (see **Table 27**). Approximately 325,000 M^3 of cut material will be excavated by dredge from a 6,500 x 50 x 1 meter patch of sea floor east of the BJE and used for beach revetment fill; and the remaining 1,188,361 M^3 of cut material will be excavated by hydraulic excavators for the creation of non-navigable canals, navigable canals and the marina basin. Surplus cut material (1.2 M M^3) along with fill materials excavated from existing on site quarries will be used for construction of carriageways (0.5 M M^3), and bringing amenity areas (1.3 MM^3) and residential lots (5.0 MM^3) to 1 meter elevation above sea level (see **Illustration 53**).

As with transportation options, the primary development option set for material supply to the proposed development consists of the proposed option described above, a downsized or otherwise modified version of the proposed option, or the non-development option. The key advantages of the proposed option is that it will serve to improve drainage of rainwater runoffs, increase coastal aquatic habitat, and provide a readily available reservoir of water for fire-fighting and manufacture of potable water, albeit at substantial cost to the proponent. The key advantages of downsizing the proposed option, principally through reduction of canal lengths, include lower development cost to the proponent, albeit with reduced amenity value and hence, a possible reduction in sales. The non-development option insures the landscape will not become degraded from abandonment should the development fail, albeit with the forfeiture of an attraction for European tourism that is presently being sought through facilities expansion of Belize's international airport; as well as the foreign exchange and economic growth that would otherwise result from successful implementation of the proposed development. Given these considerations, it seems reasonable to conclude that relocation of material requirements within the proposed development sites as dictated by the project master plan should be the preferred option for development.

TABLE 27

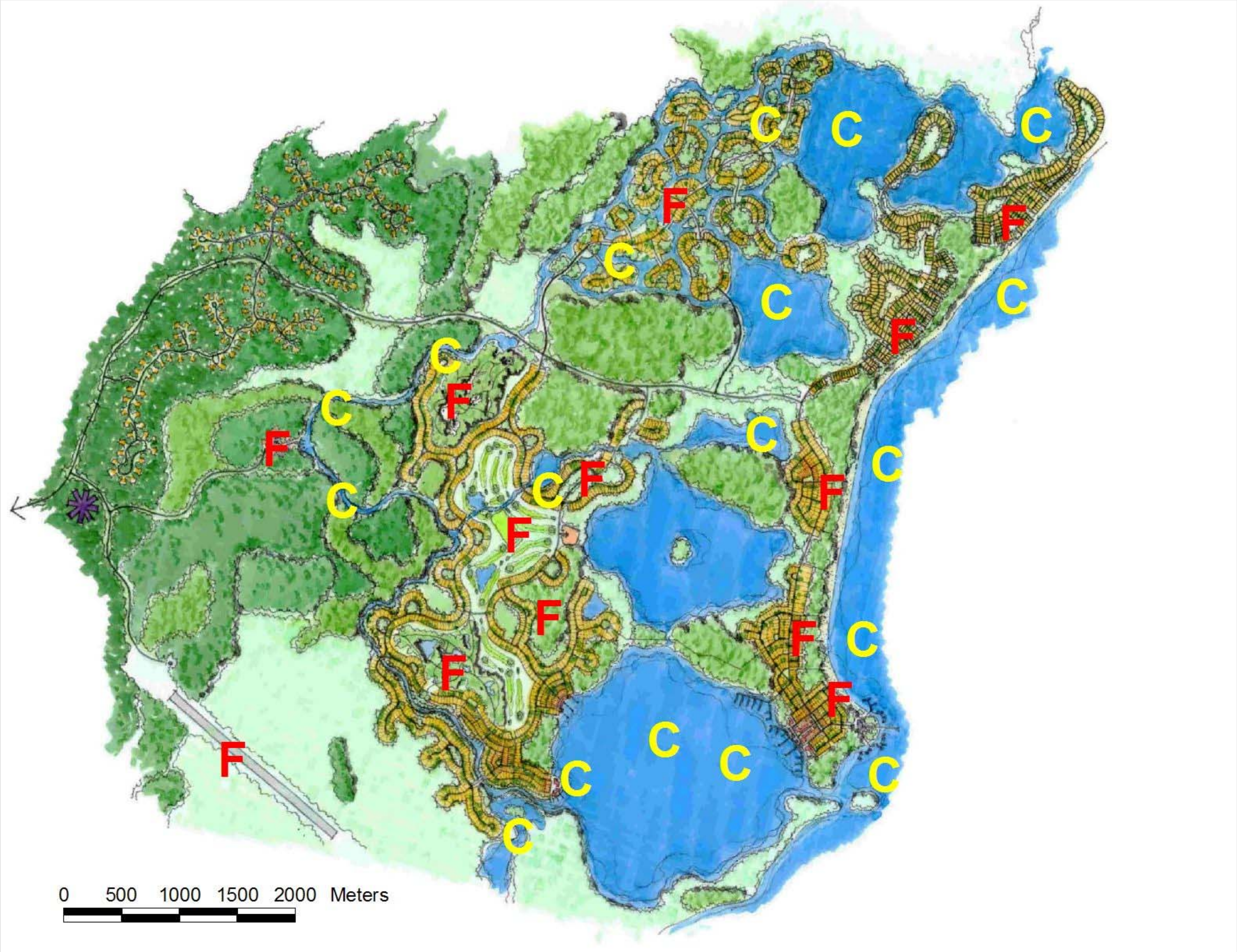
MATERIAL USAGE ESTIMATE FOR THE SECTION 1 DEVELOPMENT

(See text for discussion)

CUT & FILL VOLUMES	Area (Hectares)	Mean Cut or Fill (Meters)	Material Volume (M^3)
Cut Zones:			
Beach Revetment Zone	32.5	1.0	325,000
Navigable Canals	16.6	2.4	397,306
Non-Navigable Canals	32.8	1.8	589,655
Marina Basins	8.1	2.5	201,400
Subtotal, Cut Zones	**90.0**	**1.7**	**1,513,361**
Fill Zones:			
Beach Revetment Zone	32.5	1.0	325,000
Carriageway Alignments	43.8	1.0	438,000
Alleyway Alignments	2.0	1.0	20,000
Amenity Areas	133.4	1.0	1,334,000
Residential Lots	496.7	1.0	4,967,000
Subtotal, Fill Zones	**708.4**	**1.0**	**7,084,000**
NET MATERIALFILL REQUIREMENTS:	**618.4**	**1.0**	**5,570,639**

ILLUSTRATION 53:

CUT AND FILL ZONES WITHIN THE STAGE 1 DEVELOPMENT



EXTRACTION IMPACTS AND MITIGATION MEASURES

The impact potentials presented by the extraction of land-fill material from the marina basin are summarized in **Table 28** and **Text Box 4**.

Physical Impacts

Direct negative physical impacts from the material excavation activities proposed concern the alteration of sea floor and Bennett's Lagoon floor bathymetry, savanna topography, and alteration of the rainfall runoff characteristics of the coastal savanna habitat. These impacts are largely unavoidable and irreversible (at least in the short term), and can only be fully mitigated by non-development. Potential *indirect* negative physical impacts concern the release and entry of erosion products into Bennett's Lagoon and Bahia Chetumal during excavation activities, and canal wall slump during construction, which constitute largely avoidable and reversible impacts. Potential *residual* negative physical impacts are nil. Measures available for whole or partial mitigation of avoidable physical impacts include:

- Operational Measures that involve the deployment of silt screens capable of limiting sediment travel to the immediate vicinity of canal works, and/or the marina basin, to pre-existing levels of turbidity.
- Construction Measures that involve placement of retaining walls concurrently with canal and marina excavations in defense of both the pre-existing and final land and shoreline grades.

Biological Impacts

Direct negative biological impacts from the proposed material excavation activities include reduction of savanna groundcover and the sparse marine flora established offshore from the excavation and fill activities proposed. These impacts are unavoidable, and can only be fully mitigated (in the short term) by preventing the proposed development from taking place. Potential *indirect* and *residual* negative biological impacts from the proposed material excavation activities concern perturbation of the terrestrial landscape and marine habitat during construction and operating activities, and hence the displacement of intolerant terrestrial & marine wildlife presently extent in the area (e.g. migrant & specialist birds, Woodstork and Manatee), which can only be partially mitigated by:

- Construction Measures that require thorough re-landscaping of the project site with native vegetation and exclusion of fencing from use on the development site in order to promote re-colonization and interior movement of wildlife displaced during material movement activities; as well as deployment of silt screens capable of limiting sediment travel to the immediate vicinity of canal works, and/or the marina basin, to pre-existing levels of turbidity.

TABLE 28

MITIGATION MATRIX OF CUT AND FILL IMPACTS[1]

IMPACT CATEGORY	DIRECT IMPACTS	MITIGATING MEASURES	INDIRECT IMPACTS	MITIGATING MEASURES	RESIDUAL IMPACTS	MITIGATING MEASURES
Physical Impacts	Alteration of sea floor and Bennett's Lagoon floor bathymetry, savanna topography, and alteration of the rainfall runoff characteristics of the coastal savanna habitat	None, non-development	Release and entry of erosion products into Bennett's Lagoon and Bahia Chetumal during excavation activities Canal wall slump during excavation activities	Deploy silt screens capable of limiting sediment travel to the immediate vicinity of the marina basin or canal works Place retaining walls concurrently with canal and marina excavations in defense of both the pre-existing and final land and shoreline grades.	Nil	None
Biological Impacts	Reduction of savanna groundcover and the sparse marine flora established offshore	None, non-development	Perturbation of the terrestrial landscape and marine habitat during construction and operating activities, and hence the displacement of intolerant terrestrial & marine wildlife presently extent in the area (e.g. migrant & specialist birds, and Manatee)	Re-landscape the project site with native vegetation and exclude fencing from use on the development site in order to promote re-colonization and interior movement of wildlife displaced during material movement activities Deploy silt screens capable of limiting sediment travel to the immediate vicinity of canal works, and/or the marina basin	Permanent displacement of mobile terrestrial and marine invertebrate and vertebrate wildlife during material movement activities	Re-landscape the project site with native vegetation and prohibit the use of fencing in order to promote re-colonization and interior movement of wildlife displaced during material movement activities
Water Resource Impacts	Short-term elevation in water turbidity within Bennett's Lagoon and the near shore marine habitat from canal & marina construction and beach revetment activities	Use silt screens to prevent downstream silt and sediment travel during construction of the marina facility	Long term sedimentation of the canal system and marina basin from savanna runoffs	Employ silt screens on the downstream side of canal construction activities and surrounding marina excavation activities Postpone canal opening to the greater marine environment by leaving earthen plugs in place until canals have been constructed and adjacent lands stabilized	Long term sedimentation of the canal system and marina basin from savanna runoffs	Employ silt screens on the downstream side of canal construction activities and surrounding marina excavation activities Postpone canal opening to the greater marine environment by leaving earthen plugs in place until canals have been constructed and adjacent lands stabilized

[1]**Note:** Negative impacts shown in black type, yellow shading indicates unavoidable negative impacts, positive impacts shown in blue-green type.

Water Resource Impacts

Direct negative water resource impacts from material movement activities concern the potential for short-term elevation in water turbidity within Bennett's Lagoon and the near shore marine habitat from canal & marina construction and beach revetment activities, which is a largely avoidable construction impact. Potential *indirect* and *residual* water resource impacts from the development activities concern the long term sedimentation of the canal system and marina basin from savanna runoffs, which are avoidable and reversible impacts. Together, these potential impacts can be mitigated through:

- Construction Practices that employ silt screens on the downstream side of canal construction activities and surrounding marina excavation activities; and postponement of canal opening to the greater marine environment by leaving earthen plugs in place until the canals have been constructed and adjacent lands stabilized.

MONITORING REQUIREMENTS

Monitoring requirements in regard to material excavation operations concern the need to conduct monthly inspections of canal and marina embankments for slump and/or erosion, as well as monthly inspections of turbidity in Bennett's Lagoon during the construction phase of the development and the wet weather season to insure that area water quality does not fall below background levels.

TEXT BOX 4

SUMMARY OF KEY MATERIAL CUT AND FILL IMPACTS AND MITIGATION MEASURES

1. **UNAVOIDABLE IMPACTS:**
   - Alteration of sea floor and Bennett's Lagoon floor bathymetry, savanna topography, and alteration of the rainfall runoff characteristics of the coastal savanna habitat;
   - Reduction of savanna groundcover and the sparse marine flora established offshore.

2. **AVOIDABLE IMPACTS:**
   - Short-term elevation in water turbidity within Bennett's Lagoon and the near shore marine habitat from canal & marina construction and beach revetment activities;
   - Release and entry of erosion products into Bennett's Lagoon and Bahia Chetumal during excavation activities;
   - Canal wall slump during excavation activities;
   - Perturbation of the terrestrial landscape and marine habitat during construction and operating activities, and hence the displacement of intolerant terrestrial & marine wildlife presently extent in the area (e.g. migrant & specialist birds, and Manatee);
   - Permanent displacement of mobile terrestrial and marine invertebrate and vertebrate wildlife during material movement activities; and
   - Long term sedimentation of the canal system and marina basin from savanna runoffs

3. **MITIGATION MEASURES:**
   - Use silt screens to prevent downstream silt and sediment travel during construction of the marina facility;
   - Deploy silt screens capable of limiting sediment travel to the immediate vicinity of the marina basin or canal works;
   - Place retaining walls concurrently with canal and marina excavations in defense of both the pre-existing and final land and shoreline grades;
   - Re-landscape the project site with native vegetation and exclude fencing from use on the development site in order to promote re-colonization and interior movement of wildlife displaced during material movement activities;
   - Deploy silt screens capable of limiting sediment travel to the immediate vicinity of canal works, and/or the marina basin;
   - Re-landscape the project site with native vegetation and prohibit the use of fencing in order to promote re-colonization and interior movement of wildlife displaced during material movement activities;
   - Employ silt screens on the downstream side of canal construction activities and surrounding marina excavation activities; and
   - Postpone canal opening to the greater marine environment by leaving earthen plugs in place until canals have been constructed and adjacent lands stabilized

4. **MONITORING REQUIREMENTS:**
   - Conduct monthly inspections of canal and marina embankments for slump and/or erosion; and
   - Conduct monthly inspections of turbidity in Bennett's Lagoon during the construction phase of the development; and the wet weather season to insure that area water quality does not fall below background levels.

5. WATER RESOURCE USE

5.1 Establish a base line on the water resources of the project area. This base line should include water quality assessment of the ground water and surface waters of the project site and zone of influence. This data should be collected at appropriate intervals to establish any seasonal variation in the water quality between dry and rainy season. The base line should include, at a minimum, the following parameters

i. Temperature;
ii. Biological Oxygen Demand;
iii. Total Suspended Solids;
iv. Total Dissolved Solids;
v. Total Nitrate (as $N0^{3-}$ N);
vi. Salinity
vii. Dissolved oxygen (surface and below surface, am and pm);
viii. pH;
ix. Sulfates;
xi. Hardness;
xii. Total Phosphate;
xiii. Conductivity

5.2 Determine the projected water needs for the entire development; including drinking water (potable) supplies, supply to household appliances, irrigation of lawns, and other uses.

5.3 Assess all potential sources of water supply, quality and quantity, paying special attention to determining the sustainable yield it can provide.

5.4 Given the results from above, evaluate the alternative options for the provision of water supply for the entire development.

5.5 Evaluate the preferred option for water supply, based on environmental grounds. Where the recommended water supply source is ground water, a proper pump test of the aquifer must be completed. Specify any residual impacts of meeting water needs through this option, their significance, and any mitigation measures to be undertaken.

5.6 Provide an inventory of other users in the zone of influence with respect to the selected water supply source.

5.7 Identify and develop a water quality monitoring program able to detect any change in ground water or surface water quality, or the water quality of the proposed effluent receiving water body (if any) that could impact:

i. Public health
ii. Forest, wetland and adjacent aquatic habitats; and
iii. Endangered or threatened species in project area and zone of influence

FRESHWATER REQUIREMENTS AND SUPPLY OPTIONS

Freshwater Requirements

Bulk freshwater requirements for routine, day-to-day operations will be a function of human occupancy, pool water exchange rates, and irrigation needs for the golf course and other landscaped areas. Capacity occupation of the proposed development is estimated at 28,360 persons (see **Table 7**, **Page 33**), which at 54 gal/person-day, will require a maximum of 1,531,440 gallons, or <u>5,800 M^3 of potable water per day</u>. Bulk freshwater needs for the maintenance of 5 swimming pools planned for development, each having a volume & exchange rate of 2,500 M^3 & 25% per week (respectively), will require a total of 117,857 gallons, or <u>446 M^3 of water per day</u>.

Bulk freshwater needs for irrigation is estimated at 6,646,200 gallons, or 25,175 M^3 of water per day for 250 acres of golf course fairways and adjoining landscapes (assuming an irrigation rate of 2.5 cm/M^2/Day); and 3,987,720 gallons, or 15,105 M^3 of water per day for 250 acres of other amenity and lot irrigation needs (assuming an irrigation rate of 0.15 cm/M^2/Day). Consequently, the total bulk water need for the entire Section-1 development is on the order of 12.2 million gallons, or 46,526 cubic meters per day at capacity development, *before* discounting for supply by rainfall (see **Table 29**).

Net rainfall (after evaporation) is estimated to be capable of providing 1,382 M^3 of bulk freshwater per day (assuming an average net rainfall rate of 0.00956 M / M^2 per week as shown in **Table 30** x 1,012,195 M^2 of roof catchment as shown in **Table 7**, and divided by 7), or approximately 3 % of capacity potable water demand per week by the proposed development. Rainfall is further estimated to be capable of providing 2,751 M^3 of bulk freshwater per day (based on a rainfall rate of 0.00956 M / M^2 per week x 500 acres of irrigated landscape & pool surface x 4,028 M^2 per acre, and divided by 7), or approximately 8% of capacity bulk freshwater demand per day by the proposed development.

Hence, bulk freshwater supply requirements by the proposed development, after accounting for net rainfall, would be on the order of 39,393 M^3 per day for potable water. If grey water can be estimated at 85 % of total domestic effluent, then another 4,390 M^3 per day may be recoverable from grey water recycling, thereby reducing the balance of bulk freshwater demand to 34,463 M^3 per day for the entire development at capacity operation. This level of net water demand is less than 0.5 % of the water drawn by one 24-inch x 15,000-gpm shrimp farming pump operating for 8 hours a day.

Freshwater Supply Options

Freshwater supply options available to the proposed development include abstraction of ground water, rainfall catchment in cisterns, abstraction from non-navigable canals and/or Bahia Chetumal, and purchase from commercial distributors located in Orange Walk City. Supply from ground water is unlikely to be practical for the proposed development owing to the relatively low yield of area ground water resources, which are reputed to range from 0.04 – 40.0 M^3/minute at 10 – 50 M depth (see Buckalew *et al* 1998 & **Illustration 54**). Rain water catchment in cisterns coupled with abstraction from non-navigable canals and/or Bahia Chetumal are likely to be suitable sources of water supply owing to: (1) their volume capacity, low salinity content and hence, low brine yield, particularly from the western end of the non-navigable canal network where essentially salt-free freshwater seepage and runoffs are conveyed from higher elevations (see **Page 50**); and (2) the non-oceanic salinity of Bahia Chetumal (see **Page 64**), which might otherwise be readily combined with canal water resources for brine management.

Supply from commercial venders in Orange Walk City is unlikely to be a cost effective source of bulk water need owing principally to the distance and generally poor road conditions between the City and the BJE. Consequently, rainwater capture in cisterns coupled with abstraction from non-navigable canals and/or Bahia Chetumal and polishing of brackish water sources by reverse osmosis, is likely to be the most practical and hence, preferred option for freshwater water supply to the proposed development.

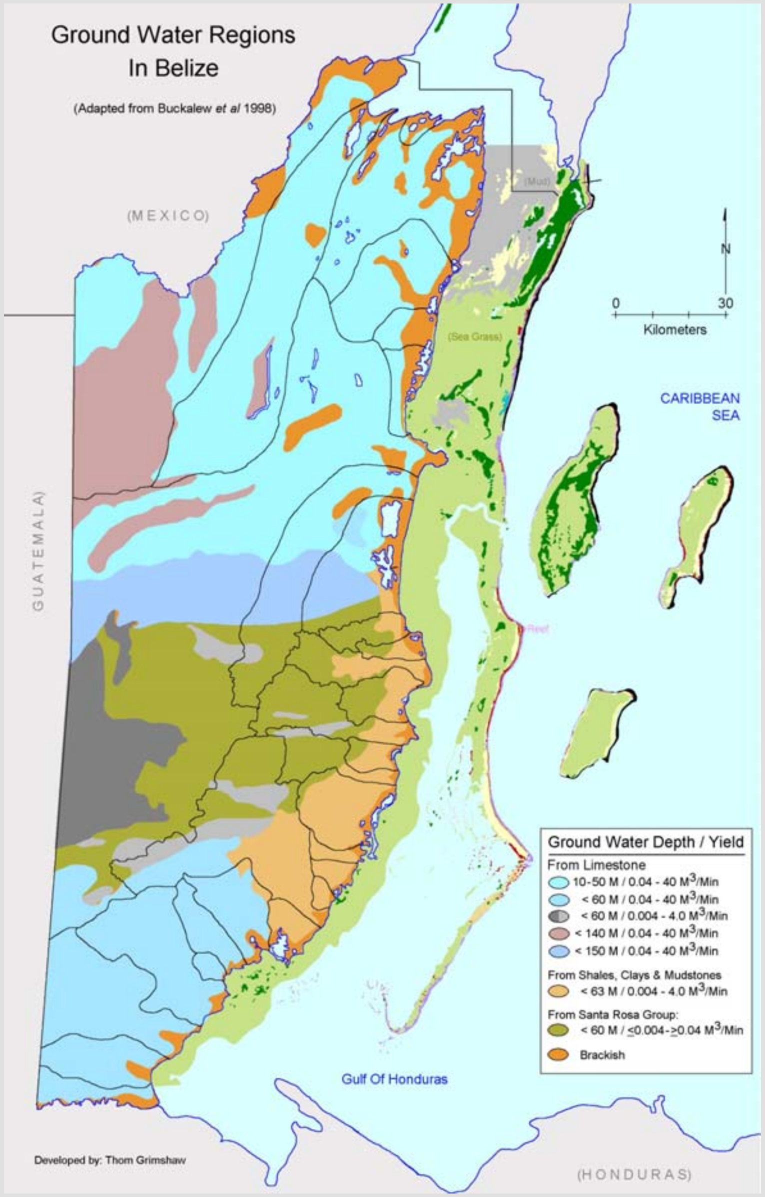
TABLE 29

FORECAST CAPACITY WATER USE FOR THE SECTION-1 DEVELOPMENT

HUMAN USE	Total Human Occupancy	Gal Water / Day	Gal Water / Minute	M^3 Water / Day	M^3 Water / Second
Phase I					
Homes On 1/5-Ac Lots	1,176	63,504	44	241	0.00278
Homes On 1/2-Ac Lots	1,374	74,196	52	281	0.00325
Employee Housing	400	21,600	15	82	0.00095
Phase II Components					
Town Houses	952	51,408	36	195	0.00225
Homes On 1/5-Ac Lots	1,760	95,040	66	360	0.00417
Homes On 1/2-Ac Lots	570	30,780	21	117	0.00135
Phase III Components					
Villas On 1-Ac Lots	664	35,856	25	136	0.00157
Villas On 2-Ac Lots	1,140	61,560	43	233	0.00270
Phase IV (A+B) Components					
Apartment/Condominiums	1,950	105,300	73	399	0.00462
Town Houses	1,080	58,320	41	221	0.00256
Homes On 1/5-Ac Lots	1,050	56,700	39	215	0.00249
Homes On 1/2-Ac Lots	200	10,800	8	41	0.00047
Hotel-Marina-Casino Complex	1,050	56,700	39	215	0.00249
Phase V Components					
Apartment/Condominiums	1,640	132,840	92	503	0.00582
Town Houses	2,460	132,840	92	503	0.00582
Homes On 1/5-Ac Lots	6,252	337,608	234	1,279	0.01480
Homes On 1/2-Ac Lots	1,568	84,672	59	321	0.00371
Hotel-Marina-Casino Complex	1,050	56,700	39	215	0.00249
Phase VI Components					
Town Houses	264	14,256	10	54	0.00063
Homes On 1/5-Ac Lots	732	39,528	27	150	0.00173
Homes On 1/2-Ac Lots	208	11,232	8	43	0.00049
Subtotal, Human Use	**28,360**	**1,531,440**	**1,064**	**5,801**	**0.06714**
IRRIGATION USE					
Swimming Pools (Each)	5	117,857	82	446	0.00517
Golf Course Irrigation (Ac)	250	6,646,200	4,615	25,175	0.29138
Landscaping Irrigation (Ac)	750	3,987,720	2,769	15,105	0.17486
Subtotal, Irrigation Use	**---**	**10,661,777**	**7,466**	**40,726**	**0.47141**
TOTAL FRESHWATER USE		**12,193,217**	**8,530**	**46,527**	**0.53855**

ILLUSTRATION 54:

WATER RESOURCE AVAILABLITY MAPS FOR BELIZE



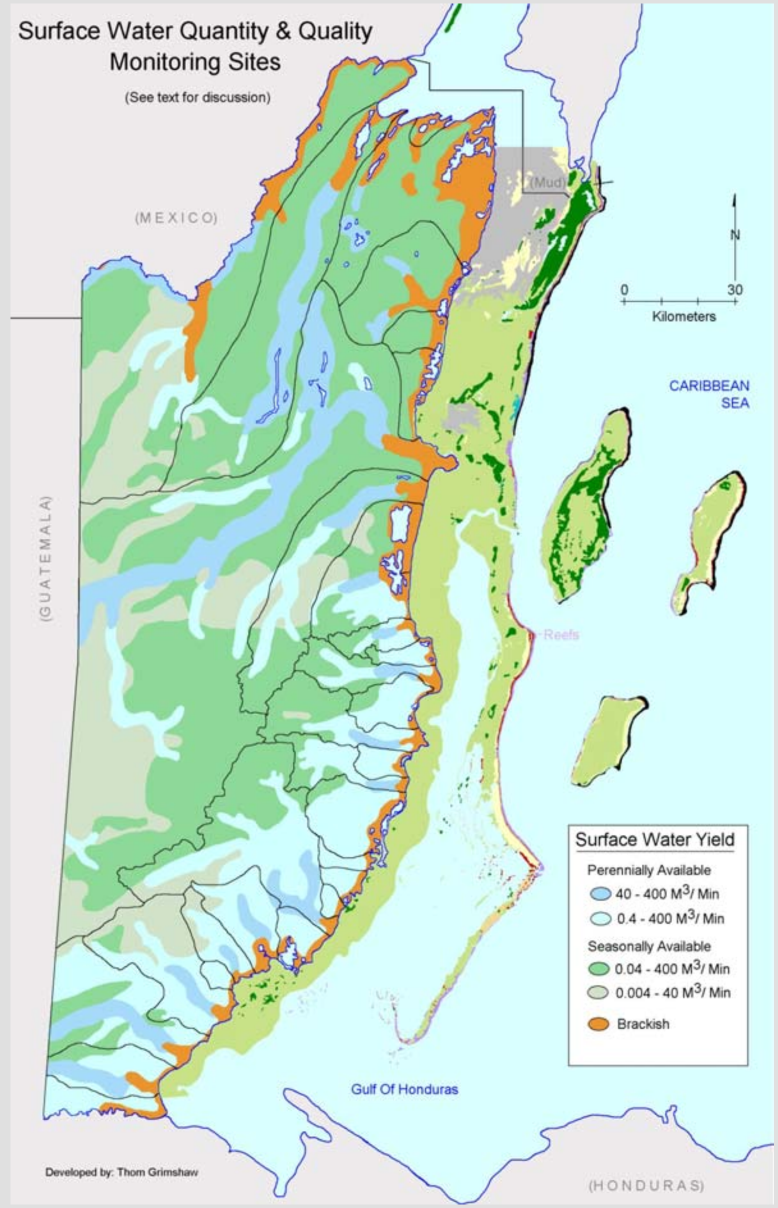


TABLE 30

EVAPORATION, RAINFALL AND NET WATER BALANCE FOR THE PROPOSED DEVELOPMENT SITE

(see text for discussion)

Month	**Rainfall**[1] (mm/mo)	**Evaporation**[2] (mm/mo)	**Net Water Balance** (mm/mo)	**Net Water Balance** (cm/wk)
January	116	76	40	0.9
February	68	86	(18)	(0.5)
March	36	105	(69)	(1.6)
April	41	133	(92)	(2.1)
May	175	144	31	0.7
June	282	167	115	2.7
July	263	171	92	2.1
August	199	167	32	0.7
September	319	153	166	3.9
October	223	122	101	2.3
November	150	96	54	1.3
December	120	70	50	1.1
Totals	**1,992**	**1,490**	**502**	**1.0**

[1]Reported by King et al 1992 for Freshwater Creek Region Of Belize.

[2]Reported by King et al 1992 for Corozal Region Of Belize.

FRESHWATER ABSTRACTION IMPACTS AND MITIGATION MEASURES

Extraction and delivery of potable water from the non-navigable canal network and/or Bahia Chetumal will require the establishment of one or more pump stations capable of delivering a total (untreated) water volume of $\leq$ 12,000 gallons per minute (see **Table 29**); (2) a treatment facility for water purification to adequate specification for human consumption; and (3) some 44 kilometers of 18 - 24 inch pipe works with lift stations as necessary along the supply route indicated in **Illustration 55**. Potential impacts of the preferred freshwater abstraction option are summarized in **Table 31** and **Text Box 5**.

Physical Impacts

Direct negative physical impact risks from freshwater abstraction and brine discharge are nil, provided potable & bulk water distribution lines are placed beneath constructed surfaces such as landfills and/or carriageway alignments. *Indirect and Residual* negative physical impacts from freshwater abstraction and the various forms of effluent discharge anticipated are nil.

Biological Impacts

Direct negative biological impacts from freshwater abstraction from the non-navigable canal system or Bahia Chetumal concern the potential for aquatic wildlife entrainment at the pump station's water intake point, which is an avoidable impact. Potential *Indirect* and *Residual* biological impacts from freshwater delivery to the project site includes the likely change in vegetation cover and wildlife occupancy in irrigated areas and along the non-navigable canal system, the vegetation component of which is a positive impact, and the wildlife occupancy component of which may be undesirable if net biodiversity decreases within the BJE, both of which are avoidable impacts. Measures available for mitigating these avoidable negative biological impacts include:

- Construction & Operating Measures that provide for water to be extracted from within a screened intake pipe to reduce the potential for aquatic wildlife entrainment at the water pump intake site.

Water Resource Impacts

Direct negative water resource impacts from landscaping runoffs, pool water & brine discharge, and septic leach fields percolation may increase toxic chemical and nutrient concentrations in the lower reaches of the non-navigable canal system and Bennett's Lagoon, thereby significantly diminishing water quality in these surface waters. Potential *Indirect* and *Residual* negative water resource impacts include the potential for rendering the marine environment unsuitable for use by coastal wildlife, particularly birds and Manatee. Measures available for mitigating these avoidable negative water resource impacts include:

- Design and Construction Measures that incorporate the use of mixing and stop gates to manage flow through the non-navigable canal system and provide opportunity for photo-oxidation of toxic chemicals, dilution of salinity concentrations, and reduction of storm induced colloid or phytoplankton turbidity prior to release into Bennett's Lagoon; while ensuring, through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms.

ILLUSTRATION 55:

WATER SUPPLY ROUTES WITHIN THE PROPOSED DEVELOPMENT

TABLE 31

MITIGATION MATRIX OF WATER RESOURCE USAGE IMPACTS[1]

IMPACT CATEGORY	DIRECT IMPACTS	MITIGATING MEASURES	INDIRECT IMPACTS	MITIGATING MEASURES	RESIDUAL IMPACTS	MITIGATING MEASURES
Physical Impacts	Nil, provided potable & bulk water distribution lines are placed beneath constructed surfaces such as landfills and/or carriageway alignments	None	Nil	None	Nil	None
Biological Impacts	Aquatic wildlife may become entrained at water intake point	Provide for water to be extracted from within a screened intake pipe to reduce the potential for aquatic wildlife entrainment at the water pump intake site	Change in botanical wildlife biodiversity along the non-navigable canal system	None Positive Impact	Change in animal wildlife biodiversity along the non-navigable canal system	None Positive Impact if wildlife biodiversity increases
Water Impacts	Landscaping runoffs, pool water & brine discharge, and septic leach-fields percolation may increase toxic chemical and nutrient concentrations in the lower reaches of the non-navigable canal system and Bennett's Lagoon, thereby significantly diminishing water quality in these surface waters	Use the non-navigable canal system as photo-oxidation and settlement ponds for any nutrient, landscaping residue and pool chemical runoffs Ensure through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms	Contaminants may render the marine environment unsuitable for use by coastal wildlife, particularly birds and Manatee	Use mixing and stop gates to manage flow through the non-navigable canal system and provide opportunity for photo-oxidation of toxic chemicals, dilution of salinity concentrations, and reduction of storm induced colloid or phytoplankton turbidity prior to release into Bennett's Lagoon; while ensuring, through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms.	Contaminants may render the marine environment unsuitable for use by coastal wildlife, particularly birds and Manatee	Use mixing and stop gates to manage flow through the non-navigable canal system and provide opportunity for photo-oxidation of toxic chemicals, dilution of salinity concentrations, and reduction of storm induced colloid or phytoplankton turbidity prior to release into Bennett's Lagoon; while ensuring, through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms.

[1]**Note:** Negative Impacts shown in black type, yellow shading indicates unavoidable impacts, positive impacts shown in blue-green type.

MONITORING REQUIREMENTS

Monitoring requirements primarily concern the need for monthly checks of water quality in all water features for total nitrogen, pesticide, chlorine and Coloform and Vibrio bacteria levels.

TEXT BOX 5

SUMMARY OF KEY FRESHWATER SUPPLY IMPACTS AND MITIGATION MEASURES

1. UNAVOIDABLE IMPACTS:

- None.

2. AVOIDABLE / POSITIVE IMPACTS:

- Aquatic wildlife may become entrained at water intake point;
- Change in botanical wildlife biodiversity along the non-navigable canal system;
- Change in animal wildlife biodiversity along the non-navigable canal system;
- Landscaping runoffs, pool water & brine discharge, and septic leach-fields percolation may increase toxic chemical and nutrient concentrations in the lower reaches of the non-navigable canal system and Bennett's Lagoon, thereby significantly diminishing water quality in these surface waters; and
- Contaminants may render the marine environment unsuitable for use by coastal wildlife, particularly birds and Manatee.

3. MITIGATION MEASURES:

- Provide for water to be extracted from within a screened intake pipe to reduce the potential for aquatic wildlife entrainment at the water pump intake site;
- None. Positive Impact if wildlife biodiversity increases;
- Use the non-navigable canal system as photo-oxidation and settlement ponds for any nutrient, landscaping residue and pool chemical runoffs;
- Ensure through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms; and
- Use mixing and stop gates to manage flow through the non-navigable canal system and provide opportunity for photo-oxidation of toxic chemicals, dilution of salinity concentrations, and reduction of storm induced colloid or phytoplankton turbidity prior to release into Bennett's Lagoon; while ensuring, through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms.

4. MONITORING REQUIREMENTS:

- Conduct monthly assessments in all water features for total nitrogen, pesticide, chlorine and Coloform and Vibrio bacteria levels.

6. LIQUID WASTE PRODUCTION AND MANAGEMENT

6.1 Determine the nature and volumes of liquid waste, including sewage and grey water, to be generated by the entire project.

6.2 Evaluate a minimum of three alternative options for the collection, treatment, recycling (if appropriate), and disposal of these liquid wastes. Be sure to identify any chemicals planned for use in the treatment or management of these wastes.

6.3 Identify the preferred option/s for liquid waste management, based on environmental grounds, including necessary infrastructure and land requirements. Specify any residual impacts of liquid waste management, their significance, and any mitigation measures to be undertaken.

EFFLUENT CLASSIFICATION AND VOLUME ESTIMATE

All of the effluent from the proposed development to be treated in remediation plants will be sewage from human occupancy, with the remaining portion coming from swimming pool & R/O effluent, which will be treated by photo-oxidation & mixing in non-navigable canals. Based on freshwater throughputs shown in **Table 29**, and allowances for batchplant capacity throughput shown in **Table 32**, the sewage effluent volume to be produced by the proposed development would be $\leq$ 5,500 M^3/Day on completion of the Section-1 development.

TREATMENT OPTIONS AND SITE REMEDIATION CAPACITY

Treatment Options and Design Plan:

The Belize Department of the Environment has recommended that all coastal developments use batch plant technology for multiple dwelling projects. The development options available will therefore concern the type and configuration of batchplant technology to be employed by the proponent. These options will be likely to affect one of two approaches to treatment, the first of which employs a large-scale plant that is economical and efficient to operate at capacity development, and the second of which employs a distributed batchplant system, which improves treatment effectiveness by mirroring the developments actual rate of build out.

The former approach is more economical to operate because all of the components are common to a single location, albeit with the trade off of concentrating effluent in a way that plant failure might compromise the entire developments capacity for treatment. The latter approach on the other hand is more costly to build and operate than the former system, but this cost is incurred in smaller amounts over time, rather than as a single, up-front cost. A distributed system may well serve to reduce infrastructure costs for irrigation since the point sources of effluent will be in closer proximity to their application point. Moreover, the distributed system provides the surety that if one component in the network fails for any reason, it will not disrupt the operation of the remaining treatment capacity.

TABLE 32

DISTRIBUTED BATCHPLANT TREATMENT SYSTEM PLAN FOR THE RESIDENTIAL TOURISM DEVELOPMENT

Development Component	No Of Structures	Occupancy Per Structure	Batch Plant Model	No Batch Plants	Capacity Flow Rate (M3/Day)	Capacity BOD (Kg/Day)	Capacity NH4N (Kg/Day)
Phase I							
Homes On 1/5-Ac Lots	294	4	BA	294	353	118	16
Homes On 1/2-Ac Lots	229	6	BA	229	275	92	12
Employee Housing	4	100	BJ	4	80	27	4
Phase II Components							0
Town Houses	238	4	BA	238	286	95	13
Homes On 1/5-Ac Lots	440	4	BA	440	528	176	23
Homes On 1/2-Ac Lots	95	6	BA	95	114	38	5
Phase III Components							0
Villas On 1-Ac Lots	83	8	BB	83	199	66	9
Villas On 2-Ac Lots	114	10	BB	114	274	91	12
Phase IV (A+B) Components							0
Apartment/Condominiums	65	20	BL	4	120	40	5
Town Houses	270	4	BA	270	324	108	14
Homes On 1/5-Ac Lots	175	6	BA	175	210	70	9
Homes On 1/2-Ac Lots	25	8	BB	25	60	20	3
Hotel-Marina-Casino Complex	3	350	BL	4	120	40	5
Phase V Components							0
Apartment/Condominiums	82	20	BL	6	180	60	8
Town Houses	615	4	BA	615	738	246	33
Homes On 1/5-Ac Lots	1,042	6	BA	1,042	1,250	417	56
Homes On 1/2-Ac Lots	196	8	BB	196	470	157	21
Hotel-Marina-Casino Complex	3	350	BL	4	120	40	5
Phase VI Components							0
Town Houses	66	4	BA	66	79	26	4
Homes On 1/5-Ac Lots	122	6	BA	122	146	49	7
Homes On 1/2-Ac Lots	26	8	BB	26	62	21	
Total	**4,187**	**---**		**4,052**	**5,989**	**1,996**	**263**

Various combinations of the two strategies are also feasible for implementation by the proponent, such that 2 - 5 intermediate sized plant-stations might be preferred for use over a distributed system of plants, base on each structural unit and occupancy as it becomes completed. In either case, the treatment load is equivalent at capacity development, which has been estimated here in the format of distributed batchplant stations as shown in **Table 32** & **Illustration 56** for the purpose of estimating effluent volumes, BOD and NH_4 loads that will be likely to be produced by each phase of the Section-1 development. Although either approach to treatment is suitable for the proposed development, the later or distributed approach reduces failure risk and therefore might best reflect the preferred option for development.

DOMESTIC EFFLUENT IMPACTS and MITIGATION MEASURES

The potential impacts associated with the preferred option are outlined in **Table 33** and **Text Box 6**.

Physical Impacts

Direct negative physical impacts from placement of a distributed effluent treatment system for irrigation use by the proposed development are nominally limited to that amount of land cover removal required for plant placement, which is an unavoidable impact. Potential *indirect* negative physical impacts concern gradual reduction of percolation capacity and/or alteration of water distribution characteristics as may result from subsoil loading with particulate organic matter during landscape irrigation applications. Potential *residual* negative physical impacts concern subsoil erosion from leakages and/or ground settlement after construction. Measures available for mitigation of these potential impacts include:

- Construction Measures that entail construction of pipe works and irrigation fields to specifications, and ensuring that leaching rates at all irrigation endpoints are less than background percolation capacity.

Biological Impacts

Direct negative biological impacts from sewage effluent discharge concern excessive irrigation leach-field damage from root growth and subsequent reduction in effectiveness. Potential *indirect* & *residual* negative biological impacts concern increased risk to aquatic wildlife in the non-navigable canals & Bennett's Lagoon from toxification by sewage leachate from pipe cracks or damaged irrigation leachfields. These negative biological impacts may be partially or wholly mitigated by:

- Construction, Monitoring & Maintenance Measures that entail use of shallow root system species such as grasses and/or perennial flowers as groundcover for irrigation leachfields; regular inspection and thinning of excessive vegetation growth over irrigation leachfields, regular repairs to and liming of leach fields in support of bacterial denitrification processes; and adherence to manufacturer's specifications for tank sludge removal rates, which can be as frequent as every 4-6 months for large scale systems supporting heavy loading rates.

ILLUSTRATION 56:

DISTRIBUTED BATCHPLANT STATION LAYOUT FOR THE PROPOSED DEVELOPMENT

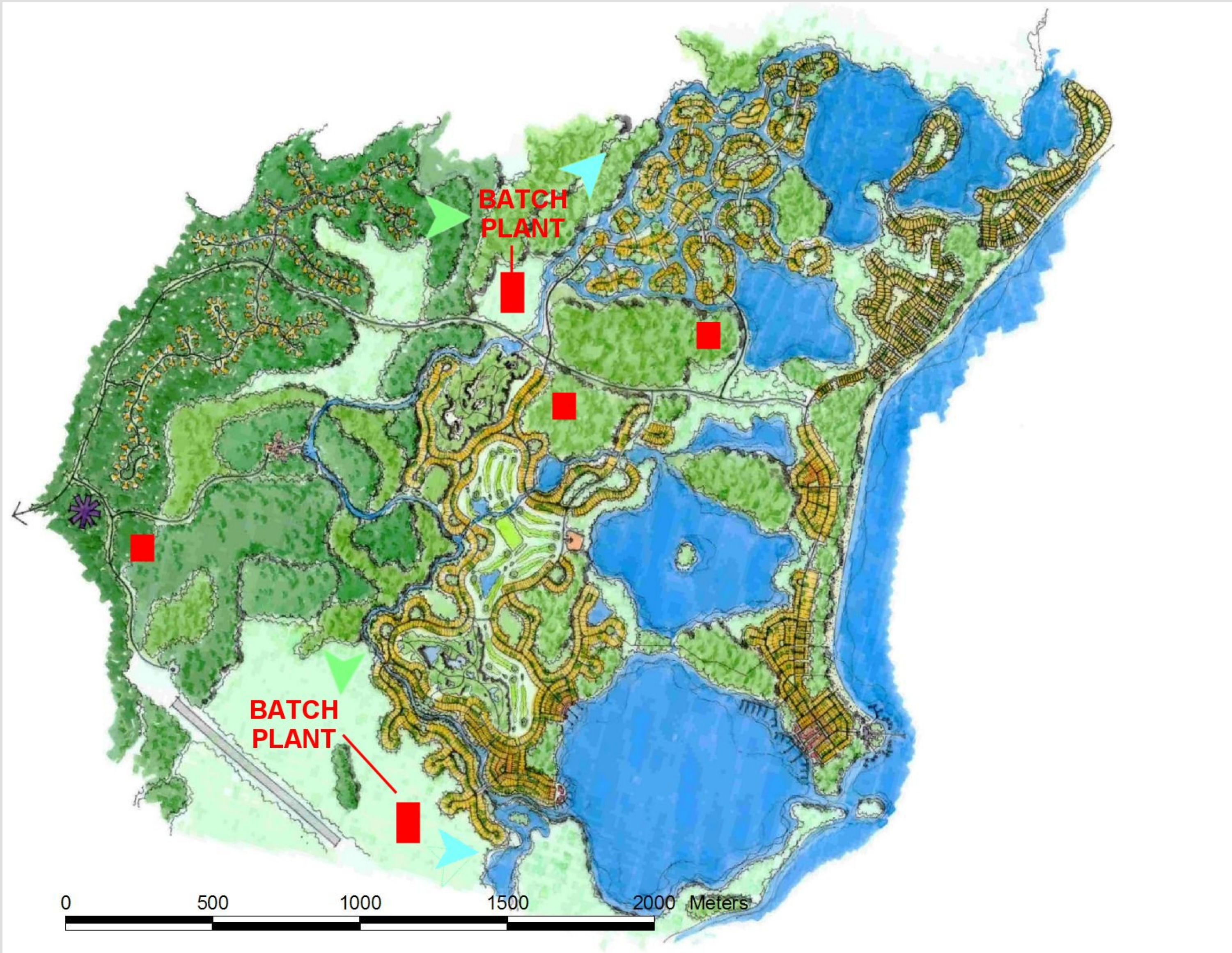


TABLE 33

MITIGATION MATRIX OF LIQUID WASTE TREATMENT IMPACTS[1]

IMPACT CATEGORY	DIRECT IMPACTS	MITIGATING MEASURES	INDIRECT IMPACTS	MITIGATING MEASURES	RESIDUAL IMPACTS	MITIGATING MEASURES
Physical Impacts	Nominal reduction in land cover associated with plant placement	None Non-Development	Reduces soil percolation capacity and/or water distribution characteristics through loading with particulate organic matter	Construction of septic tank and drain field according to specifications, insuring that leaching rate does not exceed background percolation rate	Alters direction of subsoil water transport & may potentially promote subsoil erosion	Construction of septic tank and drain field according to specifications, insuring that leaching rate does not exceed background percolation rate
Biological Impacts	Sewage loading promotes excessive vegetation growth, and subsequent blocking of irrigation leach field effectiveness	Use shallow root system vegetation such as grasses and/or annual flowers to cover irrigation leachfields Regularly inspect, repair and thin excessive vegetation growth over irrigation leachfields	Increased risk to wildlife within the non-navigable canals and Bennett's Lagoon of nutrient toxification	Regularly lime leach field in support of bacterial denitrification processes Adhere to manufacturer's specifications for tank sludge removal rates, which can be as frequent as every 4-6 months for large scale systems supporting heavy loading rates	Increased risk to wildlife within the non-navigable canals and Bennett's Lagoon of nutrient toxification	Regularly lime leach field in support of bacterial denitrification processes Adhere to manufacturer's specifications for tank sludge removal rates, which can be as frequent as every 4-6 months for large scale systems supporting heavy loading rates
Water Resource Impacts	Creates risk of contamination of ground water, water features, the non-navigable canals and Bennett's Lagoon with nutrients and human pathogens	Ensure leaching rate does not exceed background percolation capacity. Limit placement of leach field(s) to ≥ 100 meters distance, to reduce potential for effluent pooling Monitor water quality in the interior waterway and nearshore waters to ensure bacteria and nutrient levels do not exceed background levels	Increased risk of low-level eutrophication of the non-navigable canals and Bennett's Lagoon	Ensure leaching rate does not exceed background percolation capacity. Limit placement of leach field(s) to ≥ 100 meters distance, to reduce potential for effluent pooling Monitor water quality in the interior waterway and nearshore waters to ensure bacteria and nutrient levels do not exceed background levels	Increased risk of low-level eutrophication of the non-navigable canals and Bennett's Lagoon	Ensure leaching rate does not exceed background percolation capacity. Limit placement of leach field(s) to ≥ 100 meters distance, to reduce potential for effluent pooling Monitor water quality in the interior waterway and nearshore waters to ensure bacteria and nutrient levels do not exceed background levels

[1]**Note:** Negative Impacts shown in black type, yellow shading indicates unavoidable impacts, positive impacts shown in blue-green type.

Water Resource Impacts

<u>Direct</u> negative water resource impacts from sewage effluent discharge concerns risk of contamination of groundwater, the non-navigable canals and Bennett's Lagoon with nutrients and/or human pathogens. Potential *<u>indirect</u>* and *<u>residual</u>* negative water resource impacts include the potential for low level eutrophication of the proposed developments non-navigable canals and Bennett's Lagoon. These negative water resource impacts may be partially or wholly mitigated by:

- <u>Construction Measures</u> that ensure leaching rate does not exceed background percolation capacity; placement of leach field(s) at $\geq$ 100 meters distance, to reduce potential for effluent pooling; and
- <u>Monitoring Measures</u> that ensure the interior waterway and nearshore waters are regularly monitored for Coloform bacteria, Vibrio bacteria and nitrogen levels in defense of background levels in the waters surrounding non-navigable canals and Bennett's Lagoon and as a check to ensure proper septic tank and leach field function.

MONITORING REQUIREMENTS

Monitoring measures should include quarterly inspection of land adjacent to irrigation leach fields for excessive vegetation growth, pruning of vegetation and liming of leach fields in support of bacterial denitrification processes. Area water quality should be monitored on a quarterly basis for Coloform and Vibrio bacteria population levels and nitrogen levels in defense of background levels in the proposed development’s non-navigable canals and Bennett's Lagoon and as a check to ensure proper septic tank and leach field function.

TEXT BOX 6

SUMMARY OF KEY LIQUID WASTE DISCHARGE IMPACTS AND MITIGATION MEASURES

1. UNAVOIDABLE IMPACTS:

- None.

2. AVOIDABLE IMPACTS:

- Promotion of excessive vegetation growth in vicinity of irrigation leach fields;
- Increased risk of ground water, non-navigable canal and Bennett's Lagoon contamination with nutrients and human pathogens;
- Altered soil percolation capacity and direction from loading with particulate organic matter;
- Increased toxicity risk to local wildlife; and
- Increased risk of low level eutrophication in the non-navigable canals and Bennett's Lagoon.

3. MITIGATION MEASURES:

- Construct septic tank and drain field according to specifications, insuring that leaching rate does not exceed background percolation rate;
- Prune vegetation over leach fields to prevent disruption of effectiveness, and regularly lime septic tanks and leach fields in support of bacterial denitrification processes;
- Place leachfield(s) at ≥ 100 meters distance; and
- Adhere to manufacturer's specifications for tank sludge removal.

4. MONITORING REQUIREMENTS:

- Quarterly inspection of irrigation leachfield and adjacent land for excessive vegetation growth, prune and/or repair leach field accordingly;
- Quarterly evaluation of near shore Coloform and Vibrio bacteria populations and nitrogen levels.

7. SOLID WASTE MANAGEMENT

7.1 Determine the projected types and volumes of solid waste to be produced by the entire development. This should examine (at least) oil, tires, plastics, metals, protrucible wastes, batteries/hazardous materials and construction waste. It will also need to include solid waste from boats and other transportation vehicles. If composting of organic waste is to be conducted, provide specifications on the location of the site and procedures to be followed for the composting.

7.2 Evaluate at least two alternative options for the collection, treatment and disposal of these wastes.

7.3 Select the preferred option/s for disposal of these materials. Again, this should be based on environmental grounds, and should specify any residual impacts, their significance and the mitigation measures, which are to be undertaken.

COMPOSITION, VOLUME and TREATMENT OPTIONS FOR SOLID WASTE GENERATION

Estimates of solid waste production by the proposed development on completion of the second and final phase of development are shown in **Table 34**. The estimates shown are based on USEPA reported categorical distribution by municipal solid waste (MSW) category, and an average production rate of 2.05 Kg/Person-Day. As such, the annual solid waste production estimate, at capacity occupation of the proposed development site, is on the order of 20.1 million Kg per Year.

Treatment options for management of solid waste produced by the proposed development are essentially limited to onsite treatment of some or all the solid waste produced; or offsite treatment and storage of some or all solid waste at the National Solid Waste Storage Facility designated for the Orange Walk region of Belize. Owing to the volume of waste anticipated to be produced at capacity occupation of the Section-1 development, as well as the sites some 27 mile distant location from Orange Walk Town, source separation for material recycling might serve to reduce and/or offset a significant portion of transportation costs to the NSW storage facility. The key components of waste that may be best suited to separation for recycling include paper, plastic, glass and metal waste, the paper fraction of which can be incinerated in smokeless incinerators to reduce solid waste volume by 15% (*provided* safety measures are observed to prevent runway fires in the savanna & broadleaf forest habitats), and the remaining inert fractions of which could be buried on site to reduce solid waste transport requirements by another 21%, for a total of 36%. Onsite composting might further reduce transport requirements by an additional 47%, for a total of 83%. Soil characteristics of the BJE (see **Page 50**) are likely to be suitable for the onsite burial of septic tank sludge, brining the total reduction to 93%, but not petroleum and other forms of toxic waste (see **Page 47**).

Hence, source separation and incineration of paper waste, separation of plastic, glass, and metal wastes for recycling, and onsite composting of organic waste will be likely to offer the greatest overall reduction in municipal solid waste transportation and storage costs to the proposed development, and therefore should be elected as the preferred treatment plan for solid waste.

TABLE 34

MUNICIPAL SOLID WASTE PRODUCTION ESTIMATES FOR THE SECTION 1 DEVELOPMENT

(See text for discussion)

Solid Waste Constituent	Percent by Weight[1]	Material Mass[2] (Mt/Yr)	Material Density (Mt/M^3)	Production Volume (M^3/Yr)	Percent By Volume
Paper	37%	7,444,564	0.208	1,548,469	15%
Plastic	7%	1,408,431	0.416	585,907	6%
Glass	8%	1,609,635	0.832	1,339,217	13%
Metal	7%	1,408,431	0.149	209,856	2%
Organics					
Food Waste	27%	5,432,519	0.899	4,883,835	47%
Septic Sludge	6%	1,207,227	0.899	1,085,297	10%
Mixed	5%	1,006,022	0.350	352,108	3%
Motor Oil	1%	201,204	0.840	169,012	2%
Rubber Tires	1%	201,204	0.036	7,243	0%
Batteries	1%	201,204	0.963	193,760	2%
TOTALS	**100%**	**20,120,443**	**0.516**	**10,374,704**	**100%**

[1]Original values calculated from USEPA recommendations and corrected to incorporate values for sludge content. [2]Based on maximum human occupancy as shown in **Table 7** (26,890 persons) and a mean MSW production rate of 2.05 kg waste generation per person-day.

SOLID WASTE TREATMENT IMPACTS and MITIGATION

The potential negative impacts associated with the preferred option are itemized in **Table 35** and **Text Box 7**.

Physical Impacts

Direct negative physical impacts from onsite composting and other forms of solid waste reduction are limited to the land cover removal requirement, which is an unavoidable impact. *Indirect* and *Residual* negative physical impacts from source separation, recycling of plastic, glass and metal waste, onsite reduction of paper in smokeless incinerators, and transportation of remaining wastes are nil.

Biological Impacts

Direct, *Indirect* and *Residual* negative physical impacts from source separation, recycling of plastic, glass and metal waste, onsite reduction of paper in smokeless incinerators, composting of organic wastes, and transportation of remaining wastes, other than the previously referenced land cover removal requirements, are limited to the potential for personal injury to incinerator operators, which is an avoidable impact that can be mitigated by:

- Management Measures that insure proper training of incineration operators.

Water Impacts

Direct, *Indirect* and *Residual* negative water resource impacts from source separation, recycling of plastic, glass and metal waste, onsite reduction of paper in smokeless incinerators, composting of organic wastes, and transportation of remaining wastes are nil.

MONITORING REQUIREMENTS

Monitoring requirements consist of the need for the annual inspection of incinerators and staff operation to insure safe operating conditions are procedures are in place.

TABLE 35

MITIGATION MATRIX OF SOLID WASTE TREATMENT IMPACTS[1]

IMPACT CATEGORY	DIRECT IMPACTS	MITIGATING MEASURES	INDIRECT IMPACTS	MITIGATING MEASURES	RESIDUAL IMPACTS	MITIGATING MEASURES
Physical Impacts	Nominal land cover removal required for conduct of waste management practices	None, Non-development	None	Nil	None	Nil
Biological Impacts	Public safety risk from onsite operation of smokeless incinerators	Ensure incinerators are operated to specifications and that operators are property trained in their operation	Public safety risk from onsite operation of smokeless incinerators	Ensure incinerators are operated to specifications and that operators are property trained in their operation	Public safety risk from onsite operation of smokeless incinerators	Ensure incinerators are operated to specifications and that operators are property trained in their operation
Water Impacts	None	Nil	None	Nil	None	Nil

[1]**Note:** Negative Impacts shown in black type, yellow shading indicates unavoidable impacts, positive impacts shown in blue-green type.

TEXT BOX 7

SUMMARY OF KEY SOLID WASTE TREATMENT IMPACTS AND MITIGATION MEASURES

1. **UNAVOIDABLE IMPACTS**
   - Land cover removal for conduct of waste management.
2. **AVOIDABLE IMPACTS:**
   - Public safety risk from incineration of paper waste.
3. **MITIGATION MEASURES:**
   - Ensure incineration facilities are operated to specification, and staff responsible for incineration activities have proper training.
4. **MONITORING MEASURES:**
   - Annual inspection of incinerators and staff operation.

8. ENERGY USE

8.1 Determine the projected energy requirement for the entire development.

8.2 Evaluate a minimum of three alternative options for meeting these needs, using fossil fuel, solar, wind resources (and others if appropriate). For each of these options, it will be necessary to investigate:

i. fuel storage (where relevant);

ii. transportation (where relevant);

iii. health and safety;

iv. pollution sources, volumes, and types;

v. significance of any pollution that may result from energy generation; and

vi. mitigation measures

It will be necessary to divide examination of energy provision into construction, operation, and maintenance phases.

8.3 Select the preferred option for energy generation. Again, this should be based on environmental grounds, and should specify the residual impacts of generation of the preferred option, their significance and the mitigation measures, which will be undertaken.

ENERGY REQUIREMENTS AND SUPPLY OPTIONS

The total instantaneous energy requirement for the entire development is estimated to be on the order of 60 megawatts at capacity development, with approximately 54.4 megawatts allocated to room electrification & air conditioning, and the balance for refrigeration and outdoor lighting, with distribution along carriageway alignments (see **Table 36**). The 1/5th acre residential components represent the single greatest energy demand component at approximately 21.3 megawatts, or more than 1/3rd (36%) of the energy requirement for the entire development; followed by 13.8 mW (23%) for half acre lots, 8.3 mW (14%) for town homes; 3.5 mW (6%) each for apartments & 2-Ac Villas; 1.9 & 1.5 mW (3%) each for 1-Ac Villas and the Hotel/Casino Complex (respectively); 0.5 mW (1%) for employee housing; and the remaining energy use (9%) being allocated to refrigeration and outdoor lighting.

Options for energy supply to the proposed development include purchase from the public utility, Belize Electricity Limited (BEL) via either the New or Old Northern Highways (see **Illustration 57**), and/or petroleum/wood scrap-based self generation. Owing to the scale of the project being proposed, petroleum/wood scrap-based self generation, while likely to produce substantially cheaper electricity than purchase from BEL at present industrial rates, will require greater capital and management investments which the proponent is not prepared to commit to at start-up. The developer is likely, however, to elect to use BEL as a primary source of energy, perhaps with co-generation from petrochemical or wood scrap engaged at a later date to reduce overall rates. Consequently, BEL as the primary source of electrical energy has been elected as the preferred option for development in order to simplify project management.

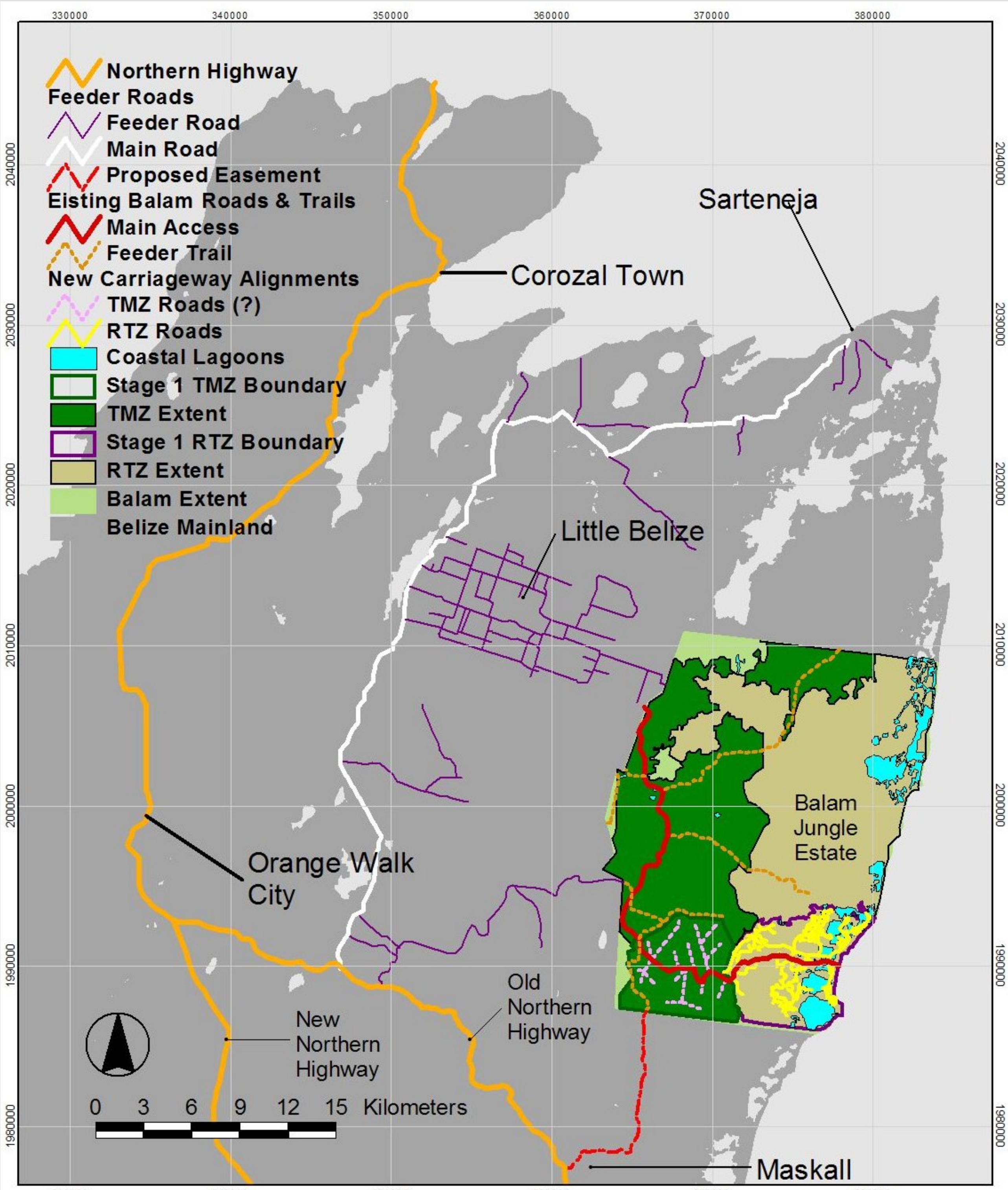
TABLE 36

POWER CONSUMPTION BUDGET FOR THE SECTION 1 DEVELOPMENT

Development Component	Total SF Roof Space	Watts Per SF	Total kW	Typical Power Factor	Total kVA	Total A/C Tons	Total A/C kW	Total A/C kVA
Phase I Components								
Homes On 1/5-Ac Lots	705,600	4	2,822,400	80%	3,528,000	1,411	1,693	2,117
Homes On 1/2-Ac Lots	824,400	4	3,297,600	80%	4,122,000	1,649	1,979	2,473
Employee Housing	100,000	4	400,000	80%	500,000	200	240	300
Phase II Components								
Town Houses	333,200	4	1,332,800	80%	1,666,000	666	800	1,000
Homes On 1/5-Ac Lots	1,056,000	4	4,224,000	80%	5,280,000	2,112	2,534	3,168
Homes On 1/2-Ac Lots	342,000	4	1,368,000	80%	1,710,000	684	821	1,026
Phase III Components								
Villas On 1-Ac Lots	381,800	4	1,527,200	80%	1,909,000	764	916	1,145
Villas On 2-Ac Lots	706,800	4	2,827,200	80%	3,534,000	1,414	1,696	2,120
Phase IV-A+B Components								
Apartment/Condominiums	312,000	4	1,248,000	80%	1,560,000	624	749	936
Town Houses	378,000	4	1,512,000	80%	1,890,000	756	907	1,134
Homes On 1/5-Ac Lots	420,000	4	1,680,000	80%	2,100,000	840	1,008	1,260
Homes On 1/2-Ac Lots	90,000	4	360,000	80%	450,000	180	216	270
Hotel-Marina-Casino Complex	150,000	4	600,000	80%	750,000	300	360	450
Phase V Components								
Apartment/Condominiums	393,600	4	1,574,400	80%	1,968,000	787	945	1,181
Town Houses	861,000	4	3,444,000	80%	4,305,000	1,722	2,066	2,583
Homes On 1/5-Ac Lots	2,500,800	4	10,003,200	80%	12,504,000	5,002	6,002	7,502
Homes On 1/2-Ac Lots	705,600	4	2,822,400	80%	3,528,000	1,411	1,693	2,117
Hotel-Marina-Casino Complex	150,000	4	600,000	80%	750,000	300	360	450
Phase VI Components								
Town Houses	92,400	4	369,600	80%	462,000	185	222	277
Homes On 1/5-Ac Lots	292,800	4	1,171,200	80%	1,464,000	586	703	878
Homes On 1/2-Ac Lots	93,600	4	374,400	80%	468,000	187	225	281
TOTAL ENERGY DEMAND	**10,889,600**	4	**43,558,400**	80%	**54,448,000**	**21,779**	**26,135**	**32,669**

ILLUSTRATION 57:

ENERGY DISTRIBUTION GRID FOR THE PROPOSED DEVELOPMENT



ENERGY USE IMPACTS AND MITIGATION

The range of potential impacts and available mitigation measures for public utility and petro-chemical / wood scrap co-generation of energy supply are itemized in **Table 37** and **Text Box 8**.

Fuel Impacts

Direct, *indirect* and *residual* negative fuel impacts from public energy use are nil. *Direct* negative fuel impacts from petroleum-based energy generation concern increased road use for fuel supply, which is an unavoidable impact that can only be mitigated by non-development. *Direct* negative fuel impacts from wood scrap-based energy generation concern the release of exhaust smoke during incineration and refueling, as well as fire risk during stockpiling of raw material for incineration, which are avoidable impacts.

Potential *indirect* and *residual* fuel impacts from public energy use are nil. Potential *indirect* negative petroleum-based fuel impacts concern spill risk, particularly in the canal system or adjoining coastal lagoons, and potential *residual* negative fuel impacts concern improper reporting of incidental or accidental spills, which may cause environmental damage without mitigating measures being imposed. Potential *indirect* negative wood scrap-based fuel impacts concern the impact of accidental fire starts on area timber stands and wildlife, but potential *residual* negative wood scrap-based fuel impacts are nil owing to the end-product (ash) being inert. Measures available for mitigation of these potential impacts include:

- Design and Construction Measures that entail the construction of fuel bonds and maintenance of all fuel containers and generating equipment within these structures.
- Operating Measures that entail training of staff in safe fuel handling and fire management procedures, and regular inspections of all fuel usage sites and handling practices.

Health & Safety Impacts

Direct negative health and safety impacts from public energy use concern increased risk of electrocution where poor electrical engineering standards are employed or from storm damage to utility lines, which are avoidable and reversible impacts. Potential *indirect* and *residual* negative health and safety impacts from public energy use are nil.

Direct negative health and safety impacts from petroleum or wood scrap-based energy generation concern increased risk of chemical contamination, explosion, smoke inhalation, and/or fire. Potential *indirect* negative health and safety impacts from petroleum or wood scrap-based energy generation concern increased risk of personal injury aggravation due to the proposed development's remote location; and potential *residual* negative health and safety impacts from petroleum or wood scrap-based energy generation concern the effect of long-term exposure to petrochemicals, noise or smoke associated with generating facilities. These impacts may be partially or wholly mitigated by:

TABLE 37

MITIGATION MATRIX OF ENERGY SUPPLY/USAGE IMPACTS[1]

IMPACT CATEGORY	DIRECT IMPACTS	MITIGATING MEASURES	INDIRECT IMPACTS	MITIGATING MEASURES	RESIDUAL IMPACTS	MITIGATING MEASURES
Fuel Impacts	Increased road use for transportation of fuel to the project / power generating site, Release of exhaust smoke during incineration and refueling of wood scrap, as well as fire risk during stockpiling of raw material for incineration,	None. Non-Development Train staff in safe fuel handling and fire management procedures, and regularly inspect all fuel usage sites and handling practices.	Creation of spill risk, particularly in the newly constructed canal system or coastal lagoons. Accidental fire starts pose direct threats to area timber stands and wildlife	Maintain all fuel containers and generating equipment in fuel bonds. Train staff in safe fuel handling procedures, and fire management along with regular monitoring of fuel storage and generating sites for spills,	Improper reporting of incidental or accidental spills may cause environmental damage before mitigating measures can be imposed	Regularly monitor fuel storage and generating sites for spills
Health and Safety Impacts	Increased risk of electrocution where poor electrical engineering standards are employed or from storm damage to utility lines, Increased risk of chemical contamination, explosion, smoke inhalation and or fire.	Ensure accredited electrical engineers during the design and construction phase of the development Use public utility endorsed protocols for handling storm damaged power lines. Maintain fuel storage facilities at safe distance from generating equipment and provide warnings about inflammable device use near fuel storage areas	Remote location of development site may aggravate personal injury status	Have at lest two full-time staff receive emergency medical training at Belize City BERT Center	Long-term exposure to petrochemical, noise or smoke from generating facilities may cause hearing loss or lung damage to staff	Provide staff with proper clothing, gloves, noise protection, smoke protection an fire fighting equipment Insure staff have been trained in appropriate safety protocols for handling and maintenance of fuel storage facilities and fires.
Pollution Impacts	Production of noise or smoke pollution and up to 2.0×10^{11} BTUs of thermal waste per year	Place generating equipment in specially designed noise-retarding or smoke arresting shelters; and discharge exhaust waste into baffled exhaust pipes buried underground	Long-term exposure to petrochemicals noise and/or smoke from generating facilities may cause hearing loss or lung damage to staff	Provide staff with proper clothing, gloves, noise and/or smoke pollution protection equipment	Long-term exposure to petrochemicals noise and/or smoke from generating facilities may cause hearing loss or lung damage to staff	Provide staff with proper clothing, gloves, noise and/or smoke pollution protection equipment

[1]**Note:** Negative Impacts shown in black type, yellow shading indicates unavoidable impacts, positive impacts shown in blue-green type.

- Operating and Training Measures that entail use of accredited electrical engineers during the design, construction and operating phases of the development, and the use of public utility endorsed protocols for handling storm damaged power lines; and

- Operating and Training Measures that entail development of a safety protocol for all fuel handlers, maintaining fuel storage facilities at safe distances from generating equipment, providing warnings against use of inflammable devises near fuel storage areas, having at least two full-time staff receive emergency medical training at the Belize City BERT Center, and providing staff with proper clothing, gloves and noise pollution protection equipment, and/or fire fighting equipment, to reduce potential for health effects.

Pollution Impacts

Direct, *indirect* and *residual* negative pollution impacts from public energy use are nil. *Direct* negative pollution impacts from energy supply and use concerns the proposed development's production of noise pollution and thermal waste up to 2.0×10^{11} BTUs per day at capacity development (based on capacity demand of 60 mW, and a conversion rate of 138,707 BTUs or 41 kW hrs/gal Diesel). Heat production is largely unavoidable, and can only be mitigated by non-development. Potential *indirect* & *residual* negative energy supply and use impacts concerns noise-induced hearing loss in staff, petroleum contamination of groundwater or adjacent canal & marine waters, and/or smoke-based air pollution. These impacts may be partially or wholly mitigated by:

- Design and Construction Measures that entail placement of generating equipment in specially designed noise-retarding or smoke-arresting shelters, and the discharge of exhaust waste into baffled exhaust pipes buried underground; and

- Operating and Monitoring Measures that entail provision of staff with proper safety clothing and noise pollution protection equipment; and the implementation of regular wildlife monitoring protocol to determine the presence/absence of noise or smoke-related impacts.

MONITORING REQUIREMENTS

Monitoring requirements for public energy use should include at monthly inspections of power lines and primary electrical connection points for damage from storms and/or tree falls. Monitoring requirements for petroleum or wood scrap-based self-generation should include regular (weekly) signed inspections of all fuel storage and power generating equipment for repair and/or maintenance requirements before and during operation.

TEXT BOX 8

SUMMARY OF KEY ENERGY SUPPLY/USE IMPACTS AND MITIGATION MEASURES

1. UNAVOIDABLE IMPACTS:

- Increased highway and feeder road use; and
- Production of 2.0 x 10^{11} BTUs thermal waste per day at capacity development.

2. AVOIDABLE IMPACTS:

- Increased risk of electrocution from improper construction or maintenance;
- Increased risk of chemical contamination, explosion, smoke inhalation and or fire;
- Spill and/or accidental fire risk;
- Increased risk of serious personal injury due to the proposed development's remote location;
- Improper reporting of incidental or accidental spills may cause environmental damage before mitigating measures can be imposed; and
- Short-term effects of exposure to petrochemicals, noise and/or smoke from generating facilities on staff health and hearing loss.

3. MITIGATION MEASURES:

- Train staff in safe fuel handling and fire management procedures, and regularly inspect all fuel usage sites and handling practices;
- Ensure accredited electrical engineers during the design and construction phase of the development;
- Develop safety protocol for training fuel handlers, maintain fuel storage facilities at safe distances from generating equipment;
- Use public utility endorsed protocols for handling storm damaged power lines;
- Maintain fuel storage facilities at safe distance from generating equipment and provide warnings about inflammable device use near fuel storage areas;
- Have at least two full time staff receive emergency medical training at the Belize City BERT Center;
- Provide staff with proper clothing, gloves and noise pollution protection equipment to reduce potential adverse health effects;
- Place generating equipment in specially designed noise or smoke-retarding shelters, and the discharge of exhaust waste into baffled exhaust pipes buried underground; and
- Provide staff with proper safety clothing and noise pollution protection equipment.

4. MONITORING RECOMMENDATIONS:

- Monthly inspections of power lines and primary electrical connection points for damage from storms and/or tree falls; and
- Weekly signed inspections of all fuel storage and power generating equipment for repair and/or maintenance requirements before and during operation.

9. WILDLIFE

9.1 Identify any species present at the site of conservation significance and specify measures for their protection. Also, identify which resident predator species are of significance to the proposed development, and the mechanisms anticipated for use in their control.

9.2 Describe any direct, indirect, and/or residual impacts on flora and fauna likely to result from the project's development, and any mitigating measures proposed, with particular reference to predator species and species of conservation significance present.

9.3 Design a wildlife-monitoring program capable of detecting any changes in species abundance, vigor and habitat use due to development of the proposed project. Highlight where appropriate measures that can be taken to enhance the habitat value of the project area.

SITE HABITATS AND WILDLIFE SPECIES

Twelve habitats fall within the potential impact envelope of the proposed development. These include: (1-2) *Tropical Evergreen Seasonal Broadleaf Lowland Forest Over Calcareous Soils: NE (northeast & high/low) Variants*; (3) *Tropical Semi-Deciduous Broadleaf Lowland Forests*; (4) *Broadleaved Lowland Shrubland: Leguminous Variant;* (5) *Tropical Lowland Tall Herbaceous Swamp*; (6) *Permanently Waterlogged Freshwater Mangrove Scrub;* (7) *Basin Mangrove Forests;* (8) *Mixed Mangrove Scrub;* (9) *Dwarf Mangrove Scrub;* (10) *Marine Salt Marsh With Many Succulent Plants;* (11) *Tropical Littoral Forest And Beach Communities;* (12) *Coastal Fringe Rhizophora Mangle –Dominated Forests.*

More than 600 resident and transient species of plants and mobile wildlife from marine and terrestrial habitats have been identified as being associated with the proposed development site (see **Table 38** and **Pages 66** - **99**). These include some 23 species of plants, 20 species of anurans; 69 species of reptiles, 260 species of birds, and 23 species of mammals (all of terrestrial origin); and 7 species of plants, 5 species of fish, and at least 2 species of mammals (all of marine origin). Endangered species that were specifically noted to occur included the Jaguar (*Panthera onca*); Baird's Tapir (*Tapirus bairdii*); Great Curassow (*Crax rubra*), Black Catbird (*Melanoptila glabrirostris*), and American Crocodile (*Crocodylus acutus*).

WILDLIFE IMPACTS AND MITIGATION

The range of potential wildlife impacts and available mitigation measures are itemized in **Table 39** and **Text Box 9**.

Marine & Aquatic Habitat Impacts

Direct marine & aquatic habitat impacts from implementation of the proposed development concern lagoon bank modification and extirpation of *Riverine Mangrove Forest* habitat where the marinas are to be established in Bennett's Lagoon, and disturbance/removal of marine sediments for creation of the marina basin, which are unavoidable impacts that can only be fully mitigated by non-development.

TABLE 38

SUMMARY WILDLIFE PROFILE FOR THE ENTIRE DEVELOPMENT

HABITAT CATEGORY	OBSERVED OR PROBABLE SPECIES COUNT
Aquatic Habitats	
Flora	< 10
Invertebrates	> 5
Vertebrates	> 5
Terrestrial Habitats	
Flora	> 258
Invertebrates	> 50
Vertebrates	> 300
Totals	**> 628**

TABLE 39

MITIGATION MATRIX OF WILDLIFE IMPACTS[1]

IMPACT CATEGORY	DIRECT IMPACTS	MITIGATING MEASURES	INDIRECT IMPACTS	MITIGATING MEASURES	RESIDUAL IMPACTS	MITIGATING MEASURES
Aquatic & Marine Habitats	Bank modification and extirpation of *Riverine Mangrove Forest* habitat where the marina is to be established in Bennett's Lagoon Disturbance / removal of marine sediments for creation of the marina basin	None, Non-Development Limit sediment travel to immediate excavation area with silt screens	Increased risk of sediment or turbidity-based degradation of the canal system and coastal lagoon water quality conditions necessary for existing marine life, during beach revetment activities, or construction of the inland canals and marinas Petroleum-based contamination of the canal system and coastal lagoons from spill accidents and gas-diesel-kerosene-powered boating activities Chemical or pesticide-induced impacts on marina and aquatic flora & fauna from utilization of the canal & lagoon system for drainage of the golf course and other amenities	Leave plugs in the canal system until any construction borne turbidity either settles or can be gradually diluted to pre-existing conditions; and use of silt screens during any dredging activities associated with beach revetment or marina construction Use bonds for storage of all petroleum-based products, along with construction and closure of canal gates in the event of a spill accident to afford time for clean up procedures to be undertaken Offer of preferential docking / storage rates for boat operators using 4-cycle engines or non-petroleum based power schemes Require the use of <u>*pest-specific*</u> compounds (i.e. pesticides which are non-toxic to untargeted species of wildlife) that also contain binders to reduce or eliminate their potential wind or water-borne migration from the application site. The latter characteristic also being complimented by (1) design of the golf course and other effluent-bearing amenities (e.g. swimming pools) to drain into designated holding ponds for photo-oxidation of any effluent-born chemicals or pesticides prior to discharge into the canal or coastal lagoon systems, and (2) pesticide application in dry, low wind conditions suited to binder adhesion.	Increased risk of sediment or turbidity-based degradation of the canal system and coastal lagoon water quality conditions necessary for existing marine life, during beach revetment activities, or construction of the inland canals and marinas petroleum-based contamination of the canal system and coastal lagoons from spill accidents and gas-diesel-kerosene-powered boating activities Chemical or pesticide-induced impacts on marina and aquatic flora & fauna from utilization of the canal & lagoon system for drainage of the golf course and other amenities	Leave plugs in the canal system until any construction borne turbidity either settles or can be gradually diluted to pre-existing conditions; and use of silt screens during any dredging activities associated with beach revetment or marina construction Use bonds for storage of all petroleum-based products, along with construction and closure of canal gates in the event of a spill accident to afford time for clean up procedures to be undertaken Offer of preferential docking / storage rates for boat operators using 4-cycle engines or non-petroleum based power schemes Require the use of <u>*pest-specific*</u> compounds (i.e. pesticides which are non-toxic to untargeted species of wildlife) that also contain binders to reduce or eliminate their potential wind or water-borne migration from the application site. The latter characteristic also being complimented by (1) design of the golf course and other effluent-bearing amenities (e.g. swimming pools) to drain into designated holding ponds for photo-oxidation of any effluent-born chemicals or pesticides prior to discharge into the canal or coastal lagoon systems, and (2) pesticide application in dry, low wind conditions suited to binder adhesion.

[1]**Note:** Negative Impacts shown in black type, yellow shading indicates unavoidable impacts, positive impacts shown in blue-green type.

Continued…

TABLE 39

MITIGATION MATRIX OF WILDLIFE IMPACTS[1]

(Continued)

IMPACT CATEGORY	DIRECT IMPACTS	MITIGATING MEASURES	INDIRECT IMPACTS	MITIGATING MEASURES	RESIDUAL IMPACTS	MITIGATING MEASURES
Terrestrial Habitats	Increased fractionation of the Xaibe Landsystem Broadleaf Forest ecosystems through creation of logging conveyances, and reduction of savanna habitat vegetation cover from landfill, canal excavation, and road & building construction activities	None, Non-Development	Increased risk for accidental fires to become ignited within the residential tourism development from novice human occupation of the area, followed by subsequent fire-burn to the remaining savanna habitat and Xaibe Landsystem Broadleaf Forest ecosystems Emigration of resident, but uncommon specialist species of wildlife (e.g. littoral birds) that are depend on the absence of human interventions in the area, followed by their replacement with more common generalist species, and hence, an overall reduction in area biodiversity	Economize in the construct of any new inter-forest conveyances by insuring that such conveyances will offer multiple, rather than solitary, stem yields Examine the feasibility of forest product eco-certification registration and/or carbon sequestration credits to improve economic yield per stem, and hence, reduce new conveyance demands; Replant exposed soils with native vegetation; along with creation and designation of buffer zones, particularly for fire management, along existing tracts of Glady and Littoral / Beach Forest.	Increased risk for accidental fires to become ignited within the residential tourism development from novice human occupation of the area, followed by subsequent fire-burn to the remaining savanna habitat and Xaibe Landsystem Broadleaf Forest ecosystems Emigration of resident, but uncommon specialist species of wildlife (e.g. littoral birds) that are depend on the absence of human interventions in the area, followed by their replacement with more common generalist species, and hence, an overall reduction in area biodiversity	Economize in the construct of any new inter-forest conveyances by insuring that such conveyances will offer multiple, rather than solitary, stem yields Examine the feasibility of forest product eco-certification registration and/or carbon sequestration credits to improve economic yield per stem, and hence, reduce new conveyance demands; Replant exposed soils with native vegetation; along with creation and designation of buffer zones, particularly for fire management, along existing tracts of Glady and Littoral / Beach Forest.

[1]**Note:** Negative Impacts shown in black type, yellow shading indicates unavoidable impacts, positive impacts shown in blue-green type.

Continued…

TABLE 39

MITIGATION MATRIX OF WILDLIFE IMPACTS[1]

(Continued)

IMPACT CATEGORY	DIRECT IMPACTS	MITIGATING MEASURES	INDIRECT IMPACTS	MITIGATING MEASURES	RESIDUAL IMPACTS	MITIGATING MEASURES
Species-Specific	Increased potential abandonment of the area by the Great Curassow, and other resident endangered species such as the black catbird, in response to the construction activity and human occupation being proposed; increased risk of rookery abandonment by resident wood storks and wading bird species as a result of excess tourism-based disturbance Increased risk of boating-based noise disorientation and mortality risk to Manatee from reciprocating engine operation and prop-injuries, all of which represent avoidable impacts.	Immediate re-landscaping of barren and/or filled areas with landscaping strategies that include adequate mixtures of native plant species having diverse food value, density & height arranged in contiguous corridors that extend between the broadleaf forest, savanna and littoral/beach habitats, in order to afford specialist species safe avenues of movement between key habitats along corridors with improved food value and hence, carrying capacity	Increased potential for predator/prey equilibrium (e.g. the jaguar-peccary-agouti food chain) to become disturbed by newly engineered access constraints and/or long term human occupation of the area Increased potential for biodiversity reduction over time from highly diverse specialist species abandonment of the area in favor of less diverse generalist species	Concerted adherence to visitation management regulations which are designed to insure all visitation is supervised by trained tour guides, that visitation frequency is not excessive, and that visitation is neither disruptive or intrusive on rookery activities Provide for *enforcement* of Manatee conservation guidelines (see **Addenda 5**) in the vicinity of the proposed development, particularly as they pertain to the imposition of: (1) demarcation of no wake zones with signage along approved navigation routes leading to the entrance to Bennett's Lagoon, marina docking facilities, and access to navigable canals that are marked with lighted navigational buoys as shown in **Illustration 52**; (2) public education, particularly for all development residents and staff concerning Manatee tourism guidelines; and (3) a mechanism for enforcement and penalty collection, in the event a Manatee is killed as a direct violation of the navigational and/or tourism guidelines for Manatee conservation.	Increased potential for predator/prey equilibrium (e.g. the jaguar-peccary-agouti food chain) to become disturbed by newly engineered access constraints and/or long term human occupation of the area Increased potential for biodiversity reduction over time from highly diverse specialist species abandonment of the area in favor of less diverse generalist species	Concerted adherence to visitation management regulations which are designed to insure all visitation is supervised by trained tour guides, that visitation frequency is not excessive, and that visitation is neither disruptive or intrusive on rookery activities Provide for *enforcement* of Manatee conservation guidelines (see **Addenda 5**) in the vicinity of the proposed development, particularly as they pertain to the imposition of: (1) demarcation of no wake zones with signage along approved navigation routes leading to the entrance to Bennett's Lagoon, marina docking facilities, and access to navigable canals that are marked with lighted navigational buoys as shown in **Illustration 52**; (2) public education, particularly for all development residents and staff concerning Manatee tourism guidelines; and (3) a mechanism for enforcement and penalty collection, in the event a Manatee is killed as a direct violation of the navigational and/or tourism guidelines for Manatee conservation.

[1]**Note:** Negative Impacts shown in black type, yellow shading indicates unavoidable impacts, positive impacts shown in blue-green type.

…End

Potential *indirect* and *residual* marine & aquatic habitat impacts from the proposed development include: (1) increased risk of sediment or turbidity-based degradation of the canal system and coastal lagoon water quality conditions necessary for existing marine life, during beach revetment activities, or construction of the inland canals and marinas; (2) petroleum-based contamination of the canal system and coastal lagoons from spill accidents and gas/diesel/kerosene-powered boating activities; and (3) chemical or pesticide-induced impacts on marina and aquatic flora & fauna from utilization of the canal & lagoon system for drainage of the golf course and other amenities.

- Construction Measures that provide for the leaving of plugs in the canal system until any construction borne turbidity either settles or can be gradually diluted to pre-existing conditions; and use of silt screens during any dredging activities associated with beach revetment or marina construction;

- Operating Measures that provide for the use of bonds for storage of all petroleum-based products; construction and closure of canal gates in the event of a spill accident to afford time for clean up procedures to be undertaken;

- Operating Measures that provide for the offer of preferential docking / storage rates for boat operators using 4-cycle engines or non-petroleum based power schemes;

- Operating & Maintenance Procedures that require the use of *pest-specific* compounds (i.e. pesticides which are non-toxic to untargeted species of wildlife) that also contain binders to reduce or eliminate their potential wind or water-borne migration from the application site. The latter characteristic also being complimented by (1) design of the golf course and other effluent-bearing amenities (e.g. swimming pools) to drain into designated holding ponds for photo-oxidation of any effluent-born chemicals or pesticides prior to discharge into the canal or coastal lagoon systems, and (2) pesticide application in dry, low wind conditions suited to binder adhesion.

Terrestrial Habitat Impacts

Direct terrestrial habitat impacts from implementation of the proposed development concern the increased fractionation of the Xaibe Landsystem Broadleaf Forest ecosystems through creation of logging conveyances, and reduction of savanna habitat vegetation cover from landfill, canal excavation, and road & building construction activities; all of which are avoidable impacts.

Potential *indirect* and *residual* terrestrial habitat impacts concern the potential for accidental fires to become ignited within the residential tourism development from novice human occupation of the area, followed by subsequent fire-burn to the remaining savanna habitat and Xaibe Landsystem Broadleaf Forest ecosystems; along with emigration of resident, but uncommon specialist species of wildlife (e.g. littoral birds) that are depend on the absence of human interventions in the area, followed by their replacement with more common generalist species, and hence, an overall reduction in area biodiversity, both of which also constitute avoidable impacts.

The key to understanding the biodiversity mechanics operating within and between the two principle ecosystems targeted for human interventions within the Balam Jungle Estate, namely the timber management zone of the Broadleaf Forest habitat and the residential tourism development of the Savanna habitat, at least for the purpose of designing biologically and economically effective mitigation for the proponent to observe, lies with an understanding of habitat size and edge design influences on species abundance.

In recent years, forest ecologists have noted with concern their increasing encounters with apparently healthy forests that exhibit low faunal biodiversity (Xxxxxxx *et al* 200X). The studies which resulted from their observations have established that habitat patch size and edge design are critically important to species richness, particularly in tropical forests, such that when they are subjected to selective logging, the unregulated creation of logging roads and skidder trials create the direct impacts on the forest by reducing the area of contiguous canopy cover, or patch size, relative to the perimeter of each patch formed by the logging conveyance, or edge size (see **Illustration 58**). When these types of impact occur, the declining 'patch' sizes can no longer support their pre-existing population size, in part because the increased edge size also affords increased predator access.

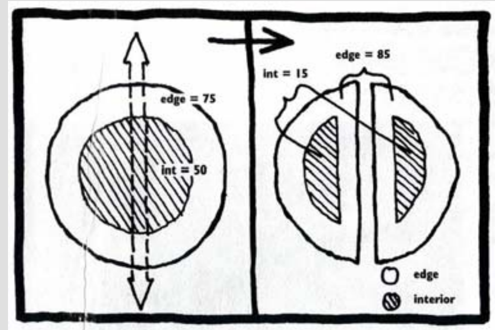
What is important to take away from these relationships in respect of the Balam Jungle Estate is that the high faunal richness of the site is largely a product of its still large contiguous canopy area. However, ground surveys of the Broadleaf Forest habitats conducted for this study also established that the former and present owners of the BJE have undertaken to conduct intensive harvesting of the site in an effort to improve their economic return in conjunction with the pending sale of the property by actions which in some cases have resulted in the reckless clearance of one skidder trail per harvestable stem, leaving the buyer to 'inherit' the consequences of their practices (see **Page 85**).

Review of the once 140,000+ acre extent of the contiguous Xaibe Broadleaf Forest land system east of the Progresso Lagoon shown in **Illustration 59**, establishes that a diverse array of development activities are concurrently fractionating the land system on a very large scale, and that the remaining areas or 'patches' which have either been set aside for conservation (e.g. the Freshwater Creek Forest Reserve) or are not yet developed, are far to distant from each other to function as a contiguous canopy habitat, leaving little respite for mitigation of fractionation impacts beyond the borders of the BJE.

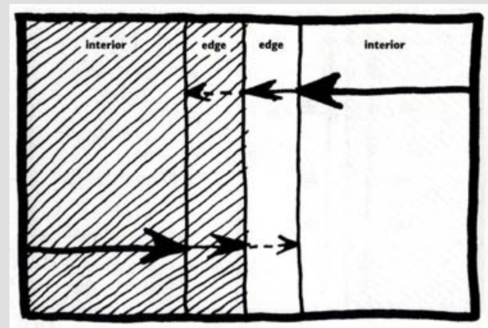
Consequently, consideration of the pre-existing road and trail development within the BJE shown in **Illustration 51** strongly suggests that new management of the site should undertake to be economical in the construct of any new inter-forest conveyances by insuring that such conveyances will offer multiple, rather than solitary, stem yields. This practice will, to the proponents benefit, also greatly reduce the cost of timber extraction. Other practices taken in concert with this primary action, such as forest product eco-certification, and forest registration for carbon sequestration credits would only serve to further advance the accrued environmental benefits to wildlife and economic benefits to the proponent.

ILLUSTRATION 58:

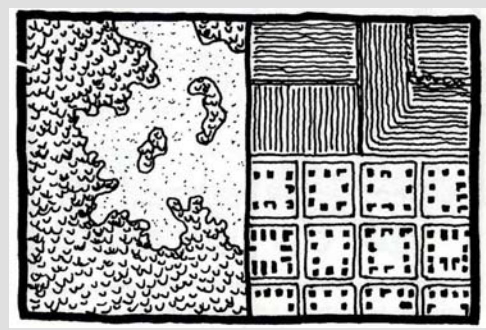
PATCH, EDGE & CORRIDORE RELATIONSHIPS IN DISTURBED ECOSYSTEMS



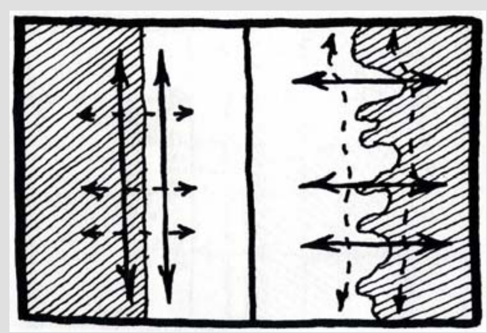
Top Right: Edge Habitat & Species. Dividing a large patch into two smaller ones creates additional edge habitat and leads to higher population sizes and slightly higher number of edge species, which are often common or widespread in the landscape.



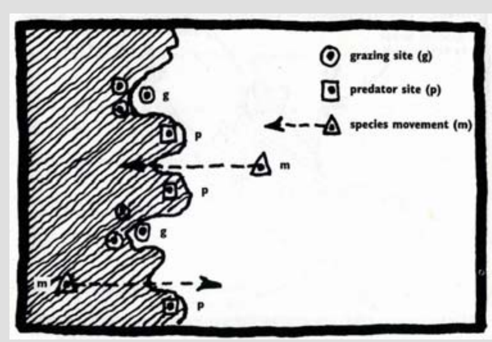
Second From Top: Edge As A Filter. Patch edges normally function as filters, which dampen influences of the surroundings on the patch interior.



Center: Natural & Human Edges. Most natural edges are curvilinear, complex and soft, whereas humans tend to make straight, simple and hard edges.



Second From Bottom: Straight & Curvilinear Boundaries. A straight boundary tends to have more species movement along it, whereas a convoluted boundary is more likely to have movement across it.

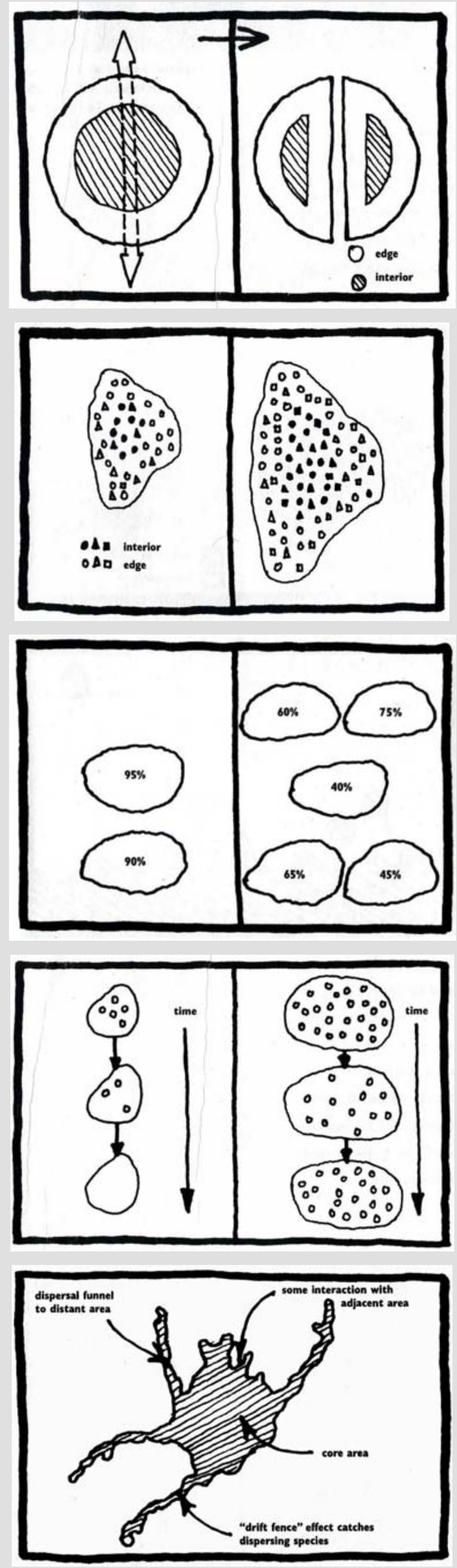


Bottom Right: Coves & Lobes. The presence of coves and lobes along an edge provides greater habitat diversity than along a straight edge, thereby encouraging higher species diversity.

Continued…

ILLUSTRATION 58:

PATCH, EDGE & CORRIDORE RELATIONSHIPS IN DISTURBED ECOSYSTEMS



Top Right: Interior Habitat & Species. Dividing a large patch into two smaller ones removes interior habitat, leading to reduced population sizes and number of interior species which are often of conservation importance.

Second From Top: Large Patch Benefits. Large patches of natural vegetation are the only structures in a landscape that protect aquifers and interconnected stream networks, sustain viable populations of most interior species, provide core habitat and escape cover for most large-home-range vertebrates, and permit near-natural disturbance regimes.

Center: Number Of Large Patches. Where one large patch contains almost all the species for that patch type in the landscape, two large patches may be considered minimum for maintaining species richness. However, where one patch contains a limited portion of the species pool, up to four or five large patches are probably required.

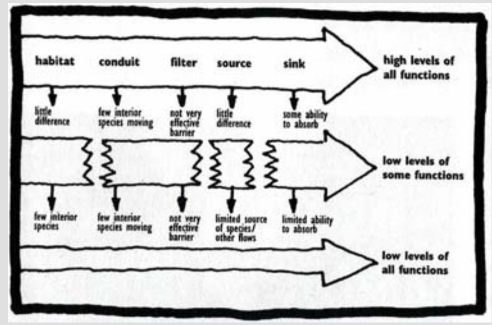
Second From Bottom: Local Extinction Probability. A larger patch normally has a larger population size for a given species than a smaller patch, making it less likely that the species, which naturally fluctuates in population size, will go locally extinct in the larger patch.

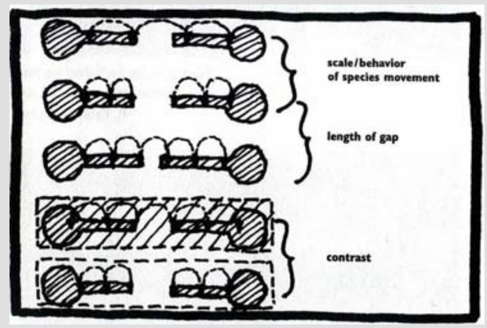
Bottom Right: Ecologically "Optimum" Patch Shape. An ecologically optimum patch provides several ecological benefits, with a rounded core for protection of resources, plus some curvilinear boundaries and a few fingers for species dispersal.

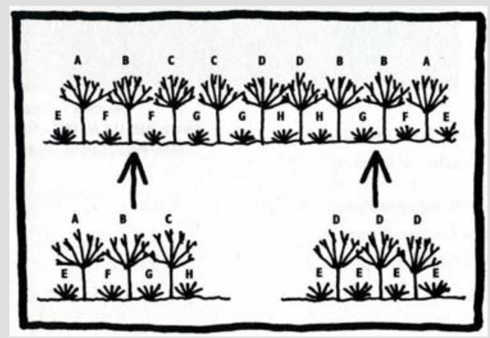
Continued…

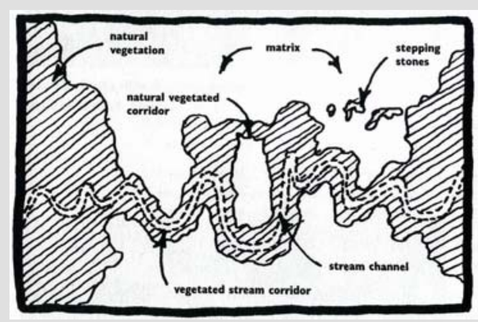
ILLUSTRATION 58:

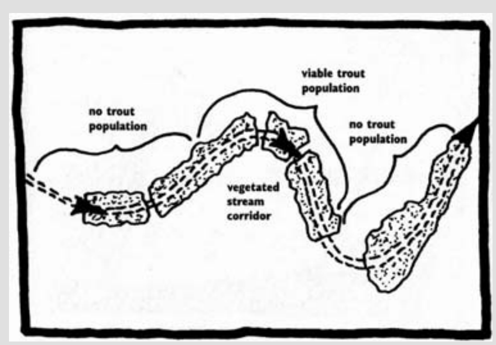
PATCH, EDGE & CORRIDORE RELATIONSHIPS IN DISTURBED ECOSYSTEMS











Top Right: Controls on Corridor Functions. Width and connectivity are the primary controls on the five major functions of corridors: habitat, conduit, filter, source and sink.

Second From Top: Corridor Gap Effectiveness. The effect of a gap in a corridor on movement of a species depends on length of the gap relative to the scale of species movement and contrast between the corridor and the gap.

Center: Structural Versus Floristic Similarity. Similarity in vegetation structure and floristics (plant species) between corridors and large patches is preferable, though similarity in structure alone is probably adequate inmost cases for interior species movement between large patches.

Second From Bottom: Loops & Alternatives. Alternative routes or loops in a network reduce the negative effects of gaps, disturbances, predators, and hunters within corridors, thus increasing efficiency of movement.

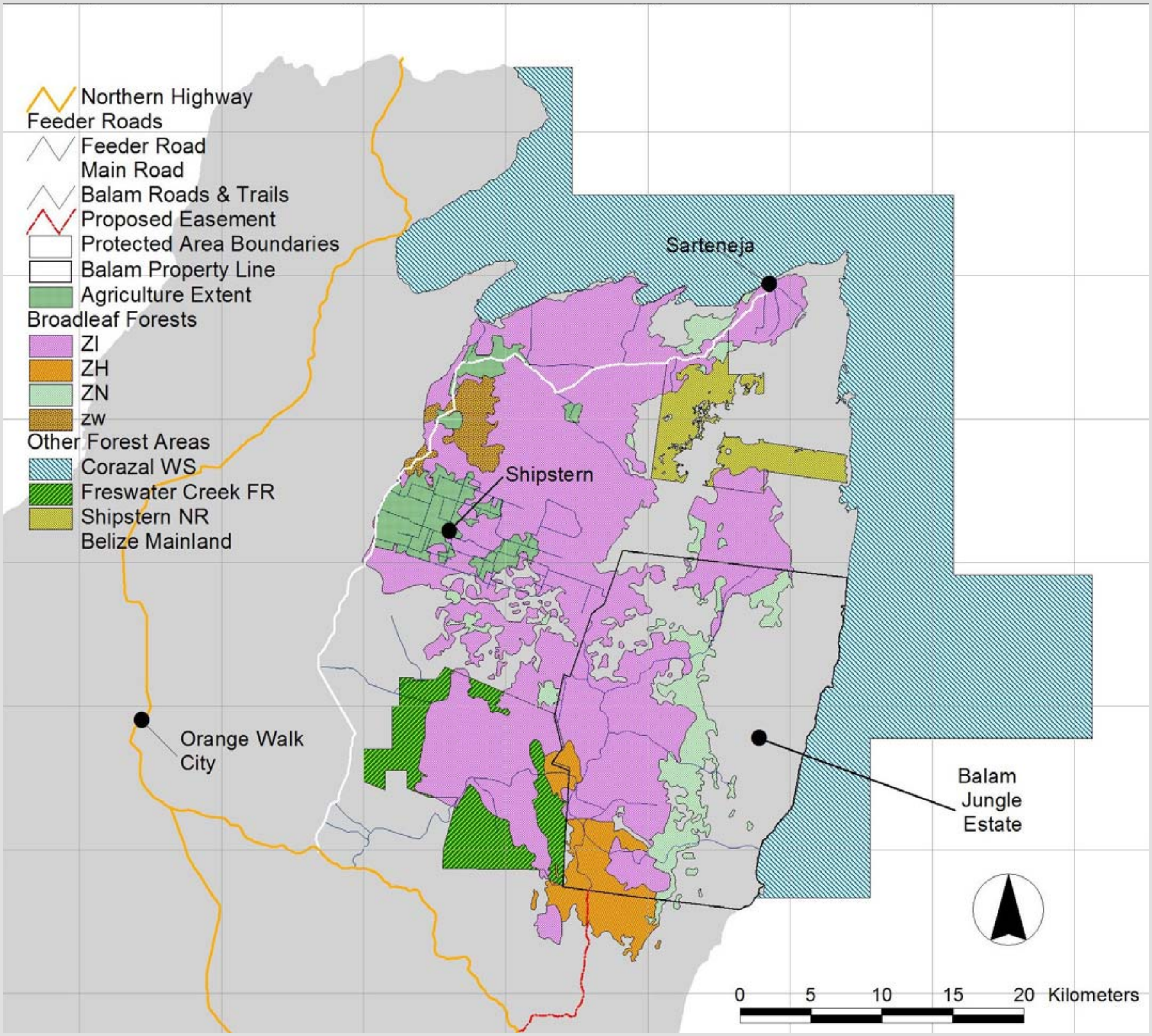
Bottom Right: Connectivity Of A Stream Corridor. Width and length of a vegetated stream corridor interact or combine to determine stream processes. However, a continuous stream corridor, without major gaps is essential to maintain aquatic conditions such as cool water temperature and high oxygen content. Without these and other physiological process, viable populations of select aquatic / marine species will not be maintained.

(Cited or paraphrased from Drumstad, et al 1996)

…End

ILLUSTRATION 59:

FRACTIONATION OF THE XAIBE PLAIN BROADLEAF FOREST LAND SYSTEM



Similar relationships govern the savanna habitat, perhaps with the exception that species richness may well be greater within the edge than the patch, this being for two reasons, the first being that the Littoral/Beach and Glady Forests bordering the savanna habitat form a wider, botanically & structurally complex transition zone than occurs when logging conveyances form abrupt edges through the center of broadleaf canopy forests. Perhaps more importantly however, the savanna habitat presents a much higher risk of fire impact on the broadleaf forest than the logging operations taking place within the forest (see **Illustration 42**, **Page 88**), and so the combination of edge complexity and fire propensity represent the key determinants of biodiversity within and between the savanna and broadleaf forest habitats (respectively), and hence, the key areas of potential impacts produced by the residential tourism development.

Consequently measures available for mitigation of these avoidable terrestrial habitat impacts include:

- Construction & Operating Measures that undertake to be economical in the construct of any new inter-forest conveyances by insuring that such conveyances will offer multiple, rather than solitary, stem yields; and examine the feasibility of forest product eco-certification registration and/or carbon sequestration credits to improve economic yield per stem, and hence, reduce new conveyance demands;
- Construction & Operating Measures that entail immediate replanting of exposed soils with native vegetation; along with creation and designation of buffer zones, particularly for fire management, along existing tracts of Glady and Littoral / Beach Forest.

Species-Specific Impacts

Direct species-specific impacts from implementation of the proposed development concern the potential abandonment of the area by the Great Curassow, and other resident endangered species such as the black catbird, in response to the construction activity and human occupation being proposed; increased risk of rookery abandonment by resident wood storks and wading bird species as a result of excess tourism-based disturbance; and increased risk of boating-based noise disorientation and mortality risk to Manatee from reciprocating engine operation and prop-injuries, all of which represent avoidable impacts.

Potential *indirect* and *residual* species-specific impacts include the potential for predator/prey equilibrium (e.g. the jaguar/peccary/agouti food chain) to become disturbed by newly engineered access constraints and/or long term human occupation of the area; and the potential for biodiversity reduction over time from highly diverse specialist species abandonment of the area in favor of less diverse generalist species.

- Construction & Operating Measures that entail immediate re-landscaping of barren and/or filled areas with landscaping strategies that include adequate mixtures of native plant species having diverse food value, density & height arranged in contiguous corridors that extend between the broadleaf forest, savanna and littoral/beach habitats, in order to afford specialist species safe avenues of movement between key habitats along corridors with improved food value and hence, carrying capacity;

- <u>Operating & Maintenance Procedures</u> that require concerted adherence to visitation management regulations which are designed to insure all visitation is supervised by trained tour guides, that visitation frequency is not excessive, and that visitation is neither disruptive or intrusive on rookery activities; and

- <u>Operating Measures</u> that provide for *enforcement* of Manatee conservation guidelines (see **Addenda 5**) in the vicinity of the proposed development, particularly as they pertain to the imposition of: (1) demarcation of no wake zones with signage along approved navigation routes leading to the entrance to Bennett's Lagoon, marina docking facilities, and access to navigable canals that are marked with lighted navigational buoys as shown in **Illustration 52** (**Page 112**); (2) public education, particularly for all development residents and staff concerning Manatee tourism guidelines; and (3) a mechanism for enforcement and penalty collection, in the event a Manatee is killed as a direct violation of the navigational and/or tourism guidelines for Manatee conservation.

MONITORING REQUIREMENTS

Monitoring requirements will include weekly inspection of all petroleum stores & pool effluent and brine ponds for leakages; quarterly inspection canal and lagoon water quality, including dissolved oxygen, turbidity, salinity, and temperature; and Annual survey of wildlife abundance and use of landscaped corridors established as replacement land cover within the design scheme of the overall residential tourism development.

TEXT BOX 9

SUMMARY OF KEY WILDLIFE IMPACTS AND MITIGATION MEASURES

1. **UNAVOIDABLE IMPACTS:**

   - Bank modification and extirpation of *Riverine Mangrove Forest* habitat where the marina is to be established in Bennett's Lagoon; and
   - Increased fractionation of the Xaibe Landsystem Broadleaf Forest ecosystems through creation of logging conveyances, and reduction of savanna habitat vegetation cover from landfill, canal excavation, and road & building construction activities.

2. **AVOIDABLE IMPACTS:**

   - Disturbance / removal of marine sediments for creation of the marina basin;
   - Increased risk of sediment or turbidity-based degradation of the canal system and coastal lagoon water quality conditions necessary for existing marine life, during beach revetment activities, or construction of the inland canals and marinas;
   - Petroleum-based contamination of the canal system and coastal lagoons from spill accidents and gas-diesel-kerosene-powered boating activities;
   - Chemical or pesticide-induced impacts on marina and aquatic flora & fauna from utilization of the canal & lagoon system for drainage of the golf course and other amenities;
   - Increased risk for accidental fires to become ignited within the residential tourism development from novice human occupation of the area, followed by subsequent fire-burn to the remaining savanna habitat and Xaibe Landsystem Broadleaf Forest ecosystems;
   - Emigration of resident, but uncommon specialist species of wildlife (e.g. littoral birds) that are depend on the absence of human interventions in the area, followed by their replacement with more common generalist species, and hence, an overall reduction in area biodiversity;
   - Increased potential abandonment of the area by the Great Curassow, and other resident endangered species such as the black catbird, in response to the construction activity and human occupation being proposed; increased risk of rookery abandonment by resident wood storks and wading bird species as a result of excess tourism-based disturbance;
   - Increased risk of boating-based noise disorientation and mortality risk to Manatee from reciprocating engine operation and prop-injuries, all of which represent avoidable impacts;
   - Increased potential for predator/prey equilibrium (e.g. the jaguar-peccary-agouti food chain) to become disturbed by newly engineered access constraints and/or long term human; occupation of the area; and
   - Increased potential for biodiversity reduction over time from highly diverse specialist species abandonment of the area in favor of less diverse generalist species.

Continued…

TEXT BOX 9

(Continued)

3. MITIGATION MEASURES:

- Limit sediment travel to immediate excavation area with silt screens;
- Leave plugs in the canal system until any construction borne turbidity either settles or can be gradually diluted to pre-existing conditions; and use of silt screens during any dredging activities associated with beach revetment or marina construction;
- Use bonds for storage of all petroleum-based products, along with construction and closure of canal gates in the event of a spill accident to afford time for clean up procedures to be undertaken;
- Offer of preferential docking / storage rates for boat operators using 4-cycle engines or non-petroleum based power schemes;
- Require the use of *pest-specific* compounds (i.e. pesticides which are non-toxic to untargeted species of wildlife) that also contain binders to reduce or eliminate their potential wind or water-borne migration from the application site. The latter characteristic also being complimented by (1) design of the golf course and other effluent-bearing amenities (e.g. swimming pools) to drain into designated holding ponds for photo-oxidation of any effluent-born chemicals or pesticides prior to discharge into the canal or coastal lagoon systems, and (2) pesticide application in dry, low wind conditions suited to binder adhesion;
- Economize in the construct of any new inter-forest conveyances by insuring that such conveyances will offer multiple, rather than solitary, stem yields
- Examine the feasibility of forest product eco-certification registration and/or carbon sequestration credits to improve economic yield per stem, and hence, reduce new conveyance demands;
- Replant_exposed soils with native vegetation; along with creation and designation of buffer zones, particularly for fire management, along existing tracts of Glady and Littoral / Beach Forest;
- Immediate re-landscaping of barren and/or filled areas with landscaping strategies that include adequate mixtures of native plant species having diverse food value, density & height arranged in contiguous corridors that extend between the broadleaf forest, savanna and littoral/beach habitats, in order to afford specialist species safe avenues of movement between key habitats along corridors with improved food value and hence, carrying capacity
- Concerted adherence to visitation management regulations which are designed to insure all visitation is supervised by trained tour guides, that visitation frequency is not excessive, and that visitation is neither disruptive or intrusive on rookery activities
- Provide for *enforcement* of Manatee conservation guidelines (see **Page X**) in the vicinity of the proposed development, particularly as they pertain to the imposition of: (1) demarcation of no wake zones with signage along approved navigation routes leading to the entrance to Bennett's Lagoon, marina docking facilities, and access to navigable canals that are marked with lighted navigational buoys as shown in **Illustration 62**; (2) public education, particularly for all development residents and staff concerning Manatee tourism guidelines; and (3) a mechanism for enforcement and penalty collection, in the event a Manatee is killed as a direct violation of the navigational and/or tourism guidelines for Manatee conservation.

TEXT BOX 9

(Continued)

4. MONITORING REQUIREMENTS:

- Weekly inspection of all petroleum stores & pool effluent and brine ponds for leakages; quarterly inspection canal and lagoon water quality, including dissolved oxygen, turbidity, salinity, and temperature;
- Annual survey of wildlife abundance and use of landscaped corridors established as replacement land cover within the design scheme of the overall residential tourism development.

…End

10. CULTURE, CUSTOMS AND SOCIAL FACTORS

10.1 Report on the presence/absence of any known structures or artifacts of archeological significance located on or within impact distance of the development site. In the event such features are present, describe their present status with the Department of Archeology and the project's potential for deteriorating these artifacts.

10.2 Conduct a study to determine the potential social impacts of the proposed development, taking into account factors such as (i) labor (i.e. employment opportunities); (ii) integration; (iii) customs and culture; and (iv) provision of basic health care and hygienic facilities for all workers during the construction and operation of the project.

10.3 The EIA team will report on the views and concerns of local NGO's, public interest groups and relevant government departments/agencies regarding the development of the project.

CULTURAL IMPACT RISKS

Archaeological evidence found at the site (see **Page 102**) established the BJE to have been occupied by the ancient Maya and possibly colonial settlers, before contemporary times. Ancient Maya occupation appears to have entailed two principle types of settlement, including: several (at least 3) temple sites located within the Cohune Ridge habitats of the Xaibe Broadleaf Forest land system; and numerous independent salt making and/or coastal trading sites located on hammocks populated with the Saltwater Palmetto Palm (*Thrinax radiata*) within the coastal savanna habitat.

CUSTOM AND SOCIAL IMPACT RISKS

Employment Characteristics

The proposed development will likely employ several hundred persons during each construction phase, and well in excess of 1,000 persons during operation of the development, more than 95% of whom are anticipated to be Belizean Nationals, which constitutes a positive impact. Most staff will be trained on site, but those staff undertaking management or other specialized responsibilities such as boat operators, or tour guides, may be trained off-site (e.g. BERT Services).

Customs And Culture

Contemporary cultural use of the proposed development sites has been largely concerned with timber extraction, and incidental hunting and fishing. The proposed development will be unlikely to impact any of the traditional uses, save perhaps for timber and game poaching by area residents. The development will otherwise provide sanitary housing conditions and traditional food for all management and staff in residence; and all employees will have access to clean, separate-sex, indoor toilet and shower facilities.

Health Care Provision

Health care needs for guests should be supported through development of a local (on-site) clinic; while health care needs for management and staff of the proposed development could more reasonably be met by social security provision and available resources in Orange Walk City, Ladyville, or Belize City. However, it is recommended that the development provide 3 to 5 full-time staff with emergency medical training, due to the remote location of the project site. This training is now available at Belize Emergency Response Team headquarters in Belize City.

Climate Change

Climate change considerations suggest that landfill elevations should accommodate a sea level rise on the order of 1 meter and building specifications that are capable of withstanding surge tide effects and hurricane-force wind speeds up to 150 mph (Category-5 storms), or more.

NGO Concerns

No NGO's or protected areas adjoining the BJE are anticipated to be either directly or indirectly impacted by the proposed development, save and except for (1) the potential increases in illegal timber extraction from these areas in response to the increased staff and resident presence at the site, which is an avoidable impact; and (2) the previously described fractionation of the Xaibe and Savanna land systems and subsequent impact on area wildlife abundance, which also is an avoidable impact (see **Pages 158 - 164**).

IMPACTS AND MITIGATION MEASURES

The range of potential social impacts and available mitigation measures are itemized in **Table 40** and **Text Box 10**.

Cultural Impacts

Direct cultural impact risks posed by the BJE development concern the potential / accidental damage to one or more of cultural sites of antiquity during the construction phase of development, which is an avoidable impact. *Indirect* and *Residual* cultural impact risks with respect to these sites concern their potential looting by development staff, guests and/or residents, which also constitutes an avoidable impact. Measures available for mitigation of these avoidable impacts include:

- Design Measures that eliminate or set aside these archaeological areas as green space;
- Construction Measures that provide for arrangement with the Institute of Archaeology for an archaeological monitor to be present during land clearing and construction of the proposed development; and

TABLE 40

MITIGATION MATRIX OF CULTURAL AND SOCIAL IMPACTS[1]

IMPACT CATEGORY	DIRECT IMPACTS	MITIGATING MEASURES	INDIRECT IMPACTS	MITIGATING MEASURES	RESIDUAL IMPACTS	MITIGATING MEASURES
Cultural Impacts	Potential / accidental damage to one or more of cultural sites during the construction phase of development,	Eliminate or set aside these archaeological areas as green space Provide for arrangement with the Institute of Archaeology for an archaeological monitor to be present during land clearing and construction of the proposed development	Potential looting by development staff, guests and/or residents, which also constitutes an avoidable impact.	Provide for education of development staff, guests and residents as to the importance and legal obligations for conservation for cultural sites and artifacts in Belize, perhaps along with designation of one or more sites for managed tourism use	Potential looting by development staff, guests and/or residents, which also constitutes an avoidable impact.	Provide for education of development staff, guests and residents as to the importance and legal obligations for conservation for cultural sites and artifacts in Belize, perhaps along with designation of one or more sites for managed tourism use
Social Impacts	Proposed development will create jobs and increase foreign exchange earnings through unit sales revenue	None Positive impact	Remote location of proposed development site may increases risk of complications from accidental / serious injury to workers	Have a minimum of 3 - 5 full-time staff on-site trained in emergency medical practices at the BERT facility in Belize City	Remote location of proposed development site may increases risk of complications from accidental / serious injury to workers	Have a minimum of 3 - 5 full-time staff on-site trained in emergency medical practices at the BERT facility in Belize City

[1]**Note:** Negative Impacts shown in black type, positive impacts shown in blue-green type.

- <u>Operating Measures</u> that provide for education of development staff, guests and residents as to the importance and legal obligations for conservation for cultural sites and artifacts in Belize, perhaps along with designation of one or more sites for managed tourism use.

Custom & Social Impacts

<u>Direct</u> social impacts from implementation of the proposed development concern the positive impacts of job creation and foreign exchange earnings through land sales and property development. Potential *<u>indirect</u>* social impacts concern the proposed development's remote location, which increases serious injury risk to residents, guests or workers. Potential *<u>residual</u>* social impacts are nil. Measures available for mitigation of the above-identified potential indirect negative impact risk include:

- <u>Training Measures</u> that entail having a minimum of 3 - 5 full-time staff trained in emergency medical practices at BERT facility in Belize City.

MONITORING REQUIREMENTS

The proponent will need to provide for an archaeological monitor, approved by the Belize Institute of Archaeology, to observe all land clearing and construction activities at the project site, for the purpose of advising preservation requirements in the event of an archaeological find during construction; and the proponent will need to develop a monitoring program in conjunction with the Institute of Archaeology for inspection of know sites for damage or looting by development staff, guests or residents.

TEXT BOX 10

SUMMARY OF KEY CULTURAL AND SOCIAL IMPACTS AND MITIGATION MEASURES

1. UNAVOIDABLE IMPACTS:

- None.

2. AVOIDABLE IMPACTS:

- Potential / accidental damage to one or more of cultural sites during the construction phase of development;
- Potential looting by development staff, guests and/or residents, which also constitutes an avoidable impact; and
- Potential looting by development staff, guests and/or residents, which also constitutes an avoidable impact.

3. MITIGATION MEASURES:

- Eliminate or set aside these archaeological areas as green space;
- Provide for arrangement with the Institute of Archaeology for an archaeological monitor to be present during land clearing and construction of the proposed development;
- Provide for education of development staff, guests and residents as to the importance and legal obligations for conservation for cultural sites and artifacts in Belize, perhaps along with designation of one or more sites for managed tourism use; and
- Have a minimum of 3 - 5 full-time staff on-site trained in emergency medical practices at the BERT facility in Belize City.

4. MONITORING REQUIREMENTS:

- Provide for an archaeological monitor, approved by the Belize Institute of Archaeology, to observe all land clearing and construction activities at the project site, for the purpose of advising preservation requirements in the event of an archaeological find during construction; and
- Develop a monitoring program in conjunction with the Institute of Archaeology for inspection of know sites for damage or looting by development staff, guests or residents.

11.1 DISASTER MANAGEMENT –

Specific To Fire Management and Civil Security

11.1 Disaster Management

11.1 Identify emergency preparation and applicable management measures for the proposed development (e.g. hurricane, floods, fires etc.) and use this information to develop evacuation and hazard management plans inclusive of climate change adaptation measures (such as sea level rise and structural/building design conducive with the climatic conditions of project site and considerations for cage culture).

FIRE PREPAREDNESS PLAN

Fire Management Within The Residential Tourism Zone

The key elements of a fire preparedness plan for the residential tourism zone will need to anticipate the *direct* incremental health & safety risk posed to residents and staff from a fire outbreak, as might result from accidental ignition of fuel depots, faulty building wiring, kitchen fires, lightning strikes, etc. and the *indirect* incremental fire risk posed to area ecosystems and wildlife, as might result from fire outflows from any of these same point sources. Preventative and control of these risks should include the following measures:

- Each structure and green space should be linked to one or more evacuation routes marked with signage that is capable of conveying fire-impacted residents, guests and personnel to safe areas and emergency medical facilities. All staff should be adequately trained in their location during their initial orientation as a standard condition of employment.

- Every single amenity, home and hotel/condominium structure designed for human habitat or use should be outfitted with smoke detectors and a minimum of one 2 - 3 lb foam/chemical fire extinguishers appropriate for petroleum/kitchen fires.

- All watercraft permitted to use docking facilities or convey residents, guests or staff to/from the development should be equipped with a fire extinguisher, 2 or more marine band radios, and sufficient flotation devices for a maximum number of crew/passengers.

- All extinguishers should be tested and charged (if necessary) on an annual basis.

- Pressurized water hydrants should be placed at strategic locations throughout the residential tourism development site, each having sufficient volume and pressure to deliver adequate supply of water to extinguish fire on the top floor of any structure to be constructed. All staff should be acquainted with hydrant locations during orientation as a standard condition of employment.

- All paper trash incinerators should be outfitted with cinder arrestors and placed at designated locations outfitted with pressurized water, sand and shovel fire-fighting equipment.
- 250-Ft wide fire break canals outfitted with water pump stations placed at regular intervals should be constructed along the perimeter of each stage of development, and along the Glady Forest / savanna margin to prevent fire outflows into/out of the savanna and broadleaf forest.
- Staff should be organized into fire fighting teams trained in mobilizing equipment, controlling spread, and fighting fires; each with particular zones of specialization, and 2 or 3 team levels to provide relief and backup in the event of level-specific absences.

Fire Management Within The Forest Management Zone

The key elements of a fire preparedness plan for the timber management zone will need to anticipate the *direct* incremental health & safety risk posed to timber operation staff from a fire outbreak, as might result from accidental ignition of fuel depots and/or forest fuels, spark yield from power saws & heavy equipment, unauthorized and/or unregulated use & disposal of cigarette ash & buts, ground fires originating from adjoining properties, lightning strikes, etc. and the *indirect* incremental fire risk posed to area ecosystems and wildlife, as well as the residential tourism zone, as might result from fire outflows from any of these same point sources. Key measures employed in the management of these risks include prevention through vigilant, multi-level monitoring, and control through training and outfitting fire-fighting staff. Hence, a any competent forest fire preparedness plan should include the following measures, here paraphrased from Mendoza 2006:

- Human carelessness is the number one cause of forest fires; hence a control program should be implemented to monitor human presence in the timber management zone, particularly the unauthorized presence of strangers, poachers, hunters and looters.
- Owing to the extensive area of the property, multiple observation/monitoring towers should be constructed, placed throughout the forest management area and along the forest/savanna edge, and manned by designated, full-time staff (particularly in dry weather) to provide a means for immediate fire detection. Each tower should be placed within eyesight of another, and outfitted with reliable communication equipment to provide rapid transmission of critical information on unauthorized human presence and fire location data.
- Specific sites having elevated fire risk, including (1) *moderate risk* areas such as vehicle conveyances and camps having a continuous presence workers and strangers; (2) *high risk* areas charged with significant amounts of forest fuels, especially readily inflammable light and medium fuels (i.e. leaves, sticks & grass; and branches or shrubs; respectively) found in wetland forest or Bajos locations, along with logging waste sites, areas of dense undergrowth of fast-growing pioneer species & topographically flat areas having shallow soils and poor canopy development that are particularly susceptible to drought and fire starts; and (3) *high risk* areas containing flammable agents such as petroleum stores, pest control agents, paint, etc., should be specifically and routinely patrolled, particularly in dry weather.

- All staff, as a condition of employment, should be: (1) trained in the observance of guidelines for minimizing fire risk, including such measures as requiring the owners permission for an open campfire, cook fire, or bonfire near forest lands, limiting burn materials to natural vegetation & untreated wood products, restricting burn piles to 50 feet from buildings & 500 feet from forest slash, clearing burn pile perimeters of flammable materials, keeping fire-fighting equipment & materials such as shovels & water close by and readily accessible, limiting burn events to calm weather conditions where leaves & branches are motionless or surface waters are waveless, being prepared to put a fire out if it becomes a nuisance or a significant effort to control, attending fires until they are completely out, limiting smoking to designated areas, and prevention of smoking when in transit along conveyances through forested areas, and outfitting all vehicles & machinery with proper exhaust systems and/or spark arrestors; (2) trained in fire fighting procedures; and (3) outfitted with fire-fighting equipment, including, but not necessarily limited to: 2-way radios, personnel locators, gps, round point shovels, and perhaps most importantly water reserves for control of small fires, as well as pumps and location maps of practical routes to designated areas where naturally occurring surface and ground water resources are accessible year round.
- An enforcement program should be established with the support of government, law enforcement agencies, surrounding landowners, and nearby communities to ensure a strict application of law for any person(s) that are proven to be responsible for starting an unauthorized forest fire on the property.

CIVIL SECURITY PREPAREDNESS PLAN

Civil security preparedness concerns the need to anticipate the potential for interpersonal conflicts between staff, guests and/or residents to arise which may further threaten one or more unintended 3rd parties in the immediate vicinity of the conflict. Although such incidents may be impossible to predict, basic measures should be put in place to reduce, if not eliminate the potential for their occurrence. These should include, but not be limited to the need for:

1. All guests and residents to register their passport or local identification with developments' management;
2. All guests and residents of the development to register any firearm or other weapon that may be in their possession, including martial weapons;
3. Staff, guests or residents to immediately inform management of any improper conduct by any staff, guest or resident that may, in the informer's opinion, lead to the potential injury to the person in question, or any other person; and
4. Management to prohibit the sale of alcohol to any minor or visibly intoxicated person.

11.2 DISASTER MANAGEMENT –

Specific to Hurricanes and Related Natural Disasters

11.1 Disaster Management and Climate Change Issues

11.1 Identify emergency preparation and applicable management measures for the proposed development (e.g. hurricane, floods, fires etc.) and use this information to develop evacuation and hazard management plans inclusive of climate change adaptation measures (such as sea level rise and structural/building design conducive with the climatic conditions of project site and considerations for cage culture).

HURRICANE PREPAREDNESS ACTION PLAN

Hurricane Characteristics

A hurricane is a tropical cyclone, or depression. In a hurricane, winds travel in a circular, anti-clockwise direction at very high speeds. A tropical storm becomes a hurricane when the winds exceed 73 miles per hour. Caribbean hurricanes begin as tropical depressions along the west coast of North Africa. The storms travel into the trade winds, which cross the Atlantic Ocean, and then change into tropical storms and possibly hurricanes when they reach the warmer waters of the western Caribbean Sea. The Belize hurricane season commences on June 1 and ends on November 30.

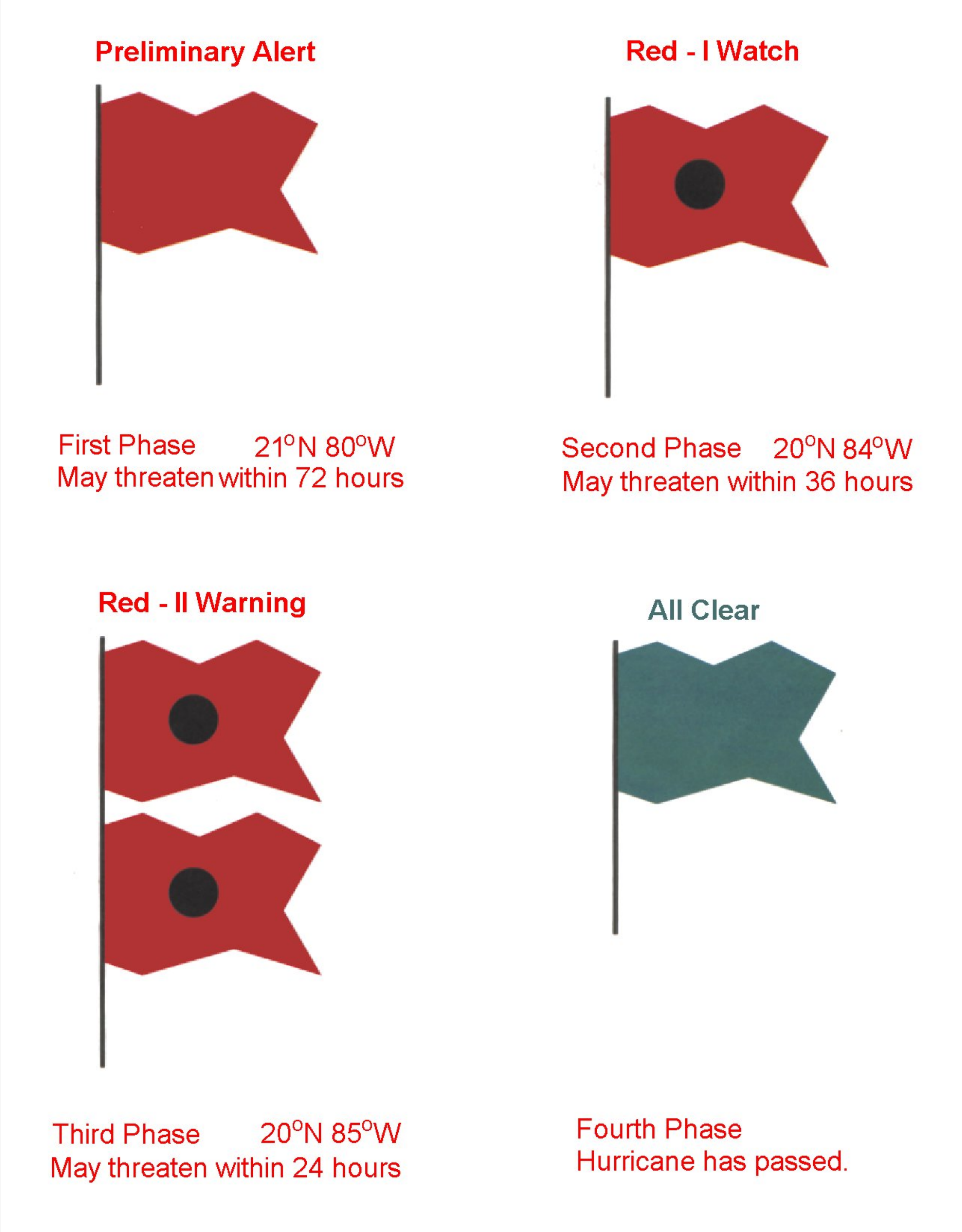
The first stage of hurricane development is when a tropical wave forms as a cluster of clouds and or thunderstorms, without a significant circulation. The second stage of hurricane development is when the tropical wave begins to rotate at speeds under 39 miles per hour. The third stage of hurricane development is when the tropical wave increases to speeds between 39 and 73 miles per hour. The third stage is called a tropical storm, and is when hurricanes receive their name.

A Category 1 hurricane has wind speeds between 74 and 95 miles per hour and raises the sea at the western edge of the storm by 4 to 6 feet, which is called the storm surge. A Category 2 hurricane has wind speeds between 96 and 110 miles per hour and a storm surge of 6 to 10 feet. A Category 3 hurricane has wind speeds between 111 and 130 miles per hour and a storm surge of 10 to 16 feet. A Category 4 hurricane has wind speeds between 131 and 155 miles per hour and a storm surge of 16 to 22 feet. A category 5 hurricane has wind speeds greater than 155 miles per hour and a storm surge greater than 22 feet.

The Meteorology Department (BNMS) is located at the Phillip S. Goldson International Airport in Ladyville and is responsible for official designation of hurricane status in Belize. The Meteorology Department communicates its designations of hurricane status to the National Emergency Management Organization (NEMO), which in turn communicates hurricane status designations to public radio stations for dissemination to the general public.

ILLUSTRATION 60:

THE FOUR FLAGS OF HURRICANE STATUS IN BELIZE



Rely on *official* reports and weather advisories only. Hurricane status is divided into 4 phases or stages, each of which is officially symbolized by a specific flag flown at the Courthouse wharf in Belize City (see **Illustration 60**), and include:

- PRELIMINARY ALERT: ONE SOLID RED FLAG
- RED I - WATCH: ONE SOLID RED FLAG WITH A BLACK DOT
- RED II - WARNING: TWO SOLID RED FLAGS WITH BLACK DOTS
- ALL CLEAR: ONE SOLID GREEN FLAG

Seasonal Preparedness Measures

The development will need to make ready all materials and personnel for the hurricane season in accordance with the measures outlined in **Table 41**, by or before May 30 each year. These measures, in general, require the procurement and storage of all tools and materials needed for preparation of a hurricane strike, as well as designation, coordination, and training of all emergency management personnel.

Stage I: Preliminary Alert

This stage is designated when a hurricane moves south of 21 degrees latitude and west of 80 degrees longitude, and is within approximately 500 miles or $\leq$ 3 days (72 hours) travel time to Belize (see **Illustration 61**). The Balam Jungle Estate Development at this stage needs to commence implementation of the measures outlined in **Tables 42** – **43** as they apply to Stage I. These measures include: grounds cleaning by removal of furniture, and any other materials that may become air or waterborne during the hurricane; insuring all fire & pollution risks are neutralized; insuring that transportation & communication equipment are secured and mobilized for use in preparation before and after the pending hurricane strike; all dry-docked boats are remove from the Pott's Creek Marina; and that all guests, residents and non-essential personnel prepare to invoke their evacuation plans

Stage II: Red I - Watch

This stage is designated when a hurricane moves south of 20 degrees latitude and west of 84 degrees longitude, and is within approximately 260 miles or $\leq$ 36 hours travel time to Belize (see **Illustration 61**). The Development at this stage needs to commence implementation of the measures outlined in **Tables 42** – **43** as they apply to Stage II. These measures include the closure of all vacant buildings with board wood to minimize wind damage to doors and windows and where necessary, roofs are strapped down; removal of boats owned by in-resident persons; that all non-residential and non-essential personnel have evacuated the site; and that all residential and non-emergency management personnel are preparing to leave the site.

TABLE 41

PREPATORY ACTIONS TO BE IMPLEMENTED BY OR BEFORE JUNE 1 EACH YEAR

Supplies For Emergency Management Team Designees:

- *Emergency Uniforms*, including color coded / labeled rain slickers, boots, gloves, hard hats, neoprene jackets, life jackets, as per each teams' requirements should be made ready.
- *Emergency Lighting*, including waterproof / underwater flashlights, glow sticks, batteries, hurricane lanterns, lighters, and flares should be made ready.
- *Communication Equipment*, including water-proof hand-held radios, spare batteries, and site maps, including laminated building floor plans, electrical schematics, sewage / irrigation schematics, and potable water supply schematics.
- *Emergency Inventories*, including potable water stores, food, and first aid kits with bandages, tourniquets, epinephrine, antibiotics and other medicine should be removed from off-season storage and topped off where necessary.
- *Emergency Tools & Supplies*, including electrical tape, duct tape, ropes (5/8" 50 meters), chain (2" x 25 meters), claw-hammers, sledge hammers, nails, axes, crow bars, ladders, tarpaulins (25' x 25' each), and lumber, (both 1" x 4"; 2 x 4"; and ½" marine grade plywood) should be made ready.

Preparation Procedures For Emergency Management Team Designees:

- *Designated Emergency Management Teams* meet, identify a command hierarchy, tasks for each team member, zones to which their tasks apply, and each teams' color code.
- *Team Members* familiarize themselves with maps and ground conditions (by onsite inspection), the location of water, sewage & electrical mains, as well as emergency material supply depots where uniforms, medical, material and tool supplies are kept.
- *All Physical Assets Of The Development*, including structural, office equipment, and vehicles should be photographed and/or video taped (in digital format with a date stamp) as evidence for insurance claims.
- *All Vehicles* owned by the development should be inspected for serviceability and should be maintained with full fuel tanks at all times from May 30 to November each year. Designated emergency management personnel with approval to operate select or designated vehicles during emergencies should maintain duplicate vehicle key in their respective emergency management depots.
- *All Portable Generators And Pumps* should be inspected and the fuel tanks maintained full from May 30 to November each year.
- *All trees* should be inspected and trimmed where necessary to reduce the potential for damage to personnel or property during the hurricane, and all electrical lines and mains should be inspected for loose wires, and secure fastenings.
- *Each Emergency Management Team's Senior Coordinator* should ensure that all international employees have registered with their respective embassies or consulates.

ILLUSTRATION 61: HURRICANE TRACKING CHART FOR THE BELIZE REGION

TABLE 42

WORK PLAN TO BE IMPLEMENTED DURING HURRICANE WARNING PHASES I & II

TO BE COMPLETED IN STAGE I:	
Grounds:	Remove any small tools, implements, furniture, containers, hoses, etc. which may become airborne by high winds or waterborne by tidal surge.
Fire & Pollution Risks:	Locate, inspect and secure all utility conveyances, including: 1. All fuel/oil storage tanks, butane tanks, pipes, valves, etc. should be secured against strike by flying debris, and/or are closed to prevent leakage in event of line-break(s); 2. All regular and/or back-up power-generation equipment, including: intake and exhaust coverings, fuel supply lines, etc. should be secured for safe operation immediately after strike; 3. All water, sewage and electrical distribution lines, connections, control boxes, etc. are secured against leakage, fire and/or electrocution risk.
Equipment:	Locate, inspect, make ready: 1. All transportation vehicles & equipment needed for movement around the Caye during and/or following the hurricane as needed to open/clear access roads of debris; and 2. All cellular and/or VHS communication equipment, by removing and securing all base station antenna(s); ensuring batteries are charged; and function boxes and/or transcieving units are secured against wind/rain damage.
TO BE COMPLETED IN STAGE II:	
Infrastructure:	Secure infrastructure, including (but not limited to): roofing tie-down cables or strapping; protective boarding for windows and doors, etc. so as to close each building for the period of the storm and thereafter until opened again in Phase IV.

TABLE 43

ZONE-SPECIFIC HURRICANE PREPAREDNESS PLAN FOR THE SECTION 1 DEVELOPMENT

Development Zone	First Phase: PRELIMINARY ALERT 21°N x 80°W May Threaten Within 72 Hours	Second Phase: Watch: RED I 20°N x 84°W May Threaten Within 36 Hours	Third Phase: Warning: RED II 20°N x 85°W May Threaten Within 24 Hours	Fourth Phase: All Clear: GREEN Hurricane Risk Is Ended
Hotel / Casino & Commercial Facilities	**Preparation:** 1. Designated emergency management staff-teams don color coded jerseys & proceed to invoke hurricane preparedness plan components for Phase I in accordance with **Table 41**. 2. All non-essential staff & non-resident guests are advised of preliminary alert status and requirement to put evacuation plans, including flight reservations & transportation plans for travel to the International airport or inland destinations in place.	**Implementation:** 1. Designated emergency management staff-teams don color coded jerseys & proceed to invoke hurricane preparedness plan components for Phase II in accordance with **Table 42**. 2. All non-essential staff & guests implement departure plans including relocation to the international airport or secure inland sites.	**Final Readiness:** 1. All grounds, fire/pollution risks, equipment and infrastructure, secured. 2. Emergency management staff-teams are evacuated.	**Recovery:** 1. Designated emergency management staff-teams return and inspect infrastructure for integrity and repair as necessary for safe usage. 2. Emergency management staff-teams demobilize safety equipment & remaining staff return and prepare hotels, the commercial village, and casino / convention center for operation.
Marina Facilities	**Preparation:** 1. Designated emergency management staff-teams don color coded jerseys & proceed to invoke hurricane preparedness plan components for Phase I in accordance with **Table 41**. 2. All dry dock watercraft and moored watercraft belonging to absentee owners are removed to safe storage facilities.	**Implementation:** 1. Designated emergency management staff-teams don color coded jerseys & proceed to invoke hurricane preparedness plan components for Phase II in accordance with **Table 42.** 2. All boats belonging to in-residence owners evacuated to safe storage facilities. 3. All non-essential marina facilities staff are evacuated.	**Final Readiness:** 1. All grounds, fire/pollution risks, and boats secured. 2. Emergency management staff-teams are evacuated.	**Recovery:** 1. Designated emergency management staff-teams return and inspect infrastructure for integrity and repair as necessary for safe usage. 2. Emergency management staff-teams demobilize safety equipment & remaining staff return and prepare marina and interior waterway facilities for operation.
Residential Facilities	**Preparation:** 1. Designated emergency management staff-teams don color coded jerseys & proceed to invoke hurricane preparedness plan components for Phase I in accordance with **Table 41**. 2. All residents & non-essential beach club staff are advised of preliminary alert status and requirement to put evacuation plans in place.	**Implementation:** 1. Designated emergency management staff-teams don color coded jerseys & proceed to invoke hurricane preparedness plan components for Phase I in accordance with **Table 42**. 2. All non-residents implement evacuation plans.	**Final Readiness:** 1. All grounds, fire/pollution risks, equipment and infrastructure, secured. 2. Emergency management staff-teams are evacuated.	**Recovery:** 1. Designated emergency management staff-teams return and inspect infrastructure for integrity and repair as necessary for safe usage. 2. Emergency management staff-teams demobilize safety equipment & beach club staff return and prepare residential areas & clubs for re-occupation.

Stage III: Red II – Warning

This stage is designated when a hurricane strike is anticipated within 1 day (24 hours) travel time to Belize (see **Illustration 61**). The Development at this stage needs to commence implementation of the measures outlined in **Tables 42** – **43** as they apply to Stage III. These measures include the completion of all previously identified measures and final readiness of grounds, fire & pollution risks, equipment, boats and infrastructure for a hurricane strike. All personnel, save and except those few security personnel designated to remain at the site during the strike should be evacuated from the site.

Stage IV: All Clear

The key emergency management personnel evacuated in STAGE III: Red II – Warning should be first to return to the site to assist in damage assessment and otherwise determine safety conditions for entry of any other operational personnel. These personnel should then be responsible for directing repairs and otherwise leading site developments for human occupancy and/or return of regular operations.

12. ALTERNATIVES FOR DEVELOPMENT

12.1 Present all reasonable alternatives for development in comparative form, exploring each alternative. Include the no-action alternative, and the reason why certain alternatives were recommended or eliminated. These alternatives should look at the following components:

I. Siting of the necessary support infrastructure and all facilities;

II. Earth Movement Activities (evaluate the different extraction/dredging methodologies, extraction/dredging points (burrow sites), extraction/dredging volumes, material fill sites etc.);

III. Liquid and Solid waste treatment and disposal options (evaluate the different treatment technologies and methodologies); and

IV. Boat storage marina/docking facilities (siting, design, etc.) facilities.

ALTERNATIVES TO DEVELOPMENT

The alternatives for development are itemized in **Table 44** and described in further detail as follows.

<u>Siting Options</u> are limited to the proposed development site owing it being private land. The design layout for the proposed development satisfies both the economic and density objectives of the development, changes in which would only serve to either reduce economic feasibility, and hence economic benefit of the project. Consequently, and given that public benefit strongly favors the project's implementation, it is reasonable to accept the proposed siting option as the preferred option for development.

<u>Land-Based Transportation Options</u> concern proposed development of 43 kilometers of roads and trails within the Year 1-5 timber management zone; 87 Km of new access roads and 6Km of alleys within the residential tourism development; and 14 Km of easement access between the Old Northern Highway at Maskall Village and the road matrix within the timber management zone, for a total of approximately 150 Km of new and/or refurbished roads, alleys and trails. No other design options for land based transportation are available to the development, save for the non-development option (see **Page 104**). Hence, the proposed option is reasonable to accept as the preferred option for development.

<u>Sea-Based Transportation Options</u> chiefly concerns (1) the design and location of the navigable canal system planned for placement on the coastal savanna; and (2) the design and location of the marina and other boating-related facilities proposed for placement on Bennett's Lagoon. The options for the inland waterway/navigable canal system include: (1) acceptance of the proposed development option; (2) addition or modification of select components and/or reduction in canal system scale; or (3) rejection of the first two options altogether and acceptance of the non-development option. Modification of the master plan for the development would require its comprehensive redesign, which in turn would likely cause the proponent to abandon the development's placement in Belize, along with the substantive economic resources that would otherwise accompany its placement, and hence, result in election of the 3rd or non-development option by default.

TABLE 44

SUMMARY OF DEVELOPMENT ALTERNATIVES AND IMPACTS[1]

IMPACT CATEGORY	OPTION 1	OPTION 2	OPTION 3
Land-Based Transportation	Proposed Road Scheme Nominal Impact Following Landfill Operations	Non-Development Loss Of > US $ 100 M In Foreign Exchange Over Next 10 Years	…………
Sea-Based Transportation and Boat Storage	Proposed Marina Incremental Risk Of Manatee Mortalities, Which Can Be Mitigated Through Enforcement Of Conservation Guidelines	No / Limited Boat Marina Capacity Transfers Viability Risk To Proponent, And Will Likely Result In Project Failure,	Non-Development Loss Of > US $ 100 M In Foreign Exchange Over Next 10 Years
Material Supply	Cut And Fill Actions As Planned Loss Of Forest Cover, And Risk of Bennett's Lagoon Erosion	Non-Development Loss Of > US $ 100 M In Foreign Exchange Over Next 10 Years	…………
Freshwater Supply	Direct extraction from Bahia Chetumal Best Water Resource Strategy For Developer And Environment	Non-Development Loss Of > US $ 100 M In Foreign Exchange Over Next 10 Years	…………
Liquid Waste Management	Batch Plant Treatment Highest Level Of Treatment Effectiveness.	Non-Development Loss Of > US $ 100 M In Foreign Exchange Over Next 10 Years	…………
Solid Waste Management	Partial Source-Separation With Storage At Designated MSW Site At 27 Miles from Orange Walk Town Lowers Storage Requirement At Designated MSW Site And Cost To Development	Complete Off-Site Storage Nominal Environmental Risks, But Significant Elevation In Development Cost	Non-Development Loss Of > US $ 100 M In Foreign Exchange Over Next 10 Years

[1]Note: Green shading indicates the preferred option for implementation by the proposed development

Given this consideration, and the fact that the savanna habitat in question, while supporting several species of wildlife, offers little to no economic value for agriculture of other revenue generating activities, it seems reasonable to accept the proposed option along with the caveat or requirement for (1) physical preservation of or increase in the number of the savanna habitats' adjoining microhabitats; and (2) placement of natural bridges that are unsuited to human use, in order to afford terrestrial wildlife continued access to natural or landscaped green spaces within the residential tourism development zone, which might otherwise be less accessible for the human presence being proposed for the area.

Scale options for the proposed marina facilities are limited to the reduction in wet slips (assuming that increased dry dock capacity, as a trade off for fewer slips, would not constitute a material reduction in prop injury risk to Manatee). A reduction in wet slip number, while likely to proportionately reduce the above-quantified incremental risk of pollution and prop injury to Manatee, would not eliminate either risk, nor the need for enforcement of Manatee conservation, and hence would simply transfer the nominal Manatee-risk to the proponent and Belize by jeopardizing the viability of the development. Consequently, and given that no alternative sea-based transportation design options are available which can both reduce pollution and manatee risks without jeopardizing the economic viability of the proposed development, the proposed marina development plan and represents the preferred options for development.

Material Supply Options concern a modified version of the proposed option, or the non-development option. The proposed option will serve to improve drainage of rainwater runoffs, increase coastal aquatic habitat, and provide a readily available reservoir of water for fire-fighting and manufacture of potable water, albeit at substantial cost to the proponent. The downsizing of the proposed option, principally through reduction of canal lengths, include lower development cost to the proponent, albeit with reduced amenity value and hence, a possible reduction in sales. The non-development option insures the landscape will not become degraded from abandonment should the development fail, albeit with the forfeiture of an attraction for European tourism that is presently being sought through facilities expansion of Belize's international airport; as well as the foreign exchange and economic growth that would otherwise result from successful implementation of the proposed development. Given these considerations, it seems reasonable to conclude that relocation of material requirements within the proposed development sites as dictated by the project master plan should be the preferred option for development.

Freshwater Supply Options available to the proposed development include abstraction of ground water, rainfall catchments in cisterns, abstraction from non-navigable canals and/or Bahia Chetumal, and purchase from commercial distributors located in Orange Walk Town. Supply from ground water is unlikely to be practical for the proposed development owing to the relatively low yield of area ground water resources, which are reputed to range from 0.04-40.0 M^3/minute at 10 – 50 M depth (see Buckalew *et al* 1998 & **Illustration 54**). Rain water catchment in cisterns coupled with abstraction from non-navigable canals and/or Bahia Chetumal are likely to be suitable sources of water supply owing to: (1) their volume capacity, low salinity content and hence, low brine yield, particularly from the western end of the non-navigable canal network where essentially salt-free freshwater seepage and runoffs are conveyed from higher elevations (see **Page 50**);

and (2) the non-oceanic salinity of Bahia Chetumal (see **Page 64**), which might otherwise be readily combined with canal water resources for brine management. Supply from commercial venders in Orange Walk Town is unlikely to be a cost effective source of bulk water need owing principally to the distance and generally poor road conditions between the Town and the BJE. Consequently, rainwater capture in cisterns coupled with abstraction from non-navigable canals and/or Bahia Chetumal of Belize River water, along with polishing of brackish water sources by reverse osmosis, is likely to be the most practical and hence, preferred option for freshwater water supply to the proposed development.

<u>Liquid Waste Treatment Options</u> available to the proposed development include: employing large-scale plant that is economical and efficient to operate at capacity development, and the second of which employs a distributed batch plant system, which improves treatment effectiveness by mirroring the developments actual rate of build out. The former approach is more economical to operate because all of the components are common to a single location, albeit with the trade off of concentrating effluent in a way that plant failure might compromise the entire developments capacity for treatment. The latter approach on the other hand is more costly to build and operate than the former system, but this cost is incurred in smaller amounts over time, rather than as a single, up-front cost. A distributed system may well serve to reduce infrastructure costs for irrigation since the point sources of effluent will be in closer proximity to their application point. Moreover, the distributed system provides the surety that if one component in the network fails for any reason; it will not disrupt the operation of the remaining treatment capacity. Although either approach to treatment is suitable for the proposed development, the later or distributed approach reduces failure risk and therefore might best reflect the preferred option for development.

<u>Solid Waste Treatment Options</u> for management of solid waste produced by the proposed development are essentially limited to onsite treatment of some or all the solid waste produced; or offsite treatment and storage of some or all solid waste at the National Solid Waste Storage Facility designated for the Orange Walk region of Belize. Owing to the volume of waste anticipated to be produced at capacity occupation of the Section-1 development, as well as the sites some 27 mile distant location from Orange Walk Town, source separation for material recycling might serve to reduce and/or offset a significant portion of transportation costs to the NSW storage facility. The key components of waste that may be best suited to separation for recycling include paper, plastic, glass and metal waste, the paper fraction of which can be incinerated in smokeless incinerators to reduce solid waste volume by 15% (*<u>provided</u>* safety measures are observed to prevent runway fires in the savanna & broadleaf forest habitats), and the remaining inert fractions of which could be buried on site to reduce solid waste transport requirements by another 21%, for a total of 36%. Onsite composting might further reduce transport requirements by an additional 47%, for a total of 83%. Soil characteristics of the BJE (see **Page 50**) are likely to be suitable for the onsite burial of septic tank sludge, brining the total reduction to 93%, but not petroleum and other forms of toxic waste (see **Page 47**).

Hence, source separation and incineration of paper waste, separation of plastic, glass, and metal wastes for recycling, and onsite composting of organic waste will be likely to offer the greatest overall reduction in municipal solid waste transportation and storage costs to the proposed development, and therefore should be elected as the preferred treatment plan for solid waste.

Energy Use Options include purchase from the public utility, Belize Electricity Limited (BEL), and/or petroleum/wood scrap-based self generation. Owing to the scale of the project being proposed, petroleum/wood scrap-based self generation while likely to produce substantially cheaper electricity than purchase from BEL at present industrial rates, will require greater capital and management investments which the proponent is not prepared to commit to at start-up. The developer is likely, however, to elect to use BEL as a primary source of energy, perhaps with co-generation from petrochemical or wood scrap engaged at a later date to reduce overall rates. Consequently, BEL as the primary source of electrical energy has been elected as the preferred option for development in order to simplify project management.

13. MITIGATION MEASURES AND MONITORING PLANS

13.1 Based on the investigations, develop a mitigation matrix outlining mitigation measures for all potential negative environmental impacts including, but not limited to, construction activities, waste treatment and disposal, habitat alteration and erosion control, and management of pests and vectors (rodents, mosquitoes, flies, etc.),.

13.2 Provide a detailed monitoring plan to be implemented for the entire operation, identifying any agency/body responsible for its implementation and any training that may be necessary for the implementation of the plan. The plan should include monitoring of wastewater discharge characteristics (if any), changes in ecological species (including endangered species), contingency measures to emergency response to accidental events (fire, flood, hurricane, leakages, spillages, etc.).

13.3 Provide a detailed plan for the decommissioning and rehabilitation of the site to other uses in the event that the project is discontinued.

13.4 Identify and develop a water quality monitoring program able to detect any change (s) in ground water or surface water quality, that will impact:

I. Public health;
II. Forest, wetland and adjacent aquatic habitats; and
III. Endangered or threatened species in the project area and zone of influence.

MITIGATION MEASURES FOR THE PROPOSED DEVELOPMENT

A summary of the potential impacts of the proposed development, and the measures proposed for their mitigation is shown in **Table 45**.

Land-Based Transportation Impacts concern the reduction of broadleaf forest and coastal savanna habitats, which is an unavoidable impact and can only be mitigated by non-development. Indirect impacts include the increased potential for fire starts from (human) smoking, and/or operation of poorly maintained heavy equipment within either the timber management zone or residential tourism development; and increased potential for rainwater, sediment and petroleum-based pollution runoffs to accumulate in ground and/or surface waters such as local cenotes, coastal lagoons and/or Chetumal Bay; both of which constitute avoidable, but more than likely irreversible impacts. Residual negative impacts include increased potential for public injury risk from increased traffic loads likely to be produced by the proposed development, which also constitutes an avoidable impact.

Avoidable impacts can be mitigated by placing settlement ponds into the overall landscape plan for the development, and insuring all drainage from these settlement areas discharges into the inland waterway/canal system planned for development where ever possible; achieving zero-fire starts through smoking and/or open fire restrictions; outfitting all petroleum powered vehicles with spark arresters, along with maintenance of electrical connections on all vehicles for the prevention of electrical spark generation; utility mapping of all natural surface water sources suited for use in fire control;

TABLE 45

SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
Land-Based Transport Impacts	I. Reduction of broadleaf forest and coastal savanna habitat along carriageway alignments; II. Increased fire risk to the broadleaf forest and/or savanna habitat from increased human presence and operation of either electric or petroleum based vehicles; III. Delivery of fresh water, sediment and/or petroleum-based run-offs into area ground and/or surface waters; IV. Increased risk of public injury.	I. None, non-development; II. Achieve zero-fire starts through smoking and/or open fire restrictions; outfitting all petroleum powered vehicles with spark arresters, along with maintenance of electrical connections on all vehicles for the prevention of electrical spark generation; utility mapping of all natural surface water sources suited for use in fire control; and outfitting all work crews and/or maintenance vehicles with fire fighting equipment such as round point shovels, chemical foam extinguishers, and water uptake, storage & dispensing equipment; III. Place settlement ponds into the overall landscape plan for the development, and insure all drainage from these settlement areas discharge into the inland waterway/canal system planned for development where ever possible; IV. Place signage and traffic stops to limit vehicle traffic speed through residential areas; ensure staff are properly trained to operate vehicles; and adhere to public licensing requirements in regard to operation of vehicles by staff residents or guests.
Sea-Based Transport Impacts	I. Increased risk to any manatee that may frequent the site of propeller injury; II. Increased risk of public injury; III. Placement of marina and fuel facilities on Bennett's Lagoon, may lead to contamination of the Lagoon with petroleum effluents; IV. Presence of petroleum point source on Bennett's Lagoon may lead to emigration of area marine life.	I. Place and enforce signage on navigational regulations in the vicinity of Bennett's Lagoon and the Corozal Bay; provide education to development occupants in regard to manatee injury risk and conservation requirements; promote use of safety propellers on guest, staff and resident boats; II. Place signage to limit boat traffic speed; ensure staff are properly trained to operate boats; adhere to public licensing requirements in regard to operation of boats by staff residents or guests; III. Insure drainage of the 9500-acre site through the Bennett's Lagoon watershed for the purpose of facilitating flushing of petroleum residues in wet weather.
Material Supply Impacts	I. Alteration of sea floor and Bennett's Lagoon floor bathymetry, savanna topography, and alteration of the rainfall runoff characteristics of the coastal savanna habitat; II. Release and entry of erosion products into Bennett's Lagoon and Bahia Chetumal during excavation activities; Canal wall slump during excavation activities; III. Reduction of savanna groundcover and the sparse marine flora established offshore;	I. None, non-development; II. Deploy silt screens capable of limiting sediment travel to the immediate vicinity of the marina basin or canal works; Place retaining walls concurrently with canal and marina excavations in defense of both the pre-existing and final land and shoreline grades; III. None, non-development;

Continued…

TABLE 46

SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS

(Continued)

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
Material Supply Impacts (Continued)	IV. V. Perturbation of the terrestrial landscape and marine habitat during construction and operating activities, and hence the displacement of intolerant terrestrial & marine wildlife presently extent in the area (e.g. migrant & specialist birds, and Manatee); VI. Permanent displacement of mobile terrestrial and marine invertebrate and vertebrate wildlife during material movement activities; VII. Short-term elevation in water turbidity within Bennett's Lagoon and the near shore marine habitat from canal & marina construction and beach revetment activities; VIII. Long term sedimentation of the canal system and marina basin from savanna runoffs	IV. Re-landscape the project site with native vegetation and exclude fencing from use on the development site in order to promote re-colonization and interior movement of wildlife displaced during material movement activities; Deploy silt screens capable of limiting sediment travel to the immediate vicinity of canal works, and/or the marina basin; V. Re-landscape the project site with native vegetation and prohibit the use of fencing in order to promote re-colonization and interior movement of wildlife displaced during material movement activities; VI. Use silt screens to prevent downstream silt and sediment travel during construction of the marina facility; VII. Employ silt screens on the downstream side of canal construction activities and surrounding marina excavation activities; Postpone canal opening to the greater marine environment by leaving earthen plugs in place until canals have been constructed and adjacent lands stabilized.
Freshwater Supply Impacts	I. Aquatic wildlife may become entrained at water intake point; II. Change in botanical wildlife biodiversity along the non-navigable canal system; III. Change in animal wildlife biodiversity along the non-navigable canal system; IV. Landscaping runoffs, pool water & brine discharge, and septic leach-fields percolation may increase toxic chemical and nutrient concentrations in the lower reaches of the non-navigable canal system and Bennett's Lagoon, thereby significantly diminishing water quality in these surface waters; V. Contaminants may render the marine environment unsuitable for use by coastal wildlife, particularly birds and Manatee;	I. Provide for water to be extracted from within a screened intake pipe to reduce the potential for aquatic wildlife entrainment at the water pump intake site; II. None; Positive impact; III. None; Positive impact if wildlife biodiversity increases; IV. Use the non-navigable canal system as photo- oxidation and settlement ponds for any nutrient, landscaping residue and pool chemical runoffs; Ensure through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms; V. Use mixing and stop gates to manage flow through the non-navigable canal system and provide opportunity for photo-oxidation of toxic chemicals, dilution of salinity concentrations, and reduction of storm induced colloid or phytoplankton turbidity prior to release into Bennett's Lagoon; while ensuring, through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms.
Liquid Waste Treatment Impacts	I. Nominal reduction in land cover associated with plant placement; II. Reduces soil percolation capacity and/or water distribution characteristics through loading with particulate organic matter III. Alters direction of subsoil water transport & may potentially promote subsoil erosion	I. None, non-development; II. Construction of septic tank and drain field according to specifications, insuring that leaching rate does not exceed background percolation rate; III. Same as (II)

Continued…

TABLE 46

SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS

(Continued)

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
Liquid Waste Treatment Impacts (Continued)	IV. Sewage loading promotes excessive vegetation growth, and subsequent blocking of irrigation leach field effectiveness; V. Increased risk to wildlife within the non-navigable canals and Bennett's Lagoon of nutrient toxification. VI. Creates risk of contamination of ground water, water features, the non-navigable canals and Bennett's Lagoon with nutrients and human Pathogens; VII. Increased risk of low-level eutrophication of the non-navigable canals and Bennett's Lagoon.	IV. Use shallow root system vegetation such as grasses and/or annual flowers to cover irrigation leach fields; Regularly inspect, repair and thin excessive vegetation growth over irrigation leach fields; V. Regularly lime leach field in support of bacterial denitrification processes; adhere to manufacturer's specifications for tank sludge removal rates, which can be as frequent as every 4-6 months for large scale systems supporting heavy loading rates; VI. Ensure leaching rate does not exceed background percolation capacity; limit placement of leach field(s) to ≥ 100 meters distance, to reduce potential for effluent pooling; monitor water quality in the interior waterway and nearshore waters to ensure bacteria and nutrient levels do not exceed background levels; VII. As above (VI).
Solid Waste Treatment Impacts	I. Nominal land cover removal required for conduct of waste management practices; II. Public safety risk from onsite operation of smokeless incinerators.	I. None, non-development; II. Ensure incinerators are operated to specifications and that operators are properly trained in their operation.
Energy Supply/Usage Impacts	I. Increased road use for transportation of fuel to the project/power generating site; release of exhaust smoke during incineration and refueling of wood scrap, as well as fire risk during stockpiling of raw material for incineration; II. Creation of spill risk, particularly in the newly constructed canal system or coastal lagoons; accidental fire starts pose direct threats to area timber stands and wildlife. III. Improper reporting of incidental or accidental spills may cause environmental damage before mitigating measures can be imposed; IV. Increased risk of electrocution where poor electrical engineering standards are employed or from storm damage to utility lines; increased risk of chemical contamination, explosion, smoke inhalation and or fire; V. Remote location of development site may aggravate personal injury status; VI. Long-term exposure to petrochemical, noise or smoke from generating facilities may cause hearing loss or lung damage to staff;	I. None, non-development; Train staff in safe fuel handling and fire management procedures, and regularly inspect all fuel usage sites and handling practices. II. Maintain all fuel containers and generating equipment in fuel bonds; train staff in safe fuel handling procedures and fire management along with regularly monitoring of fuel storage and generating sites for spills; III. Regularly monitor fuel storage and generating sites for spills; IV. Ensure accredited electrical engineers during the design and construction phase of the development; use public utility endorsed protocols for handling storm damaged power lines; maintain fuel storage facilities at safe distance from generating equipment and provide warnings about inflammable device use near fuel storage areas; V. Have at least two full-time staff receive emergency medical training at Belize City BERT Center; VI. Provide staff with proper clothing, gloves and noise protection, smoke protection and firefighting equipment; insure staff have been trained in appropriate safety protocols for handling and maintenance of fuel storage facilities and fires.

Continued…

TABLE 46

SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS

(Continued)

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
Energy Supply/Usage (Continued)	VII. Production of noise or smoke pollution and up to 2.0 x 10^{11} BTUs of thermal waste per year.	VII. Place generating equipment in specially designed noise-retarding shelters; and discharge exhaust waste into baffled exhaust pipes buried underground.
Aquatic & Marine Wildlife Habitat Impacts	I. Bank modification and extirpation of Riverine Mangrove Forest habitat where the Marina is to be established in Bennett's Lagoon; disturbance/removal of marine sediments for creation of the marina basin; II. Increased risk of sediment or turbidity-based degradation of the canal system and coastal lagoon water quality conditions necessary for existing marine life, during beach revetment activities, or construction of the inland canals and marinas; Petroleum-based contamination of the canal system and coastal lagoons from spill accidents and gas-diesel-kerosene-powered boating activities; chemical or pesticide-induced impacts on marina and aquatic flora & fauna from utilization of the canal &l lagoon system for drainage of the golf course and other amenities.	I. None, Non-Development; II. Leave plugs in the canal system until any construction borne turbidity either settles or can be gradually diluted to pre-existing conditions; and use of silt screens during any dredging activities associated with beach revetment or marina construction; use bonds for storage of all petroleum-based products, along with construction and closure of canal gates in the event of a spill accident to afford time for clean up procedures to be undertaken; offer of preferential docking/storage rates for boat operators using 4-cycle engines or non-petroleum based power schemes; require the use of pest-specific compounds (i.e. pesticides which are non-toxic to untargeted species of wildlife) that also contain binders to reduce or eliminate their potential wind or water borne migration from the application site. The latter characteristic also being complimented by (1) design of the golf course and other effluent-bearing amenities (e.g. swimming pools) to drain into designated holding ponds for photo-oxidation of any effluent born chemicals or pesticides prior to discharge into the canal or coastal lagoon systems, and (2) pesticide application in dry, low wind conditions suited to binder adhesion.
Terrestrial Wildlife Habitat Impacts	I. Increased fractionation of the Xaibe Landsystem Broadleaf Forest ecosystems through creation of logging conveyances, and reduction of savanna habitat vegetation cover from landfill, canal excavation, and road & building construction activities; and II. Increased risk for accidental fires to become ignited within the residential tourism development from novice human occupation of the area, followed by subsequent fire-burn to the remaining savanna habitat and Xaibe Landsystem Broadleaf Forest ecosystems; emigration of resident, but uncommon specialist species of wildlife (e.g. littoral birds) that are dependent on the absence of human interventions in the area, followed by their replacement with more common generalist species, and hence, an overall reduction in area biodiversity.	I. None, non-development; II. Economize in the construction of any new inter-forest conveyances by insuring that such conveyances will offer multiple, rather than solitary, stem yields; examine the feasibility of forest product eco-certification registration and/or carbon sequestration credits to improve economic yield per stem, and hence, reduce new conveyance demands; replant exposed soils with native vegetation; along with creation and designation of buffer zones, particularly for fire management along existing tracks of Glady and Littoral/Beach Forest.

Continued…

TABLE 46

SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS

(Continued)

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
Species-Specific Wildlife Impacts	I. Increased potential abandonment of the area by the Great Curassow, and other resident endangered species such as the black catbird, in response to the construction activity and human occupation being proposed; increased risk of rookery abandonment by resident wood storks and wading bird species as a result of excess tourism-based disturbance; increased risk of boating-based noise disorientation and mortality risk to Manatee from reciprocating engine operation and prop-injuries, II. Increased potential for predator/prey equilibrium (e.g. the jaguar- peccary-agouti food chain) to become disturbed by newly engineered access constraints and/or long term human occupation of the area; increased potential for biodiversity reduction over time from highly diverse specialist species abandonment of the area in favor of less diverse generalist species.	I. Immediate re-landscaping of barren and/or filled areas with landscaping strategies that include adequate mixtures of native plant species having diverse food value, density & height arranged in contiguous corridors that extend between the broadleaf forest, savanna and littoral/beach habitats, in order to afford specialist species safe avenues of movement between key habitats along corridors with improved food value and hence, carrying capacity; II. Concerted adherence to visitation management regulations which are designed to insure all visitation is supervised by trained tour guides, that visitation frequency is not excessive, and that visitation is neither disruptive or intrusive on rookery activities; provide for enforcement of Manatee conservation guidelines in the vicinity of the proposed development, particularly as they pertain to the imposition of: (1) demarcation of no wake zones with signage along approved navigation routes leading to the entrance to Bennett's Lagoon, marina, docking facilities, and access to navigable canals that are marked with lighted navigational buoys; (2) public education, particularly for all development residents and staff concerning Manatee tourism guidelines; and (3) a mechanism for enforcement and penalty collection, in the event a Manatee is killed as a direct violation of the navigational and/or tourism guidelines for Manatee conservation.
Cultural & Social Impacts	I. Potential / accidental damage to one or more of cultural sites during the construction phase of development; II. Release Potential looting by development staff, guests and/or residents, which also constitutes an avoidable impact. III. Reduction Proposed development will create jobs and increase foreign exchange earnings through unit sales revenue of savanna groundcover and the sparse marine flora established offshore; IV. Remote location of proposed development site may increases risk of complications from accidental / serious injury to workers	I. Eliminate or set aside these archaeological areas as green space; Provide for arrangement with the Institute of Archaeology for an archaeological monitor to be present during land clearing and construction of the proposed development; II. Provide for education of development staff, guests and residents as to the importance and legal obligations for conservation for cultural sites and artifacts in Belize, perhaps along with designation of one or more sites for managed tourism use; III. None, positive impact; IV. Have a minimum of 3 - 5 full-time staff on-site trained in emergency medical practices at the BERT facility in Belize City

…End

and outfitting all work crews and/or maintenance vehicles with fire fighting equipment such as round-point shovels, chemical foam extinguishers, and water uptake, storage and dispensing equipment; providing for slow speed (i.e. < 15 mph), sign placements along roads and trails, placement of traffic stops in residential areas, appropriate training for all development staff operating vehicles at the site, and adherence to public licensing requirements for all vehicle operators, inclusive of staff, residents and guests.

Sea-Based Transportation Impacts concern the increased risk of prop injury to Manatee; increased potential for public injury risk, both are irreversible but avoidable impacts. Residual negative sea-based transportation impact risks concern increased potential for public injury risk. Water impacts on area water resources posed by the proposed development concern the potential for contamination of area surface waters with petroleum effluent; and the reduction of marine flora and fauna in response to petroleum contamination, both are avoidable and reversible.

Mitigation measures for the irreversible impacts include: establishing regulations and placing signage in near shore waters of Bennett's Lagoon and the Corozal Bay indicating boat speed, and approved navigational corridors for boats approaching or departing from Bennett's Lagoon and the Corozal Bay, as well as the reporting and procedural requirements in the event of prop injury to Manatee; providing education for all boat operators using the marina about (1)navigational regulations for the area; and (2) the importance of Manatee conservation and the need for responsible navigation practices and slow operating speeds when navigation in the vicinity of Bennett's Lagoon and/or Corozal Bay. Mitigating measures for the water impacts include: insuring drainage of the 9500-acre site through the Bennett's Lagoon watershed for the purpose of facilitating flushing of petroleum residues in wet weather; insuring the responsible storage and handling of petroleum products at the marina's fuel depot, and hence prevent or eliminate the risk of petroleum spills and contamination of area waters; and educational measures that communicate the advantages of 4-cycle marine engine use.

Material Supply Impacts concern the alteration of sea floor and Bennett's Lagoon floor bathymetry, savanna topography, and alteration of the rainfall runoff characteristics of the coastal savanna habitat due to material excavation. These impacts are largely unavoidable and irreversible and can only be mitigated by non-development. Indirect impacts include the release and entry of erosion products into Bennett's Lagoon and Chetumal Bay during excavation activities and canal wall slump during construction. Measures available for impact mitigation include: deployment of silt screens capable of limiting sediment travel to the immediate vicinity of canal works, and/or the marina basin, to pre-existing levels of turbidity; and placement of retaining walls concurrently with canal and marina excavations in defense of both the pre-existing and final land and shoreline grades.

Biological impacts include: reduction of savanna groundcover and the sparse marine flora established offshore from the excavation and fill activities proposed; perturbation of the terrestrial landscape and marine habitat during construction and operating activities, and hence the displacement of intolerant terrestrial and marine wildlife present in the area (e.g. migrant and specialist birds, Wood stork and Manatee).

Mitigation measure include thorough re-landscaping of the project site with native vegetation and exclusion of fencing from use on the development site in order to promote re-colonization and interior movement of wildlife displaced during material movement activities; as well as deployment of silt screens capable of limiting sediment travel to the immediate vicinity of canal works, and/or the marina basin, to pre-existing levels of turbidity.

Water resource impacts concern the potential for short-term elevation in water turbidity within Bennett's Lagoon and the near shore marine habitat from canal and marina construction and beach revetment activities; long term sedimentation of the canal system and marina basin from savanna runoffs, which are avoidable and reversible impacts. These impacts can be mitigated by employing silt screens on the downstream side of canal construction activities and surrounding marina excavation activities; and postponement of canal opening to the greater marine environment by leaving earthen plugs in place until the canals have been constructed and adjacent lands stabilized.

Freshwater Supply Impacts concerns the potential for aquatic wildlife entrainment at the pump station's water intake point, which is an avoidable impact. Biological impacts from freshwater delivery to the project site includes that likely change in vegetation cover and wildlife occupancy in irrigated areas and along the non-navigable canal system, the vegetation component of which is a positive impact, and the wildlife occupancy component of which may be undesirable if net biodiversity decreases within the BJE, both of which are avoidable impacts. Water resource impacts from landscaping runoffs, pool water and brine discharge, and septic leach field's percolation may increase toxic chemical and nutrient concentrations in the lower reaches of the non-navigable canal system and Bennett's Lagoon, thereby significantly diminishing water quality in these surface waters. Indirect and Residual negative water resource impacts include the potential for rendering the marine environment unsuitable for use by coastal wildlife, particularly birds and Manatee. Measures available for mitigating these impacts include: extraction of water from within a screened intake pipe to reduce the potential for aquatic wildlife entrainment at the water pump intake site; and the incorporation of mixing and stop gates to manage flow through the non-navigable canal system and provide opportunity for photo-oxidation of toxic chemicals, dilution of salinity concentrations, and reduction of storm induced colloid or phytoplankton turbidity prior to release into Bennett's Lagoon; while ensuring, through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms.

Liquid Waste Discharge Impacts concerns: the amount of land cover removal required for plant placement; gradual reduction of percolation capacity and/or alteration of water distribution characteristics as may result from subsoil loading with particulate organic matter during landscape irrigation applications; and subsoil erosion from leakages and/or ground settlement after construction. These physical impacts can be mitigated by construction of pipe works and irrigation fields to specification, and ensuring that leaching rates at all irrigation endpoint are less than background percolation capacity. Biological impacts include: excessive irrigation leach-field damage from root growth and subsequent reduction in effectiveness; increased risk to aquatic wildlife in the non-navigable canals and Bennett's Lagoon from toxification by sewage leachate from pipe cracks or damaged irrigation leach fields.

These biological impacts can be partially or wholly mitigated by: using shallow root system species such as grasses and/or perennial flowers as groundcover for irrigation leach fields; regular inspection and thinning of excessive vegetation growth over irrigation leach fields, regular repairs to and liming of leach fields in support of bacterial denitrification processes; and adherence to manufacturer's specification for tank sludge removal rates, which can be as frequent as every 4-6 months for large scale systems supporting heavy loading rates.

Water Resource Impacts from sewage effluent discharge concerns risk of contamination of groundwater, the non-navigable canals and Bennett's Lagoon with nutrients and/or human pathogens. Indirect and residual impacts include the potential for low level eutrophication of the proposed developments non-navigable canals and Bennett's Lagoon. These impacts can be partially or wholly mitigated by: ensuring leaching rate does not exceed background percolation capacity, placement of leach field(s) at $\geq$ 100 meters distance, to reduce potential for effluent pooling; and ensuring the interior waterway and near shore waters are regularly monitored for Coloform bacteria, Vibrio bacteria and nitrogen levels in defense of background levels in the waters surrounding non-navigable canals and Bennett's Lagoon and as a check to ensure proper septic tank and leach field function.

Solid Waste Storage Impacts concern land cover removal requirement; and potential injury to incinerator operators. Mitigating measures include insuring proper training of incinerator operators.

Energy Use Impacts concern increased road use for fuel supply due to fuel impacts from petroleum-based energy generation; and the release of exhaust smoke during incineration and refueling, as well as fire risk during stockpiling of raw material for incineration. Potential indirect negative petroleum-based fuel impacts concern spill risk, particularly in the canal system or adjoining coastal lagoons, and potential residual negative fuel impacts concern improper reporting of incidental or accidental spills, which my cause environmental damage without mitigating measures being imposed.

Potential indirect negative wood scrap-based fuel impacts concern the impact of accidental fire starts on area timber stands and wildlife, but potential residual negative wood scrap-based fuel impacts are nil owing to the end-product (ash) being inert. Measures available for mitigation of these potential impacts include: construction of fuel bonds and maintenance of all fuel containers and generating equipment within these structures; and training of staff in safe fuel handling and fire management procedures, and regular inspections of all fuel usage sites and handling practices.

Health and Safety impacts concern increased risk of electrocution where poor electrical engineering standards are employed or from storm damage to utility lines, which are avoidable and reversible impacts. Direct negative impacts concern increased risk of chemical contamination, explosion, smoke inhalation, and/or fire. Potential indirect negative health and safety impacts from petroleum or wood scrap-based energy generation concern increased risk of personal injury aggravation due to the proposed development's remote location; the effect of long-term exposure to petrochemicals, noise or smoke associated with generating facilities.

These impacts may be partially or wholly mitigated by: using accredited electrical engineers during the design, construction and operating phases of the development and the use of public utility endorsed protocols for handling storm damaged power lines; and development of a safety protocol for all fuel handlers, maintaining fuel storage facilities at safe distances from generating equipment, providing warnings against use of inflammable devises near fuel storage areas, having at least two full-time staff receive emergency medical training at the Belize City BERT Center, and providing staff with proper clothing , gloves and noise pollution protection equipment, and/or fire fighting equipment, to reduce potential for health effects.

Pollution impacts from energy supply concerns the proposed development's production of noise pollution and thermal waste up to 2.0 x 10^{11} BTUs per day at capacity development (based on capacity demand of 60 mW, and a conversion rate of 138,707 BTUs or 41 kW hrs/gal Diesel). Other impacts include noise induced hearing loss in staff, petroleum contamination of groundwater or adjacent canal and marine waters, and/or smoke-based air pollution. Mitigation measures for these impacts include: placement of generating equipment in specially designed noise-retarding or smoke-arresting shelters, and the discharge of exhaust waste into baffled exhaust pipes buried underground; and providing staff with proper safety clothing and noise pollution protection equipment; and the implementation of regular wildlife monitoring protocol to determine the presence/absence of noise or smoke-related impacts.

Wildlife Impacts concern lagoon bank modification and extirpation of *Riverine Mangrove Forest* habitat where the marinas are to be established in Bennett's Lagoon, and disturbance/removal of marine sediments for creation of the marina basin, which directly affects marine and aquatic habitats. Other impacts include: increased risk of sediment or turbidity-based degradation of the canal system and coastal lagoon water quality conditions necessary for existing marine life, during beach revetment activities, or construction of the inland canals and marinas; petroleum-based contamination of the canal system and coastal lagoons from spill accidents and gas/diesel/kerosene-powered boating activities; and chemical or pesticide-induced impacts on marina and aquatic flora and fauna from utilization of the canal and lagoon system for drainage of the golf course and other amenities.

Mitigation measures for the above mentioned impacts include; leaving plugs in the canal system until any construction borne turbidity either settles or can be gradually diluted to pre-existing conditions; and use of silt screens during any dredging activities associated with beach revetment or marina construction; use of bonds for storage of all petroleum-based products; construction and closure of canal gates in the event of a spill accident to afford time for clean up procedures to be undertaken; offer of preferential docking / storage rates for boat operators using 4-cycle engines or non-petroleum based power schemes; use of *pest-specific* compounds (i.e. pesticides which are non-toxic to untargeted species of wildlife) that also contain binders to reduce or eliminate their potential wind or water-borne migration from the application site. The latter characteristic also being complimented by (1) design of the golf course and other effluent-bearing amenities (e.g. swimming pools) to drain into designated holding ponds for photo-oxidation of any effluent-born chemicals or pesticides prior to discharge into the canal or coastal lagoon systems, and (2) pesticide application in dry, low wind conditions suited to binder adhesion.

Terrestrial habitat impacts from implementation of the proposed development concern the increased fractionation of the Xaibe Landsystem Broadleaf Forest ecosystems through creation of logging conveyances, and reduction of savanna habitat vegetation cover from landfill, canal excavation, and road & building construction activities; all of which are avoidable impacts. Other terrestrial habitat impacts concern the potential for accidental fires to become ignited within the residential tourism development from novice human occupation of the area, followed by subsequent fire-burn to the remaining savanna habitat and Xaibe Landsystem Broadleaf Forest ecosystems; along with emigration of resident, but uncommon specialist species of wildlife (e.g. littoral birds) that are dependent on the absence of human interventions in the area, followed by their replacement with more common generalist species, and hence, an overall reduction in area biodiversity, both of which also constitute avoidable impacts.

Mitigating measures for the terrestrial habitat impacts include: the economical construction of any new inter-forest conveyances by insuring that such conveyances will offer multiple, rather than solitary, stem yields; and examine the feasibility of forest product eco-certification registration and/or carbon sequestration credits to improve economic yield per stem, and hence, reduce new conveyance demands; immediate replanting of exposed soils with native vegetation; along with creation and designation of buffer zones, particularly for fire management, along existing tracks of Glady and Littoral / Beach Forest.

Species-specific impacts concern the potential abandonment of the area by the Great Curassow, and other resident endangered species such as the black catbird, in response to the construction activity and human occupation being proposed; increased risk of rookery abandonment by resident wood storks and wading bird species as a result of excess tourism-based disturbance; and increased risk of boating-based noise disorientation and mortality risk to Manatee from reciprocating engine operation and prop-injuries, all of which represent avoidable impacts. Other impacts include: the potential for predator/prey equilibrium (e.g. the jaguar/peccary/agouti food chain) to become disturbed by newly engineered access constraints and/or long term human occupation of the area; and the potential for biodiversity reduction over time from highly diverse specialist species abandonment of the area in favor of less diverse generalist species.

Mitigating measures of species-specific impacts include: immediate re-landscaping of barren and/or filled areas with landscaping strategies that include adequate mixtures of native plant species having diverse food value, density & height arranged in contiguous corridors that extend between the broadleaf forest, savanna and littoral/beach habitats, in order to afford specialist species safe avenues of movement between key habitats along corridors with improved food value and hence, carrying capacity; adherence to visitation management regulations which are designed to insure all visitation is supervised by trained tour guides, that visitation frequency is not excessive, and that visitation is neither disruptive or intrusive on rookery activities; and *enforcement* of Manatee conservation guidelines (see **Addenda 5**) in the vicinity of the proposed development, particularly as they pertain to the imposition of: (1) demarcation of no wake zones with signage along approved navigation routes leading to the entrance to Bennett's Lagoon, marina docking facilities, and access to navigable canals that are marked with lighted navigational buoys as shown in **Illustration 52**;

(2) public education, particularly for all development residents and staff concerning Manatee tourism guidelines; and (3) a mechanism for enforcement and penalty collection, in the event a Manatee is killed as a direct violation of the navigational and/or tourism guidelines for Manatee conservation.

<u>Culture, Customs and Social Impacts</u> concern the potential / accidental damage to one or more of cultural sites of antiquity during the construction phase of development; potential looting by development staff, guests and/or residents.

Mitigation measures include: eliminate or set aside these archaeological areas as green space; arrange with the Institute of Archaeology for an archaeological monitor to be present during land clearing and construction of the proposed development; and provide education for development staff, guests and residents as to the importance and legal obligations for conservation for cultural sites and artifacts in Belize, perhaps along with designation of one or more sites for managed tourism use. Other impacts include the possibility of the remote location, increasing serious injury risk to residents, guests or workers; which can be mitigated by 3 - 5 full-time staff trained in emergency medical practices at BERT facility in Belize City.

CUMULATIVE IMPACTS & MITIGATION MEASURES

Potential cumulative impacts presented by the proposed development are summarized in **Table 46**.

Land Use Impacts

Cumulative land use impacts of the proposed development concern the disturbance of approximately 4,178 acres of *Marine Salt Marsh*; 100 acres of *Littoral Forest*; and reduction of *Coastal Rhizophora mange Forest* habitats, which are underprotected habitats in Belize, through canal excavation, landfill and beach revetment activities. These activities constitute unavoidable impacts that can only be partially mitigated by replanting landfill sites with natural vegetation immediately following the construction activities being proposed.

Infrastructure Impacts

Cumulative infrastructure impacts of the proposed development, particularly new roads, canals, buildings and mechanical plants concern: (1) Increased fractionation of the Xaibe Plain / Lowland Broadleaf Forest Land System from construction of new logging trail conveyances, which ultimately results in displacement of specialist species of high conservation value, and is an unavoidable impact that can only be partially mitigated by optimizing new conveyance placement within the timber management zone (see **Page 158 - 164**); (2) Increased risk of development-born chemical and petroleum pollution of coastal waters from dredging and excavation activities, swimming pool treatment with chlorine, brine production during production of potable water from sea water, and petroleum release from depots, boats, and vehicles, all of which are largely avoidable impacts that can be mitigated through use of plugs and silt screens to retain & settle sediments, use of holding

TABLE 46

MITIGATION MATRIX OF CUMULATIVE IMPACTS

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
Land Use	I. Disturbance of approximately 4,178 acres of *Marine Salt Marsh*; 100 acres of *Littoral Forest*; and removal of 100 acres of *Coastal Rhizophora mange Forest*; or all of their present extent within the Stage 1 development through canal excavation, landfill and beach revetment activities.	I. Replant with natural vegetation. .
Infrastructure	I. Increased fractionation of the Xaibe Plain / Lowland Broadleaf Forest Land System from construction of new logging trail conveyances, which ultimately results in displacement of specialist species of high conservation value, II. Increased risk of development-born chemical and petroleum pollution of coastal waters from dredging and excavation activities, swimming pool treatment with chlorine, brine production during production of potable water from sea water, and petroleum release from depots, boats, and vehicles; and III. Additional vehicles will be operated throughout the national highway infrastructure, imposing further reductions in existing carriageway lifespan, and increased risk to public injury.	I. Optimize new conveyance placement within the timber management zone; II. Use plugs and silt screens to retain & settle sediments, use of holding ponds to photo-oxidize coloring in pool effluent and afford slow release of brine into brackish coastal waters, use of bonds for petroleum storage, and incentives for boat owners to use 4-cycle diesel outboard engines; and III. Collection of taxes from new community residents for proportional remuneration of maintenance and depreciation costs.
Traffic	I. The significant level of employment and occupancy anticipated by the proposed development will undoubtedly increase passenger traffic levels along roads leading to/from the proposed development site, which will in turn impose cumulative traffic impacts in the form of noise pollution (duration), wear on public roads, and increased risk of accidental injury to area residents and facility staff alike,	I. Insure all vehicles used to access the project site comply with licensing regulations, and are driven by licensed operators.
Water Quality	I. Cumulative water quality abstraction impacts are anticipated to be nil, owing the development principally relying on rainwater catchment in cisterns, with only partial abstraction and treatment of canal and bay waters by reverse osmosis, neither of which are limiting in supply. II. Increased risk of development-born chemical and petroleum pollution of coastal waters from dredging and excavation activities, swimming pool treatment with chlorine, brine production during production of potable water from sea water, and petroleum release from depots, boats, and vehicles.	I. None, Nil. II. Use water features as photo-oxidation and settlement ponds for any nutrient, landscape and pool chemical runoffs. Ensure through monitoring, that abstracted or discharged water is devoid of these constituents, as well as any noxious microbial blooms.

Continued…

TABLE 46

MITIGATION MATRIX OF CUMULATIVE IMPACTS

(Continued)

CATEGORY	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
Wildlife	I. Incremental mortality risk posed to Manatee from potential contamination of coastal waters with chemical and/or petroleum-based pollutants and prop injury from increase outboard motor presence on the previously rural coastline of Northern Belize. II. Cumulative impacts on terrestrial wildlife concern endangered species habitat loss from development-born landscape modification and endangered species emigration from the BJE from increased human presence and unmanaged tourism visitation, particularly among resident and transient coastal birds, but also among predator-prey systems.	I. Both of these impacts are avoidable and can be partially or wholly mitigated through the contaminant control measures outlined above, and observance of Manatee tourism guidelines outlined in Addenda 5. II. While the former of these impacts is not avoidable, it may be partially or wholly mitigated through design engineering measures that either defend or create wildlife corridors through the development footprint. Conversely however, the latter of these impacts is avoidable through use of trained tour-guides administration of wildlife viewing within the BJE development site
Cultural & Social	I. Potential damage or destruction and loss of culturally important artifacts during landscape modification activities, and/or looting of found sites having cultural importance represent continuing and widespread impacts on Belize's cultural resources that must be administered by the IOA. II. The proposed development will clearly have an important positive impact on employment in the Sarteneja, Maskall, Shipyard, Chunox, Copperbank and Corozal communities and perhaps even more importantly, increase foreign revenue earnings and national economic growth.	I. These impacts are avoidable, and in the former case can be mitigated by ensuring an IOA-approved archaeological observer is present on site during all landscape modification activities to evaluate the significance of any finds and to make recommendations as to an appropriate course of action regarding their preservation, while in the latter case can best be mitigated by proactive supervision and control of the sites rich potential for ecotourism through supervision by trained guides. II. This growth however, will also be likely to increase demand on area social services (i.e. schools and heath care services), which can only be mitigated through taxation and GOB provision of the material & intellectual resources.
		...End

ponds to photo-oxidize chlorine in pool effluent and afford slow release of brine into brackish coastal waters, use of bonds for petroleum storage, and incentives for boat owners to use 4-cycle diesel outboard engines; and (3) the proposed development site will undoubtedly bring new and additional vehicles to be operated throughout the national highway infrastructure, imposing further reductions in existing carriageway lifespan, and increased risk to public injury, which are unavoidable impacts that can only partially be mitigated through collection of taxes from new community residents for proportional remuneration of maintenance costs for public road use.

Traffic Impacts

The significant level of employment and occupancy anticipated by the proposed development will undoubtedly increase passenger traffic levels along roads leading to/from the proposed development site, which will in turn impose cumulative traffic impacts in the form of noise pollution (duration), wear on public roads, and increased risk of accidental injury to area residents and facility staff alike, the former two being direct, unavoidable impacts, and the latter being an indirect impact which can be either partially or wholly mitigated by insuring all vehicles used to access the project site comply with licensing regulations, and are driven by licensed operators.

Water Quality Impacts

Cumulative water quality abstraction impacts are anticipated to be limited to the potential for wildlife entrainment on pump screens, owing the development principally relying on rainwater catchment in cisterns, with only partial abstraction and treatment of canal and bay waters by reverse osmosis, neither of which are limiting in supply. Development born pollution impacts of the variety detailed above embody the types of cumulative water quality impacts that can arise from the proposed development, but are avoidable by the above-recommended measures.

Impacts On Wildlife Abundance

Cumulative impacts on aquatic wildlife concern the incremental mortality risk posed to Manatee from potential contamination of coastal waters with chemical and/or petroleum-based pollutants and prop injury from increase outboard motor presence on the previously rural coastline of Northern Belize. Both of these impacts are avoidable and can be partially or wholly mitigated through the contaminant control measures outlined above, and observance of Manatee tourism guidelines outlined in Addenda 5.

Cumulative impacts on terrestrial wildlife concern endangered species habitat loss from development-born landscape modification and endangered species emigration from the BJE from increased human presence and unmanaged tourism visitation, particularly among resident and transient coastal birds, but also among predator-prey systems. While the former of these impacts is not avoidable, it may be partially or wholly mitigated through design engineering measures that either defend or create wildlife corridors through the development footprint. Conversely however, the latter of these impacts is avoidable through use of trained tour-guides administration of wildlife viewing within the BJE development site.

Cultural & Social Impacts

The cumulative social impact risks of the proposed development concern the potential damage or destruction and loss of culturally important artifacts during landscape modification activities; and/or looting of found sites having cultural importance; both of which represent continuing and widespread impacts on Belize's cultural resources that must be administered by the IOA. These impacts are avoidable, and in the former case can be mitigated by ensuring an IOA-approved archaeological observer is present on site during all landscape modification activities to evaluate the significance of any finds and to make recommendations as to an appropriate course of action regarding their preservation, while in the latter case can best be mitigated by proactive supervision and control of the sites rich potential for ecotourism through supervision by trained guides.

The proposed development will clearly have an important positive impact on employment in the Sarteneja, Maskall, Shipyard, Chunox, Copperbank and Corozal communities and perhaps even more importantly, increase foreign revenue earnings and national economic growth. This growth however, will also be likely to increase demand on area social services (i.e. schools and heath care services), which can only be mitigated through taxation and GOB provision of the material & intellectual resources.

14. MONITORING PLANS

14.1 Provide a detailed monitoring plan to be implemented for the entire operation, identifying any agency/body responsible for its implementation and any training that may be necessary for the implementation of the plan. The plan should include monitoring of wastewater discharge characteristics (if any), changes in ecological species (including endangered species), contingency measures to emergency response to accidental events (fire, flood, hurricane, leakages, spillages, etc.).

14.2 Provide a detailed plan for the decommissioning and rehabilitation of the site to other uses in the event that the project is discontinued.

14.3 Identify and develop a water quality monitoring program able to detect any change (s) in ground water or surface water quality, that will impact:

I. Public health;
II. Forest, wetland and adjacent aquatic habitats; and
III. Endangered or threatened species in the project area and zone of influence.

MONITORING PLANS FOR THE PROPOSED DEVELOPMENT

The parameters and scheduling of monitoring activities recommended for the development are shown in **Table 46**; and recommended monitoring points are shown in **Illustration 62**.

Land-Based Transportation Monitoring Requirements consist of inspections of fire fighting equipment to be conducted weekly; while roadway runoff settlement areas for containment integrity should be inspected monthly; and staff operating licenses should be inspected annually for necessary renewal requirements.

Sea-Based Transportation Monitoring Requirements concern the need to establish the degree, if any, of petroleum contamination occurring within the navigable canal system and/or Bennett's Lagoon on a quarterly basis; and for the development to support and/or participate in enforcement of Manatee conservation in the area by conducting weekly monitoring patrols to educate and enforce navigational regulations in the area, particularly as they relate to boat speed and Manatee injury. Manatee conservation education effectiveness should be assessed at least once yearly.

Material Supply Monitoring Requirements concern the need to conduct monthly inspections of canal and marina embankments for slump and/or erosion, as well as monthly inspections of turbidity in Bennett's Lagoon during the construction phase of the development and the wet weather season to insure that area water quality does not fall below background levels.

Water Resource Monitoring Requirements Monitoring requirements primarily concern the need for monthly checks of water quality in all water features for total nitrogen, pesticide, chlorine and Coloform and Vibrio bacteria levels.

Liquid Waste Monitoring Requirements include quarterly inspection of land adjacent to irrigation leach fields for excessive vegetation growth, pruning of vegetation and liming of leach fields in support of bacterial denitrification processes. Area water quality should be monitored on a quarterly basis for Coloform and Vibrio bacteria population levels and nitrogen levels in defense of background levels in the proposed development's non-navigable canals and Bennett's Lagoon and as a check to ensure proper septic tank and leach field function.

Solid Waste Monitoring Requirements consist of the need for the annual inspection of incinerators and staff operation to insure safe operating conditions are procedures are in place.

Energy Monitoring Requirements for public energy use should include monthly inspections of power lines and primary electrical connection points for damage from storms and/or tree falls. Monitoring requirements for petroleum or wood scrap-based self-generation should include regular (weekly) signed inspections of all fuel storage and power generating equipment for repair and/or maintenance requirements before and during operation

Wildlife Monitoring Requirements will include weekly inspection of all petroleum stores & pool effluent and brine ponds for leakages; quarterly inspection canal and lagoon water quality, including dissolved oxygen, turbidity, salinity, and temperature; and Annual survey of wildlife abundance and use of landscaped corridors established as replacement land cover within the design scheme of the overall residential tourism development.

Culture, Customs and Social Monitoring Requirements will require the need for an archaeological monitor, approved by the Belize Institute of Archaeology, to observe all land clearing and construction activities at the project site, for the purpose of advising preservation requirements in the event of an archaeological find during construction; and the proponent will need to develop a monitoring program in conjunction with the Institute of Archaeology for inspection of known sites for damage or looting by development staff, guests or residents.

TABLE 47

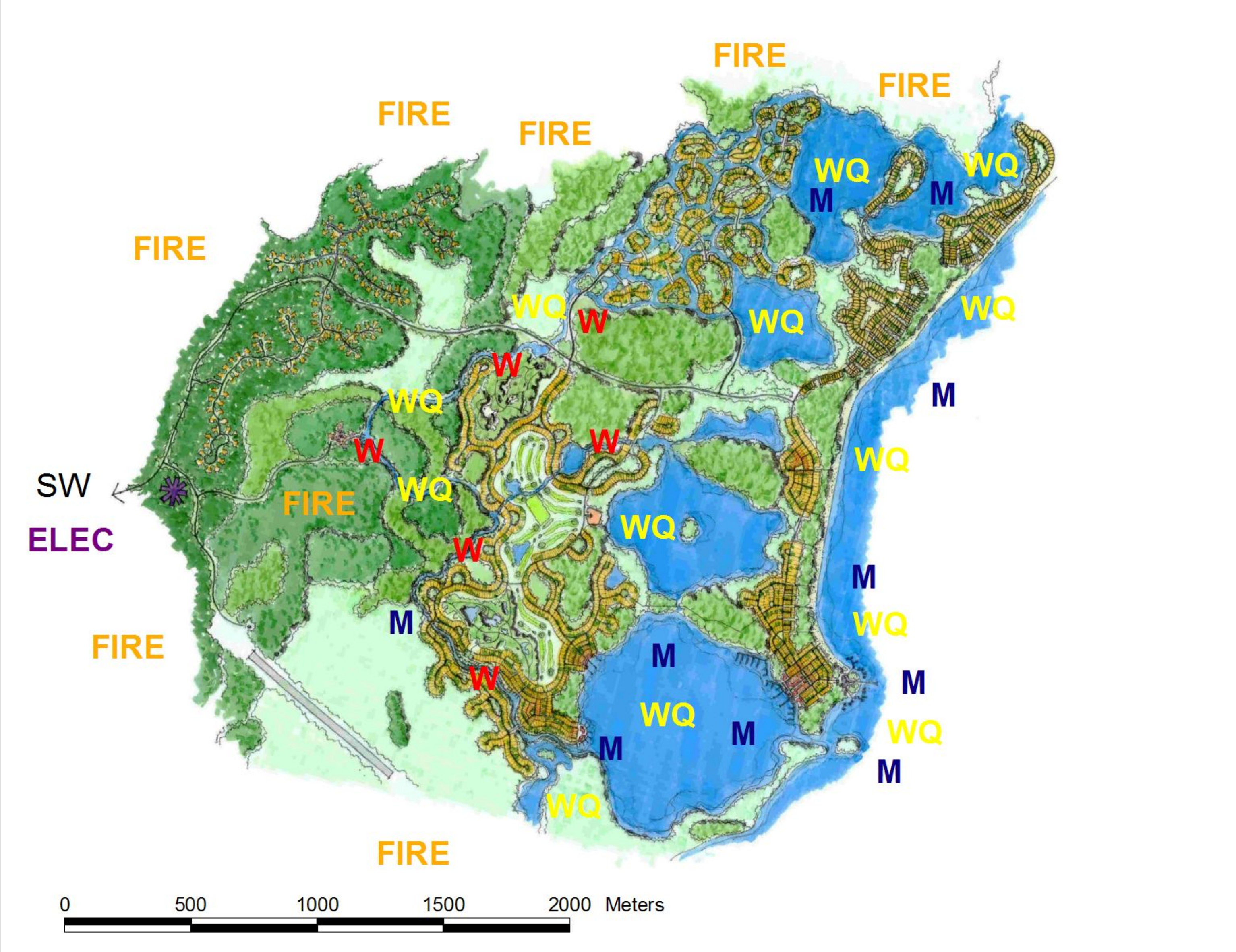
RECOMMENDED MITIGATION-MONITORING PROGRAM FOR THE PROPOSED DEVELOPMENT

DEVELOPMENT CATEGORY	PROGRAM OR ACTION TO BE UNDERTAKEN	CRITICAL LEVELS, PARAMETERS OR CHARACTERISTICS	COMPLETION DATE OR FREQUENCY	MAP SYMBOL REFERENCE[1]
TRANSPORTATION	*Land Based:* Inspect all firefighting equipment on a weekly basis, and staff vehicle operating licenses should be inspected on an annual basis for renewal requirements. *Sea Based:* Identify marine pollution status on a quarterly basis by assessing water quality in coastal canals and lagoons. Support enforcement of manatee conservation and navigational regulations, as well as assess manatee conservation education effectiveness yearly.	Water Quality Assessments Should Be Conducted As Shown In **Table 11, Page 64**	Land Based: Weekly / Annually Sea Based: Quarterly / Annually	**---** **WQ / M**
MATERIAL SUPPLY	Inspect canal & marina walls on a monthly basis, and monitor turbidity in Bennett's Lagoon on a quarterly basis during the construction phase of development.	As Above	Monthly / Quarterly	**W**
FRESHWATER SUPPLY	Conduct quarterly determinations of chemical and biological water quality in all water features.	As Above	Quarterly	**WQ**
LIQUID WASTE MANAGEMENT	Inspect leach fields for maintenance needs on a quarterly basis, and conduct quarterly determinations of chemical and biological water quality in all water features.	Lime Leach Fields: 150g-Each As Above	Quarterly	**WQ**
SOLID WASTE MANAGEMENT	Inspect incinerator equipment (s), burial sites, and operational practices a quarterly basis for effective operation.	None	Quarterly	**SW**
ENERGY USE	Conduct quarterly inspections of power lines and primary electrical connection points for storm damage and/or tree falls; and conduct weekly inspections self-generation operations for fuel bond leakage, and equipment maintenance.	None	Quarterly / Weekly	**ELEC**
WILDLIFE	Conduct weekly inspections of petroleum bonds for leakage and quarterly evaluation of surface waters for contamination with chemical or biological pollutants.	As Above	Weekly / Quarterly	**WQ**
CULTURE, CUSTOMS & SOCIAL FACTORS	Arrange For Archaeological Monitoring With IOA during land modification activities.	None	Prior To Construction	**---**

[1]Monitoring sites are shown in **Illustration 62.**

ILLUSTRATION 62:

MONITORING SITES WITHIN THE STAGE 1 DEVELOPMENT



REPORT ADDENDA

Resume Thom Grimshaw Effective Date: June 2004

Contact Information

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Cellular: (501) 610-3393
Home: (501) 822-3772

E-Mail: ecoworks@btl.net

Address: No. 12 Raccoon Street, Belmopan, Belize Central America.

Personal Data

Born: 10/17/52 Detroit, Michigan (USA); **Height**: 6'4"
Weight: 200 Lbs.; **Race**: Caucasian; **Disabilities**: None
Nationality: US / BZ (Permanent Resident)
Married: 4 Children: 7; 12; 20; 22 Yrs of Age (All Belizean Nationals)
Education: M. Sc. (1982) & B.Sc. (1976) University Of Michigan
Professional Field: Aquaculture; Quantitative Aquatic & Marine Ecology; Environmental Biology
Special Skills: Technical Writing; Spatial Imaging (Aerial Photography, Remote Sensing, GIS)
Read/Type: 900 / 100 Words/Min; **Annual Written Word Product:**: (2000 - 04) ~ 200,000 W/Y
Languages: English, Fluent; Spanish, Speak/Read; **Hobbies**: Philosophy, Theology & Fiction

Employment & Client History

ECO-WORKS: Environmental Consulting Services (Formerly AECS) 1995 – Present. Founder & Owner. Ecoworks employs > 60 network-based, national & foreign PhDs, Engineers, Geologists, Archaeologists, and M Sc specialists to provide a fully contextual, relational and quantitative approach to environmental and economic assessments used in private & public sector planning, development, expansion, risk-analysis & impact mitigation. Ecowork's team of specialists can profile, classify, value or verify environmental/economic detail with respect to:

- *VHR Remote Sensing*
- *Soils & Geology*
- *Plant & Animal Wildlife*
- *Land Value*
- *Financial Structure*
- *Ocean Currents*
- *Land Survey*
- *Pollution*
- *Archaeology*
- *Economic Value*
- *Marine Resources*
- *Land Cover & Use*
- *Water Quality & Hydrology*
- *Conservation Value*
- *Tourism Value*

Ecoworks has engaged this combined technical capacity in fisheries, aquaculture, agriculture, timber, public & urban infrastructure, tourism, and conservation sector assessments in Belize for more than a dozen years. In my capacity as coordinator and director of Ecoworks, I design the analytical approach for the target assessment, select & direct the field-specialists required for its execution, conduct the spatial imaging & data analysis, write select topical assessments and the key opinions of the assessment, and then integrate the final product into a professionally written & illustrated manuscript, database and/or GIS product. Ecoworks typically conducts & delivers 7 to 10 such assessments in any given calendar year. A select client & project history follows:

Project Planning & Assessment

Aqua Mar Belize Shrimp Farm, Bel-Euro Shrimp Farm, Belize-Taiwan Mariculture, Crustaceans Shrimp Farm, Fresh-Catch Tilapia, Royal Mayan Shrimp Farm, Tex-Mar Shrimp Farm, Toledo Fish Farming Company and Triton Mariculture. Ecoworks has been variously commissioned by these enterprises to assist in development-site selection & evaluation, design/create business cases appropriate to site characteristics & client financial resources, undertake representations to partners, lenders & government permitting committees, assist with or provide design engineering & effluent management plans; and more recently, design/create data management software. One client commissioned a pre-litigation livestock-pathology assessment, which resulted in a comprehensive out of court settlement for the client.

Commonwealth Development Corporation (London). A range of projects were undertaken for this client, including: appraisal & valuation of the 12,000+ Ac Starich Aquaculture Holdings in Stann Creek & Toledo Districts; a 6-Site Selection for cage culture production in the offshore waters of Belize; and a 4-site selection & commercial scale cost assessment for tilapia production in Belize.

Marine Farms (Norway). This project entailed a month-long survey of ocean currents within the Belize Barrier Reef Lagoon between Placencia & Belize City for marine fish cage farming potential. A total of 26 sites were evaluated and the first models ever developed of coastal current patters for Belize were produced by the project, which ultimately led to the identification of significant commercial potential for development.

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Impact Assessments

Aberdeen Ltd. This project entailed environmental impact assessment of an eco-tourism resort to be developed in association with Jean-Michael Cousteau & located on the 15,000+ Ac White Ridge Farms estate in Stann Creek District. The assessment entailed comprehensive evaluation of the proposed development site with respect to water resource use, sewage treatment, land use & wildlife perturbation, as well as potential for positive & negative social impacts on the labor force & economies of two nearby rural villages.

ARCOS-1 Fiber Optic Ring. Ecoworks conducted the environmental impact assessment for placement of approximately 22 Km of underwater fiber optic cable in the coastal waters of Belize, a part of which crossed the Belize Barrier Reef. Ecoworks surveyed & redesigned the route for the cable company saving considerable installation expense and virtually eliminating environmental impact caused by placement. Ecoworks was also contracted to supervise cable placement, and take underwater video footage of the placement for environmental verification.

Coral Sands Resort Limited, Dolphin Development Company Limited and Stann Creek Development Company Limited. Ecoworks conducted environmental impact assessments for the first two of these projects, the former of which involved a 195 lot subdivision on a 500 acre offshore island, and the second of which involved a US $ 10 M diversified investment in an 8,000 acre coastal resort, subdivision, marina, shrimp farm and conservation reserve development. The third of these projects is currently in progress and involves the evaluation of a 1,000+ acre / US $ 75 M coastal island tourism development.
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Impact Assessments (Continued)

Beca International Consultants Ltd. Two projects were undertaken in regard to pre-feasibility/environmental assessment of paving of the Manatee (Coastal) Highway (~50 km), and creation of the new International Airport Link Road (~15 Km). This work entailed hydrological, geological, archaeological & wildlife assessments along ~ 65 kms of rural highways in Belize, and development of mitigation measures for potential impacts related to their re-alignment/creation & paving.

Belize City Council. This project entailed an assessment of a land creation project to be undertaken in association with the renovation & extension of Marine Parade Boulevard in Belize City. Ecoworks conducted a remote sensing & GIS analysis of the Belize River sediment plume, as well as a marine benthos evaluation, and re-designed the coastal profile of the land-fill in order to downsize its potential impact on area sediment transport characteristics. This project also entailed a public consultation of the assessments & its recommendations, and defense of the project to the National Environmental Appraisal Committee.

Sir John Halcrow & Partners. This project entailed an assessment of the institutional capacities & requirements for community based conservation, and technical assistance in the region to be affected by the Guatemala-Link Road presently under development by the Government of Belize, between San Antonio & Jalacte in the Toledo District of Belize.

Aqua Mar Belize Shrimp Farm, Bel-Euro Shrimp Farm, Belize-Taiwan Mariculture, Crustaceans Shrimp Farm, Fresh-Catch Tilapia, Royal Mayan Shrimp Farm, Tex-Mar Shrimp Farm, Toledo Fish Farming Company and Triton Mariculture. Ecoworks conducted environmental impact assessments of all the above named aquaculture developments. Ecoworks has been instrumental in getting these and other large scale aquaculture developments in Belize to utilized environmentally responsible effluent management practices based on the principles of environmental carrying capacity, and in making environmental impact assessments pre-requisite for Shrimp Farmers Association membership.

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Regional Planning

Coastal Zone Management Authority & Institute. Two projects were undertaken for this client. The first project entailed the preparation of a National Environmental Quality Monitoring Plan for the Coastal Zone of Belize. This work involved a comprehensive review of more than 50 historical & ongoing monitoring initiatives, along with construction & costing of a 9-part program to evaluate commercial species, coastal lagoons & wetland microfauna, sea grass & plankton, coral, marine vertebrates, climate change impacts, organic pollution impacts and toxic chemical impacts and initiate a national environmental monitoring coordination unit. The second project, undertaken in association with Tunich Nah consultants, entailed the construction of a national zoning scheme for aquaculture development in Belize. This work entailed identification of the key criteria needed for aquaculture zoning development along with the development of a provisional national map of aquaculture zone characteristics.
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Regional Planning
(Continued)

Environmental Social And Technical Assistance Project. Two projects were undertaken for this client. The first entailed a hydrological, land use & economic assessment of wetlands in the south Stann Creek Region of Belize (undertaken in association with Belize Environmental Consultancies), and the second entailed editing the ESTAP Project's 60,000 word Regional Level Plan for presentation to Cabinet.

Food & Agriculture Organization of the United Nations (Barbados). This project entailed an assessment of small-scale inland aquaculture potential in Belize. It included a comprehensive review of Belize's existing fisheries and aquaculture sectors, a national environmental data assessment, identification of critical zoning constraints & the sector's technical potential, review & selection of suitable species for development, a pilot project design & analysis, assessment of input short-falls, and a comprehensive strategy & action plan for the sectors development, which included the development of a policy framework for the sector, a very specific 21-step program plan for the sectors development, and a costing for each component's implementation.

Government of Honduras. Ecoworks conducted an assessment of the country's north coast potential for shrimp farming & other forms of aquaculture development. The survey entailed pre-selection of potential development sites by remote sensing analysis; and verification by aerial & onsite field inspection using a privately commissioned helicopter. This work resulted in the classification of 1.3 million Ha of north coast water & land systems; identification & description of 20 distinct wetland systems; and profiling of 70 potential coastal aquaculture development sites.

IDEADS & PROARCA/Costas (Guatemala). This project involved the development of a scientific basis for harmonization of Lobster & Conch fisheries regulations in the Gulf of Honduras region of Central America, and subsequently a tri-national research program for Conch. This project required the establishment of a close working relationship with the fisheries departments of Honduras & Guatemala; and frequent travel & work in these countries for planning & presentation purposes. Reports produced for the consultancy were translated into Spanish for distribution to Spanish speaking participants.

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Institutional Assistance & Lobby

Belize Fisheries Department. Ecoworks long-term working relationship with this GOB department has resulted in several *pro-bono*' works, including design & funding proposal for the original Conservation Compliance Unit (CCU) by USAID; review of various project proposals; assistance with various policy issues, including Salvage Rights To Wrecks Of Antiquity.
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Institutional Assistance & Lobby (Continued)

Belize Fisherman's Cooperative Association. Ecoworks is currently assisting the BFCA with development of an institutional policy framework which recognize the need to consolidate sector resources, assist fisher enlistment in alternative livelihood occupation, and otherwise develop concilliance with Belize's national conservation agenda.

Belize Shrimp Growers Association. Ecoworks has worked with this group in regard to legislative initiatives in the sector, and is currently working with the BSGA to develop a mechanism for Eco-labeling Belize's cultured marine shrimp products in association with the World Wildlife Foundation and Summit Foundation (US – Washington DC).

Hol Chan Marine Reserve/IUCN Ecoworks produced a pollution assessment proposal for Hol Chan Marine Reserve area and greater San Pedro Island.

Kolbe Foundation. Ecoworks provided this organization, which is now responsible for operation of the Belize Correctional Facility (Prison) at Hattieville, with a business model-based brochure to use in petitions for donor-support. As a *pro-bono* undertaking, the project is representative of the Ecoworks continuing support for responsible initiatives that can create wide ranging benefits for Belize.

National & Northern Fishermen Cooperative Societies. National Fishermen Cooperative commissioned testimony as aquaculture expert at closed-door government hearings on national fishing license issue. Northern Fishermen Cooperative commissioned a 3,000-word position statement for publication in all local newspapers on national issue of local fishermen opposition to licensing practices of government. Both the above consignments involved extremely sensitive interviews with, and representation of local fishermen interests to ministerial government. These representations and related efforts ultimately led to retraction of licenses and repeal of legislation enacted by sitting government.

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Marine Conservation & Research

Nassau Grouper Research & Advocacy. This project was undertaken in association with Green Reef Environmental Institute and entailed the first trans-national underwater survey of spawning aggregation sites ever conducted in Belize. The survey engaged the collective effort of a number of coastal marine conservation NGO's and involved a simultaneous evaluation of 9 Nassau Grouper spawning aggregation sites. Green Reef Environmental Institute was responsible for project administration and all field-related activities. Ecoworks assisted with the projects organization, donor proposal petitions, data analysis, final report composition & public presentation.
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Marine Conservation & Research (Continued)

Bacalar Chico Marine Reserve Zoning Assessment & Management Plan. These projects were undertaken in association with Green Reef Environmental Institute, the Caribena Fisherman's Cooperative Society in San Pedro, the United Nations Development Foundation and the Coastal Zone Management Authority & Institute. The projects involved a comprehensive field assessment of fishery resources within the Reserve, and development of a 10-year economic and conservation plan for the Reserve.

Hol Chan Marine Reserve Carrying Capacity Assessment. This recently concluded project was undertaken in association with Green Reef Environmental Institute, Hol Chan Marine Reserve and the World Wildlife Foundation. The project involved the execution & evaluation of visitor & snokeler surveys to quantify visitor impact risks, and identify management needs to mitigate those risks. Ecoworks assisted with the execution of the project by developing a custom for data analysis, and subsequently with final report compilation.

Spawning Aggregation Site Identification. This nearly concluded project was undertaken in association with Green Reef Environmental Institute and the World Wildlife Foundation. The project involved underwater identification/validation of Conch, Goliath Grouper, Nassau Grouper and Black Grouper spawning aggregation sites. Ecoworks assisted with the execution of the project by providing satellite imagery for site identification.

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Other Employment History

UNITED TROPICAL AQUATICS 1986 - 1997 Founder & Owner. Designed, built and operated the first integrated, commercial scale ornamental fish farm & plant nursery in south-central Belize which produced over 140 species of non-native fishes & plants for export to the USA. All phases of production, marketing & direct distribution to regional wholesale outlets in over a dozen cities in the USA were established.

GENERAL SHRIMP LIMITED 1984 – 1986. General Manager & Technical Director of Belize's first large-scale commercial shrimp farming venture. Supervised construction & development of 1st 300-acre marine shrimp farm & hatchery in Belize. Supervised 70+ local Maya, Garifuna & Creole employees native to the southern Belize.

DEPARTMENT OF ENERGY: 1984. Awarded a 5-year research fellowship in theoretical ecology & biophysical energetics, which was declined as a career decision in favor of an opportunity to emigrate to Belize.

UNIVERSITY OF WISCONSIN AQUACULTURE RESEARCH LABORATORY 1982 – 1984. Life Sciences Research Specialist. Coordinator of physiology research in fish nutrition; hormonal control of growth; and pond aquaculture methods.
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Reports & Publications

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Grimshaw, T. *et al*. 2000. *Marine Tour Guide Manual For Belize* (In Prep).

Grimshaw, T 2000. *Business Plan Brief For Trigone Ltd.* 19 Pgs.

Grimshaw, T. 2000. *Belize's Shrimp Farming Industry: Win-Win or Die*. (published by 4 local newspapers).

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Grimshaw, T. 2000. *An Environmental Impact Assessment of Crustaceans Ltd*.

Grimshaw, T. 2000. *An Environmental Impact Assessment of Triton Mariculture*. (In Prep).

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Grimshaw, T. 2000. *Proposal For A Quantitative Assessment Of Water & Environmental Resource Pollution At Ambergris Caye, Belize Central America*. 13 Pgs.

Grimshaw, T. 2000. *Business Plan Brief For Triton Shrimp Farms Ltd.* 20 Pgs.

Grimshaw, T. 2000. *Business Plan Brief For Crustaceans Ltd. Shrimp Farms Ltd.* 17 Pgs.

Grimshaw, T. 2000. *A Rapid Environmental Assessment of Resurfacing the Manatee (Coastal) Highway in Belize*. 30 pgs + 3 Addenda.

Grimshaw, T. 1999. *An Environmental Impact Assessment of Aqua Mar Ltd.* UTA Report. 421 pgs.

Grimshaw, T. 1999. *Wetland Hydrology, Land Use, Tenure & Economics* In: An Assessment Of The Social, Economic And Environmental Development Options Of The Southern Stann Creek Coastal Wetlands. 44 Pgs.

Grimshaw, T. 1999. *ESTAP Regional Level Plan (Ed).* 250 Pgs.

Grimshaw, T., and Meerman, J. 1999. *An Environmental Impact Assessment Of Aberdeen Ltd. Eco-Tourism Resort*. UTA Report. 283 Pgs.

Grimshaw, T. 1999 *An Environmental Impact Statement For Royal Mayan Shrimp Farms Ltd*. 15 Pgs.

Grimshaw, T. 1998. *Business Plan For Royal Mayan Shrimp Farms Ltd.* 32 Pgs.

Grimshaw, T. 1998. *An Environmental Impact Assessment of Belize – Taiwan Mariculture Ltd*. 226 Pgs.

Grimshaw, T. 1998. *An Environmental Impact Assessment of Toledo Fish Farming Company Ltd*. 132 Pgs.

Grimshaw, T 1998. *Business Plan For Toledo Fish Farming Company Ltd*. 42 Pages.

Grimshaw, T 1998. *Pathology Assay Findings For Toledo Fish Farming Company* 42 Pgs.

Grimshaw, T. 1998. *Appraisal Report For The Starich Companies of Belize*. 386 Pgs.

Grimshaw, T. 1997. *Northern Fishermen's Position Statement On Aquaculture and Fisheries Management Of Spiny Lobster*. August 31st Issue of The Reporter (Newspaper).

Grimshaw, T. 1997. *An Environmental Impact Assessment Of Tex – Mar Ltd*. 130 Pgs.

Grimshaw, T. 1997. *Business Plan For Tex-Mar Aquaculture Development*. 38 Pgs.

Grimshaw, T. 1996. *Aquaculture & The Environment, The History, Status and Economic Impact Of Aquaculture, Part I*. The People's Pulse (Newspaper) April 18th Issue.

Grimshaw, T. 1996. *Aquaculture & The Environment, The History, Status and Economic Impact Of Aquaculture, Part II*. The People's Pulse (Newspaper) April 25th Issue.

Grimshaw, T. 1996. *Aquaculture & The Environment, The History, Status and Economic Impact Of Aquaculture, Part III*. The People's Pulse (Newspaper) May 9th Issue.

Reports & Publications (Continued)

Grimshaw, T. 1996. *Aquaculture & The Environment, The History, Status and Economic Impact Of Aquaculture, Part IV*. The People's Pulse (Newspaper) May 23rd Issue.

Grimshaw, T. 1995. 6-Site Selection for Cage Aquaculture Production in Belize. 43 Pgs.

Grimshaw, T. 1995. *Cost & Commercial Analysis for Tilapia Aquaculture Production in Belize*. 362 Pgs.

Grimshaw, T. 1994. *Freshwater Aquaculture Site Identification in Belize, Central America.* 420 Pgs.

Grimshaw, T. 1986. *Response To Corny Mock Article on Belize Aquaculture Potential.* Shrimp Notes. March, Issue.

Kim, K., Kayes, T. Grimshaw, T., Admunson, C. & Benevenga, J. 1985. *Effects Of Fasting Or Feeding Diets Containing Different Levels of Protein Or Amino Acids on the Activities of Liver Amino Acid Degrading Enzymes and Amino Acid Oxidation in Rainbow Trout*.

Grimshaw, T. 1985. *Status Of Aquaculture Development In Belize*. Shrimp Notes.

Grimshaw, T. 1984. *Status Of Aquaculture Development In Belize*. Shrimp Notes.

Malison, J., Kayes, T., Admunson, C. & Grimshaw, T. 1985. *Trip-Net Capture Methods For Yellow Perch Fry*.

Smith, G., Taylor, J. N. & Grimshaw, T. (1979) *An Ecological Assessment of Raisin River.* Michigan Academy Of Sciences.

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Collecting Expeditions

2002: Honduras, North Coast (1.3 M Ha of coastal resource assessment)
1985-98: Rural Belize (Fish Collection Expedition with Private Collectors)
1992-94: Honduras, North Coast (Fish Collection Expedition with Private Collectors)
1985: Atlantic, Pacific & Peten Guatemala (Fish Collection Expedition with Private Collectors)
1979: Argentina, Brazil, Bolivia & Paraguay (Univ. of Mich. Museum of Zoology Expedition).
1976: Atlantic & Pacific Costa Rica (Cichlid Collection Expedition with Private Collector)
1974: Yucatan, Mexico (Univ. of Mich. Museum of Zoology Expedition)

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Organizations Worked or Listed With

CDB: Caribbean Development Bank
CDC: Commonwealth Development Corporation
FAO: Food & Agriculture Organization of the United Nations
IUCN: International Union for the Conservation of Nature
MEP: MacAlister Elliott & Partners, Hampshire England (Listed)
USAID: United States Agency For International Development
USDOE: United States Department Of Energy
WWF: World Wildlife Foundation

Addendum 1.2

Virginia Burns
 # 11 Orange Walk Street,
Belmopan, Cayo, Belize

Contact	Telephone: Home: 822-0244 Email: virginiaburns31@gmail.com
Personal Data:	Born: 03/04/83 Belize City, Belize
Education:	Jan 2003 – Dec 2004 Canisius College, Buffalo, NY, USA B.Sc. Environmental Science 2000- 2002 Saint John's Junior College General Studies 1996 - 2000 Belmopan Comprehensive High School

Professional Experience:

- Ecoworks: Environmental Consulting Services. Assistant EIA Preparer / Diver

Other Experience:

- Volunteer: Belize Audubon Society (April – May 2005)
- Internship: Protected Areas Conservation Trust (June - August 2003)

Awards:

- Protected Areas Conservation Trust Scholarship (2004)
- Saint John's College Junior College Jesuit Scholarship (2002)

Other Skills:

- PADI Advanced Open Water Certification

Colin Albert Young

P. O. Box 1428, Belize City
Belize, Central America
501-209-2033
belize007@hotmail.com

Current Position

Assistant Professor
Ecology/Environmental Science
Director of Environmental Science Program
Galen University
San Ignacio, Cayo

Education

Ph.D. Ecology	University of Connecticut, Storrs, CT	August 2005
Dissertation Topic:	"A comprehensive and quantitative assessment of Belize Creole ethnobotany: Implications for forest conservation."	
M.S. Ecology	University of Connecticut, Storrs, CT	August 2002
B.S. Biology/ Ethnobotany	Marlboro College, Marlboro, VT Suma cum laude	May 2000
Thesis Topic:	"Concepts of disease and illness and ethnobotanically useful plants among Belizean Creoles in North-Central Belize."	
Thesis Topic:	"A comprehensive literature review of Neotropical Dry Forests."	

Research Experience

Dissertation research in Belize May 2003-July 2004

- Completed an extensive quantitative assessment of Belizean Creole ethnobotany;
- Catalogued over 400 plant species of ethnobotanical importance to Belizean Creoles;
- Collected more than 1200 herbarium voucher specimens;
- Demarcated and conducted vegetation sampling on 27 plots (0.5 ha each) in lowland tropical rainforest of Belize;
- Ascertained the importance of old growth and second growth forest to Belizean Creoles;
- Calculated species richness and diversity indices of useful species among forest types
- Assessed the reliability of ethnobotanical data collected from collaborators;
- Investigated the efficacy of Creole medicinal plants using bioassays, laboratory tests, and extensive literature searches.

Undergraduate thesis research May 1999-August 1999
Kapulehu Dry Forest Reserve, Kona, Hawaii

- Experimented with various methods to control an invasive grass in the reserve;
- Assisted in the restoration of native flora in the reserve.

Undergraduate thesis research cont. December 1999-March 2000
Belize River Valley, Belize, Central America

- Documented 100 medicinal plants used by Belizean Creoles to treat over 40 categories of disease;
- Evaluated the concepts of disease among Belizean Creoles.

Research Assistant
Scripps Institute of Oceanography, San Diego, CA. May 1998-August 1998

- Assisted in research to understand the regulation of bioluminescence in dinoflaggelate *Lingulodinium polyedrum*.

Research Assistant May 1996-August 1996
Coral Caye Conservation, Belize, Central America

- Conducted extensive underwater sampling of coral diversity of Belize's barrier reef;
- Assisted in the evaluation of the effects of sedimentation of Belize's barrier reef.

Other Research Experience July, 2001

- Conducted an ethnographic study on AIDS and Migration in Benque Viejo Del Carmen, Cayo District, Belize.

Teaching Experience

Field Instructor, School for International Training May 2006

- Conducted short and intensive courses in anthropological and ecological field methods for SIT students in Belize;

Assistant Professor, Galen University August 2005-Current

- Developed and thought courses at both the undergraduate and graduate level in sustainable development, applications in sustainable development, ecology of a tropical forests, general ecology, plants and society, introduction to botany, *consultancy process*, and adventure and ecotourism.

Foundations of Biology Teaching Assistant August 2002-December 2003
University of Connecticut, Department of Ecology and Evolutionary Biology, Storrs, CT

- Administered and taught undergraduate students in the laboratory section of introductory biology
- Evaluated student performance in the laboratory section of the course

Ecosystem and Cultural Studies Field Instructor June 2002-July 2002
San Francisco State University, School of Continuing Studies, San Francisco, CA

- Taught tropical ecology to American students in Belize
- Familiarized students with conservation initiatives in Belize
- Assessed major threats to Biodiversity in Belize

Principles of Biology Teaching Assistant August 2000-May 2001
University of Connecticut, Department of Ecology and Evolutionary Biology, Storrs, CT

- Administered and taught undergraduate students in the laboratory section of biology for majors
- Evaluated student performance in the laboratory section of the course

Publications:

Young, Colin and Horwich, Robert. 2006. The History of Protected Areas Designation, Co-management and Community Participation in Belize. Cubola Productions (Book chapter, in Press).

Young, Colin. 2004. *The Common Flora and Fauna of the Community Baboon Sanctuary*. Angelus Press. Belize City, Belize.

Young, Colin. 2001. An Ethnographic Study on AIDS and migration in Benque Viejo Del Carmen, Cayo District, Belize, Central America. University of Belize.

Young, Colin. 2000. Concepts of disease and illness and ethnobotanical uses of plants among Belizean Creoles in North-Central Belize. Undergraduate Thesis. Marlboro College, Marlboro, Vermont.

In prep **Young, Colin and Gregory Anderson**. 2005. The ethnobotanical importance of young secondary, old secondary and old growth forests to Belizean Creoles. Biotropica (intended journal).

In prep **Young, Colin and Gregory Anderson**. 2005. Screening of medicinal plants used by Belizean Creoles for the presence of bioactive compounds. *Journal of Ethnopharmacology* (intended journal).

In prep **Young, Colin and Gregory Anderson**. 2005. Ethnobotany of Belizean Creoles in Belize, Central America. Economic Botany (intended journal).

In prep **Young, Colin and Gregory Anderson**. 2005. Random versus ethnodirected approach to identify Creole medicinals: The use of brine shrimp bioassays to identify effective Creole medicinals. Journal of Ethnopharmacology (intended journal).

In prep **Young, Colin and Gregory Anderson**. 2005. Evaluation of reliability of ethnobotanical data: A repeat "walk in the woods" in Belizean lowland forests. Economic Botany (intended journal).

Honors and Distinctions:

Graduate Assistantship, University of Connecticut	August 2005-December 2005
President, Graduate Student Senate, University of Connecticut	August 2001-August 2002
Multicultural Fellowship, University of Connecticut	August 2000-December 2005
American Institute of Biological Sciences Poster Award	October 2001
Bamford Award for Botany, University of Connecticut	May 2001-May 2003
National Forest Service Internship in Hawaii	May 1999-July 1999
MacArthur Scholarship, Marlboro College	May 1999
Amemiya Scholarship, Marlboro College	August 1997-May 2000
Elected President of Student Government, University College of Belize	May 1997
Outstanding Student of the Year Award, University College of Belize	April 1997

Leadership Award, Belize Defense Force Jungle Survival Training	August 1995
Caribbean Examination Council award for Academic Excellence (7 awards)	May 1995

Lectures and Presentations:

Young, Colin. 2005. Species richness and diversity patterns of ethnobotanically useful species in Belizean lowland, tropical rainforest. University of Calgary, Canada.

Young, Colin. 2005. The relative importance of young secondary, old secondary and old growth forests to Belizean Creoles. Implications for forest conservation. University of Indianapolis, Indiana. U.S.A.

Young, Colin. 2005. A comprehensive ands quantitative assessment of Belizean Creole ethnobotany: Implications for forest conservation. Dissertation defense. University of Connecticut.

Young, Colin. 2005. Stinking toe, scorpion tail, and snake root: Belizean Creole Ethnobotany and its Implications for Forest Conservation. Museum of Natural History, University of Connecticut.

Young, Colin. 2002. Belize and Conservation: Community conservation as a lasting conservation strategy. Marlboro College. Marlboro, Vermont.

Young, Colin. 2002. Community Participation: A Lasting model for Conservation? Windham High School, Willimantic, Connecticut.

Young, Colin. 2001. Ethonobotanical uses of plants among Creoles of north central Belize. Ecology and Evolutionary Biology 11th Graduate student symposium. University of Connecticut.

Young, Colin. 2000. Community Conservation: The Community Baboon Sanctuary (CBS) as a working model for conservation. Museum of Natural History, Raleigh, North Carolina.

Young, Colin. 2000. The Ethnobotany of the Creoles of north central Belize, Marlboro College.

Young, Colin. 2001. Pharmacopoeia of the Belizean Creoles, Museum of Natural History, University of Connecticut.

Young, Colin. 2001. Belizean Creole Ethnobotany. Poster presented at the American Institute of Biological Sciences National Conference, Washington, D.C

Grants:

Demi Fellowship, University of Connecticut	May 2005
Organization of American States Doctoral Fellowship	August 2002- August 2004
Doctoral Dissertation Fellowship, University of Connecticut	August 2003
Garden Club of America Anne Chatham Fellowship in Medicinal Botany	January 2002
Ronald Bamford Endowment to the Department of Ecology and Evolutionary Biology, University of Connecticut	May 2001-2002
United Nations Development Program Small Grants Program/ Global Environment Facility	May 2000

Memberships:

The Society for Economic Botany
American Society of Plant Taxonomists
American Institute of Biological Sciences
Torrey Botanical Club
Society of Conservation Biology
The Association for Tropical Biology and Conservation

Selected University Service:

Chair of sub-committee on the Rationalization of Programs for Higher Education Conference, University of Belize and Galen University
Search Committee, Vice Provost for Research & Graduate Education and Dean, Graduate School University of Connecticut;
University Senator, University of Connecticut;
University Senate, Faculty Standards Committee, University of Connecticut;
Chancellors committee on Leadership and Programming, University of Connecticut;
Vice Chancellor's Student Leadership Committee, University of Connecticut;
Chancellor's Library Advisory Committee, University of Connecticut.

Selected Voluntary Service

Organizing Committee for 25th Annual Society of Ethnobiology Conference "Art and Soul: Celebrating Indigenous Artisans" (March 6-9, 2002), University of Connecticut.
Consultant, Community Baboon Sanctuary, Belize
Cockscomb Basin Wildlife Sanctuary, Belize

Graduate Students

Percy Lewis completed an MBA in Sustainable Development at Galen University
Travis Steffens, University of Calgary, Canada. In country advisor
Kelley WitkowskiEmilie, Miller-Garnett
Aurora Marin Mendez
Jill Mackenzie
Allen Genus
Katherine Ghantous
Glen Enriquez

Consultancies

UNDP/GEF/SGP August 2002

- Wrote a successful grant proposal ($86,000) on behalf of the Community Baboon Sanctuary Women's Conservation Group and assisted with project implementation;
  University of Belize May, 2000
- Completed a consultancy on Ethnographic Study on AIDS and migration in Benque Viejo Del Carmen, Cayo District, Belize, Central America;
- Assisted with a PACT funded project implementation at Community Baboon Sanctuary

Other

In 1990, a children's book entitled "Colin en de Brulapen" or "Colin and the Monkeys" was published in three languages that chronicled my efforts to protect the endangered Black Howler Monkeys (*A. pigra*). A second edition is scheduled to be published in Spanish in July 2006.

Addendum 1.3

DAVID ROBERT TZUL
P.O.BOX 97, BELMOPAN,
TELEPHONE: # 610-1076/ 662-0667,
Email: cracid2000@yahoo.com.

EDUCATION

Sacred Heart College, San Ignacio, Cayo District, graduated with credit And General Certificate of Education in English Language, Spanish, History & Biology.	1975 – 1979
Diploma in Animal Health Science and Veterinary Public Health from the Regional Education Program for Animal Health Assistants, Regional Institute of Guyana, South America.	1980 – 1982
Certificate in Integrated Pest Management, Escuela Agricola Panamericana, Zamorano, Honduras.	March 1992
Certificate in Conservation Techniques and Skills, from the Natural Resource Management Project, U.S.AI.D., San Ignacio, Cayo, Belize.	June 1995
Certificate in Conservation and Protected Areas Management from Colorado State University & the Belize Audubon Society, Cockscomb Basin Wildlife Sanctuary, Stann Creek, Belize.	Aug. 1995
Certificate in Supervision Techniques from the Belize Institute of Management Belize.	Jan. 1996
Certificate in Leadership and Organizational Management skills from Santa Cruz Institute, Tucson , Arizona, U.S.A.	May-June 1996
Diploma in Management of Natural Resources and Protected Areas from the Of Forestry and Natural Resources, Mexico and the World Federation of Park Rangers, Valle de Bravo, Distrito Federal, Mexico.	Oct. 1998
Certificate in Guiding and Avitourism, Programme for Belice & Wings of Americas, Hill Bank Field Station, Rio Bravo Conservation and Management Area.	April 1999
Certificate of Tour Guiding and First Aid, Belize Tourism Board, Belize City.	June 1999
Semester course at Cornell University, (Bsc, level), U.S.A., in Ornithology, Neotropical Biology and Avian Taxidermy, sponsored by the Park Foundation and Programme for Belize	June 2000 Aug.-Dec. 2000

WORK EXPERIENCE

Extension officer and Veterinary Assistant, Agriculture Department, Belize City, Orange Walk, Corozal, Cayo and Toledo Districts, Belize – 1982 – 1987

Assistant Livestock Lecturer, Belize College of Agriculture, Cayo District, Belize -1988 – 1990

Head Warden, Tapir Mountain Nature Reserve, Belize Audubon Society, Cayo Belize – 1995-96

Park Manager, Guanacaste National Park, Belize Audubon Society, Cayo District, Belize – 1996 – 1997

Naturalist, Hill Bank Field Station (Rio Bravo Conservation and Management Area), Programme for Belize – 1997 – 2003

Researcher, Birds Without Borders-Aves Sin Fronteras Project under the auspices of The Zoological Society of Milwaukee County and the Foundation for Wildlife Conservation, U.S.A. and Belize – 2003 – 2006

Administrative Coordinator, Birds Without Borders-Aves Sin Fronteras, the Zoological Society of Milwaukee and Foundation for Wildlife Conservation, U.S.A. and Belize – 2006-2007

RESPONSIBILITIES

- Member of the Bird Census team for the Rio Bravo Conservation and Management Area, Programme for Belize.

- Principal Investigator for the Cornell University's Mangrove Swallow Research Project and other studies at the Hill Bank Field Station.

- Technical Assistant for the EU funded Agro-forestry Project, Hill Bank Field Station and buffer zone communities, Programme for Belize.

- Delivery of the majority of the educational programs in Tropical Ecology offered at the Hill Bank Field Station, Programme for Belize.

- Coordinate and conduct Bird Census and Bird Mist Netting in the selected study sites in the Runaway Creek Nature Reserve, managed by the Foundation for Wildlife Conservation under the project Birds Without Borders-Aves Sin Fronteras.

- Conduct Rapid Ecological Assessments in the Runaway Creek Nature Reserve for the Birds Without Borders Project.

Addendum 2

SECRETARY OF STATE

STATE OF NEVADA

CERTIFICATE OF EXISTENCE
WITH STATUS IN GOOD STANDING

I, ROSS MILLER, the duly elected and qualified Nevada Secretary of State, do hereby certify that I am, by the laws of said State, the custodian of the records relating to filings by corporations, non-profit corporations, corporation soles, limited-liability companies, limited partnerships, limited-liability partnerships and business trusts pursuant to Title 7 of the Nevada Revised Statutes which are either presently in a status of good standing or were in good standing for a time period subsequent of 1976 and am the proper officer to execute this certificate.

I further certify that the records of the Nevada Secretary of State, at the date of this certificate, evidence, **BALAM INVESTMENTS, LLC**, as a limited liability company duly organized under the laws of Nevada and existing under and by virtue of the laws of the State of Nevada since March 12, 2007, and is in good standing in this state.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the Great Seal of State, at my office on August 20, 2007.

ROSS MILLER
Secretary of State

Electronic Certificate
Certificate Number: C20070820-1102
You may verify this electronic certificate online at http://secretaryofstate.biz/

STATE OF NEVADA

ROSS MILLER
Secretary of State

SCOTT W. ANDERSON
Deputy Secretary
for Commercial Recordings

OFFICE OF THE
SECRETARY OF STATE

Certified Copy

August 20, 2007

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Through Date:

The undersigned filing officer hereby certifies that the attached copies are true and exact copies of all requested statements and related subsequent documentation filed with the Secretary of State's Office, Commercial Recordings Division listed on the attached report.

Document Number(s)	Description	Number of Pages
20070172684-57	Articles of Organization	1 Pages/1 Copies

Respectfully,

ROSS MILLER
Secretary of State

By

Certification Clerk

Commercial Recording Division
202 N. Carson Street
Carson City, Nevada 89701-4069
Telephone (775) 684-5708
Fax (775) 684-7138

ROSS MILLER
Secretary of State
206 North Carson Street
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Articles of Organization Limited-Liability Company

(PURSUANT TO NRS 86)

USE BLACK INK ONLY - DO NOT HIGHLIGHT

ABOVE SPACE IS FOR OFFICE USE ONLY

1. **Name of Limited-Liability Company:** (must contain approved limited-liability company wording; see instructions)
BALAM INVESTMENTS, LLC
Check box if a Series Limited-Liability Company ☐

2. **Resident Agent Name and Street Address:** (must be a Nevada address where process may be served)
PARACORP INCORPORATED
Name
318 N. CARSON ST. #208 | CARSON CITY | Nevada | 89701
(MANDATORY) Physical Street Address | City | | Zip Code
(OPTIONAL) Mailing Address | City | State | Zip Code

3. **Dissolution Date:** (OPTIONAL; see instructions)
Latest date upon which the company is to dissolve (if existence is not perpetual):

4. **Management:**
Company shall be managed by ☐ Manager(s) **OR** ☒ Members
(check only one box)

5. **Name and Address of each Manager or Managing Member:** (attach additional page if more than 3)
Dr. h.c. Hartmut Porsch
Name
318 N. CARSON ST. #208 | CARSON CITY | NV | 89701
Address | City | State | Zip Code

Name
Address | City | State | Zip Code

Name
Address | City | State | Zip Code

6. **Name, Address and Signature of Organizer:** (attach additional page if more than 1)
DEBORAH A COOKE
Name
X Deborah A Cooke
Signature
318 N. CARSON ST. #208 | CARSON CITY | NV | 89701
Address | City | State | Zip Code

7. **Certificate of Acceptance of Appointment of Resident Agent:**
I hereby accept appointment as Resident Agent for the above named limited-liability company.
X Deborah A Cooke for Paracorp Incorporated 3/12/07
Authorized Signature of R.A. or On Behalf of R.A. Company Date

This form must be accompanied by appropriate fees.

Nevada Secretary of State Form LLC Arts 2007
Revised on 01/01/07

Addendum 3

TERMS OF REFERENCE AND FORMAT FOR EIA TO BE PREPARED FOR BALAM JUNGLE ESTATE DEVELOPMENT A PROPOSED TOURISM DEVELOPMENT AND SUBDIVISION IN THE COROZAL DISTRICT

This Terms of Reference (TOR) has been prepared following the scoping for the most critical issues that will need to be addressed by the proposed development.

In the preparation of the EIA, the EIA preparers will need to focus on addressing the main areas of concern, such as:

WATER RESOURCES, LIQUID / SEWAGE WASTE, SOLID WASTE, ENERGY GENERATION, TRANSPORTATION, WILDLIFE, ARCHAEOLOGY, EXTRACTION OF MATERIALS, BOAT RELATED ACTIVITIES AND INFRASTRUCTURE, AND SOCIO-ECONOMIC FACTORS.

Scoping of these issues speeds up the EIA process, cuts down its cost, improves the quality of the development, and ensures that environmental concerns are clearly addressed.

This Term of Reference (TOR) is divided into three (3) sections:

A. PROJECT DESCRIPTION AND PHYSICAL ENVIRONMENT

This section of the document deals primarily with information pertaining to the background of the project, and the physical environment within which it is proposed.

The EIA will need to address:

1.0 THE PROJECT DESCRIPTION AND LAYOUT PLAN

Maps at appropriate scales must be provided and with proper labels and legends to illustrate the general settings of project related development sites as well as surrounding areas likely to be environmentally affected. These maps shall include topographic contours, where available, as well as location of major surface waters, roads, parks or reserves, political boundaries and existing adjacent land uses (tourism, agricultural, industrial) and a photo-geologic/geomorphic map of the project area showing geomorphic features (by use of aerial photographs, if available). Additionally the following should be provided:

1.01 Give the exact location of the project and provide proof of ownership of the parcel of land comprising the project site. Include a copy of a lease document or land title.

1.02 Provide the following plans:

a. The layout plan for the overall development, including siting of all facilities such as the utilities, water treatment facilities, sewage treatment facilities, storage facilities, drainage facilities, administrative buildings, residential/vacation buildings, power generation, battery/fuel storage facilities, recycling/composting facilities, garbage storage/treatment facilities, pier/docks, golf course, water park etc.;

1.03 Describe briefly the facilities provided in the plans above (1.02 a).

1.04 Provide specifications for the following (if applicable):

a. Collection and disposal systems for solid waste;
b. Sewage collection, treatment systems and disposal;
c. Water source, treatment, storage and distribution systems;
d. Recreational Sites
e. Marinas, piers, sea walls, docking facilities, dry docking facilities and related infrastructure;
f. Inland waterways (location, depth, width and design);
g. Golf course.

1.05 Provide outline of the overall management structure anticipated for the proposed development.

1.06 Describe the implementation of the project in phases (if applicable). Detail the time-frame of the project in terms of:

(a) The total time frame within which the undertaking is to take place, including starting date and conclusion;

(b) Describing the various phases of the project and the time-frame within which each phase is to be accomplished;

(c) Outlining the duration and time(s) of the day within which dredging and filling is to take place

1.07 Give detailed information on all water sport activities that will be carried out in the area.

2.0 THE PHYSICAL ENVIRONMENT

2.01 Provide details of the basic physical environment of the project site and zone of influence. This should include: -

- Topography: including degree of slopes, drainage patterns around project site, and flood hazard and the effects of rainfall averages on these conditions;

- Provide information on current flow patterns;

- Climate, hydrology and meteorology: Include the rainfall average per year, prevailing wind patterns and susceptibility to natural disasters (i.e. hurricanes, tropical storms and flooding);

- Geology*:*

  (a) Geomorphology — detailed description of the characteristics of landform, land surface including exposed rock types, types of unconsolidated materials exposed (sediments), ridges, and geological structures — faults, folds, if they can be determined by field mapping.

  (b) Subsurface geology; detailed description of the stratigraphy of the rocks or unconsolidated materials, within the project site, to depths allowing for maintenance of suitable impermeable layer for the protection of the water table. This must be done by core sampling (mechanical or manual) using a pre-determined borehole grid. Cross sections of the rock types or unconsolidated materials should also be presented. The engineering properties of the rocks and/or unconsolidated materials must be tested (including permeability) to determine the suitability for the proposed development.

- Give the fertility, permeability, agricultural value and classification, and the potential for erosion of the soils on the project site;
- Current land use of project site and adjacent properties;
- Physical, biological and ecological description of surrounding receiving water bodies including creeks, lagoons and sea front and relation to protected areas or marine reserves within the zone of influence;
- Vegetation types.

3.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

3.01 Describe the pertinent regulations, standards and policies, at the local and national levels, governing environmental quality, health and safety and protection of sensitive areas. These could include cultural resources, protection of endangered or threatened species, siting, infrastructure development, land use policy and tourism policy that may have an impact on the proposed development. Provide and discuss any policy, legal or administrative issues as they may relate to the proposed development.

B. ENVIRONMENTAL ISSUES

This section of the document primarily targets the environmental issues of critical concerns based on information provided in section A.

Map terrestrial habitats at 1:15,000 or as detailed as possible, including streams, lagoons, rivers, slopes, natural drains, etc. This should incorporate clear indicators of percent cover and habitat composition and health.

The following are the critical issues a high quality EIA will need to address for the development proposed at BALAM JUNGLE ESTATE Development:

1.0 FLORA AND FAUNA

For the project site and the zone of influence:

1.01 Collect base line data (field study) on the terrestrial and aquatic fauna and flora; rare or endangered species or commercially valuable species within or in areas adjacent to the project- site; with special emphasis on sensitive habitats such as national parks or reserves within or adjacent to project site, effluent receiving water bodies and immediate areas to be used for recreational activities. This should provide a baseline from which to detect any changes in the abundance and vigour of the species due to this development.

1.02 Estimate and provide maps of the acreage and type of vegetation within the development site designated for removal and percent to be removed, taking into consideration the establishment of appropriate buffer zones along all permanent water bodies on site.

1.03 Identify any species (flora, fauna, aquatic and terrestrial) of conservation significance, threatened and endangered species, (such as manatees, crocodiles, turtles, etc.), and specify detailed measures for their protection, which may include the establishment of reserves within the project site.

1.04 Highlight, where appropriate, measures that could be taken to enhance the habitat value of the project area.

2.0 WATER RESOURCES

2.01 Establish a base line on the water resources of the project area. This base line should include water quality assessment of the ground water and surface waters of the project site and zone of influence. This data should be collected at appropriate intervals to establish any seasonal variation in the water quality between dry and rainy season. The base line should include, at a minimum, the following parameters:

i. Temperature; vii. Dissolved oxygen (surface & below surface, a.m. & p.m)
ii. Biological Oxygen Demand; viii. PH;
iii. Total suspended solids; ix. Sulphates;
iv. Total dissolved solids; x. Hardness;
v. Total Nitrate (as N03- N); xi. Total Phosphate;
vi. Salinity xii. Conductivity

2.02 Determine the projected water needs for the entire development; including drinking water (potable) supplies, supply to household appliances, irrigation of lawns and golf course, and other uses.

2.03 Assess all potential sources of water supply, quality and quantity, paying special attention to determining the sustainable yield it can provide.

2.04 Given the results from above, evaluate the alternative options for the provision of water supply for the entire development.

2.05 Evaluate the preferred option for water supply, based on environmental grounds. Where the recommended water supply source is ground water, a proper pump test of the aquifer must be completed. Specify any residual impacts of meeting water needs through this option, their significance, and any mitigatory measures to be undertaken.

2.06 Provide an inventory of other users in the zone of influence with respect to the selected water supply source.

2.07 Identify and develop a water quality monitoring programme able to detect any change in ground water or surface water quality, or the water quality of the proposed effluent receiving water body (if any) that could impact:

- o Public health
- o Forest, wetland and adjacent aquatic habitats; and
- o Endangered or threatened species in project area and zone of influence

3.0 LIQUID / SEWAGE WASTE

3.01 Determine the nature and volumes of liquid waste, including sewage and grey water, to be generated by the entire project.

3.02 Evaluate alternative options for the collection, treatment, recycling (if appropriate), and a minimum of three options for disposal of these liquid wastes. Be sure to identify all chemicals planned for use in the treatment or management of these wastes, including waters for golf course maintenance.

3.03 Identify the preferred option/s for liquid waste management, based on environmental grounds, including necessary infrastructure and land requirements. Specify any residual impacts of liquid waste management, their significance, and any mitigation measures to be undertaken.

3.04 Provide a description of the methods for collection, treatment and disposal of liquid wastes from expected vessels utilizing the marina components.

3.05 Give a detailed description of the physical and chemical characteristics and profile of the landform to be used for any treatment facility.

3.06 Estimate volumes of surface run off at project location.

3.07 Identify preferred option for surface drainage system for project area including drains, sedimentation structures and settling/ run off ponds

4.0 SOLID WASTE GENERATION

4.01 Determine the projected types and volumes of solid waste to be produced by the entire development. This should examine (at least) oil, tyres, plastics, metals, putrescible wastes, batteries/hazardous materials and construction waste. It will also need to include solid waste from boats and other transportation vehicles. If composting of organic waste is to be conducted, provide specifications on the location of the site and procedures to be followed for the composting.

4.02 Evaluate at least two alternative options, including the appropriate mitigation measures and management plans for the collection, transportation, treatment and disposal of this waste.

4.03 Select the preferred option/s for disposal of these materials. Again, this should be based on environmental grounds, and should specify any residual impacts, their significance and the mitigatory measures, which are to be undertaken.

4.04 Assess the ability of the community or local government to provide the necessary infrastructure, resources and management for the collection, storage, treatment and final disposal of solid waste generated by the project should the EIA recommend the use of an existing landfill; and provide appropriate recommendations for these in the event that they are inadequate.

4.05 Should the EIA determine that the construction of an on site land fill is the preferred option; the EIA should include a study to determine the most suitable site for the construction of the landfill. This study must include a detailed soil analyses (profile, topographic surveys, permeability tests, etc.), designs of the proposed landfill, layout plan showing the landfill in relation to the project site, appropriate mitigation measures and management plans for the collection, transportation and disposal of the wastes.

5.0 GEOLOGY AND EXTRACTION OF MATERIALS

5.01 Provide information on the specific soil type and submit results of analysis carried out to determine soil permeability/profile in the proposed project area.

5.02 Provide the soil profile of at least three bores of a diagonal transect of the property.

5.03 Determine the type and volume of construction materials required for the entire development.

5.04 Consult with the Geology and Petroleum Department over fulfilling requirements for a quarry/mining license, which will be required before any dredging/mining commences (if applicable.)

5.05 In light of this consultation, evaluate options for meeting these needs, reviewing their sources, volume, extraction methods and transportation (if applicable) and identifying;

5.05.1 direct and indirect biological impacts;
5.05.2 direct and indirect physical impacts;
5.05.3 impact on water resources;
5.05.4 specific mitigation measures

5.06 Evaluate the potential impacts of dredging/excavation on flora, fauna (aquatic and terrestrial) and human beings including information on sub-tidal habitats such as sea grass beds and surrounding environments and the necessary mitigation measures to address said impacts.

5.07 Identify the preferred option for the extraction methods, source, and transportation of materials, specifying the necessary mitigation measures, their residual impacts and significance (if applicable.)

6.0 TRANSPORTATION

6.1 Roads/Walkways

6.11 Evaluate options for the provision of suitable roads/walkways (if any) for the development, taking into account proper access to lots, etc.

6.12 Provide justification(s) for the construction of the feeder roads and interior waterway components of the proposed project, including possible alternatives.

6.13 Select preferred option for the provision of suitable roads/walkways for the development. This will need to examine construction materials (types, sources, volumes, transportation) and methods in relation to their environmental impacts.

6.14 Recommend precise mitigation measures, based on the specific option selected, for the proper management of the vehicular/boat traffic close to and within the project area. These mitigation measures must include recommendations for protection features against siltation, erosion, and other potential pollution to the environment.

PHYSICAL ENVIRONMENT

6.15 Provide a detailed description of the physical environment to be affected by the construction of the feeder roads and interior waterway, including:

(a) A description of the marine environment to be impacted by the proposed activity, including depths, hydrographic profiles, water quality parameters including dissolved oxygen, macro-nutrients and heavy metals, sediment characteristics including origin, distribution and composition, and meteorological and physical oceanographic features including wind speed and direction, and wave height and current direction;

(b) A detailed description of the marine flora and fauna in the vicinity of the dredging site, including seagrass (es), and corals as well as fin-fishes, marine mammals, reptiles, seabirds and macro-invertebrates, particularly those of commercial importance;

6.16 Provide an inventory of the activities associated with the project area(s), including activities (if any.)

6.2 Marina and Boat Related Activities and Infrastructure

6.21 Evaluate options for storage of water borne vessels, (if applicable). This will require examination of:

i. Dredging requirements/volume of materials to be dredged;
ii. Disposal/use of dredged materials;
iii. Physical character of materials to be dredged;
iv. Benthic substrate
v. Design of marina facility, including access channel (if applicable);
vi. Type of dredging equipment;
vii. Need for shoreline protection;
viii. Near shore and off shore current patterns;
ix. Near shore and off shore sedimentation patterns;
x. Wind conditions;
xi. Wave conditions;
xii. Transportation of construction materials;
xiii. Methods of controlling sedimentation of marina (if applicable);
xv. Requirement for maintenance dredging (frequency & volume)

6.22 Evaluate options for the construction of beach protection structures/devices and identify the preferred option (if applicable).

6.23 Determine the projected number and types of boats likely to be associated with the entire development.

6.24 Provide specifications (dimensions) of the proposed piers and dry dock indicating the type(s) of construction materials that will be used.

6.25 Provide bathymetry on the area to be dredged in particular the waterway and marina(s).

6.26 Identify the preferred option for the extraction method, the source, and transportation of materials for the construction of piers and marina, specifying the necessary mitigation measures to be used, their residual impacts and significance.

6.27 Provide the layout plans of the marina(s) which must include dimensions to scale (e.g. length, height, width) for all related structures both land and water based, berthing and mooring arrangements as well as the specific siting for the various facilities such as fuel dispensing and boat storage off-land. Text must be submitted (accompanying the plan) justifying the size and scope of the marina(s) and details on the type, size and number of vessels to be involved with this undertaking.

6.28 Evaluate options for boat storage, i.e parking facilities and size of facility. This will require examination of dredging/mining requirements, construction methods and transportation of materials (if applicable).

6.29 Determine the need for mining and impacts associated with the construction of the parking facility (if any).

6.30 Evaluate options for the supply of fuel to boats and identify the best method for eliminating potential spillages and maximizing health and safety. This should include options for the proper storage of the fuels.

6.31 Recommend precise mitigation measures, based on the specific option selected, for the proper management of the vehicular/boat traffic close to and within the project area. These mitigation measures must include recommendations for protection features against siltation, erosion, and other potential pollution to the environment.

7.0 ENERGY GENERATION

7.01 Determine the projected energy requirement for the entire development.

7.02 Evaluate a minimum of three alternative options for meeting these needs, using fossil fuel, solar, wind resources (and others if appropriate). For each of these options, it will be necessary to investigate:

7.02.1 fuel storage (where relevant);

7.02.2 transportation (where relevant);

7.02.3 health and safety;

7.02.4 pollution sources, volumes, and types;

7.02.5 significance of any pollution that may result from energy generation; and

7.02.6 mitigatory measures

It will be necessary to divide examination of energy provision into construction, operation, and maintenance phases.

7.03 Select the preferred option for energy generation. Again, this should be based on environmental grounds, and should specify the residual impacts of generation of the preferred option, their significance and the mitigatory measures, which will be undertaken.

8.0 SOCIAL FACTORS

8.01 Conduct a study to determine the potential social impacts of the proposed development taking into account factors such as:

a. Traditional resource users within the project area and zone of influence;
b. Population (present and projected, resident & seasonal);
c. Integration;
d. Customs & culture;
e. Displacement and resettlement (if any);

8.02 An analysis of the requirements of areas for public services should be incorporated into this study. Issues such as the following should be addressed;

i. Fire protection;
ii. Security services;
iii. Educational institutions;
iv. Recreational centres;
v. Medical emergency services/evacuation

8.03 Also an analysis of Labor;- employment opportunities; and provision of basic health care and hygiene, the provision of recreational spaces, sanitary facilities for all workers, during construction and operation of the project.

9.0 ARCHAEOLOGY

9.01 Provide a discussion of the archaeological and historical occupation of the development site detailing the rationale and design of any requisite ground surveys to be undertaken prior to project construction. The Archaeological Assessment report is to be properly incorporated and integrated into the overall development plan and recommendations for the protection of any features must be identified and properly addressed.

10.0 NGO AND PUBLIC INTEREST

10.01 Conduct consultations with different stakeholders i.e. local NGO's, public interest groups and relevant government departments/agencies regarding the proposed project.

10.02 The EIA team will report on the views and concerns of local NGOs, public interest groups and relevant government departments/agencies regarding the development of the project.

11.0 DISASTER MANAGEMENT AND CLIMATE CHANGE ISSUES

11.01 Identify emergency preparation and applicable management measures for the proposed development (e.g. hurricane, floods, fires etc.). This should include evacuation and hazard management plans inclusive of climate change adaptation measures (such as sea level rise and structural/building design conducive with the climatic conditions of project site).

C. ISSUES PERTAINING TO THE DIFFERENT DEVELOPMENT COMPONENTS

This section has been developed to ensure that issues pertaining to each individual component of the proposed development are adequately addressed:

1.0 TOURISM COMPONENT (HOTEL, CONDOMINIUMS, TOWN HOMES, HOMES, VILLAS, GOLF COURSE)

1.01 Determine the projected number of buildings to be constructed, including hotels, condominiums, beach clubs, casino, or other similar complexes.

1.01 Provide a layout of all complexes and other infrastructure to be built. This should include the location of the pier(s) and marina(s).

1.02 Identify the number of buildings and number of persons residing and visiting the project site/resort. This information will be used to determine the physical carrying capacity requirement of the area, which is to be included in the EIA report.

1.03 Provide information of the species of grass to be used as golf turf and identify the chemicals to be used for treatment purposes, as well as the management mechanisms to be used to minimize impacts to the environment.

1.04 Project the volume of fresh water for the overall tourism component and indicate its proposed source.

1.05 Project the volume of water needed for irrigation of the golf turf and indicate its proposed source.

1.06 Provide a detailed waste management plan (solid and liquid) for the tourism component of the project.

1.07 Indicate the energy source to be used.

2.0 MARINA COMPONENT (S)

2.01 Provide a layout for the marina components including dimensions to scale for all related structures both land and water based including but not limited to:

a. Berthing and mooring
b. Piers and boat slips
c. Fuel stations
d. Dry docking facilities
e. Boat repair facilities
f. Sea walls and jetties (if any), etc.

2.02 Project the volume of water needed for the overall marina component and indicate its proposed source.

2.03 Provide a detailed waste management plan (solid and liquid) for the marina(s) including vessels.

2.04 Describe the management mechanisms to be used to minimize impacts to the environment.

3.0 SUBDIVISION COMPONENT

3.01 Indicate the acreage of the parcel of land to be subdivided, and the proposed size (surface area) of the individual lots. Provide all relevant subdivision plans, drawn to scale and identifying setbacks from any water body.

D. POTENTIAL CUMULATIVE IMPACTS

1.0 Identify all potential cumulative impacts and significant changes that may result from the implementation of this overall project. This should include, but not be limited to, changes in the following:

(a) Water Quality of the area;
(b) Current patterns and hydrographic characteristics;
(c) Land Use pattern;
(d) Boat Traffic;
(e) Infrastructure;
(f) Employment opportunities;
(g) Socio-cultural environment; and
(h) Abundance of flora and fauna.

2.0 The above analysis should distinguish between significant positive and negative impacts; direct and indirect impacts; immediate, medium and long-term impacts, irreversible or unavoidable impacts and identify impacts that may result from accidental events (i.e. oil/fuel spills, accidental release of untreated wastewater/ effluent, etc.). This analysis should be divided into construction, operational and maintenance activities / phases.

3.0 Characterize the extent and quality of available data, explaining significant information deficiencies (gaps) and uncertainties associated with the prediction of such potential impacts.

E. CONCLUSIONS/RECOMMENDATIONS

This section proposes alternatives to the execution of the project based on the information generated by Section B, C, and D.

1.0 DETERMINATION OF POTENTIAL IMPACTS

1.01 Identify all significant changes that may result from the implementation of this project. This should include, but not be limited to, changes in the quality of any permanent water body on or near the project site, hydrographic characteristics, land use, solid wastes, potential land use conflicts, boat traffic, changes in navigation, infrastructure, employment opportunities, socio-cultural behaviour, abundance and vigour of flora and fauna, changes in abundance of pests and vectors, effects of the development on aesthetics and visual quality.

1.02 The analysis should distinguish between significant positive and negative impacts; direct and indirect impacts; immediate, medium and long-term impacts; irreversible or unavoidable impacts including the magnitude of these impacts (low medium, high); identify impacts that may result from accidental events (i.e. spills of hazardous waste, accidental release of untreated effluent discharges, etc.). The analysis should be divided into construction, operational and maintenance activities.

1.03 Characterize the extent and quality of available data, explaining significant information deficiencies and any uncertainties associated with the prediction of impacts. This section proposes alternatives to the execution of the project based on the information generated by Section B.

2.0 ALTERNATIVES FOR DEVELOPMENT

Present all reasonable alternatives for development, including the no-action alternative, in comparative form, exploring each alternative. Alternatives to the development shall be examined with some orientation in regards to the merit(s) and demerit(s) of the various possible options, as well as justifying and confirming the utility of the preferred option. This should include a presentation of all reasonable alternatives in comparative form, including the no-action alternative. These alternatives should look at the following components:

a. Siting of the necessary support infrastructure and all facilities including feeder roads, and interior waterway;
b. Water supply alternatives (examine the different abstraction points investigated);
c. Liquid and Solid waste treatment and disposal options (evaluate the different treatment technologies and methodologies); and
d. Boat storage facilities.
e. Fuel storage and dispensing facilities
f. Marina facilities

3.0. MITIGATION AND MONITORING PLAN

3.01 Based on the investigations, research and tests conducted, develop a Mitigation Matrix outlining Mitigation Measures for all potential negative environmental impacts including, this should include:

(a)The monitoring of water quality parameters as well as the monitoring of waste water discharge characteristics, water abstraction levels and changes in ecological species (including endangered species);

(b)The monitoring of the physical aspects of the dredging operation itself and the land reclamation aspects of the project;

(c)The monitoring of ecosystem recovery, including the re-colonization of flora and fauna, in particular fin-fish and macro-invertebrate life.

3.02 Provide a Monitoring Plan to be implemented for the entire project. This should include the monitoring of key environmental indicators (flora or fauna), wastewater discharge characteristics (if any), water abstraction levels, and changes in ecological species (including endangered species).

Addendum 4

MANATEES IN BELIZE

Guidelines for Protection

Photo by Leszek Karczmarski

DO YOUR PART TO PROTECT BELIZE'S HERITAGE, ENVIRONMENT, AND FUTURE!!

MANATEE DOs & DON'ts ;

The West Indian manatee is an endangered species and is protected by law.

Manatees are important in many ways: (i) they are part of Belize's rich biological diversity; (ii) the Antillean manatee population in Belize is the greatest for any country in its range; (iii) they are an indicator for species ecosystem health; (iv) they are a part of our cultural heritage; and (v) they provide diverse opportunity for tourism.

WHEN NEAR MANATEES:

- Don't touch manatees, only look.
- Don't chase a manatee while in the water nor in a boat.
- Don't separate a mother and her calf.

WHEN BOATING:

- Abide by posted speed zone signs in manatee areas.
- Look out for manatees in manatee areas: listen for it surfacing to breathe; notice the animal's back, snout, tail or flipper break the water's surface; also notice swirls in water from them diving.
- Try to stay in deep water channels. This will prevent running over them.
- For tour operators: Slow boat to idle speed when 100 yards from manatee site. Drift or pole into position once within 75-100 feet of site.

Please don't throw trash where manatees splash!!!!!

Please Help Save the Manatee!

For more information, or to report manatee deaths or injury, please contact:

Manatee Researcher*
Coastal Zone Management Authority and Institute
8 St. Mark Street
Belize City, Belize
Phone: (501)2230719/2235739/2232616
Fax: (501)2235738
Email: czmbze@btl.net
Web site: coastalzonebelize.org
* [Also call to report manatee sightings at 0-800-MANATEE].

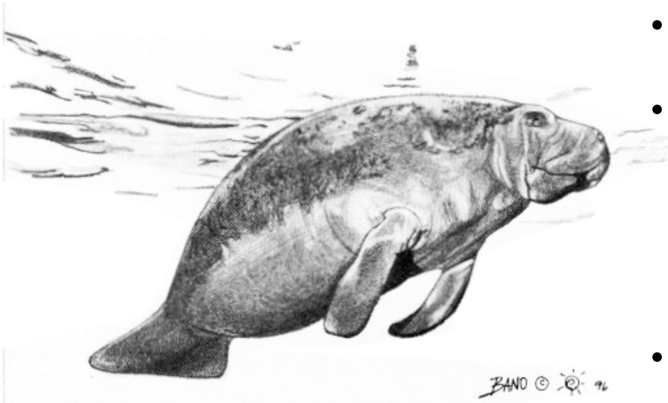
Belize Audubon Society
12 Fort Street
Belize City, Belize
Phone: (501)2234533
Email:base@btl.net

Forest Department
Belmopan, Belize
Phone: (501)8223629

Fisheries Department
Princess Margaret Drive
Belize City, Belize
Phone:(501)2244552/2232623
Email:species@btl.net

BELIZE COASTAL ZONE MANAGEMENT AUTHORITY & INSTITUTE

MANATEE FACTS



WEST INDIAN MANATEE IN BELIZE

- **SCIENTIFIC NAME:** *Trichechus manatus manatus*
  Antillean manatee
- **DESCRIPTION:**
  - Large, grey or grey-brown marine mammal.
  - Has two flippers on both sides of its body, and round, paddle-like tail.
  - Can be 1-4 meters (3-12 ft) long and weigh 1000 lbs.
- **HABITAT:**
  - They live in both salt and fresh water, especially where seagrass beds are plentiful. They like shallow, slow moving rivers, estuaries, saltwater bays, canals, and coastal areas.

Primary manatee areas in Belize

Although Belize has the largest population of the Antillean manatee (a subspecies of the West Indian manatee) in the Caribbean, it is still small and considered threatened. There are probably less than 900 manatees countrywide. Help to increase that number by boating carefully in these areas:

- **BELIZE CITY COAST and CAYS**:

Swallow Cay, Moho Cay, Port-O-Stuck, Drowned Cays, Hicks Cay, Bluefield Range, Rider Cay, Turneffe Atoll.

- **SOUTHERN AND NORTHERN LAGOON**
- **PLACENTIA LAGOON**
- **CHETUMAL BAY**
- **PORT HONDURAS AREA**
- **INDIAN HILL LAGOON**
- **RIVERS:**

Deep River, Belize River, Monkey River, Rio Hondo, Mullins River.

Protection by law

The manatee is protected in Belize under the **Wildlife Protection Act, No. 4 of 1981**. Jurisdiction is under the Forest Department, Ministry of Natural Resources.

Under this Act, **no person shall hunt, meaning "to kill, molest by any methods and includes attempting to kill, take or molest by any method" any manatee**.

Anyone who hunts a manatee will be fined **$500.00** on a first offence, and **$1000.00** and/or imprisonment for 6 months, for previously convicted wildlife offenders.

CALL THE COASTAL ZONE MANAGEMENT AUTHORITY AND INSTITUTE @ 0-800-MANATEE (0-800-6262833) TO REPORT MANATEE INJURIES, DEATHS, OR SIGHTINGS.

Drawings by Gilvano Swasey

Manatee Facts

Belize has the largest population of the West Indian manatee *Trichechus manatus manatus* in the world. Still small, Belize's manatee population is probably less than 700 country wide. It is an endangered species and is protected by law. Manatees bring revenue for the tourist sector, they provide an ecological balance, and they help to diversify Belize's animal life!

Help to increase the manatee population in Belize by abiding by the suggested guidelines. Be especially careful in the following areas:

- **BELIZE CITY COAST and CAYS:** Swallow Cay, St. Georges Cay, Moho Cay, Port-O-Stuck, Drowned Cays, Hicks Cay, Bluefield Range, Rider Cay, Turneffe Atoll.
- **SOUTHERN AND NORTHERN LAGOON**
- **PLACENTIA LAGOON**
- **CHETUMAL BAY**
- **PORT HONDURAS AREA**
- **INDIAN HILL LAGOON**
- **RIVERS:** Deep River, The Belize River, Monkey River, Rio Hondo, Mullins River.

Please Help Save the Manatee!
For more information, or to report manatee deaths or injury, please contact:

Manatee Researcher*
Coastal Zone Management Authority and Institute
Princess Margaret Drive
P.O. Box 1884
Belize City, Belize
Phone: 501-223-0719/5739/2616
Toll Free: 0-800-MANATEE
email:czmbze@btl.net

Belize Audubon Society
12 Fort Street
Belize City, Belize
Phone:

Forest Department
Belmopan, Belize
Phone: 501-822-3629

Fisheries Department
Princess Margaret Drive
Belize City, Belize
Phone: 501-224-4552/223-2623
Email: species@btl.net

BELIZE COASTAL ZONE MANAGEMENT AUTHORITY & INSTITUTE

MANATEES IN BELIZE

Guidelines for Tour Operations

DO YOUR PART TO PROTECT BELIZE'S HERITAGE, ENVIRONMENT, AND FUTURE!!

ONLY YOU CAN HELP SAVE THE MANATEE

TOURIST ORIENTATION:

☞ ***Familiarize tourists with proper behavior for viewing manatees:***

☞ **NO loud noises** as it frightens manatees.

☞ **NO touching or feeding** the manatees, this can alter their natural behavior.

☞ **NO approaching females with calves.**

BOAT APPROACH:

☞ **Slow to idle speed 1/2 mile to 100 yards from manatee site** to prevent hitting or scaring away the manatees.

☞ Once within 75 to 100 feet from the site, turn engine off and drift or pole to site.

☞ When in position, use pole to hold boat.

NUMBER OF BOATS AT A SITE:

This will be different at each site, but guides should not use an area if many boats and tourists are already there.

☞ NO more than 2 boats at a site. Very large areas can possibly accomodate 3-4 boats (without swimmers).

☞ Boats should cooperate and share a site.

SWIMMING:

☞ **NO swimming** in "Manatee Hole" at **Swallow Cay** and at **Gales Point**.

☞ Swim only at deep, clear holes.

☞ Enter the water only if manatees seem undisturbed and stay in area.

☞ Enter water quietly and stay on surface of water with a guide [do not dive].

☞ No chasing nor attempting to corner or isolate a manatee.

☞ **Small groups** at a time in the water (about 5 persons).

☞ Minimize time in the water (no more than 15 minuites).

TIME AT A SITE:

☞ If a boat is waiting, the boat using the site should only stay 20 minutes more, or share the site if big enough. *Accommodate one another.*

DEPARTURE OF BOATS:

☞ Leave site by drifting or poling away 75-100 ft. before starting engine.

☞ Leave boat at idle speed, do not rev motor.

☞ ***Please don't throw trash where manatee splash!!!***

PROTECTION BY LAW

The West Indian Manatee is protected in Belize under the **Wildlife Protection Act, No. 4 of 1981**. Jurisdiction is under the Forest Department, Ministry of Natural Resources.

Under this act, **no person shall hunt, meaning "to kill, molest by any method and includes attempting to kill, take or molest by any method" any manatee**.

Anyone who hunts a manatee will be fined **$500.00** on a first offence, and **$1000.00 and/or imprisonment** for 6 months for previously convicted wildlife offenders.

CALL THE COASTAL ZONE MANAGEMENT AUTHORITY AND INSTITUTE TO REPORT MANATEE INJURIES, DEATHS, OR BIRTHS

0-800-MANATEE

ADDENDUM 5

BELIZE

THE SUBSTANTIVE LAWS OF BELIZE.
IN FORCE ON THE 31ST OF DECEMBER, 2000.

REVISED EDITION 2000,
PREPARED UNDER THE AUTHORITY OF THE LAW REVISION ACT, CHAPTER 3.

REVISED BY

OFFICE OF THE CHIEF PARLIAMENTARY COUNSEL
ATTORNEY GENERAL'S MINISTRY,
BELMOPAN

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ENVIRONMENTAL, REGULATION AND CONTROL, CULTURE AND HISTORY

TITLE XXXIII

REGULATION AND CONTROL OF MISCELLANEOUS MATTERS

[printed by the Government Printer,
No. 1 Power Lane,
Belmopan,
by the authority of the Government of Belize.]

TITLE XXXIV

SUSPENDED ENACTMENTS

printed by the Government Printer,
No. 1 Power Lane,
Belmopan,
by the authority of the Government of Belize.

FORM 20

(RULE 24)

BELIZE

FOLIO NO. 105

VOLUME 28

GENERAL REGISTRY ACT, CHAPTER 258 of the LAWS of BELIZE R.E. 1980 GENERAL REGISTRY RULES. 1954.

Addendum 6

TRANSFER CERTIFICATE OF TITLE

Know all men to whom these present shall come that by transfer effected by

COLLGERRY REALTY INC. of a Comapny incorporated in the State of Florida in the United States of America having a place of business at No. 2 Regent Street West in Belize in British Honduras

COROZAL TIMBER COMPANY LIMITED of a Company incorporated in Belize with its registered office at No. 99 Albert Street in Belize City

~~XXXXXX~~ has (or have) become and is (or are) the registered ~~proprietor~~ (or proprietors) of ALL THAT parcel of land situate on the Sea Coast of British Honduras numbered 257 on the Property Map called Northern Bulkhead and comprising approximately 17,808 acres bounded and described as follows: Commencing at the mouth of Grant's Creek and extending Northward along the Sea Coast for an approximate distance of 240 chains in a straight line to the southern boundary of a block of land numbered 50 on Duvernay's Map the Northern and Southern side lines running due West magnetic (in 1864) for approximately 840 chains and 715 chains respectively to the back lines of the 99 years Lease and Freshwater Creek Forest Reserve, being the northern portion of the block of land recorded in Entry 141 in Lands Titles Register Book 7 and containing approximately seventeen thousand eight hundred and eight acres.---

subject, nevertheless, to the legal charges and incumbrances which are noted herein, or endorsed hereon. hereof or endorsed hereon.

(Mortgage)

In faith and testimony whereof I have hereunto subscribed my signature and affixed the seal of the Registrar General's Office, this 9th day of DECEMBER 1994 at the General Registry.

NOTINGS

A Memorandum of transfer was presented at the General Registry on the 18th Nov 1994 at 11 a.m. Transfer 22nd June 1962 ... Volume 14 at folio ...

REGISTRAR GENERAL

A charge by way of Legal Mortgage in favour of Collgerry Inc lodged for registration this 18th day of November 1994 at 3 3? and registered in Volume 93 at folio 32

Registrar General

A charge by way of Legal Mortgage in favour of Alpstein Holding Co lodged for registration this 18th day of November 1994 at 3.3 and registered in Volume 93 at folio 33

Registrar

Assignment CIBS Trust & Mercha (Barbados) 99 December 94 at 3 3 2 32

A charge by way of *Variation of Mortgage &*
in favor of *Collgerry Inc.*
lodged for registration this *14th*
day of *July* 19*95 at 3:30p.m.*
and registered in Volume *23*
at folio *63*
Deputy Registrar General

A charge by way of *Incumbrance*
in favor of *Barrow & Williams*
lodged for registration this *19th*
day of *January* 19*96 at 3:30p.m.*
are registered in Volume *7*
at folio *83*
(Sgd.) E.O. Pennil
Deputy Registrar General

A charge by way of *Deed of Assignment & Transfer of Mortgage Debenture*
in favor of *Canadian Maple Leaf Financial Corporation*
lodge for registration this *30th*
day of *May* 20*00 at 3:30p.m.*
are registered in Volume ~~at~~ *2 at*
folio *100*
E.C. Howes
for REGISTRAR OF LANDS

(RULE 24)

BELIZE

FOLIO NO.
VOLUME

GENERAL REGISTRY ACT, CHAPTER 258 of the LAWS of BELIZE R.E. 1980 GENERAL REGISTRY RULES, 19

TRANSFER CERTIFICATE OF TITLE

Know all men to whom these present shall come that by transfer effected by

COLLGERRY REALTY INC. ~~x~~of a Company incorporated in the State of Florida, in the United States of America having a place of business at No. 2 Regent Street West in Belize, British Honduras

COROZAL TIMBER COMPANY LIMITED ~~x~~of a Company incorporated in Belize with its registered office at No. 99 Albert Street in Belize City

~~has~~ (or have) become and ~~is~~ (or are) the registered ~~proprietor~~ (or proprietors) of ALL the estate and interest which were of James Young, William Harrison, Frederick Robert Bevan of the City of London and of Malcolm Glassford and Philip Toledo of Belize lately carrying on business together as Merchants in Belize under the style of Young Toledo and Co. and in London under the style of Young Harrison and Bevan and of the late firms of F. R. Bevan & Co. of London and P. Toledo and Co. of Belize in and to all those lands tenements and hereditaments numbered 124 in the Register of Applications and delineated on Du Vernay's Plan as Number 52 and containing approximately nineteen thousand eight hundred and five acres,

subject, nevertheless, to the legal charges and incumbrances which are noted herein, or endorsed hereon. hereof or endorsed hereon.

In faith and testimony whereof **I have hereunto subscribed my signature and affixed the seal of the Registrar General's Office, this** 9th **day of** DECEMBER **19**94 **at the General Registry.**

(Mortgage)

NOTINGS

A Memorandum of trans... presented ... General ... on ... 15th ... at 11:00 AM ... 7400 ... day of June ... respect of which ... is registered in the Land T... Volume

REGISTRA...

A charge by way of Leg... in favor of Collgerry ... lodged for registration ... day of November 199... and registered in Vol... at folio 32

Registrar Gen...

A charge by way of ... in favor of Shepstein ... lodged for registration ... day November ... and registered in ... at folio 33

Registrar ...

Assi... CIBC Trust... (Bah...

December

39

J.B.
Uf

A charge by way of Variation of Mortgage
in favor of Collgerry Inc.
lodged for registration this 14th
day of July 1995 at 3:30 p.m.
and registered in Volume 23
at folio 63
Registrar General

A charge by way of Incumbrance
in favor of Borrow & Williams
lodged for registration this 19th
day of January 1996
are registered in Volume 7
at folio 84
(Sgd.) E. O. Pennil
Deputy Registrar General

A charge by way of Deed of Assignment & Transfer of Mortgage Debenture
in favor of Canadian Maple Leaf Financial Corporation
lodge for registration this 30th
day of May 2000 at 3:30 p.m.
are registered in ~~Volume at~~ 2 at
folio 100
E.C. Flowers
for REGISTRAR OF LANDS

FORM 20

(RULE 24)

BELIZE

FOLIO NO. 107
VOLUME 28

GENERAL REGISTRY ACT, CHAPTER 258 of the LAWS of BELIZE R.E. 1980 GENERAL REGISTRY RULES, 1954.

TRANSFER CERTIFICATE OF TITLE

Know all men to whom these present shall come that by transfer effected by

COLLGERRY REALTY INC. of a company incorporated in the State of Florida in the United States of America, having a place of business at No. 2 Regent Street West in Belize, British Honduras

COROZAL TIMBER COMPANY LIMITED of a company incorporated in Belize with its registered office at No. 99 Albert Street in Belize City

has (or have) become and is (or are) the registered proprietor (or proprietors) of ALL THAT parcel of land situate on the Sea Coast of British Honduras known as Southern Bulkhead and numbered 256 on the Property Map of the Colony comprising approximately 17,286 acres bounded and described as follows: Commencing at the mouth of Grant's Creek and extending southward along the Sea Coast for an approximate distance of 260 chains in a straight line to the Northern side line of Will Edwards Estate, the northern and Southern side lines running due west magnetic (in 1864) for approximate distances of 7.5 and 645 chains respectively to the back lines of 99 years lease and Xcanha Forst Reserve being the southern portion of the block of land described in Entry 141 in Lands Titles Register Book 7.

subject, nevertheless, to the legal charges and incumbrances which are noted herein, or endorsed hereon.
hereof or endorsed hereon.

In faith and testimony whereof **I have hereunto subscribed my signature and affixed the seal of the Registrar General's Office, this** 9K

(Legal Mortgage)

NOTINGS

A Memorandum of transfer was presented at the General Registry on the 18th [illegible] November 8[illegible] at 11 o'c AM [illegible] Transfer Certificate [illegible] the 22nd day of June [illegible] 62 [illegible] respect of the land [illegible] is registered in the Land Titles [illegible] Volume 4 at folio [illegible]

[signature]
REGISTRAR GENERAL

Legal Mortgage
Collgerry Inc.
18th November 94 at 3:30
23
33 [signature]

Legal Mortgage
Shipstern Holding [illegible]
18th November 94 at 3:3[illegible]
23
33 [signature]

Assign
CIBC (Trust & Merchant) (Barbados) Ltd
December 1994 at 3[illegible]

A charge by way of Variation of Mortgage
in favor of Collgerty Inc.
lodged for registration this 14th
day of July 1995 at 3:30 p.m.
and registered in Volume 23
at folio 63
Dep. Registrar General

A charge by way of Incumbrance
in favor of Barrow & Williams
lodged for registration this 19th
day of January 1996
and registered in Volume 7
at folio 85
(Sgd.) E. O. Pennil
Deputy Registrar General

A charge by way of Deed of Assignment & Transfer of Mortgage Debenture
in favor of Canadian Maple Leaf Financial Corporation
lodge for registration this 30th
day of May 2000 at 3:30 p.m.
are registered in Volume as 2 at
folio 100

for E.C. Flowers
REGISTRAR OF LANDS

FORM 20

(RULE 24)

BELIZE

FOLIO NO. 108
VOLUME 26

GENERAL REGISTRY ACT, CHAPTER 258 of the LAWS of BELIZE R.E. 1980 GENERAL REGISTRY RULES, 1954.

TRANSFER CERTIFICATE OF TITLE

Know all men to whom these present shall come that by transfer effected by

COLLGERRY REALTY INC. of a company incorporated in the State of Florida in the United States of America having a place of business at No. 2 Regent Street West in Belize, British Honduras

COROZAL TIMBER COMPANY LIMITED of a company incorporated in Belize with its registered office at No. 93 Albert Street in Belize City

has (or have) become and is (or are) the registered proprietor (or proprietors) of all the estate and interest which were of James Young, William Harrison Frederick Robert Bevan of the City of London and of Malcolm Glassford and Philip Toledo of Belize lately carrying on business together as Merchants in Belize under the style of Young Toledo and Co. and in London under the style of Young Harrison and Bevan and of the late firms of F. R. Bevan & Co. of London and P. Toledo and Co. of Belize in and to all those lands tenements and hereditaments numbered 123 in the Register of applications and delineated on Du Vernay's Plan as numbered 51, and containing approximately twenty-one thousand and forty-eight acres.

subject, nevertheless, to the legal charges and incumbrances which are noted herein, or endorsed hereon.
hereof or endorsed hereon.

In faith and testimony whereof I have hereunto subscribed my signature and affixed the seal of the Registrar General's Office, this 9th

NOTINGS

A memorandum of ... was presented at the General Registry on the 18th November 19.. at 11.00 AM ... Transfer ... day of June 62 ... is registered in the ... Volume 4 at folio ...

REGISTRAR GENERAL

A charge by way of Legal Mortgage in favour of Collgerry Inc lodged for registration this ... day of November 1974 at ... and registered in Volume ... at folio 32

A charge by way of Legal Mortgage in favour of Alipstem Holdings ... lodged for registration this ... day of November 1974 at ... and registered in Volume ... at folio 33

(Mortgage) Ass... CIBC Trust (Barbados) ...

December

39

A charge by way of Variation of Mortgage
in favor of Collgerry Inc.
lodged for registration this 14th
da' of July 1995 at 3:30p.m.
an.c registered in Volume 23
at folio 63
Registrar General

A charge by way of Incumbrance
in favor of Barrow & Williams
lodged for registration this 19th
da' of January 1996
an.c registered in Volume 7
at folio 86
(Sgd.) E.O. Pennil
Deputy Registrar General

A charge by way of Deed of Assignment & Transfer of Mortgage Debenture
in favor of Canadian Maple Leaf Financial Corporation
lodge for registration this 30th
day of May 2000 at 3:30p.m.
are registered in Volume ~~at~~ 2 at
folio 100

EC. Flowers
for REGISTRAR OF LANDS

FORM 20

(RULE 24)

FOLIO NO. 109
VOLUME 28

BELIZE

GENERAL REGISTRY ACT, CHAPTER 258 of the LAWS of BELIZE R.E. 1980 GENERAL REGISTRY RULES, 1954.

TRANSFER CERTIFICATE OF TITLE

Know all men to whom these present shall come that by transfer effected by

COLLGERRY REALTY INC. of a company incorporated in the State of Florida in the United States of America having a place of business at No. 2 Regent Street West in Belize, British Honduras

COROZAL TIMBER COMPANY LIMITED of a company incorporated in Belize with its registered office at No. 99 Albert Street in Belize City

has (or have) become and is (or are) the registered proprietor (or proprietors) of ALL THE estate and interest which were of James Young, William Harrison, Frederick Robert Bevan of the City of London and of Malcolm Glassford and Philip Toledo of Belize lately carrying on business together as Merchants in Belize under the style of Young Toledo and Co. and in London under the style of Young Harrison and Bevan and of the late firms of F. R. Bevan and Co. of London and P. Toledo and Co. of Belize in and to all those lands tenements and hereditaments numbered 122 in the Register of Applications and delineated on Du Vernay's Plan as Number 50, and containing approximately 20, 875 acres, SAVE AND EXCEPT (1) that piece or portion thereof comprised in a Transfer Certificate of Title dated the 8th day of July 1964 and registered in the Land Titles Register in Volume 5 at folio No. 113 and containing 480 acres; (2) that piece or portion thereof comprised in a Transfer Certificate of Title dated the 8th day of July 1964 and registered in the Land Titles Register in Volume 5 at folio No. 114 the said piece or parcel being comprised of two

CONT' OVERLEAF

subject, nevertheless, to the legal charges and incumbrances which are noted herein, or endorsed hereon.

hereof or endorsed hereon.

In faith and testimony whereof **I have hereunto subscribed my signature and affixed the seal of the Registrar General's Office, this** 9K

NOTINGS

A Memorandum of ... presented ... on the 18th November 94 at 11.00 AM ... June 62 ... Volume 4 ... 16

REGISTRAR GENERAL

... Legal Mortgage in favour of Collgerry Inc ... 18th ... of November 94 at 33 ... 23 ... Folio 32

Legal Mortgage Shipstern Holding Company 18th November 94 at 33 ... 23 33

(Mortgage) Assignment ... CIBC Trust & Merchant (Barbados) Ltd 9 ... December 94 at 33 ... 2 ... 39

A charge by way of Variation of Mortgage
in favor of Collgerry Inc.
lodged for registration this 14th
day of July 1995 at 3:30 p.m.
and registered in Volume 23
at folio 63

Deputy Registrar General

tracts containing 960 acres and 260 acres respectively; (3) that piece or portion thereof comprised in a Transfer Certificate of Title dated the 8th day of July 1964 and registered in the Land Titles Register in Volume 5 at Folio No. 119 and containing 20 acres.

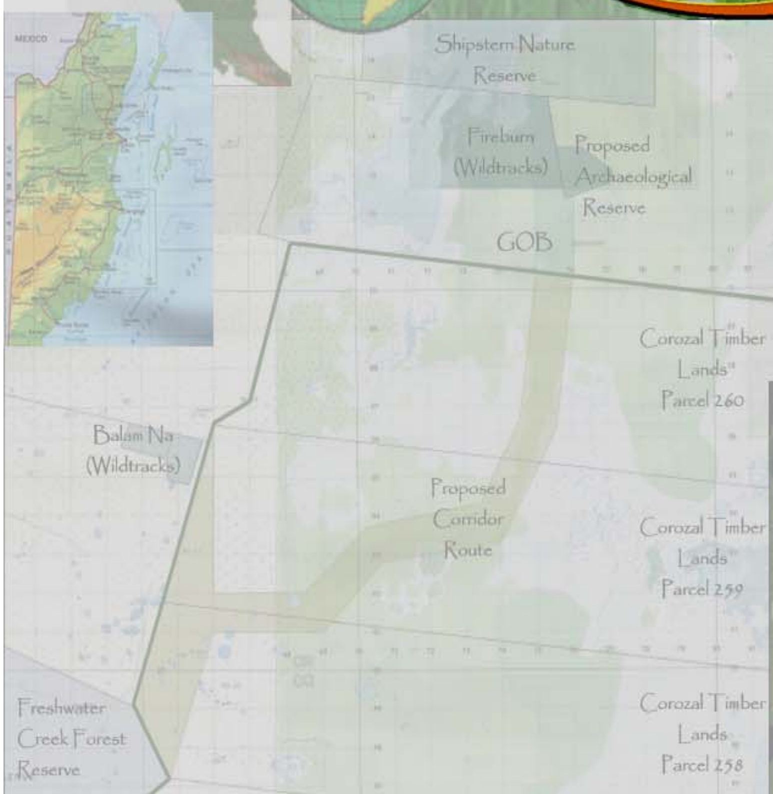
A charge by way of Incumbrance
in favor of Bartow & Williams
lodged for registration this 19th
day of January 1996
and registered in Volume 7
at folio 87
(Sgd.) E. O. Fennil
Deputy Registrar General

A charge by way of Deed of Assignment & Transfer of Mortgage Debenture
in favor of Canadian Maple Leaf Financial Corporation
lodge for registration this 30th
day of May 2000 at 3:30 p.m
are registered in Volume at 2 at
folio 100

for E.C. Flowers
REGISTRAR OF LANDS

Addendum 7

SUSTAINABLE FOREST MANAGEMENT PLAN



BALAM JUNGLE ESTATES

Corozal District, Belize, Central America

February 2006

SUSTAINABLE FOREST MANAGEMENT PLAN

COROZAL TIMBER COMPANY LTD.

Balam Jungle Estates/Corozal Timber Lands
Corozal District, Belize, Central America

February 2006

THE BALAM JUNGLE ESTATES, legally referred to as the **COROZAL TIMBER LANDS**

Information on the Corozal Timber Lands

Registered in the Lands Title Registrar
in Belmopan, Belize as:

Parcel 260 (Vol 28. Folio. 106)
Parcel 259 (Vol.28. Folio. 108)
Parcel 258 (Vol.28, Folio. 109)
Parcel 257 (Vol.28, Folio. 105)
Parcel 256 (VoL 28, Folio. 107)

PLAN PREPARED BY: Suamy Rafael Aguilar Mendoza
Fundación Naturaleza para la Vida.
Santa Elena, Petén, Guatemala
Tel: 00502 59396888
00502 79260608
Website: www.fnpv.org

SUBMITTED TO: ***National CITES Scientific Authority***

FOREST MANAGEMENT PLAN SIGNATURE PAGE

This plan was prepared to provide a framework for the management of timber resources and other forest values on the Balam Jungle Estates. The plan was developed in consultation with the Forest Department of the Government of Belize, the management of the Balam Jungle Estates and other concerned stakeholders. It is submitted to the National CITES Scientific Authority for their consideration.

Statement of Approval:

I have reviewed the enclosed Forest Management Plan for the Balam Jungle Estates and concur with the observations and assertions made herein. I further agree that the prescriptions and recommendations made in this plan offer a reasonable and plausible strategy for the implementation of a sustainable management program for the timber and other forest values occurring within the said property. In testimony of this, we inscribe out signatures as members of the National CITES Scientific Authority.

Name and Position	Date

Name and Position — Date

Name and Position — Date

Name and Position — Date

Name and Position — Date

Name and Position — Date

MESSAGE FROM THE FUNDACIÓN NATURALEZA PARA LA VIDA

Fundación Naturaleza Para la Vida - NPV - has the satisfaction of providing another technical document with the purpose of guiding the sustainable forest management of a private property.

This Integrated Management Plan for the Balam Jungle Estates is the fruition of efforts carried out by the consultants' team along with technical and administrative personnel of NPV in order to invigorate the process of sustainable forest management. The success of this process will be the prudent vision of a group of people (organizations), which establishes consistency and harmony among the socioeconomic development of people and the conservation of important natural and cultural resources.

Fundación NPV is proud to have been selected by the Managing Director of the Balam Jungle Estates to participate in the development of this document. With the participation of NPV, Balam Jungle Company Ltd. (herein referred to as “BJC Ltd.”) has addressed the concern of establishing proper management of its forest area.

Fundación NPV, a local organization from Petén, Guatemala, continues to rise to the challenge of “conserving nature by means of sustainable development.” As a dedicated organization, NPV promotes the integral and sustainable management of natural and archaeological resources in the Petén region by linking forest companies with community participation to create a mutually beneficial environment. By applying a regional model for forest management, which includes the consolidation of socioeconomic alternatives, NPV has been successful in reducing the loss of precious biodiversity while generating valuable employment opportunities for surrounding communities.

The development of this document was made possible by BJC Ltd.’s tireless support and the Forestry Department’s ongoing leadership. Through combined participation, the technicians of NPV have undertaken to consider and integrate each proposed suggestion, with the aim of creating much more than just a required document, but a valuable tool that can guide the sustainable management of the Balam Jungle Estates.

NPV is very appreciative and extends sincere gratitude to all the persons that participated in the maturity of this Management Plan. A special thanks is given to the members of BJC Inc. who assisted the management unit and the technical team of NPV as they carried out the critical forest inventory phase of the Management Plan.

Cordially,

Technical Director.
Fundación Naturaleza Para la Vida.
- NPV -

EXECUTIVE SUMMARY

This present Management Plan is the result of the willingness and environmental conscience of BJC Inc. and the technical assistance provided by NPV. This Management Plan consolidates and combines all information and data derived from the latest forest inventory/timber cruise report, which was conducted to assess the state of the timber resources on the Balam Jungle Estates (herein referred to as “the Property”). This plan is the most recent, comprehensive, and reliable assessment of the property’s standing timber resources and potential for development of these resources. The plan will then serve as a strict guide for all future operations initiated on the Property. The current landowners are committed to engaging in proper timber harvest practices only as prescribed under a sustainable Management Plan in order to ensure conservation of the property’s flora and fauna.

The Management unit has a total area of 39,897.0 ha, which embraces 1,997.6 ha of water bodies, 17,081.0 ha of wetlands, 2,439.1 ha of mangrove ecosystems, 1,911.00 ha of high broadleaf forest, 15,969.0 ha as medium broad leaf forest, and 513 ha of low broad leaf forest. The protection zones are composed water protection buffers and wetlands. The total productive or harvestable area realized within the Management unit is 17,881.0 ha

A key objective of this Plan is the proper sustainable management of timber resources and non-wood forest products - specifically the Bay Leaf Palm - within the management unit of the Property. The Plan also serves to minimize the impact to the environment, guaranteeing protection of Balam Jungle’s rich biodiversity.

The forestry inventory was completed using a stratified systematic sampling technique with a sampling intensity of 0.53% on the identified productive area. The forest classification was based on physiographic criteria, floristic composition, and forestry variables. The sampling units had a rectangular form, oriented in North-South or East-West direction, according to the productive area of the forest. All trees with a diameter in excess of 25 cm DBH found within the sample unit dimension of 20 m x 500 m (1 ha) were measured. The results of the inventory also demonstrate the quantity of individuals per hectare over 10 cm DBH.

For the purpose of analysis, the “TABLA DE RODAL” model was applied and the desired species were grouped according to their commercial potential and their diameter class distribution. These groups are:

- Highly Commercial Species **(HIGHCOM)**
- Actually Commercial Species **(ACTCOM)**
- Potentially Commercial Species **(POTCOM)**
- Non Commercial Species **(NONCOM)**
- Special Protected Species **(PROTEC)**

The HIGHCOM represents 2.5% of the total number of commercial individuals/ha and 2.6% of the basal area/ha The ACTCOM represents 52.8% of the total number of individuals/ha and 50.7% of the basal area/ha The POTCOM represents 44.7% of the total individuals/ha and 46.7% of Basal area/ha

Information concerning pole timber, Bayleaf palm, seedlings and saplings was gathered on regeneration sub plots. A total of 95 sampling units were established, yielding a sampling error of 10.84% based on the commercial volume.

Concerning the regeneration, a normal regeneration was found to be occurring on the Property as the HIGHCOM group represents 1% of the seedlings/ha and saplings/ha for all species. Normal regeneration of HIGHCOM was further evidenced after finding 71.8 seedlings/ha The ACTCOM group represents 14% of the saplings/ha and 15% of the seedlings/ha

The POTCOM group represents 65% of the seedlings/ha and 73% of the saplings/ha Due to their scarcity, the protected (PROTEC) species represent 19% of the saplings/ha and 12% of the seedlings/ha This indicates that it's necessary to favor the population growth of HIGHCOM and ACTCOM species.

During the transformation of HIGHCOM seedling to sapling, there is an average loss of 96%, indicating that the death rate during regeneration is quite high but very normal for forests without any silvicultural treatment. For ACTCOM there is an average loss of 95%. Opening the higher canopy can change this situation because many species are helophytes and with the increase in illumination more regeneration will be established. It will be important to maintain this situation under examination in order to prescribe future treatments if necessary.

This Management Plan proposes a system of harvesting which is based on a fixed Minimum Cutting Diameter (herein referred to as the "MCD") and a specific cutting intensity. By setting standards and selectively harvesting species of commercial value, a proposed cutting cycle of 25 years can be a realistic management objective, especially with an annual tree growth of 0.4cm/year reported in the zone.

This area of land presents special soil characteristics. This is evidenced in the Geological Study conducted on management area by respected geologist, Mr. Brian Holland of Belize Minerals Ltd. One of the most striking bedrock features in the Property is the widespread occurrence of a hard, well cemented, limestone bed, up to 2m thick. This bed was observed along the logging roads throughout the Management area.

On the analysis of the inventory data, it was determined that this area of land does not host trees of large diameters. After collecting data on the number of individual trees, the basal area and volume were projected on a graph and the results show no individuals in excess of 50cm in diameters. The examination was done specifically for the mahogany specie and the results were the same. By considering the unique geological factors, specifically the shallow soil types, in combination with the data collected for the average diameter of the tree species on the Property, the following conclusion was able to be drawn: the typical shallow soils found on the Property have limited potential for diameter growth of tree species. While a tree flourishes, the actual diameter of that tree on the Property will not likely be an accurate indication as to the maturity of that tree. Mature species will have smaller than usual diameters.

Since there were no trees found that had a diameter greater than 60cm, which is the MCD initially established by the Forestry Department for mahogany and the productive area of this forest, we recommend applying a MCD of 45cm in order to produce a more moderate harvesting volume. A MCD of 40cm will be more appropriate and adapted to suite the unique maturing process on the Property's shallower soil types.

We recommend a total production of 26.86 cubic meters of lumber for all the strata of HIGHCOM AND ACTCOM species and 16.5 cubic meters of POTCOM species.

In the next five-year period of harvesting (6,708.23 ha), we recommend extracting not more than 2,034 m^3 of the high commercial species and 12,291 m^3 of other commercial species.

A model will be applied in order to minimize the negative impact to the forest during harvest by identifying, demarcating, and coordinating areas of operation at the pre-harvesting stage. The commercial census and the Annual Operative Plan (herein referred to as "the AOP") will be harmonized. The AOP will be elaborated and the extraction roads will be pre-designed. The harvesting stage consists of extraction and millwork. The post-harvesting stage consists of commercialization, closing of roads, diagnostic sampling, silvicultural treatments, and other concentrated efforts.

Simultaneously with harvesting operations, we recommend that BJC Ltd. looks to create relationships by teaming the present private forest rangers, who protect the Property on a daily basis, with other nearby community members in order to create a presence and awareness, which can better mitigate illicit activities inside the management unit. For mutually beneficial purposes, BJC Ltd. has already established and continues to build a relationship with Friends of Freshwater Forest Reserve in order to create overlapping protection efforts that can benefit both the Property and the national reserve from would-be poachers. Combined efforts can more effectively preserve the integrity of the Property by not only eliminating illicit activity in the area, but also by ensuring that prevention measures are taken to lower the risk of forest fires and to clearly demarcate and maintain visible property boundaries.

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1 COMPANY PROFILE

1.1 BACKGROUND -

The 86,021+- acres (34,811+- ha) of private property located in the Corozal District of Northern Belize is currently managed by the Balam Jungle Company Ltd. (herein referred to as "BJC Ltd.") The property is a diverse universe of diverse ecosystems, which has been highlighted in the intensive Biodiversity Study conducted on the property in 2003. The Plan for management of the property is built around the principle of diversification determined by best land use. Currently management of the property is focused on protection and conservation, sustainable timber harvesting, and the installation of basic infrastructure so that a prudent subdivision of the land can later be effected in order to attract more responsible development to the area.

After many years of managing this asset, an enormous amount of time, effort, money, and planning has been invested by the stakeholders of Balam Jungle Estates Incorporated to effectively bring about the preservation and revitalization of this asset while they have also actively progressed with development initiatives on this relatively large tract of land.

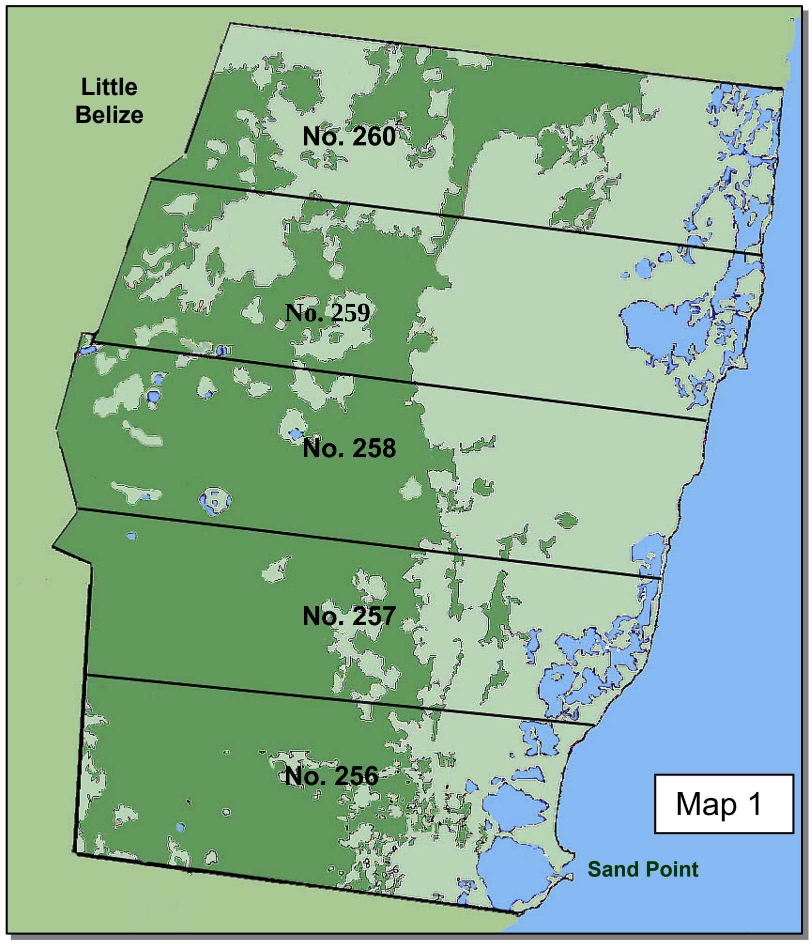
Although the Balam Jungle Estates (herein referred to as "the Property"), legally referred to as the Corozal Timber Lands, is not officially a protected area or reserve, its management system is in tune with conservation and biodiversity management objectives in Belize and throughout the world. BJC Ltd. maintains and actively upholds a strict no hunting policy within their boundaries and has actively promoted and protected critical conservation areas throughout the Property.

The commitment of BJC Ltd. to the protection of the land through the creation of conservation priority areas and the establishment of the Northern Biological Corridor is further evidenced by continuous work with environmental organizations in the assessment and analysis of the property's ecological, geological, and historical (Mayan structures) attributes, and their ongoing efforts to implement best practices for its sustained land use.

This is also true for their harvesting operation, which already exhibits low impact logging. Prior to the preparation and implementation of the Management Plan, only low impact selective logging had been conducted, initially restricted to the felling and salvaging of logs removed during road construction operations. Conducting the harvest operations only during the dry season has further minimized damage to the land. In the rainy season, the logging crew and the other employed staff (forest rangers) continue their work in mapping undiscovered regions of the property while collecting seedlings for the ongoing reforestation program, which prepares three seedlings for the replacement of each mature specimen removed. Special attention is given to mahogany and zericote as seedlings are planted in bags filled with rich soil to increase the survival rate of the fragile seeds.

1.2 STATUS OF THE PROPERTY

The Balam Jungle Estates is a wholly owned private property that encompasses five contiguous properties, Parcels 256, 257, 258, 259, and 260, each of which is basically rectangular in shape, stretching west from the coast.



There are no communities inside the property and interactions between the property management and outside communities fall into the norms of business transactions. The management of BJC Ltd. obtains most of its labor from surrounding villages or nearby communities of the Corozal District, such as Little Belize, Chunox, Sarteneja and even from the more distant areas like San Estevan and Orange Walk Town.

1.3 PAST IMPACTS

1.3.1 Hurricanes -

Hurricanes have not affected the area frequently, but during the last 48 years, damage has been sustained from two major storms, with the effects of Hurricanes Janet (1955) and Keith (2000) being evident throughout most of the Property. While large fallen trunks of Sapote and Black Poisonwood remain as a reminder of the force of Hurricane Janet, tremendous regeneration has taken place in the subsequent period, resulting in a tall and rich forest structure. (Walker, 2003)

The track of the second hurricane, Hurricane Keith, was poorly documented as it hit the mainland – having diminished in strength after causing extensive damage on Ambergris Cay and Cay Caulker. While it toppled relatively few large trees in the vicinity of Sarteneja (19 km north of the property), the eye of the storm appears to have hit the coast much closer to Balam Jungle, with notable tree damage being observed in some sections of the forest. This damage was not uniform, some areas being almost untouched while others were heavily impacted. "Greatest damage was observed in the vicinities of quadrants C and G, with many large trees having been toppled, snapped 3-4 meters above ground, or tilted partially over. In these areas a dense growth of the understory layer has resulted in an almost impenetrable thicket reaching 4-5 meters, often dominated by the Escoba, Pokenoboy, and Basket Tie-Tie palms," stated Walker (2003). These impacts were localized, and it was observed that the areas with Cohune Palm were less damaged than adjacent areas without the specie. In general, it would appear that the damage from Hurricane Keith does decrease with increasing distance from the coast – with some of the most northwestern forest tracts apparently remaining untouched. The fact that this impact gradient is observable over a distance of only 10-12 kilometers is indicative of the rapid decrease in strength of Hurricane Keith as it hit the mainland coastline (Walker, 2003).

1.3.2 Logging History -

Although selectively logged over the past two decades, Balam Jungle's forests are a remarkably resilient ecotype, surviving and flourishing through these exploits. The forests and other vegetation patterns have never been severely damaged and the area is with regards to its rich diversity of flora and fauna, one of the last important coastal forest refuges of the Yucatan Peninsula.

Further, the previous owners of the Property – Corozal Timber Company Ltd. – conducted logging operations throughout the many regions of the forest tracts. The operation was conducted over a 1 - 1½-year period and ended over 10 years ago. Corozal Timber Company failed as a timber operation for many reasons but mainly it was due to poor management and planning; they had no actual logging plans or budget. Their sole Management was the supervision of local crews on a day-to-day basis. They had no formal business or forestry plans, no management information systems and limited internal controls.

With the strict export restrictions intact at the time, Corozal was probably forced to sell domestically much more than they would have liked. In 1992, the Food and Agriculture Organization of the United Nations estimated that Belize consumed only about 30% of domestic production. This would indicate that the domestic market was very small during the time Corozal Timber was in operation. Domestic prices were drastically less than export market prices. Domestic prices continue to be considerably less than export prices to this day.

Following the collapse of the Corozal Timber Company and its operations, the land was largely left untouched and protected by Forest Wardens. Main entrances have been gated to prevent vehicle access, which has successfully prevented negative impact due to poaching.

2 MANAGEMENT PLAN

2.1 INTRODUCTION TO THE PLAN

The Sustainable Forest Management Plan (SFMP) has been designed through the consolidation and combination of all relevant information and formal data collected the most recent forest inventory and past reports/assessment of the Property and its resources. By consolidating all relevant information and data, it was then possible to develop the most accurate, comprehensive, and up-to-date perspective of the property's standing timber crop and the future potential of its resources. The SFMP was fashioned through this gained perspective and will be will prove a valuable tool for the owner in guiding future harvesting operations on the Property according to the rules and guidelines established by the Ministry of Natural Resources and the Forestry Department. The SFMP is the foundation for the global planning in the management unit (MU) and for the preparation of the respective Annual Operative Plans (AOP).

2.2 EVOLUTION OF THE PLAN

BJC Ltd. and their forest operations will be under periodic review to analyze the level of achievement in relation to the proposed objectives described in this document. We propose that harvesting operations should be examined every five years (5) and revisions to the plan made and applied if necessary. An investigation of the application of the AOP will also be made during the periodic review process.

2.3 PLAN EXECUSION & DURATION

The Management Plan will be implemented January 15th, 2006 and have an initial duration of 25 years in a polycyclic system.

2.4 OVERVIEW OF OBJECTIVES

The main purpose of this integrated Management Plan is to organize and systematize the management of approximately 17,881.0 ha of broadleaf forest on the Balam Jungle Estates, applying sustainable forest practices in order to guarantee sustainability from both an ecological and economical standpoint.

2.5 DISCUSSION OF SPECIFIC OBJECTIVES

The following is a list outlines the specific objectives for sustainable managment of the Property:

a. To harvest timber and non-timber products in a sustainable way in order to minimize impact to the forest while satisfying the local and international demand.

b. To promote forest conservation by practicing low impact harvesting.

c. To protect the forest from illegal logging, hunting, and invasions, which endanger the natural environment and abuse the precious natural resources within the forest area.

d. To establish high priority protection zones with archeological richness and fragile ecology.

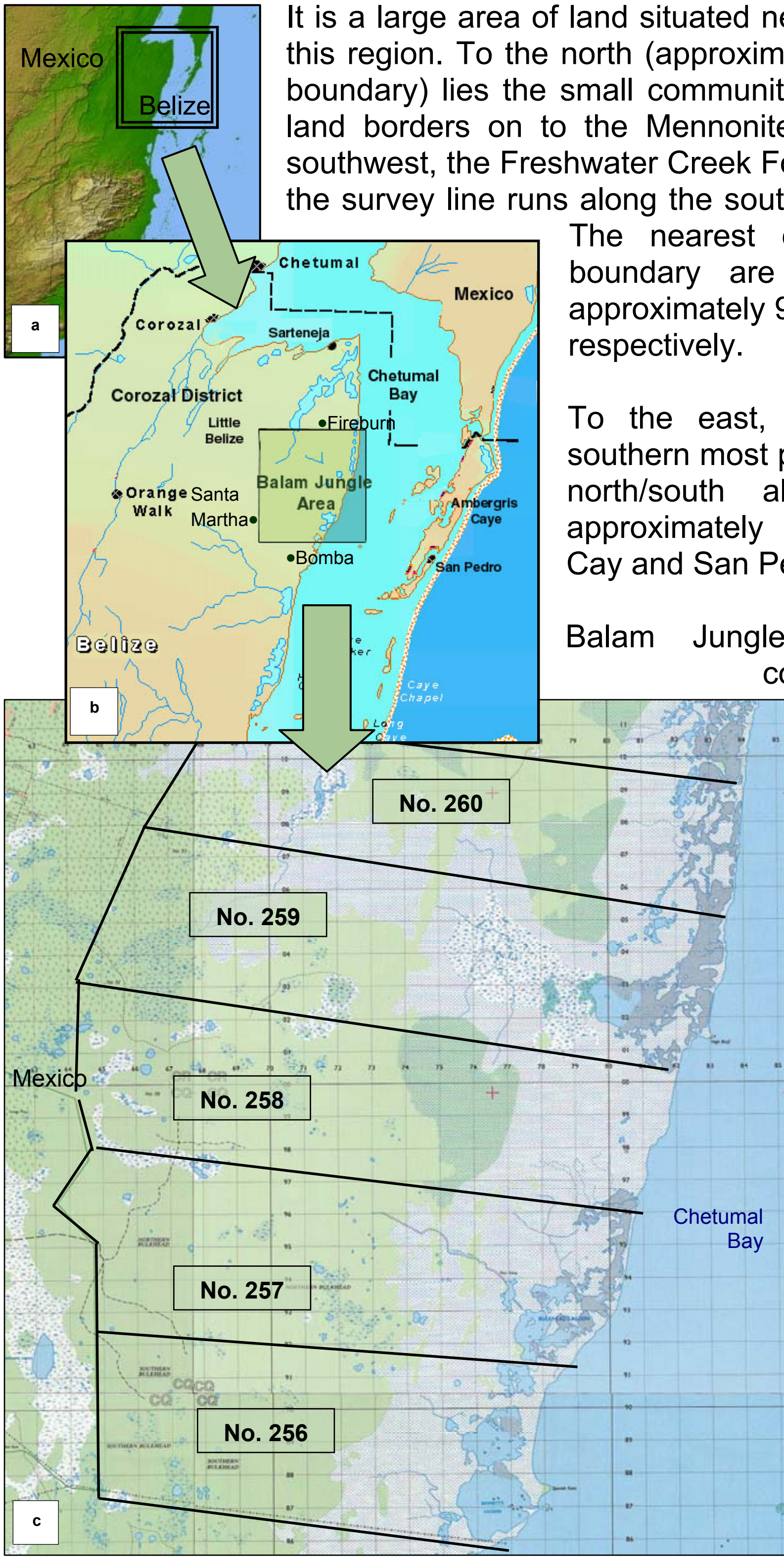
e. To preserve and protect the bodies of water in order to maintain vital ecological functions.

3 BASIC RESOURCE DATA

3.1 GEOGRAPHIC LOCATION & MANAGEMENT AREA

3.1.1 Property Location -

The Balam Jungle Estates is approximately 86,021+- acres (34,811+- ha) of land situated in Corozal District, in the northeast corner of the Central American country of Belize, as shown in Map 2a/2b below.



It is a large area of land situated near a number of communities in this region. To the north (approximately 6km north of the northern boundary) lies the small community of Fireburn. To the west, the land borders on to the Mennonite lands of Little Belize; to the southwest, the Freshwater Creek Forest Reserve; and to the south, the survey line runs along the southern Corozal District Boundary. The nearest communities to the southern boundary are Santa Martha and Bomba, approximately 9km to the south west and south respectively.

To the east, the land borders on to the southern most part of Chetumal Bay, stretching north/south along the coast for 25km, approximately 20km due west of Ambergris Cay and San Pedro (Map 2b).

Balam Jungle Estate encompasses five contiguous properties, Parcels 256, 257, 258, 259, and 260 each of which is basically rectangular in shape, stretching west from the coast (Map 2c).

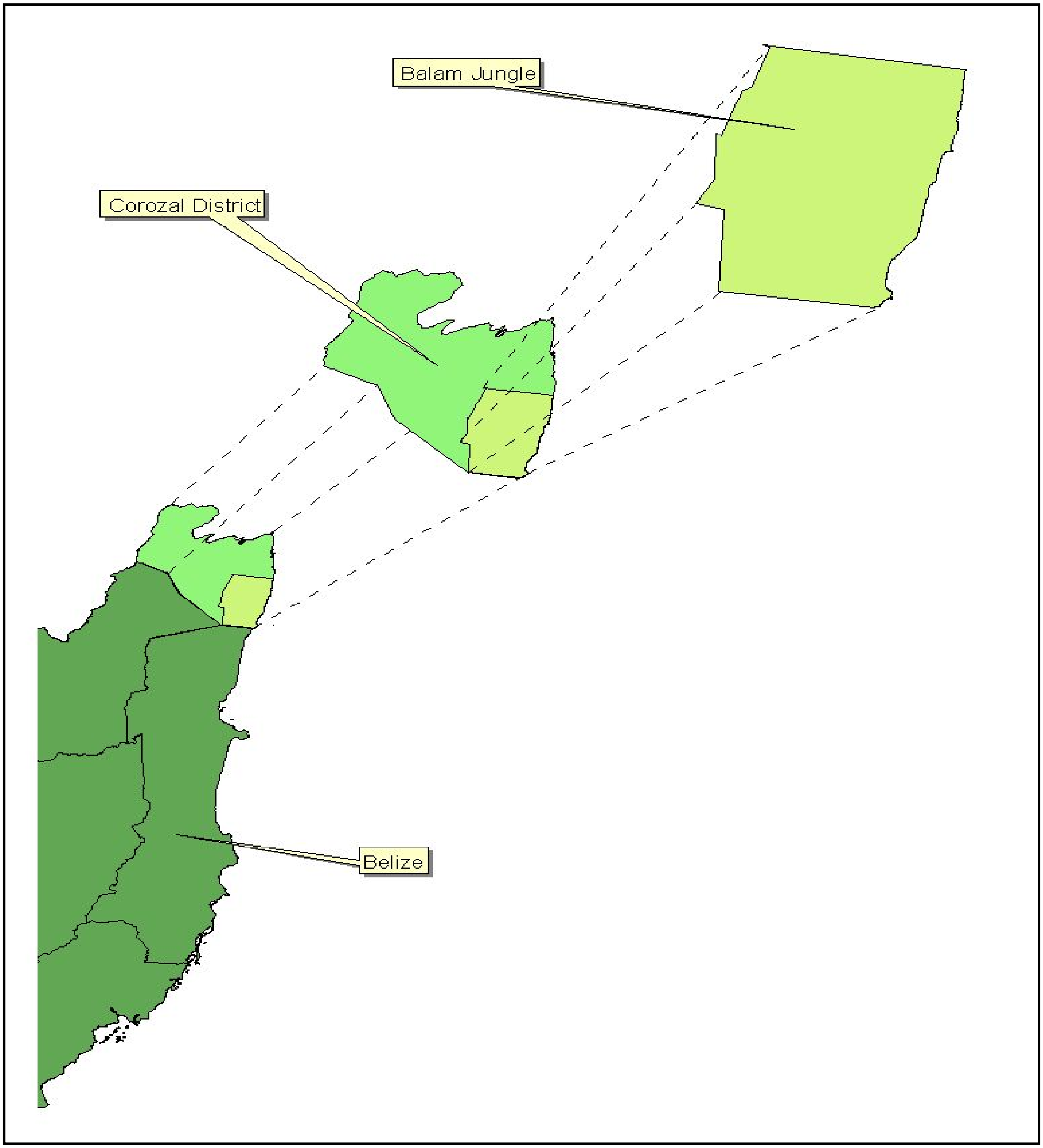
For another location map of the property, please see map 3 below.

MAP 2 a,b,c:

Location of Balam Jungle Estate, in the North East of Belize.

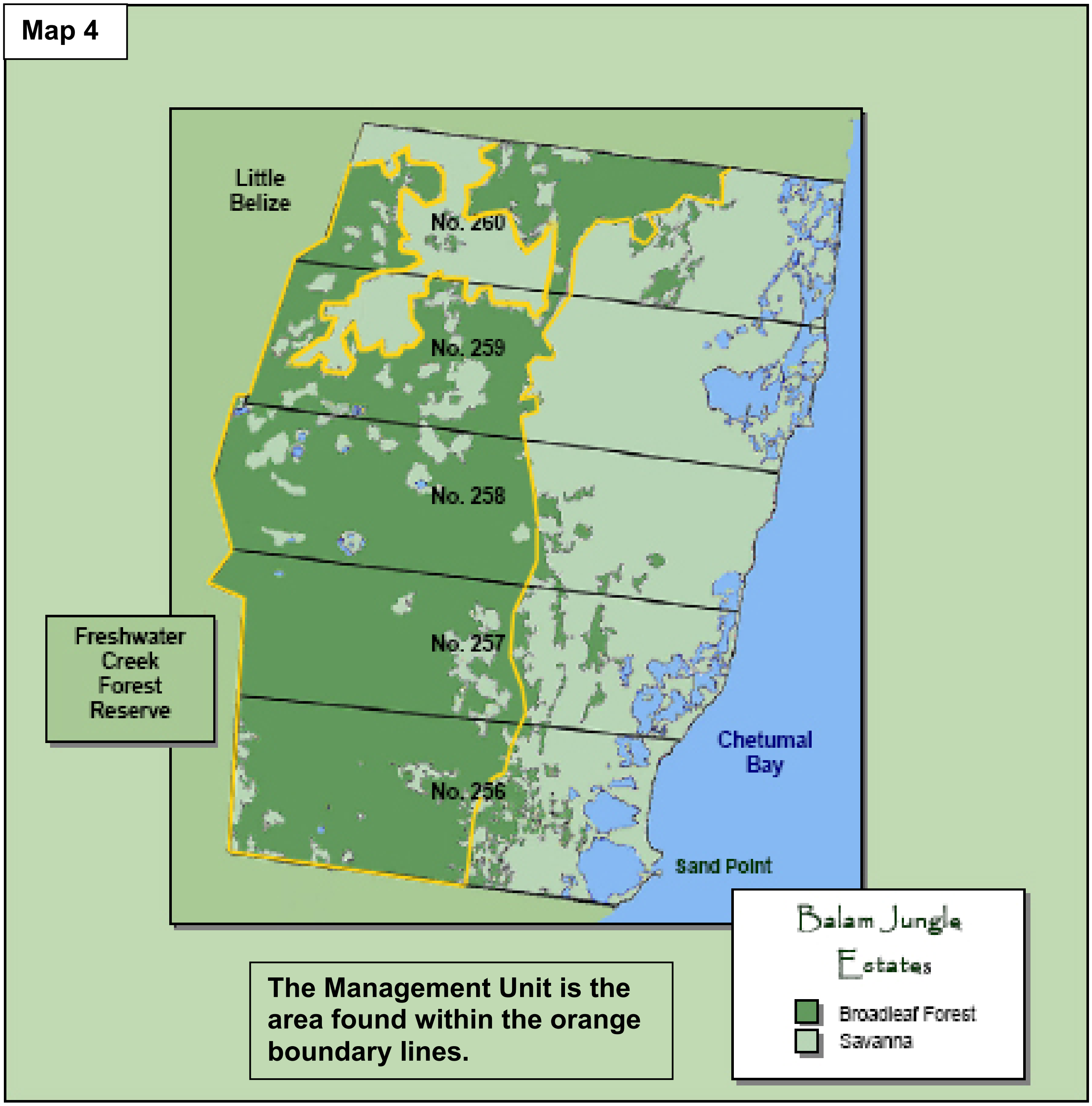
(After OS Map Sheets 6, 12, 1992)

Map 3. Location of Balam Jungle Estates



3.1.2 Location of the Management Area -

The Management Area has a total area of over approximately 44,184.74 acres (17,881.0 ha) and is located almost entirely in the western half of the property. (See map 4)



3.2 TOPOGRAPHY

The north east of Belize is part of the low-lying Yucatan Platform and, characteristic of the entire Yucatan Peninsula; the entire area is extremely flat with little variation in height. On the western boundary, the forested land lies at an altitude of approximately 5m above sea level, then slopes gently towards the mangrove savannas to the north and east.

The forested area can be characterized as an 'undulating plain', as can be seen very clearly in the north west corner of the property, and in the nearby cleared farmland of Little Belize (Photograph One). This undulation follows the top surface of the limestone bedrock, and can be observed in varying degrees from Sarteneja through the entire breadth of Little Belize. Within the Balam Jungle Estate, these vary from shallow, widely spaced undulations (as shown in Photograph One) to low, but steep, limestone ridges 3 to 4m in height, where the limestone top is exposed and lacks soil cover. Other characteristic features of limestone are also present within the area, such as cenotes, and a lack of surface flowing rivers and streams.

Photograph 1:
Cleared land in Little Belize, adjacent to Balam Jungle Estate, showing undulating characteristics of landscape

There is a very definite divide between the higher forested region to the west, and the lower savanna coastal areas, indicative of different past eras of inundation and deposition. The coastal savanna, stretching from the forest edge to the sea, has very little altitude, rarely exceeding 0.7m above sea level, and is frequently inundated during wet season. The only exceptions are the small, forested, limestone 'islands', or hummocks – low limestone protrusions that occur scattered throughout the area. The southern portion of the coastal zone has a thick deposit of fine carbonate sediment left by the most recent geological inundation period. Towards the more northern part of the Balam Jungle coastal area, the limestone bedrock is much closer to the surface, with sharp, unweathered rocks often projecting above.

3.3 CLIMATE & LIFE ZONE

This region falls under the Holdridge Life Zone Classification System, along the transitional line between two theoretical life zones, namely the sub tropical moist and subtropical wet.

The Balam Jungle Estates is situated in northern Belize; an area defined climatically as sub-tropical, with distinct wet and dry seasons. It lies within the driest rainfall belt for the country, with an annual rainfall averaging approximately 1260mm a year, with a minimum of 1030mm (Map 3).

The pronounced dry season stretches from February through to the end of May, and can be seen clearly from Graph 1 (covering a four-year period of data (1989 to 1993) from Shipstern Nature Reserve, Meerman, 1993). During this period, the minimum monthly rainfall can be as low as 3mm (as recorded in March, the driest month). This is followed by a wetter season (June to December / January), punctuated by a mini dry season in the month of August. The majority of rain falls within the hurricane season, associated with passing tropical storms (particularly in September).

3.4 HYDROLOGY

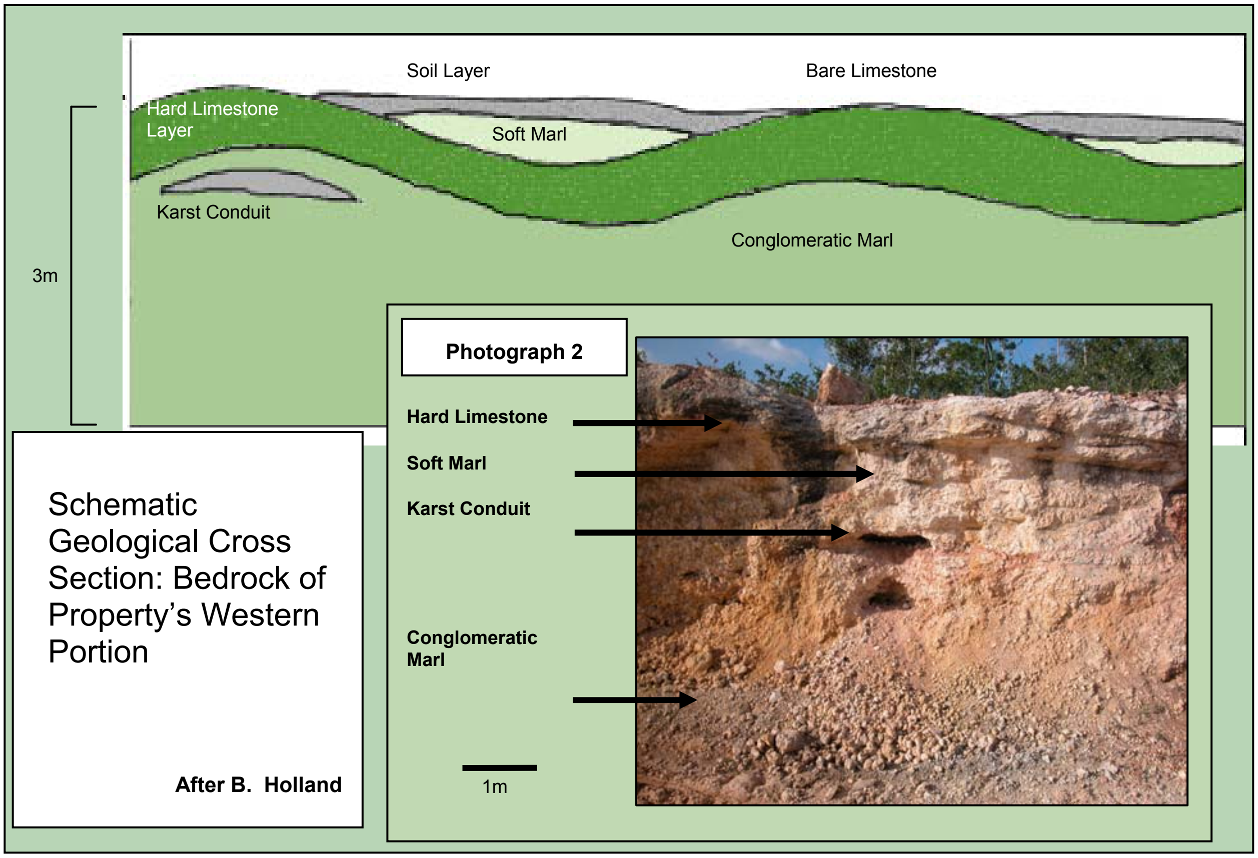
The Balam Jungle Estate wetlands portion of the Shipstern watershed of Corozalito is a patchwork maze of interconnected creeks and freshwater pools – a horseshoe of drainage channels for water running from the encircling forest into Shipstern Lagoon to the north. The vegetation assemblages vary from area to area, though that along the banks of the channels tends to be taller than that in between. Freshwater basin mangrove merges with herbaceous swamp, and mixed mangrove scrub, which in turn is dotted with open areas of Cladium grasslands with raised hummocks of forest habitat. The creeks vary from 2m to 10m in width, and from 0.4m to 1.5m in depth. The bottom substrate is largely smooth rock and mollusk shells and the water is generally clear but with a dark peat-color year round.

3.5 GEOLOGY & SOILS

The geology of the northern part of Belize is known only in very general terms, but is known to be composed of Tertiary limestones and dolomites (Cornec, 2002). Core studies of the rock formation and sedimentation at Bulkhead Shoal, a few kilometers offshore, show that deposition of the sedimentary bedrock occurred during the Pleistocene era. This bedrock, found throughout the project area and in the surrounding Sarteneja-Chunox-Little Belize region, is composed of horizontally layered, white/light grey to buff colored, well cemented (hard) limestone and conglomeratic marls (marl with cobbles and pebbles of hard limestone), believed to be of Pleistocene/ Pliocene age. Reference Figure 1, below, for a schematic geological cross section of the bedrock on the western area of Balam Jungle.

A major Land Resources Assessment of northern Belize in 1992 sought to categorize land types according to their potential productivity levels, and made recommendations as to the best land use that could be used within a specific land system. The Balam Jungle Estates lies on the northern coastal plain, with a bedrock composed of the youngest limestones to be found in Belize, being formed in the Pleistocene. These limestones provide the parent material for the different soil types found in the survey area. Soil classification is based on a Land System/Suite-Sub suite system, with five land system categories recognized by King et. al. (1992) as being represented within Balam Jungle Estate. The five land system categories are as follows:

- Corozal Saline Swamp
- Xaibe Plain
- Sibal Swamps
- Shipstern Plain
- Northern Bulkhead Plain



3.6 Forest Description

Approximately 46.9% of the total area of the property is classified as productive forest. The 54.1% is composed to other ecosystems such as savanna and mangrove ecosystems. According to the forest inventory results, 169 species were recorded as having a DBH (diameter at breast height) of 10 cm or greater. (See appendix 2)

The species (>25 cm DBH) with strong commercial value have the following abundance ratings (ref. Annex 5): No.1 - Black Poison Wood (IVI 13.92%); No.2 - Yaxnic (IVI 10.68%); No.3 - Red Gumbolimbo (IVI 8.97%), No.4 – Nargusta (IVI 6.35%); No.5 - Sapodilla (IVI 5.92%) and; No.5 - Santa Maria (IVI 4.69 %).

In regards to abundance, the inventory results demonstrate a mean number of 162.63 Individuals/ha measuring 10 cm DBH and greater. The mean Basal Area is 16.23m^2/ha The commercial volume for all the species ≥ 25 cm DBH, is 43.01 m^3/ha

In regards to natural regeneration, the HIGHCOM group was represented by 71.8 seedling/ha and by 2.6 saplings/ha The ACTCOM group was represented by 72.9 saplings/ha and 1,577.3 seedlings/ha were registered. The total for all species recorded during the forest inventory is 10,346.4 saplings/ha and 513.6 seedlings/ha

Although the forest would be typified as logged forest, or residual primary forest, since logging has occurred in the past, the property has been well protected for a decade now and regeneration is a major reason why the area is a remarkable resilient ecotype.

3.7 FAUNA DESCRIPTION

The Property has very healthy populations of several species of birds and animals. Of the larger species recorded within the forested area of Balam Jungle, the most commonly sighted mammals were Grey Fox, White-tailed Deer and Red Brocket Deer, though tracks of White-lipped Peccary, Collared Peccary and Tapir suggest that these species, too, are relatively abundant. Jaguars (*Panthera onca*), which are listed under CITES, are common on the property and seen often along the logging trails as are the other neotropical cats, including the Puma (*Puma concolor*) and the Margay (*Lepardus wiedii*).

Seven of the species found within the Property (jaguar, puma, margay, ocelot, Baird's tapir and the West Indian Manatee) are threatened (IUCN Mammals Red Data book), and are CITES Appendix I listed. A further two species expected to occur within the area but not yet confirmed (Jaguarundi and the Neotropical River Otter) are also species of concern. In addition, for other species such as the White-lipped Peccary, the population status is unclear and numbers may be declining in other areas of Belize and are already reaching critical levels in other countries in Central America. (Wildtracks, 2003)

From analysing bird reports from the surrounding area, it was found that a total of 260 bird species can be expected to be recorded within the area, over 45% of the species to be found in Belize. Of these, 180 can be confidently expected to occur, while a further 80 are expected to occur. (Wildtracks, 2003).

Table 1. Fauna species reported in the management unit.

Birds of Balam Jungle Estate			
Common name	***Scientific name***	***Common name***	***Scientific name***
Tinamidae		***Cracidae***	
Great Tinamou	Tinamus major	Plain Chachalaca	Ortalis vetula
Pelicanidae		Great Curassow	Crax rubra
Brown Pelican	Pelecanus occidentalis	***Columbidae***	
Phalocrocoracidae		White-winged Dove	Zenaida asiatica
Double-crested Cormorant	Phalacrocorax auritus	***Psittacidae***	
		Olive-throated	

Fregatidae		Parakeet	Aratinga nana
Magnificent Frigatebird	Fregata magnificens	**Apopidae**	
Adeidae		Vaux's Swift	Chaeturi vauxi
Bare-throated Tiger Heron	Tigrisoma mexicanum	**Momotidae**	
		Blue-crowned Motmot	Momotus momota
Great Egret	Ardea alba	**Alcedinidae**	
Little Blue Heron	Egretta caerulea	Ringed Kingfisher	Ceryle torquata
Reddish Egret	Egretta rufescens	Amazon Kingfisher	Chloroceryle amazona
Cattle Egret	Bubulcus ibis	American Pygmy Kingfisher	Chloroceryle aenea
Green Heron	Butorides virescens		
Threskiornithidae		**Ramphastidae**	
White Ibis	Eudocimus albus	Collared Aracari	Pteroglossus torquatus
Roseate Spoonbill	Ajaia ajaia	Keel-billed Toucan	Ramphastos sulfuratus
Ciconiidae		**Thamnophilidae**	
Wood Stork	Mycteria Americana	Barred Antshrike	Thamnophilus doliatus
Cathartidae		**Corvidae**	
Black Vulture	Coragyps atratus	Brown Jay	Cyanocorax morio
Turkey Vulture	Cathartes aura	Yucatan Jay	Cyanocorax yucatanicus
Lesser Yellow-headed Vulture	Cathartes burrovianus	**Hirundinidae**	
		Mangrove Swallow	Tachycineta albilinea
Accipitridae		**Mimidae**	
Osprey	Pandion haliaetus	Black Catbird	Melanoptila glabirostris
Common Black-Hawk	Buteogallus anthracinus	Tropical Mockingbird	Mimus gilvus
Roadside Hawk	Buteo magnirostris	**Thraupidae**	
Falconidae		Red-throated Ant-Tanager	Habia fuscicauda
Laughing Falcon	Herpetotheres cachinnans		

Table 1 continued next page …

Fauna of Balam Jungle Estate				
Common Name	***Scientific name***	***Scientific names***		
Mammals		***AMPHIBIANS AN REPTILES***		
Red Rrocket, Deer	Mazama americana	***Salamanders***	***Freshwater Turtles***	***Snakes***
Collared Peccary	Pecari tajacu	Bolitoglossa yucatana	Staurotypus triporcatus	Typhlops microstomus
Northern Tamandua	Tamandua mexicana	***Frogs and Toads***	Kinosternon acutum	Boa constrictor
Baird's Tapir	Tapirus bardii	Rhinophrynas dorsalis	Kinosternon leucostomum	Coniophanes bipunctatus
Nine-Banded Armadillo	Dasypus novemcinctus	Leptodactylus labialis	Kinosternon scorpiodes	Coniophanes imperialis
White-lipped Peccary	Tayassu pecari	Leptodactylus	Rhinoclemmys areolata	Coniophanes schmidti
Jaguar	Panthera onca	melanonotus	Trachemys scripta	Dipsas brevifacies
Nightwalker, Kinkajou	Potos flavus	Bufo marinus	***Lizards***	Dryadophis melanolomus
Ocelote	Leopardus pardalis	Bufo valliceps	Coleonyx elegans	Drymarchon corais
White nosed Coati	Nasua narica	Agalychnis callidryas	Phyllodactylus	Ninia sebae
Common Tent Marketing Bat	Uroderma Bilobatum	Hyla loquax	tuberculosus	Oxybelis aenus
Puma	Puma concolor	Hyla microcephala	Sphaerodactylus glaucus	Oxybelis fulgidus
Gibnut, Tepesquintle, Paca	Agouti paca	Hyla picta	Thecadactylu rapicauda	Pseustes poecilonotus
Yucatan Squirrel	Sciurus Yucatanensis	Phrynohyas venulosa	Basiliscus vittatus	Sibon nebulata
Margay	Leopardus wiedii	Gastrophryne elegans	Sceloporus chrysostictus	Symphimus mayae
Striped Hog-nosed Skunk	Conepatus semistriatus	Hypopachus variolosus	Sceloporus lundelli	Tantilla schistosa
Tayra	Eria Barbara	Rana berlandieri	Anolis lemurinus	Tantillita canula
Northern Raccoon	Procyon lotor	***Crocodiles***	Anolis rodriguezii	Thamnophis proximus
White-tailed Deer	Odocoileus virginianus	Crocodylus acutus	Anolis sagrei	Xenodon rabdocephalus
Virginia Possum	Didielphia Virginiana	Crocodylus morletii	Anolis sericeus	Micrurus nigrocinctus
Central American Agouti	Dasyprocta puntata	***Freshwater Turtles***	Eumeces schwartzi	Agkistrodon bilineatus
Grey Fox	Urocyon Cineraoargentes	Dermatemys mawii	Mabuya unimarginata	Bothrops asper
Black Howler Monkey, Baboon	Alouatta pigra	Claudius angustatus	Ameiva undulata	Crotalus durissus

3.8 INFRASTRUCTURE

The Property can be accessed by all weather marl roadway, either from the southwest via the Old Northern Highway and Bomba Village road, or the northwest via the Mennonite community of Little Belize), or by suing older logging tracks that allow for access through the North via roadway that connects to Fireburn Village near the Shipstern Nature Reserve.

Main access points –

- ***Bomb Village Road access:*** This road, running northwards from Bomba to Shipstern Landing, is an old access track that has now been upgraded to all-weather marl roadway and maintained with direct linkage to the 20 miles of already existing main artery roadway recently installed on the property. The property is 1 hour's drive from the International Airport in Belize City using this road access. Branching off from road is a network of older logging tracks created in the early 1990's during the former ownership by the Corozal Timber Company. Thanks to the ongoing efforts made by BJC Ltd., a few necessary tracks remain cleared and easily passable with a 4X4 vehicle while other logging tracks have been restored to their natural state.

- ***Little Belize:*** The road entering from Little Belize (which joins the main track from Bomba), once an older track, was upgraded in 2003 and is now a 2-way, all weather marl road that first made it possible to establish the main artery roadway, which grants access to all other paths, tracks and roadway on the property. This initial main entrance to the property is approximately one hour's drive from Orange Walk. In the interests of preventing uncontrolled access, an impressive gated entrance has been constructed at the Little Belize entry point.

3.9 ARCHEOLOGY

There is a wide range of smaller archeological sites located within the productive forest on the management area. The vastness of these sites are currently being explored, however not enough information has been gathered regarding various site characteristics in order to discuss historical significance on the Property in any detail within this document. Ongoing discoveries made by BJC Ltd. will be recorded an included in any future revisions of the SFMP.

4 FOREST ORGANIZATION & CLASSIFICATION

4.1 MANAGEMENT RECOMMENDATIONS

The greatest economic value of the forested portion of the property is its timber. Calculated per acre timber values far exceed potential agricultural values for the land. Walker (2003) explained that "with increasing timber prices, decreasing world tropical timber stocks, and the high value on the international market of timber crops maintained under an approved sustainable management plan, there is substantial long term investment potential in maintaining sufficient forested land within one large tract to allow for sustainable management techniques. Best use for the land would therefore be management towards the sustainable harvest of timber, combined with tourism development in the scenically most attractive areas – such as within the cohune ridge and at the edge of the freshwater habitats. Developing worthwhile economic returns from these two activities would be the best guarantee for the maintenance of the forest and the high biodiversity therein."

As one of the most significant market potentials for BJE is for tourism development, it is logical that this potential should not be negatively impacted by investments in infrastructural development aimed at improving marketability of the property. In this regard, it is therefore important to assess potential negative impacts and advisable to take mitigation activities wherever possible and financially viable.

4.2 METHODOLOGY FOR FOREST CLASSIFICATION

4.2.1 Image selection -

Remote source sensors were used: A LANDSAT Thematic "Mapper" with a spatial resolution of 30 meter (See Map 5 below)

The analysis focuses on the use of the multi spectral information of the LANDSAT scene and the information texture.

4.2.2 Geometric Rectification –

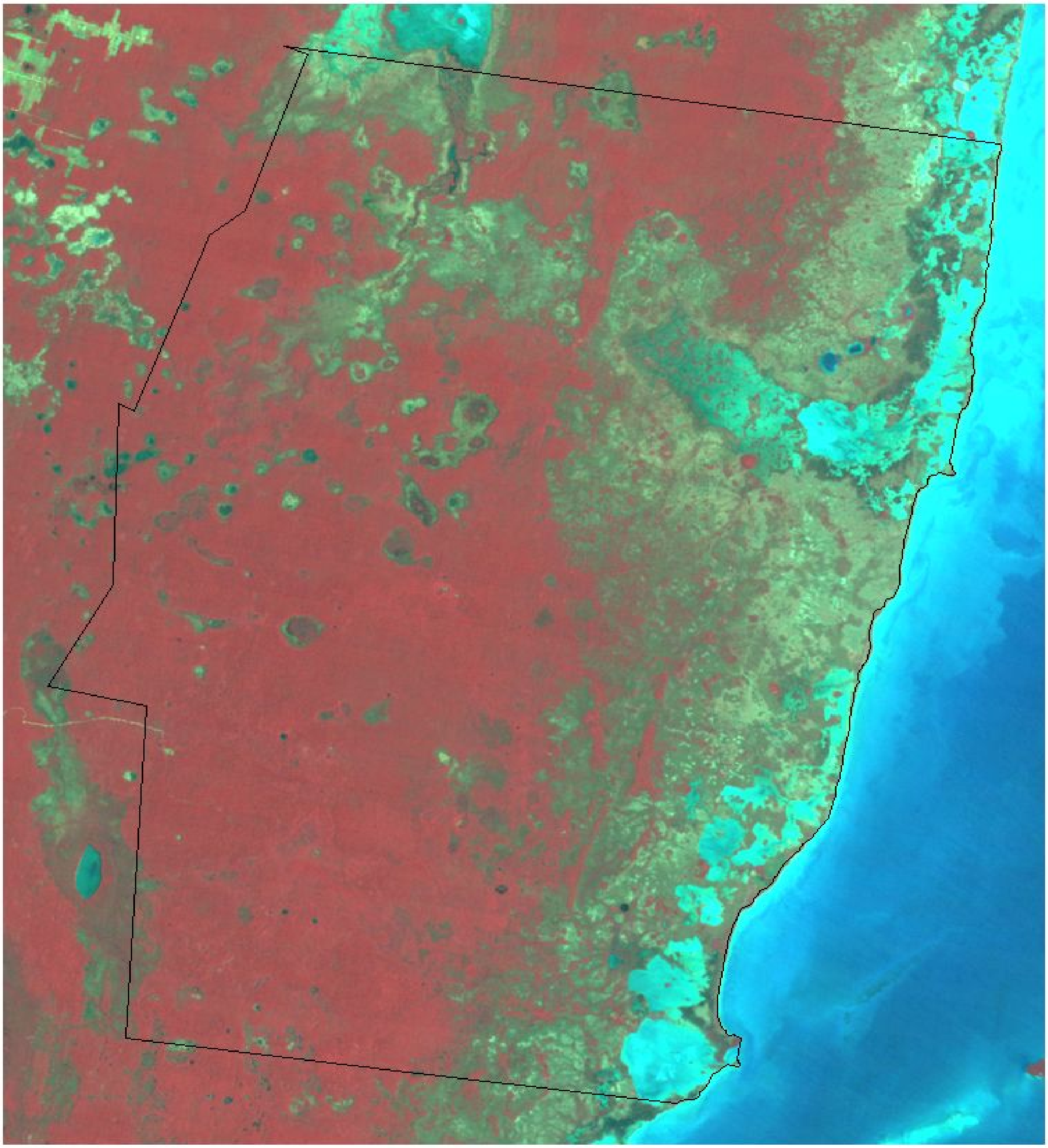
This definition is understood as the process of assigning map coordinates to imagery data. In this particular case, the scenes LANDSAT was rectified to a projection UTM area 16, datum North American Datum 27 Central American. They were used as reference for the rectification available vectors of roads and other places of interest and radar images with a horizontal precision of 2.5mt of rectification.

235 control points were identified for the LANDSAT scene. The rectification method was a Polynomial transformation of First Order and for the re-sampling the Nearer Neighbor's method. Nearest Neighbor's was used for the calculation of values of the pixels re-sampled.

4.2.3 Interpretation Process –

The rectified data was visually interpreted using different contrast and brightness levels to allow for a more accurate initial interpretation of the strata inside the management area.

Map 5. LANDSAT TM scene



4.3 FOREST CLASSIFICATION

Auto-organization (ISODATA), which uses the spectral distance to classify pixels, generated an unverified classification with the clusters method, which was extracted through the Data Analysis technique. Initially 50 classes were created, establishing a maximum of 25 iterations and a threshold of convergence of 0.98. As a result, a preliminary classified thematic image was obtained. The classes generated were assigned by visual interpretation for the following classes:

- Water
- Productive broadleaf forest
- Lowland flooded Forest
- Wetlands

The preliminarily reclassified image was vectored and manually reclassified at pixel level, by visual interpretation. This step was implemented to correct potential assignment pixel errors, peculiar to the incorrect aim class. This process was particularly appropriate to separate the different strata that were consistently confused by the automatic process and were separated by visual analysis based on the context of each class (geometry, adjacent classes, etc). Map 6, found on the following page, demonstrates the results.

Table 2. Balam Jungle Forest Classification.

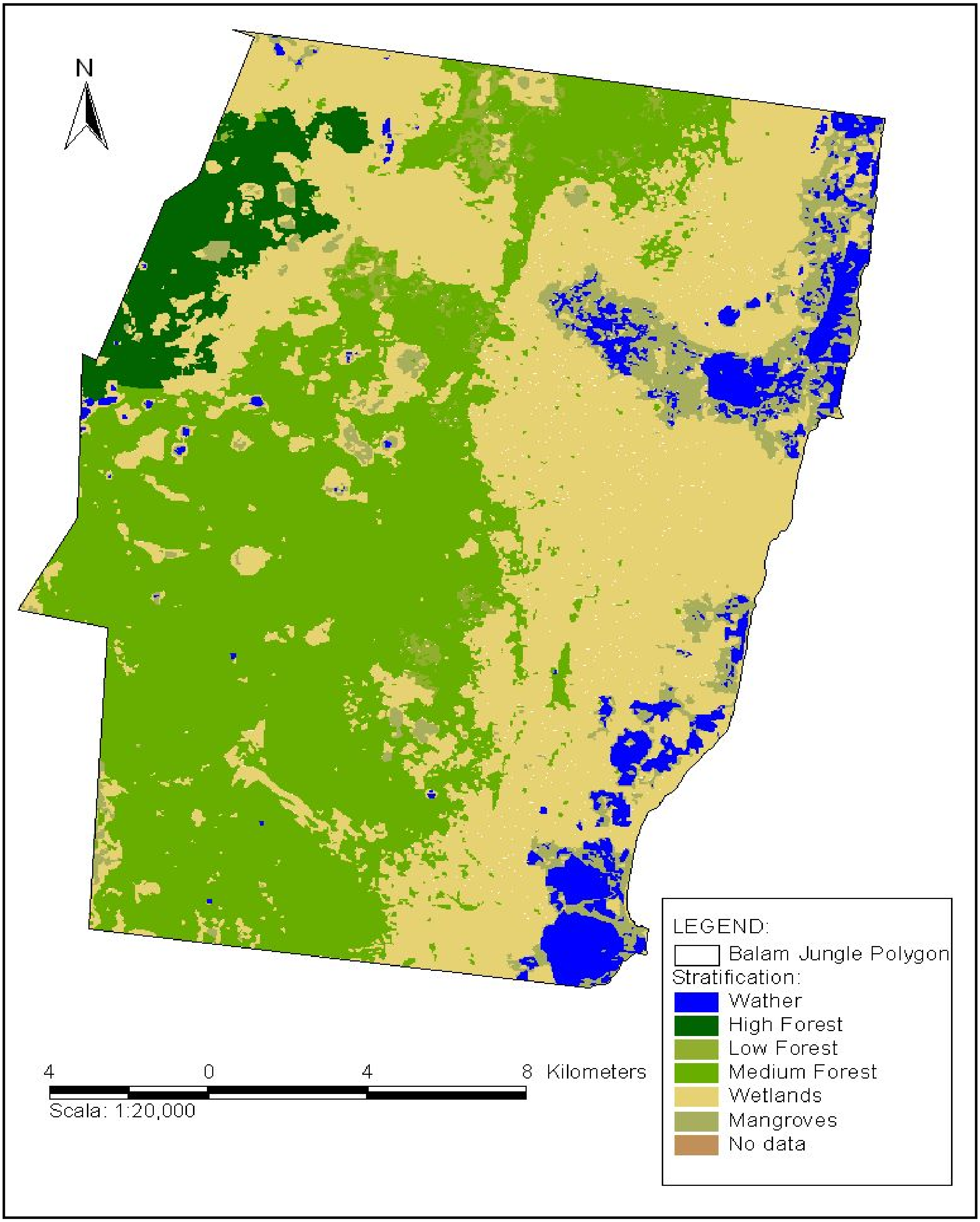
Description	Area	
	Hectares	Percentage %
Water bodies	1,997.6	5.0
High broadleaf forest	1,911.0	4.8
Medium broadleaf forest	15,969.7	40.0
Low broadleaf forest	513.0	1.3
Mangrove	2,423.9	6.1
Wetlands with trees/shrubs	3,887.4	9.7
Wetland with grass	9,726.0	24.4
Wetlands without vegetation/beach	3,468.4	8.7
TOTAL	39,897.0	100

Based on the results of the satellite image analysis the productive forest in the area are 18,394ha However, for management proposes this area was reduced to 17,881ha because the small areas that appeared dispersed on the wetland ecosystem, which were eliminated with the objective of minimizing the impact on other ecosystems adjacent to the forest.

The Protection Zones are composed of archeological sites, water bodies and Wetlands.

The buffer of river and water bodies consists on a protection zone of 20-mt left on both sides of the water sources. When logging is conducted near the water sources no trees can be harvested within this area.

Map 6. Forest Classification



5 FORESTRY INVENTORY

5.1 INVENTORY DESIGN

5.1.1 Inventory Type -

An integrated forest inventory was planned based on satellite imagery, designed to support the sustainable management of the forested areas wood and non-wood resources. The type of inventory that was applied for this management plan was a stratified systematic sampling method.

5.1.2 Sample Plan -

A systematic stratified sampling technique was applied on the productive area of the Property, taking into consideration a sampling intensity of 0.53%. On a topographic map of the area, 95 sampling plots (SP) were placed on the productive forest. The distance between the plots was 1300 meters among them and 1300 meters between lines, throughout the productive forest area (please reference map 7).

5.1.3 Sample Plot Location -

The sampling plots (SP) were located on the field by means of a GPS unit (GLOBAL POSITIONING SYSTEM Garmin V). They were established heading towards the north, south, east or west, depending on the topography. The decision to use a GPS unit in order to locate sampling plots was justified due to the distance between them. Opening of trails to successfully connect one plot to another wouold have been extremely difficult without the benefit of a GPS unit.

5.1.4 Sample Plot Design -

The sampling plot has a rectangular shape with 20m of width (10m each side of the trail), and a length of 500m, giving an area of **10,000m^2**, in which all the > 25cm DBH trees were measured. This was divided in 20 subplots of 50m x 10m (**50m^2**), numbered 1 through 20. For the evaluation of regeneration, 8 sub-plots (1,4,7,10,11,14,17 and 20) were selected. The trees between 10.0 and 24.9cm DBH (Pole timber) were measured on the sub-plot of 50m x 10m (500m^2 unit). The trees between 5.0cm and 9.9cm DBH (Saplings) are counted on the regeneration sub-plots of **100m^2**. The individuals (seedlings) over 30.0cm of height or < 4.9cm of diameter are counted on the regeneration sub-plot of **10m^2**. BayLeaf palm data was collected on the 8 regeneration sub-plots (1,4,7,10,11,14,17 and 20), on a sub plot of 5m x 10m.

In the established sampling plots, the following variables were measured: Specie, diameter at breast height (DBH), commercial height, and log quality.

Table 3. Evaluated Variables

Type of individual	Variable			
	Specie	Number	D B H	Commercial Height
Trees > 25cm DBH (inventory trees)	X	X	X	X
Trees > 9.9 < 24.9cm DBH (Pole timber)	X	X	X	
Trees > 4.9 < 10.0cm DBH (Saplings)	X	X		
Trees > 30cm height < 5.0cm diameter (Seedlings)	X	X		

Additional information was collected in the 500m^2 sampling units concerning topography, drainage, archeological sites presence, and forest type.

5.2 PRODUCTIVE FOREST CLASSIFICATION

In table 4, a summary of the principal dasometric values corresponding to the productive forest within the Management unit (MU) is presented.

Table 4. The productive forest stratum general information

Description	Unit	Value
Area	Ha	17,881
Percentage in relation to the management unit	%	46.9
Species $\geq$ 10 cm DBH	Richness	169
Mean abundance $\geq$ 10 cm DBH	Ind/ha	162.63
Mean Basal Area $\geq$ 10 cm DBH	m^2/ha	16.23
Mean Volume $\geq$ 25 cm DBH	m^3/ha	43.01
Seedlings	Ind/ha	10,346.40
Saplings	Ind/ha	513.60

In table 5, the most abundant species according to the Importance Value Index (IVI) are presented.

Table 5. Important Value Index for species with higher commercial value

No	Species			IVI %
	Common Name (Guatemala)	Common Name (Belize)	Scientific Name	
1	Chechen negro	Black Poisonwood,	*Metopium brownei*	13.926
2	Yaxnik	Fiddlewood, Yashnik	*Vitex gaumeri*	10.685
3	Chacaj colorado	Red Gombolimbo	*Bursera simaruba*	8.973
4	Mano de leon	White Gombolimbo	*Dendropanax arboreum*	6.354
5	Chico zapote	Sapodilla	*Manilkara zapota*	5.923
6	Santa maria	leche maria, santa maria	*Calophyllum brasiliense*	4.469
7	Zacuayum		*Matayba oppositifolia*	4.032
8	Cátalos		*Swartzia lundellii*	3.317
9	Silion	Silion, Silly Young	*Pouteria amigdalina*	2.89

No	Species			IVI %
	Common Name (Guatemala)	Common Name (Belize)	Scientific Name	
10	Jobo	Hog plum	*Spondias mombin*	2.87
11	Quisainche			2.82
12	Caoba	Mahogany	*Swietenia macrophylla*	2.542
13	Manchiche	Black Cabbage Barl	*Lonchocarpus castilloi*	2.279
14	Papaturro	Wild grape	*Coccoloba sp.*	1.985
15	Chacaj blanco		*Bursera graveolens*	1.921
16	Palo de coche			1.764
17	Pasaque hembra	Negrito	*Simarouba glauca.*	1.758
18	Pucte	Bullet tree	*Bucida buceras*	1.398
19	Laurel	Salmwood	*Cordia alliodora*	1.363

Reference: The number shows the position that the specie occupies according to the IVI. The number in IVI % column is the index.

The area has been logged before through selective extraction, especially mahogany and Santa Maria.

5.3 INVENTORY RESULTS

The inventory results for High Commercial Species (HIGHCOM) and Actual Commercial species (ACTCOM) are presented in Table 7. The results for the Potential Commercial (POTCOM), protected and regeneration data are included in Appendix 4. The volume was obtained by means of the FAO[1] formula for all the logs with bark.

The statistical analysis of volume/ha at 95% reliance for all the species is ≥ 25 cm DBH.

Table 6. Statistical analysis of the volume for all species ≥ 25 cm DBH.

STATISTICAL MEASURMENT UNITS	RESULTS
No. of plots	95
Sampling intensity %	0.53
Mean m^3/ha	21.58
Standard Deviation	11.45
Coefficient of. Variation	53.06
Standard Error of the mean	1.19
" T" de student value	1.96
Limits of Confidence	
Upper limit m^3/ha	23.93
Lower limit m^3/ha	19.24
Minimum reliable esteem	19.57
Sampling error	**10.84**
Allowable Error	15.00

[1] $V=0.0567+0.5074\ DBH^2 \times ComH$

As it is shown in the above table, the sampling error for the inventory is 10.84%. Carrera (1996), proposed a maximum sampling error from 15% at 95% reliance for the stratum, with the objective of getting cost effective but reliable information on an area.

Map 7. Stratification of MU and Inventory Sampling Plots Location

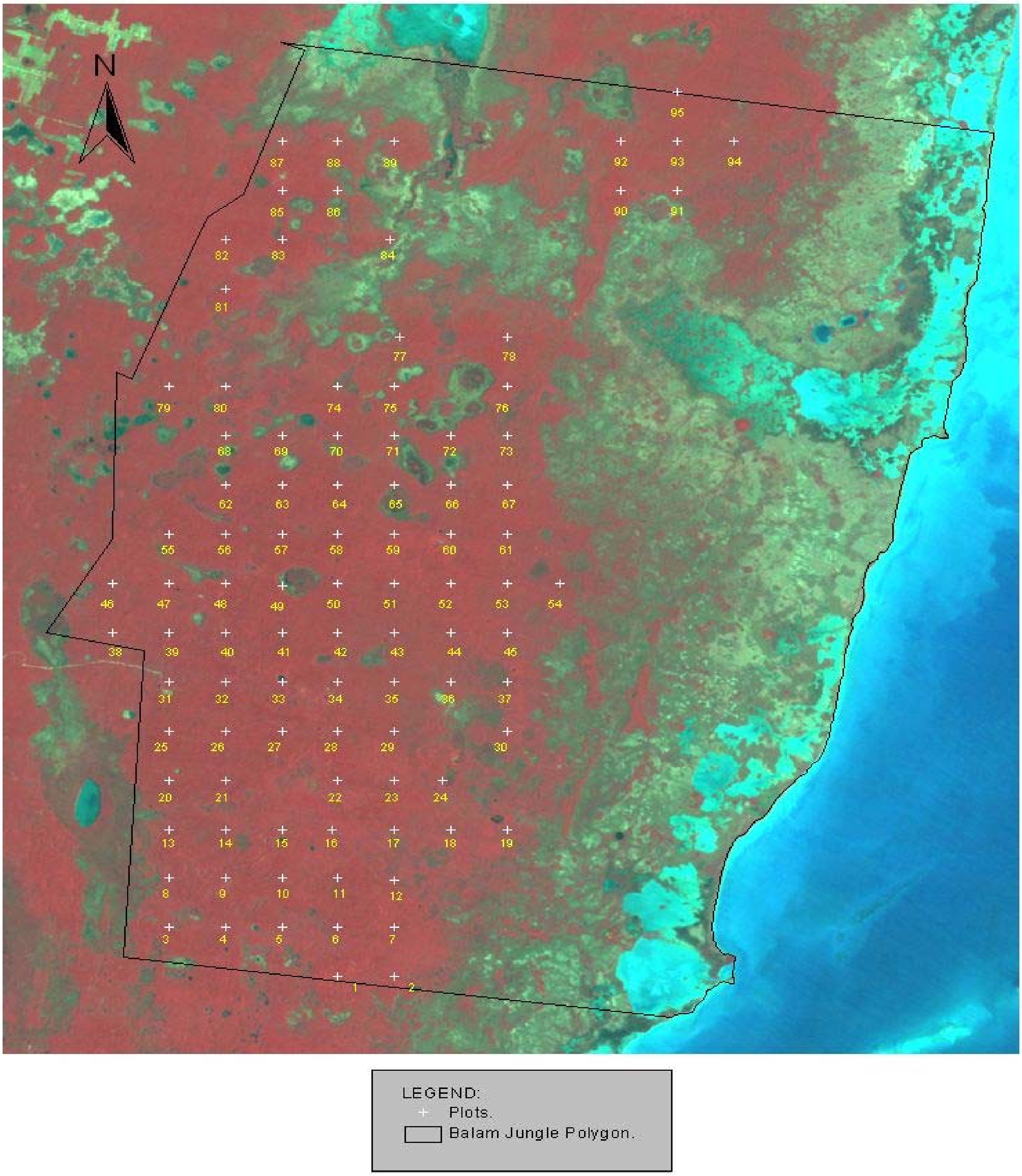


Table 7. Size Class distribution of Trees, Basal Area & Volume for Highly Commercial (HIGHCOM) and Actually Commercial (ACTCOM) Species.

Common name (in Guatemala)	COMMERCIAL GROUP	VARIABLE	SIZE CLASS IN CM									TOTAL
			10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>90	
Caoba	HIGHCOM	N	0	0.4	1.1	0.4	0.1	0	0	0	0	2
		BA	0	0.022	0.101	0.059	0.012	0	0	0.005	0.008	0.206
		VOL	0	0.09	0.429	0.245	0.039	0	0	0.032	0	0.835
Amapola	ACT	N	0	0.1	0.3	0.2	0.1	0	0	0	0	0.7
		BA	0	0.008	0.023	0.023	0.015	0.01	0.01	0	0	0.089
		VOL	0	0.029	0.083	0.097	0.056	0.033	0.051	0	0	0.349
Cátalos	ACT	N	0	1	1.2	0.3	0.1	0	0	0	0	2.6
		BA	0	0.056	0.103	0.039	0.029	0.004	0.013	0	0	0.243
		VOL	0	0.18	0.297	0.075	0.07	0.022	0	0	0	0.644
Chacal blanco	ACT	N	0	0.4	0.8	0.3	0.1	0	0	0	0	1.7
		BA	0	0.025	0.074	0.04	0.023	0.011	0.005	0	0	0.178
		VOL	0	0.063	0.18	0.101	0.045	0	0.01	0	0	0.4
Chacaj colorado	ACT	N	0	3.9	3.6	0.6	0	0	0	0	0	8.1
		BA	0	0.22	0.315	0.09	0.008	0	0.005	0	0	0.637
		VOL	0	0.652	0.987	0.29	0.021	0	0.014	0	0	1.964
Chechen negro	ACT	N	0	6.2	5.7	1	0.3	0.1	0	0	0	13.3
		BA	0	0.355	0.503	0.149	0.063	0.026	0	0	0	1.096
		VOL	0	1.071	1.497	0.468	0.192	0.093	0	0	0	3.32
Chico zapote	ACT	N	0	1.2	1.7	0.9	0.4	0.1	0.1	0	0	4.6
		BA	0	0.071	0.16	0.142	0.1	0.047	0.044	0.013	0.008	0.585
		VOL	0	0.192	0.438	0.44	0.327	0.16	0.077	0.041	0	1.673
Cola de coche	ACT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.001	0	0	0	0	0	0	0.002
		VOL	0	0	0.003	0	0	0	0	0	0	0.003
Danto	ACT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0.002	0	0	0	0	0	0.003
		VOL	0	0.002	0	0.006	0	0	0	0	0	0.008
Jobillo	ACT	N	0	0	0	0	0	0	0	0	0	0.1
		BA	0	0.003	0.001	0	0	0	0	0	0	0.004

Common name (in Guatemala)	COMMERCIAL GROUP	VARIABLE	SIZE CLASS IN CM									TOTAL
			10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>90	
		VOL	0	0.005	0.005	0	0	0	0	0	0	0.01
Malerio blanco	ACT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.001	0	0	0	0	0	0	0.002
		VOL	0	0	0.005	0	0	0	0	0	0	0.005
Malerio colorado	ACT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.002	0	0.002	0	0	0	0	0.004
		VOL	0	0	0.015	0	0.017	0	0	0	0	0.032
Manchiche	ACT	N	0	0.6	0.9	0.3	0	0	0	0	0	1.9
		BA	0	0.036	0.079	0.052	0.01	0	0	0	0	0.176
		VOL	0	0.131	0.289	0.186	0.042	0	0	0	0	0.648
Mano de leon	ACT	N	0	1.7	2.8	0.9	0.2	0	0	0	0	5.6
		BA	0	0.096	0.252	0.139	0.036	0.007	0.004	0	0.008	0.542
		VOL	0.001	0.27	0.786	0.423	0.089	0.011	0.012	0	0.032	1.624
Matilisguate	ACT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.001	0	0	0	0	0	0	0.002
		VOL	0	0.005	0.003	0	0	0	0	0	0	0.008
Palo blanco	ACT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.002	0.003	0	0	0	0	0	0.005
		VOL	0	0	0.009	0.008	0	0	0	0	0	0.017
Palo de lagarto	ACT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0	0	0	0	0.005	0	0.008	0.014
		VOL	0	0	0	0	0	0	0.031	0	0.033	0.064
Pucte	ACT	N	0	0.3	0.4	0.2	0.1	0.1	0	0	0	1.1
		BA	0	0.019	0.036	0.038	0.013	0.017	0.014	0	0	0.136
		VOL	0	0.041	0.062	0.072	0.039	0.009	0.049	0	0	0.272
Santa maria	ACT	N	0	0.8	1.6	0.9	0.2	0	0	0	0	3.5
		BA	0	0.046	0.15	0.139	0.037	0.01	0.004	0.005	0	0.391
		VOL	0	0.13	0.562	0.586	0.17	0.032	0.026	0.025	0	1.532

6 MANAGEMENT LIMITATIONS & PROPOSED SOLUTIONS

6.1 BIO-PHYSICAL CONDITIONS

BJC Ltd. has recently constructed a network of dependable road systems within the management unit. These roadways represent high quality infrastructure for the entire area, which will be used to safely facilitate the transportation of timber according to the AOP and excellently suited for the required activities.

When logging occurs, heavy equipment will be used, therefore most activity has to be done during the dry season to allow for first-rate transfer of vehicles from one location to another while avoiding the cost elevation on road maintenance caused by wear and tear, especially during times of flooding on the property. The area is a high-risk zone because of the inflammable material like grasses in the lowland forests. Therefore, a careful control will be necessary in detecting any forest fire.

6.2 CONDITIONS OF HUMAN RESOURCES AND MATERIALS

BJC Ltd. now employs directly and indirectly, over 40 local professionals and laborers. BJC Ltd. obtains nearly 100% of its labor force from surrounding communities and villages, which include Chunox, Sarteneja, Bomba, Santa Marta, and from more distant areas, such as San Estevan and Orange Walk Town.

Through the development of the local logging operation on the Property, BJC Ltd. has been able to employee a complete logging outfit while building various partnerships to continually upgrade the overall timber operation. They continue to upgrade facilities and equipment to ensure optimum efficiency of operations.

Beyond the timber operation, the following is a list of accomplishment for BJC Ltd.:

- Recruited and hired an experienced international consultant and Harvard Business School Graduate to evaluate and assess the entire corporate and asset situation.
- Employed a local Belizean to co-manage all operations pertaining to the property with our two North American consultants currently working in country.
- Hired 2 North American consultants to live and manage all of the following operations in country.
- Pushed forward with a master-planned subdivision of the estate according to best land use. As of November 2003, provisional approval has been granted from the GOB to subdivide.
- Formulated a sales & marketing strategy for international publicity.
- Built 2 websites to give the property and our ongoing sustainable timber operation worldwide exposure: www.balamjungle.com & www.balamhardwood.com
- Used GPS mapping equipment to complete ground reconnaissance of the raw, undeveloped land and to identify specific land characteristics across BJE. State of the art software, such as AutoCAD and ArcView GIS were used to

successfully plot all roadwork and more precisely analyze and identify overall topography.

- A prominent local geologist, Technical Director of Belize Minerals Ltd., was contracted to undertake a geological investigation to determine the potential for commercial occurrences of hydrocarbons, metalliferous ores and industrial minerals/rocks (non-metallic) on the property.
- Developed government and professional relationships that have lead to the active involvement of the country in backing the pragmatic development of the lands.
- Employed directly and indirectly over 40 various in-country professionals from their respective firms.
- After seeking out and receiving recommendations from Smartwood, the world's leading nonprofit forestry certifier, a Guatemalan organization, called Fundación Naturaleza para la Vida (NPV), was contracted to complete a full forest inventory of the Property's timberland and to produce a sustainable Management Plan that would qualify the area for forest certification status. The Management Plan is utilized guide the timber operation's current harvesting cycles.
- A Natural Resource Inventory was completed to identify non-wood forest products with commercial value and to identify critical conservation areas, such as a Northern Biological Corridor and a Woodstork sanctuary. The inventory includes recommendations for proper management and preservation of the property's resources, while prudently considering how to put BJE towards its best possible productive use.
- Employed two forest rangers to establish vehicular and foot mounted patrols to protect wildlife and all valuable natural resources from hunters/poachers - unexcavated Mayan Ruins, timber, ecosystems, wildlife, medicinal plants, aquaculture etc. Managed on-site employees and assisted directly in responsible preservation of the lands resources.
- Formed a Subdivision Advisory Committee by strategically selecting a group of prominent professionals with physical experience on the land, utilizing expertise from their respected fields to collectively determine the best possible course of action for development based on land use analysis.
- Contracted Wildtracks, a multi-facetted, non-profit, conservation organization to complete a Coastal Survey and Biodiversity Assessment of the property to steer initial development planning through consideration for vital natural environment on BJE.
- Contracted a local construction crew, to build over 20 miles of two-lane, all-weather, marl roadway, in order to provide access to every region of BJE.
- Completed an Environmental Impact Assessment (EIA) in preparation for construction of a coastal roadway. After obtaining Environmental Clearance, they completed construction of a new Coastal Road and pier that accesses the Caribbean Sea between Spanish Pt. Lagoon and Bulkhead Lagoon from the interiors of BJE. This coastal access is currently the first and only coastal access to the Caribbean in this region of northern Belize.
- Completed roadwork that connects the southern boarder of BJE with the old northern highway system via Bomba and Maskall Village. This established roadway puts BJE approx. one hour's drive from Philip Goldson International Airport in Ladyville (currently the only international airport in Belize)

6.3 SOCIAL CONDITIONS: RESOURCE THREATS & CONFLICTS

BJC Ltd. has employed two forest rangers to establish vehicular and foot mounted patrols to protect wildlife and all valuable natural resources (i.e. unexcavated Mayan Ruins, timber, ecosystems, medicinal plants, aquaculture etc.) from would-be hunters/poachers. On-site employees have been integral to the responsible preservation of the lands resources. Surrounding communities have taken notice of BJC Ltd.'s efforts and an apparent respect exists for the company's dedication to the Property. Therefore, at this time, there are no present threats or conflicts to report.

7 FOREST MANAGEMENT

7.1 JUSTIFICATION OF CUTTING CYCLE & MINIMUMM CUTTING DIAMETER (MCD)

7.1.1 Type of soil -

King, et. al. (1992) made a soil classification based on a Land System/Suite-Sub suite system, with five land system categories recognized as being presented within the Property:

- Corozal Saline Swamp
- Xaibe Plain
- Sibal Swamps
- Shipstern Plain
- Northern Bulkhead Plain

Two of the above five classifications, represent the soils beneath the forested area of the property (See table 8):

i. **Shipstern Plain:** This second land system forms a transition zone between the coastal swamplands and the Xaibe Plain, the latter occurring in areas where the bedrock is higher and slightly older. The soil layer of the Shipstern Plain is generally thin, resulting in much of the vegetation showing signs of seasonal water stress during the dry season. Conversely, in wet season, there is a problem of seasonal flooding in parts. These conditions, along with low nutrient levels and, in some locations, high salinity, create a difficult environment for agriculture. (King et. al, 1992)

ii. **Xaibe Plain:** Xaibe Plain is formed on higher bedrock with deeper soil, though is still somewhat limited by low nutrient levels and, in places, seasonal water stress. Two sub-units are found within the area – Flat Plain being the most extensive, underlying most of the forested areas, with patches of the Lower Slope sub-unit distributed throughout. The main soil types to be found within this land system are the Xaibe, Puluacax and Remate subsuites. These are equal in abundance in the Flat Plain areas, but the imperfectly drained Puluacax subsuite predominates in the lower plain areas.

Table 8. Soil for Zones and Sub-zones.

Zones	Sub Zones
Shipstern Plain:	Glady Forest Plain
	Clumped Tree Savanna
	Mangrove
Xaibe Plain:	Flat Plain
	Lower Slope

7.1.2 Diametric Distribution of Species -

The inventory data analysis shows that these areas of land possess species without immense sized trees. After obtaining the results for tree count, basal area and volume from the analysis, it was graphed and the graph demonstrated that there were no individuals with a diameter greater than 50cm. Likewise, the mahogany specie results were the same. With the data, our conclusion was that the possible factor for the incident on this forest is the type of soil, which has a growth margin of the species at a certain diameter. The graphs of all the species and mahogany diametric distribution are presented on the following figures.

Figure 2. Diametric Distribution of Species in Management Unit

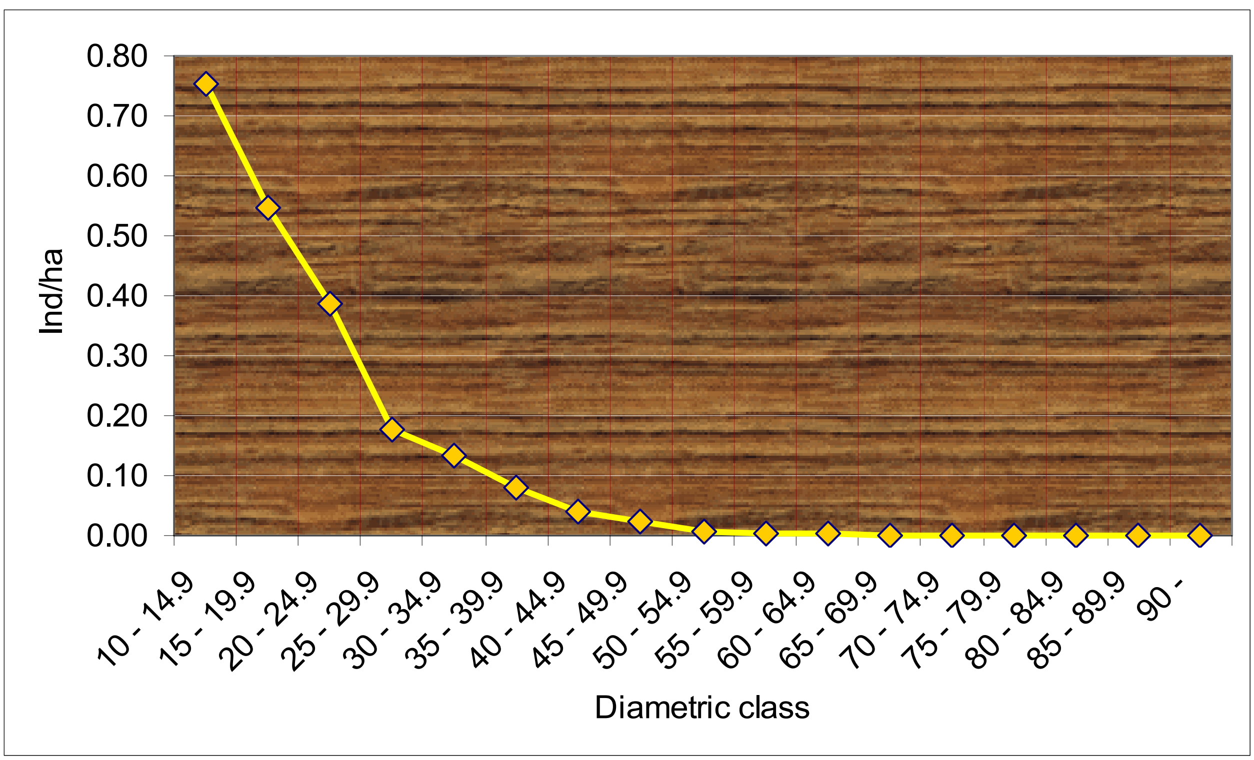
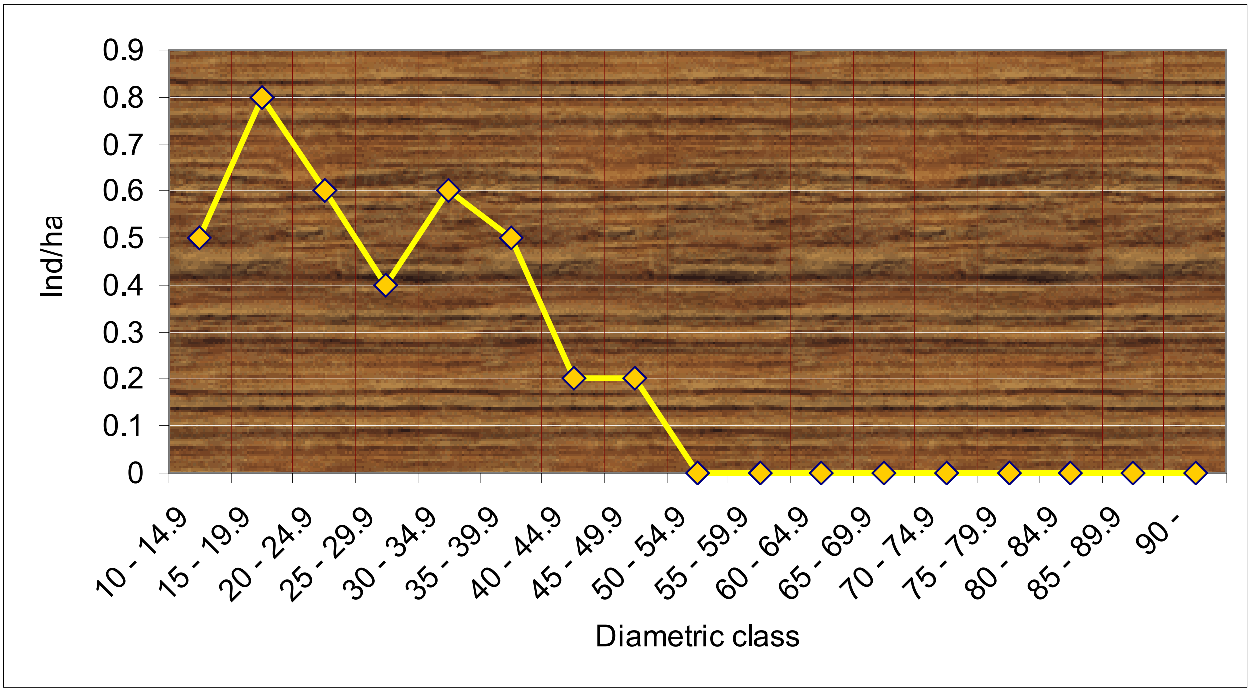


Figure 3. Diametric Distribution of Mahogany in Centimeters



First it is important to consider the fact that there are no trees with >60cm of diameter and that the productive area on this forest is not overly abundant in Mahogany. The species is represented by a figure of 1.7m^3/ha in total for all the diametric distribution and considering the shallower soil types are not ideal for natural development of the Mahogany and other species, it is recommended applying an MCD of 45cm, which is a reasonable size limit, yielding a more moderate volume of this specie under sustainable management. A cutting cycle of 25 years is recommended, taking into consideration the management objectives and annual growth of the trees (0.4 cm per year[2]).

The cutting period of 25 years should be revised and actualized when results of diametric growth are obtained from permanent sampling plots that will be installed in the management unit.

7.1.3 Harvested Species List & Minimum Cutting Diameter (MCD)

The species are first grouped according to their commercial potential and then according to the size class distribution, with the objective of having groups of species to which similar treatments could be applied. The groupings were based on diametric distribution of individuals/ha (See Table 7 and Annex 6). The grouping is as follows:

Ecological groups:

a. **Low quantity species (LQ):** This group includes species that have a mean less than 0.33 individuals/ha $\geq$ 10 cm DBH. Therefore, a special management is required to guarantee its regeneration and reestablishment. Logging is possible with careful consideration for impact to specie density.

b. **Species without big trees (WOBT):** The species in this group have less than 1 tree every 10 hectares over the MCD (60 cm or 45 cm). Some of these species don't grow over 50 cm DBH in diameter, which makes it necessary to work with smaller MCD. They present lower than 0.10 trees/ha in abundance for upper classes of 60cm.

c. **Species without regeneration (WOR):** Species not represented in the lower diametric classes. (< 0.40 trees/ha between classes of 10 to 29.9 cm DBH).

d. **Species with Irregular diametric distribution (IRREG):** This Species have one or many intermediate classes with little to no representation, particularly the classes that have to provide for the next harvest.

e. **Species with good diametric distribution (NORM):** These Species present a diametric distribution similar to the inverted "J."

Commercial Groups:

The following is divided and grouped according to the timber market and special uses:

High Commercial Species	**(HIGHCOM)**
Actual Commercial Species	**(ACTCOM)**
Potential Commercial Species	**(POTCOM)**
Non-Commercial Species	**(NONCOM)**
Special Protected Species	**(PROTEC)**

Table 9 shows the MCD for the species of HIGHCOM and ACTCOM, as well as for the POTCOM group, with expected market value for these species. The MCD was established according to the optimal allowable cut and the diametric distribution, establishing minimum diameters that guarantee resource sustainability.

It is important to highlight that the present list doesn't means that all the species are going to be logged in the productive area. This will depend on the diametric distribution in the cutting areas according to the demand of both local and international markets.

Table 9. List of Species by Commercial Group, Ecological Group, and MCD

No	Commercial Group	Species			Ecological Group	Minimum Cutting Diameter (MCD)
		Common Name (Guatemala)	Common Name (Belize)	Scientific Name		
1	ACT	Amapola	Mapola	*Pseudobombax ellipticum*	IRE	45
2	POT	Baquelac		*Laetia thamnia*	WOBT	45
3	POT	Baqueman			WOBT	45
4	POT	Botoncillo			WOBT	45
5	HIGH	Caoba	Mahogany	*Swietenia macrophylla*	IRE	45
6	POT	Cascario			WOBT	45
7	ACT	Catalox		*Swartzia lundellii*	NORM	45
8	ACT	Chacaj blanco		*Bursera graveolens*	NORM	45
9	ACT	Chacaj colorado	Red Gombolimbo	*Bursera simaruba*	NORM	45
10	POT	Chacpon			WOBT	45
11	POT	Chaltecoco		*Caesalpinia velutina*	WOBT	45
12	POT	Chechen blanco			WOBT	45
13	ACT	Chechen negro	Black Poisonwood,	*Metopium brownei*	NORM	45
14	ACT	Chico zapote	Sapodilla	*Manilkara zapota*	NORM	45
15	POT	Chilonche		*Eugenia capuli*	WOBT	45
16	POT	Chojche			WOBT	45
17	POT	Chonte	Grande betty	*Cupania macrophylla*	WOBT	45
18	POT	Copal			WOBT	45
19	POT	Cortez		*Tabebuia ochracea*	WOBT	45
20	POT	Desconocido			WOBT	45
21	POT	Frijolillo			WOBT	45
22	POT	Gesmo		*Lysiloma sp.*	WOBT	45
23	POT	Guacimo			WOBT	45
24	POT	Guatop			WOBT	45
25	POT	Guaya		*Talisia olivaeformis*	WOBT	45
26	POT	Guayabillo		*Colubrina hetereneura*	WOBT	45
27	POT	Jabin			WOBT	45
28	POT	Jaboncillo			WOBT	45
29	POT	Jobo	Hog plum	*Spondias mombin*	IRE	45
30	POT	Laurel	Salmwood	*Cordia alliodora*	NORM	45
31	POT	Madre cacao			WOBT	45
32	POT	Manax	Cherry	*Pseudolmedia panamensis*	WOBT	45
33	ACT	Manchiche	Black Cabbage Barl	*Lonchocarpus castilloi*	NORM	45
34	ACT	Mano de leon	White Gombolimbo	*Dendropanax arboreum*	NORM	45
35	POT	Manzanillo			WOBT	45
36	POT	Occhuul			WOBT	45
37	POT	Palo de agua			WOBT	45
38	POT	Palo de coche			NORM	45
39	POT	Papaturrito		*Coccoloba reflexiflora.*	WOBT	45
40	POT	Papaturro	Wild grape	*Coccoloba sp.*	WOBT	45
41	POT	Pasaque hembra	Negrito	*Simarouba glauca.*	WOBT	45
42	POT	Pataxte			NORM	45
43	POT	Pij		*Gymnanthes lucida*	WOBT	45

No	Commercial Group	Species			Ecological Group	Minimum Cutting Diameter (MCD)
		Common Name (Guatemala)	Common Name (Belize)	Scientific Name		
44	POT	Pimienta	black pepper	*Pimenta dioca*	WOBT	45
45	POT	Pimientillo			WOBT	45
46	POT	Piñon		*Jatropa curcas*	WOBT	45
47	POT	Pixoy			WOBT	45
48	ACT	Pucte	Bullet tree	*Bucida buceras*	NORM	45
49	POT	Putziquil			WOBT	45
50	POT	Quiebra hacha			WOBT	45
51	POT	Quisainche			NORM	45
52	POT	Ramon blanco	Breadnut	*Brosimum alicastrum*	NORM	45
53	POT	Roble		*Cordia sp.*	WOBT	45
54	POT	Sacpaj		*Byrsonima sp.*	WOBT	45
55	POT	Saltemuche		*Sickingia salvadorensis*	WOBT	45
56	ACT	Santa maria	leche maria, santa maria	*Calophyllum brasiliense*	NORM	45
57	POT	Sapamuche			WOBT	45
58	POT	Silion	Silion, Silly Young	*Pouteria amigdalina*	NORM	45
59	POT	Siquiyaa	Wild star apple	*Crysophyllum mexicanum*	WOBT	45
60	POT	Sosni		*Ocotea lundellii*	WOBT	45
61	POT	Susuco			WOBT	45
62	POT	Testap	Glassy wood	*Guettarda combsii*	WOBT	45
63	POT	Tinto	Logwood		WOBT	45
64	POT	Tzuzul			WOBT	45
65	POT	Yaaxjochoc			WOBT	45
66	POT	Yaxnik	Fiddlewood, Yashnik	*Vitex gaumeri*	NORM	45
67	POT	Zacuayum		*Matayba oppositifolia*	NORM	45
68	POT	Zapotillo hoja ancha	Mammee Ciruela	*Pouteria sp*	WOBT	45
69	POT	Zapotillo hoja fina	Zapotillo	*Pouteria reticulata*	WOBT	45

7.2 Evaluation of Forest Inventory Results

Table 10 illustrates the number of trees, basal area, and volume for the management unit.

Table 10. DBH, Abundance, Basal Area & Volume of Commercial Trees over ≥ 10 cm.

Commercial Group	N (Ind/ha)	Basal Area (m^2/ha)	Volume (m^3/ha)
HIGHCOM	4.00	0.42	1.71
ACT	85.90	8.22	25.15
POT	72.73	7.58	16.15
TOTAL	162.63	16.23	43.01

The HIGHCOM represents the 2.5% of the total number of commercial individuals/ha and 2.6% of the basal area/ha The ACTCOM represents 52.8% of the total number of Individuals/ha and 50.7% of the basal area/ha The POTCOM represents 44.7% of the total individuals/ha and 46.7% of basal area/ha

These results imply that management within the productive area should be carried out under a *polycyclic system*, which promotes enrichment of impacted species of commercial importance. Table 11 demonstrates the basal area and volume per hectare according to the commercial groups.

Table 11. Abundance, Basal Area & Volume per hectare of Commercial Trees ≥ the MCD

Commercial Group	Ecological Group	MCD	No/ha	BA (m^2/ha)	Vol (m^3/ha)
HIGHCOM	IRRE	45	0.2	0.053	0.185
Subtotal HIGHCOM			**0.2**	**0.053**	**0.185**
ACT	IRRE	45	0.1	0.047	0.194
	NORM	45	3.8	0.93	2.875
Subtotal ACTCOM			**3.9**	**0.977**	**3.069**
POT	IRRE	45	0.1	0.043	0.194
	NORM	45	2.2	0.572	0.743
	WOGT	45	0.1	0.091	0.119
Subtotal POTCOM			**2.4**	**0.706**	**1.056**
TOTAL			**6.5**	**1.736**	**4.31**

Map 8 below illustrates the distribution of Black Poisonwood, Red Gumbolimbo, White Gumbolimbo, Sapodilla Tree and Santa Maria volume m^3/ha above the MCD. This map was used to determine the first five-year harvesting areas, taking into account the distribution of the highlighted species' volume over the MCD. This distribution was made by interpolation with the software *ArcView,* applying the system of *WN*.

Concerning the information of regeneration shown in Table 12, quantity data for seedlings and saplings for the different commercial groups is presented.

Table 12. Seedlings & Saplings per hectare for Commercial Groups

COMMERCIAL GROUP	SEEDLING	SAPLING
	No./Ha	No./Ha
ACTCOM	1577.3	72.9
POTCOM	6758.1	374.4
PROTEC	1939.2	63.7
HIGHCOM	71.8	2.6
TOTAL	10346.4	513.6

The HIGHCOM group represents 1% of the seedlings/ha for all species and 1% of saplings/ha The regeneration of HIGHCOM is normal with finding of 71.8 seedlings/ha The ACTCOM group has 14% of saplings/ha and 15% of seedlings/ha

The POTCOM group represents 65% of seedlings/ha and 73% of saplings/ha The protected (PROTEC) species represents the 19% saplings/ha and the 12% of seedlings/ha because of their scarcity. This indicates that it is necessary to favor the population growth of HIGHCOM and ACTCOM species.

In the transformation of HICHCOM seedlings to saplings there is a loss of 96%, indicating that the death rate for the regeneration is very high, which is very normal for a forest without any silvicultural treatment. There is a loss of 95% for the ACTCOM group.

Opening the higher canopy can change this situation, because many species are helophytes and with the increase in illumination, more regeneration will be established. It will be necessary to maintain this situation under study in order to prescribe treatments if necessary.

7.3 CUTTING INTENSITY (CI)

The cutting intensity (CI) is referred to as the percentage of basal area and volume (not including trees ≥ 90 cm DBH) that can be harvested, guaranteeing the reestablishment of the original conditions of the forest at the end of the cutting cycle. It will depend principally on the diametric distribution of species, MCD, and the growth rate of the forest.

Table 13 presents the volume that can be extracted annually per hectare by commercial and ecological group. In addition, there is an estimation of the existing volume that can be harvested.

The CI for the individuals' ≥ 90cm DBH is 50% since the trees that reach this age, accomplish specific ecological functions for fauna and some seed dispersal.

It is important to mention that the calculations done (CI, Abundance/ha, BA/ha, and Vol/ha) are mean values. This will be rectified, based on the results obtained in every commercial census done for the AOP.

Map 8. Distribution of volume m/ha of B. Poisonwood, R. Gumbolimbo, W. Gumbolimbo, Sapodilla, and Santa Maria.

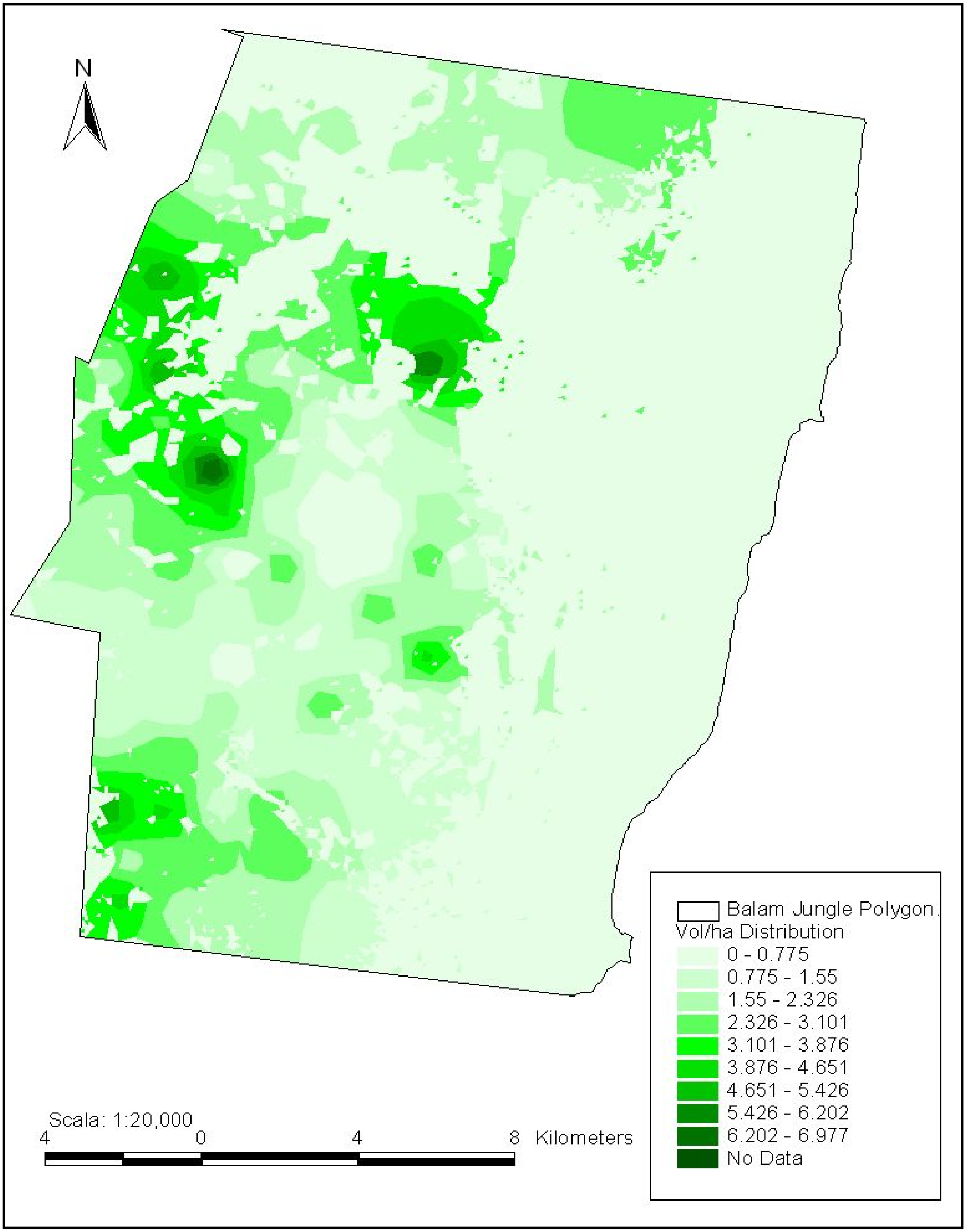


Table 13. The Basal Area and Volume per hectare of Commercial and Ecological Groups to be harvested in the Management Unit.

Commercial Group	Ecological Group	MCD	CI	No/ha	BA (m^2/ha)	Vol (m^3/ha)
HIGHCOM	IRRE	45	0.75	0.15	0.038	0.139
Subtotal HIGHCOM			**0.75**	**0.15**	**0.04**	**0.14**
ACT	IRRE	45	0.53	0.05	0.025	0.103
	NORM	45	0.77	2.81	0.671	2.103
Subtotal ACTCOM			**0.65**	**2.867**	**0.696**	**2.206**
POT	IRRE	45	0.75	0.08	0.032	0.146
	NORM	45	0.77	1.81	0.457	0.533
	WOGT	45	0.22	0.10	0.065	0.073
Subtotal POTCOM			**0.58**	**1.983**	**0.555**	**0.751**
TOTAL			**0.66**	**5.001**	**1.288**	**3.096**

7.4 Protected & Special Management Species

As part of the management plan, Table 14 presents the protected species, which includes legally established species as well as HIGHCOM and POTCOM species that have been recorded as having low densities. Therefore, the presented species will be harvested only if their size class in the cutting area allows it or if dry or fallen trees are found.

Table 14. List of Protected or Special Management Species

Commercial Group	Species		
	Common Name (Guatemala)	Common Name (Belize)	Scientific Name
PROTEC	Aguacatillo		
PROTEC	Amate	Fig tree	*Ficus sp.*
PROTEC	Anona de montaña		*Anona souamosa.*
PROTEC	Cafe silvestre		
PROTEC	Cancetillo		
PROTEC	Cantemo		
PROTEC	Carboncillo		Cupania Guatemalensis
PROTEC	Carcomo		
PROTEC	Cedrillo		*Guatteria leiophylla*
PROTEC	Cedrillo hoja fina		*Guarea tonduzii*
PROTEC	Cedro	Cedar	*Cedrela odorata*
PROTEC	Ceiba	Cotton, ceiba	*Ceiba pentandra*
PROTEC	Cericote	Ziritcote	*Cordia dodecandra*

Commercial Group	Species		
	Common Name (Guatemala)	Common Name (Belize)	Scientific Name
PROTEC	Chijoy		
PROTEC	Chile chachalaca		*Allophylus sp.*
PROTEC	Chintoc blanco		*Wimmeria concolor*
PROTEC	Chintoc negro		*Krugiodendrum ferreum*
PROTEC	Chique		*Ternstroemia tepezapote*
PROTEC	Ciruelillo		
PROTEC	Cojon de caballo	Horseballs	*Stemmadenia donnell-smithii*
PROTEC	Cola de coche		*Pithecelobium arboreum*
PROTEC	Cola de pava		
PROTEC	Coloc		Talisia Floresii
PROTEC	Colorin		Ormosia toledoana
PROTEC	Conacaste	Guanacaste	*Enterolobium cyclocarpum*
PROTEC	Copo		*Coussapoa sp.*
PROTEC	Cuero de sapo		
PROTEC	Danto	Bitter Wood	*Vitairea lundellii*
PROTEC	Flor amarilla		
PROTEC	Flor de chombo	Frangipani	*Plumria Sp.*
PROTEC	Flor de mayo	May flower	*Tabebuia pentaphylla*
PROTEC	Granadillo		Platymiscium yucatanum
PROTEC	Guachapin		
PROTEC	Guachipilin		
PROTEC	Guarumo		*Cecropia obtusifolia.*
PROTEC	Higo		
PROTEC	Hormigo		*Platymiscium dimorphandrum*
PROTEC	Hule		Castilla elastica
PROTEC	Jaquiña		
PROTEC	Jobillo	Glassywood, Jobillo	*Astronium graveolens*
PROTEC	Julup		
PROTEC	Llama del bosque		
PROTEC	Locche		
PROTEC	Lotoche		
PROTEC	Luin hembra	Female bullhoof	*Ampelocera hottlei*
PROTEC	Mabeju		
PROTEC	Majagua		
PROTEC	Malerio blanco	White Mylady	*Aspidosperma stegomeris*
PROTEC	Malerio colorado	Mylady	*Aspidosperma megalocarpon*
PROTEC	Manazanillo		
PROTEC	Matapalo	Fig	*Ficus sp.*
PROTEC	Matilisguate		*Tabeuia Rosea*
PROTEC	Molinillo		*Quararibea fieldii*

Commercial Group	Species		
	Common Name (Guatemala)	Common Name (Belize)	Scientific Name
PROTEC	Mora		
PROTEC	Morro	Calabash	Crecdentia cujete.
PROTEC	Nance	Craboo	*Byrsonima crassifolia*
PROTEC	Naranjillo		*Zanthoxylum elephantiasis*
PROTEC	Negrito		
PROTEC	Ocbat		*Pithecolobium tonduzzi*
PROTEC	Overo		
PROTEC	Palo blanco		
PROTEC	Palo de chombo		
PROTEC	Palo de clavo		Rosedendron denell-smithii
PROTEC	Palo de diente		Trichila glabra
PROTEC	Palo de gusano		Lonchucarpus guatemalensis
PROTEC	Palo de lagarto		Zanthoxylum belizanse
PROTEC	Palo de rosa		
PROTEC	Palo de zope		
PROTEC	Palo espinudo		*Mosquitoxylon jamaicense*
PROTEC	Palo rojo		
PROTEC	Pasaque macho		Mosquitoxylon jamaicense
PROTEC	Perezcuche		
PROTEC	Pitanche		
PROTEC	Pito		
PROTEC	Pochote		*Bombacopsis sp.*
PROTEC	Quequeo		
PROTEC	Quina	Pigeon plum	*Quiina schippii*
PROTEC	Ramon colorado	Red breadnut	*Trophis racemosa*
PROTEC	Ramon oreja de mico	Bread nut	*Brosimum costaricanum*
PROTEC	Sacanche		
PROTEC	Sacuche	Hinge Hinge	*Vochysia hondurensis*
PROTEC	Sajap	Pole wood	*Xilopia frutescens*
PROTEC	San juan	Wild mammee	*Alseis yucatanensis*
PROTEC	Sastante		Xilopia frutescens
PROTEC	Son	Waterwood	*Zuelania guidonia*
PROTEC	Sufricay		*Bumelia mayana*
PROTEC	Tama-hay		Zuelania guidonia
PROTEC	Tempisque		*Matechondendron capiri var tempisque*
PROTEC	Tucuy		
PROTEC	Tzalam	Salam	*Lysiloma bahamensis*
PROTEC	Verde lucero		
PROTEC	Yaje		
PROTEC	Yalpac	Lance Wood,	*Malmea depressa*

Commercial Group	Species		
	Common Name (Guatemala)	Common Name (Belize)	Scientific Name
		Wild Soursop	
PROTEC	Yaxche		
PROTEC	Yaya		Mlmea deprresa
PROTEC	Zapote macho		Pauteria Reticulata
PROTEC	Zapote mamey		*Pauteria Mamosa*
PROTEC	Zapuyul		

The species are presently found to have a low abundance may significantly increase in density due to the growth of the species. Therefore, any specie mentioned above can be harvested on the next 25-year cutting cycle. The final decision to harvest a particular specie or not will be justified and based on the results obtained from every AOP or commercial census.

7.5 Forest Management & Regeneration Method

The area will be managed by establishing a MCD system through selective cutting of commercial species; dividing the forest into annual cutting areas.

For the more scarce species, it’s necessary to monitor their development in cutting areas and, if necessary, to prescribe silvicultural treatments such as enrichment in special habitats or canopy opening. The objective here is to promote a better presence of the specie as it’s expected that in the future, the harvested forest will maintain its same floristic composition while the more scarce commercial species increase in density.

In the annual commercial census, the trees to be logged will be marked and the vines infesting future tree to be logged will be cut out. It will also be necessary to mark the seed trees that guarantee the natural regeneration of the harvested species, since they need to have an adequate distribution for the total harvesting area.

In the second year of harvesting, a diagnostic sampling must take place in order to decide the convenience of a silvicultural treatment that benefits the scarce and commercial species. The methodology to be used is proposed by Stanley (1998) for the forest of Petén. (See Annex 9)

BJC Ltd. has been practicing enrichment to guarantee the regeneration of mahogany and zericote, planting three trees for every one harvested. Most of the planting has taken place in area where harvesting has taken place, along skidder trails and log yards. BJC Ltd. is also planning to implement other types of enrichment method to counter the impacts of harvesting in the management unit.

7.6 Annual harvest units & volume estimations

The first Five-Year Harvest Area was selected based on the species with the highest IVI found on the volume concentration map (reference Map 8) and because it was a productive area within the management unit. The Annual Harvest Units are 715.24 ha in size and in order to facilitate proper sustainability of the forest, five annual harvest units have been joined to create one complete harvest area to be worked on for a period of five years. So, in total, five separate Annual Harvest Units have been identified and combined to create one Five-Year Harvest Area (5Y Harvest Area).

For an illustration of the 5Y Harvest Area, please reference Maps 9 & 10.

Table 15. Forest Division in Annual Harvest Areas

Productive Forest Area	Cutting Cycle	Five-Year Harvest Area	Annual Harvest Unit
17,881.0 Ha	25 years	3,576.1 Ha	715.24 Ha

The five Annual Harvest Units can be worked in any order without altering the integrity of the management plan. However, the overall 5Y Harvest Area cannot be altered and all harvest operations must take place inside the active 5Y Harvest Area.

In order to estimate the cutting intensity and annual allowable cut for the first 5Y Harvest Area, inventory sampling plots conducted within the first 5Y Harvest Area were analyzed to establish a solid reference point from the sample study results. The cutting intensity and annual allowable cut will be rectified on the commercial census made for the AOP.

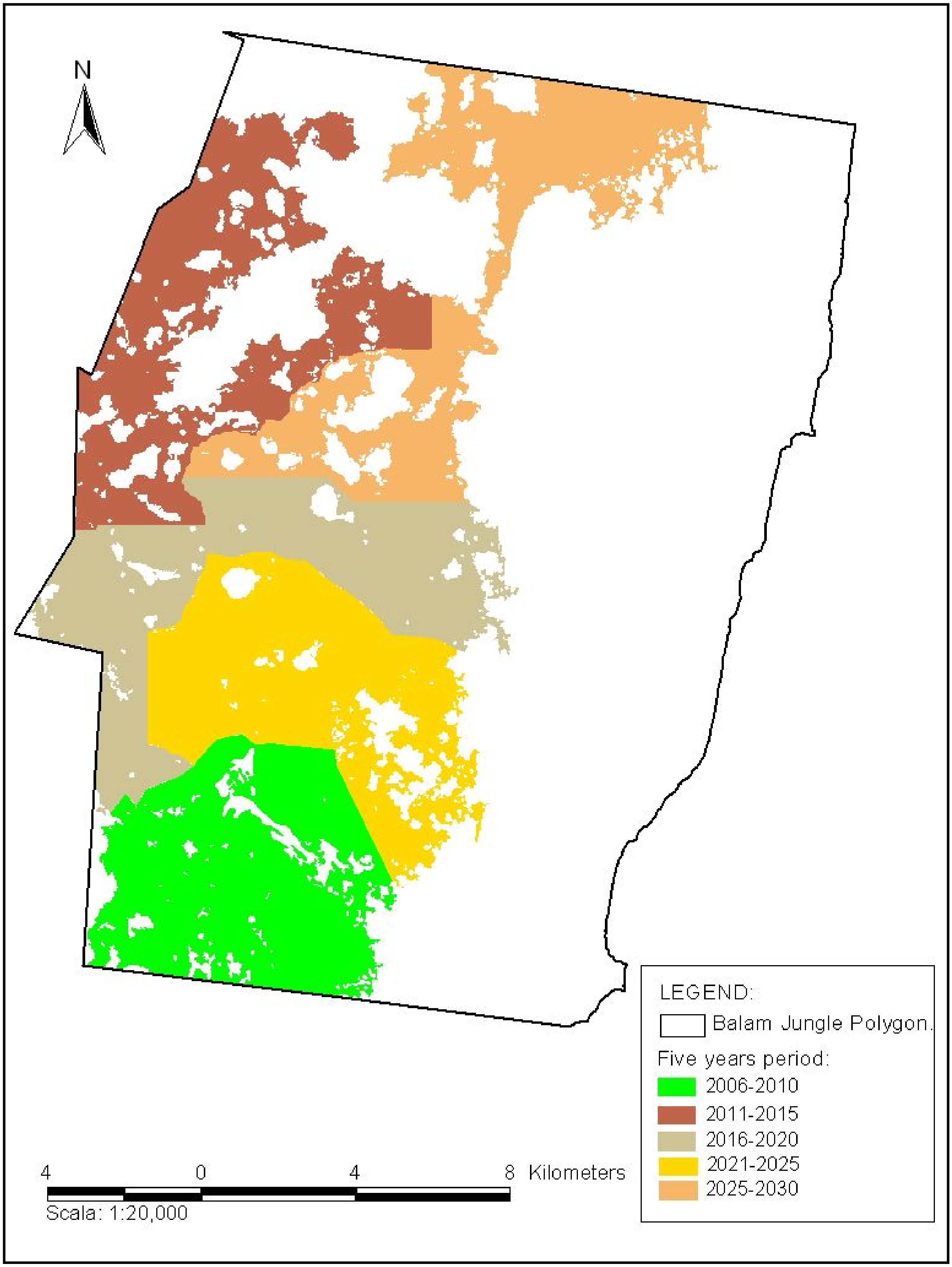
The results for the first 5Y Harvest Area demonstrate a change in volume for mahogany compared to results obtained for the rest of the management area. This is due to a higher concentration of mahogany found in the 5Y Harvest Area in comparison to the rest of the productive area (reference Map 11).

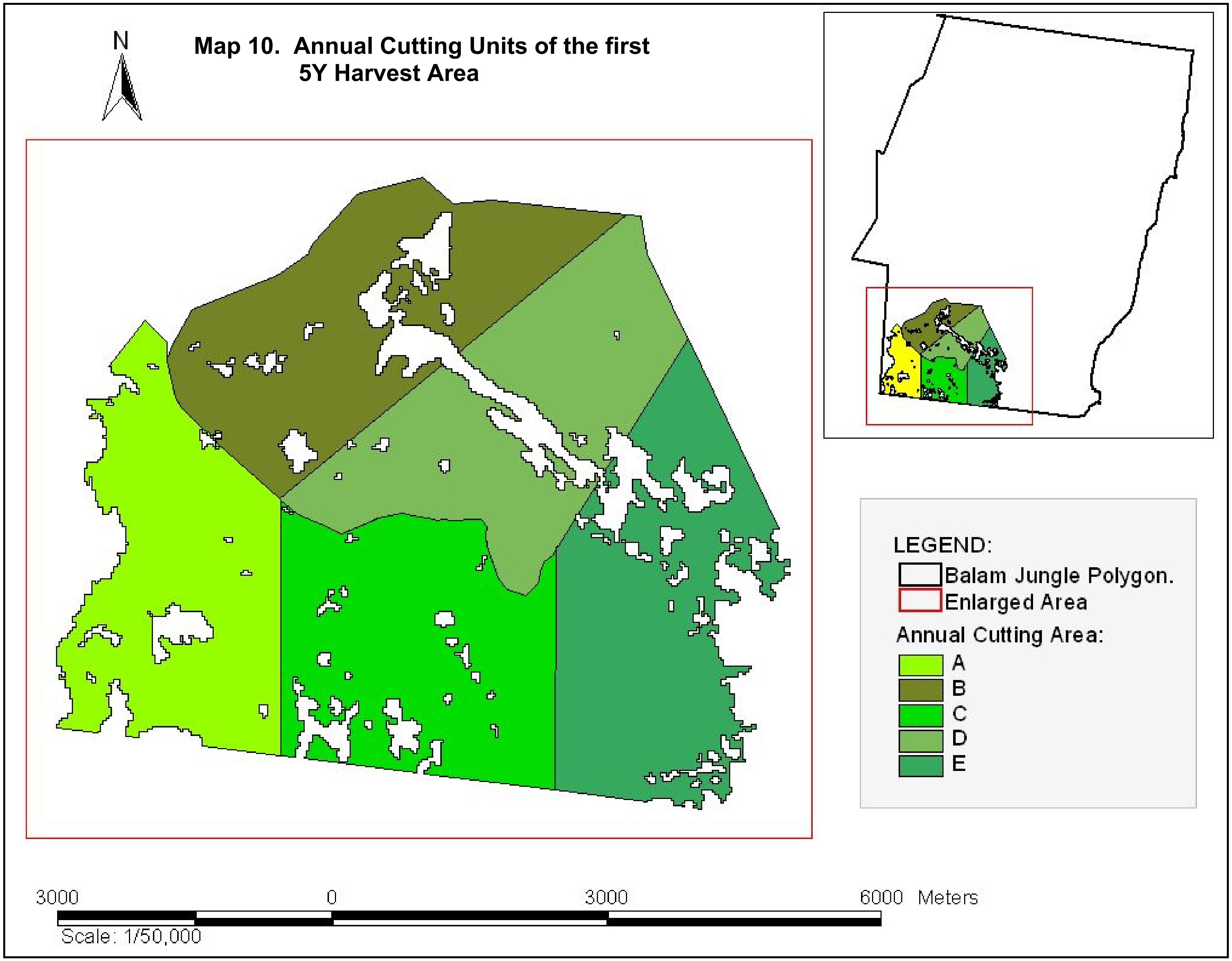
Table 16, below, presents the cutting intensity for the first 5Y Harvest Area by group, which was obtained from analysis made of the area.

Table 16. Cutting Intensity by Group in relation to the Basal Area, Volume/ha of Trees for the first 5Y Harvest Area

NUMBER OF FIVE PERIOD AREA	NUMBER OF ANNUAL HARVESTING AREA	EFECTIVE AREA (HA)	COMMERCIAL GROUP	TREES		BASAL AREA		VOLUME		TOTAL VOLUME TO BE HARVEST
				Available	To harvest	Available	To harvest	Available	To harvest	
				Trees/ha	Trees/ha	m2/ha	m2/ha	m3/ha	m3/ha	
1	1	705.27	HIGHCOM	1.0	0.85	0.152	0.13	0.669	0.57	401.05
			ACTCOM	7.5	5.49	1.298	0.92	4.752	3.44	2,422.61
			POTCOM	6.3	3.72	0.988	0.55	3.03	1.52	1,075.09
1	2	719.69	HIGHCOM	1.0	0.85	0.152	0.13	0.669	0.57	409.25
			ACTCOM	7.5	5.49	1.298	0.92	4.752	3.44	2,472.14
			POTCOM	6.3	3.72	0.988	0.55	3.03	1.52	1,097.07
1	3	723.41	HIGHCOM	1.0	0.85	0.152	0.13	0.669	0.57	411.37
			ACTCOM	7.5	5.49	1.298	0.92	4.752	3.44	2,484.92
			PTCOM	6.3	3.72	0.988	0.55	3.03	1.52	1,102.74
1	4	719.84	HIGHCOM	1.0	0.85	0.152	0.13	0.669	0.57	409.34
			ACTCOM	7.5	5.49	1.298	0.92	4.752	3.44	2,472.65
			POTCOM	6.3	3.72	0.988	0.55	3.03	1.52	1,097.30
1	5	710.18	HIGHCOM	1.0	0.85	0.152	0.13	0.669	0.57	403.84
			ACTCOM	7.5	5.49	1.298	0.92	4.752	3.44	2,439.47
			POTCOM	6.3	3.72	0.988	0.55	3.03	1.52	1,082.58
TOTAL			HIGHCOM	5.0	4.25	0.760	0.65	3.345	2.84	2,034.85
			ACTCOM	37.5	27.47	6.490	4.60	23.760	17.18	12,291.79
			POTCOM	31.5	18.59	4.940	2.75	15.150	7.62	5,454.79

Map 9. 5Y Harvesting Areas on the Property

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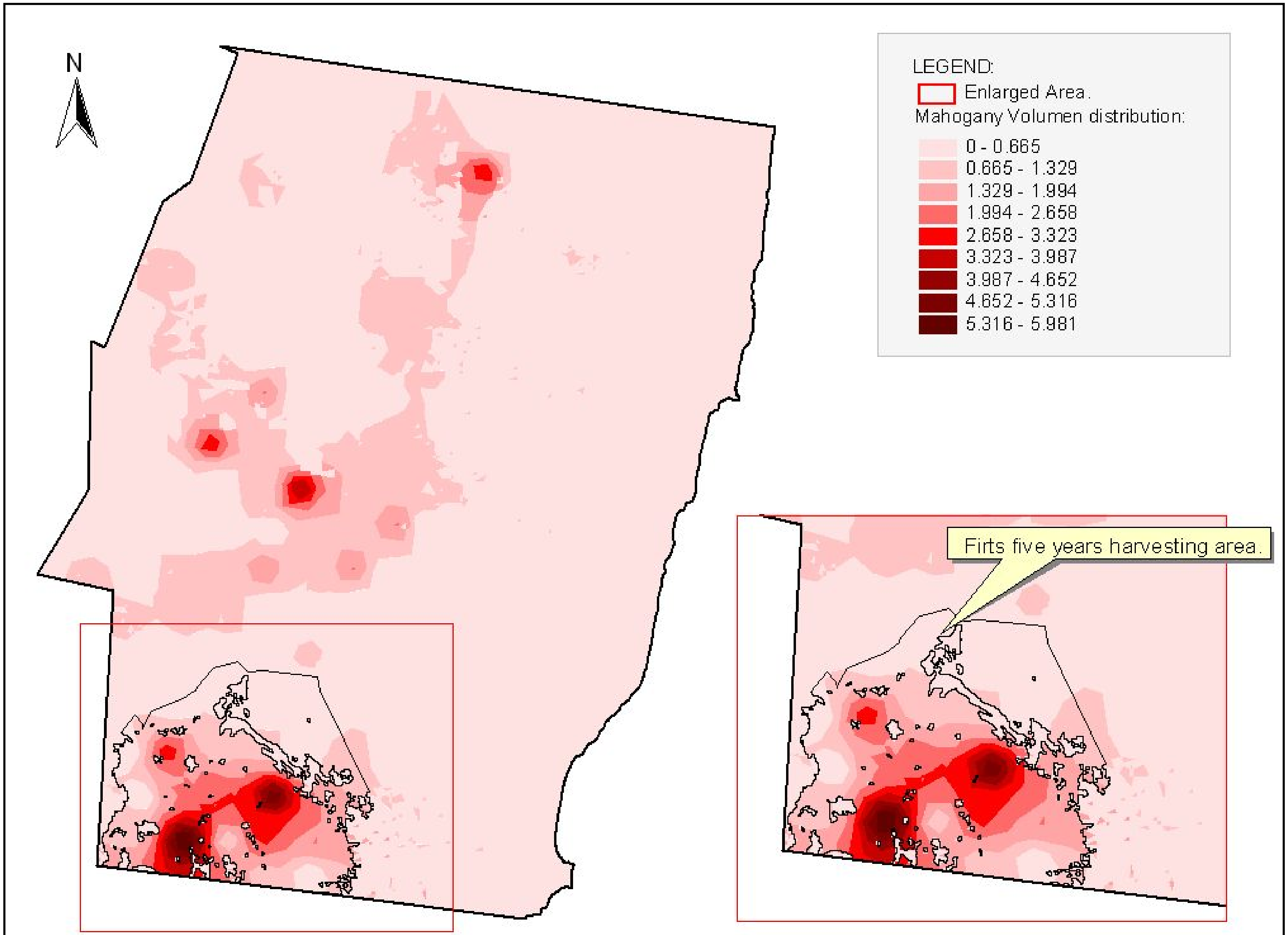
Map 10. Annual Cutting Units of the first
5Y Harvest Area
LEGEND:
Balam Jungle Polygon.
Enlarged Area
Annual Cutting Area:
A
B
C
D
E
3000
0
3000
6000 Meters
Scale: 1/50,000



Map 11. Distribution of Harvestable Mahogany

8 LOGGING

8.1 GENERAL DESCRIPTION OF LOGGING ACTIVITIES

Logging activities should consider the working systems, techniques and equipment used in each harvesting phase. This is done with the aim of qualifying for forest certification status, which is proof of sustainable management and minimal ecosystem impact within a sustainable yield context. (Carrera & Pinelo, 1995)

The harvesting phases of the timber operation are ddescribed below.

8.2 PRE-LOGGING ACTIVITIES

Temporary access roads (logging roads) and landing locations will be planned before operations begin to hold exposed soil down to the smallest area possible. Road construction should be kept to a minimal, consistent with reasonable skidding distance. Springheads, natural drainages, and gullies will be avoided. Landings should also be kept as small as possible, consistent with safe and efficient operation. Logging roads and landings must be located on firm ground, outside of critical Management Zones, such as watershed areas, and above the ordinary high water mark of streams.

Landings should be located to prevent the adverse impact of skidding on water quality. Locating logging decks uphill and skidding up to them results in a cone-shaped pattern of skid trails, which disperses water running downhill. If the trees must be skidded downhill, using several, smaller logging decks with fewer, smaller skid trails leading to any one, can minimize erosion.

8.2.1 Logging Area Realization & Selection -

For the first 5Y Harvest Area, five Annual Harvest Units were established. The logging area selection will be supported by technical criteria in order to establish guidelines for realization and actual selection of the ideal sites. Aspects taken into consideration are:

- **a.** Location in the management area
- **b.** Abundance of commercial species
- **c.** Market demand for highly commercial species
- **d.** Commercial timber quality
- **e.** Accessibility, transportation distances and future infrastructure.
- **f.** Regeneration of commercial species
- **g.** Slope and topography

8.2.2 Boundary Lines of Annual Harvesting Area -

In order to have a well-defined boundary lines for the area being logged, trails should be opened around the entire perimeter of the entire active Annual Cutting Unit. The trails should meet the following criteria:

a. Trails cut to a width of 2 meters.
b. Removal of all non-commercial species from 5 to 15 cm DBH. If there are species that can be used for other purposes, such as arts & crafts, constructions, etc., those species can be transported and used as wished.
c. No cutting of commercial palm species.
d. Elimination of Shrubs.

The boundary line should be marked every 50 meters with flagging tape along the trail. Boundary posts should be placed at the vertexes and will be painted to indicate the orientation and the horizontal distance from the starting point.

8.2.3 Training and Implementation -

The implementation of training for various logging related activities can be done during the pre-logging phase. The principal training activities will be:

- Compass management
- Trace and marking of trail
- Opening of trails (mitigation aspects)
- Marking of limits (boundary stones and labeling)
- Censed tree markings (with aluminum tag plates or paint)
- Commercial tree identification
- Data registration
- Mapping exercises
- Growth rate monitoring of selected species
- Controlled felling
- Fire prevention and combat
- Patrol and protection
- Field monitoring and Management

8.2.4 Commercial Census and Vine Cutting –

The commercial census and vine cutting are two parallel-developed activities. The census will be done with the help of organized field teams, using the Belt System methodology. A distance of 100m in width is maintained between belts, and the system of polar coordinates (x, y) is used to locate the trees. This system presents the advantage of allowing of locating trees for future logging efforts, while recording remnants and seed trees. As a result, a *minimum error* is obtained in the census and it's possible to locate geographic accidents and ecological sites of interest that deserve protection.

The vine cutting will be done for all censed commercial species ≥ MCD, future harvested species, mahogany and other commercial species; censed commercial trees ≥ 20 cm DBH, will be marked at 1.30 meters height with phosphorescent paint.

A map will be designed to illustrate, “future harvest and seed trees.” Other information will be included into the design of the map such as: logged species, archeological sites, forest type, roads and tree positions. The main purpose of this mapping exercise will be guide road planning and construction, log yard, and prudent felling practices.

8.2.5 Determination of Trees to be Logged -

According to ecological and market requirements, a species list will be elaborated. This will have the objective of guiding the identification process of all the logging and protected trees.

Different categories will be established for this purpose:

a. Actual High commercial interest (Mahogany)
b. Actual Commercial
c. Protection

The trees to be logged will be marked with aluminum tags or spray paint, registering the tree number and respective code quadrant, to be placed in a map. The selection criteria for the trees to be logged are:

a. List of commercial interest species
b. DBH more than the MCD
c. Health condition
d. Qualitative Characteristics

8.2.6 Determination of Trees for Future Harvest –

Trees that will be harvested in the future are all species with commercial interest that are healthy and vigorous but currently possess a DBH that is less than the MCD. The qualitative conditions of these trees are not a determining factor for the objectives relating to the AOP, but location and relation to the trees being logged is very important. Therefore, the proximity, distance, and position of each future tree to be logged will be registered to avoid any harm during current extraction operations. The future trees to be harvest will be mapped.

8.2.7 Identification & Determination of Seed Trees -

Seed trees will be marked in the field with aluminum tags, indicating the tree number and it’s respective quadrant code. These trees will be identified on a map, serving as a tool to guide seed tree protection during hauling operations. This will be vital to regeneration of the impacted forest.

Of the total available volume of trees between 45cm and 90cm in diameter, a minimum of 15% will be reserved for tree nurseries. For species 90cm in diameter or greater, 50% of the total volume will be reserved for tree nurseries. These calculations have been applied for the present general inventory, as well as for the commercial census and AOP.

The following is the criteria for seed tree selection:

a. List of commercial species.
b. DBH greater than or equal to the MCD.
c. Health conditions.
d. Log and crown quality.
e. Distribution and abundance.
f. Emergent and dominance.
g. Ecological characteristics of importance for fauna.

8.2.8 Infrastructure Design -

A network of roads and log yards currently exist on the area but it will be necessary to design additional infrastructure for each new Annual Harvest Unit in order to minimize the hauling operation distances to the log yards. According to the dimension and frequency of use, the following three types of roads should be used to avoid extensive impact to areas being harvested:

1. Primary (to transport logs from the property to the millsite)
2. Secondary (to access Harvest Units and log yards from the primary roadway)
3. Skid trails (to haul logs to the log yards)

Road design should consider the following factors:

a. Topography and gradient.
b. Streambed levels and natural lowlands.
c. Current infrastructure.
d. Location and density of the trees to be harvested.
e. Protected fauna and flora species.

An infrastructure map will be included in the AOP to illustrate road access networks.

8.2.9 Annual Operative Plan

The AOP is the principal planning instrument that defines the technical guidelines such as norms, coordination and guidelines for all annual field and office activities relating to the harvesting and marketing of the timber. It also indicates a cost estimation, production yield and income analyses (cost/benefits).

8.3 LOGGING ACTIVITIES

8.3.1 Responsible Logging -

All logging activities will be done following technical guidelines and recommendations proposed by the Forestry Department. Ongoing management must also adhere to the principles and criteria established by the Forest Stewardship Council (F.S.C.) in order to qualify the Property for forest certification.

8.3.2 Basic Equipment -

The most common machinery used is the following:

a. D6 Bulldozer – used for first and secondary road construction, fitting out, and maintenance.
b. Motor Grader – used for road shaping and maintenance.
c. Small Skidder and Tractors – used for hauling logs along extraction routes to log yards, where log loading can occur.
d. Front-end loader, 920 minimum – used to load logs onto flat beds and for patching roadwork with material when necessary.
e. (2) Ten-Wheelers – flat beds are used for transportation of logs from the area to the millsite.
f. (2) 4X4 Vehicles – used for patrol, emergency extractions, and the timber operation team's daily aid and supplies.

8.3.3 Controlled Felling -

The timber operation has always applied the control felling method during past harvesting operations. The outfit will include an operator, an assistant, and an assigned felling supervisor with field experience and understanding of the management philosophies being implemented.

Depending on the number of working outfits and the number of trees to be felled/limbed, the felling process is predicted to take ten to fifteen days with consideration for the type of tree that is to be logged, specie diversity, and mean distances between them. Felling will take place using the Belt System, which means that each logger will have a belt to work with.

The controlled felling technique is applied with the objective of protecting all the commercial species, future harvest potential and to reduce the impact to the surrounding environment.

When this technique is applied, the following is expected:

a. Logger safety and protection (the appropriate gear such as forestry helmet, gloves, ear protectors, wedges and a first aid kit is to be provided to loggers).

b. Maximum tree volume is obtained. Low cuts and a good felling direction prevent the log from splitting or cracking.
c. Seed trees and the future harvest potential are protected.
d. Trees are left in excellent position for hauling.

Only trees marked for actual harvest will be cut. Each logging outfit will be given a set of maps indicating the remnant and seed trees that are to be untouched. These maps will also guide outfits to the location of the protected and harvested trees. When a logger locates the mapped tree in the field, he/she will proceed to identify it by using aluminum tags or paint, recording the tree and quadrant number.

8.3.4 Log yards

The log yards must be constructed according to the distribution of the trees to be harvested, the trees that will be harvested in the future, seed trees, topography, and drainage. The yard should avoid a hauling operation by more than 1km. The approximate size of the log yard should be 0.25 ha. The yard can be constructed with a rubber tire skidder or track skidder. The area to be cleared should be marked along the perimeter with red or white flagging tape.

8.3.5 Forestry Roads

a. **Primary:** This is the main artery roadway, which connects to all existing roadways, tracks, and paths on the Property. This will be the chief access route for all vehicles and construction equipment of any size due to the road all-weather marl foundation. The roadway will also serve as the main extraction route for logs being transported from the management unit to BJC Ltd.'s sawmill site.

b. **Secondary:** These are temporary roads used to take out the timber in trucks from the log yards to the primary road for further transport to the sawmill site.

c. **Skid Trails:** Small paths constructed in order to drag the logs from the stump to the log yards.

8.3.6 Hauling

This activity requires a skidder and two persons (operator and assistant). Two additional persons will be assigned to complete the limbing and damage evaluation, while assisting with any other ongoing activities.

8.3.7 Timber Bucking and Log Cubing -

The log limbing will be done to increment the volume and quality of the log. Two persons will carry out this activity (operator and assistant).

During the cubing operations, the Forestry Department's personnel will be supervising. BJC Ltd. and the Forestry Department will coordinate this phase of work.

A cubic-volume table will be used to obtain the volume of the logs for necessary permits and royalty payment purposes. The logs will be marked with the forestry department's seal and spray-painted to indicate the control number for each log.

8.3.8 Loading and Transport -

BJC Ltd. will be fully responsible ensuring that timber is identified, well labeled, cubed, and stamped before transport in order to ensure the source of the logs and to avoid any potential disputed or conflicts that could affect the efficiency of the operation. Consignment will be by means of mechanical loading using a front loader and it will be transported on flatbed, ten-wheel trucks.

8.4 POST-LOGGING ACTIVITIES

8.4.1 Primary Timber Transformation -

The activities in this phase, will take place at Balam Jungle sawmill, located just north of Orange Walk Town. Once at the sawmill site, the logs are milled into rough lumber then treated, and air-dried.

8.4.2 Branch Harvesting -

It is recommended that BJC Ltd. harvest all the residual timber left at the felling sites and log yards, perhaps employing a separate outfit to salvage and any useful timber parts, such as branches and points, that may not be included in the primary extraction process.

By salvaging and milling branches with considerable volume left on the crown, 20% - 30% of the total volume can rescued through salvage operations and sold to the local market.

8.4.3 Commercialization -

BJC Ltd. has and remains engaged in timber harvesting and lumber production for both the local and export markets. Mahogany has only been harvested in relatively small volumes in the past to meet local demands, however, as the Management Plan will qualify BJC Ltd. for a CITES license for export of mahogany, the company will continue to provide lumber locally while selecting and exporting lumber that meets international standards. Other hardwoods are harvested for export depending on the demand and the opportunities of the international markets.

8.4.4 Road Closing -

Most of the temporary roads used during logging operations will be closed immediately after the logging activities conclude, keeping them open only for reasons relating to the monitoring, evaluation, control, and investigation of timber operations activities.

8.4.5 Diagnostic Sampling -

After every two years of logging in the 5Y Harvest Area, a diagnostic sampling will be done with 10m x 100m plots, systematically distributed over the area.

8.4.6 Silvicultural Treatments -

The continued planting of 3 mahogany plants for every one tree harvested is a recommended enrichment activity to guarantee the successful regeneration of mahogany on the Property. Enrichment can be carried out along skid trails, secondary roadways and at log yard locations. The seeds that are collected during harvesting activities can be used to establish nurseries. Direct planting is another option, taking the proper storage of the mahogany seeds into consideration. Enrichment should take place for other heavily impacted species as well.

Depending on the results obtained in the diagnostic sampling and the ecological impact assessment, silvicultural treatments such as liberation treatments, improvement cuttings, and vine cutting will be considered. The diagnostic sampling will take place every two years after the logging of each Harvest Unit to monitor the need for regeneration and the growth of commercial and protected tree species.

8.4.7 Other Preservation Activities -

a. Organic residuals that present elevate risk of a forest fire are to be eliminated.

b. Inorganic products in logging areas and log yards such cable pieces, plastic gallons, empty cylinders and any inorganic waste should be cleared from the area.

9 MITIGATION TECHNIQUES

This segment summarizes the mitigation techniques recommended as a means to minimize the negative impacts of harvesting operations within the Property.

9.1 ROADS & LOG YARD CONSTRUCTION

a. Soil disturbances and obstacles that could congest natural drainage are to be removed.

b. Small temporary bridges are to be constructed for the transportation routes that cross streams or other waterways.

c. Secondary roads should not exceed 5m in width. Unless a road will be used for future monitoring and investigative activities, it should be closed after extraction operations have completed.

d. After the log yards have served their purpose, the soil surface should be plowed with the tractor to encourage natural regeneration.

e. Skid trails should not exceed 4m in width. Skid trails are to be constructed with manpower, using machetes and chainsaws for clearing. It's recommended that branches that are approximately 10cm thick be placed over the surface of the trail in order to serve as soil absorbers.

f. Skid trials and Secondary roads are to be designed to avoid negatively impacting wildlife, commercial trees, protected remnant trees, and other such trees that provide food for fauna on the Property.

g. Construction of roads, skid trails and log yards are to be avoided in areas near water bodies and runoffs.

h. When extraction operations and use of log yards, trails, and roadways are exhausted; measures are to be taken to ensure that inorganic wastes are disposed of properly.

9.2 WATER

a. Obstruction of natural streams and water flow should be avoided whenever possible.

b. If rains temporarily inundate soils, logging activities are to be suspended until sufficient drainage can occur.

c. A protection area or buffer zone of 20m (66ft) will be left around water bodies found in the logging area according to the Forestry Department's recommendations.

d. As it is illegal, precautionary measures are to be taken in order to prevent contamination of water bodies and waterways from deposits containing oil residuals, fuels, or pesticides.

e. Any bathing or clothing washed will be done using specific wells site locations near field camps. This is done in order to prevent any kind of contaminants from being directly introduced into any significant water bodies.

9.3 WASTE TREATMENTS

a. Trash cans and collectors will be located in camp and at work sites in the field so that rubbish such as plastic, glass, aluminum, paper, etc. is collected and disposed of correctly.

b. Two waste deposits should be built and classified as organic and inorganic wastes. A compost pile can be built near camp for disposal of all organic wastes built while inorganic wastes should be transported and disposed of in dump compounds.

c. Garbage is not to be disposed of in or around unoccupied sites or water bodies within the management unit.

9.4 HERITAGE SITES

a. Any archeological sites found within area for extraction will be left untouched and a buffer zone (50m radius) will be marked with flagging tape. There will not be logging activities or road constructions in this area.

b. Identified sites will be registered and mapped. Authorities will be contacted should a significant site be discovered.

c. Any findings will be left undisturbed as it's prohibited to remove or transport any piece or portion of any archeological artifact.

A more in depth discussion regarding the protection of cultural heritage sites can be found in the "Forest Protection" section of this management plan.

9.5 VEHICLES

a. Extraction vehicles that effectively disperse weight, which minimizes pressure points, are recommended to reduce the damage, sinking and compaction of soils.

b. The skidder should be operated with the shovel elevated to avoid damage to soils and transit should be restricted to skid trails only.

c. A parking and maintenance area should be established for all vehicles and field equipment.

9.6 WILDLIFE

a. BJC Ltd. has declared that hunting has and will continue to be strictly prohibited on the Property.

b. Authorities will be notified of any wild animal is found wounded during logging operations in order to preserve life when possible.

c. If, during construction of roads or harvesting activities, any endangered wildlife is found in trees, caves or at ground level, findings are to be reported immediately.

10 NON-TIMBER PRODUCTS

Non-timber products are a source of economical income and the demand for non-timber resources is growing. The Bayleaf palm is a non-timber product that is growing in demand because of the tourism related businesses favor the incorporation of thatch roofing because of the rustic appeal it brings to an establishment. There has been an increased demand for other palms as well and as markets gain strength both locally and internationally, any harvesting activities should take place under a sustainable management to guarantee production and preservation.

Within the management unit of the Property there are many non-timber products that have the potential to be harvested such as:

- **Xate –** BJC Ltd. is beginning to network with serious individuals and companies dedicated to sustainable harvest and agricultural based growth. As a result BJI is now excited about teaming up with a company to begin sustainable harvest of Xate (Chamaedorea spp.), found in abundance within the forests of the Property.

- **Hardwood Agro-forestry Project –** These practices have benefits for both farmers and the environment. By integrating hardwood tree species into an agro-forestry program, BJC Ltd. believes they can lessen the degrading effects of timber extraction and manage productive crop. In the future, BJC Ltd. and their forest rangers plan to use tree litter to fertilize and improve soil conditions and/or use leaves and fruit as fodder for livestock. The environment benefits from the trees holding soil, protection from wind and heavy rainfall that can cause leaching of soils and erosion. Furthermore there are timber and fuelwood trees for shelter and energy; medicinal trees to combat disease particularly in an area where there is no pharmacy; and trees that produce gums, resins or latex products such as the chicle tree (Manilkara zapota). Many of the trees found on the Property can be utilized in multiple ways, each providing a range of benefits.

- **Alternative Economic Fruits –** BJC Ltd. is working to further diversify the nature and agriculture on the Property and to promote a healthier region and economy in Belize. BJC Ltd. is encouraging partnerships that can assist in creating agricultural diversity with experimental orchards established on the Property. For instance, the lychee trees have produced a saleable crop and received a positive response from local market tests. Some believe that exportable tropical fruits such as the mangosteen, lychee, rambutan and longan will prove to surpass the currently favored citrus and banana in income potential.

- **Bayleaf Palm -** The Bayleaf (*Sabal maritiiformis*) has long been popular among Belizean Maya and Mestizo. Now the Bayleaf is gaining huge popularity in the tourism industry. As the Bayleaf becomes scarce due to habitat loss and over collection, leaf seekers become less careful about healthy gathering practices. To ensure the health of Bayleaf palm populations, BJC Ltd. has inventoried the Bayleaf palm population on the Property to incorporate collected data into their Sustainable Forest Management Plan, which is used to guide the sustainable harvest of commercial tree species on the property.

- **Cohune Palm -** As Balam Jungle experiences months of high rainfall, Cohune Palm is another crop found in great abundance on the Property. Individual Cohune Palms (Orbignya cobune) produce about 1000-2000 fruits per annum in large bunches yielding l500 kg/ha. The oil contained within the kernel of the nut is somewhat similar to coconut nut oil. When refined the oil is suitable for margarine production, baking and biscuit making. Damaged kernels can be used as cattle feed. The shells are a good source of fuel. The cake remaining after oil extraction also finds use in animal feed.

During the timber inventory conducted on the Property, it became evident that Balam Jungle has significant commercial quantities of Cohune Palm to support export markets with instances of palms found at a density of over 15 palms per hectare.

10.1 BAYLEAF PALM POTENTIAL

At this time, BJC Ltd. is specifically interested in Bayleaf palm (sabal morrisiana) because of the rapidly increasing local demand. During the inventory, Bayleaf palm information was collected on the 50m x 10m regeneration subplots, taking into account the number of palms, the number of leaves, the number of harvestable leaves, and the number of potentially harvestable leaves.

10.1.1 Inventory Results -

By taking the total live foliage of mature individuals recorded from sampling plots at an intensity of 0.23% of the total area, a sampling error of 9.73% and a coefficient variation of 33.54% was obtained (reference Table 17).

Table 17. Statistical Analysis of Sabal Morrisana (Bayleaf Palm) Leaves

STATISTICAL MEASUREMENT UNITS	RESULTS
No. of plots	95
Sampling intensity %	0.23
Mean leaf/ha	33.54
Standard Deviation	15.94
Coefficient of. Variation	47.53
Standard Error of the mean	1.64
" T" de student value	1.99
Limits of Confidence	
Upper limit leaf/ha	36.81
Lower limit Leaf/ha	30.28
Minimum reliable esteem	30.8
Sampling error	**9.73**
Allowable Error	25

According to the statistical analysis of harvestable leaves by palm, there is an average of 5.21 harvestable leaves per palm. It is possible to assume, at a 95% level of certainty, that the mature palms have a maximum of 5.35 and a minimum of 5.06 harvestable leaves per palm. (See Table 18)

Table 18. Statistical Analysis of Harvestable Leaves of Sabal Morrisiana

STATISTICAL MEASUREMENT UNITS	RESULTS
Mean (Leaf/palm)	5.21
Standard Deviation	1.89
Limits of Confidence	
Upper limit (Leaf/palm)	5.35
Lower limit (Leaf/palms)	5.06
Sampling error	2.83

The average number of mature palms per hectare is 17.22. The mature palms have an average of 89.7 harvestable leaves/ha and 22.5 leaves/ha of regeneration. There is an abundance of 103.3 regeneration palms/ha, which produce 366.8 harvestable leaves/ha and 160.2 unusable leaves leaves/ha (reference Table 19)

Table 19. Information about Mature & Regeneration Palms

Description	Mature palms	Regeneration palms.
Abundance (palms/ha)	17.22	103.3
Harvestable leaves/ha	89.7	
Regeneration leaves/ha	22.5	
Good Leaves/ha		366.8
Bad Leaves/ha		160.2

10.1.2 Sustainable Harvest of Bayleaf Palm Calcuation Method -

In order estimate a sustainable harvest rate for the leaves of the Bayleaf Palm on the Property, the criteria preposed by Argüelles and Caballero (1999) in the management area of Noh Bec, Mexico and experiences of field work in the Zone of Multiple Uses of the Mayan Biosphere Reserve, was taken into acount.

10.1.3 Regeneration -

In order to guarantee regeneration, 80% of the total palms encountered should be harvested. Argulles (1999) proposed the harvest of 80% of individuals that have reached maturity. By preserving 20% of the total palms encountered, an abundant germoplasma source is guaranteed for perpetuation of the specie.

In addition, seeds should be collected from the mature palms and dispersed in order to favor regeneration. This is done when the palm has reached its reproductive stage and the seedling process has concluded.

10.1.4 Cutting Intensity -

Embracing the recommendations of Argüelles (1999), the cutting intensity that is to be applied to the management unit for the leaves of each palm is 75%. The rest of the leaves are to be left in the area where the terminal growth is registered (at the top), with the objective of leaving each harvested palm in a condition that favors regeneration of its foliage and continued development.

According to experiences in the management area of Noh Bec in Mexico and the Zone of Multiple Use of the Mayan Biosphere Reserve, in Petèn, the regeneration of foliage appears after a period of one year. Although the Bayleaf palm has a quick recovery cycle, to ensure regeneration, the management plan proposes that after harvesting, the palms are given a three-year regeneration cycle before their leaves are harvested again.

In order to calculate the harvest potential, the following formula proposed by Argüelles (1999) was applied:

$$P = \frac{S \times F \times I \times HA}{C}$$

P = Harvesting Possibility (number of leaves to harvest in one year)
S = Total harvesting area on hectares
F = Population frequency per hectare (abundance)
I = Cutting intensity
HA = Harvestable leaves
C = Regeneration cycle

This formula was applied to a total area of 18,394 ha A harvesting factor of 75% to the inferior limits of leaves/palm was applied and an 80% cutting intensity for 17.22 palms/ha Applying a regeneration cycle of 3 years, a total of 337,861 leaves can be sustainably harvested each year (reference Table 20).

Table 20. Annual Harvestable Leaves for *Sabal Morrisiana*

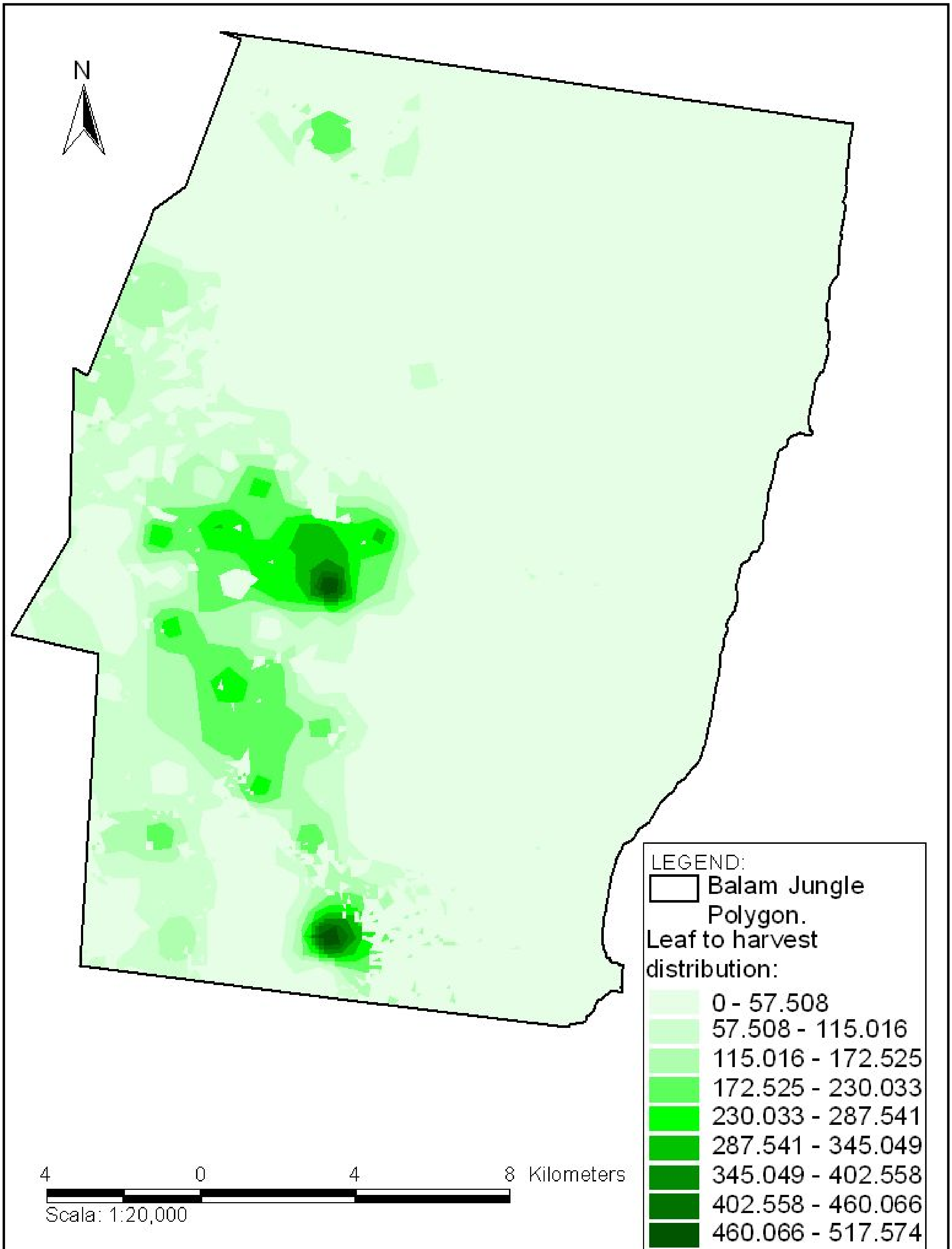
CUTTING POSSIBILITY / YEAR			
	Minimum Leaves/palm	Harvesting Factor	
Lower Limit Leaf/palms(HA)	5.06	0.75	4
Abundance (F)			17.22
Cutting intensity (I)			0.8
Total harvesting area (S)			18,394
Regeneration cycle (C)			3 Years
HARVESTABLE LEAVES PER YEAR			**337,861**

10.1.5 Estimated Production Cycle -

The production cycle will be based on the regeneration cycle, which has been set at 3 years to preserve the integrity of the Bayleaf palm harvested within the management unit. This means that the same palm can be harvested again three years from the time of the initial harvest.

Map below illustrated the distribution/density of Bayleaf palm leaves on the Property.

Map 12. Distribution of Harvestable Leaves



10.2 Harvesting Specification

The traditional method of harvesting the Bayleaf palm consists of cutting the leaves with a machete. The ability and experience of the personnel who perform this task will help minimize damage to the palm.

During the cutting of the leaves the collectors must leave a surplus of leafstalk to minimize mechanical damages to the stem. The leaves should be grouped in bunches of 50 so that there is a clear control of the amount of leaves harvested.

Again, only 75% of the leaves on a palm must be harvested in order to ensure recovery and development. Experienced collectors from the management area of Noh Bec, Mexico, observed, during fieldwork, that harvesting in a sustainable manner actually increases the number of leaves per palm.

Because regulations are based on volume and not in area, recommendations should be applied to the Property's entire productive area and not just in a concentrated area.

10.3 HARVESTING CONTROL

Harvest control consists of the following actions:

- Registry control: BJC Ltd. will establish control registries and specific guidelines for extraction of the palm leaves.

- Registries of harvest amounts and sales by bundle: This is done to monitor the amount of leaves harvested with the amount of leaves being sold, confirming extraction amounts.

- Elaboration of Annual report: BJC Ltd. must update information regarding harvest amounts and other activities involving this product in an Annual report of the amount of leaves harvested and activities elaborates on this product.

- Onsite management and review of harvesting crews.

10.4 Industrialization & Marketing of Product

Currently, Belize has a strong local market for Bayleaf Palm (*Sabal maritiiformis*). The leaf is used mainly for thatch roofing and it has long been popular among Belizean Maya and Mestizo people. Now the Bayleaf is gaining huge popularity in the tourism industry as many are seeking to incorporate the "rustic" look of thatched roofs as part of their tourism facilities. By harvesting the Bayleaf simultaneously along side the timber harvesting operation, international markets for the commercialization of this product can be considered.

The Bayleaf is an ideal sustainable agriculture crop for BJC Ltd. as the management unit is the natural habitat for this specie, which is already found in abundance on the

Property. The natural environment for the Bayleaf palm on the property lowers overhead through the little need for irrigation or pest control. With existing and emerging international markets, Bayleaf has great potential as a cash crop for BJC Ltd. In additional, there exists a significant local demand for just the seedlings of the palm.

11 FOREST PROTECTION

The forest protection plan includes prevention strategies for forest fires, invasions and illegal acts, as well as the implementation of respected mitigation techniques. Protection zones have also been determined based on topographic, ecological, and cultural aspects.

11.1 VIGILANCE & CONTROL

The vigilance and control of the management unit will correspond to a designated commission. The development of these activities will be done based on a strategic plan. The guidelines that will direct the actions are:

11.2 OBJECTIVES -

The general and specific objectives of the commission are:

a. General -

   i. To protect and preserve the integrity of natural and archeological resources within the management unit.

b. Specific -

   i. To protect the management unit from all any activities that threaten the principles of the management plan.

   ii. To prevent illegal activities within the management unit such as illegal logging, hunting, and looting of archeological artifacts and/or sites.

   iii. To coordinate with related authorities, institutions, neighboring landowners and nearby communities to ally labors of vigilance and control.

   iv. To provide steadfast assistance and support relating involving judicial actions and sanctions.

   v. To elaborate and execute the annual vigilance and control plan.

11.3 ADMINISTRATION & CONTROL -

The vigilance and control team should be organized in the following form:

a. Single coordinator
b. Secretary/accountant (BJC Ltd. Administrator)
c. Control and fire prevention
   - Brigade chief
   - Two combat squads (5 persons/squad)
d. Vigilance and control
   - A managing director
   - Two patrolling squads (3-4 persons/squad)

The operation activities and administrative aspects related to fire control and prevention are described in detail on section 8.3.

The coordinator and the responsible for the vigilance and control should be permanent personnel; the others could be temporary contracted.

The coordinator's responsibility is to elaborate the budget for functioning and assure the necessary funds for the operations in critical times, such as the fire season and sudden trips to do or attend denunciations.

11.4 VIGILANCE & CONTROL OPERATIONS -

The vigilance and control squad will verify priority sites and areas most susceptible to illegal activities. These sites will be plotting on a map to guide ongoing patrol and protection efforts.

a. Priority Sites -

   i. Archeological sites and buffer zone
   ii. Strict conservation zones, including watersheds, biological corridors, endangered specie habitats, and other sensitive ecosystems.
   iii. Annual Harvest Units, specifically protected and commercial remnant species and seed trees of high value found in these areas.

b. Susceptible Areas:

   i. Areas having highly concentrated fauna, such as fresh water sources and nesting sites.
   ii. Areas rich with timber products of commercial interest, including priority species such as mahogany and zericote.
   iii. Areas in close proximity to nearby communities such as villages or camps.

iv. Areas in close proximity to logging outfits operating on neighboring land holdings.
v. Access roads and trails on the property.

11.5 PATROLLING & SUPPORT FROM PERSONNEL -

The patrolling plan should be evolved to include at least three to four periodic walks a year through the priority sites and susceptible areas, incorporating additional sectors of the management unit limits whenever possible. Special patrols must take place in addition to the planned protection in order to maintain unpredictable monitoring efforts, which would-be thieves/poachers cannot plan around. Random spot-checks should be conducted and any tips regarding suspicious activity offered by informants from nearby communities should be followed up on to help catch and deter illegal trespassers and/or poachers on the Property. Gated entryways have been placed at the main access points of the Property in order to regulate access to the management unit.

The following recommendations will help improve the effectiveness of patrolling activities:

1. Logistical Planning: Patrol routes, campsites, and usable roadways should be identified and mapped for patrol planning.

2. Materials and equipment to be provided to the forest rangers conducing the patrols:

    - Maps of the priority sites and susceptible areas
    - Compass
    - Field notebook
    - A checklist of prohibited activities for the management unit according to the management plan and environmental impact assessment.
    - Procedure manual in case illegal activities are detected.
    - Authorization that legally empowers the forest rangers to manage all affairs in regards to patrol and protection of natural resources in the management unit.

Personnel in charge of harvesting non-timber products will constitute a permanent vigilance and are required to report any illegal acts observed in the area. Any personnel working within the management unit should know the list of prohibited activities and the basic procedure in case of illegal detections.

11.6 Neighboring & Institution Coordination -

The execution of control and vigilance activities should be coordinated on two levels:

a. Institutional: BJC Ltd. should continue to collaborate with the Forestry Department, Ministry of Natural Resources, and any other related institutions in order to understand proper procedures and ensure adequate support networks. Furthermore, these institutions will be able to assist BJC Ltd. in coordinating quicker response times when law enforcement is necessary. Both the Belize Defense Force (BDF) and the Belize Police Force will help guarantee the safety and integrity of personnel.

b. Neighboring Land Owners & Nearby Communities: The principal reason for collaborating with neighboring land owners and members of nearby communities/villages is to build mutual support and camaraderie, to identify and mark boundaries/limits that will be acknowledge and respected, and to create greater awareness the seriousness of BJC Ltd.'s preservation efforts.

11.7 DEMARCATION, SIGNAGE & MAINTENANCE OF BOUNDARY LINES -

The vigilance commission will be responsible for the following activities:

a. Allied efforts with neighboring land owners to reaffirm mutual respect for property boundary lines.

b. Upgrade and maintenance of existing boundary lines should be completed. Survey lines should be cut to a minimum width of two meters, removing all trees $\geq$10 cm DBH. The felling of commercial and protected species should be avoided.

c. All property lines should be positioned with GPS, including natural accidents and roadways. When there is no physical identification found, trails will be reopened when rehabilitation is not an option.

d. Existing boundary pillars should be rediscovered and recorded.

e. All the trails, corners, principal access roads and natural accidents that affect the boundaries of the management unit should be identified and mapped. Significant pathways should be marked every 500m with durable materials. The minimum size will be 40cm in width and 65cm in length.

f. Special signs are to be visibly placed at all major access locations in order to present information regarding the legal status, administration, and restrictions of the Property.

g. Annual monitoring of property boundary lines and signs. Clearing, trail rehabilitation and labeling upgrades should be completed biannually.

h. Updating of property maps with information collected during monitoring and maintenance of the Property boundaries.

12 FOREST HAZARDS

12.1 FOREST FIRES

Tropical forests don't usually burn. In their natural state, fuel loads are low and not highly flammable, and the humidity is high even during drought years.

Fires in broadleaf forests are often ignored and bear no resemblance to the massive blazes that can be seen in burning needle-leaf forests. The fire is usually low, and slowly creeping through the leaf litter. Often it is possible to walk close up to it and even through it without too much danger. There is usually little "media value" in such fires. Only in areas with Cohune (*Attalea cohune)*, the effects can be more dramatic. The abundant leaf litter under these palms explodes into flames, often igniting the crown and spraying sparks over great distances. But even in the case of these slow, low fires, the damage can be profound. Trees, especially young trees may appear unharmed but still die over time. The mortality either being the result of direct damage or indirect damage such as increased pathogen access through the fire damaged bark.

Tree mortality as the result of such slow fires may continue for several years after the actual fire (pers. obs.). Each fire, which leaves more dead or dying trees behind makes the forest even more prone to fire damage.

Due to the increased activity relating to the ongoing management and harvesting activities on the Property, an increased danger of forest fires has become a reality. And obviously, any kind of forest fire has the potential of being extremely devastating to the conservation and management of the existing natural resources within the management area.

12.2 Forest Fire Prevention -

Human carelessness is the number one reason forest fires occur. To help prevent fires on the Property, the following steps should be followed:

- Landowner's permission for an open campfire, cooking fire or bonfire in or near forest land;
- Burn only natural vegetation or untreated wood products.
- Burn piles are at least 50 feet from structures and 500 feet from any forest slash.
- Clear the area around the burn pile of any flammable debris.
- Keep firefighting equipment handy - a connected water hose or at least five gallons of water and a shovel should be nearby.
- Don't burn if it's too windy to burn - if trees are swaying, flags are extended, or waves appear on open water.
- Be prepared to extinguish the fire if it becomes a nuisance.
- Attend the fire until it is completely out.
- Smoking should not be done while moving from one place to

another in forestland. Make sure your butt is out - "dead out!"
- Power saws must have a proper muffler and be accompanied by a round point shovel or fire extinguisher.
- Cars, trucks and machinery must have proper exhaust systems when operated in or near forestland. Exhaust spark arresters are a requirement on certain machines.
- Know your local emergency telephone number if a fire becomes uncontrollable.

Present personnel should be trained and fully equipped to prevent, if possible, a fire from becoming uncontrollable.

12.3 SPECIFIC FOREST FIRE CONSIDERATIONS

12.3.1 Forest Fuels -

Critical areas within the management unit that contribute large amounts of forest fuels, which can feed the rampant spread of forest fires, are known as bajos or lowland forest.

Forest fuels refer to vegetation associated with grass, shrubs, etc. that are difficult to control once aflame.

Three is a high percentage of light fuel (5-25 mm in thickness; i.e. leaves, sticks, grass, small stems, etc.), found on the property, although the percentage medium fuels (25 to 75 mm in thickness such as branches, shrubs, etc.) and heavy fuels (75mm+ in thickness; i.e. stumps, branches, etc.) are quite considerable, especially given the current timber harvesting operations on the Property.

Logging waste and dense undergrowth of fast-growing pioneer species provide large amounts of fuel that feed the rampant spread of forest fires.

12.3.2 Topography -

Topographic factors such as flat areas and lack of canopy can cause harsh periods of drought, specifically in lowland areas, which have been the origin of many fire incidents. Furthermore, these areas often have an abundance of forest fuels such as shrubs and tall grass that feed forest fires.

12.3.3 Illegal activity hazards -

Activities such as illegal logging, illegal hunting, archeological site looting and illegal trespassing all contribute to the increased risk of forest fires on the Property.

Although these activities are difficult to control completely on such a large property area, a protection program should be established with the government, law enforcement agencies, surrounding landowners, and nearby communities in order ensure a strict application of law for any person(s) that are proven to be responsible, in any way, for the start of a forest fire.

12.3.4 Slash-and-Burn Agriculture -

Neighboring land holdings, where slash-and-burn agriculture is being practiced and is weakening ecosystems, present a seriously risk for a forest fire occurrence, especially during times of drought. Particular attention and monitoring should be placed toward individuals/groups who are using slash-and-burn techniques near the Property boundaries. Measures should be taken to insure that fires are being constantly monitored and controlled.

12.3.5 Accessibility -

Primary and secondary roadways established on the property and the opening of new skid trails during timber harvesting operations, provide vehicles access to nearly every region of the property. This is important given a scenario where equipment and personnel need to be transported to control forest fire emergencies.

12.3.6 Water Sources -

Water sources are available in abundance through the management unit, even during the dry season. It is important that water bodies are identified and made available as part of the forest fire prevention efforts.

12.4 HIGH RISK AREAS

Using forest fire risk and assessment factors, a map was designed to illustrate areas that have greater susceptibility to forest fires (reference Map 13 below):

a. Moderate Risk Areas: These areas are located by roads, truck passes and camps located within the management area, which have continuous presence of workers and/or strangers. In these areas, it's highly recommended that continuous patrols occur simultaneously with regular prevention activities.

b. High Risk Areas: These areas contain significant amounts of forest fuels, especially light and medium fuels found in wetland forest or bajos locations. Continues monitoring of these high-risk areas should be established during the summer or dry season.

c. Extreme Risk Areas: These areas presence contain flammable agents related to fuel accumulation. In these areas, the activities of prevention should be intensified through increasing patrols and close observation with an established perimeter. Strict control should be used to control the activities of workers in these areas.

Generally speaking, in order to effectively reduce the risk of forest fires on the Property, it's important that a vigilance and control program is implemented to monitor human presence in the area. A detection tower or lookout should be constructed to provide a means for immediate detection of any forest fire. Reliable communication equipment should be installed in the detection tower to provide rapid transmission of critical information when needed. Trained personnel relating to forest fire control and prevention is key to the effectiveness of any prevention program.

12.5 OTHER FOREST DESTRUCTION AGENTS

Ecosystem equilibrium found under normal forest conditions can be broken by natural causes or by human influences. Insects, diseases, wildlife, and human invasions are all destructive forces within the management area that must be considered.

12.5.1 Stress -

Basic elements that influence plant health include sufficient water and light, and a proper balance of nutrients. Too much or too little of any of these environmental conditions may cause plant stress.

Environmental stress weakens plants and makes them more susceptible to insect and disease attack.

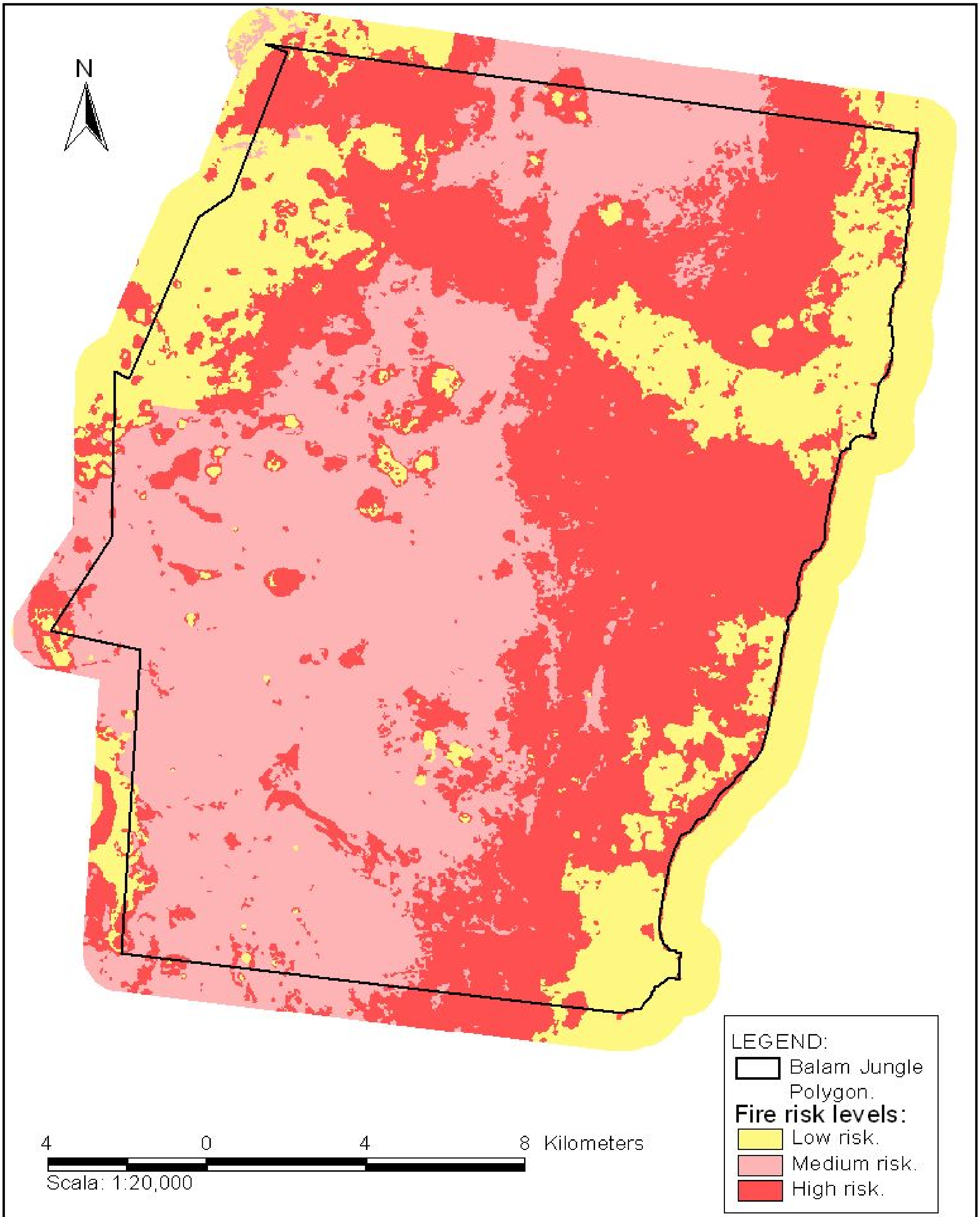
Trees deal with environmental stresses, such as shading and competition for water and nutrients in their native environment, by adjusting their growth and development patterns to reflect the availability of the resources. Although trees are adapted to living in stressful conditions in nature, many times the stresses they experience in the landscape are more than they can handle and may make them more susceptible to insects and diseases.

12.5.2 Diagnosis -

Correct diagnosis of plant health problems requires a careful examination of the situation.

1. **Accurately identify the plant.** Because many insects and diseases are plant-specific, this information can quickly limit the number of suspected diseases and disorders.

Map 13. Susceptible Forest Fire Areas in the Management Unit



2. **Look for a pattern of abnormality.** It may be helpful to compare the affected plant with other plants on the site, especially those of the same species. Differences in color or growth may present clues as to the source of the problem. Non-uniform damage patterns may indicate insects or diseases. Uniform damage over a large area (perhaps several plant species) usually indicates disorders caused by such factors as physical injury, poor drainage, or weather. Furthermore, the timber quality produced is another great indicator as to the health of trees in the management area.
3. **Carefully examine the landscape.** The history of the property and adjacent land may reveal many problems. The number of species affected may also help distinguish between infectious pathogens that are more plant-specific as compared to chemical or environmental factors that affect many different species. Most living pathogens take a relatively long time to spread throughout an area, so if a large percentage of plants becomes diseased virtually overnight, a pathogen is probably not involved.
4. **Examine the roots.** Note their color: brown or black roots may signal problems. Brown roots often indicate dry soil conditions or the presence of toxic chemicals. Black roots usually reflect overly wet soil or the presence of root-rotting organisms.
5. **Check the trunk and branches.** Examine the trunk thoroughly for wounds because they provide entrances for pathogens and wood-rotting organisms. Weather, fire, and rodents, as well as a variety of other environmental and mechanical factors can cause wounds. Large defects may indicate a potentially hazardous tree. Again, the logs and timber quality that appears during stages of the timber operation will bring valuable insight into the health conditions of the trees in the management area.
6. **Note the position and appearance of affected leaves.** Dead leaves at the top of the tree are usually the result of environmental or mechanical root stress. Twisted or curled leaves may indicate viral infection, insect feeding, or exposure to herbicides. The size and color of the foliage may tell a great deal about the plant's condition. Make note of these and any other abnormalities.

12.5.3 Insects & Diseases

Insects and diseases can threaten tree health. As soon as you notice any abnormality in a tree's appearance, there should be careful examination of the problem. By identifying the specific symptoms of damage and understanding their causes, one may be able to diagnose the problem and select an appropriate treatment.

Three things are required for a disease to develop:

1. The presence of a pathogen (the disease-causing agent)

2. Plant susceptibility to that particular pathogen
3. An environment suitable for disease development

Plants vary in susceptibility to pathogens. Many disease-prevention programs focus on the use of pathogen-resistant plant varieties. Even if the pathogen is present and a susceptible plant host is available, the proper environmental conditions must be present over the correct period of time for the pathogen to infect the plant.

Diseases can be classified into two broad categories: those caused by infectious or living agents (diseases) and those caused by noninfectious or nonliving agents (disorders).

Examples of infectious agents include fungi, viruses, and bacteria. Noninfectious diseases, which account for an estimated 70-90% of all plant problems, can be caused by such factors as nutrient deficiencies, temperature extremes, vandalism, pollutants, and fluctuations in moisture. Noninfectious disorders often produce symptoms similar to those caused by infectious diseases; therefore, it is essential to distinguish between the two in order to give proper treatment.

12.5.4 Insects

Some insects can cause injury and damage to trees and shrubs. By defoliating trees or sucking their sap, insects can retard plant growth. By boring into the trunk and branches, they interfere with sap flow and weaken the tree structure. Insects may also carry some plant diseases. In many cases, however, the insect problem is secondary to problems brought on by a stress disorder or pathogen.

It is important to remember that most insects are beneficial rather than destructive. They help with pollination or act as predators of more harmful species. Therefore, killing all insects without regard to their kind and function can actually be detrimental to tree health.

Insects may be divided into three categories according to their method of feeding: chewing, sucking, or boring. Insects from each group have characteristic patterns of damage that will help you determine the culprit and the proper treatment. Always consult a tree care expert if you have any doubt about the nature of the insect problem or the proper treatment

- **Chewing insects** eat plant tissue such as leaves, flowers, buds, and twigs. Indications of damage by these insects are often seen by uneven or broken margins on the leaves, skeletonization of the leaves, and leaf mining. Chewing insects can be beetle adults or larvae, moth larvae (caterpillars), and many other groups of insects. The damage they cause (leaf notching, leaf mining, leaf skeletonizing, etc.) will help in identifying the pest insect.

- **Sucking** insects insert their beak (proboscis) into the tissues of leaves, twigs, branches, flowers, or fruit and then feed on the plant's juices. Some examples of sucking insects are aphids, mealy bugs, thrips, and leafhoppers. Damage caused by these pests is often indicated by discoloration, drooping, wilting, leaf spots (stippling), honeydew, or general lack of vigor in the affected plant.

- **Boring insects** spend time feeding somewhere beneath the bark of a tree as larvae. Some borers kill twigs and leaders when adults feed or when eggs hatch into larvae that bore into the stem and develop into adults. Other borers, known as bark beetles, mate at or near the bark surface, and adults lay eggs in tunnels beneath the bark.

12.5.5 Treatment -

The treatment method used for a particular insect or disease problem will depend on the species involved, the extent of the problem, and a variety of other factors specific to the situation and local regulations. Always consult a professional if you have any doubt about the nature of the problem or proper treatment.

12.5.6 Wildlife -

The forest is the shelter for fauna, sharing equilibrium between birds, mammals, reptiles, and other animals. An unbalance of the equilibrium can influence the regeneration of trees. For example, the uncontrolled hunting of predators (jaguars) could result in the increase of the deer population, causing great damage to regeneration process due to their foraging habits. Or, a disturbance (i.e. development) to the migratory bird population, which pollinates the trees, could cause a serious reduction in seed production.

Determination of animal population by area unit and monitoring of populations will provide the ability to learn how best to manage wildlife in the management area.

12.5.7 Human invasions -

Two types of human invasions in the management unit can be:

- Settlements for living
- Illegal harvesting of natural resources

Patrolling must be done to control and verify that illegal acts are not occurring in the management unit. If any unlawful situations are found to exist, there should be direct and immediate communication with the proper law enforcement agencies.

12.6 CONTROL & REGISTRATION

The objective of control during and after the logging phase is to verify that all marked trees were felled, the established MCD was respected, and the extractions trails were properly constructed. This verification will confirm whether or not seed trees were properly respected. In the present management plan and the future AOP technical guidelines for evaluation will be made.

Timber harvesting activities will be recorded and registered in the field with the objective of evaluating the operations. These activities include analysis of cost of laborers, special project costs, management expenses, used materials, fuel and oils, acquired or rented materials and equipment. All the accounting, finance, and technical matters will be registered and described in the Annual Operative.
The control and registration of activities will be the responsibility of BJC Ltd. Other registrations to be implemented include:

a. Operative Plan updates and elaboration.
b. Yield records by harvested compartment, strata and products.
c. Participation of employed persons
d. Costs, incomes and rate records
e. Experimental applications of silvicultural treatments

Careful and complete record keeping can give valuable insights into the efficiencies and control of the timber operation and management activities.

13 IMPACTS & MITIGATION TECHNIQUES

13.1 IMPACT ON WATER

Removing too many trees, especially in watershed areas, can change a stream's hydrology and result in higher flood flows, movement of stream channels, and excessive erosion. Logging too close to surface waters or skidding across streams can deposit sediment that degrades habitat for plants and animals that live in those waters.

In order to avoid temporary or permanent impacts to superficial water sources (creeks, rivers, lagoons temporary or permanent) and/or subterranean water sources, responsible felling and log hauling activities should be ensured. By planning and monitoring logging and hauling activities, negative impacts to water resources such as the crossing of superficial flows and natural drainage disturbances, can be avoided or at least minimized.

13.2 IMPACT ON SOILS

Heavy machinery can compact the soil and destroy vegetation while making areas impermeable, which spreads negative impact to surrounding root systems resulting in further tree damage.

High-volume harvesting can contribute to erosion, and reduce species diversity and regenerative capacity. Excess organic debris can make forests more vulnerable to destruction in the event of fire.

In order to counter negative impacts caused to soils, roads and log yards are to be closed when logging activities are over, allowing natural regeneration to occur in the area. The closing of roads, opening of canals (for the runoff) and cleaning of residues are considered to be constructive aids to bolster natural regeneration.

13.3 IMPACT ON THE ATMOSPHERE

Due to the development of this Management Plan and ongoing responsible management practices, the negative environmental impacts are considered to be minimized and temporary.

Because of BJC Ltd.'s responsible harvesting practices, the management area will continue to absorb sufficient levels of carbon dioxide, one of the most prevalent greenhouse gases on earth. A well-managed forest will not contribute to the escape of excess amounts of carbon dioxide into the atmosphere, which some scientists believe causes global warming of the earth's climate.

13.4 IMPACT ON ECOSYSTEMS

The most common dangers facing the Property's natural ecosystems are forest fires and natural phenomenon (hurricanes, droughts, etc). These threats can deplete important ecosystems, even causing them to disappearing over time. The sustainable management of resources through selective harvesting of timber will help finance important protection efforts and contribute to the preservation of these natural ecosystems.

13.5 IMPACT OF FOREST MANAGEMENT

Beyond the previously discussed impacts to the forest caused by harvesting activities, overall, forest management ensures many positive impacts, including:

- The survival and prosper of flora and fauna species and vegetation communities.
- Conservation of cultural heritage.
- Forest environment are maintained and enhanced for the enjoyment of generations to come.
- Forest based industries are developed.
- Forest values are maintained/enhanced.

13.6 TIMBER OPERATION: PHASES OF IMPACTS

Impacts begin with the census activities, especially when vines are eliminated, since the epiphyte strata is an important part of the diversity along with the thin stand. However, the majority of impact takes place during the timber operation's felling phase. This affects the Annual Cutting Area in the following ways:

1. Openings in the canopy create excess light conditions in areas, therefore increasing the temperature and humidity. Depending on the specie, these conditions can have both a positive and negative affect on the flora and fauna. The helophytes species quickly invade clearings created by the felling and have been reported to cause damage climbing plants, favoring insect eaters.

2. Heavy machinery affects the vegetation during the opening and maintenance of roads and skid trails. The damage is classified as direct and indirect damage due to the immediate impact on vegetation (direct) and soil structure changes over time (indirect). An example of indirect damage caused by the heavy equipment is the compaction of soils, creating impermeable conditions that severely hinder the development of new vegetation in the area. Compaction is not a permanent problem, but impact is significant given the fact that it takes approximately 10 - 30 years before soils can recover a natural structure.

Low impact logging takes into consideration the impacts described above and develops strategies to prevent and repair certain damages. BJC Ltd. uses tractors and skidders with less weight on temporary roads, along with trucks that haul a lower % of their total load capacity in order to reduce damages to soils while balancing cost efficient and sustainable operations.

After closing temporary roads and log yards, a ploughing treatment of the impacted soils is recommended to oxygenate the compacted area, thus increasing the potential for seeds to flower.

13.7 CULTURAL IMPACTS

Historical sites must be considered at all times. Damage to these sites can occur if there is a lack of sensitivity for their historical importance. Careful and thoughtful management must exist in order to ensure that all personnel present on the Property are respectful of any heritage sites or archaeological artifacts encountered.

The closing of the roadways after their purpose is served is considered a positive impact for archeological sites as their locations remain hidden and inaccessible by vehicle, reducing the threat of would-be raiders and thieves.

13.8 SOCIO-ECONOMIC IMPACTS

The owner of a forested area has a responsibility to protect and preserve the integrity of their forest. And, through proper management, an owner can safeguard biodiversity while generating a direct economic benefit through sustainable harvest of commercial forest products.

By promoting sustainable operations and management of the forest area, local employment can be promoted. Through the hiring and training of staff from surrounding communities, skills and experience can be shared that will increase expertise and capabilities, which, in turn, will increase the effectiveness of responsible forest management.

13.9 MITIGATION

Mitigation techniques are used to minimize, eliminate, correct or compensate for the negative impacts to the environment generated by harvest activities within the management area.

13.9.1 General Techniques -

Some effective mitigation techniques to be applied to the management area include:

- Suitable machinery/equipment should be put into operation on the management area with a reevaluation every 2 to 5 years to promote awareness of technological advances that can increase efficiencies.
- Evaluation of Primary and significant Secondary roadways, to identify and treat low points. Further stabilization improvements should be made through the placement of additional drainage structures. Bulldozers or steel wheel tractors are recommended for the opening of Secondary or temporary roadways in order to avoid significant compaction density levels. BJC Ltd., lightweight skidder is ideal for low impact and minimal compaction to soils.
- Vehicle speeds should not exceed 40km/hr on the Property.
- Schedules and behaviors should be well regulated and managed.
- Implementation of appropriate security equipment.
- Respect for and protection of heritage sites, critical conservation areas and preservation of the management area's ecosystems.
- Control accessibility to the Property.
- Monitor and control illicit activities through an established control station, strategic patrolling, law enforcement agency networking, etc.
- Diversification of forest resources and maximizing of harvested resources.
- Ensure that the cutting capacity is not exceeded and there is respect for MCD and cutting cycles.
- Conduct transect for biological recognition in the proposed protection areas.
- Conduct surveys of heritage sites found in harvest areas or sites located during development of the AOP.

13.9.2 Techniques for the Environment -

To lessen future environmental loss, there must be efficient and sustainable productivity in the management area while restoring species and ecosystems to degraded habitats. By reducing wasteful land-use practices, consolidating gains on existing cleared lands, and improving already developed lands, BJC Ltd. can diminish the need to clear additional forest.

Research and experience has shown that the restoration of entire ecosystems is most possible in regions where parts or at least remnants of the original forest still remain and there are few human population pressures. This applies perfectly to the management area of the Property. The small clearings being made during harvesting can recover quickly, and larger sections will recover in time, especially with assistance in the reforestation process

A few important mitigation techniques recommended for environmental protection are:

- Protection areas or buffer zones of 20 meters (66 feet) are to be left on all sides of all the water bodies identified in the management area, respecting the recommendations established by the Forestry Department of Belize.
- Since BJC Ltd. already enforces a strict no hunting policy, their policy is in tune with the recommendations of this management plan. Furthermore, if the AOP identifies important habitats of species listed by CITES, particular efforts are to be made in order to ensure that these species and habitats are secured.

13.9.3 Techniques for Heritage Sites -

A proposed protection area should be established for each discovered heritage range until an “official” site assessment can be carried out by the Archaeological Department of Belize.

The AOP will begin to physically define archeological sites in order to establish the following protection requirements:

- When sites of up to two associates are found, a buffer area of 25 meters should be established from each of the four cardinal points.
- When sites of more than two associates are found, both the Archaeological Department and the Forestry Department should be contacted in order to conduct the necessary investigations to determine the most appropriate course of actions.
- Any discovered sites should be GPSed, marking the exact location where the readings were taken. Recorded information should be shared with the Archaeological Department and with the Forestry Department if necessary.

- Pictures should be taken, whenever possible, to further document findings.
- Record any other interesting observations, including fauna in proximity to the heritage site being examined.

Constant communication with the Archaeological Department should be maintained in order to ensure a current understanding of the Government regulations and controls in relation to heritage sites.

13.9.4 Techniques for Forest Fires -

The following techniques are recommended to lower the risk of a forest fire occurrence in the management area.

- Understand and apply strategies for forest fire prevention developed by the Forestry Department.
- Identify, evaluate and minimize potential risks.
- Design protection plans for heritage sites and scenic areas.
- Conduct ordinary belts for monitoring purposed during summer months.
- Organize squads for control and prevention of forest fires.

For further details, please reference the forest fire section of the management plan.

14 INVESTIGATION

The results obtained from the permanent sampling plots established on the management area will help guide future decision making concerning the silvicultural treatments and mitigation techniques. Collected data will allow prudent planning to take place, which is critical to ensuring the sustainability of the natural resources and maintenance of the forest. Investigation efforts will be made using Permanent Sampling Plots.

NPV has installed various permanent sampling plots in management units established in Guatemala. For example, NPV is currently collecting data from the permanent sampling plot network that was introduced on the Mayan Biosphere Reserve in Guatemala that presents a strong template for the collection of relevant information (i.e. management strategies). Utilizing a solid base of developed experience, permanent sampling plots will be established on the Balam Jungle Estates and data collected will continue to ensure true insight into the conditions of the management

Note: Monitoring of non-timber products are not a part of this management plan.

TIMETABLE

ACTIVITIES	Year 0	Year 1				Year 2				Year 3				Year 4				Year 5			
Trimesters	2nd. Sem.	1 tr.	2 tr.	3 tr.	4 tr.	1 tr.	2 tr.	3 tr.	4 tr.	1 tr.	2 tr.	3 tr.	4 tr.	1 tr.	2 tr.	3 tr.	4 tr.	1 tr.	2 tr.	3 tr.	4 tr.
TIMBER RESOURCES																					
Pre-logging activities																			■		
AOP coordination and planning	■		■				■				■				■				■		
Recognition and delimitation of the logging area	■		■				■				■				■				■		
Training	■	■	■	■	■	■	■				■										
Commercial Census	■		■				■				■				■				■		
AOP elaboration and approval.	■			■	■			■	■			■	■			■	■			■	■
Road construction and fitting out		■				■				■				■				■			
Logging activities																					
Controlled felling, haulage, limbing, cubing and transport		■	■			■	■			■	■			■	■			■	■		
Primary transformation of timber			■	■			■	■			■	■			■	■			■	■	
Pre-logging activities																					
Commercialization		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Road closing			■				■				■				■				■		
Diagnostic sampling											■				■				■		
Silvicultural treatments																■				■	
FOREST PROTECTION																					
Vigilance and Control																					
Control and Vigilance commission fortification		■	■	■	■																
Training		■	■	■	■	■	■														
Vigilance operations		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Limit marking and maintenance																					
Marking		■	■	■	■	■	■	■	■												
Maintenance														■	■			■	■		
Forest fire protection		■	■			■	■			■	■			■	■			■	■		
OTHERS																					
Certificate obtaining "Good forestry management"						■	■	■	■	■	■	■	■								
Investigation		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Institutional fortification Balam Jungle Estate Ltd.		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Revision and actualization of the management plan and EIA																				■	■

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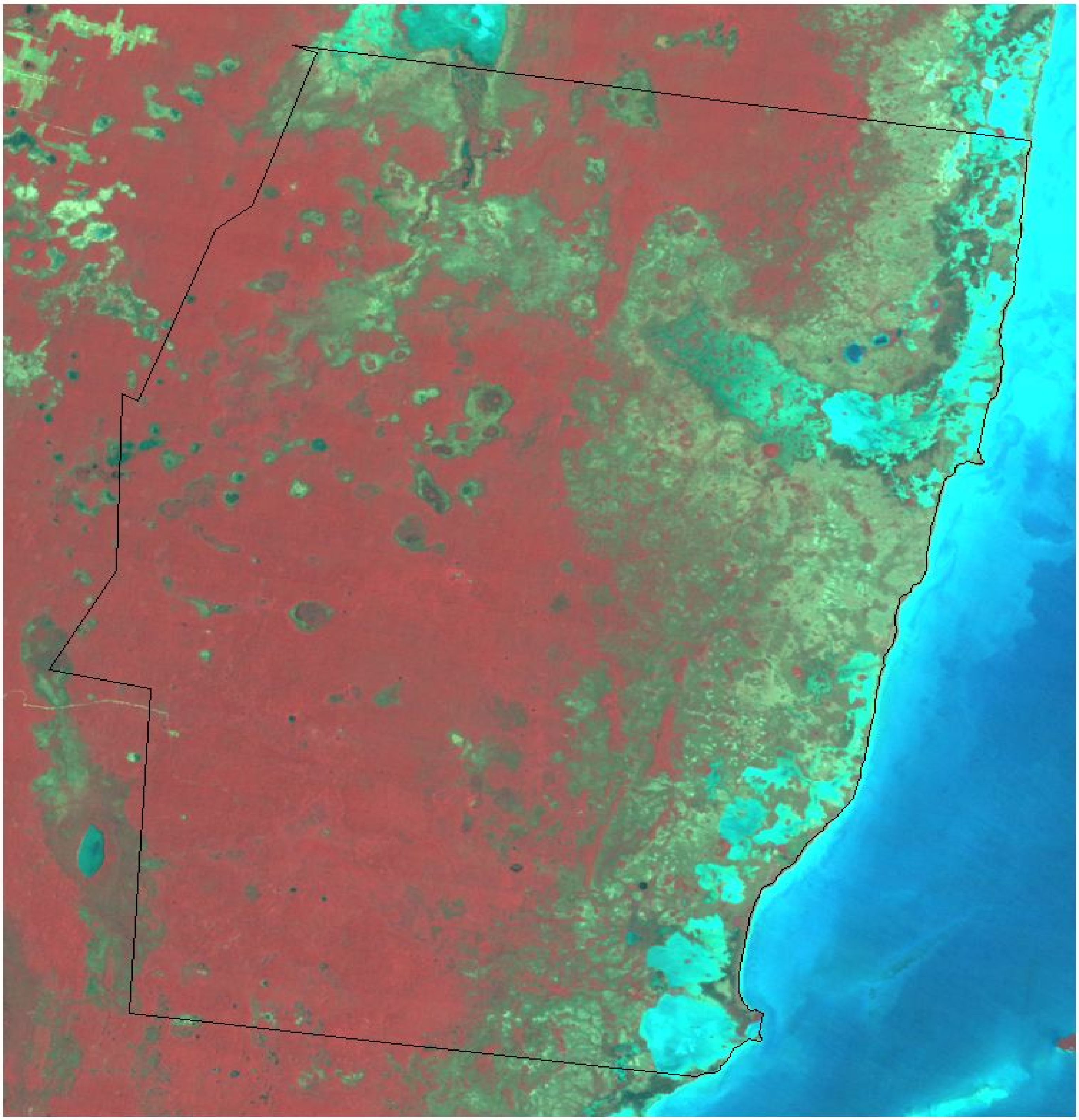
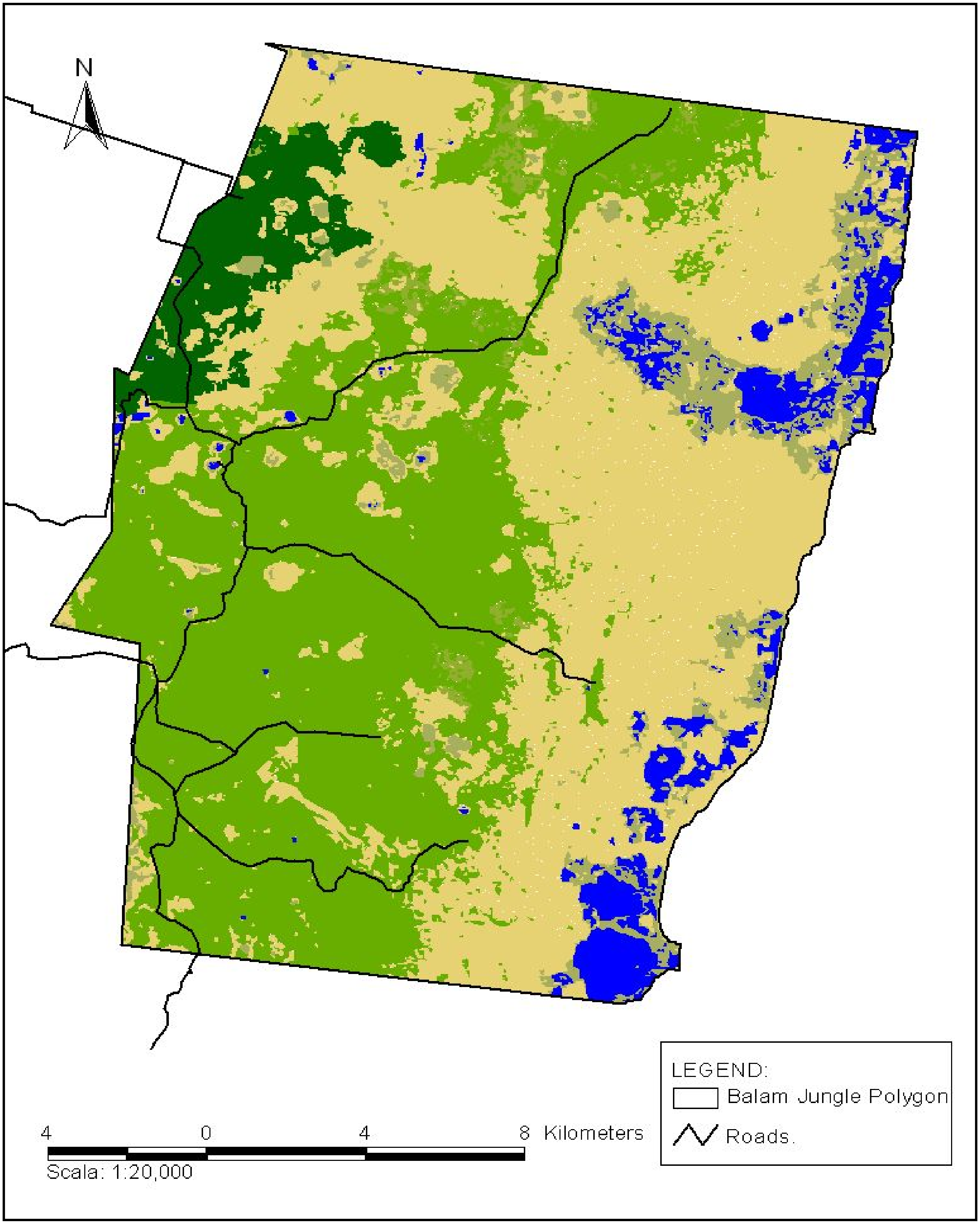
ANNEXES

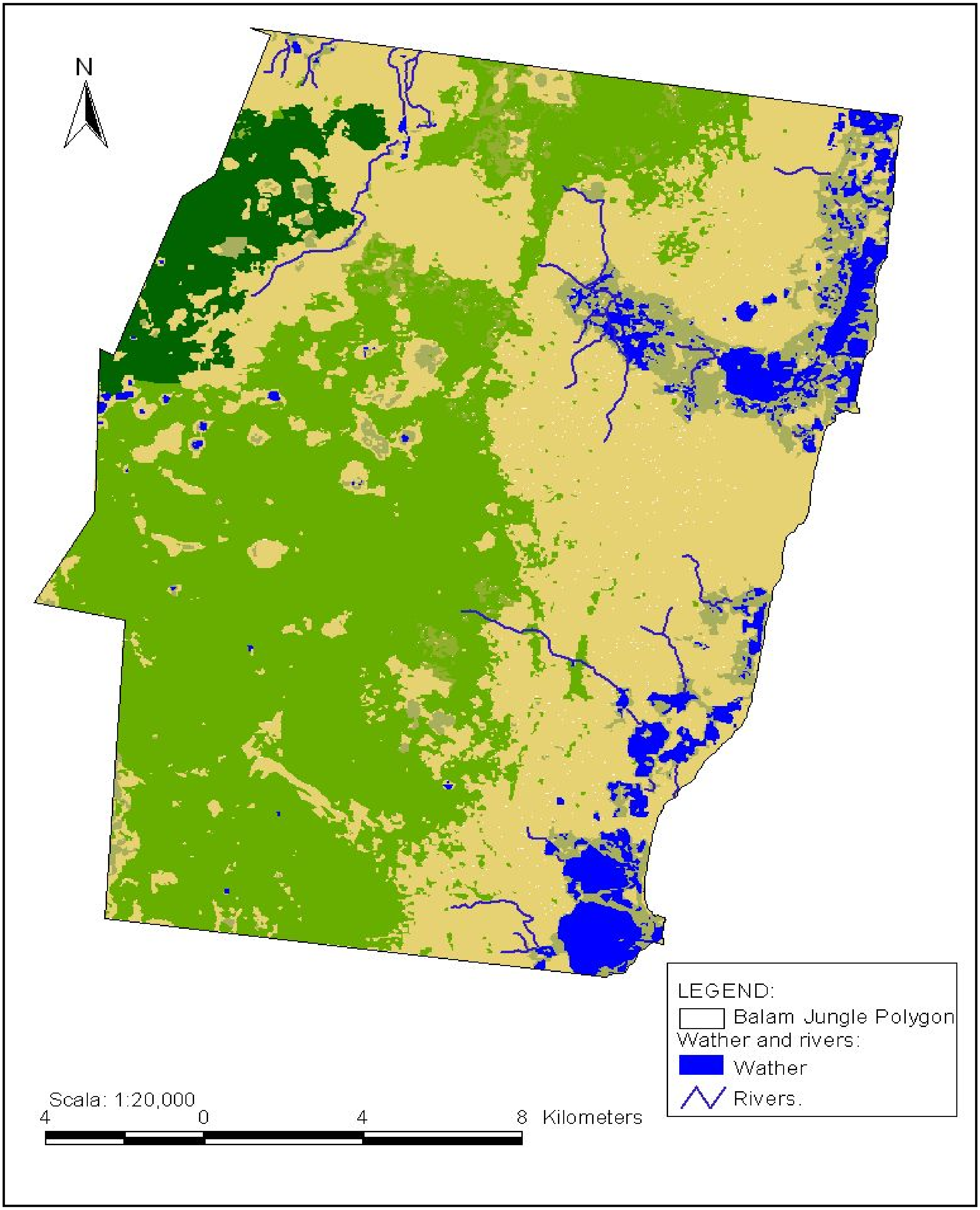
ANNEX 1. Satellite Image of Management Unit.



ANNEX 2. Road Map



ANNEX 3. Watershed & Drainage Map



ANNEX 4. Natural Abundance (No./Ha) of Samplings & Seedlings for Commercial Species

Specie	Commercial Group	SEEDLING No./Ha	SAPLIING No./Ha
Caoba	AAA	71.8	2.6
Catalox	ACTCOM	88.4	4.8
Chacaj blanco	ACTCOM	70.4	1.8
Chacaj colorado	ACTCOM	51.1	4.8
Chechen negro	ACTCOM	251.4	20.3
Chico zapote	ACTCOM	247.3	17.3
Manchiche	ACTCOM	96.7	5
Mano de leon	ACTCOM	48.3	11
Pucte	ACTCOM	5.5	0.6
Santa maria	ACTCOM	718.2	7.3
Avalo	POTCOM	0	0.3
Baquelac	POTCOM	71.8	12
Baqueman	POTCOM	44.2	4.7
Barbasco	POTCOM	1.4	0.1
Bojon negro	POTCOM	0	0.1
Botoncillo	POTCOM	22.1	7.9
Cacho de venado	POTCOM	42.8	0.8
Canelillo	POTCOM	1.4	0
Cascario	POTCOM	30.4	1.5
Cerezo	POTCOM	5.5	0.8
Chacpon	POTCOM	30.4	1.2
Chacsic	POTCOM	6.9	0.3
Chaltecoco	POTCOM	0	0.1
Chechen blanco	POTCOM	114.6	6.4
Chile malache	POTCOM	1.4	0.3
Chilonche	POTCOM	700.3	38.5
Chojche	POTCOM	5.5	1.9
Chonte	POTCOM	281.8	7.2
Copal	POTCOM	301.1	14.2
Cordoncillo	POTCOM	42.8	1.2
Cortez	POTCOM	8.3	1
Cotoche	POTCOM	0	1.2
Frijolillo	POTCOM	205.8	15.5
Guacimo	POTCOM	258.3	8.8
Guatop	POTCOM	20.7	3.2
Guaya	POTCOM	2.8	0.6
Guayabillo	POTCOM	208.6	22.5
Ixain	POTCOM	1.4	0.1
Izote de montaña	POTCOM	4.1	0.7
Jabin	POTCOM	63.5	5.2
Jaboncillo	POTCOM	38.7	7.5
Jobo	POTCOM	20.7	0.1
Laurel	POTCOM	476.5	17.1
Madre cacao	POTCOM	4.1	1.8
Manax	POTCOM	88.4	16.6
Manguillo	POTCOM	18	0
Manzanillo	POTCOM	6.9	1.2
Occhuul	POTCOM	0	0.3
Palo de agua	POTCOM	52.5	5.4
Palo de coche	POTCOM	33.1	1.8

Specie	Commercial Group	SEEDLING	SAPLIING
		No./Ha	No./Ha
Papaturrito	POTCOM	78.7	11.6
Papaturro	POTCOM	204.4	19.1
Pataxte	POTCOM	0	0.7
Pij	POTCOM	158.8	20.6
Pimienta	POTCOM	37.3	2.6
Pimientillo	POTCOM	5.5	0
Piñon	POTCOM	9.7	2.2
Pixoy	POTCOM	0	0.1
Putziquil	POTCOM	9.7	1
Quiebra hacha	POTCOM	6.9	1.1
Quisainche	POTCOM	53.9	5.9
Ramon blanco	POTCOM	22.1	1.4
Roble	POTCOM	22.1	2.5
Sacpaj	POTCOM	4.1	0.7
Saltemuche	POTCOM	69.1	4.3
Sapamuche	POTCOM	138.1	5.1
Silion	POTCOM	67.7	9.9
Sinanche	POTCOM	16.6	0.8
Siquiyaa	POTCOM	35.9	2.9
Soscha	POTCOM	0	0.3
Sosni	POTCOM	33.1	2.8
Subin	POTCOM	1.4	0.1
Sununte	POTCOM	0	0.1
Susuco	POTCOM	4.1	0.4
Testap	POTCOM	40.1	9.5
Tijerillo	POTCOM	26.2	0
Tinto	POTCOM	4.1	0.4
Tres marias	POTCOM	19.3	0.3
Tzuzul	POTCOM	0	1
Violeta serrana	POTCOM	1.4	0
Yaaxjochoc	POTCOM	1411.6	6.8
Yaxnik	POTCOM	71.8	5.1
Zacuayum	POTCOM	466.9	4.7
Zapotillo hoja ancha	POTCOM	59.4	6.2
Zapotillo hoja fina	POTCOM	461.3	34.1
Aceituno peludo	PROTEC	208.6	6.8
Achotillo	PROTEC	0	0.1
Amate	PROTEC	1.4	0.4
Anona de montaña.	PROTEC	2.8	0.7
Cafe silvestre	PROTEC	712.7	13.7
Cancetillo	PROTEC	4.1	0.1
Carboncillo	PROTEC	153.3	0.3
Carcomo	PROTEC	1.4	0
Cedrillo	PROTEC	1.4	0
Cericote	PROTEC	2.8	0.4
Chijoy	PROTEC	33.1	1
Chile chachalaca	PROTEC	5.5	2.2
Chintoc blanco	PROTEC	0	0.1
Chintoc negro	PROTEC	16.6	0.7
Chique	PROTEC	30.4	1
Ciruelillo	PROTEC	0	0.1
Cojon de caballo	PROTEC	11	2.6
Coloc	PROTEC	1.4	0.1

Specie	Commercial Group	SEEDLING	SAPLIING
		No./Ha	No./Ha
Colorin	PROTEC	1.4	0
Cuero de sapo	PROTEC	11	0.1
Flor amarilla	PROTEC	0	0.1
Granadillo	PROTEC	0	0.1
Guachapin	PROTEC	23.5	0.3
Guachipilin	PROTEC	0	0.1
Higo	PROTEC	6.9	0
Jaquiña	PROTEC	13.8	0.3
Jobillo	PROTEC	8.3	0.1
Julup	PROTEC	193.4	0.1
Lotoche	PROTEC	0	2.2
Mabeju	PROTEC	1.4	0
Majagua	PROTEC	4.1	1.2
Malerio blanco	PROTEC	1.4	0
Malerio colorado	PROTEC	6.9	0.3
Matilisguate	PROTEC	8.3	0
Molinillo	PROTEC	19.3	3.3
Morro	PROTEC	0	0.1
Naranjillo	PROTEC	24.9	0.3
Ocbat	PROTEC	0	0.1
Overo	PROTEC	0	0.1
Palo blanco	PROTEC	2.8	0.1
Palo de chombo	PROTEC	0	0.3
Palo de clavo	PROTEC	85.6	3.5
Palo de diente	PROTEC	5.5	0.3
Palo de hule	PROTEC	37.3	1.7
Palo de lagarto	PROTEC	0	0.1
Palo rojo	PROTEC	4.1	0.4
Pasaque hembra	PROTEC	29	2.8
Perezcuche	PROTEC	13.8	0.7
Pitanche	PROTEC	0	0.1
Quequeo	PROTEC	0	0.6
Ramon colorado	PROTEC	52.5	3.7
Ramon oreja de mico	PROTEC	6.9	0.7
Sacanche	PROTEC	15.2	0
Sacuche	PROTEC	2.8	0.4
Sastante	PROTEC	24.9	0.1
Sufricay	PROTEC	41.4	2.6
Tamaay	PROTEC	35.9	3.3
Tempisque	PROTEC	0	0.1
Tucuy	PROTEC	0	0.6
Verde lucero	PROTEC	4.1	0
Yaya	PROTEC	55.2	2.5
Zapote macho	PROTEC	9.7	0
Zapote mamey	PROTEC	1.4	0

ANNEX 5. Importance Value Index (IVI) of the species ≥ 25 cm DBH

No	Nombre	ABSOLUTE VALUES			RELATIVE VALUES			IVI	%
		A	D	F	AR	DR	FR	SUM	IVI
1	Chechen negro	13.308	1.098	686	15.784	13.518	12.477	41.779	13.926
2	Yaxnik	8.832	1.024	493	10.475	12.613	8.967	32.055	10.685
3	Chacaj colorado	8.155	0.638	516	9.672	7.862	9.385	26.92	8.973
4	Mano de leon	5.633	0.543	313	6.681	6.688	5.693	19.063	6.354
5	Chico zapote	4.552	0.564	298	5.399	6.949	5.42	17.769	5.923
6	Santa maria	3.537	0.392	241	4.195	4.827	4.383	13.406	4.469
7	Zacuayum	3.635	0.287	234	4.312	3.529	4.256	12.097	4.032
8	Catalox	2.576	0.244	214	3.056	3.004	3.892	9.952	3.317
9	Silion	2.38	0.225	169	2.823	2.773	3.074	8.669	2.89
10	Jobo	2.445	0.226	161	2.9	2.781	2.928	8.61	2.87
11	Quisainche	2.391	0.229	154	2.836	2.823	2.801	8.459	2.82
12	Caoba	1.954	0.207	152	2.318	2.544	2.765	7.627	2.542
13	Manchiche	1.889	0.177	133	2.24	2.177	2.419	6.836	2.279
14	Papaturro	1.648	0.13	132	1.955	1.598	2.401	5.954	1.985
15	Chacaj blanco	1.67	0.179	87	1.981	2.199	1.582	5.763	1.921
16	Palo de coche	1.452	0.139	102	1.722	1.715	1.855	5.292	1.764
17	Pasaque hembra	1.474	0.112	118	1.748	1.379	2.146	5.273	1.758
18	Pucte	1.124	0.136	65	1.334	1.678	1.182	4.194	1.398
19	Laurel	1.212	0.097	80	1.437	1.198	1.455	4.09	1.363
20	Zapotillo hoja ancha	0.917	0.078	75	1.088	0.961	1.364	3.412	1.137
21	Guacimo	0.939	0.071	78	1.114	0.873	1.419	3.406	1.135
22	Aceituno peludo	0.884	0.066	67	1.049	0.819	1.219	3.086	1.029
23	Testap	0.808	0.057	69	0.958	0.697	1.255	2.91	0.97
24	Tamaay	0.742	0.06	63	0.88	0.733	1.146	2.759	0.92
25	Amapola	0.666	0.089	46	0.79	1.099	0.837	2.725	0.908
26	Ramon blanco	0.459	0.07	38	0.544	0.858	0.691	2.093	0.698
27	Matapalo	0.48	0.066	39	0.57	0.81	0.709	2.089	0.696
28	Ramon oreja de mico	0.48	0.076	29	0.57	0.94	0.527	2.037	0.679
29	Zapotillo hoja fina	0.491	0.037	43	0.583	0.456	0.782	1.82	0.607
30	Higo	0.415	0.055	31	0.492	0.681	0.564	1.737	0.579
31	Pataxte	0.371	0.035	24	0.44	0.435	0.437	1.312	0.437
32	Jabin	0.306	0.029	23	0.363	0.36	0.418	1.14	0.38
33	Tinto	0.284	0.035	16	0.337	0.434	0.291	1.061	0.354
34	Madre cacao	0.273	0.022	24	0.324	0.272	0.437	1.032	0.344
35	Amate	0.207	0.039	16	0.246	0.482	0.291	1.019	0.34
36	Papaturrito	0.273	0.022	22	0.324	0.269	0.4	0.993	0.331
37	Copal	0.262	0.018	21	0.311	0.222	0.382	0.915	0.305
38	Ocbat	0.229	0.022	20	0.272	0.274	0.364	0.909	0.303
39	T'zalam	0.218	0.028	17	0.259	0.34	0.309	0.908	0.303
40	Zapote mamey	0.164	0.032	13	0.194	0.397	0.236	0.827	0.276
41	Saltemuche	0.218	0.014	19	0.259	0.176	0.346	0.781	0.26
42	Roble	0.186	0.018	17	0.22	0.224	0.309	0.753	0.251
43	Pitanche	0.164	0.026	13	0.194	0.317	0.236	0.747	0.249
44	Palo de hule	0.197	0.025	11	0.233	0.303	0.2	0.736	0.245
45	Manax	0.207	0.014	17	0.246	0.17	0.309	0.726	0.242
46	Palo de chombo	0.142	0.027	12	0.168	0.335	0.218	0.722	0.241
47	Cericote	0.131	0.014	11	0.155	0.169	0.2	0.524	0.175
48	Palo de zope	0.142	0.012	11	0.168	0.15	0.2	0.518	0.173
49	Hormigo	0.131	0.013	11	0.155	0.159	0.2	0.514	0.171
50	Sosni	0.109	0.018	8	0.129	0.223	0.146	0.498	0.166
51	Mabeju	0.131	0.013	9	0.155	0.154	0.164	0.473	0.158

No	Nombre	ABSOLUTE VALUES			RELATIVE VALUES			IVI	%
		A	D	F	AR	DR	FR	SUM	IVI
52	Putziquil	0.131	0.01	10	0.155	0.126	0.182	0.464	0.155
53	Ramon colorado	0.109	0.014	9	0.129	0.168	0.164	0.461	0.154
54	Baqueman	0.12	0.009	11	0.142	0.113	0.2	0.456	0.152
55	Siquiyaa	0.12	0.009	10	0.142	0.115	0.182	0.44	0.147
56	Zapote macho	0.098	0.011	8	0.117	0.133	0.146	0.395	0.132
57	Palo rojo	0.098	0.007	9	0.117	0.081	0.164	0.361	0.12
58	Pixoy	0.098	0.009	7	0.117	0.115	0.127	0.358	0.119
59	Chechen blanco	0.098	0.007	8	0.117	0.092	0.146	0.354	0.118
60	Quequeo	0.087	0.006	7	0.104	0.078	0.127	0.309	0.103
61	Guaya	0.076	0.005	7	0.091	0.06	0.127	0.278	0.093
62	Guatop	0.076	0.004	7	0.091	0.051	0.127	0.269	0.09
63	Granadillo	0.066	0.007	5	0.078	0.092	0.091	0.261	0.087
64	Jaboncillo	0.066	0.005	6	0.078	0.055	0.109	0.242	0.081
65	Chonte	0.066	0.004	6	0.078	0.046	0.109	0.233	0.078
66	Palo de lagarto	0.022	0.014	2	0.026	0.168	0.036	0.23	0.077
67	Tempisque	0.044	0.007	4	0.052	0.09	0.073	0.214	0.071
68	Jobillo	0.055	0.004	5	0.065	0.046	0.091	0.201	0.067
69	Palo espinudo	0.055	0.004	5	0.065	0.045	0.091	0.201	0.067
70	Chintoc negro	0.055	0.003	5	0.065	0.041	0.091	0.197	0.066
71	Chacpon	0.055	0.005	3	0.065	0.066	0.055	0.186	0.062
72	Palo blanco	0.044	0.005	4	0.052	0.059	0.073	0.184	0.061
73	Cortez	0.044	0.005	4	0.052	0.058	0.073	0.182	0.061
74	Guayabillo	0.044	0.005	4	0.052	0.057	0.073	0.182	0.061
75	Quiebra hacha	0.044	0.004	4	0.052	0.048	0.073	0.173	0.058
76	Cedro	0.044	0.005	3	0.052	0.065	0.055	0.172	0.057
77	Naranjillo	0.044	0.003	4	0.052	0.04	0.073	0.164	0.055
78	Ceiba	0.033	0.006	3	0.039	0.07	0.055	0.163	0.054
79	Pimientillo	0.044	0.002	4	0.052	0.029	0.073	0.154	0.051
80	Malerio colorado	0.033	0.004	3	0.039	0.055	0.055	0.149	0.05
81	Verde lucero	0.033	0.005	2	0.039	0.056	0.036	0.132	0.044
82	Pochote	0.033	0.003	3	0.039	0.035	0.055	0.129	0.043
83	Colorin	0.022	0.005	2	0.026	0.063	0.036	0.126	0.042
84	Chojche	0.033	0.002	3	0.039	0.027	0.055	0.121	0.04
85	Chilonche	0.033	0.002	3	0.039	0.026	0.055	0.119	0.04
86	Palo de rosa	0.033	0.003	2	0.039	0.042	0.036	0.117	0.039
87	Pimienta	0.033	0.002	3	0.039	0.021	0.055	0.115	0.038
88	Desconocido	0.033	0.003	2	0.039	0.036	0.036	0.111	0.037
89	Matilisguate	0.033	0.002	2	0.039	0.026	0.036	0.102	0.034
90	Danto	0.022	0.003	2	0.026	0.031	0.036	0.094	0.031
91	Chaltecoco	0.022	0.002	2	0.026	0.03	0.036	0.092	0.031
92	Ciruelillo	0.022	0.002	2	0.026	0.027	0.036	0.089	0.03
93	Morro	0.022	0.002	2	0.026	0.025	0.036	0.087	0.029
94	Malerio blanco	0.022	0.002	2	0.026	0.024	0.036	0.086	0.029
95	Occhuul	0.022	0.002	2	0.026	0.022	0.036	0.085	0.028
96	Cola de coche	0.022	0.002	2	0.026	0.021	0.036	0.083	0.028
97	Pij	0.022	0.001	2	0.026	0.017	0.036	0.08	0.027
98	Susuco	0.022	0.001	2	0.026	0.016	0.036	0.078	0.026
99	Conacaste	0.011	0.004	1	0.013	0.045	0.018	0.076	0.025
100	Quina	0.022	0.001	2	0.026	0.013	0.036	0.075	0.025
101	Pasaque macho	0.011	0.002	1	0.013	0.023	0.018	0.054	0.018
102	Overo	0.011	0.001	1	0.013	0.017	0.018	0.048	0.016
103	Cuero de sapo	0.011	0.001	1	0.013	0.014	0.018	0.045	0.015
104	Molinillo	0.011	0.001	1	0.013	0.012	0.018	0.043	0.014
105	Son	0.011	0.001	1	0.013	0.011	0.018	0.043	0.014

No	Nombre	ABSOLUTE VALUES			RELATIVE VALUES			IVI	%
		A	D	F	AR	DR	FR	SUM	IVI
106	San juan	0.011	0.001	1	0.013	0.011	0.018	0.042	0.014
107	Llama del bosque	0.011	0.001	1	0.013	0.011	0.018	0.042	0.014
108	Tzuzul	0.011	0.001	1	0.013	0.01	0.018	0.041	0.014
109	Guarumo	0.011	0.001	1	0.013	0.01	0.018	0.041	0.014
110	Chique	0.011	0.001	1	0.013	0.01	0.018	0.041	0.014
111	Cascario	0.011	0.001	1	0.013	0.01	0.018	0.041	0.014
112	Negrito	0.011	0.001	1	0.013	0.009	0.018	0.04	0.013
113	Flor amarilla	0.011	0.001	1	0.013	0.008	0.018	0.039	0.013
114	Flor de mayo	0.011	0.001	1	0.013	0.008	0.018	0.039	0.013
115	Sacpaj	0.011	0.001	1	0.013	0.008	0.018	0.039	0.013
116	Palo de agua	0.011	0.001	1	0.013	0.007	0.018	0.038	0.013
117	Cola de pava	0.011	0.001	1	0.013	0.007	0.018	0.038	0.013
118	Baquelac	0.011	0.001	1	0.013	0.007	0.018	0.038	0.013
119	Gesmo	0.011	0.001	1	0.013	0.007	0.018	0.038	0.013
120	Palo de diente	0.011	0.001	1	0.013	0.007	0.018	0.038	0.013
121	Sacanche	0.011	0.001	1	0.013	0.007	0.018	0.038	0.013

ANNEX 6. Size class distribution (cm) for Tree Population (No./Ha), Volume (m3/Ha), and Basal Area (m2/Ha) for POTCOM Species

Common name	COMMERCIAL GROUP	VARIABLE	SIZE CLASS IN CM									TOTAL
			10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>90	
Aceituno peludo	POT	N	0	0.5	0.4	0	0	0	0	0	0	0.9
		BA	0	0.026	0.034	0.006	0	0	0	0	0	0.066
		VOL	0	0.091	0.117	0.018	0	0	0	0	0	0.225
Aguacatillo	POT	N	0	0	0	0	0	0	0	0	0	0.1
		BA	0	0	0	0.001	0.002	0.01	0	0	0	0.013
		VOL	0	0	0	0.005	0	0.015	0	0	0	0.02
Amate	POT	N	0	0	0.1	0	0	0	0	0	0	0.2
		BA	0	0.001	0.007	0.007	0.01	0.007	0	0	0.007	0.039
		VOL	0	0	0.02	0.03	0.032	0.022	0	0	0.033	0.137
Baquelac	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0	0	0	0.001
		VOL	0	0	0	0	0	0	0	0	0	0
Baqueman	POT	N	0	0.1	0	0	0	0	0	0	0	0.1
		BA	0	0.003	0.004	0.002	0	0	0	0	0	0.009
		VOL	0	0.012	0.011	0.006	0	0	0	0	0	0.028
Caimito silvestre	POT	N	0	0	0	0	0	0	0	0	0	0.1
		BA	0	0	0.004	0.001	0	0	0	0	0	0.005
		VOL	0	0	0.012	0	0	0	0	0	0	0.012
Cascario	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.001	0	0	0	0	0	0	0.001
		VOL	0	0	0	0	0	0	0	0	0	0
Cascat	POT	N	0	0.1	0.1	0	0	0	0	0	0	0.2
		BA	0	0.004	0.008	0.003	0	0.003	0	0	0	0.018
		VOL	0	0.012	0.03	0.011	0	0	0	0	0	0.053
Ceiba	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0.004	0	0	0.006
		VOL	0	0.006	0	0	0	0	0.034	0	0	0.04
Cericote	POT	N	0	0	0.1	0	0	0	0	0	0	0.1
		BA	0	0.002	0.005	0.004	0.002	0	0	0	0	0.014
		VOL	0	0.007	0.011	0.014	0.007	0	0	0	0	0.039
Chacpon	POT	N	0	0	0	0	0	0	0	0	0	0.1
		BA	0	0.002	0.001	0	0.002	0	0	0	0	0.005
		VOL	0	0.006	0.003	0	0.014	0	0	0	0	0.022
Chaltecoc	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.001	0	0	0	0	0	0	0.001
		VOL	0	0	0.003	0	0	0	0	0	0	0.003
Chaltecoco	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0	0.001	0	0	0	0	0	0.001
		VOL	0	0	0	0.008	0	0	0	0	0	0.008
Chechen blanco	POT	N	0	0.1	0	0	0	0	0	0	0	0.1
		BA	0	0.003	0.003	0.002	0	0	0	0	0	0.007
		VOL	0	0.008	0.005	0.006	0	0	0	0	0	0.019

Common name	COMMERCIAL GROUP	VARIABLE	SIZE CLASS IN CM									TOTAL
			10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>90	
Chilonche	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.002	0	0	0	0	0	0	0.002
		VOL	0	0.003	0.005	0	0	0	0	0	0	0.008
Chintoc negro	POT	N	0	0	0	0	0	0	0	0	0	0.1
		BA	0	0.002	0.001	0	0	0	0	0	0	0.004
		VOL	0	0.01	0	0	0	0	0	0	0	0.01
Chique	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.001	0	0	0	0	0	0	0.001
		VOL	0	0	0.002	0	0	0	0	0	0	0.002
Chojche	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.002	0	0	0	0	0	0	0.002
		VOL	0	0	0.002	0	0	0	0	0	0	0.002
Chonte	POT	N	0	0.1	0	0	0	0	0	0	0	0.1
		BA	0	0.003	0.001	0	0	0	0	0	0	0.004
		VOL	0	0.008	0.003	0	0	0	0	0	0	0.01
Ciruelillo	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0.002	0	0	0	0	0	0.002
		VOL	0	0	0	0	0	0	0	0	0	0
Cola de pava	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0	0	0	0.001
		VOL	0	0.002	0	0	0	0	0	0	0	0.002
Colorin	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.001	0	0	0	0.004	0	0	0.005
		VOL	0	0	0.004	0	0	0	0.02	0	0	0.023
Conacaste	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0	0	0	0.004	0	0	0	0.004
		VOL	0	0	0	0	0	0.008	0	0	0	0.008
Copal	POT	N	0	0.1	0	0	0	0	0	0	0	0.1
		BA	0	0.005	0.002	0.001	0	0	0	0	0	0.008
		VOL	0	0.017	0.006	0.002	0	0	0	0	0	0.025
Copal colorado	POT	N	0	0.1	0.1	0	0	0	0	0	0	0.1
		BA	0	0.003	0.007	0	0	0	0	0	0	0.01
		VOL	0	0.009	0.02	0	0	0	0	0	0	0.03
Copo	POT	N	0	0.1	0.2	0.1	0	0	0	0	0	0.4
		BA	0	0.007	0.016	0.014	0	0.004	0.01	0	0	0.051
		VOL	0	0.015	0.019	0.015	0	0	0	0	0	0.049
Cortez	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.002	0.002	0	0	0	0	0	0.005
		VOL	0	0.002	0.006	0.006	0	0	0	0	0	0.014
Desconocido	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.003	0	0	0	0	0	0	0.003
		VOL	0	0	0.003	0	0	0	0	0	0	0.003
Flor amarilla	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0	0	0	0.001
		VOL	0	0.003	0	0	0	0	0	0	0	0.003
Flor de mayo	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0	0	0	0.001

Common name	COMMERCIAL GROUP	VARIABLE	SIZE CLASS IN CM									TOTAL
			10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>90	
		VOL	0	0.002	0	0	0	0	0	0	0	0.002
Gesmo	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0	0	0	0.001
		VOL	0	0.001	0	0	0	0	0	0	0	0.001
Granadillo	POT	N	0	0	0	0	0	0	0	0	0	0.1
		BA	0	0.001	0.004	0	0.002	0	0	0	0	0.007
		VOL	0	0.005	0.011	0	0	0	0	0	0	0.016
Guacimo	POT	N	0	0.5	0.4	0.1	0	0	0	0	0	0.9
		BA	0	0.027	0.033	0.011	0	0	0	0	0	0.071
		VOL	0	0.051	0.05	0.009	0	0	0	0	0	0.109
Guarumo	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.001	0	0	0	0	0	0	0.001
		VOL	0	0	0.003	0	0	0	0	0	0	0.003
Guatop	POT	N	0	0.1	0	0	0	0	0	0	0	0.1
		BA	0	0.004	0	0	0	0	0	0	0	0.004
		VOL	0	0.012	0	0	0	0	0	0	0	0.012
Guaya	POT	N	0	0.1	0	0	0	0	0	0	0	0.1
		BA	0	0.003	0.002	0	0	0	0	0	0	0.005
		VOL	0	0.01	0.006	0	0	0	0	0	0	0.016
Guayabillo	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.002	0.002	0	0	0	0	0	0.005
		VOL	0	0.002	0.007	0.009	0	0	0	0	0	0.018
Higo	POT	N	0	0.1	0.1	0.1	0.1	0	0	0	0	0.4
		BA	0	0.005	0.013	0.016	0.012	0.009	0	0	0	0.055
		VOL	0	0.006	0.018	0.032	0.027	0.013	0	0	0	0.096
Hormigo	POT	N	0	0	0	0	0	0	0	0	0	0.1
		BA	0	0.003	0.004	0.006	0	0	0	0	0	0.013
		VOL	0	0.012	0.017	0.024	0	0	0	0	0	0.052
Jabin	POT	N	0	0.1	0.2	0	0	0	0	0	0	0.3
		BA	0	0.006	0.016	0.005	0.003	0	0	0	0	0.029
		VOL	0	0.016	0.044	0.007	0.009	0	0	0	0	0.077
Jaboncillo	POT	N	0	0.001	0.003	0	0	0	0	0	0	0.004
		BA	0	0.004	0.008	0	0	0	0	0	0	0.012
		VOL	0	0	0	0	0	0	0	0	0	0.1
Jobo	POT	N	0	0.9	1.1	0.3	0.1	0	0	0	0	2.4
		BA	0	0.054	0.098	0.045	0.012	0.007	0.009	0	0	0.225
		VOL	0	0.169	0.291	0.154	0.05	0.038	0.05	0	0	0.752
Laurel	POT	N	0	0.6	0.5	0.1	0	0	0	0	0	1.2
		BA	0	0.032	0.044	0.014	0.007	0	0	0	0	0.097
		VOL	0	0.095	0.127	0.044	0.014	0	0	0	0	0.28
Llama del bosque	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.001	0	0	0	0	0	0	0.001
		VOL	0	0	0.003	0	0	0	0	0	0	0.003
Mabeju	POT	N	0	0	0.1	0	0	0	0	0	0	0.1
		BA	0	0.001	0.006	0.005	0	0	0	0	0	0.012
		VOL	0	0.003	0.023	0.011	0	0	0	0	0	0.037
Madre cacao	POT	N	0	0.1	0.1	0	0	0	0	0	0	0.3

Common name	COMMERCIAL GROUP	VARIABLE	SIZE CLASS IN CM									TOTAL
			10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>90	
		BA	0	0.008	0.011	0.003	0	0	0	0	0	0.022
		VOL	0	0.012	0.014	0.004	0	0	0	0	0	0.03
Manax	POT	N	0	0.1	0.1	0	0	0	0	0	0	0.2
		BA	0	0.008	0.006	0	0	0	0	0	0	0.014
		VOL	0	0.012	0.017	0	0	0	0	0	0	0.029
Matapalo	POT	N	0	0	0	0	0	0	0	0	0	0.1
		BA	0	0	0.002	0.002	0.002	0	0.008	0	0	0.015
		VOL	0	0	0.005	0	0.009	0	0.011	0	0	0.025
Molinillo	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.001	0	0	0	0	0	0	0.001
		VOL	0	0	0.004	0	0	0	0	0	0	0.004
Morro	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.002	0	0	0	0	0	0	0.002
		VOL	0	0	0	0	0	0	0	0	0	0
Naranjillo	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.003	0	0	0	0	0	0	0.003
		VOL	0	0	0.003	0	0	0	0	0	0	0.003
Negrito	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0	0	0	0.001
		VOL	0	0.002	0	0	0	0	0	0	0	0.002
Ocbat	POT	N	0	0.1	0.1	0.1	0	0	0	0	0	0.2
		BA	0	0.004	0.006	0.012	0	0	0	0	0	0.022
		VOL	0	0.015	0.019	0.036	0	0	0	0	0	0.07
Occhul	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.002	0	0	0	0	0	0	0.002
		VOL	0	0	0.009	0	0	0	0	0	0	0.009
Overo	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0	0.001	0	0	0	0	0	0.001
		VOL	0	0	0	0.005	0	0	0	0	0	0.005
Palo de agua	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0	0	0	0.001
		VOL	0	0	0	0	0	0	0	0	0	0
Palo de chombo	POT	N	0	0	0	0	0.1	0	0	0	0	0.1
		BA	0	0.001	0.001	0.006	0.013	0.006	0	0	0	0.027
		VOL	0	0.002	0.003	0.026	0.077	0.032	0	0	0	0.14
Palo de coche	POT	N	0	0.4	0.8	0.2	0	0	0	0	0	1.4
		BA	0	0.023	0.07	0.035	0.007	0.003	0	0	0	0.139
		VOL	0	0.027	0.071	0.014	0.017	0.009	0	0	0	0.138
Palo de diente	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0	0	0	0.001
		VOL	0	0.002	0	0	0	0	0	0	0	0.002
Palo de hule	POT	N	0	0.1	0.1	0	0	0	0	0	0	0.2
		BA	0	0.003	0.007	0.003	0.005	0.007	0	0	0	0.025
		VOL	0	0.01	0.022	0.016	0.026	0.029	0	0	0	0.103
Palo de rosa	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.001	0.002	0	0	0	0	0	0.003
		VOL	0	0.002	0.003	0.006	0	0	0	0	0	0.012

Common name	COMMERCIAL GROUP	VARIABLE	SIZE CLASS IN CM									TOTAL
			10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>90	
Palo de sapo	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.001	0	0	0	0	0	0	0.001
		VOL	0	0	0.004	0	0	0	0	0	0	0.004
Palo de zope	POT	N	0	0	0.1	0	0	0	0	0	0	0.1
		BA	0	0.002	0.008	0.002	0	0	0	0	0	0.012
		VOL	0	0.002	0.021	0.006	0	0	0	0	0	0.027
Palo espinudo	POT	N	0	0	0	0	0	0	0	0	0	0.1
		BA	0	0.002	0.002	0	0	0	0	0	0	0.004
		VOL	0	0.007	0.006	0	0	0	0	0	0	0.013
Palo rojo	POT	N	0	0.1	0	0	0	0	0	0	0	0.1
		BA	0	0.004	0.003	0	0	0	0	0	0	0.007
		VOL	0	0.014	0.008	0	0	0	0	0	0	0.021
Papaturrito	POT	N	0	0.1	0.1	0	0	0	0	0	0	0.3
		BA	0	0.007	0.01	0.005	0	0	0	0	0	0.022
		VOL	0	0.02	0.028	0.014	0	0	0	0	0	0.061
Papaturro	POT	N	0	0.9	0.6	0.1	0	0	0	0	0	1.6
		BA	0	0.052	0.051	0.014	0.008	0.004	0	0	0	0.13
		VOL	0	0.092	0.095	0.021	0	0	0	0	0	0.208
Pasaque hembra	POT	N	0	0.7	0.6	0.1	0	0	0	0	0	1.5
		BA	0	0.041	0.053	0.016	0.002	0	0	0	0	0.112
		VOL	0	0.138	0.167	0.052	0.011	0	0	0	0	0.368
Pasaque macho	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0	0.002	0	0	0	0	0	0.002
		VOL	0	0	0	0.007	0	0	0	0	0	0.007
Pataxte	POT	N	0	0.1	0.1	0.1	0	0	0	0	0	0.2
		BA	0	0.003	0.006	0.008	0	0	0	0	0	0.017
		VOL	0	0.002	0.004	0.015	0	0	0	0	0	0.021
Pij	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.001	0	0	0	0	0	0	0.001
		VOL	0	0.002	0.003	0	0	0	0	0	0	0.005
Pimienta	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.002	0	0	0	0	0	0	0	0.002
		VOL	0	0	0	0	0	0	0	0	0	0
Pimientillo	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.002	0	0	0	0	0	0	0	0.002
		VOL	0	0.011	0	0	0	0	0	0	0	0.011
Pitanche	POT	N	0	0	0	0	0	0	0	0	0	0.1
		BA	0	0.001	0.002	0.001	0	0.007	0.004	0	0	0.015
		VOL	0	0	0	0	0	0	0	0	0	0
Pixoy	POT	N	0	0	0	0	0	0	0	0	0	0.1
		BA	0	0.002	0.004	0.002	0.002	0	0	0	0	0.009
		VOL	0	0.004	0.007	0	0.002	0	0	0	0	0.013
Pochote	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.001	0.001	0	0	0	0	0	0.003
		VOL	0	0.002	0	0.005	0	0	0	0	0	0.008
Poxiquil	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0	0	0	0.001

Common name	COMMERCIAL GROUP	VARIABLE	SIZE CLASS IN CM									TOTAL
			10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>90	
		VOL	0	0.002	0	0	0	0	0	0	0	0.002
Putziquil	POT	N	0	0.1	0	0	0	0	0	0	0	0.1
		BA	0	0.004	0.003	0.003	0	0	0	0	0	0.01
		VOL	0	0.01	0.008	0.009	0	0	0	0	0	0.027
Quequeo (quitanche)	POT	N	0	0.1	0	0	0	0	0	0	0	0.1
		BA	0	0.004	0.001	0.002	0	0	0	0	0	0.007
		VOL	0	0.004	0	0	0	0	0	0	0	0.004
Quiebra hacha	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.003	0	0	0	0	0	0	0.004
		VOL	0	0.002	0.011	0	0	0	0	0	0	0.013
Quina	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0	0	0	0.001
		VOL	0	0	0	0	0	0	0	0	0	0
Quitanche	POT	N	0	0.7	1.2	0.4	0.1	0	0	0	0	2.5
		BA	0	0.041	0.112	0.061	0.019	0.007	0	0	0	0.24
		VOL	0	0.012	0.027	0.004	0.01	0	0	0	0	0.053
Ramon blanco	POT	N	0	0.2	0.1	0.1	0.1	0	0	0	0	0.5
		BA	0	0.01	0.01	0.009	0.019	0.014	0.005	0.006	0	0.072
		VOL	0	0.021	0.034	0.034	0.06	0.051	0.013	0.017	0	0.23
Ramon colorado	POT	N	0	0	0	0	0	0	0	0	0	0.1
		BA	0	0.002	0.003	0.004	0.005	0	0	0	0	0.014
		VOL	0	0.006	0.007	0.006	0.007	0	0	0	0	0.025
Ramon oreja de mico	POT	N	0	0	0.2	0.1	0.1	0	0	0	0	0.5
		BA	0	0.003	0.014	0.02	0.015	0.006	0.009	0	0.007	0.075
		VOL	0	0	0.016	0.041	0.037	0.013	0.025	0	0	0.131
Roble	POT	N	0	0	0.1	0	0	0	0	0	0	0.2
		BA	0	0.002	0.009	0.007	0	0	0	0	0	0.018
		VOL	0	0.005	0.01	0.011	0	0	0	0	0	0.026
Sacanche	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0	0	0	0.001
		VOL	0	0.002	0	0	0	0	0	0	0	0.002
Sacpaj	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0	0	0	0	0	0	0.001
		VOL	0	0.003	0	0	0	0	0	0	0	0.003
Sacuayun	POT	N	0	0.8	0.9	0	0	0	0	0	0	1.8
		BA	0	0.048	0.079	0.007	0.003	0.003	0	0	0	0.139
		VOL	0	0.158	0.256	0.033	0	0.011	0	0	0	0.457
Saltemuche	POT	N	0	0.1	0.1	0	0	0	0	0	0	0.2
		BA	0	0.007	0.006	0.001	0	0	0	0	0	0.014
		VOL	0	0.026	0.022	0.009	0	0	0	0	0	0.057
San juan	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.001	0	0	0	0	0	0	0.001
		VOL	0	0	0.003	0	0	0	0	0	0	0.003
Silion	POT	N	0	0.7	1.3	0.2	0.1	0	0	0	0	2.4
		BA	0	0.041	0.115	0.038	0.024	0.007	0	0	0	0.225
		VOL	0	0.121	0.405	0.121	0.082	0.016	0	0	0	0.745
Siquiya	POT	N	0	0	0	0	0	0	0	0	0	0

Common name	COMMERCIAL GROUP	VARIABLE	SIZE CLASS IN CM									TOTAL
			10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>90	
		BA	0	0.003	0.002	0	0	0	0	0	0	0.005
		VOL	0	0.004	0.006	0	0	0	0	0	0	0.01
Son	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.001	0	0	0	0	0	0	0.001
		VOL	0	0	0.004	0	0	0	0	0	0	0.004
Sosni	POT	N	0.001	0	0.004	0.005	0	0	0	0	0	0.01
		BA	0	0	0	0	0	0	0	0	0	0
		VOL	0	0.002	0.002	0.002	0	0	0	0	0	0.005
Susuco	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.001	0	0	0	0	0	0	0.001
		VOL	0	0	0.003	0	0	0	0	0	0	0.003
Tamaay	POT	N	0	0.1	0.3	0	0	0	0	0	0	0.4
		BA	0	0.02	0.031	0.008	0	0	0	0	0	0.06
		VOL	0	0.07	0.103	0.041	0	0	0	0	0	0.214
Tempisque	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0	0.002	0.005	0	0	0	0	0.007
		VOL	0	0.003	0	0.006	0.016	0	0	0	0	0.024
Testap	POT	N	0	0.4	0.3	0	0	0	0	0	0	0.7
		BA	0	0.023	0.026	0.003	0	0	0	0	0	0.051
		VOL	0	0.069	0.059	0.007	0	0	0	0	0	0.135
Testap rojo	POT	N	0	0.1	0	0	0	0	0	0	0	0.1
		BA	0	0.003	0.002	0	0	0	0	0	0	0.005
		VOL	0	0.003	0.004	0	0	0	0	0	0	0.007
Tinto	POT	N	0	0.1	0.1	0.1	0	0	0	0	0	0.3
		BA	0	0.005	0.011	0.009	0.005	0	0	0.005	0	0.035
		VOL	0	0.002	0	0	0	0	0	0	0	0.002
Tzalam	POT	N	0	0	0.1	0.1	0	0	0	0	0	0.2
		BA	0	0.003	0.01	0.008	0	0	0	0	0.007	0.028
		VOL	0	0.009	0.029	0.019	0	0	0	0	0	0.057
Tzuzul	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0.001	0	0	0	0	0	0	0.001
		VOL	0	0	0.003	0	0	0	0	0	0	0.003
Yaaxjochoc	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0	0	0	0	0	0	0	0	0
		VOL	0.001	0	0	0	0	0	0	0	0	0.001
Yaxnic	POT	N	0	2.1	3.6	2.1	0.6	0.2	0.1	0	0	8.7
		BA	0	0.121	0.332	0.31	0.137	0.065	0.03	0.023	0	1.018
		VOL	0	0.218	0.517	0.414	0.076	0.038	0.014	0.009	0	1.284
Yoxche	POT	N	0	0	0	0	0	0	0	0	0	0
		BA	0	0.001	0.003	0	0	0	0	0	0	0.004
		VOL	0	0	0.01	0	0	0	0	0	0	0.01
Zacuayum	POT	N	0	0.7	0.9	0.1	0	0	0	0	0	1.8
		BA	0	0.042	0.085	0.02	0	0	0	0	0	0.146
		VOL	0	0.14	0.298	0.047	0	0	0	0	0	0.485
Zapote macho	POT	N	0	0.1	0	0	0	0	0	0	0	0.1
		BA	0	0.004	0.002	0	0	0	0	0.005	0	0.01
		VOL	0	0.012	0.002	0	0	0	0	0.018	0	0.032

Common name	COMMERCIAL GROUP	VARIABLE	SIZE CLASS IN CM									TOTAL
			10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>90	
Zapote mamey	POT	N	0	0	0.1	0	0	0	0	0	0	0.2
		BA	0	0.001	0.005	0.006	0.003	0.004	0	0.005	0.007	0.032
		VOL	0	0.005	0.02	0.029	0.01	0.019	0	0.025	0.045	0.154
Zapotillo hoja ancha	POT	N	0	0.4	0.4	0.1	0	0	0	0	0	0.9
		BA	0	0.024	0.034	0.017	0.002	0	0	0	0	0.078
		VOL	0	0.058	0.055	0.012	0.006	0	0	0	0	0.131
Zapotillo hoja fina	POT	N	0	0.2	0.2	0	0	0	0	0	0	0.5
		BA	0	0.012	0.019	0.003	0.002	0	0	0	0	0.036
		VOL	0	0.029	0.04	0.004	0	0	0	0	0	0.073

Annex 7. Glossary of Registered Species & Common Names

No	Commercial Group	Species		
		Common Name (Guatemala)	Common Name (Belize)	Scientific Name
1	ACT	Amapola	Mapola	*Pseudobombax ellipticum*
2	POT	Baquelac		*Laetia thamnia*
3	POT	Baqueman		
4	POT	Botoncillo		
5	AAA	Caoba	Mahogany	*Swietenia macrophylla*
6	POT	Cascario		
7	ACT	Catalox		*Swartzia lundellii*
8	ACT	Chacaj blanco		*Bursera graveolens*
9	ACT	Chacaj colorado	Red Gombolimbo	*Bursera simaruba*
10	POT	Chacpon		
11	POT	Chaltecoco		*Caesalpinia velutina*
12	POT	Chechen blanco		*Sebastiana Longicuspis*
13	ACT	Chechen negro	Black Poisonwood,	*Metopium brownei*
14	ACT	Chico zapote	sapodilla	*Manilkara zapota*
15	POT	Chilonche		*Eugenia capuli*
16	POT	Chojche		
17	POT	Chonte	Grande betty	*Cupania macrophylla*
18	POT	Copal	Copal	*Protium Copal*
19	POT	Cortez		*Tabebuia ochracea*
20	POT	Desconocido		
21	POT	Frijolillo		
22	POT	Gesmo		*Lysiloma sp.*
23	POT	Guacimo		
24	POT	Guatop		
25	POT	Guaya		*Talisia olivaeformis*
26	POT	Guayabillo		*Colubrina hetereneura*
27	POT	Jabin	Dogwood	*Piscidia piscipula*
28	POT	Jaboncillo		
29	POT	Jobo	Hog plum	*Spondias mombin*
30	POT	Laurel	salmwood	*Cordia alliodora*
31	POT	Madre cacao	Madre cacao	Gliricidia sepium
32	POT	Manax	Cherry	*Pseudolmedia panamensis*
33	ACT	Manchiche	Black Cabbage Bark	*Lonchocarpus castilloi*
34	ACT	Mano de leon	White Gombolimbo	*Dendropanax arboreum*
35	POT	Manzanillo		
36	POT	Occhuul		
37	POT	Palo de agua		
38	POT	Palo de coche		
39	POT	Papaturrito		*Coccoloba reflexiflora.*
40	POT	Papaturro	Wild grape	*Coccoloba sp.*
41	POT	Pasaque hembra	Negrito	*Simarouba glauca.*
42	POT	Pataxte		
43	POT	Pij		*Gymnanthes lucida*

No	Commercial Group	Species		
		Common Name (Guatemala)	Common Name (Belize)	Scientific Name
44	POT	Pimienta	black pepper	*Pimenta dioca*
45	POT	Pimientillo		
46	POT	Piñon		*Jatropa curcas*
47	POT	Pixoy	Bay Cedar	Guazuma ulmifolia
48	ACT	Pucte	Bullet tree	*Bucida buceras*
49	POT	Putziquil		Farmea occidentalis
50	POT	Quiebra hacha		
51	POT	Quisainche		
52	POT	Ramon blanco	breadnut	*Brosimum alicastrum*
53	POT	Roble		*Cordia sp.*
54	POT	Sacpaj		*Byrsonima sp.*
55	POT	Saltemuche		*Sickingia salvadorensis*
56	ACT	Santa maria	leche maria, santa maria	*Calophyllum brasiliense*
57	POT	Sapamuche		
58	POT	Silion	Silion, Silly Young	*Pouteria amigdalina*
59	POT	Siquiyaa	Wild star apple	*Crysophyllum mexicanum*
60	POT	Sosni		*Ocotea lundellii*
61	POT	Susuco		
62	POT	Testap	Glassy wood	*Guettarda combsii*
63	POT	Tinto	Logwood	Haematoxylon campechianum
64	POT	Tzuzul		
65	POT	Yaaxjochoc		*Vitex Sp.*
66	POT	Yaxnik	Fiddlewood, Yashnik	*Vitex gaumeri*
67	POT	Zacuayum		*Matayba oppositifolia*
68	POT	Zapotillo hoja ancha	Mammee Ciruela	*Pouteria sp*
69	POT	Zapotillo hoja fina	Zapotillo	*Pouteria reticulata*
70	PROTEC	Aceituno peludo	Pigeon plum	*Hirtella americana*
71	PROTEC	Aguacatillo		
72	PROTEC	Amate	Fig tree	*Ficus sp.*
73	PROTEC	Anona de montaña		*Anona souamosa.*
74	PROTEC	Cafe silvestre		
75	PROTEC	Cancetillo		
76	PROTEC	Cantemo		
77	PROTEC	Carboncillo		Cupania Guatemalensis
78	PROTEC	Carcomo		
79	PROTEC	Cedrillo		*Guatteria leiophylla*
80	PROTEC	Cedrillo hoja fina		*Guarea tonduzii*
81	PROTEC	Cedro	Cedar	*Cedrela odorata*
82	PROTEC	Ceiba	Cotton, ceiba	*Ceiba pentandra*
83	PROTEC	Cericote	Ziritcote	*Cordia dodecandra*
84	PROTEC	Chijoy		
85	PROTEC	Chile chachalaca		*Allophylus sp.*
86	PROTEC	Chintoc blanco		*Wimmeria concolor*
87	PROTEC	Chintoc negro		*Krugiodendrum ferreum*
88	PROTEC	Chique		*Ternstroemia tepezapote*

No	Commercial Group	Species		
		Common Name (Guatemala)	Common Name (Belize)	Scientific Name
89	PROTEC	Ciruelillo		
90	PROTEC	Cojon de caballo	Horseballs	*Stemmadenia donnell-smithii*
91	PROTEC	Cola de coche		*Pithecelobium arboreum*
92	PROTEC	Cola de pava		
93	PROTEC	Coloc		Talisia Floresii
94	PROTEC	Colorin		Ormosia toledoana
95	PROTEC	Conacaste	Guanacaste	*Enterolobium cyclocarpum*
96	PROTEC	Copo		*Coussapoa sp.*
97	PROTEC	Cuero de sapo		
98	PROTEC	Danto	Bitter Wood	*Vitairea lundellii*
99	PROTEC	Flor amarilla		
100	PROTEC	Flor de chombo	Frangipani	*Plumria Sp.*
101	PROTEC	Flor de mayo	May flower	*Tabebuia pentaphylla*
102	PROTEC	Granadillo		Platymiscium yucatanum
103	PROTEC	Guachapin		
104	PROTEC	Guachipilin		
105	PROTEC	Guarumo		*Cecropia obtusifolia.*
106	PROTEC	Higo		
107	PROTEC	Hormigo		*Platymiscium dimorphandrum*
108	PROTEC	Hule		Castilla elastica
109	PROTEC	Jaquiña		
110	PROTEC	Jobillo	glassywood, Jobillo	*Astronium graveolens*
111	PROTEC	Julup		
112	PROTEC	Llama del bosque		
113	PROTEC	Locche		
114	PROTEC	Lotoche		
115	PROTEC	Luin hembra	Female bullhoof	*Ampelocera hottlei*
116	PROTEC	Mabeju		
117	PROTEC	Majagua		
118	PROTEC	Malerio blanco	White Mylady	*Aspidosperma stegomeris*
119	PROTEC	Malerio colorado	Mylady	*Aspidosperma megalocarpon*
120	PROTEC	Manazanillo		
121	PROTEC	Matapalo	Fig	*Ficus sp.*
122	PROTEC	Matilisguate		*Tabeuia Rosea*
123	PROTEC	Molinillo		*Quararibea fieldii*
124	PROTEC	Mora		
125	PROTEC	Morro	Calabash	crecdentia cujete.
126	PROTEC	Nance	craboo	*Byrsonima crassifolia*
127	PROTEC	Naranjillo		*Zanthoxylum elephantiasis*
128	PROTEC	Negrito		
129	PROTEC	Ocbat		*Pithecolobium tonduzzi*
130	PROTEC	Overo		
131	PROTEC	Palo blanco		
132	PROTEC	Palo de chombo		
133	PROTEC	Palo de clavo		Rosedendron denell-smithii
134	PROTEC	Palo de diente		Trichila glabra

No	Commercial Group	Species		
		Common Name (Guatemala)	Common Name (Belize)	Scientific Name
135	PROTEC	Palo de gusano		Lonchucarpus guatemalensis
137	PROTEC	Palo de lagarto		Zanthoxylum belizanse
138	PROTEC	Palo de rosa		
139	PROTEC	Palo de zope		
140	PROTEC	Palo espinudo		*Mosquitoxylon jamaicense*
141	PROTEC	Palo rojo		
142	PROTEC	Pasaque macho		Mosquitoxylon jamaicense
143	PROTEC	Perezcuche		
144	PROTEC	Pitanche		
145	PROTEC	Pito		
146	PROTEC	Pochote		*Bombacopsis sp.*
147	PROTEC	Quequeo		
148	PROTEC	Quina	Pigeon plum	*Quiina schippii*
149	PROTEC	Ramon colorado	Red breadnut	*Trophis racemosa*
150	PROTEC	Ramon oreja de mico	Bread nut	*Brosimum costaricanum*
151	PROTEC	Sacanche		
152	PROTEC	Sacuche	Hinge Hinge	*Vochysia hondurensis*
153	PROTEC	Sajap	Pole wood	*Xilopia frutescens*
154	PROTEC	San juan	Wild mammee	*Alseis yucatanensis*
155	PROTEC	Sastante		Xilopia frutescens
156	PROTEC	Son	Waterwood	*Zuelania guidonia*
157	PROTEC	Sufricay		*Bumelia mayana*
158	PROTEC	Tama-hay		Zuelania guidonia
159	PROTEC	Tempisque		*Matechondendron capiri var tempisque*
160	PROTEC	Tucuy		
161	PROTEC	Tzalam	Tsalam	*Lysiloma bahamensis*
162	PROTEC	Verde lucero		
163	PROTEC	Yaje		
164	PROTEC	Yalpac	Lance Wood, Wild Soursop	*Malmea depressa*
165	PROTEC	Yaxche		
166	PROTEC	Yaya		Mlmea deprresa
167	PROTEC	Zapote macho		Pauteria Reticulata
168	PROTEC	Zapote mamey		*Pauteria Mamosa*
169	PROTEC	Zapuyul		

ANNEX 8. Field Guide for Diagnostic Sampling

Using the commercial Census lanes, data will be collected from the diagnostic sampling conducted in the Annual Harvest Units. The sampling method will be random distribution and stratified lines. The number of sampling plots to be established will be 300-500, each plot measuring 10m x 10m (0.01ha) and 3-5 lineal kilometers or 3-5 hectares for stratum. A map will be designed to demonstrate the lines where sampling plots will be located.

ANNEX 9. Field Guide for Selecting Desirable Tree Species

In order to effectively implement diagnostic sampling, it's important to have a basic understanding of the methodology used to select an individual (tree, pole timber, sapling or seedling). The following steps will be used to select an outstanding individual:

Step 1: Selection of a Desirable Tree

The tree to be selected has to be the best tree present of the arboreal species with commercial value that meets the standards of an outstanding desirable tree, which means an individual should have the following characteristics:

1. Many times the tallest, straightest, and largest diameter among the commercially desirable trees within the 10m x 10m plot.
2. A DBH greater than 25cm, but preferably less than the MCD.
3. A single, healthy, straight shaped trunk at least three meters long, free of defects, deformations or large knots. The incline on verticals should not exceed 20°.
4. A well-formed and vigorous crown.

Step 2: Selection of Desirable Pole Timber

Desirable pole timber is found when a plot does not contain any tree acceptable as an outstanding desirable individual but contains individuals that have an appropriate trunk with an estimated10cm to 24.9cm of dap.

Step 3: Selection of Desirable Saplings

If a plot does not contain any appropriate pole timber for selection, it becomes necessary to choose among the best saplings with the following characteristics:

- Specie of commercial value.
- Between 5cm and 9.9cm dap.
- A single, straight, healthy trunk, free of defects and deformations.
- Without heavy branches.

- A well-formed and vigorous crown.

Step 4: Selection of Desirable Seedlings

If a plot does not contain any desirable trees, pole timber, or saplings, it becomes necessary to substitute the lack of desirable individuals with desirable seedlings possessing the following characteristics:

- Specie of commercial value.
- Height exceeds 30cm.
- DBH of less than 4.9cm.
- Trunk without damage or visible defects.
- A well-formed and vigorous crown.

Step 5: Absence of Desirables

When a plot does not contain any outstanding desirables, technically, it's unoccupied. The following is registered:

1. The plot area is considered potentially productive. This finding is important as it indicates the proportion of ample forest to potentially productive forest area.
2. If the area is found to be unoccupied due to inhospitable conditions, the plot is considered permanently unproductive.

The intensity of illumination is always measured at the center of the plot.

For more information, please reference Figure 3 below.

ANNEX 10. IMPLEMENTATION OF THE DIAGNOSTIC SAMPLING

The diagnostic sampling will be implemented using the commercial census belts indicated on the census map. Sticks with flagging tape will be set at every 10m, beginning from the principal trail established. The sticks marked with flagging tape, indicating the line number and the distance of the trail, will facilitate the data to be collected. The trail openers will have to be careful not to cut the seedlings of commercial species.

The specie expert identifiers (baquianos) have to identify the trees over the MCD inside the plot by measuring the diameter. The technician will register collected data and determine the trunk quality and the commercial height of the tree or trees > the MCD. The baquiano, along with the technician, are to identify and select the outstanding desirable trees, taking into consideration the 5 steps previously listed. The data collected using the 5-step process will be registered and the category will be indicated (tree, pole timber, sapling, seedling), including if there are no individuals found in any category. If it corresponds, the baquiano will take the DBH of the outstanding individual and the technician will determine the illumination class and the lianas presence.

It is very important to make certain the proper standards are met when selecting an outstanding desirable tree.

Priority is given to the presence of mahogany. However, that will only be possible if the outstanding desirable tree in a plot belongs to the same diametric range or category (tree, pole timber, sapling and seedling). For example, if a mahogany is found and classified as a sapling (between 5 and 9.9 cm dap) and a Santa Maria is found and classified as pole timber (between 10 and 24.9 cm dap), then the Santa Maria pole timber will be chosen as the outstanding desirable individual. However, if the two individuals were categorized as pole timber, then the desirable individual will be the mahogany.

To help facilitate the selection process when there is more than one outstanding desirable individual of same diametric range or category in the same plot, the following priority groupings have been made to divide and organize the commercial species:

FIRST	**SECOND**	**THIRD**
1. Caoba	1. Santa maría	1. Danto
2. Cedro	2. Cola de coche	2. Canxán
3. Manchiche	3. Amapola	3. San Juan
	4. Jobillo	4. Plumajillo
	5. Hormigo	5. Malerio colorado
	6. Rozul	6. Malerio blanco
	7. Cericote	

ANNEX 11. Sample Data Sheet No. 3 (Sampling Diagnosis)

Names of the place:
Date:
No. of working group:
Person in charge of identifying (*identification*):
Person in charge of writing down the information on the data sheet:

No. of Lines or Trails: Based on the inventory design map, the number of the trail is indicated where the sampling is carried out.

FROM: The distance in meters from the beginning of each datasheet of the Diagnostic Sampling
TO: The distance in meters up to where the registered data in the respective datasheet finished.

Distances Along the Line: Distances in the line where each plot of 10m x 10m is located:

FROM: The distances on the line where the plot begins
UNTIL: The distances on the line up to where the plot finishes.

Forest Type Code:

1. High

2. Medium
3. Low
4. Very low.

Inventory of Harvesting Trees: The data is indicated from the biggest trees to the MCD inside each of the plots:

Common Names: The common names of the species. In case a tree over the MCD is found , write "9".

DAP: The diameter in cm, to a height of 1.30m above the floor

Trunk Quality (1 - 6): The same qualification used in the inventory sampling plots will be applied.

Commercial Height: In the same way as in the sampling plots of the inventory.

Inventory Outstanding Desirable Individuals: Refers to the best individual below the MCD based on quality and vigor; considered the future harvest potential.

Type: indicates the individual's category:

1 - tree (of > 25 cm dap)
2 - Pole timber (> 10 cm and < 25 cm dap)
3 - Sapling (> 5 cm and < 10 cm dap)
4 - Seedling (> 30 cm height and < 5 cm dap)
9 - Where no Desirable individual was found (In this case, to estimate the intensity of illumination in the center of the plot).

Name of Outstanding Desirable Individual: The common name of the outstanding desirable tree is indicated. If no outstanding desirable individuals are found, the plot will be labeled with a (P) for productive or (NP) for unproductive.

DAP: The diameter in cm, without fractions.

Illumination of the Crown: It refers to the direct illumination the crown receives (please reference Figure 4 below) in the following ways:

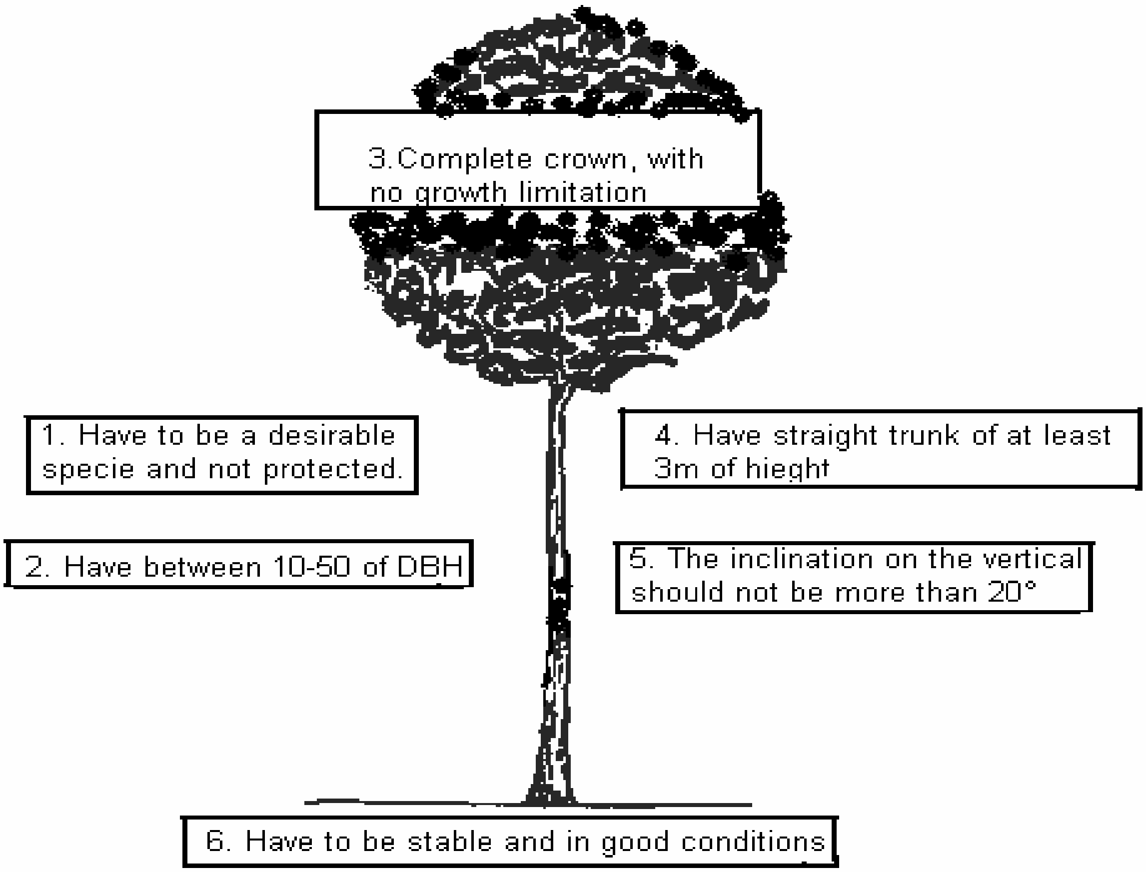
1. Emergent: Tree crown totally free.
2. Full vertical: Receives vertical light directly.
3. Vertical Partially: Receives little vertical light directly.
4. Oblique illumination: Receives lateral light directly, not more (near a clearing).
5. Nothing Direct: No direct light received; individual is surrounded and totally covered.

Lianas: refers to the presence of woody aerial roots that could affect the growth of the Desirable Tree:

1. Not visible on the trunk and crown
2. Loose in the trunk, but not present on the crown
3. Loose in the trunk, present in the crown or excising only in the crown
4. Pressing the trunk; present or not existent in the crown

Observations: Any obstacles or vegetation (i.e. palms) that affects regeneration and restoration of a plot's area.

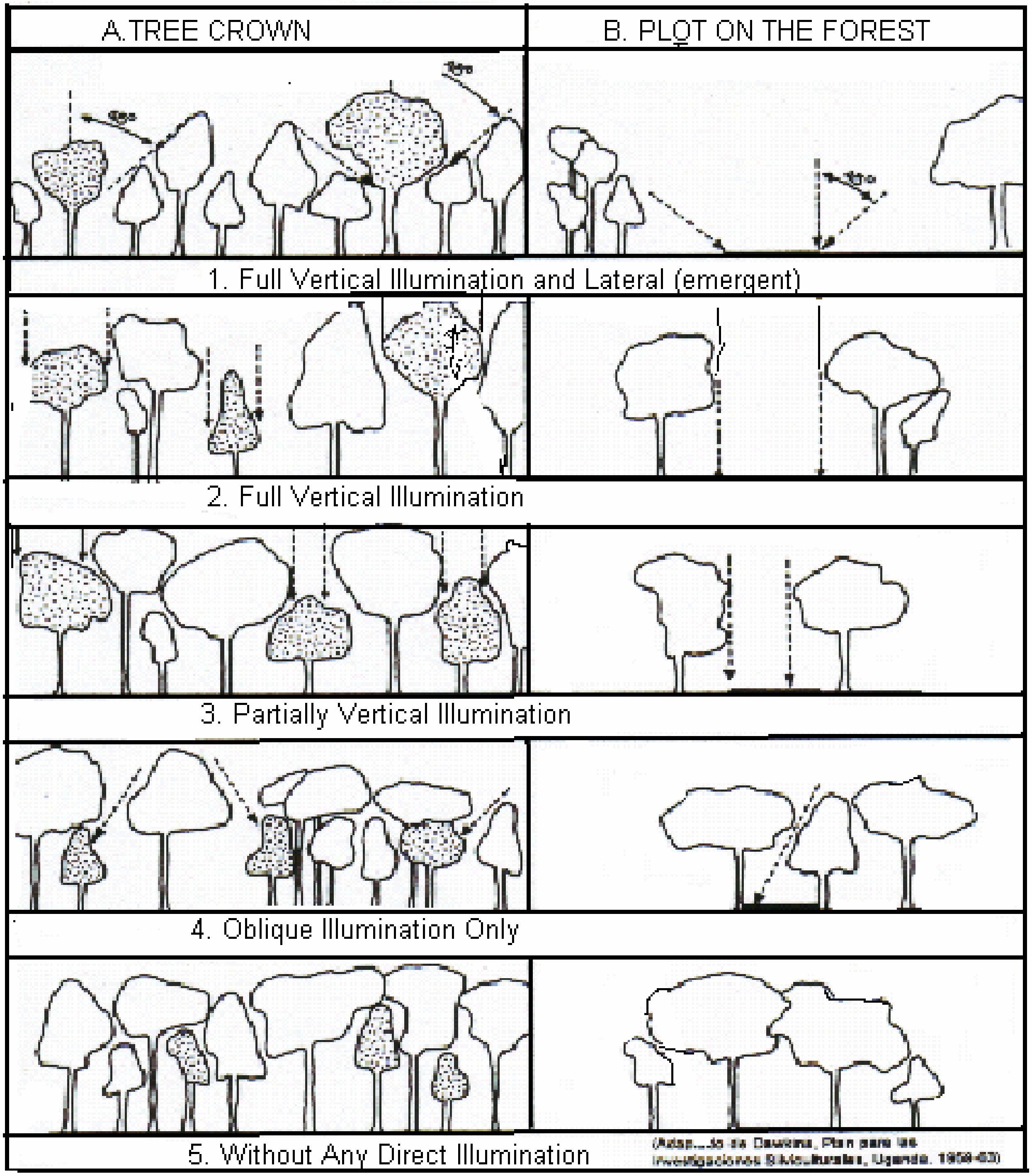
Figure No. 4. Outstanding Desirable Tree



ANNEX 12: Analysis of Information

For proper interpretation of the diagnostic sampling results, the methodology proposed by Stanley, 1998, outlined in Technical Document 9 for the Collective Forest Management of the Mayan Biosphere Reserve (CATIE-CONAP), can be applied. This applied methodology reveals how diagnostic sampling can be a very useful tool in making silvicultural decisions. The triangular interpretation during diagnosis sampling can give true insight into effective silvicultural activities of post-harvesting mitigation efforts.

Figure No. 4. Illumination Type & Crown Position (Huchinson 1993)



ANNEX 13. Sample Field Data Sheet for Lineal Diagnostic Sampling **PLOT 10 x 10 m**

Place name: ____________________ **No. of working group:** _____**Date:** ________________
Identificador: ________________________ **Anotador:** ______________________________
No. of lane: ____________ **From:** ____________ **m** **To:** ___________ **m**

Distance along The Línea		**Forest Type 1, 2 3, 4**	**IHARVESTING TREES INVENTORY**				**Outstanding desirable tree< 60 cm Mahogany; < 45 others**				
From M	To m		≥ 60 cm Mahogany ≥ 45 cm DBH for other Species Common name or **9** if not existent	DBH (cm)	Trunk Quality (1 – 6)	Com. Alt. (m)	Type 1, 2,3 4, 9	Outstanding Desirable Name	DBH (cm)	Ilum. crown type (1-5)	Lianas Type (1-4)

OBSERVACIONES:
____
____
____

Annex 14. Carbon Sequestration: Preliminary Estimations

The calculation of carbon dioxide sequestration of the Property was made using the following procedure.

- ***Estimation of Stored Biomass:*** In order to consider the biomass stored in the forested area of Balam Jungle, an equation of biomass was applied; first generated by Mr. Suamy Aguilar in 2002 for the Mayan Biosphere Reserve in Guatemala. This equation is a logarithmic model using diameter at breast height, which explains more of 95% of the variability of the data.

  Although this equation was used to generate a model for other broadleaf forest areas very similar in characteristic to Balam Jungle's forest, it is important to indicate that more carbon sequestration specific studies of the Property and the conditions of this zone would need to take place in order to increase the level accuracy of the generated biomass equation. The biomass equation used for the calculations is:

  - LogBt = -3.89391+2.40215*LogDap

- ***Stored Carbon Estimation*****:** The carbon sequestration calculation was based on a fraction of the present carbon in the biomass, which is 50%. Ciesla mentioned by Segura (1996) indicates that the relation of total dry biomass with carbon is approximately 2:1 (50%). This relation was confirmed by Aguilar (2002) and Arreaga (2002) in studies conducted on the Mayan Biosphere Reserve. Of the total biomass and carbon stored for all the standing timber, a 5% and 1% was respectively considered in the case of saplings and seedlings by Aguilar (2002), and by Arreaga (2002).

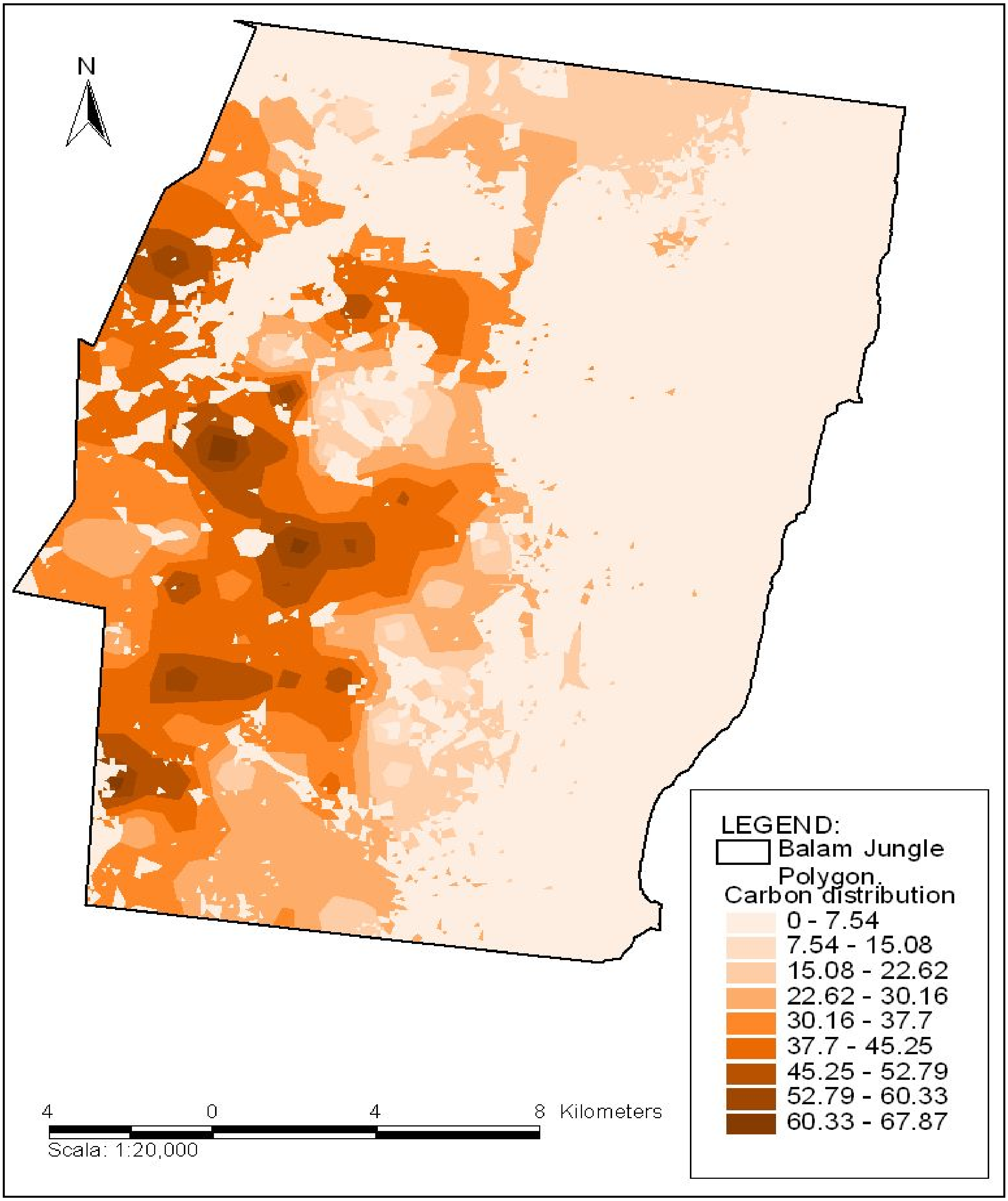
A biomass of 72.39 t/ha was calculated for the forested area of the Property. Arreaga (2002) reports 55-513 ranks t/ha for a tropical forest located to the east of the Zone of Multiple Uses of the Mayan Biosphere Reserve.

Applying the fraction of carbon, it was possible to determine an average of 36.20 tC/ha of carbon existing on the Property. And, 95% of the total carbon calculated is contained in the standing trees of the forested area. A total estimation of 665,808.48 tons of stored carbon was for this zone.

Vegetation Type	**Bt**	**CA**	**CA**
	t/ha	**tC/ha**	**tC total**
Fustales	67.66	33.83	622,250.91
Latizales	4.06	2.03	37,335.05
Brinzales	0.68	0.34	6,222.51
Total	72.39	**36.20**	**665,808.48**

The concentrations of carbon sequestration on tons/hectare, based on the extrapolation generated with state-of-the-art software (ArcView), is demonstrated below on Map 14.

Map 14. Carbon Distribution



Addendum 8

purestream inc. WASTEWATER TREATMENT EQUIPMENT

purestream ES ADVANCED ENVIROMENTAL TREATMENT SYSTE

10584 Dixie Highway Walton, Kentucky 4

859-371-9898 Fax: 859-371-3

AER-O-FLO EXTENDED AERATION PACKAGE PLANTS

FRAIJANES, GUATEMALA 100,000 GPD

The PURESTREAM, INC. package sewage treatment plant is an Extended Aeration treatment syster This treatment system works by providing ideal conditions for aerobic bacteria and other micro-organisms; these micro-organisms then decompose the biological contaminants in the raw sewage.

The treatment plant provides the proper environment, sufficient oxygen and other elements which allo the bacteria to consume the organic matter and to live and multiply within the treatment plant. In this way the aerobic bacteria and microbes decompose the sewage and waste to a stable form - odor anc nuisance free.

The package sewage treatment plant is used to fill the gap between individual septic type systems ar large municipal plants. They are used to provide sewage treatment for **subdivisions, mobile home parks, schools, recreational parks, nursing homes, factories** and other commercial businesses ir outlying areas without municipal sewer facilities.

ADVANTAGES

- CAN BE INSTALLED IN LESS THAN ONE DAY
- ECONOMICAL TO OPERATE AND EASY TO MAINTAIN
- SIMPLE TO EXPAND

View More Products

purestream inc.
WASTEWATER TREATMENT EQUIPMENT

purestream ES
ADVANCED ENVIROMENTAL TREATMENT SYSTE

10584 Dixie Highway Walton, Kentucky 4
859-371-9898 Fax: 859-371-3

Products Menu

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PURESTREAM INC.
PURESTREAM ES
LOCATION
EMPLOYMENT
CONTACT US
HOME

PURESTREAM SEQUENCING BATCH REACTOR

LAUREL VALLEY, SOUTH CAROLINA 200,000 GPD SBR

Purestream's Sequencing Batch Reactors bring STATE-OF-THE-ART, modern technology to a 75 ye old proven process for biologically treating wastwater. The SBR system is a natural process of **FILL, REACT, SETTLE, DECANT, and IDLE** without the use of chemicals. The necessary bacteria, which found everywhere in nature, can be selectively chosen and cultured in the SBR process to remove carbon, nitrogen and phosphorous found in most wastewater. The simplicity of this time based proce makes it easy to control and operate, resulting in an effluent that is low in BOD, TSS, nitrogen, and phosphorous - usually much lower than regulatory requirements. The flexibility of the SBR system allows it to adapt readily to changing conditions of hydraulic and/or organic loads.

SPECIAL APPLICATIONS

Although the Purestream SBR process can be applied successfully to all biologically degradable wastewaters, with minimal operator attention, it is especially suited for the following applications:

Unusually strong and/or variable organic loads created by industrial wastes, such as:

- MEAT AND POULTRY
- DAIRIES
- LANDFILL LEACHATES

Highly variable daily hydraulic flow patterns found in:

- SHOPPING CENTERS
- SCHOOLS
- SUBDIVISIONS
- CAMPGROUNDS
- SMALL COMMUNITIES

Environmentally sensitive areas requiring advanced treatment, such as:

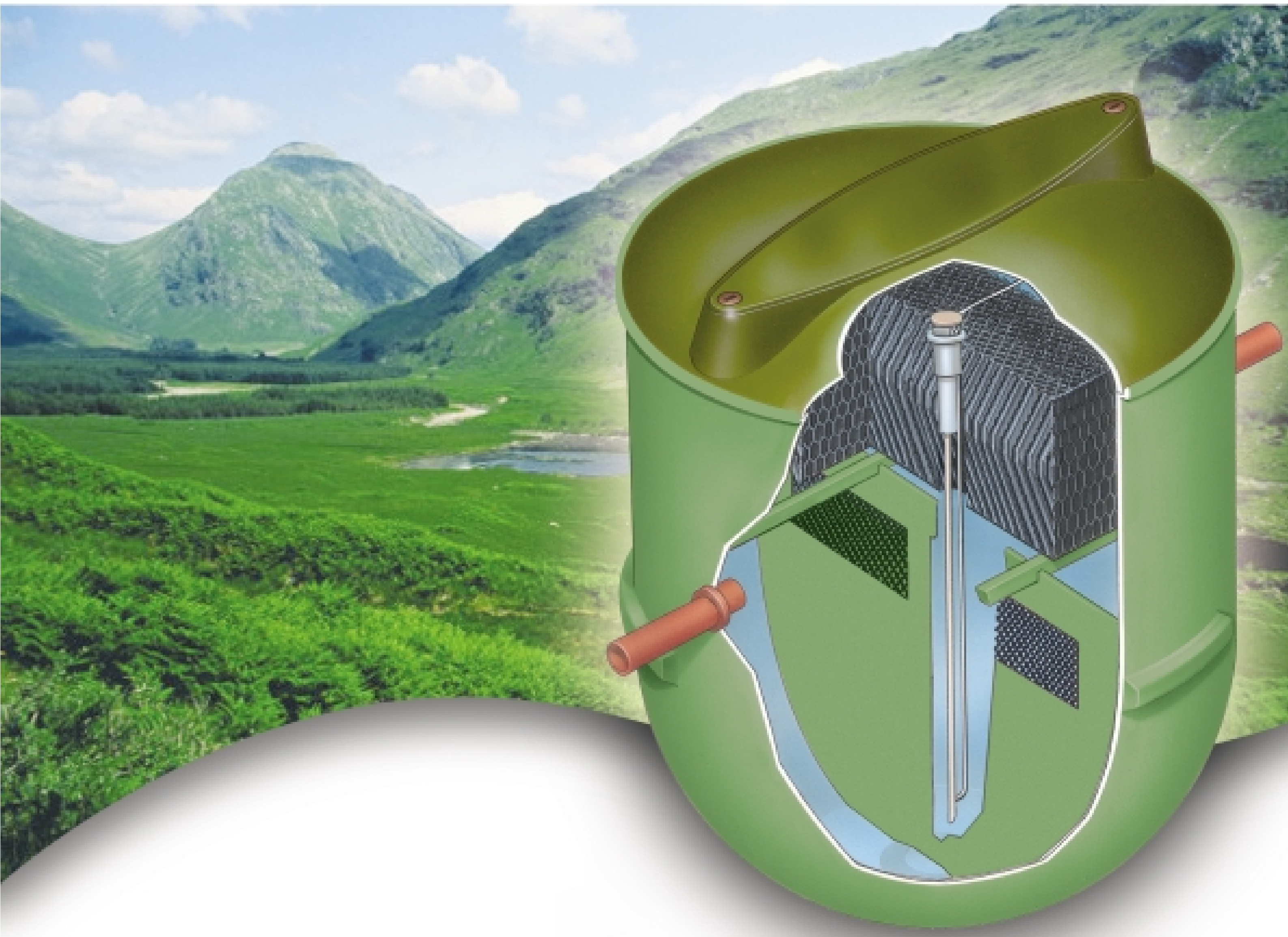
- RESORT AREAS
- COMMERCIAL FISHING AREAS

View More Products
Extended Aeration
Sigma Low Speed Surface Aerators
Rotating Biological Contactors (RBC's)
Sequencing Batch Reactors (SBR's)

Addendum 9

AirFlow AF1 - AF4

for 1-5 properties



Sewage Treatment
for a Caring Environment

www.klargester.co.uk

Klargester
Treatment Systems

Sewage Treatment for a caring environment.

Applications

- Airflow package sewage treatment plants are available in a range extending from a single house to a population equivalent of 375 persons.

  Applications for populations in excess of 375 are also catered for. For more information contact Klargester Sales.
- Individual houses.
- Small developments.
- Offices and commercial properties.
- Upgrading existing septic tanks.

Features

- Below ground installation.
- No mechanical or electrical components within the plant.
- Single tank unit delivered direct to site.
- Quiet in operation.
- Low running costs.
- Deep inverts available on request.
- Hydraulic surge control.
- Low cost after sales service.
- Manufactured under the quality procedures of BS ISO 9001: 2000
- Low visual impact pedestrian covers.

Design

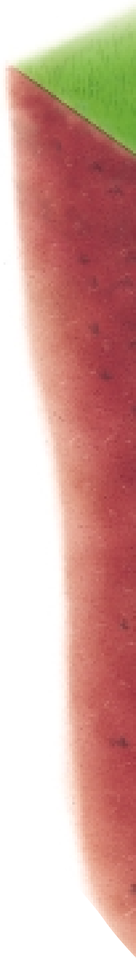
The AirFlow sewage treatment plant employs the well proven aerobic biological process for the treatment of sewage 3 process stages take place within the single tank.

- Coarse solids are separated and retained for gradual breakdown.
- The separated liquor is continuously distributed over specialist bacteria supported media by an airlift operated by a remotely sited blower.
- Final settlement of solids takes place. Under normal domestic conditions a discharge of 20mg/l BOD, 30mg/l S.S., 20mg/l amonia can be achieved.

AirFlow Specification

Max no. of full-time residents		6	12	18	25
Model No.		AF1	AF2	AF3	AF4
Daily flow	m^3/day	1.2	2.4	3.6	5.0
BOD Load	kg/day	0.36	0.72	1.08	1.5
Weight empty	kg	200	250	300	320
Outside diameter	m	1.88	1.88	2.6	2.6
Inlet invert	m	1.0	1.0	1.0	1.0
Inlet invert to base	m	1.2	1.7	1.6	1.6
Outlet invert	m	1.1	1.1	1.15	1.15
Motor rating	watts	60	60	150	150
Drainage fitting	mm	110	110	110	110

These charts are a general guide.



Klargester Treatment Systems

Dispersal

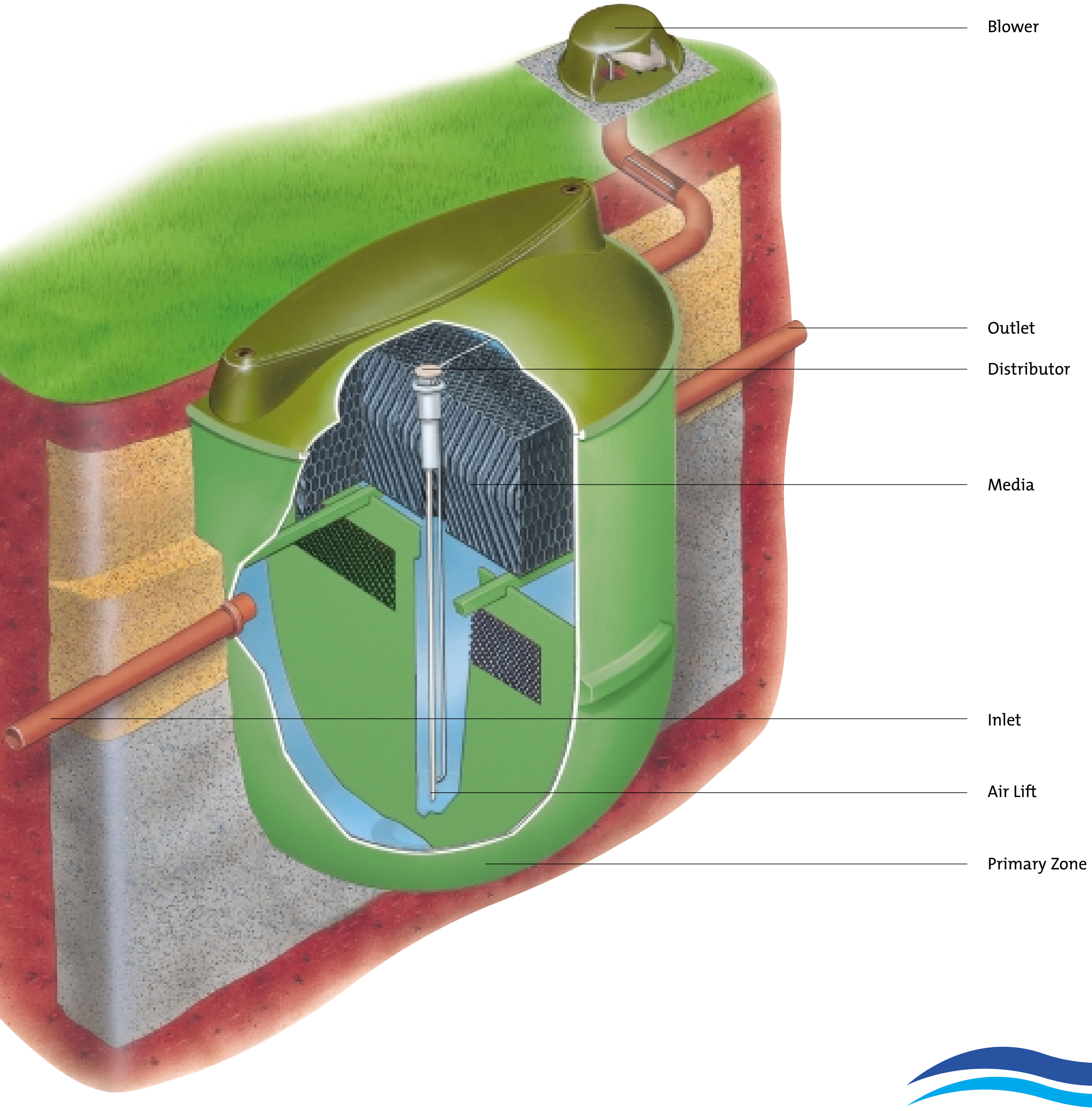
Subject to the relevant authorities consent, the plant discharge can be a water course or to a designed infiltration system, provided the soil percolation test is satisfactory, to a ground soakaway.

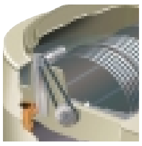
Options

- Integral Pumpsets - for lifting treated effluent to a level where discharge cannot be by gravity.
- Separate Sample Chambers - for accurate and convenient effluent sampling, as required by the relevant authorities.

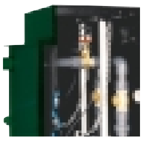
Advice

The information in this sales literature is only brief. For more detailed technical literature please contact Klargester.



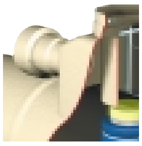


TREAT IT!

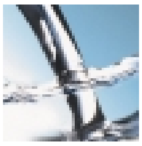


PUMP IT!

STORE IT!



SEPARATE IT!



SAVE IT!

Other products from Klargester

- BioDisc® Sewage Treatment Plants
- Pumping Stations
- Septic Tanks
- Cesspools
- Grease Traps
- Light Liquid Separators
- Silage Effluent Tanks
- Reed Beds
- Rainwater Harvesting

Certified Installers

Strategically located throughout the UK, Klargester Certified Installers are appointed following rigorous selection procedures which assess their installation expertise, reputation and financial status.

These performance criteria, together with their design skills and knowledge of Klargester products are also reviewed on an annual basis to ensure that the highest levels of professionalism are maintained.

Klargester
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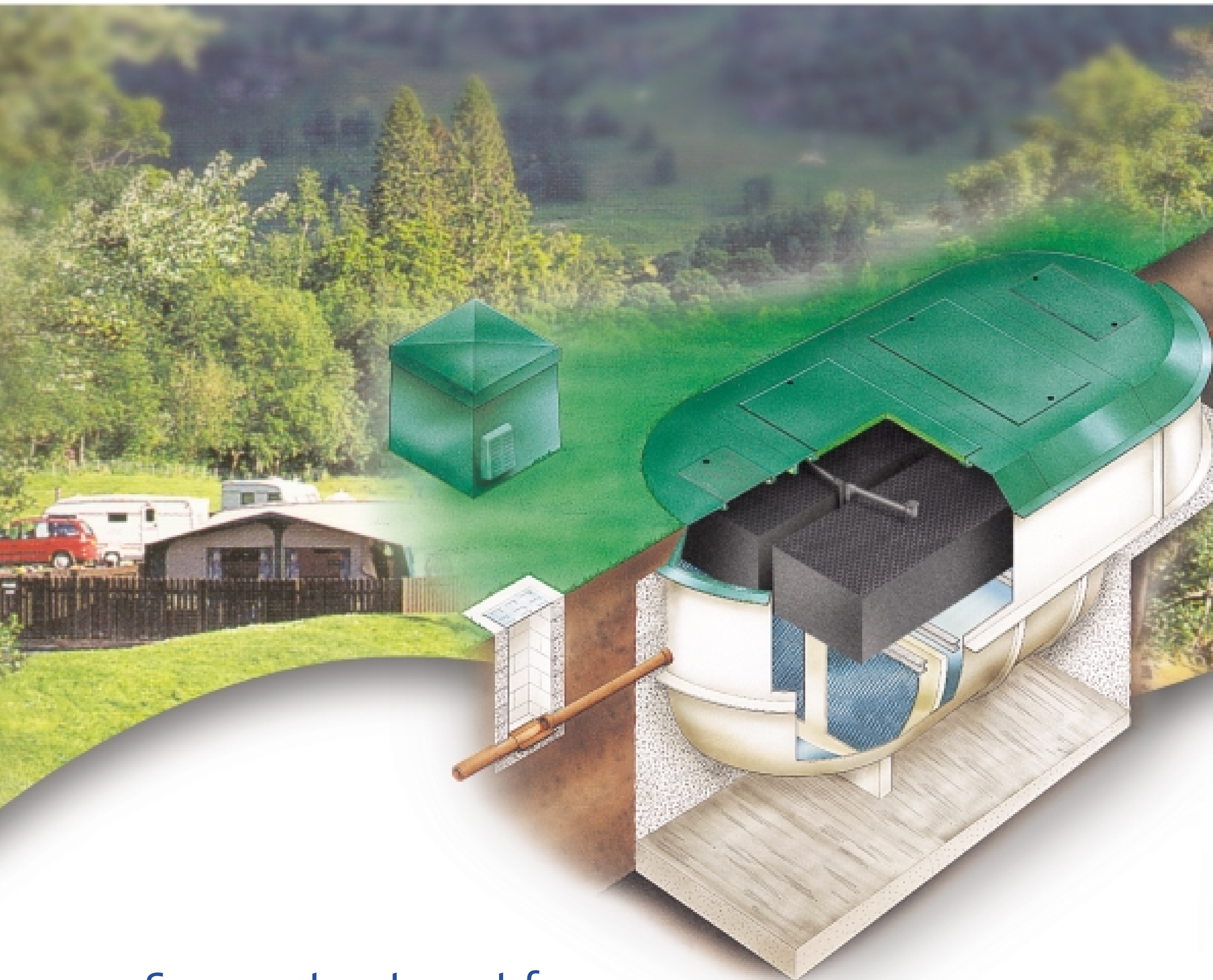
BRITISH WATER

Issue No. 5/1: May 2004

AirFlow AF4 - AF10

for Residential and Commercial Developments



Sewage treatment for
a caring environment

www.klargester.com

Klargester
Treatment Systems

AirFlow AF4 - AF10

for Residential and Commercial Developments

Applications

The Klargester AirFlow series of package sewage treatment plants is designed to treat the sewage from a whole range of developments where access to the main sewer is not possible.

Housing estates, camping and caravan sites, rest homes, schools, construction sites, hotels, country clubs, public houses and restaurants.

Features

- Below ground installation, minimises visual impact
- The cover has been specifically designed to blend with surroundings. Generous access for maintenance
- Efficient air blower is quiet and ensures low running and maintenance costs
- Casing construction to BS4994 (1987) in GRP (Glass Reinforced Plastic)
- Built in surge flow control
- No moving mechanical parts or electrical components within the plant
- All Klargester products are manufactured under the quality procedures of BS EN ISO 9001 : 2000

Design

AirFlow sewage treatment plants are available as standard or high level nitrification plants. They employ a development of the well proven aerobic biological process for the purification of sewage and waste water.

This process takes place in four distinct stages:-

1. Primary Settlement

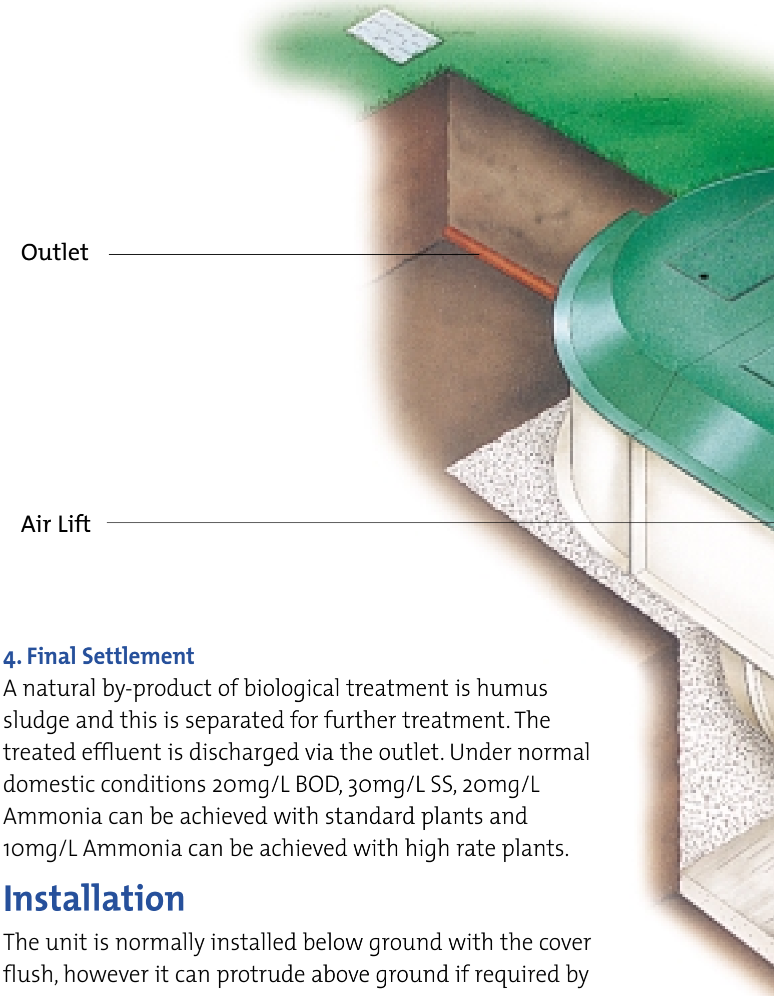
This is the initial stage of treatment and simply involves the retention of coarse solids present in raw sewage and waste water for subsequent gradual breakdown.

2. Carbonaceous Biological Treatment

Substantial BOD reduction takes place here, where the carbonaceous pollutants are removed by presenting the sewage to the micro-organisms in the presence of oxygen. The treatment is achieved by continually distributing the screened liquids over the biological media.

3. Nitrifying Biological Treatment

Additional treatment is provided in order to reduce the Ammoniacal Nitrogen. There are several levels of Nitrification available. For most applications the standard is suitable. However, for particularly sensitive applications a high level unit can be selected.



4. Final Settlement

A natural by-product of biological treatment is humus sludge and this is separated for further treatment. The treated effluent is discharged via the outlet. Under normal domestic conditions 20mg/L BOD, 30mg/L SS, 20mg/L Ammonia can be achieved with standard plants and 10mg/L Ammonia can be achieved with high rate plants.

Installation

The unit is normally installed below ground with the cover flush, however it can protrude above ground if required by site levels. Ideally siting should be under a pedestrian area no closer than 15m from the nearest house. The tank should be vented independently or back through a local building vent stack.

Installation is quick and economical, the plant requiring only to be seated on a concrete base with a surround of concrete.

The blower housing can be sited anywhere with access to mains electricity within a 15m radius of the plant itself.

Maintenance

AirFlow sewage treatment plant are designed for minimum low cost maintenance.

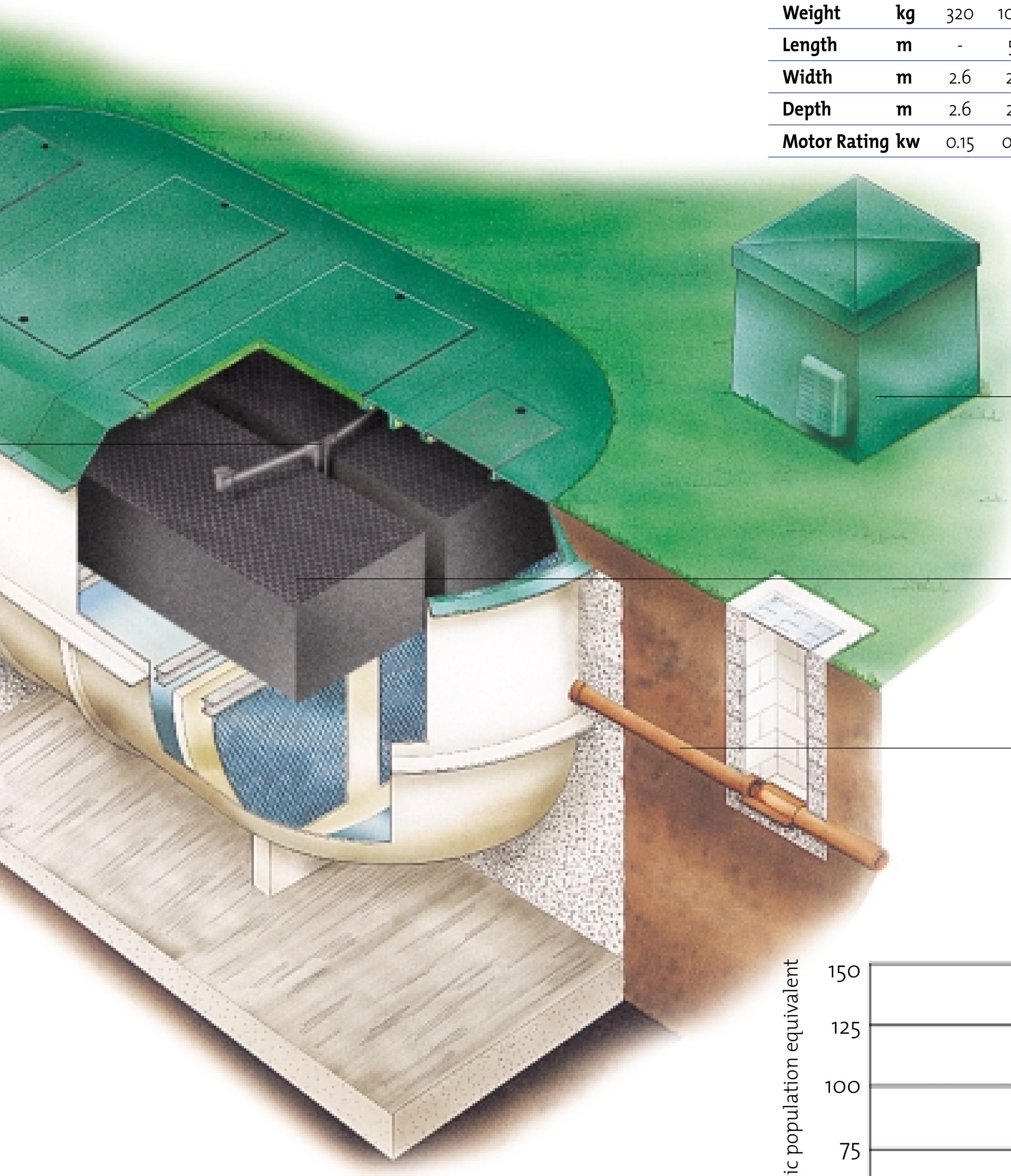
Klargester offers a full commissioning and after sales service involving planned maintenance visits on the UK mainland.

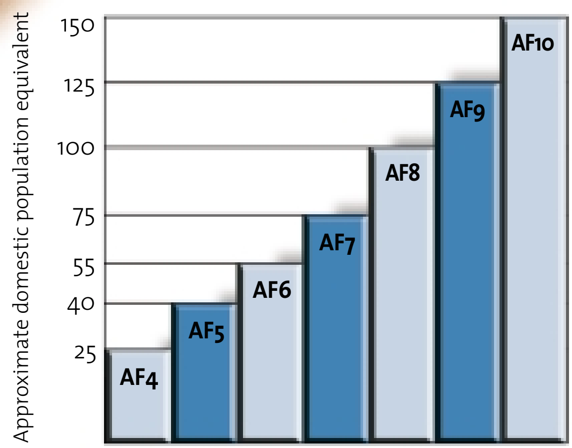
Under normal usage the plant will require periodic emptying to prevent excessive build up of surplus sludge.

Options

- Pumpsets - where the treated effluent has to be dispersed to a higher area because of site levels or ground water.
- Sample Chambers - for accurate and convenient effluent sampling, as required by the Environment Agency.
- Alarm Systems - for the warning of power or equipment failure.

AirFlow Unit Size		AF4	AF5	AF6	AF7	AF8	AF9	AF10
Weight	kg	320	1080	1100	1500	2000	2500	2900
Length	m	-	5.1	5.1	6.8	7.6	8.1	9.9
Width	m	2.6	2.9	2.9	2.8	2.8	2.8	2.8
Depth	m	2.6	2.8	2.8	2.5	2.5	2.5	2.5
Motor Rating	kw	0.15	0.37	0.37	0.55	0.55	0.55	0.75





Maximum Flow m³/day

5	8	11	15	20	25	30
1.5	2.4	3.3	4.5	6.0	7.5	9.0

BOD Load kg/day

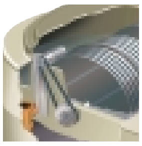
Advice

The information in this sales literature is, by necessity, brief. For more detailed technical literature and drawings regarding applications, installation, maintenance or specific options, please contact Klargester. We have both internal and field sales staff who will be pleased to assist.

Legal Requirements

Prior to installation, there is a legal requirement to obtain a Consent to Discharge from the appropriate agency. Klargester offer full assistance in this respect.

Klargester Treatment Systems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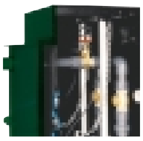
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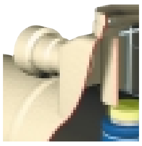
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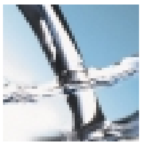
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BRITISH WATER

Issue No. 5/1: May 2004

NOAA's 2007 Atlantic Hurricane Outlook
Date Issued: 9 August 2007

Season and Activity Type	2007 Outlooks August	2007 Outlooks May	1951-2000 Normals
Chance Above Normal	85%	75%	
Chance Near Normal	10%	20%	
Chance Below Normal	5%	5%	
Named Storms	13-16	13-17	11
Hurricanes	7-9	7-10	6
Major Hurricanes	3-5	3-5	2
ACE Index (% Medn)	140-200	125-210	100

NOAA PRESS RELEASE

NOAA: 2007 Atlantic Hurricane Season Outlook Update

Issued: 9 August 2007

Realtime monitoring of tropical Atlantic conditions
Realtime monitoring of tropical East Pacific conditions

Atlantic Hurricane Outlook & Seasonal Climate Summary Archive

SUMMARY

NOAA is predicting a very high likelihood (85% chance) of an above-normal 2007 Atlantic hurricane season, a 10% chance of a near-normal season, and only a 5% chance of a below-normal season, according to a consensus of scientists at the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center, National Hurricane Center, Hurricane Research Division, and Hydrometeorological Prediction Center.

The outlook calls for an even higher probability of an above-normal season than was predicted in May (75%), and reiterates the expectation for a sharp increase in activity from the near-normal season observed last year. The 2007 season is expected to become the tenth above-normal season since the current active hurricane era began twelve years ago (in 1995). See NOAA's definitions of above-, near-, and below-normal seasons.

The 2007 outlook calls for a likely range of 13-16 named storms, 7-9 hurricanes, and 3-5 major hurricanes. The likely range of the ACE index is 140%-200% of the median. These ranges are slightly tighter than those predicted in May (13-17 named storms, 7-10 hurricanes, 3-5 major hurricanes, and an ACE range of 125%-210%). The tighter ranges reflect not only an increased confidence for an above normal season, but also a reduced likelihood of seeing as many as 10 hurricanes and 17 named storms.

The prediction for an above-normal 2007 hurricane season reflects the combination of two main climate factors: 1) the continuation of conditions that have been conducive to above-normal Atlantic hurricane seasons since 1995, and 2) the continued La Niña-like pattern of tropical convection. In

addition, temperatures in the western tropical Atlantic and Caribbean Sea remain well above average (0.56^{o}C). This combination of conditions is known to produce high levels of Atlantic hurricane activity.

So far this season, there have been three Atlantic named storms (Andrea, Barry, and Chantal), which is slightly above average for June and July. The Atlantic hurricane season runs from June 1 through November 30. However, the vast majority of the activity in 2007 is expected during the peak months of the season- August through October (ASO).

DISCUSSION

1. Expected Activity - **85% chance above normal, 10% chance near normal, 5% chance below normal**

An important measure of the total seasonal activity is NOAA's Accumulated Cyclone Energy (ACE) index, which accounts for the collective intensity and duration of Atlantic named storms and hurricanes during the hurricane season. The ACE index is also used to define above-, near-, and below-normal hurricane seasons (see Background Information). A value of 117% of the median (median value is 87.5) corresponds to the lower boundary for an above-normal season.

For 2007, the ACE index is expected to be in the range of 140% to 200% of the median. The upper portion of the range is above the 175% baseline used to define a hyperactive season (Goldenberg et al. 2001). Based on this predicted ACE range, and on the 85% probability of an above-normal season, we expect a likely range of 13-16 named storms, 7-9 hurricanes, and 3-5 major hurricanes [categories 3-4-5 on the Saffir-Simpson scale]. This predicted ACE range can be satisfied even if the numbers of named storms, hurricanes, or major hurricanes fall outside their expected ranges.

The majority of tropical storms and hurricanes during 2007 are expected to form over the tropical Atlantic Ocean, which is typical for above-normal seasons. These systems generally track westward toward the Caribbean Sea and/or United States as they strengthen. Historically, similar conditions have typically produced 2-4 hurricane strikes in the continental United States and 2-3 hurricanes in the region around the Caribbean Sea. However, it is currently not possible to confidently predict at these extended ranges the number or intensity of landfalling hurricanes, or whether a given locality will be impacted by a hurricane this season.

2. Expected Climate Conditions – **Active multi-decadal signal, La Niña-like pattern of tropical convection, warmer western tropical Atlantic and Caribbean Sea**

The prediction for an above-normal 2007 hurricane season reflects the combination of two main climate factors: 1) the continuation of conditions that have been conducive to above-normal Atlantic hurricane seasons since 1995, and 2) the continued La Niña-like pattern of tropical convection. All features of the multi-decadal signal are already in place across the tropical Atlantic, as is a persistent La Niña-like pattern of tropical convection across the eastern half of the equatorial Pacific. In addition, temperatures in the western tropical Atlantic and Caribbean Sea remain well above average

(0.56^oC). This combination of conditions is known to produce very active Atlantic hurricane seasons. Therefore, the probability of an above-normal season has increased to 85% (from 75% in May), and the lower bound for the ACE range has increased to 140% (from 125% in May).

At the same time, the upper bound for ACE has dropped slightly to 200% (from 210% in May), and the maximum expected number of hurricanes has dropped slightly to 9 (from 10 in May). These changes reflect: 1) A reduced chance of a moderate to strong La Niña episode, and 2) Cooler SSTs in the eastern tropical Atlantic Ocean compared to previous record levels.

a. Continuation of active Atlantic hurricane era

Atlantic hurricane seasons exhibit prolonged periods, lasting decades, of generally above-normal or below-normal activity. These fluctuations in hurricane activity result almost entirely from differences in the number of hurricanes and major hurricanes forming from tropical storms first named in the main development region (MDR), which spans the tropical Atlantic Ocean and Caribbean Sea between 30^{o}W-87.5^{o}W and 10^{o}N-21.5^{o}N (Goldenberg et al. 2001).

Hurricane seasons during 1995-2006 have averaged 14.4 named storms, 8.2 hurricanes, and 4 major hurricanes, with an average ACE index of 172% of the median. NOAA classifies nine of the last twelve hurricane seasons as above normal, with seven being hyperactive. Only three seasons since 1995 have not been above normal. These are the El Niño years of 1997, 2002, and 2006.

This high level of activity contrasts sharply to the 1971-1994 period of generally below-normal hurricane seasons, when seasons averaged 8.5 named storms, 5 hurricanes, and 1.5 major hurricanes, with an average ACE index of only 75% of the median. One-half of those seasons were below normal, only three were above normal (1980, 1988, 1989), and none were hyperactive. Time series of key atmospheric wind parameters highlight the dramatic differences between these above-normal and below-normal hurricane eras.

The regional atmospheric circulation contributing to these long-period fluctuations in hurricane activity is strongly linked to the tropics-wide multi-decadal signal (Bell and Chelliah, 2006). A change in phase of that signal accounts for the transition in 1995 from the below-normal era to the above normal era. The multi-decadal signal is again a major factor guiding the 2007 outlook. Three key features of this signal that are associated with the current active hurricane era are: 1) a stronger West African monsoon system, 2) below-average convection in the Amazon Basin, and 3) warmer than average SSTs in the tropical Atlantic and Caribbean Sea.

Other ongoing regional aspects of the multi-decadal signal again expected during the 2007 hurricane season include 1) lower surface air pressure, and increased moisture across the tropical Atlantic, 2) an amplified ridge at upper levels across the central and eastern subtropical North Atlantic, 3) reduced vertical wind shear in the MDR, which results from an expanded area of easterly winds in the upper atmosphere (green arrows) and weaker easterly trade winds in the lower atmosphere (dark blue arrows), and 4) weaker easterly winds in the middle and lower atmosphere, which produce a configuration of the African easterly jet (wavy blue arrow) that favors hurricane development from tropical waves moving westward from the African coast.

b. Continuation of a La Niña-like pattern of convection in the tropical Pacific Ocean

The second key predictor for the 2007 hurricane season is the possibility of a La Niña episode in the tropical Pacific during ASO. The Climate Prediction Center is currently indicating a slightly greater than 50% chance that La Niña will develop during the peak of the hurricane season. As discussed by Gray (1984), La Niña favors more Atlantic hurricanes and El Niño favors fewer hurricanes.

Equatorial Pacific SSTs remain below-average in the east and above average in the west. This anomaly pattern has been associated with suppressed convection over the central and eastern equatorial Pacific and enhanced convection over the western equatorial Pacific. This La Niña-like pattern of tropical convection has already acted to suppress the East Pacific hurricane season. This pattern is expected to continue even if La Niña does not develop.

There is a strong inverse relationship between eastern Pacific and Atlantic hurricane activity, primarily because similar circulation anomalies impact the basins oppositely through differing climatological flow patterns. The significantly below-average eastern Pacific activity to date increases our confidence for an active Atlantic hurricane season.

La Niña also helps to extend the Atlantic activity into November. The high likelihood of a La Niña-like influence on the 2007 Atlantic hurricane season contrasts to last year, when a rapidly developing El Niño during August-September helped to shut-down Atlantic hurricanes in October and November (Bell et al. 2007).

c. Tropical Atlantic sea-surface temperatures (SSTs)

In the western tropical Atlantic/ Caribbean Sea, sea-surface temperatures remained well above average (0.56^{o}C) during June and July, and departures of approximately +0.5^{o}C are expected in that region during ASO 2007. In the eastern tropical Atlantic, SSTs fell back to only slightly above-average levels (0.18^{o}C) during June-July, following record warm ASO temperatures in that region since 2004. This cooling was associated with a persistent high pressure pattern over the Atlantic Ocean, which brought strong northeasterly winds into the tropics that cooled the SSTs through increased upwelling and evaporation.

During the last few weeks this wind pattern disappeared and an enhanced southerly flow of moist tropical air typical of above-normal seasons became established. Associated with this evolution, the moist static stability has decreased, the African Easterly Jet has shifted to well north of normal, the easterly trade winds have weakened, and portions of the eastern tropical Atlantic have warmed to more than 0.5^{o}C above average.

3. Uncertainties in the Outlook

There are two unrelated sources of uncertainty in this forecast. The first is whether or not La Niña will develop and if so, how strong it will become. Even with ENSO-neutral conditions, the combination of an active hurricane era with the ongoing La Niña-like pattern of tropical convection and winds produces a very high probability of an above-normal season. The development of La Niña increases the probability for a hyperactive season with activity in the upper end of the predicted range.

The second source of uncertainty is whether conditions over the eastern tropical Atlantic will continue to become increasingly conducive for hurricane formation. Atmospheric conditions in that region are already consistent with other above-normal seasons, and the associated SSTs have returned to above-average in many areas. However, the latest Climate Forecast System (CFS) forecast from the NOAA Environmental Monitoring Center indicates a continuation during ASO of near-average temperatures in the eastern tropical Atlantic, suggesting atmospheric conditions might be slightly less conducive to hurricane formation than current trends indicate.

CAUTIONARY NOTES

1) It is currently not possible to confidently predict at these extended ranges the number or intensity of landfalling hurricanes, or whether a particular locality will be impacted by a hurricane this season. Therefore, residents and government agencies of coastal and near-coastal regions should always maintain hurricane preparedness efforts regardless of the overall seasonal outlook.

2) Far more damage can be done by one major hurricane hitting a heavily populated area than by several hurricanes hitting sparsely populated areas. Therefore, hurricane-spawned disasters can occur even in years with near-normal or below-normal levels of activity. Examples of years with near-normal activity that featured extensive hurricane damage and numerous fatalities include 1960 (Hurricane Donna), 1979 (Hurricanes David and Frederic), and 1985 (Hurricanes Elena, Gloria and Juan). Moreover, the nation's second most damaging hurricane, Andrew in 1992, occurred during a season with otherwise below normal activity.

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The 2006 North Atlantic Hurricane Season
A Climate Perspective

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Contents:

1. Overview

The 2006 Atlantic hurricane season produced ten tropical storms (TS), five hurricanes (H) and two major hurricanes (MH) [categories 3-5 on the Saffir-Simpson scale (Simpson (1974)] (Fig. 1). These values are slightly below the 1950-2000 averages of 11 TS, 6 H, and 2.5 MH. Only three Atlantic tropical storms, Alberto, Beryl, and Ernesto, struck the continental U.S. during 2006. This was the first year since 2001 that no hurricanes struck the continental United States.

A widely-used measure of seasonal activity is the National Oceanic and Atmospheric Administration's (NOAA's) Accumulated Cyclone Energy (ACE) index (Bell et al. 2000). The ACE index accounts for the combined strength and duration of tropical cyclones (TC) during the season. The 2006 ACE index was 90% of the 1950-2000 median value (87.5 x 10^4 kt^2),

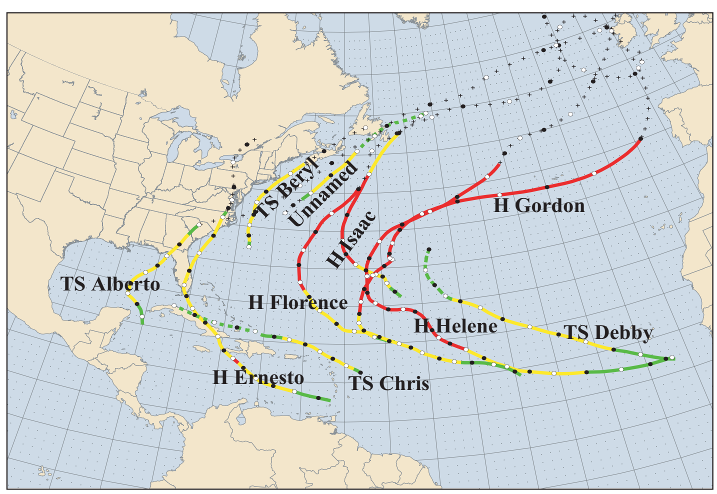

Fig. 1. Atlantic tropical storm and hurricane tracks during 2006. Shading indicates strength, with green indicating tropical depression intensity, yellow indicating tropical storm intensity, and red indicating hurricane intensity.

indicating a near-normal season (Fig. 2). However, this value is well below the previous three seasons which averaged 247% (Bell et al. 2005), and less than one-third of the record high (284%) seen in 2005 (Bell et al. 2006).

The regional atmospheric and oceanic anomalies during the climatological peak months (August-October, ASO) of the 2006 hurricane season are shown schematically in Fig. 3. To the first order, the reduced activity reflected the competing influences of two dominant climate factors. The first dominant factor is El Niño, which suppressed activity mainly during September and October through anomalous upper-level convergence and sinking motion across the Caribbean Sea (Fig. 4). Anomalous circulation features not related to El Niño accentuated this

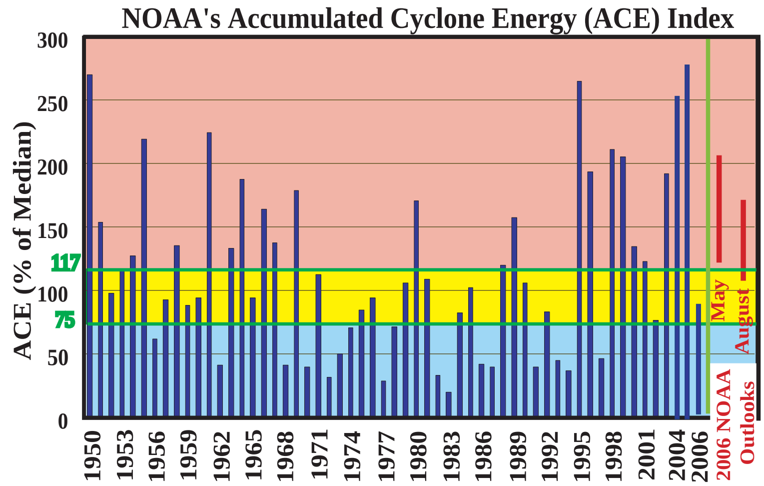

Fig. 2. NOAA's Accumulated Cyclone Energy (ACE) index expressed as percent of the 1951-2000 median value (87.5 x 10^4 kt^2). ACE is a wind energy index, and is calculated by summing the squares of the 6-hourly maximum sustained wind speed in knots ($Vmax^2$) for all periods while the system is a tropical storm, subtropical storm, or hurricane. Season types are indicated by the background shading, with pink, yellow, and blue indicating NOAA's classifications for above-, near-, and below-normal seasons, respectively.

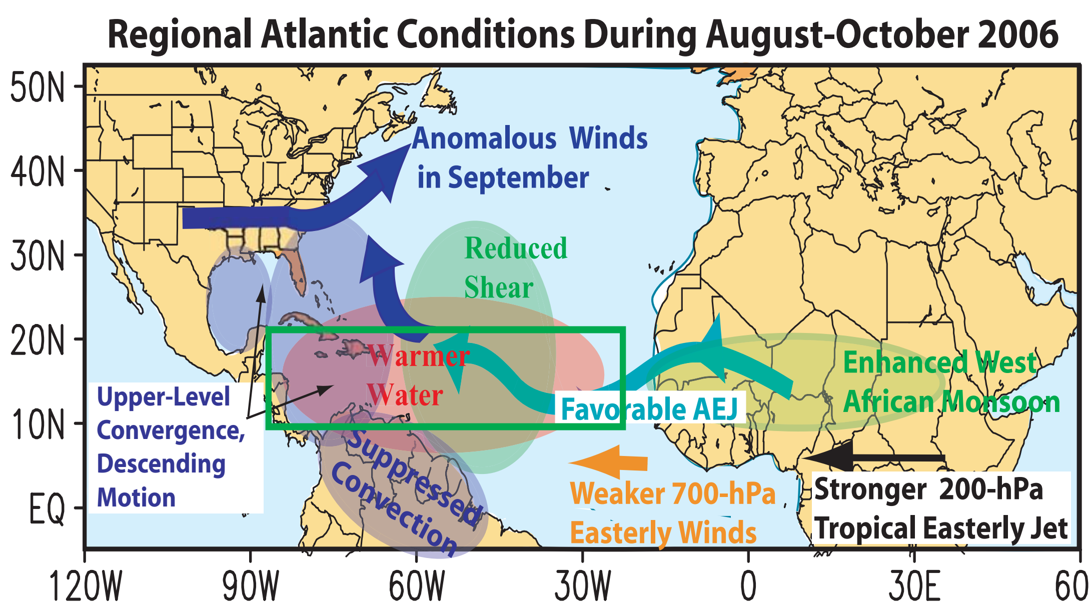

Fig. 3. Schematic of conditions during August-October 2006. The near-normal season mainly reflected the competing influence of El Niño and the ongoing conditions associated with the current active hurricane era that began in 1995. El Niño contributed to anomalous upper-level convergence and anomalous sinking motion over the Caribbean Sea. The active hurricane era conditions again prevailed across the central and eastern tropical Atlantic, the West African monsoon region, and the Amazon Basin.

signal at times, and also contributed to the reduced activity. The second dominant climate factor is the set of ongoing oceanic and atmospheric conditions over the eastern half of the tropical Atlantic, western Africa, and the Amazon Basin. These conditions have been conducive to above normal hurricane seasons since 1995, and they were again very pronounced during 2006.

2. Dominant climate patterns

a. El Niño

El Niño's suppressing influence on Atlantic hurricane activity is well documented (Gray 1984, Tang and Neelin 2004, Bell and Chelliah 2006), and is clearly evident during the current active hurricane era that began in 1995. During 1995-2006, nine of twelve hurricane seasons are in the above normal tercile, which is defined as ACE larger than 117% of the median. The three exceptions are all El Niño years (1997, 2002, and 2006).

During 2006, there were no late-season (Oct-Nov) tropical cyclones (TC), resulting in the third earliest end (following 1983 and 1993) to seasonal activity since routine daily satellite coverage began in 1966. Historically, El Niño suppresses the late season activity over the Caribbean Sea and western tropical Atlantic Ocean. This impact is especially significant during active hurricane eras (Fig. 5), when the mean Oct-Nov ACE index for El Niño years is almost five times less than for non-El Niño years. In the absence of El Niño, an active era features an average of one hurricane per season during Oct-Nov., and roughly one MH every other season. During El Niño, these averages drop to one short-lived hurricane every three seasons, and no MH. In contrast, during inactive hurricane eras, conditions are normally so unfavorable during Oct-Nov that neither El Niño nor La Niña has a strong impact on late season activity. For example, there has never been a late-season

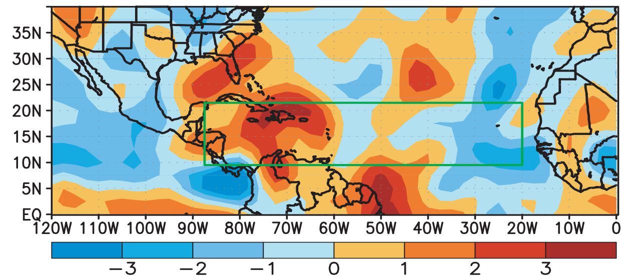

Fig. 4. August-October 2006: Anomalous 300-hPa vertical motion (x 10^{-2} Pa s^{-1}). Anomalous sinking motion is indicated by positive (red shading) values, and anomalous ascending motion is indicated by blue shading. Green box denotes the Main Development Region. Anomalies are departures from the 1971-2000 period monthly means.

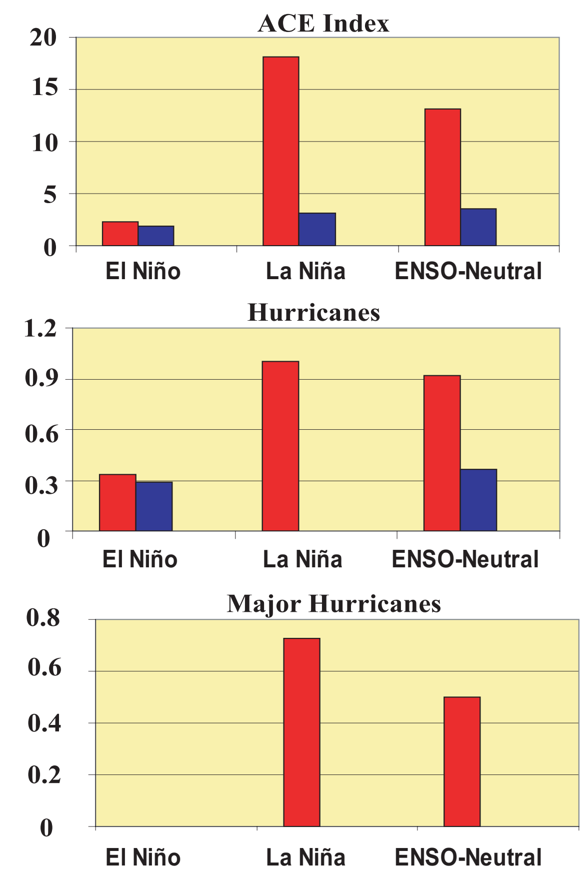

Fig. 5. October-November mean tropical cyclone (TC) activity forming over the Caribbean Sea as a function of active/ inactive hurricane era and ENSO: a) the ACE index, b) hurricanes, and c) major hurricanes. The active era means (red) are based on the periods 1951-1970 and 1995-2005. The inactive era means (blue) are based on the years 1971-1994.

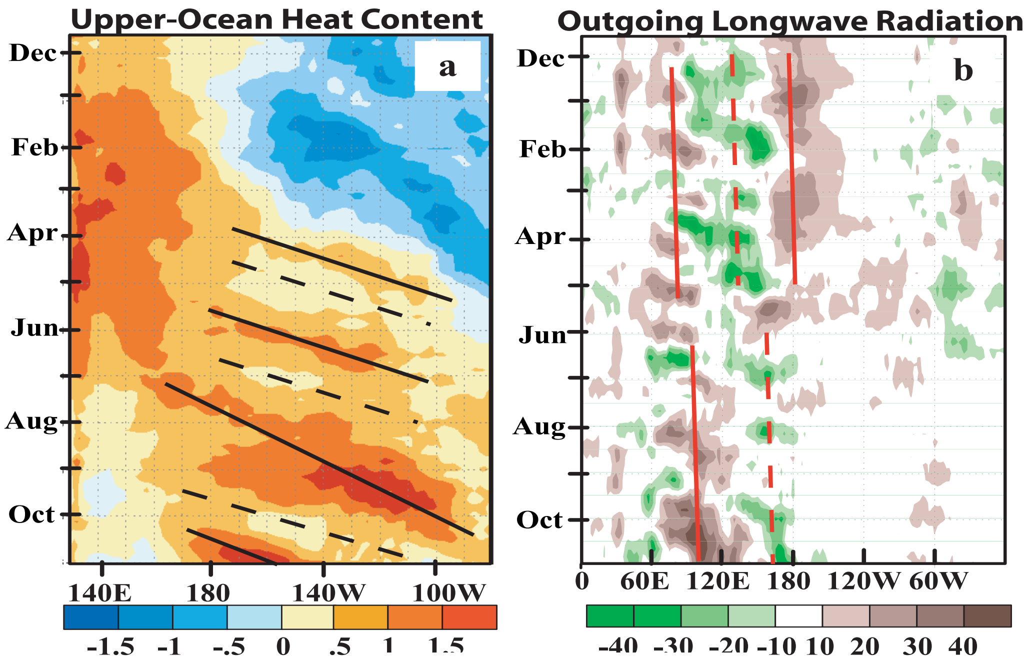

Fig. 6. Time-longitude sections calculated between 5°N-5°S of anomalous (a) upper-ocean heat content (°C) and (b) Outgoing Longwave Radiation (OLR, W m^2). In (a) dashed and solid black lines indicate the warm and cool phases of equatorial oceanic Kelvin Waves, respectively. Heat content anomalies are departures from the 1982-2004 pentad means, and OLR anomalies are departures from the 1979-2000 pentad means.

MH form in the Caribbean Sea during an inactive hurricane era, regardless of El Niño or La Niña.

A time-longitude section of upper-ocean heat content illustrates the rapid development of El Niño during the 2006 Atlantic hurricane season (Fig. 6a). Before the season began, anomalously cold temperatures had disappeared from the central equatorial Pacific. By June a series of Kelvin waves began contributing to a progressive warming in the central and east-central equatorial Pacific. A particularly strong equatorial Kelvin wave during September led to additional significant warming and the development of El Niño. During this period, there was a sharp transition in the distribution of anomalous convection across the equatorial Pacific (Fig. 6b), with the El Niño-like pattern of suppressed convection over the

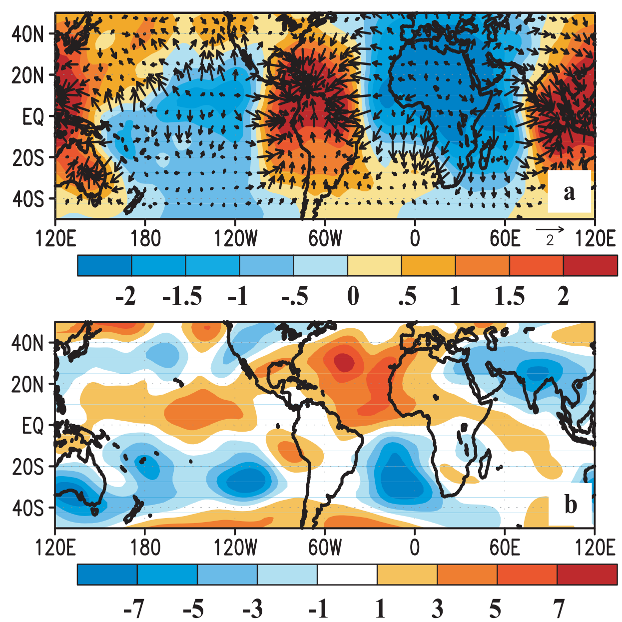

Fig. 7. August – October 2006: (a) Anomalous 200-hpa velocity potential (x 10^6 m^2 s^{-1}) and divergent wind vectors (m s^{-1}), and (b) Anomalous 200-hpa streamfunction (contour interval is 2 x 10^6 m^2 s^{-1}). In (b), anomalous ridges are indicated by positive values (red) in the NH and negative values (blue) in the SH. Anomalous troughs are indicated by negative values in the NH and positive values in the SH. Anomalies are departures from the 1971-2000 period monthly means.

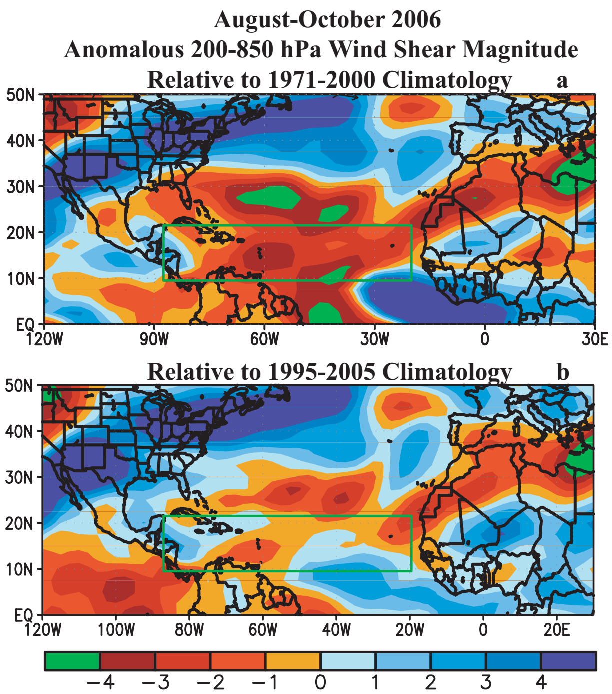

Fig. 8. August-October 2006: Anomalous strength of the total 200-850 hPa vertical wind shear, calculated with respect to (a) the 1971-2000 and (b) the 1995-2005, period monthly means. Red shading indicates below-average strength of the vertical shear. Green box denotes the Main Development Region.

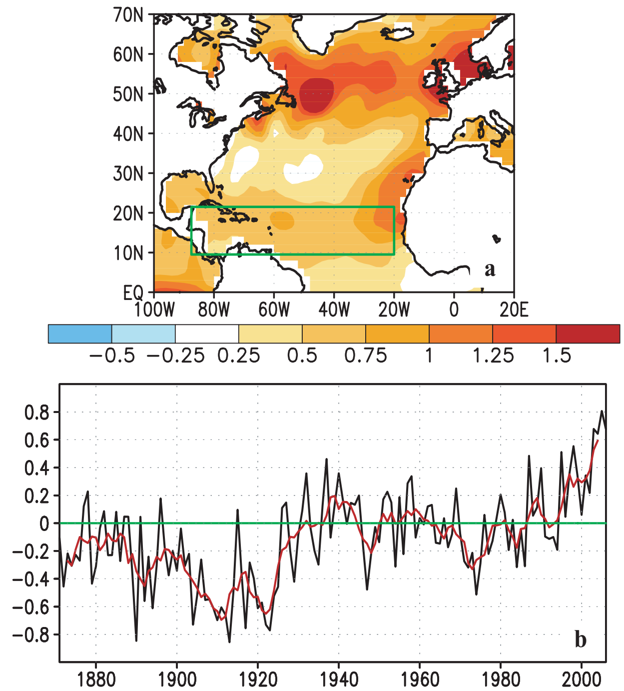

Fig. 9. (a) Sea-surface temperature (SST) anomalies (°C) during August-October 2006, and (b) Time series of area-averaged SST anomalies for the Main Development Region [green boxed region shown in (a)]. Red line in (b) shows the corresponding 5-yr running mean. Anomalies are departures from the 1971-2000 period monthly means.

western Pacific and enhanced convection near the date line beginning to establish itself during July.

The large-scale El Niño signal during ASO 2006 is evident in the patterns of anomalous 200-hPa velocity potential (Fig. 7a) and streamfunction (Fig. 7b). In the tropics velocity potential anomalies are related to the upper-level divergent circulation and anomalous convection. Negative velocity potential anomalies across the central and east-central equatorial Pacific reflect the El Niño-related enhanced convection and anomalous upper-level divergence. Positive values over both the western Pacific/ Indonesia region and the Caribbean Sea reflect compensating anomalous upper-level convergence and suppressed convection. Another characteristic El Niño signature is anomalous upper-level ridges (positive streamfunction anomalies in NH, negative in SH) in the subtropics of both hemispheres flanking the region of enhanced convection over the central equatorial Pacific. However, this feature was not evident until October.

El Niño's typical impacts over the western tropical Atlantic Ocean and Caribbean Sea include increased vertical wind shear between 200-850-hPa and anomalous sinking motion in the middle and upper atmosphere. During ASO 2006 El Niño appears to have suppressed TC activity mainly by contributing to anomalous upper-level convergence and sinking motion across the Caribbean Sea. This suppressing influence was particularly notable during September and October, when only one TC developed over the Caribbean Sea despite low wind shear (< 8 m s^{-1}) (Fig. 8a) and a continuation of anomalously warm sea-surface temperatures (SSTs, Fig. 9). During September these same conditions, but with no anomalous sinking motion, led to the formation of several hurricanes and major hurricanes over the central and eastern tropical Atlantic Ocean.

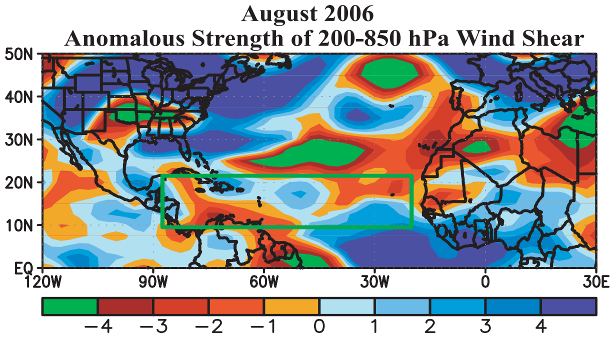

Fig. 10. August 2006: Anomalous strength of the total 200-850 hPa vertical wind shear (m s^{-1}) Green box denotes the Main Development Region. Anomalies are departures from the 1971-2000 period monthly means.

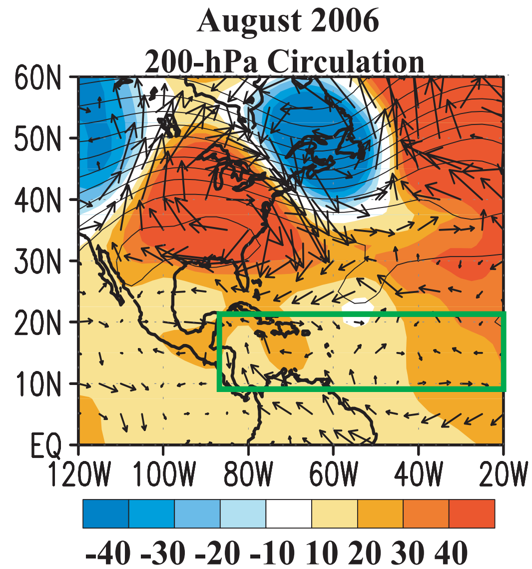

Fig. 11. August 2006: 200-hPa heights (contour interval is 60 m), height anomalies (shading), and vector wind anomalies. Green box denotes the Main Development Region. Anomalies are departures from the 1971-2000 period monthly means.

For the entire Main Development Region (MDR, green box), which encompasses the tropical Atlantic Ocean and Caribbean Sea (Goldenberg and Shapiro 1996), area-averaged SSTs during ASO were 0.68°C above average, the second warmest in the historical record dating back to 1871 (Fig. 9b). The reduced activity, in spite of this anomalous warmth, is consistent with previous findings indicating that local atmospheric circulation anomalies, rather than local SST anomalies, are the dominant contributor to seasonal fluctuations in Atlantic hurricane activity (Shapiro and Goldenberg 1998, Bell and Chelliah 2006).

The vertical wind shear pattern during ASO 2006 primarily reflected anomalously weak shear (relative to the period 1971-2000) throughout the MDR in association with the ongoing active hurricane era (Fig. 8a). A modest El Niño-related increase in wind shear is perhaps evident over the western Caribbean Sea, but only when the departures are calculated relative to the current active era (Fig. 8b). As with the 200-hPa streamfunction anomalies, there is little indication that El Niño affected the vertical wind shear prior to October. Even then, there is little evidence that the increased shear contributed to the shut-down in activity. For example, the main suppressing influence from strong vertical shear (> 8 ms^{-1}) occurred in August, prior to the time when El Niño began affecting this field (Fig. 10). During September and October, the shear was quite weak across the Caribbean Sea, and was therefore not a suppressing factor. It is not clear why the El Niño signal was manifested mainly in the upper-level divergence and vertical motion fields, as opposed to the 200-850 hPa vertical shear, as is typical for most episodes.

b. Mid-latitude and tropical variability

Although El Niño appears to be a primary cause for the reduced TC activity, highly variable circulation features not linked to El Niño also helped to suppress the activity. During August increased vertical wind shear in association with an enhanced mid-oceanic trough led reduced activity across the central MDR (Fig. 11). During September a deep trough near the U.S. east coast contributed to anomalous sinking motion over the Gulf of Mexico (Fig. 12). During October, an enhanced upper-level ridge over the south-central U.S. and western Gulf of Mexico contributed to the anomalous sinking motion over the Gulf of Mexico and

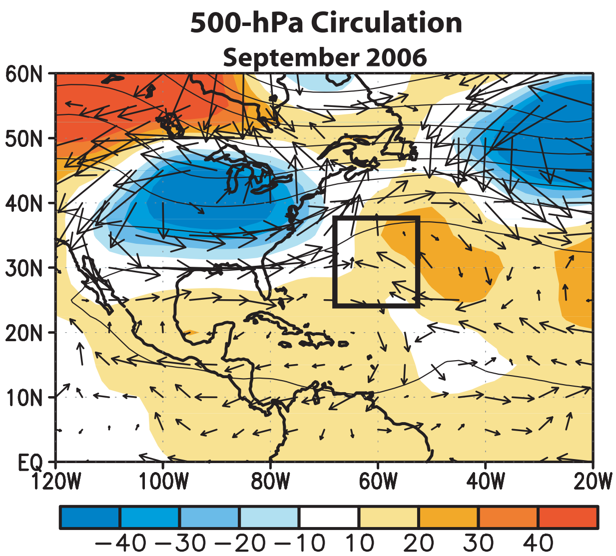

Fig. 12. September 2006: 500-hPa heights (contour interval is 60 m), height anomalies (shading), and vector wind anomalies. Black box shows where many hurricanes were steered during the month. Anomalies are departures from the 1971-2000 period monthly means.

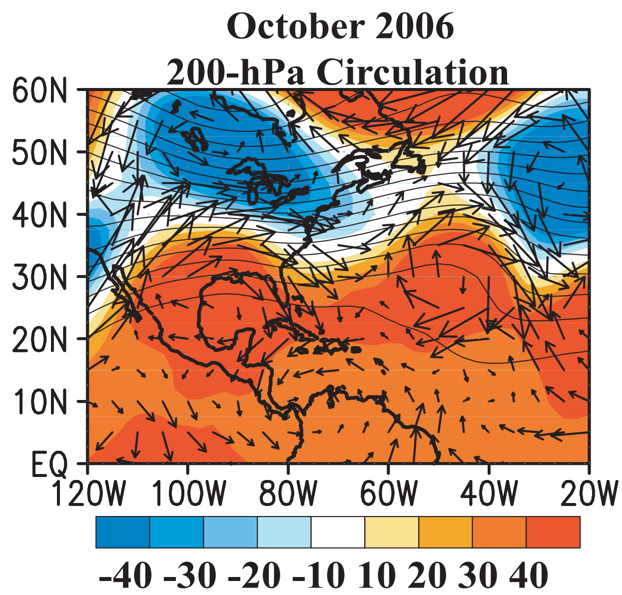

Fig. 13. October 2006: 200-hPa heights (contour interval is 60 m), height anomalies (shading), and vector wind anomalies. Anomalies are departures from the 1971-2000 period monthly means.

also accentuated the sinking motion over Caribbean Sea (Fig. 13).

Only three Atlantic tropical storms, Alberto, Beryl, and Ernesto, struck the continental U.S. during 2006. Also, this was the first year since 2001 that no hurricanes struck the continental United States. This is a sharp drop in strikes compared to the prior four years (2002-2005), when an average of seven tropical storms and three hurricanes per season struck the continental United States. In September, (four of the five 2006 hurricanes formed in September) a deep trough near the U.S. east coast was critical in steering hurricanes out to sea long before they reached the coast (Fig. 12). The overall suppression of activity over the western part of the Atlantic Basin, due in part to El Niño, also contributed to fewer U. S. strikes.

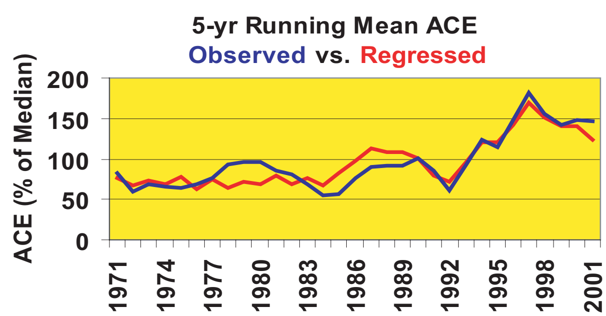

Fig. 14. Time series of the 5-yr running mean ACE index (blue curve) and the regressed seasonal ACE index associated with the tropical multi-decadal signal (red), from Bell and Chelliah (2006). The tropical multi-decadal signal accounts for 82% of the low frequency variance in the ACE index. The transition from the inactive hurricane era to the active hurricane era is captured by a phase change in the tropical multi-decadal signal.

c. Ongoing active Atlantic hurricane era

Despite the reduced 2006 activity, key oceanic and atmospheric features continued to reflect the ongoing active Atlantic hurricane era. A main contributing factor to this active era is the tropical multi-decadal signal, which reflects the leading modes of tropical convective rainfall variability occurring on multi-decadal time scales (Bell and Chelliah 2006). A regression analysis shows that the tropical multi-decadal signal captures 82% of the variance in the 5-yr running

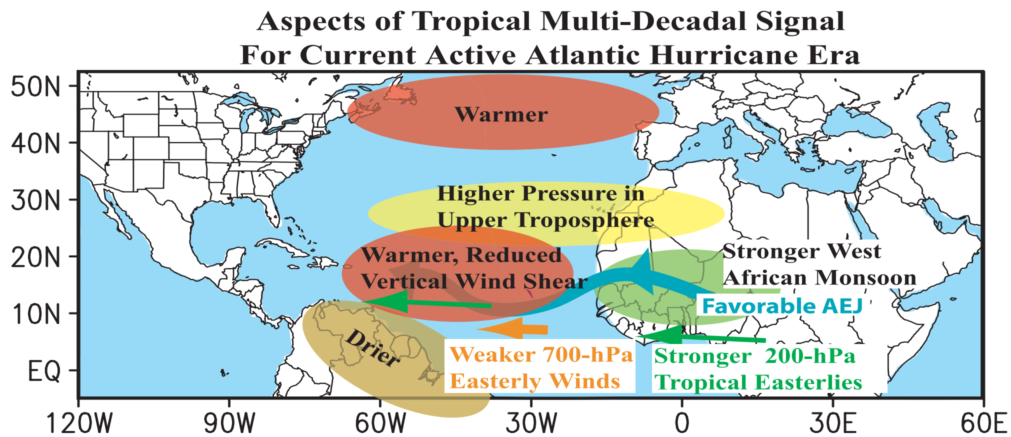

Fig. 15. Schematic showing regional conditions associated with the tropical multi-decadal signal during the current active hurricane era, based on Bell and Chelliah (2006).

mean ACE index since 1970 (Fig. 14). The tropical multi-decadal signal also captures the dramatic increase in ACE beginning in 1995, indicating that the transition from the inactive era to the active era is strongly associated with a phase change in that signal.

One key aspect of the tropical multi-decadal signal associated with the current active hurricane era is an east-west oscillation in anomalous tropical convection between the West African monsoon region and the Amazon Basin, signaling an enhanced West African monsoon system (see also Landsea and Gray 1992) and suppressed convection in the Amazon Basin (Fig. 15). This feature was pronounced during 2006, as seen in the pattern of 200-hPa velocity potential anomalies (Fig. 7a). A second prominent aspect of the tropical multi-decadal signal is a continuation of above average SSTs in the North Atlantic, consistent with the warm phase of the Atlantic multi-decadal mode (Goldenberg et al. 2001). Some of this anomalous warmth has also been linked to an increase in global temperatures over the last 100 years (Santer et al. 2006) not related to the tropical multi-decadal signal.

As shown by Bell and Chelliah (2006), the tropical multi-decadal signal is associated with an inter-related set of atmospheric anomalies known to favor active hurricane seasons. All of these

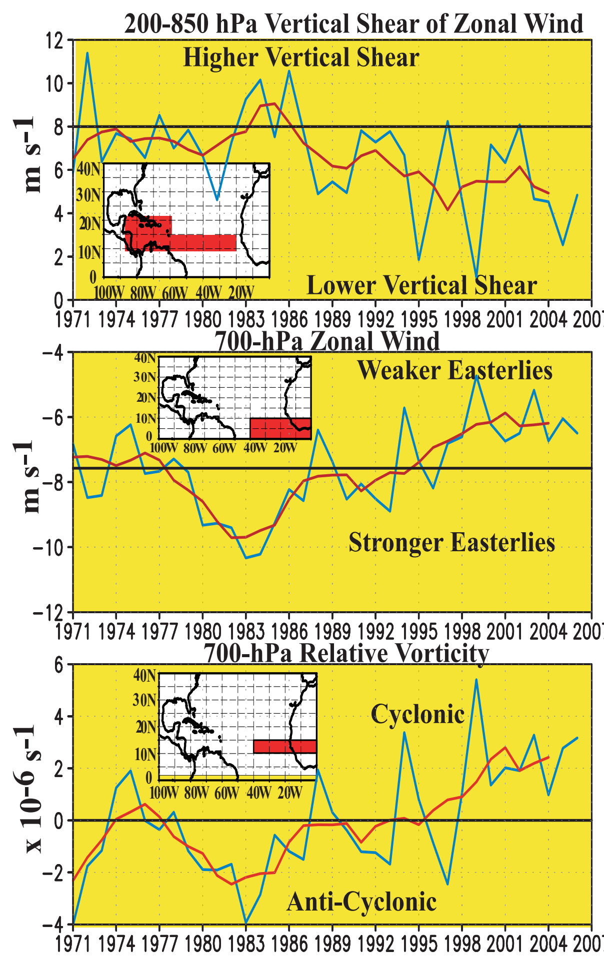

Fig. 16. August-October seasonal time series showing area-averaged values for key regions: (a) magnitude of the 200-850 hPa vertical shear of the zonal wind (m s^{-1}), (b) 700-hPa zonal wind (m s^{-1}) and (c) 700-Pa relative vorticity (x 10^{-6} s^{-1}). Blue curve shows unsmoothed three-month values, and red curve shows a 5-pt running mean of the time series. Averaging regions are shown in the insets.

anomalies were again in place during 2006, including (1) enhanced upper tropospheric (200-hPa) ridges in both hemispheres over the Atlantic Ocean (Fig. 7b), (2) an enhanced tropical easterly jet and a westward expansion of the area of anomalous easterly winds at 200-hPa, and (3) reduced tropical easterlies at 700-hPa across the central and eastern Atlantic (Fig. 16b).

These conditions lead to reduced wind shear across the tropical Atlantic (Fig. 16a, also Fig. 8a), increased cyclonic relative vorticity across the eastern MDR (Fig. 16c), and a more favorable configuration of the 700-hPa African easterly jet (AEJ). As a result, African easterly waves can more easily strengthen over the eastern tropical Atlantic, and then transform into hurricanes and major hurricanes as they move progressively westward into an extensive area of low wind shear and warmer SSTs.

In light of these conditions, there is no indication that the current active hurricane era has ended. Instead, the El Niño-related reduction in activity likely represents a short-term break (similar to the1997 and 2002 El Niño years) from an ongoing string of active hurricane seasons that began in 1995.

3. NOAA's Seasonal Outlooks

NOAA's seasonal Atlantic hurricane outlooks issued in both May and early August over-predicted the 2006 Atlantic hurricane activity. The May outlook called for a very active season with 13-16 named storms, 8-10 hurricanes, 4-6 major hurricanes, and an ACE value of 135%-205% of the median. The August outlook called for less activity, with 12-15 named storms, 7-9 hurricanes, 3-4 major hurricanes, and an ACE value of 110%-170% of the median. For these forecasts, the probabilities of an above-normal season were placed at 80% and 75%, respectively.

These over-predictions largely reflected a failure to forecast the rapid development of El Niño that occurred during August and September. This marks the first time since inception in August 1998 that NOAA's August outlook over-forecasted the seasonal ACE value, and the second time that NOAA's May outlook over-forecasted the ACE value. The other instance was also related to a rapidly developing El Niño in 2002.

4. Summary

The near-normal 2006 Atlantic hurricane season was consistent historically with moderate El Niño conditions occurring during an active hurricane era. The El Niño developed rapidly during August and early September, and strengthened to moderate intensity during October-November. NOAA's over-predictions of the seasonal activity largely reflected the failure to forecast the rapidly developing El Niño.

Since 1995 only three seasons have not been in the above-normal range (1997, 2002, and 2006), and all three were associated with El Niño. During 2006 El Niño's main impacts included anomalous upper-level convergence and sinking motion across the Caribbean Sea. It is not clear why this signal was manifested mainly in the upper-level convergence and vertical motion fields, as opposed to the 200-850 hPa vertical wind shear, as is typical for most episodes.

Anomalous mid-latitude and tropical circulations also contributed to the decreased activity in the central MDR in August, and to the reduced activity over the Caribbean Sea in October. A combination of El Niño and the anomalous mid-latitude circulation resulted in the 3rd earliest end to TC activity since the satellite era began.

The 2006 season saw no landfalling hurricanes in the continental United States. A deep trough over the eastern U.S. in September helped to steer hurricanes far out to sea. The overall suppression of activity over the western part of the Atlantic Basin, due in part to El Niño, also contributed to fewer U. S. strikes.

Despite the reduced activity, many of the ongoing atmospheric and oceanic conditions that have favored very active hurricane seasons since 1995 were again in place during 2006. In fact, tropical Atlantic sea-surface temperatures were the second warmest on record during the peak months of the season. The reduced activity, in spite of this anomalous warmth, is consistent with previous findings indicating that local atmospheric circulation anomalies, rather than local SST anomalies, are the dominant contributor to seasonal fluctuations in Atlantic hurricane activity (Shapiro and Goldenberg 1998, Bell and Chelliah 2006).

The analysis provides no indication that the current active hurricane era has ended. Instead, it indicates that the El Niño-related reduction in activity merely represents a short-term break (similar to the1997 and 2002 El Niño years) from an ongoing string of active hurricane seasons that began in 1995.

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Professional Engineering Services Limited
Belize City, Belize, Central America.

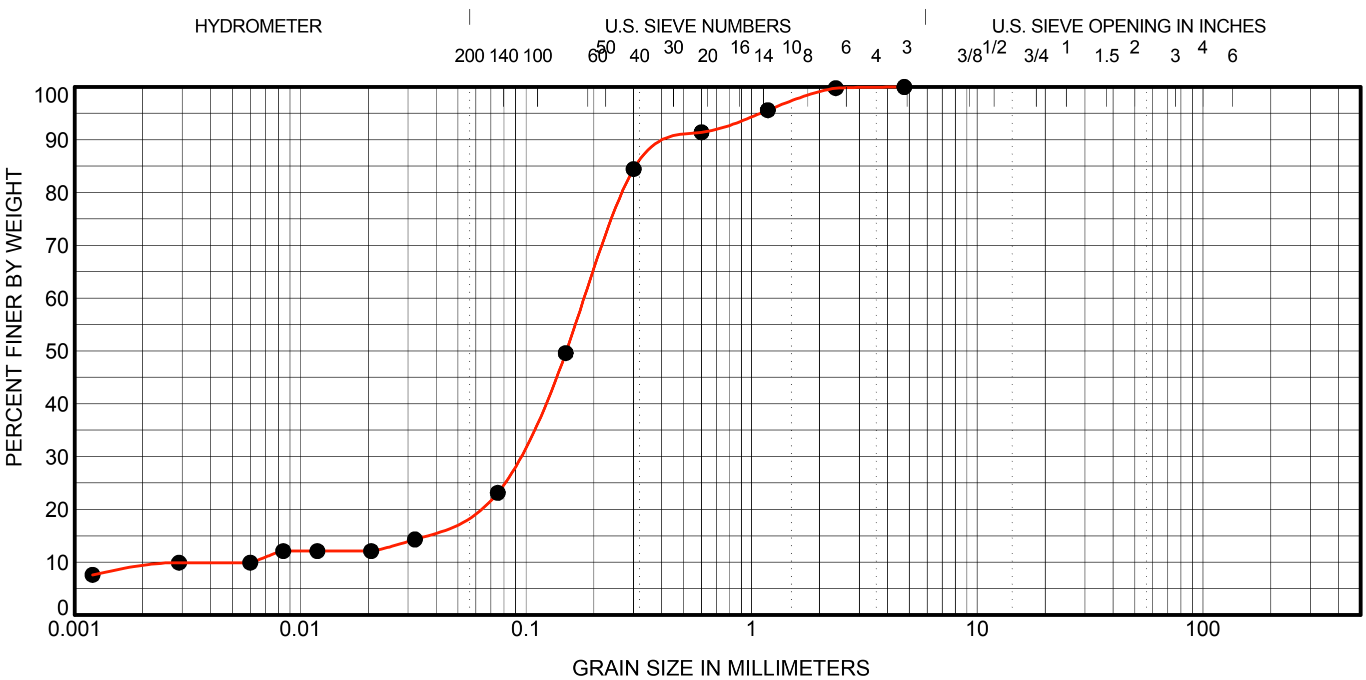
CLIENT: Ecoworks/Development & Environmental
PROJECT: Caye Caulker
JOB No.: 29005
LOCATION: Delivered Samples
SAMPLING DATE:

Addendum 11

HYDROMETER ANALYSIS TO ASTM D422-63

Sample Description:Silt with small shells

Graph Limits:



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Id		Classification	LL	PL	PI	Cc	Cu
●	**WP 117**	**0.0**	**SILTY SAND(SM)**	**20**	**NP**	**20**	**7.17**	**30.28**

	Specimen Id		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**WP 117**	**0.0**	**4.75**	**0.184**	**0.09**	**0.006**	**0.0**	**76.9**	**13.2**	**9.9**

Technician_______________________________ Supervisor_______________________________

PES_HYDROMETER_ANALYSIS 29005.GPJ PESNEW.GDT 19/7/07

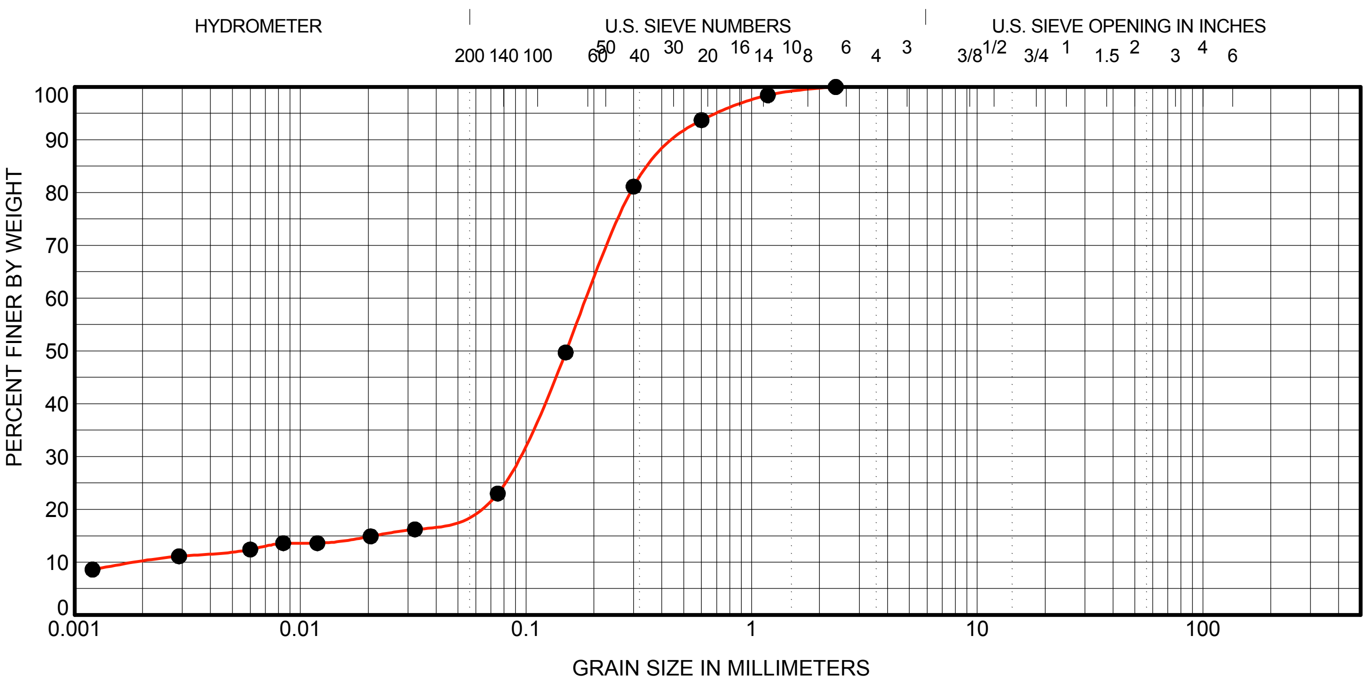
Professional Engineering Services Limited
Belize City, Belize, Central America.

CLIENT: Ecoworks/Development & Environmental
PROJECT: Caye Caulker
JOB No.: 29005
LOCATION: Delivered Samples
SAMPLING DATE:

HYDROMETER ANALYSIS TO ASTM D422-63

Sample Description:Silt

Graph Limits:



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Id		Classification	LL	PL	PI	Cc	Cu
●	**WP 118**	**0.0**	**SILTY SAND(SM)**	**20**	**NP**	**20**	**21.86**	**95.69**

	Specimen Id		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**WP 118**	**0.0**	**2.36**	**0.188**	**0.09**	**0.002**	**0.0**	**77.0**	**10.9**	**12.1**

Technician________________________ Supervisor________________________

PES_HYDROMETER_ANALYSIS 29005.GPJ PESNEW.GDT 19/7/07

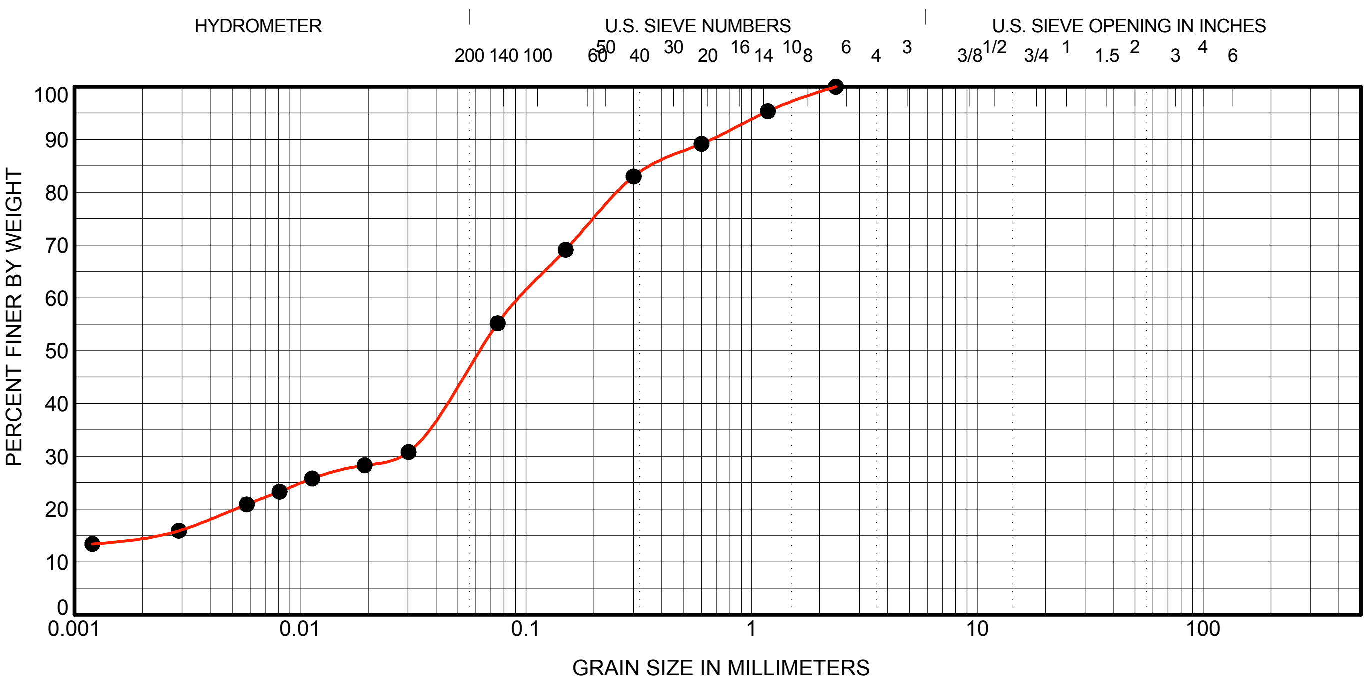
Professional Engineering Services Limited
Belize City, Belize, Central America.

CLIENT: Ecoworks/Development & Environmental
PROJECT: Caye Caulker
JOB No.: 29005
LOCATION: Delivered Samples
SAMPLING DATE:

HYDROMETER ANALYSIS TO ASTM D422-63

Sample Description:Silt

Graph Limits:



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Id		Classification	LL	PL	PI	Cc	Cu
●	**WP 119**	**0.0**	**SANDY SILT(ML)**	**20**	**NP**	**20**		

	Specimen Id		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**WP 119**	**0.0**	**2.36**	**0.095**	**0.026**		**0.0**	**44.8**	**35.4**	**19.8**

Technician________________________________ Supervisor________________________________

PES_HYDROMETER_ANALYSIS 29005.GPJ PESNEW.GDT 19/7/07

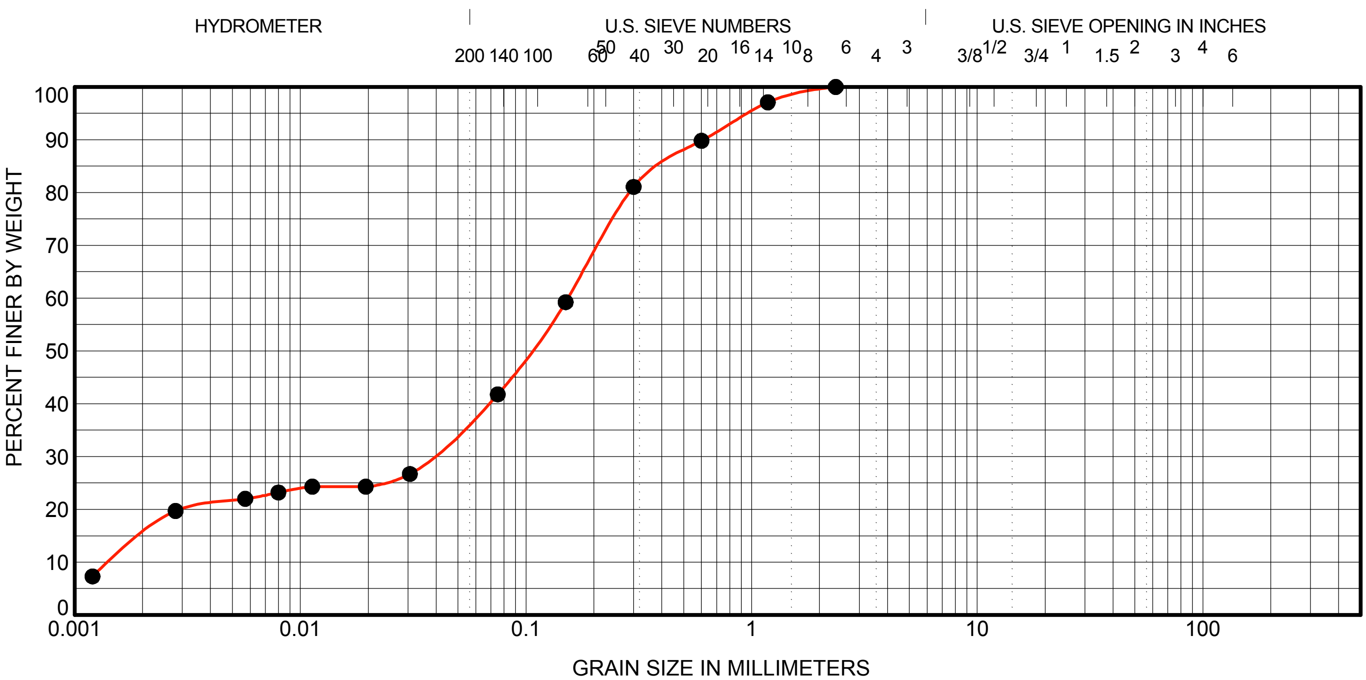
Professional Engineering Services Limited
Belize City, Belize, Central America.

CLIENT: Ecoworks/Development & Environmental
PROJECT: Caye Caulker
JOB No.: 29005
LOCATION: Delivered Samples
SAMPLING DATE:

HYDROMETER ANALYSIS TO ASTM D422-63

Sample Description:Silt

Graph Limits:



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Id		Classification	LL	PL	PI	Cc	Cu
●	**WP 120**	**0.0**	**SILTY SAND(SM)**	**20**	**NP**	**20**	**6.25**	**106.48**

	Specimen Id		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**WP 120**	**0.0**	**2.36**	**0.154**	**0.037**	**0.001**	**0.0**	**58.2**	**20.2**	**21.6**

Technician____________________________ Supervisor____________________________

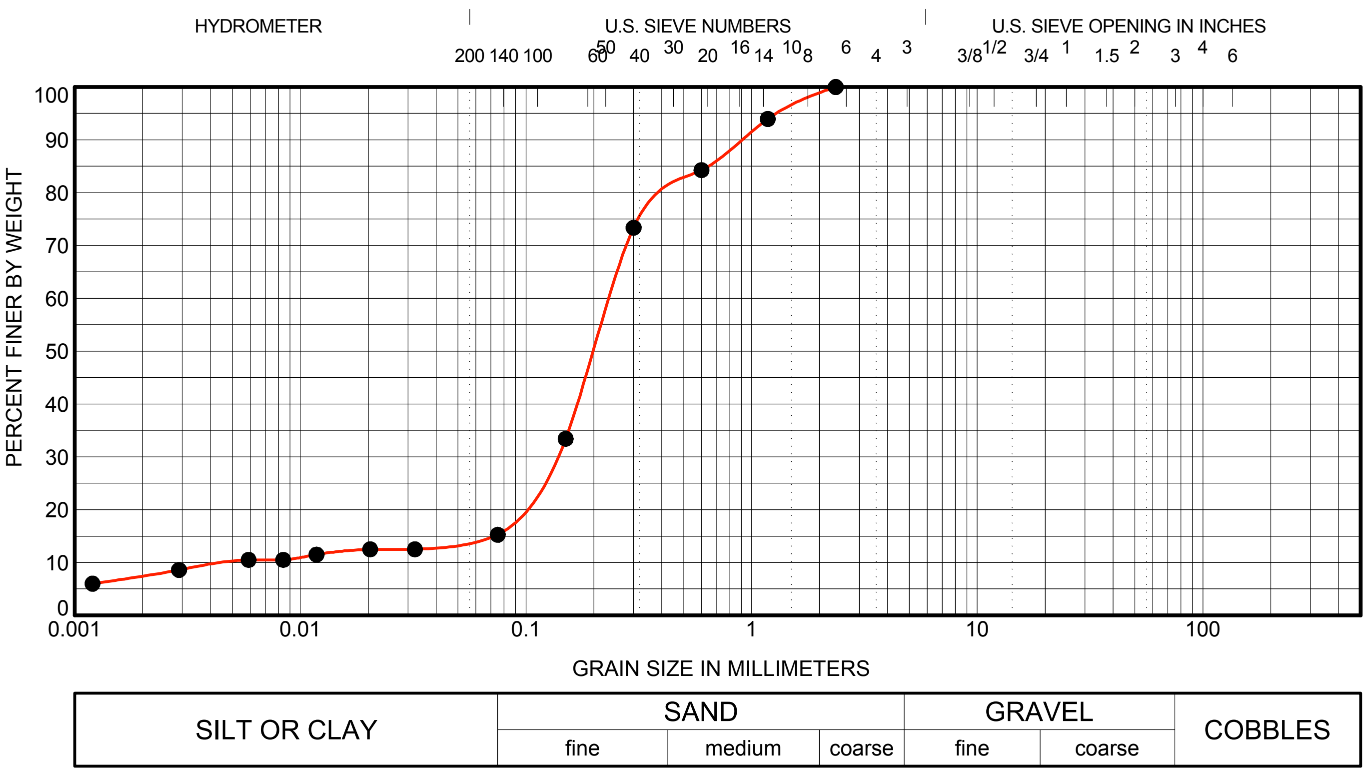
Professional Engineering Services Limited
Belize City, Belize, Central America.

CLIENT: Ecoworks/Development & Environmental
PROJECT: Caye Caulker
JOB No.: 29005
LOCATION: Delivered Samples
SAMPLING DATE:

HYDROMETER ANALYSIS TO ASTM D422-63

Sample Description:Silt

Graph Limits:



	Specimen Id		Classification	LL	PL	PI	Cc	Cu
●	**WP 121**	**0.0**	**SILTY SAND(SM)**	**20**	**NP**	**20**	**14.89**	**48.61**

	Specimen Id		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**WP 121**	**0.0**	**2.36**	**0.238**	**0.132**	**0.005**	**0.0**	**84.7**	**5.2**	**10.1**

Technician________________________________ Supervisor________________________________

PES_HYDROMETER_ANALYSIS 29005.GPJ PESNEW.GDT 19/7/07

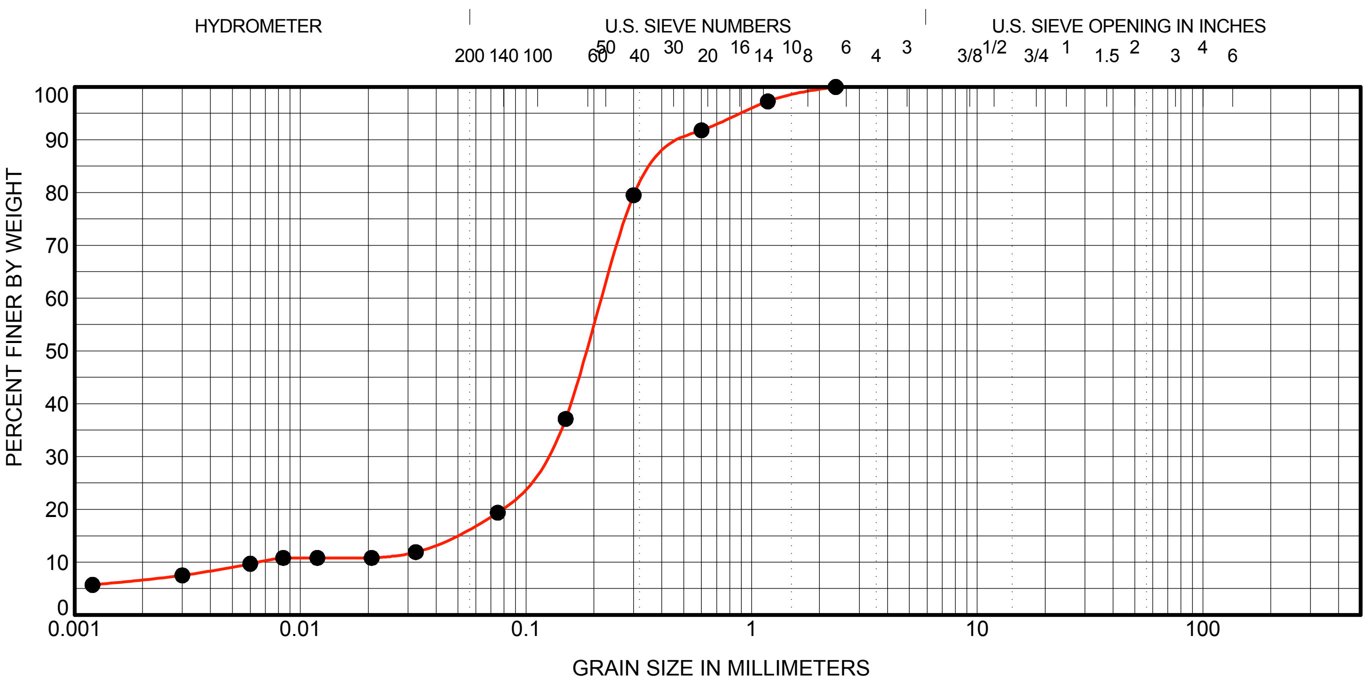
Professional Engineering Services Limited
Belize City, Belize, Central America.

CLIENT: Ecoworks/Development & Environmental
PROJECT: Caye Caulker
JOB No.: 29005
LOCATION: Delivered Samples
SAMPLING DATE:

HYDROMETER ANALYSIS TO ASTM D422-63

Sample Description:Silt

Graph Limits:



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Id		Classification	LL	PL	PI	Cc	Cu
●	**WP 123**	**0.0**	**SILTY SAND(SM)**	**20**	**NP**	**20**	**8.99**	**33.16**

	Specimen Id		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**WP 123**	**0.0**	**2.36**	**0.218**	**0.114**	**0.007**	**0.0**	**80.6**	**10.2**	**9.1**

Technician_______________________________ Supervisor_______________________________

PES_HYDROMETER_ANALYSIS 29005.GPJ PESNEW.GDT 19/7/07

**Professional
Engineering
Services
Limited**

10 August 2007

Ecoworks
Belmopan

Attn: Tom Grimshaw

Dear Sir:

Balam Soil Investigations
Estimate of settlements

As per your request, I have estimated the field densities and likely compacted densities for the underlying soils based on the classification for these materials. The attached table summarizes the results which show predicted maximum settlements varying from 100-300mm approximately depending on location.

We are currently performing supplementary tests on samples and may adjust the prediction in due course based on forthcoming data.

Yours truly,

EurIng Douglas P. Walker C.Eng., M.I.C.E., P.Eng (Belize)

#2 FIRST STREET, PO BOX 826, BELIZE CITY, BELIZE, CENTRAL AMERICA TEL +501-224-5659 FAX +501-223-0244 EMAIL PESL@BTL.NET

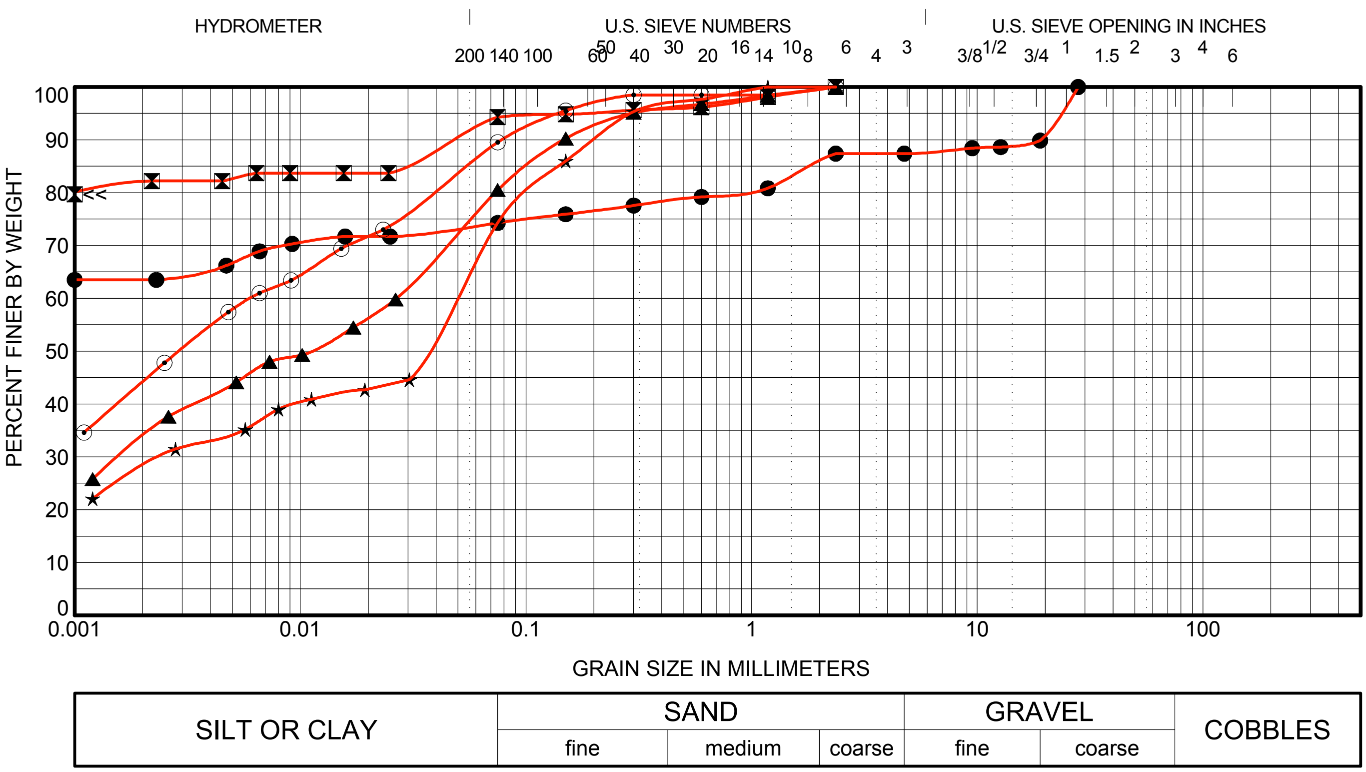
Professional Engineering Services Limited
Belize City, Belize, Central America.

CLIENT: Ecoworks/Development & Environmental
PROJECT: Bacam Jungle
JOB No.: 29006
LOCATION: Delivered Samples
SAMPLING DATE:

HYDROMETER ANALYSIS TO ASTM D422-63

Sample Description:

Graph Limits:



	Specimen Id		Classification	LL	PL	PI	Cc	Cu
●	**Site 1 - H2**	**0.0**	**SILT with SAND(ML)**	**NP**	**NP**	**NP**		
⧗	**Site 1 - H3**	**0.0**	**FAT CLAY(CH)**	**77**	**35**	**42**		
▲	**Site 2 - H1**	**0.0**	**ELASTIC SILT with SAND(MH)**	**97**	**51**	**46**		
★	**Site 2 - H3**	**0.0**	**FAT CLAY with SAND(CH)**	**77**	**35**	**42**		
⊙	**Site 3 - H2**	**0.0**	**SILT(ML)**	**NP**	**NP**	**NP**		

	Specimen Id		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**Site 1 - H2**	**0.0**	**28**				**12.6**	**13.1**	**7.6**	**66.7**
⧗	**Site 1 - H3**	**0.0**	**2.36**				**0.0**	**5.7**	**11.6**	**82.6**
▲	**Site 2 - H1**	**0.0**	**2.36**	**0.027**	**0.002**		**0.0**	**19.5**	**36.8**	**43.7**
★	**Site 2 - H3**	**0.0**	**2.36**	**0.049**	**0.002**		**0.0**	**25.7**	**39.8**	**34.5**
⊙	**Site 3 - H2**	**0.0**	**2.36**	**0.006**			**0.0**	**10.5**	**31.7**	**57.9**

Technician________________________________ Supervisor________________________________

PES_HYDROMETER_ANALYSIS 29006.GPJ PESNEW.GDT 10/8/07

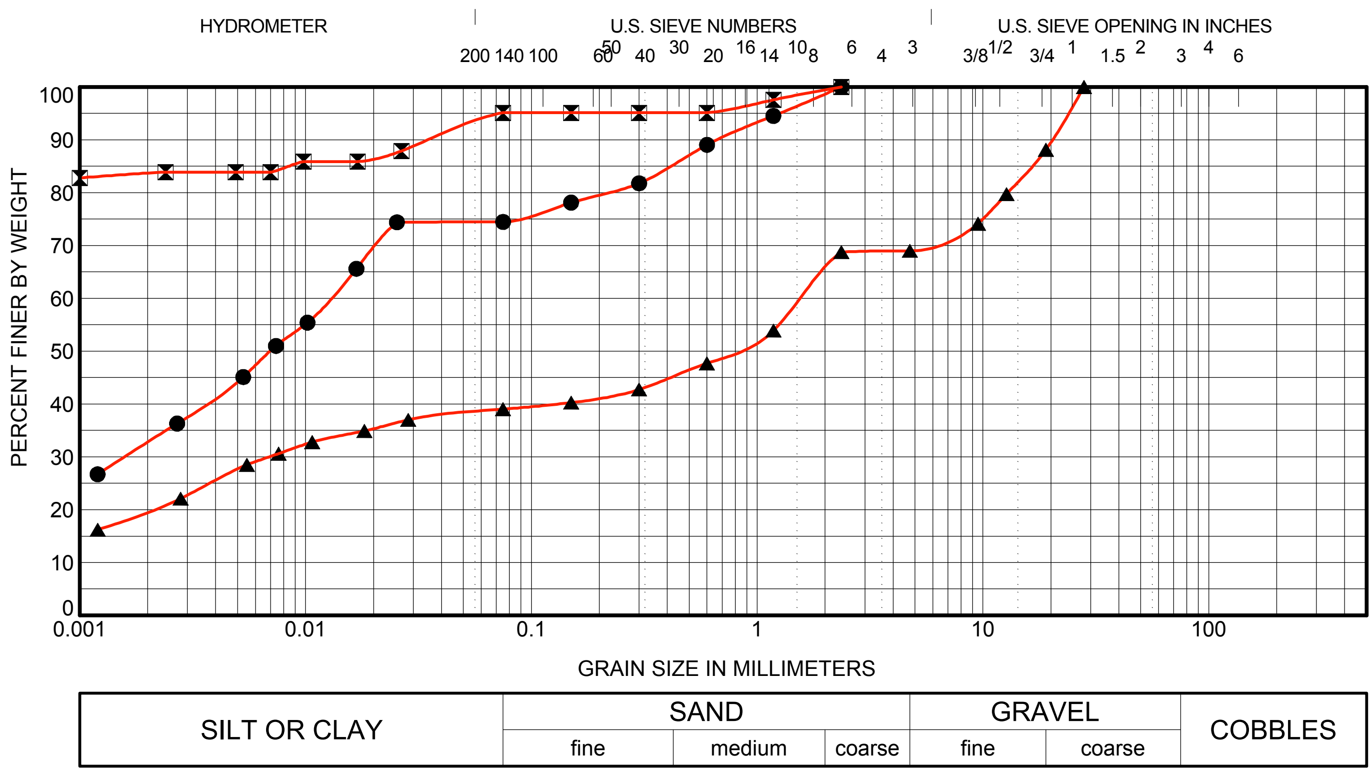
Professional Engineering Services Limited
Belize City, Belize, Central America.

CLIENT:	Ecoworks/Development & Environmental
PROJECT:	Bacam Jungle
JOB No.:	29006
LOCATION:	Delivered Samples
SAMPLING DATE:	

HYDROMETER ANALYSIS TO ASTM D422-63

Sample Description:

Graph Limits:



	Specimen Id		Classification	LL	PL	PI	Cc	Cu
●	**Site 5 - H3**	**0.0**	**FAT CLAY with SAND(CH)**	**107**	**43**	**64**		
⧗	**Site 6 - H2**	**0.0**	**FAT CLAY(CH)**	**107**	**43**	**64**		
▲	**Site 6 - H4**	**0.0**	**CLAYEY GRAVEL with SAND(GC)**	**41**	**23**	**18**		

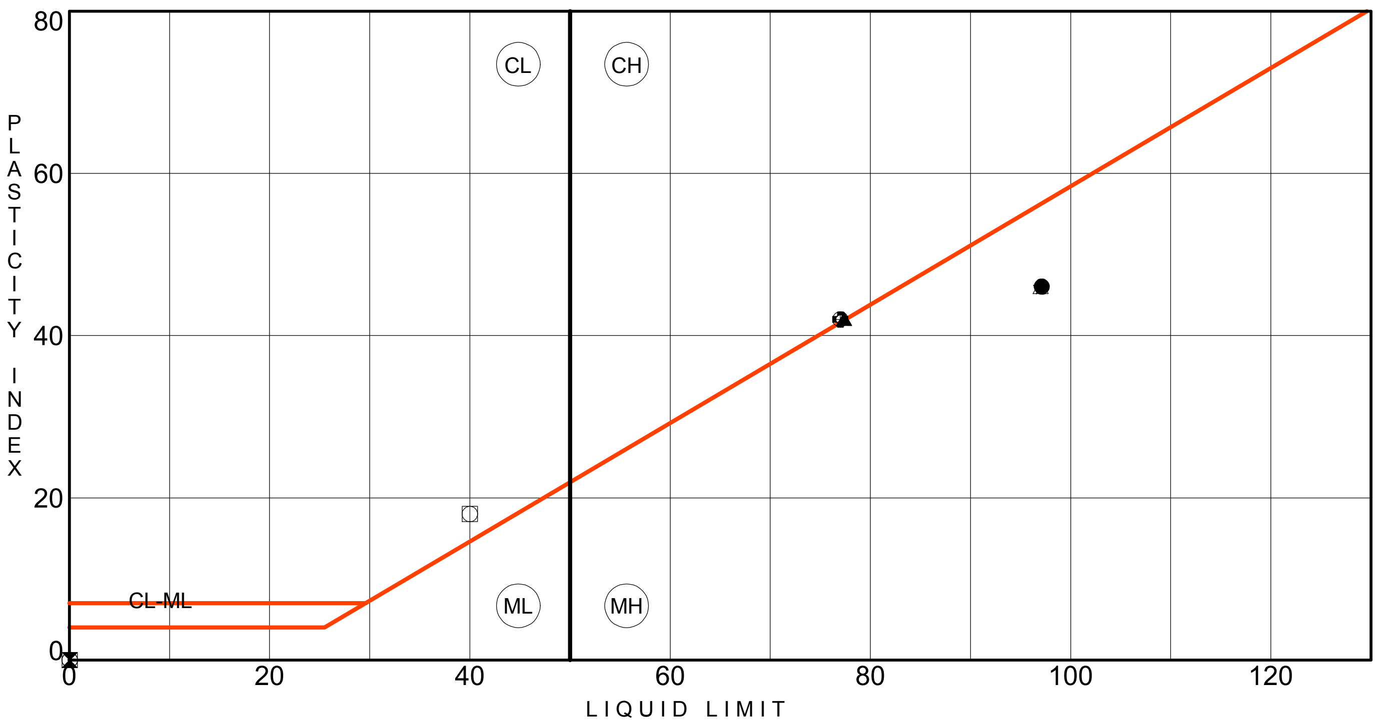
	Specimen Id		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**Site 5 - H3**	**0.0**	**2.36**	**0.013**	**0.002**		**0.0**	**25.5**	**30.1**	**44.3**
⧗	**Site 6 - H2**	**0.0**	**2.36**				**0.0**	**4.9**	**11.2**	**83.9**
▲	**Site 6 - H4**	**0.0**	**28**	**1.568**	**0.007**		**31.0**	**30.0**	**11.4**	**27.6**

Technician________________________________ Supervisor________________________________

Professional Engineering Services Limited
Belize City, Belize, Central America.

CLIENT: Ecoworks/Development & Environmental
PROJECT: Bacam Jungle
JOB No.: 29006
LOCATION: Delivered Samples
ELEV: N/A

ATTERBERG LIMITS TO ASTM



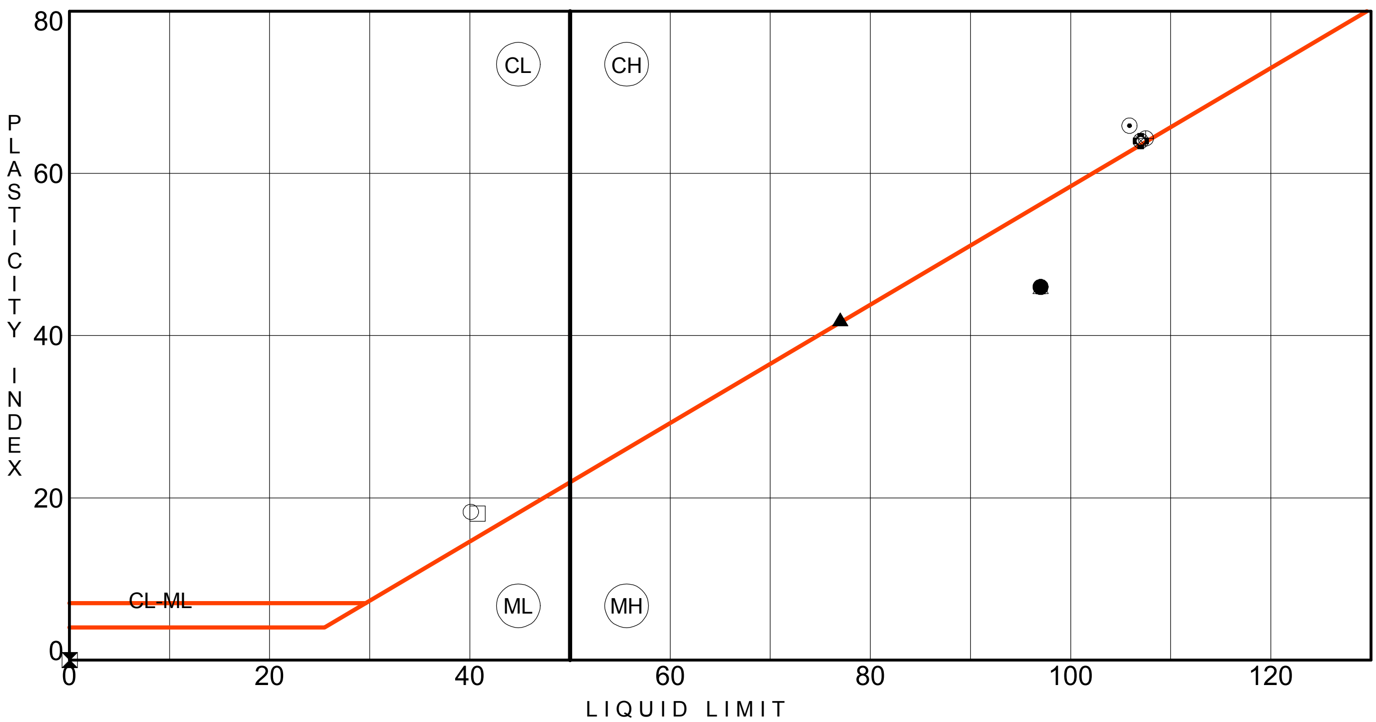
	Specimen Identification		LL	PL	PI	Fines	Classification
●	**Site 1 - H1**	**0.0**	**97**	**51**	**46**		
⧗	**Site 1 - H2**	**0.0**	**NP**	**NP**	**NP**	**74**	**SILT with SAND(ML)**
▲	**Site 1 - H3**	**0.0**	**77**	**35**	**42**	**94**	**FAT CLAY(CH)**
★	**Site 2 - H1**	**0.0**	**97**	**51**	**46**	**81**	**ELASTIC SILT with SAND(MH)**
⊙	**Site 2 - H2**	**0.0**	**NP**	**NP**	**NP**		
✿	**Site 2 - H3**	**0.0**	**77**	**35**	**42**	**74**	**FAT CLAY with SAND(CH)**
○	**Site 2 - H4**	**0.0**	**40**	**22**	**18**		
△	**Site 3 - H1**	**0.0**	**97**	**51**	**46**		
⊗	**Site 3 - H2**	**0.0**	**NP**	**NP**	**NP**	**90**	**SILT(ML)**
⊕	**Site 3 - H3**	**0.0**	**77**	**35**	**42**		

Technician________________________________ Supervisor________________________________

Professional Engineering Services Limited
Belize City, Belize, Central America.

CLIENT: Ecoworks/Development & Environmental
PROJECT: Bacam Jungle
JOB No.: 29006
LOCATION: Delivered Samples
ELEV: N/A

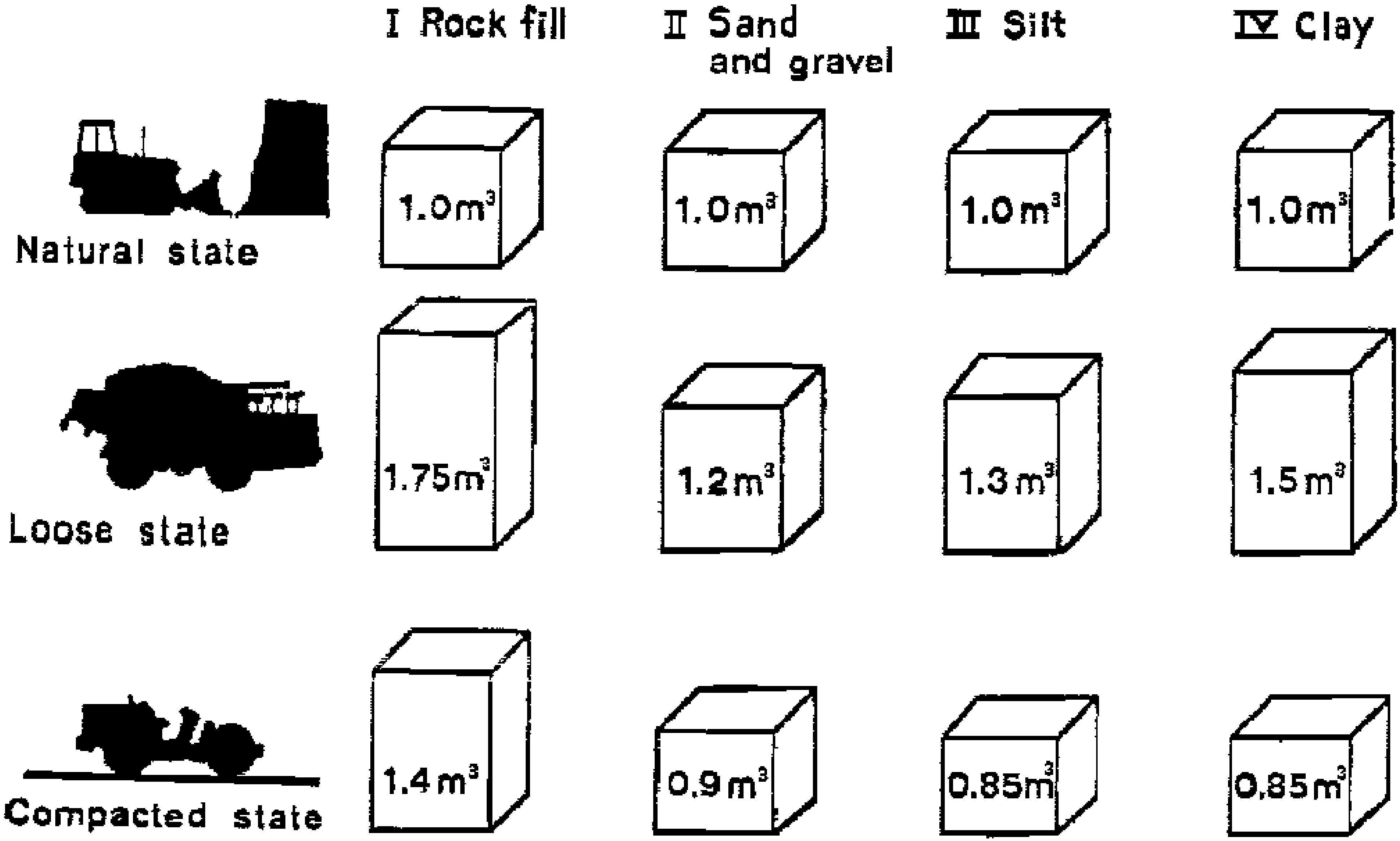
ATTERBERG LIMITS TO ASTM



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**Site 4 - H1**	**0.0**	**97**	**51**	**46**		
⧗	**Site 4 - H2**	**0.0**	**NP**	**NP**	**NP**		
▲	**Site 4 - H3**	**0.0**	**77**	**35**	**42**		
★	**Site 5 - H1**	**0.0**	**97**	**51**	**46**		
⊙	**Site 5 - H2**	**0.0**	**106**	**40**	**66**		
✪	**Site 5 - H3**	**0.0**	**107**	**43**	**64**	**74**	**FAT CLAY with SAND(CH)**
○	**Site 5 - H4**	**0.0**	**40**	**22**	**18**		
△	**Site 6 - H1**	**0.0**	**97**	**51**	**46**		
⊗	**Site 6 - H2**	**0.0**	**107**	**43**	**64**	**95**	**FAT CLAY(CH)**
⊕	**Site 6 - H3**	**0.0**	**108**	**43**	**65**		

Technician_________________________ Supervisor_________________________

SITE	HORIZON	LAYER DEPTH mm	NATURAL MOISTURE %	MAX DRY DENSITY kg/m3	NATURAL DENSITY %	COMPACT R.D. %	COMPACT DENSITY kg/m3	VOLUME CHANGE %	THICKNESS CHANGE mm	LAYER DESCRIPTION	TOTAL SETTLEMENT mm
1	1	152	45.6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Black Topsoil	
	2	432	55.5	1600	1386	95	1520	9.7%	42	Brown Silt with Sand	
	3	508	53.5	1900	1586	95	1805	13.8%	70	Yellow Brown Fat Clay	
	4	152	40	1700	1500	95	1615	7.7%	12	White Marl	124
2	1	76	56.3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Black Topsoil	
	2	1753	47.8	1950	1643	95	1853	12.8%	224	Grey Fat Clay with Sand	224
3	1	76	68.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Black Topsoil	
	2	584	60.5	1600	1374	95	1520	10.6%	62	Light Grey Silt	
	3	1118	257.6	1400	1112	95	1330	19.6%	219	Organic Soil with Shells	281
4	1	102	158.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Black Topsoil	
	2	305	140.1	1900	1375	95	1805	31.3%	95	Light Grey Fat Clay	
	3	864	14.8	1900	1784	95	1805	1.2%	10	Light Grey Fat Clay	106
5	1	51	93.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Black Topsoil	
	2	559	105.1	1900	1439	95	1805	25.5%	142	Brown Fat Clay	
	3	762	45.8	1950	1652	95	1853	12.2%	93	Brown Fat Clay with Sand	
	4	203	36.5	1650	1476	95	1568	6.2%	13	White Clayey Sand with Gravel	247
6	1	51	75.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Black Topsoil	
	2	203	106.5	1900	1436	95	1805	25.7%	52	Brown Fat Clay	
	3	229	58	1900	1570	95	1805	15.0%	34	Orange/Yellow Fat Clay	
	4	254	42.2	1650	1457	95	1568	7.6%	19	White Clayey Gravel with Sand	
	5	305	40	1700	1500	95	1615	7.7%	23	White Marl	129


I Rock fill
II Sand and gravel
III Silt
IV Clay
Natural state
Loose state
Compacted state
1.0m³
1.75m³
1.4m³
1.0m³
1.2m³
0.9m³
1.0m³
1.3m³
0.85m³
1.0m³
1.5m³
0.85m³

Addendum 13

ATTN: Mr. Tom Grimshaw.

BELIZE BREWING COMPANY LIMITED
WATER and WASTEWATER LABORATORY

Sample ID:

DATE: 27 June, 2007

INORGANIC CHEMISTRY

PHYSICAL	UNIT	METHOD	RESULTS				
			WP117	WP118	WP119	WP120	WP123
COLOUR, TRUE	units	Platinum - Cobalt Standard/ UV VIS Spectro					
COLOUR, APPARENT	units	Platinum - Cobalt Standard/ UV VIS Spectro					
CONDUCTIVITY	µs/cm	CONDUCTIVITY (probe)					
LANG. INDEX	units	Calculated/ Titration					
OIL IN WATER	ppm						
pH	unit	pH/ISE meter (probe)					
SILT DENSITY INDEX (SDI)	units	Filtration					
SUSPENDED SOLIDS (SS)	ppm	Colorimeter	28	29	58	31	21
TEMPERATURE (IN LAB)	°C	Probe/Termometer					
TOTAL DISSOLVED SOLIDS (TDS)	ppm	CONDUCTIVITY (probe)					
TURBIDITY	ntu	Nephelometric -Tungsten	14.57	14.93	21.3	19.8	20.6
METALS	**UNIT**	**METHOD**					
ALUMINUM (Al)	ppm	Aluminon/UV VIS Spectro					
BARIUM (Ba)	ppm	Turbidimetric/ UV VIS Spectro					
BROMINE (Br)	ppm	DPD/ UV VIS Spectro					
CALCIUM (Ca)	ppm	UV VIS Spectro/ Titration					
CHROMIUM (Cr) **	ppm	1,5-Diphenylcarbohydrazide/UV VIS Spectro					
COPPER (Cu)	ppm	Bicinchoninate/ UV VIS Spectro	1.56	1.3	1.24	1.36	1.48
IRON, TOTAL (Fe)	ppm	UV VIS Spectro					
LEAD (Pb) **	ppm	Dithizone/ UV VIS Spectro					
MANGANESE (Mn)	ppm	Periodate Oxidation/UV VIS Spectro					
MAGNESIUM (Mg)	ppm	UV VIS Spectro / Titration					
MERCURY (Hg) **	ppm	Cold Vapor					
SELENIUM (Se) **	ppm	Diaminobenzidine/ UV VIS Spectro					
SILVER (Ag) **	ppm	Colorimetric/ UV VIS Spectro					
SODIUM (Na)	ppm	Probe					
ZINC (Zn)	ppm	Zincon/ UV VIS Spectro					
NON-METALS	**UNIT**	**METHOD**					
CHLORINE, FREE (Cl)	ppm	UV VIS Spectro /DPD					
CHLORINE, TOTAL (Cl)	ppm	UV VIS Spectro/DPD					
FLUORIDE (F)	ppm	SPADNS/UV VIS Spectro					
NITROGEN, TOTAL (N)	ppm	Cadmium Reduction/ UV VIS Spectro	N/D	N/D	N/D	N/D	N/D
DISSOLVED OXYGEN (DO)	ppm	PROBE					
PHOSPHORUS, TOTAL (P)	ppm	PhosVer / Orthophosphate/ UV VIS Spectrc	0.07	0.04	0.09	0.03	0.09
INORGANIC COMPOUNDS	**UNIT**	**METHOD**					
ACIDITY (as $CaCO_3$)	ppm	Titration					
AMMONIA (NH_3)	ppm	Salicylate / Probe	N/D	N/D	N/D	N/D	N/D
BICARBONATE (HCO_3)	ppm	Titration					
CARBON DIOXIDE (CO_2)	ppm	Titration					
CARBONATE (CO_3)	ppt	Titration					
CHLORIDE (Cl)	ppm	Mercuric Nitrate					
CHROMATE (CrO_4)	ppm	Titration					
CYANIDE (CN)	ppm	Pyridine-Pyrazalone/ UV VIS Spectro					
TOTAL HARDNESS (as $CaCO_3$)	ppm	EDTA Titration/ UV VIS Spectro					
HYDROGEN SULFIDE (H_2S)	ppm	Titration / UV VIS Spectro					
HYPOCHLORITE (BLEACH)	ppm	Titration					
M ALKALINITY(TOTAL), (as $CaCO_3$)	ppm	Sulfuric acid titration					
NITRATE (NO_3)	ppm	Cadmium Reduction/ UV VIS Spectro					
NITRATE NITROGEN (NO_3-N)	ppm	Cadmium Reduction/ UV VIS Spectro					
NITRITE (NO_2)	ppm	Diazotization/ UV VIS Spectro					
HYDROXIDE ALKALINITY (OH)	ppm	Titration					
OZONE (O_3)	ppm	Indigo Trisulfonate/ UV VIS Spectro					
PHENOLPHTHALEIN ALKALINITY (as $CaCO_3$	ppm	Sulfuric acid titration					
PHOSPHATE (PO_4)	ppm	PhosVer / Orthophosphate/ UV VIS Spectro					
SALINITY	ppt	Mercuric Nitrate titration					
SILICA (SiO_2)	ppm	Smcomolybdate/Colometric	9.2	6.5	3.2	3.4	10.2
SODIUM CHLORIDE (NaCl)	ppm	UV VIS Spectro / Titration					
SULFIDE ($S^{=}$)	ppm	Methylene Blue Titration					
SULFITE (SO_3)	ppm	Titration					
SULPHATE (SO_4)	ppm	Sulfa Ver 4/ UV VIS Spectro					

ORGANIC CHEMISTRY

OXYGEN DEMAND, BIOCHEMICAL (BOD_5)	mg/l	BODTRAK / 5 days Digestion					
OXYGEN DEMAND, CHEMICAL (COD)	mg/l	Reactor Digestion					
ORGANIC	1/cm	Direct method/ UV VIS Spectro					
ORGANIC CARBON, TOTAL (TOC)	ppm	Direct method/UV VIS Spectro	55	65	75	80	90
TRIHALOMETHANES (THMs)	ppb	Chloroform/UV VIS Spectro					

MICROBIOLOGICAL ANALYSIS

	UNIT	METHOD					
TOTAL COLIFORM	count	m-Endo (MF)	58/100ml	39/100ml	104/100ml	T.N.T.C	T.N.T.C
ESCHERICHIA COLI (E.coli)	count	m-Endo (MF)					
FECAL COLIFORM	count	m-FC/ROSOLIC Broth (MF)	3/100ml	3/100ml	2/100ml	0/100ml	2/100ml
ENTEROCCOCCI	count	m-EL Broth (MF)					
YEAST	count	R. B. Agar (MF)					
MOLD	count	R. B. Agar (MF)					

Analyst: Damian Espat

N.B.
T.N.T.C = Too Numerous to Count

SIGNATURE________________

Appendix 1 To The RBA By Young, et al 2007: Comprehensive Species List Of The Flora Occurring In The Balam Jungle Estate

SCIENTIFIC NAME	LOCAL NAME
ANACARDIACEAE	
Astronium graveolans	Jobillo
Metopium brownei	Black Poison Wood; Chechem
Spondias mombin	Hogplum
Spondias purpurea	May Plum
ANNONACEAE	
Annona glabra	Gobapple
Annona primigenia	Wild Custard Apple
Annona scleroderma	Willdcustard apple
Annona sp.	Annona
Guatteria diospyroides	Wild Orange
Malmea depressa	Wild Orange
ARISTLOCHIACEAE	
Aristolochia maxima	Guaco
APOCYNACEAE	
Aspidosperma megalocarpon	Mylady
Cameraria latifolia	White poisonwood
Stemmadenia donnell-smithii	Cojotone
Plumeria multiflora	Wild Frangipani
Tabernaemontana alba	Dog Tone
Thevetia ahouai	Dog Balls
ARACACEAE	
Acoelorraphe wrightii	Palmeto; Primenta
Attalea cohune	Cohune
Bactris major	Poke-and-dough boy
Bactris mexicana	Warrie Hones
Crysophilia staurocantha	Give and Take
Desmoncus orthocanthos	Basket-ti-tie
Roystonea regia	Royal Palm; Cabbage Palm
Sabal yaba	tiger bayleaf
Sabal mauritiformis	Bay leaf
Thrinax radiata	Salt Water Palmeto
ARACEAE	
Anthurium sp.	Bird nest
Monstera deliciousa	belly full ti-tie
ARALIACEAE	
Dendropanax arboreus	White gombolimbo; Kill Man
ASTERACEAE	
Borrichia frutescens	Sea Oxeye
SCIENTIFIC NAME	**LOCAL NAME**
Neurolaena lobtata	Jack Ass Bitters
Pluchea odorata	Mountain Cow Bush
Sphagneticola trilobata	Rabitt's Paw

AVICENNIACEAE

Avicennia germinans	Black Mangrove

BIGNONIACEAE

Amphitecna latifolia	Wid Calabash
Arrabidaea chica	Spice Ti-tie
Arrabidaea corallina	Mahognay Vine
Crescentia cujute	Calabash
Macfadyena uncata	Guana Ti-tie
Tabebuia guyacaban	Cortez

BATACEAE

Batis maritima	Batis

BIXACEAE

Cochlospermum vitifolium	Dry Weather Cotton

BOMBACACEAE

Ceiba aesculifolia	Unknown
Ceiba pentandra	Cotton tree; Kapok
Ochroma pyrimidale	Polak
Pseudobombax ellipticum	Mapola
Quararibea sp.	Guavabillo

BORAGINACEAE

Bourerria oxyphyllaria	Wild Craboo
Cordia dodecandra	Zericote
Cordia stillifera	Jekwood; Swivel Stick
Cordia diversiflora	Cordia
Heliotropium curassavicum	Scorpion Tail
Tournefortia hirsuitissima	Crocos Bush

BOMBACACEAE

Ceiba aescufolia	
Ceiba pentandra	Cotton tree; Kapok
Pseudobombax ellipticum	
Quararibea funebris	Swivel stick tree

BROMELIACEAE

Aechmea magdalenae	
Bromelia pinguin	pinguin; wild pinaple
Tillandsia sp.	

BURSERACEAE

Bursera simarouba	Red gombolimbo; gombolimbo
SCIENTIFIC NAME	**LOCAL NAME**
Protium copal	Copal

CACTACEAE

Rhipsalis baccifera	Cat Guts

CARICACEAE

Jacaratia dolichaula	Wild Papaya

CHENOPODIACEAE

Salicornia bigelovii	Salicornia

CHRYSOBALANACEAE	
Chrysobalanus icaco	Coco Plum
Hirtella americana	Pigeon plum
Hirtella racemosa	Pigeon plum
Hirtella guatemalensis	Pigeon plum
Licania sp.	Pigeon plum
CLAUSIACEAE	
Calophyllum brasiliense	Santa maria
Clausia rosea	Clausia
Vismia macrophylla	Ring-worm bush
COMBRETACEAE	
Bucida buceras	Bullet Tree
Bucida spinosa	spiny bullet tree
Conocarpus erectus	Button wood
Conocarpus erustus var. silveri	Silver Button wood
Laguncularia racemosa	White mangrove
COMMELINACEAE	
Tradescanthia spathacea	Moses in the Cradle
CONVULVULACEAE	
Ipomoea alba	Morning Glory
CUCURBITACEAE	
Momordica charantia	Sersi; Serosi
unknown sp.	Maklala Watermelon
CYADACEAE	
Zamia loddigesi	Bull rush
Zamia sp.	Bull Rush
CYPERACEAE	
Cladium jamaicense	Sawgrass
Eleocharis geniculata	Reed
Eleocharis intersticta	Sedge
Eleocharis sp.	Sedge
SCIENTIFIC NAME	**LOCAL NAME**
Sclera bracteata	Sawgrass
DILLENIACEAE	
Davilla kunthii	Yaha
Doliocarpus sp.	Yaha
EUPHORBIACEAE	
Croton schiedeanus	Wild Cinnamon
EBENACEAE	
Diospyros salicifolia	Sillion
ERYTHROXYLACEAE	
Erythroxylum guatemalensis	Redwood
ELAEOCARPACEAE	

Sloanea tuerckheimii ?	Wild atta

EUPHORBIACEAE

Chamaesyce hirta	Chicken weed
Chamaesyce hyssopifolia	Chicken weed
Cnidoscolus souzae	Mountain Cow Cowitch
Cnidoscolus urens	Mountain Cow Cowitch
Drypetes brownii	Male BullHoff
Gymnanthes lucida	Pee

FABACEAE

Abarema idiopodum	Salam
Acacia colliisii	Black Cockspur
Acacia cornigera	White Cockspur
Acacia dolichostachya	Hesmo; Wild Tambran
Acacia sp.	Acacia
Bauhinia divaricata	Cow Hoof
Bauhinia herare	Goat Hoff
Bauhinia jennengsii	Goat Hoff
Bauhinia ungulata	Cat Face
Caesalpinia gaumeri	Waree Wood
Cassia grandis	Stinking toe-bokut
Dalbergia glabra	Logwood Brush
Desmodium adscendens	Strong Back
Diphysa cartaginensis	Wild ruda
Enterolobium cyclocarpum	Guanacaste
Gliricidia sepium	Madre de cacao
Haematoxylon campechianum	Logwood
Inga vera	High Ridge Bri-Bri; Tama Tama
Inga sp.	Bri-Bri?
Lonchocarpus castilloi	Mancich Cabbage Bark
Lonchocarpus guatemalensis	Dogwood
Lonchocarpus rogusus	Black Cabbage Bark
SCIENTIFIC NAME	**LOCAL NAME**
Lysiloma latisiliqum	Salam
Machaerium kegelii	Blood-ti-tie
Mimosa hemiendyta	Catzim
Ormosia sp.	Hormigo
Piscidia piscipula	Jabin
Pithecellobium erythrocarpum	Red Fowl
Pithecellobium pachypus	Red Fowl
Pithecellobium sp.	Red Fowl
Pithecellobium stevensonii	Red Fowl
Platymiscium yucatanum	Granadillo
Swartzia cubensis	Bastard Rosewood; Northern Rosewood
Vatairea lundellii	BitterWood

FLACOURTIACEAE

Caseria corymbosa	Paletito
Laetia procera	Laetia
Laetia thaminea	Laetia
Zuelania guidonia	Drunken Bayman Stick

JUNCACEAE

Juncus marginatus	Sword Grass

LAURACEAE	
Cassytha filiformis	Jaundice Ti-tie
Nectandra sp.	Laurel
Nectandra cuspidata	Timber sweet
Nectandra lundellii	Laurel
Licaria peckii	Timber sweet
Licaria sp.	Timber sweet
LOGANIACEAE	
Strychnos panamensis	Snake Vine
Strychnos brachistantha	Chicoloro
LORANTHACEAE	
Phoradendron sp.	Scorn-de-Earth
Struthanthus sp.	Scorn-de-Earth
MALPIGHIACEAE	
Byrsonima crassifolia	Craboo
Brysonima bucidifolia	Deer Craboo; Sapra
MALVACEAE	
Hampea euryphylla	Broad Leaf Moho
Hampea trilobata	Moho
Malvaviscus arborescens	Wild Hibiscus
MELASTOMATACEAE	
Henrietta sp.	Sugar Loaf
SCIENTIFIC NAME	**LOCAL NAME**
Miconia affinis	Miconia
Miconia sp.	Miconia
Mouri exilis	Cherry Berry
Mouri myrtilloides	Fine Leaf Cacho
MELIACEAE	
Cedrela odorata	Cedar
Swietenia macrophylla	Mahogany
Trichilia havanensis	Wild Lime
Trichilla pallida	Cardon del Rio
Trichilia sp.	Wild Lime
MENISPERMEACEAE	
Hyperbaena winzerlingii	Juk Mi Back
MORACEAE	
Brosimum alicastrum	Breadnut; Ramon
Castilla elastica	Wild Rubber; Rubber
Cecropia peltata	Trumpet Tree
Ficus aurea	Fig
Ficus glabrata	Fig
Ficus lapathifolia	Strangler Fig
Ficus maxima	Hicatee Fig
Ficus sp.	Fig
Ficus sp.	Strangler Fig
Ficus sp.	Strangelr Fig
Pseudolmedia spuria	Wild cherry
Trophis mexicana	Ramon

Trophis racemosa	Ramon
MYRICACEAE	
Myrica cerifera	Tea Box
MYRSINACEAE	
Ardisia sp.	Ardsia
MYRTACEAE	
Eugenia sp.?	Gooseberry
Eugenia buxifolia?	Wild Guava
Eugenia sp.	Wild Guava
Pimenta dioica	All Spice
OCHNACEAE	
Ouratea lucens	Laurel
Ouratea nitida	Bastard Blossom Berries
ORCHIDACEAE	
Brassavola nodosa	Orchid
Myrmecophila tibicinis	Cow-horn orchid
SCIENTIFIC NAME	**LOCAL NAME**
PASSIFOLRACEAE	
Passsiflora belizensis	Passionvine
Passifolra sp.	Passionvine
Passifolra sp.	Passionvine
PIPERACEAE	
Piper amalago	Buttonwood
Piper auritum	Sweet Cowfoot
Piper hispidum	Buttonwood
Piper jacquemontianum	Spanish Elder
Piper aduncum	Sapnish Elder
POACEAE	
Distlichis spicata	Salt march grass
Merostachys pauciflora	Grass
Spartina spartinae	Swordgrass
POLYGONACEAE	
Coccoloba beliziensis	Wild Grape
Coccoloba cozumelensis	Wild Grape
Coccoloba hondurensis	Wild Grape
Coccoloba diversifolia	Wild Grape
Coccoloba spicata	Wild Grape
Coccoloba sp.	Wild Grape
Gymnopodium floribundum	Wild Grape
RHIZOPHORACEAE	
Cassipourea guianensis	Water Wood
Rhizophora mangle	Red Mangrove
RUBIACEAE	
Alibertia edulis	Sol Sol
Guettarda combsii	Glassywood
Hamelia patens	Polly Red Head
Morinda royoc	Wart vine

Psychotria fruticetorum	turtle bones
Psychotria glomerulata	Anal
Randia armata	Wild Lime
Simira salvadorensis	Jancro Red Wood

RUTACEAE

Zanthoxylum panamense	Prickly Yellow
Zanthoxylum riedelianum	Prickly Yellow
Zanthoxylum setulosum ?	Prickly Yellow

SAPINDACEAE

Allophyllus cominia	Cherry
Cupania belizensis	Bastard Grande Betty
Cupania rufescens	White Grande Betty
Matayba oppositifolia	Boy Job
Talisia sp.	
Thouinia sp.	

SAPOTACEAE

Chrysophyllum mexicanum	Wild Star Apple
Manilkara chicle	Macho Sapadilla
Manilkara zapote	Sapailla
Pouteria amygdalina	Sillion; Silly Young
Pouteria campechiana	Black Mamee Ciruela
Pouteria mammosa	Mamee Ciruela
Pouteria reticulata	Sapotillo

SIMAROUBACEAE

Simarouba glauca	Negrito

SMILACEAE

Smilax ornata	Red chiny root
Smilax sp.	chiny root

SOLONACEAE

Physalis ungulata	Bird egg ; hissop
Cestrum nocturnum	night bloom
Solanum ruddepannum	Solanum
Solanum rugosum	Bird egg
Solanum torvum	Susumba

STERCULIACEAE

Guazuma ulmifolia	Bay Cedar

THREOPHRASTACEAE

Jaquinia macrocarpa	Juk mi back

TILIACEAE

Heliocarpus mexicanus	Moho
Luehea seemannii	Mapola
Luehea speciosa	Mountain Moho
Muntingia calabura	Moho
Trichospermum grewiifolium	Narrow Leaf Moho

ULMACEAE

Celtis schippii	Female Bullhoff
Trema micrantha	Capulin; bastard baycedar

VERBENACEAE

Citharexylum caudatum	Pigeon Berrries
Petra volubilis	Lava platos
Vitex gaumeri	Fiddle Wood

SCIENTIFIC NAME	**LOCAL NAME**
VIOLACEAE	
Rinorea hummelii	Wild Coffee
Rinorea guatemalensis	Wild Coffee
VITACEAE	
Cissus gossypiifolia	Rooster's crest
Vitis tiliifolia	Water vine

Appe

Annex 7. Glossary of Registered Species & Common Names

No	Commercial Group	Species		
		Common Name (Guatemala)	Common Name (Belize)	Scientific Name
1	ACT	Amapola	Mapola	*Pseudobombax ellipticum*
2	POT	Baquelac		*Laetia thamnia*
3	POT	Baqueman		
4	POT	Botoncillo		
5	AAA	Caoba	Mahogany	*Swietenia macrophylla*
6	POT	Cascario		
7	ACT	Catalox		*Swartzia lundellii*
8	ACT	Chacaj blanco		*Bursera graveolens*
9	ACT	Chacaj colorado	Red Gombolimbo	*Bursera simaruba*
10	POT	Chacpon		
11	POT	Chaltecoco		*Caesalpinia velutina*
12	POT	Chechen blanco		*Sebastiana Longicuspis*
13	ACT	Chechen negro	Black Poisonwood,	*Metopium brownei*
14	ACT	Chico zapote	sapodilla	*Manilkara zapota*
15	POT	Chilonche		*Eugenia capuli*
16	POT	Chojche		
17	POT	Chonte	Grande betty	*Cupania macrophylla*
18	POT	Copal	Copal	*Protium Copal*
19	POT	Cortez		*Tabebuia ochracea*
20	POT	Desconocido		
21	POT	Frijolillo		
22	POT	Gesmo		*Lysiloma sp.*
23	POT	Guacimo		
24	POT	Guatop		
25	POT	Guaya		*Talisia olivaeformis*
26	POT	Guayabillo		*Colubrina hetereneura*
27	POT	Jabin	Dogwood	*Piscidia piscipula*
28	POT	Jaboncillo		
29	POT	Jobo	Hog plum	*Spondias mombin*
30	POT	Laurel	salmwood	*Cordia alliodora*
31	POT	Madre cacao	Madre cacao	Gliricidia sepium
32	POT	Manax	Cherry	*Pseudolmedia panamensis*
33	ACT	Manchiche	Black Cabbage Bark	*Lonchocarpus castilloi*
34	ACT	Mano de leon	White Gombolimbo	*Dendropanax arboreum*
35	POT	Manzanillo		
36	POT	Occhuul		
37	POT	Palo de agua		
38	POT	Palo de coche		
39	POT	Papaturrito		*Coccoloba reflexiflora.*
40	POT	Papaturro	Wild grape	*Coccoloba sp.*
41	POT	Pasaque hembra	Negrito	*Simarouba glauca.*
42	POT	Pataxte		
43	POT	Pij		*Gymnanthes lucida*

No	Commercial Group	Species		
		Common Name (Guatemala)	Common Name (Belize)	Scientific Name
44	POT	Pimienta	black pepper	*Pimenta dioca*
45	POT	Pimientillo		
46	POT	Piñon		*Jatropa curcas*
47	POT	Pixoy	Bay Cedar	Guazuma ulmifolia
48	ACT	Pucte	Bullet tree	*Bucida buceras*
49	POT	Putziquil		Farmea occidentalis
50	POT	Quiebra hacha		
51	POT	Quisainche		
52	POT	Ramon blanco	breadnut	*Brosimum alicastrum*
53	POT	Roble		*Cordia sp.*
54	POT	Sacpaj		*Byrsonima sp.*
55	POT	Saltemuche		*Sickingia salvadorensis*
56	ACT	Santa maria	leche maria, santa maria	*Calophyllum brasiliense*
57	POT	Sapamuche		
58	POT	Silion	Silion, Silly Young	*Pouteria amigdalina*
59	POT	Siquiyaa	Wild star apple	*Crysophyllum mexicanum*
60	POT	Sosni		*Ocotea lundellii*
61	POT	Susuco		
62	POT	Testap	Glassy wood	*Guettarda combsii*
63	POT	Tinto	Logwood	Haematoxylon campechianum
64	POT	Tzuzul		
65	POT	Yaaxjochoc		*Vitex Sp.*
66	POT	Yaxnik	Fiddlewood, Yashnik	*Vitex gaumeri*
67	POT	Zacuayum		*Matayba oppositifolia*
68	POT	Zapotillo hoja ancha	Mammee Ciruela	*Pouteria sp*
69	POT	Zapotillo hoja fina	Zapotillo	*Pouteria reticulata*
70	PROTEC	Aceituno peludo	Pigeon plum	*Hirtella americana*
71	PROTEC	Aguacatillo		
72	PROTEC	Amate	Fig tree	*Ficus sp.*
73	PROTEC	Anona de montaña		*Anona souamosa.*
74	PROTEC	Cafe silvestre		
75	PROTEC	Cancetillo		
76	PROTEC	Cantemo		
77	PROTEC	Carboncillo		Cupania Guatemalensis
78	PROTEC	Carcomo		
79	PROTEC	Cedrillo		*Guatteria leiophylla*
80	PROTEC	Cedrillo hoja fina		*Guarea tonduzii*
81	PROTEC	Cedro	Cedar	*Cedrela odorata*
82	PROTEC	Ceiba	Cotton, ceiba	*Ceiba pentandra*
83	PROTEC	Cericote	Ziritcote	*Cordia dodecandra*
84	PROTEC	Chijoy		
85	PROTEC	Chile chachalaca		*Allophylus sp.*
86	PROTEC	Chintoc blanco		*Wimmeria concolor*
87	PROTEC	Chintoc negro		*Krugiodendrum ferreum*
88	PROTEC	Chique		*Ternstroemia tepezapote*

No	Commercial Group	Species		
		Common Name (Guatemala)	Common Name (Belize)	Scientific Name
89	PROTEC	Ciruelillo		
90	PROTEC	Cojon de caballo	Horseballs	*Stemmadenia donnell-smithii*
91	PROTEC	Cola de coche		*Pithecelobium arboreum*
92	PROTEC	Cola de pava		
93	PROTEC	Coloc		Talisia Floresii
94	PROTEC	Colorin		Ormosia toledoana
95	PROTEC	Conacaste	Guanacaste	*Enterolobium cyclocarpum*
96	PROTEC	Copo		*Coussapoa sp.*
97	PROTEC	Cuero de sapo		
98	PROTEC	Danto	Bitter Wood	*Vitairea lundellii*
99	PROTEC	Flor amarilla		
100	PROTEC	Flor de chombo	Frangipani	*Plumria Sp.*
101	PROTEC	Flor de mayo	May flower	*Tabebuia pentaphylla*
102	PROTEC	Granadillo		Platymiscium yucatanum
103	PROTEC	Guachapin		
104	PROTEC	Guachipilin		
105	PROTEC	Guarumo		*Cecropia obtusifolia.*
106	PROTEC	Higo		
107	PROTEC	Hormigo		*Platymiscium dimorphandrum*
108	PROTEC	Hule		Castilla elastica
109	PROTEC	Jaquiña		
110	PROTEC	Jobillo	glassywood, Jobillo	*Astronium graveolens*
111	PROTEC	Julup		
112	PROTEC	Llama del bosque		
113	PROTEC	Locche		
114	PROTEC	Lotoche		
115	PROTEC	Luin hembra	Female bullhoof	*Ampelocera hottlei*
116	PROTEC	Mabeju		
117	PROTEC	Majagua		
118	PROTEC	Malerio blanco	White Mylady	*Aspidosperma stegomeris*
119	PROTEC	Malerio colorado	Mylady	*Aspidosperma megalocarpon*
120	PROTEC	Manazanillo		
121	PROTEC	Matapalo	Fig	*Ficus sp.*
122	PROTEC	Matilisguate		*Tabeuia Rosea*
123	PROTEC	Molinillo		*Quararibea fieldii*
124	PROTEC	Mora		
125	PROTEC	Morro	Calabash	crecdentia cujete.
126	PROTEC	Nance	craboo	*Byrsonima crassifolia*
127	PROTEC	Naranjillo		*Zanthoxylum elephantiasis*
128	PROTEC	Negrito		
129	PROTEC	Ocbat		*Pithecolobium tonduzzi*
130	PROTEC	Overo		
131	PROTEC	Palo blanco		
132	PROTEC	Palo de chombo		
133	PROTEC	Palo de clavo		Rosedendron denell-smithii
134	PROTEC	Palo de diente		Trichila glabra

No	Commercial Group	Species		
		Common Name (Guatemala)	Common Name (Belize)	Scientific Name
135	PROTEC	Palo de gusano		Lonchucarpus guatemalensis
137	PROTEC	Palo de lagarto		Zanthoxylum belizanse
138	PROTEC	Palo de rosa		
139	PROTEC	Palo de zope		
140	PROTEC	Palo espinudo		*Mosquitoxylon jamaicense*
141	PROTEC	Palo rojo		
142	PROTEC	Pasaque macho		Mosquitoxylon jamaicense
143	PROTEC	Perezcuche		
144	PROTEC	Pitanche		
145	PROTEC	Pito		
146	PROTEC	Pochote		*Bombacopsis sp.*
147	PROTEC	Quequeo		
148	PROTEC	Quina	Pigeon plum	*Quiina schippii*
149	PROTEC	Ramon colorado	Red breadnut	*Trophis racemosa*
150	PROTEC	Ramon oreja de mico	Bread nut	*Brosimum costaricanum*
151	PROTEC	Sacanche		
152	PROTEC	Sacuche	Hinge Hinge	*Vochysia hondurensis*
153	PROTEC	Sajap	Pole wood	*Xilopia frutescens*
154	PROTEC	San juan	Wild mammee	*Alseis yucatanensis*
155	PROTEC	Sastante		Xilopia frutescens
156	PROTEC	Son	Waterwood	*Zuelania guidonia*
157	PROTEC	Sufricay		*Bumelia mayana*
158	PROTEC	Tama-hay		Zuelania guidonia
159	PROTEC	Tempisque		*Matechondendron capiri var tempisque*
160	PROTEC	Tucuy		
161	PROTEC	Tzalam	Tsalam	*Lysiloma bahamensis*
162	PROTEC	Verde lucero		
163	PROTEC	Yaje		
164	PROTEC	Yalpac	Lance Wood, Wild Soursop	*Malmea depressa*
165	PROTEC	Yaxche		
166	PROTEC	Yaya		Mlmea deprresa
167	PROTEC	Zapote macho		Pauteria Reticulata
168	PROTEC	Zapote mamey		*Pauteria Mamosa*
169	PROTEC	Zapuyul		

2.02.4 Plant Species of Balam Jungle Estate

Table 6: Plant Species of Balam Jungle Estate

Family, Species Name	Local Name
ACANTHACEAE	
Bravaisia tubiflora	Hulub
ANACARDIACEAE	
Astronium graveolans	Jobillo, Glassy wood
Metopium brownei	Black Poisonwood, Chechem
Spondias mombin	Hogplum
ANNONACEAE	
Annona scleroderma	Wild annona
Malmea depressa	Elemui
APOCYNACEAE	
Aspidosperma megalocarpon	Mylady
Cameraria latifolia	White poisonwood
Plumeria multiflora	Wild frangipani, flor de mayo
ARACEAE	
Anthurium sp.	Birds' nest 'fern'
Philodendron hederaceum	Philodendron
ARALIACEAE	
Dendropanax arboreus	White Chaca, Sac-chaca, Mano-de-lion
AVICENNIACEAE	
Avicennia germinans	Black Mangrove
BIGNONIACEAE	
Crescentia cujete	Calabash
BORAGINACEAE	
Cordia dodecandra	Zericote
Ceiba pentandra	Cotton tree
BROMELIACEAE	
Aechmea magdalenae	Pinuela
Aechmea sp.	Bromeliad (red-flowering)
Tillandsia spp.	Air-plants
BURSERACEAE	
Bursera simaruba	Gumbo limbo
Protium copal	Copal
Casuarinaceae	
Casuarina equisetifolia	Casuarina
CHRYSOBALANACEAE	
Hirtella americana (?)	Pigeon plum
COMBRETACEAE	
Bucida buceras	Bullet Tree
Bucida spinosa	Spiny Bullet Tree
Conocarpus erectus	Buttonwood
Laguncularia racemosa	White Mangrove
Terminalia catappa	Almond

Plant Species of Balam Jungle Estate

Family, Species Name	Local Name
COMPOSITAE	
Borrichia frutescens	Sea Oxeye
CYADACEAE	
Zamia loddigesi	Palmita
CYMODOCEACEAE	
Halodule beaudettei	Halodule
CYPERACEAE	
Cladium jamaicense	Sawgrass
Eleocharis geniculata	Freshwater reed
Scleria bracteata	Sawgrass
CYSTOSEIRACEAE	
Turbinaria turbinata	Turbinaria seaweed
DASYCLADACEAE	
Batophora oerstedii	Batophora seaweed
ERYTHROXYLACEAE	
Erythroxylum areolatum	Redwood
EUPHORBIACEAE	
Jatropha curcus	Pinon, Physic nut
Jathropha urens	Chaya
FABACEAE	
Dalbergia glabra	Kibix
FLACOURTIACEAE	
Zuelania guidonia	Water Wood
GRAMINEAE	
Distlichis spicata	Salt marsh grass
Spartina spartinae	Swordgrass
GUTTIFERAE	
Calophyllum brasiliense Camb	Santa Maria
HALIMEDACEAE	
Udotea sp.	Udotea seaweed
HYDROCHERITACEAE	
Thalassia testudinum	Turtle grass
JUNCACEAE	
Juncus roemerianus	Sword grass
LAURACEAE	
Nectandra sp.	Laurel
LEGUMINOSAE: Caesalpinaeae	
Caesalpinia gaumeri	Warree wood
Cassia grandis	Bukut, Stinking toe
Haematoxylon campechianum	Logwood
Bauhinia jennengsii	Pata de Vaca

Plant Species of Balam Jungle Estate

Family, Species Name	Local Name
LEGUMINOSAE: Mimoseae	
Acacia collinsii	Subin
Enterolobium cyclocarpum	Guanacaste, Tubroos
Inga spp	Inga
Lysiloma latisiliqum	Salam
Mimosa hemiendyta	Citzim
Pithocellobium stevensonii	
Pithocellobium donnell-smithii	John Crow Wood, Tamai
LEGUMINOSAE: Papilionaceae	
Lonchocarpus castilloi	Cabbage Bark, machich
Piscidia piscipula	Habin, Dogwood
Platymiscium yucatanum	Granadillo
Swartzia cubensis	Catalox, yura-sangre, bastard tambran
Diphysa carthaginensis	Suzuk, wild ruda
Gliricidia sepium	Madre de Cacao
MALVACEA	
Hampea euryphylla	Majagua
MELIACEAE	
Cedrela odorata	Spanish Cedar
Swietenia macrophylla	Mahogany
MORACEAE	
Castilla elastica	Wild rubber
Cecropia peltata	Trumpet tree
Brosimum alicastrum	Ramon, Breadnut
Ficus lapathifolia	Strangler fig
Ficus glabrata	Wild fig
Ficus sp.	Higo
Pseudolmedia sp.	Cherry
Trophis racemosa (?)	Yaxox, Red breadnut, White ramon
MYRTACEAE	
Pimenta dioica	Allspice
ORCHIDACEAE	
Brassavola nodosa	orchid
Myrmecophila tibicinis	cow-horn orchid
PALMAE	
Acoelorraphe wrightii	Tasiste
Acrocomia aculeata	Supa palm, coco-yol
Bactris major	Pokenoboy
Chamaedorea seifrizzi	Bamboo palm, Xate
Cocos nucifera	Coconut
Cryosophila staurocantha	Escoba palm
Desmonchus orthancanthos	Basket tie tie, Stay-a-while
Orbignya cohune	Cohune palm
Roystonea regia	Royal palm, Cabbage palm
Sabal yapa	Wano, Botan
Thrinax radiata	Chit
PASSIFLORACEAE	
Passiflora beliziensis	Passionflower
Passiflora serratifolia	Passionflower
Passiflora yucatanensis	Passionflower

Plant Species of Balam Jungle Estate

Family, Species Name	Local Name
PIPERACEAE	
Piper amalago	Cordonzillo
Piper auritum	Xmacolan
Piper hispidum	Cordonzillo
POLYGONACEAE	
Coccoloba beliziensis	Bob
Coccoloba sp.	
Coccoloba uvifera	Sea-grape
Gymnopodium floribundum	Canelita
POLYPHYSACEAE	
Acetabularia calyculus	Mermaid's wine glass
POLYPODIACEAE	
Acrosticum aureum	Mangrove fern
RHIZOPHORACEAE	
Rhizophora mangle	Red Mangrove
RUBIACEAE	
Guettarda combsii	Tastab, Glassy-wood
Hamelia patens	Polly red head
RUTACEAE	
Esenbeckia pentaphylla	Naranjillo, Candle wood
Xanthoxylum fagara	Tankaxche
Xanthoxylum sp.	Prickly yellow
SAPOTACEAE	
Chrysophyllum oliviforme	Chiceh
Manilkara Sapote	Sapote, Sapote
Pouteria amygdalina	Silion
Pouteria campechiana	Mammee cerillo
Pouteria mammosa	Mammee apple
Pouteria reticulata	Sapotillo
SARGASSACEAE	
Sargassum platycarpum (?)	Sargassum seaweed
Sargassum sp.	Sargassum seaweed
SMILACACEAE	
Smilax sp.	Chinee yam, Chinee root
STERCULIACEAE	
Guazuma ulmifolia	Bay Cedar, pixoy, tapa
SIMAROUBACEAE	
Simaruba glauca	Negrito
THREOPHRASTACEAE	
Jaquinia aurantiaca	Xcansic, Jaquinia
VERBENACEAE	
Petrea volubilis	Petrea
Vitex gaumeri	Yaxnik

Addendum 15

Archaeological Impact Assessment
Of the Balam Jungle Estate,
Corozal District, Belize

Prepared by

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San Ignacio, Cayo, Belize

July, 2007

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INTRODUCTION

In July of 2007 the authors were contracted by Ecoworks Consultancy to perform an archaeological survey of a section of the Balam Jungle Estate (BJE) property in south east Corozal District. The entire property covers an area of 95,000 acres and is located just south of the archaeological site of Kakantulix in the Shipstern Nature Reserve.

The BJE property development plan comprises two separate projects:

1) Timber Management Project (TMP), restricted to the 'upland forest' that covers 46,940.7 acres and
2) Residential Tourism Project (RTP) that will take place on all the land within the wetland savanna covering an area of 48,059.3 acres.

The residential tourism project area will be developed in 6 (six) phases and will encompass approximately 20% of the total wetland savanna area. Our contract with Ecoworks Consultancy was to conduct an archaeological survey of an area measuring 9,500 acres, all within the wetland savanna area (see Figs. 5 and 7). In accordance with the National Institute of Culture and History laws of Belize the purpose of our survey was to investigate whether this parcel of the property contained any features of archaeological significance (both historical and prehistorical) and to make provisions for the protection of any such features before any development of the parcel can proceed.

The area of our survey therefore encompasses the section of the property that has been earmarked for development during the phase 1 of the project. As indicated above, this area covers a total of 9500 acres of the RTP (Fig 2) and is located within the southeast wetlands of the estate. During the greater part of the year this section of the property is predominantly covered by water. During our survey we reconnoitered this area with the specific purpose of identifying any features of archaeological significance. In addition we visited two sites within the upland rainforest, outside of our survey area. We recorded these sites in an effort to ensure that they be incorporated into future assessments of the region and that future developments in the TMP may include cultural resource management plans for the sites.

In the next sections of this report we present the following information:

- **A.** A review of the extant archaeological literature on prehistoric coastal settlements;
- **B.** A description of the area surveyed,
- **C.** The methods employed by our research,
- **D.** The results of our investigations, and
- **E.** Recommendations and options for mitigation of archaeologically significant features during the development of the property.

REVIEW OF LITERATURE ON COASTAL SITES IN BELIZE

Although archaeologically significant features have been located along the entire coastal zone of Belize, the evidence for particular sections ranges from excellent to poor. The reasons for this uneven data base result from the simple fact that some areas have been more intensively studied while others have remained largely ignored by archaeologists. The rise of sea levels during the last two millennia has also inundated much of the coastline thus areas that do contain archaeological sites are often submerged and are only identifiable through the process of underwater archaeology (see for example McKillop 2006, 2007).

Despite these obvious challenges we know that the Belizean coastal zones contain evidence of Pre-Hispanic Maya and Colonial Period Spanish and British activities. This information has been produced by archaeological work and surveys that have been conducted by several researchers. For the northern Corozal District this include investigations by Diane and Arlen Chase (1981, 1988, 2006) at the site of Santa Rita, explorations by Mathew Boxt (1983, 1988) around the area of Sarteneja, and by David Friedel, Vernon Scarborough (1978), Deborah Walker (1990) and their colleagues at Cerros. More recently, numerous Postclassic Maya Lagoon sites (particularly around Progresso Lagoon) have been recorded and investigated by the Corozal Postclassic Project under the direction of Marilyn Masson (Masson 1997, 1999, 2000, 2004; Masson and Mock 2004).

Within the Belize District archaeological research has focused particular attention on Ambergris Caye and along the north coastal zone of the district. At Ambergris Tom Guderjan, James Garber and others (Guderjan et al. 1989, 1995) investigated the northern half of the island, while Elizabeth Graham and David Pendergast (1989) conducted research on the southern half of the caye, particularly at Marco Gonzalez. Along the coastal zone of the Belize District Heather McKillop (1980) and Paul Healy (1989) conducted extensive excavations at the site of Moho Caye near the mouth of the Belize River. Since then Shirley Mock (1994, 1997, 1999, 2004, 2005) has recorded a number of sites along the coast in the area of Northern Lagoon and Satoru Murata and colleagues have investigated an extensive site just west of Belize City.

Most of the research in the Stann Creek District was conducted in the 1970-80's by Elizabeth Graham (1989) and Jefferson MacKinnon (1989). Graham's work focused primarily in and around the coastal site of Colson Point, while MacKinnon work investigated the area around the Placencia peninsula.

Further south, in the Toledo District, most coastal research has been conducted by Heather McKillop from Louisiana State University. During the last decade McKillop has recorded several sites on the offshore cayes, and more recently she has identified and investigated several underwater sites within the Paynes Creek National Park (McKillop 2002, 2004, 2005a,b, 2006, 2007).

The data collected by all these investigations have served to establish that the coastal regions of Belize were an important economic zone for the ancient Maya, particularly from Late Preclassic to Historic times (300 B.C. – A.D. 1900). On the mainland, just north of Belize City and west of our survey area, evidence for human exploitation of coastal regions extends much earlier into the Paleo-Indian and Archaic periods (10,000 – 2,000) (Hammond 1982). This is particularly true of the area around Ladyville, Sandhill, Colha, Laguna de On and San Estevan. To date, sporadic investigations in these localities have produced the largest numbers of Preceramic artifacts in Belize and there is every indication that more intensive research will likely produce substantially more evidence for early human activities in these areas (Lohse et al. 2006, Rosenwig 2004).

For the Preclassic and Classic periods present evidence suggests that several coastal sites experienced considerable development during these times. This is evident at Cerros and at Altun Ha where David Freidel and his colleagues and David Pendergast respectively have noted substantial construction at these sites. In the case of Cerros, that site became a major center by the end of the Late Preclassic period and may have served as the primary trading post for marine products being shipped to Maya cities located in the interior along the watershed of the New River. Further south at Altun Ha, Pendergast (1979, 1982, 1992) has argued that this site became economically affluent as a result of its control of flint tool production along the north-coastal zone of Belize.

Developments on the offshore islands contrasts significantly with that of mainland sites for there does not appear to be any permanent settlements on the cayes during much of the Preclassic period (MacKinnon 1989; MacKinnon et al. 1987). Despite this apparent pattern, several researchers (MacKinnon 1989 McKillop 2002, 2005) have found evidence for periodic visits to the islands by inland inhabitants for the procurement of shells, fish, salt and other marine products. Two exceptions to this rule appear to be Moho Caye and Ambergris Caye. At Moho Caye considerable evidence for Late Preclassic and Classic period Maya activity was identified by Heather McKillop. Both McKillop (1980) and Healy (1989) argue that the location of Moho Caye at the mouth of the Belize River suggests that this site served as a major transshipment point for marine and other exotic goods en route to sties in western Belize and the Peten. At other island sites, such as Marco Gonzalez in the southern end of Ambergris Caye, Elizabeth Graham and David Pendergast (1989) found evidence which suggests that the earliest occupants settled in this area towards the end of the Late Preclassic period (100 B.C. – 250 A.D.). Thomas Guderjan (1993:19) has suggested that this small community may have served as traders for the large coastal site of Cerros on Corozal Bay.

During the Classic Period (A.D. 250-800) human activity on the coast and offshore islands continued to increase. Several island sites, such as those on Moho Caye, Caye Caulker, and the sites of Chac Balam, Ek Luum, Marco Gonzalez and San Juan on Ambergris Caye (Guderjan 1988, 1993), experienced a slight rise in population and increased commercial activity.

By Terminal Classic times (A.D. 800-1000) and certainly in the Postclassic period (A.D. 1000-1500) there are dramatic changes in Maya coastal activities. Investigations by Elizabeth Graham (1987, 1994), Jeff MacKinnon (1989), Heather McKillop (1987, 1994), Thomas Guderjan et al. (1988, 1989, 1993) and Shirley Mock (1994) have all recorded evidence for increased activity at this time. All these researchers argue that during the Early Postclassic people begin to move out to the coast and Cayes and begin to develop a complex trading network that would remain in place until well after the arrival of the Spanish at the end of the 15th century. On some islands these settlements represent the earliest evidence for Maya activity. Interestingly, many of these Postclassic settlements are located along geographic points that may have served as trans-shipment points along established maritime trade routes (Graham 1994; MacKinnon 1989). With the increased reliance on sea trade, coastal habitation became more common and many cayes, some quite distant from the coast, began to be exploited. This is confirmed by Maya settlements as far out as the Light House and Turneffe Atolls (personal observation).

Increasing numbers of sites along the coast have also been recorded by Shirley Mock for the area to the north of Belize City, and by Marilyn Masson in the Corozal District. This is particularly evident during the Late Postclassic period (1300-1500 A.D.) which marked the climax of Maya maritime and coastal activity in Belize. Research by Masson at Caye Coco and other sites around Progresso Lagoon in the Corozal District "reveal substantial occupations from the 8th through 17th centuries A.D. Patterns observed in the organization and location of architecture and the variation in artifact assemblages of the Terminal Classic, Postclassic, and Colonial periods reflect important changes through time in the political economy of the northeast Belize area (Masson 2004:257)". The Progresso Lagoon settlements also provide data which suggests that many of the Terminal Classic – Postclassic period sites were economically and culturally linked to such large cities in the northern Yucatan peninsula like Chichen Itza, Mayapan, and Colonial Merida, while they continued to maintain ties with other neighbors to the south.

On the islands, Ambergris Caye, Wild Cane Caye, Green Snake Caye, Moho Caye, and Frenchman's Caye all have evidence of Late Postclassic occupation (McKillop 2002, 2005). At all these sites, Archaeologists have recorded evidence for the construction of both domestic and ritual architecture, for salt production, the exchange of obsidian, and the harvesting of various marine products and pumice.

For the Colonial period we know that there was substantial activity along the north coastal regions of Belize. Indeed, from the first Spanish voyages in the early 1500's, Belizean waters were well traveled by English, Spanish, and Dutch ships during most of the 16th to 19th centuries. Much of the British shipping activity focused on the removal of Mahogany and other hardwoods, particularly in the northern half of the country. The British also established several small settlements on the mainland (along the Belize and New Rivers) and on several Cayes, particularly on St. George's and Ambergris Cayes (Finnamore 1994).

Description of BJE Property:

As we indicated above, the section of the BJE property which we were contracted to survey covers an area of 9500 acres (Fig.5). This eastern section of the property is comprised primarily of wetland savanna, mangroves and lagoons. Along the coast the parcel extends approximately 7 km along a strip of “beach front”. Most of this so-called “beach”, however, is represented by mangrove that separates the sea from several salt and brackish water lagoons. Beyond the lagoons the terrain rises gently towards wetland savanna and eventually into upland rainforest in the far western borders of the property.

A preliminary assessment of the geography of the area (Fig. 4) suggested that the property is located south of the ancient Maya sites of Kakantulix (Shipstern), Sarteneja and Ramonal, and Northeast of Altun Ha, Saktunja, Maskal Bomba, Yacalche and Colha. Unfortunately, no GPS readings of the latter sites were taken during their investigation by archaeologist’s in the 1970’s-80’s thus it is difficult to determine their exact location *vis a vis* the BJE property.

THE BJE PROPERTY IN ARCHAEOLOGICAL CONTEXT

Within the files of the Institute of Archaeology only one site appears to be recorded in the area of our survey. This site is known as Spanish Point and is located on the southeastern tip of the BJE parcel that is slated for development during the phase 1 part of the project. Unfortunately the record for this site provides limited description of its archaeological significance. Our assessment of the area indicates that Spanish Point may actually represent a Historic Period site with limited or ephemeral evidence of past use.

Outside the borders of the greater BJE property there are a number of known archaeological sites. Some of these sites are within 10 miles of the property and others are at much greater distance. They include several sites in the Corozal and Belize Districts for which existing information ranges from very good to very poor.

Corozal Sub-Region

In 1974, Raymond V. Sidrys of the University of California Los Angeles carried out some of the earliest archaeological research in the Corozal District of Belize. At this time he explored mapped and excavated 10 sites in Northwest Corozal (Aventura, Patchacan, Caledonia, Chan Chen, Santa Rita, Cerros, Consejo, Sajomal, Laguna and Wilson’s Corozal Beach) and 5 sites in Northeast Corozal (Sarteneja, Cenote, Bandera, Ramonal and Kakantulix [Shipstern]). Following his research, Sidrys (1982) published a report of his findings and this monograph is available at the Belize Institute of Archaeology. Concurrent with the UCLA survey was a major project at the site of Cerros in Corozal Bay. This site was intensively excavated between 1976 and 1982 and again in the early 1990’s by a project from Southern Methodist University in Dallas Texas (Garber 1986, Reese 89, Robertson and Freidel 1986, Scarborough 1991, Scarborough and Robertson 1986, Walker 1995).

Cerros was apparently first occupied during the Middle Preclassic period (900-300 B.C.). By Late Preclassic times the Cerros community peaked and was likely an important center for trade and commerce between the Caribbean coast and the large inland cities of Belize and the Peten. Despite this early affluence, the fortunes of Cerros apparently fell on bad times during the Early Classic period, and it appears that the site may have been partially abandoned at this time. It was later resettled by the Postclassic Maya and may have had a small community at the time of Spanish contact.

Following Sidrys' research Diane and Arlen Chase (1981, 1988) investigated the site of Santa Rita, and Mathew Boxt (1983, 1988), a student of Sidrys, explored the region around Sarteneja. Santa Rita is now known to have been occupied from the Middle Preclassic period right up to the early Historic period (Chase and Chase 2006). At Sarteneja Boxt noted that like most other major settlements in northern Belize the site may have been initially settled during the Preclassic period, expanded during the Classic period, and continued into the Postclassic.

Within the Corozal District, the largest site north of the BJE property is Kakantulix. This site is a major center and contains temple-pyramids, range-type palaces, a ballcourt, and several other monumental buildings. Kakantulix was first recorded by Raymond Sidrys in the 1980 but no significant archaeological research has ever been conducted at the site. In the early 2000 the authors visited the site and noted that several of the large structures had been vandalized. Ceramic remains found on the surface pointed to major occupation in the latter part of the Classic period.

Belize Sub-Region

Previously known sites bordering the BJE property in the Belize District sub-region include Altun Ha, Bomba, Maskall and Yacalche. Altun Ha was intensively excavated in the 1970's by David Pendergast of the Royal Ontario Museum and information for this site is considerable (and has been provided above). In contrast, data for the other sites is severely lacking. All have been visited at one time or the other by various archaeologists but limited, if any, investigations have been carried out at any of them.

Along the coastal zone of the Belize sub-region some research has and continues to be conducted by the Northern Belize Coastal Project (NBCP) directed by Dr. Shirley Mock. A major goal of the MBCP is to locate and record coastal sites in the Belize District in an effort to determine their chronological placement in relation to Northern River Lagoon. In a recent publication Mock (200) noted that:

> *With the exception of Cabbage Ridge (Saktunja) (see Figure 3), a working plantation owned by Mr. Hilly Martinez of Belize City, surveys have revealed no present-day habitation on this area of the coast. As one travels north by boat from Belize City, sites are distinguished by their height and canopy of forest vegetation nourished by ancient anthropogenic soils.*

> *However once disembarking, one inevitably discovers that these sites are fringed by dense, sometimes impenetrable mangrove swamps leading to questions about ecological changes and settlement in this coastal arena. Access is difficult and progress is slow requiring extensive cutting or canoe dugout travel. The extreme difficulties in reconnaissance, surveying, and testing are outweighed by the great potential of these sites to provide new evidence to nourish our models of ancient Maya economies and settlement.*

As Figure 3 indicates, Mock has been able to find several sites in areas where the terrain is above water levels and where changes of vegetation are indicative of previous anthropogenic utilization. During our aerial survey we took this observation into account and were able to record several possible sites in the parcel of land surveyed by our field crew.

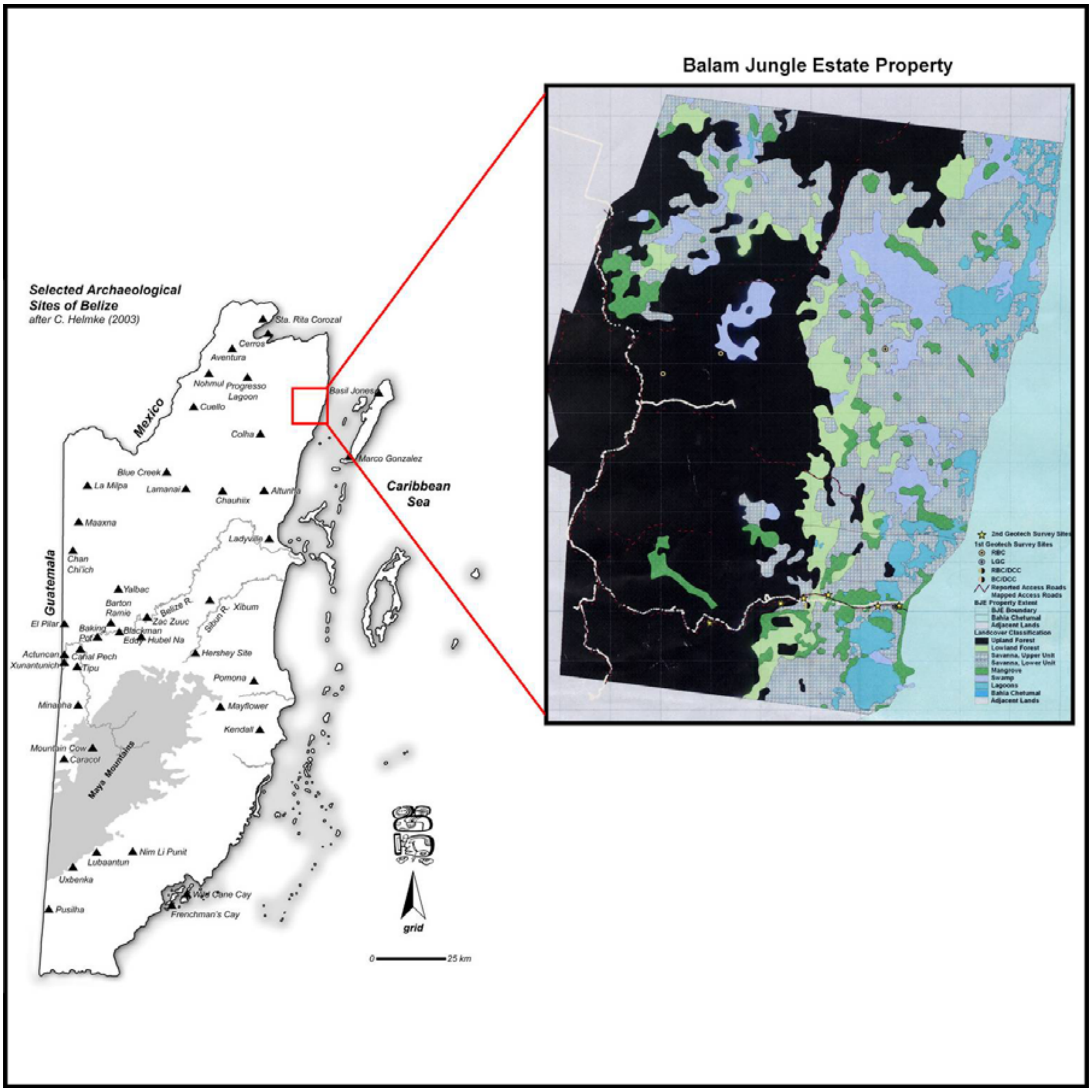

Figure 1:
Map of Belize showing location of Balam Jungle Estate Property

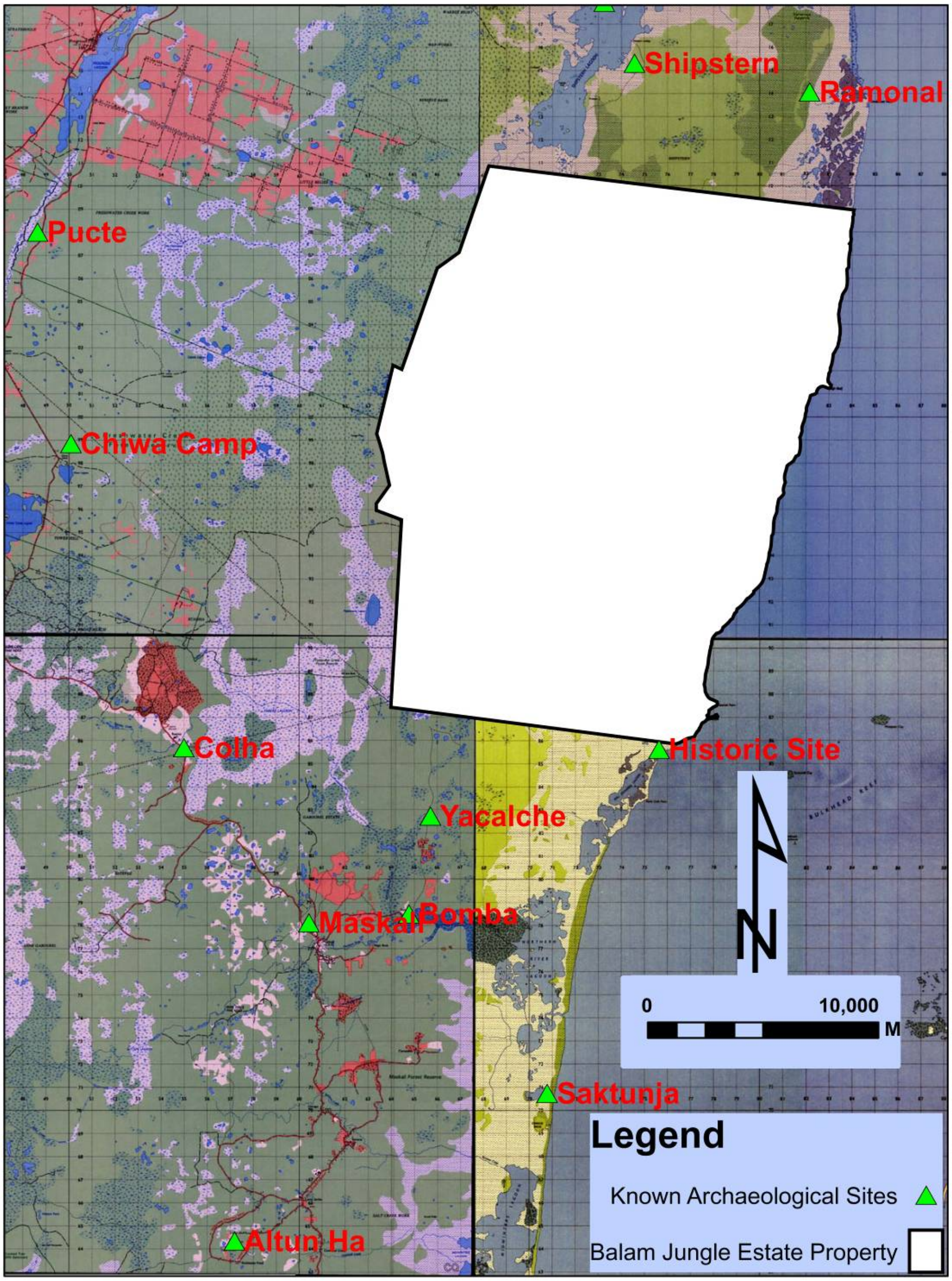

Figure 2:
Map of Northern Belize showing Balam Jungle Estate Property with neighbouring known archaeological sites

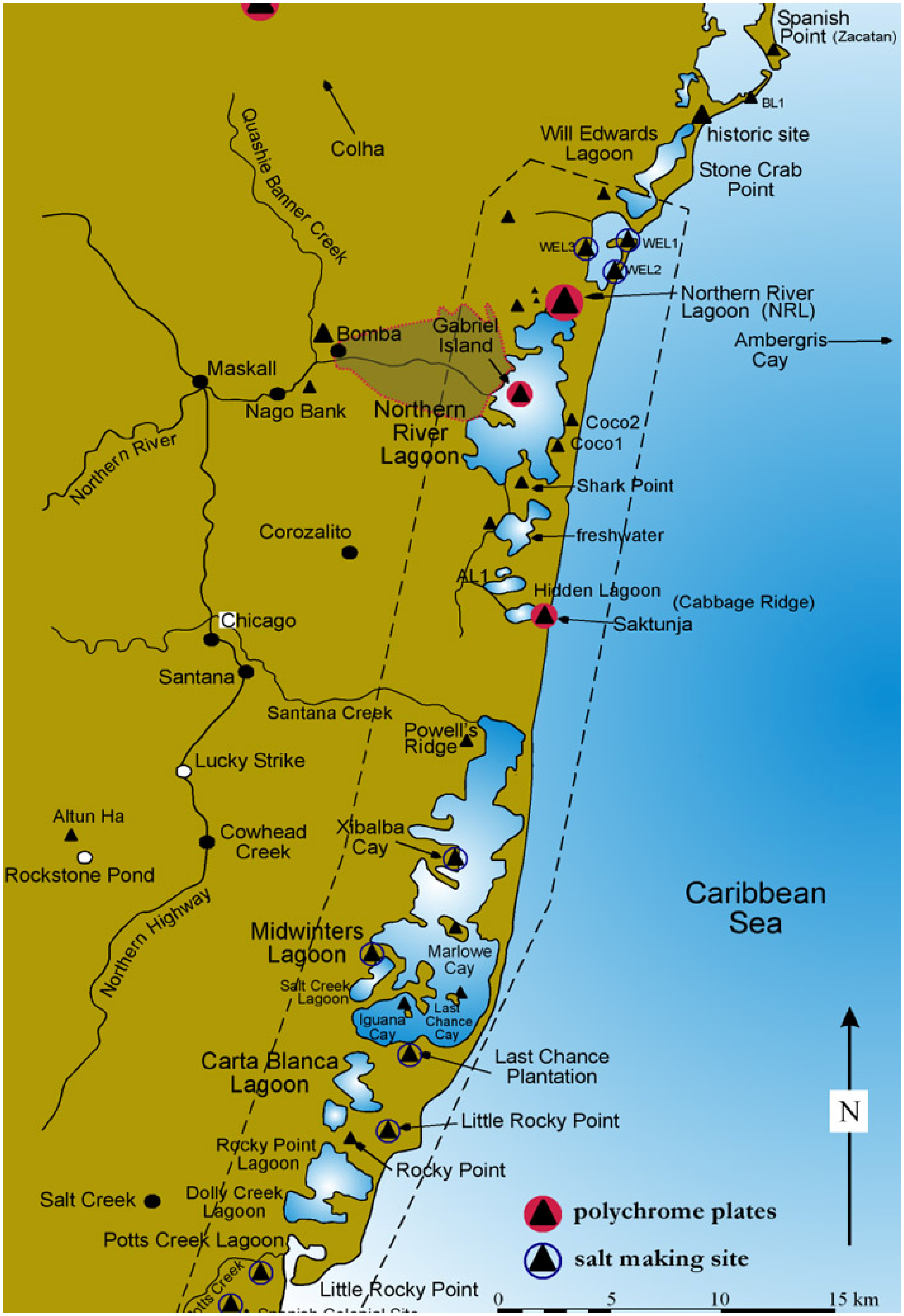

Figure 3:
Map of Northern Belize District showing location of previously recorded archaeological sites

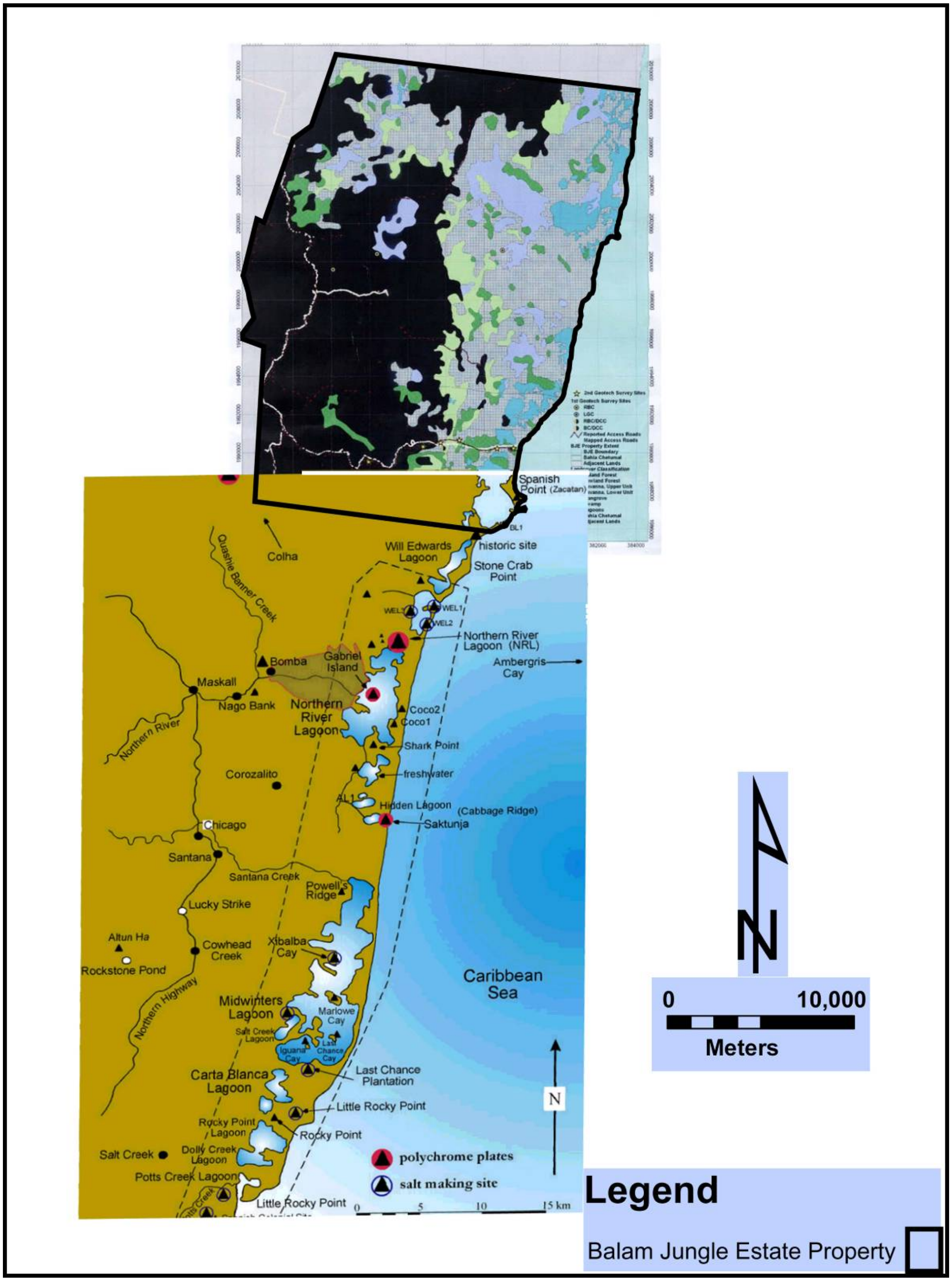

Figure 4:

Map of Northern Belize District showing location of previouslyrecorded archaeological sites in relation to BJE property

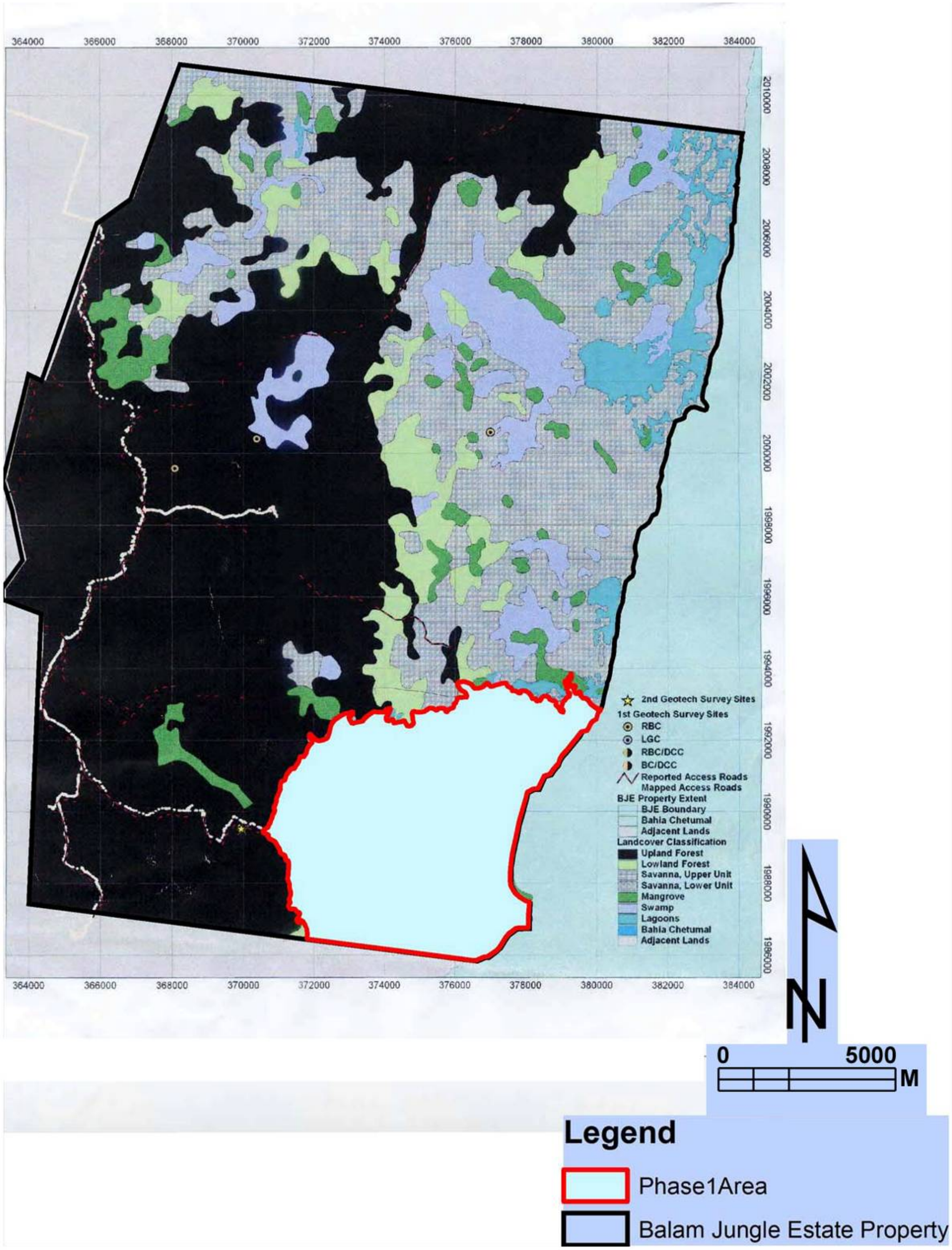

Figure 5:
Map of Balam Jungle Estate showing phase-1 development area surveyed.

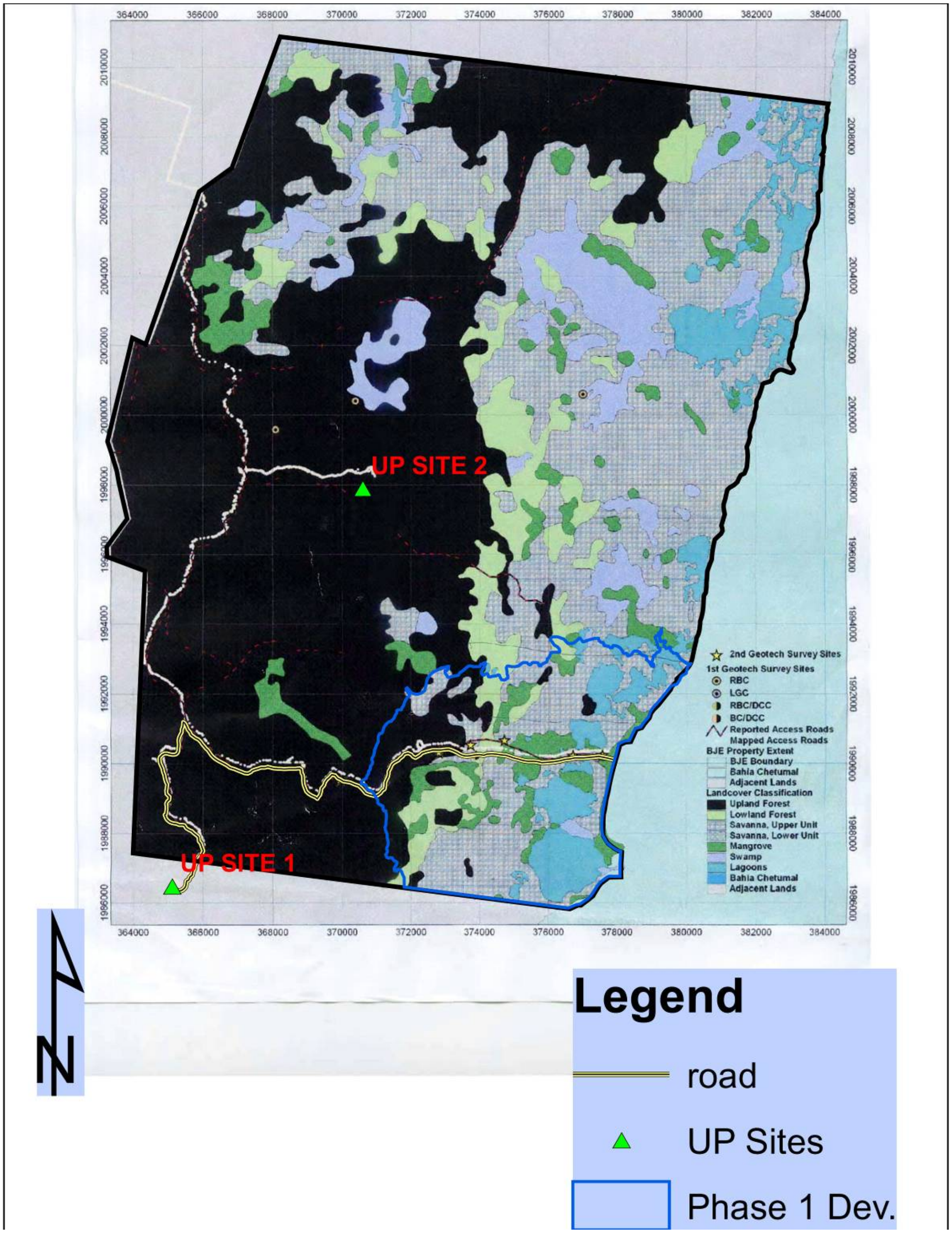

Figure 6:
Map of Balam Jungle Estate showing upland sites visited.

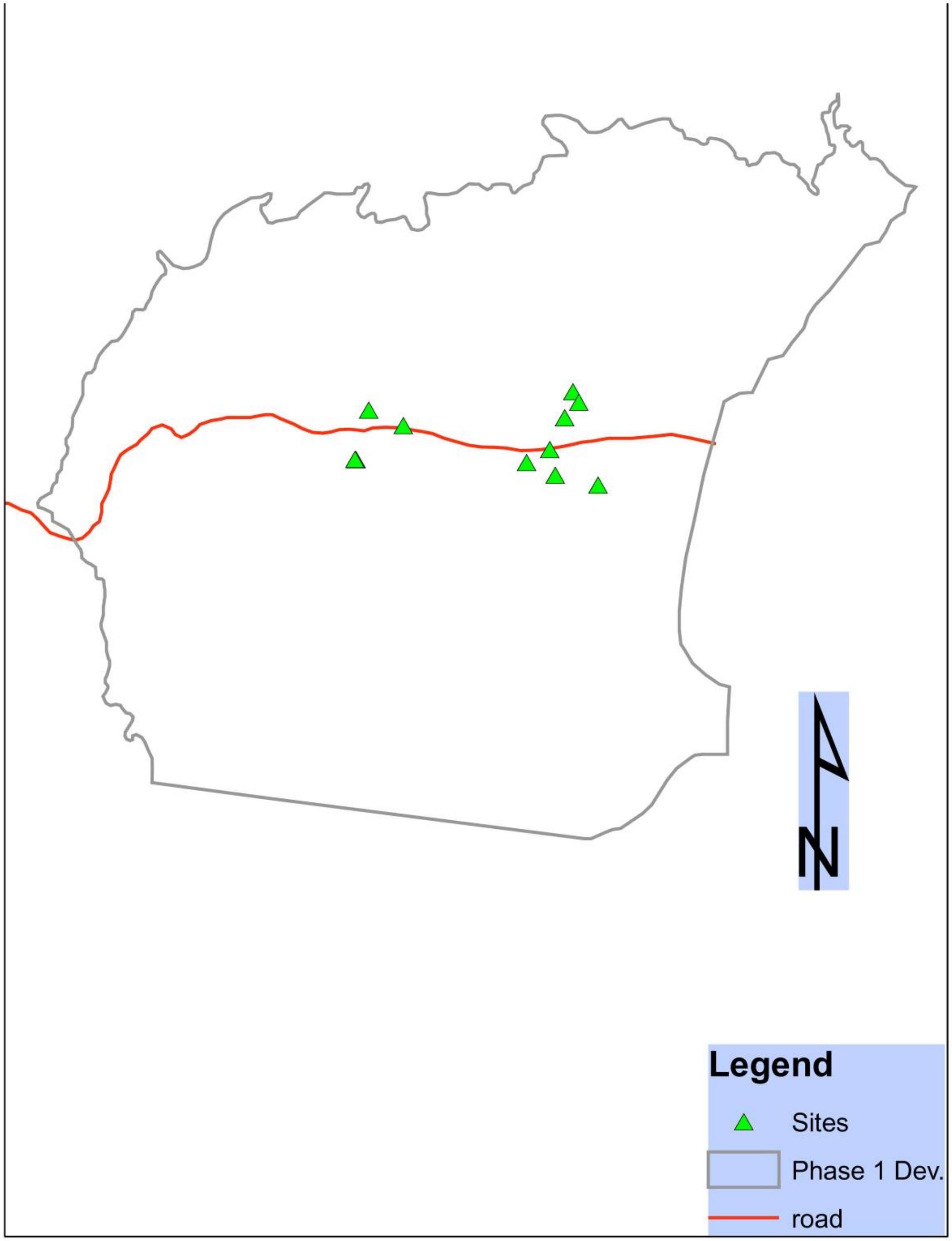

Figure 7:
Map of Balam Jungle Estate showing phase-1 development area with mangrove clusters visited.

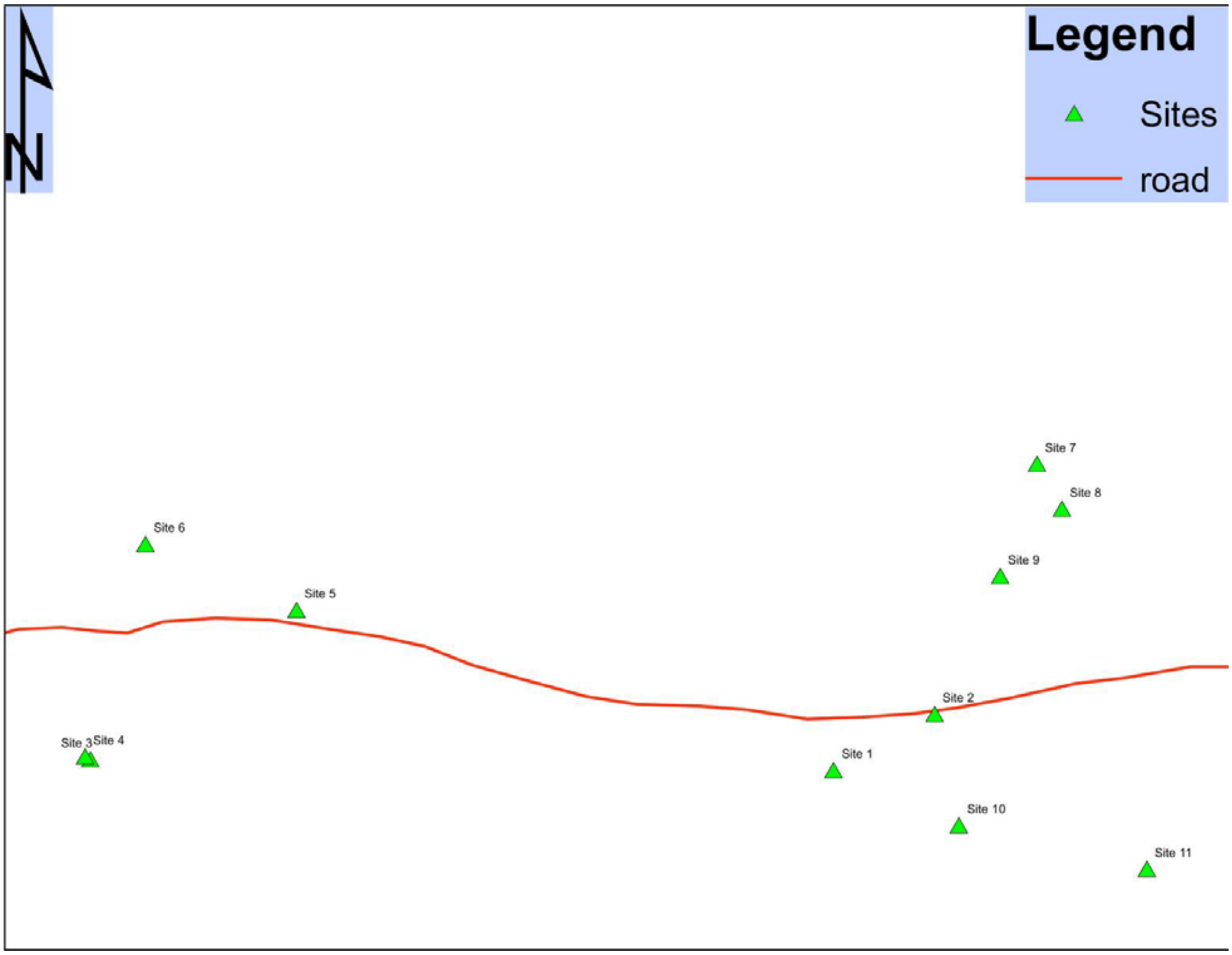

Figure 8:

Map of Balam Jungle Estate showing phase-1 development area with sites.

Site Numbers	Easting	Northing
UP SITE 1	365180.49	1986669.15
Site 1	375893.48	1990094.75
Site 2	376142.71	1990233.69
Site 3	374053.61	1990121.61
Site 4	374041.13	1990129.37
Site 5	374563.82	1990492.17
Site 6	374190.99	1990655.67
Site 7	376396.33	1990854.23
Site 8	376458.12	1990742.7
Site 9	376304.95	1990576.06
Site 10	376202.81	1989957.89
Site 11	376667.79	1989850.38
UP SITE 2	370665.71	1998088.06

Table 1:
Description of the GPS points taken within the Balam Jungle Estate Property

SURVEY AND RESEARCH METHODOLOGY:

Survey Methodology

For the purpose of this survey it is important to note that despite their more widespread distribution, small Postclassic sites along the coast are very difficult to locate. McKillop (1994) reports that these sites are often invisible to investigators, as the settlements have been severely destroyed by the forces of nature (wind, tidal waves and hurricanes). Compounding the problem is the fact that there has been a significant increase in sea levels (approximately 1 meter in the past 1400 years). The result is that much of the area that was once utilized by the ancient Maya is now underwater. Today mangrove swamps actually cover numerous communities that were once on dry land. During excavations at a site located on Wild Cane Cay, McKillop noted, “The distribution of buried deposits (under what is now ocean) virtually doubled the size of the ancient site…” (1994:116). Numerous other sites, including Tiger Mound, Green Vine Snake, Killer Bee, and Pelican One Pot are buried beneath modern red mangrove swamps and are invisible from the modern ground surface. Only sub-surface and sub-aquatic test pitting and excavations can reveal sites in this type of environment.

Given the property’s apparent proximity to the archaeological sites noted above, we decided to conduct an intensive survey of the parcel slated for development. To achieve these goal three methods of survey were employed.

1. Aerial Reconnaissance using a helicopter
2. Terrestrial survey using an ATV and
3. The typical pedestrian walk over survey.

The aerial reconnaissance was used to acquire an overview of the property, to locate the types of vegetation change noted by Shirley Mock, and to identify possible areas of archaeological significance from the air. During the aerial survey we noted that the vast majority of the property was covered in lagoons, sedge, and open savanna, with interspersed mangrove and palmetto clumps. Some mangrove and palmetto clumps were marked using a GPS receiver and later reconnoitered terrestrially. The existence of palmetto indicates that these areas may only be seasonally inundated and could contain possible cultural materials.

The terrestrial survey was conducted shortly after using the typical pedestrian walkover survey combined with ATV’s wherever possible. Due to recent rains many of the mangrove and palmetto clusters, previously identified by air, were unreachable by ATV or by foot. Judging from the water on the property these are only accessible by boat even in the dry seasons. To access other areas we used an existing road that runs along a low ridge that dissect the phase 1 development area. From this road our survey crew was able to cross the wet lands and then use the ATV to visit the accessible clusters. In other areas we practically used the ATV to create north-south and east-west paths that crossed through the savanna and dwarf mangrove vegetation. In more difficult of access areas we had to abandon the ATV and the crew had to revert to the pedestrian walkover survey. For each site noted GPS locations were taken and recorded (see Table 1).

Although the TMP area was not the primary focus of this survey (and not part of our contractual obligation) we visited two archaeological sites that had been spotted by the aerial survey. One of these sites is located south of the property line and one is actually on the property. The purpose of our visit was to confirm the archaeological significance of these two sites and to determine possible conservation measures if and when the land on which they were located should be developed in the future. The sites were assigned site names of UPS1 and UPS 2 respectively.

Excavations and Shovel Tests

In collaboration with the EIA consultant, a number of test pits were excavated with a post-hole digger. These units averaged about 35 cm in diameter, and were conducted in areas where we considered they could yield important subsurface information. The test pits were placed on elevated areas exhibiting dark soils. In coastal sites it is noted that areas with dark organic soils are often associated with prehistoric middens, hence our choice of location for the test units. Descriptions of the test pits are provided below. For the purpose of this survey each mangrove and palmetto cluster visited was also given a site number.

RESULTS OF THE INVESTIGATIONS

Site 1:

This site is an earthen mound, exhibiting no signs of limestone architecture. The mounded area measures approximately 6 meters in diameter and rises at the most 60 cm above the savanna floor.

Test Pit 1

The unit descended 1.2 m below surface. The excavation revealed three stratigraphic levels in the unit. The first stratum was a 20 cm layer of humus and roots where ceramics were identified. The second stratum was grayish-white clay measuring between 20 – 80 cm and was devoid of artifacts. The third stratum was roughly 40 cm thick and consisted of a layer of pure grey clay. Like stratum 2, this third stratigraphic level contained no cultural materials.

Test Pit 2

This unit was excavated to the level of the second stratum identified in TP1. It descended to a depth of 75 cm from surface, and was located at approximately the center of the mound. The reason for taking the unit only to the depth of strata 2 lies in the fact that in all our other units we noted that both strata 2 and strata 3 were consistently sterile.

Test Pit 3

Test Pit 3, like Test Pit 2 was only excavated to the level of strata 2. The excavation descended for 35 cm below surface. Like the two previous test pits cultural remains were again located only in the upper strata.

Site 2:

This site is comprised of multiple earthen mounds forming a u shape 'plaza' with no northern structure. Each mound rose to roughly 40 cm above the savanna floor. No test pits were conducted at this site as ceramic scatters were identified right on the surface of the mounds. **See appendix A**

Site 3:

This site contains a fairly large mound that measures 10 meters in diameter and I meter in height. At this site ceramic remains were scattered across the surface. We also noted two conch shells adjacent to the mound. Here no test pits were opened as it was obvious that the mound was definitely occupied by the Maya.

Site 4:

Unlike Sites 1-3, Site 4 only rises a few centimeters above the savanna floor and is prone to seasonal flooding that covers the entire mound. The site does, however, exhibit a dark brownish black soil identified at the other sites. While investigating this area several historic/colonial period artifacts were identified including: bottles, carriage axle and a broken olive jar. The nature of these objects therefore suggests that the site may be historic in date and that it was used by either the Spanish or British. **See Appendix A.**

A series of test pits, labeled 1-5 were excavated in and around Site 4 but none resulted in the recovery of any maya artefactual remains. Despite the lack of pre-colombian remains it was noted that TP 4 and 5 were dug through a limestone fill area that resembles the ballast of ancient Maya floors. **See Appendix A.**

Site 5:

This site is located near to site 4 and contained both palmetto and mangrove trees. Unlike Site 1-4, however, Site 5 did not contain any of the salt water Palmetto species (Thirax Radiata). This specie of palmetto is apparently a good indicator of higher elevations and is often located in the proximity of cultural mounds. In the case of Site 5, only the red mangrove specie was identified and as such was inundated with a foot and a half of water. Given this situation no test pits were conducted and it is not surprising that any archaeological remains were identified around the site.

Site 6:

Like Sites 1-4, Site 6 exhibited clusters of saltwater palmetto around the edges and the center. Here 3 test pits were excavated within a two by two meter area and no artifacts were recovered, despite the fact that we recovered two ceramic sherds and a lithic flake in the near vicinity. Along the southern edge of this 4-meter diameter mound, several limestone rocks were identified as a possible platform. One can only speculate that the limestone must have been brought there as there are no visible limestone outcrops in the savanna area.

Site 7 -11

Sites 7 - 11 were dispersed across the landscape of the area slated for development during phase 1 of the project. We checked these sites because of differences in the flora and the possibility that they may contain evidence of archaeological significance. Despite our search, no archaeological remains were identified on any of them. Unlike any of the other sites, these were dominated by the growth of Red, Black and White mangrove trees and are inundated with at least two feet of water during most of the year. This situation may likely account for the absence of cultural remains on any of them.

UPS 1:

Upland Rainforest site 1 lies at approximately 1 km south of the BJE property (Fig.6). A quick reconnaissance of the site indicates that there is a central plaza with a 10 meter high mound. Unfortunately both the western and the southern mounds have been looted in the past. During this brief visit no artifacts were identified and it is unclear if the site consists of multiple plaza units.

UPS 2:

Upland Rainforest site 2 lies within the TMP of the BJE property (Fig.6). This site may have been previously identified under a Biodiversity assessment conducted in the late 1990's. The site consists of multiple plazas with structures ranging from 0.5 – 8 meters in height. Due to the time spent at the site it was difficult to ascertain how many plaza groups make up the core of the site. If and when development is planned for this area, however, the site warrants a full scale assessment and survey before any land clearing is effected. During our visit only two structures were identified as being looted. These include the largest (8 meters tall) structure at the site and a smaller structure in an adjacent plaza (approximately 3 meters tall).

Once again it should be noted that the upland sites were not within the area for which we had responsibility to survey as part of this archaeological impact assessment. The reasons we visited these sites during this survey were to:

a) Get an idea of any possible archaeological remains in the broadleaf upland forest, and
b) To make recommendations for measures that should be taken into account upon the implementation of the Timber Management Project.

CONCLUSIONS AND RECOMMENDATIONS

Our survey of the southeast parcel of land on the BJE property indicates that the area slated for development during phase 1 of the project is in close proximity to two recorded archaeological settlements (the Kakantulix and Saktunja Sites), and that it incorporates a possible Historic period site known as Spanish Point. With the data collected from both the aerial and terrestrial survey, we are certain that other cultural sites can be pinpointed from the air by identifying the patches of mangrove where Salt water palmetto abounds. The developers should take into account that despite the fact that no cultural material were identified within most of the mangrove clusters that lack salt water palmetto growth, cultural features and archaeological remains could still be present below surface and below present water levels. This has been noted in the area south of the property where archaeologist Shirley Mock has recorded several salt making sites in the north coastal Belize District. Mock further notes that these sites are not readily visible on the surface, they are rarely extensive and are predominantly found below surface. In view of this we strongly recommended that special attention be paid to all areas where there are clusters of palmetto and mangrove. By special attention we mean that land clearing in these areas should be done carefully and meticulously, preferably under the supervision of an observer (see below). If cultural materials are found within any cluster these should be mapped with a single point using a GPS receiver and the Institute of Archaeology should be informed.

Developments on other sections of the phase1 property should also be sensitive to the possible presence of archaeological remains in the area. This is especially true of the so-called "beach front". As archaeological excavations of other coastal areas of Belize have noted, prehistoric and historic remains have been found below the present sea levels and in areas containing mangrove coastlines (see for example McKillop's work in Payne's Creek National Park). It is therefore imperative that both developers and contractors be aware of this situation and that they take this into serious consideration when dredging or clearing these "beach front" areas.

To address these concerns we recommend that NEAC allows development of the property to proceed but with the stipulation that the developer hires someone with past excavation experience to observe all land clearing and excavation activities. This individual is not required to have a university degree but should be someone with several years experience on archaeological projects, and with official clearance from the Institute of Archaeology. In Belize many workers with extensive archaeological field experience can be found in the communities of San Jose Succotz, Benque Viejo, Bullet Tree Falls and San Antonio in the Cayo District.

This assistant/observer only need be present during the early stages of land filling and construction. He would be expected to observe preliminary land clearing activities, and all excavations associated with construction activities (such as the construction of structural foundations, roads, septic systems, canals, and docks). If any cultural materials are located, (e.g. ancient garbage heaps and/or structures) excavation should be halted in those specific areas and the observer and developer should notify the Institute of Archaeology immediately.

Whenever remains of archaeological significance are located in any part of the site, the developers or contractors should be required to contact the Institute of Archaeology immediately, and then take one of the two options noted below.

1. Modify their development plan by avoiding the area completely and leaving any archaeological material intact.

Or

2. Make arrangements with the Institute of Archaeology for the professional excavation of the archaeological remains.

The second option should be expedited in a timely manner and if possible, make every effort not to place undue hindrance on the development. Any such mitigation must be conducted by a professional archaeologist with adequate excavation experience in Belize. The work must also be conducted in compliance with the National Institute of History and Culture Act, and the conditions for Archaeological research in Belize.

In respect to the area designated as the Timber management program a systematic archaeological survey needs to be conducted in that area before any development can proceed. This survey should make every effort to determine site and ancient population density in that area, and it should provide a cultural resource management plan for these large sites.

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