ENVIRONMENTAL IMPACT ASSESSMENT

for

Ambergris Caye Belize Resort Development

A TOURIST RESORT TO BE LOCATED ON NORTHERN AMBERGRIS CAYE

Prepared by

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Glossary of Terms

Algae: one celled or many celled plants that have no root, stem, or leaf system.
Bathymetry: depth profile of the ocean bottom or seafloor.

Beach: sediment seaward of the coastline through the surf zone that is in transport along the shore and within the surf zone.

Benthic: pertaining to the ocean bottom or seafloor.

Benthos: the forms of marine life that live on the ocean bottom or seafloor.

Biogenic Sediments: sediments containing materials produced by plants or animals such as corals, shell fragments and tests housing diatoms and radiolarians.

Biomass: total weight of the organisms in a particular habitat, species, or group of species.

Biota: the total plants and animals of a given area.

Coast: a strip of land that extends inland from the coastline as far as marine influence is evidenced in the landforms.

Coastline: landward limit of the highest storm waves' effect on the shore.

Coliform: Type of bacterial found in feaces.

Construction: excavation, movement of earth, erection of forms or structures, or similar activities at a development or project site.

Disposal: the discharge, deposit, injection, dumping, spilling, leaking, or placing of any waste into or on any land, water so that it may enter the wider environment, including ground water sources.

Effluent: water discharged from a development into receiving water body or the environment otherwise.

Euryhaline: pertaining to the ability of a marine organism to tolerate a wide range of salinity.

Eutrophication: elevation of nutrient content of water through input of fertilizers, fecal materials and domestic effluents

Fauna: animals.

Fecal: of or related to feces.
Flora: plants.

Finfish: collective terns for aquatic vertebrates with scales which uses fins for propulsion.

Groundwater: water below the land surface in a zone of saturation.

Habitat: a place where a particular plant or animal lives: Generally refers to a smaller area than environment.

Intertidal Zone: lies between the high and low tide extremes and can be divided into a high tide zone which is mostly dry and covered by the highest high tide but not the lowest high tide, the middle tide zone exposed and covered equally by all high tides and exposed during all low tides, and the low tide zone which is mostly wet and covered during the highest low tides and exposed during the lowest low tides.

Lagoon: a body of water separated from the sea by a bank or coral reef: Also the region between a shore and a barrier reef or inside a ring of islands composing an atoll.

Littoral Zone: also known as the foreshore or intertidal zone, lies between the high and low tide extremes.

Lagoonal: of or pertaining to lagoon.

Macroalgae: algae that project more than 1 cm above the substrate, such as Dictyota spp., and Halimeda spp.

Mangal: a swamp dominated by mangroves.

Mangroves: collective term used for range of salt-tolerated inter-tidal plants found throughout the tropics and within latitude of 20° north and south of the equator.

Neap Tide: tide of minimal range occurring when the moon in quadrature, or its 1st Quarter and 3rd Quarter Phases.

Nearshore Zone: the seaward zone from the shoreline to the line of breakers.

Pelagic Environment: the open ocean environment which is divided into a neretic province with water depths 0 to 200 m and the oceanic province with depths greater than 200 m.

Pelagic Organism: free-swimming or floating biota that live exclusively in the water column, not on the sea floor or ocean bottom.

Permitting Agency: a Government Agency responsible for issuing permits to allow various aspects of a development to proceed within the context of the Laws of Belize.
Permit: authorization, license, or equivalent control document issued by an Agency of the Government of Belize to implement various aspects of a development.

Pollutant: any dredged spoil, solid waste, incinerator residue, sewage, garbage, chemical waste, heat, industrial, domestic, municipal or agriculture waste discharged into the environment.

Primary Productivity: the amount of organic matter organisms synthesize from inorganic substances within a given volume of water or habitat in a unit of time.

Project Proponent: developer proposing a particular project.

Red List: Catalogue of Threatened Species compiled by IUCN.

Salinity: a measure of the quantity of dissolved solids in ocean water: it is expressed in part per thousand by weight after all carbonates have been converted to oxide, the bromide and iodide to chloride, and all the organic matter oxidized.

Sessile: attached to the bottom or to rocks, pilings, etc. and unable to move.

Sewage: any human body waste and the waste from toilets and other receptacles intended to receive or retain body wastes that are discharged into the environment.

Sand: particle size ranging from 1/16 to 2 mm: It pertains to particles that lie between silt and granules on the Wentworth Scale of grain size.

Sanitary Landfill Site: a facility at which municipal, industrial wastes and hazardous wastes are applied onto or incorporated into the soil surface.

Shore: the section of land seaward of the coast: This extends from the highest level of wave action during storms to the low water line.

Shoreline: the line marking the intersection of the water surface with the shore: It migrates up and down as the tide rises and falls.

Silt: a particle size ranging from 1/128 to 1/16 mm: It is intermediate between sand and clay.

Spring Tide: tide of maximum range occurring every fortnight and coincides with when the moon is new and full respectively.

Sublittoral: seabed below the low tide mark.

Tide: periodic rise and fall of the ocean surface and connected bodies of water resulting from the unequal gravitational attraction of the moon and sun on different parts of the earth.
Tidal Range or Amplitude: the difference in height between consecutive high and low water: The comparison may also be a day, month or year.

Topography: the physical shape of the land surface.

Transect: a line or narrow belt used to survey the distribution of organisms or substrate across a given area.

Vertebrates: animals belonging to the Subphylum Chordata, also known as the Chordates that include those animals with a well-developed brain and a skeleton of bone or cartilage: Includes fishes, amphibians, reptiles, birds and mammals.

Wave: a disturbance that moves over or through a medium with a speed determined by the properties of the medium.

Wave Height: vertical distance between a crest and the preceding trough.

Wave Length: horizontal distance between two corresponding points on successive waves such as from crest to crest.

Glossary of Acronyms

ABR: Ambergris Caye Belize Resort Development

BCNP/MR: Bacalar Chico National Park and Marine Reserve

CITES: Convention on the International Trade in Endangered Species of wild flora and fauna.

CZMAI: Coastal Zone Management Authority and Institute.

EIA: Environmental Impact Assessment.

DOE: Department of the Environment.

GOB: Government of Belize.

IUCN: International Union for the Conservation of Nature.

NGO: Non-Government Organization.

TOR: Terms of Reference.

ORIENTATION NOTES

The current EIA submission consists of two (2) major components, viz: a project brief or executive summary and an expansive narrative. The latter consists of the immediate project concerns as stipulated by the TOR for the initiative, supplemented by a number of annexes which in principle provides further details to issues covered in the main part of the narrative.

The main narrative is broken down into a number of components which are to some extent segregated into chapters. The narrative begins with the physical description of the project which is captured in chapter 1. This includes among other issues an introductory overview of how the utilities for the project are to be addressed – these issues are further expanded and dealt with in details in chapters 4, 5, 6 & 7 of the document. A description of the physical and biological environment is the focus of chapter 2 of the narrative. This includes a description of the flora and fauna of the area, as well as issues such as water quality, bathymetry and water quality.

The orientation of the document changes in Chapter 9, which is focused on disaster preparedness and response.

Arguably, the most substantive part of the document deals with the magnitude and orientation of the impacts arising as a consequence of the implementation of the project: This is captured in chapter 10 of the document. The assessment of the impacts of the project is divided into two (2) main areas, viz: the ecological impacts and the social impacts. The mitigation to ameliorate or circumvent the negative environmental impacts are dealt with in chapter 11 of the document.

The issue of environmental monitoring was dealt with in chapter 12 of the document. The final chapter of the document (Chapter 13) deals with ‘alternatives to development’. This section entails some detailed analysis and response: This was both in relation to the broad concepts of the project, as well as specific components. Great care was taken to avoiding generic and elementary responses to issues that would require some studied introspection.

The overall document was prepared not only with a view of responding to the prescriptions of the TOR, but also with the view of understanding that documents of this nature are an resource material for researchers, administrators, natural resource managers, students, faculty and the public at large. In this regard great care was taken in undertaking the necessary field based surveys and assessments, as well as in providing information with the requisite level of academic integrity.

Executive Summary

Project Location

The proposed project: Ambergris Caye Belize Resort Development, or 'ABR', is to be located on northern Ambergris Caye. The project site is located approximately 23 miles north of San Pedro, or 59 miles north-east of Belize City.

The project site is on the windward or eastern side of Ambergris Caye. The project site has both an ocean side, and a lagoonal side: The Caribbean Sea washes the shores of the property on the eastern side, and the Laguna de Cantena delimits the boundary on the western side of the property.

The property is 185 acres and entails a well developed sandy beach, as well as a fairly extensive tropical littoral forest, and lowland mangroves.

The property is a part of the larger area of Ambergris Caye known as Bacalar Chico. The larger Bacalar Chico area runs to the northern border with Mexico and comprises 28,169 acres land and coastal waters.

The larger Bacalar Chico area is a National Park and Marine Reserve: This protected area is the Bacalar Chico National Park and Marine Reserve [BCNP/MR].

There is no development on the property: Neither is there a history of any development(s) that may have been pre-existing.

The project site is not serviced by any roads or airport. The only immediate access to the site is by boat. The nearest airstrip to the area is the Nova Airstrip, which is 4.5 miles by the shortest navigable overland route.

Project Profile

The proposed project is of a recreational tourism orientation, complimented by an upscale residential development. The hotel resort development entails rooming accommodations, meeting/conferencing facilities, restaurants and bars, pool facilities and recreational facilities for children: This aspect of the development is to cover 126,986 sq. ft. of the property.

The time-share condominium component of the development entails beachfront villas, cottages and bungalows: This aspect of the proposed development is to take up 128,700 sq. ft.

The overall development, including lawns, gardens, hedgerows and recreational open spaces is to take up 27 acres of property. This represents approximately 30% of the land area, and 15% of the overall property, including the lagoonal portion.

The resort facilities include:
(i) Eighteen 56 units hotel rooms;
(ii) Eight pool cabanas;
(iii) Thirteen beach palapas;
(iv) Six spa cabanas;
(v) Twelve over-water cabanas;
(vi) A specialty restaurant;
(vii) A business centre.

The residential facilities are to include:
(i) Fourteen beach-front villas;
(ii) Twenty-five beach cottages;
(iii) Eleven bungalows;
(iv) A centralized owner’s club.

Supporting infrastructure and amenities are to include:
(i) An employee dorm;
(ii) An extensive boardwalk;
(iii) A utility zone;
(iv) A swimming pool;
(v) A children’s play park;
(vi) Three piers that are to be coincident with the overwater cabanas and dive center;
(vii) 4.5 miles of road leading from Nova Pier to

The project is to be developed over a two (2) years time-frame: it is to be subdivided into two phases with a concentration on the resort and infrastructure facilities in phase I [See Table 1].

The ABR facilities have been designed to accommodate 967 persons: Apart from tourists and home owners, this includes 289 workers [See Table 2]. Almost all of these workers are to be Belizeans.

The Utility Zone is to house energy generation facilities, potable water storage and harvesting infrastructure, sewage treatment technologies and solid waste sorting, storage and disposal facilities.

The primary source of energy is to be from diesel generators, supplement by solar panels and wind turbines. The latter two (2) sources of electricity are to be integrated with banks of batteries for energy storage purposes.

The primary source of potable water is to be ferried from Reverse Osmosis: This is to be complimented by rainwater harvesting. Both of these sources of potable water are to be integrated with cisterns installed in the Utility Zone.

Table 1.2: Construction Schedule

Project Concept	Project Components	Time Frame							
		Yr. 1				Yr. 2			
		Qt. 1	Qt. 2	Qt. 3	Qt. 4	Qt. 1	Qt. 2	Qt. 3	Qt. 4
Hotel/ Resort	Main Hotel, Hotel Cananas and Kitchen	→	→	→	→	→	→		
	Conference Facilities			→	→				
	3-Meal Restaurant and Pool Bar			→	→	→			
	Spa and Spa Cabanas				→	→			
	Overwater Cabanas			→	→		→	→	→
	Specialty Restaurant				→	→			
	Pier Construction and Dredging	→	→						
	Swimming Pools			→	→				
	Pool Bar and Ocean Pool Bar				→	→			
	Beach Cottages and Palapas			→	→	→	→	→	
	Beach and Nearshore Swimming Area		→	→	→				
	Utilities Zone		→	→					
	Boardwalk and Lagoonal Restaurant			→	→	→			
	Children Play Park				→	→			
	Road Construction	→	→	→					
	Infrastructure at Nova Pier	→	→						
Residential	Housing Quarters for Workers			→	→				
	Owner's Club				→	→			
	Beach Front Villas		→	→	→				
	Beach Cottages				→	→	→	→	→

Table 2: Caye Occupancy

Type	Description	Units	Occupancy
A	Hotel	56 rooms	112
B	Hotel Suites Type A	8 suite buildings	24
C	Hotel Suites Type B	12 suite buildings	36
D	Water Cabanas	12 Cabana buildings	36
E	Beach Front Villas	14 villa buildings	126
F	Beach Cottages	12 cottage buildings	72
G	Apartments	22 Units	88
H	Future Developments	13 Units	78
I	Owner's Club House	1 unit	6
J	Employee Housing	1 unit	289
K	Transient Visitors	persons	100
Totals			**967 Persons**

Sewage derived from human waste and domestic effluents is to be treated through the deployment of secondary treatment technology. A 'package plant' known by its trade name "BESST" is to be employed in the treatment of all wastewater generated by the resort facilities. This technology, which the acronym stands for Biologically Engineered Single Sludge Treatment - reduces major pollutants such as the macro-nutrients nitrates and phosphates, and ammonia, as well as Total Suspended Solids (TSS), BOD substances and microbes to levels where they do not pose a threat to the integrity of environment, or human health. The post-treated effluents from the BESST Treatment Plant, is to be chlorinated, stored and used for the flushing of toilets, as well as the irrigation of lawns and hedgerows, and fire-fighting purposes.

Solid waste management entails the separation of the garbage generated by the facilities into its organic and inorganic components. The organic or biodegradable component is to be composted on-site through the application of 'earth tub' technology. The waste in the form of a semi-dry mulch is to be used as an organic fertilizer for the hedge rows and lawns. The inorganic components are to be further separated into combustible and non-combustible components: These are to be bagged in color coded impervious plastic bags and transported to the San Pedro Sanitary Land-fill for disposal.

State of the Environment

The project site can be segregated into two (2) distinct terrestrial ecosystems, viz: a beach vegetation herbaceous and shrubbery component and littoral forest on the beach berm and higher ground on the windward or eastern 2/3rd of the property, and a mangrove forest on the leeward or lower end of the property. Both the littoral forest and mangrove lowlands were in a robust and hardy state of health.

The sub-tidal flora in the sea off the eastern side of the property was dominated by seagrass beds in the nearshore areas, and by coral reef in the more distal areas. The dominant species of seagrass was the Turtle Grass (Thalassia testudinium). A number of macro-algae were found growing in intermittent tufts with the seagrass, these included: the Clump Halimeda (Halimeda opuntia), the Shaving Bush Algae (Penicillus spp.), the Feather Algae (Caulerpa prolifera), and the Smooth Leather-fan Algae (Udotea flabellum).

Coral species in the offshore areas included: the Staghorn Coral (Acropora cervicornis), the Elkhorn Coral (Acropora palmata), the Lettuce Coral (Agaricia agaricites) and the Grooved Brain Coral (Diplora labyrinthiformes).

Apart from corals, the nearshore and offshore waters off the eastern side of the property were inhabited by a number of invertebrate and vertebrate species. The invertebrate species such as Spiny Lobster (Panulirus argus), the Queen Conch or 'conch' (Strombus gigas)the Bleeding Tooth (Nertia peloronta), the Mantis Shrimps (Squilla sp.) and the Long Spined Black Urchin (Diadema antillarum.)

The vertebrate fauna included a number of fish species such as the Rockfish Grouper (Mycteroperca bonaci), the Honeycomb Cowfish (Lactophrys polygonia), the Long jaw Squirrelfish (Holocentrus ascensionis), and the Spotted Moray (Gymnothorax moringa). The vertebrate fauna were also represented by a number of reptile species. These included: the Smooth-Scaled Gecko (Sphaerodactylus glaucus), the Wish-Willy or Spiny-tail Iguana (Ctenosaura similis), and the Green Vine Snake (Oxybelis fulgidus).

The Amphibians were the least represented class of vertebrates, both in relation to abudance and species diversity, which is typical in mangrove and littoral forest areas.

The vertebrate fauna in the area also included aquatic mammals such as the West Indian Manatee (Trichechus manatus) and the Bottlenose Dolphin (Tursiops truncatus). The most prominent terrestrial mammals were the Four-Eyed Opossum (Philander opossum). The birds were the most abundant and diverse non-aquatic vertebrate fauna. These included the Brown Pelican (Pelicanus occidentalis), the Herring Gull (Larus argentatus), the Golden-fronted Woodpecker (Melanerpes aurifrons), and the Tropical Kingbird (Tyrannus melancholicus).

Environmental Impacts

The environmental impacts arising from the project were both ecological and social in orientation. The project activities that are likely to give rise to some environmental impacts of note are the dredging and reclamation operations, the generation of domestic effluents and solid wastes, as well as energy generation.

The primary turbidity and sedimentation impacts arising as a consequence of the dredging activities scheduled to be undertaken in conjunction with the currently proposed project are moderate in scope. The secondary impacts have been assessed as 'minor' at their most severe: This is related to the limited dredging volumes, the modest sensitivity of the area, and the dredging methods and associated protocols to be applied. In relation to the latter, a cutter-head dredge will be applied: This is to be accompanied by sediment curtains. Additional mitigative measures will also be applied such as dredging in calm sea-states only, and suctioning the barrow pits of mobile sediments on a daily basis to curtail re-suspension and the re-broadcasting of sediments.

The primary impacts in relation to human and domestic wastes were evaluated as major given the scope of the development. These relate to nutrient enrichment or eutrophication, increase in BOD compounds and the elevation of fecal pathogens in the water column. Much of the secondary nutrient effluent impacts were positive, given the very limited liberation of nutrients into the environment and its positive influence on primary production and fisheries productivity. The secondary impacts in regard to BOD and fecal coliform were evaluated in the minor deleterious category at their most severe.

Apart from the limited dispersal of effluents into the environment, the sewage treatment methodology applied was also responsible for the minor deleterious categorization of the secondary impacts. The adoption of the BESST Sewage Treatment System in the design of the proposed project will reduce macro-nutrients, BOD substances and fecal pathogens to levels that are well within national standards. The storage and chlorination of effluents that are to be reused for flushing toilets and the watering of lawns and hedgerows should denature any pathogens that would remain after treatment by the BESST Plant.

The most severe primary impacts in regard to solid waste, has been evaluated as major. The secondary ecosystems level impacts have been evaluated as minor deleterious. This is attributable to the solid waste management strategies to be applied. The composting of organic wastes, and the collection and off-site disposal of the inorganic components should greatly reduce its impacts on feral animals such as the raccoon (Procyon lotor), the Wish-Willy (Ctenosaura similis) and the Great Tailed Grackle (Quiscalus mexicanus).

The more relevant social impacts of the proposed project include continued access to the resources and geographic space of the areas, as well as the potential human health risks of exposure to pathogenic microbes. Other impacts of relevance are the threat of trauma and injury and trauma and exposure to aesthetic pollution. These have all be classified as 'level 3' or 'tertiary level' impacts.

The issue of 'access to resource' relates to the need to ensure uninterrupted access to the fishery resources of the area by sports fishers and commercial fishermen, as well as need to ensure continued access to the area by dive guides and tour operators. The need of guaranteeing access of the BCNP/MR Staff is also of relevance. The pathogenic disease issues relates to the risk of augmenting or creating additional habitats for malaria bearing mosquitoes and other insect pests. The threat of injury and trauma relates to potential encounter with guests of the facilities with wildlife attracted to the area such as raccoons, as well as road-traffic accidents and mishaps, and collision-at-sea events. These tertiary level impacts have all been assesses as insignificant or 'minor deleterious' in scope.

Chapter 1

1.0 Project Description

1.1 Project Location

ABR is a resort and time share condominium development. The project is to be located on the upper north-eastern portion of Ambergris Caye [See Fig. 1.1]. This places the project site approximately 23 miles north of San Pedro Town [See Fig. 1.1]. This places the project location 59 miles north-east of Belize City [See Fig. 1.1].

Rocky Point, which is a popularly know area to mariners and the local towns people, lies just to the south of the property. Rocky Point is the only known area in Belize where the reef crest merges with the shore, to produce a situation of relatively deep and turbulent water right next to shore [See PL 1.1]

The project location is a moderately thick strip of land with the Caribbean sea on the windward or eastern side, and a saline lagoon, the Laguna de Cantena, on the leeward side of the property [See Fig. 1.1, and PL 1.1 & PL 1.2].

The windward side of the property is relatively shallow, with maximum depths within 20 ft. [See PL 1.2]. This shallow area proceeds from the beaches of the property, to the reef crest of the Belize Barrier Reef [See light blue contour in Fig. 1.2].

The Laguna de Cantena is an expansive semi-isolated body of water measuring over 2,300 acres [See PL 1.1].

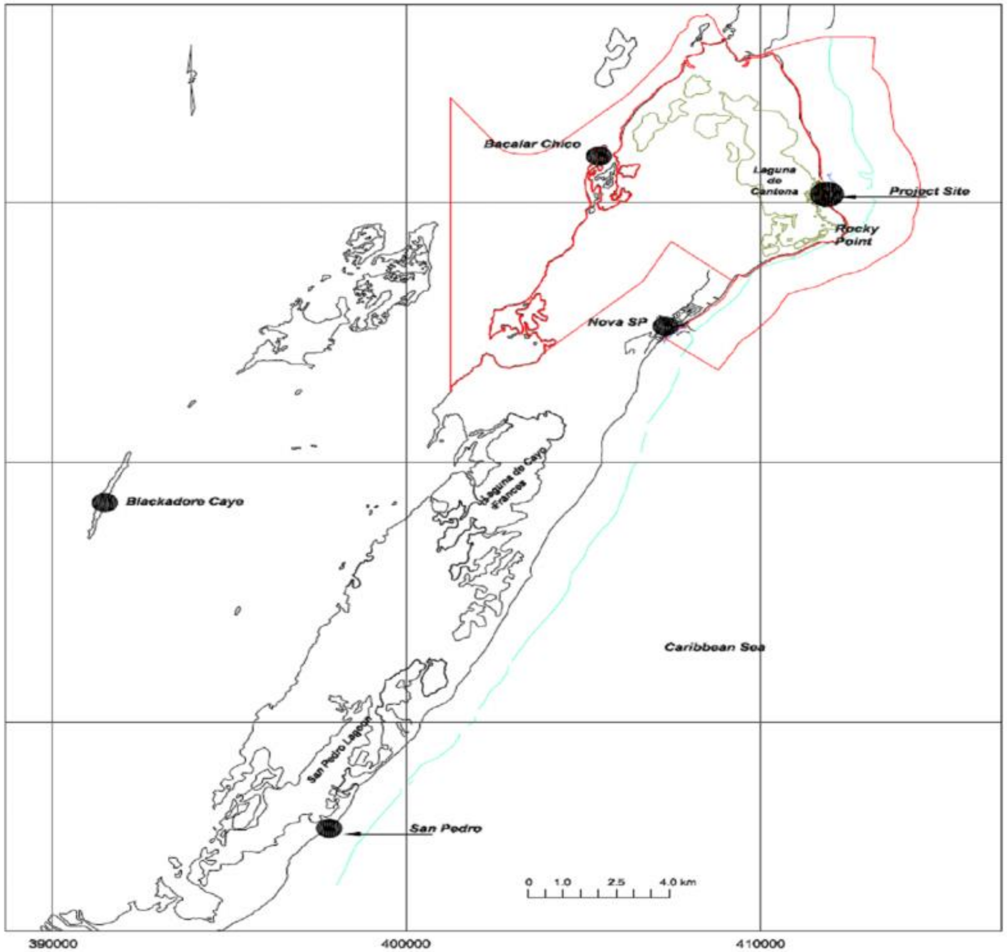
The property is 185 acres and entails a well developed beach and berm, as well as relatively high ridge colonized by a tropical littoral forest, and lowland mangroves. The nearshore portions of the Laguna de Cantena on the leeward side of the property, is a part of the legal description of the property [See PL 1.1].

The littoral forest and beach environment comprises 48 acres of the property, while the lowland mangroves comprise 43 acres, and the lagoon 93 acres of the property.

The property is a part of a larger area of Ambergris Caye known as Bacalar Chico. The larger Bacalar Chico area runs to the northern border with Mexico. The area comprises 28,169 acres land and coastal waters.

The larger Bacalar Chico area is a National Park and Marine Reserve. The protected area is dubbed the Bacalar Chico National Park and Marine Reserve [BCNP/MR].

The project site is not serviced by any roads or airport. The only immediate access to the site is by boat. The nearest airstrip to the area is the Nova Airstrip: This area is 4.5 miles overland. Although no road runs to the property, a road reserve has been delineated.



Detail A- Map of San Pedro showing Project Site

Scale 1":5000m

Map of Belize

LEGEND

Barrier Reef Crest

Bacalar Chico Marine Reserve (15,575 acs.) & National Park (12,810 acs.)

TUNICH- NAH CONSULTANTS
&
ENGINEERING
José García P Eng. # 053-2001

Fig. 1.1: Project Location

PL 1.1

PL 1.1: North/South view of proposed project area: Water body to the left proceeding from 9 o'clock of frame is Laguna de Cantena – Strip of land at right proceeding from the 3 o/clock latitude to the distal end of the frame is proposed project site…

PL 1.2

PL 1.2: East/West view of project site: Bloches in lower to mid-portion of frame are coral formations, dark arcuate swath leading up to beach are seagrass beds – Note Laguna de Cantena just beyond strip of land in mid-ground describing proposed project site.

1.2 Physical Plan

1.2.1 Existing Development

There is no development on the property: Neither is there a history of any development(s) that may have been pre-existing. There is a private residence just north of the property.

The nearest developments in the area are two (2) unfinished or abandoned houses just north of the Nova pier, which lies 4.5 miles to the south of the property.

The only other development of note is the Ranger Station for the staff of the Bacalar Chico Marine Reserve. This facility lies 4.6 miles, as the crow flies, west of the proposed project site

Ninety percent (90%) of the project area is comprised of a well developed and fairly dense littoral forest on the higher grounds of the property, and low-land mangroves in the swampy or inter-tidal portions of the property.

1.2.3 Planned Development

The proposed project is conceptually a hotel resort development complimented by a time-share residential condominium component. The hotel resort development is to cover 130,066 sq. ft. of the property [See Table 1.1]. This part of the development is to entail rooming accommodations, meeting/conferencing facilities, restaurants and bars, pool facilities and recreational facilities for children [See Table 1.1].

The time-share or residential component of the development is to occupy 160,100 sq. ft. [See Table 1.1]. This consists of cottages, villas and bungalows.

The overall development, including lawns, gardens, hedgerows and recreational open spaces is to take up 36.8 acres of property. This represents approximately 30% of the land area, and 15% of the overall property, including he lagoonal portion. The development entails the placement of buildings and associated infrastructure on the seaward, mid-latitude and lagoonal berms, as well as the nearshore environment on the seaward side of the property [See Fig. 1.2].

Fig. 1.2: Conceptual Development Plan

Table 1.1: ABR Development Summary

Components	**No. of Units/ Lots**	**No. of Keys**	**Unit Area S.F. A/C**	**Unit Area S.F. Terr.**	**Per Rm T/Area S.F.**	**Total Area S.F.**
HOTEL						
Lobby, Front Desk, Admin., Accounts, Bar						4,800
Banquet & Meeting						2,400
Kids Play Room						1,800
Business Center, Adults Games Room						2,600
3-Meal Restaurant						7,000
Specialty Restaurant						1,800
Kitchen						3,000
Pool Bar						1,100
Lakeside Bar & Grill						3,000
Ocean Pool Bar						930
Diving Center						910
B.O.H & Service						16,700
Employee Housing						7,100
Pool Cabanas	8		200		200	1,600
Beach Palapas	13		50		50	650
Spa						6,600
Spa Cabanas	6		500	180	680	4,080
Hotel Suites (Type A)	6	6	680	180	860	5,160
Hotel Suites (Type B)	12	12	596	167	763	9,156
Hotel Rooms	56	56	650	130	780	43,680
Over-water Cabanas	6	6	650	350	1,000	6,000
SUB-TOTAL	80	80				130,066

Components	No. of Units/ Lots	No. of Keys	Unit Area S.F. A/C	Unit Area S.F. Terr.	Per Rm T/Area S.F.	Total Area S.F.
Residential						
Owner's Club						2,800
Beach Front Villas	14	42	100' x 70'		3,000	42,000
Beach Cottages	12	24	100' x 50'		2,500	30,000
Bungalows	22	44	100 x 50'		2,400	52,800
Future Development (Beach Cottages)	13	26			2,500	32,500
SUB-TOTAL	50	114				160,100
TOTAL	130	194				290,166

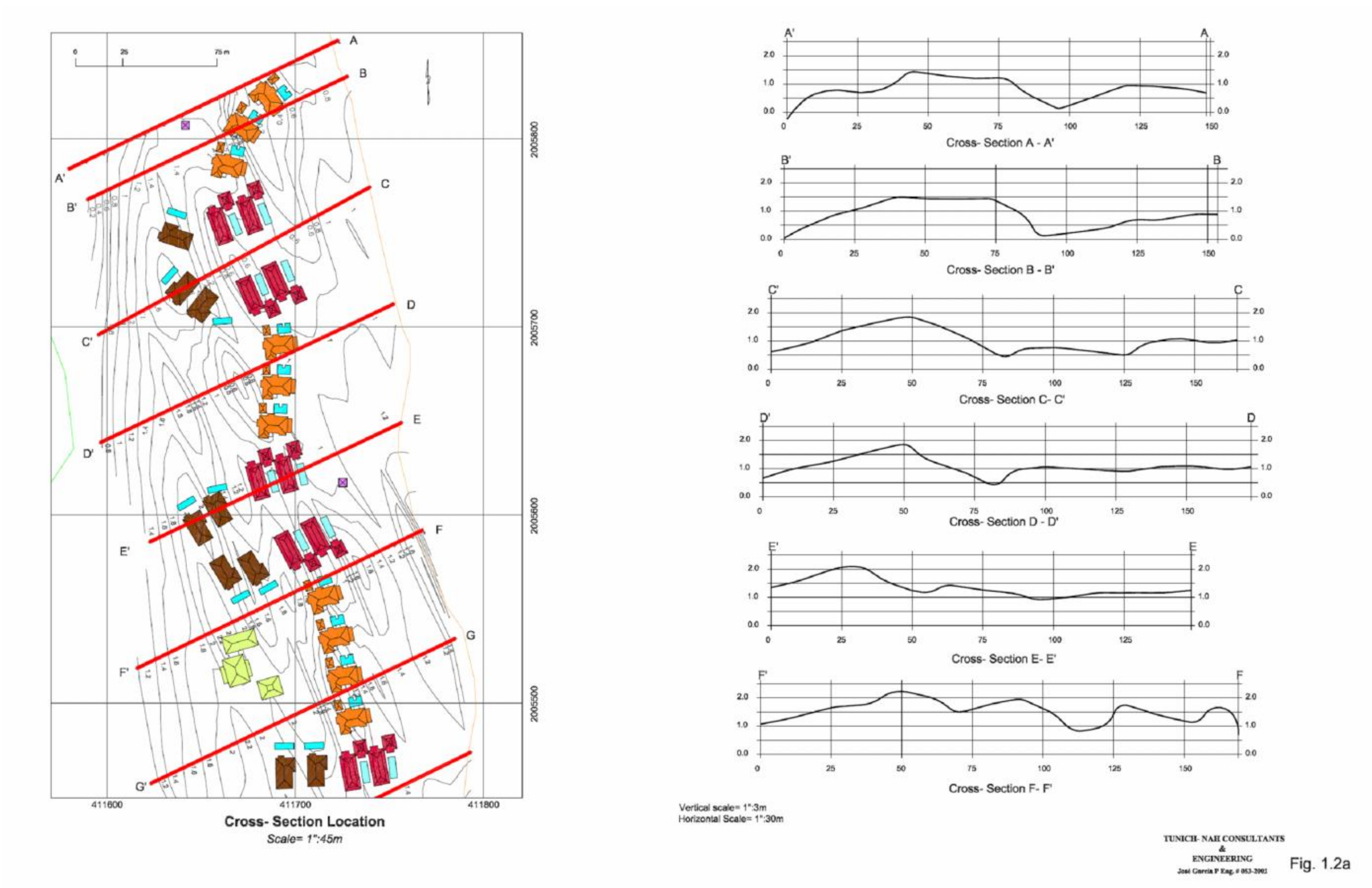


Fig. 1.2a: Elevation Contours in relation to Placement of Buildings

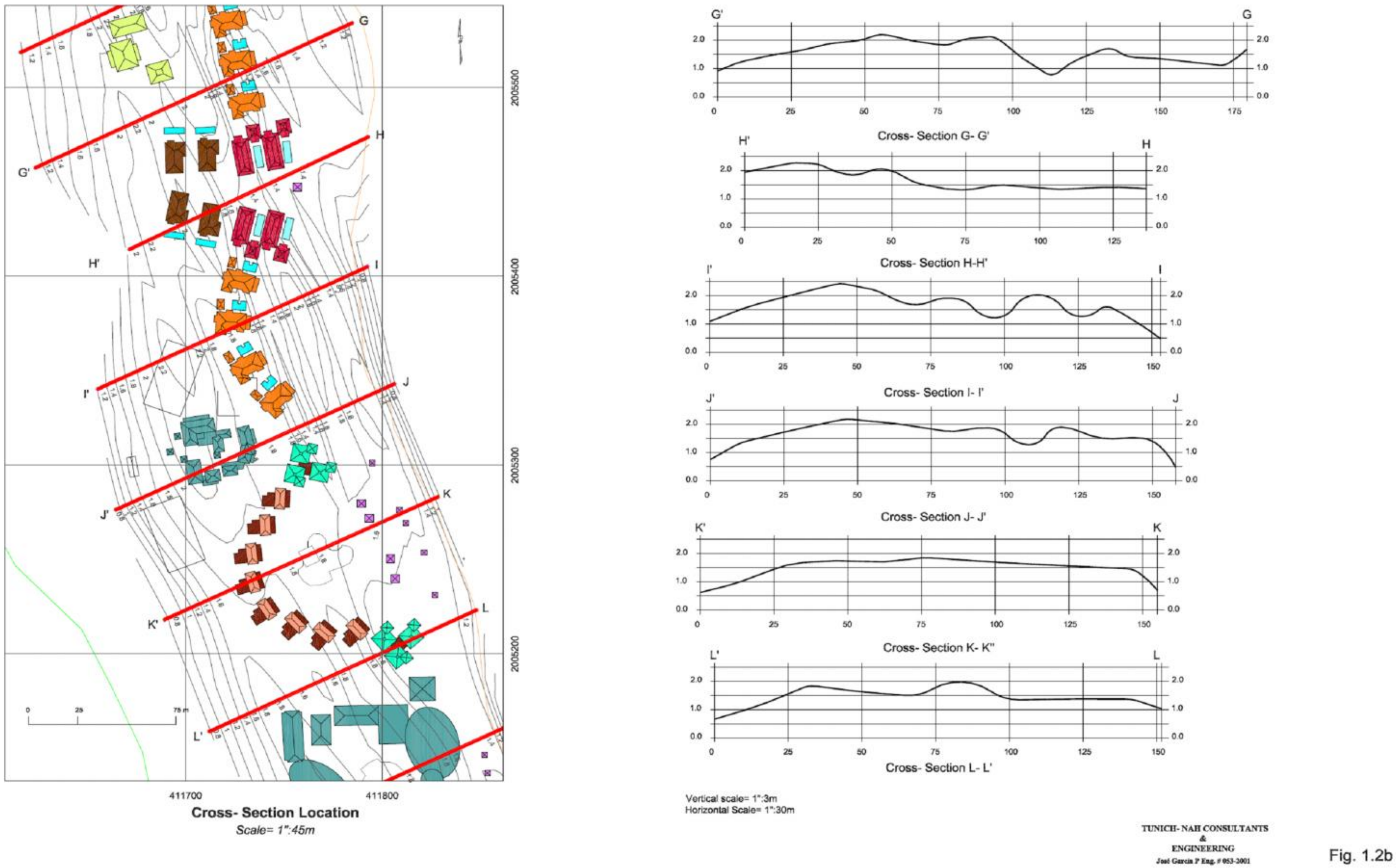


Fig. 1.2b: Elevation Contours in relation to Placement of Buildings (Cont'd)

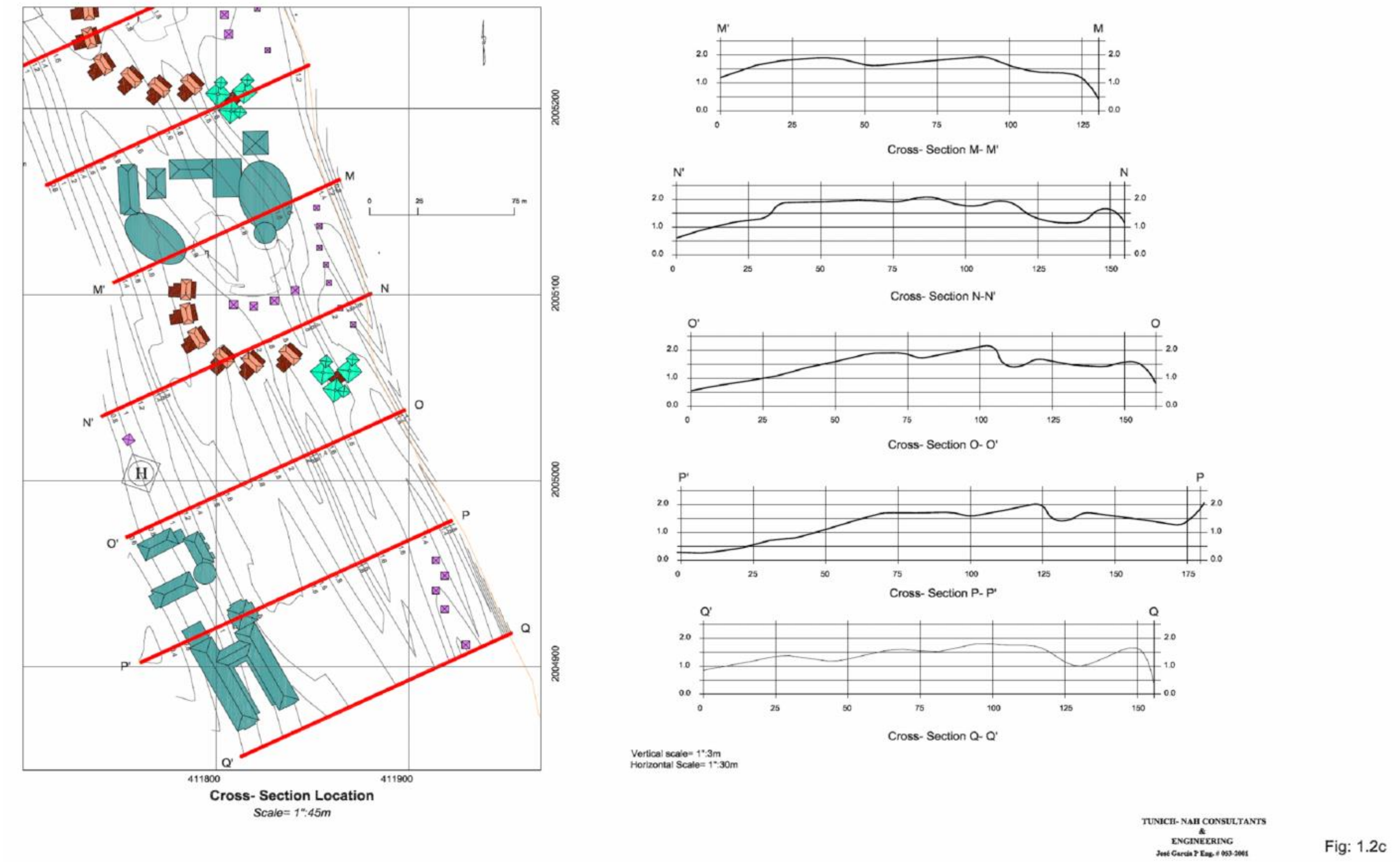
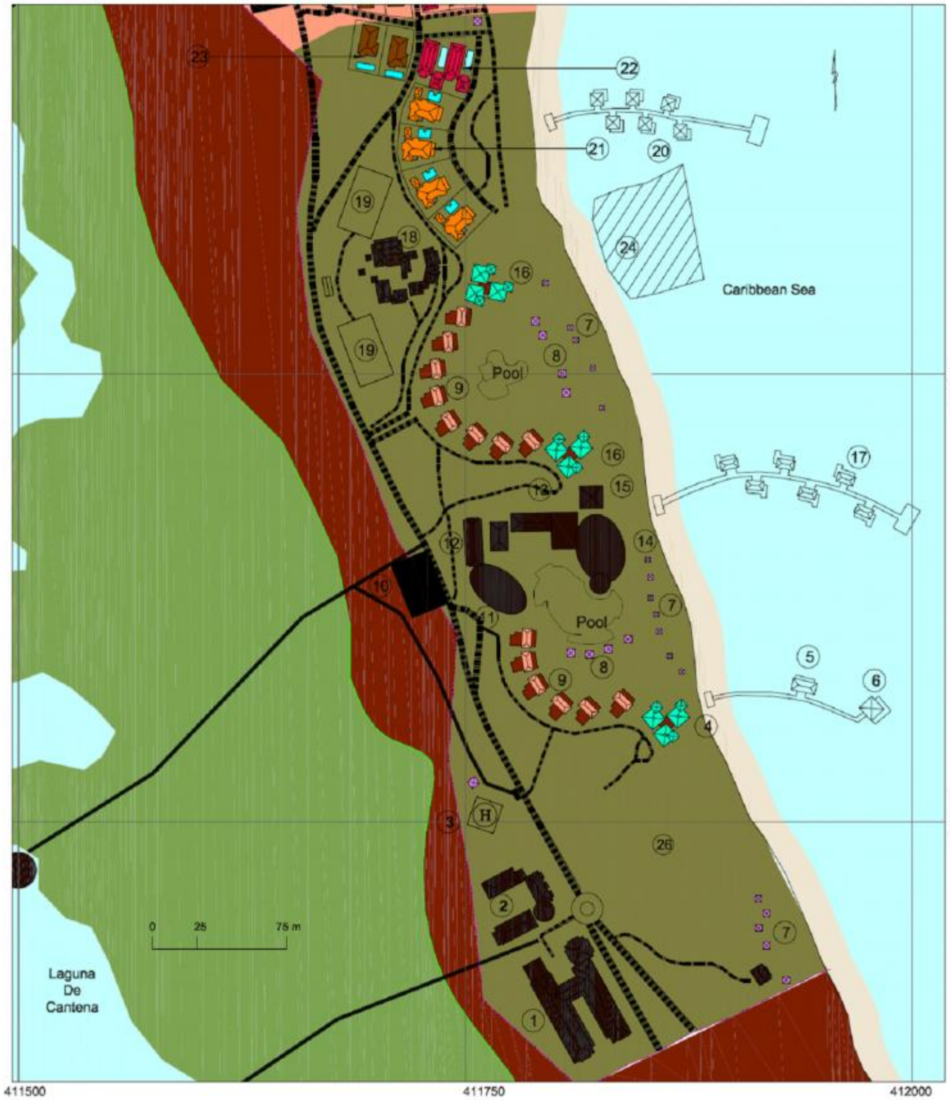
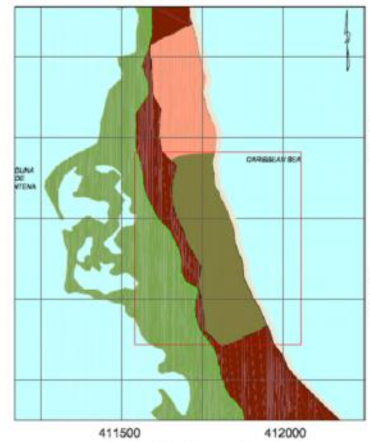


Fig. 1.2c: Elevation Contours in relation to Placement of Buildings (Cont'd)



Phase 1 Development Zone
Scale= 1":65m



Project Location
Scale= 1":350m

Phase 1 & Future Infrastructure Development			
Description	Number Units/ lots	Area (sq.ft)	Total Area (sq.ft)
BOH & Service	1	16,700	16,700
Employee Housing	1	7,100	7,100
Hotel Suites A	6	860	5,160
Ocean Pool Bar	1	930	930
Diving Center	1	910	910
Beach Palapas	13	50	650
Pool Cabanas	8	200	1,600
Hotel Rooms	14	3,120	43,680
Lobby	1	4,800	4,800
Restaurants & Services	1	18,600	18,600
Over water Cabanas	6	1,000	6,000
Spa	1	6,600	6,600
Spa Cabanas	6	680	4,080
Beach Front Villas	4	3,000	12,000
Beach Cottages	2	2,500	5,000
2- Bedroom Bungalow	4	2,400	9,600
Bar Grill	1	3,000	3,000
Pool Bar	1	1,100	1,100
Hotel Suites B	12	763	9,156
Total Area (Phase 1)			156,666
Future Developments			32,500
Total Area			189,166

LEGEND

Road Network
Phase 1 Development area
Phase 2 Development Area
Boardwalk
Littoral forest
Mangrove
Water Bodies
Beach

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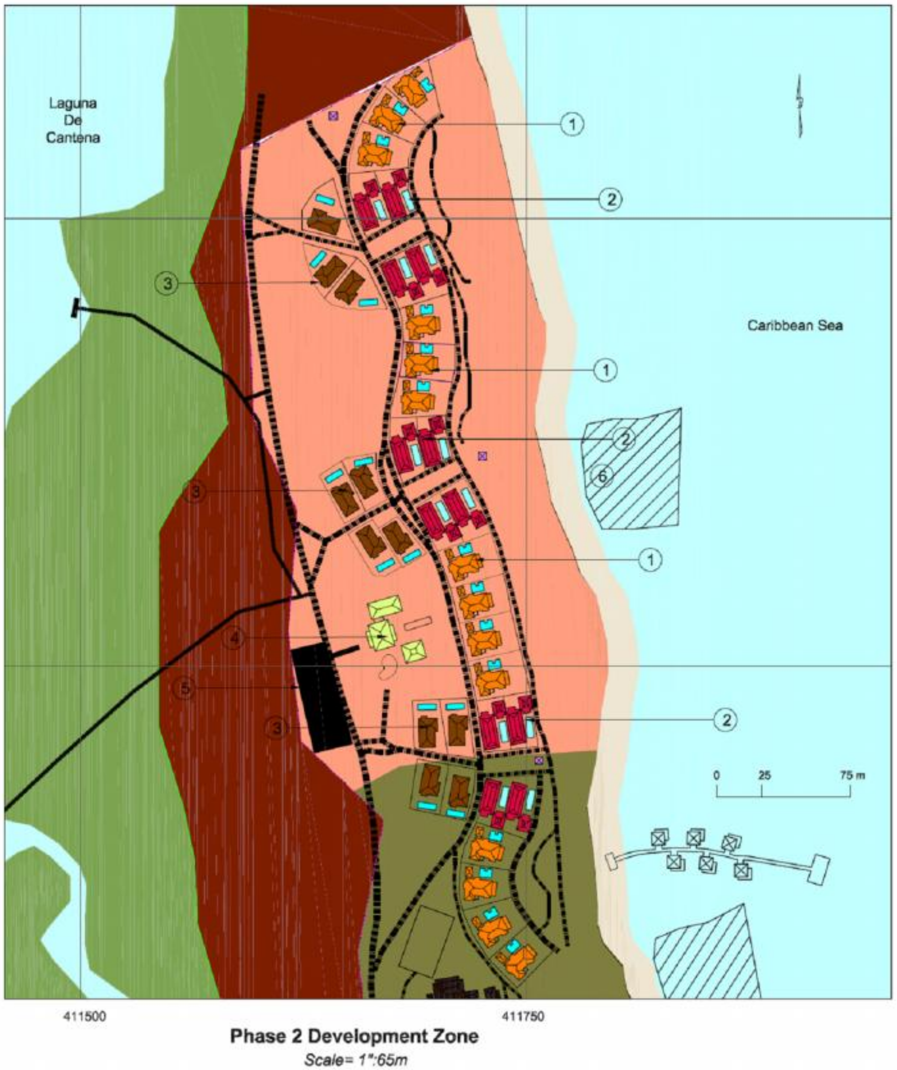
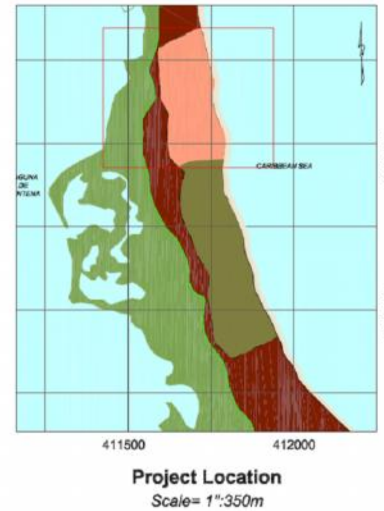
Fig. 1.3a

Fig. 1.3a: Phase I of Development





Phase 2 Infrastructure Development			
Description	Number of Units/ Lots	Area (sq.ft)	Total Area (sq.ft)
Beach Front Villas	10	3,000	30,000
Beach Cottages	10	2,500	25,000
2 Bedroom Apartments	18	2,400	43,200
Home Owners Club House	1	2,800	2,800
Total Area			101,000

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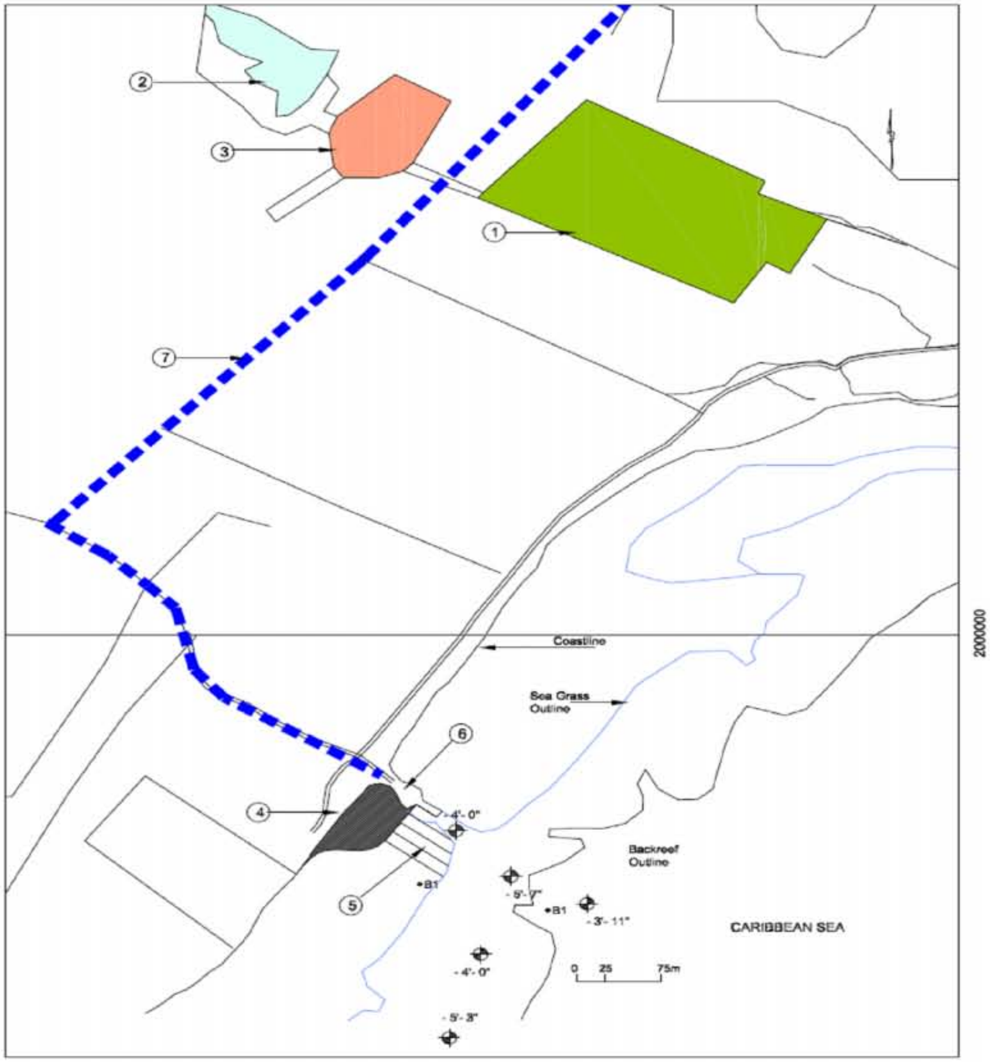
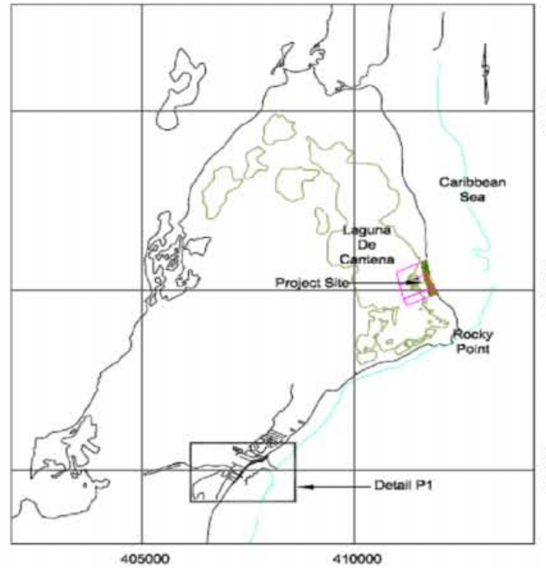
Fig. 1.3b

Fig. 1.3b: Phase 2 of Development



Detail P1: Proposed Expansion at Nova Pier



Project & Nova Pier Location
Northern Ambergris Cay

Roads and Pier Fill Requirement			
Description	Type of material	Length/ Area	Total Materials (m^3)
Proposed access road	Granular	8.44 km	58,838
Project Roads	Granular	4.25 km	19,840
Nova Pier expansion	Granular	0.9 acs	5,780
		TOTAL	84,458

KEY

1. Nova San Pedro
2. Lagoon
3. Nova Quarry
4. Proposed Pier Expansion (0.9 acs)
5. Proposed Dredge Area (0.6 acs)
6. Existing Pier
7. Proposed Road

B1 Bouy

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Fig. 1.4: Development Components at Nova Pier.

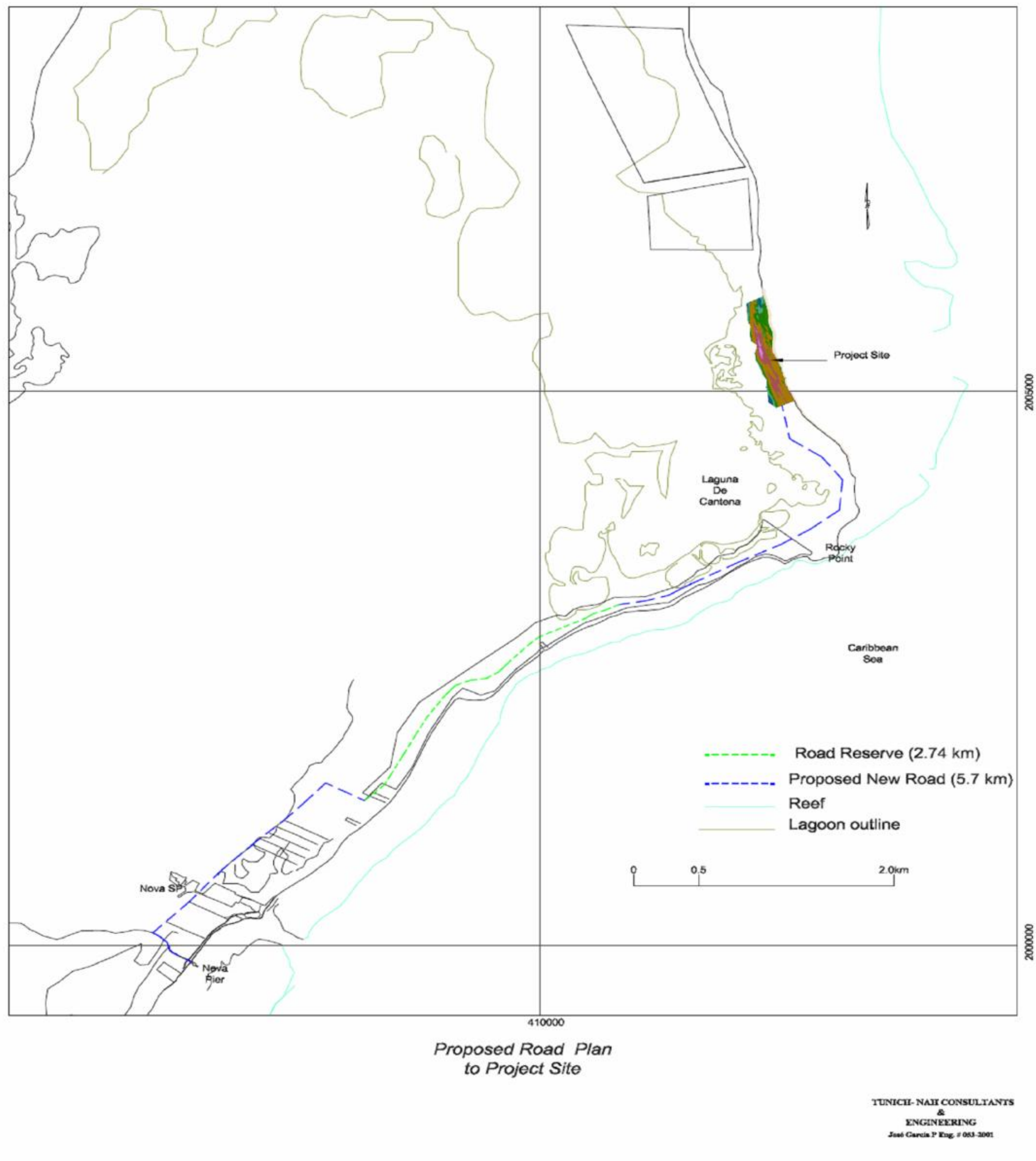


Fig. 1.5a: Roads and Paths from Nova Pier to Proposed Project Site.

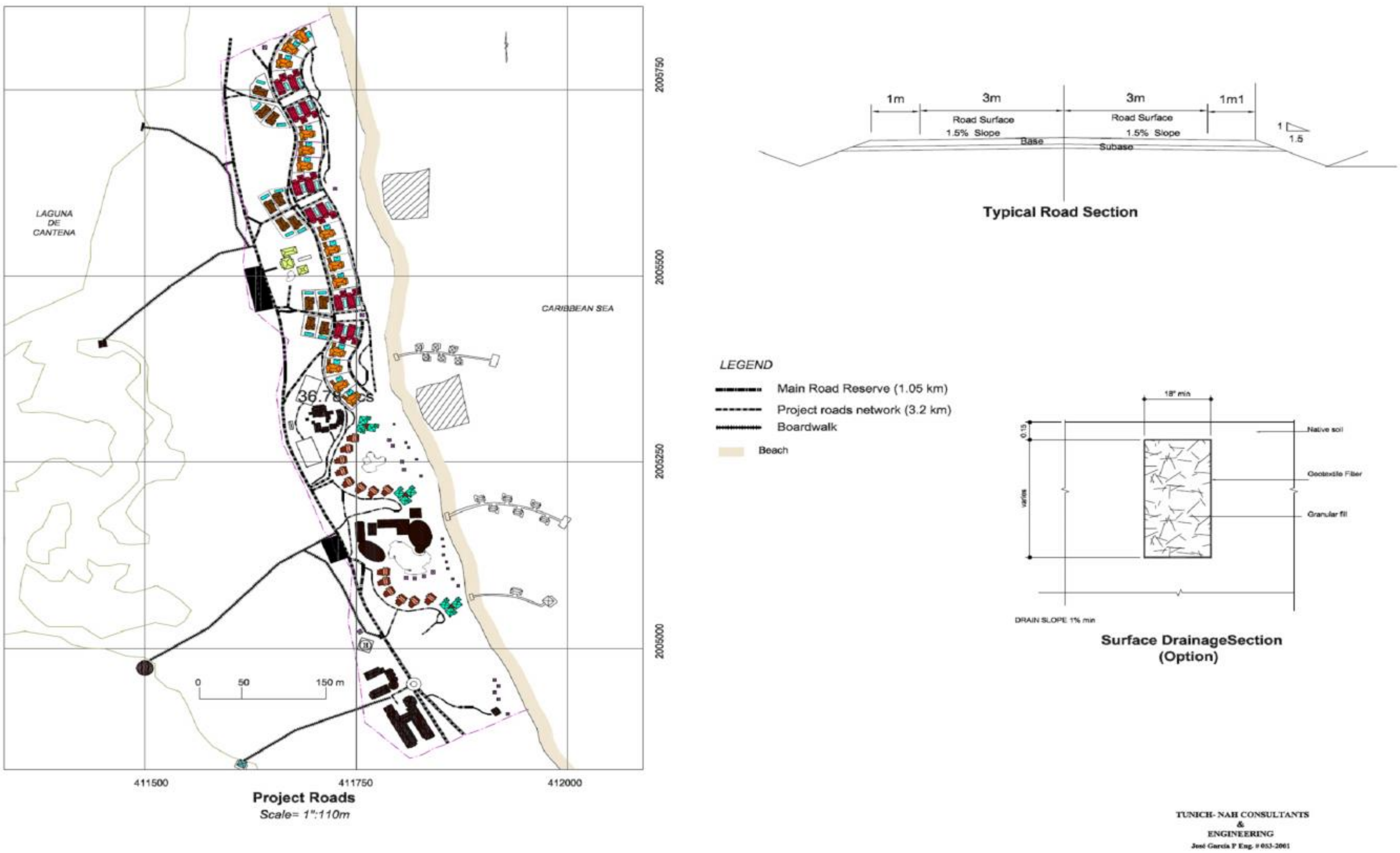
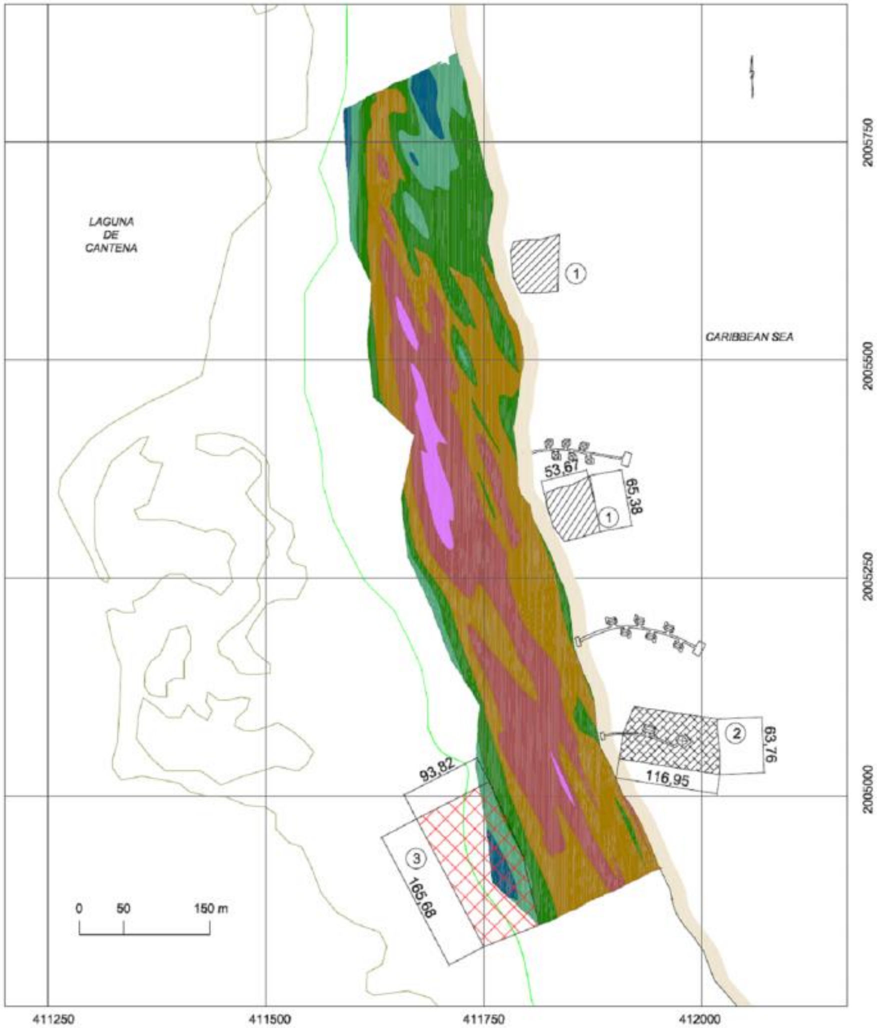


Fig. 1.5b: On-Site Project Roads and Pathways



Project Contour Map

Scale= 1":130m

Project Site Available Existing Materials					
	Type of material	Area (acs)	Depth above sea level (ft)	Depth Below Ground Level (ft)	Total Materials (yd^3)
Development Site	Sand	36.8	0.2-7.2	-	**270,340**
Foundation Excavation	Sand	3.9	-	5	**31,460**
TOTAL					**301,800**

Project Site Proposed New Grade Level & Beach Fill Requirement					
	Type of material	Area (acs)	Finished Grade Height (ft)	Depth of Fill (ft)	Total Materials (yd^3)
Development Site	Sand	36.8	5.43	-	**295,347**
NSSA	Sand	1.6	-	2.5	**6,453**
TOTAL					**301,800**

NSSA - Near Shore Swimming Area

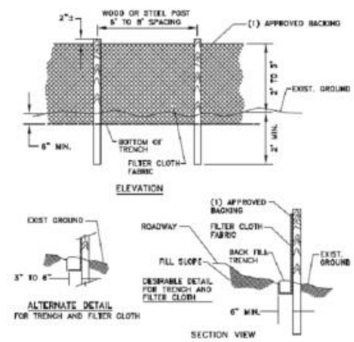
Key

1. 2 # NSSA (0.8 acs each)
2. Dredge Pier access area (1.7 acs)
3. Proposed Excavated Materials Disposition Site

LEGEND

- 0.2 - 0.6
- 0.6 - 1.0
- 1.0 - 1.4
- 1.4 - 1.8
- 1.8 - 2.2
- + 2.2
- Beach

MSL = 0.0
Height are meters



TYPICAL
TEMPORARY SILT FENCE

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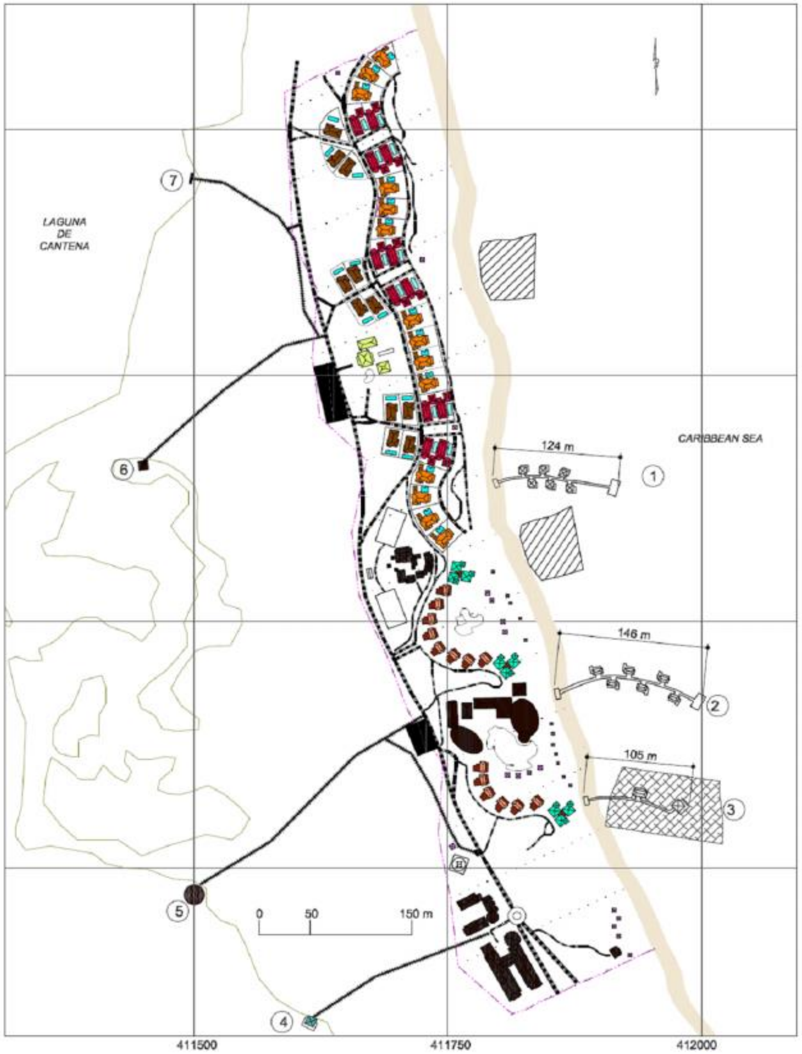
Fig. 1.6

Fig. 1.6: Project Contour Map



Project Over Water Buildings & Pier Schedule (Sea)				
ID	Development	Buildings	Description	Access Pier Length (m)
1	Spa Cabanas	6	PVC Encasing Concrete pile/ Wooden Deck	124
2	Over water Cabanas	8	PVC Encasing Concrete pile/ Wooden Deck	146
3	Bar/ Dive Center	2	PVC Encasing Concrete pile/ Wooden Deck	105

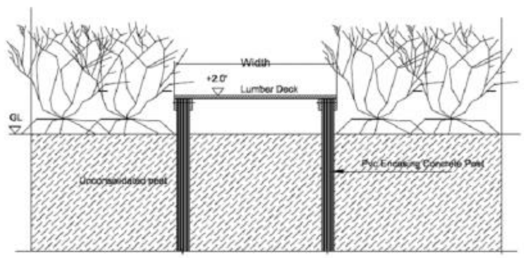
Project Over Water Buildings & Pier Schedule (Lagoon)				
ID	Development	Buildings	Description	Access Boardwalk Length (m)
4	Covered Pier	1	PVC Encasing Concrete pile/ Wooden Deck	242
5	Bar & Grill	1		224
6	Covered Pier	1	PVC Encasing Concrete pile/ Wooden Deck	440
7	Pier	-	PVC Encasing Concrete pile/ Wooden Deck	195
			TOTAL LENGTH	1,101

Key

1. Spa Cabanas
2. Water cabanas
3. Bar/Diving Center
4. Lagoon Covered Pier
5. Bar/Grill
6. Lagoon Covered Pier
7. Pier

Legend

- 2 # Ocean Beach (0.8 acs each)
- Pier Dredge access area (1.7 acs)
- Boardwalk
- Main Road Reserve
- Project roads network



Typical Board walk Section

OVER WATER BUILDINGS - PIER & BOARDWALK PLAN

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Fig. 1.7

Fig. 1.7a: Over-water Buildings, Piers and Boardwalk Plan

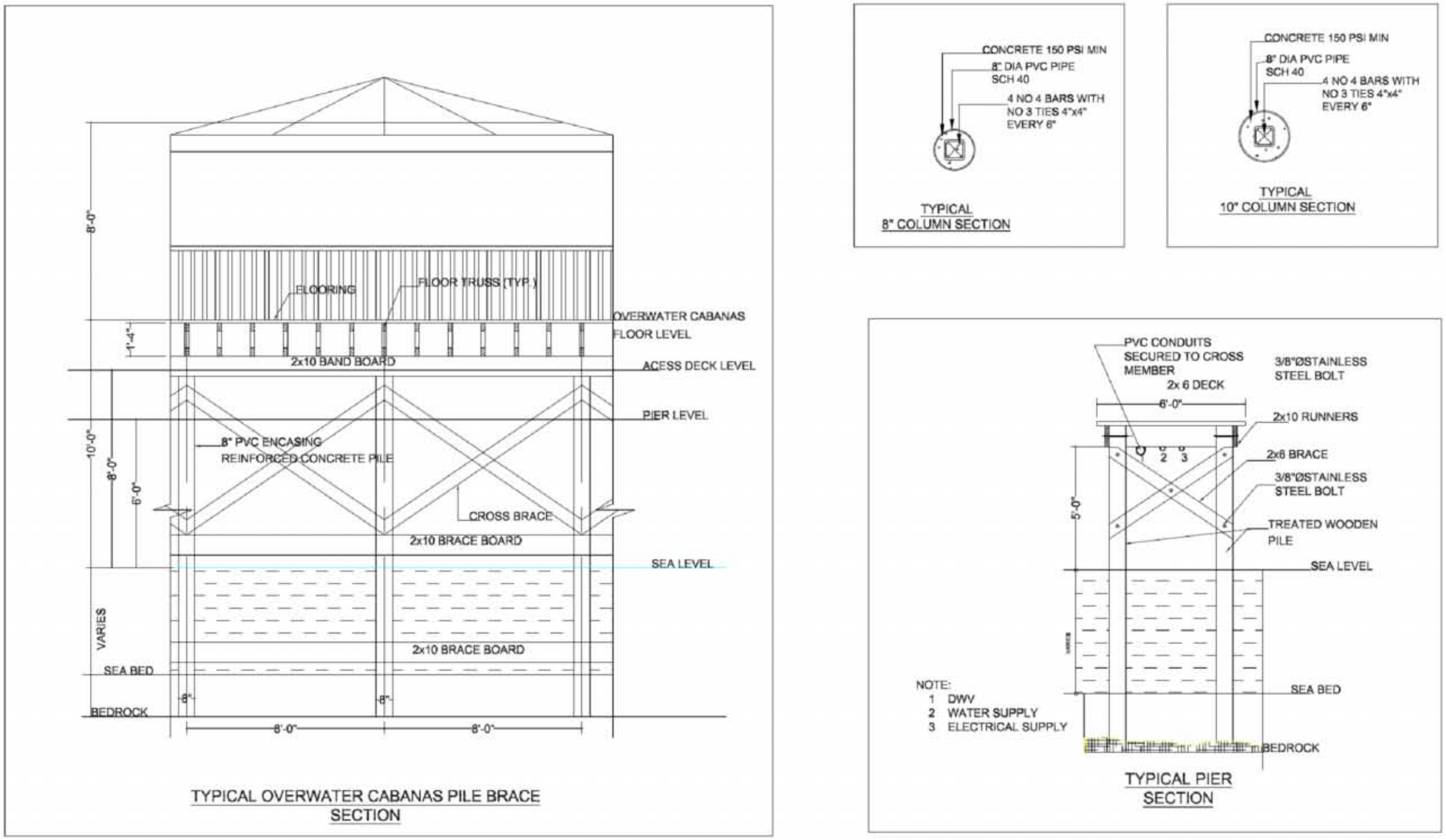

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Fig. 1.7b: Typical Over-water Cabana and Pier End View

1.2.3.1 Construction Phase

Most of the land-based resort facilities, time-share condominiums and other associated infrastructure are to be constructed on the higher grounds, currently occupied by the littoral forest [See Figs. 1.2a, 1.2b, 1.2c & 1.6]. The construction work is to be completed in two (2) main phases [See Figs. 1.3a & 1.3b], over a two (2) years timeframe [See Table 1.2]. The development is to be sub-divided in two (2) more or less equal parts with the southern portion of the development being constructed in phase 1, and the northern portion in phase 2.

Construction supplies are to be brought in by barge from Belize City and landed at the Nova pier where it is to be unloaded and taken overland by vehicles. A pre-existing road reserve is to be build into an all weather road [See Fig. 1.5a]. The volume of quarry material is 84,458 m^3. This material is to be obtained from the Nova Quarry [See Fig. 1.4]. A network of on-site pathways is also to be constructed as a corollary to the all weather road [See Fig. 1.5b].

The area of the Nova pier is to be dredged to accommodate the berthing of the barges bringing construction supplies and equipment [See Fig. 1.4]. The volume of material to be dredged is to be 1,963 cu yds. [See Fig. 1.4]. The excavated material will be placed on the leeward side of the caye in the low-lying mangroves [See Fig. 1.4].

The shoreline near the Nova pier is also to be reclaimed and bulk-headed to facilitate the loading and unloading operations associated with the construction phase of the operation: This facility should also serve the bulk freighting needs of the project during the operational or post-construction phase of the proposed development [See Fig. 1.4].

Two (2) swimming areas are to be developed in the nearshore areas of the project site [See Fig. 1.6]. No dredging is to take place to develop these areas. The areas will be developed by the placement of a geo-textile matting on the seafloor which will be loaded with shore-based sand to be excavated from the higher portions of the caye [See Fig. 11.6]. The weight of the sand on the geo-textile matting will have the effect of compressing the unconsolidated material on the seafloor to the appropriate depth to accommodate swimming and wading. The volume of shore-based material to be placed on the geo-textile mats is 6,453 cu yds.

Apart from the land-based buildings, there are also to be 14 over-water cabanas [See Figs. 1.2a, 1.2b & 1.7a]. Three (3) piers are also to be constructed in the nearshore areas to allow the docking of the vessels owned of the facilities [See Fig. 1.7a & 1.7b].

The dredging to be associated with the nearshore areas of the project site is to provide the appropriate depth for the berthing of boats at the head of the pier/dive shop area [See ‘2’ Fig.1.6]: The volume of material to be dredged is 7,000 cu yds.

1.2.3.2 Utility Zone Construction and Installation of Associated Infrastructure

All of the utilities are to be located in a centralized utility zone [See ‘5’ Fig. 1.3b]. This is to make for the efficient use of space. It also cuts down on visual or aesthetic pollution.

Table 1.2: Construction Schedule

Project Concept	**Project Components**	**Time Frame**							
		Yr. 1				**Yr. 2**			
		Qt. 1	Qt. 2	Qt. 3	Qt. 4	Qt. 1	Qt. 2	Qt. 3	Qt. 4
Hotel/ Resort	Main Hotel, Hotel Cananas and Kitchen	→	→	→	→	→	→		
	Conference Facilities			→	→				
	3-Meal Restaurant and Pool Bar			→	→	→			
	Spa and Spa Cabanas				→	→			
	Overwater Cabanas			→	→		→	→	→
	Specialty Restaurant				→	→			
	Pier Construction and Dredging	→	→						
	Swimming Pools			→	→				
	Pool Bar and Ocean Pool Bar				→	→			
	Beach Cottages and Palapas			→	→	→	→	→	
	Beach and Nearshore Swimming Area		→	→	→				
	Utilities Zone		→	→					
	Boardwalk and Lagoonal Restaurant			→	→	→			
	Children Play Park				→	→			
	Road Construction	→	→	→					
	Infrastructure at Nova Pier	→	→						
Residential	Housing Quarters for Workers			→	→				
	Owner's Club				→	→			
	Beach Front Villas		→	→	→				
	Beach Cottages				→	→	→	→	→

The utilities to be located in the utility zone includes: electrical generation facilities, waste water treatment installation, potable water sourcing equipment and solid waste sorting and storage facilities.

1.2.3.3 Energy Generation Facilities

The primary electrical generation facilities are to be from diesel generators supplemented solar sources and wind generators.

The primary source of energy is to be from two 15 KV Generators with and additional one being held in a stand-by mode. The source of energy from solar generators is to be from solar panels in sequence with banks of batteries for storage purpose. This is to be used mainly for heating water, and at night for night lights along footpaths and in landscaped hedgerows.

The source of wind energy is to be from wind mills or wind generators that are to be deployed in sequence with banks of batteries for storage purposes.

It has been estimated that the total energy consumption for the year has been estimated at 2.93 MW or 8,000KWH/Dy.

The issue of energy generation has been comprehensively dealt with in Chapter 6.

1.2.3.4 Potable Water Supply Infrastructure

The primary source of water is to be from reverse osmosis or 'R.O.'. This is to be supplemented by rainwater catchment, assisted by waste water recycling. The post-treated waste water associated with the waste water treatment facilities if to be reintegrated into the system. This is to be used mainly for the flushing of toilets, the washing of equipments, and the irrigation of lawns and hedgerows.

The sourcing of potable has been comprehensively dealt with in Chapter 5.

1.2.3.5 Sewage Treatment Facilities

The sewage and waste water associated with the proposed development is to be treated to secondary levels using a 'Package Plant'. The particular Package Plant to be deployed is known by its trade name "BESST". This technology, of which the acronym stands for **B**iologically **E**ngineered **S**ingle **S**ludge **T**reatment, reduces major pollutants such as the macro-nutrients nitrates and phosphates, and ammonia, as well as Total Suspended Solids (TSS), BOD substances and microbes to levels where they do not pose a threat to the integrity of environment, or human health. The post-treated effluents from the BESST Treatment Plant, is to be stored and used for the flushing of toilets, as well as for irrigation and fire-fighting.

The management of waste water has been comprehensively dealt with in Chapter 5.

1.2.3.6 Solid Waste Infrastructure

The solid waste management strategy is to entail a sequence of activities. This is to begin with the initial separation of the waste into its organic and inorganic components. The organic component is then to be composted using an ‘earth tub’. The mulch from the earth tub is to then be redeployed as a fertilizer in gardening operations to fertilize lawns and hedgerows.

After the initial separation, the inorganic component is to be further separated into combustible and non-combustible components. The combustible component is to be incinerated on-site: The non-combustible is to be tagged, bagged and stored and transported intermittently to the San Pedro Landfill Site.

The management of solid waste has been dealt with comprehensively in Chapter 7.

1.3 Operational Phase

The facilities are to be commissioned upon the completion of the construction phase of the development. The total clientele for the facility at full development is expected to be 967 persons [See Table 1.3].

The water-based activities of the area are to include swimming, snorkeling, scuba diving and para-sailing. The shore-based activities are to include a range of recreational activities and everyday living activities. These include sunbathing, walking, swimming, light motor vehicle use.

Table 1.3: Maximum Daily Occupancy

Type	Description	Units	Occupancy
A	Hotel	56 rooms	112
B	Hotel Suites Type A	8 suite buildings	24
C	Hotel Suites Type B	12 suite buildings	36
D	Water Cabanas	12 Cabana buildings	36
E	Beach Front Villas	14 villa buildings	126
F	Beach Cottages	12 cottage buildings	72
G	Apartments	22 Units	88
H	Future Developments	13 Units	78
I	Owner's Club House	1 unit	6
J	Employee Housing	1 unit	289
K	Transient Visitors	persons	100
Totals			**967 Persons**

1.4 Staffing

The total staffing for the facilities at full development is 289 persons. These include managers, administrative staff, chamber maids, bar tenders, chefs, waitresses, grounds keepers, security personnel, boat handlers and tour guides.

Chapter 2

2.0 Bio-Physical Description of Proposed Development Site

The proposed development site in northeastern Ambergris Caye is invested with three (3) major ecosystem types. These include the sea off the eastern end of the property, a supra-tidal and intertidal ecosystem components which describes the legal and functional boundaries of the property, and an expansive semi-isolated lagoonal ecosystem referred to as the Laguna de Cantena [See Fig. 2.1].

The sea area can be ecologically divided into two (2) components, viz the continental shelf and continental slope which is defined by longitude from ‘H’ to ‘C’, and the ‘open sea’ or ‘deep sea’ which is characterized by great depths and in effect an expansive pelagic zone or ‘water column’ and a seafloor that is far beyond the influence of sunlight and in general photosynthetic-driven primary production processes. This deep sea environment referred to as ‘the blue’ in local parlance is characterized by relatively large waves and rough or turbulent sea states for the most part, except in sustained calm and windless conditions which are for the most part a function of the ‘doldrums’ which affects Belize in August and September [Pers. comm.., G. Myvett]. The doldrums describes the situation where the sun is in symmetrical alignment with Belize in regards to the tidal bulge, as qualified by the Dynamic Tidal Theory [Pers. comm.., G. Myvett]. This a functional part of the annual cycles which drives the season and which is in effect marks the ‘migration’ of the sun from the northern to the southern hemisphere and *vice versa* [Pers. comm.., G. Myvett].

The ‘deep sea’ zone is described by ‘I’ in Fig. 2.1.

The shallower portion of the sea in front of the proposed project site can be sub-divided into the continental slope and the continental slope. The continental slope runs from the seaward side of the reef crest at its shallower and landward limit, down to great depths before it merges into the continental rise [Pers. comm.., G. Myvett]. Much of the upper portion of the continental slope is colonized by coral reef. This coral reef zone is ecologically divided into a shallower fore-reef slope which runs from the reef crest to a depth of 40 – 50 ft., and a deeper fore reef slope which extends to a depth of 250 – 280 ft. in the vicinity of the project site [Pers. comm.., G. Myvett].

The shallow and deep fore-reef zones are defined by H in Fig. 2.1. The continental shelf described by DEFG in Fig. 2.1 is about 0.75 mile in geographic extent. It is characterized by a coral reef environment [See F & G, Fig. 2.1], a relatively deep area running parallel to the beach that is largely devoid of colonization of any biota that describes the mid-reaches of the ‘barrier lagoon’ that has been labeled ‘E’ in Fig. 2.1, and a prolific shallow sea grass beds defined as ‘D’ in Fig. 2.1. The ‘barrier lagoon’ is an ecological component of the barrier reef system: It is a relatively deep and uninterrupted body of water that runs from the back reef environment to the beach - this area is described by D and E in Fig. 2.1. The reef crest in the coral reef zone [See G, fig. 2.1] is characterized by breaking

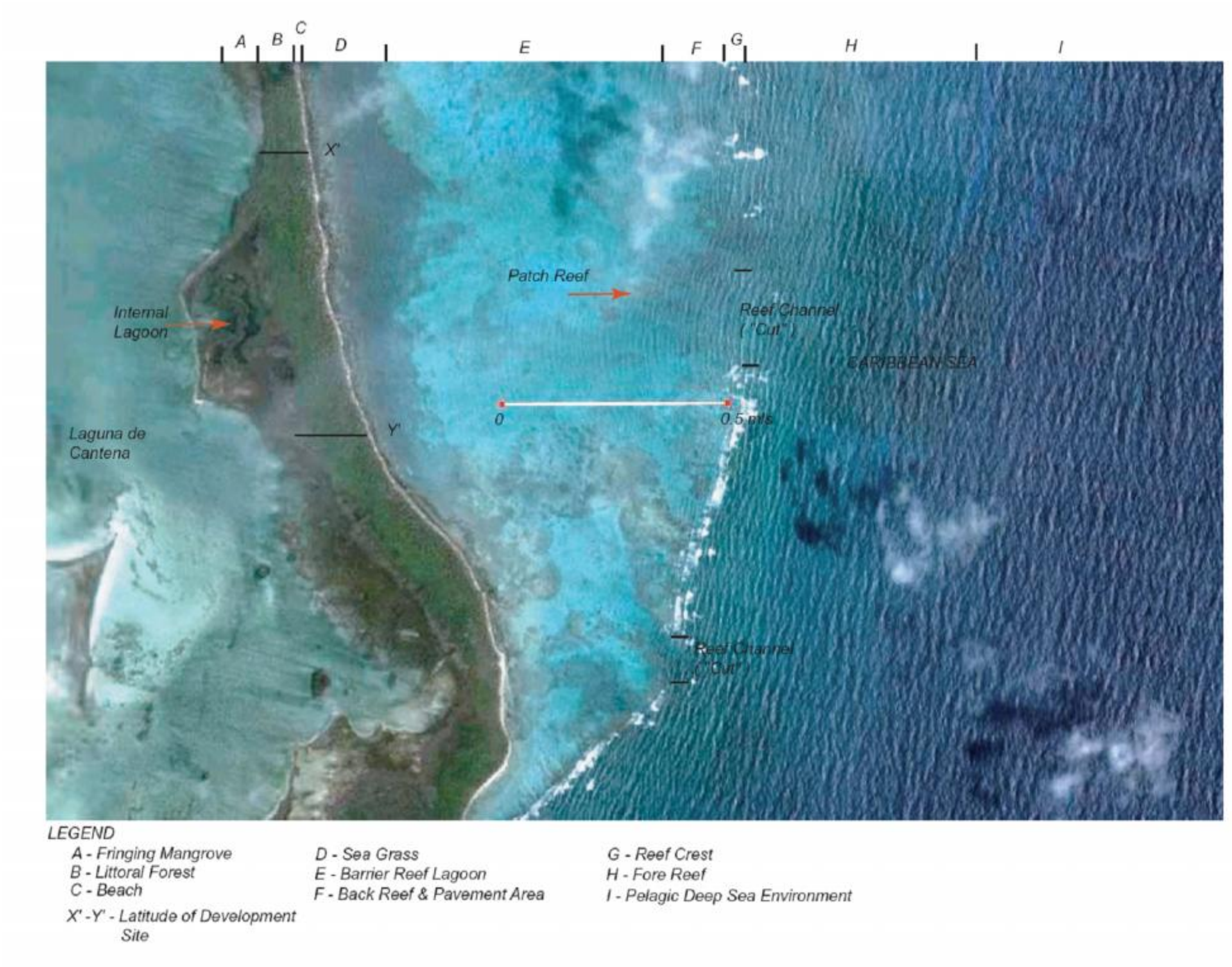

Fig. 2.1: Ecosystems Map of Proposed Project Area

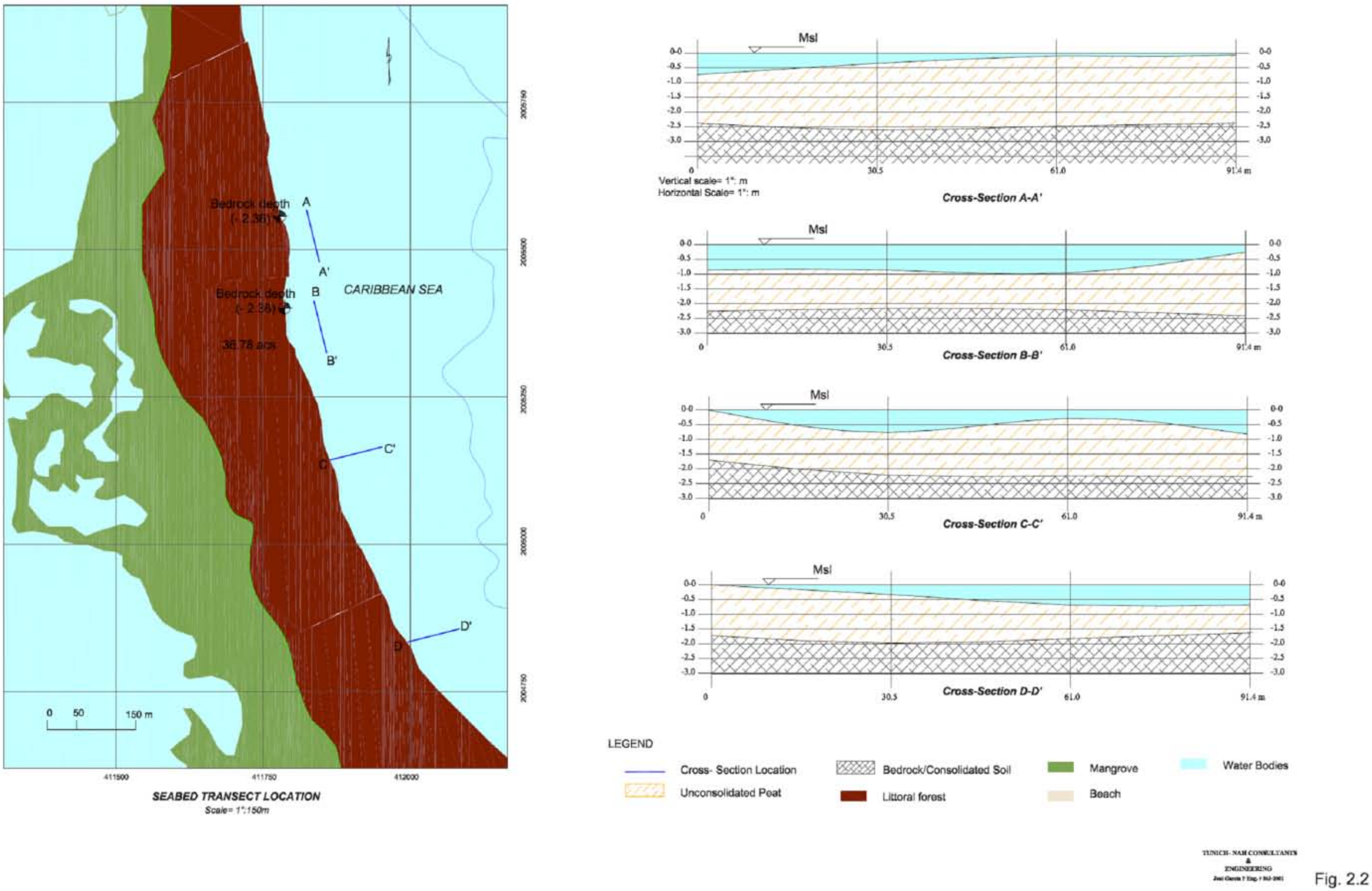

Fig. 2.2: Soundings or Depth Profile in Nearshore Areas of Project Site

waves, which forms an extensive zone of surf especially under heavy sea state, runs parallel to the shoreline of the property and indeed the caye, is punctuated by tidal channels or ‘cuts’ which runs perpendicular to it, and which in the wider and deeper examples are used as access channels to go from the ‘blue’ to the calmer and shallower barrier lagoon, and *vice versa* [Pers. comm.., G. Myvett].

The land ‘proper’ which is functionally above the high tide line, runs from what is referred to as the ‘supra-tidal’ zone, on the eastern side of the property, to the Laguna de Cantena on the western side of the property [See Fig. 2.1]. The denuded part of the beach above the high tide line comprises the ‘supra-littoral’ zone. The sandy shoulder of the beach that is vegetated or colonized by a range of herbaceous bush and shrubs, and in part coconut trees, is referred to as the beach berm. The beach, which runs along the eastern margins of the property, is shown as ‘C’in Fig. 2.1

The land beyond the beach is characterized by a series of promontories running parallel to the shoreline: These promontories are in effect relic or ancient beach bermsthat have been left behind as a function of the retreating seas over geologic time frames [Pers. comm.., G. Myvett].

The relic ridges and the intervening troughs or depressions were heavily colonized by a range of trees, shrubs and herbaceous vegetation. The approaches to the Laguna de Cantena were colonized by a belt of mangroves of varying thickness [See B, Fig. 2.1].

The portion of the Laguna de Cantena that abuts or delimits the western side of the property has been defined as the southern portion of the Lagoon [See Fig. 2.1]. The Lagoon is a relatively expansive, saline body of water.

There are conflicting reports in relation to the biota associated with the lagoon. Gibson (1991) stated that the Lagoon was once an important fishing area for species groups such as snappers, grunts, sharks, bone fish and snooks. The Belize Center for Environmental Studies [BCES] reported to the contrary (1993) that the Lagoon was devoid of fish life. This latter observation was the experience of the Tunich Nah Survey Team in April/May 2006.

2.1 Meteorology

Air temperatures for the project area have been cited to range from 22.8 to 26.1 oC in the cooler months which generally runs from October to February [Grimshaw and Paz, 2004]. During these times the coast of Belize and by extension the project area are impacted by ‘Northerns’ or ‘Cold Fronts’ which last for 3 to 4 days at a spell and which are accompanied by northerly winds blowing at 15 to 20 knots with gusts to 25 to 30 knots on the open sea [Stoddart, 1962].

Air temperatures during the warmer months in San Pedro range from 27.8 to 31.1 oC [Grimshaw and Paz, 2004]. During the early dry season, prevailing winds in the area are from the south-east and may reach

Rainfall in the San Pedro area, which is the nearest weather station for which there is reliable historical data, ranges from 143 cm in 1952 to 200 cm in 2002 [Grimshaw and Paz, 2004].

2.2 Oceanography

The oceanography in the area refers to two (2) main bodies of water: the sea off the eastern shores of the property, and the Laguna de Cantena on the leeward or western shores of the property.

2.2.1 Bathymetry

There has been no published or anecdotal data or information on the depth profile or bathymetry of the proposed project area. The bathymetric charts that have been published for Belize are not of a scale or geographic focus to be relevant to the project site [Pers. comm.., G. Myvett].

The Tunich Nah Survey Team in its April/May site specific survey effort has done some limited work in this area [See Fig. 2.2]. This survey was undertaken mainly to provide information to guide informed judgment in regard to the placement and dimension of the access piers that are to be constructed, that are an integral part of the proposed development.

The water depth 250 to 300 ft. from the beach is generally less than 0.5 m [See A-A' & B-B', Fig. 2.2]. The depth profile as one proceeds in an eastward direction from the beach varies from '0' at the low tide line, to approximately 0.3 to 0.4 m 20 to 30 ft. from the beach – the depth then gets progressively shallower up to a distance of 200 to 250 ft. from the beach [See Fig. 2.2]. Beyond the 250 to 300 ft. mark, the water depth then again gets progressively deeper, where it proceeds to 15 – 20 ft in the mid-reaches of the barrier lagoon. Seaward of the mid-reaches of the barrier lagoon the water depth begins to get progressively shallower until a depth of 4 – 5 ft. is attained at the landward or western limits of the back reef area. Water depths in the area of the reef flat and pavement area varies from 1.5 ft. landward of the reef crest, to 4.0 ft at the landward limit of the zone.

The shallow fore-reef zone varies from 15 – 20 ft in depth. The water depth proceeds to 350 – 400 ft. 150 m seaward of the reef crest. The deeper areas of the open ocean, referred to locally as 'the blue', is readily apparent 400 – 500 m seaward of the reef crest [Pers. comm.., G. Myvett].

Water Sampling Location
Scale= 1":185m

Water Sample GPS Location

ID	E	N	Location
1	411547	2005773	In Lagoon
2	411294	2005127	In Lagoon
3	411876	2006053	In Sea North of Property
4	412052	2005566	In Sea in front of Property
5	412205	2004984	In Sea in front of Property

Coordinates are UTM Nad 27 Central

Inorganic Chemistry — Water Sample Analysis — Date: 16 May, 2006

Physical	Unit	Method	Results			
			1	3	4	5
Conductivity	us/cm	CONDUCTIVITY (probe)	65,200	52,700	52,300	51,800
pH	unit	pH/ISE meter (probe)	8.32	8.25	8.42	8.09
Salinity	ppt	Mercuric Nitrate titration	47.7	36.48	36.44	36.43
Total Suspended Solids (TSS)	ppm	Colorimeter	5	2	3	2
Total Dissolved Solids (TDS)	ppm	CONDUCTIVITY (probe)	32,600	26,400	26,100	25,900
Dissolved oxygen (DO)	ppm	Probe	5.58	7.20	7.49	8.26
Inorganic Compounds						
Total Hardness (as $CaCo_3$)	ppm	Tritation / UV VIS Spectro	8,195	6,355	6,295	6,245
Total Nitrate (NO_3)	ppm	Cadmium Reduction / UV VIS Spectro	2.8	3.6	2.7	2.3
Phosphate (PO_4)	ppm	PhosVer/Orthophosphate/ UV Vis Spectro	0.5	0.6	0.5	0.4
Sulphate (SO_4)	ppm	Sulfa Ver 4/ UV Vis spectro	4,420	3,870	3,840	3,830
Microbiological Analysis						
Total Coliform	count	m-ENDO Broth (MF)	-	72/100 ml	-	142/100 ml
Escheria Coli (E.coli)	count	m-ENDO Broth (MF)	-	0/100 ml	-	0/100 ml
Focal Coliform	count	m- FC/ROSILIC Broth (MF)	-	0/100 ml	-	0/100 ml

Inorganic Chemistry — Water Sample Analysis — Date: 11 May, 2006

Physical	Unit	Method	Results							
			1	2	3	4	5	A	B	C
Conductivity	us/cm	CONDUCTIVITY (probe)	65,200	65,200	53,200	53,100	53,100	26,800	22,500	33,900
pH	unit	pH/ISE meter (probe)	8	8	8	8	8	7	7	7
Salinity	ppt	Mercuric Nitrate titration	45	42	34	29	36	12	12	12
Total Suspended Solids (TSS)	ppm	Colorimeter	17	6	2	1	1	307	626	83
Total Dissolved Solids (TDS)	ppm	CONDUCTIVITY (probe)	32,600	32,600	26,600	26,500	26,500	13,390	11,260	17,980
Dissolved oxygen (DO)	ppm	Probe	6.2	5.3	7.13	7.81	8.35			
Inorganic Compounds										
Total Hardness (as $CaCo_3$)	ppm	Tritation / UV VIS Spectro	8,180	7,395	6,090	5,825	6,070	3,425	2,895	4,205
Total Nitrate (NO_3)	ppm	Cadmium Reduction / UV VIS Spectro	4	4	2	1	1	1	N/D	1
Phosphate (PO_4)	ppm	PhosVer/Orthophosphate/ UV Vis Spectro	4	2	0	0	0	1	0	0
Sulphate (SO_4)	ppm	Sulfa Ver 4/ UV Vis spectro	3,805	3,840	2,375	3,045	3,125	1,550	735	2,000
Microbiological Analysis										
Escheria Coli (E.coli)	count	m-ENDO Broth (MF)	36/100 ml	42/100 ml	3/100 ml	-	3/100 ml	3/100 ml	-	-
Fecal Coliform	count	m- FC/ROSILIC Broth (MF)	23/100 ml	0/100 ml	0/100 ml	-	0/100 ml	0/100 ml	-	-

LEGEND

Sea Grass Outline

Beach

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Table 2.1: Water Quality Tests Results

2.2.2 Winds and Waves

There are no scientifically determined wind data for the project site. Anecdotal information however is to the effect that wind speeds associated with the south-easterlies in the earlier part of the year, and the northerlies during the cooler months of the year may approach 25 knots during stormier conditions [Grimshaw and Paz, 2004].

There are also no site-specific scientifically based wave data for the proposed project area. It has been observed however that heavy sea states are associated with the outside of the reef, to the extent that navigation for smaller crafts becomes difficult if not impossible during high wind conditions and consequently heavy sea states [Pers. comm.., P. Marin]. The relatively reduced degree of exposure and in general calmer sea states, allows for the navigations of small crafts under most conditions, except for catastrophic storms [Pers. comm.., P. Marin].

2.2.3 Tides

Tides in the area are semi-diurnal in nature with two (2) high tides and two (2) low tides over the 24 hours daily cycle [Pers. comm.., G. Myvett]. The tidal amplitude ranged from 37 to 45 cms on the seaward or eastern shores of the property, and from 0 to 15 cms on the lagoonal shores of the Laguna de Cantena [Grimshaw and Paz, 2004].

The tidal height can reach 55 cm on the eastern shores of the project area during high tide [Grimshaw and Paz, 2004]. During the period of the sun tides which generally impacts Belize in late September through October, and late February through March which increases tidal height by 15 to 20 percent [Pers. comm.., G. Myvett]: This is particularly apparent during the highest phases of the Spring Tides which are referred to as Higher High Water Spring Tides (HHWS) which occurs during the New Moon and Full Moon Phases of the lunar cycle [Pers. comm.., G. Myvett].

Extreme low tides and the greatest variation in tidal amplitudes are experienced in the area during the northerlies: At these times fairly extensive portions of the near shore sea grass beds on the seaward side of the property are exposed [Pers. comm.., G. Myvett].

2.2.4 Currents

The current measurements recorded in the area were relevant to waters off the eastern side of the property. There was no discernible current in the southern portions of the Laguna de Cantena off the western shores of the project site during the time of the Tunich Nah Survey in April and May of 2006. The currents measured in the barrier lagoon off the eastern shores of the property ranged from 1 to 3 knots [Grimshaw and Paz, 2004]. Currents of up to 7 knots have been recorded in the barrier lagoon during low tide [Grimshaw and Paz, 2004].

2.2.5 Water Temperature

The in situ water temperature recorded by the Tunic Nah Survey Team ranged from 29.3 to 31.7 oC. Ishmael in 1984 stated that water temperatures go as high 30 oC [Grimshaw and Paz, 2004].

2.2.6 Salinity

The proposed project site is abutted on the eastern side by the open sea, and a lagoonal system referred to as the Laguna de Cantena on the western or leeward side [See PL 1.1 and Fig. 2.1]. The seaward side of the property was characterized by oceanic quality water which ranged from 29 ppt to 36 ppt, at the time of the Tunich Nah Survey, which took place between mid-April and mid-May 2006, [See Table 2.1]. The salinity of the waters off the eastern shores of the property are expected to approximate oceanic quality throughout the year, with some slight elevations in value during the drier portions of the year [Pers. comm.., G. Myvett]: This is particularly relevant to the reef environment and the offshore areas of the project site [See Sample Sites #'s 3, 4 & 5], given the proximity and contiguous articulation of the area with the pelagic deep ocean environment [See 'I' Fig. 2.1]. The average salinity in the area of the reef lagoon off the eastern shores of the property has been stated as 37.2 ppt [BCES, 1993].

The Laguna de Cantena is a fairly hyper saline body of water with limited connection with the moderating influences of the open sea environment, through various mangrove channels rereffred to as 'Bogues' [Pers. comm.., G. Myvett]. Salinity in the Lagoon ranged from 42 to 45 ppt [See Sample Sites #'s 1 & 2 Table 2.1]. The stated average for salinity in the Laguna de Cantena was 40.9 ppt [BCES]. The hypersaline condition of the lagoon in the vicinity of the project site is understandable given the limited inflows of water from the wider marine environment [Pers. comm., G. Myvett].

Apart from the open sea and the relatively expansive Laguna de Cantena, there are isolated hypersaline ponds and inundated depressions throughout the greater Bacalar Chico area with salinities as high as 123.8 ppt [Grimshaw and Paz, 2004]. None of these hypersaline ponds or inundated depressions was seen on the property during the Tunich Nah survey in April and May 2006.

Salinity is arguably among the most important physico-chemical parameters influencing the evolutionary history of the flora and fauna in the area: These biota are adapted to live in fairly high saline conditions and are not physiologically equipped to deal with any appreciable variation in salinities. The fauna adapted to live in these conditions have been characterized as being 'stenohaline' in character.

2.2.7 Turbidity

Visibility in the water column was approximately 250 ft. in the reef environment and 150 to 170 ft. in the nearshore sea grass beds [Pers. comm., G. Myvett]. This was consistent with the Turbidity Values recorded in the area by the Tunich Survey Team: These values ranged from 2 to 3 ppm on the 11th May 2006, and from 1 to 2 ppm on the 16th May 2006.

The turbidity in the area varies with wave energy and currents: It generally increases with heavy sea states and strong tidal currents. Heavy sea states, in terms of annual cycles, are associated with the strong and sustained southeasterly winds in April and May, and the northerlies which affect the area from October to February [Pers. comm.., G. Myvett]. The stronger tidal currents are associated with the rising and falling tides in the area: These currents are functionally non-existent and at their weakest during 'slack' tide when the tides are changing from low tide to high tides and vice versa, and during the times immediately approaching 'slack tide' as well as in the aftermath of same [Pers. comm.., G. Myvett].

2.2.8 Total Coliform and E. coli

Total coliform as documented by the Tunich Nah Survey team ranged from 72/100 ml to 142/100 ml. [See Table 2.1]. The *E. coli* counts for the samples taken were 0/100 ml [See Table 2.1]. The latter means that the sea in front of the property has no discernible levels of pollution from human waste and the water is safe for swimming, snorkeling, scuba diving and other sea-based recreational activities.

The total coliform count recorded for the area would in effect be derived from warm blooded creatures such as marine mammals, vis-à-vis dolphins and manatees, as well as sea birds such as gulls and cormorants [Pers. comm.., G. Myvett].

2.3 Biological Oceanography

The location of the proposed project site in north-eastern Ambergris Caye is reflective of a diverse aggregation of species and ecosystems. Both the flora and faunal forms entails supra-tidal terrestrial forms, as well as sub-tidal components. The flora and faunal forms also varies in terms of the complexity of biological organization as well as in relation to their evolutionary history, abundance and distribution.

2.3.1 Flora and Fauna

The sub-tidal floral forms documented in the area varied from simpler macro-algal forms such as the Feather Algae (*Caulerpa spp.*) and the Shaving Bush Algae (*Penicillus capitatus*), to flowering forms such as the Turtle Grass (*Thallasia testudinium*) and Halodule (*Halodule beaudettel*) [See Table 2.2 B].

The supratidal dune and terrestrial vegetation have been collectively classified as a 'littoral forest' [Meerman and Sabido, 2000]. This is one of seven (7) forest types identified by Grimshaw and Paz [2004] for the larger Bacalar Chico area. Tree species on the property were a reflection of the diversity of soil chemistry and landform, and ranged from typical beach inhibants like the coconut (*Cocos nocifera*) and the Australian Pine (*Casuarina equisetifolia*), to salt tolerant species such as the Red Mangrove (*Rhiziphora mangle*) and the Black Mangrove (*Avicennia germinans*), as well as ubiquitous coastal species such as Gumbo Limbo (*Bursera simaruba*), the Buttonwood (*Conocarpus erectus*) and the Sea Grape (*Coccolaba uvifera*) [See Table 2.2A].

The faunal forms of the proposed project area cover all of the five (5) phylogenetic classes of vertebrates, as well as an even more diverse assemblage of invertebrates. The most diverse and abundant classes of vertebrates were the fishes and the birds [See Tables 2.4 and 2.7], and the least diverse and numerically limited faunal assemblage were the amphibians and the mammals [See Table 2.5 and 2.6]. The abundance and diversity among the various vertebrate classes at the project site is reflective of the situation encountered in other parts of coastal Belize by the Tunich Nah Survey Team [Pers. comm.., G. Myvett].

2.3.1.1 Flora

The greater Bacalar Chico National Park and Marine Reserve [BCNP/MR] is characterized by a range of landforms and plant species that have been grouped into seven (7) forest types, viz:

- Tropical Littoral Forest and Beach Communities
- Mixed Mangrove Scrub
- Coastal Fringe Rhizophora mangle-Dominated Forest
- Basin Mangrove Forest
- Marine Salt Marsh With Many Succulent Species
- Tropical Semi-Deciduous Broadleaf Lowland Forest
- Tropical Drought-Deciduous Microphyllous Lowland Forest.

These forest types have been identified by Meerman and Sabido [2000]. The forest type of the proposed project site has been ascribed by Myvett [Pers. comm.] to two (2) categories, viz:

- Tropical Littoral Forest and Beach Communities
- Mixed Mangrove Scrub

This classification for the proposed project area is shown in Fig. 2.3A. The littoral forest component proceed landward from the beach for a distance of about 2/3rd the width of the property, while the mangrove scrub runs from this area to the shores of the Laguna de Cantena [See Figs. 2.3A & 2.3B].

Grimshaw and Paz [2004] have cited the existence of 206 intertidal and terrestrial plant species in the larger BCNP/MR area [See Table 2.2A]. The Tunich Nah Survey Team has identified 37 intertidal and terrestrial plant species at the propose project site [See Table 2.2A]. Some of the herbaceous bracts and shrubs includes: the Spider Lily (Hymenocallis littoralis), the Verdolaga de playa (Sesuvium portulacastrum), the Yama Bush or Rat Bean (Senna occidentalis) and the Espino de playa or Burr-burr (Cenchrus echinatus) [See Table 2.2A].

Some of the Tree species found in the Littoral Forest included: the Chechem Negro or Black Poisonwood (Metopium brownei), the Anona or Wild Custard Apple (Annona reticulata), and the Ziricote (Cordia curassavica) [See Table 2.2A].

The canopy coverage of the littoral forest was 80-90%. The position of the various tree species have been defined relative to the series of ridges running parallel to the beach [See Table 2.2A]. The ridges proceeding from the beach to leeward side of the property have been defined as: the Beach Berm [BB], the Littoral Forest Seaward Consolidated Berm [LFSCB], the Littoral Forest Mid-Lattitude Berm [LFMLB], and the Littoral Forest Lagunal Berm [LFLB] (See Table 2.2A).

Most of the grasses and weeds, and vines, and herbaceous bracts and shrubs were confined to the Beach Berm [See PL 2.17], and the seaward 1/4th of the Littoral Forest Seaward Consolidated Berm. The succeeding berms or ridges were heavily forested. Except for a small area at the mid-latitude of the property immediately landward of the beach berm, as well as the survey trails [See PLs' 2.18 and 2.27 respectively], there were no signs of previous land-clearing [Pers. comm.., G. Myvett]. The forest was surmised to be of primary growth form [See PL's 2.19 & 2.20].

The Mangrove Scrub component of the forest included two (2) components, viz: an area characterized by littoral forest species interspersed by mangroves species, and a zone dominated 90-100% by mangroves. The mixed mangrove shrub component was located mainly in the area titled 'Littoral Forest Lagunal Berm'. The mangrove species found in this area were the Black Mangrove (*Avicennia germinans*) and the White Mangrove (*Laguncularia racemosa*) [See Table 2.2A]. The more frequently encountered species was the Black Mangrove (*Avicennia germinans*).

The monospecific mangrove zone has been defined as the Laguna de Cantena Low-lands [LdCLL] in Table 2.2A. Although all three (3) species of mangroves present in Belize were found in the area, the most dominant species was the Red Mangrove (*Rhizophora mangle*) [See PL's 2.7 & 2.8], followed by the Black Mangrove (*Avicennia germinans*).

Apart from the land-based trees, shrubs and grasses, the site was also richly invested with sub-tidal or sea-based plant life. The dominant species was the Turtle Grass (*Thalassia testudinium*) which formed extensive meadows or 'bed' [See PL's 2.2 & 2.3], which proceeded from the nearshore areas, to the medial shallows about 400-500 m from the shoreline [See D Fig. 2.1].

Apart from the Turtle Grass (*Thalassia testudinium*) [See PL 2.12], the two (2) other seagrass species found in the area included the Manatee Grass (*Syringodium filiforme*) [See PL 2.13] and Halodule (*Halodule beaudettel*) [See Table 2.2A].

The macro-algae figured prominently in regards to the sub-tidal species found in the area. The Shag Carpet Algae (*Dasycladus vermicularis*) was found in great profusion in the Laguna de Cantena. The Disc Tree Halimeda (*Halimeda copiosa*) [See PL 2.11] was found in the mid-reaches of the barrier lagoon in the seas off the front or eastern side of the property. The floating seaweed or sargassum (*Sargassum polycerathum*) was also found off the front of the property in the barrier lagoon, as well as on the beach [See PL's 2.6, 2.17 & 2.22]. Other macro-algal species of note found in the area include: the Dichotomously Branched Algae (*Dictyota spp.*), Valonia (*Valonia ventricosa*), the Feather Algae (*Caulerpa prolifera*) and the Cactus Branchlets (*Caulerpa cupressoides*) [See Table 2.2B].

Much of the macor-algae were found in the primary reef zone, including the pavement area and backreef zone [See F, Fig. 2.1].

Grimshaw and Paz [2004] cited the existence of 37 species seagrasses and macro-algae in the greater Bacalar Chico National Park and Marine Reserve [BCNP/MR]. The Tunich Nah Survey Team documented 19 species, of which 3 were not previously cited by Grimsha and Paz [2004].

These included the seagrass Halodule (*Halodule beaudettel*), and the macro-algae Shag Carpet Algae (*Dasycladus vermicularis*) and Valonia (*Valonia ventricosa*) [See Table 2.2B].

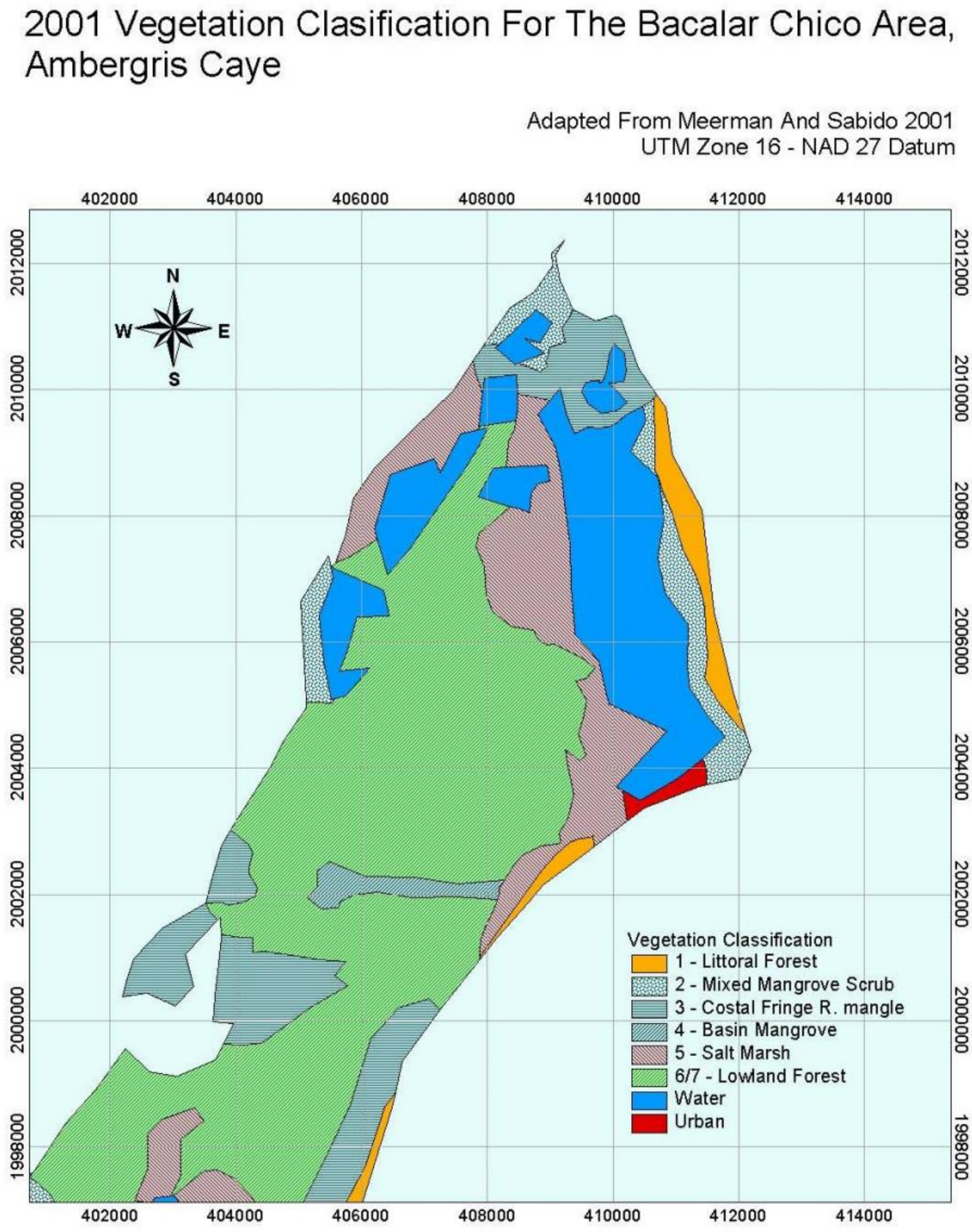
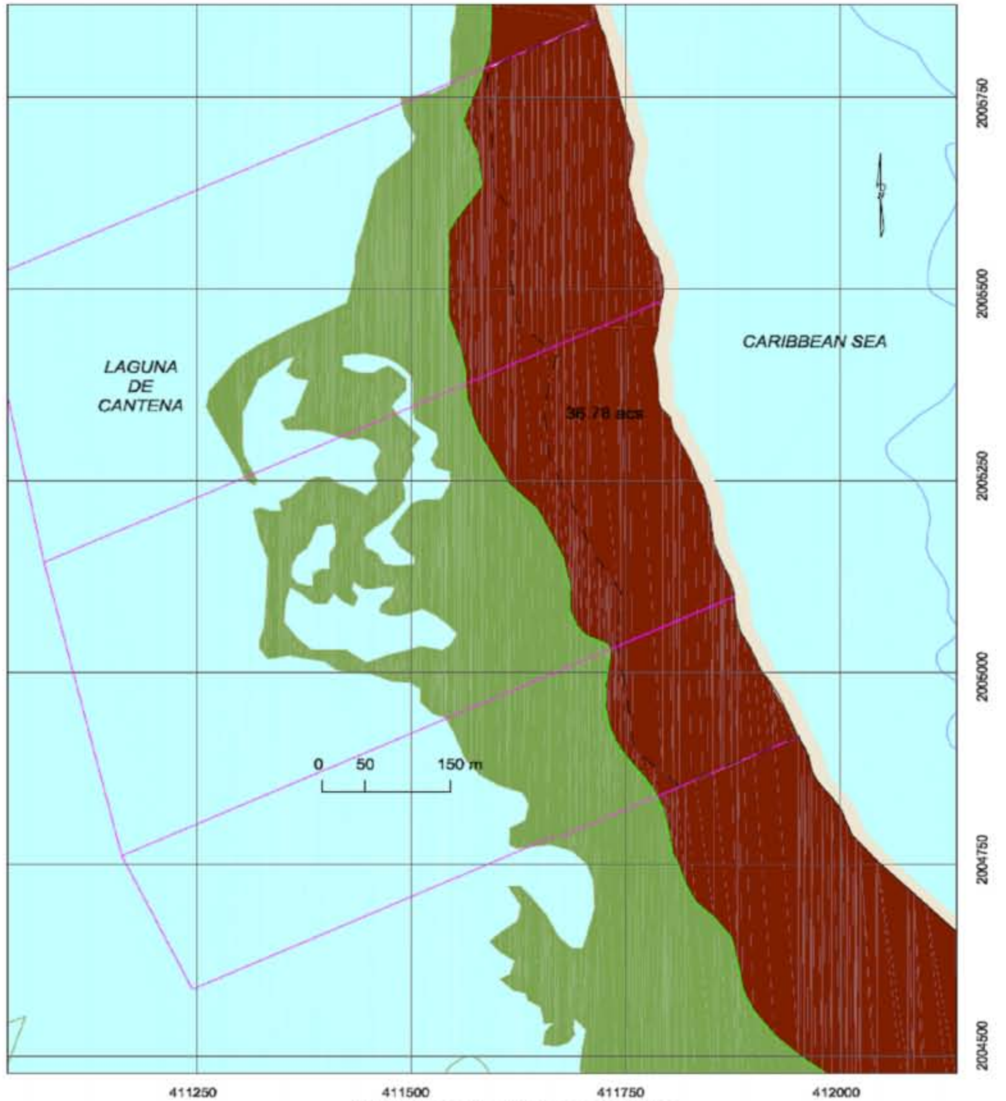


Fig. 2.3A: Vegetation Classification of Greater BCNP/MR.



Vegetation near project location

Scale= 1":200m

ABR Vegetation Area		
Description	Area (acs.)	Area (%)
Littoral forest	48.41	26.1
Mangrove	43.09	23.3
Lagoon	93.63	50.6
Total Area	185.13	100.00

LEGEND

- Property Survey
- Development Site Limits Outline
- Beach
- Littoral forest
- Mangrove

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Fig. 2.3B: Vegetation Map of Project Site

Table 2.2A: Terrestrial and Inter-tidal Plants of the Project Area

Common Name and/or Local Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
POLYPODIACEAE				
Helecho de manglar, Mangrove Fern	*Acrostichum danaeifolium*	☺	☺	LdCLL
---	*Adiantum princeps*		☺	
Culantrillo	*Adiantum tricholepis*		☺	
H-hesajo	*Cheilanthes microphylla*		☺	
Tsos'ak	*Microgramma nitida*		☺	
Helecho	*Phlebodium*		☺	
SCHIZACEAE				
---	*Anemia adiantifolia*		☺	
ACANTHACEAE				
Hulub	*Bravaisia tubiflora*		☺	
AGAVACEAE				
---	*Agave angustifolia*	☺	☺	LFMLB
AIZOACEAE				
Verdolaga de playa	*Sesuvium portulacastrum*	☺	☺	BB
AMARANTHACEAE				
---	*Amaranthus spinosus*		☺	
---	*Celosia argentea*		☺	
---	*Iresine diffusa*		☺	
AMARYLLIDACEAE				
Lirio, Spider lily	*Hymenocallis littoralis*	☺	☺	BB, LFSCB
ANACARDIACEAE				
Mango	*Mangifera indica*		☺	
Chechem Negro, Black Poisonwood	*Metopium brownei*	☺	☺	LFMLB

Common Name and/or Local Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
ANNONACEAE				
Palo de corcho	*Annona glabra*		☺	
Guanábana, Soursop	*Annona muricata*		☺	
---	*Annona primigenia*		☺	
Anona, Wild Custard apple	*Annona reticulata*	☺	☺	LFMLB, LFLB
Saramuyo, Sugar apple	*Annona squamosa*		☺	
APOCYNACEAE				
Chechem blanco, White Poisonwood	*Cameraria latifolia*	☺	☺	LFMLB, LFLB
Vicaria blanca	*Lochnera rosea*		☺	
Chakleón	*Mandevilla subsagittata*		☺	
Oleander	*Nerium oleander*		☺	
Flor de mayo, Fransipansi	*Plumeria obtusa*		☺	
Akitz	*Thevetia gaumeri*		☺	
---	*Thevetia peruviana*		☺	
ASCLEPIADACEAE				
Cancerillo, Cochinita, Cuchillo, Blood flower	*Asclepias curassavica*		☺	
BATACEAE				
---	*Batis maritima*	☺	☺	BB, LFSCB
BORAGINACEAE				
Siricote, Ziricote	*Cordia curassavica*	☺	☺	LFSCB
Siricote de Playa, Ziricote	*Cordia sevestena*		☺	
X-coi	*Tournefortia gnaphalodes*	☺	☺	BB, LFSCB

Common Name and/or Local Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
---	*Tournefortia volubilis*	☺	☺	BB
BROMELIACEAE				
X-chu	*Aechmea bracteata*		☺	
Piñuela, Wild Pineapple	*Bromelia alsodes*	☺	☺	LFMLB
X-ch'u	*Tillandsia dasyrilifolia*		☺	
BURSERACEAE				
Chacah, Gumbo Limbo, Indio desnudo	*Bursera simaruba*	☺	☺	LFMLB, LFLB
LAURACEAE			☺	
Kankubal	*Cassytha filiformis*		☺	
Aguacate, Avocado	*Persea americana*		☺	
LEGUMINOSAE				
Katzim	*Acacia gentle*		☺	
---	*Canavalia brasiliensis*		☺	
Frijol de playa	*Canavalia rosea*		☺	
---	*Caesalpinia pulcherrima*		☺	
---	*Crotalaria pumila*		☺	
Ahmuk	*Dalbergia glabra*		☺	
Pakum pak	*Desmodium incanum*		☺	
---	*Desmodium tortuosum*		☺	
Ruda de monte	*Diphysa carthagenensis*		☺	
---	*Galactia striata*		☺	
Palo de tinta	*Haematoxylan campechianum*		☺	

Common Name and/or Local Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Huaxim, Waxim	*Leucaena leucocephala*		☺	
Kanasin	*Lonchocarpus rugosus*		☺	
Tsalam, Dzalam	*Lysiloma latisiliqua*		☺	
Katsim blanco	*Minosa bahamensis*	☺	☺	BB
Dormilona	*Minosa pudica*		☺	
Habín	*Piscidia piscipula*		☺	
Chucum blanco	*Pithecellobium dulce*		☺	
Xyaxk'aax	*Pithecellobium keyense*		☺	
Verde lucero, Chakchucum	*Pithecellobium mangense*		☺	
Frijolillo, Yama bush, Rat bean	*Senna occidentalis*	☺	☺	LFSCB
Frijolillo	*Sophora tomentosa*		☺	
LILIACEAE				
Despeinada, Corcho	*Beaucarnea ameliae*		☺	
LORANTHACEAE				
Matapalo	*Struthanthus cassythoides*		☺	
LYTHRACEAE				
Crepe Myrtle	*Lagerstroemia indica*		☺	
MALPIGHIACEAE				
Nance agrio	*Byrsonima bucidaefolia*		☺	
Nance	*Byrsonima crassifolia*		☺	
MALVACEAE				
Sakwis	*Albutilon permolle*		☺	
Majahua	*Hampea trilobata*		☺	

Common Name and/or Local Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
Tulipán	*Hibiscus rosa-sinensis*	☺	☺	LFMLB
---	*Gossypium hirsutum*		☺	
Tulipán de monte	*Malvaviscus arboreus*		☺	
Chichibe	*Sida rhombifolia*	☺	☺	BB, LFSCB
---	*Thespesia sp.*		☺	
MORACEAE			☺	
---	*Artocarpus communis*		☺	
Guarumo, Trompeta, Trumpet tree	*Cecropia peltata*		☺	
---	*Ficus elastica*		☺	
Higuero, Amate, Fig tree	*Ficus maxima*		☺	
MUSACEAE				
MYRTACEAE				
Granada cimarrona	*Eugenia axillaris*		☺	
Guayaba, Guava	*Psidium guajava*	☺	☺	LFMLB, LFLB
CATCEAE				
—	*Acanthocereus pentagonus*		☺	
—	*Selenicereus donkelaarii*		☺	
A de tortuga	*Selenicereus testudo*		☺	
---	*Stenocereus griseus*		☺	
NACEAE				
Lengua de dragón	*Canna edulis*		☺	
PARIDACEAE				
---	*Capparis incana*		☺	

Common Name and/or Local Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
RICACEAE				
	Carica papaya		☺	
SUARINACEAE				
De mar, Australian Pine	*Casuarina equisetifolia*	☺	☺	LFSCB
STRACEAE				
----	*Rhacoma gaumeri*		☺	
ACEAE				
---	*Salicornia bigelovii*		☺	
---	*Suaeda linearis*		☺	
LANACEAE				
Icaco, Jicaco, Cocoplum	*Chrysobalanus icaco*	☺	☺	LFMLB, LFLB
BRETACEAE				
espinoso, Una de gato	*Bucida spinosa*		☺	
Botoncillo, Buttonwood	*Conocarpus erectus var typica*	☺	☺	LFLB, LdCLL
Botoncillo, Buttonwood	*Conocarpus erectus var sericeus*		☺	LFLB
Blanco, Sacocum, White Mangrove	*Laguncularia racemorsa*	☺	☺	LFLB, LdCLL
---	*Terminalia cattapa*		☺	
POSITAE				
Awayche	*Ageratum littorale*		☺	
De mar, Bay tansy	*Ambrosia hispida*		☺	
---	*Aster subularis*		☺	
---	*Bidens pilosa*		☺	
De playa	*Borrichia arborescens*		☺	
---	*Calea peckii*		☺	

Common Name and/or Local Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
---	*Eupatorium albicaule*		☺	
---	*Eupatorium odoratum*		☺	
Iu	*Flaveria linearis*		☺	Aaaaaa
De plata	*Melanthera nivea*		☺	
---	*Parthenium hysterophorus*		☺	
Pechuk'il	*Porophyllum punctatum*		☺	
Santa Maria	*Pluchea odorata*		☺	
CEAE				
---	*Ipomoea alba*	☺	☺	LFSCB
---	*Ipomoea indica*		☺	
Margarita, Morning Glory	*Ipomoea pes caprae*		☺	
---	*Ipomoea tuxtlensis*		☺	
CEAE				
Cortadera	*Cyperus ligularis*		☺	
---	*Dichromena ciliaris*		☺	
---	*Fimbristylis spadicea*		☺	
---	*Fimbristylis spathacea*		☺	
---	*Scleria bracteata*		☺	
CEAE				
	Diospyros verae-crucis		☺	
NYCTAGINACEAE				
	Guapira linearibracteata		☺	

Common Name and/or Local Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
ORCHIDACEAE				
X-k'ubemba	*Schomburgkia tibicinis*		☺	
PALMAE				
Tasiste	*Acoelorrhaphe wrightii*		☺	
---	*Chamaedrea sp*		☺	
Coco, Coconut	*Cocos nucifera*	☺	☺	BB, LFSCB
Kuka	*Pseudophoenix sargentii*		☺	
Guana	*Sabal yapa*		☺	
Chit	*Thrinax radiata*	☺	☺	LFSCB
PASSIFLORACEAE				
Love-in-a-Mist	*Passiflora foetida*		☺	
Pap bush	*Passiflora suberosa*		☺	
POLYPODIACEAE				
Mangrove Fern	*Acrostichum aureum*	☺	☺	LdCLL
POLYGONACEAE				
Sea Grape	*Coccolaba diversifolia*		☺	
Uva de mar, Sea Grape	*Coccolaba uvifera*	☺	☺	LFLL
	Gymnopodium floribundum		☺	
PORTULACACEAE				
Verdolaga de mar, Pussley			☺	
Purslane	*Portulaca oleracea*		☺	
RHAMNACEAE				
---	*Colubrine asiatica*		☺	
---	*Zizypus mauritiana*		☺	

Common Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
RHIZOPHORACEAE				
Mangle rojo, Tapche, Red Mangrove	*Rhizophora mangle*	☺	☺	LdCLL, LFLB
RUBIACEAE			☺	
Ibchu-ichhu, ich-hu	*Asemnanthe pubescens*		☺	
---	*Bourreria verticillata*		☺	
Skunk root, Rat root, Zorillo	*Chiococca alba*		☺	
---	*Clerodendron*		☺	
---	*speciosissimum*		☺	A
---	*Erithalis fruticosa*		☺	
Guayabillo	*Ernodea littoralis*		☺	
Xhanan, Tres hojitas, Red head,			☺	
Sanalo-todo	*Hamelia patens*		☺	
Noni	*Molinda panamensis*		☺	
Pinita	*Morinda royoc*		☺	
K'anal, Planta macho	*Psychotria nervosa*		☺	
Cruceta	*Randia aculeate*		☺	
Yaaxkanche	*Randia longiloba*		☺	
--	*Strumpfia maritima*	☺	☺	BB
RUTACEAE				
Limón agrio	*Citrus limon*		☺	
SAPINDACEAE				
Xakanke	*Cupania dentata*		☺	

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Huaya, Guaya	*Talisis olivaeformis*		☺	
SAPOTACEAE				
---	*Bumelia americana*	☺	☺	BB, LFSCB
Chicozapote	*Manilkara zapota*		☺	
Kaniste	*Pouteria campechiana*		☺	
ERYTHROXYLACEAE				
---	*Erythroxylum confusum*		☺	
EUPHORBIACEAE				
---	*Chamaesyce buxifolia*		☺	
Chaya mansa	*Cnidoscolus chayamansa*		☺	
---	*Euphobia heterophylla*	☺	☺	BB, LLSCB
Flor de pascua del monte, Wild poinsettia	*Euphorbia pulcherrima*		☺	
---	*Phyllantus niruri*		☺	
---	*Ricinus communis*		☺	
FLACOURTIACEAE				
Cafetillo de monte	*Casearia nitida*		☺	
GENTIANACEAE				
---	*Eustoma exaltatum*		☺	
GRAMINEAE				
---	*Andropogon bicornis*		☺	
-- .	*Bambusa sp*		☺	
Espino de playa, Burr-burr, Burr	*Cenchrus echinatus*	☺	☺	BB, LFSCB
---	*Cenchrus incertus*	☺	☺	BB, LFSCB

Common Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
---	*Dactyloctenium aegyptium*		☺	
---	*Distichlis spicata*		☺	
---	*Laciasis divaricata*		☺	
--	*Paspalum sp.*		☺	
---	*Sacharum officinalis*		☺	
---	*Sporobolus virginicus*	☺	☺	BB, LFSCB
Maíz	*Zea mays*		☺	
GOODENIACEAE				
---	*Scaevola plumier*		☺	
SCROPHULARIACEAE				
Claudiosa, Apote de monte, Tan chi	*Capraria biflora*		☺	
---	*Stemodia maritima*		☺	
SIMAROUBACHEAE				
Pantsil	*Suriana maritima*	☺	☺	BB, LFSCB
SOLANACEAE				
Chile habanero	*Capsicus sp*		☺	
Chile max, Chile de monte	*Capsicus frutescens*		☺	
Hierba mora	*Solanum americanum*		☺	
---	*Solanum erianthum*		☺	
---	*Solanum schlechtendalianum*		☺	
STERCULIACEAE				
Trompillo, Tzutup	*Helicteres baruensis*		☺	
Malva de monte	*Waltheria americana*		☺	

Common Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
THEOPHRASTACEAE				
Palo de animas	*Jacquinia aurantiaca*		☺	
TURNERACEAE				
---	*Turnera ulmifolia*		☺	
ULMACEAE				
---	*Trema micrantha*		☺	
VERBENACEAE				
Mangle Negro, Tapche, Black Mangrove	*Avicennia germinans*	☺	☺	LFLB, LdCLL
Pukim	*Callicarpa acuminata*		☺	
Corona de sol, Wild Sage	*Lantana camara*		☺	
Sikilhaxiw, Oregano de monte	*Lantana involucrata*		☺	
---	*Phyla nodiflora*			
Mosate, Sticky burr burr, pega ropa	*Priva luppulacea*	☺	☺	LFSCB
Ibin xiw, Verbena, Verveine	*Stachytarpheta jamaicensis*		☺	
VITACEAE				
Xtakanil	*Cissus sicyoides*		☺	

Key:

BB = Beach Berm
LdCLL = Laguna de Cantena Low-lands
LFLB = Littoral Forest Lagunal Berm
LFSCB = Littoral Forest Seaward Consolidated Berm
LFMLB = Littoral Forest Mid-Lattitude Berm

Table 2.2B: Sub-tidal plants of the project area

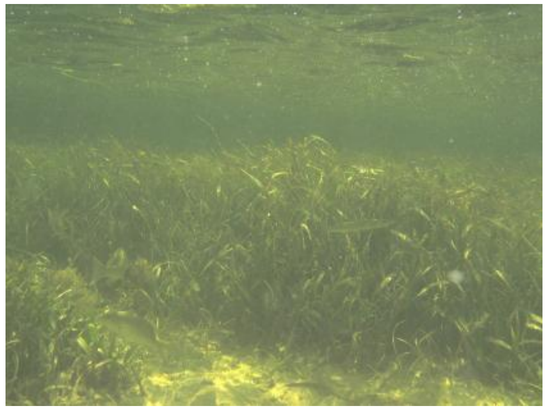
Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Sea Grasses				
Turtle Grass	*Thallasia testudinium*	☺	☺	
Manatee Grass	*Syringodium filiforme*	☺	☺	
Halodule	*Halodule beaudettel*	☺		
Macro-Algae				
Green Algae or Chlorophyta				
Firm Lettuce Algae	*Ulva spp.*	☺	☺	
Mermaid's Wine Glass	*Acetabularia spp*	☺	☺	
Feather Algae	*Caulerpa spp*		☺	
Palm Tree Algae	*Caulerpa paspaloides*		☺	
Cactus Branchlets	*Caulerpa cupressoides*	☺	☺	
Feather Algae	*Caulerpa prolifera*	☺	☺	
Calcareous Tree Algae	*Rhapocephalus phoenix*		☺	
Shaving Bush Algae, Cap Pencilus	*Penicillus capitatus*		☺	
SmoothLeather Fan Algae	*Udotea flabellum*	☺	☺	
Udotea	*Udotea wilsonii*		☺	
Firm Ruffled Fan Algae	*Udotea occidentalis*		☺	
Cup-like Udotea	*Udotea cyathiformis*	☺	☺	
-	*Cladocephalus luteofuscus*		☺	
Plate Halimeda, Disc Tree Algae	*Halimeda incrassata*	☺	☺	
Tree Halimeda, Disc Tree Algae	*Halimeda monile*		☺	
Clump Halimeda, Disc Tree Halimeda, Water Crest Algae	*Halimeda opuntia*	☺	☺	

Common Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
Single Strand Chain Halimeda, Small-leaf Hanging Vine	*Halimeda goreaui*		☺	
Green Chain Algae, Disc Tree Algae, Large-leaf Hanging Vine	*Halimeda copiosa*		☺	
Oatmeal Disc Algae, Stalked Lettuce Leaf Algae	*Halimeda tuna*		☺	
Variable Disc Algae, Large Leaf Water Crest Algae	*Halimeda discoidea*	☺	☺	
-	*Cladophora prolifera*		☺	
Sea Grape Algae	*Ventricaria ventricosa*		☺	
-	*Enteromorpha flexuosa*		☺	
Shag Carpet Algae	*Dasycladus vermicularis*	☺		
Valonia	*Valonia ventricosa*	☺		
Red Algae or Rhodophyta				
Clumped Calcareous Algae	*Amphiroa spp.*	☺	☺	
Purple-red Turf Algae	*Wrangelia argus*		☺	
-	*Liagora spp.*	☺	☺	
-	*Halymenia floresia*		☺	
-	*Kallymenia limminghei*		☺	
Brown Algae or Phaeophyta				
Dichotomously Branched Algae	*Dictyota spp*	☺	☺	
Brown Ruffle Algae	*Lobophora variegata*		☺	
Sargassum	*Sargassum spp*	☺	☺	BRSGB, NSSGB

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Rooted Sargassum	*Sargassum hystrix*		☺	
Trumpet Brown Algae	*Turbinaria turbinara*		☺	
Ruffled Algae	*Padina gymnospora*	☺	☺	
Ruffled Algae	*Padina stypopodium*		☺	

Key:

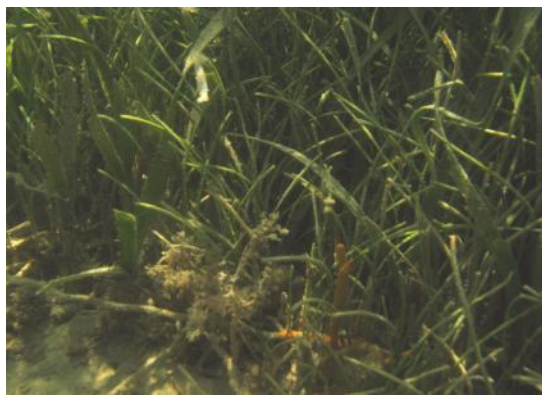
MLBL = Mid-latitude Barrier Lagoon
NSSGB = Near-shore Seagrass Beds
RF = Reef Flat
BR = Back Reef
SFR = Shallow Fore-reef
TC = Tidal Channel
BRSGB = Back Reef Seagrass Beds
MLSG = Mid-latitude Seagrass Bed



PL 2.1 **PL 2.2**

PL 2.1: Gray Snapper (*Lutjanus griseus*) in seagrass habitat in nearshore seagrass habitat of project site…

PL 2.2: Juvenile Barracuda (*Sphyraena barracuda*) at right mid-latitude of frame and Gray Snapper (*Lutjanus grisues*) at lower left…



PL 2.3 **PL 2.4**

PL 2.3: Seagrass bed dominated by Turtle Grass (*Thalassia testudinium*) found in the nearshore areas of the project site…

PL 2.4: Close-up of seagrass meadow showing undescribed encrusting sponge as yellow digitating form at 6 o'clock in frame.


PL 2.5 **PL 2.6**

PL 2.5: Eastern approaches of project site – Note isolated clumps of mangroves in nearshore waters and continuous line of beach behind this…

PL 2.6: Nearshore and beach environment of project site looking west – Note detritus as dark contours on seafloor and accumulation of organic debris mainly in the form of seagrass blades along beach…


PL 2.7 **PL 2.8**

PL 2.7: Nearshore environment of project site at low tide - Note semi-exposed seagrass and macro-algae in mid-latitude of frame and isolated Red Mangrove (*Rhizophora mangle*) stand at left...

PL 2.8: Nearshore environment of southwestern reaches of the ‘Laguna de Cantena’ Lagoon, looking west.

PL 2.9

PL 2.10

PL 2.9: Nearshore environment of 'Laguna de Cantena' Lagoon: Note calcerous white sand in beach environment and contiguous mangrove zone…

PL 2.10: Littoral forest landward of mangrove zone from Laguna de Cantena: Note Buttonwood (*Conocarpus erectus*), an ubiquitous mangrove associate in foreground…

PL 2.11

PL 2.12

PL 2.11: Disc Tree Halimeda (*Halimeda copiosa*) collected from nearshore areas of Laguna de Cantena…

PL 2.12: Turtle Grass (*Thalassia testudinium*) collected from nearshore seas bordering eastern side of project site.

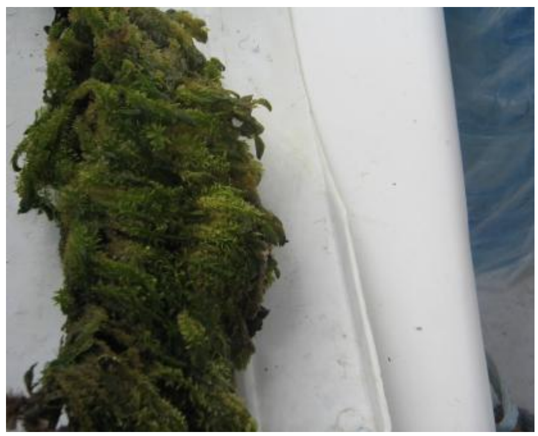
PL 2.13

PL 2.14

PL 2.13: Manatee Grass (*Syringodium filiforme*) found in nearshore environment immediately off eastern beaches of project site…

PL 2.14: Sea Fan (*Gorgonia vetalina*) found stranded on eastern beaches of property…

PL 2.15



PL 2.16

PL 2.15: Bushy Sargassum (*Sargassum polycerathum*) found in nearshore waters immediately off eastern beaches of project site…

PL 2.16: Shag Carpet Algae (*Dasycladus vermicularis*) found growing in dense profusion on a piece of Red Mangrove (*Rhizophora mangle*) root in the nearshore environment of the southwestern reaches of the Laguna de Cantena off the northern borders of the property.

PL 2.17

PL 2.18

PL 2.17: Mid-latitude beach environment on eastern side of property – Note degree of dry and decomposing seagrass litter on beach berm…

PL 2.18: Area described as the 'Littoral Forest Seaward Consolidated Berm' in the narrative – Note secondary growth in foreground and coconut dominated littoral forest in background…

PL 2.19

PL 2.20

PL 2.19: Area described as 'Littoral Forest Mid-Latitude Berm' – Note Sea Grape (*Coccolaba uvifera*)…

PL 2.20: Area described as 'Littoral Forest Lagunal Berm' in narrative – Note thick profusion of mangroves in background of frame.

PL 2.21

PL 2.22

PL 2.21: Stakes or 'brush sticks' harvested from area of Mid-latitude Berm…

PL 2.22: Northern portion of beach at low tide on eastern side of property – Note 'Wrack Line' of bio-debris deposited from the receding tide, note also exposed seagrass in the middle ground of the frame.

2.3.1.2 Fauna

The invertebrate phyla and the vertebrate classes found in the area have been listed in Tables 2.3 – 2.7. The faunal assemblage listed by both Brimshaw and Paz, as well as the Tunich Nah Survey Team are in no way an exhaustive audit of the species found in the area, but simply represent an output of the work done thus far. The Tunich Nah effort was based on a Rapid Ecological Assessment of the area, and is thus inherently limited in the discovery that would be made.

The Tunich Nah effort was has been convened to yield a representative portfolio of the nature of the habitat and the range of species present, with the evaluating how these systems and species would be impacted by the currently proposed development, and *vice versa*.

The cataloguing of the faunal assemblages by Grimshaw and Paz [2004] relates to the greater Bacalar Chico National park and Marine Reserve [BCNP/MR] which covers an area of 28,169 acres, 12,640 acres of which are wetlands, terrestrial areas and lagoons, and 15,520 acres of which are coastal waters or the sea 'proper' [Grimshaw and Paz, 2004].

The total area of the titled property for the proposed development is 185 acres: This includes the 'highlands' or truly terrestrial portion, the mangrove wetlands and a portion of the Laguna de Cantena. The area of the littoral forest and beach environment is 48 acrea or 26%, while that of the intertidal mangroves is 43 acres or 23%, and that of the lagoonal portion of the property is 94 acres or 51% of the total quantum of the title.

The area of the coastal waters as defined by the latitude of the northern and southern boundaries of the property and running from the shoreline to the reef crest is 405 acres.

The ratio of the area of the terrestrial habitats, and wetlands and lagoons of the property to these habitats in the greater BCNP/MR is approximately 1.5%. The ratio of the coastal seas of the immediate project area to the waters of the greater BCNP/MR is approximately 2.6%. The ratio of property boundaries and coastal seas to the greater BCNP/MR is approximately 2.1%.

2.3.1.2.1 Invertebrates

The invertebrates found in the area have been listed in Table 2.3. Grimshaw and Paz [2004] have cited the existence of 145 species in the overall BCNP/MR whereas the Tunich Nah Survey Team has documented 60 species [See Table 2.3]. Grimshaw and Paz [2004] have cited the existence 44 species of hard corals and 24 species of soft corals [SeeTable 2.3]. The Tunich Nah Survey Team has documented 16 species of Hard Corals and 7 Species of Soft Corals [See Table 2.3]. Two (2) of the species of soft corals documented by the Tunich Nah Survey were not previously recorded by Grimshaw and Paz [2004] (See Table 2.3).

The Tunich Nah Survey Team documented representatives from six (6) invertebrate phyla. These included: the Cnidarians or Jellyfishes and corals, the Poriferans or sponges, the Molluscans which includes the conch, as well as the Crustaceans which includes the crabs and lobsters, the Ehinodermatans which includes the star-fishes, and the Annelidans or earthworm group.

In terms of the molluscs, the Horse Conch (*Pleuroplanca gigantean*) was found in the nearshore seagrass beds in front of the property [See PL's 2.23 & 2.24]. The Periwinkle (*Littorina angulifera*) was found in some abundance in the nearshore waters of the Laguna de Cantena [See PL 2.27]. A scientifically undescribed bivalve mollusc was also collected from the Laguna de Cantena [See PL 2.28].

One of the most frequently encountered crustacean on land was the Soldier Crabs (*Calcinus tibicen*) which was found throughout the littoral forest floor [See PL 2.25].

In terms of the crustacean assemblage, the Sally Lightfoot Crab (*Graspus sp.*) and the familiar Large Land Crab (*Cardisoma guanhumi*) were also encountered in the littoral forest and the beach environment [See Table 2.3].

The most abundant invertebrates encountered were the corals. The large reef-building forms or Hard Corals such as the Boulder Star Coral (Montastrea annulari), the Pillar Coral (Dendrogyra cylindricus) and the Mustard Hill Coral (Porites astreoides) were prominent in the shallow fore-reef and back-reef areas [See Tabole 2.3]

Table 2.3: Invertebrates including corals found in and around the project site.

Common Name or Local Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
Jellyfishes and Fire Corals				
Moon Jellyfish	*Aurelia sp.*	☺	☺	MLBL
Sea Wasp	*Carybdea sp.*		☺	
Sea Wasp	*Chiropsalmus sp.*		☺	
Upside-Down Jellyfish	*Cassiopeia xamachana*	☺	☺	NSSGB
Portuguese Man-of War	*Physalia physalia*	☺	☺	NSSGB, BH
Colonial Anemone	*Palythoa*		☺	
Sun Anemone	*Stoichactus helianthus*	☺	☺	NSSGB
Giant Caribbean Anemone	*Condyiaclis wantea*	☺	☺	NSSGB
Ringed Anemone	*Bartholomea annulata*		☺	
Flat Topped Fire Coral	*Millepora complanta*	☺	☺	RF, BR
Encrusting Fire Coral	*Millepora squarrosa*		☺	
Crenelated Fire Coral	*Millepora alcicornis*	☺	☺	BR
Sponges or Poriferans				
Black Chimney Sponge	*Pellina carbonaria*	☺	☺	SFR, TC, BR
Loggerhead Sponge	*Spheciospong vesparium:*		☺	
Branching Vase Sponge	*Callyspongia vaginalis*	☺	☺	SFR, TC
Fire Sponge	*Tedania ignis*	☺	☺	NSSGB
Brown Tube Sponge	*Aplysina fistularis*	☺	☺	SFR
Branching Tube Sponge	*Pseudoceratina crassa*	☺	☺	SFR, TC

Common Name or Local Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
Netted Barrel Sponge	*Verongula gigantean*	☺	☺	SFR
Molluscs				
Queen Conch, Pink Roller	*Strombus gigas*	☺	☺	BRSGB, MLSG NSSGB
Milk Conch	*Strombus costatus*	☺	☺	BRSGS
Rooster-tail Conch	*Strombus gallus*		☺	
Hawkswing Conch	*Strombus raninus*		☺	
West-Indian Fighting Conch	*Strombus pugilis*	☺	☺	NSSGB
Atlantic Carrier Shell	*Xenophora canchyliophora*		☺	
West Indian Turban Shell	*Cittarium pica*		☺	
Tulip Shell	*Fasciolaria tulipa*	☺	☺	MLSG, NSSGB
Horse Conch	*Pleuroploca gigantean*	☺	☺	NSSGB
Emperor Helmet	*Cassis madagascariensis*	☺	☺	BRSGB
Royal Triton	*Charonia variegate*		☺	
Scotch Bonnet	*Phalium granulatum*		☺	
Atlantic Partridge Tun	*Tonna maculosa*		☺	
Long-spined Star-shell	*Astraea phoebia*		☺	
Moon Snail	*Polinices sp*		☺	
Common Atlantic Bubble	*Bulla striata*	☺	☺	BR, RF
Flamingo Tongue	*Cyphoma gibbosum*	☺	☺	RF
Caribbean Vase	*Vasum muricatum*		☺	
West Indian Crown Conch	*Melongena melongena*		☺	

Common Name or Local Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Nerites	*Nerita sp.*	☺	☺	BR
Tessellate Nerite	*Nerita tessellata*		☺	
Four-toothed Nerite	*Nerita versicolor*		☺	
Bleeding Tooth	*Nertia peloronta*	☺	☺	RF, BR
Cayenne Keyhole Limpet	*Diodora cayensis*		☺	
Spotted Sea Hare	*Aplysia dactylomela*		☺	
Cross-barred Venus	*Chione cancellata*		☺	
Flat Tree Oyster	*Isognomon alatus*		☺	
Crustaceans				
Spiny Lobster	*Panulirus argus*	☺	☺	RF, TC
Slipper Lobster	*Scyllarides species*		☺	
Spotted Spiney Lobster	*Panulirus guttatus*		☺	
American Pink Shrimp	*Panaeus duorarum*		☺	
White Shrimp	*Panaeus sp.*		☺	
Mantis Shrimps	*Squilla sp.*	☺	☺	NSSGB
Common Wat-chman Shrimp	*Patonia mexicana*		☺	
Snapping Shrimps	*Alpheus sp.*		☺	
Sponge Shrimps	*Synalpheus sp.*		☺	
Common Cleaner Shrimp	*Stenopus hispidus*	☺	☺	TC
Blue Crab	*Callinectes sp.*	☺	☺	NSSGB

Common Name or Local Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Coral Crab	*Carpilius corallinus*		☺	
Stone Crab	*Menippe mercenaria*		☺	
Large Reef Spider Crab	*Mithrax sp.*	☺	☺	TC, SFR
Shamefaced or Box Crab	*Calappa sp.*		☺	
Spotted Porcelain Crab	*Porcellana sayana*		☺	
Arrow Crab	*Stenorhynchus seticornis*	☺	☺	RF, BR
Giant Decorator Crab	*Stenocionopus turcata*		☺	
Sally Lightfoot Crab	*Graspus sp*	☺	☺	BH
Red Hermit Crab	*Petrochirus Diogenes*	☺	☺	LF
Large Land Crab	*Cardisoma guanhumi*	☺	☺	LF
Goose Barnacle	*Lepas anatifera*		☺	
Echinoderms				
Reticulated Sea Star	*Oreaster reticulatus*	☺	☺	NSSGB
Beaded Sea Star	*Astropecten articulates*		☺	
Sea Egg	*Tripneustes ventricosus*		☺	
Green Sea Urchin	*Lytechinus variegatus*	☺	☺	NSSGB
Long Spined Black Urchin	*Diadema antillarum*	☺	☺	RC, RF
Sea Pussy	*Meomaventricosa*		☺	
Donkey Dung Sea Cucumber	*Holothuria mexicana*	☺	☺	TC, MLSG
Burrowing Sea Cucumber	*Holothuria arenicola*		☺	

Common Name or Local Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
Beaded Sea Cucumber	*Euapta lappa*		☺	
Annelids				
Christmas Tree Worm	*Spirobranchus giganteus*	☺	☺	RF, BR, TC
Reef-building or Hard Corals				
Staghorn Coral	*Acropora cervicornis*	☺	☺	RF, BR
Elkhorn Coral	*Acropora palmata*	☺	☺	RC, RF, SFR
Fused Staghorn	*Acropora prolifera*		☺	
Lettuce Coral	*Agaricia agaricites*	☺	☺	SFR, BR, TC
Fragile Saucer Coral	*Agaricia fragilis*		☺	
Low Relief Lettuce Coral	*Agaricia humilis*		☺	
Lamarck's Sheet Coral	*Agaricia lamarcki*		☺	
Thin Leaf Lettuce Coral	*Agaricia tenuifolia*		☺	
Lettuce Coral	*Agaricia purpurea*	☺	☺	BR
Scroll Coral	*Agaricia undata*		☺	
Scroll Coral	*Agaricia undata*		☺	
Sunray Lettuce Cora	*Leptoseris cucullata*		☺	
Blushing Star Coral	*Stephanocoenia michelinii*		☺	
Smooth Flower Coral	*Eusmilia fastigiata*	☺	☺	BR
Knobby Brain Coral	*Diplora clivosa*	☺	☺	RF, BR, SFR
Grooved Brain Coral	*Diplora labyrinthiformes*	☺	☺	SFR, RF
Symmetrical Brain Coral	*Diplora strigosa*	☺	☺	BR

Common Name or Local Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Boulder Star Coral	*Montastrea annularis*	☺	☺	RF, BR, TC
Great Star Coral	*Montastrea cavernosa*		☺	
Rose Coral	*Manicina areolata*		☺	
Golfball Coral	*Favia fragum*	☺	☺	BR, NSSGB
Smooth Star Coral	*Solenastrea bournoni*		☺	
Knobby Star Coral	*Solenastrea hyades*	☺	☺	BR
Pillar Coral	*Dendrogyra cylindrus*	☺	☺	BR, SFR
Elliptical Star Coral	*Dichocoenia stokesii*		☺	
Maze Coral	*Meandrina meandrites*		☺	
Rough Star Coral	*Isophyllastrea rigida*		☺	
Sinuous Cactus Coral	*Isophyllia sinuosa*		☺	
Knobby Cactus Coral	*Mycetophyllia aliciae*		☺	
Rough Cactus Coral	*Mycetophyllia ferox*		☺	
Lowridge Cactus Coral	*Mycetophyllia danaana*		☺	
Ridged Cactus Coral	*Mycetophyllia lamamarckiana*		☺	
Spiny Flower Coral	*Mussa angulosa*		☺	
Atlantic Mushroom Coral	*Scolymia lacera*		☺	
Lesser Starlet Coral	*Siderastrea radians*		☺	
Massive Starlet Coral	*Siderastrea siderea*	☺	☺	SFR, RF, BR
Finger Coral	*Porites porites*	☺	☺	RF, BR

Common Name or Local Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Mustard Hill coral	*Porites astreoides*	☺	☺	RF, BR
---	*Porites furcata*		☺	
Honeycomb Plate Coral	*Porites colonensis*		☺	
---	*Porites divaricata*	☺	☺	BR
Ten-Ray Star Coral	*Madracis decactis*		☺	
Yellow Pencil Coral	*Madracis mirabillis*		☺	
Star Coral	*Madracis pharensis*		☺	
Soft Corals				
Encrusting Gorgonian	*Caribaeorum*		☺	
Deep water Sea Fan	*Schrammi*		☺	
Corky Sea Finger	*Asbestinum*	☺	☺	BR, TC
Warty Sea Rod	*Calyculata*		☺	
Doughnut Sea Rod	*Fusca*		☺	
Swollen-Knob Sea Rod	*Mammosa*	☺	☺	BR
Shelf-Knob Sea Rod	*Succinea*		☺	
---	*Tourneforti*		☺	
---	*ucicea atlantica*		☺	
Orange Spiny Sea Rod	*ucicea elongata*		☺	
Delicate Spiny Sea Rod	*ucicea laxa*		☺	
Spiny Sea Rod	*Ucicea muricata*		☺	
Rough Sea Plume	*uriceopsis flavida*		☺	

Common Name or Local Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Bent Sea Rod	*Flexuosa*		☺	
Black Sea Rod	*Homomalla*		☺	
Silt-Pore Sea Rod	*Grandiflora*		☺	
Giant Slit-Pore Sea Rod	*Nutans*		☺	
Porous Sea Rod	*Porosa*		☺	
Venus Sea Fan	*flavellum*	☺	☺	RF, BR, TC
Wide-Mesh Sea Fan	*Mariae*		☺	
Common Sea Fan	*Ventalina*	☺	☺	RF, TC
Sea Plumes	*Sp*	☺	☺	BR, TC
Bipinnate Sea Plume	*bipinnat*		☺	
Angular Sea Whip	*Anceps*		☺	
Corky Sea Finger	*Briareum asbestinum*	☺		BR, TC, MLSG
Soft Coral	*Plexaura flexuosa*	☺		SFR, RF, BR

Key:

MLBL = Mid-latitude Barrier Lagoon
NSSGB = Near-shore Seagrass Beds
BH = Beach
RF = Reef Flat
BR = Back Reef
SFR = Shallow Fore-reef
TC = Tidal Channel
BRSGB = Back Reef Seagrass Beds
MLSG = Mid-latitude Seagrass Bed
RC = Reef Crest

PL 2.23

PL 2.24

PL 2.23: Horse Conch (*Pleuroplanca gigantean*) found in sea-grass beds off eastern beaches of project site…

PL 2.24: Dorsal view of Horse Conch (*Pleuroplanca gigantean*)…

PL 2.25

PL 2.26

PL 2.25: Soldier Crabs (*Calcinus tibicen*) found in Littoral Forest of project site…

PL 2.26: Tellin (*Tellina sp.*) found intertwined in Shag Carpet Algae (*Dasycladus vermicularis*) in nearhore areas of south-eastern extreme of the 'Laguna de Cantena' Lagoon.

PL 2.27

PL 2.28

PL 2.27: Periwinkle (*Littorina angulifera*) collected in the nearshore areas of the Laguna de Cantena where it borders the proposed project site…

PL 2.28: Undescribed mussel found in the nearshore areas of the Laguna de Cantena where it borders the proposed project site.

2.3.1.2.2 Vertebrates

The documentation of vertebrate species by the Tunich Nah Survey Team entails both aquatic and terrestrial forms. This approach is consistent with the strategy adopted for the invertebrates.

2.3.1.2.2.1 Fish

Grimshaw and Paz [2004] cited the existence of 144 species of vertebrate fish for the larger BCNP/MR [See Table 2.4]. The Tunich Nah Survey Team has documented the existence of 44 species in the immediate project area 25 of which were not previously documented by Grimshaw and Paz in their 2004 endeavour [See Table 2.4].

The documentation of species by the Tunich Nah Team that were not listed by Grimshaw and Paz [2004] are a likely function of the scope for further work on species identification in the area. The situation is also a likely reflection of the species richness and in general robust health status of the ecosystems in the area.

The Tunich Nah Survey Team did not detect any vertebrate fish species in the south-eastern portion of the Laguna de Cantena, which is in some measure a legal part of the

Table 2.4: Fish Species Found in Project Area

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Sergeant Major	*Abudefduf saxatilis*	☺	☺	RF, BR
Doctorfish	*Acanthurus chirurgus*	☺		RF, SFR
Reef Squirrelfish	*Adioryx coruscus*	☺	☺	TC, SFR
Bonefish	*Albula vulpes*		☺	
Hawkfish	*Amblycirritus pinos*		☺	
Flamefish	*Apogon maculatus*		☺	
Bronze Cardinalfish	*Astropagon alutus*		☺	
Silverside	*Athermomorus stipes*		☺	
Queen Trigger	*Balistes vetula*	☺	☺	NSSGB, TC
Peacock Flounder	*Bothus lunatus*	☺	☺	RF
Orangespotted Filefish	*Cantherhinus pullus*	☺	☺	TC, SFR, MLBL
Blue Runner	*Caranx crysos*	☺	☺	BR, BRSGB
Horse-eye Jack	*Caranx latus*		☺	
Bull Shark	*Carcharhinus leucas*			
Nurse Shark	*Ginglymostoma cirratum*	☺	☺	RF, BRSGB
Spadefish	*Chaetodipterus faber*		☺	
Spotfin Butterflyfish	*Chaetodon ocellatus*	☺		RF
Striped Burrfish	*Chilomycterus schoepfi*	☺		SFR, RF
Dolphinfish	*Coryphaena hippurus*		☺	
Masked Goby	*Coryphopterus personatus*	☺		SFR

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Atlantic Flyingfish	*Cypselurus heterurus*			
Southern Stingray	*Dasyatis americana*	☺	☺	NSSGB, BRSGB
Porcupinefish	*Diodon hystrix*	☺	☺	RF
Rock Hind	*Epinephalus adscensionis*	☺	☺	SFR
Red Hind Grouper	*Epinephalus gattatus*	☺		TC, SFR
Jewfish	*Epinephalus itajara*		☺	
Nassau Grouper	*Epinephalus striatus*	☺		RF
Mojarra	*Eucinostomas sp.*	☺		NSSGB
Longspine Squirrelfish	*falmmeo marianus*	☺		SFR
Yellowfin mojarra	*Gerres cinereus*		☺	
Fairy Basslet	*Gramma loreto*	☺		SFR, RF
Spotted Moray	*Gymnothorax moringa*	☺		RF
Margate	*Haemulon album*	☺		SFR, RF
Small Mouth Grunt	*Haemulon chrysargyreum*	☺		NSSGB, BRSGB
Cottonwick	*Haemulon melanurum*	☺		RF
Blue-Striped Grunt	*Haemulon sciurus*	☺		BRSGB
Yellowhead Wrasse	*Halichoeres garnotti*	☺		RF, RC
Rainbow Wrasse	*Halichoeres pictus*	☺		RF
Scaled Sardine	*Harengula jaguana*		☺	
Seahorse	*Hippocampus sp.*	☺		TC

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Long jaw Squirrelfish	*Holocentrus ascensionis*	☺		SFR
Queen Angelfish	*Holacanthus ciliaris*	☺		RF, SFR
Hamlet	*Hypoplectus sp.*	☺		SFR
Dwarf Herring (Sprat)	*Jenkensia lamprotaenia*	☺		NSSGB
Bermuda Chub	*Kyphosus sectatrix*	☺		RF
Honeycomb Cowfish	*Lactophrys polygonia*	☺		BR, BRSGB
Trunkfish	*Lactophrys trigonus*		☺	
Candy Bass	*Liopropoma carmabi*		☺	
Crested Goby	*Lophogobius eyprinoides*		☺	
Schoolmaster Snapper	*Lutjanus apodus*	☺		RF, BR, BRSGB
Grey Snapper	*Lutjanus griseus*	☺		NSSGB
Rock Hind	*Epinephalus adscensionis*		☺	
Red Hind Grouper	*Epinephalus gattatus*		☺	
Jewfish	*Epinephalus itajara*		☺	
Nassau Grouper	*Epinephalus striatus*	☺	☺	RF, SFR
Mahogany Snapper	*Lutjanus mahogoni*		☺	
Sand Tilefish	*Malacanthus plumieri*		☺	
Tarpon	*Megalops atlanticus*		☺	
Yellowtail damselfish	*Microspathodon chrysurus*		☺	
Yellow Goatfish	*Mulloidichthys martinicus*	☺	☺	BR

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Rockfish Grouper	*Mycteroperca bonaci*		☺	
Yellowfin Grouper	*Mycteroperca venenosa*		☺	
Yellowtail Snapper	*Ocyurus chrysurus*	☺	☺	BR, BRSGB
Yellowhead Jawfish	*Opistognathus aurifrons*		☺	
Glassy Sweeper	*Pempheris schomburgki*		☺	
Sailfin Molly	*Poecilia latipinna*		☺	
French Angelfish	*Pomacanthus paru*	☺	☺	SFR
Beaugregory	*Pomacentrus leucostictus*	☺	☺	RF
Three Spot Damselfish	*Pomacentrus planifrons*		☺	
Spotted Goatfish	*Pseudopeneus maculatus*		☺	
Soapfish	*Rypticus sp.*		☺	
Blue Parrotfish	*Scarus coeruleus*	☺	☺	RF, SFR
Rainbow Parrotfish	*Scarus guacamaia*		☺	
Queen Parrotfish	*Scarus vetula*		☺	
Reef Scorpionfish	*Scorpaena caribbaeus*		☺	
Look Down	*Selene vomer*		☺	
Harlequin Bass	*Serranus tigrinus*	☺	☺	SFR
Red-tailed Parrotfish	*Sparisoma chrysopterum*		☺	
Redfin Parrotfish	*Sparisoma rubripinne*		☺	
Southern Puffer	*Sphoeroides nephelus*		☺	

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Checkered Puffer	*Sphoeroides testudineus*		☺	
Great Hammerhead Shark	*Sphyrna mokarran*		☺	
Pipefish	*Syngnathus sp.*		☺	
Red Lizardfish	*Synodus synodus*		☺	
Permit	*Trachinotus falcatus*		☺	
Yellow Stingray	*Urolophus jamaicensis*	☺	☺	NSSGB
Ocean Surgeonfish	*Acanthuirus bahianus*	☺	☺	RF, SFR
Blue Tang	*Acanthurus coeruleus*	☺	☺	RF
Spotted Eagle Ray	*Aetoboatus narinari*		☺	
Scrawled Filefish	*Aluterus scriptus*	☺	☺	TC
Black Margate	*Anisotremus surinamensis*	☺	☺	SFR, RF
Bridled Cardinalfish	*Apogon aurolineatus*		☺	
Sea Bream	*Archosargus rhomboidals*		☺	
Conchfish	*Astrapogon stellatus*		☺	
Spanish Hogfish	*Bodianus rufus*		☺	
Saucereye Porgy	*Calamus calamus*		☺	
Sharpnose Puffer	*Canthigaster rostrata*	☺	☺	TC
Crevalle Jack	*Caranx hippos*	☺	☺	BRSGB
Bar Jack	*Caranx ruber*	☺	☺	BR, BRSGB
Black Tip Shark	*Carcharhinus limbatus*		☺	

Common Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
Snook	*Centropomus undecimalis*		☺	
Four-eye Butterflyfish	*Chaetodoncapistr atu*		☺	
Banded Butterflyfish	*Chaetodon striatus*	☺	☺	RF
Blue Chromis	*Chromis cyaneus*	☺	☺	RF, RC
Bridled Goby	*Coryphopterus glaucofraenum*		☺	
Sheepshead Minnow	*Cyprinodon variegatus*		☺	
Flying Grunard	*Dactylopterus volitans*		☺	
Balloonfish	*Diodon holocanthus*	☺	☺	TC, RF
Shark Sucker	*Echeneis naucrates*		☺	
Graysby	*Epinephalus cruentatus*		☺	
Coney	*Epinephalus fulvus*		☺	
Red Grouper	*Epinephalus mario*		☺	
Jackknife Fish	*Equetus lanceolatus*		☺	
Cornetfish	*Fistularia tabacaria*		☺	
Tiger Shark	*Galeocerdo cuvieri*		☺	
Neon Goby	*Gobiosoma oceanops*	☺	☺	RF, BR
Green Moray	*Gymnothorax funebris*	☺	☺	RF
Purple Mouth Moray	*Gymnothorax vicinus*		☺	
Tomate	*Haemulon aurolineatum*		☺	
French Grunt	*Haemulon flavolineatum*	☺	☺	

Common Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
White Grunt	*Haemulon plumieri*	☺	☺	
Slippery Dick	*Halichoeres bivittatus*		☺	
Clown Wrasse	*Halichoeres maculipinna*		☺	
Puddingwife	*Halichoeres radiatus*	☺	☺	RF
Ballyhoo	*Hemiramphus brasiliensis*		☺	
Squirrelfish	*Holocentrus sp.*	☺	☺	TC
Longspine Squirrelfish	*Holocentrus rufus*		☺	TC, SFR
Rock Beauty	*Holacanthus tricolor*	☺	☺	SFR
Indego Hamlet	*Hypoplectus indego*	☺	☺	RC
Chub	*Kyphosus sp.*	☺	☺	BR, RF
Hogfish	*Lachnolaimus maximus*	☺	☺	BRSGB
Scrawled Cowfish	*Lactophrys quadricornis*	☺	☺	BR
Perpermint Bass	*Liopropoma rubre*		☺	
Triple-tail	*Loliotes surinamensis*		☺	
Mutton Snapper	*Lutjanus analis*		☺	
Cubera Snapper	*Lutjanus cyanopterus*		☺	
Dog Snapper	*Lutjanus jocu*	☺	☺	SFR, BR, BRSGB
Graysby	*Epinephalus cruentatus*		☺	
Coney	*Epinephalus fulvus*	☺	☺	SFR
Red Grouper	*Epinephalus mario*		☺	

Common Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
Jackknife Fish	*Equetus lanceolatus*		☺	
Lane Snapper	*Lutjanus synagris*		☺	
Atlantic Manta	*Manta birostris*		☺	
Black Durgon	*Melichthys niger*		☺	
White Mullet	*Mugil curema*		☺	
Goldentail Moray	*Muraena miliaris*		☺	
Tiger Grouper	*Mycteroperca tigris*		☺	
Lemon Shark	*Negaprion brevirostris*	☺	☺	BR, BRSGB
Shortnose Batfish	*Ogcocephalus nasutus*		☺	
Creole Fish	*Paranthias fucifer*	☺	☺	SFR
Freckled Cardinalfish	*Phaeoptyx conklini*		☺	
Gray Angelfish	*Pomacanthus arcuatus*		☺	
Dusky Damselfish	*Pomacentrus fuscus*		☺	
Bicolor Damselfish	*Pomascentrus partitus*	☺	☺	SFR
Cocoa Damselfish	*Pomacentrus variabilis*		☺	
Southern Guitarfish	*Rhinoboutos percellens*		☺	
Midnight Parrotfish	*Scarus coelestinus*		☺	
Striped Parrotfish	*Scarus croicensis*	☺	☺	RC, RF
Princess Parrotfish	*Scarus taeniopterus*		☺	
Cero	*Scomberomorus regalis*		☺	

Common Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
Plumed Scorpionfish	*Scorpaena grandicornis*		☺	
Greater Amberjack	*Seriola dumerili*		☺	
Redband Parrotfish	*Sparisoma aurofrenatum*		☺	
Bucktooth Parrotfish	*Sparisoma radians*		☺	
Stoplight Parrotfish	*Sparisoma viride*		☺	
Bandtail Puffer	*Sphoeroides spengleri*		☺	
Great Barracuda	*Sphyraena barracuda*	☺	☺	SFR, BR, BRSGB
Redfin Needlefish	*Strongylura notata*		☺	
Lizardfish	*Synodus sp.*		☺	
Bluehead Wrasse	*Thalassoma bifasciatum*	☺	☺	RF
Houndfish	*Tylosurus crocodilus*		☺	

Key:

MLBL = Mid-latitude Barrier Lagoon
NSSGB = Near-shore Seagrass Beds
BH = Beach
RF = Reef Flat
BR = Back Reef
SFR = Shallow Fore-reef
TC = Tidal Channel
BRSGB = Back Reef Seagrass Beds
MLSG = Mid-latitude Seagrass Bed
RC = Reef Crest

description of the property. The situation of the lack of fishlife in the lagoon has also been cited by Grimshaw and Paz [2004] as the experience of other authors. It would be very unlikely that there would be no fishlife in the lagoon, since although it is understandable that ecological functions of the lagoon would change over annual cycles and longer time frames, it is unlikely that the changes encountererd, including that of fishing pressures, would be of a magnitude or orientation to completely wiped out the fish stocks from the area [Pers. comm.., G. Myvett].

Much of the species encountered are stenohaline stocks that are incapable of withstanding freshwater influences and in general large shifts in salinity. The species encountererd by the Tunich Nah Survey Team, as well as those cited by Grimshaw and Paz [2004], typically includes reef species such as the Blue Tang (*Acanthurus coeruleus*), the Dog Snapper (*Lutjanus jocu*), and the Hogfish (*Lachnolaimus maximus*), as well as oceanic stocks such as the Greater Amberjack (*Seriola dumerili*), the Dolphinfish (*Coryphaena hippurus*) and the Houndfish (*Tylosurus crocodilus*) [See Table 2.4].

Much of the euryhaline species, which can adjust to low salinity circumstances, and which can tolerate relatively wide variations in salinity, that were listed by Grimshaw and Paz [2004] were not seen or reported anectdotally by the Tunich Nah Survey Team for the proposed project area. These include species such as the Tarpon (*Megalops atlanticus*), the Snook (*Centropomus undecimalis*) and the White Mullet (*Mugil curema*) [See Table 2.4].

The presence of euryhaline stocks in the Grimshaw and Paz endeavour [2004] relates to the fact that it is unlikely that these species were recorded in the immediate project area: Given the diversity of habitats and the expansive extent of the wider Bacalar Chico National Park and Marine Reserve [BCNP/MR], it is likely that the euryhaline stocks were documented or reported for some locale other than the current project site that would be characterized by low salinities and consequently significant freshwater inputs.

2.3.1.2.2.2 Reptiles and Amphibians

Grimshaw and Paz [2004] cited the existence of 33 reptiles in the larger BCNP/MR: These included 15 species of snakes and 1 crocodilian [See Table 2.5]. The Tunich Nah Survey Team documented 5 species of reptiles, with 2 species of snakes and no crocodilian [See Table 2.5].

The limited number of reptilian species documented on the project site is a function of the size of the property, geography and ecological characterization. The property is a relatively thin strip of land with the sea on one side and a lagoon on the other. It’s geographic placement and size does not allow for the diversity and geographic extent of habitats that would allow for a wide array of species.

The most abundant species documented by the Tunich Nah Team was the Wish-Willy, Spiny-tail Iguana (*Ctenosaura similis*), followed by the Smooth-Scaled Gecko

Table 2.5 Reptiles and Amphibians

Common Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
LIZZARDS				
Mangrove Gecko	*Phylodactylus tuberculosus*		☺	
Smooth-Scaled Gecko	*Sphaerodactylus glaucus*	☺	☺	LFLB, LFSCB, LFMLB
Lemurs Anole	*Norops (Anolis) lemurinus*		☺	
Yellow Fan Anole	*Norops (Anolis) limifrons*		☺	
Brown Anole, Bark Anole	*Norops (Anolis) sagrei*		☺	
Jesus Christ Lizard, Stripped Basilisk	*Basiliscus vittatus*	☺	☺	LFMLB, LFSCB
Wish-Willy, Spiny-tail Iguana	*Ctenosaura similis*	☺	☺	LdCLL, LFLB, LFMLB
Yucatan Spiny Lizard	*Sceloporus chrysostictus*		☺	
Skink	*Eumeces sp. (probably) schwartzei*		☺	
Rainbow Ameiva	*Ameiva undulata*		☺	
Black-bellied Racerunner	*Cnemidophorus sp. (probably) gularis*		☺	
Weatherman	*Aristelliger georgeensis*		☺	
SNAKES				
Blind Snake	*Leptotyphlops goudoti*		☺	
Boa, Wowla	*Boa constrictor*	☺	☺	LFMLB
Black Tailed Indigo snake	*Drymarchan corasis*		☺	
Speckled Racer	*Drymobius margaritiferus*		☺	
Mexican Tree Snake	*Leptophis mexicanus*		☺	
Gray Vine Snake	*Oxybelis aeneus*		☺	

Common Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
Green Vine Snake	*Oxybelis fulgidus*	☺	☺	LFMLB, LFSCB
Black-Headed Snake	*Tantilla canula*		☺	
Cat-eyed Snake	*Leptodeira frenata*		☺	
Central American Cat-eyed Snake	*Leptodeira septentrionalis*		☺	
Thunder and Lightning Snake, Cribo	*Spilotes pullatus*		☺	
Black-headed Snake	*Tantilla schistosa*		☺	
Central American Ribbon Snake	*Thamnophis proximus*		☺	
Coral Snake	*Micrurus diastema*		☺	
Coral Snake	*Micrurus nigrocinctus*		☺	
CROCODILIDANS				
Crocodile	*Crocodylus acutus*		☺	
TURTLES				
Mud Turtle	*Kinosternon scorpioides*		☺	
White-faced Mud Turtle	*Kinostermon leucostomum*		☺	
Black Belly Turtle	*Rhinoclemys areolata*		☺	
Loggerhead Sea Turtle	*Caretta caretta*		☺	
Hawksbill Sea Turtle	*Eretmochelys imbricata*		☺	
AMPHIBIANS				
Marine Toad	*Bufo marinus*	☺	☺	LFLB
Gulf Coast Toad	*Bufo valliceps*		☺	

Key: BB = Beach Berm
LdCLL = Laguna de Cantena Low-lands
LFLB = Littoral Forest Lagunal Berm
LFSCB = Littoral Forest Seaward Consolidated Berm
LFMLB = Littoral Forest Mid-Lattitude Berm

(*Sphaerodactylus glaucus*) [See Table 2.5]. The Green Vine Snake (*Oxybelis fulgidus*) was also fairly frequently encountered [See Table 2.5].

Grimshaw and Paz [2004] cited the existence of two (2) species of amphibians for the larger BCNP/MR area [See Table 2.5]. Only one (1) species of Amphibian was documented by the Tunich Nah Survey Team: This was the Marine Toad (*Bufo marinus*) [See Table 2.5]. The paucity of amphibian species in a coastal/marine environment is typical, it is unlikely however that the two (2) species cited by Grimshaw and Paz [2004] is the full extent of the species portfolio in the area given the overall size of the BCNP/MR and the diversity of habitats, some of which are know to be suitable for colonization by amphibians [Pers. comm.., G. Myvett].

2.3.1.2.2.3 Mammals

Grimshaw and Paz [2004] have documented the existence of 31 mammalian species, including marine mammals, for the larger BCNP/MR [See Table 2.6]. The Tunich Nah Survey Team documented 3 species of mammals for the proposed project site [See Table 2.6]. Although the Bottlenose Dolphin (*Tursiops truncatus*) would be a likely inhabitant of the project area, none was observed by the Tunich Nah Team [Pers. comm.., G. Myvett].

The mammalian species most frequently encountered species by the Tunich Nah Team was the Raccoon (*Procyon lotor*) [See Table 2.6]. This was probably a function of the availability of food in the form of the Large Land Crab (*Cardisoma guanhumi*) [Pers. comm., G. Myvett].

Table 2.6: Mammals

Common Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
Four-Eyed Opossum	*Philander (Metachirops) opossum*	☺	☺	LFLB, LFMLB
Ant Bear, Tamandua	*Tamandua mexicana*		☺	
Gibnut	*Agouti paca*		☺	
Spiny Pocket Mouse	*Heteromys gaumeri*	☺	☺	LFMLB
Hispid Cotton Rat	*Sigmodon hispidus*		☺	
Mexican Porcupine	*Sphiggurus (Coendou) mexicannus*		☺	
Yucatan Squirrel	*Sciurus sp.(probably) deppei*		☺	
Black-eared Rice Rat	*Oryzomys couesi*		☺	
Slender Harvest Mouse	*Reithrodontomys gracilis*		☺	
Grey Fox	*Urocyon cinereoargenteus*		☺	
Raccoon	*Procyon lotor*	☺	☺	LdCLL, LFSCB, LFMLB
Ocelot	*Leopardis (Felis) pardalis*		☺	
Jaguar	*Panthera (Felis) onca*		☺	
Puma, Mountain Lion	*Puma (Felis) concolor*		☺	
Bush dog, Gray-headed Tayra	*Eira barbara*		☺	
Cocomistle or Ring-tail Cat	*Bassariscus sumichrasti*		☺	
Martucha, Kinkajou, Nightwalker	*Patos flavus*		☺	

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Quash, Coatimundi, White-nosed Coati	*Nasua nasua*		☺	
Jaguarundi, Halar	*Herpailurus (Felis) yagouaroundi*		☺	
Margay	*Leopardis (Felis) wiedii*		☺	
Greater Grison, Grisón	*Galictis vittata*		☺	
White-Lipped Peccary, Warrie	*Tayassu pecari*		☺	
Collared Peccary	*Tayassu tajacu*		☺	
Savanna Deer, White-Tail Deer	*Odocoileus virginianus*		☺	
Jamaican Fruit-eating Bat	*Artibeus jamaicensis*		☺	
Brazilian Large-eared Bat	*Micronycteris mealotis*		☺	
Pygmy Fruit-eating Bat	*Dermanura (Artibeus) phoeotis*		☺	
Common Tent-making Bat	*Uroderma bilobatum*		☺	
Central American Yellow Bat	*Rhogeessa tumida*		☺	
Bottlenose Dolphin	*Tursiops truncatus*		☺	
Manatee	*Trichechus manatus*		☺	

Key:

BB = Beach Berm
LdCLL = Laguna de Cantena Low-lands
LFLB = Littoral Forest Lagunal Berm
LFSCB = Littoral Forest Seaward Consolidated Berm
LFMLB = Littoral Forest Mid-Latitude Berm

2.3.1.2.2.4 Avi-fauna or Birds

The project site was richly invested with bird species. Grimshaw and Paz cited the existence of 182 species of birds for the larger BCNP/MR [See Table 2.7]. The Tunich Nah Survey Team documented 52 species of birds for the project site: Seven (7) of these species have not been previously documented by Grimshaw and Paz [2004].

In 1995 Martin Meadows identified 186 species of birds in the Laguna de Cantena area of Bacalar Chico National Park. The survey by the Tunich Nah Team revealed that tropical Littoral forest supports three times (3x) the level of species as compared to the more central scrub forest. The Laguna de Cantena area is important for several Yucatan endemics such as the **Red Vented Woodpecker** (*Malenerpes pymaeus*), **Yucatan Vireo** (*Vireo magister*), and the **Black Catbird** (*Melanoptila glarirostris*). The lagoon is an important feeding area for wetland species such as **Reddish Egret** (*Egretta rufescens*), **Roseate Spoonbill Heron** (*Ajaia ajaja*) and **Wood Storks**. Some mangrove cayes in the lagoon are roosting areas for over ten species (Meadows 1995).

Fifteen (15) North American migrants were identified on the site, these observations all occurred at the end of bird migration period (Mar-May). The birds use the property and adjacent areas as feeding and roosting grounds. Olive Throated Parakeets (*Aratinga nana*) are reported by local fishers to nest in coconut palms. The key bird habitat observed on this site is the Beach/Littoral forest located along the shoreline that supports the Black Catbird (*Melanoptila glabrirostris*), which is endemic to Belize.

Table 2.7: Birds Found in and Around the Project Area

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Least Grebe	*Tachybaptus dominicus*		☺	
Pied-billed Grebe	*Podilymbus podiceps*	☺	☺	
Brown Pelican	*Pelecanus occidentalis*	☺	☺	v-V
Double crested Cormorant	*Phalacrocorax auritus*		☺	
Neotropic Cormorant	*Phalacrocorax brasilianus*	☺		v-P
Anhinga	*Anhinga anhinga*		☺	
Magnificent Frigatebird	*Fregata magnificens*	☺	☺	v-V
Bare-throated Tiger-Heron	*Tigrisoma mexicanum*		☺	
Boat-billed Heron	*Cochlearius cochlearius*		☺	
Cattle Egret	*Bubulcus ibis*		☺	
Green Heron	*Butorides virescens*	☺	☺	c-P
Little Blue Heron	*Egretta caerulea*	☺	☺	v-W
Great Blue Heron	*Ardea herodias*	☺		c-V
Tricolored Heron	*Egretta tricolor*		☺	
Reddish Egret	*Egretta rufescens*		☺	
Great Egret	*Ardea albus*	☺	☺	v-P
White Ibis	*Eudocimus albus*		☺	
Roseate Spoonbill	*Platalea ajaja*		☺	
Wood Stork	*Mycteria americana*		☺	
Turkey Vulture	*Cathartes aura*		☺	

Common Name	**Scientific Name**	**Obs. Tunich Nah Team**	**BCMP Survey**	**Environment**
Lesser Yellow-headed Vulture	*Cathartes burrovianus*		☺	
Black Vulture	*Coragyps atratus*	☺	☺	v-P
American Wigeon	*Anas americana Anas americana*		☺	
Blue-winged Teal	*Anas discors*		☺	
Lesser Scaup	*Aythya affinis*		☺	
Osprey	*Pandion haliaetus*		☺	
Hook-billed Kite	Chondrohierax uncinatus		☺	
Black-Shouldered Kite	*Elanus caeruleus*		☺	
Crane Hawk	*Geranospiza caerulescens*		☺	
Common Black-Hawk	*Buteogallus anthracinus*	☺	☺	u-P
Roadside Hawk	*Buteo magnirostris*		☺	
Common Nighthawk	*Chordeiles minor*		☺	
Lesser Nighthawk	*Chordeiles acutipennis*		☺	
Common Pauraque	*Nyctidromus albicollis*		☺	
Tawny-Collared Nightjar	*Caprimulgus salvini*		☺	
Chimney Swift	*Chaetura pelagica*		☺	
Vaux's Swift	*Chaetura vauxi*		☺	
Fork-Tailed Emerald	*Chlorostilbon canivetii*		☺	
Cinnamon Hummingbird	*Amazilia rutila*		☺	

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Ruby-throated Hummingbird	*Archilochus colubris*		☺	
Rufous Tailed Hummingbird	*Amazilia tzacatl*	☺		v-P
Black-headed Trogon	*Trogon melanocephalus*		☺	
Belted Kingfisher	*Ceryle alcyon*		☺	
Green Kingfisher	*Chloroceryle americana*		☺	
Golden-fronted Woodpecker	*Melanerpes aurifrons*	☺	☺	c-P
Red-vented Woodpecker	*Melanerpes pgymaeus*		☺	
Yellow-bellied Sapsucker	*Sphyrapicus varius*		☺	
Lineated Woodpecker	*Dryocopus lineatus*	☺	☺	c-P
Caribbean Elaenia	*Elaenia martinica*		☺	
Yellow-bellied Elaenia	*Elaenia flavogaster*		☺	
Common Tody-flycatcher	*Todirostrum cinereum*		☺	
Least flycatcher	*Empidonax minimus*		☺	
Yucantan Flycatcher	*Myiarchus yucatanensis*		☺	
Dusky-capped Flycatcher	*Myiarchus tuberculifer*	☺	☺	c-p
Brown Crested Flycatcher	*Myiarchus tyrannulus*		☺	
Great Kisdadee	*Pitangus sulphuratus*	☺	☺	v-P
Social Flycatcher	*Mylozetates similis*	☺	☺	v-P
Tropical Kingbird	*Tyrannus melancholicus*	☺	☺	v-P
Eastern Kingbird	*Tyrannus tyrannus*		☺	
Merlin	*Falco columbarius*		☺	
Peregrine Falcon	*Falco peregrinus*		☺	

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Plain Chachalaca	*Ortalis vetula*		☺	
Gray Necked Wood Rail	*Aramides cajanea*	☺	☺	f-P
Rufous-necked Wood-Rail	*Aramides axillaris*		☺	
Sora	*Porzana carolina*		☺	
Common Moorhen, Tap-na-chick	*Gallinula chloropus*		☺	
Clapper Rail	*Rallus longirostris*		☺	
American Coot	*Fulica americana*		☺	
Limpkin	*amus guarauna*		☺	
American Golden-Plover	*Pluvialis dominica*		☺	
Black-bellied Plover	*Pluvialis squatarola*	☺	☺	f-W
Semipalmated Plover	*Charadrius semipalmatus*	☺	☺	f-W
Wilson's Plover	*Charadrius wilsonia*		☺	
Killdeer	*Charadrius vociferus*		☺	
Black-necked Stilt	*Himantopus mexicanus*	☺	☺	l-P
Black-necked Stilt	*Himantopus mexicanus*	☺		l-P
Whimbrel	*Numenius phaeopus*		☺	
Long-billed Curlew	*Numenius americanus*		☺	
Upland Sandpiper	*Bartramia longicauda*		☺	
Greater Yellowlegs	*Tringa melanoleuca*	☺	☺	f-W
Lesser Yellowlegs	*Tinga flavipes*		☺	
Solitary Sandpiper	*Tinga solitaria*	☺	☺	f-W
Willet	*Catoptrophorus semipalmatus*	☺	☺	u-W
Spotted Sandpiper	*Actitis macularia*	☺	☺	c-W
Ruddy Turnstone	*Arenaria interpres*		☺	
Common Snipe	*Gallinago gallinago*		☺	
Short-billed Dowitcher	*Limnodromus griseus*	☺	☺	f-W
Sanderling	*Calidris alba*		☺	
Semipalmated Sandpiper	*Calidris pusilla*	☺	☺	u –T
Least Sandpiper	*Calidris minutilla*		☺	
Western Sandpiper	*Calidris mauri*		☺	
Parasitic Jaeger	*Stercorarius parasiticus*		☺	
Laughing Gull	*Larus atricilla*	☺	☺	v-V
Gull-billed Tern	*Sterna nilotica*		☺	

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Caspian Tern	*Sterna caspia*	☺	☺	F
Least Tern	*Sterna antillarum*		☺	
Royal Tern	*Sterna maxima*	☺	☺	C,V
Sandwich Tern	*Sterna sandvicensis*	☺	☺	V,V
Blue-winged Warbler	*Vermivora pinus*		☺	
Tennessee Warbler	*Vermivora peregrinaeopygia*		☺	
Northern Parula	*Parula americana*		☺	
Yellow/Mangrove Warbler	*Dendroica petchia*		☺	
Magnolia Warbler	*Dendroica magnolia*	☺	☺	c-W
Cape May Warbler	*Dendroica tigrina*		☺	
Black-throated Blue Warbler	*Dendroica caerulescens*		☺	
Yellow-rumped Warbler	*Dendroica coronata*		☺	
Black-throated Green Warbler	*Dendroica vinens*		☺	
Blackburnian Warbler	*Dendroica fusca*		☺	
Yellow-throated Warbler	*Dendroica dominica*		☺	
Prairie Warbler	*Dendroica discolor*		☺	
Palm Warbler	*Dendroica palmarum*		☺	
Black-poll Warbler	*Dendroica striata*		☺	
Black and White Warbler	*Mniotilta varia*	☺	☺	c-W
American Redstart	*Setophaga ruticilla*		☺	
Prothonotary Warbler	*Protonotaria eitrea*		☺	
Worm-eating Warbler	*Helmitheros vermivorus*		☺	
Swainson's Warbler	*Limnothlyps swainsonii*		☺	
Oven Bird	*Seiurus aurocapillus*		☺	
NorthernWaterthrush	*Seiurus noveboracensis*	☺	☺	
Louisiana Waterthrush	*Seiurus motacilla*		☺	
Kentucky Warbler	*Oporornis formosus*		☺	
Mourning Warbler	*Oporornis philadelphia*		☺	
Common Yellowthroat	*Geothylpis trichas*	☺	☺	c-W
Gray-crowned Yellowthrouat	*Geothylpis poliocephala*		☺	
Hooded Warbler	*Wilsonia citrina*	☺	☺	c-W
Yellow-breasted Chat	*Icteria virens*		☺	
Purple Martin	*Progne subis*		☺	
Gray-breasted Martin	*Progne chalybea*		☺	

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Tree Swallow	*Tachycineta bicolor*		☺	
Mangrove Swallow	*Tachycineta albilinea*		☺	
North Rouchwing Swallow	*Stelgidopteryx serripennis*		☺	
Bank Swallow	*Riparia riparia*		☺	
Cliff Swallow	*Hirundo pyrrhonota*		☺	
Barn Swallow	*Hirundo rustica*		☺	
Purple Martin	*Progne subis*		☺	
Gray-breasted Martin	*Progne chalybea*		☺	
Tree Swallow	*Tachycineta bicolor*		☺	
Mangrove Swallow	*Tachycineta albilinea*	☺	☺	c-P
North Rouchwing Swallow	*Stelgidopteryx serripennis*	☺	☺	c-W
Bank Swallow	*Riparia riparia*		☺	
Cliff Swallow	*Hirundo pyrrhonota*		☺	
Barn Swallow	*Hirundo rustica*		☺	
Lesser Swallow Tailed- Swift	*Panyptila cayennensis*		☺	
Yucatan Jay	*Cyanocorax yucatanicus*		☺	
Blue-gray Gnatcatcher	*Polioptila caerulea*		☺	
Veery	*Catharus fuscescens*		☺	
Gray-cheeked Thrush	*Catharus minimus*		☺	
Swainson's Thrush	*Catharus ustulatus*		☺	
Wood Thrush	*Hylocichla mustelina*		☺	
Gray Catbird	*Dumetella cardolinensis*		☺	
Black Catbird	*Melanoptila glabrirostris*	☺	☺	l-P
Tropical Mockingbird	*Mimus gilvus*	☺	☺	c-P
White-eyed Vireo	*Vireo griseus*		☺	
Mangrove Vireo	*Vireo pallens*	☺	☺	c-P
Yellow-throated Vireo	*Vireo flavifrons*		☺	
Red-eyed Vireo	*Vireo olivaceus*		☺	
Yucatan Vireo	*Vireosylva magister*	☺	☺	v-P
Rufous-browned Peppershrike	*Cyclarhis gujanensis*		☺	
White-crowned Pigeon	*Columba leucocephala*	☺	☺	u-P
Pale Vented Pigeon	*Columba cayennensis*	☺		v-P
White-winged Dove	*Zenaida asiatica*		☺	
Common Ground-Dove	*Columbina passerine*		☺	

Common Name	Scientific Name	Obs. Tunich Nah Team	BCMP Survey	Environment
Caribbean Dove	*Leptotila jamaicensis*		☺	
Olive-throated Parakeet	*Aratinga nana*	☺	☺	c-P
Yellow-billed Cuckoo	*Coccyzus americanus*		☺	
Mangrove Cuckoo	*Coccyzus minor*		☺	
Squirrel Cuckoo	*Piaya cayana*		☺	
Groove-billed Ani	*Crotophaga sulcirostris*		☺	
Smooth-billed Ani	*Crotophaga ani*		☺	
Great Horned Owl	*Bubo virginianus*		☺	
Mottled Owl	*Ciccaba virgata*		☺	
Banana Quit	*Coereba flaveola*		☺	
Summer Tanager	*Piranga rubra*		☺	
Scarlet Tanager	*Piranga olivacea*		☺	
Blue Gray Tanager	*Thraupis episcopus*	☺		v-P
Black-headed Saltator	*Saltator atriceps*		☺	
Rose-breasted Grosbeak	*Pheucticus ludovicianus*		☺	
Blue Grosbeak	*Guiraca caerulea*		☺	
Indigo Bunting	*Passerina cyanea*		☺	
White-collared Seedeater	*Sporophila torqueola*		☺	
Lincoln's Sparrow	*Melospiza lincolnii*		☺	
Melodius Blackbird	*Dives dives*		☺	
Great-tailed Grackle	*Quiscalus mexicanus*	☺	☺	v-P
Oachard Oriole	*Icterus spurious*		☺	
Hooded Oriole	*Icterus cucullatus*		☺	
Yellow-backed Oriole	*Icterus chrysater*	☺	☺	f-P
Northern Oriole	*Icterus galbula*		☺	
Altamira Oriole	*Icterus gularis*	☺		c-W
Yellow-billed Cacique	*Amblycercus holosericeus*	☺	☺	c-P

Key:

<u>Abundance</u>
v = very common c = common f = fairly common u = uncommon
r = rare o = occasional l = uncommon locally but absent in other districts

<u>Seasonality</u>
P = permanent resident S = seasonal resident V = visitor T = Transient
W = winter resident X = Known from only two records.

2.4 Conservation Issues

The conservation issues in regards to the proposed undertaking relates to both conservation areas and species of special interest. The Bacalar Chico area is a National Park and Marine Reserve: Thus the title Bacalar Chico National Park and Marine Reserve [BCNP/MR]. Relatedly, in terms of the issue of 'conservation area' status, some of the neighbouring beaches have been identified as important nesting sites for sea turtles.

In terms of species of special interest: There are ten (10) species existing in the larger BCNP/MR that have been classified as 'threatened' or 'endangered' [Grimshaw and Paz, 2004].

2.4.1 Endangered Species of Special Significance

There are a number of threatened and endangered species. These includes: sea turtles, crocodiles, marine mammals and birds.

The sea turtles of relevance are the Green Turtle (*Chelonia mydas*), the Hawksbill Turtle (*Eretmochelys imbricata*), and the Loggerhead (*Caretta caretta*). The beaches south of the proposed project area running from Robles to Rocky Point are an important nesting site for these species: This is especially relevant to the Green Turtle (*Chelonia mydas*) and the Loggerhead (*Caretta caretta*) [Grimshaw and Paz [2004]. It has been reported that the Hawksbill Turtle (*Eretmochelys imbricata*) is only an occasional visitor to the beaches [Grimshaw and Paz, 2004]. The development activities, both during the construction and operational phases of the undertaking, should in no way interfere with the nesting activities on these beaches.

There have been no reports of any use of the beaches of the project site for nesting activities for sea turtles.

The Hawks Bill Turtle (*Eretmochelys imbricata*) is listed in Appendix I of the CITES Regulations which means that the species is threatened with extinction and is or would be affected by trade. Trade in the Hawks Bill (*Eretmochelys imbricata*) in compliance with the goals of the convention, must be accompanied by the strictest of regulations to ensure that the species is not further imperiled, and should only be authorized under exceptional circumstances [Pers. comm. G. Myvett]. The Fisheries Regulations were strengthened in 2003 in regards to the Hawks Bill (*Eretmochelys imbricata*) and sea turtles in general: SI 66 of 2002, Reg. 2 prohibits the harvesting of sea turtles. Prior to this amendment in the Fisheries Act, harvest was regulated by size limits and closed season [Pers. comm. G. Myvett].

In addition to the issue of the harvesting and trade, the nesting sites the Hawks Bill Turtle (*Eretmochelys imbricata*) are also protected. SI 66 of 2002 Reg. 3 prohibits the taking of turtle egg or the interference with any nesting site(s).

The CITES listing of the Hawks Bill (*Eretmochelys imbricata*) and the follow-on national legislations derives from a recognition of the reduced number of individuals in the wild and the inferred or projected continuation in the decline of the population [Pers. comm. G. Myvett]. The perceived decline and degradation of the habitat of Turtle was also a valid consideration in relation to the subscription to principles of CITES and the consequent strengthening national legislations [Pers. comm. G. Myvett]. The proposed project is not designed in any way to impact, or erode the integrity of the nesting sites or aquatic habitat of the Hawks Bill (*Eretmochelys imbricata*), or indeed to in any way contribute to any perceived or real decline in the abundance or distribution of the species.

Apart from the CITES Designation and national legislation, the Hawks Bill Turtle (*Eretmochelys imbricata*) is listed as “Critically Endangered” by IUCN.

The Green Turtle (*Chelonia mydas*) is also listed in Appendix I of CITES. All of the provisions relating to the Hawks Bill Turtle (*Eretmochelys imbricata*) in regard to CITES as well as national legislations also apply to the species. Allowances are made however for the utilization of the Green Turtle for cultural reasons: SI 66 of 2002 Reg. #5 stipulates that permission can be obtained form the Fisheries Administrator for those parties that would qualify [Pers. comm. G.Myvett].

The Green Turtle (*Chelonia mydas*) is not known to nest in the Manatee Area or indeed the project area. It has been reported to be taken occasionally by fishermen in offshore areas.

Apart form the CITES Designation and national legislation, the Green Turtle (*Chelonia mydas*) is listed as “Endangered” by IUCN.

Although the American Crocodile (*Crocodylus acutus*) has not been seen at the project site during the survey efforts by the Tunich Nah Team, the ecological range certainly embraces the area. The American Crocodile (*Crocodylus acutus*) has in fact been reported to range from Northern Ambergris Caye up to Bacalar Chico [Perkins, 1983; Smith 1995], as well as the Laguna de Cayo Frances [J. Garcia, pers, comm.] which lies to the south of the project site.

The American Crocodile (*Crocodylus acutus*) has been listed in Appendix I of the CITES Regulations. The Forest Act also prohibits the hunting or exploitation of this species otherwise [Pers. comm. G. Myvett].

The American Crocodile (*Crocodylus acutus*) has been listed as “Vulnerable” by IUCN.

The proposed development is in no way designed to destroy, erode or to otherwise negatively impact the populations of crocodiles that may be found in the area.

Although Manatees (*Trichechus manatus*) have been reported generally in the back reef areas or barrier lagoon of Ambergris Caye, the Tunich Nah Survey Team did not document any in the project area during the April/May 2006 site-specific survey. The 1995 and 1999 aerial surveys by the CZMA/I also did not identify the barrier lagoon in front of the site as a habitat for manatees.

The absence of manatees (*Trichechus manatus*) from the project area may be as a result of the fact that the area is not prime habitat for the species [Pers. comm. G. Myvett].

The Manatee (*Trichechus manatus*) has been listed in Appendix I of the CITES Regulations. The Manatee (*Trichechus manatus*) has been listed as “Vulnerable” in the IUCN Registry of species.

In the zoological report for the “National Protected Areas Systems Plan for Belize” [Miller and Miller, 1995], mention was made of the vulnerability of the Black Catbird (*Melanoptila glabrirostris*). This bird is a regional endemic species with a narrow range that is limited to the east coast of the Yucatan and northeastern Belize [Phillips, 1986]. The latter is consistent with the citing of the species in the wider BCNP/MR area by Grimshaw and Paz [2004].

2.4.2 Conservation Areas

The land, sea and lagoon of the project area fall within three (3) different zone within the BCNP/MR. The sea in front of the property falls within the Bacalar Chico Marine Reserve General Use Zone I [BCMR:GZ I] (See Fig. 2.4). The activities slated for this zone in regards to the proposed hotel and resort development, are all non-extractive in nature. This includes swimming, snorkeling, scuba diving, wind surfing and para-sailing. These should in no way conflict with the rules and regulations of the reserve.

The land portion of the property falls within the boundaries of the National Park component of the ‘Protected Area’. The construction of the hotel and resort infrastructure and the associated activities associated with the commissioning of operations should not pose any conflicts with National Park designation since provisions are made for private land holding within the Park. This was in recognition of the fact that many of the private parcels predated the designation of the Park.

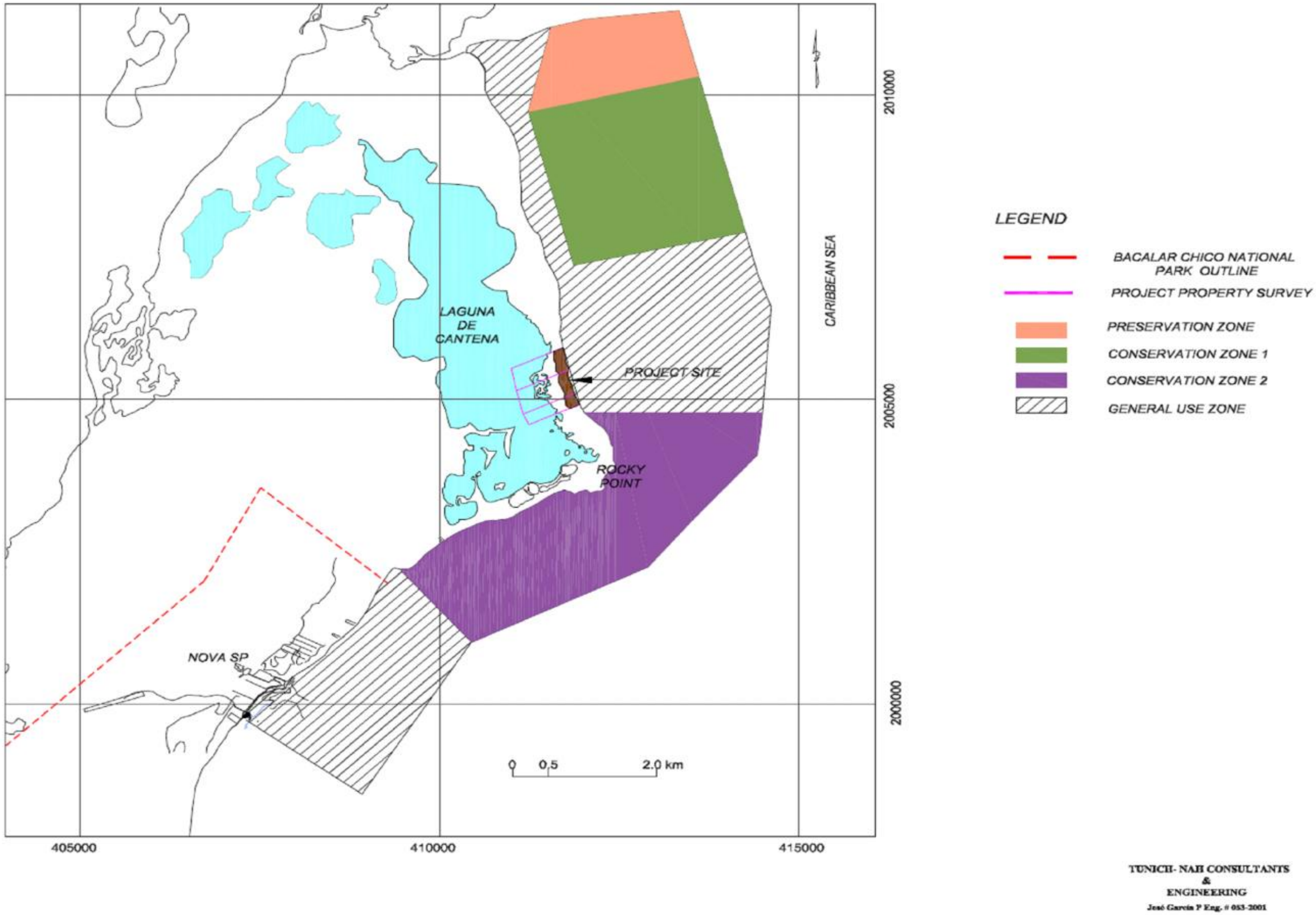


Fig. 2.4: BCNP/MR Zoning Scheme

2.5 Geology

2.5.1 Regional Geology

Belize straddles two (2) of the major morphometric units of Central America: These are the ‘Sierras’ of northern Central America which runs into Belize as the Maya Mountains in the south, and the Yucatan Platform in the north. The Maya Mountains are a rugged area comprising of unmetamorphosed to slightly metamorphosed late Palaeozoic Sedimentary Rocks and granitic intrusions [James and Ginsburg 1979]. The Yucatan Platform in the north of Belize is underlain by low and flat-lying carbonate of Cenozoic age [James and Ginsburg 1979]. This cenezoic limestone is overlained by a yoke of coastal plain sediments that includes Tertiary deposits in the east and some portions of the north [James and Ginsburg 1979].

2.5.2 Structural Geology

There is no evidence of faulting at the proposed project site. The nearest fault line which is aligned in a north-north-east direction lies just east of the reef crest [Pers. comm.., G. Myvett]. This fault is not active [Purdy 2003] and is thus not expected to have any immediate impacts on the depositional or erosional processes of the project site [Pers. comm.., G. Myvett].

Ambergris Caye and in effect the proposed project site is a part of the Yucatan Platform. The area is formed from Pleistocene limestone bedrock, eroded over the years by rainfall and dissolution to form sinkholes and cenotes. A relict ridge forms the backbone of Ambergris Caye, and a raised beach ridge, 3 meters thick and 40-90 meters wide, runs along the east coast. This is covered by calcareous sand, except at Rocky Point, just south of the project site, where the bedrock is exposed. Robles Point is probably the highest natural elevation on the caye, where coral boulders have been piled into a 5 meter-high barrier by heavy wave action and storms. Elevations in the remainder of the area vary from 1-3 m [Smith 1995, Tebbutt 1975, and Ebanks 1975].

During the Pleistocene era, when sea levels were higher, much of what is now land on Northern Ambergris Caye was reef. Outcrops of fossilized reefs and associated communities can therefore be found throughout the area, especially in the central and western portions, along Rocky Point and in the inland lagoons.

Although Ambergris Caye has been the focus of much of the geological efforts from the scientific and academic communities, Rocky Point is of particular interest as the reef crest and back reef facies are exposed [Tebbutt 1975; BCES 1993].
Modern sediments include mainly white coralline sand on the beach: The barrier lagoon bottom is comprised of fragments of reef animals and calcareous algae.

Sandy sediment on the west coast in Corozal/Chetumal Bay area is composed of peneroplid foraminiferans.

2.5.3 Geomorphology

The beaches of the project site are linear with no discernible embayments. This configuration is consistent with the orientation of the crest of the barrier reef which lies 0.8 miles from the beach.

The sand grains are angular and moderate in size. The sand is biogeneic in origin and are derived from the bio-erosional processes of corals shells, calcareous algae, and other calcareous materials.

The beach is approximately 1 m in elevation and is gently sloping with a vegetated berm that is about 1.5m in height, as measured from the low tide line. The property is defined by a number of ridges running parallel with the beach and which begins about 100 m from the beach: These are in effect relic beach berms that are a function of the rise and fall of sea level over geologic time-frames.

The leeward side of the property is characterized by lowland mangrove which merges with the Laguna de Cantena.

2.5.3 Local Area Geology

The depositional processes of the area are wholly influenced by marine processes. The net long-shore drift along the beach is from north to south, which is co-incident with the net current flow in the area.

The major beach sediments were Halimeda sand.

The topography of the development site is generally flat, punctuated intermittently by the relic beach berms cited earlier. The caye slopes gently upwards to about 3/5th the distance from the sea to the lagoon [See Figs. 2.5A & 2.5B]. After the highest point of the project site is reached, the elevation then gently falls until it reaches the low-land mangroves [See Fig. 2.5A & 2.5B].

The surficial sediments consists of a thin layers of humus interspersed with sand followed by a pure layer of sand. The layer of humus is especially apparent in the midreaches of the littoral forest and on the leeward side of the caye leading to the approaches of the lowland mangroves. The mid 2/5th portion of the caye is characterized by a fair amount of small to medium sized rocks, which are probably intermittently deposited by catastrophic storm events [Pers. comm.., G. Myvett].

The major component of unconsolidated sediments is fairly fine-grained calcareous sand. The depth of unconsolidated sediments, relative to the bedrock layer, varies from 3 to 7 meters [See Fig. 2.5]. The thickest layers occur at the highest elevation, with the thinnest layers being at the beach on the windward side, and at the shores of the lagoon on the leeward side [See Fig. 2.5].

The bedrock was consolidated limestone [See Fig. 2.5].

The Water Table varied from 0.5 to 4.5 meters [See Figs. 2.5]

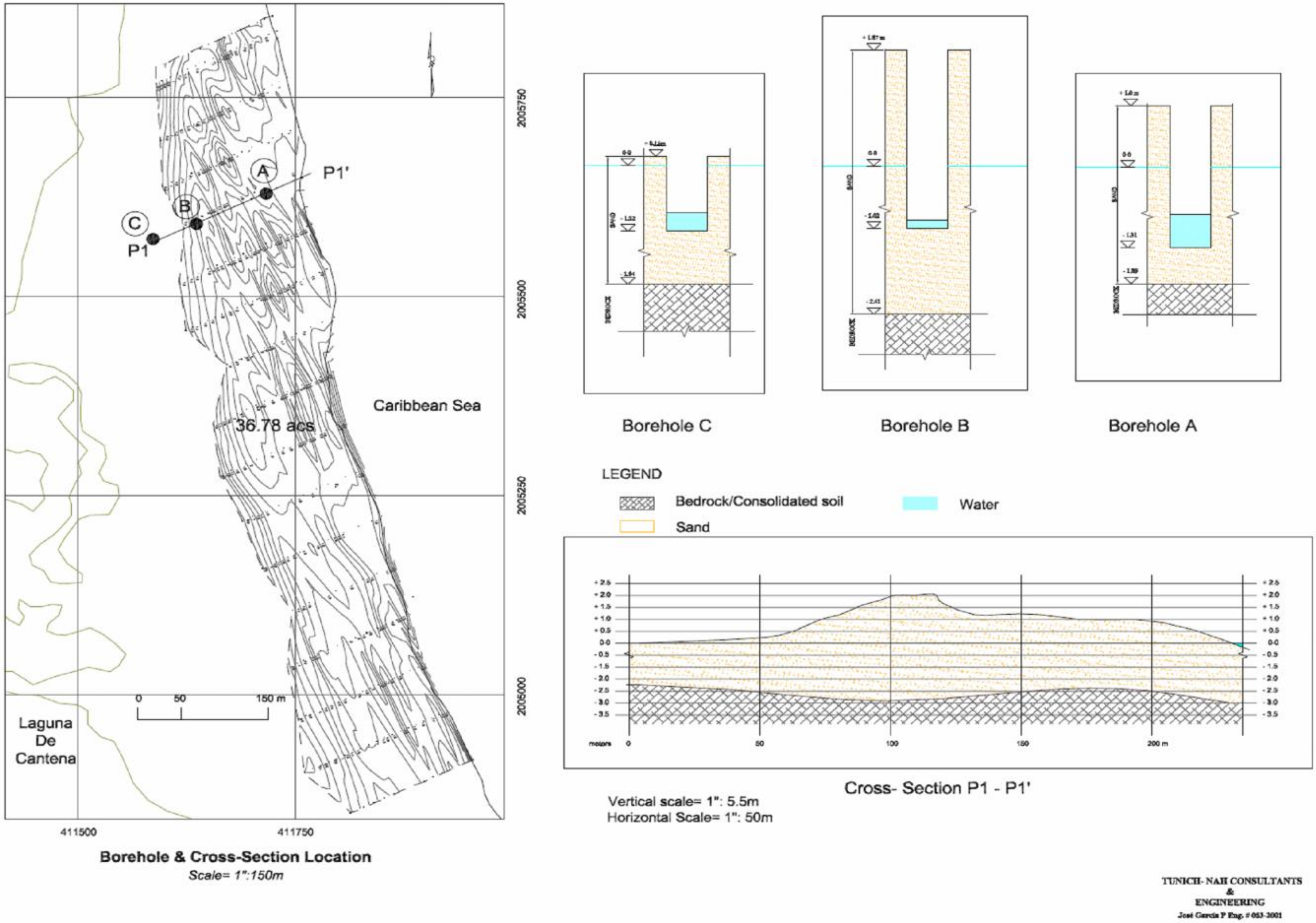


Fig. 2.5: Sediment Profile and Groundwater Availability at Project Site

Chapter 3

3.0 Policy Review

3.1 INTRODUCTION

Current national environmental policies are based on the need to take an integrated approach to environmental management and the need to work towards the goal of sustainable development. The Government of Belize through the Department of Environment, Coastal Zone Management Authority and Institute, the Department of Fisheries, and the other government institutions are the regulatory bodies of the various instruments.

Of importance to the proposed development is the need to identify those regulations and legislations which will need compliance for development activities in respect to the area and region of the proposed development. In light of the fact that the area and region of the proposed development is within an area of significant importance in terms of its ecological and biological importance and proposed planning regime, it is also of important that development activities strike a balance development and the environment.

This section is aimed at reviewing relevant environmental resource and planning legislations and regulations to ensure that "development projects" meets policy and legislative criteria, and that relevant requirements are built into project design and implementation. The policy review also outlines specific procedures and measures to be carried out before, during and after project development. It is noted that the proposed development site is located within two protected areas. Specific conservation zones been established for all user activities within marine reserve.

3.1.1 The Environmental Protection Act SI 22/1992 and 328/2003

THE ENVIRONMENTAL PROTECTION ACT established the Department of the Environment. Under section 3 (3) the Department has the responsibility to monitor the implementation of the Act and Regulations, and to take necessary actions to enforce the provisions of the Act and Regulations. This enabling legislation provides the Government and the Department with comprehensive environmental protection authority it needs in order to address modern environmental pollution problems. The ACT also grants the Department of Environment broad regulatory and enforcement authority for the prevention and control of environmental pollution, conservation and management of natural resources, and environmental impact assessment (EIA).

The Environmental Protection Act entrusted the Department of the Environment and Ministry of Tourism with broad range of functions relating but not limited to the assessment of water pollution, the coordination of activities relating to the discharge of wastes, the licensing of activities that may cause water pollution, the registration of sources of pollution and the carrying out of research and investigations as to the causes, nature and extent of water pollution, and the necessary prevention and control measures (section 4). The Department is also empowered to approve EIAs.

Under the revised edition 2000 Part III 7 (1) (d) specifying the standards in excess of which pollutants discharged into the environment shall not be discharged or emitted; (e) formulating environmental codes of practices specifying procedures, practices or releases limits for environmental control relating to works, undertakings and activities during any phase of the development and operation, including the location, design, construction, start-up, closure, dismantling and clean-up phases and any subsequent monitoring activities and (f) environmental quality guidelines specifying recommendations in quantitative or qualitative terms to support and maintain particular uses of the environment and *(j)* the control of noise.

Under the Act, no person, installation, factory or plant shall, unless specifically permitted by the Department, emit, deposit or discharge or cause emission of any pollutant or contaminant into the atmosphere or environment in contravention of the permitted levels: Every person, installation, factory or plant emitting air pollutants is required to maintain and submit to the Department, records of the type, composition and quantity of pollutants emitted.

No person shall cause or permit the extracting, crushing, screening, handling or conveyance of materials or other operations likely to give rise to airborne dust without taking reasonable precautions, by means of spray bars or wetting agents, to prevent particulate matter form becoming airborne.

Furthermore any person or undertaking exploiting the land, water resources, seas or other natural resources shall ensure the protection of the environment against unnecessary damage or from pollution by harmful substances; and no person shall emit, import, discharge, deposit, dispose of or dump any waste that might directly or indirectly pollute water resources or damage or destroy marine life.

3.1.2 Environmental Impact Assessment Regulations SI 107/1995

The Environmental Impact Assessment (1995) regulations describe in detail the processes involved in the preparation and evaluation of environmental impact assessments. The regulations divide projects or activities into three categories. The first category consists of those projects that automatically require an environmental assessment based on the sensitivity of the surroundings or the nature of the undertaking. The second category comprises those projects that may require an assessment to be carried out, but with some modifications based on the location and size of a project. The third category encompasses activities or programs that do not require an assessment to be conducted which may not have significant impacts on the environment.

The Environmental Impact Assessment Part V - 20 (4) states that every project, programme or activity shall be assessed with a view to the need to protect and improve human health and living conditions and the need to preserve the reproductive capacity of ecosystems as well as the diversity of species; under 20 (5) when making an environmental impact assessment, a proposed developer shall consult with public and other interested bodies or organizations and under 20 (7) a decision by the DOE to approve an environmental impact assessment *may* be subjected to conditions which are reasonably required for environmental purposes

3.1.3 Coastal Zone Management Strategy Chap. 329 2000 Revised Edition

The Coastal Zone Management was legally established in 1998 with the passage of the Coastal Zone Management Authority Act (Act # 5 of 1998). Under section 5 (1), the main functions of the Authority include (i) to advise Government on matters related to development and use of resources in the coastal zone in an orderly and sustainable manner; (ii) formulation of policies on coastal zone management; (iii) development of a coastal zone management plan and revise it as needed; (iv) commission monitoring and research of coastal areas and; (v) promote public awareness; (vi) prepare guidelines for developers.

The Coastal Zone Management Strategy seeks to facilitate improved management of coastal resources, to ensure economic growth is balanced with sound environmental management practices. The Strategy seeks to review and 'enhance existing laws, regulations, 'policies' and guidelines relating to conservation, resource management and development controls in the coastal zone are.' These support a coastal area management framework that addresses the need for management approaches in location between, as well as within, Coastal and marine Protected Areas, and special requirements for management development and conservation in the barrier reef region, particularly the cayes.

3.1.4 Effluent Limitation Regulations SI 94/1995

THE ENVIRONMENTAL PROTECTION EFFLUENT LIMITATION REGULATIONS came into force in 1996, at which time the Department of the Environment commenced enforcing the Regulations. The Regulations are intended to control and monitor discharges of effluent into any inland waters or the marine environment of Belize.

3.1.5 Pollution Regulations SI 56/1996

The Pollution Regulations of 1996 addresses issues of air, water and soil pollution, including noise pollution. Part III – 6 (1) deals generally with the emission of contaminants into the air where no person shall cause, allow or permit contaminants to be emitted or discharged either directly or indirectly into the air from any source.

Part X 31 (c & d) deals with pollution of land generally that could be harmful, or potentially harmful to animals, birds, wildlife, plants or vegetation. The Department of Environment is responsible for the enforcement of the Regulations made Act.

3.1.6 Solid Waste Management Authority Act SI 224 of 2000

Under the Act, the Authority shall devise ways and means for the efficient collection and disposal of solid waste employing modern methods and techniques and exploring the possibility of recycling waste materials. Under the Act "construction waste material" includes building materials from construction, alteration and remodeling building or structure of any kind, such as lumber, concrete, steel roofing, etc. SI 13/1991 established the Solid Waste Management Authority and gave it broad powers for the collection and disposal of solid waste.

3.1.7 Ancient Monuments and Antiquities Act SI 330/2000

Under section (4) of the Ancient Monuments and Antiquities Act, all ancient monuments and antiquities however situate, whether upon any land or in any river, stream or watercourse, or under territorial waters of the country, and whether or not before the date of the commencement of this Act in private ownership, possession, custody or control, shall absolutely vest in the Government

Under section (12), if any person finds any ancient monument or antiquity he shall within fourteen days of such findings report the details of the findings to the Minister.

3.1.8 Belize Water Industry Act No. 1 of 2001

The Water Industry Act repeals the Water and Sewerage Act, Chapter 185 of 1971 Laws of Belize. Chapter one of the Act deals with controlling disposal of wastes generated from sewer treatment. The Act makes new provisions with respect to the supply and control of water and sewerage services in Belize.

The Water Industry Act also establishes the responsibility of private entities to provide facilities for the final disposal of sewerage taking into consideration 36 of the Environmental Protection Act 1 of 2001.

3.1.9 Belize Port Authority Act SI 233 of 2000/2003

Under Part III Sec. 23 (1) the Minister may, after consultation with the Authority, grant in writing a license to any person, corporation or other body to construct and operate a private port subject to such terms, conditions and restrictions and on the payment of such fees as the Minister may consider appropriate (Private ports 15 of 1989).

Under part III 19 –(3) and in particular and without prejudice to the generality of the provisions of subsections (1) and (2), it is the duty of the Authority- *(a)* to operate the ports as appears to it best calculated to serve the public interest; *(b)* to regulate and control navigation within the limits of ports and their approaches; *(c)* to maintain, improve and regulate the use of such ports and services and facilities therein as it considers necessary or desirable; *(d)* to provide for such ports and the approaches thereto such pilotage services, beacons, buoys and other navigational services and aids as it considers necessary or desirable; *(e)* to exercise the duties and functions relating to shipping and navigation exercisable under the provisions of any other law.

3.1.10 Belize Public Health Act Revised Edition SI 40/2000

Under Part VIII of Offensive Trades 128 (1) b the Minister can make regulations relating to nuisances for the prevention, control or reduction of pollution or contamination of air, soil or water caused by any activity or condition resulting in the emission of a pollutant or contaminant into the environment. The Act also specifies restrictions and regulations for nuisances from factories or other industrial developments, and incidental provisions relating to offensive businesses.

3.1.11 National Lands Act (No. 6 of 1992) and SI 191 of 2000

The Act is designed to establish a framework for the management of national lands. The Act applies to all lands (other than Reserved Forest) not already "located" or granted, including any lands acquired by or ceded to the Crown. They are classified as town, suburban, rural, mineral lands and beach lands.

In section 28 where the sea, or any sound bay or creek is described as forming part of the boundary of any national land to be granted or disposed of, then the high water mark shall be considered to be the property boundary. Under the Act, the seabed defined as the land extending seawards from the high water mark of ordinary tides is National Land owned by the Government of Belize under the authority of the National Lands Act.

3.1.12 Crown Land Rules SI 60 of 1939

Under Crown Land Rules (Statutory Rules and Orders 66 of 1939), a 66 ft wide strip of land along all water frontages, measured from high water mark, is designated as public easement, but lands titles prior to 1930 included the land to the high water mark and in some cases, below the high water mark.

3.1.13 Mines and Minerals Act Chap. 226 of 2000

The Mines and Minerals (General) Regulations provide a general framework for the implementation of the Mines and Minerals Act. These Regulations cover a range of topics such as application, duties, terms and conditions and failure to comply with the conditions of a mining license. Under the Act “land” includes land beneath water. The Act also addresses dredging and sand mining, which is essential in avoiding destruction to coastal habitats such as seagrass beds and the coral reef.

3.1.14 Bacalar Chico Marine Reserve SI 88/1996

Statutory Instrument 88 of 1996 created the Bacalar Chico Marine Reserve (BCMR) under the Fisheries Act of 2000. The marine reserve encompasses 15,529.33 acres of coral reefs, sea grass beds and mangrove habitats. The boundaries of the eastern Marine Reserve run from the northeast corner of the National Park at the Belize/Mexico Boarder eastward to 600 meters fathom outside the barrier reef, then southwest to the 600 meters fathom just south of Basil Jones, then to the northwest until intersection with the coastline, and thereafter along the coastline to the north eastern corner of the National Park.

The boundaries of the western Marine Reserve run from Santa Rita westward across the Chetumal Bay to the south eastern corner of the Corozal Bay Manatee Wildlife Sanctuary, then northward to the Belize/Mexico Boarder, then eastward along the Belize/Mexico Boarder to the north western corner of the National Park, and thereafter southward along the coastline to Santa Rita. Signs at key locations inform users as to the boundaries of the National Park and Marine Reserve. The marine reserve spans coastal waters, which include the northernmost portion of the Belize Barrier Reef and the northernmost portion of the Barrier Reef Lagoon on the east, and a portion of Corozal - Chetumal Bay on the west.

Statutory Instruments 68 established the zones and regulations for the Bacalar Chico Marine Reserve. The legislative basis for conservation of marine resources within the Bacalar Chico Marine Reserve is defined by Statutory Instrument 136 of 2001.

3.1.15 Bacalar Chico Marine Reserve Regulations Chap 210/2003 (& 68/2001)

Under the Fisheries (Bacalar Chico Marine Reserve) Regulations, Part II established zones and rules for the four zones within the marine reserve. These include, the General Use Zone, the Conservation Zones I and II and the Preservation Zone for Rules for the General Use. The following includes rules for the various zones and activities permitted or not permitted within the marine reserve.

3.1.15.1 Rules for the General Use Zone Part II (4) 1 – 9

(1) The General Use Zone shall be restricted for fishing only by fishermen who currently use this zone and such fishermen shall apply for a license in accordance with the regulations;

(2) Only residents of the Bacalar Chico who have special license shall be allowed to fish solely for subsistence purposes and such fishing shall be determined by the terms and conditions of each resident’s license;

(3) No person shall be permitted to use long lines, spear guns, or gill nets in the BCMR;

(4) No person shall be permitted to use or erect beach traps other than beach traps that have been there before 1996;

(5) No traps shall be constructed with seine, cast nets, gill nets, trammel nets or tangle nets;

(6) Nets may only be used to round up the fish within the beach trap;

(7) Each traps shall be monitored each day by the caretakers and birds, manatees, rays, turtles, crocodiles, nurse sharks, and dolphins caught in or by the nets shall be released;

(8) No beach traps shall be allowed to catch fish beyond its capacity where such fish maim and kill each other. Persons removing fish from traps shall do so at least every three days. Juvenile fish shall be released and;

(9) No person shall within the General Use Zone cast or drag any anchor in any manner which may damage coral

3.1.15.2 Rules for the Conservation I Zone Part II (5)

There shall be only non – extractive recreational activities in the Conservation I Zone

3.1.15.3 Rules for the Conservation II Zone Part II (6) a – d

(a) Sport fishing shall only be carried out under a license in accordance with this Regulations and such fishing shall only be carried out on a catch and release basis;

(b) Spear fishing shall not be permitted;

(c) Only trolling shall be allowed in the months of December to February each year and

(d) Catch and release fishing tours may only remove fish for subsistence purposes during the tour.

3.1.15.4 Special Rules for Conservation Zones I and II Part II (7) 1 –3

7 (1) No person shall secure a boat to the seabed of the Conservation Zones I and II except by means of a mooring that is officially designated for this purpose (save in the case of an emergency where life and property are endangered), or with the prior written permission of the Reserve Manager.

7 (2) states that all divers in Conservation Zone I and II shall adhere to the following rules:

a) Divers shall register with the reserve manager prior to entering any of the conservation zones;

b) charter divers shall first obtain a license in accordance with the Regulations before operating in any of the Conservation Zones, and all dive boats shall "divers down flag" when they have divers in the water;

c) Only certified scuba divers undergoing a training course conducted by a recognize instructor shall be allowed to use scuba equipment in the whole of the reserve;

d) Dive guides shall be required to explain the rules of the reserve to a diver within the reserve;

e) All boats which need to operate in any of the zones shall first obtain registration from the Fisheries Administrator

3) For the purpose of the regulation, “Divers Flag Down” means a flag with a white diagonal stripe upon a red or blue background.

3.1.15.5 **Rules for the Preservation Zone** Part II 8 (1 and 2)

(1) Subject to sub regulation (2) below, no fishing, sport fishing, diving, or any other water activity shall be permitted within the Preservation Zone and;

(2) No motorized boat shall be permitted within the Preservation Zone except in case of emergency or where written permission has first been obtained from the Fisheries Administrator.

Part III of the Act sets out the licenses and requirements for various activities such as commercial fishing, research, sport fishing, licenses and registration of dive boats.

3.1.16 National Park System Act SI 215/2000

The National Parks Systems Act - This Act establishes four types or categories of protected areas: Natural Monuments, National Parks, Nature Reserves and Wildlife Sanctuaries. Several reports have suggested the usefulness of a revision of this Act to address the mandatory requirement of management plans for protected areas, assessment of the success of protected areas, and the periodic review of existing Management Plans for Protected Areas.

Under part II of the act the Minister may declare any specified area of land to be designated a national park, a nature reserve, a wildlife sanctuary or a natural monument. Essential features include but are not limited to the following:

a) No person shall be entitled to enter any national park except for the purpose of observing the fauna and flora therein and for the purpose of education, recreation and scientific research;

(b) No person shall be entitled to enter any nature reserve or in any way disturb the fauna and flora therein;

(c) No animal shall be hunted, killed or taken and no plant shall be damaged, collected or destroyed in a national park or nature reserve;

(d) No person shall hunt, shoot, kill or take any wild animal, or take or destroy any egg of any bird or reptile or any nest of any bird, in any wildlife sanctuary and;

(e) No person shall disturb the natural features of a natural monument, but may use the unit for interpretation, education, appreciation and research.

A special permit can be obtained to carry out various activities in the protected area; however, specific rules are also enforced for various activities. Section III sets out the general rules and regulations pertaining to the Act.

3.1.17 Bacalar Chico National Park SI 89 of 1996

Statutory Instrument 89 of 1996 created the Bacalar Chico National Park (BCNP) under the National Park Systems Act. The national park encompasses 12,640 acres of land and includes the Laguna de Cantena, which is one of the largest lagoons in Northern Ambergris Caye. Private lands within the National Park boundary acquired prior to designation are regulated by the Lands Department under the Ministry of Natural Resources, Environment and Industry.

The boundaries of the National Park run from the Belize/Mexico Border southward along the eastern coastline to a point just south of Robles Point, then northwest to a point near the middle of Ambergris Caye, then southwest to a point east of Santa Rita, then northward along the western coastline to the Belize/Mexico Boarder. The National Park has a maximum width of 7.5 km between Rocky Point on the east coast and San Juan on the west, and encompasses terrestrial habitats, wetlands and inland lagoons.

Ministerial responsibility for the Bacalar Chico National Park and Marine Reserve is shared between the Ministry of Natural Resources, Environment and Industry (responsible for National Parks, Natural Monuments, Wildlife Sanctuaries and Reserves) and the Ministry of Agriculture and Fisheries (responsible for marine reserves).

3.1.18 Forests (Mangrove Protection) Regulations, SI No. 52 of 1989

The Forests (Protection of Mangrove) Regulations, 1989, prohibit any "alteration" (which includes cutting and defoliating, but does not include "selective trimming") of mangroves on any land except with a permit (reg. 4). Alterations which involve dredging or filling can be authorized only in "exceptional circumstances."

Factors considered for issuing or denying permits include the proximity of the proposed project to coastal and reef areas known to be of outstandingly high ecological value (reg. 5(2) (i)), and the existing or proposed plans such as the barrier reef regional management and development plan. The Mangrove Regulations were amended in 1992 to increase the level of fines and sanctions.

3.1.19 The Forest Act SI 213/2000

The protection of all mangroves fall under this Act via the Forest (Protection of Mangrove) Regulations. Mangrove clearance may be permitted under this Act. In most cases a permit to clear mangroves is issued after a multi-agency assessment is conducted. This Act includes the establishment of Forest Reserves which may include mangroves, littoral forests and water bodies. However, no specific regulations exist under this Act that address littoral forests. The Forest Act is currently being revised.

The legislative basis for conservation of national lands within BCNP is defined by the Forest and Wildlife Conservation Acts. The Forest Act provides for the protection and conservation of all mangrove forests on both private and national lands, any alterations to which require evaluation and permit by the Forestry Department.

3.1.20 Fisheries Act SI 210/2000

Under 6(1) of the Act, no person shall use or employ any boat in commercial fishing unless there is in force in respect of such boat a "license to fish" issued under the provisions of any regulations made under this Act. (7) No person shall engage in commercial fishing or be engaged or employed in or on any boat while in use for commercial fishing unless he is the holder of a valid "fisherman's license" issued under the regulations made under this Act (2 of 1972).

(8) No person shall conduct or be engaged or employed in any scientific or research operations in any water or waters to which this Act applies which involve the taking, killing or capturing of any fish, or any interference or disturbances of fish, or with the seabed, unless there is in force in respect of such operations a license granted under the regulations made under this Act (2 of 1972).

9.-(1) No person shall export, attempt to export or purchase with a view to export any fish unless he is the holder of a valid fish exporter's license issued under the regulations made under this Act (2 of 1972,1 of 1983 &19 of 1989). Penalties for breach of the regulations are also included in the Act.

The Fisheries Amendment Regulation also provides complete protection for the marine turtles of Belize. This is aimed at bringing Belize in line with the Inter-American Convention for the Protection and Conservation of Marine Turtles (IAC), which Belize ratified in February 2003, these Regulations prohibit:

- fishing in the waters of Belize or the purchase, sale or possession any marine turtle;
- the take of any turtle found on land; the disturbance, take, purchase, sale or possession of any turtle or turtle eggs; and the interference with any turtle nest, except under written
- permission by the Fisheries Administrator; and

- The import into, transit through or export from Belize of any turtle or turtle products.

3.1.21 The Wildlife Protection Act SI 220/2000

The Wildlife Protection Act - This Act seeks to control hunting, research and trade of wildlife. It protects many species from hunting, killing and harassment Part II (a). Many coastal and marine species are protected under this Act and includes two species of crocodiles, the manatee, all birds with the exception of six species, whales, dolphins, and the Caribbean monk seal.

The Act prohibits the hunting of endangered species such as cetaceans, freshwater turtles and crocodiles. A formal conservation zoning scheme for the BCNP has yet to be developed and recommended to Cabinet for legislative enactment. Several key localities of particular conservation interest, and therefore potential suitability for legislative zoning and protection,

3.1.22 The Ministry of Housing and the Central Housing Planning Committee

The Ministry of Housing has responsibility through the implementation of the Ambergris Caye Master Plan which applies to all the private land within the national park. The Ambergris Caye Planning Authority of the Central Housing and Planning Authority (Ministry of Housing) was established in 1990 under the Housing and Town Planning Act (Laws of Belize Chapter 182, Revised 2000) to implement the provisions of a declaration to prepare a zoning plan for Ambergris Caye. The Ambergris Caye Master Plan (ACMP), accepted by Cabinet, provides this zoning plan (Anon. 1992).

The zoning scheme in the Ambergris Caye Master Plan includes provisions for the establishment of protected areas in Northern Ambergris Caye but none have ever been established as specified in the zoning scheme.

3.1.23 Housing and Town Planning Act SI 182/2000

Part II of the Act, gives general powers of the Central Authority. Under the Completion of Schemes and Consequential Powers and Duties of the Central Authority 31 (2) the Central Authority may, in connection with any scheme, authorize the laying out and construction of roads and services upon the land acquired by it, and all roads and services as laid out and constructed, if situated within the jurisdiction of a local authority, shall thenceforth be public roads and services maintained by the local authority.

3.1.24 Wildlife Sanctuary Declaration (Corozal Bay) (Manatee) Order Chapter 215 /2003

All that portion of the Caribbean Sea being the northeastern portion of the country of Belize and bounded on the North by the International Boundary between Belize and Mexico; on the East by the said International Boundary and the Western Boundary of Bacalar Chico Marine Reserve; on the South by two East-West lines one between Deer Cay and Swab Cay, the other from Mosquito Cay to Sand Cay; on the west by the high water mark on the Coast of Corozal District thence south - easterly along the said International Boundary to a point having a UTM coordinate of 401 293 East and 2009 073 North said point being the northwestern corner of Bacalar Chico Marine Reserve; Saving and accepting thereof and therefrom all land, cayes, islands, within the described areas.

3.1.25 Hotels and Tourist Accommodation Act 285/2000

Under Part II (2) an application for registration in respect of any premises used for the business of a hotel or tourist accommodation should be carried out. Part III (14) defines the minimum standards to be observed by hotel and tourist accommodation. Part III of the Act defines registration and Regulations of Hotels and Tourist Accommodations. Under the Act the Belize Tourism Board has the responsibility of registering all hotel and tourist accommodation in Belize.

Subject to the provisions of the Act, Part IV (22 91)) states that "there shall be levied and paid a tax at the rate of seven per centum of all the accommodation charges in regards to lodging." Part V General, sets out Offences and penalties and regulations prescribing standards for hotels and tourist accommodation. The Hotels Act and the Housing and Town Planning Act complement each other, since they both address tourism and residential developments in coastal areas.

3.1.26 Protected Areas Conservation Trust Act (PACT) Chap. 218/2000

The Protected Areas Conservation Trust Act (PACT**)** establishes a fund for the financing of all protected areas, including marine reserves and all other protected areas on the coast. Indirectly related is the Fiscal Incentives Act, which provides numerous facilities for coastal developments. A portion of the fees collected at the border points is used to finance local community based initiatives.

3.1.27 Belize Tourist Board Act

The Belize Tourist Board Act indirectly encompasses most of the other Acts, since it contains provisions for the development of tourism policies, which would need to consider the effects and roles of all sectors in the development of tourism.

3.1.28 International Conventions and Agreements

Belize is signatory or party to many international conventions and agreements, and is a member of many regional organizations involved in the management and protection of biological resources. Those that impact on biodiversity are listed below.

(a) United Nations Law of the Sea Convention (LOSC) (ratified 13 August, 1983).

(b) World Heritage Convention (ratified in 1990).

(c) Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) (ratified 1976).

(d) Convention on Biological Diversity (CBD) (ratified in December, 1993).

(e) Central American Biodiversity Convention.

(f) Convention for the Conservation of Biodiveristy and the Protection of Priority Areas in Central America.

(g) Agreement on Cooperation between Belize and Mexico for the Protection and the Improvement of the Environment and the Conservation of Natural Resources in the Border Zone (signed 20 September, 1991).

(h) Protocol on Specially Protected Wildlife (SPAW Protocol)

(I) Land-Based Sources of Pollution Protocol (LBSP).

(j) United Nations Framework Convention on Climate Change (ratified September, 1994).

(k) Convention for the Prevention of Pollution from Ships (MARPOL 73/78) (ratified 12 May, 1995).

(l) International Convention for the Regulation of Whaling (signed 1982).

(m) Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (signed 1995).

(n) Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) Toxins and their Destruction (signed 1980).

(o) Western Central Atlantic Fisheries Commission (WECAFC) (1985).

(p) Latin American Organization for Fisheries Development (OLDEPESCA) (1997).

(q) Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (The Cartagena Convention).

(r) The Convention on Wetlands of International Importance Especially as Waterfowl Habitats (RAMSAR)(Signed 1971).

Belize's compliance with its commitments under the above mentioned conventions has been minimal due to the lack of appropriate enforcement mechanisms. Belize may soon become party or signatory to the following conventions and agreements:

- International Dolphin Conservation Program (IDCP).

- International Commission for the Conservation of Atlantic Tunas (ICCAT)

- Inter-American Convention for the Conservation and Protection of Marine Turtles (in progress)

Table 3.1 Licenses and Permits required by the Development

Activity	License or Permit required	Permitting Agency
Pier Construction	Permit to construct pier, marina (or sea wall)	Land Utilization Authority
Land Clearing	Permit to alter mangrove required	Forest Department
Road Reserve		
Dredging and Quarry	Mining license and permit for extraction of materials	Geology and Petroleum Dept.
Hotel License	Establishment and operation of hotel and prescribing conditions	Belize Tourism Board
Tour Operation	License to conduct offshore and inland tours and fishing trip	Belize Tourism Board, Dept. of Fisheries
Food Handler's Certificate	Handling of food certificate for persons working in restaurants and kitchens	Public Health Dept.
Effluent Discharge	Effluent Discharge of gray water and effluent from waste treatment plant	Dept. of Environment

Chapter 4

4.0 WATER RESOURCES

4.1 Occupancy

The general occupancy for the project was based on the different infrastructures described in Table 4.1 below. The maximum daily number of people that can possibly be accommodated at any one time within the project at full development is 967 persons**.** This in effect represents 100 % occupancy of the project at full operation. This percentage also considers the transient visitors that would visit the resort to utilize the various amenities and services.

Table 4.1 Maximum Daily Occupancy

Type	Description	Units	Occupancy
A	Hotel	56 rooms	112
B	Hotel Suites Type A	8 suite buildings	24
C	Hotel Suites Type B	12 suite buildings	36
D	Water Cabanas	12 Cabana buildings	36
E	Beach Front Villas	14 villa buildings	126
F	Beach Cottages	12 cottage buildings	72
G	Apartments	22 Units	88
H	Future Developments	13 Units	78
I	Owner's Club House	1 unit	6
J	Employee Housing	1 unit	289
K	Transient Visitors	persons	100
Totals			**967 Persons**

The anticipated occupancy rate for the project would be about 578 residents/guests at 100%. The standard hotel occupancy rate as per the Belize Tourism industry would be about 40 % or 387 residents/guests. For the purpose of the environmental engineering calculations, the occupancy rate of 100 % was taken into considerations for assessing the water demand of the project.

4.2 Water Source

The project site is located in an undeveloped area on Northern Ambergris Caye. This site is also about 18 miles north of San Pedro Town and presently out of reach of the town's water distribution line. With this in mind, the project will rely on finding its own source of potable water for both construction and operation. Consideration will also be given for the possibility of any future connection to the town's potable water distribution mains and use it in combination to the project water source.

4.3 Potable Water Demand.

The project will require about 40,070 gallons of water a day as described in table 4.1. This represents 100% of the initial water demand for the project.

Table 4.2 Projected potable water demand for ABR

Type	Unit Description	Maximum Occupancy	Water Demand Units (gals/day)	Water Demand Total Volume (gallons)
A	Hotel	112	50	5,600
B	Hotel Suites Type A	24	50	1,200
C	Hotel Suites Type B	36	50	1,800
D	Water Cabanas	36	50	1,800
E	Beach Front Villas	126	50	6,300
F	Beach Cottages	72	50	3,600
G	Apartments	88	50	4,400
H	Future Developments	78	50	3,900
I	Owner's Club House	6	50	300
J	Employee Housing	289	30	8,670
K	Transient Visitors	100	25	2.500
L	Amenities	1	15%	
Totals		**967 Persons**	**44.5 avg.**	**40,070 gals**

Since the northern most portion of the project will serve to semi permanent to permanent residents, the project water consumption and demand were divided into 2 development zones or tiers as described in table 4.3 below:

Table 4.3 Projected ABR Water demand according to zones

Tiers	Description	Tier Demand
1	Beach Front Villas, Beach Cottages, Apartments, Owner Club House	14,600
2	Hotel, Hotel Suites, Water Cabanas, Spa Cabanas, Visitors, Restaurants, Bars, Employee Housing	25,470
	Totals	**40,070**

As can be seen from the table above, tier 2 has the highest water demand per zone. These tiers were developed to better manage the water demand for the project and reduce water loss via excessive piping and eliminating dead ends throughout the project distribution mains.

4.4 Selection of the preferred source

A number of potential water sources were discussed and analyzed in order to meet the project demand. Table 4.4 summarizes the various sources analyzed. These sources are by no means options but a possible combination of sources that would suffice the project's demand. This would also eliminate the dependency of a single water source.

Table 4.4 Selection of the preferred water source for ABR

OPTION	SOURCE	INFRASTRUTURE	TYPE OF TREATMENT	COMMENTS
GROUND WATER	Wells, Cenotes	Pumps, storage tanks, transmission lines	chlorination	Even though these were the most likely sources, the wells perforated on site yielded brackish water. There was no cenote found.
RAIN WATER HARVESTING	Seasonal rains	Storage tanks, water transmission lines, gutters	Chlorination, Ozonation, UV	Excellent water source, easy to treat, water cisterns can be constructed as part of the building foundation, no long term cost.
WATER DESALINIZATION	Wells,	Pumps, power line, treatment plant, water transmission line, storage tank	Reverse Osmosis, Coagulation, sedimentation, filtration, UV chlorination,	More expensive and complicated to operate, but highly dependable and reliable, good for dry season.
WATER RECYCLING	BESST Wastewater treatment or equivalent	Storage tanks, water transmission lines, dosing tanks	Chlorination, UV	Supplementary option exclusively used for restroom and Bathroom flushing
TRANSPORTATION OF POTABLE WATER TO THE SITE	San Pedro Distribution System	Water trucks, barge, pumps, storage tanks	None	Good source for construction, alternate source for emergencies. Not feasible for in the long term.

From the information in table 4.4, the project will source their water by means of rain water harvesting. The basic roof catchment system will be augmented by recycling of the gray water produced by the various facilities. During periods of heavy water use the roof catchment will be augmented by the small reverse osmosis system.

4.5 Source Supply Description

The total potable water demand for the project will be about 40,070 gallons a day at full development and operation. This volume will be the initial capital water supply requirement for the project and this volume is expected to be reduced as recycled and desalted water is used to supplement the existing demand. The sources will be as follows:

1- *Main Source*: Potable water for operation will be gotten from rain water harvesting. Since the project will consist primarily of condos, villas and other buildings, rain water sequestered from individual roofs will be stored under buildings in cisterns designed as integral structural elements of the foundation structure. Each building will have its own rain water cistern along with all the necessary equipment needed to supply the building with water. The roof of the buildings will harvest the water where it will be conveyed to the foundation via gutters and pipes. A small in line filtration system will be installed on each building to treat the water. Potable water for the water cabanas will be gotten from the activation of the R.O. plant. Water transmission lines will be laid underneath the piers and branched off to each cabana.

2- *Secondary Source:* In case of water shortage due to over consumption, as could be the case during the dry months, water can be gotten from the activation of the Water desalinization plant installed in the utility zone and transported to the desired area. The volume generated by this process will be small to medium and will be used as a back up source to drinking water, and to supply water to the pools, spa, kitchen, restaurants and bars. This will also be the primary source for the construction phases. The RO Unit to be deployed will yield 3,000 gallons/day. The desalted water will be chlorinated and stored in a 5,000 gallons ground reservoir.

3- Tertiary Source: The basic roof catchment system will be augmented by recycling of the gray water produced by the various facilities for such heavy water consumptive uses as toilet flushing, landscaping and other non-potable use. The treated (chlorinated) wastewater will be stored in a 10,000 gallons tank and sent to the different areas to be used as required. For the flushing of toilets a color coded water transmission line will be facilitating this process. Table 4.6 shows the volume required by the project to enable this water to be used for the required purpose.

4- Construction Demand: It is difficult to ascertain the volume of water required for construction purposes. Moreover, the daily demand required for the construction workers since they may vary depending on the work load or construction schedule. Nevertheless, it is expected that this demand will be high and consistent with a gradual decrease in the demand towards the end of the construction cycle. With this in mind, the project will obtain their water from two sources, mainly from the installation of the R.O. plant which will produce 10,000 gals/day and potable water from San Pedro Town. Barges will transport water to the Basil Jones pier where it will be pumped into water trucks and transported to the site where it will be stored in tanks for construction purposes.

4.5.1 Main Source Supply Description

Rain water will be sequestered from individual roofs and stored under buildings in cisterns designed as an integral part of the foundation structure. It is estimated that 141 units will be constructed on the ± 37 acre property. This would represent 100 % of the units being used for rain water harvesting. Considering the different building designs and layout, the total volume of rain water stored by these buildings would be over 5 million gallons as described in table 4.5.

The roof of buildings will collect the rain water where it will be conveyed to the foundation via gutters and pipes. Each building will have an in line cartridge filtering system designed built into them so as to make the water potable for human consumption and other uses. These filters can vary according to the volume of water being stored and will also require maintenance over time.

4.5.1.1 Average Rainfall

Similar to other sub-tropical areas, Belize generally experiences a wet and dry season. The average rainfall throughout the country of Belize may vary significantly with geographical area and time. Average yearly rainfall can range from 40 to 160 inches (Parisner, 1995). Annual rainfall on Ambergris Caye averaged 138 cm between 1952 and 1970, 143 cm between 1971 and 1980 and 200 cm between 1981 and 2003.

The dry season, with strong southeasterly winds, runs from January/February to May/June. The rest of the year has an average of 50 inches (127 cm) rain, with easterly but variable winds, and often a drier period in August. September, October and November are usually the months with most rainfall. However, there are wide variations between years.

Figure 4.2 illustrates the water harvesting layout plan for the proposed project. This layout is in connection with table 4.5 described further in this section.

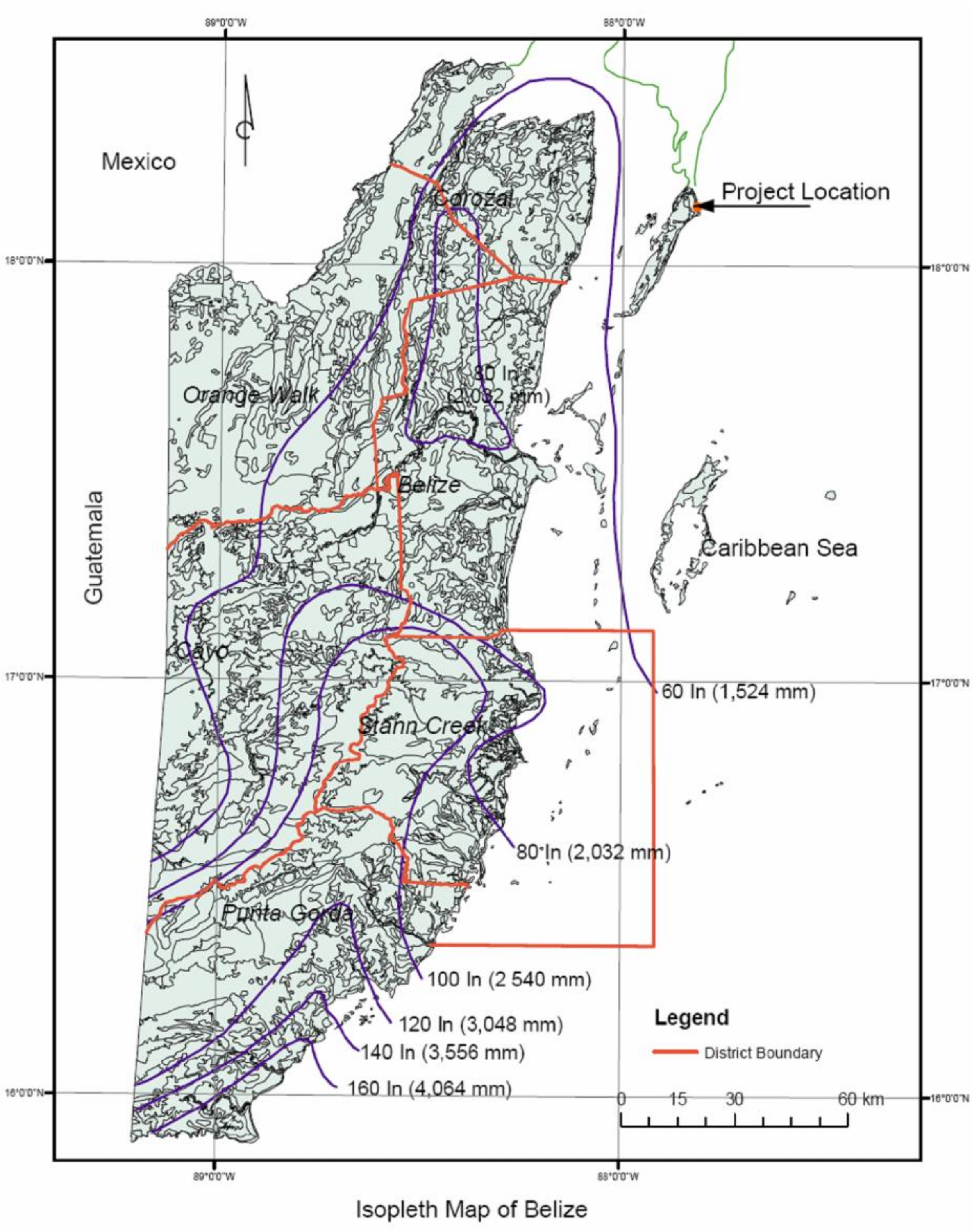


Fig. 4.1 Rainfall Isopleths of Belize

Table 4.5 Rainfall Volume collected for the buildings at ABR

Building Zones	Units	Area (ft^2)	Total Area (ft^2)
Zone 2			
Villas	6	3,000	18,000
Beach cottages	6	2,500	15,000
two bedroom	5	2,400	12,000
Sub Total		7,900	**45,000**
Zone 1			
Villas	8	3,000	24,000
Beach cottages	6	2,500	15,000
two bedroom	6	2,400	14,400
Sub Total		7,900	**53,400**
Hotel suites A	1	860x3	2,580
Hotel suites B	2	763x3	4,578
hotel rooms	14	21,840	21,840
Sub Total			**28,998**
Banquet		2,400	2,400
home owners club	1	2,800	2,800
Project Amenities			29,500
Sub Total		5,200	**34,700**
Housing	1	7,100	**7,100**
Future Developments	13	32,500	**32,500**
Total		39,600	**201,698**
			5,657,628.90
Harvested Volume			**5,091,866.01**

* 90 % of the average rainfall collected was use to calculate the final volume stored

Since ABR is located on the northern region of Ambergris Caye, the rain fall isopleths best describing the project site would be around the range of 40-60 inches of rainfall per year as illustrated in figure 4.2. Therefore the rainfall volume collected by each building considering the average rainfall was calculated using the following formula:

$$V_F = \text{Total Rainfall (inches) x building surface area x factor x 7.48 gals/ft}^3$$

: Where a factor of 90 % was considered due to wind activity, evaporation, structural beams and columns.

4.5.1.2 Water Source Treatment

Rain water harvesting will collected and treated prior to consumption. Water treatment techniques for rainwater catchments systems will include:

- *Screening:* Strainers and leaf screens located in the gutters and downspouts will be used to prevent the debris, like leaves, from entering the reservoir tank.

- *Settling.* Sedimentation within the tank is necessary to settle out any potential particulate matter and solids.

- *Filtering*. In-line multi cartridge systems with activated charcoal will be used to remove potential contaminants either at the pump tank or tap.

- *Disinfecting*. The use of chemical treatment (chlorine, iodine), ultraviolet light, and/or ozonation will be used to kill the microorganism usually found in the tank.

4.5.2 Secondary Source Description

It is estimated that a 10,000 gallons a day water desalinization plant will be used to provide potable water to the amenities and be used as a back up source to drinking water. The Desalinization plant or R.O. plant as it is normally referred to will get its water from a well that will be dug on the project site. Figure 4.3 show a typical well cross section.

The plant will consist of a set of membrane filters that will be cleaned regularly. Water generated by this process will be sent to a 15,000 gallons tank where it will be treated and piped via water transmission lines to the different areas as required by the development.

The brine waste produced won't be of concern as there are two disposal options that are presently being contemplated by the project developer (figure 4.4). The first option includes the injection of the brine into a deep well, dug some distance away in the property. This brine, which comprises of most salt precipitates, would be safely contained in the well, where it would diffuse eventually. The other option includes the use of diffusers to safely diffuse the brine into the lagoon. Water quality data in the lagoon indicated elevated levels of salinity. This elevated level, can possible be attributed to the shallowness of the lagoons and water exchange rate. Discharging the brine solution into the lagoon would not significantly affect the biological diversity.

Fig 4.2 Water Harvesting Layout for the Proposed Project.

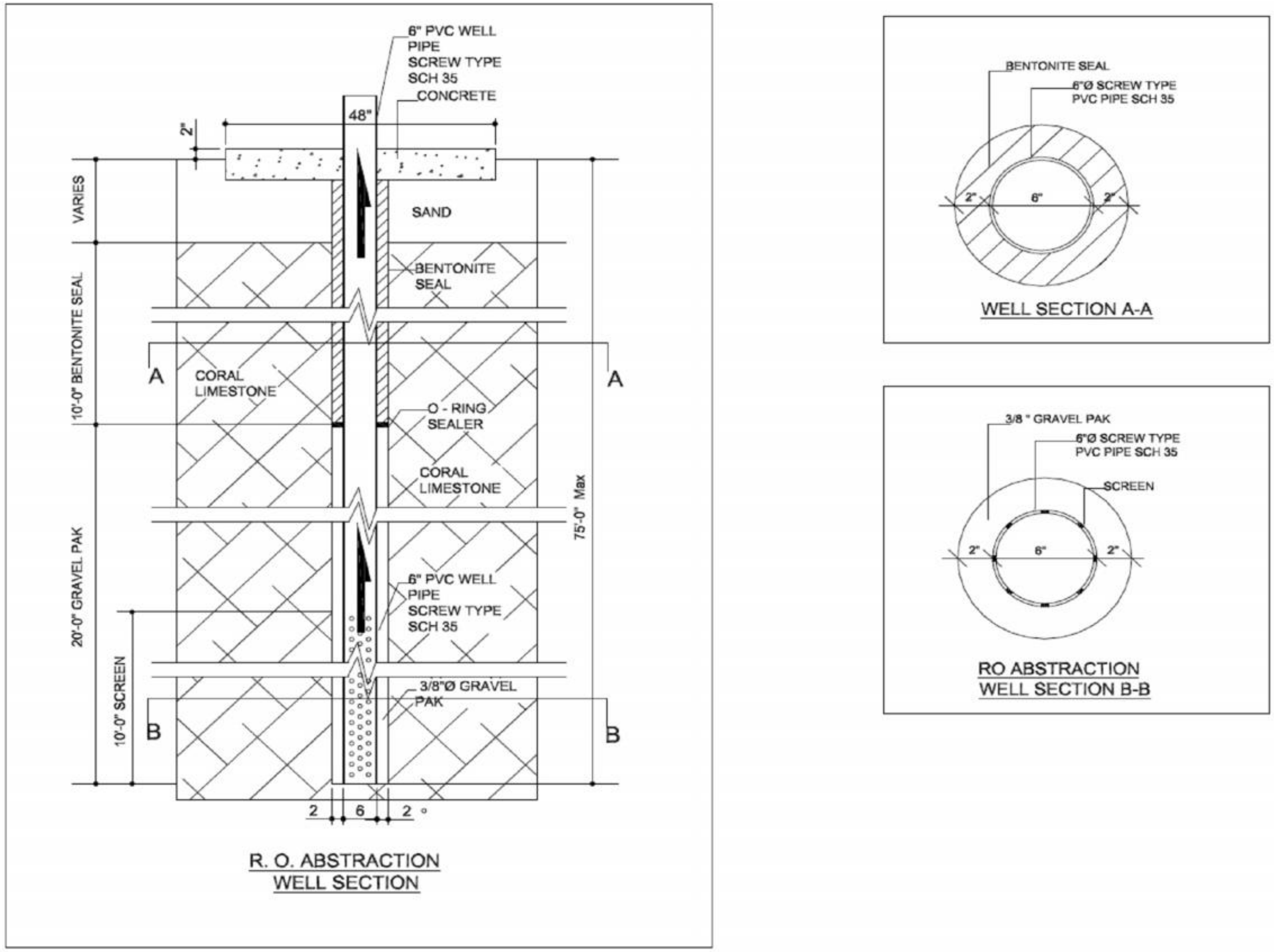


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Fig. 4.3 Typical R.O. well section

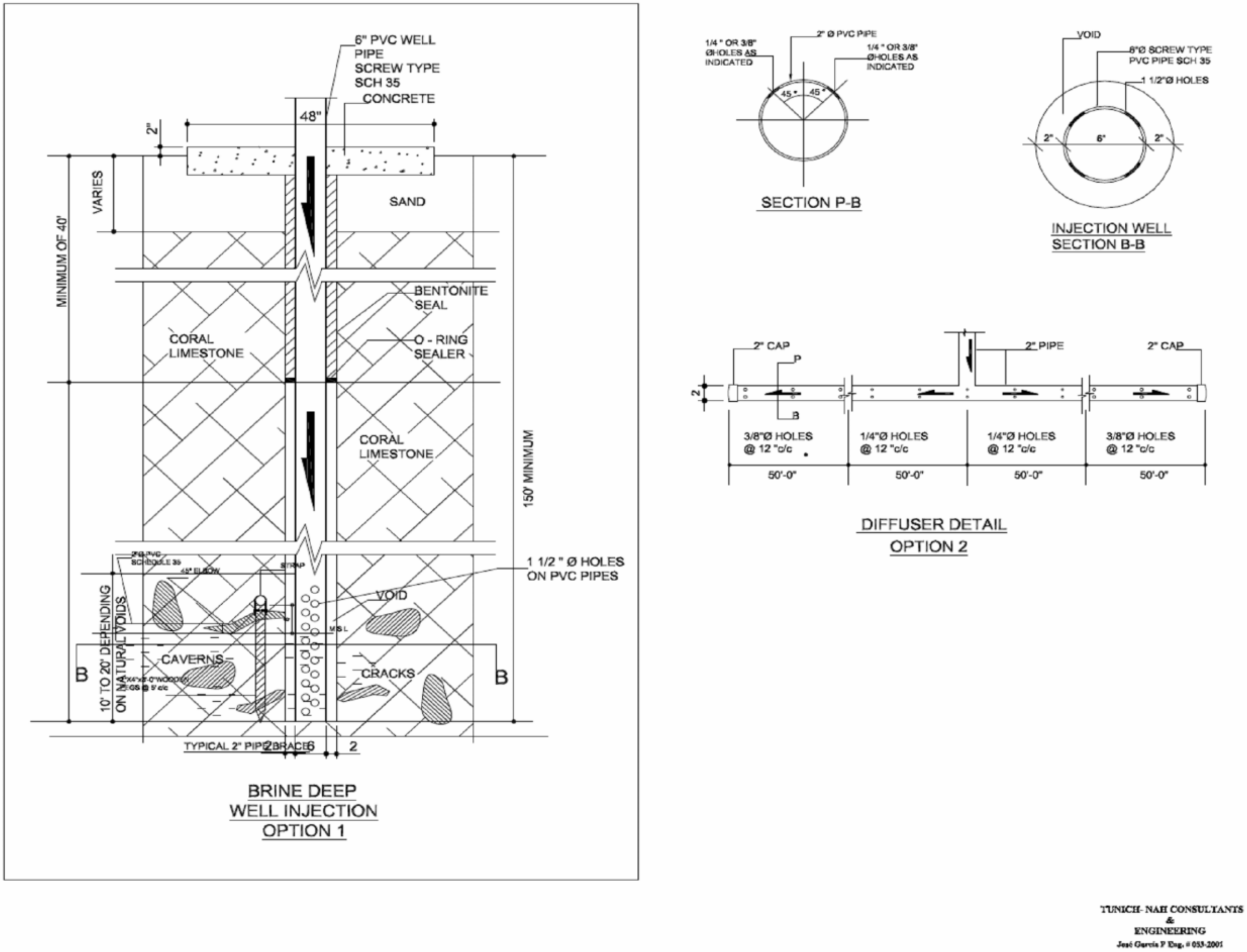


Fig. 4.4 Typical Brine Injection Well

4.5.3 Tertiary Source Description

The estimated volume of water required for the flushing of toilets would be around 12,171 gallons a day at full occupancy or 4,869 gallons a day according to the 40 % occupancy of the Belize Tourist Board. Table 4.6 summarizes the recycled wastewater volume required at full occupancy.

Table 4.6 Volume of recycled Wastewater required for flushing

Type	Infrastructure	Maximum Occupancy Residents	Water Consumption			
			Unit	**Water Demand gals/day**	**Recycled Water for the flushing toilets**	
A	Hotel	112	50	5,600	15	1,680
B	Hotel Suites Type A	24	50	1,200	15	360
C	Hotel Suites Type B	36	50	1,800	15	540
D	Water Cabanas	36	50	1,800	15	540
E	Beach Front Villas	126	50	6,300	15	1,890
F	Beach Cottages	72	50	3,600	15	1,080
G	Apartments	88	50	4,400	15	1,320
H	Future Developments	78	50	3,900	15	1,170
I	Owner's Club House	6	50	300	15	90
J	Employee Housing	289	30	8,670	9	2,601
K	Transient Visitors	100	25	2,500	9	900
Totals		**967**		**40,070**		**12,171**

* Consider 3 gals of recycled wastewater per flush from the BESST Treatment System.

The volume of potable water needed to supplement the demand for the project once in full operation would be about 27,889 gallons a day or 68 %. This would therefore be the maximum capacity required.

The recycled wastewater will be stored in reservoir tanks as described in table 4.6 (see chapter 5 for details. This water will be chlorinated by a chlorination system prior to being stored (see figure 4.5). The excess water generated by the treatment plant will be used for irrigation purposes, fire fighting requirements and other non potable uses.

ABR project is not expected to affect other users of water in the area since the primary source will be mainly from the rain water system. Any excess treated wastewater will be discarded in the lagoon.

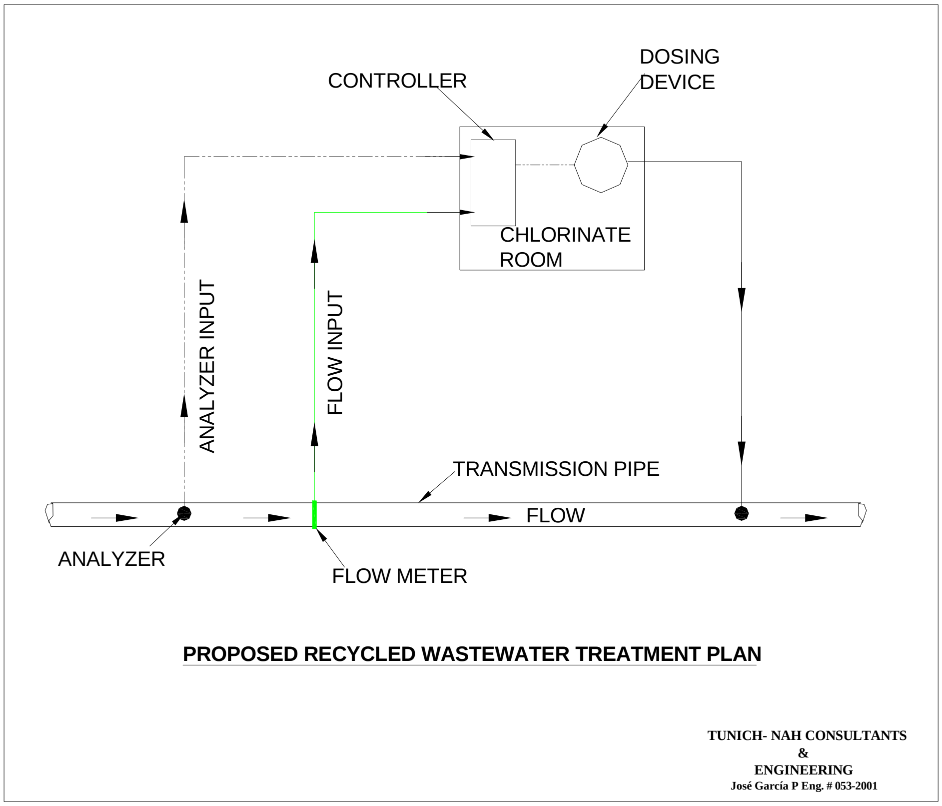


Fig 4.5 Recycled wastewater treatment plan

4.5.4 Water Conservation

Since the project is located some distance away from San Pedro town, ABR Limited will develop and incorporate a strict water conservation code. These measures will include the education of the staff and guests on the importance of water conservation and by the installation flow reduction devices. These procedures will be implemented to reduce the water consumption and minimized water loss. This is especially important since rain water harvesting will be the primary source of water. In the end, this method will ultimately conserve both resources and energy. Table 4.7 describes the different demands according to population as well as the required conservation measures required.

Table 4.7 Projected Water Demand at different occupational rates for ABR

Water Consumption	Occupancy Percentage Rates (%)			
	100%	**70%**	**40%**	**20%**
Occupation (persons)	967	677	387	193
Water Demand (gals/day)	40,070	28,049	16,028	8,014
Wastewater Production (gals/day)	28,049	19,634	11,220	5,610
Recycled Wastewater (gals/day)	12,171	8,520	4,868	2,434
Required Demand (gals/day)	27,899	19,529	11,160	5,580
Non Potable Uses (gals/day)	15,878	11,115	6,351	3,176

4.6 Surface and Ground Water Analysis

Various water samples were collected at the project site as can be seen in figure 4.6. From table 4.7, two lagoon samples (1&2), three coastal samples (3,4 & 5) and three wells samples (A,B and C) were taken and analyzed by an accredited DOE laboratory. The same was done for table 4.8, where the three coastal samples were analyzed along with one (2) lagoon sample.

As can be seen from both tables, there is a big salinity difference between the coastal water and the lagoon. The lagoon salinities are high compared to the coast. This also holds true for the conductivity values as well as the total hardness concentration. Both these parameters indicate a difference in water body. This difference could be attributed to the lagoon's water depth which is considerably low. TSS concentrations for both water bodies were low making it crystal clear and excellent for recreational activities.

As can be seen from the tables and figure 4.6, the well water showed typical values characteristic of brackish water. This fact is demonstrated by the salinity values being low as well as the conductivity concentration and total hardness levels. In considering the values, it is only indicative that the water found in the wells is mixed with rain water as it trickles down to the underlying water table.

The nutrients levels were low and characteristic low to medium impacts. Conversely the microbiological analysis showed little to no traces of E.Coli and Fecal Coliform in some sites. Total Coliform levels were low also, making these parameters indicative of low impact.

4.7 Water Quality Monitoring Program

A complete water quality monitoring program will be developed for the entire project. Water samples will be collected and analyzed on a monthly basis for the following parameters using the recommended protocol required by the *Effluent Limitations Regulations* (this regulation recommends the use of the Standard Methods for the Analysis of Water and Wastewater):\

a) In situ Measurements

- Salinity
- Temperature
- Dissolved Oxygen
- Ph
- Turbidity
- Total Dissolved Solids
- Conductivity

b) Laboratory Analysis

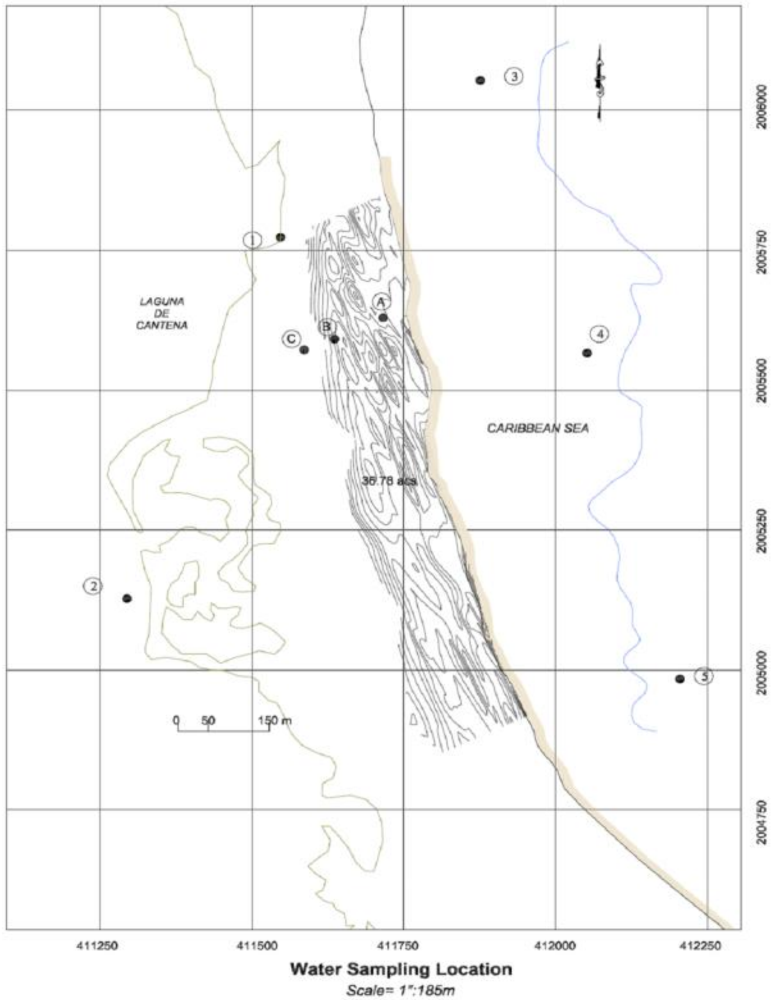
This will include the determination of

- Total Suspended Solids
- Total Nitrate
- Total Phosphate
- Total and Fecal Coliform
- E. Coli

Total suspended solids are necessary as it increases may adversely affect aquatic life due to the reduction of light penetration.

c) Reporting Requirements

Reports on water quality monitoring will be submitted to the Department of Environment on a yearly basis.



Water Sample GPS Location

ID	E	N	Location
1	411547	2005773	In Lagoon
2	411294	2005127	In Lagoon
3	411876	2006053	In Sea North of Property
4	412052	2005568	In Sea in front of Property
5	412205	2004984	In Sea in front of Property

Coordinates are UTM Nad 27 Central

Inorganic Chemistry — Water Sample Analysis — Date: 16 May, 2006

Physical	Unit	Method	Results 1	3	4	5
Conductivity	us/cm	CONDUCTIVITY (probe)	65,200	52,700	52,300	51,800
pH	unit	pH/ISE meter (probe)	8.32	8.25	8.42	8.09
Salinity	ppt	Mercuric Nitrate titration	47.7	36.48	36.44	36.43
Total Suspended Solids (TSS)	ppm	Colorimeter	5	2	3	2
Total Dissolved Solids (TDS)	ppm	CONDUCTIVITY (probe)	32,600	26,400	26,100	25,900
Dissolved oxygen (DO)	ppm	Probe	5.58	7.20	7.49	8.26
Inorganic Compounds						
Total Hardness (as $CaCo_3$)	ppm	Tritation / UV VIS Spectro	8,195	6,355	6,295	6,245
Total Nitrate (NO_3)	ppm	Cadmium Reduction / UV VIS Spectro	2.8	3.6	2.7	2.3
Phosphate (PO_4)	ppm	PhosVer/Orthophosphate/ UV Vis Spectro	0.5	0.6	0.5	0.4
Sulphate (SO_4)	ppm	Sulfa Ver 4/ UV Vis spectro	4,420	3,870	3,840	3,830
Microbiological Analysis						
Total Coliform	count	m-ENDO Broth (MF)	-	72/100 ml	-	142/100 ml
Escheria Coli (E.coli)	count	m-ENDO Broth (MF)	-	0/100 ml	-	0/100 ml
Fecal Coliform	count	m- FC/ROSILIC Broth (MF)	-	0/100 ml	-	0/100 ml

Inorganic Chemistry — Water Sample Analysis — Date: 11 May, 2006

Physical	Unit	Method	Results 1	2	3	4	5	A	B	C
Conductivity	us/cm	CONDUCTIVITY (probe)	65,200	65,200	53,200	53,100	53,100	26,800	22,500	33,900
pH	unit	pH/ISE meter (probe)	8	8	8	8	8	7	7	7
Salinity	ppt	Mercuric Nitrate titration	45	42	34	29	36	12	12	12
Total Suspended Solids (TSS)	ppm	Colorimeter	17	6	2	1	1	307	626	83
Total Dissolved Solids (TDS)	ppm	CONDUCTIVITY (probe)	32,600	32,600	26,600	26,500	26,500	13,390	11,260	17,960
Dissolved oxygen (DO)	ppm	Probe	6.2	5.3	7.13	7.61	8.35			
Inorganic Compounds										
Total Hardness (as $CaCo_3$)	ppm	Tritation / UV VIS Spectro	8,180	7,395	6,090	5,825	6,070	3,425	2,895	4,205
Total Nitrate (NO_3)	ppm	Cadmium Reduction / UV VIS Spectro	4	4	2	1	1	1	N/D	1
Phosphate (PO_4)	ppm	PhosVer/Orthophosphate/ UV Vis Spectro	4	2	0	0	0	1	0	0
Sulphate (SO_4)	ppm	Sulfa Ver 4/ UV Vis spectro	3,805	3,840	2,375	3,045	3,125	1,550	735	2,000
Microbiological Analysis										
Escheria Coli (E.coli)	count	m-ENDO Broth (MF)	36/100 ml	42/100 ml	3/100 ml	-	3/100 ml	3/100 ml	-	-
Fecal Coliform	count	m- FC/ROSILIC Broth (MF)	23/100 ml	0/100 ml	0/100 ml	-	0/100 ml	0/100 ml	-	-

LEGEND

Sea Grass Outline

Beach

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Fig. 4.6

Fig. 4.6 Water Sampling sites for the ABR Project

Table 4.8 ABR Surface water and well water Analysis results

Sample ID: ABR Project **Date: 11 May, 2006**

PHYSICAL	**UNIT**	**METHOD**	**RESULTS**							
			1	**2**	**3**	**4**	**5**	**A**	**B**	**C**
CONDUCTIVITY	µs/cm	CONDUCTIVITY (probe)	65,200	65,200	53,200	53,100	53,100	26,800	22,500	33,900
pH	unit	pH/ISE meter (probe)	8	8	8	8	8	7	7	7
SALINITY	ppt	Mercuric Nitrate titration	45	42	34	29	36	12	12	21
TOTAL SUSPENDED SOLIDS (TSS)	ppm	Colorimeter	17	6	2	1	1	307	626	83
TOTAL DISSOLVED SOLIDS (TDS)	ppm	CONDUCTIVITY (probe)	32,600	32,600	26,600	26,500	26,500	13,390	11,260	17,960
TOTAL HARDNESS (as $CaCO_3$)	ppm	EDTA Titration/ UV VIS Spectro	8,180	7,395	6,090	5,825	6,070	3,425	2,895	4,205
TOTAL NITRATE (NO_3)	ppm	Cadmium Reduction/ UV VIS Spectro	4	4	2	1	1	1	N/D	1
PHOSPHATE (PO4)	ppm	PhosVer UV VIS Spectro	4	2	0	0	0	1	0	0
SULPHATE (SO4)	ppm	Sulfa Ver 4/ UV VIS Spectro	3,805	3,840	2,375	3,045	3,125	1,550	735	2,000
ESCHERICHIA COLI (E.coli)	count	m-COLIBLUE24 (MF)	36/100ml	42/100ml	3/100ml		0/100ml			
FECAL COLIFORM	count	m-FC/ROSOLIC Broth (MF)	23/100ml	0/100ml	0/100ml		0/100ml			

Table 4.9 ABR Second Surface Water Analysis Results

Sample ID: ABR Project (North San Pedro)			DATE: 19 May, 2006			
PHYSICAL	**UNIT**	**METHOD**	**RESULTS**			
			Sample C1	**Sample C2**	**Sample C3**	**Sample L1**
CONDUCTIVITY	µs/cm	CONDUCTIVITY (probe)	52,700	52,300	51,800	65,200
pH	unit	pH/ISE meter (probe)	8.25	8.42	8.09	8.32
SALINITY	ppt	Mercuric Nitrate titration	36.48	36.44	36.43	47.7
TOTAL SUSPENDED SOLIDS (TSS)	ppm	Colorimeter	2	3	2	5
TOTAL DISSOLVED SOLIDS (TDS)	ppm	CONDUCTIVITY (probe)	26,400	26,100	25,900	32,600
TOTAL HARDNESS (as $CaCO_3$)	ppm	EDTA Titration/ UV VIS Spectro	6,355	6,295	6,245	8,195
TOTAL NITRATE (NO_3)	ppm	Cadmium Reduction/ UV VIS Spectro	3.6	2.7	2.3	2.8
PHOSPHATE (PO4)	ppm	PhosVer / Orthophosphate/ UV VIS Spectro	0.6	0.5	0.4	0.5
SULPHATE (SO4)	ppm	Sulfa Ver 4/ UV VIS Spectro	3,870	3,840	3,830	4,420
			1	**1a**	**2**	**2b**
TOTAL COLIFORM	count	m-ENDO Broth (MF)	72/100ml	204/100ml	518/100ml	142/100ml
ESCHERICHIA COLI (E.coli)	count	m-ENDO Broth (MF)	0/100ml	0/100ml	0/100ml	0/100ml
FECAL COLIFORM	count	m-FC/ROSOLIC Broth (MF)	2/100ml	0/100ml	0/100ml	0/100ml

Chapter 5

5.0 Wastewater Disposal

5.1 Nature of Wastewater

Wastewater is a combination of the liquid and water carried wastes from residents, commercial buildings, industrial plants, and institutions, together with any ground water, surface water and storm water that may be present. It is expected that the wastewater generated by the project will be that of Domestic wastewater.

Domestic wastewater is the spent water originating from all aspects of human sanitary water usage. It typically institutes a combination of flows from the kitchen, bathroom and laundry, encompassing lavatories, toilets, baths, kitchen sinks, dishwashers, and washing machines. Domestic wastewater as the name implies, principally originates in residences, commercial and institutional establishments and is also referred to as sanitary sewage.

5.2 Wastewater Characteristics

Raw or untreated sewage is mostly pure water. In fact, sanitary wastewater comprises about 99.9 % water and 0.1% impurities. Most of these impurities are biodegradable organic material and pathogenic microorganism. Sea water on the other hand is only about 96.5 % water and 3.5 % impurities. Although sea water has more impurities than sanitary sewage, it's not the concentration but the type of impurities that's important. For this reason wastewater is characterized in terms of its physical, chemical and biological composition.

The expected characteristics of the wastewater produced by the project site will be that of a typical domestic housing development as shown in table 5.1. Fresh, aerobic wastewater has been said to have the odor of kerosene or freshly turned earth. Fresh sewage is typically gray in color as well.

***Table 5.1** Typical Composition of untreated domestic sewage

	Weak	**Medium**	**Strong**
Constituent	**(all mg/l, except for settleable solids)**		
Alkalinity (as CaC03)	50	100	200
BOD	100	200	300
COD	250	500	1000
Total Suspended Solids (TSS)	100	200	350
Settleable Solids	5	10	20
Total Dissolved Solids (TDS)	200	500	1000
Total Kjeldahl Nitrogen (TON)	20	40	80
Total Organic Carbon (TOC)	75	150	300
Total Phosphorus	5	10	20

* adapted from Davis-Cromwell: Introduction to Environmental Engineering, pp 353

5.3 Waste Water Production

The ABR Project will produce wastewater as a result of its operation. It is estimated that the entire development will require about 40,070 gallons of water a day at full operation and 100 % occupancy rate. For the purpose of the environmental engineering calculations the wastewater production was calculated as 70 % of the water demand as it is normally the standard.

Table 5.2 Projected Wastewater Production according to Facilities

Type	Unit Description	Maximum Occupancy	Water Demand Units (gals/day)	Water Demand Total Volume (gallons)
A	Hotel	112	50	3,920
B	Hotel Suites Type A	24	50	840
C	Hotel Suites Type B	36	50	1,260
D	Water Cabanas	36	50	1,260
E	Beach Front Villas	126	50	4,410
F	Beach Cottages	72	50	2,520
G	Apartments	88	50	3,080
H	Future Developments	78	50	2,730
I	Owner's Club House	6	50	210
J	Employee Housing	289	30	6,069
K	Transient Visitors	100	25	1,750
Totals		**967 Persons**	45.9	**28,049**

As can be seen from the table, the total volume of wastewater generated during full operation and occupancy is 28,049 gallons a day. Type H produced 47 % of the wastewater volume which is followed by Type A with 18 %. These volume percentages can fluctuate according to time of day, occupancy and project activity.

Since these volumes vary and considering the project layout, the wastewater and treatment was divided into zones or tiers as the developer refers to it. There are four developmental zones, each having its own treatment plant and sanitary sewer system. In addition, each zone will have its own highly treated wastewater reservoir tank as described in the previous chapter. These tanks can be interconnected between the zones if it is so required.

In addition the whole concept of each zone having its own treatment plant is to facilitate future expansion without having to purchase a big treatment plant from the beginning. Moreover, it reduces the piping distances thereby reducing the risks of raw sewage spillages and equipment downtime.

5.4 Environmental Wastewater Load

Considering the different infrastructures of the project and the nature of the generated wastewater, the typical strong load will be used as illustrated in table 5.1. TSS and BOD_5 are basically 300 mg/l, with 80 mg/l for TKN, and 20 mg/l for Phosphorus and 300 mg/l for TOC. This is the typical daily load that any treatment method will have to handle to reduce the concentrations to the acceptable national effluent standards. The pH of all these wastes will be in the range of 6.5 to 8.5, with a majority being slightly on the alkaline side of 7.0.

Table 5.3 Project Domestic Wastewater Profile

Constituent	Typical Wastewater (mg/l)	Daily Resort Load (kg/day)
Alkalinity (as CaC03)	200	30.4
BOD	300	45.6
COD	1000	152.0
Total Suspended Solids (TSS)	350	53.2
Total Dissolved Solids (TDS)	1000	152.0
Total Kjeldahl Nitrogen (TKN)	80	12.2
Total Organic Carbon (TOC)	300	45.6
Total Phosphorus	20	3.0

Phosphorus may appear in many forms in wastewater. Among the forms found are the orthophosphate, polyphosphates, and organic phosphates. For the purpose of table 5.3, all these are grouped as total phosphorus. Similarly, the TKN is a measure of the total organic and ammonia nitrogen in the wastewater.

5.5 National Environmental Effluent Standards

The Environmental Protection Effluent Limitation Regulations came into force in 1995, at which time the Department of the Environment commenced enforcing the Regulations. The regulations are intended to control and monitor discharges of effluent into any inland waters or the marine environment of Belize. The standards as per the Second Schedule of the Environmental Protection Effluent Limitation Regulations are shown in table 5.4 below:

Table 5.4 Effluent Limitation Standard for Commercial Activities

Parameter/Pollutant	Maximum Value
Temperature (T °C)	30 – 33 °C
Ph	6 – 9
Dissolved Oxygen (D.O.)	> 4.0 mg/l
BOD_5 at 20°C	50 mg/l
Chemical Oxygen Demand (COD)	200 mg/l

Total Suspended Solids (TSS)	50 mg/l
Total Dissolved Solids (TDS)	2000 mg/l
Sulphate(as SO_4)	600 mg/l
Sulphide (as S)	500 mg/l
Oil and Grease	10 mg/l
Phosphate(PO_4^-)	5 mg/l
Nitrates (NO_3)	3 mg/l
Ammonia (NH_4)	1 mg/l
Total Organic Carbon (TOC)	200 mg/l
Total Coliform	0 – 10 MPN/100 ml
Fecal Coliform	0 MPN/100 ml

5.6 Wastewater Treatment Options

The wastewater treatment options are expanded and rationalized in Table 5.5 below:

Table 5.5 Wastewater Treatment Options

OPTION	DISCUSSION
1. Septic Tanks plus Soak-aways or Leach-fields	This option will not function as a consequence of the existing soil condition, which is mainly comprised of coarse sand, coupled with the fact that these systems do not treat the effluent properly making the quality of the effluent inadequate for disposal at surface levels. Contamination into the sea, lagoon and underground water systems (cenotes) will occur in regards to BOD, Nitrates, Phosphates and pathogen persistence. For this reason, this option is not recommended because it can degrade the environment especially since the project is located near the reef, which is an ecologically fragile environment and also because the project is in Bacalar Chico Reserve. These systems can also affect the general sanitation and health of the area and affect bathers, swimmers and other living marine organisms at risk.

2. Prefabricated Secondary Treatment Plant	A prefabricated metal treatment plant would utilize little space, be capable of handling large volumes and would provide an excellent treatment of the project's wastewater. Moreover, the treated effluent could be recycled into the project's water demand. Post-chlorination would make the water pathogen free and suitable for the flushing of toilets, for irrigation and fire fighting purposes as well as for other non potable uses. The excess effluent would be discarded into the environment with no problem as the treatment levels would meet and supercede the national standards. This is especially important as the project is located in an ecologically fragile environment. The level of treatment of this system would ensure that the area surrounding the project remains pathogen free as much as possible, which is a pre-requisite for possible swimming and other possible water based recreational activities.

Preferred Option – The ABR Project will employ Option 2 as the preferred option. The system recommends is a series of prefabricated treatment plant. ABR will employ the "Purestream ES Model BESST" or approved equivalent treatment plant. BESST is an acronym used for a Biologically Engineered Single Sludge Treatment. The BESST system is based on the principals of single sludge treatment for efficient BOD, TSS and nutrient removal, and sludge blanket clarification for efficient solids separation. Also, with its efficient use of the mixed liquor, the BESST system produces less sludge build up. This process places all these components into one vessel thereby reducing the parameters to much less than required by the national standards.

The efficiency of the process, and velocity gradient sludge blanket clarifier, produces effluent quality well below 10 mg/l BOD_5, < 10 mg/l TSS, less that 1 mg/l Ammonia, less than 10 mg/l Total Nitrogen (<5 mg/l TKN) and effluent phosphorus levels between 2 and 3 mg/l by Luxury uptake and less than 0.5 mg/l with the use of metal salts. This option has been guided by the awareness in the sensitivity of the environment by the EIA preparers and the good being injected into the project by the project proponents

The collection system associated with the BESST Treatment Plant entails a combination of gravity collection and pumping system with manholes and cleanouts which would convey the wastewater to a final zone pumping station. The waste would then be pumped from this area to the zone where it is to be handled by the BESST Treatment Plant which is capable of treating liquid wastes to a higher level than those mandated by the National Effluent Standards.

5.7 Typical BESST Plant Treatment Effluent and Loading Parameters

The BESST Plant recommended for the proposed project can reduce the Biological Oxygen Demand and Total Suspended Solids to less than 10 mg/L. The treatment plant can also reduce TSS and BOD5 total loading by some 97%, and decrease the daily Organic Nitrogen Total Loading by 67%. Additionally this system could reduce Total

Free Ammonia Loading by 97.5% and Total Phosphate Loading by some 80%. The projected performance of the BESST Treatment is summarized in Table 5.6.

Table 5.6 Projected Performance of BESST Treatment Plant.

Constituents	Typical wastewater post treatment	Daily load reduction post treatment
Total Suspended Solids	10 mg/L	**97%**
Total Organic Nitrogen	5 mg/L	**67%**
Free Ammonia	1 mg/L	**97.5%**
BOD_5 (5 day)	10 mg/L	**97%**
Phosphate	2 mg/L	**80%**

5.8 Wastewater Recycling

The recycling of wastewater is an important factor in reducing the projects water demand. For the purpose of the ABR project, this wastewater will be recycled. The treated wastewater will be post chlorinated by a chlorination system as described in the previous chapter. This process is necessary to remove any harmful pathogens and the treated water will be conveyed to the zone's holding tank.

As described earlier in the chapter, the development will be divided into four developmental zones which could also be described as four sewer zones each with their respective holding tanks. ABR will recycle 46 % of its wastewater for the flushing of toilets. All water lines will be color coded. The remaining volume or about 40 % will be used for the irrigation of lawns, hedgerows and other related non potable uses and most importantly for fire combating intentions as portrayed in table 5.7.

Table 5.7 Wastewater Alternative Uses.

	Purpose	Description
Wastewater	Irrigation	Lawns, hedgerows, shrubs ect
	Fire Fighting	Fire combating
	Other	Non potable uses

All excess wastewater will be discharge into the receiving environment. The developers will ensure that the discharge wastewater meets and exceeds the environmental guidelines for the discharge of effluent.

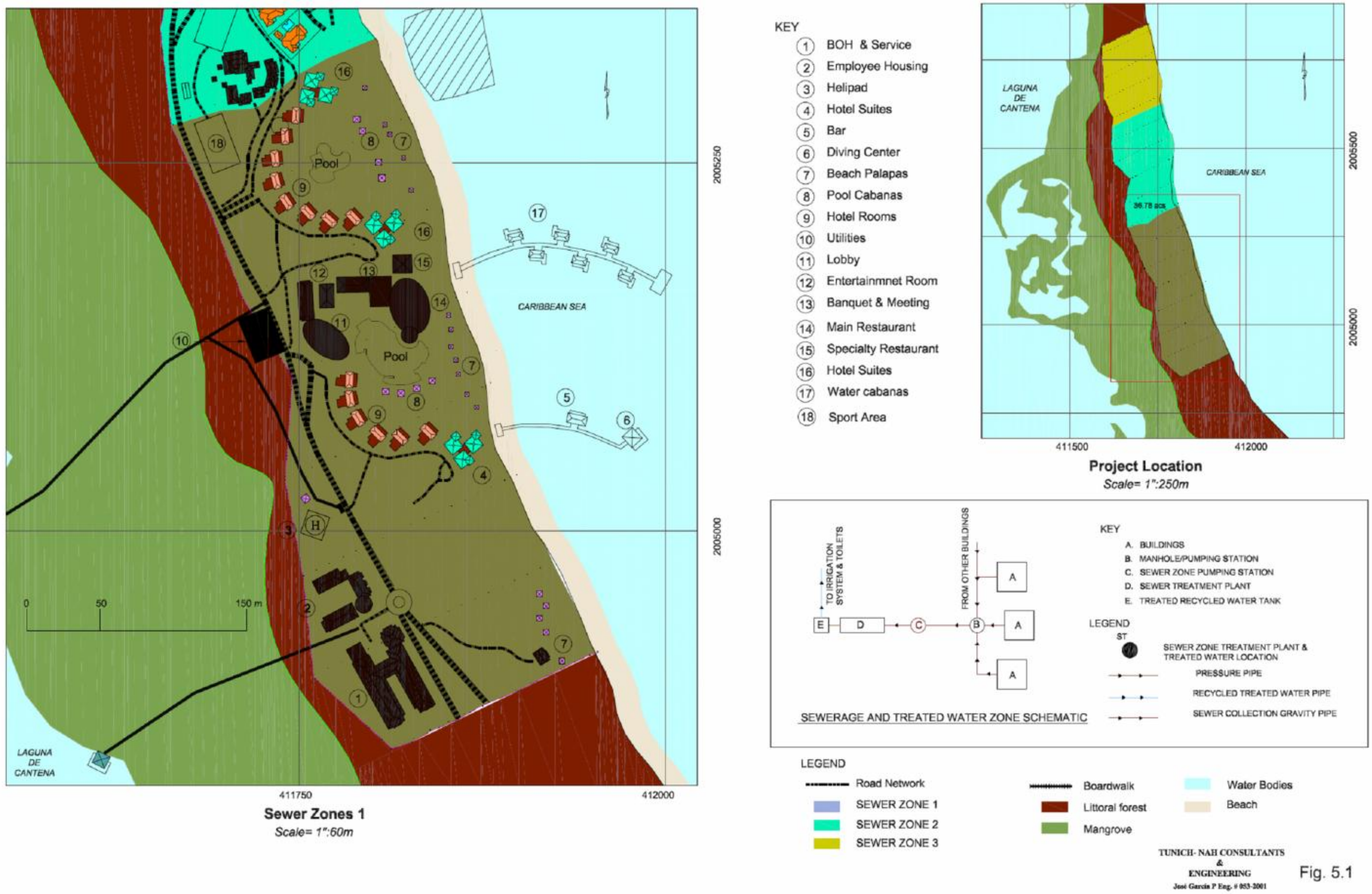


Fig. 5.1 Proposed Project Sewer Treatment Zones (Zone 1)

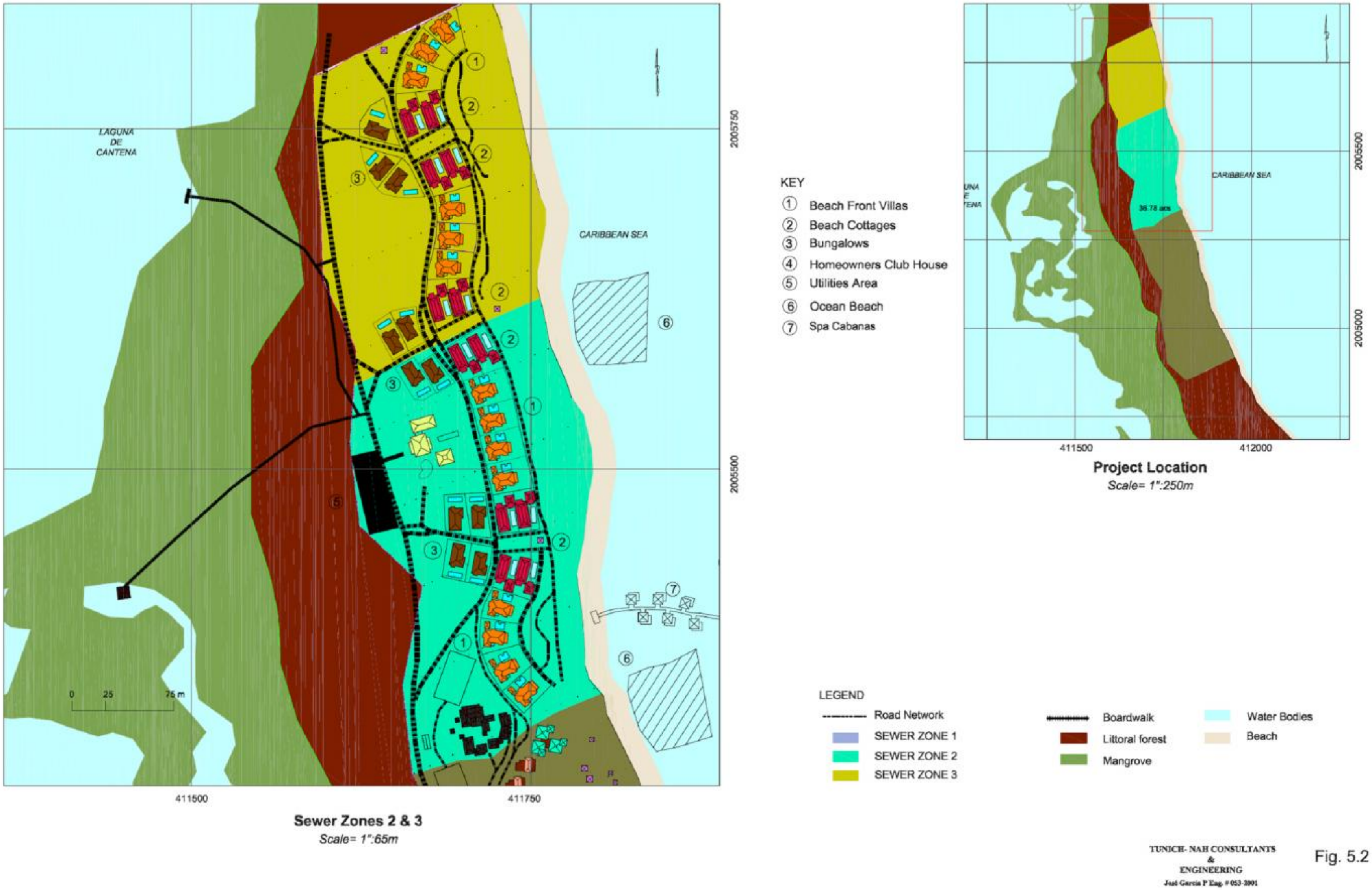


Fig.5.2 Proposed Sewer Treatment Zones (2 &3)

Chapter 6

6.0 ENERGY GENERATION

6.1 Energy Demand

The ABR project will consist of a tourism sector and a residential sector. Both sectors will target tourism visitors, both local and international, as well as retired full time and part time residential inhabitants. The tourism sector comprises mainly of different size condos and villas, and amenities such as Restaurants, Retail shops and the Ecological Cultural Center. These facilities at full operation will require an overall constant, adequate and reliable source of energy.

The energy requirements of this project are expected to be mainly for domestic and semi-commercial purposes. Industrial activity, if any will be limited to the boat storage areas, construction work, and maintenance activities. The energy requirements are described in table 6.1. The daily energy demand at full occupancy and operation will be about 13,181 kilowatt hours

Table 6.1 Project Energy Demand

Type	Facility	Quantity	Unit Equivalent	Yearly Energy Use x (10,000 kwh)	Daily Demand (kwh)
A	Hotel	56	1.0	560,000	1,556
B	Hotel Suites Type A	8	4.0	320,000	889
C	Hotel Suites Type B	12	4.5	540,000	1,500
D	Water Cabanas	12	3.5	420,000	1,167
E	Beach Front Villas	42	2.0	840,000	2,333
F	Beach Cottages	12	3.5	420,000	1,167
G	Apartments	22	3.5	770,000	2,139
H	Future Developments	13	3.5	455,000	1,264
I	Owner's Club House	1	3.5	35,000	97
J	Employee Housing	1	2.0	20,000	56
K	Restaurant and Bars	3	2.5	75,000	208
L	Spas Cabanas	6	4.0	240,000	667
M	Others (Admin/lighting)	2	2.5	50,000	139
	Totals	**162**		**4,745,000**	**13,181**
				4,745 MWh	**13.181 MWh**

* Other facilities include the piers, security equipments, road side and walkways illuminations etc.

A typical hotel, villa and cottage designs were used to calculate the energy requirements for the project. As well, it is assume that the energy use includes lighting and the use of common domestic appliances. It is estimated that there will be a demand of about 200 kwh - 400 kwh during construction of the project. All of the energy demand will be gotten from a portable gas powered generator.

6.2 Energy Supply Source

The project site is located some 27 miles from the San Pedro Town and some 16 miles from the last BEL transmission line as the crow flies. Since there is no transmission line near the project site, ABR Limited is considering the installation and use of diesel generators as its primary source of producing electrical energy. The use of diesel generators will probably be supplemented by electrical energy provided by BEL in the future. It is anticipated that electrical energy will reach the project site as the area develops. It is uncertain, however, when this process will be facilitated but what is certain is that any impact related to diesel generation will be drastically reduced once connected to BEL's transmission line.

With this in mind, the project will install diesel generators to produce and meet its electrical demand. The project will utilize three diesel generators with a combined capacity of 1,320 KW a day. Generators will be purchased according to the project's energy demand. These generators will eventually be used as back up generator units once the project is connect to the town's grid. These generators will be housed in sound attenuation enclosure to reduce any noise pollution and will be installed in the Utilities area of the proposed project. The utilities area is hidden away from the visiting population and will be located on the western portion of the project property. Trained technicians and skilled workers will service and maintain the generators in good working order.

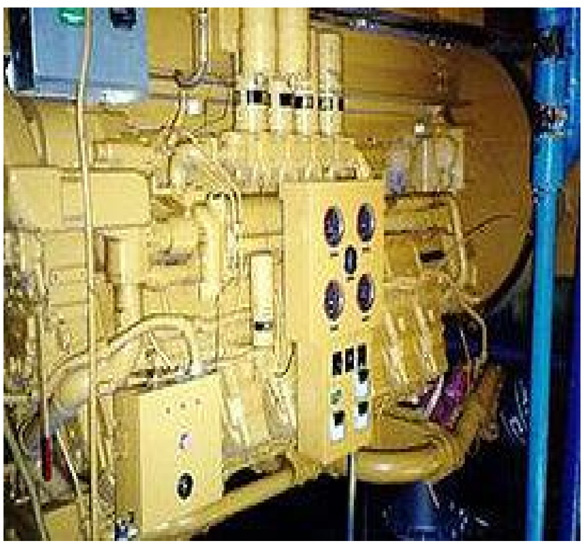


Plate a. Typical diesel generator

Plate b. Generator sound attenuation house

6.2.1 Alternate Energy Source

Alternate energy can be derived from a myriad of sources including thermal, solar, wind, tidal, natural gas and nuclear energy. Solar panels and wind energy are recommended as secondary sources of electricity but their use is limited to night time lighting. These two options may be used along with the generator energy source. The site has a good potential for solar and to wind power but these should be chosen as optional. The various options for energy generation are compared in table 6.2 These options however are secondary sources of electricity which are designed to reduce the overall dependence on the generators

Table 6.2 Comparison of alternate energy sources for ABR

Criteria	Solar Power	Wind Power	Generators
Installation Cost	High	High	Low to Medium
Operation Cost	Low	Low	Medium
Reliability	Dependent on available radiant energy	Dependent on wind speed	Very reliable
Environmental Pollution	Low	Low	Medium
Capacity	Requires battery storage for night time use	Requires large windmill to electrify one house	Able to work continuously

From an environmental standpoint the use of solar or wind power is preferred as it results in very low environmental pollution. Both of these sources have zero emission. However both these options cost significantly higher than a diesel generator to install and operate.

Solar power is only able to operate during the day when radiant energy is available even though the electricity generated may be stored in battery cells for use at a later time. This increases the cost of this option. Wind energy is dependent on the duration of the wind as well as the wind speed. Wind energy also requires more space as the installed wind vanes occupy a large amount of space. Wind vanes usually measure a minimum of 75 feet in diameter. Thus for this project these will not be appropriate.

Liquefied Petroleum Gas (LPG) and Natural gas have the ability to drastically reduce the overall energy demand. This type of fuel is primarily used as cooking fuel, but technology has expanded their range. For example, generators running on LPG or Natural gas can drastically reduce cost and pollution as well as for water heaters (pool, spa or showering).

6.3 Power Transmission Lines

Once the diesel generators are operational, power transmission lines will need to be installed. This will mainly involve the electrification of the different infrastructures. Most of the power transmission lines will be laid underground. This will increase the aesthetic appeal of the project site as well as reduce the risk of fallen power lines in the event of a storm. However, underground cable systems have to be insulated are more expensive, and have a higher maintenance cost. The route with the least environmental impact will be followed throughout the project. However, the final design layout and routes of the power transmission lines will need to be approved by a certified electrician.

6.4 Fuel Management, Health and Safety

The project will also require fuel for its operational purposes. The fuel sources (diesel, gasoline and butane) are readily available from the commercial sector. The demand will be according to the different facilities such as the hotel, restaurants and most importantly the diesel generators, as well as the maintenance facilities.

64.1 Cooking Fuel

Fuel such as butane and propane used for cooking and refrigeration if necessary will be stored using the recommended guidelines. Each facility such as the hotel and restaurants will store these fuels at the back of each building with the proper containment measures.

The transportation of butane and propane will be the responsibility of the supplier, who will follow the recommended guidelines for the transportation of Hazardous Materials. The supplier will also be responsible for the refilling and/or replacement of any faulty or corroded container. Cylinder will be filled in San Pedro town and taken to the project site via boat or barge. The cylinders will be offloaded at the Basil Jones Municipal pier and transported to the site.

6.4.2 Fuel Storage and Transportation

Fuel for the project will be transported by a 10,000 gallons fuelling barge to the site. Fuel will be pumped into the barge at a Fuelling Depot location and taken to the Basil Jones pier where it will discharge into an awaiting tanker. Proper pumping equipment will be used but will not be fixed. The tanker will then take the fuel to the site and discharge the fuel into the respective holding tanks. The handling of fuel will follow the standard protocol for the loading and unloading of fuel in the sea. The fuel demand for the generators of this capacity can range anywhere from 79 gallons/hr to 150 gallons/hr. For this reason, fuel for the generators will be stored in two- 15,000 gallons Above Storage Tank [AST] contained in a re-enforce concrete containment wall. Fiber glass piping will be used for the fuel transmission lines. The containment wall will be constructed so as to hold 110% of the volume of the tank. This volume will supply the project generators site and with the necessary fuel needed for development and operation.

The fuel supply will be managed by ABR with the assistance of a designated Fuel Supplier. The installation of the AST tanks will be ensured to follow the environmental clearance process, which requires the application of operation of a service station, and follow up inspections by relevant authorities, including DOE and the National Fire Service (NFS). The transportation of fuel will be the responsibility of the supplier and ABR, who will follow recommended guidelines for the transportation of Hazardous Materials.

The accidental spill of fuel will be avoided as much as possible. An Oil Spill and Fire Contingency Plan will be developed to address all issues pertaining to spills, leaks and fires both on the island and at sea. The plan will contain mitigation measures (booms, kits), clean up processes as well as the required training for safety and health. Additional information is explained in Chapter 8.

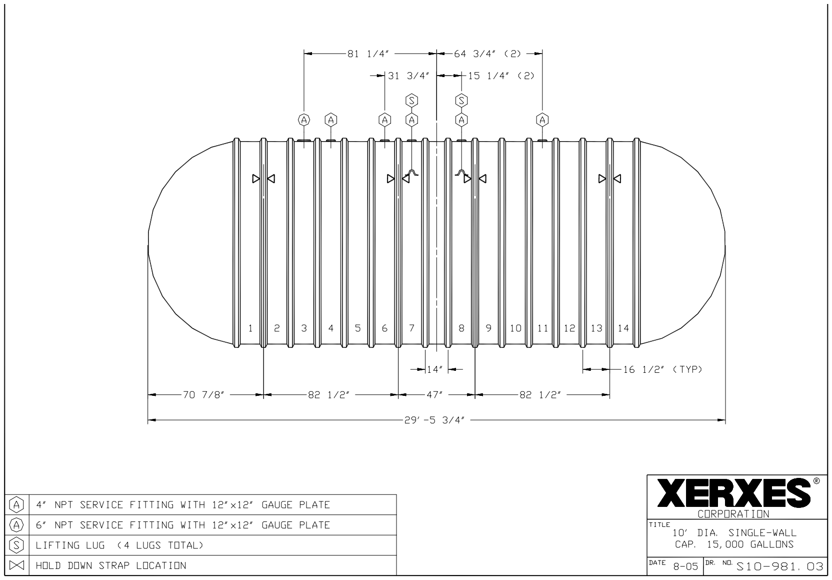


Fig. 6.1 Above Ground Storage Tank that will be used for ABR

6.5 Impacts and Mitigative Measures

The installation of the diesel generators will create negative environmental impacts in the following areas:

- Orientation to the site will focus on the environmental contributions of these structures. Management should place these towers in less visible locations provided there is enough wind. It should also be possible to hide the lower portions behind small trees.

- Negative impacts will result from the sitting and placement of the diesel generator. These are in the form of diesel and waste oil spills and leaks. All spills and leaks will be mopped up and disposed according to the environmental guidelines. All waste oil or contaminated fuel will be removed from the island and taken to Belize City and other destinations that may prove viable for recycling.

- Negative impacts will result from the operation of the generators. Noise displacement will be minimized by individual engine houses enclosed in a central generator building with acoustic tiling.

- Batteries from the system will eventually wear out and will have to be replaced. In view of their toxic nature they will be removed from the island and taken to Belize City and other destinations that may prove viable for recycling

Table 6.3 Matrix of potential impacts to the environment within the project area as a result of power generation, plus proposed mitigative measures and residual impact ratings

Category of Project Activity	Preferred Options for Carrying out Project Activity	Direct and Indirect biological and physical Impacts	Recommended Mitigative Measures	Residual Impacts Mag/ Dir/ Dur/ Slope
A. Construction Phase:	1.0 Diesel Generators	Excessive noise pollution	Use silencers on muffler, route muffler pipes underground. Use acoustic tiling on wall of shed, use generator housings	low/ dec/ short/ local
		Pollution risk due to accidental spill from fuel and oil storage tanks	Place fuel tank in an enclosed bond wall with 110% capacity of fuel tank	
			Transport fuel in sealed containers and seaworthy vessels only	
		Air pollution and combustion fumes	Keep machines properly serviced used recommended fuels and additives only	
	2.0 Backup Diesel Generator System	Same as above	Same as above	
B. Operational Phase:	1.0 Diesel Generators	Excessive noise pollution	Enclose engine in generator house having acoustic tiling. Route mufflers underground to muffle vibrations.	low/ dec/ short/ local
		Pollution risk due to accidental spill from fuel and oil storage tanks	Place fuel tank in an enclosed bond wall with 110% capacity of fuel tank	
			Transport fuel in sealed containers in seaworthy vessels only	
		Air pollution and combustion fumes	Keep machines properly serviced used recommended fuels and additives only	
	2.0 Backup Diesel Generator System	Same as above	Same as above	

Chapter 7

7.0 SOLID WASTE

7.1 Solid Waste Categories

An essential component in the management of solid waste is that a proper procedure be devised to sort and categorize these waste. In sorting solid waste the development intends to create a differential system, assigning each class of solid waste to a different treatment category. The four broad categories of solid waste are:

1. Construction and Field Waste (Waste category 1)
2. Household and Kitchen Waste (Waste category 2)
3. Industrial Waste (Waste category 3)
4. Toxic Waste (Waste category 4)

7.2 Projected Solid Waste Production and Waste Category Profile

ABR is a proposed transit to residential site with an important tourism component. The proposed undertaking will result in increased population growth over the years, increased visitation to the site, and an increase in the temporary and full time labor force. This increase in population will result in an increase of solid waste production. Although full occupancy is difficult to achieve at any given time, it is recommended that solid waste management needs to be put in place for maximum occupancy at the project site.

It is hard to project how much waste will be produced by each visitor and staff at the resort, however the development will have the means and capacity to house up to 578 guest at full capacity (between the hotels, condos and villas) who will be served by a complement of staff equivalent to 0.5 staff per guest or 289 persons at full capacity. Although its difficult to predict, its suffice to say that upper scale tourists resorts consume far more processed goods, cleaning products and disposable goods (Conservation International, 1999) than the local population or staff who will be producing nearer to the Belizean average.

The Belize Solid Waste Management Project [Stantec 1999] estimates that the average person in San Pedro was producing about 4.8 lbs of solid waste per day as per Table 7.2. This was well above the amounts being produced in inland locations like Belize City (3.4 lbs/capita/day) and Orange Walk Town (2.8 lbs/capita/day). It is expected that the average high roller at ABR will be producing at least as much solid waste per day as the average San Pedrano. Likewise, the staff and office workers would be producing a little less than the average. The profile of the average householder as an investor/retiree/vacationer with higher income levels tend to fit these profiles especially in the case of the higher end condos and villas to the north of the property.

On the assumption that these extrapolated figures will hold for the ABR resort, then one arrives at the following figures for domestic waste production at the resort recalling the following dwelling/accommodation capacities:

- Hotel = 56 rooms (>112 person capacity)
- Hotel Suites = 18 separate structures = (60 person capacity)
- Beach Front Villas = 14 separate structures as duplex units = (126 person capacity)
- Workers = 2 or 3 structure =(289 workers capacity, 0.5:1)
- Transient Visitors = 100 visitors to the site, including from neighboring Mexico

Table 7.1: Projected Domestic Waste Production for ABR during Operational Phase.

Type	Facility	No of Producers in Category	Lbs per Capita per day (ppcd)	Projected Solid Waste Production per Day (lbs)	Projected Solid Waste Production per week (lbs)
A	Hotel	112	4.8	538	3,763
B	Hotel Suites Type A	24	4.8	115	806
C	Hotel Suites Type B	36	4.8	173	1,210
D	Water Cabanas	36	4.8	173	1,210
E	Beach Front Villas	126	4.8	605	4,234
F	Beach Cottages	72	4.8	346	2,419
G	Apartments	88	4.8	422	2,957
H	Future Developments	78	4.8	374	2,621
I	Owner's Club House	6	4.8	29	202
J	Employee Housing	289	3.0	867	6,069
K	Transient Visitors	100	3.0	300	2,100
Totals			**4.5**	**3,941**	**27,590**

Table 7.1 shows that at full occupancy (see chapter 4), the resort can expect to produce in the order of 3,941 lbs (3.9 Cubic Yards) of domestic waste per day or 27,590 lbs (27.6 cubic yards) per week. Although full occupancy may never be achieved given the nature of the development, the systems adopted for the site must have enough capacity to accommodate the waste at full capacity continuously or otherwise it will be viewed as potentially inadequate.

The system adopted for managing this waste must be efficient and environmentally dependable. It should also be noted that in terms of waste management, volumes are a more useful quantity to consider than weight. This is especially true for ABR where its solid waste will be out by marine vessels (eg. Boats docked at the Basil Jones pier) where space will be at a premium and cost prohibitive. This suggests that somewhere along the line it will be in the resort’s interest to purchase a good quality compactor, however with this the resort can take many measures to reduce its waste output and save cost.

According to the BSWMP (Stantec 1999), there is no data on the volume of the municipal versus domestic waste, as there is no separation at source for Belize at the different municipalities. Municipal waste includes waste generated by the commercial and business sector located within or near municipalities. Municipal waste also includes very little industrial waste in Belize Municipalities.

Table 7.2: Estimated Solid Waste Generation for Belize Municipalities.

City/Town	Population	Tons per annum	Tons per day	lbs/capita/day
Belize City	49,050	29,770	81.6	3.4
Orange Walk	13,483	6,365	17.4	2.8
San Ignacio/Santa Elena	13,260	7,104	19.5	2.9
Stann Creek	7,888	4,680	12.8	3.3
San Pedro	4,499	3,900	10.7	4.8
Belmopan	8,130	3,510	9.6	2.6
Benque Viejo	5,088	2,080	5.7	2.5
Dangriga	8,814	3,120	8.5	2.1
Punta Gorda	4,329	1,560	4.3	2.2
TOTAL	**114,541**	**62,089**	**170.1**	**26.6**
MEAN		**6,899**	**18.9**	**3.0**

Source: Stantec 2001, & CS0 2000

The project is not expected to produce any industrial waste, as no industrial activity is planned. Waste will be similar to that produced for other Belize municipalities as described in the following section.

7.3 Types of Waste

Belize has little data on volumes and types of materials being disposed onto open air landfills, incineration, burial etc. The Belize Solid Waste Management Project (Stantec, 2000) and the Central Statistical Office, 2000, estimate that most domestic waste is organic (60%), while the remaining consists of metals, plastics; glass, other waste (5%) and paper comprises 20%. The production of waste for ABR is expected to be similar, except for the inclusion of construction material to be produced during the construction period.

The composition of municipal waste in Belize has been estimated as follows:

Organics	60%	Plastic	5%
Metals	5%	Paper	20%
Glass	5%	Other Waste	5%

Source: BSWMP/Stantec 1999 and CSO, 2000.

Construction waste will include (i) construction rubble [concrete and wood material], (ii) plastics, (iii) paper [primarily from cement waste bags], (iv) scrap metal, and; (v), small quantities of glass. Food waste during the construction period will be negligible.

7.4 Waste Category I – Construction and Field Waste

(i) **Construction Waste** – At ABR almost all the waste produced during this phase will come from construction of the resort's infrastructure. The resort intends to construct 88 condo units and 56 villas of different size ranges, besides a 105, room hotel, spas, and ancillary and auxiliary facilities such as an Ecological and Cultural Center. Buildings will be built out of organic natural materials such as timber, however foundations will particular will require large volumes of concrete since they will also house the water cisterns for the houses.

It is commonly assumed in building construction that between 5-10% of all building materials will eventually be discarded as waste and purchasers will normally allow for this. Beside the usual scraps and discards common to construction sites generally, the development must also get rid of wrappings and packing, which will be considerable given the amount of building materials and furnishing which will be imported.

Construction waste will include pieces of concrete, wood ends, nails and other ferrous products, casing materials, piping and wires among others. An average of 5-10m^3 of compact waste materials will be produced on average from each of the villa structures and probably the same from the structures giving an estimated total volume of between 375 – 750m3 of discarded construction waste, which will be produced over the life of the project. The hotels and remaining facilities including the piers will probably produce another 100 -125m3 of waste.

Once the owners of the residential stock takes charge of their buildings further construction, alteration or additions may take place as allowed under the Code of Covenants signed between the developer and his clients. This may include structures such as store sheds laundry areas and staff quarters.

All inorganic construction waste produced at the site such as plasterboard, mortar, tiles will be retired to the lower areas on the rear of the property as landfill. Wood pieces will be recycled as will other materials that can find additional application around the site. Organic materials such as wood that cannot be recycled further will be collected and burned in open air fires or given to the communities as firewood.

(ii) **Field Waste** - The little field waste produced will be from clearing of certain trees to erect structures but as noted in Chapter 2 it is the intention of the developer to retain as much of the native vegetation as possible. Notwithstanding this the shear size of the island and number of buildings to be erected will have a considerable footprint. Calculations of the footprint of the villas and condos alone suggest that they will take up approx. 11 acres. The plants from these areas will have to be removed not to mention additional clearing for site enhancement (e.g. small gardens), ventilation and to allow natural lighting.

The trees cleared from the property will have little commercial value however some may be gainfully deployed into the construction effort as formworks, otherwise they will have to be collected piled and burned in open air fires under close supervision.

7.5 Waste Category II – Domestic Waste

During the operational phase of the development between 75 -85 % of all the waste produced will fall into this category. Although often overlooked, it is important to remember that the range of domestic waste can run the full gamut of waste categories and therefore the term "domestic" refers more to origin than to a specific waste category. The resort must ensure that domestic waste is sorted into appropriate groupings before disposal. To achieve this, waste must be stored in separate containers depending on whether they are biodegradable, non-biodegradable or toxic and properly labeled so that all conscientious individuals feel comfortable and encouraged in using them.

The amount of this type of waste produced on the island is expected to be large given the size of the development and the fact that much of the food produced for the residents will be by catered restaurant type arrangements. The various offices and households will supplement this amount considerably by their daily production of waste paper etc.

7.5.1 Domestic Waste disposal

Due to the pre-existing conditions, the options for solid waste disposal are limited to two options: **Option A and B**, on site disposal, and **Option C**, disposal at the San Pedro landfill site. The solid waste is also classified into groups mainly organic and inorganic, with organic being combustible and non combustible.

Table 7.3 is a summary for the solid waste disposal for ABR. The first option considered was Option A, the option to dispose solid waste at a site within the project area. The second option was to consider the incineration of combustible waste and the transportation of the non combustible waste to the existing San Pedro Municipal landfill, after approval by the relevant authorities.

7.5.2 Selection of the preferred option

The advantages and disadvantages for each option were discussed and analyzed. Taking into consideration the fragility and ecological sensitive nature of the area, Option C was chosen. The analysis identified that it would be environmentally and ecologically beneficial to install a medium size incinerator to incinerate all the combustible waste produced on site. This incinerator would be installed at the back of the property, in the direction of the prevalent winds. The incinerator will have a capacity of incinerating over 500 lbs/day of combustible waste.

Table 7.3 ABR Solid Waste Disposal Options

OPTION A Disposal	**OPTION B Disposal**	**OPTION C Disposal**
Option A-1 is the composting of the organic waste and disposing of the inorganic/combustable waste within a disposal site on the property.	Option B is the composting of the organic waste within the site and carting the inorganic/combustable waste to San Pedro Site	Option C is the composting of the organic waste within the property, incineration of the combustible waste and carting the non combustible waste to San Pedro
Composting in soils that are high in salinity could pose a problem to the bacteria.	Composting in soils that are high in salinity could pose a problem to the bacteria.	Composting in soils that are high in salinity could pose a problem to the bacteria.
The compost would have to be utilized within the island.	The compost would have to be utilized within the site.	The compost would have to be utilized within the property.
A disposal site on the property for the inorganic would contaminate the site with pests and diseases as well as the need for adequate land. Water contamination can also occur given the nature of the fragility of the area.	The carting of the inorganic and combustible waste to San Pedro could easily be handled by the service boat that will commute on a regular basis. But space would be at a premium and its not hygienically safe to transport this waste with other products or items.	The incineration of the combustible waste would drastically reduce the waste volume. Non Combustible waste will be separated and carted out to the San Pedro landfill. The volume will be far less that Option A-2 and would be safe to transport.

All the non combustible waste will be carted to the San Pedro landfill. Waste will be stored on site until a sizeable load can be taken. ABR will make every effort to consolidate its load in order to reduce boat traffic in the area. The project will also encourage the composting of its organic waster. The organic waste generated by the project will basically consist of food scraps, grass and hedge trimmings and clippings. ABR will install composting bins to process the organic waste thereby producing a rich source of nutrient for the existing landscape.

7.6 Waste Category III and IV - Industrial and Toxic Waste

For the purpose of this assessment industrial waste will refer to all waste products produced from the operation of machinery and other mechanized equipment. Within this list will fall objects such as used tires, batteries, used oil and grease and discarded electronic equipment among others. Most transportation type waste will come from the expected large fleet of golf carts and boats. Used tires will be stockpiled and taken out to the landfill when ready. Used batteries and waste oil will be contained in the containment walls constructed for the fuel tanks. These will be adequately stored and discarded by a certified disposal for recycling.

Toxic waste is outright dangerous to human health and should only be handled with specialized equipment and carefully disposed of far away from any inhabited area.

7.7 Waste Minimization Strategies

Transportation of waste materials from the site by whatever means will be an expensive proposition given the fact that ABR is a great distance from San Pedro where the waste disposal site is located. The developers will understandably be loath to bear this cost and will therefore aggressively pursue other less expensive options as long as they are compatible with maintaining sound environmental values. The developer is therefore well advice to subscribe to the new terminology associated with solid waste management. The three R's as it's called refer to reduction, recycling and reuse of the generated solid waste. This process should be greatly incorporated as a proposition of reducing the solid waste thereby reducing the overhead expenses associated with the incineration of such waste.

These options are now examined in turn with a view of applying them to solving the expected waste disposal problems of the site.

(i) **Reduction –** The developer of the resort should work with all the inhabitants of the area both permanent and transient to create a hierarchy of waste management where simply reducing the amounts of waste generated should be a priority. Such a reduction can take many forms but is especially evident in such ways as reducing the amounts of shopping bags and packaging brought from the store by buying products with less packaging and taking ones own bag to calculating construction materials more accurately to take account of waste etc. He should also purchase his goods in bulk obviating the need for many small packages.

(ii) **Reuse** - Once materials are bought they should be reused as many times as possible. There are many opportunities for reusing products such as substituting Styrofoam plates and cups with regular plates to putting used clothes up for sale as second hand items etc.

(iii) **Recycle –** Many of the items that the residents and staff of the development uses will be recyclable. Items such as glass can be crushed and reused in concrete. By the same token buying drinks in glass bottles which can be exchanged at the store instead of plastic can help to reduce waste volumes (although they may incur higher transportation cost). Composting kitchen waste is another example where useful products can be obtained for gardening, soil conditioning etc from waste which would otherwise be discarded. In Belize there are established business operations that will take paper cardboard and metal waste for recycling into useful products e.g. toilet paper. Used tires can be recycled and used for road barriers or as flower pots.

7.7.1 Waste Minimization Volumes

As gotten from the Waste Minimization Strategies, much of the generated waste produced by the project during operation will consist of domestic waste. Applying the composition percentages from section 7.3, the following yields can be obtained as from the table below:

Table 7.4 Waste Reduction Yield for ABR after WMS

Composition	Percentages	Solid Waste Generated (lbs)	Volume Composition (lbs)	Waste Minimization Strategy
Organics	60	3,941 ($3.94\ yd^3$)	2,364.6	Composting
Plastic	5		197.05	Recy/Incin
Paper, Cardboard	20		788.2	Comp/Incin
Glass	5		197.05	Recycling
Metal	5		197.05	Landfill/Recy
Other Waste	5		197.05	Landfill/ Incin
Totals	**100%**	**3,941 lbs**		

As can be seen from table 7.4, about 60 % of the solid waste produced during operation can be recycled by composting. Moreover, waste such as card board, paper, grass trimmings, hedge trimmings and wood chippings can be added as well. The end result of the composting process is a rich fertilizer that can be added to the landscape.

Considering the volume of waste to be composted, the project will utilize a composting system with a processing capacity of 40 – 200 pounds per day of biomass per system. This system is ideal considering the current national occupancy rate of Belize (see table 7.4b). With this in mind the project will install 7 of these systems around the project site. Additional tubs will be installed as needs be to facilitate the occupation increase.

7.8 Garbage Collection

The garbage depot will be divided into two sections, one for organic (putricible) and the other for inorganic refuse. Inorganic waste will divided into combustible and non combustible. Combustible waste would include cardboard, paper, and certain plastics.

Table 7.4b Waste Reduction Yield for ABR according to Occupancy

Composition	Percentages	Volume Composition (3,941 lbs)	Occupancy Levels 70%	Occupancy Levels 40%
Organics	60	2,364.6	1,655.2	945.8
Plastic	5	197.1	137.9	78.8
Paper, cardboard	20	788.2	551.7	315.3
Glass	5	197.1	137.9	78.8
Metal	5	197.1	137.9	78.8
Other Waste	5	197.1	137.9	78.8
Totals	**100%**	**3,941.0**	**2,758.7**	**1,576.4**
		3.9 yd^3	**2.8 yd^3**	**1.6 yd^3**

Non combustible waste, such as glass, scrap iron, and PVC will be compacted and transported to the San Pedro landfill. Carting out of the solid waste will be done whenever possible or when a complete load has been accumulated.

7.8.1 Educational Program. Solid waste collection and disposal will also include an educational program so as to inform and educate the staff, management and residents as to the collection schedule, waste separation, the need to store waste in containers, collection frequency etc. At all times the relevant authorities will be involved in reviewing components or all parts of the solid waste management plan to further increase the disposal efficiency.

7.8.2 Collection Schedule. Waste from the condos, villas, hotels and other building will be collected daily. The worker's quarters will be serviced once a week initially, then twice a week, and later on a daily basis if the demand increases to warrant daily collection. The precise collection days will be finalized after discussion with residents and management, and will be determined on the demand needs.

7.8.3 Reporting Requirements and Compliance Monitoring.

All relevant information will be made available to all pertinent authorities such as the SWMA, Ministry of Health, and the Department of the Environment.

ABR Limited will ensure that contractual obligations, if any, are fulfilled at all times, and any guidelines and the monitoring of these guidelines and practices will be done internally, wherever possible. Any gross violations requiring notification to the enforcement authorities will be done as soon as possible, if necessary.

Chapter 8

8.0 Disaster Management

8.1 Introduction

The Disaster Management Plan for ABR Limited will focus on four potential types of disasters that could affect the operation and livelihood of the resort in some way or the other. The four types that are refer to are both anthropogenic and natural in origin. A more comprehensive and detail plan shall be develop for the ABR once the resort is in operation. These disasters are outlined in table 8.1 below and further summarized in the chapter:

Table 8.1 Disaster Preparedness Plans for ABR Limited

Disaster	Description	Response Plan	Stages
Hurricanes and tropical storms	This natural phenomenon can drastically affect the resort's infrastructure and operation should a hurricane strike the caye.	Hurricane Preparedness Plan	Alert, Response, Recovery
Fire	This anthropogenic and to some extent natural event poses a serious problem to the infrastructure and occupants of the resort.	Fire Prevention and Response Plan	Response
Fuel/oil Spills and leaks	This incident affects the soil and water on a whole if not properly addressed.	Spill Contingency Plan (Tier levels)	Response, Recovery
Sea level Rise	This phenomenon can affect the resort over the years to come.	Tidal Rise Contingency Plan	Alert, Response

ABR Limited will take into considerations these four disasters and plan accordingly in order to mitigate and remediate the negative effects these disasters could have on the infrastructure and operation of the project.

8.1.1 Management Structure

The management and staff (employees) of ABR will formulate an Emergency Committee to address the aforementioned disaster management plans. The committee will be charged with electing an Emergency Coordinator, who shall direct all the activities outlined by the plans. The committee shall also appoint assistants should the one in charge is not available. The emergency committee must conduct periodic meetings to address important issues concerning the disaster management plans. Such important issues should be the objectives of the committee, their roles and responsibilities, updates as well as their terms of reference (TOR) which they will abide by.

8.2 Hurricane Preparedness Plan (Evacuation Plan)

This is the most common natural phenomenon occurring in Belize and the only one that would require a full scale evacuation. Belize lies within the hurricane belt, and is vulnerable to high wind and storm surge. During the past 100 years, Belize has been hit several times by major hurricanes. Belize has been hit 40 times by storms ranging from tropical depressions to hurricanes (Usher, 2000). The return period for storms since 1870 is three (3) years, and the vulnerability increases from North to South (Usher 2000).

The hurricane season in Belize commences officially on June 1st and ends on November 30th. As part of its overall Management Plan, the EIA has also considered the issue of safety needs resulting from potential threats other than hurricane. The Hurricane Preparedness Plan (HPP) is aimed at making reasonable preparations should ABR Limited be threatened by an imminent Tropical Depression or Hurricane strike. This is to enable the developers to protect their employees and assets, and also to ensure that the project is able to continue to function after the hurricane has passed.

For this plan to be effective there will be a full meeting between the management and the employees to review the plan prior to the beginning of the Hurricane Season every year: There will also be simulation exercises in relation to various elements of the plan.

8.2.1 Purpose of Plan

The purpose of this hurricane preparedness plan is to:

- (i) increase awareness to land owner, management and others of the need for hurricane preparedness,
- (ii) To establish the coordinating mechanisms necessary for ABR to prepare and implement measures to safeguard property and lives of all concerned during the threat of a storm or hurricane.

The basic responsibilities of the ABR Management is to ensure that the coordinating mechanism that will ensure maximum safety of property or lives during an incoming storm, is put in place, and to make sure the developer or residents/guests are familiar with the mechanism.

8.2.2 Storm Information System

The "official alert" system for hurricane entails coordination between the management of ABR, National Emergency Management Organization (NEMO) and the Belize National Meteorological Service (NMS). The ABR Management will also supplement their information on the threat of a hurricane from the Internet with satellite tracking maps. The emergency coordinator will therefore activate the Hurricane Plan.

8.2.3 NEMO Storm Categories

ABR will follow the official alert system currently in place by NEMO.
Hurricanes Categories and Wind Speeds can be described by the following:

Tropical Depression	29 mph – 38 mph
Tropical Storm	39 mph – 73 mph
Hurricane Category 1	74 mph – 95 mph
Hurricane Category 2	96 mph – 110 mph
Hurricane Category 3	111 mph – 130 mph
Hurricane Category 4	131 mph – 155 mph
Hurricane Category 5	Above 155 mph

8.2.4 NEMO Summary of Hurricane Warning Flags

ABR will adopt the official Warning Flag System as follows:

Flags	Phases
One Red Flag	Preliminary Alert Phase (Storm/Hurricane Watch)
One Red flag with Black Center	RED I Phase (storm or hurricane watch)
Two Red Flags with Black Centers	RED II (Warning Phase)
One Green Flag	Green Phase (ALL CLEAR)

8.2.5 Pre-Season Preparation

At the beginning of May each year the Emergency Committee of ABR Limited will elect an Emergency Coordinator and he/she will ensure that the following items are available and properly maintained ready for use and that every member of staff is familiar with this document:

- Emergency lighting, including both plug-ins and flashlights with spare batteries and bulbs.

- Electrical tape with spare heavy-duty extension cords.

- Standard first aid kits fully up to complement.

- Rainwear, rubber boots, hard hats, gloves, swim vests.

- All hand held radios are functional with spare batteries and chargers.

- Duct tape minimum 12 rolls 2”. Spare rope 5/8” 200 feet.

- Tools, hammer, nails. Sledge hammer, axe.

- Lumber, both 1” and 4”, also plywood sheeting for protection of windows etc.

- Ladders, tow bar/chain.

- At least two tarpaulins for damage control.

- Wrecking bars for use afterwards.

The Emergency Coordinator will ensure that all of these equipments are checked and available at all times during the hurricane season. During the hurricane season, any overhanging trees at ABR will be trimmed. The Emergency Coordinator of ABR Limited will also ensure that all buildings and assets such as equipment, boats and vehicles are photographed (digital with date) at the beginning of each hurricane season, for possible insurance claims.

The Emergency Coordinator will also ensure that all company boats are inspected for serviceability and maintained with full fuel tanks at all times. The assignment of boats for hurricane emergency response purposes will be made at the beginning of the hurricane season. All portable electrical generators will also be inspected and the fuel tanks maintained full. All fire and portable water pumps will be similarly inspected and kept in a state of readiness.

The Emergency Coordinator will also ensure that all non-national employees are registered with their respective Embassies or Consuls.

8.2.6 Implementation Plan during Threats

Preliminary Alert - Hurricane Watch

This is the First Phase, and means that a storm or hurricane may threaten within 72 hours. A storm or hurricane is within 21° N 80° W of Belize.

Actions to be Taken:

(i) The Emergency Committee should be prepared to convene and take action if the Belize Weather Bureau issues a warning.

(ii) Stay informed by radio and television of the storm progress.

(iii) Obtain hurricane tracking chart for Committee members and project management,

(iv) Obtain the contact number etc. from the ABR Management, including residents and guests with marine vessels, and inform vessel owners of the alert phase,

(v) Ensure that contact is made with all guests and captains of vessels, whether by direct or indirect means to alert them of the phase and to make initial contact.

(vi) Prepare a checklist (electronically) of items required in the event of a strike

(vii) The Emergency Coordinator will identify and categorize items or equipment to be removed as follows: list of equipment to stay, and list of those to be removed to designated site.

(viii) Prepare a tentative list of all the guests and management staff on the island.

Hurricane Warning – Red 1 Phase (Watch)

During this phase, a hurricane may threaten within (36) thirty-six hours. A hurricane or storm is located within 20° N 85° W.

Actions to be taken:

(i) Advise all vessel Captains to leave the marine areas immediately and take their vessel to safe harbor.

(ii) The Emergency Coordinator will advise all employees and available human resources to install the hurricane shutters on the villas, hotel and other buildings.

(iii) Advise all occupants of the island including guests and employees to be prepared to evacuate the island upon the recommendations of NEMO.

(iv) Identify official shelter for ABR Limited guests and island residents and any other employee in need of such shelters,

(iv) The ABR Limited Management will identify employees to report to work after the hurricane or after the Green Phase all clear is given.

(iv) Update NEMO on all actions taken.

Hurricane Warning – RED 2 Phase

Whenever Phase 2 (Red) is given, this means that a hurricane is likely to strike Belize within (24) twenty-four hours.

Actions to be taken:

(i) The checklist of items required will then be printed and each head of department will be provided with a checklist,

(ii) The precautionary list (See below Annex 1) will be printed and provided to each head of department,

(iii) Final hurricane preparations should be concluded

(iv) Evacuation of employees, guests and residents should be completed

Fourth Phase – Green (All Clear)

This is the ALL CLEAR, which will be declared by NEMO after the hurricane has passed and it is safe to return to review the effects of the hurricane.

Actions to be taken:

(i) The Emergency Committee will attempt to return and survey the project site as soon as possible,

(ii) The Emergency Committee will immediately make a brief report on all damages (supported with photographs), and prepare an estimate of damages, and submit the same to NEMO and Management for their perusal.

(ii) Employees of the project ownership will report as previously advised.

(iii) Clean-up phase will commence with the assistance of project employees, and all available human resources, where possible.

8.2.7 Safety Precautions

These precautions will be made available to each caye occupant and employees in the event of a hurricane. These will be delivered during Phase 2 – Red Warning Phase, and shall be updated every year by the Emergency Committee.
The following are some basic precautionary guidelines:

1. Pay no attention to rumors. Only rely on the official reports and weather advisories but under no circumstances telephone the Weather Services, nor any other national radio station) or B.T.L. exchange as this will hamper the hurricane tracking and information service for everyone.

2. Close and secure all hurricane shutters properly.

3. Be sure that a window or door can be opened on the side of the house opposite to the one facing the wind.

4. Be sure that you have an adequate supply of drinking water as well as canned food or other food that needs no cooking or refrigeration. If you own a coal or kerosene stove get it into working order and procure a supply of kerosene and coal as it may come in handy after a hurricane.

5. Keep a good flashlight handy as well as candles and storm lanterns as the electricity supply will likely be cut off or knocked out during the storm.

6. Check on everything that may blow away or be torn loose during a storm and store them inside the buildings if possible. Remember that garbage cans, garden tools, signs, awnings and other objects may become weapons of destruction in hurricane winds.

7. If the center of the "eye" of the storm passes directly over you, there will be a lull in the wind lasting from a few minutes to half an hour or more depending on the speed of movement of the hurricane. Remain in a safe place. Make emergency repairs if necessary during the lull, but remember that the wind may return suddenly from the opposite direction, frequently with even greater violence.

8. Never leave your shelter until the official "ALL CLEAR" has been given.

8.3 Fire Prevention and Response Plan

Fire outbreaks are considered a life-threatening event should it occur. It is therefore important to have a conscientious approach to the likelihood of this event. This plan outlines the standards and practices that will minimize the risk of fire danger, and in case of fire, provide for immediate suppression and notification. Presently, the National Fire Service closest fire station is 18 miles away in San Pedro Town. Any fire incident occurring on the project will have to be dealt with locally.

8.3.1 Purpose of Plan

The purpose of this Fire Prevention and Response plan is to:

(i) increase awareness to guests, management and others of the need for a fire prevention and response plan,

(ii) To establish the coordinating mechanisms necessary for ABR Limited to prepare and implement measures to safeguard property and lives of all concerned should a fire occur in a building

(iii) Indicate all possible evacuation routes for each condo, villa and other buildings on the property.

The basic responsibilities of the ABR Management is to ensure that the coordinating mechanism that will ensure maximum safety of property or lives during a blaze, is put in place, and to make sure the developer or residents/guests are familiar with the mechanism.

8.3.2 Fire Prevention

Fire prevention is an important aspect in precluding its occurrence. While water is plentiful at the project site, its immediate availability may not be possible. Measures designed to prevent and control fires include:

I. Use of fire retardant material

The use of nonflammable building material will be encouraged within the project. For example the use of sheet roofing instead of shingles will be encouraged and the use of fire rated doors and fire resistant barriers.

II. Qualified personnel to install electrical system

Only certified wiring Technicians will be allowed to carry out any electrical work on the premises. This will need to be approved by the Belize Electricity Limited.

III Building Codes

The project will call for the construction of condos, villas, a hotel and commercial buildings, with heights above (1) one and (2) two stores high. A set of building codes will be developed by the engineers of the project, in order to ensure adequate construction of buildings. The engineering standards will also include provisions for adequate and safe wiring; plumbing, heating, and cooling systems are also in conformity with acceptable building codes.

8.3.3 Fire Protection Equipment/Systems

All the units and buildings on the property will be protected from fire in one form or another. ABR will install these systems to protect lives and property. The following are fire detection, notification and suppression systems that can control a fire.

1) *Fire alarm detection and notification systems.*
   - *Smoke and heat detectors:* The project will install fire detection equipment in the form of smoke and heat detectors in each of the units and in the building hall ways and walkways. The smoke/heat detectors will activate the smoke alarm possibly signaling a fire or of something burning.
   - *Manually activated pull station:* Certain buildings will also have a manually activated pull station in the event that someone sees a fire. It is essential that both guests and staff are aware of these warning devices and their potential use in detecting fires.

2) *Fire Suppression Systems.*
   - *Sprinkler Systems:* The only sprinkler system that will be installed is in the hotel's upper level floor. This is because of the high risk of a delayed response. Sprinklers will be installed in every unit of the floor and water for this system will be gotten from the recycled wastewater via a pressurized system.
   - *Hydrants:* Fire hydrants will also be used on the project. These hydrants will be spaced out according to each developmental zone and zone densities. Water for these hydrants will be gotten from the recycled wastewater. A portable water pump with hoses will be coupled to the hydrants and used to extinguish the fire.
   - *Commercial Kitchen hood exhaust/suppression system (foam):* This only applies to the restaurants on the property. Industrial ranges have an exhaust hood to vent fumes and integrated in the hood is a fire suppression system consisting of a foam water mixture.
   - *Fire Extinguishers:* ABR will install multi-purpose dry chemical (Class ABC) fire extinguishers. Dry chemical extinguishers will range in sizes of 5 lbs to 10 lbs and will be installed in every building, condo, and villa as well as in the hotel rooms. These will also be installed at key areas such as hallways, walkways, piers, containment walls, generators, electrical panels, maintenance areas, ect.

8.3.4. Fire Response

It is difficult to portray a response plan for the project site considering the different scenarios that might arise from a fire. It is important though, to have in mind certain tips and guidelines as to the advent of a fire. These guidelines may come in the form of a fire combating plan where by trained workers would utilize the fire extinguishers to extinguish small fires or utilizing the fire hydrants and sprinkler system to smolder bigger flames.

Another important guideline also comes in the form of an evacuation plan involving fire. Although an unlikely occurrence, it is important that the project develops such a plan, especially for the hotel, restaurants and other areas constantly congested by guests and visitors. The evacuation plan will involve the use of evacuation cards to disseminate the procedures and conditions necessary for an evacuation. These cards must be handed out and made known to each member of staff and management as well as permanent residents on the resort. These cards should also be posted in each building, condo, villa, as well as public areas.

8.4 Spill Contingency Plan

The Spill Contingency plan provides an organizational structure and procedures for preparing and responding to spills and leaks. This plan is to be used by ABR Limited in response to petroleum product spills and/or leaks.

Each spill is different and it is not practical to develop a spill response procedure, which will encompass every situation. It is better to understand the goals of the response plan in order to tackle every spill situation. Such understanding coupled with training will enable those involved in the response effort to determine the best practical procedures given the various conditions.

8.4.1 Purpose of Plan

The purpose of the plan is to outline the procedures necessary to reduce and contain the effect of a spill by means of a well-coordinated response and is intended for the following purposes:

- To increase staff awareness on Spill Response procedures taking into consideration the different governmental Tier response levels.
- To define the coordinating mechanisms necessary for Managers and support staff to utilize their resources in Response Procedures.
- To establish and define clearly the roles and responsibility of Management in Spill Contingency and Response procedures.

8.4.2 Mechanism

This plan institutes the need for a timely and effective response to incidents. In order to respond rapidly and successfully to a spill, personnel responsible for containing and cleaning up the spill must know the steps that need to be followed during and after the spill. Contingency plans describe information and processes for containing and cleaning up a spill that occurs in a defined area of the project. Because the approaches and methods for responding to oil spills are constantly evolving, and each spill provides an opportunity to learn how to better prepare for future incidents, contingency plans also are constantly improving and providing increased protection to human health and the environment from these accidents.

8.4.3 Response Policy

The following tables are DOE Tier levels as described by the National Emergency Preparedness Plan for Oil Spills (NEPPOS)

Table 8.2 Marine Spills Levels

Tier	Quantity (gals)	Location	Response
I	1,000-10,000	Coastal/ Marine	To be manage by polluter
II	10,000-100,000	Coastal/ Marine	Requires government assistance for management
III	>100,000	Coastal/ Marine	Requires Government and/or external assistance

Table 8.3 Inland Spill Level

Level	Quantity	Location	Response
A	<1,000	On land or Inland	To be manage by polluter
B	>1,000 or poses significant health hazard and requires evacuation	On land or Inland	Responsible party requires GoB assistance to manage the discharge.

For the purpose of this project both Tier I and Level A will be considered. This is especially so because of the fuel transportation from the mainland or San Pedro town to the project site, as well as the project's daily operations.

8.4.4 Fuel Management

Fuel management is a very critical safety issue considering the remoteness of the project site. It is however, not a difficult task to do considering the small to medium volumes that will be handled by the project during construction and operation. Fuel will be managed to prevent spills and leaks via the following:

- *Storage:* Fuel will be stored inside a reinforced concrete containment wall. This will be designed to contain 110% of the maximum tank volume. To protect against any accidental fire the tank will be sited away from all electrical installations within the utility zone.
- *Documentation:* It is important to keep in mind that the project must order the correct amount or volume of fuel required for operation. For this reason, all the fuel consumed and received must be recorded.
- *Maintenance:* It is necessary to inspect all containment walls and fuel containers. Improper functioning of these can lead to unnecessary spills and leaks. Another important issue is fuel lines. The less there are, the better. It is with that reason that the fuel tanks must be as close as possible to the generators.

8.4.5 Waste Oil Management

Although not required to be developed fully considering the volumes produced, it is important however, to reiterate that the project is in an ecologically fragile environment. Small oil spills for this matter, do fall under the Spill Contingency Plan. Waste oil will be managed according to the following:

- *Storage:* All waste oil will be stored in properly sealed drums and inside a containment wall. This would most probably be inside a fuel tank containment wall.

- *Handling:* Used oils are a legal responsibility of ABR and thus should be handled adequately and with care.
- *Disposal:* Although the volume may be very small, it is important to properly discard the accumulated waste oil. Once stored, the waste oil should be disposed in conjunction with that of a neighboring resort or industry such as the Ambergris Aquaculture Limited hatchery.

8.4.6 Contingency Equipment

Spill response equipment is the most important component in the Spill Contingency Plan. This equipment can vary depending on the size and type of the activity. For the interest of ABR the following equipment will be required:

- Spill response Kits – these will be made available to the maintenance staff and installed at key locations such as generators, boats, ect.

- Containment Booms **–** these are mostly for marine spills and will be deployed in need be the case.

8.4.7 Safety and Response Priorities

The Emergency Committee for ABR Limited will ensure that the following priorities are taken into consideration:

- Safety to human life is the highest priority in any response, and should be ensured that all management personnel are protected.
- Containment of incident to stabilize the situation.
- Minimize and prevent any adverse environmental impact

Basic response information that should be available whenever an action is taken includes the following:

- Type of oil involved: this could be lubricating oil, engine oil, waste oil, diesel fuel, and gasoline fuel.
- Size of spill: this includes all the Tier levels described by DOE.
- Location of spill: this involves the shoreline and entire caye.
- Prevailing Conditions: choppy seas, windy, rainy, overcast, sunny, calm, low/high tide.
- Environmental sensitivity of potential or actual impact area: this includes the sensitive area of the beach and inland locations.

Chapter 9

9.0 Integrated Social Assessment Review

9.1 Background

The island of San Pedro Ambergris Caye is situated about 36 miles from Belize City and is the largest island in Belize in terms of tourism activities, infrastructure and marine destinations (protected areas). The main economic stay and employment opportunities is generated from tourism and related activities. The central settlement on Ambergris Caye is San Pedro Town (**Fig.** 9.1), which is the focus of Belize's marine attractions. The Town is made up of various cultural and ethnic groups from within which these communities are the main service providers to the tourism industry.

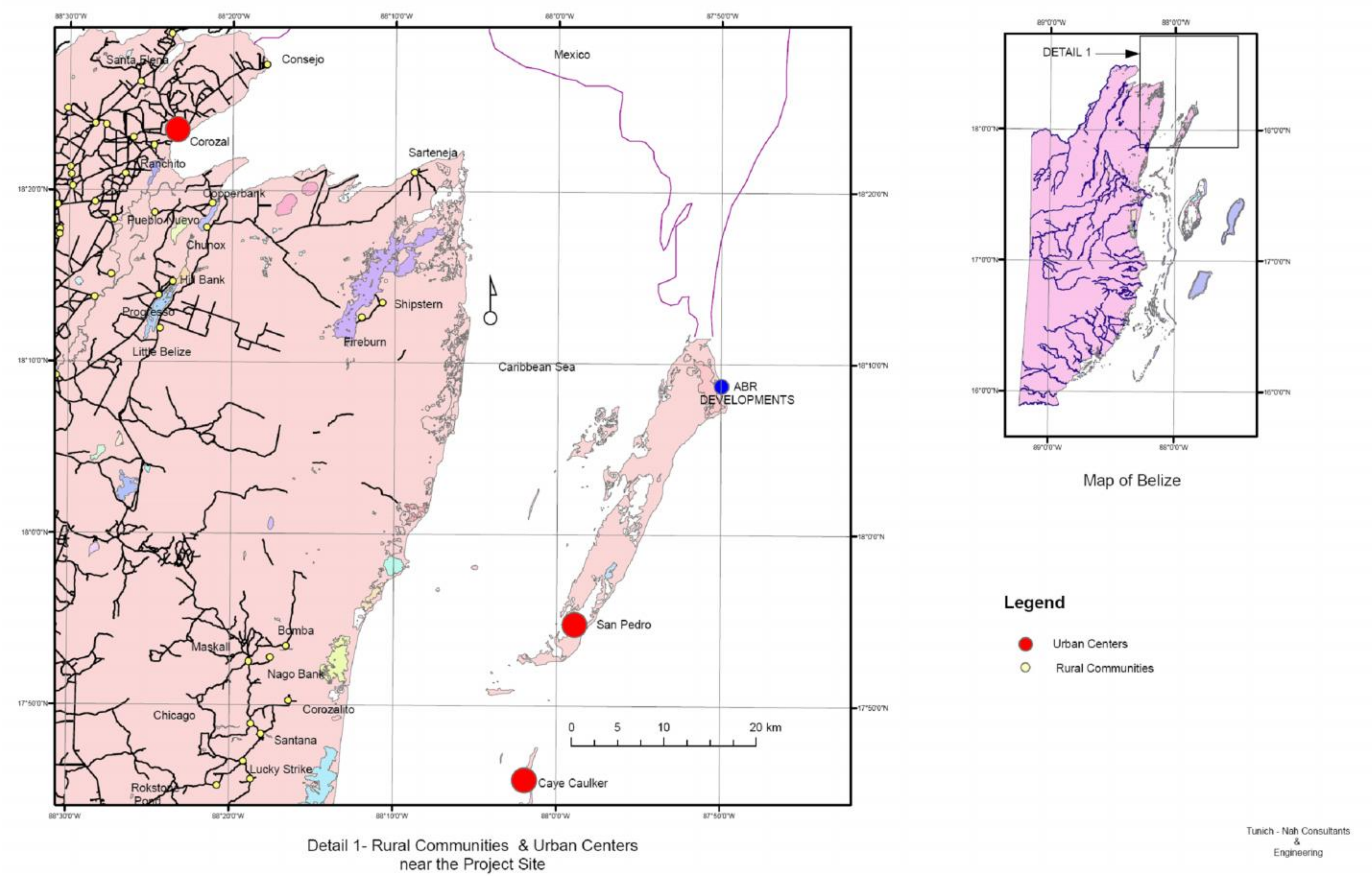
Demographically, the other nearest town is Corozal, with a calculated population of about 35,829 (2006) including other smaller villages dotted along Corozal District coast (**Fig.** 9.1). Similarly, the fishing/tourism village of Caye Caulker with a population of about 2,000 is situated about 10 miles south of the town of San Pedro and about approximately 31 miles from the proposed development site. The Mexican border town of Ixcalak is located some 9.8 miles north of the proposed development site.

Over the past two and a half decades, population on the island of Ambergris has increased to over 50% due to the rapid increase in tourism activities. Reflecting this dynamism, tourism and residential developments have also expanded north of the Town beyond the San Pedro River and along the coast to past Boca Bacalar Chico. Scattered along this windward or eastern side of the island, are the many residential and holiday homes, hotels and sea-side resorts. Because of its pristine environment, areas along both the north eastern and north western sides of Ambergris have been declared protected areas with built in conservation zones.

In terms of infrastructure development, construction materials, equipment, goods and supplies are transported weekly from Belize City to the island of Ambergris Caye in large and small cargo barges. Locally, smaller barges and boats transfer cargo to areas north of Boca Del Rio (San Pedro River) to construction development sites north of the River.

In terms of transportation and access to and from the town to northern Ambergris, there is a track or road commencing from Boca Del Rio to about thirteen miles north of the River; mainly golf carts and bicycles utilize this track or road. From this point, the beach area and smaller tracks are utilized by locals to access the areas of northern Ambergris. There is no road access to the area of the proposed development site however there is a designated road reserve. Noteworthy, the main access to areas north is by boat.

Besides the various hotels/resort scattered along the northern coast of Ambergris Caye, the NOVA shrimp farm established in late 1997, is the only other private industrial developer in the area. This shrimp farm is located some 13 miles north of the town of San Pedro and has established its own private commercial pier adjacent to the property. A small airstrip is located



Detail 1- Rural Communities & Urban Centers near the Project Site

Fig. 9.1 – Rural Communities & Urban Centers near the Project Site

some 1.3 miles south west of the NOVA site. Shrimp larvae from the farm are transported from the NOVA site to Cucumber Beach near mile 3 along the Western Highway.

9.1.1 Introduction

The proposed development is for tourism facilities on northern Ambergris Caye, situate just north of Boca Bacalar Chico and about 21 ± miles north of the town of San Pedro (or about 53 miles from Belize City along the eastern coast). Proposed development activities include the construction of hotel facilities, of 105 rooms and 6 over-the-water cabanas.

At completion, and at full capacity, the proposed development is expected to have some 578 residents and holiday-makers, and a staff of 289 persons and an estimated 100 transient visitors. The proposed development will also include the construction of two elevated walkways on the western or lagoon side of the development. Two piers, one to be utilized for tourism activities and the other for hotel loading and unloading of supplies and materials will be constructed on the windward side of the development. Tourism activities will include snorkeling, diving, canoeing, kayaking, catch and release and fly-fishing.

It is anticipated that the area of land at both the southern and northern end of the property will be left in its natural state as a buffer zone for the proposed development. The Developer will also look toward the area of land along the lagoon (Lagoona Cantena) to be left in its natural state as part of the Boca Bacalar Chico National Park.

9.1.2 Core Concerns of the Social Assessment

The core concerns of the social assessment are intended to identify those social, cultural and economic activities within the area and region as it relates to all aspects of the proposed development. The social assessment will also identify proposed transportation routes and related conservation environments as it relates to the proposed tourism development activities. Only after the identification of related core concerns, those associated impacts can then be analyzed for both positive and/or negative impacts in respect to the proposed development.

The following assessment is merely an examination of those issues [that may be] related to project development activities and is not intended to change or modify social groups or values of communities or daily activities. It is intended to compliment and enhance the execution of the development activities during all phases of construction and, completion of the project. It is also important to mention however, that the proposed development will bring increased economic opportunities to the area and the country on a whole.

9.2 Demographics

Those related socio-cultural, economic and demographic data in the area and region of the proposed development site will assist in identifying relevant information which may be impacted by proposed development activities.

9.2.1 Population and Housing

In 2000, population census on the island of Ambergris Caye was estimated at 4,499 with 2,289 males and 2,210 females and 1,519 households. However, unofficially, population count on the whole island is estimated at 15,000 (pers.com.). This is also based on the fact that during the last elections, about 5,000 votes were casted (pers. com.).

The town is hemmed in by highly expensive private properties, particularly on the windward or reef-facing side of the caye. Private sector residential, commercial and tourism related growth continue to take place in these areas, with increasing higher density near the town center. This growth increase has seen the need for additional residential subdivisions to accommodate the local San Pedranos and the influx of worker populations. Further town expansion will have to be undertaken southwest of the town in the less valuable mangrove swamp. Expansion of public residential subdivisions north of the San Pedro River is prohibited by private properties.

Many private residential subdivisions have been carried out in northern Ambergris on both the western and eastern coast of the island north of the San Pedro River. However, these are mostly private subdivisions with high price values. It is noted however, that there are remaining public lands (on northern Ambergris) which could accommodate local residential subdivision for new resident and worker populations, but this effort may prove very expensive as the areas will require expensive fill and road access to these areas.

The proposed development will construct staffing quarters to accommodate temporary and permanent worker populations during all phases of development. However, there is a proposed road reserve to access the proposed development site, which should facilitate temporary and permanent worker populations' return travel to residential homes in the town of San Pedro.

9.2.2 Employment

Ambergris Caye prosperity is dependent on tourism which takes an ever increasing share of the islands' economic and human resources. Over 80% of employment activities are associated with the tourism and spin off sectors. In employment terms, the economy of San Pedro is dominated by tourism and associated activities. Innumerable job opportunities are created by tourism and related activities and services which have attracted many individuals from throughout Belize including Caye Caulker, Corozal: immigrants from Central America continue to mix with the local and island population.

Fishing, previously the dominant activity has declined and now only accounts for a small percent of full time fishermen. Two non-basic employment sectors include commercial and administrative services, and construction, which is largely generated by the tourism industry.

There are existing worker populations on the island such as tour guides, construction workers, hotel mangers, etc, which could be utilized in related infrastructure works and activities during and after construction phases of the project. However, any large influx or new worker populations not found on the island will marginalize existing worker populations on Ambergris Caye.

9.2.3 Social Infrastructure

The highest level of infrastructural service is found in Belize City. Based on the analysis of population growth and inward migration to the island, the town of San Pedro has a major gap in most of its services. For example there is only one high school including a 6^{th} form, one public primary school and 8 private primary schools. The St. Luke's University School of Medicine and University of the Americas are two medical colleges on the island.

There is one public polytechnic clinic hospital, one dentist, one eye clinic and about 6 private clinics. The clinic includes 1 doctor and 4 nurses; which does not satisfy the daily population needs. The one doctor is the only public doctor on call on the island. There is no overnight hospitalization. Though, private health practices on the island also include two general practitioners, the Lions Club and the Wings of Hope for local and international medical emergencies. These facilities serve both the locals and tourists alike.

More recently, an ambulance service was established, a new fire house constructed to house two new fire trucks, a tourism center inaugurated, and the San Pedro airstrip and streets were resurfaced to ensure safety of people, airplane and vehicular traffic. Future infrastructural projects for San Pedro include a new civic center, a new police station, a new stadium, new basketball court and new health center. The town also has 12 churches and about 125 bars.

The proposed development project to be undertaken will not necessarily have any impact on the schools in the area. The impact will occur if worker populations with families are relocated to the island for work related activities. In terms of emergency services, the recommendation is that the proposed development comprises its own in-house doctor and facilities and emergency facilities especially in light of the fact that the proposed development site is situated some 21 miles from the center of San Pedro Town.

9.2.4 Communication and Services

In line with world trends in communication, San Pedro Town boasts a TV station, cable network, fax machine, fixed regular telephone, cellular and Belize Direct, and internet and email services. No communication or other ancillary services have been established at or near the site of the proposed development. The nearest partial ancillary service is at least six miles from the proposed development site.

With the advent of the proposed road to be constructed, communication and services at the proposed development site should be facilitated.

9.2.5 Cultural

Culturally, the island continues to see growth in both ethnic and racial mix. The original inhabitants have long since been integrated with new additions to the island. The increase in tourism and the construction of new and bigger hotels on the island have seen an influx of Central American immigrants to the island to satisfy construction needs. Though integrated, this has caused a great deal of impacts to existing lifestyles and local social institutions. It is important to mention however, that a large number of Belizeans from all over Belize have also migrated to the island for employment within the tourism industry. Many of these individuals seek and find employment, and on many occasions a few have returned to the mainland or place of origin.

Noteworthy, the island will continue to see ethnic and racial mix overtime; it is a natural human social process.

9.2.6 Traditional Activities

In terms of tourism, fishing remains an important economic activity within the Bacalar Chico Marine Reserve (BCMR). Fishermen from Sarteneja and Corozal utilize the BCMR for extractive commercial fishing, while most of the fishing activity by San Pedro-based users is centered on extractive sport or tourism-related fishing. Both of these groups recognize the declining economic return of extractive fishing, and the increasing economic potential of tourism-related activity, and have enlisted in programs that promise to enhance their capacity for more sustainable and economically viable livelihoods.

Boats from San Pedro make regular day trips to fish on the eastern side of the BCMR for lobster and conch, while Fishermen from Corozal and Sarteneja stay and fish in the area for one and two weeks. Based on the Bacalar Chico Management plan, two families from Sarteneja and one from Corozal Town use the area, setting traps for reef fish from May to September.

Since the declaration of the BCMR’s zoning regulations, no additional traps have been allowed within the reserve. However, a substantial amount of illegal fishing is taking place in the area by both Belizean and Mexican fishers alike, but the impact of these activities has never been quantified. Again, it is noted, that the number of traditional fishermen from San Pedro has declined over the years because of tourism growth and associated activities.

Information gathered indicated that during various times of the year, the area of the coast between Punta Azul and Rocky Point is utilized by various individuals (beach combers) where they collect whelks, coconuts, conch etc. The hotels use the whelks for boca (finger food) while the shells are recollected and sold to individuals from Belize City to make local jewelry for sale. Coconuts from the area are also collected for use in San Pedro. Coconuts and conch are sold on the local market for drink and local dishes.

It is noted that no fishing and or the collection of conch is prohibited in the marine reserve.

9.3 Land Tenure

In the early 1990s a large portion of northern Ambergris Caye was in public hands (acquired crown lands). Today, all the lands along the eastern coast and to some degree most of the land along the western coast of northern Ambergris is privately owned leaving a moderate amount of public lands vested in the Government of Belize.

Land tenure near the proposed development site is private. There was also a proposal for a tourism/resort development for the piece or parcel of land immediately south of the proposed development site, however this was never materialized.

Field visit along the coast commencing from the Nova Shrimp farm heading north reveals many small local hotels and privately residential developments, one over - the water restaurant and bar and one over - the water residential wooden structure. In many cases, perhaps because of the limited access to properties along this coast, construction of many the homes were commenced but have since been abandoned. It was also noted that there were quite a number of properties for sale along this eastern coastline.

9.4 Transportation/Access

9.4.1 Sea Access

Currently, the only access to the proposed development site is by sea. Travel time from San Pedro to Boca Bacalar Chico via the eastern or windward side of Ambergris Caye is about one hour in moderate weather conditions. Travel time from this eastern side is not recommended in heavy seas as boats must pass over the reef at Rocky Point to gain access to the northernmost span of the Barrier Reef Lagoon.

Travel time from San Pedro to the Bacalar Chico Canal entrance via the western side of Ambergris Caye is about an hour and a half, with an additional 30 minutes to traverse the Bacalar Chico Canal to the eastern side of the BCNP/MR (approx. 29.6 miles). The western approach can be used in most weather conditions, however it is only suitable for shallow draft vessels as the maximum depth along this coast is about 1.5 - 2.0 meters (or 4.92 – 6.56 ft.).

Travel time from Sarteneja Village, 20 – 25 kilometers (18 – 23 miles) across Corozal/Chetumal Bay, is about an hour and a half, however it is limited to shallow draft vessels. During November to March, navigation on the western side is affected by strong northerly winds. Wind speeds during these conditions can blow from the North or West at 15 – 25 knots causing rough sea conditions and virtually zero navigation visibility.

Channel Cuts along the eastern or windward side of Ambergris Caye

The following includes those reef cuts and access areas in the region of the proposed development site. These were included in order that the developer and associated employees/

marine vessels could get an indication of the inaccessibility of traversing in or near these areas during post and completion development phases, as well as to warn as to the dangers especially in times of rough seas and during times of emergency.

Habaneros

Access to the Habaneros channel, south of Punta Azul, is about 5 miles from the proposed development site and has limited characteristics. Access via this point is difficult as there are many coral heads which are close to the surface. The depth within the middle of this cut is 2.3 meters (7.55 feet).

Punta Azul

The channel at Punta Azul is 100 meters wide (328.08 ft.), but once inside the reef, the lagoon depth is very shallow limiting use to boats with one meter draft. Entry through this access point heads parallel to the reef crest and then north once inside the reef. Once inside the reef the channel and lagoon area is very shallow. The depth within this channel is 3.35 meters (10.99 ft.). In the lagoon the depth varies from 2.55 meters (8.37 feet) to 1.45 meters (4.76 feet). Scattered patch reef in the reef lagoon make navigation extremely hazardous.

Basil Jones

Basil Jones has the deepest access point through the reef crest north of the San Pedro River (Fig. 9.2). The narrowest navigable width is 50 – 70 meters (164.04 – 229.66 ft.) at two locations. Here, the primary navigational hazard is sun glare between 5:30 and 8:30 a.m. depending on travel direction. Large changes in headings to avoid coral configuration combined with sun glare have caused locals to hit parts of the reef during passage. Strong currents in this channel have also affected navigation. Once inside the reef, the channel and lagoon area is very shallow.

Smaller Channels between Rocky Point and Basil Jones

All accesses are very small but navigable by knowledgeable local fishermen and guides under *very calm conditions*. During periods of rough weather and high wave conditions, these cuts are not navigable. The three channels have living and dead coral formations that extend to within a half a meter (0.16 ft.) from the surface and must be carefully avoided during navigation.

The shallowest point of these channels is generally on the seaward side of the reef crest where depths average 1.5 meters (4.92 ft.). The smallest width encountered within the three channels is 3 meters (9.84 ft.) and the largest is 5 meters (16.40 ft). However, navigational hazards of corals in the channels limit navigation width to 2 and 3 meters (6.56 – 9.84 ft.) respectively.

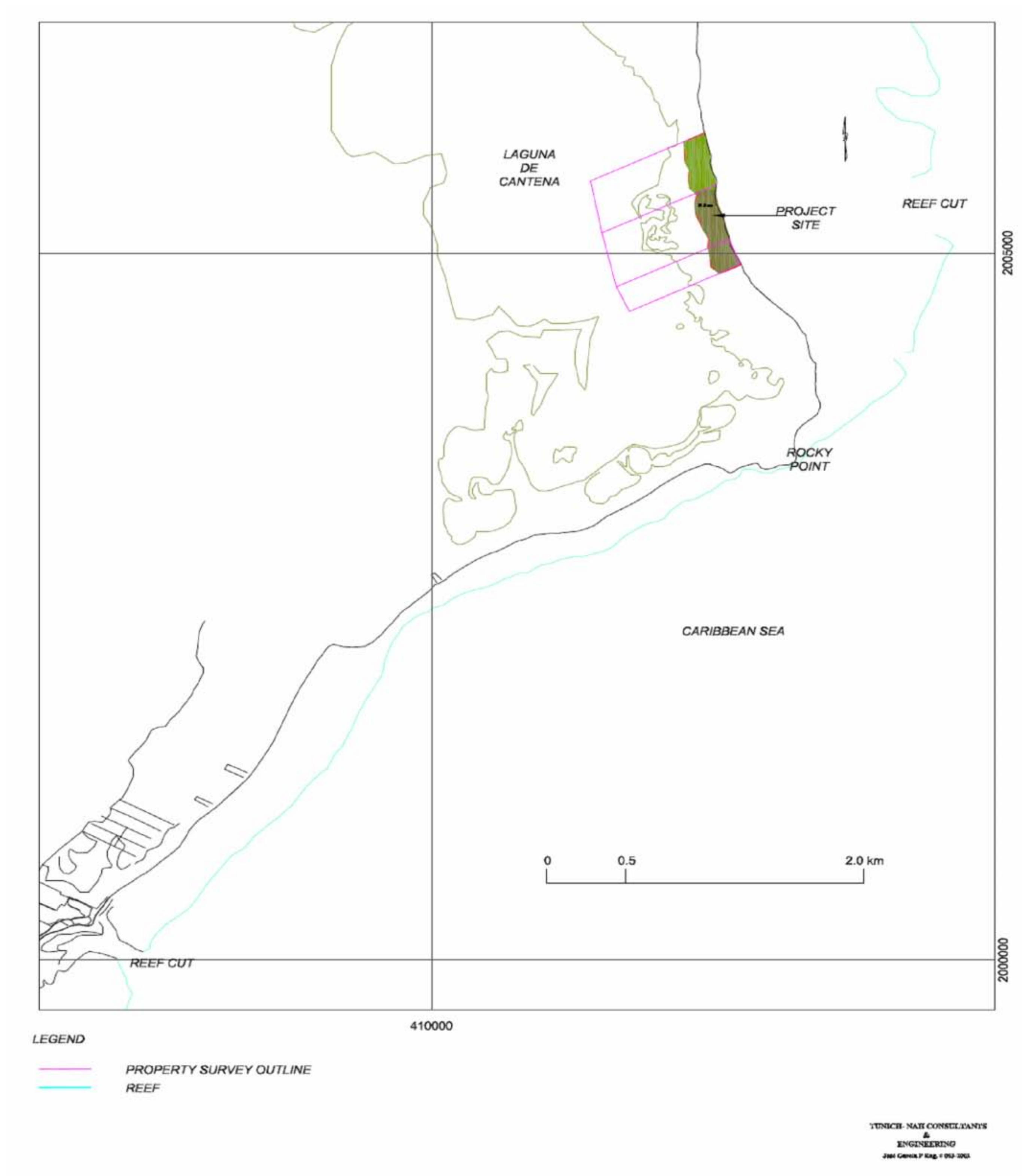


Fig. 9.2 Reef Cuts In the Region of the Proposed Development Site

Channels between Rocky Point and Bacalar Chico

There are two wide channels north of Rocky Point that have shallow depths (Fig. 9.2). These are the Two and Three Channel cuts named for the number of openings in the reef at these sites. Access through these channels is possible, weather permitting.

Two Channel cut has depths of 3.20 meters (10.5 ft.) to the north and 2.20 meters (7.22 ft.) in the south and in the middle of the channel the depth is about 2.00 meters (6.56 ft.). However, there is a patch reef just inside the reef in the middle of the channel where elkhorn coral comes within centimeters of the surface. The length and width of this patch reef is 40.00 and 21.50 meters respectively (131.23 and 70.54 ft).

Three Channel cut is about 2 miles north of the Mexico Border. Near the northern edge of the reef crest the depth is 1.50 meters (4.92 ft.); at the southern edge the depth is about 3.00 meters (9.84 ft.). In the middle of the channel, the depth is about 5.80 meters (19.03 ft.) and seaward of the reef crest the depth is 4.60 meters (15.09 ft.).

Access into Laguna de Cantena and Chetumal Bay

Accesses including Bacalar Chico and other tributaries are characterized by red mangrove borders and soft sand and silt bottoms with sparse to heavy growth of turtle grass. These waterways have areas of restricted width where only one boat at a time can easily pass; two boats would be unable to pass each other safely.

Depths into the Bacalar Chico and Laguna de Cantena begin at the cutoff from Bacalar Chico. At the turnoff point there is a large boulder that comes to within 1.75 meters (5.74 ft.) of the surface. Surrounding the boulder the depths are 3.50 meters (11.48 ft.). From here depths vary from 3.55 to 1.40 meters (11.65 and 4.59 ft.) in a small channel that leads into Laguna de Cantena.

Fig. 9.3 Laguna Cantena facing north showing a portion of Rocky Point on the bottom left and a portion of the proposed development site facing east.

Depth in a small lagoon that leads into Bacalar Chico Lagoon is 1.00 and 0.50 meters (3.28 and 1.64 ft.). The entrance into Bacalar Lagoon has a depth of 1.70 meters and southward across this lagoon the depth varies from 1.35 meters to 3.60 meters (4.43 to 11.81 ft) near a sinkhole and 1.30 meters and 0.00 (4.27 to 0.00 ft) at the southern end where sea grass reaches the air-water interface.

To get to Laguna de Cantena, Rio Cantena must be followed further south; here the depths vary from1.20 to 1.70 meters (3.94 to 5.58 ft.). The entrance from Laguna de Cantena is 1.20 meters (3.94 ft.) deep. Within the middle of Laguna de Cantena the depth ranges from 1.00 – 1.60 meters (3.28 ft – 5.25 ft) and at the southern end, the depth decreases to 0.50 meters (1.64 ft.)

9.4.2 Road Access

Currently, there is no real road access from the Town of San Pedro to the proposed development site north of Bacalar Chico. In the past, bicycles, golf carts and pedestrians would utilize an existing track to access areas north of the San Pedro River. Most of the northern Ambergris Caye home rentals are accessible by this sand or access track/road. However, all eastern coastal properties can be accessed by water taxis (boats). It is noted that road access to areas of northern Ambergris Caye has been one of the limiting factors to development activities.

In 2006, Northern Ambergris was connected by a bridge over the San Pedro River. Golf carts, ATVs, bicycles and pedestrians only are allowed over the bridge. The new triple span bridge, is 120 feet long and 23 feet wide, and is capable of allowing emergency vehicles passage (as necessary).

The 1992 Land Use and Zoning Plan for Ambergris Caye indicate that “there is an existing proposal for a road right of way from the San Pedro River north. The document further recommends that a road reserve of 40 feet should be made and “aligned along the most westerly edge of the beach ridge where it meets the mangrove flat and that this alignment should be mapped immediately.” The road alignment recommended is to be designed at the furthest point from the beach to allow site development flexibility as well as prove safer in times of emergencies (i.e. hurricanes). The road would be designated public.

Site visits to the area utilized both the track and the beach areas as in some instances the existing track was covered with vegetation. This track is not necessarily passable during the wet season, but is regularly used by beachcombers, tourists and locals alike to access the San Juan area. Based on the characteristics of the area, and especially near Rocky Point, reinforced road infrastructure works will need to be completed.

Beginning at NOVA, there is an existing proposal for a road reserve near Basil Jones. This proposed road will run north along the western boundary of NOVA Shrimp Farm and the eastern boundary of BELTRADE to a point, then east along the property boundary of land now or formerly Nella Reid. The Developer is in the process of negotiating to purchase the property at this point in order to facilitate the free flow of traffic at this point. From here, the road will run north in the middle of private subdivisions to near Robles and then along the westerly edge of the

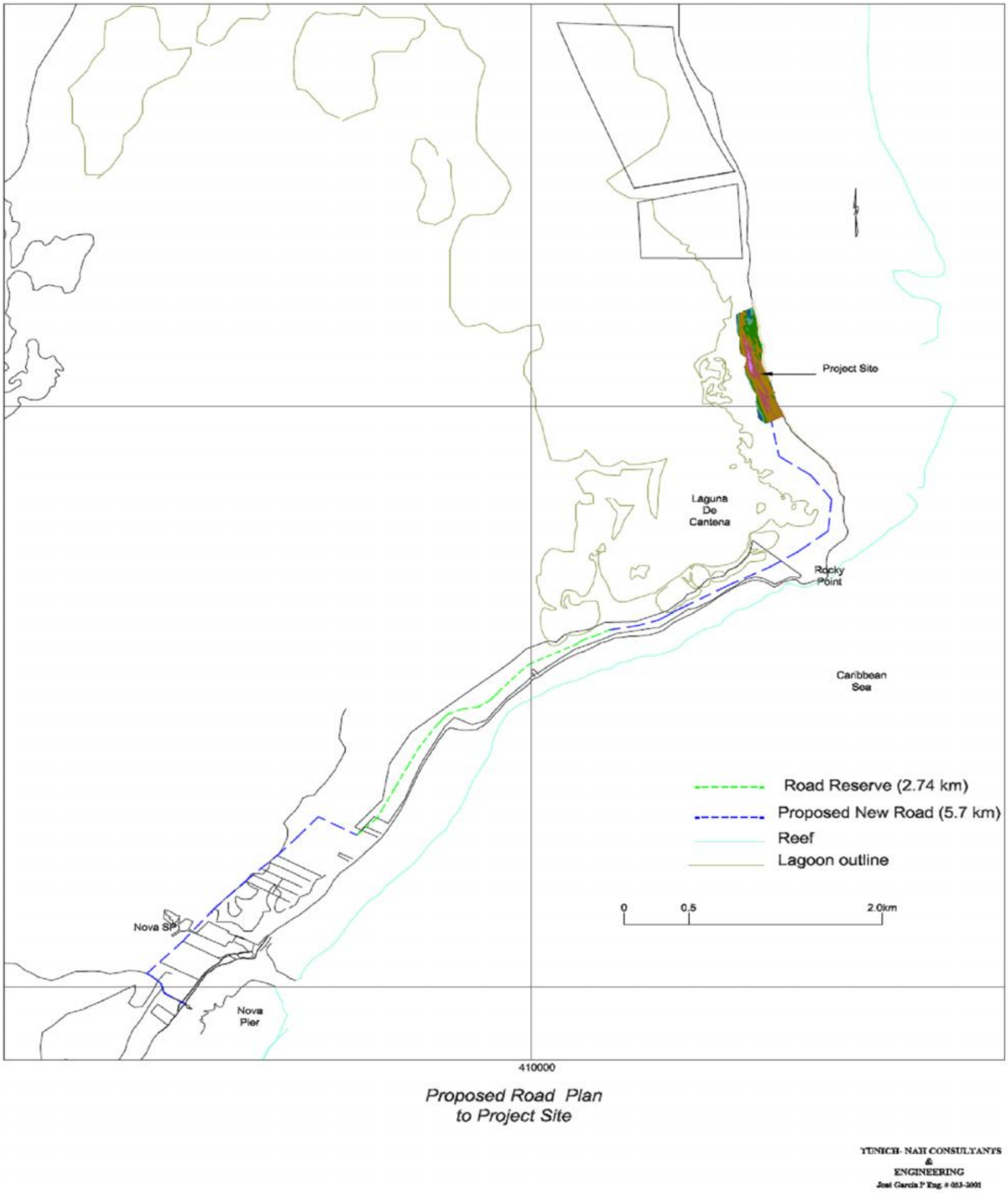


Fig. 9.4 Proposed Road to Project Development Site

beach ridge where it meets the mangrove flats to behind Rocky Point and Bacalar Chico to the proposed development site (**Fig**. 9.4).

It is noted that the San Pedro Town Council is aware that there is a proposal for a registered road reserve running north of the NOVA Shrimp Farm to near Robles Point. The construction of the road to the proposed development site will facilitate and improve new infrastructural services to the area, provide road access to areas not currently being developed by existing land owners, provide access to the site during all phases of development, will also be important in times of emergencies, and therefore will have less impacts on the marine environment. It is also important however, that the road should facilitate double lane for the free flow of traffic during all weather conditions. This road will require proper stabilization and planning.

The municipal or public pier near NOVA facility is located about 13.5 miles from the San Pedro River and from here along the coast is about 5.1 miles from the proposed development site. This municipal pier is utilized by the public to unload cargo and materials to access areas north of this point. From this point north, to the proposed development site, field visits were carried out to try to locate the registered road reserve as well as to assess topographical conditions of a road reserve in the area.

The proposed development to be undertaken north of Boca Bacalar Chico will also utilize the municipal pier to unload construction and other materials: from here it is anticipated that the proposed road reserve north of this point (the municipal pier) to the development site will be utilized to transfer all other materials and equipment overland etc. to the site.

9.5 Air Access

There are dozens of daily flights between Belize City and San Pedro Airport (SPR) on Ambergris Caye. Flights leave from both Philip S.W. Goldson International Airport and Municipal Airport roughly every hour. Most flights stop en route at San Pedro, stop off at Caye Chapel or Caye Caulker to drop off or pick up passengers as is required.

There are two airstrips on San Pedro Ambergris Caye: one in the center of San Pedro Town, and a small public airstrip west of the NOVA facility, about five miles south of the proposed development site. The airstrip near NOVA site has been closed for some time now. There is an existing proposal by a private developer to purchase 200 acres of land adjacent to this municipal airstrip; this developer would like to assist in infrastructure works to rehabilitate this airstrip (pers.com).

9.6 Tourism Activities

The growth of the tourism industry began in the mid 1960's when Belize became known for its diving. It is estimated that tourism is the single largest contributor to economic growth accounting for as much as 17.5% of the total gross domestic product, providing approximately 1 in 5 jobs (including spin offs), and as much as 25% of total foreign exchange earnings.

Recent statistics indicate that Ambergris caye had the highest distribution of tourism related operatives (excluding tour operators) in the country (Table 8.1). In 2005, there were 92 registered hotels with 1,259 rooms and 2,208 beds. Registered and trained tour guides were noted as 164 with 35 registered tour operators for San Pedro. The island's biggest tourist attraction is the Belize Barrier Reef which runs parallel the entire coastline of Belize: Statistics indicated that for every 10 visitors, 7 prefer the cayes.

Employment in the hotel sector for 2005 reportedly was 4,045, an increase of 7.3% over the 2003 (3,447) figures. Of the 4,045, there were more males (2,153) than females (1,892) employed in the industry. In San Pedro, employment in the hotel industry was the highest for the country for the last two years with 891; the Cayo District had the second highest (724), and Belize District (606) the third highest employed in this sector.

Table 9.1 Tourism Statistics

Area	No. of Hotels	No. of Rooms	No. of Beds	Tour Guides	Tour Oper.	Employ-ment
Belize District	60	913	1383	378	49	606
Ambergris	92	1259	2208	164	35	891
Caye Caulker	67	546	895	69	21	145
Cayo	87	836	1519	183	46	724
Corozal	29	255	358	35	0	125
Orange Walk	17	198	337	49	1	126
Stann Creek	55	460	759	93	21	374
Placencia	81	575	855	83	29	514
Toledo	33	255	463	59	7	261
Other Islands	36	296	550	-	-	279
TOTAL	**557**	**5593**	**9,327**	**1,113**	**209**	**4,045**

BTB, 2005

San Pedro is the center of the tourism industry in Belize, offering a wide variety of recreational activities ranging from sports fishing, diving, snorkeling, birding, and manatee watching. The reef is a quarter mile from the beach of Ambergris Caye making diving easily accessible. There are over 30 great dive sites along the island to include Hol Chan Marine Reserve Shark Ray Alley etc. (**Fig**. 9.5). The reef's beauty and richness has put Belize among the top ten dive destinations in the world.

The proposed development site is located within the BCMR and the BCNP. Marine activities by the developer can utilize a number public accredited dive sites along the eastern coast of Ambergris Caye.

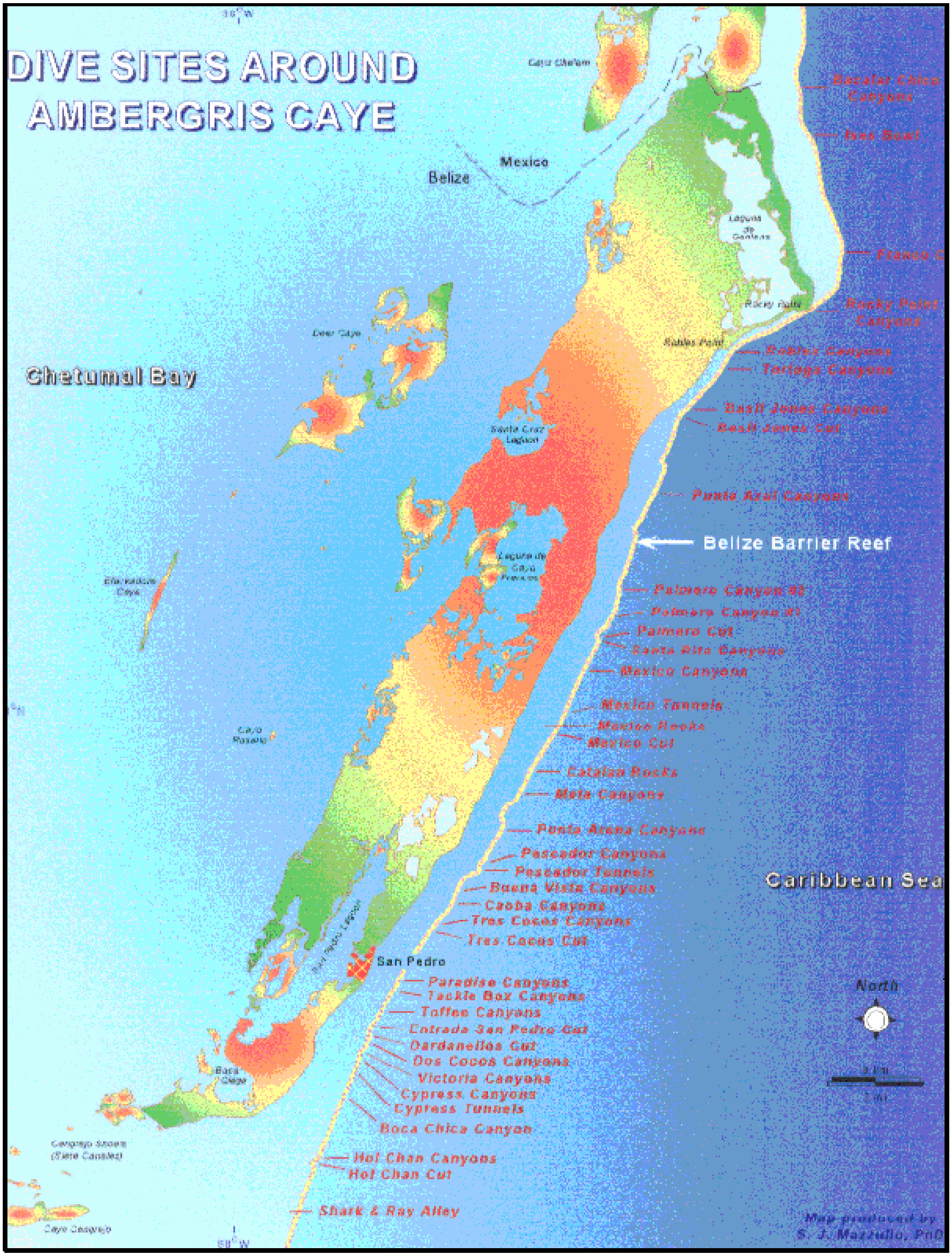


Fig. 9.5 Dive Sites at Ambergris Caye and the Region of the Proposed Development

9.7 Regional Planning

Various planning regimes and regulatory bodies have been set up in regards to planning and development of Ambergris Caye and Belize's Coastal Zone and environment. The following includes those related regulatory systems and planning bodies.

9.7.1 The Ambergris Caye Planning Authority

In 1993, the Ambergris Caye Planning Authority was renamed the Ambergris Caye Planning Committee (ACPC) and is responsible for the implementation of the ACMP. The Ambergris Caye Planning Authority of the Central Housing and Planning Authority (Ministry of Housing) was established in 1990 under the Housing and Town Planning Act (Chapter 182, Revised 2000) to implement the provisions of a declaration to prepare a zoning plan for Ambergris Caye.

All development plans such as this are to be submitted for vetting by the ACPC. The ACPC along with the CHPA carry out a monthly review of all development plans which should be submitted at least three days prior to the meeting. After completion of the EIA, a copy should also be forwarded to the ACPA.

9.7.2 The Ambergris Caye Master Plan

The Ambergris Caye Master Plan (ACMP), have been accepted by Cabinet and provides zoning plan for all of Ambergris Caye. Special responsibility for the development and management of Northern Ambergris Caye lies with the Northern Ambergris Caye Development Corporation (NACDC) set up in 1991 under Act No. 25 of 1991. "The zoning scheme in the Ambergris Caye Master Plan includes provisions for the establishment of protected areas in Northern Ambergris Caye but none have ever been established as specified in the zoning scheme."

9.7.3 Bacalar Chico Advisory Committee

A Bacalar Chico Advisory Committee (BCAC) was established in 1995 to address all matters pertaining to the BCNP/MR. The committee consists of a Chairman (Fisheries Dept.), Secretary (CZMI), a representative of ITCF, and representatives of key community groups from San Pedro and Sarteneja. The BCAC meets every 6 weeks, with the location alternated between San Pedro Town, Sarteneja and Belize City.

The Fisheries Department has been discussing co-management with the Green Reef Environmental Institute, a non-governmental organization based in San Pedro. A Memorandum of Understanding (MOU) has been drafted, and is anticipated to be signed as soon as the policy guidelines for the National Protected Area System Plan (2004) for Belize have been finalized. In the meantime, a letter of intent was given to Green Reef Institute to seek funds to assist primarily in the monitoring programs for the protected areas.

9.7.4 The San Pedro Town Council

The San Pedro Town Council is the main entity of local government on the island of Ambergris Caye, Belize. Besides day to day planning of the Council, the main duties of the council members include the following: Finance, Economic Development, Investment, & Special Events; Foreign Relation, Public Relations & Community Education; sanitation, solid waste, public works and the environment; Small Business Initiative and Tourism and; parks, playgrounds beautification & traffic.

9.8 Belize Tourism Policy 2005

In 1998, the first ever National tourism Strategy Plan was developed for Belize. The plan was prepared with the goal of developing a strategy and action plan to stimulate economic growth while protecting the country's environmental and natural resources and ensuring benefits to locals. The policy adopted focused on ecological-cultural tourism (ecotourism). The 2005 tourism strategy builds on the 1998 strategy refined to fit today's global tourism market realities and potential.

The Strategy include policies to be adopted and designed to improve the quality of life for locals and communities, coordinated government and industry sector participation, integrated national economic, social and cultural benefits, a meaningful balance between the main tourism (stay over) and cruise sectors and ensuring that Belize's destination position in the global tourism sector is not compromised.

The Belize Tourism Policy guides the development of all types of tourism. In essence the new tourism policy is predicated on policies to also look at significant changes in the external environment. These include but are not limited to: i) increased cruise tourism forecast; ii) the impact of cruise tourism on Belize's eco-tourism sites and; iii) increasing competitiveness Belize faces globally and regionally.

9.8.1 Tourism Master Plan

The 2005 Belize Tourism Policy addresses the need for the development of a new "Tourism Master Plan" as the industry is "facing many development challenges involving land and marine use, infrastructure, resource use and visitor impacts." The Tourism Master Plan will build on results of the Phase I policy document and will be guided by priorities and directions established within the document. Primarily, the Master Plan will look at (but not be limited to) area plans from a tourism perspective integrating considerations to quality of life for locals; development of carrying capacity limits at the various sites; policies relating to waste management, land use, security and investments and assisting local communities to develop community tourism products.

9.8.2 Belize Tourism Board

The Belize Tourism Board is a statutory board within the Ministry of Tourism. Its functions as a strategic partnership between government and the private sector is to develop, market and implement tourism programs to fulfill the emerging needs of local industries and the international tourism market place for the benefit of Belize and Belizeans. The industry is promoted worldwide by the Belize Tourism Board, which also involves itself in training of local tour guides, licensing of ships and other sustainable approaches to development of the industry.

9.8.3 Belize Tourism Industry Association

The Belize Tourism Industry Association (BTIA) is a non-profit private sector membership organization that promotes the development of sustainable, eco-cultural tourism for the benefit of Belize. The purpose of the BTIA is to serve and promote the interest of its members, to develop and promote the Belize Tourism product and to secure and influence the improvement of the industry. BTIA currently have a membership encompassing Belize's six districts and all major sectors of industry. Its membership is drawn from, but not limited to the tourism sector.

9.8.4 The National Protected Areas Policy and System Plan

In 1996, the National Protected Area Policy and System Plan (NPASP) was drafted. However, the draft document was never finalized. In 2003, the Ministry of Natural Resources took the lead in formulating a national protected areas policy and system plan. This initiative resulted in a two year project which specifically focused on developing a work plan for the NPASP and the subsequent development of the policy and system plan.

In 2005, the NPASP was completed and in 2006 was endorsed by Cabinet as the National Policy and System Plan on the role and management of Belize's protected areas inclusive of the Belize Barrier Reef Reserve System World Heritage Site (BBRRS-WHS). The aim of the policy is "to create a national Protected Area System in which important sites are included in one coherent framework that meets all obligations under international agreements to which Belize is a signatory."

The National Protected Areas Policy is the guiding statement on the role and management of Belize's protected areas. The NPASP is the tool that will be used to implement the policy. The plan has five main strategic actions; however, the overall aim of the plan is to create a more effective protected area system that provides tangible benefits and is cost effective to manage.

9.9 The Belize Port Authority

The Belize Port Authority (BPA) is the statutory body responsible for maintenance and control of marine transportation and port facilities. The BPA is important in regulating ship and boat traffic which can pose a threat to the BBBRS through groundings crashes and spills.

9.10 Cayes Development Policy and the Coastal Zone Management Strategy

The 2001 Cayes Development Policy and the Coastal Zone Management Strategy were developed by the Coastal Zone Management Authority and Institute to address the continued stress on Belizean Cayes; the need for strategic management in the Belize's coastal resources and; to ensure economic growth is balanced with sound environmental management. Both documents address the management of shoreline construction, infrastructure and setbacks, and the need to consolidate existing legislations regulations, and guidelines relating to the development and sustainable environmental management of cayes throughout Belize.

9.11 Mooring Buoy Program

A national mooring buoy program was commenced in Belize as early as 1988. In 1997, mooring buoys were set up in the Boca Bacalar Chico Marine Reserve, Hol Chan and Shark Ray Alley and in front of the town of San Pedro. The Green Reef Institute has also installed additional buoys near the reef to warn of coral and shoal areas. The Belize Fisheries Department is also in the process of identifying funds for a National Marine Reserve Mooring Buoy program for Belize to deploy additional buoys in all the marine reserves systems in Belize to minimize the impacts on coral reefs by anchor damage.

9.12 Pier Guidelines and Seawall Development

The Physical Planning Section of the Lands and Survey Department produced a set of guidelines in 1999, following the spate of requests for construction or reconstruction of piers after Hurricane Mitch. They guidelines seek to promote consistent design criteria for piers. Provisions of the guidelines include: i) Length limited to 350 feet; ii) Proper illumination; iii) Minimum recommended separation of 1000 feet between piers in rural settings; iv) 'Proper' architectural design, and use of 'safe' construction materials; v) No enclosures and: vi) Public access to be allowed.

The pier guidelines also seek to reduce shoreline congestion and increase public safety and pier management. All pier and seawall applications should be sent to the Physical Planning Authority for approval.

The 2000 Coastal Zone Report recommended that the CZMA along with the Physical Planning Section of the Lands and Survey Department undertake to develop comprehensive guidelines for construction on beaches, incorporating a revision of the pier guidelines, but taking into account seawalls, groins, jetties and harbor arms.

9.13 Local Non Profit Organizations

Green Reef is the first conservation NGO established in 1997 on San Pedro Ambergris Caye. "Green Reef is a non-profit, non-governmental membership organization dedicated to the conservation and sustainable use of Belize's vast barrier reef complex and the associated marine environment in order to maintain the integrity of the ecosystems for the benefit of all humans."

A memorandum of understanding (MOU) has been signed by the Green Reef Institute and the Fisheries Department (GOB) for the co-management of the Bacalar Chico marine reserve. The MOU allows Green Reef to conduct research within the reserve through permits issued by the Fisheries Administrator; Green Reef shall be exempt from paying the Fisheries Department its proscribed fees for research conducted within the reserve.

Among other things, the MOU also states that Green Reef and the Reserve staff shall jointly develop and provide the Fisheries Administrator with quarterly financial statements, annual reports and reports on any major revision in operations regarding management of the reserve and for its part, the Fisheries Department, upon written request from Green Reef, shall provide Green Reef with relevant financial information pertaining to the reserve.

The Fisheries Department shall also, in accordance with the Fisheries Regulations, process all applications for scientific research by any other organizations, after consultation with Green Reef, and the Bacalar Chico Advisory Committee. Recreational an extractive activities pertaining to the Reserve shall be decided jointly by the Parties herein mentioned and the Fisheries Department reserves the right to refuse any activity, including extractive activities, within the reserve which in its judgment, is not consistent with the goals and legal framework governing the reserve. The Fisheries Department shall also provide assistance to Green Reef in the form of tax exemptions and other like benefits as are enjoyed by non-profit, non-governmental organizations for the carrying out of activities related to the management of the reserve.

9.14 Protected Areas in the Region

Marine protected areas are declared under the Fisheries Act allowing multiple uses under a zonation scheme which typically designates three zones: 1) General use zones, 2) conservation zones and 3) preservation zones. Belize’s marine reserves or protected areas also include terrestrial areas, either as islands or adjacent mainland areas.

Management objectives include protection, scientific, research, visitation, education, conservation of marine flora and fauna, natural regeneration of aquatic life, preservation of fish breeding grounds and habitats, and for controlled extractive use (within specified zones). Marine reserves area also established to provide protection of habitat utilized by manatees. The National Parks Systems Act (1981) provides for the creation of protected areas on National Land, which includes seabed.

The proposed development site at Bacalar Chico is located immediately within declared Boca Bacalar Chico Marine and National Park Reserve. There are also other identified protected areas in the region that forms a network of protected areas of importance to the proposed development. The Revised Management Plan for BCNP/MR was designed to serve as a comprehensive 10-year strategic to addresses both the conservation and economic sustainability needs of the BCNP/MR.

9.14.1 Bacalar Chico National Park and Marine Reserve (BCNP/MR)

The BCNP/MR spans the northern portion of Ambergris Caye from the Bahía Chetumal on the west to the Caribbean Sea on the east, and encompasses a total of 28,169 acres. The northern boundary of the BCNP/MR is formed by Belize's international boundary with Mexico. A portion of this boundary is described by the Bacalar Chico Canal which is reputed to have been created by the ancient Maya.

Specifically the BCNP/MR was created because of the following:

- All known or Found Marine Bird Nesting Sites
- Marine Turtle Nesting Beach Between Robles Point And Rocky Point
- Exposed Pleistocene Reef Along The Rocky Point Shoreline
- Littoral Forest Along Both The Eastern and Western Coast
- Crocodile Nesting Sites
- Cenotes And Sink Holes Having Perennial Freshwater Availability For Wildlife
- Salt Marsh Habitat
- Bacalar Lagoon
- Archaeological Sites

Bacalar Chico Marine Reserve was declared in 1996 and consists of 15,529 acres (Fig. 9.6). The coastal region of Bacalar Chico Marine Reserve supports many unique natural characteristics, such as Rocky Point. This point is the only location in Belize where the Belize Barrier Reef touches the shoreline and hosts nesting activity by Loggerhead, Green, and Hawksbill sea turtles. The offshore marine habitat of the reserve is also an important breeding area for Queen Conch, as well as a seasonal spawning bank for Nassau Groupers, Black Groupers, Yellowfin Groupers, Mutton Snapper, Dog Snapper, Cubera Snapper, Yellow-tail Snappers, White Margate, Horse-eye Jacks, Permit, Yellow Jacks, and a variety of other reef fishes. Bacalar Chico has been recognized as a UNESCO World Heritage Site for its unique geographical features and variety of its flora and fauna.

Bacalar Chico National Park was also declared in 1996 and consists under the National Park Systems Act. The national park encompasses 12,640 acres of land and includes the Laguna de Cantena, which is one of the largest lagoons in Northern Ambergris Caye. Private lands within the National Park boundary acquired prior to designation are regulated by the Lands Department under the Ministry of Natural Resources, Environment and Industry.

Ministerial responsibility for the Bacalar Chico National Park and Marine Reserve is shared between the Ministry of Natural Resources, Environment and Industry (responsible for National Parks, Natural Monuments, Wildlife Sanctuaries and Reserves) and the Ministry of Agriculture and Fisheries (responsible for marine reserves). The Ministry of Housing has responsibility through the implementation of the Ambergris Caye Master Plan which applies to all the private land within the national park.

In 2005, eighteen-kilometer of nature trail within the Bacalar Chico National Park was cleared by Green Reef with the assistance of Trekforce which is utilized by tourist and park rangers etc. The southernmost reach of the BCNP/MR can be accessed overland via a dirt track which apparently extends along the east coast.

Infrastructure within the park include: a headquarters building constructed in the San Juan area, a ranger station constructed on the eastern side of the BCNP on lands belonging to ITCF, and a new building which houses the staff quarters, a visitor center and a storage area. The BCNP/MR is presently equipped with three boats, SCUBA equipment and equipment for the staff to conduct research, monitoring, patrols and environmental education.

The regulations and guidelines for which are described as follows:

- *Research*
  All persons intending to conduct research within the reserve must first obtain approval from the Fisheries Department. Permits are granted based on research priorities of the BCNP/MR. Research permits the geographic boundary for which permission is granted, as well as guidelines, which include (but are not limited to) the types and quantities of flora and/or fauna allowed for extraction. Regulations and guidelines for each permit may be tailored on a case-by-case basis. Licensees should carry their permit at all times while conducting research in the marine reserve.

- *Boat Operators*
  All persons seeking to operate a boat within the reserve must obtain a license from the Fisheries Department. In order to qualify for a license, a person should be a Belizean, age eighteen or older, with first preference given to traditional fishers, or former fishers conducting tourism activities. Licensees should carry their permit at all times while operating a boat in the BCMR.

- *Fishing*
  All persons seeking to undertake commercial or sport fishing within the reserve must obtain a license from the Fisheries Department. Licenses will only be issued to persons whom have traditionally fished within the marine reserve for their livelihood. Licensees should carry their permit at all times while fishing in the marine reserve.

The legislative basis for conservation of private lands within Bacalar Chico National Park is administered by the Central Housing and Planning Authority (CHPA) and the North Ambergris Caye Development Committee (NACDC) in accordance with the zoning regulations stipulated in the Master Plan for Ambergris Caye (ACMP). The ACMP was developed for the Bacalar Chico region prior to legislative declaration of the BCNP, and is reconciled with conservation zoning and protection recommendations developed by the BCAC. The zoning regulations of the ACMP therefore include:

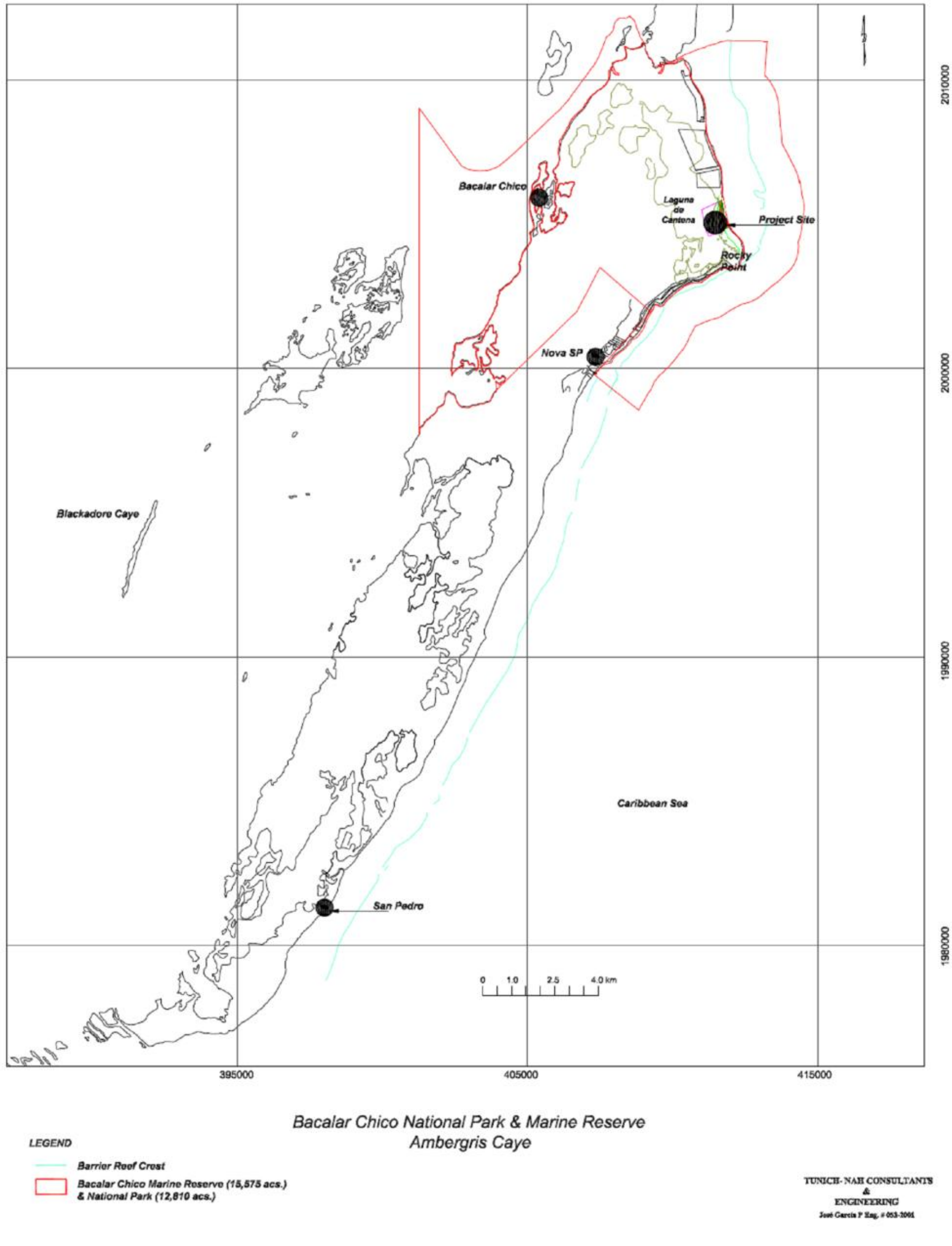


Fig. 9.6 **Bacalar Chico National Park and Marine Reserve (BCNP/MR)**

- Low Density General Residential Land Use Zone For The Eastern Shoreline Extending Back To The Shore Of Laguna De Cantena, From The Bacalar Chico Channel South To Rocky Point

- Conservation Area from Rocky Point South to Robles Point

- A Special Coordinated Development Area Encompassing the Former Pinkerton Estate

9.14.1.1 Marine Component

The rationale, objectives and key enforcement and management needs of the BCMR's four management zones include the following:

ک *General Use Zones (1 and 2)* allows for the sustainable management of existing traditional uses within the BCMR prior to declaration. This zone lies apart from areas in need of greater protection, and it is easily accessible to local fisher folks who use the area for commercial fishing (**Fig.** 9.7). A combination of the zone's existing fishing banks and proximity to the adjacent Conservation Area (I) replenishment area offers fishermen fertile and potentially valuable fishing grounds.

The key objectives of the zones are to provide the opportunity for established uses and activities to be continued in a sustainable manner under a stringent monitoring scheme. The key enforcement and monitoring needs of the zone also include intensive patrols to institute fisher folk compliance, specifically with respect to fishing gear, catch sizes etc. and to deter the potential for incursions into conservation and preservation zones.

ک- *Conservation Zone (I)* is essentially a non-extractive zone, designed for baseline monitoring, research, education and limited recreational use. This zone represents a transverse section of the BCMR, which includes intertidal flats and grass flats, patch reefs, back reef and reef crest types and coralline grove formations in the outer reef. The zone serves as a replenishing and nursery area and provides habitats for threatened and endangered species such as the West Indian Manatee and marine turtles. The key objectives of this zone are to conserve a representative sample of certain habitats within the BCMR, to provide an undisturbed area for recruitment of species to adjacent areas, and to provide opportunities for research, education, and comparison with unprotected areas. The key enforcement and monitoring needs of the zone primarily concern control of Illegal fishing, particularly nighttime poaching (Fig. 9.7).

ک C*onservation Zone (II)* is a controlled extraction zone designed to accommodate subsistence fishing, recreation and tourism. The zone accommodates all of the different types of recreational activities permitted in the reserve, in affording beach areas for swimming, corals for diving and snorkeling, areas for canoeing and good areas for fishing. The key objectives of this zone are to prevent fishery stocks from overexploitation by commercial fishing and to enhance the value of the area for recreational and tourism activities. The key enforcement and monitoring needs of the zone include monitoring of catch and gear use, and recreational and tourism impacts (Fig. 9.7).

ك Preservation Zone (PZ) is closed to visitors, including researchers except under special permission. This zone includes fragile patch reefs, back reef, reef crest and fore reef areas, which comprise important habitats for commercial species such as the Queen Conch and Spiny Lobster. Human impact on this zone has been intense due to easy accessibility and the shallow back reef area, and its zoning protection has consequently been designed to restore the area to its original condition over time (Fig. 9.7).

The key objectives of the zones are to preserve an area within the BCMR in an entirely natural state, to protect the areas habitat and threatened/rare species. The key enforcement and monitoring needs of the zone concern the reduction of illegal usage by Mexican visitors, which the area is vulnerable to as a result of its proximity to Belize/Mexico border.

9.14.1.2 The Terrestrial Component

The Boca Bacalar Chico National Park lands consist of Crown Lands held by the GOB and Private Lands held by independent title. Approximately 80 % of the National Park consists of Crown Lands acquired in 1990 by the GOB from the former Pinkerton Estate. Approximately 20 % of the National Park is within private lands that were titled prior to designation and are held as one parcel at San Juan on the west (where BCNP/MR headquarters are located) and as several parcels along the entire shoreline on the eastern side of the BCNP.

The seabed (defined as the land extending seawards from the high water mark of ordinary tides) is National Land owned by the Government of Belize under the authority of the National Lands Act (Laws of Belize Chapter 191, Revised 2000). Under Crown Land Rules (Statutory Rules and Orders 66 of 1939), a 66 ft wide strip of land along all water frontages, measured from high water mark, is designated as public easement, but lands titles prior to 1930 included the land to the high water mark and in some cases, below the high water mark.

The area of the proposed development site and associated tourism activities borders both the BCNP and the BCMR. As is noted from designated zoning within the BCNP/MR, all development and tourism activities to be undertaken will need to follow the management objectives of the reserves.

9.14.2 Hol Chan Marine Reserve

Hol Chan Marine Reserve is made up of 18.13 km2 of nationally owned land and seabed, the latter comprising over 90% of the total area. It includes the seabed, seven small mangrove islands, and a narrow strip of mangrove forest on the southern tip of Ambergris Caye (Fig 9.8). The Fisheries Regulations 1977 shall apply within the Reserve.

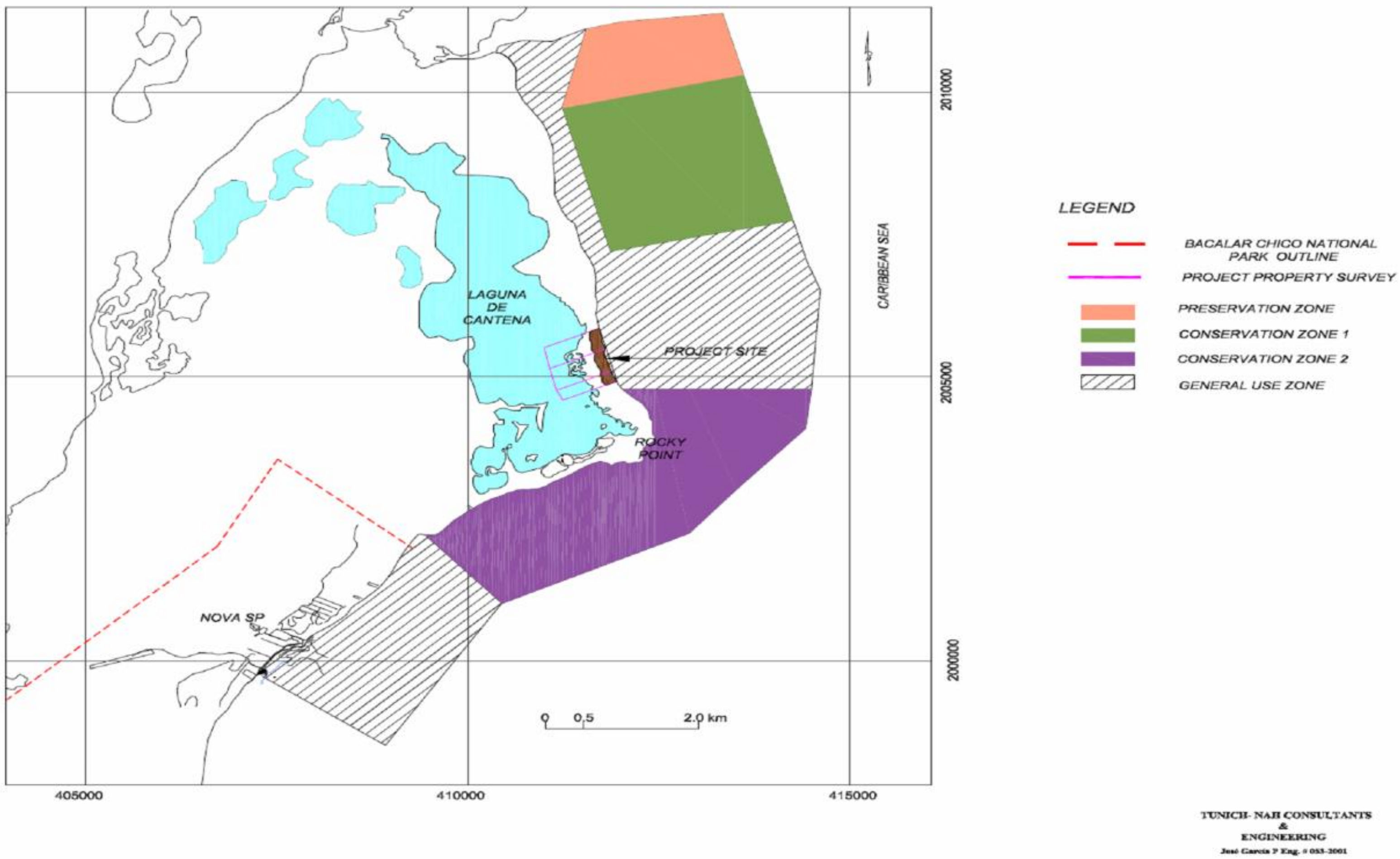


Fig. 9.7 Management Zones within the BCNP/MR Ambergris Caye
(*See above caption 'Marine Component" for definition of zones)*

9.14.3 Rocky Point

The entire beach from Robles Point north is a known turtle nesting site for three species of turtles, two of which are on the endangered species list. Along this coast, this is the only known point where the reef actually touches the land.

The 1992 revised master plan for Ambergris Caye, indicate that if the entire 320 acres is zoned, proposed zoning would allow the lowest permitted density – i.e. an area in which the maximum density allowed is 2 dwelling per acre with a minimum lot size of 14,000 sq. ft. creating the potential for the construction of 600 houses. However, given its critical nature, it was recommended that a NO DEVELOPMENT policy be adopted for the area. To date, no old or new recommendations have been implemented to guide the development of this very sensitive area.

9.14.4 Mexico Rocks

The area was proposed for protection as it is one of the few areas in Belize with a well organized system of patched reef between the coast and barrier reef. The creation of another reserve was to alleviate some of the pressure at the Hol Chan Marine Reserve. The long term objective was also to put in place management systems for development activities such as pier construction, sea walls, sewerage and other discharges onto the beach and the sea, dredging of near shore areas to create beaches, vegetation clearance, and alteration of the sea bed. However, the one of the main problems was the fact that this 220 acre proposed reserve, was within privately owned lands. To date, no old or new recommendations have been implemented to guide development activities in this area.

9.14.5 Little Guana & Los Salones Caye Bird Sanctuaries

Legislative authority for the declaration, protection and management of bird sanctuaries falls under the Ministry of Natural Resources. On September 6, 1977 the Ministry of Agriculture and Lands declared seven (7) cayes as Crown Reserves in accordance with the provisions of Section 6 of the Crown Lands Ordinance (Chapter 110 of the Laws of Belize, Revised Edition 1957) for the protection of waterfowl nesting and roosting colonies. The authority for the management and protection of these 7 cayes were subsequently handed over to the Belize Audubon Society. On April 26, 1998 the Society and Green Reef signed a MOU giving Green Reef the authority to manage Little Guana Cay and Los Salones Bird Sanctuaries (Fig. 9.8).

9.14.6 UNESCO World Heritage Site

The coastal area of Belize is an outstanding natural system consisting of the largest barrier reef in the northern hemisphere, offshore atolls, several hundred sand cays, mangrove forests, coastal lagoons and estuaries. In 1996 the Belize Barrier Reef Reserve System was granted World Heritage status based on its global significance as a natural site of "outstanding universal value".

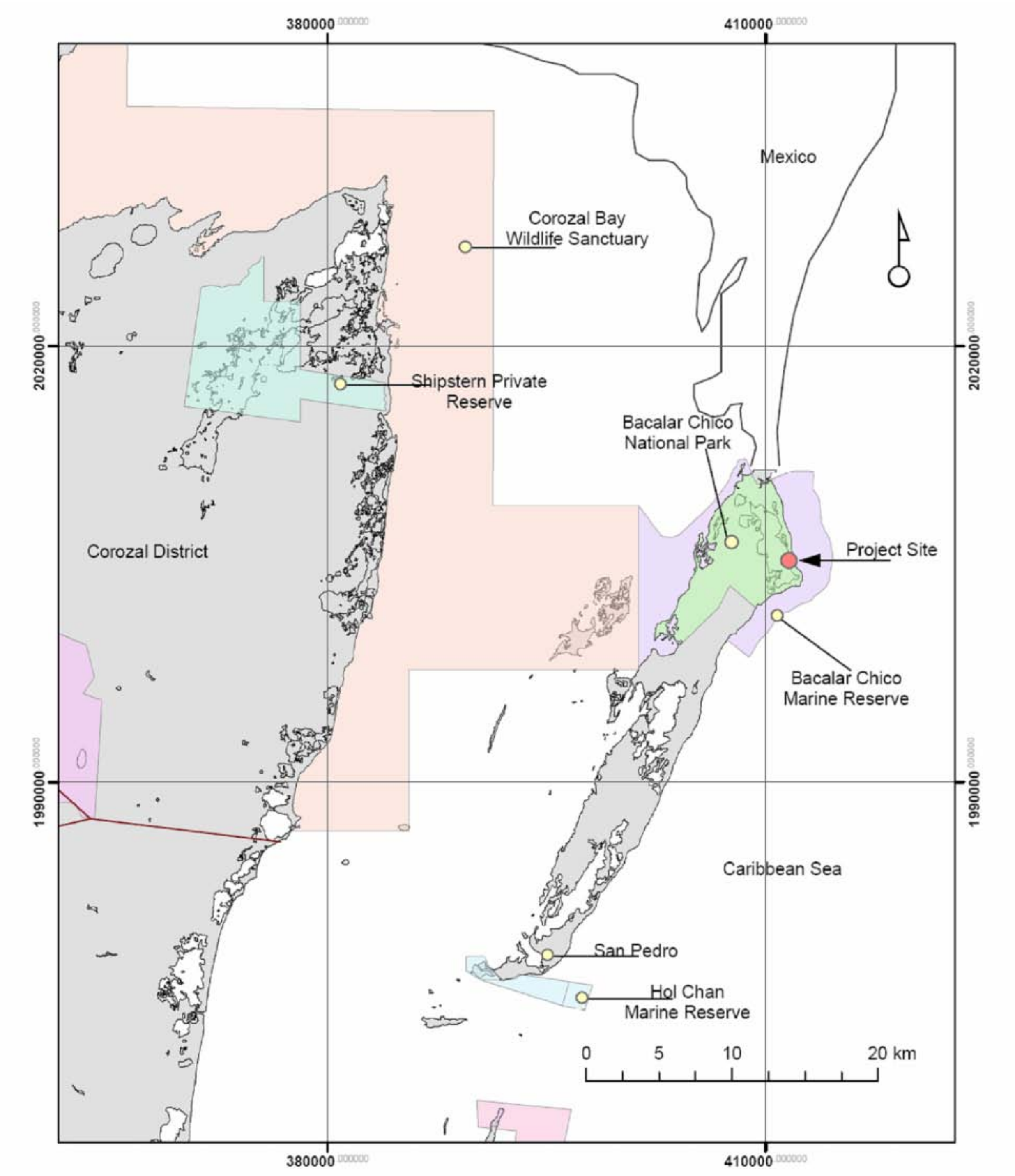


Fig. 9.8 Protected Areas in the Region of the Proposed Development

The system's seven sites illustrate the evolutionary history of reef development and are a significant habitat for threatened species, including marine turtles, manatees and the American marine crocodile. The Reef illustrates a classic example of reefs through fringing, barrier and atoll reef types.

The bird sanctuaries are located within the Northern Shelf Lagoon between Chetumal Bay, the mainland and Ambergris Caye and comprise three small cayes known as Little Guana and Los Salones. Los Salones (two cayes) is situated approximately 3 ¼ miles southeast of the D.O.S. Trig Station at Sand Point at Latitude 17° 57′ 20″ N and Longitude 88° 06′ 10″ W. Little Guana Caye is situated approximately 2 miles Southwest of the D.O.S. Trig Station at Bracilite at Latitude 18° 02′ 50″ N and Longitude 87° 58′ 10″W. The draft management plan includes a zoning plan in which various rules is applied.

The existing boundaries extend to the high water mark surrounding the cayes and do not include any of the marine waters or the wetland areas that support the breeding colonies. Little Guana Caye is 1 acre (0.4 ha) in size while Los Salones has a combined area of 1.9 acres (0.78 ha). The three cayes are National Land and belongs to the Government and people of Belize. As mentioned above, these cayes were declared as Crown Reserves under the Crown Lands Ordinance in 1977.

9.14.7 The Corozal Bay Wildlife Sanctuary

The Corozal Bay Wildlife Sanctuary was established in 1998 for the protection of the Manatees. The 180,508.5 acres park currently, has no zoning or co-management activities (**Fig.** 9.8).

9.15 NGO and Public Consultations

In conducting the social assessment, contact and/or interviews were conducted with four of the major planning authorities and the one NGO on San Pedro Ambergris Caye. These include the San Pedro Town Council, the Ambergris Caye Planning Committee, a member of the San Pedro NEAC and Mito Paz from the NGO, Green Reef Institute. The main stakeholder concerns include the following which they would like to see be addressed within the EIA:

- Solid and liquid waste disposal, as there are no nearby disposal sites
- Sewer system, will there be a sewer system plan?
- Monitoring, who will be responsible for monitoring construction and post construction activities, especially in the marine reserve
- Construction waste, where and how will these be disposed of
- How will the developer access the development site
- Dredging activities in the marine reserve and national park

- Clearing of littoral forests, mangrove removal and sea grass damage form dredging activities

- Turtle nesting site impacted from increased tourists etc to and through the area

- Illegal hunting by local workers to the area

- All marine tourism activities take into consideration and abide by the management zones within the marine reserve

- Hurricane plan be submitted to the San Pedro NEAC for coordination in the unlikely event of emergency evacuation

To expand on one point, one of the main concerns were the fact that the biggest threat in the tourism industry were from workers in the industry who (for example), walk the beach and take undersize lobster and have no regard for the turtle beach. These workers are also known to spear fish and catch out of season marine animals, as the area is shallow and access to these areas are easy. Another point of interest is that developments on the northern Ambergris Caye do not necessarily provide housing for their workers. This has caused additional concerns as workers are known to trespass in private properties, and swim in ‘no swimming areas’.

Two main recommendations by these stakeholders includes: based on its location from the town of San Pedro, emergency facilities for the resort should be included in the design plan, and that the portion of the property which fall within the national park should be donated to the park.

Chapter 10

10.0 Environmental Impacts of Proposed Development

10.1 General Principles Underpinning Environmental Impacts

In principle the need to address some requirement(s) of the human species gives rise to the definition and implementation of some specific development project(s) or programme(s). In the context of the proposed development, the human requirement to be addressed is the need for recreation and knowledge of the ecosystem. In the case of the latter this relates to the research and educational components of the project.

Inherent in development projects and programmes are activities which alter the environment, or causes some "environmental disturbance". These environmental disturbances have a number of "effects" which in turn leads to "environmental impacts", which are categorized as being either negative or positive. This impact cycle is summarized in Fig. 10.1.

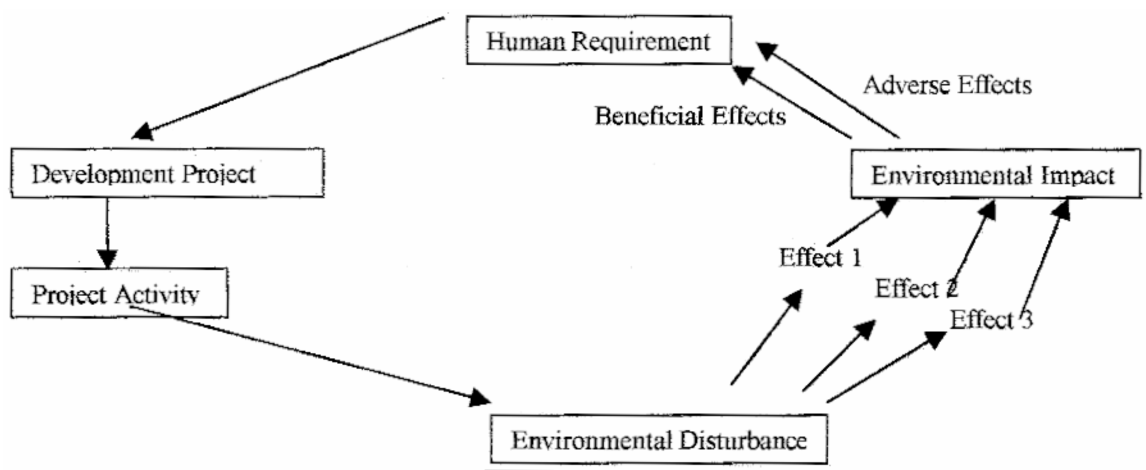


Fig. 10.1: Environmental Impact Cycle

Environmental impacts are in principle hierarchal and in this regard are described as being sequentially 'primary', 'secondary', 'tertiary', etc., in orientation. An example of this impact sequence which specifically relate to the currently proposed project is show in Table 10.1. Primary impacts are those impacts arising immediately from particular development activities such as land clearing or dredging, and affect basic ecosystem functions such as primary productivity, metabolic rate, mechanical damage to anatomical structures and the physical destruction of habitats. Parameters relevant in regards to these ecosystem functions are; suspended solids, turbidity, macro-nutrients, and dissolved oxygen [See Table 10.1].

The 'primary impact' parameters in turn have another level of impacts on various ecosystem components, which are qualified by both magnitude and direction. This is unlike the 'primary impacts', which within the context of the current EIA varies in magnitude only [See EIA Matrix outlined in Table 10.1]. In the case of primary or "Level 1" impacts, this may be explained by the fact that variations in the magnitude of these parameters in and of themselves are neither deleterious nor beneficial. Thus an increase in dissolved oxygen, macro-nutrients, or turbidity are neither positive nor negative, until and/or unless they in turn act on some other ecosystem component(s). This is in principle the secondary or "level 2" impacts. The consequence of increased nutrients on sea-grass productivity near the caye should be beneficial – thus within the context of the EIA Matrix outlined in Table 10.1, the impacts are assigned a positive values, i.e. they are beneficial. Conversely the impacts of sedimentation on these sea-grass meadows is deleterious and is consequently assigned a negative value.

Primary or level '1' impacts may also have an effect on 'higher order' activities, which are usually human systems or human development activities. These are generally referred to as 'tertiary' or 'level 3' impacts. Thus within the context of the currently proposed project, an increase in sedimentation associated with dredging activities could have a deleterious or negative impact on seagrass productivity and macro-invertebrate populations in the nearshore seagrass beds: These are referred to as 'level 2' impacts [See Table 10.1]. The increase in sedimentation may also have negative consequences on fishing activities for lobsters and conch, not only in regards to the potentially decreased number of lobster and conch in the area, but also as a consequence of increasing the incidence of "Trap" loss and the increased amount of time spent searching for the traps, or diving for conch, given the poor visibility caused by sediments in the water column [See Table 10.1]. The direct impacts to fishing activities are in principle "level 3" impacts [See Table 10.1].

Under the current analytical process outlined in the EIA Matrix [See Table 10.1], although a relationship may exist, the magnitude of change of the particular parameter may be so small or insignificant, that no discernible impact is identified: In such circumstances the event is assigned a score of "0" in the EIA Matrix.

10.2 Overview of Environmental Impacts

The level of adverse, or alternatively, beneficial impacts on the ecosystem and in general flora and fauna is a function of the magnitude of the development activity, the nature of the resource in question, the capacity of the environment to assimilate these influences and the methodology to be applied in relation to the particular project activity.

The connectivity or hierarchal nature of the impacts of the proposed project has been underscored by the integration of a color scheme in the EIA Matrix outlined in Table 10.1. The vertical commonality of a particular color in the Matrix has been done to underscore the cascade of the impacts of a particular parameter at the primary, secondary and tertiary levels of the system.

The primary activities that are likely to give rise to environmental impacts of note are the dredging activities, the construction of the swimming beach, the sourcing of potable water, energy generation, the production of sewage and domestic effluents, and the production of solid wastes [See Table 10.1].

Apart from the ‘ecological oriented’ environmental impacts, the social and economic impacts are also relevant. These relates to the impacts of the proposed development on pre-existing economic activities in the area such as recreational diving, commercial fishing and maritime traffic in the area.

10.3 Details of the Ecological Impacts

10.3.1 Dredging Impacts

The most notable primary aquatic impacts arising from the dredging operations are expected to be an increase in sedimentation and turbidity, as well as an increase in BOD and Hydrogen Sulphide [See Table 10.1].

There are two (2) sets of dredging activities associated with the proposed project, viz: dredging in the nearshore areas of the project site to accommodate the construction of the access pier and the construction of the over-water cabanas, and the dredging at the Nova Pier four (4) miles south of the proposed project site to accommodate the berthing of barged with construction supplies and equipment. The volume of material associated with the project site is 7,000 cu yds, while that associated with the Nova pier is 1,936 cu yds. These dredging volumes are modest given the scale of the seabed to be excavated relative to the wider barrier lagoon.

The impact of dredging on the reef systems in the area is predicted to be insignificant, thus a score of ‘0’ has been accorded to the issue in the impact matrix shown as Table 10.1. This has been as a function of the modest scale of the dredging operations, the consistency of the seafloor material to be dredged and consequently the mobility of the sediments, as well as the distance of the proposed dredging operations to the reef systems. The distance of the reef from the burrow pit at the proposed project site is almost a mile [0.8 mile]: This coupled with the fact that the prevailing current within the barrier lagoon is north to south virtually eliminate the risk of the reef being impacted by the dredging operation. Although the reef is nearer in the area of the Nova Pier [0.5 mile], the impact is also expected to be negligible [See Table 10.1].

The sedimentation and turbidity impacts associated with the dredging operations were more notable for the seagrass beds than they were for the reef: These impacts however were predicted to be ‘minor deleterious’ and were accorded a score of ‘-1’ in the Impact Matrix [See Secondary Impacts for sedimentation and Turbidity, Table 10.1].

The method of dredging to be applied is the ‘Clam Bucket’. The sedimentation impacts are to be ameliorated with the deployment of sediment curtains.

The impacts from the dredging operations are expected to be localized and should be confined to the areas immediately associated with the burrow pits in the nearshore seagrass beds [See Table 10.1]. The ecosystems north and south of the project site, described as the ‘Barrier Lagoon Eco-

Table 10.1: EIA Matrix ABR.

	LEVEL 1 IMPACTS (PARAMETRICALCHANGES) / ACTIVITIES	Marine Water Quality										Landform Project Site								Ecology							
		Increased Nutrients	Increased Sedimentation & Turbidity	Increased Fecal Coliform	Increased BOD	Increased Hydrogen Sulphide	Increased Petroleum Pollution	Increase in Temp. Stratification	Decreased Dissolved Oxygen	Increase in Salinity	Increased Temperature	Increased Salinization of Soils	Increased Erosion	Increase in Noise	Solid Waste Accumulation	Decrease Forest Cover	Increased Land Run-off	Attraction of Feral Species to Site	Increase Human vs. Wildlife Interaction	Increase in pelagic Habitat	Decrease in Benthic seafloor Habitat	Decrease in Nursery Habitat	Elimination or Decrease Roosting Habitat	Increase in Artificial Benthic Habitat	Decrease Caye-based Habitat for Wading Birds	Decrease in Seagrass Biomass	Decrease Coral Cover and Diversity
Construction Phase	Land Clearing		1										2	1	3	3	2		2				2		1		
	Dredging Nova Main Pier		2		1	1		1	1					1						2		1				1	1
	Dredging Nearshore Development Site Piers		1		1	1		1	1					1						1		1				1	1
	Dredging Overwater Cabanas Site		1		1	1		1	1					1						1		1				1	1
	Placement Geotextile Mats for Swimming Area		1												1					1		1				1	
	Deposition Spoil from Dredging Ops		1									2				1							1				
	Land-based Excavation of Spoils to Build Beach												1	1		1			1								
	Deposition L/based Spoils for Beach and Bathing Area		2		1	1															1	1					
	Deposition Land Fill for Berthing adj. Nova Pier		1		1	1						2				1											
	Barging of Construction Supplies to Nova Pier																										
	Construction Roadway from Nova Pier to Site													1	1	2	2										
	Construction Overwater Cabanas														1									2			
	Construction Land-based Buildings														3												
	Construction of Foot Paths														1	1	1		1								
	Construction Boardwalks & Piers Lagoonal Side														1	1			1					1	1		
	Construction Children Play Park														1												
	Installation Sewer Infrastructure														1												
	Installation & Operation Electricity Generation Infrast.													2	1												
	Installation & Appl Potable Water Infrastructure									1		3			1												
	Placement Fuel Storage Facilities						1																				
Operational Phase	Overland Freight Traffic													1													
	Dockside Berthing Operations Boats																										
	Dockside Berthing Operations Barges Nova Pier																										
	Dockside Fueling Operations						1																				
	Dockside Loading/Unloading Ops Project Site														1												
	Nearshore Swimming & Beach Use																		1								
	Snorkelling, Scuba Diving, Wind Surfing etc...																										
	General Navigation Barrier Lagoon Project Site																										
	On-Shore Recreational Activities														1												
	Land-based Vehicular Traffic																										
	Occupancy Hotel and Resort Facilities	3		3	2					2				1	3		1	2	2								
	LEVEL 2 IMPACTS																										
Nearshore Ecosystem 0 to 0.8 Seaward of Beach	Coral Cover & Diversity	0	0						0							0											0
	Phytoplankton Productivity	+1	-1	0						0			0				-1										
	Zooplankton Productivity	+1	-1	0	0					0			0				-1										
	Sea-grass Productivity	+1	-1	0						0			0				-1				-1	-1				-1	
	Macro-Invertebrate Population	+1	-1	0	-1		0	0	0	0			0				-1			+1	-1	-1		+2		-1	
	Fin-Fish Population	+1	-1	0	0		0	0	0	0			0				-1			+1	0	0		+1		-1	
	Crocodile Populations	0	0												1												
	Sea Turtle Populations	0	0												+1												
	Seabird Population	0	0												-1	-1							-1		0		
Barrier Lagoon Ecosystem 0.8 - 3.0 Miles of Property	Coral Reef Cover and Diversity		0														0										
	General Pelagic Fish Populations		0														0									0	0
	Reef Fish Abundance and Diversity		0														0									0	
	Seagrass Productivity		0														0										
	Seagrass Finfish Populations		0														0									0	
	Seagrass Macro-invertebrate Populations		0														0									0	
	General Lobster and Conch Populations		0														0										
	Phytoplankton Productivity		0														0										
	Zooplankton Productivity		0														0										
	Dolphin Populations														0												
	Seabird Population														0								0				
	Sea Turtle Population														0												
Mangroves & Nearshore Laguna de C Ecosystem	Mangrove Canopy Biomass	+1														-1											
	Mangrove Canopy Habitat	+1														-1											
	Mangrove Prop Root Habitat	0														-1											
	Swamp Floor Habitat	+1														-1											
	Macro-Invertebrate Productivity	0			0											-1											
	Macro-algal biomass and productivity	0																									
	Crocodile Populations																										
	Migratory Bird Population															0											
	Zooplankton Productivity	0																									
	Phytoplankton Productivity	0																									
	General Species Diversity	0			0											-1											
Land-based Ecosyste Project Site	Decrease in Forest Cover		0									-1													0		
	Decrease in Abundance and Diversity Plant Species		0									-1				-1									0		
	Decrease Forage Source for Birds											0				-1							-2				
	Decrease Abundance & Diversity Reptiles											0				-1											
	Increase in Non-Native Plant Species	+1																									
	Invasion Feral Fauna Not Previously Present														-2			-1									
	Increase in Domestic Fauna/Pet Species																										
	LEVEL 3 IMPACTS																										
Economic Activities	Boat Traffic Barrier Lagoon																			0							
	Beach Combing	0	-1												+1												
	Recreational Bird Watching		-1											-1	+1	-1							-1				
	Lobster and Conch Commercial Fishing	+1	-1		0																			+1		-1	0
	Sport & Recreational Fishing	+1	-1		0															0				+1		-1	0
	Scuba Diving other water sports activities		-1	0																							
	Mgmt. Activities BCNP/MR		0																								
Human Settlement	Pathogenic Diseases			-1											-1	+1											
	Mosquitos, Sandflies &Nuisance Insects														-1	+1											
	Culture conflicts									0					-1			-1									
	Injury and physical trauma		-1												-1			-1	-1								
	Noise Pollution		-1											-1													
	Odour pollution		-1			-1	0					-1			-1												
	Muds & Sight Pollutiom		-2		-1		0			0		-1	0		-2		0	-1					-1				

KEY

Minor Change	1	Minor Beneficial Impact	+1	Minor Adverse Impact	-1
Moderate Change	2	Moderate Beneficial Impact	+2	Moderate Adverse Impact	-2
Major Change	3	Major Beneficial Impact	+3	Major Adverse Impact	-3
No Change		Relationship exist but no impact is expected	0		

system 0.8 – 3 Miles North and South of the Property' should not be impacted in any measurable way: Thus the 'level 2' or 'secondary' impacts have been accorded a score of '0' at their most significant [See Table 10.1].

The tertiary sedimentation and turbidity impacts have been assessed the 'minor adverse' category, save for the 'muds and sight pollution' impacts which have assessed as 'moderate adverse' [See Table 10.1]. The latter is related to the deposition of the dredged spoils on-shore in the case of the project site.

10.3.2 Domestic Effluent Impacts

The two (2) main impacts relevant to the proposed undertaking are increased nutrients and fecal coliform in the water column.

The situation of increased nutrients in the water column is generally referred to as eutrophication. This relates to the macro-nutrients, which are 'phosphates' and 'nitrates'. These are generally derived from gray water effluents, as well as sewage effluents from the flushing of toilets.

In general a major source of macro-nutrients in gray water effluents is from detergents. This is also relevant to the proposed development. The greater contribution of nutrients would come from human waste. The main source of macronutrients would be from the occupancy or commissioning of the Hotel, and Theme Park. The magnitude of the 'primary impact' from this source has been assessed as '3' or 'major' [See Table 10.1].

The secondary impacts of macronutrients are relevant to both the sea off the eastern side of the property, as well as waters of the Laguna de Cantena on the western of leeward side of the property [See Table 10.1]. This has been assessed at its most extreme as '+1' or 'minor beneficial' [See Table 10.1]. The 'minor' impact categorization is a function of the sewage treatment technology to be applied which incorporates a water recycling scheme with very limited discharge of effluents for irrigation and fire fighting purposes [See Chap. 1].

The sewage technology to be applied is secondary treatment with the reduction of nutrients to levels that are not a threat to the environment and that are well within national standards. The system to be adopted for the proposed project is a prefabricated treatment plant or 'Package Plant' titled a "Purestream ES Model BESST" [See Chap. 5]. The acronym of the systems stands for **B**iologically **E**ngineered **S**ingle **S**ludge **T**reatment.

The BESST Plant can reduce the Biological Oxygen Demand and Total Suspended Solids by 97% to less than 10 mg/L [See Annex IV]. Total Nitrogen Loads can be reduced by 67% to less than 10 mg/L and Total Free Ammonia Loading can be reduced by 97.5% to less than 1 mg/L [See Annex IV].

Phosphorus can be reduced by 80% by the BESST System to 2 – 3 mg/L [See Annex IV].

The level of phosphates and nitrates found in the waters in and around the caye, as shown in Table 2.1 varies from 0.4 – 0.6 ppm which is relatively low and that would not be considered as ‘polluting’.

The minor ‘beneficial’ secondary impacts are an indicator that macronutrients are getting into the environment. This is not a measure of the default of the BESST System to be deployed, but a function of the runoff from lawns and hedgerows that are to be irrigated by post chlorinated effluents. It needs to be noted that the BESST Technology is to be integrated with a recycling scheme where the treated effluents are to be chlorinated and stored for future use.

The issue of fecal coliform associated with the development is an important one. As may be seen from Table 2.1, the *E. coli* readings were zero. The generation of *E. coli* becomes a significant consideration with the commissioning of the development. The primary impact from these features of the development has been characterized as ‘major’. The application of the BESST Sewage Treatment Technology combined with water conservation measures vis-à-vis the water recirculation/reuse scheme dampens and greatly diminishes the potential human health impacts from fecal coliform. Thus the ‘Tertiary Impact’ for the potential of ‘Pathogenic Diseases’ has been assessed as ‘-1’ or minor adverse [See Table 10.1].

10.3.3 Potable Water Impacts

One of the potential threats of the sourcing of potable water through Reverse Osmosis [RO] is the threat of salinization of soils. The primary impacts of this activity are connected with the deposition of dredged spoils on-shore, as well as the deployment and operation of the RO Plant [See Table 10.1]. The primary impacts have been ranked as major given the volume of water to be used and the volume of hypersaline brine to be derived as a corollary to the process.

The secondary impacts associated with the sourcing of potable water has been assessed as ‘-1’ or ‘minor deleterious’ [See Table 10.1]. This has been a function of the strategy to supplement the RO source with rainwater catchment. The ‘deep well’ injection of the hypersaline brine from the RO Process is the main strategy to reduce the ecological impacts from this source.

The main areas to be impacted are the canopy biomass and a decrease the diversity of plant species [See Table 10.1]. This would be in regards to both the littoral forest and the wetland mangroves.

The main tertiary impacts are in relation to ‘odor pollution’ and ‘muds and sight pollution’. These have been assessed as ‘minor’ deleterious given the limited scope of the dredging and consequent deposition of spoils on-shore and the above-mentioned strategy to supplement the RO technology for the sourcing of potable water with rainwater catchment.

10.3.4 Solid Waste Impacts

The generation of solid waste relates to both the construction and operational phases of the proposed project. The construction phase activities has the capacity to generate substantial volumes of solid wastes. This varies from felled trees and shrubbery in relation to land-clearing, to concrete mouldings and form boards from the erection of buildings, to styrofoam packaging, wooden planks and metal strips from shipping crates. Other significant solid waste components from the construction phase includes: PVC piping, masonry slabs and chippings, food wrappings, aluminum cans and beverage cartons, as well as plastic and glass bottles are also expected to be a substantial part of the solid waste. Discarded food is also a relevant solid waste item during the construction phase.

During the operational phase of the project solid waste constituent is expected to span a wide range of possibilities, encompassing food discards, plastics, paper, glass, metals, rubber and wood. The food discard component is expected to increase by orders of magnitude given the relatively large numbers of clientele forecasted. Most of the other solid waste components are also expected to increase, especially plastics, paper and glass.

The proposed management scheme for solid waste for the ABR Project Site involves the initial separation of the garbage into biodegradable and non-biodegradable components. The biodegradable components are to then be composted on site using an ‘Earth Tub’: This reduces the wastes to a semi-dry mulch and organic fertilizer for gardens and hedge rows.

During the construction phase of the project, the vegetation accruing from land clearing is to be collected and burned on-site.

The non-biodegradables components are to be assimilated at the project site and transported to the San Pedro municipal dump site two (2) to three (3) times per week.

The two (2) main environmental issues related to the generation and management of solid waste are the potential for the attraction of feral animals to the site, and the potential for increasing the abundance of nuisance insects. The attraction of feral animals to the main area would be as a result of the increased availability of food in the form of discards from the restaurants and other vending outlets. The animals relevant in this regard would vary from the raccoon (*Procyon lotor*) to the opossum (*Philander opossum*), and include vagrant and opportunistic birds such as the Great-tailed Grackle (*Quiscalus mexicanus*), the Herring Gull (*Larus argentatus*) and the Frigate Bird ((*Fregata magnificens*).

The primary impact has been assessed as ‘2’ or ‘moderate’ in scope [See Table 10.1] and is associated with the occupancy of the resort and residential facilities during the operational phase of the development.

The only secondary impact of note would be in regards to the land-based ecosystems [See Table 10.1]. These impacts have both been assessed in the ‘minor deleterious’ category. The ‘minor’ element of the designation relates to the fact that there is to be little or no discarded food lying around in a way that would be available to feral animals, given the regular collection, bagging, composting and disposal of this category of waste.

The impacts to wildlife relates to the availability of food from non-natural sources and the consequent ‘fattening’ and proliferation of wild stocks.

The tertiary impacts in regards to solid wastes have also been assessed as ‘minor’: The ‘adverse’ categorization of these impacts relate to the threat of pathogenic diseases and injury from potential encounters between the guests or staff and scavenging racoons and birds. The issue of ‘culture conflicts’ and aesthetic impacts are also of relevance. These impacts have been assessed as ‘minor adverse’ [See Table 10.1]. Again, the ‘minor’ categorization of these impacts is related to the judicious management of solid wastes that are a part of the response of the ABR Management Structure.

10.3.5 Boating and Dockside Impacts

The boating and dockside impacts are related to petroleum pollution: These impacts are related in large measure to the fueling operation of boats at the head of the pier. Another potential source of petroleum pollution would be from the unauthorized and inappropriate discharge of ‘bilges’ of boats tied up at the dock for extended periods by clienteles of the facility.

The primary impacts of petroleum pollution have been categorized as ‘minor’ in scope [See Table 10.2] given the non-spillage protocol to be adopted by the ABR Management and the relatively small volumes of fuel involved. Two 2,000 gallon storage tanks for diesel and petrol are to be installed at the project site in the utility area. These storage tanks are to be enclosed in a retaining trough with vertical walls 2.5 ft in height.

The secondary and tertiary impacts from petroleum are expected to be largely indiscernible in scope given the non-spillage protocol mentioned above, and the limited volumes involved.

10.3.6 Impacts from Energy Generation

The two (2) main impacts associated with energy generation are petroleum pollution and noise pollution. The containment structure to house the bulk fuel tanks on the caye and the non-spillage protocol in dispensing fuel greatly reduces the probability of any environmental impact from this source.

The noise pollution issue is of greater relevance than the petroleum pollution issue, in regard to energy generation. The installation of diesel generators as the primary source of electricity makes noise pollution an important issue. The scope of the proposed development and the overall energy requirement of the initiative have resulted in a categorization of the most significant ‘primary impact’ as ‘2’ or moderate [See Table 10.1].

There are no secondary impacts of note in relation to noise pollution. The 'tertiary impacts' have been assessed as '-1' or 'minor adverse' [See Table 10.1], given the 'muffling' of the generators and the use of sound-proof tiles on the walls of the generator house [See Chap. 6]. The placement of the generators in the 'utility zone' away from the hub of the recreational activities and residential zone, where they are removed from the centre of human habitation [See Fig. 1.3].

10.4 Details of the Social Impacts

10.4.1 Core Issues of the Social Impact Assessment

The proposed development site is located just north of Rocky Point and is situated in the middle of two protected areas: the Bacalcar Bacalar Chico National Park and Marine Reserve. The boundary of the marine reserve at or near the proposed development site is stated as the high water mark. The Bacalar Chico Management Plan delineates the area in front of the site as General Use Zone 1; however the site also borders Conservation Zone 2.

The *General Use Zone 1* allows for the sustainable management of existing traditional uses within the marine reserve prior to declaration. This zone runs from in front of the development site north to the Bacalar Chico Canal and is accessible to local fisher folks who utilize the area for commercial fishing. The key objective of this zone is to provide the opportunity for established uses and activities to be continued in a sustainable manner under a stringent monitoring scheme.

The adjacent *Conservation Zone 2* which borders the property is designated as a controlled extraction zone designed to accommodate subsistence fishing, recreation and tourism. The zone accommodates all of the different types of recreational activities permitted in the reserve, in affording beach areas for swimming, corals for diving and snorkeling, areas for canoeing and good areas for fishing. The key objectives of this zone are to prevent fishery stocks from overexploitation by commercial fishing and to enhance the value of the area for recreational and tourism activities.

It is important to note that the Bacalar Chico Management Plan shows a proposed surveillance route at Rocky Point; and two new ranger stations at Rocky Point and Robles. Since the 1990s, the terrestrial and marine area between Robles Point and Rocky Point was recognized as an important area for marine turtles nesting, breeding area for the Queen Conch, seasonal spawning bank for Nassau Grouper the and Yellow-fin Grouper, as well as a variety of other species. It is also important to note that specific regulations also govern the BC National Park where hunting of wild animals etc. is prohibited.

Currently, the only access to the site is by boat through an access channel near two cut. Marine access to the site from the town of San Pedro is outside the reef. There is no existing real road access to the site; however, there is a registered road reserve which commences west of the municipal pier near NOVA. Because the area of the coast between Robles and Rocky Point is very sensitive in terms of both overland road access and marine traffic, potential impacts on the existing environments will need to be analyzed both in terms of construction and completion activities of the project.

To determine those unintended impacts of the proposed development, the social impact assessment (SIA) carried out examined those issues related to proposed development activities without intending to change or modify social groups, values, or activities in the area and the region [Table 10.1]. In general, the will SIA attempt to provide essential and valuable input for higher and more strategic levels of decision making during all phases of development and will incorporate data collected and assessed during the social assessment review. The social impact assessment is not intended as a scientific evaluation, but merely as guide to assessing those main issues of concern. For consideration, other associated direct impacts include increased sea traffic and safety to and through the area during and at completion of project, and indirect impacts such as basic needs for workers and emergency services.

The SIA conducted will build on reported information and activities within the existing local and regional environments and will identify and analyze those impacts [if any] of the proposed development during all phases of construction. In general terms, the impact assessment will include analyzing, monitoring and managing the social consequences of proposed development activities.

10.4.2 The Impact Review

Development projects of any kind can modify or enhance the economic viability of a given area. The main purpose of the social impact assessment is to analyze those potential social, cultural, economic and transportation impacts, the proposed development may have on the immediate area and the region on a whole. Associated impacts will be analyzed for both positive and/or negative factors based on the proposal for resort development at its current site.

In view of proposed development activities, conditions relating to the construction and operation of the resort development at it current site was completed by examining those components that could potentially affect proposed activities:

- Likelihood and/or probability of impacts to occur
- Magnitude or degree of the impacts and significance
- Mitigating measures
- How the impacts can be reduced (mitigated) or prevented

In assessing the overall social environment as it relates to the socio-economic, cultural, tourism and transportation conditions the potential impacts of the proposed development may have on the area and the region, the following components were assessed:

- Existing and Proposed Activities
- Marine Traffic

- Road Access
- Disturbances (noise, air quality)
- Population/Housing
- Socio - Cultural
- Education/Health Services
- Employment/Safety
- Emergency Services
- Tourism Activities
- Economic Impact

10.4.3 Sources of Impacts

Determination and Evaluation

Project activities were divided for determination and evaluation of potential impacts:

1) Mag = Magnitude of impact (high, medium, low)
2) Dir = Direction of impact (positive, negative, no change)
3) Dur = Duration (months, years, decade)
4) Scope = area affected (local, long)

10.4.4 The Social Impact

10.4.4.1 Existing and Proposed Activities

- Location and size of project and existing uses
- Access to the area by traditional users
- Ability of traditional users to adopt to change
- Increase usage of the area of development by new comers

The proposed development site is situated in the middle of the Bacalar Chico National Park and Marine Reserve. Land tenure in the immediate area and along this eastern coast is private holdings. The National Park is Government or national lands. Except for a recently constructed wooden structure on the beachfront of the northern adjacent property, there is no other nearby developments in the immediate the vicinity of the development site.

The current development site and adjacent properties are for the most part still under vegetation. Information gathered indicated that there were a proposal for the development of hotel/resort on the adjacent southern adjacent property, but this was never materialized. With the advent of the proposed development, and an access road to the site, land values and the potential for additional private developments will increase. Existing users to and through the area, are the traditional fisherfolk and local tour operators mostly from the town of San Pedro.

During the post-construction and other phases of development, marine traffic to the area and the region will increase. Seemingly, there will also transportation of workers and materials to and from the site daily.

10.4.4.2 Marine Traffic

- Impact on traditional users to the area
- Increase number of users and vessels to the area
- Impact on natural environment by increased boat usage
- Safety for traditional and other users

The region in front of the development site has been zoned general use zone 1 by the Bacalar Chico management plan which allows for sustainable management of existing traditional uses within the marine reserve prior to declaration. The key objective of the zone is to provide the opportunity for established uses and activities to be continued in a sustainable manner under a stringent monitoring scheme. Information gathered indicates that the area of the proposed development is generally utilized by local tour operators from San Pedro for marine tourism activities.

It is expected that there will be a marked increase in the movement of marine vessels to and through the area of the development site during all phases. Marine traffic includes transporting employees, tourists and other marine traffic to and from the development. Increase of marine traffic will require that safety measures be installed for users to and through the area of the proposed development.

10.4.4.3 Road Access

- Impacts from road construction on adjacent properties and the existing environment
- Transportation of construction materials and equipment during all phases of development

- Noise pollution from equipment and machinery transporting materials and supplies to the site

Currently there is no road access to the development site, and very limited access for the development of properties on Northern Ambergris Caye. It is noted that there is an existing road or track that leads from the San Pedro River to near Journey's end. This road however, cannot support heavy equipment and machinery. Because of the topography of the area, choices regarding road construction standards will be influenced by site characteristics and the value of the resources to be utilized.

Recent planning for the area indicates that there has been a proposal for a road reserve on northern Ambergris since the early 1990s. With the GOB acquiring the Pinkerton estate in 1990, and the approval of huge parcels of lands on Northern Ambergris, property owners have increasingly been lobbying for a road to access northern properties. The construction of an all weather road on northern Ambergris will not only complement the developer but will also pave the way for many undeveloped properties which have been abandoned due to limited access.

Because of the limitations and hazards for the transportation of equipment and materials to the site by marine vessels, road access to the site is most feasible and eco-sensible recommendation. The description for the road reserve to the site is described within "road access" within the social assessment. This road access have been envisioned by the San Pedro Town Council for over a decade: road access recommended is along western property boundaries to include road reserves within existing subdivisions along the coast from near the municipal pier to the development site.

At completion of a road to the property, and during all phases of construction and development it is expected that a large amount of materials and equipment will be transported overland from near the NOVA shrimp facility to the proposed development site. It is also expected that unfamiliar noise pollution will be one of the main concerns of the residents. A walkway along the western edge of the development along lagoon will also be constructed. This is not expected to have any major impacts, as the walkway will not be constructed in the national park.

10.4.4.5 Disturbances (noise, air quality)

- Noise pollution from the operation of construction equipment and machinery
- Disturbance from airborne pollutants, contaminants, from proposed activities

During the construction phase and completion phase, noise and air pollution will be one of the main impacts from equipment and machinery. Impacts on road construction works on the environment include noise, dust and air pollution.

10.4.4.6 Population/Housing

- Temporary/permanent worker population increases
- Voluntary populations from elsewhere in the region
- Unplanned communities
- Pressure on existing resources
- Demand for services
- Impacts on areas of ecological importance

Because of the demographic location of the proposed development, the area and the region of the proposed development site will see increases in worker populations during all phases of construction. It is expected that voluntary populations from San Pedro and elsewhere in the region will be seeking employment within the new development.

The area and region of the development site along the Ambergris Caye eastern coast consists entirely of private properties, of which there is no available public land for spontaneous or unplanned communities. Also, because of the topography the area and the site can only support general low density land use.

The demand for unavailable services not found at the site will put pressures on existing resources. Increased populations in the area and the region will also see impacts by users in areas of ecological importance.

10.4.4.7 Socio - Cultural

- Cultural displacement
- Pressure on existing customs and lifestyles
- Locals become marginalized
- Pressure on existing institutions and social groups

The town of San Pedro is where the core of the population of the island resides. Over the past two decades, because of growth tourism activities, the Town have experienced increases in population growth from different cultural and ethnic groups, be it local Belizeans, Central American Immigrants or North Americans etc. This growth in and of itself has had great impact on the lifestyle, culture and social institutions in the Town of San Pedro.

In the area of the development site, there are no nearby resident population or nearby local residential housing. Any additional or new immigrants to the island will place extra pressure on existing institutions and social groups.

10.4.4.8 Education/Health Services

- Pressure on educational institutions by migrant worker populations
- Pressure on health and sanitary facilities by migrant worker populations
- Locals become marginalized by migrant worker population

The town of San Pedro is the nearest town from the development with limited educational and health services facilities. Because of the demographic location of the project, the relocation of additional immigrant populations to the island will place a high demand for housing, schools and other ancillary services. The improvement or addition of health facilities will not only complement growing needs of the population of San Pedro, but will also afford additional available services and facilities for this tourist destination.

Because the town of San Pedro is some 21 miles north of the project and Belize City with the highest level of health and infrastructural services is even farther from the site, it is recommend that the Developer include in the project development on site emergency and health facilities for onsite personnel and visitors during and after project completion.

10.4.4.9 Employment/Safety

- Skilled laborers not employed during construction phases; unskilled laborers not trained
- Safety measures not installed for all laborers and employment types
- Security and safety of users and visitors to the area
- Endangerment of pier and docking facilities to life and properties

Employment of locally available employable workers and safety issues are two main concerns within new development projects. Unskilled and untrained laborers can also prove very expensive to project development. Also of importance, are safety of new infrastructure development and the area of the proposed development, for employees, tourist and traditional users to and through the area of the terrestrial and marine environment.

10.4.4.10 Emergency Services

- Staff not trained in basic emergency procedures

- Emergency service not available on site during and at completion of project development

- Emergency facilities not available on the island for employees, visitors and unrelated actions

In most development projects, emergency services are not necessarily built into project design as it is one of the least requirements of any development. In most cases, employees and visitors alike are seldom aware of dangers relating to project development activities.

10.4.4.11 Tourism Activities

- Impact of inland and marine attractions
- Carrying capacities of marine and inland sites
- Impact on fishery resources
- Disruption of tourist activities relating to marine traffic through the area

The proposed development site is within the BCNP and MR. The main concerns within the national park and marine reserves are impacts of development activities by both construction operations and related tourism activities within these areas. Another main concern is impact on turtle nesting site and the no hunting activities. Increased boating activities in and through the area may also have some impact on fishery resource and on traditional tourist activities in the area.

10.4.4.12 Economic Impact

- Increased employment
- Increased economic benefits generated by direct expenditure
- Increased revenue for the marine reserve
- Impact on fishery resources by traditional users

The proposed development will bring increased economic benefits to the area and the region. In respect to the marine reserve areas have been zoned for specific areas for activities by traditional users. It will generate both on-site direct employment and indirect supply-industry jobs and spin off for many other individuals and businesses. Jobs will be created at both local and national levels.

Local workers, especially in the town of San Pedro and the region will be needed throughout all phases of the project, and the income generated will boost economic growth and development. In addition, some of the construction materials like sand, marl, and gravels are available nearby with the capacity to supply a huge quantity of material for road construction.

Table 10.2 ABR Social Impact Summary

Category of Project Activity	Potential Impacts	Recommended Mitigation Measures	Residual Impacts Magnitude Direction/Duration/Scope
Existing and Proposed Activities	- Location and size of project and existing uses - Access to the area by traditional users - Ability of traditional users to adopt to change - Increase usage of the area of development by new comers	- All development activities scheduled so as not to obstruct existing uses and future activities of the area - traditional users continue to have access to areas of traditional uses - planned dredging activities avoid areas of traditional use by fishermen - traditional users flexible to new owner proposed activities during and after completion of project development - development planned so as not to impact on traditional user areas and activities - machinery and equipment be maintained	- High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long - High/medium/months/local - High/positive/decade/local/ long
Marine Traffic	- Impact on traditional users to the area - Increase number of users and marine vessels to the area - Impact on natural environment by increased boat usage - safety for traditional users and other users	- the Developer and staff should be advised of areas of traditional uses - the movement of marine vessels to the area should be scheduled - all watercraft activities be regulated and designated markers in places in special impact areas - workers be transported to and from the site to their respective areas during all phases of construction - safe and secure mooring of craft, when off-loading materials and equipment at docking facility - all watercraft activities be monitored and regulated - Marine traffic through and near the area be regulated; buoys and markers should be fitted to facilitate day and night vessels in the area - Hazardous areas and areas of specific importance be demarcated	- High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long

		- [lighted] buoys and markers should be installed to facilitate day and night users in and through the area	
Road Access	- Impacts from road construction on adjacent properties and the existing environment - Transportation of construction materials and equipment during all phases of development - Noise pollution from equipment and machinery transporting materials and supplies to the site - Opening up access road could increase demand pressure on sensitive areas	- road construction be completed so as not to cause or create undue impacts on property and environment - All materials transported should be covered and properly secured - Equipment and machinery be maintained in quality condition - All on site materials should be properly stored and unused materials disposed of – offsite - Carrying capacity studies should be conducted to determine acceptable limits of change due to increased access and use.	- High/positive/decade/local/ long - High/medium/years/local/ long High/medium/years/local/ long
Disturbances (noise, air quality)	- Noise pollution from the operation of construction equipment and machinery - Disturbance from airborne pollutants from proposed activities	- All installed equipment such as a power generator etc., be enclosed to minimize noise impacts during day and night time uses - operation of heavy machinery and equipment operated during daylight hours - Equipment and machinery maintained in quality condition - No burning of debris allowed	High/medium/years/local/ long - High/medium/months/local/ long - High/negative/months/local
Population/Housing	-Temporary/permanent worker population increases - Voluntary populations from else-where in the region - Unplanned communities - Pressure on existing resources	- Developer provide for all on site needs of the workers and visitors (i.e. housing, food, water, etc.) - Additional staff quarters be constructed at the site - the area and region of the proposed development is private land tenure - All adjacent lands are private lands except for adjacent protected area - Construction workers, personnel, visitors be	- High/positive/decade/local/ long - High/positive/decade/local/ long - High/no change/decade/local/ long - High/no change/decade/long - High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long

	- Demand for services - Impacts on areas of eco-importance	educated as to existing plan and uses of the area - Developer provide for all on site needs of the workers and visitors - Construction workers, personnel, visitors, etc., be educated as to existing plan and uses of the area	
Socio - Cultural	- Cultural displacement - Pressure on existing customs and lifestyles - Locals become marginalized - Pressure on existing institutions and social groups	- Locally strengthen existing institutions and social groups or develop new ones - Strengthen existing institutions, and regulatory systems	- High/negative/decade/local/ long - High/medium/decade/long - High/medium/decade/long/
Education/Health Services	- Pressure on educational institutions by migrant worker populations - Pressure on health and sanitary facilities by increased migrant worker populations - Locals become marginalized by new influx of migrant worker population	- the local authorities will need to develop an institutional plan to meet the needs of the growing population and visitors alike	High/negative/decade/local/ long
Employment/Safety	- Skilled laborers not employed during construction phases; unskilled laborers not trained - Safety measures not installed for all laborers and employment types - Security and safety of users and visitors to the area - Endangerment of pier and docking facilities to life and properties	- Employ skilled and unskilled laborers from the greater Belize - Train locals from San Pedro and the region with the potential for long term employment - All operators be trained and involved in development plans, safety procedures and use of safety equipment - Proper gear be utilized for all labor types - Warning signs, buoys, lights etc, be installed in the terrestrial and marine environments of the development	- High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long - High/positive/decade/local/ long
Emergency Services	Staff not trained in basic emergency procedures - Emergency service not available on site	- Staff trained in basic emergency procedures, and all operational machinery and equipment - Install emergency equipment and facilities on	- High/positive/years/local - High/positive/years/local

	during and at completion of project development - Emergency facilities not available on the island	site - The development should have a sound emergency plan and emergency first aid in place on site for employees, resident population and visitors - Emergency plan for accessing facilities on the mainland as needed	- High/positive/years/local - High/positive/years/local
Emergency Services	Staff not trained in basic emergency procedures - Emergency service not available on site during and at completion of project development - Emergency facilities not available on the island	- Staff trained in basic emergency procedures, and all operational machinery and equipment - Install emergency equipment and facilities on site - The development should have a sound emergency plan and emergency first aid in place on site for employees, resident population and visitors - Emergency plan for accessing facilities on the mainland as needed	- High/positive/years/local - High/positive/years/local - High/positive/years/local - High/positive/years/local
Tourism Activities	- Impact on turtle nesting beach by tourist activity - impact on turtle nesting beach by newcomers to the site - Impact on national park (i.e. no hunting etc.)	- visitors and employees be educated as to the importance of the site - Turtle and other nesting and spawning areas should be demarcated as no access zones. - planned activity to avoid disrupting nesting site - no hunting, fishing, setting of traps etc on protected area - licenses and permits required for various activities	- High/negative/decades/local/ long - High/negative/decades/local/ long - High/negative/decades/local/ long
Economic Impact	- Increased employment - Increased economic benefits generated by direct expenditure - Increased revenue for the marine reserve - Impact on fishery resources by traditional users	- increased revenue to area and region and lifestyle - increased domino effects and spin offs on the island and the mainland - additional income for the marine reserve	- High/positive/decades/local/ long - High/positive/decades/local/ long - High/positive/decades/local/ long

Chapter 11

11.0 Impact Mitigation

11.1 General Principles Underpinning Environmental Impact Mitigation

The mitigation measures to be implemented are in relation to circumventing or ameliorating those impacts that have been assessed as having a 'moderate adverse impact' or a 'major adverse impact', as shown in Table 10.1. The four (4) main developmental issues requiring specific mitigative responses are: dredging, domestic effluents, solid wastes management, and socio-economic concerns.

11.2 Specific Mitigation Measures

11.2.1 Mitigation Measures In Relation To Dredging and Land Reclamation Activities

The issues of concern related to the dredging operation are the navigational and berthing of the dredge at the burrow site, as well as the dredging or excavation activity itself. The issue related to the navigation and the berthing of the dredge is the threat of physical harm and injury arising from collision at sea accidents. This is especially relevant to boat traffic in the nearshore areas. The mitigative responses to this are in large part in relation to the placement of navigational aids such as buoys and beacons to alert and ward off mariners. This is dealt with in Table 11.1 below.

Table 11.1: Mitigation Responses in relation to Dredging Impacts

Development Activity	**Primary Impacts or Environmental Disturbance**	**Secondary and Tertiary Level Environmental Impacts**	**Mitigation Measures**
1. Actual Dredging or Burrowing of 'Cutter Head'	1a. Disturbance of seafloor, the suspension of fine sediments and the re-deposition of coarse factions.	1a1. Direct physical destruction of benthic habitat, and attenuation of light impeding photosynthesis of seagrass, macro-algae and other autotrophs.	1a1a. Use of 'Silt Curtains' at burrow pit, ensuring that lower end of 'skirt' is resting upon the seafloor, and ensuring that top of the 'skirt' is always above the surface of sea.

Development Activity	Primary Impacts or Environmental Disturbance	Secondary and Tertiary Level Environmental Impacts	Mitigation Measures
			1a1b. Monitoring and where necessary repairing and/or replacing leaky pipes and faulty couplings of the spoil discharge pipes.
			1a1c. Applying velocity reduction measures where spoils are deposited such as baffles to precipitate solids and curtail turbid influences in effluent stream.
			1a1d. Decrease time frame over which the dredging operation is to take place, to avoid the daily re-suspension of sediments.
			1a1e. Ameliorate the impacts of the daily re-suspension of sediments by the suctioning of sediments that have resettled.

Development Activity	Primary Impacts or Environmental Disturbance	Secondary and Tertiary Level Environmental Impacts	Mitigation Measures
			1a1f. Ameliorate the re-suspension of sediments by confining the dredging operations to calmer sea states.
			1a1g. Assist the re-colonization of seafloor by seagrass and other benthic plants as well as by invertebrates through ensuring that the gradient of the walls of the burrow pits are not at an angle that is steeper than 35 degrees.
		1a2. "Blanketing" or smothering effects on benthic habitat and sessile and slow-moving invertebrates.	1a2a. Institute monitoring programme to ensure that light penetration at seafloor is at least 25% of that at the surface.
	1b. Decrease in Dissolved Oxygen and increase in BOD.	1b1. Physiological stress and lethal effects on benthic invertebrates and to a lesser extent, fin-fishes.	1b1a. Completion of dredging operation in as short a time-frame as possible.

Development Activity	Primary Impacts or Environmental Disturbance	Secondary and Tertiary Level Environmental Impacts	Mitigation Measures
	1c. Increase in temperatures brought about by the re-suspension of sediments with a ‘specific heat capacity’ capable of raising water temperatures by as much as 4 – 6˚C.	1c1. Lethal and sub-lethal effects on sessile and slow-moving benthic invertebrates.	1c1a. Proper deployment of ‘silt curtains’ to ensure that suspended sediments at burrow sites are corralled and that any re-deposited sediments are ‘suctioned’ and rapidly deposited on shore.
2. Navigation, Berthing of Dredge and Deployment of Spoil Discharge Pipes.	2a. Navigational hazard.	2a1. Threat of injury and possibly death associated with boat traffic.	2a1a. Ensure that marker buoys and navigational lights are deployed and activated on dredge, sediment curtains and spoil discharge pipes – Buoys are to be large and brightly colored in florescent hues: Navigational lights are to be fully operational from 6:00 a.m. to 6:00 p.m. on a daily basis.

The primary impacts related to the actual dredging or excavations itself are sedimentation and turbidity [See Table 10.1]. The mitigation response to deal with this is to mechanically ‘contain’ or ‘corral’ the sediment plume arising from the excavation process through the deployment of ‘sediment curtains’ [See #1a1a., in Table 11.1]. Other related responses include activities to circumvent or ameliorate the re-suspension of sediments, as well as measures that would decrease or ameliorate the physiological stress on sessile and slow-moving organisms. Secondary effects related to sediments in the water column such as temperature increases are also relevant. Responses to these impacts include: the rapid undertaking of the overall dredging operation to conceptually decrease the severity and range of impacts in space and time, the suctioning or ‘vacuuming’ of re-suspended sediments ashore to decrease the potential of the expansive dispersal of sediments, and adjusting the overall mechanics of the dredging operation to allow for the re-colonization of the area by benthic plants and sessile and slow-moving invertebrates [See Table 11.1].

11.2.2 Mitigation Measures In Relation To Human Wastes and Domestic Effluents

The primary impacts associated with human wastes and domestic effluents are: eutrophication or nutrient-enrichment, increases in the risks of pathogenic diseases, and increases in BOD and suspended solids. The mitigative responses for dealing with these impacts include the application of BESST Sewage Treatment Technology and the recycling and reuse of effluents [See Table 12.2]. These responses reduce the levels of macro-nutrients, BOD substances and suspended solids to levels where they do not constitute a threat to human health, or a risk to the integrity of the environment [See Table 11.2].

The various impacts and the consequent responses to these have been detailed Table 11.2.

Table 11. 2: Summary of impacts associated with human wastes and domestic effluents

Development Activity	**Primary Impacts or Environmental Disturbance**	**Secondary and Tertiary Level Environmental Impacts**	**Mitigation Measures**
1.0 Human Waste and Domestic Effluents	1a. Nutrient enrichment from the injection of macro-nutrients into the environment.	1a1. Stimulus to plant growth on land and in the water column, in the case of the latter this includes phytoplanktons, seagrass and macroalgae, including the possibility of the overgrowth of reefs by macroalgae.	1a1a. Installation of BESST Treatment technology (Biologically Engineered Single Sludge Treatment) to treat waste to 'Secondary' Levels, where Total Nitrogen Loads are reduced to less than 10 mg/l and Phosphorus are reduced to 2-3mg/l.
			1a1b. Reduce effluents going into the environment by recycling effluents to flush toilets – effluents from BESST Treatment Plant will be stored and disinfected through chlorination before it is reused for flushing toilets.

Development Activity	Primary Impacts or Environmental Disturbance	Secondary and Tertiary Level Environmental Impacts	Mitigation Measures
			1a1c. Reduce further nutrient loads going into the water column by using stored effluents from BESST Treatment Plant to irrigate lawn and hedgerows.
	1b. Pathogenic microbes that can negatively impact human health.	1b1. Infection of tourists and staff at the project site by pathogenic viruses and bacteria.	1b1a. Thorough disinfection of effluents potentially going into water column or otherwise making contact with humans by use of BESST Sewer Treatment Plant, combined with chlorination of post-treated effluents.
			1b1b. Reduction of effluents going into the environment by use of BESST Treatment Plant and incorporation of recycling and reuse of effluents for flushing of toilets and watering of lawn.

Development Activity	Primary Impacts or Environmental Disturbance	Secondary and Tertiary Level Environmental Impacts	Mitigation Measures
	1c. Suspended Solids from un-dissolved components of human waste and domestic effluents.	1c1. Suspended solids impedes light penetration of the water column and erode or arrest photosynthesis.	1c1a. Application of BESST Treatment technology reduces TSS to less than 10 mg/l, this in combination with effluent recycling and reuse regime reduces suspended solids to insignificant levels in the water column.
	1d. Sedimentation associated with settlement of flocculent faction of human waste and domestic effluents.	1d1. Blanketing of seafloor and suffocation of slow-moving and sedentary invertebrates.	1d1a. Application of BESST Treatment technology reduces TSS to less than 10 mg/l, this in combination with effluent recycling and reuse regime reduces suspended solids to insignificant levels in the water column.

Development Activity	Primary Impacts or Environmental Disturbance	Secondary and Tertiary Level Environmental Impacts	Mitigation Measures
	1e. Increase in BOD substances and consequent reduction in dissolved oxygen.	1e1. Precipitation of physiological stress and in extreme circumstances death in relation to sessile and slow moving invertebrates.	1e1a. Application of BESST Treatment technology reduces BOD to less than 10 mg/l, this in combination with effluent recycling and reuse regime reduces BOD to insignificant levels in the water column.

11.2.3 Mitigation Measures In Relation To Solid Wastes

The solid waste accruing from the general commissioning of the ABR Resort and Condominium Development includes biodegradable and non-biodegradable components. The biodegradable components includes in large part discarded and unconsumed food from the restaurant and bar and refreshment stands. The non-biodegradable component relates to packaging materials, construction wastes and damaged and abandoned equipment and equipment parts. A major component of the non-biodegradable wastes would be ‘plastics’ in general in the form of bottles, cups, boxes and wrappings.

One of the major impacts of the wastes generated by the development would be the attraction of feral animals and household pests such as rats, raccoons and birds to the area to scavenge. The mitigative response to be implemented by the ABR Resort and Condominium Development is the judicious collection and segregation of the wastes into biodegradable and non-biodegradable components [See Table 11.3]. These wastes are to be composted and/or transported from the project site on a regular and recurrent basis [See Table 11.3]. The implementation of a public education campaign focused on the tourists and visitors in general will also be a part of the mitigative response [See #1a1b, Table 11.3].

The entanglement and ingestion of plastics by sea turtles, birds and other fauna is also a relevant concern that will be dealt with in a judicious manner [See #1b2., Table 11.3]. The full range of impacts and mitigative responses has been dealt with in the appropriate details in Table 11.3 below.

Table 11.3: Mitigation Matrix in Relation to Solid Wastes

Development Activity	Primary Impacts or Environmental Disturbance	Secondary and Tertiary Level Environmental Impacts	Mitigation Measures
1.0 Commissioning of the resort and residential components of the development.	1a. Discarding of waste food and associated packaging materials.	1a1. Attraction of feral animals such as rats, raccoons, and vagrant birds to the project to scavenge and in effect shift the ecological balance in a way not induced by nature.	1a1a. Judicious collection of discards by staff with composting biodegradable component and storage of non-biodegradable component in impervious plastic bins for transportation to San Pedro Landfill Site on a sustained and recurrent basis.
			1a1b. Definition and implementation of public education campaign focused on tourists and visitors in general, in the form of interactive posters and brochures posted in strategic locations such as restaurants, gift shops, and rest-rooms and docks/dive shop.

Development Activity	Primary Impacts or Environmental Disturbance	Secondary and Tertiary Level Environmental Impacts	Mitigation Measures
	1b. General discarding of cans, bottles and plastics in general from foods, beverages and in general packing materials.	1b1. Habitat for mosquitoes and other insect pests, as well as aesthetic pollution from odor and unsightly accumulation of solid waste.	1b1a. Separation of discard and refuse into biodegradable and non-biodegradable components where they will be secured in plastic garbage bags and stored in plastic bins for transportation to San Pedro – Biodegradables will be composted and used as mulch for lawns and hedgerows, non-biodegradable component will be transported San Pedro Landfill Site on regular and recurrent basis.
		1b2. Entanglement and ingestion of plastics floating in the water column by sea turtles, sea birds and other fauna in the area.	1b2a. Judicious collection, confinement and disposal of solid wastes as described above.

11.2.5 Mitigation Measures In Relation To Socio-Economic Concerns

The social impact assessment in principle include the process of evaluating the intended and unintended consequences of the development, and identifying and articulating the mitigative measures that are to be put in place to circumvent and ameliorate these impacts. Relevant in this regard are the issues of the disruption and erosion of economic activities in the area: The most pertinent being fishing. The issues of the loss of fishing gears, and declines in the productivity of fishing grounds have been dealt with in Table 11.5 below. Pertinent also in terms of resource use conflicts is the issue of tourism. The area is used as general sea-lane for general marine traffic as well as a general 'sea lane' for transporting tourists to and from the atolls and surrounding cayes. The navigational issues dealing with the relationship of these to dredging activities are outlined in Table 11.5 below.

The issues of employment, safety considerations and other socio-economic aspects have also been dealt with in Table 11.4 below.

Table 11.4: Mitigations In Relation to Socio-Economic Concerns

Development Activity	**General Social Concerns or Impacts**	**Specific Social Concerns of Impacts**	**Mitigation Measures**
1. Construction Activities	1a. Temporary but potentially marked increase in amount of people moving into the area.	1a1. Increased demand on services in the area.	1a1a. Construction will be planned and strictly scheduled such that only the absolute amounts of people that are needed are in the area at any given time.
			1a1b. ABR shall seek to employ as much people as possible from the immediate area…In this regard all workers save for the security personnel will be shuttled between the project site and San Pedro on a daily during the construction phase.
			1a1c. ABR will make arrangements for food for the construction crew by either establishing an on-site kitchen.
			1a1d. Because of the location of the project, all development activities will be scheduled so as not to conflict with existing and on-going activities in the area.

Development Activity	General Social Concerns or Impacts	Specific Social Concerns of Impacts	Mitigation Measures
			1a1e. All and construction related activities, especially transportation will be coordinated with the BCNP/MR so as to avoid any breaching of the rules and regulations of that institution.
	1b. Movement of materials and supplies and heavy equipment into the area.	1b1. Human health and safety issues.	1b1a. Safe and secure mooring of boats when loading and offloading equipment and supplies will be strictly adhered to by the Management. of ABR.
			1b1b. Navigation of boats to and from San Pedro and other locale observing international and national sea lane rules and navigational protocol, and ensuring that equipment and supplies are securely stored and fastened during transportation.
			1b1c. Access to the project site through channels in reef in front project site shall be suspended during periods of heavy seas and poor visibility conditions.: The channel shall be adequately marked with large florescent buoys and beacons that shall be kept in operational readiness at all times.

Development Activity	General Social Concerns or Impacts	Specific Social Concerns of Impacts	Mitigation Measures
			1b1d. Response to construction injury includes first aid kit on-site, and in severe case the deployment of boat to ferry injured party (ies) to San Pedro.
			1b1e. Berthing of dredge securely with adequate lighting at nights, and deployment of buoys and beacons with warning flags marking sediment curtains and spoil discharge pipes.
			1b1e. The Developer shall comply with all applicable building codes and performance standards in regards to all standing structures.
			1b1f. Proper alignment and construction of road with focus on safety, lower maintenance costs, and minimal impacts to habitat through which road will be built.
			1b1g. All non-combustible construction wastes including metals, plastics, glass, rubber, styrofoam, etc are to be collected and transported to the San Pedro Municipal Dump Site.

Development Activity	General Social Concerns or Impacts	Specific Social Concerns of Impacts	Mitigation Measures
	1c. Employment of foreigners and persons that are not from immediate areas.	1c1. Lack of economic opportunities for people in proximity to the development site.	1c1a. Hiring people from San Pedro and its environs in circumstances where requisite skills and competencies are available will be a priority of ABR.
2. Resource use conflicts	2a. Loss of habitat for lobster and conch in nearshore seagrass beds at project site and Nova pier from physical destruction of seafloor biota, and sedimentation and turbidity effects from dredging.	2a1. Potential decline in recruitment of lobsters and conch with consequent decrease in landings.	2a1a. Deployment of 'silt curtains' during dredging operations greatly erodes or eliminates broadcasting of sediment plume in area thus circumventing or ameliorating damage to nearshore habitats.
	2b.Potentianl disruption of boat traffic traveling in the vicinity of the dredging operation, including fishermen, tour guides and the staff of the BCNP/MR.	2b1. Potentials for collisions with consequent injury and loss.	2b1a. Installation of buoys, beacons and other navigational aids to ward off marine traffic from the silt curtains and spoil discharge pipes: Also relevant is relatively small volumes and short duration of dredging operation.
3. Operational Phase of Development.	3a. Employment of foreigners and persons not from San Pedro and immediate environs.	3a1. Lack of economic opportunities.	3a1a. Hiring people from San Pedro in circumstances where requisite skills and competencies are available.

Development Activity	General Social Concerns or Impacts	Specific Social Concerns of Impacts	Mitigation Measures
	3b. Health and safety issues.	3b1. Fractures, broken bones and possible mortality from boating activities, the children play park.	3b1a. Access by boat to emergency services in San Pedro.
	3c. Lack of amenable infrastructure to accommodate workers on-site.	3c1. Rapid turn-over of staff, low productivity and worker satisfaction.	3c1a. Staff to be transported into San Pedro on a daily basis by shuttle provided by ABR Management.
	3d. Increase in marine traffic.	3d1. Increase in potential for injury and trauma from navigational accidents and mishaps.	3d1a. Ensure that piers and docks are well lit with adequate berthing facilities, and that strict protocols are adhered to in regards to boarding and leaving seaborne crafts.

Chapter 12

12.0 Monitoring Plans

12.1 Principles Underpinning Environmental Monitoring

The principles underlying environmental monitoring for the currently proposed project is to observe changes over time that may be associated with some developmental activity. Any change arising from the project would vary over time, in both magnitude and direction. In the case of the latter it is important to bear in mind that changes in environmental parameters may be positive or negative. Thus in principle a monitoring programme for the project would not necessarily focus only on the perceived or anticipated negative changes precipitated by a given development activity, but also on the positive or beneficial changes. The parameter chosen are those that have been identified in the analytical process as being affected in the most significant way by the proposed development.

12.2 Specific Monitoring Issues

The proposed monitoring plan for ABR entail those parameters that have been identified was being significant in the EIA Matrix outlined in Table 10.1. A number of these issue have also been highlighted in the mitigation plans and matrices associated with the previous section [Sec. 11.0]. These issues includes: water quality parameters, biodiversity issues, engineering considerations and socio-economic issues. The proposed monitoring programme has been developed not only in relation to satisfying the statutory requirements of the EIA process, but also as a consequence of the proper implementation of the proposed development and its relationship to the integrity of the environment and indeed stakeholders in the area.

The details of the proposed monitoring plan are outlined in Table 12.1 below.

Table 12.1: Proposed Monitoring Plan for ABR

Parameter	Frequency	Critical Level	Geographic Area	Priority	Agency Responsible
Water Quality Impact					
Phosphate and Nitrates	Monthly	10 mg/l	- 3 sample points immediately off mid-latitude of beach and proceeding to reef crest - Replicate of the above 1 and 2 miles north of project site - 3 smaples in Laguna de Cantena at shoreline 300 m and 500 m from shore	High Priority	DOE

Parameter	Frequency	Critical Level	Geographic Area	Priority	Agency Responsible
TSS	Monthly	100 mg/l	- 3 sample points immediately off mid-latitude of beach and proceeding to reef crest - Replicate of the above 1 and 2 miles north of project site - 3 smaples in Laguna de Cantena at shoreline 300 m and 500 m from shore	High Priority	DOE
Turbidity	Monthly	Observing disappearance of secchi disc and comparing this over time at different locations.	- 3 sample points immediately off mid-latitude of beach and proceeding to reef crest - Replicate of the above 1 and 2 miles north of project site - 3 smaples in Laguna de Cantena at shoreline 300 m and 500 m from shore	High Priority	DOE

Parameter	Frequency	Critical Level	Geographic Area	Priority	Agency Responsible
BOD	Monthly	200 mg/l (EPA/WHO)	- 3 sample points immediately off mid-latitude of beach and proceeding to reef crest - Replicate of the above 1 and 2 miles north of project site - 3 smaples in Laguna de Cantena at shoreline 300 m and 500 m from shore	High Priority	DOE, CZMAI
- Total Coliform - E. coli - Fecal coliform	Monthly		- 3 sample points immediately off mid-latitude of beach and proceeding to reef crest - Replicate of the above 1 and 2 miles north of project site - 3 smaples in Laguna de Cantena at shoreline 300 m and 500 m from shore	High Priority	Public Health

Parameter	Frequency	Critical Level	Geographic Area	Priority	Agency Responsible
Beach Dynamics					
Beach erosion	Quarterly	Observable loss of beach material as documented by definitive measurements.	- Entire shoreline on eastern side of property	High Priority	Fish. Dept.
Engineering Aspects					
Safety considerations in relation to navigational lights, marker buoy for the dredge.	Construction phase activities to be done on a weekly basis.	All lights aboard the dredge as well as beacons marking the path of the spoil delivery pipes and sediment curtains must be functional, and all marker buoys must be deployed appropriately.	- Nearshore areas Nova Pier and Nearshore areas primary development site in vicinity of pier.	High Priority	Port Authority
Technical integrity of dredging operation.	Construction phase activity to be done on a daily basis.	Inspection of sediment curtains and spoil delivery pipe for overflows and leakages respectively.	- Done along the entire path of the sediment curtains and spoil delivery pipes.	High Priority	Fish. Dept.

Parameter	Frequency	Critical Level	Geographic Area	Priority	Agency Responsible
		Inspection of land-based de-watering ‘bund’ for leakages and collapse of walls	- Done along perimeter of bund.	High Priority	DOE, Fish. Dept.
		Biodiversity			
Bird Abundance	Twice per year, during December and in June (i.e. winter and summer)	Population changes and diversity profile to be noted and compared with pre-development situation.	To be done on caye, as well as over sea and in Laguna de Cantena.	Moderate Priority	Forest Dept.
Feral Animal Population (Racoons, opossum and scavenging birds)	Twice per year during June and December	Population changes to be observed over time.	- Entire development site.	Moderate Priority	Forest Dept., Public Health, Fish Dept.
Coral Reef Cover and Diversity	Twice per year, during June and December	Population changes and diversity profiles to be compared over time.	- Corals in back reef areas as well as in mid-latitude of the barrier lagoon	High Priority	Fish. Dept.

Parameter	Frequency	Critical Level	Geographic Area	Priority	Agency Responsible
Finfish Populations	Twice per year during June and December, and coincident with coral reef survey	Population changes and shifts in diversity to be observed over time and compared with pre-development situation.	- Backreef area and nearshore seagrass beds, as well as nearshore areas of Laguna de Cantena.	High Priority	Fish. Dept.
Sea-grass biomass and density	Twice per year during June and December.	Sea-grass biomass and density to be observed over time for any discernible trend that may be associated with the proposed development.	- 4 transects 300 m in length, evenly distributed and proceeding from the beach, with sampling stations every 20 m	High Priority	Fish. Dept.
Sea-grass Re-colonization Rate of the Burrow Pits.	Twice annually in June and December.	Estimate seagrass density and biomass by count and of rhizomes and stalk per unit area.	Burrow pits at Nova Pier and at project site around piers on eastern side of property.	Moderate Priority	Fish. Dept.

Parameter	Frequency	Critical Level	Geographic Area	Priority	Agency Responsible
Socio-economic					
Fisheries Landings	Quarterly	Determine any changes in the availability of fishes harvested in the immediate area.	Assess lobster and conch landings from area bounded by northern and southern latitudes of property from shoreline to reef crest.	Moderate Priority	Fish. Dept.
Historical useage of area	Quarterly	Determine any changes in the area as a dive site.	Monitor use of seas within project area bounded by the northern southern latitudes of property from shoreline to reef crest.		

Chapter 13

13.0 Alternatives to Development

13.1 Principles Underpinning Alternatives to Development

The general principle involved in identifying option(s) to the proposed development is to ensure that the option chosen, which indeed may be the 'non development' option, would result in optimal returns in social and environmental capital: In effect the option chosen should bode well not only for the developer, but also for the environment and stakeholders in the area. The various options are detailed in Table 13.1 below.

Table 13.1: Options for Development

Development Issue	**Option #1 & Justifications (Chosen Option)**	**Option #2 & Justifications**	**Option #3 & Justifications (Non-Development)**
Development Concept			
	Hotel/Resort + Time-share Residential condos and Villas: *Addresses demands of market for general San Pedro area…And is consistent with natural endowment of area with pristine beaches, sunshine and an azure seascape, as well as being in tandem with the décor and design of developments to the south..*	Resort: *Resort facilities alone would negatively affect strategy to generate capital necessary to realize development that is environment friendly and in tandem with configuration of neighbouring developments.*	Non-Development Option: *Loss of development opportunities to the tune of US$35 million in Capital Investment and the creation of temporary employment of 250 persons during the construction phase of the project, as well as full-time jobs for 289 persons, 95% of whom are to be Belizeans…Th generation of foreign exchange on a annual basis has been estimated at US$12-$15 million.*

Development Issue	Option #1 & Justifications (Chosen Option)	Option #2 & Justifications	Option #3 & Justifications (Non-Development)
Siting			
Siting of Overall Development	Bacalar Chico Area: *Siting of project within larger Bacalar Chico National Park and Marine Reserve [BCNP/MR] consistent with concept of complementary coexistence…Legal provisions made with BCNP/MR management regime to allow for private property and development activities that would not negatively impact the environment, or otherwise be at variance with the mandate of the Protected Area..*	Un-Named mainland location: *No other parcel of land is available to the Developers in San Pedro/Ambergris Caye or any other location in Belize…Also the declared interest of the Developers is to pursue the development of the project in the configuration that it has been submitted at the proposed location, given the natural assets of the area.*	Status Quo Situation: *The project proponents have no other developments in Belize, thus the Status Quo situation of non-development would not serve the interest of the developers or indeed the tourism industry.*
Siting of land-based facilities.	Land-based Hotel/Resort and Residential Facilities: *Current strategy entails siting 90% of Infrastructure on higher portion of land in current area of littoral fores.*	Extending Siting of Hotel/Resort and Resedential Facilities Leeward Mangrove Low Lands: *Strategy increases pressure on ecologically sensitive habitat, with attendant negative impacts to fishlife and birdlife.*	Non-Development Option: *Circumvents any environmental impacts, however failure to yield any social or economic benefits that are consistent with the macro-economic policies of the nation, and that are consistent with the goals of conservation.*

Development Issue	Option #1 & Justifications (Chosen Option)	Option #2 & Justifications	Option #3 & Justifications (Non-Development)
Siting of the Over-Water Cabanas	Siting of Over-Water Cabanas in Nearshore Environment: *Current siting takes advantage of pleasant prevailing winds and over-water siting capitalizes on vista of the sea and seafarers longing for gently lapping waves…Strategy also provides competitive advantage in the market relative to both local experiences as well as regional markets such as Cancun, Cozumel and Guanaha in the Bay Islands…Location also relieves pressures on lowland mangroves on leeward side of property, as well as providing a reprieve from nuisance insects during calm weather.*	Location on North-Eastern or South-Western End of caye: *Exposure to heavy seastates and battering of crafts – Would result in damage claims and loss of clientele to more amenable locations.*	Non-development Option: *Results in default position of siting all amenities and infrastructure on land…Issue of increased and undesired high density development in an area where such developments would be out of character with other developments in the area, and where such strategy would require exceeding two (2) storey height for buildings adopted by developers to be in tandem with height of vegetation and other developments in the area…Strategy would also entail use of mangroves on leeward side of caye for resort and housing development.*

Development Issue	**Option #1 & Justifications (Chosen Option)**	**Option #2 & Justifications**	**Option #3 & Justifications (Non-Development)**
Siting and Dimension of Access Piers	Site Chosen Mid-Latitude of Property and Length is 300 m: *Siting at mid-latitude of property optimal for servicing of facilities…300 m length necessary to reach required depth to accommodate crafts with drafts of 1-4 ft.* .	Siting at either Northern or Southern Ends of Beach: *Eliminates advantage of equidistance in servicing both northern and southern portions of facilities.*	Non-development option: *Makes project infeasible and impractical since there is no pre-existing pier to accommodate the sea-based transportation needs of the project.*
Siting of Recreational Beach	Current Siting of Two Bathing Beaches: *Two locations needed given extended length of seafront of property and commitment of developers to provide equal opportunities to clients enjoying northern and southern portions of property.*	One Bathing Beach of Combined Capacity of Two (2) Beaches in Chosen Option: *This would be juxtaposed with the origins of the access pier where it adjoins the shoreline and it would pose some discomfiture with bathers and persons regularly accessing the pier.*	Non-development Option: *The absence of a bathing beach in an environment endowed with an expansive sea-frontage and a natural beach that is not useable because of the shallow nearshore seagrass beds, would detract from the experience that should be a natural response to such a location.*

Development Issue	Option #1 & Justifications (Chosen Option)	Option #2 & Justifications	Option #3 & Justifications (Non-Development)
Bathing Beach Construction Method	Adopted Method of Placement of Geo-Textile Mat in Nearshore Seagrass Bed and Loading with Sand Excavated from On-Shore: *Method chosen is an alternative to dredging the seagrass beds to produce an environment that is safe and confortable to the feel of bathers and that provides the requisite depth of water…Strategy of loading geo-textile mats with sand compresses seagrass beds to provide required depth.*	Dredging Seagrass Beds to Produce Requisite Depth and Feel for Swimmers: *Dredging to the extent required to produce the bathing beach, comes with a higher ecological cost than the chosen method, given the degree of siltation and turbid influences.*	Non-development Option: *This is the default position that would result in non-action…This would not be of benefit to the developers or clients of the facilities.*
Dredging Nova Pier Location	Dredging to Allow Access to Nova Pier and Shore-side Berthing: *Dockside berthing of freight barge necessary during construction phase of operation and to a lesser extent during the operational phase of the project…Strategy is to off-load equipment and supplies at Nova pier and truck them overland to project site…Access to the*	Dredging an Access Channel Through the Reef to Accommodate a Barge: *This would entail creating a channel through dredging and blasting in the reef crest of the barrier reef, an ecologically fragile and productive ecosystem…This is not desirable to the developers given the eco-friendly orientation of the*	The Non Development Option: *This is the Status Quo position that would allow neither large crafts to access the reef at the project site, or the Nova Pier to the south…This coupled with the absence of a road would make the incremental overland freighting of supplies impossible arresting the development of the project.*

Development Issue	**Option #1 & Justifications (Chosen Option)**	**Option #2 & Justifications**	**Option #3 & Justifications (Non-Development)**
	the project site by a freight barge is not possible given the fact that there are to cuts or channels in the reef wide and deep enough to accommodate a barge.	*development, the ecological costs to the environment and the financial costs and technological investments.*	
Dredging to Accommodate Pier Construction at Project Site	Dredging of the Nearshore Areas in the Vicinity of the Access Pier at the Project Site: *Caye 'Over-wash Mangrove' area with* not *much solid land on caye, mainly mangrove peat and muck – Caye currently unsuitable for any construction activities without being reclaimed.*	Reclaiming 50% or 75% of Caye: *Caye relatively small at 18 acres, and is just large enough to accommodate various components of the development, thus reclaiming smaller portion would not be consistent with providing range and quality of amenities and experiences to tourists*.	Non-Development Option: *No standing structures possible without reclamation – thus project would not be viable.*

Development Issue	**Option #1 & Justifications (Chosen Option)**	**Option #2 & Justifications**	**Option #3 & Justifications (Non-Development)**
Water Supply	Reverse Osmosis Supplemented by Rainwater Catchment and Waste Water Recycling: *Entails the extraction of seawater and the exhaustion of hypersaline by deep-well injection… There is no risk of contaminating water table by saline intrusion..*	Reverse Osmosis plant for 100% of needs: *This is expensive in terms of financial cost, energy and environmental costs in terms of solid waste vis-à-vis the volumes of cartridges or membranes to be used and the disposal of these*.	Non-development Option: *No source of freshwater exists on the caye thus said non-development option would make the project infeasible*.
Sewage/Wastewater	Installation of BESST Treatment Technology: *This entails 'secondary' level treatment of sewage and the recycling of effluents to flush toilets and irrigate lawns and hedge rows - Option is least deleterious on the environment, not only in terms of direct ecological impact, but also because it significantly reduces water demand, which is a scarce commodity on the cayes in general.*	Septic Tank System: *Lack of freshwater resources and presence of saline influences greatly constrains functionality of 'soak away' to reduce nutrients and fecal pathogens…Also possibility of leaching of effluents into sea which is a threat to both human health from viruses and bacteria, as well as threat to the environment from eutrophic or nutrient enrichment influences*.	Non-Development Option: *This is redundant given the fact that such a development cannot take place without effective waste-water treatment*.

Development Issue	Option #1 & Justifications (Chosen Option)	Option #2 & Justifications	Option #3 & Justifications (Non-Development)
Solid Waste	Chosen Option Separation of the Waste into its Organic and Inorganic Components…Composting Organics Using 'Earth Tub'…Inorganic Component to be Further Separated into Combustible and Non-combustible Components…Combustible Component is to be Incinerated On-Site…The Non-Combustible Component is to be Tagged, Bagged, Stored and Transported Intermittently to the San Pedro Landfill Site : *Most environmentally sound option given reduction of organic waste to form that does not attract feral animals or household pests…Carting inorganic waste away eliminates habitat for breeding of insect pests and interaction of plastics with sea turtles and other marine animals.*	Burning and Burial of Wastes on the Caye: *Burning and burial of wastes would result in significant aerial, aesthetic and ecological impacts*.	Non-Development Option: *This is un-tenable given the volume of garbage that would accumulate over time and the fact that a development of this magnitude would not be able to sustain over time with this strategy*.
Energy Generation	Chosen Option Entails Use of Diesel Generators Supplemented by Solar Sources and Wind Generators: *The supplementing of the primary diesel generator with rainwater catchment and wind generators reduces the reliance on fossils fuel and internal*	Diesel Generators: *Diesel generators alone as the source of energy for the facilities entails heavier cost on the environment in terms of increased use of fossil fuel, air pollution and noise pollution.*	Non-Development Option: *The non-development is untenable since the project cannot proceed without energy generation …This is especially relevant given the fact that the area is beyond the -*

Development Issue	Option #1 & Justifications (Chosen Option)	Option #2 & Justifications	Option #3 & Justifications (Non-Development)
	combustion both of which have positive implications for the environment …Disposal of spent batteries and ion exchange cartridges associated with both wind generation and solar generators are an issue for the environment.		*Geographic reach of the BEL Power Grid.*

References

Auil, N. 1997. Manatee Research Progress Report, March – July 1997, Coastal Zone Management Project.

Auil, N.E. (1998). Belize Manatee Recovery Plan, Coastal Zone Management Project. (GEF UNDP)

Azueta, J. 2002. Draft Revised Management Plan For Bacalar Chico Marine Reserve, Unpublished Report.

Belize, Natural History and Archaeology. 1996. International Expeditions, Inc., Helena Alabama.

Blackstone Corporation. 1998. Tourism Strategy for Belize. Ministry of Tourism and Environment, & IADB.

BTB. 2003. Belize Cruise Ship Policy. Belize Tourism Board.

BTB. 2004. Tourism & Travel Statistics. Belize Tourism Board

Cayes Development Policy. 1995. Coastal Zone Management Committee. CZMAI./FD. Government of Belize

CSO. 2004. Environmental Statistics for Belize. Central Statistical Office, Ministry of National Development, Belize.

CZMAI. 1996. Belize City Cayes Development Guidelines.

CZMAI. The National Integrated Coastal Zone Management Strategy for Belize.

Development Solutions. 2004. Belize City Cayes Region Development Guidelines Volume 5.

Edwards, Ernest P. 1998. The Birds of Mexico and Adjacent areas.

Gibson, J. 1991. Trip Report. Reef Pt - Bacalar Chico, Ambergris Cay.

Gischler E. and A.J. Lomando. 1999. Recent sedimentary facies of isolated carbonate platforms, Belize-Yucatan System, Central America. Jour. Sedimentary Res., Vol. 69, No. 3.

Gobin, Judith. 2001. Coastal Infrastructure Design, Construction and Maintenance A Course in Coastal Zone/Island Systems Management. Organized by Department of Civil Engineering, The University of the West Indies, in conjunction with Old Dominion University, Norfolk, VA, USA and Coastal Engineering Research Centre, US Army, Corps of Engineers, Vicksburg, MS, USA.

Goldsmith F.B. 1991. Monitoring for Conservation and Ecology. Chapman and Hall.

Green Reef Environmental Institute (2004). The Revised Bacalar Chico National Park and Marine Reserve Manage Plan.San Pedro Town, Belize

Grimshaw, T. & G.M. Paz. 2004. The Revised Bacalar Chico National Park and Marine Reserve Management Plan. Green Reef Environmental Institute, San Pedro Town, Belize, Central America.

Guderjan, T.H. 1993. *Ancient Maya Traders of Ambergris Caye.* Cubola Publications, Benque Viejo del Carmen, Belize. 39 pp.

Halcrow Group. 2000. The Coastal Zone Management Strategy for Belize. Draft. CZMA&I, Belize.

Hartshorn, G.. Nicolait, J., et al. 1984. Belize Country Environmental Profile. A field study. United States Agency for International Development
High, L.R. 1969. Geomorphology and Sedimentology of Holocene Coastal Deposits. Taken form PhD thesis, Rice Univ.

Hoese, H. D., and R. H. Moore. 1977. Fishes of the Gulf of Mexico, Texas, Louisiana, and Adjacent Waters. Texas A&M University Press.

Ishmael, L. 1994. Development of North Ambergris Caye, Belize: An Investment in the Future. Report to the Inter-American Development Bank, Washington D.C.

James, N.P. and R.N. Ginsburg. 1979. The seaward margin of the Belize barrier reef and atoll reefs. Int. Ass. of Sedimentologists, Special Publication; No. 3.

Jolly, K. and E. McRae. 1998. The Environment of Belize: our life support system, Cubola Productions.

Jones H. L. 2003. Birds of Belize. University of Texas Press, Austin.

Jones H. L., & A.C. Vallely. 2000. Annotated Checklist of the Birds of Belize. Lynx Edition.

King, R. B., Baillie, I.C., Abel, T.M.B., Dunsmore, J.R., Gray, D.A., Pratt, J.H., Versey, H.R., Wright, A.C.S., and Zisman, S.A. 1992. *Land Resource Assessment of Northern Belize. Natural Resources Institute Bulletin* No 43. 513pp. (2 volumes)

Kricher, J.C, (1989). A Neotropical Companion, Princeton University Press.

Launchpad Consulting. 2005. Belize Tourism Policy 2005. Belize Tourism Board.

Littler, D.S., M.M. Littler and B.L. Brooks. 1995. Marine Algae and Seagrasses from the Tobacco Range Fracture Zone, Belize, C.A. Atoll Research Bulletin, Nos. 426-431.

Majil, I. 2000. Sea Turtle Monitoring And Conservation Programme, Unpublished Report. 8 Pp.

Mazzullo, S.J., Anderson-Underwood, K.E., Burke, C.D. and Bischoff, W.D. 1992. Holocene coral patch reef.

Mazzullo, S.J. Teal, C.S. Bischoff, W.D., Dimmick-Wells, K., And Wilhite, B.W. 2003.Sedimentary Architecture And Genesis Of Holocene Shallow-Water Mud-Mounds, Northern Belize *Sedimentology* 50, 743-770.

McCalla. W. 1995. Guide for Developers. Ministry of Tourism and the Environment.

McField, M. et al. 1996. State of the Coastal Zone Report, Belize 1995. Coastal Zone Management Programme. Government of Belize

McField, M.D. 2000. Evaluation of management effectiveness - Belize marine protected areas system. Prepared for the CZM Authority & Institute, Belize City, Belize. August 2000. 20 p.

McGee, M. Understanding and interpreting water quality. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Meadows, M. 1995. Bacalar Chico Bird Report. Report to ITCF.

Meerman, J. C. & W. Sabido. 2001. Belize Ecosystems Map and classification. Programme for Belize.

Miller, B.W., and Carolyn M. Miller. 2000. Birds of Belize: a check list. Belize Audubon Society: Belize, Central America. 2nd revised edition.

Miller B.W, & C. M. Miller. 1994. National Protected Areas Systems Plan For Belize, Full Report Vol. 3 Zoological Report.

Mumby, P.J., A.R.Harborne and P.S.Raines. 1998. Classification scheme for marine habitats of Belize. Unpublished report for the UNDP/GEF Belize Coastal Zone Management Project.

Nicolait, R. 1984. Belize Country Environmental Profile, A Field Study.

Odum, E., C.C. McIvor and T.J. Smith. 1982. The Ecology of the Mangroves of South Florida: A Community Profile. Dept. Env. Sc., Univ. Virginia, Charlottesville, Virginia.

PAHO. 2002. Health Systems and Services Profile. Organization and Management of Health Systems and Services Division of Health Systems and Services Development.

Paz, G.M. and T. Grimshaw. 2001. Status report for Nassau groupers in Belize. Workshop Report “Towards a sustainable management of Nassau groupers in Belize”, Belize City, 30 July 2001.

Perkins, J.S. 1983. The Belize Barrier Reef Ecosystem: an assessment of its resources, conservation status and management. New York Zoological Soc. Report pp. 189.

Platt, S. G., Thorbjarnarson, J. B. 1997. Status and Life History of the American Crocodile in Belize. ix + 164 Pgs.

Purdy, E.G. 1974. Karst-determined facies patterns in British Honduras: Holocene carbonate sedimentation model. Am. Ass. Petrol. Geol. Bull. 58: pp. 825-855.

Purdy, E.G. and E. Gischler. 2003. The Belize margin revisited: Holocene marine facies. Int J Earth Sci. (Geol Rundsch) 92: 532-551.

Raines, P., Wells, S. and Harborne, A. 1995. Coral Cay Conservation Interim Report. April-December 1994. Belize Coastal Zone Management Programme, B7-5040/93. Report to European Union.

Rauscher, F. and J.M. Wilensky. 1996. Cruising Guide to Belize and Mexico’s Caribbean Coast, including Guatemala’s Rio Dulce, 2nd Ed.

Sedberry, G.R. and Carter, J. 1993. The fish community of a shallow tropical lagoon in Belize, Central America. *Estuaries* 16 (2): 198-215.

Smith, G. W. 1995. Survey of Reptiles and Mammals in the Proposed Bacalar Chico Marine Reserve and Wildlife Sanctuary.

Smith, G. W. 1990. Ground Surveying for Sea Turtle Nesting Sites in Belize, 1990. Belize Audubon Society, Belize City. 24 p.

Stake Bank Cruise Ship Facility Development: Dec. 21st , 2005.

State of the Coast Report of Belize, 1999. Coastal Zone Management Authority and Institute.

Stoddart, D.R. 1974. Post-hurricane changes on the British Honduras reefs: resurvey of 1972. Proc. 2nd Int. Coral Reef Symp. Pp. 473-483.

Stoddart, D.R., F.R. Fosberg and D.L. Spellman. 1982. Cays of the Belize Reef and Lagoon. Atoll Res. Bull. 256: pp. 1-76.

Sullivan, K.M., G.A. Delgado, G.A. Meester, and W.K. Miller. 1994. Rapid Ecological Assessment Methods for Tropical Estuarine Ecosystems: Port Honduras, Belize. The Nature Conservancy, Florida and Caribbean Conservation Science Center, University of Miami.

Thurman, H.V. 1988. Introductory Oceanography, Fifth Ed. Published by Merrill Publishing Company.

Tunich Nah Consultants. 2001. Environmental Impact Assessment of Deep Water Port and Haulover Creek Mouth dredging proposal.

Tunich Nah Consultants. 2002. Castaways Reef Resort Environmental Impact Assessment on Calabash Caye.

Tunich Nah Consultants. 2003. Long Caye, Light house reef residential & tourism Environmental Impact Assessment.

Tunich Nah Consultants & Eng. Ltd. 2001. Environmental Impact Assessment Spanish Bay Resort to be Established on Spanish Lookout Caye South-East of Belize City.

Wantland. K.D. 1967. Recent Benthic Foraminifera of the British Honduras Shelf. Ph.D. thesis, Rice Univ., Houston, Texas. pp. 299.

Woods, T.L. 1998. An Overview of Belizean History (html document).

Woods, R.L., ST. Reid, & A.M. Reid. 1988. The field guide to Ambergris Caye Belize. C.A. including other areas. 176 p.

Chapter 14

Archaeology Report

Archaeological Impact Assessment Of the ABR Development Property, Northern Ambergris Caye, Belize

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INTRODUCTION

In August of 2006 the authors were contracted by Tunich - Nah Consultants to perform an archaeological survey of the ABS property on Ambergris Caye. The property covers an area of 185.13 acres and is located just north of Rocky Point, on northern Ambergris Caye. In accordance with the National Institute of Culture and History laws of Belize the purpose of our survey was to investigate whether 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 property can proceed. The authors spent three days surveying the area with the specific purpose of identifying any such remains. Archaeologically significant features have been located on various Cayes in both southern and northern Belize and many of the islands contain evidence of Pre-Hispanic Maya and Colonial Period Spanish/British use. The discovery of two ceramic sherds dating to the Maya Terminal Classic period (850-1000 A.D.), and the proximity of the property to several ancient Maya sites confirm that northern Ambergris Caye reflects a similar pattern of prehistoric use. This report presents: 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

In the coastal regions of Belize, important archaeological field work has been conducted by several researchers. In the northern Corozal District, Diane and Arlen Chase (1981, 1988) investigated the site of Santa Rita, Mathew Boxt (1983, 1988) explored the region around Sarteneja, and David Friedel, Vernon Scarborough (1978) and their colleagues conducted several seasons of research at Cerros. On Ambergris Caye, 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. In the Stann Creek District, Elizabeth Graham (1989) and Jefferson MacKinnon (1989) spent several years investigating coastal sites around the Colson Point and Placencia regions. In the Belize District, Heather McKillop (1980) and Paul Healy (1989) worked at Moho Caye, while Shirley Mock (2005, 2006) and McKillop (2002, 2004, 2005) continue to investigate several coastal sites in the Belize and Toledo Districts respectively.

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, evidence for human exploitation of coastal regions extends much earlier into the Paleo-Indian and Archaic periods (10,000 – 2,000) but coeval data for the islands are presently still lacking (Hammond 1982; Lohse et al. 2006). A description of the results of the research listed above is summarized below.

During the Preclassic and Classic periods there does not appear to be any permanent settlements on the cayes (MacKinnon 1989; MacKinnon et al. 1987). Despite this apparent pattern, several researchers (MacKinnon 1989 McKillop 2002, 2005) have found evidence of periodic visits to the islands by inland inhabitants for the procurement of shells, fish, salt and other marine products. The one exception to this rule appears to be on Ambergris Caye. At the Marco Gonzalez site, in the southern end of the island, Elizabeth Graham and David Pendergast (1989) found evidence which suggests that the earliest occupants of the island settled in this area as early as the Late Preclassic period (100 B.C. – 250 A.D.). Thomas Guderjan (1993:19) has suggested that this small community may have acted as traders for the large coastal site of Cerros on Corozal Bay.

During the Early Classic Period (A.D. 250-800) human activity on the 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 major 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).

The Late Postclassic period (1300-1500 A.D.) marks the climax of Maya maritime activity in Belize. 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 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 test pitting and excavations can reveal sites in this type of environment.

Colonial period activity has been well documented on the Caribbean region. 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, but several small settlements were established on the mainland and on several Cayes, particularly on St. George's and Ambergris Cayes (Finnamore 1994).

AMBERGRIS CAYE IN ARCHAEOLOGICAL CONTEXT

Ambergris Caye is located at the northeastern tip of Belize (Figs. 1-2). Although classified as an island, Ambergris actually represents the southern extension of the Xcalac Peninsula of the Mexican state of Quintana Roo. The border between the two countries is demarcated by a feature known as the Bacalar Chico canal. To the south of the canal this narrow canal is actually a one mile long anthropogenic feature that was constructed by the ancient Maya sometime around A.D. 600. For most of its length Ambergris Caye runs parallel to the great Belize barrier reef. The one exception to this geography is at Rocky Point where the barrier reef converges with the mainland and remains so for about 1 kilometer till they separate again at Robles Point. Between Rocky and Robles Points the reef heads and currents presented a treacherous passage for ancient Maya merchants who transported their goods up and down the east coast

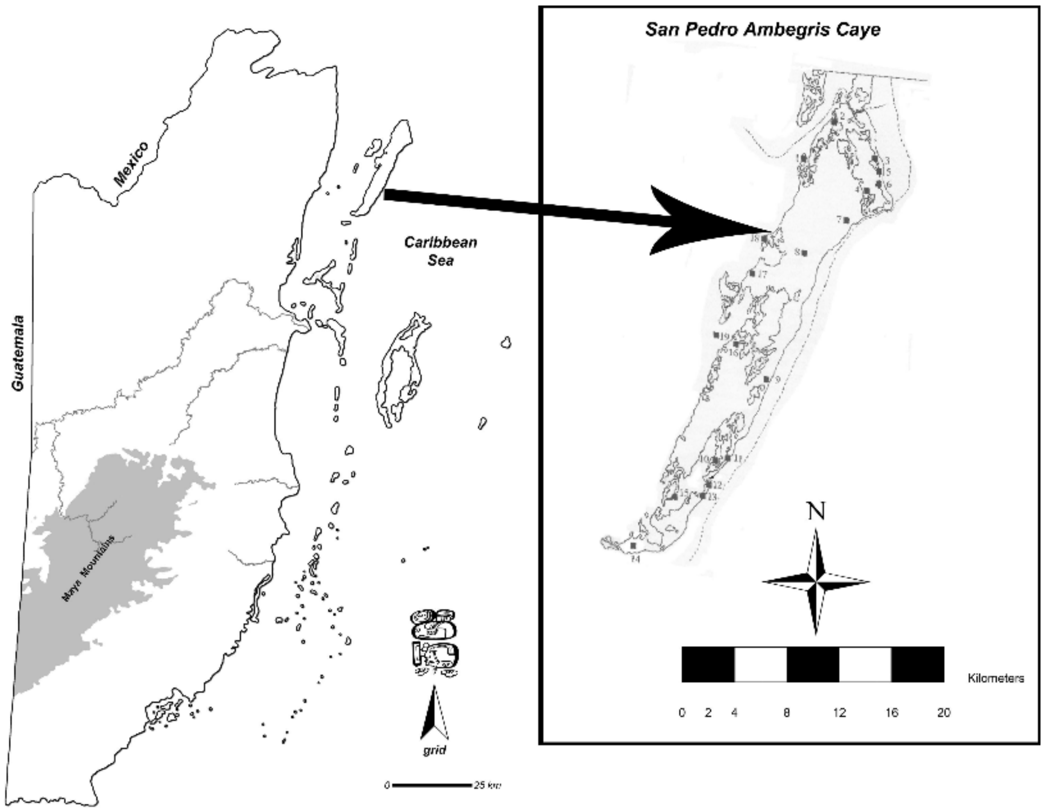


Figure 1: Map of Belize showing location of Ambergris Caye.

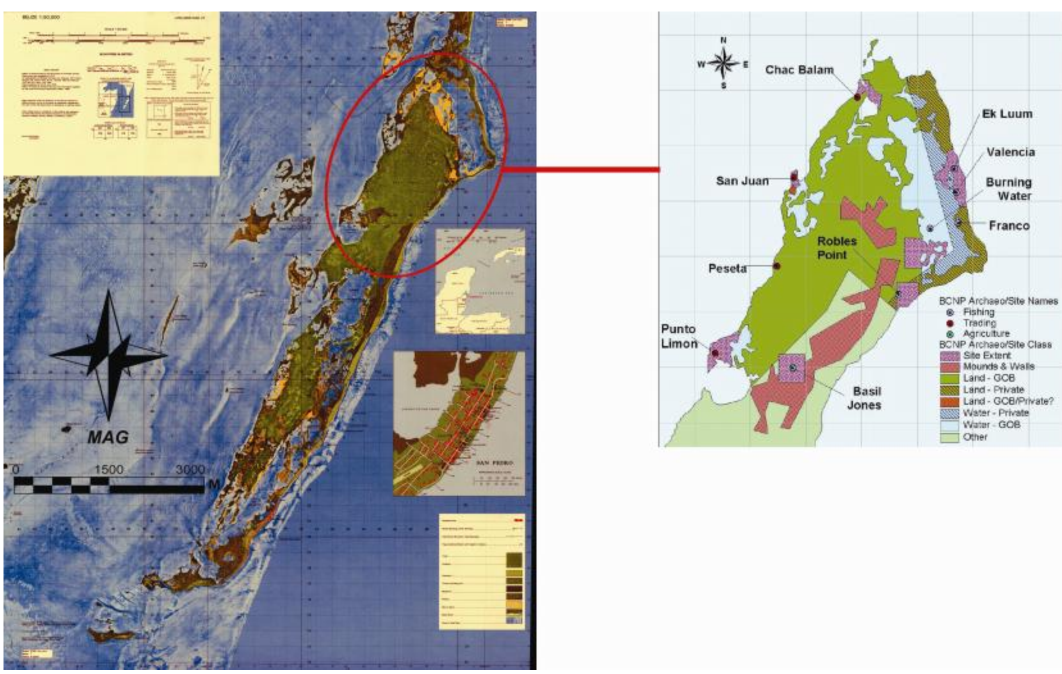


Figure 2: Map of Ambergris Caye with inset showing north Ambergris and archaeological sites recorded in the area.

of the Yucatan Peninsula. To address this concern we believe that the ancient Maya excavated the canal at the north end of Ambergris sometime in the 7th century A.D. The canal subsequently allowed them to move goods along the calmer waters on the leeward side of the island.

Ambergris measures approximately 30 kilometers from the border with Mexico to the southern tip of the island. At its widest point the caye is slightly less than 4 kilometers wide; at its narrowest it is about 1.5 kilometers. Ambergris is also very low-lying, with few natural surfaces higher than 3 meters above sea level. The windward side of the island, particularly the area north of Rocky Point, has the most attractive beaches on the caye. Like the rest of the island, however, mangrove swamps, marches, and estuarine lagoons, dominate the leeward side. The latter description certainly reflects the environment within the ABR property, where sandy beaches are located on the eastern seaboard, 2 to 3 meter sand dunes form a low ridge a short distance from the beaches, and the large Laguna Cantena lies along the western boundary of the property.

Ambergris Caye has received considerable archaeological attention in the past. In the latter half of the 1980's Thomas Guderjan, James Garber and Herman Smith conducted extensive survey and test excavations on the northern half of the island. To the south, Elizabeth Graham and David Pendergast excavated the large site of Marco Gonzales, and they salvaged numerous settlements in and around the modern town of San Pedro. Conjointly these investigations concluded the following:

1. That while they identified some 19 archaeological sites on the island (see Fig. 3), it is likely that more intensive field work would identify substantially more prehistoric settlements.

2. That the sea was important to the ancient Maya as an avenue of transportation and that Ambergris Caye sites may have served as transshipment points for exotic goods moving along the length of the Yucatan Peninsula.

3. That Ambergris Caye was exploited for various marine resources, including the production of salt by the "sal cocida" process (see description below).

4. That geo-archaeological evidence indicates that there has been a rise in sea levels from the Maya Postclassic period (1400 A.D.) to modern times. This evidence has been recorded at mainland coastal sites like Cerros in northern Belize (Freidel and Scarborough 1982; map 5.1), at Moho Caye and Wild Cane Caye (McKillop 2002:135) and at Marco Gonzalez on southern Ambergris Caye (Graham 1994, Graham and Pendergast 1989).

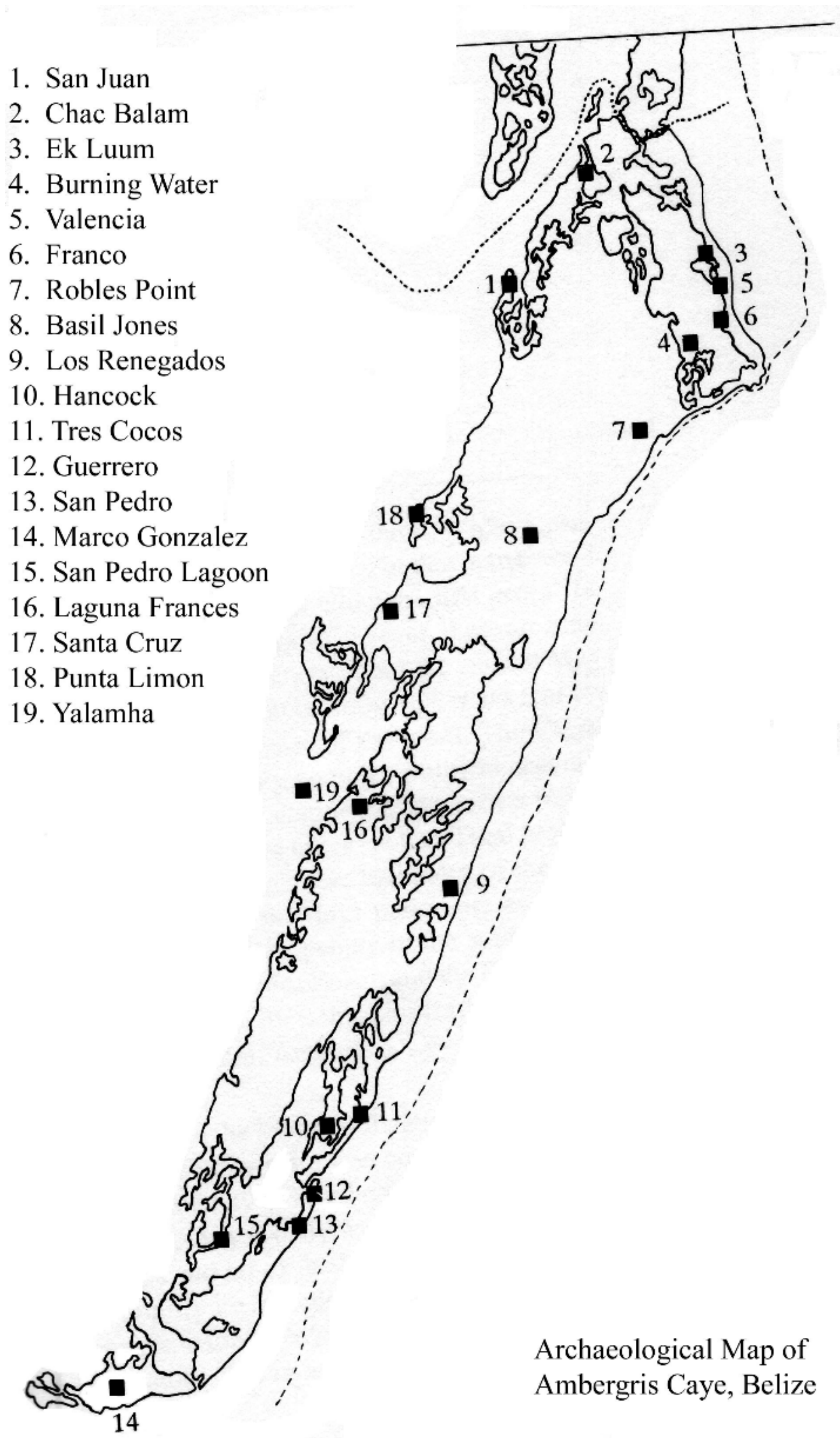


Fig. 3: Map of Ambergris Caye showing location of previously recorded archaeological sites.

PREHISTORIC SALT PRODUCTION ON AMBERGRIS CAYE

Two methods of salt production were employed by the ancient Maya. These are known as the "sal solar" and "sal cocida" methods. Sal solar is produced naturally by evaporation and the salt is simply recovered from naturally occurring salt beds along coastal areas. The major source for this type of salt in the Maya region is from the northern tip of the Yucatan Peninsula, north of the modern city of Merida. In the sal cocida method salt water or brine is boiled in large pots and the resulting salt is recovered in loose form or shaped into salt cakes. The latter method appears to have been the primary mode of production along the Belizean coast and fragments of the specialized ceramic vessels that were used in the process have been found at most coastal sites. On Ambergris Caye, ceramic vessels used for salt production were classified as Coconut Walk ceramics. Elizabeth Graham (1994) describes these ceramics as friable open platters, likely used for making salt cakes. These vessels differ from those used for salt production in southern Belize The southern Belize Maya predominantly used restricted-orifice jars, spacers, and sockets for producing salt (McKillop 2002:112-114).

On places like San Pedro, salt pans were sometimes naturally created on the interior of the island as a result of seasonal conditions. This often occurred on small lagoons that were flooded during rainy seasons. One such small lagoon, which connects with the Laguna Cantena, is found at the western edge of the ABR property. It should also be noted that we did discover two ceramic sherds that may have been associated with salt production in this area. It is therefore likely that more could be present in sub-surface deposits and would be exposed if the area is dredged or excavated during construction.

SURVEY AND RESEARCH METHODOLOGY

Description of ABR Property:

As we indicate above, the ABR property which we were contracted to survey covers an area of 185.13 acres. The parcel is comprised of an approximately 1 km long, narrow strip of beach front that rises gently towards a 2-4 meter high dune, then gradually drops off towards the west where the narrow strip of land is bordered by the Laguna Cantena (Fig. 3).

A preliminary assessment of the geography of the area (Fig. 4) suggested that the property is located south of the ancient Maya sites of Ek Luum and Valencia (see description of these sites below). Unfortunately, no GPS readings of these sites were taken during the 1980's archaeological investigation of the area thus it is difficult to determine the accuracy of this

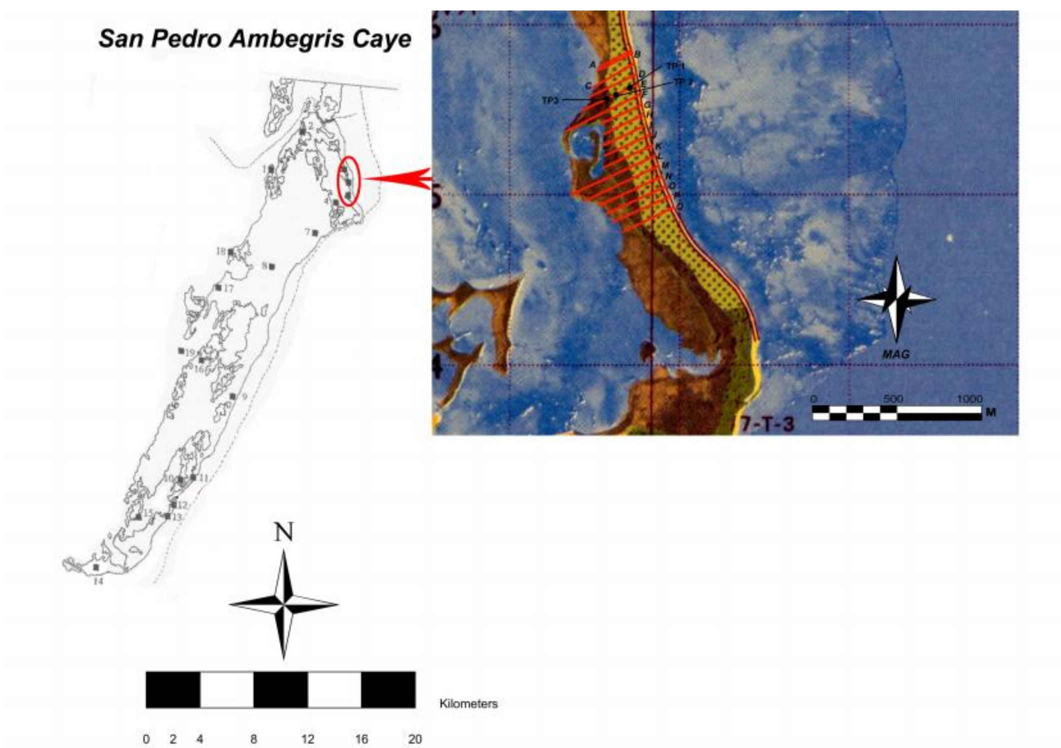


Fig. 4: Map of Ambergris Caye showing location of ABR property.

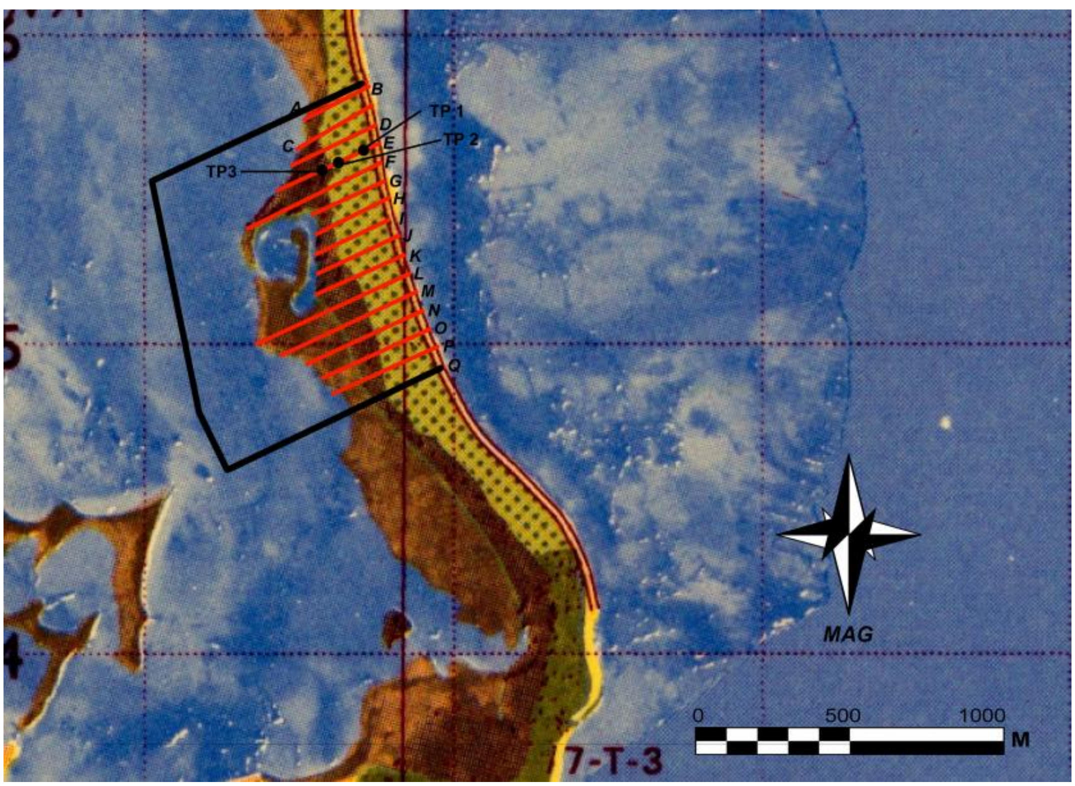


Fig. 5: Map of ABR property showing location of transects.

Transect Data for ABR Development

All GPS point taken in NAD 27 Central

Transects	Start		End		Length (m)	Distance (m)
	Easting	Northing	Easting	Northing		
A	411716	2005848	411551	2005769	165	0
B	411721	2005830	411544	2005746	177	18
C	411740	2005774	411518	2005653	222	56
D	411752	2005712	411496	2005590	256	62
E	411764	2005653	411431	2005495	333	59
F	411772	2005592	411338	2005385	434	61
G	411783	2005533	411556	2005425	227	59
H	411793	2005474	411561	2005359	232	59
I	411810	2005413	411554	2005292	256	61
J	411829	2005353	411559	2005223	270	60
K	411843	2005292	411555	2005155	288	61
L	411862	2005229	411372	2004995	490	63
M	411882	2005171	411457	2004969	425	58
N	411902	2005109	411544	2004942	358	62
O	411922	2005048	411583	2004889	339	61
P	411948	2004989	411635	2004841	313	59
Q	411973	2004928	411670	2004784	303	61
TP1	411717	2005630				23
TP2	411635	2005591				39
TP3	411588	2005570				21

Table 1: Transect Data for ABR Development property, northern Ambergris Caye, Belize.

assessment. If we are accurate, however, it would indicate that the small Franco site (see below) might be within the boundaries of the property.

Survey Methodology

Given the property's apparent proximity to the three archaeological sites noted above, we decided to conduct an intensive survey of the property. To achieve this goal a total of 17 transects were cut across the property (See Fig. 5). These transects were labeled A to Q and they extended east to west from the sandy beaches on the windward side of the island, to the Laguna Cantena on the leeward side.

The lengths of each transect and the distances between transects are listed on Table 1. GPS coordinates were also taken for all transects and these too can be found listed in Table 1. During our survey all the transects were reconnoitered by the cutting crew and later double checked by the authors. In addition to searching along the transects for evidence of archaeological remains, our crew also traversed the areas between the transects. These traverses were made along the beach front, the crest of the dune, and along the lagoon side of the property. These areas were purposely chosen because previous archaeological surveys indicate that they are the typical locations of prehistoric settlements.

Excavations and Shovel Tests

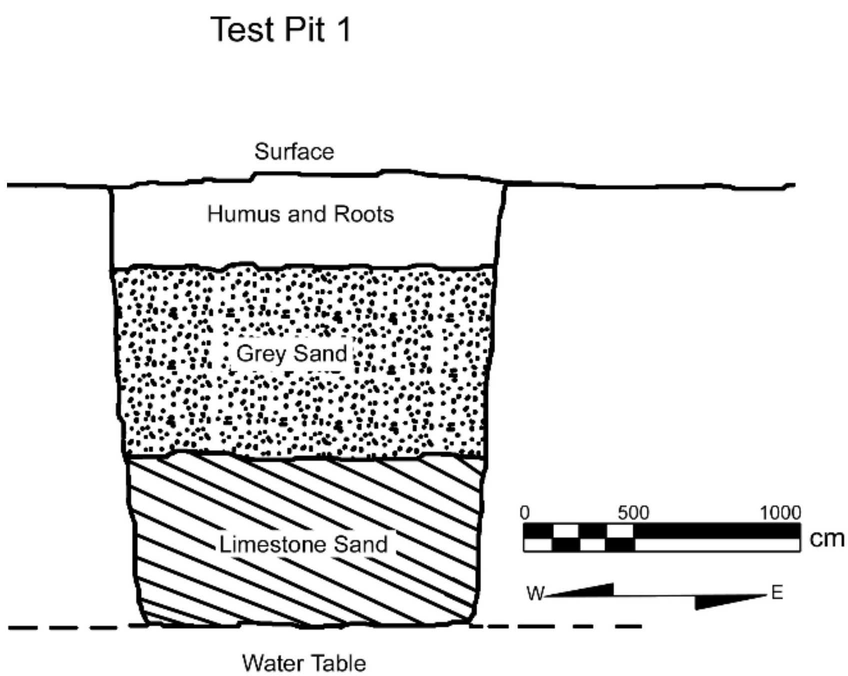
In collaboration with the EIA consultant, two test pits and a shovel test were conducted on Transect E. The tests were placed on and near the crest of the dune, in an area with dark soils. In the descriptions of the Franco and Valencia sites it will be noted that areas with dark organic soils are often associated with prehistoric middens, hence our choice of location for the test units. Descriptions and illustrations (Fig. 6) of the two units and shovel test are provided below.

Test Pit 1

The unit measured 1.40 m square and descended 1.6 m below surface. The excavation revealed three stratigraphic levels in the unit. The first strata was a 30 cm layer of humus and roots. The second stratum was mostly sand and measured between 50 – 70 cm. The third strata was roughly 60 cm thick and consisted of a layer of limestone and sand.

Test Pit 2

This unit measured 1.30 m square and descended 2.40 meters from surface. Like Test Pit 1, Test Pit 2 had three stratigraphic levels. Level 1 was represented by a layer of humus/roots that extended 20-25 cm below



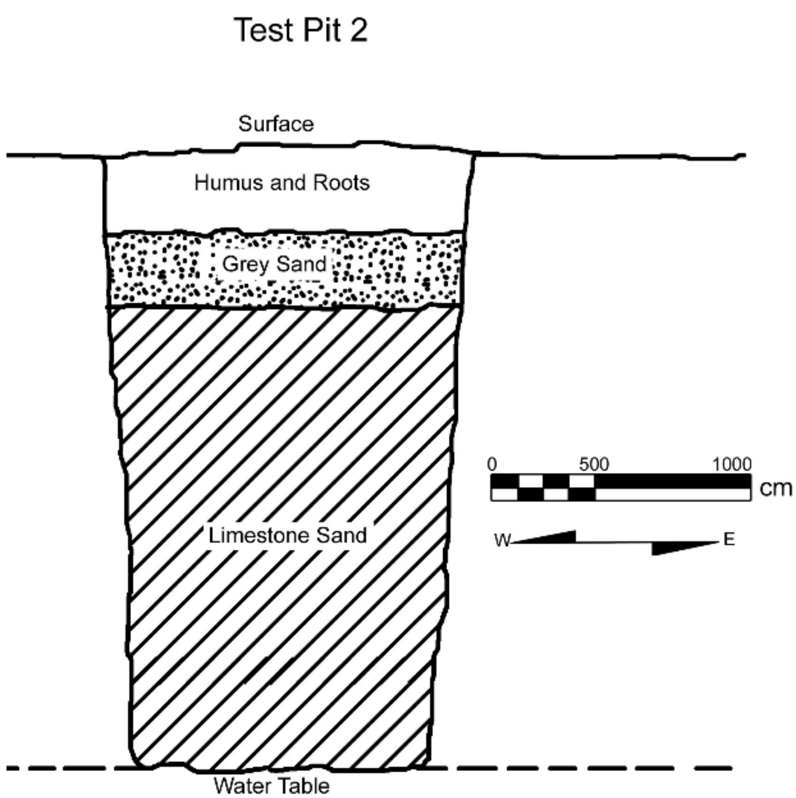


Fig. 6: Section plans of Test Pits 1 and 2.

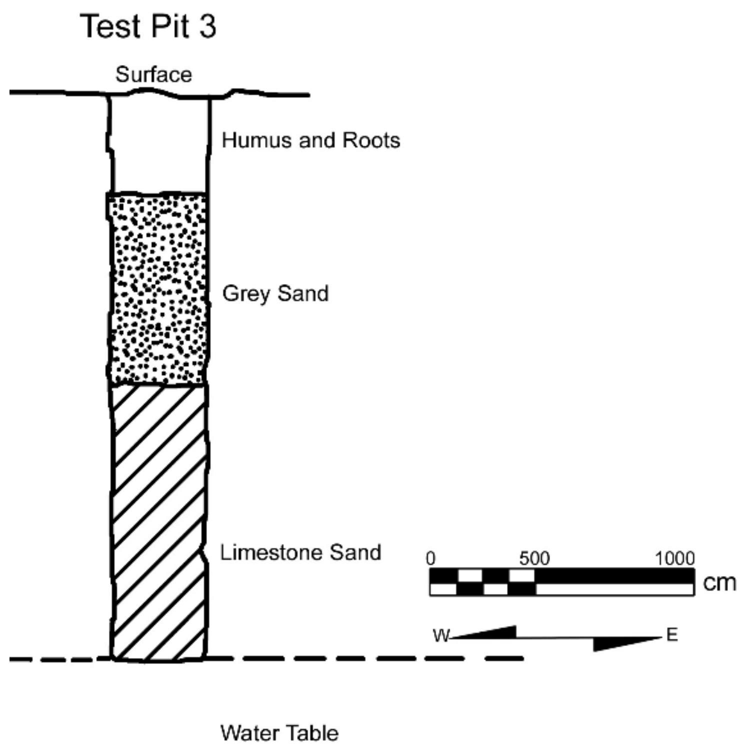


Fig. 7: Section Plan of posthole test.

Fig. 8: Photo of potsherds discovered on Transect C.

surface. Level 2 was a grey sandy strata that averaged 25 cm in thickness. Level 3 is a layer of limestone and coarse sand, 190 cm in depth.

Test Pit 3 (shovel test)

Test Pit 3 was a post hole unit that measured 35 cm in diameter. The unit descended 2 meters below surface and ended at the water table. The first level was represented by a 36 cm thick layer of humus and roots. Level 2 consisted of a grey-coloured, sandy strata 68 cm in thickness. Level 3 was represented by a layer of limestone and coarse sand, 96 cm thick.

RESULTS OF THE INVESTIGATIONS

Surprisingly, none of the test pits recovered any prehistoric remains. This, however, likely reflects the fact that both of the nearest sites to the property (Franco and Valencia) are located closer to the lagoon, and the fact that they only reflect ephemeral occupation by the ancient Maya. It is possible that more intensive research could reveal more evidence of prehistoric human activity in this zone but this type of excavation was beyond the scope of our survey.

In contrast to our test pits, the survey along Transect C recovered 2 potsherds (Fig.8). The two pieces of pottery were discovered on the surface, at the start of the mangrove flats. The first specimen was approx. 1 cm thick with a diameter of 5 cm. The second specimen was oval in shape, 0.8 cm thick, and 2 cm in diameter. Both specimens were poorly preserved and consisted of two small, unslipped, friable potsherds reminiscent of pottery classified as Coconut Walk ceramics by Elizabeth Graham (1994). If we are accurate in our identification, these are the type of ceramics used on coastal sites for the production of salt cakes in the *sal cocida* process described above. It would also suggest that the Franco site may have been used for the production of this resource.

On Transect J we noted two small, mound-like, features. We shovel tested around the perimeter of the features but recovered no remains of archaeological significance. We therefore suspect that the mound-like features may be part of the natural sand dunes.

Beside these remains, we recovered no other materials of archaeological significance. This, however, in no way negates their possible presence on the property. As we have noted above, archaeological materials in this type of environment are often buried under silt, mangrove swamps or under sand dunes. Because we only conducted a limited number of test pits on our survey, we cannot rule out the possibility that further archaeological remains from the ancient Maya are present on the property. This is particularly noteworthy given the fact that the sites of Ek Luum, Valencia are in close proximity to the property, and that the Franco Site may actually be within the property boundaries. Our discovery of the ceramic fragments and Guderjan and Garber's (1995) previous archaeological investigations strongly supports this assessment. These findings should therefore be taken into careful consideration during development of the area. To alert all concerned of the archaeology of the immediate area we have provided descriptions of all three neighbouring sites below.

SITE DESCRIPTIONS

Ek Luum

Ek Luum, Maya for "Black Dirt", covers over 17,000 square meters and is one of the largest sites on Ambergris Caye (Guderjan and Garber 1995:17). The settlement is located just north of the ABR property, on the eastern banks of the Laguna Cantena (Fig. 9), and about 250 meters from the sandy beaches of the windward side of the island. This location provided easy access to reef resources and a safe harbour on the more protected leeward side of the caye. From its location, the inhabitants of Ek Luum would have also been in sight of other prehistoric communities such as Burning Water and Chac Balam on the western shores of the Laguna Cantena.

Archaeological investigations by Guderjan and his colleagues (1993; 1995) noted that Ek Luum was occupied for several centuries during the Classic period. Guderjan (1993:32-34) also reports that "Unlike other windward side sites, Ek Luum includes monumental architecture as well as residences". Two structures, (Mound 1, and Mound 2) are both approximately 4 meters in height and revealed several phases of construction. Around Mound 1 Guderjan et al. (1993, 1995) discovered thousands of potsherds of the Coconut Walk variety, while Mound 2 contained mostly residential debris. It should be noted that the Coconut Walk ceramics are similar to those that Elizabeth Graham (1994) proposed were used for making salt cakes by the "*sal cocida*" method.

Excavations at Ek Luum recovered various other cultural remains. These objects include tools produced from local materials such as conch shell, and a few exotics like obsidian, chert implements made from Colha flint, and a couple pottery vessels.

Settlement data indicates that the settlement at Ek Luum expanded gradually throughout the Classic period. By the end of the Terminal Classic (1000 A.D.) period construction activity ceases and the site appears to have been abandoned by the onset of the Postclassic period (A.D. 1000-1200).

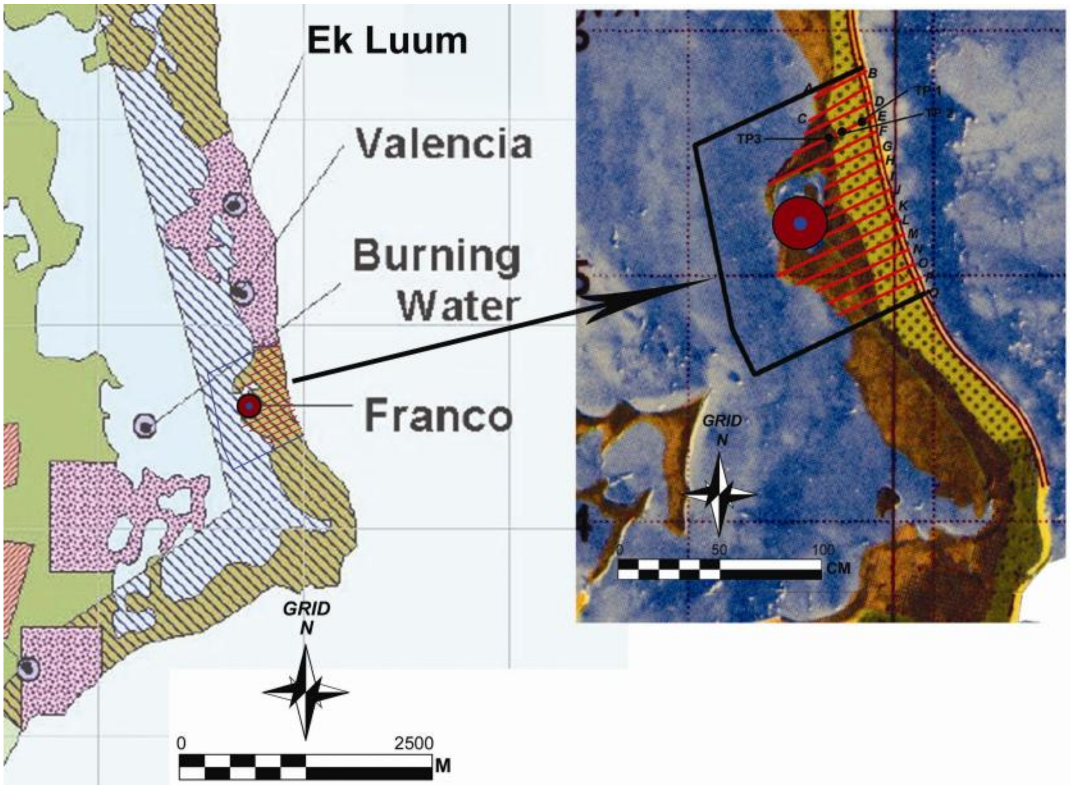


Fig. 9: Map showing location of Ek Luum, Valencia and Franco archaeological sites in reference to ABR property.

Valencia

Valencia (see Fig. 9) is a small prehistoric Maya settlement that is located approximately 1 kilometer south of Ek Luum. The site was tested by archaeologist Herman Smith in 1987 and reported by Guderjan and Garber in their 1995 publication (see References Cited). In the latter publication Guderjan (Guderjan and Garber 1995:15) reports that:

> The Valencia site is quite similar in proportions to the Franco site. It lies about 1 km north of the Franco site and about 250 – 300m from the present beach. Although its area has not been measured precisely, it encompasses approximately 100x50 m. A reasonable estimate for the depth of the deposit is 60 to 100 cm.
>
> Potsherds from the site, collected by local fishermen while clearing the land to grow vegetables, dated from the Early or Middle Postclassic. Unlike the materials from the Franco site, these were well made sherds and clearly not manufactured at the site. However, the sample bias is clear in that the fishermen probably presented us the “best” sherds they found. No formal construction exists.

Franco

The Franco site is located about 1 kilometer south of Valencia and very likely is within the ABR property (see Fig. 9). The site was tested by Guderjan in 1987 and reported in the volume by Guderjan and Garber (1995). These authors (Guderjan and Garber 1995:15) note that:

> The Franco is situated about 300 m from the present beach on the windward side. The site covers about 100x50 m. Test excavations indicate that it is a black-dirt deposit with no formal architecture or mounds. An ephemeral floor was found in the test unit. This feature was very thin and badly disturbed to the degree that it was not possible to follow the floor in a lateral excavation.
>
> In the area of this test the deposit is about 80 cm thick. The ceramics recovered from the site were porous, friable, and badly eroded, dating to the Late Classic or Early Postclassic periods. Many sherds had coarse sand tempering and were very poorly fired, which would suggest they were locally manufactured. An adult male burial was encountered with no associated grave goods. Based on the cultural materials recovered the occupants of the Franco site could best be characterized as impoverished. Even the shell tools were poorly crafted.

CONCLUSIONS AND RECOMMENDATIONS

Our survey of the ABR property indicates that this parcel of land is in close proximity to two recorded archaeological settlements (the Ek Luum and Valencia Sites) and that it likely encompasses the Franco Site. In view of the above we recommend that if construction is planned for the area around the locality of Franco, that this area should be mitigated prior to construction. Given the ephemeral occupation of the Franco site this work could likely be accomplished in a relatively short period of time (1 week).

Developments on other sections of the property should also be sensitive to the presence of archaeological remains in the area. 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 construction. He would be expected to observe preliminary land clearing activities, and all excavations associated with such activities 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 should notify the Institute of Archaeology immediately.

If remains of archaeological significance are located, the developers or contractors should be required to contact the Institute of Archaeology immediately, 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.

REFERENCES CITED

Boxt, Matthew

1983 The 1982 UCLA Archaeological Reconnaissance of Sarteneja, Belize. *Institute of Archaeology, University of California Los Angeles, Newsletter*, Volume 2, No. 11.

1988 Archaeological Research at Sarteneja, Belize, 1986-1987. *Mexicon* 10(2):30-35.

Chase, Diane

1981 The Maya Postclassic at Santa Rita, Corozal. *Journal of Field Archaeology* 33:25-33.

Chase, Diane and Arlen Chase

1988 *Postclassic Perspective: Excavations at the Maya Site of Santa Rita Corozal, Belize*. Pre-Columbian Art Research Institute Monograph 4, San Francisco.

Finnamore, Daniel

1994 Sailors and Slaves on the Wood-Cutting Frontier: Archaeology of the British Bay Settlement, Belize. PhD dissertation, Department of Anthropology, Boston University, Boston.

Friedel, David

1978 Maritime Adaptation and the Rise of Maya Civilization: The View from Cerros, Belize. In *Prehistoric Coastal Adaptations: the Economy and Ecology of Maritime Middle America*, edited by Barbara L. Stark and Barbara Voorhies, 239-265. Academic Press, New York.

Friedel, David and Vernon Scarborough

1978 Subsistence, Trade and Development of the Coastal Maya. *In Maya Subsistence*, Edited by Kent V. Flannery, 131-155. Academic Press, New York.

Hammond, N.

1982 Prehistory of Belize. *Journal of Field Archaeology*, 9(3):349-362

Graham, Elizabeth

1986 Resource Diversity in Belize and Its Implications for Models of Lowland Trade. *American Antiquity* 52: 753-767.

1989 Synthesis of Coastal Data from Colson Point, Placencia and Marco Gonzalez, Belize. In *Coastal Maya Trade and Exchange*, Edited by Heather McKillop and Paul Healy. *Occasional Papers in Anthropology*. Trent University; Peterborough, Ontario.

1994 The Sands of Time: San Pedro, Ambergris Caye. *Royal Ontario Museum Archaeological Newsletter*, Toronto, Ontario.

Graham, Elizabeth and David Pendergast
1989 Excavations at the Marco Gonzalez site, Ambergris Caye, Belize. *Journal of Field Archaeology*.

Guderjan, Thomas H.
1993 Ancient Maya Traders of Ambergris Caye. *Cubola Productions*, Belize.

1988 Maya Maritime Trade at San Juan Ambergris Caye, Belize. Ph.D. Dissertation, Department of Anthropology, Southern Methodist University, Dallas, TX.

Guderjan, Thomas H. and James F. Garber
1995 Maya Maritime Trade, Settlement and Population on Ambergris Caye, Belize, *Labyrinthos Press*, Culver City, California.

Guderjan, Thomas H., James F. Garber and Herman A. Smith
1988 San Juan: A Maya Trans-Shipment point on Ambergris Caye, Belize. *Mexicon* 10(2):35-37.

1989 Maritime Trade on Ambergris Caye, Belize. In *Coastal Maya Trade and Exchange*. Edited by Heather McKillop and Paul Healy, Occasional Papers in Anthropology, Trent University, Ontario, Canada.

Guderjan, Thomas H., James F. Garber, Herman A. Smith, Fred Stross, Helen Michel and Frank Asaro
1989 Maya Maritime Trade and Sources of Obsidian at San Juan, Ambergris Caye, Belize." *Journal of Field Archaeology* 16:3:363- 369.

Lohse, Jon, Jaime Awe, Cameron Griffith, Robert Rosenswig, & Fred Valdez Jr.
2006 Preceramic Occupations in Belize: Updating the Paleo-Indian and Archaic Record. *Latin American Antiquity*.

MacKinnon, J. Jefferson
1989 Spatial and Temporal Patterns of Prehistoric Maya Settlement, Procurement, and Exchange on the Coast and Cays of Southern Belize. Unpublished Ph.D. Dissertation submitted at the University of Wisconsin, Madison.

MacKinnon, J. Jefferson and Gary Rex Walters
1987 Archaeological Investigation in the Placencia Area, Stann Creek District, Belize, Central America. 1983-1986). Manuscript in the Department of Archaeology, Belize.

McKillop, Heather

1980 Moho Caye, Belize: Preliminary Investigations of Trade, Settlement and Marine Resource Exploitation. Masters Thesis, Department of Anthropology, Trent University, Ontario, Canada.

2002 *Salt: White Gold of the Ancient Maya*. University Press of Florida, Gainesville.

2004 T*he Ancient Maya: New Perspectives*. ABC-CLIO, Inc., Santa Barbara, California.

2005 *In Search of Maya Sea Traders*. Texas A&M University Press, College Station, Texas.

Mock, Shirley Boteler

1994 The Northern River Lagoon Site (NRL): Late to Terminal Classic Maya Settlement, Saltmaking, and Survival on the Northern Belize Coast. Ph.D. dissertation, Department of Anthropology, University of Texas, Austin.

2004 Maya Traders on the North-Central Belize Coast. In *Research Reports in Belizean Archaeology*, Volume 1, pp359-370. Edited by Jaime Awe, John Morris and Sherilyne Jones. Institute of Archaeology, Belmopan, Belize.

2005 The Terminal Classic to Postclassic Ceramics from Saktunja, a Coastal Site in Northern Belize. In *Research Reports in Belizean Archaeology*, Volume 2, pp 425-440. Edited by Jaime Awe, John Morris, Sherilyne Jones and Christophe Helmke. Institute of Archaeology, Belmopan, Belize

Appendix A

Photographs of Project Area

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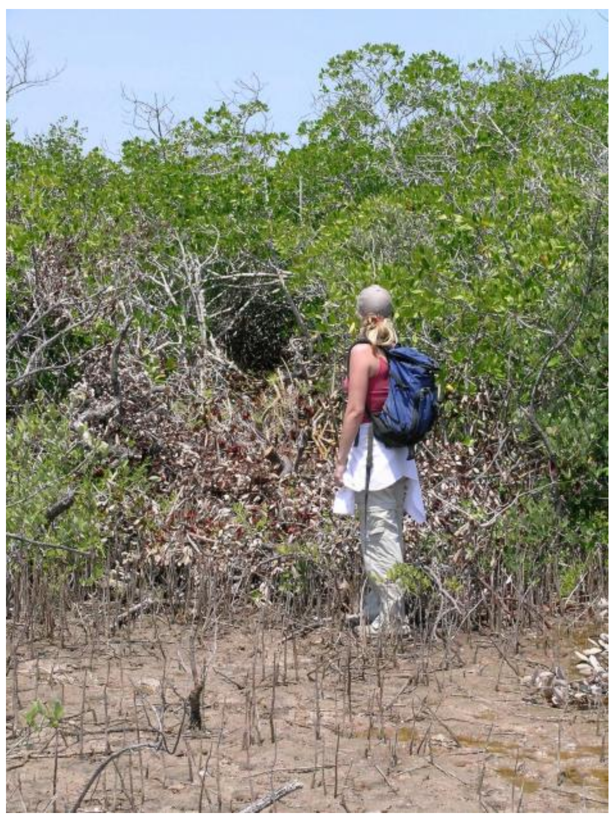
Photo 1: View of Rocky Point

Photo 2: View of ABR Property Shoreline

Photo 3: Beachfront of ABR Property. Note Rocky Point at far left.

Photo: 4 Start of transect along shoreline

Photos 5—8: Various views of transect through property. (Bottom right photo shows transect at start of swamp.



Photos 9 &10: Transects through swampy area on ABR Property.

Photo 11 & 12: Photograph of Unit 1.

Photo 13 & 14: Pictures of Unit 2 and
Posthole Test 1

Photo 15: Photograph of potsherds recovered on Transect C.

References

Auil, N. 1997. Manatee Research Progress Report, March – July 1997, Coastal Zone Management Project.

Auil, N.E. (1998). Belize Manatee Recovery Plan, Coastal Zone Management Project. (GEF UNDP)

Azueta, J. 2002. Draft Revised Management Plan For Bacalar Chico Marine Reserve, Unpublished Report.

Belize, Natural History and Archaeology. 1996. International Expeditions, Inc., Helena Alabama.

Blackstone Corporation. 1998. Tourism Strategy for Belize. Ministry of Tourism and Environment, & IADB.

BTB. 2003. Belize Cruise Ship Policy. Belize Tourism Board.

BTB. 2004. Tourism & Travel Statistics. Belize Tourism Board

Cayes Development Policy. 1995. Coastal Zone Management Committee. CZMAI./FD. Government of Belize

CSO. 2004. Environmental Statistics for Belize. Central Statistical Office, Ministry of National Development, Belize.

CZMAI. 1996. Belize City Cayes Development Guidelines.

CZMAI. The National Integrated Coastal Zone Management Strategy for Belize.

Development Solutions. 2004. Belize City Cayes Region Development Guidelines Volume 5.

Edwards, Ernest P. 1998. The Birds of Mexico and Adjacent areas.

Gibson, J. 1991. Trip Report. Reef Pt - Bacalar Chico, Ambergris Cay.

Gischler E. and A.J. Lomando. 1999. Recent sedimentary facies of isolated carbonate platforms, Belize-Yucatan System, Central America. Jour. Sedimentary Res., Vol. 69, No. 3.

Gobin, Judith. 2001. Coastal Infrastructure Design, Construction and Maintenance A Course in Coastal Zone/Island Systems Management. Organized by Department of Civil Engineering, The University of the West Indies, in conjunction with Old Dominion University, Norfolk, VA, USA and Coastal Engineering Research Centre, US Army, Corps of Engineers, Vicksburg, MS, USA.

Goldsmith F.B. 1991. Monitoring for Conservation and Ecology. Chapman and Hall.

Green Reef Environmental Institute (2004). The Revised Bacalar Chico National Park and Marine Reserve Manage Plan.San Pedro Town, Belize

Grimshaw, T. & G.M. Paz. 2004. The Revised Bacalar Chico National Park and Marine Reserve Management Plan. Green Reef Environmental Institute, San Pedro Town, Belize, Central America.

Guderjan, T.H. 1993. *Ancient Maya Traders of Ambergris Caye.* Cubola Publications, Benque Viejo del Carmen, Belize. 39 pp.

Halcrow Group. 2000. The Coastal Zone Management Strategy for Belize. Draft. CZMA&I, Belize.

Hartshorn, G.. Nicolait, J., et al. 1984. Belize Country Environmental Profile. A field study. United States Agency for International Development

High, L.R. 1969. Geomorphology and Sedimentology of Holocene Coastal Deposits. Taken form PhD thesis, Rice Univ.

Hoese, H. D., and R. H. Moore. 1977. Fishes of the Gulf of Mexico, Texas, Louisiana, and Adjacent Waters. Texas A&M University Press.

Ishmael, L. 1994. Development of North Ambergris Caye, Belize: An Investment in the Future. Report to the Inter-American Development Bank, Washington D.C.

James, N.P. and R.N. Ginsburg. 1979. The seaward margin of the Belize barrier reef and atoll reefs. Int. Ass. of Sedimentologists, Special Publication; No. 3.

Jolly, K. and E. McRae. 1998. The Environment of Belize: our life support system, Cubola Productions.

Jones H. L. 2003. Birds of Belize. University of Texas Press, Austin.

Jones H. L., & A.C. Vallely. 2000. Annotated Checklist of the Birds of Belize. Lynx Edition.

King, R. B., Baillie, I.C., Abel, T.M.B., Dunsmore, J.R., Gray, D.A., Pratt, J.H., Versey, H.R., Wright, A.C.S., and Zisman, S.A. 1992. *Land Resource Assessment of Northern Belize. Natural Resources Institute Bulletin* No 43. 513pp. (2 volumes)

Kricher, J.C, (1989). A Neotropical Companion, Princeton University Press.

Launchpad Consulting. 2005. Belize Tourism Policy 2005. Belize Tourism Board.

Littler, D.S., M.M. Littler and B.L. Brooks. 1995. Marine Algae and Seagrasses from the Tobacco Range Fracture Zone, Belize, C.A. Atoll Research Bulletin, Nos. 426-431.

Majil, I. 2000. Sea Turtle Monitoring And Conservation Programme, Unpublished Report. 8 Pp.

Mazzullo, S.J., Anderson-Underwood, K.E., Burke, C.D. and Bischoff, W.D. 1992. Holocene coral patch reef.

Mazzullo, S.J. Teal, C.S. Bischoff, W.D., Dimmick-Wells, K., And Wilhite, B.W. 2003.Sedimentary Architecture And Genesis Of Holocene Shallow-Water Mud-Mounds, Northern Belize *Sedimentology* 50, 743-770.

McCalla. W. 1995. Guide for Developers. Ministry of Tourism and the Environment.

McField, M. et al. 1996. State of the Coastal Zone Report, Belize 1995. Coastal Zone Management Programme. Government of Belize

McField, M.D. 2000. Evaluation of management effectiveness - Belize marine protected areas system. Prepared for the CZM Authority & Institute, Belize City, Belize. August 2000. 20 p.

McGee, M. Understanding and interpreting water quality. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Meadows, M. 1995. Bacalar Chico Bird Report. Report to ITCF.

Meerman, J. C. & W. Sabido. 2001. Belize Ecosystems Map and classification. Programme for Belize.

Miller, B.W., and Carolyn M. Miller. 2000. Birds of Belize: a check list. Belize Audubon Society: Belize, Central America. 2nd revised edition.

Miller B.W, & C. M. Miller. 1994. National Protected Areas Systems Plan For Belize, Full Report Vol. 3 Zoological Report.

Mumby, P.J., A.R.Harborne and P.S.Raines. 1998. Classification scheme for marine habitats of Belize. Unpublished report for the UNDP/GEF Belize Coastal Zone Management Project.

Nicolait, R. 1984. Belize Country Environmental Profile, A Field Study.

Odum, E., C.C. McIvor and T.J. Smith. 1982. The Ecology of the Mangroves of South Florida: A Community Profile. Dept. Env. Sc., Univ. Virginia, Charlottesville, Virginia.

PAHO. 2002. Health Systems and Services Profile. Organization and Management of Health Systems and Services Division of Health Systems and Services Development.

Paz, G.M. and T. Grimshaw. 2001. Status report for Nassau groupers in Belize. Workshop Report "Towards a sustainable management of Nassau groupers in Belize", Belize City, 30 July 2001.

Perkins, J.S. 1983. The Belize Barrier Reef Ecosystem: an assessment of its resources, conservation status and management. New York Zoological Soc. Report pp. 189.

Platt, S. G., Thorbjarnarson, J. B. 1997. Status and Life History of the American Crocodile in Belize. ix + 164 Pgs.

Purdy, E.G. 1974. Karst-determined facies patterns in British Honduras: Holocene carbonate sedimentation model. Am. Ass. Petrol. Geol. Bull. 58: pp. 825-855.

Purdy, E.G. and E. Gischler. 2003. The Belize margin revisited: Holocene marine facies. Int J Earth Sci. (Geol Rundsch) 92: 532-551.

Raines, P., Wells, S. and Harborne, A. 1995. Coral Cay Conservation Interim Report. April-December 1994. Belize Coastal Zone Management Programme, B7-5040/93. Report to European Union.

Rauscher, F. and J.M. Wilensky. 1996. Cruising Guide to Belize and Mexico's Caribbean Coast, including Guatemala's Rio Dulce, 2nd Ed.

Sedberry, G.R. and Carter, J. 1993. The fish community of a shallow tropical lagoon in Belize, Central America. *Estuaries* 16 (2): 198-215.

Smith, G. W. 1995. Survey of Reptiles and Mammals in the Proposed Bacalar Chico Marine Reserve and Wildlife Sanctuary.

Smith, G. W. 1990. Ground Surveying for Sea Turtle Nesting Sites in Belize, 1990. Belize Audubon Society, Belize City. 24 p.

Stake Bank Cruise Ship Facility Development: Dec. 21st , 2005.

State of the Coast Report of Belize, 1999. Coastal Zone Management Authority and Institute.

Stoddart, D.R. 1974. Post-hurricane changes on the British Honduras reefs: resurvey of 1972. Proc. 2nd Int. Coral Reef Symp. Pp. 473-483.

Stoddart, D.R., F.R. Fosberg and D.L. Spellman. 1982. Cays of the Belize Reef and Lagoon. Atoll Res. Bull. 256: pp. 1-76.

Sullivan, K.M., G.A. Delgado, G.A. Meester, and W.K. Miller. 1994. Rapid Ecological Assessment Methods for Tropical Estuarine Ecosystems: Port Honduras, Belize. The Nature Conservancy, Florida and Caribbean Conservation Science Center, University of Miami.

Thurman, H.V. 1988. Introductory Oceanography, Fifth Ed. Published by Merrill Publishing Company.

Tunich Nah Consultants. 2001. Environmental Impact Assessment of Deep Water Port and Haulover Creek Mouth dredging proposal.

Tunich Nah Consultants. 2002. Castaways Reef Resort Environmental Impact Assessment on Calabash Caye.

Tunich Nah Consultants. 2003. Long Caye, Light house reef residential & tourism Environmental Impact Assessment.

Tunich Nah Consultants & Eng. Ltd. 2001. Environmental Impact Assessment Spanish Bay Resort to be Established on Spanish Lookout Caye South-East of Belize City.

Wantland. K.D. 1967. Recent Benthic Foraminifera of the British Honduras Shelf. Ph.D. thesis, Rice Univ., Houston, Texas. pp. 299.

Woods, T.L. 1998. An Overview of Belizean History (html document).

Woods, R.L., ST. Reid, & A.M. Reid. 1988. The field guide to Ambergris Caye Belize. C.A. including other areas. 176 p.