

## 12. ALTERNATIVES FOR DEVELOPMENT

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

- I. Siting of the necessary support infrastructure and all facilities;
- II. Earth Movement Activities (evaluate the different extraction/dredging methodologies, extraction/dredging points (burrow sites), extraction/dredging volumes, material fill sites etc.);
- III. Liquid and solid waste treatment and disposal options (evaluate the different treatment technologies and methodologies); and
- IV. Boat storage and marina/docking facilities (siting, design, etc.).

### EXAMINATION OF ALTERNATIVES TO DEVELOPMENT

The alternatives for development are itemized in **Table 31** and described in further detail as follows:

**Siting Options** are limited to the proposed development site owing it being private land, and having already been zoned for tourism-related development. The design layout for the proposed development satisfies both the economic and density objectives of the development, changes in which would only serve to either reduce economic feasibility of the project, or increase density. The unavoidable negative impacts of the proposed option primarily concern:

*Limited reduction of 4 forest types and*

*Limited disturbance of pre-existing topography*

The non-development option will entail loss of more than US \$ 15 M in investment and foreign exchange revenue over the next 10 years (alone). Of the previously described habitats that will be impacted, only one remain under-protected in Belize, and majority of the area covered by this habitat (Dwarf Mangrove Forest) is planned for conservation through incorporating this habitat in the physical planning of the development. Consequently, and given that public benefit strongly favors the project's implementation, it is reasonable to accept the proposed siting option as the preferred option for development.

**Land-Based Transportation Options** rely on use of the existing public road, and the addition of approximately 1,000 meters of golf cart trails which have been designed specifically for light vehicular traffic to move between the land-locked Hotel, Beach and Garden residencies; and, 1,100 meters of access decking, also planned for access to the water-front Garden, Island and Mangrove Residences. The development is also planning to pave the section of the Placencia Highway that bisects the development site in accordance with existing engineering specifications for the section that have been identified by the Ministry of Works, which will decrease the dust impact on the development site.

**TABLE 31:  
SUMMARY OF DEVELOPMENT ALTERNATIVES AND IMPACTS<sup>1</sup>**

IMPACT CATEGORY	OPTION 1	OPTION 2	OPTION 3
<b>Siting Options</b>	<u>Proposed Siting Scheme</u>	<u>Non-Development</u>	
	Maximization of Social and Economic Benefits	Loss of > US \$ 15 M in Foreign Exchange Over Next 10 Years	.....
<b>Land-Based Transportation</b>	<u>Proposed Road Scheme</u>	<u>Non-Development</u>	
	Limited loss of forest cover	Loss of > US \$ 15 M in Foreign Exchange Over Next 10 Years	.....
<b>Sea-Based Transportation and Boat Storage</b>	<u>Proposed Marina and Piers</u>	<u>No Boat Marina Or Piers</u>	
	Limited Risk to Manatee	Significant Reduction in Development Potential for Success	.....
<b>Material Supply</b>	<u>Cut and Fill Actions as Planned</u>	<u>Alternate Supply Sourcing</u>	<u>Non-Development</u>
	Limited loss of forest cover, and risk of sediment drift into Placencia Lagoon	Displacement of impact site and loss of marina component	Loss of > US \$ 15 M in Foreign Exchange Over Next 10 Years
<b>Freshwater Supply</b>	<u>Purchase from Seine Bight Water Utility</u>	<u>Desalinization, Groundwater Abstraction, and/or Cisterns</u>	<u>Non-Development</u>
	Maximization of Social and Economic Benefits.	Increased Impact Envelope and Subsequent Significant Reduction in Development Potential for Success	Loss of > US \$ 15 M in Foreign Exchange Over Next 10 Years
<b>Liquid Waste Management</b>	<u>Batch Plant Treatment</u>	<u>Septic &amp; Composting System</u>	<u>Non-Development</u>
	Highest Level of Treatment Effectiveness.	Use of septic tanks and composting toilets has been eliminated due to recently upgraded DOE regulations.	Loss of > US \$ 15 M in Foreign Exchange Over Next 10 Years
<b>Solid Waste Management</b>	<u>Partial source-separation with storage at designated MSW site at Riversdale</u>	<u>Complete Off-Site Storage</u>	<u>Non-Development</u>
	Lowers storage requirement at designated msw site and cost to development	Nominal Environmental Risks, but significant elevation in development cost	Loss of > US \$ 15 M in Foreign Exchange Over Next 10 Years

<sup>1</sup>Note: Green shading indicates the preferred option for implementation by the proposed development

Planning also includes placing a paved concrete overpass along the section where the central earthen trail intersects the Highway in order to afford golf cart passage between the eastern and western portions of the development site. Options for walkway alignments are in essence limited to the proposed and non-development options, owing to the proposed plan adequately addressing access requirements to all of the features of the proposed development. The proposed development is not likely to change drainage patterns since there will be no major landfill practice or redirection of rainfall runoff into any canal or lagoon system. Therefore, the land-based transportation plan for the proposed development is not anticipated to create any significant negative impact risks related to material supply. Hence, the proposed option constitutes the preferred option for development.

**Sea-Based Transportation and Boat Storage Options** available to the proposed development entail a semicircular canal on the Placencia Lagoon, fitted with adjoining decking areas for pedestrian access and boat mooring for each residential unit (approximately 75 slips), as well as the Hotel suites (approximately 75 additional slips). The canal design will provide slip and buoy moorings for small marine craft only (i.e. 20 – 40 ft skiffs and sailboats). The location of the canal was selected to offer secure, storm protected storage for resident, guest and staff boats. In addition to the collective 150 wet slips designated for the development, there will be an added 50 dry slips for boat maintenance and storage; and one boat refueling station will be constructed on the extended Placencia Lagoon pier, which will be supplied from an adjoining fuel tank positioned within a concrete bund having 110% of storage volume capacity. The options include (1) acceptance of the proposed development option; (2) addition or modification of select components and/or reduction in design scale; or (3) rejection of the first two options altogether and acceptance of the non-development option. Modification of the master plan for the development would require its comprehensive redesign, which in turn would likely cause the proponent to abandon the development's placement in Belize, along with the substantive economic resources that would otherwise accompany its placement, and hence, result in election of the 3<sup>rd</sup> or non-development option by default. Hence, the proposed option is reasonable to accept as the preferred option for development.

**Material Supply Options** Approximately 75,000 m<sup>3</sup> of cut material will be produced from excavation of 6.7 acre boating canal to approximately 3 meters depths, and used to fill the 2.7-acre mangrove island, 1.8-acre land island, and garden residence lands to approximately 2 meters elevation. Material extraction will be done with a suction dredge. The only alternative option for material movement in this regard is the non-development option, since extraction from an alternative point source will only serve to increase, rather than diminish the potential impact from material use by the proposed development and, the boating canal amenity is required for the development to succeed. Hence, while the non-development alternative supports the current environmental status of the project site, it forfeits the potential economic benefits of the project. With these considerations in mind, it is logical to conclude that extraction of land-fill material from the boating canal as dictated by the proposed development plan should be the preferred option for development.

**Freshwater Supply Options** available to the proposed development include: (1) abstraction from island ground waters; (2) rainwater catchments in cisterns; (3) purchase from the local municipal water utility in Seine Bight Village and/or; (4) abstraction and desalination of area marine waters by reverse osmosis.

Abstraction from island ground waters is an improbable option for the proposed development due to the volume of water required, the high likelihood of promoting sea water intrusion, and the negative effect of drawing down the island's water table on local vegetation. Although conversations with the Chairman of the Seine Bight Water Board, Mr. Emmanuel Ogaldez, have established that the water board presently has the capacity to supply the entire development, it is important to note that groundwater is already being abstracted in considerable volumes to support both the nearby shrimp farming industry's processing plants, as well as virtually all of the current demand in Mango Creek, Independence, Big Creek villages and the Placencia Peninsula, such that further and additional demand on area groundwater resources may soon or eventually lead to the cumulative impact of reducing availability to all commercial, tourism and residential occupants of the area, not even to mention the potential impacts on area vegetation and animal wildlife from a falling groundwater table or saltwater intrusion.

Collection of rainwater in cisterns would appear to be a viable option for the majority of potable water demands at full development, as annual rainfall should be able to supply approximately 80% of the freshwater requirements for the entire development. Saltwater purification is also likely to be both a technically and economically feasible option for potable water supply to the proposed development, albeit with the limitation of creating effluent which is slightly more concentrated than supply waters. Although the true advantage of R/O is that potable water can be produced at a cost effective rate on the order of USD \$0.06 per gallon, its disadvantage of brine disposal remains. One option in this regard is for the proposed development to dilute R/O brine with effluent from the tertiary treatment plant, which can be achieved at little additional economic and technical cost to the proponent. This option would of necessity need to be effected by mixing effluent brine and plant water in designated landscape pools for settlement and photo-oxidation before discharging into the coastal sea or use for irrigation (see **Illustration 20, Page 31**).

Consideration of the above options would appear to exempt the local water utility in Seine Bight Village from the potential economic benefit of supplying water to the proposed development. However, the proponent may elect to make-up the 20% shortfall of rainwater capture in cisterns with small additions of municipal (ground) water from either municipality and/or by R/O production of potable water, particularly during construction, when charging cisterns with rainwater during the first year of project implementation, or in very dry years. Clearly this option is preferable on environmental grounds and so should represent the preferred option for development.

**Liquid Waste Treatment Options** available to the proposed development include, upon the recommendation of the Department of Environment, the use of batch plant technology for multiple housing projects, thereby limiting the options for treatment to only that option, or the non-development option. Batchplant type and configuration(s) however, remain as options to the development proponent. A state of the art separation technology, Masko-Zoll FDS (Fixed Dewatering System) is planned for use by the project proponent. Given that the cost of treatment for the proposed option is not cost prohibitive to the proponent and offers the highest level of treatment effectiveness it seems reasonable to accept the proposed option as the preferred option for development.

**Solid Waste Treatment Options** available to the development involve the extent of source separation and the location site for solid waste storage. Source separation is expected to be an important consideration due to the level of solid waste production anticipated. Solid waste is unsuitable for storage at the proposed development site will include slow degrading materials such as plastic, glass, metal and rubber, because their storage will require additional allocations of space. Additionally, materials that contain toxic waste such as motor oil and/or batteries should also be removed from the proposed development site.

On the other hand, paper waste may be eliminated through on-site incineration; this reduction of paper would reduce the annual requirement for transportation and storage of solid waste at the municipal solid waste storage site near Riversdale by 15%. Furthermore, organic food waste can be stored efficiently in compost sites, and therefore can further contribute to reducing transportation and storage requirements by a further 47%. Together source separation and treatment of paper and organic waste offers the reduction of municipal solid waste transportation and storage requirements on the mainland by as much as 62%, and therefore should be elected as the preferred treatment plan for solid waste.

**Energy Use Options** include purchase from the area utility, Belize Electricity Limited (BEL). Passive generation for the entire development is unlikely to be practical for the proposed development owing to both the rate of demand growth and management cost to the project. Furthermore, emergency/back-up energy requirements of 15% will be supplied by self-generation with one or more reciprocating / turbine diesel-electric plant(s). Fuel and other petroleum products used in support of the back-up power facility will be stored in either a concrete or buried earthen bund or the manufacturers' containers as the case may apply. Spilled petroleum, spent oils and related materials will be stored in 55 gal drums also located within the above-described fuel bunds. Consequently, purchase of power from BEL, with self-generation petroleum-based backup energy has been elected as the preferred option for development in order to simplify project management.

## 13. MITIGATION MEASURES AND MONITORING PLANS

- 13.1 Based on the investigations, develop a mitigation matrix outlining mitigation measures for all potential negative environmental impacts including, but not limited to, construction activities, waste treatment and disposal, habitat alteration and erosion control, and management of pests and vectors (rodents, mosquitoes, flies, etc.).
- 13.2 Provide a detailed monitoring plan to be implemented for the entire operation, identifying any agency/body responsible for its implementation and any training that may be necessary for the implementation of the plan. The plan should include monitoring of wastewater discharge characteristics (if any), changes in ecological species (including endangered species), contingency measures to emergency response to accidental events (fire, flood, hurricane, leakages, spillages, etc.).
- 13.3 Provide a detailed plan for the decommissioning and rehabilitation of the site to other uses in the event that the project is discontinued.
- 13.4 Identify and develop a water quality monitoring program able to detect any change (s) in ground water or surface water quality, that will impact:
  - I. Public health;
  - II. Forest, wetland and adjacent aquatic habitats; and
  - III. Endangered or threatened species in the project area and zone of influence.

### MITIGATION MEASURES FOR THE PROPOSED DEVELOPMENT

A summary of the potential impacts of the proposed development, and the measures proposed for their mitigation is shown in **Table 32**.

**Construction and Habitat Impacts** concern the direct reduction of four forest types. The reduction of such vegetation cover is unavoidable, but is partially reversible through replanting of native vegetation following construction. The indirect and residual impacts of such forest disturbance include lowered storm resistance of the Placencia Peninsula to erosion, which can only be mitigated by replanting the site following construction with native vegetation.

**Land-Based Transportation Impacts** concern the reduction of forest cover as a result of establishment of access trails and decking and parking areas at the proposed development site, which constitutes a direct unavoidable impact. Indirect and residual impacts concern increased potential for sediment travel and petroleum based pollution runoff into the adjoining surface waters of the proposed development. Additionally, the highway overpass structure may impede travel of non-resort based pedestrian and bicycle traffic originating from other developments and villages of the Placencia Peninsula, both of which are avoidable impacts. Residual negative land-based transportation impact risks concern increased potential for public injury risk, particularly at the point where pedestrian traffic will re-enter the Placencia Highway easement, which is also an avoidable impact.

**TABLE 32:  
SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS**

IMPACT	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
<b>Construction</b>	<ul style="list-style-type: none"> <li>I. Construction will reduce 3 forest types; and</li> <li>II. Promote temporary disturbance and emigration of mobile wildlife.</li> </ul>	<ul style="list-style-type: none"> <li>I. None, non-development;</li> <li>II. Replant the development site with native vegetation following construction activities.</li> </ul>
<b>Land-Based Transportation</b>	<ul style="list-style-type: none"> <li>I. Reduction of forest cover due to construction of golf cart trails and access decking;</li> <li>II. Release of sediment and/or petroleum-based run-offs into the Placencia Lagoon; Impediment of travel involving non-resort based pedestrians due to construction of overpass;</li> <li>III. Increased risk of public injury.</li> </ul>	<ul style="list-style-type: none"> <li>I. None, Non-development, Replant native or specialized plant species along trails;</li> <li>II. Promote the exclusive use of golf carts by resort guests, staff and residents within the resort development;</li> <li>III. Establish slow speed limits along access trails and decking, and highway overpass; Ensure staffs are adequately trained to operate vehicles; and adhere to public licensing requirements in regards to operation of vehicles by staff, residents or guests.</li> </ul>
<b>Sea-Based Transportation</b>	<ul style="list-style-type: none"> <li>I. Increased sediment and petroleum-based pollution risk in the marina basin and adjoining Placencia Lagoon;</li> <li>II. Increased risk to manatees of propeller injury;</li> <li>III. Increased risk of public injury.</li> </ul>	<ul style="list-style-type: none"> <li>I. Ensure use of silt screens during construction of the boating canal; Eliminate spill risk by ensuring maintenance of all petroleum products in two or more fuel bund(s) having 110% of the stored petroleum volume; Educate guests, residents and staff as to environmental benefits of 4-cycle engine use;</li> <li>II. Provide education to guests in regards to manatee conservation, penalties for neglect of tourism or conservation guidelines, and possible injury risk; Promote use of safety propellers on guest, staff and resident boats; and place signs establishing shallow areas near the marina as manatee habitat and no wake zone; Provide education to boat operators about the importance of responsible navigation and slow boat traffic speed;</li> <li>III. Provide education to boat operators about the importance of responsible navigation and slow boat traffic speed.</li> </ul>
<b>Material Supply (Cut and Fill)</b>	<ul style="list-style-type: none"> <li>I. Alteration of marina basin and the Placencia Lagoon's shoreline;</li> <li>II. Reduction of Dwarf Mangrove forest, Savanna Orchard, Palmetto Thicket and other local fruit bearing plant species;</li> <li>III. Temporary disturbance of Placencia Lagoon water quality characteristics;</li> <li>IV. Release of erosion products and slumping of boat canal sidewalls into Placencia Lagoon;</li> <li>V. Reduction of water quality-dependent marine wildlife such as sedentary plants and invertebrates;</li> <li>VI. Reduction of water quality-dependent sedentary plants and invertebrates;</li> <li>VII. Long-term degradation of area geo-morphology;</li> </ul>	<ul style="list-style-type: none"> <li>I. None, non-development;</li> <li>II. Replanting of native and specialized plant species;</li> <li>III. Use suction dredge outfitted with silt screens to minimize travel of silt and sediment borne-water;</li> <li>IV. Utilize appropriate angle of repose for boating canal side walls; Deploy suction dredge surrounded with silt screens to limits sediment travel into the Placencia Lagoon;</li> <li>V. Respect extraction management guidelines in defense of marine water quality in the vicinity of the extraction site;</li> <li>VI. As above (V);</li> <li>VII. As above (IV);</li> </ul>

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**TABLE 32:  
SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS**

*(Continued)*

IMPACT	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
<b>Freshwater Supply</b>	<ul style="list-style-type: none"> <li>I. Increased risk of marine organisms entrainment at the sea water intake point;</li> <li>II. Increase in chlorine levels and possible alteration of salinity levels in BRL should the plant fail for any reason;</li> <li>III. Elimination of marine organisms from the region of the development site;</li> <li>IV. Gradual reduction in area water quality from long term discharge treated effluent;</li> </ul>	<ul style="list-style-type: none"> <li>I. Use proper screening to cover intake pipe, and place entry point within a depressurizing chamber to reduce suction force at the point of water entry;</li> <li>II. Use landscape pools as photo-oxidation ponds for chlorinated effluent and to mix effluent brine with water from tertiary plant treatment to ensure the effluent water quality matches ambient water quality in the BRL;</li> <li>III. Provide posting of caution signs near the intake pipe; Routine daily inspection of the pump intake to insure screens are intact and that the intake pipe has not been compromised by wildlife or the boating public;</li> <li>IV. Examine water quality in the landscape pools and BRL to ensure that chemical conditions are not favorable to microbial population blooms.</li> </ul>
<b>Liquid Waste Treatment</b>	<ul style="list-style-type: none"> <li>I. Loss of vegetation cover where batchplant is placed;</li> <li>II. Bio-accumulation of eutrophic algae and bacteria in the BRL;</li> <li>III. Creates risk of contamination of coastal and ground water resources with nutrients and human pathogens;</li> <li>IV. Increased interference to wildlife and resident communication due to plant noise;</li> <li>V. Increased risk to the near shore BRL of eutrophication, and either loss or overpopulation of the unique echinoderm fauna identified in the area;</li> <li>VI. Increased risk of low-level eutrophication of near shore waters of Barrier Reef Lagoon.</li> </ul>	<ul style="list-style-type: none"> <li>I. None, Non-development;</li> <li>II. Routine inspection of chemical water quality and algal/bacterial populations in mixing ponds; if conditions are above nominal levels, treat with environmentally safe compounds or flocking agents to reduce their populations prior to discharge;</li> <li>III. Ensure BRL water quality is regularly monitored for Coloform bacteria, Vibrio bacteria and nitrogen levels in defense of previous background levels and as a check to ensure proper batchplant function;</li> <li>IV. Construct sound-proof structures such as walls or buildings and/or landscaping to reduce noise travel in the area, and thereby preventing wildlife and human emigration from the area;</li> <li>V. Balanced mixing of brine and treated effluent to suit the prevailing BRL water quality conditions;</li> <li>VI. Ensure plant operation at design specification; Ensure BRL water quality is regularly monitored for Coloform bacteria, Vibrio bacteria and nitrogen levels in defense of previous background levels and as a check to ensure proper batchplant function.</li> </ul>
<b>Solid Waste Treatment</b>	<ul style="list-style-type: none"> <li>I. Creation of composting areas require land conversion;</li> <li>II. Reduction of <i>Palmetto Thicket</i> habitat for composting and incinerating areas;</li> <li>III. Seepage from composting pits can contaminate local ground and coastal waters with nutrients;</li> <li>IV. Disturbance of resident terrestrial (and avian) wildlife by paper incineration.</li> </ul>	<ul style="list-style-type: none"> <li>I. None, non-development; Regular management and recycling of compost sites to limit land conversion requirements;</li> <li>II. None, non-development;</li> <li>III. Cover composting pits to reduce rainfall leaching, Regular management and recycling of compost sites to limit land conversion requirements;</li> <li>IV. Utilize a commercial incinerator to burn paper waste that has been designed to reduce smoke and heat emissions into the environment; and ensure proper training of compost site handlers.</li> </ul>

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**TABLE 32:  
SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS**  
(Continued)

IMPACT	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
<b>Energy Supply/Usage</b>	<ul style="list-style-type: none"> <li>I. Increased traffic and use of the Placencia Road;</li> <li>II. Increased risk of electrocution from improper construction or maintenance; Increased risk of chemical contamination and explosion;</li> <li>III. Production of noise pollution and up to 6.2 x 10<sup>8</sup> BTUs of thermal waste per year;</li> <li>IV. Creation of spill risk;</li> <li>V. Remote location of development site may increase potential for serious injury;</li> <li>VI. Long-term exposure to petrochemicals and/or noise from generating facilities may cause noise-induced hearing loss in staff; and may cause wildlife to abandon the area.</li> </ul>	<ul style="list-style-type: none"> <li>I. None, non-development;</li> <li>II. Ensure qualified electrical engineers are employed during the design and construction phase of the development; Develop safety protocol for training fuel handlers; Maintain fuel storage facilities at safe distance from generating equipment and provide warnings about inflammable device use near fuel storage areas;</li> <li>III. Place generating equipment in specially designed noise-retarding shelters; and discharge exhaust waste into baffled exhaust pipes buried underground;</li> <li>IV. Maintain all fuel containers and generating equipment within fuel bunds; Train staff in safe fuel handling procedures, and regularly monitoring of fuel usage sites</li> <li>V. Have at least two full-time staff receive emergency medical training at Belize City BERT Center;</li> <li>VI. Provide staff with proper clothing, gloves and noise pollution protection equipment;</li> <li>VII. Develop a regular monitoring protocol to determine presence/absence of noise-related impacts.</li> </ul>
<b>Wildlife Disturbance</b>	<ul style="list-style-type: none"> <li>I. Development will reduce local and national inventory of 4 forest assemblages and various fruit bearing plant species;</li> <li>II. Reduction of Placencia Lagoon mangrove habitat from creation of the boating canal;</li> <li>III. Permanent displacement of any remaining bird and/or terrestrial animals from the development site during construction activities;</li> <li>IV. Increased erosion and decreased storm resistance and increased erosion of Placencia Peninsula as a result of vegetation removal for the resort developments;</li> <li>V. Near shore patch reefs may deteriorate from visitor impacts;</li> <li>VI. Manatee will be subjected to increased prop-born mortality risk by new and novice boaters operating out of the proposed development site;</li> <li>VII. Increased mortality risk to commercially valued fishes, such as snapper, grouper and snook, to the point where they are no longer available to exploit by native and artisanal fishermen.</li> </ul>	<ul style="list-style-type: none"> <li>I. None, Non-development;</li> <li>II. None, non-development. Insure a net increase, rather than decrease in mangrove edge habitat, as planned by incorporating mangroves into the overall build-out theme of the western side of the proposed development;</li> <li>III. Build-out the development in phases punctuated by re-landscaping activities which include the creation of vegetation corridors between phases that provide an opportunity for wildlife to relocate to stable habitat within the proposed development site;</li> <li>IV. Preservation of existing vegetation wherever possible, particularly along sea margins; and otherwise encourages the establishment of native vegetation species following land filling and housing development;</li> <li>V. Require all guests and residents to be given an orientation as to appropriate interactions with the nearshore patch reefs; to be accompanied by trained guides, and placement of mooring buoys at patch reef sites to be utilized by the development for guest visitation to prevent anchor damage to the habitat;</li> <li>VI. Educate residents, guests and staff of the importance of observing Manatee conservation guidelines, the consequence in the event of injury to Manatee from neglect of the guidelines, and surveillance of the development site for infraction against the guidelines; and (VII) Educate residents, guests and staff of the need to conserve Belize's dwindling fisheries resources, along with the measures available for participating in national conservation efforts, including the engagement of trained and licensed tour guides, use of capture/release fishing practices, and/or preferred catch and size limits.</li> </ul>

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**TABLE 32:**  
**SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS**  
*(Continued)*

IMPACT	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
<b>Archaeology And Social Factors</b>	<ul style="list-style-type: none"> <li>I. Artifacts of historical and/or cultural significance may be uncovered, damaged or destroyed during construction of the proposed development;</li> <li>II. Proposed development will create jobs and increase foreign exchange earnings through land sales and property development and income revenue from accommodation rentals;</li> <li>III. 40 + mile distance of proposed development on Placencia Peninsula from hospital resources increases risk of complications from accidental serious injury to workers;</li> <li>IV. Long-term support for traditional cultural practice of artisanal fishing.</li> </ul>	<ul style="list-style-type: none"> <li>I. Presence of an archaeological observer appointed by the Institute of Archaeology during all excavation activities to assess the significance of any finds and to make recommendations as to appropriate course of action regarding their preservation</li> <li>II. None, positive impact;</li> <li>III. Have a minimum of two full-time staff trained in emergency medical practices at BERT facility in Belize City; and</li> <li>IV. None, positive impact.</li> </ul>

*...End*

Measures available for mitigating avoidable impacts include: providing adequate land resources for (1) creation of settlement areas with sufficient capacity to reduce the velocity and otherwise capture overpass and Highway runoffs before they are directed into the Highway's master drainage scheme; and (2) creation of pedestrian and bicycle bypass easements along the overpass corridor. Also, enforcing slow speed restrictions along access trails and decking (i.e.  $\leq 5$  mph) and along the highway overpass (i.e.  $\leq 15$  mph), as well as appropriate training for staff operating vehicles at the site, and adherence to public licensing requirements for all vehicle operators, inclusive of staff, residents and guests.

**Sea-Based Transportation Impacts** concern the establishment and operation of a Lagoon-side boating canal mooring facility on the proposed development site; primarily the increased risk of sediment and/or petroleum-based pollution within the boating canal basin and adjoining Placencia Lagoon, which is an avoidable impact. Indirect negative sea-based transportation impact risks concern increased risk of propeller-injury to manatees in the Placencia Lagoon; and Residual negative sea-based transportation impact risks concern increased potential for public injury risk during boating activities. Measures available for mitigating avoidable impacts include: providing education for all the boat operators using the boating canal about (1) the significance of the Placencia Lagoon as a manatee habitat, and about the need for responsible navigational practices and slow operating speeds inside the boating canal and Placencia Lagoon, particularly in shallow waters; and (2) the advantages of utilizing 4-cycle marine engines, as well as the potential for reducing manatee injury risks through use of shrouded safety propellers; and placement of signs in nearshore waters of the boating canal and residences establishing the area as a manatee habitat and thus classification as a no-wake zone.

**Material Supply Impacts** include the modification of the Placencia Lagoon's shoreline and mangrove habitat. These impacts are unavoidable, and can only be mitigated by preventing the proposed development from taking place. Indirect negative physical impacts concern the discharge of erosion products and slumping of boating canal sidewalls into the Placencia Lagoon during construction and/or operating activities. Potential residual negative physical impacts concern long-term degradation of the area's geomorphology. Measures available for mitigating avoidable physical impacts include: identifying the appropriate angle of repose for boating canal side walls; and the use of a suction dredge surrounded with silt screens to minimize the potential for sediment/turbidity travel into the Placencia Lagoon.

Biological Impacts from the proposed development activities include reduction of Dwarf Mangrove Forest, Savanna Orchard, Horticultural Garden and Palmetto Thicket habitats which are unavoidable impacts that can only be mitigated by non-development. Potential indirect and residual negative biological impacts concern the reduction of water quality-dependent marine wildlife such as sedentary plants & invertebrates that may be affected by changes in local water quality during excavation activities. These impacts can be partially mitigated through observance of the previously identified extraction management guidelines such as using silt screens in defense of marine water quality in the vicinity of the material extraction site.

Other mitigation measure include re-landscaping of the project site with native vegetation in order to promote re-colonization and interior movement of wildlife displaced during material movement activities.

Water Resource Impacts from material movement activities concern the potential for temporary disturbance of Placencia Lagoon water quality which is an avoidable impact. Potential indirect and residual water resource impacts from the proposed development activities concern, as previously mentioned under biological impacts, reduction of water quality-dependent marine wildlife such as sedentary plants & invertebrates that may be affected by changes in local water quality during excavation activities. Mitigation measures include: employing silt screens around the suction dredge in order to minimize the spread of silt-born water into the Placencia Lagoon; and, operating measures that respect the previously identified extraction management guidelines, in defense of marine water quality in the vicinity of the material extraction site.

**Freshwater Supply Impacts** concerns the potential for marine organisms, particularly marine larval entrainment at the point of seawater intake. Potential indirect and residual negative biological impacts concern the elimination of these organisms from the region of the development site. Measures available for mitigating avoidable biological impacts include: insuring the intake pipe is adequately screened, and set within a depressurizing chamber to reduce suction force at the point of water entry; and posting of caution signs near to the intake pipe, and as well as routine daily inspection of the pump intake to insure screens are intact and that the intake pipe has not been compromised by wildlife or the boating public.

Water Resource Impacts from discharge of water from reverse osmosis through the 3-stage batchplant system concern increases in chlorine levels, and alteration of salinity levels in BRL water should the plant fail for any reason. Potential indirect and residual negative water resource impacts include a gradual reduction in area water quality from long term discharge treated effluent. Measures available for mitigating direct water resource impacts include: entailing construction of landscape pools within the development to allow effluent water to mix with plant water for settlement and photo oxidation so as to ensure the effluent water quality matches ambient water quality in the BRL; and routine examination of water quality in the landscape pools and Placencia Lagoon to ensure that chemical conditions are not favorable to microbial population blooms.

**Liquid Waste Discharge Impacts** concern plant noise to interfere with wildlife and resident communication. This impact can be mitigated by ensuring sound-proof structures such as walls or buildings and/or landscaping is used to reduce noise travel in the area, and thereby preventing wildlife and human emigration from the area.

Biological Impacts from sewage effluent holding in brine-laden photo-oxidation pools and subsequent discharge into the BRL concern bio-accumulation of eutrophic algae and bacteria, which is an avoidable impact. Potential indirect and residual negative biological impacts concern increased risk to the nearshore BRL of eutrophication, and either loss or overpopulation of the unique echinoderm fauna identified in the area, which are avoidable impacts.

These negative biological impacts may be partially or wholly mitigated by: balanced mixing of brine and treated effluent to suit the prevailing BRL water quality conditions, along with routine inspection of chemical water quality and algal / bacterial populations in mixing ponds, which if above nominal levels, should be treated with environmentally save compounds or flocking agents to reduce their populations prior to discharge.

Water Resource Impacts from sewage effluent discharge concerns risk of contamination of coastal waters with nutrients and/or human pathogens. Potential *indirect* and *residual* negative water resource impacts include the potential for low level eutrophication of the nearshore waters of the Barrier Reef Lagoon. These negative water resource impacts may be partially or wholly mitigated by: ensuring plant operation at design specification; and ensuring BRL water quality is regularly monitored for Coliform bacteria, Vibrio bacteria and nitrogen levels in defense of previous background levels and as a check to ensure proper batchplant function.

**Solid Waste Storage Impacts** concern the land conversion requirements for development of composting sites from onsite incineration of paper and composting of organic wastes. This impact can be mitigated by ensuring appropriate staff training and regular management and recycling of composting sites, in order to limit land conversion requirements. Other impacts include biological impacts from onsite incineration of paper and composting of organic wastes concern the reduction of *Palmetto Thicket* habitat that will be utilized for composting. This impact is unavoidable, save and except by non-development. Potential indirect negative biological impacts also concerns disturbance to resident terrestrial (and avian) wildlife from paper incineration. Potential residual negative biological impacts are nil. The potential indirect impact of resident species disturbance may be partially or wholly mitigated by: incineration of all paper solid waste in a commercial incinerator designed to limit smoke and heat discharge to the environment and to ensure proper training of incineration operators.

Water Resource Impacts from onsite incineration of paper and composting of organic wastes concern the possibility of seepage of nitrogen and other nutrients from composting pits into ground or coastal waters. Potential *indirect* and *residual* negative water resource impacts are nil. Seepage impacts may be partially or wholly mitigated by: covering of composting pits to reduce rainfall leaching; and regular management and recycling of composting sites, in order to prevent anaerobic digestion of organic wastes which reduces composting speed and promotes toxification of the compost site.

**Energy Use Impacts** from public energy use are essentially nil. However, fuel impacts from petroleum-based, backup-energy generation concern increased road use for fuel supply. This impact is potentially unavoidable, and can only be mitigated by non-development. Fuel impacts concern spill risk and potential residual negative fuel impacts are nil owing to transport of toxic solid waste to designated mainland storage sites. Measures available for mitigation of these potential impacts include: ensuring the construction of either a concrete or buried earthen bund and maintenance of all fuel containers and generating equipment within these structures; and ensuring training of staff in safe fuel handling procedures, and regular inspections of fuel usage sites.

Health and safety impacts from public energy use concern increased risk of electrocution wherever poor electrical engineering standards are employed or storms may cause failure of utility poles, which are avoidable and reversible impacts. Health and safety impacts from petroleum-based, backup-energy generation concern increased risk of chemical contamination and explosion; increased risk of serious personal injury due to the proposed development's remote location; potential residual negative health and safety impacts from petroleum-based, backup-energy generation concern the effect of short-term exposure to petrochemicals and/or noise from generating facilities effects on staff health and hearing loss. These impacts may be partially or wholly mitigated by: ensuring use of properly qualified electrical engineers during the design and construction phase of the development, suitable grounding infrastructure; and ensuring development of a safety protocol for training fuel handlers, maintaining fuel storage facilities at safe distances from generating equipment, providing warnings against use of inflammable devices near fuel storage areas, having at least two full-time staff receive emergency medical training at the Belize City BERT Center, and providing staff with proper clothing, gloves and noise pollution protection equipment to reduce potential for health effects.

Pollution impacts from energy supply and use concerns the proposed development's production of noise pollution and thermal waste up to  $6.2 \times 10^8$  BTUs per hour at capacity development (based on a conversion rate of 138,707 BTUs and 41 kW hrs/gal Diesel). Direct negative pollution impacts heat production is greatly unavoidable, and can only be mitigated by non-development. Potential indirect negative energy supply and use impacts concerns noise-induced hearing loss in staff, and potential residual negative energy supply and use impacts concerns noise induced wildlife desertion of the area. These impacts may be partially or wholly mitigated by: ensuring placement of generating equipment in specially designed noise-retarding shelters, and the discharge of exhaust waste into baffled exhaust pipes buried underground; and ensure provision of staff with proper safety clothing and noise pollution protection equipment, and the implementation of regular wildlife monitoring protocol to determine the presence/absence of noise-related impacts.

**Wildlife Impacts** concern partial reduction of the four forest assemblages and local fruit bearing trees of the proposed development site. This impact is greatly unavoidable and can only be mitigated by non-development. Potential indirect and residual terrestrial habitat impacts concern increased erosion and lowered storm resistance of the Placencia Peninsula as a result of vegetation removal for the proposed spa, hotel, residences, and marina developments. Measures available for mitigation of this latter potential impact include: preservation of existing vegetation wherever possible, particularly along sea margins; and otherwise encourages the establishment of native vegetation species following land filling and housing development.

Marine Habitat Impacts from implementation of the proposed development concern the reduction of Placencia Lagoon mangrove habitat from creation of the boating canal, which is an unavoidable impact. Potential indirect and residual marine habitat impacts from the proposed development concern deterioration of nearshore patch reefs from visitor impacts, which is an avoidable impact. Measures available for mitigation of the above impacts include: incorporating mangroves into the overall build-out theme of the western side of the proposed development; and, requiring all guests and residents to be given an orientation as to appropriate interactions with the nearshore patch-

reefs; to be accompanied by trained guides and placement of mooring buoys at patch reef sites to be utilized by the development for guest visitation to prevent anchor damage to the habitat.

Species-Specific Impacts from implementation of the proposed development concerns the potential for permanent displacement of any remaining bird and/or terrestrial animals from the development site during construction activities, which is an avoidable impact. Potential indirect species-specific impacts concern the increased prop-born mortality risk posed to Manatee by new and novice boaters operating out of the proposed development, which is an avoidable impact. Potential residual species-specific impacts concerns increased mortality risk to commercially valued fishes, such as snapper, grouper and snook, to the point where they are no longer available to exploit by native and artisanal fishermen. Measures available for mitigation of these potential impacts include: build-out in phases punctuated by re-landscaping activities which include the creation of vegetation corridors between phases that provide an opportunity for wildlife to relocate to stable habitat within the proposed development site; educating residents, guests and staff of the importance of observing Manatee conservation guidelines, the consequence in the event of injury to Manatee from neglect of the guidelines, and surveillance of the development site for infraction against the guidelines; and, educating residents, guests and staff of the need to conserve Belize's dwindling fisheries resources, along with the measures available for participating in national conservation efforts, including the engagement of trained and licensed tour guides, use of capture/release fishing practices, and/or preferred catch and size limits.

**Culture, Customs and Social Impacts** concern the potential damage or destruction of culturally important artifacts during excavation of the boating canal and construction of buildings. This impact can be mitigated by ensuring an archaeological observer is present on site during excavation activities to evaluate the significance of any finds and to make recommendations as to an appropriate course of action regarding their preservation.

Custom and Social Impacts from implementation of the proposed development concern the positive impacts of employment opportunities for locals and foreign exchange earnings through land sales and property development. Potential indirect social impacts concern the proposed development's 40+ mile distance from hospital services, which may increase serious injury-related risk to residents, guests or workers. Potential residual social impacts concern the development's likely support for traditional cultural practices, which is a positive impact. Measures available for mitigation of the above-identified potential indirect negative impact include: having a minimum of two full-time staff trained in emergency medical practices at BERT facility in Belize City.

## CUMULATIVE IMPACTS

Cumulative land use impacts of the proposed development concern the further alteration of land extent and elevation on the Placencia Peninsula itself, and the land margin along the Placencia Lagoon. These are unavoidable but reversible impacts, which can only be fully mitigated by non-development. Available measures which may partially mitigate these impacts include leaving mangrove edge habitat, albeit reconfigured and longer, intact and environmentally functional; as well as insuring sediment runoffs are kept in check from reducing water quality in the either the adjacent BRL and Placencia Lagoon.

Cumulative infrastructure impacts of the proposed development, particularly in regard to water supply and sewage treatment are unlikely to result from the state of the art technologies and systems planned for use. Negative impacts can therefore only result in the event that less robust infrastructure are ultimately put into use, or they are poorly maintained, which I turn would result in further reductions in environmental quality beyond those presently resulting from residential sprawl on the Placencia Peninsula. Hence cumulative infrastructure impacts are avoidable, and reversible. Under such circumstances, sewage treatment systems can fail, thereby compromising the environmental quality of adjacent surface waters, and hence, its resident wildlife.

Cumulative traffic impacts are likely to result because the proposed development will result in a net gain in both land and sea vehicle operations. Such impacts however, are largely avoidable and reversible insuring all development residents, guests and staff are property trained in vehicle use, and minimize the risk of human injury in this regard. Road wear and degradation has already been taken into consideration by the design works for the paving of the paving of the Placencia Highway, and the proposed developments interest in placement of a short overpass will only further serve this purpose by slowing traffic down.

Cumulative water supply impacts are anticipated to be nil if only minimal amounts of municipal water are used in support of development operations, while the majority is converted to potable water from Placencia Lagoon water.

Cumulative impacts on wildlife abundance will be a function of the means by which the proposed development site is converted from its present or pre-existing status to that of the planned development. In the absence of any regard for mobile wildlife on the Peninsula during construction and operation of the proposed development, wildlife will continue its already well established trend of egress to elsewhere in Belize. This impact is avoidable and reversible however, if select sections of land cover can be left intact until new land cover becomes available.

Cumulative impacts on employment are anticipated to be positive, as the little foreign employment is anticipated to be used for construction and operation of the proposed development. Although statistics on unemployment of eligible workers on the Placencia Peninsula are difficult to extract from national population census, the potential employment of 74 Peninsula residents will, regardless, provide important revenues to the economy of, and help to build further social linkages within the Placencia Peninsula.

## MONITORING PLANS FOR THE PROPOSED DEVELOPMENT

The parameters and scheduling of monitoring activities recommended for the development are shown in **Table 33**; and recommended monitoring points are shown in **Illustration 62**.

**Land- and Sea-Based Transportation Monitoring Requirements** concern the need to verify that recommended guidelines for vehicle use, education and signage measures are being adhered to. Compliance with these requirements can be verified during random site visits by management and the DOE conducted once or twice a year during operation of the proposed development.

**Sea-Based Transportation Monitoring Requirements** concern the need to verify that recommended education and signage measures are being adhered to. Compliance with these requirements can be verified during random site visits by management and DOE conducted once or twice a year during operation of the proposed development.

**Material Extraction Monitoring Requirements** concern verification that material excavation activities are restricted to designate areas, that silt screens are used during shoreline breach, and that the water quality impacts to the Placencia Lagoon are localized and temporary. Monitoring actions should entail regular site visits by the DOE and the Geology & Petroleum Department (GPD) or its assignees on a monthly basis until these material supply activities are completed.

**Water Resource Monitoring Requirements** consists of scheduled checks of water quality in the landscape pools and Placencia Lagoon, particularly in regards to salinity, chlorine, temperature, Coloform and Vibrio bacteria levels and nutrient load. Water quality monitoring and reporting will be conducted on a monthly basis. The water quality of the Municipal Water System will be checked monthly by the proponent at the Bowen & Bowen Laboratory particularly for nitrogen, total Coloform bacteria and protozoans.

**Liquid Waste Monitoring Requirements** include weekly assessments of the prevailing BRL water quality conditions, along with weekly inspection of chemical water quality and algal / bacterial populations in mixing ponds, which if above nominal levels, should be treated with environmentally safe compounds or flocking agents to reduce their populations prior to discharge. BRL water quality should also be monitored on a monthly basis for Coliform and Vibrio bacteria population levels and nitrogen levels in defense of previous background levels and as a check to ensure proper batchplant function.

**Solid Waste Monitoring Requirements** consist of the need for DOE to verify that a commercial incinerator has been installed for burning paper trash, that staff designated to manage any and all composting areas are adequately trained in composting procedures, and that necessary arrangements have been made to cover composting pits in wet weather. In addition, monitoring requirements should include regular (monthly) inspection of composting sites for appropriate management.

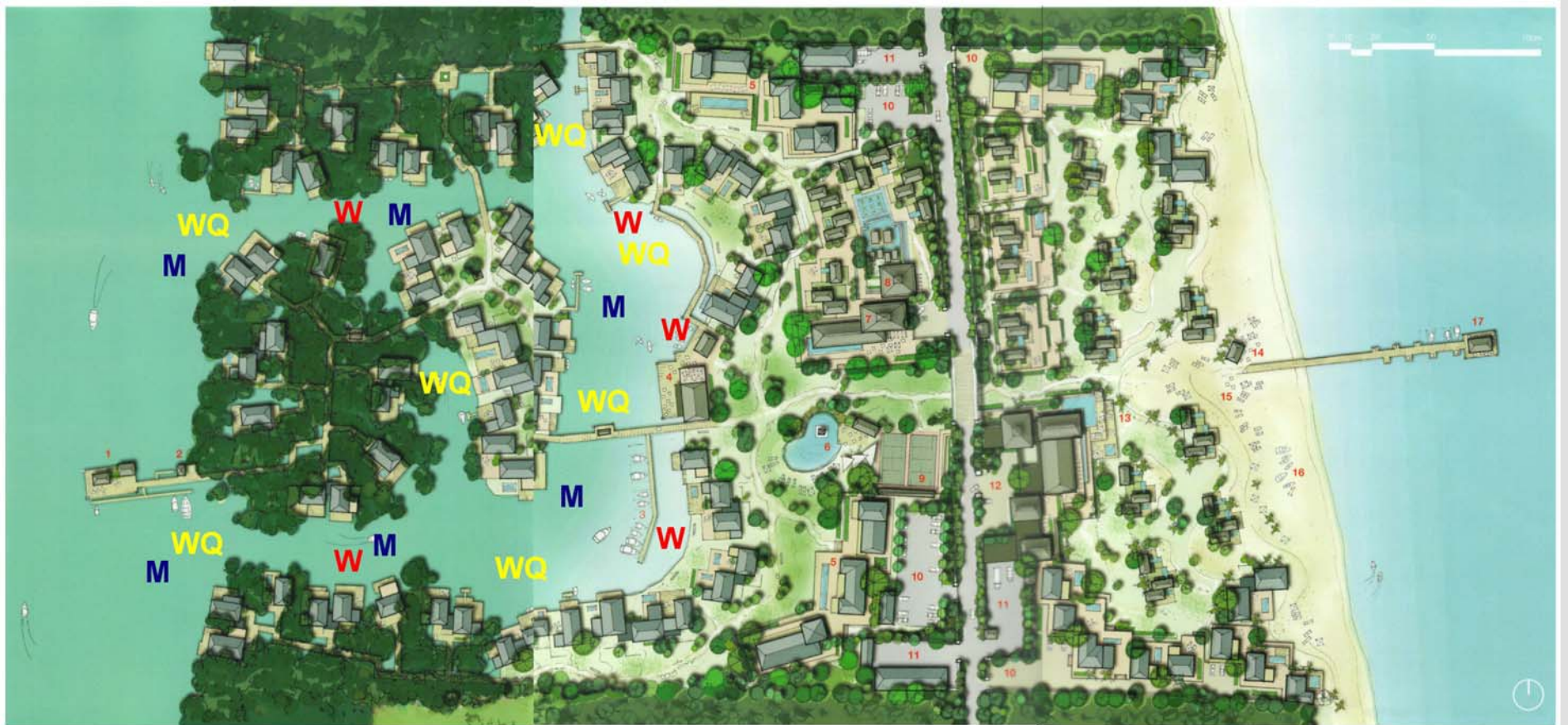
**TABLE 33**

**MONITORING PLAN FOR THE ENTIRE DEVELOPMENT**

DEVELOPMENT CATEGORY	PROGRAM OR ACTION TO BE UNDERTAKEN	PARAMETERS	COMPLETION DATE OR FREQUENCY <sup>1</sup>	MAP SYMBOL REFERENCE <sup>2</sup>
<b>TRANSPORTATION</b>	<p><i>Land Based:</i> Train / License Vehicle Operators; licenses should be inspected on an annual basis for renewal requirements.</p> <p><i>Sea Based:</i> Identify marine pollution status on a quarterly basis by assessing water quality in lagoon and canal; support enforcement of manatee conservation and navigational regulations, as well as assess manatee conservation education effectiveness yearly.</p>	<p>Water Quality Assessments Should Be Conducted As Shown In Table 7 &amp; 8, Pages 60 &amp; 61</p>	<p>Land Based: Weekly / Annually</p> <p>Sea Based: Quarterly / Annually</p>	<p>-</p> <p><b>WQ / M</b></p>
<b>MATERIAL SUPPLY</b>	<p>Inspect canal &amp; marina walls on a monthly basis, and monitor turbidity in Placencia Lagoon on a quarterly basis during the construction phase of development.</p>	<p>As Above</p>	<p>Monthly / Quarterly</p>	<p><b>W</b></p>
<b>FRESHWATER SUPPLY</b>	<p>Conduct quarterly determinations of chemical and biological water quality in all water features.</p>	<p>As Above</p>	<p>Quarterly</p>	<p><b>WQ</b></p>
<b>LIQUID WASTE MANAGEMENT</b>	<p>Build Treatment System to Specifications Water Quality Monitoring</p>	<p>Water Nitrate Levels Coliform and Vibreo bacteria levels</p>	<p>Quarterly</p>	<p><b>WQ</b></p>
<b>SOLID WASTE MANAGEMENT</b>	<p>Establish Commercial Incinerator, Train Composting Staff, Cover Composting Pits Composting Site Inspections</p>	<p>None</p>	<p>By Onset Of Operations During Operation Monthly</p>	<p>-</p> <p>-</p> <p><b>S</b></p>
<b>ENERGY USE</b>	<p>Establish Fuel Bunds, Develop Handlers Protocol, Train Staff, Supply Clothing, EMT Training For <math>\geq 2</math> Staff Fuel Storage and Power Generation Equipment Inspections Photo-Validation of Equipment Status Wildlife Monitoring for Noise-Related Impacts Public Power Supply Related Inspections</p>		<p>Before Operation</p> <p>Weekly Annually Monthly Monthly</p>	<p>-</p> <p><b>E</b> <b>E</b> <b>C</b> <b>E</b></p>
<b>WILDLIFE</b>	<p>Placencia Lagoon Water Quality Monitoring (Sed Drift) Monitoring for Return of Native Wildlife Design/Implement Fisheries-Education Program</p>	<p>None</p>	<p>Daily During Excavation Monthly Continual</p>	<p><b>WQ</b> <b>C</b> -</p>
<b>CULTURE, CUSTOMS &amp; SOCIAL FACTORS</b>	<p>EMT Training for <math>\geq 2</math> Staff Design/Implement Visitor Impact Management Program</p>	<p>None</p>	<p>By Onset Of Operations By Onset Of Operations</p>	<p><b>None</b></p>

<sup>1</sup>Monitoring sites are shown in **Illustration 63**

ILLUSTRATION 62  
MONITORING PLAN FOR THE ENTIRE DEVELOPMENT



**Energy Monitoring Requirements** include regular (monthly) signed inspection of all primary electrical connection points to development structures, voltage levels, and utility infrastructure for damage and/or potential failure of function. Monitoring requirements for petroleum-based self-generation should include regular (weekly) signed inspections of all fuel storage and power generating equipment for repair and/or maintenance requirements before and during operation; and regular (monthly) wildlife monitoring to determine the presence/absence of noise related impacts.

**Wildlife Monitoring Requirements** include daily inspection of the Placencia Lagoon water quality (turbidity in particular) for sediment travel into lagoon waters during excavation of the boating canal and standard monthly post-development inspection of the various development components for return of native wildlife. If species abundance fails to return to pre-existing levels, the proponent will need to increase plantings of native fruit bearing trees having various sized fruits and flowering shrubs in order to promote the return of native bird and butterfly wildlife to the area. Residents, staff and guests should also be informed of fisheries regulations and conservation initiatives.

**Culture, Customs and Social Monitoring Requirements** consist of the need for DOE to establish that at least two staff has been trained in emergency medical support and that a visitor impact management program has been put in place prior to operation of the development.