SECTION FIVE

ENVIRONMENTAL IMPACT ANALYSIS

5.1 Introduction

It must be a basic premise that all developments will produce some environmental impacts and therefore the basic question is how much is acceptable under the circumstances? The obvious consensus is that the country needs development but only of the kind that is sustainable and in conformity to national development priorities. The challenge throughout is to find an acceptable level that will strike the necessary balance between the need to develop and the need to protect vital environmental resources. Also important is the planned scale of the infrastructural development and their potential to unravel the social fabric and lifestyles of the people in the area within which they are based.

5.1.1 Conceptual Approach towards Development

The impacts of this development will be felt mainly in the areas of physical alterations to the surrounding ecosystem, solid and liquid waste disposal, water supply and distribution, energy generation, effects on the native wildlife species of the area from a combination of factors, extraction of materials and transportation. The point has been made that no project of this size can be successfully implemented without some negative environmental impacts, however it is incumbent on the developer to reduce these to their lowest possible level, or negate them entirely if the situation allows.

The developer will be aided in this undertaking by the impacts and mitigation discussion in the relevant sections of this study which have been identified by the DOE as liable to produce significant environmental impacts among others.

The process is taken one step further with outlines for a monitoring regime in Section 6 which will further protect the physical and biological resources of the site by prompting the developer to go one step further by actively gauging and measuring the impacts of his development in the post operational era. This monitoring program will constitute the defining litmus test to see whether the developer's mitigation measures are working or whether they need to be modified or replaced entirely. The environmental compliance plan to be prepared for the developer by the DoE (if necessary) will set out further measures deemed necessary by the environmental community to maintain this pristine and sensitive site from undue environmental violation.

It is the view of the project's environmental advisors that if best management practices are incorporated throughout the stages of project implementation and if mitigation measures contained elsewhere in this report and below are implemented, then the level of impacts will be within acceptable limits and will not place an unbearable stress to the area's ecosystem to the detriment of man and the areas life support systems. As always, the ultimate hope is that this

project will become a model for others, demonstrating that economic gains and social advancement is possible without sacrificing important environmental principles.

5.1.2 Environmental Principles in Impact Analysis

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 program(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 programs are activities which alter the environment, or cause 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.

Environmental impacts are in principle hierarchical and in this regard are described as being sequentially 'primary', 'secondary', 'tertiary', etc., in orientation. An example of this impact sequence which specifically relates to the currently proposed project is shown in Table 5.1. Primary impacts are those impacts arising immediately from particular development activities such as land clearing and affect basic ecosystem functions such as primary productivity, metabolic rate, mechanical damage to anatomical structures and the physical destruction of habitats.

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 Rating Matrix outlined in Table 5.1). In the case of primary 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. Conversely, under the current analytical process outlined in the EIA Impact Rating Matrix (See Table 5.1), 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.

5.2 Overview of Proposed Cumulative Impacts

In considering the proposed project, the importance of identifying the anticipated cumulative environmental impacts is of great value. This approach is designed in such a way as to preserve and conserve the environment as much as possible while undertaking the required activities necessary to bring life to the project.

In addition, a monitoring plan must also be visualized in order to quantify the potential adverse impact that may result as part for a developmental activity. These plans must be carefully designed, planned, and implemented using techniques designed to reduce and possibly eliminate the severity of the effects.

Such circumstances have been extensively studied by the Council for Environmental Quality (CEQ) and they have defined the measures as those that include:

1. *Avoiding* the impact
2. *Minimizing* the impact by limiting the degree or magnitude of the action
3. *Rectifying the* impact by repairing, rehabilitating, or restoring the affected environment.
4. *Reducing* or eliminating the impact over time
5. *Compensating* for the impact by replacing or providing substitute resources or environments.

These measures applied by the Council, can be adapted to suit the proposed project and assist the decision makers in the course of action. Figure 5.1 illustrates the generic impacts and its related influences in regards to the measures implemented by CEQ.

Fig. 5.1 CEQ's Impact Structure

5.2.1 Impact Rating Matrix

Figure 5.2 summarizes the potential impacts that can be encountered during construction and operation of the project. These impacts can be viewed as affecting both marine and land environments and its associated cumulative impacts.

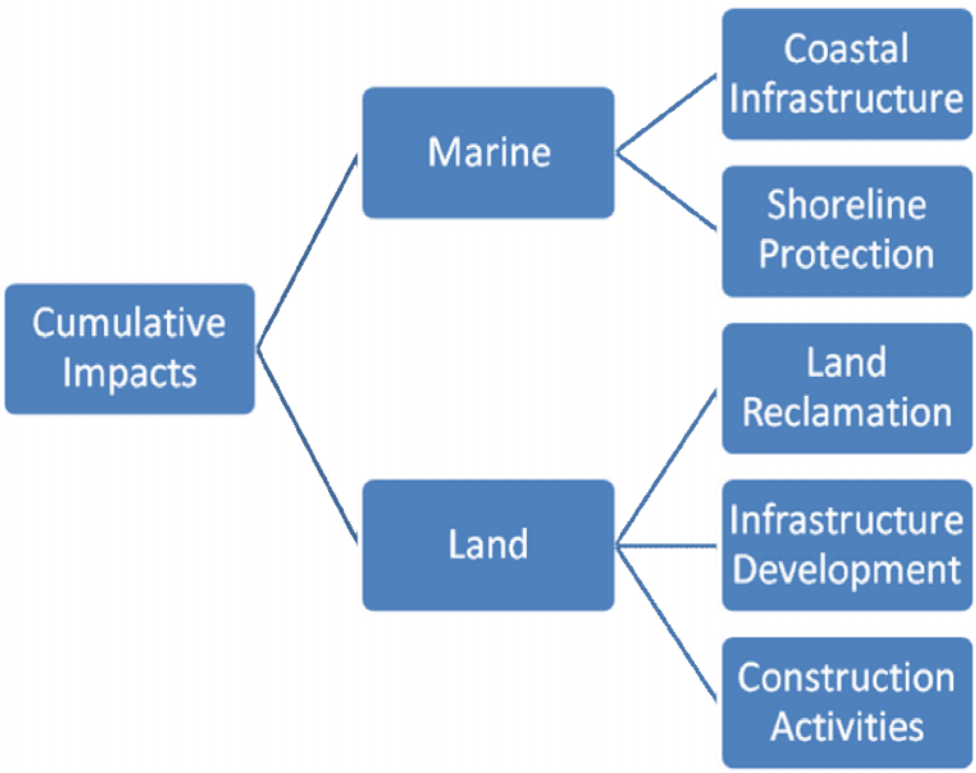

Fig. 5.2 Cumulative Potential Impacts

5.2.2 Interpretation

The level of adverse, or alternatively, beneficial impacts on the environment is a function of the nature and magnitude of the particular development activity, and the capacity of the receiving environment to assimilate and/or respond to these impacts.

In considering the proposed low density project, the importance of identifying the anticipated cumulative environmental impacts is of great value. This approach is designed in such a way as to preserve and conserve the environment as much as possible while undertaking the required activities necessary to bring life to the project.

In addition, a monitoring plan must also be visualized in order to quantify the potential adverse impact that may result as part for a developmental activity. These plans must be carefully designed, planned and implemented to techniques designed to reduce and possibly eliminate the severity of the effects.

5.2.3 Impact Rating Matrix

The impact matrix was designed as a tool to understand the level of adverse, or alternatively, beneficial impacts on the ecosystem and in general of any given area in question. It is a function of the scope of the development, the ecological fragility or sensitivity of the receiving environment, and the conceptual value assigned to the integrity of the natural resources of the area by the wider community.

The figure below summarizes the potential cumulative impacts that can be encountered during construction and operation of the proposed project. These impacts can be view as affecting both marina and land environments and its associated cumulative impacts. The connectivity or hierarchical nature of the impacts of the proposed project has been reinforced by the integration of a residual impact rating matrix outlined in Table 5.1. This matrix evaluates the mitigation measures options in the following terms:

- **Magnitude**: High (H), Medium (M), or Low (L);
- **Direction**: Beneficial (+) or Adverse (-);
- **Duration**: Instantaneous (I), Short term (S), Medium (M) or Long term (L);
- **Scope**: Instantaneous (I), Short term (S) , Medium (M) or Long term (L);
- **Significance**: Not Significant (NS), Low (L), Medium (M) or High (H) significance

5.2.4 Rating Summary

Based on the Table 5.1, various potential cumulative impacts were identified as part of the Impact Rating Matrix for the proposed Chrysalis project. The level of adverse, or alternatively, beneficial impacts is a function of the magnitude of the development activity, the nature of the impact in question, the capacity of the environment to assimilate these influences and the methodology to be applied in relation to the particular project activity.

Table 5.1 Impact Rating Matrix for the Proposed Chrysalis Project

Potential impact			Magnitude	Direction	Duration	Scope	Significance
Marine Environment	Dredging Activities	Sedimentation/Siltation	H	-	S,M	S	H
		Water Quality Alteration	M	-/+	I,S	I	L
		Nutrient Alteration	M	-/+	S	I	L
		Habitat Alteration	H	-	M,L	S	M
		Coral Reef Cover/Diversity	M	-	L	M	H
		Near shore Ecosystem	H	-	S	S	H
	Pier Construction	Sedimentation/Siltation	L	-	I	I	M
		Water Quality Alteration	L	-/+	I	I	L
		Oceanographic Alteration	L	-	M	S	L
		Habitat Alteration	L	-	I,S	S	L
		Coral Reef Cover/Diversity	M	-	S,M	S	L
		Near shore Ecosystem	M	-	S	S	L
		Socio-economic influence	M	+	L	L/+	M
	Wind Turbine Installation	Sedimentation/Siltation	H	-	I	I	NS
		Water Quality Alteration	L	-/+	I,S	I	NS
		Nutrient Alteration	L	-/+	I,S	I	NS
		Oceanographic Alteration	M	-/+	M	S	M
		Habitat Alteration	L	-/+	S	S	L
		Coral Reef Cover/Diversity	L	-	S	S	L
		Near shore Ecosystem	L	-	S,M	I,S	L

Land Based Facilities	**Building Construction**	Soil Alteration	M	-	S	S	NS
		Land Alteration	M	-	S	S	NS
		Surface Water Alteration	L	-	S	S	L
		Noise Generation	H	-	I,S	I,S	L
		Fugitive Emissions	L	-	I,S	I,S	NS
		Solid Waste Generation	L	-	S	S	L
		Socio-economic Influence	H	+	S	S	H
	Infrastructure Develop. & Oper.	Soil Alteration/Pollution	L	-	S	S	L
		Water Contamination	L	-	I,S	I,S	L
		Spills and Leaks/Services	L	-	I	I	L
		Drainage Alteration	L	-	S,M	S,M	L
		Fugitive Emissions	L	-	S	S	NS
		Noise Generation	L	-	I	I,S	L
		Solid Waste Accumulation	L	-	S	S	L
		Socio-economic Influence	L	+	M,L	M	H
	Land/Beach Reclamation	Habitat Alteration	L	-	L	S	L
		Soil Alteration	M	-	L	S	L
		Surface Water Alteration	L	-	S	S	L
		Drainage Alteration	L	-	S	S	L
		Aesthetic Appeal	M	+	L	L	H
		Mangrove Cover/Abundance	L	-	I,S	S	M
		Socio-economic Attraction	H	+	L	L	H

The primary activities that are likely to give rise to environmental impacts of note are the dredging activities, infrastructure development (supporting services) and the land reclamation processes (See Fig. 5.1 and Table 5.1).

The deposition of dredged spoils for land reclamation purposes, also gives rise to environmental impacts. The deposition of dredge spoils, although immediately related to dredging, is conceptually separate from dredging, which has been technically qualified as the physical excavation aspect of the operation.

Other primary impacts arising as a consequence of dredging relates to habitat alteration and aerial extent. These have been categorized as “ecological” impacts and include: a decrease in nursery habitat, an increase in benthic habitat, an increase in pelagic habitat and a decrease in mangrove prop root habitat.

The most notable primary aquatic impacts that are likely to arise from the general commissioning of operation of the proposed development are an increase in macro-nutrients and turbidity.

Apart from water quality issues and aquatic impacts otherwise, the engagement of the land based facilities is also relevant in term of environmental impacts. This includes the related impacts such as building and infrastructure development, boardwalks and the land and beach reclamation.

5.3 Details of Environmental Impacts

Various potential cumulative impacts were identified as part of the Impact Rate Matrix (See Table 5.1). The level of adverse, or alternatively, beneficial impacts is a function of the magnitude of the development activity, the nature of the impact 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 primary activities that are likely to give rise to the environmental impacts of note are the constrained dredging and reclamation activities, infrastructure development (supporting services installation, piers and amenities), and units construction (See Fig. 5.2 and Table 5.1). These potential impacts are expected to be, minor to moderate in scope considering the location of the proposed project.

Another impact of note is the deposition of the spoils that will be used for land reclamation activities. The anticipated project plans to utilize some type of shoreline protection mechanisms to develop the reclaimed areas (building footprint) of the development site. The deposition of dredged spoils, although immediately related to excavation, is conceptually separate and has been technically qualified as the physical extraction aspect of the operation.

Other primary impacts related to the dredging activities include habitat alteration. These impacts have been classified as 'ecological/physical' impacts. In considering the project location, the most notable primary aquatic impacts associated with the proposed undertaking are an increase in macro-nutrients and turbidity. These impacts can arise especially when operating the wastewater treatment plants. Apart from the water quality issues and aquatic impacts, the engagement of the land based facilities is also relevant in terms of the environmental impacts. This includes related impacts such as residential/building and infrastructure development, walkways and the land reclamation.

The following sections summarize the potential cumulative impacts that can be experienced by the proposed undertaking during construction and operation. It is important to note that some of the contents of this document is generalized for its simplicity. Many of the proposed potential impacts are generic and can be applied to other projects where appropriate.

5.3.1 Dredging Impacts

The most notable primary aquatic impacts arising from the development process is the dredging activities that are expected to be carried out. This activity will result in an increase in sedimentation and turbidity, and an increase in hydrogen sulphide in the water column (See Table 5.1).

The areas that are expected to be affected from the dredging impacts is limited to only to the immediate vicinity of the channel location (See Fig. 2.13). In this case, activity relates to the acquisition of 'spoils' or 'fill material' to reclaim the proposed development areas of the Channel Cayes (See 'Dredged Material/Fill Requirements' in Fig. 2.13 and 2.14).

The turbidity and sedimentation impacts has been estimated to be 'medium to high' at its most extreme (See Table 5.1), given the volume of 'fill' material to be extracted, the time-frame over which the material is to be extracted, the physical form of the material, and the proximity of the channel area to ecologically sensitive areas.

The channel area is to be located in areas characterized by coralgal or calcareous sand ('pipeshennk') on a substrate of consolidate calcerous sediments, intermixed with calcareous debris. This layer sits on a fairly substantial layer of firm, semi-compacted 'Halimeda' sand, which is of calcareous origin. Halimeda sand is made up primarily of the 'tests' or skeleton of the marine calcerous algae *Halimeda spp.,*. It is this layer of sand that is being harnessed as the 'dredge spoil' to be deposited in the area to be reclaimed

Given the coarse nature of the sand, and its relatively high density, the suspended sediments upended by the excavation process should re-settle in a relatively short time after the cessation of the overall dredging event. Thus even those areas that are nearest to the dredging site should not be catastrophically affected by the event. The particular areas have been listed as the "Near-shore Ecosystem" in the Impact Rating Matrix (Table 5.1), and are in effect the near-shore areas and mangrove stands immediately near the barrier platform.

The volume of the spoils to be dredged from the sea to 'reclaim' the areas to be developed by 3 feet is 16, 561.4 m^3 (See 'Proposed Fill Material, Fig. 2.14). It is noteworthy to point out that the 'near shore ecosystem' is not expected to be adversely affected by this activity. The impact of sedimentation from the dredging activities within the confines of the receiving environment rates, for the most part a moderate to highly adverse. This mainly includes the patch coral reef circumventing the dredged area and the adjacent sea floor of the surrounding impact sites which intermittently consist of some calcareous deposits and macro algal productivity.

The 'moderate impact' category has been assigned to the "mangrove prop root habitat" mainly as a result of the fact that the dredge spoils will not be deposited among the ecologically sensitive prop roots immediately adjacent to the development areas of the project site. Moreover, the impacts are also categorized as instantaneous and short considering the area to be physically impacted relative to the expanse of the sea.

Socially, the dredging activities will temporarily impair the fishing industry by 'disturbing' the access and use of traditional fishing grounds The issue of visibility and harvesting efficiency is also relevant to the conch fishery. The overall impacts of the dredging events of the proposed project on the conch and lobster fishery are projected to be very limited and localized in time.

It is also anticipated that the dredging of materials will have both physical and biological effects on the area to be dredged. Dredging operations can therefore potentially affect the area in a number of different ways, most notably the following:

1.0 Possible Biological Impacts

a. Direct biological impacts include:

- Possible Death or temporary migration of fish and other marine life (only migration may occur)
- Micro-algae and invertebrates are either entrained or crushed during dredging operations (Minimal considering habitat)
- Loss of habitat (minimal expected)
- If crocs, manatees or other animal of interest are near the dredged site, disturbance would likely occur possibly causing injury and migration (considered minimal)

b. Indirect biological impacts include:

- Possible decrease in primary productivity due to increased turbidity (minimal)
- Effects on habitat and benthos intolerant of high sedimentation (use of curtains)
- Bioavailability of contaminants in dredged material if presently accumulated in the sediments (reduced by dredging in dry season only and use of curtains)
- Increased wildlife potential as deeper navigable waters are introduced (post dredging operations)

2.0 Possible Physical Impacts

c. Direct Physical Impacts include:

- Possible increased siltation and turbidity (minimized by using curtains and dredging only on dry season).
- Changes in topography and bathymetry of channels.

d. Indirect Physical Impacts include:

- Indirect turbidity of water column from sediments that are continuously introduced into the water column (minimize by using curtains)
- Changes in current speed (minimal and dredge only on dry season)
- Changes on water circulation due to changes in bathymetry (velocity during dry season will decrease)
- Increased erosion of shoreline (shoreline protection is required)
- Increased deposition of material on the shoreline (minimal)

5.3.2 Land Reclamation Impacts

The land reclamation activities slated for the proposed development will be limited in scope. The areas to be reclaimed include the service areas, residential and recreational areas of the project. The cumulative impacts associated immediately to the reclamation process include possible

salinization of soils where these will be used as 'fill' material in order to elevate the terrain, increase beach erosion, increase turbidity in the water column, deposition of anoxic sediments and removal of habitat in the area where the spoils will be deposited (See Table 5.1). These impacts are both biological and physical in nature and relate to a number to other variables such as biodiversity, conservation value etc. Although there are identifiable primary impacts, these consequences mentioned are not expected to translate into significant secondary and tertiary impacts as they relate to various ecosystems and their components in the area.

5.3.3 Potable Water Impacts

There are no extractive processes associated with the primary sourcing of potable water for the proposed development. The main source of potable water for direct human consumption is from rain-fed cisterns supplemented by supplies obtained from water desalinization. In relation to the rainwater source, the roofs of the various buildings are to be fitted with gutters to 'harvest' the water. The plumbing associated with the water delivery system, is detailed in Fig. 3.1. There are, in effect, no deleterious impacts associated with the potable water infrastructure and/or use.

In terms of the secondary source, the potential threat of sourcing of potable water through Water Desalinization (Reverse Osmosis) is the threat of salinization of soils. The primary impacts of this activity are the deployment and operation of the RO Plant (See Table 5.1). The primary impacts have been marked as minor 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 secondary source of potable water has also been assessed as minor since the strategy for this source is to supplement the 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 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 excavation and consequent deposition of spoils and the above-mentioned strategy to use the R.O. technology to supplement the sourcing of potable water.

5.3.4 Domestic Effluent Impacts

In relation to the domestic effluent impacts which are basically linked to the generation of liquid waste, the development will be associated with two main generic impacts which are increased nutrients and pathogens in the water column. The effects of pollutants on aquatic systems are primarily a function of the amount and nature of the contaminants introduced (Corbitt, 2005). 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 and human waste. These sources would be primarily generated by the residential component of the

anticipated development. Another potential source of macro-nutrients is from the general decomposition of the organic substances along with some fertilizer use. The magnitude and scope of this potential sources and its impact has been assessed as 'moderate to high' without mitigation measures (See Table 5.1).

The secondary impact of macro-nutrients also extend to the coastal portions of the project site and more importantly to the shores where little or slow water circulation occurs. If mitigated successfully, these impacts would be considered as insignificant to minor based on the function of the sewage treatment technology applied.

The level of phosphates and nitrates found in the waters in and around the caye as shown in Figs. 2.5, 2.6 and 2.7 (Annex IV) is relatively low and is in no way considered to be at a level where it can be considered as 'polluting'. The effect of increased levels of macro-nutrients in the water column is to, in general, increase 'primary production' or photosynthesis in autotrophic plant-life. This relates to micro-algae such as *Chaetocerus spp*., and *Tetraselmis spp*., flowerings plants such as the sea grasses *Thalassia spp.*, and *Syringodium spp.*, and macro-algae such as *Halimeda spp.*, and *Udotea spp*.

Potential increases in nutrient and pathological levels for the proposed development relates to both the construction and operational phases with the greater nutrient impacts associated with the commissioning of the development. It is noteworthy to point out that the change in nutrient profile associated with the development should not impact any coral reef ecosystem. This is a function of distance or more appropriately 'dilution effect' of the sea, as well as the use of proper mitigating measures such as the use of a tertiary treatment plant. It is important to note that the coral reef east of the project site is considered important as recently stated in several documents produced by the different stakeholders of the country.

The issue of fecal coliform associated with the project is an important one. As may be seen from Fig. 2.7 (See Section 2.1.2.6), there were detectable levels of fecal coliform but not of *E. coli*. It is expected however that there may be a modest increase of these pathogens at full project development. Although a non-discharge tertiary treatment facility is to be installed (See Annex IX), an increase in non-project boats generally visiting the area is expected.

Associated with this is the increased probability of sewage discharge from these boats. The potential impacts of an increase in the levels of fecal coliform in the water column, is an indicator that there may be an increase in the probability contracting some pathogenic or infectious diseases. The impact associated with this, however, has been assessed to be low.

Although in principle there should be no fecal coliform or other associated pathogen in the 'tertiary' treated effluents from the treatment plants to be installed, the adoption of a 'precautionary approach' leaves room for a situation that is less than perfect. The use of tertiary treated effluents to flush toilets and water the lawn is a good conservation strategy. However the latter scenario brings with it the possibility for the presence of pathogens, all-be-it at low levels. This has been taken into account as being short and of low significance (See Table 5.1).

5.3.5 Energy Generation Impacts

The proposed project plans to source their energy from alternative energy sources primarily solar and wind energy. In view of this there the only potential impacts related to the generation of energy via solar is the clearing of the mangrove to get sunlight. The impacts associated with the installation of the turbine unit in the sea can be viewed as moderate especially considering the environment in which both options are located. The impact is categorized as such because there is some scattered coral cover in the proposed area but the activity is no different from the placement of a sea marker, pole or buoy for that matter.

Another impact related to the energy generation is the operation of the wind turbines and its associated influence on the surrounding environment and on bird population. Other potential impacts include noise generation, 'shadowing' effect on the residents. There are no secondary or tertiary impacts related to the wind turbine operation other than the localized impact due to the footprint of the turbine foundation.

The primary source will also be supplemented by a standby diesel generator that will be used on occasion given the restrictions of the alternative sources. In terms of this secondary sources of energy, the anticipated project plans to utilize generators to supplement their energy demands. There are two (2) main impacts associated with the secondary source generation which are petroleum and noise pollution. The containment structure to house the bulk fuel tanks on the project site and the non-spillage protocol in dispensing fuel greatly reduces the probability of any environmental impact from this source. In considering the hydrocarbon spills and leaks, these can be deleterious to the receiving environment. This issue has been labeled as 'low' in the Impact Rating Matrix (See Table 5.1). This impact considers both land and sea environments which usually cause localized contamination if not properly contained.

The noise pollution issue is of greater relevance than the petroleum pollution issue, in regard to energy generation due to the 'standby' mode. The installation of diesel generators as the secondary source of electricity makes noise pollution an important issue. The scope of the proposed development and the overall energy requirement has resulted in a categorization of the most significant 'primary impact' (See Table 5.1).

There are no secondary impacts of note in relation to noise pollution. The 'tertiary impacts' have been assessed as 'minor adverse', given the 'muffling' of the generators and the use of sound-proof tiles on the walls of the generator house (See Section 3.5). The placement of the generators in the 'Utility Zone' away from the hub of the recreational activities and residential zone is expected to drastically ameliorate the potential noise impacts.

In comparing the benefits of renewable energy against fossil fuel, one would think that the decision was clear cut. The operation of the wind turbine can impact the development if placed closer and the migratory bird population of the caye. Therefore, in applying the best technology to limit energy related impacts, the developer and stakeholders of the area must exercise caution as presently both fossil fuel and alternative sources have their share of potential impacts.

5.3.6 Solid Waste Impacts

The proposed project will generate solid waste as it relates to the construction and operational phases. It is anticipated that the solid waste generated during the construction phase will be viewed as instantaneous and short term (substantial volumes over a short period of time) as opposed to the operational phase which can be viewed as long term (steady continuum).

The proposed solid waste management scheme for the anticipated project site will involve the collection and separation of garbage into organic and inorganic components. The organic components as is customary, will be composed on site using an 'Earth Tub composter or its equivalent. This action will reduce the waste to semi-dry mulch that can be used as organic fertilizers for gardens, hedgerows, and general landscaping. During the construction phase, the vegetation accruing from the minimal land clearing will be collected and composted as well.

The inorganic component will be collected at the project site and transported to the Placencia dump site once per week as required until enough has been accumulated to justify its transportation. There is also a possibility of collecting the inorganic waste from several developments around the project site. This issue would have to be agreed upon and sorted out.

In relating to the solid waste impacts, the development anticipated that there will be two main generic environmental impacts related to the generation and management of the solid waste. These impacts include the potential attraction of feral animals to the site and the potential for increasing the incidence of pestilence and pathogenic diseases. In addition the wanton disregard of solid waste can be aesthetically unpleasing.

The attraction of feral animals to the project site would be as a consequence of the increased availability of food in the form of discards from several sources. The animals relevant in this regard would be the opportunistic bird species such as the Grackle (*Quiscalus mexicanus*), the Herring Gull (*Larus argentatus*) and the Frigate Bird ((*Fregata magnificens*).

The impacts of feral animals in regards to the proposed development have been assessed as 'low' impact in regards to seabird and migrant bird populations. There are also some adverse impacts however and these relate to general species diversity and the possibility of injury from competing with each other. These impacts however have been all categorized as 'low'.

The only secondary impact would be in regards to the land based ecosystem as described earlier and has been classified as 'minor'. This impact related to the little or no food discard lying around in a way that would be available to attract the feral animals. The impacts to wildlife relates to the availability of food from a non-natural sources and the consequent 'bioavailability' and proliferation of wild stocks.

As to the incidence to pestilence and pathogenic diseases, these impacts are considered minor to insignificant given the judicious nature of the management scheme. The most important issue is the possible proliferation of mosquitoes and sand flies.

5.3.7 Infrastructural Impacts

For the purpose of this Limited Level Study, the infrastructural impacts will be utilized to define the possible impacts arising from the construction of buildings, boardwalks, helipad and piers. These impacts are generic and related to any infrastructural works that are to be undertaken. The following sections summarize the possible impacts related to the construction, installation and placement of the infrastructural works.

5.3.7.1 Impacts from the Building Construction

The main impacts associated with the construction phase includes the clearing of land where required, the placement of construction material and the actual construction phase itself. These impacts for the most part are classified as low considering building density of the proposed development concept.

The removal of the vegetation is classified as low due to the low density that the proposed project plans to develop. The footprint for the buildings, walkways and helipad is minimal compared to the wider area of the Channel Cayes. Other associated impacts related to the construction phase include the actual construction phase that will primarily involve the generation of noise and other construction related pollution. This impact is anticipated to be 'short and low' (See Table 5.1).

In discussing the operational phase, the associated impacts include the subsequent maintenance of the developed areas and proposed daily activities within the developed zones. Both these impacts are considered to be 'short and low' as it is anticipated that the activity will be enhanced by efficiency, especially the maintenance component.

5.3.7.2 Boardwalk Impacts

The anticipated impacts associated with the infrastructural components are rated as 'low and short' considering the footprint of the boardwalk and the associated construction of this component. The design and routing of the boardwalks would result in some short term sedimentation impacts and to a lesser extent sight pollution. This is primarily due to the 'limited' reclamation of the project site and the need to conserve as much vegetation as possible.

The construction of the boardwalk entails the construction of a wooden platform supported by either wooden or concrete stilts interconnected by various small 'islands' that will serve as roundabouts for the boardwalk. As described previously, these 'islands' will be made up of dredged spoils that will be contained by stakes. It is also anticipated that the impact related to the construction of this boardwalk be minimal as little to no mangrove will be removed. However, it is considered that the creation of the intermittent 'islands' may pose some 'aesthetic or sight pollution' in the short to medium term.

In general the proposed boardwalk far outweighs the alternative of road or path construction in terms of impacts. Essentially, the proposed board walk will not interfere with the underbrush or ground of the proposed route and will not interfere with the natural drainage patterns of the

impacted areas as well as with the loss of any vegetation. The construction of the boardwalks is not expected to cause any discernible ecological impacts. This is as a result of the miniscule scale of the operation relative to the size of the caye and the abundant extent of the mangrove resources.

5.3.7.3 Ground Level Helipad

The proposed project plans to construct a heliport for the eventual landing of helicopters. The anticipated impacts related to the operation of the heliport involves the generation of noise on approach and departure as well as the loss of vegetation for the placement of the heliport. It is anticipated that these impacts are considered as minor or low relative to the operation timeframe and small impact radius (localized).

This component must be identified as an important impact considering the overall combined effect (noise and turbulence) it might have in relation to the operation of the wind turbine. Noise levels are low considering the nature of the area and its undeveloped state. It is anticipated that as development progress in and around the project site, the noise levels will eventually increase as is customary in any developing area. This activity will hold true for any immediate neighbor. This notion would not be a factor as it is considered that there will be no development near the project site in the near future. Therefore the noise impact related to the placement of the heliport has been assessed as low and instantaneous. Other impacts include the possibility of physical harm and injury as a result of accidents and incidents involving the helicopter. The impact related to this scenario has been assessed as high considering the probable outcome.

5.3.7.4 Piers and Boating Impacts

The anticipated impact associated with this activity is primarily the placement of the piles in order to suffice the development concept. The main ‘primary impact’ associated with the construction of the marina pier, the service pier and recreational decks in the sea is the accumulation of solid wastes (See Table 5.1). This impact however has been assessed as low in scope. The other primary impact of piers and decks is that they form an artificial habitat for attached benthic flora and fauna. This primary impact had been assessed as ‘moderate’ and ‘beneficial’ as these structures will protect and shelter the benthic organisms as well as other marine organisms.

In relation to the dockside impacts, these are largely related to the refueling of the project’s and owner’s boat. 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 clientele of the facility. This unauthorized activity will be sanctioned by the project and reported to the relevant authorities for prosecution.

Other important impacts associated with the piers and berthing of boats is petroleum pollution associated with the project and general navigation of the vessels within the project site. This impact has been categorized as ‘minor’ in scope given the non-spillage protocol to be adopted by management and the relatively small volumes of fuel involved. In addition, the classification has been considered as minimal due to the fact that no fuel will be dispensed to clientele. 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. Pier impacts are related to both sedimentation and petroleum pollution impacts.

The other impact of note in relation to piers and decks is fishing which has been assessed as low and beneficial. This categorization has been based on the fact that the project site is located within the South Water Caye Marine Reserve and therefore commercial fishing is prohibited.

5.3.8 Social Impacts

The social impact assessment will cover both the social and cultural impacts as well as the economic impacts of the project. This assessment will also include the overall value and changes of the resources taking into account the future value of the natural resources by users and impacts of the proposed development on these areas; the general role of traditional users in response to both the fishery and tourism value, and future value of the fishery resource, as well as other impacts on increased usage of the area during post construction and development and completion phases.

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 its current site were 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
- Disturbances (noise, air quality)
- Socio - Cultural
- Education/Health Services

- Employment/Safety
- Emergency Services
- Tourism Activities

  Economic Impact

5.3.8.1 Existing and Proposed Activities

The anticipated development site is situated in the southern portion of the South Water Caye Marine Reserve. Land tenure in this area is mostly private with a few owned by the government and hence the activities are in this area are limited and presently under scrutiny by the relevant stakeholders. With this in mind the following details of the area are briefly described:

Development Activities

- ♦ Small population during all phases of construction
- ♦ Demand for services
- ♦ Marine traffic increase
- ♦ Transportation of materials

During all phases of construction increased boat and human activity to the region will increase slightly. Increase in traffic to and from the site will include worker populations, transportation of equipment, supplies and materials and guests to the site. Demand for services by worker populations will occur during all phases of construction.

Current and Existing uses of the area

Potential or proposed Impacts

- ♦ Disruption of traditional user activities in the area
- ♦ Regulated use of traditional activities
- ♦ Access to the marine reserve and surrounding areas by traditional users
- ♦ Ability of users to adapt to changes
- ♦ Increased use by other newcomer users

One of the major concerns indicated by stakeholders was proposed dredging activities required by the project to obtain fill. Continued access and use of the surrounding area and views of the developers in respect to traditional uses is another main concern.

Development activities of this nature especially in area of marine importance do have impact to some degree. The major impact could see decreased economic benefits to those small fishermen who utilize the Pelican Range as a fishery resource.

Economic Impact

- Increased employment
- Increased economic benefits generated by direct expenditure
- Increased revenue for the marine reserve
- Impact on fishery resources by traditional users (fishing and sport fishing)

The proposed development will bring increased economic benefits to the area and the region. 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 from the peninsula 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, and gravels are from the mainland. On the flip side, there could be some degree of impacts to the marine importance. The major impact could see decreased economic benefits to those small fishermen who utilize the Pelican Range as a fishery resource.

Employment and 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

One of the major concerns is the availability of jobs, mainly for skilled laborers to satisfy the project's demand. Unskilled and untrained laborers can also prove very expensive to project development. Major impacts include the lack of adequate hospitality training as well as minimum wages for unskilled labor.

Transportation / Sea Traffic

Potential or proposed Impacts

- Increase in number of vessels to the area and the region
- Impact on natural environment by increased boat usage
- Operation of construction and all machinery
- Safety for traditional users

Emergency and Health Services

- Staff not trained in basic emergency procedures.
- Emergency service not available on site during and at completion of project development.
- Emergency care not available on the onsite for employees, visitors and unrelated actions.
- Pressure on health and sanitary facilities by migrant worker populations

In most developments, 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. In any event, the anticipated development will secure the relevant Disaster Preparedness Plan.

Population and Housing

Potential or proposed Impacts

- Increased population density in the area
- Increased housing needs at site

The proposed development will experience a temporary increase in population (workers) during all phases of construction. The site can also support the proposed amount of temporary workers to be employed during all phases of construction.

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 SWCMR. The main concerns within the national marine reserve are impacts of development activities by both construction operations and related tourism activities. Another main concern is increased boating activities in and through the area which may have some impact on fishery resource and on traditional tourist activities in the area.

Disturbances (Noise and Air Quality)

- Noise pollution from the operation of construction equipment and machinery
- Disturbance from airborne pollutants, contaminants, from proposed activities

Noise and disturbance from heliport activities and wind turbine

During the construction phase and completion phase, noise and air pollution will be one of the main impacts from equipment and machinery. Impacts on construction works include noise, dust and air pollution. Similarly, noise from the operation of the heliport and energy generation (wind turbine) will also be an issue.

5.4 Indirect Related Impacts

It is anticipated that the proposed project will also have indirect cumulative impacts on the receiving environment as summarized below.

5.4.1 Impacts on Tourism Activities

In analyzing the tourism related impacts, it has been determined that there are virtually no existing impacts on the pre-existing tourism activities in the area. The nearest known permanent tourism infrastructure is on South Water Caye which lies 6 miles to the north of the development. In addition, there has been no known previous use of the areas surrounding the Channel Cayes for tourism purposes.

5.4.2 Other Related Impacts

The most notable impact not dealt with above is that relating to the encounter of different cultures. The major clientele for the proposed Chrysalis project should be foreign tourists. The encounter with local staff and stakeholders in the area in general has social impacts. These impacts have been considered as 'moderate' and include – boat access for fishing, diseases, 'culture conflicts', tourism related activities (reef visits, bird watching etc.), injury and pollution (noise, soil and water).

The issue of 'pathogenic disease' relates to those associated with insect pests such as mosquitoes. The development if allowed to proceed in an environmentally irresponsible way that would, for example, result in an increase in 'standing water', would provide a habitat of mosquitoes, which would increase the risk of malaria. The increased contact of tourists with certain activities increases the potential for insect-borne pathogenic diseases. The focus on handling solid wastes in a responsible way should leave no additional breeding habitat for mosquitoes.

The issue of 'sand-flies and associated pests' are relevant in the context of nuisance pests. They are generally discomfiting to humans in modest numbers and are intolerable to many when in abundance. The plying of tourists in unspoiled environments brings with it insect pests. The reclamation on various part of the island eliminates a number of inundated and wetland areas.

These reclamations in themselves eliminates breeding grounds for mosquitoes, however in many cases they provide additional habitats for sand flies. In the case of the latter, a number of species breed at the moist/dry interface just above the high tide line. Given that these pests could be in formidable numbers and given that if they are not managed in an environmentally sound way,

this could also cause harm to the environment thereby requiring the need for some mitigative measure(s).

The ‘culture conflicts’ in principle arises from the encounter of two (2) different cultures with different languages, ethnicity, race, religion and value systems. Most of the tourists that are to be the clientele of the proposed project are ‘white’ or ‘near-white’ tourists from the United States and to a lesser extent Europe. Their encounter with local stakeholders in the area, as well as the local staff could be an issue of some significance. This ‘moderate adverse’ categorization of impact signals the need for some mitigative intervention.

The issue of ‘reef visitation’ relates to the impacts of tourists and guest in general on the health and well-being of the nearby Mesoamerican Barrier Reef. This is limited almost exclusively to scuba diving and snorkeling since this is almost the only circumstance under which these guests are likely to encounter corals in any marked assemblages. The potential for holding onto coral, or standing on corals, or other physical modes of contact exists.

The issue of ‘injury and physical trauma’ relates specifically to accidents and incidents that could occur on the caye either to a guest, visitor or member of staff. These include diving incidences both on the reef visitation. Other associated incidents include the construction phase especially for the workmen and contractors since this phase experiences a high incident rate. Considering the potential for human safety being jeopardized, this impact was considered as moderate.

The issue of noise pollution would be associated mainly with the fuel driven electricity generator and wind turbine operation. The generators could be a nuisance, especially at nights. The assignment of a rating of ‘low’ in the Impact Rating Matrix is recognition of the fact that the use of the generator during the late night will only be on a standby basis since the primary source of electricity will be from windmills and solar cells.

5.5 Conclusion

Thus in considering the proposed undertaking and its developmental approach to sustainable development, the related impacts are not that different from most other projects of the area. What sets the project apart from others of the areas is the size and magnitude along with the fact that the relevant studies have been carried out in order to determine the potential environmental impacts.

In order to get a perspective of the potential impacts, data was cross-referenced with known authors in order to corroborate the ‘prediction’ and ‘sequence of environmental impacts’ if any. This action can only be ascertained if a scaled model was generated and the impacts recorded, but that notion is up to speculation especially considering that the data reflects only a ‘snap shot’ of the existing conditions. It is therefore anticipated that the proposed project is within the appropriate confines of sustainable development.