Executive Summary

1.0 BACKGROUND

The Government of Belize is in the process of implementing a national Solid Waste Management Plan, which will guide the management of solid wastes for twenty years into the future. Work on the development of the Plan began in 1998. The selected conceptual solid waste plan was identified from among eight (8) possible conceptual waste disposal plans. Each made use of a combination of sanitary landfills and modified landfills (i.e., upgrading of existing disposal sites to provide cover, but on a reduced frequency, compared to sanitary landfills). Final disposal sites and transfer station locations have been identified and recommended in the preferred integrated option.

An important feature in the proposed Plan is the identification of a final disposal site at a central location, which will receive Municipal Solid Wastes (MSW) from the Western Corridor Communities. This facility is proposed as a MSW sanitary landfill to be located at Mile 22 on the Western Highway, west of Belize City. A MSW transfer station has also been proposed to be located at Mile 3 on the Western Highway to receive waste collected from Belize City and surrounding areas plus the Cayes for disposal at the regional sanitary landfill. In addition, the recommended plan includes modified MSW disposal facilities (at Corozal, Orange Walk, and new MSW sites located at Dangriga, Placencia and Punta Gorda).

In preparation for the detailed design of the regional landfill, the GOB requires that an Environmental Impact Assessment (EIA) be conducted to assess the potential environmental and related impacts of the proposed facility. This Report presents the results of an EIA for the Mile 22 Site, including siting criteria and rapid assessments of alternative sites investigated leading to the selection of the site. It also includes the results of an updated review and assessment of the plan and previously approved EIA report

prepared by Stantec Consulting International Ltd in 2001. While the report focuses on an EIA prepared for the proposed regional waste management site located at the Mile 22 Site, it also provides information relevant to the municipal waste management sites (Recycling / Transfer Stations) located in San Pedro, Caye Caulker and Belize City.

2.0 PROJECT DESCRIPTION

This section provides a general updated overview of the Solid Waste Management Plan for the Western Corridor and an overview of the proposed sanitary landfill project is given in the EIA Report, in terms of environmental and socio-economic setting, comparison of alternatives, layout and design, operations and decommissioning. The Western Corridor project involves the construction of a regional sanitary landfill for disposal of municipal solid waste from Belize City and its surrounding environs, San Pedro and Caye Caulker with provisions for recyclables storage. It is also expected that the Mile 22 Facility would, at some future point, serve the needs of the other communities situated along the Western Highway including Belmopan City, San Ignacio and Benque Viejo Towns. The Mile 22 facility will have a surface water management system, leachate control, groundwater and gas monitoring systems and other systems to ensure environmental safety.

2.1 Western Corridor- Solid Waste Management Plan

This project entails a solid waste management system for Belize that includes open dump closures, waste minimization through recycling, waste transfer, long-haul and waste disposal at Mile 22 Waste Management Site, a regional waste disposal facility which meets the Government of Belize (GOB) solid waste regulations. Recyclables generated by participating communities including San Pedro (Ambergris Caye) and Caye Caulker will be transported to a temporary storage facility at the Western Corridor Transfer Station (WCTS), also called Belize City Transfer Station or Belize City Recycling Station, or to a designated recycling business. Management of the recyclables will primarily involve separation at the source but provisions are made for their commingled acceptance at the WCTS and at the Mile 22 Site. Recyclables generated at the Cayes will be separated and

baled as part of a recyclable transfer process that includes barging to Belize City. The waste transfer from the WCTS to the Mile 22 site will include trailers designed to optimize the long haul operation. The entire system will be implemented using Design–Build–Operate (DBO) contractors which will be required to meet both operational and environmental related performance measures. In agreement with existing regulatory requirements, the Solid Waste Management Authority will be directly responsible for the project's implementation and its operation.

2.1.1 Integrated Solid Waste Management Planning Update

The Solid Waste Management Project in Belize is based on an integrated solid waste management approach that aims at reducing the amount and toxicity of waste by utilizing source separation, recycling and composting. The project focuses on employing recycling as the main component for waste diversion. The components of the project are summarized below.

2.1.2 Source Separation

Households, public institutions, businesses, commercial and tourism related outfits are required to participate in the separation of recyclables and compostables from the mixed waste. This activity will rely on a city ordinance requiring public participation in the source separation effort.

Collecting and transporting the recyclable matter to the Local Recycling Station will continue to be a responsibility of the local municipal waste management authorities through their agreements with private companies.

2.1.3 Recycling Facilities

A low-technology recycling scheme operated by the SWMA or its contracted representatives is proposed for the project. A low-technology materials recycling facility is a low capacity, relatively simple to operate, labour intensive, minimum hardware and low cost system. The incoming materials are delivered commingled

and include paper, ferrous metals, aluminium, glass, PET and HDPE (See Appendix K and L). For each of the incoming types of recyclable materials, the facility provides raw material storage, a means for separation and processing, storage of finished products and for shipping the finished products. Some of the forms and conditions applicable to the finished products include:

- Paper and Cardboard, separated by grade and baled;
- Ferrous Containers, flattened or baled;
- Aluminium Containers, flattened or baled;
- PET and HDPE, separated by colour and baled;
- Glass, separated by colour.

All recyclables originating from San Pedro and Caye Caulker should be shipped on roll-on–roll-off type containers suited for barging on small flat barges, see Figure B.2.2. Recyclables originating from Belize City and other inland localities should be transported to the WCTS using the contracted collection vehicles.

2.1.4 Composting

Organic waste should be transported to the waste management facility for composting treatment. The waste management facility should be operated by SWMA or its contracted representatives. A review of the advantages and disadvantages of the composting technological options has lead to the selection of simple mechanically aerated windrows.

In the windrow composting system proposed for the project, the material is mechanically shredded to less than 2 inches in size to maintain adequate porosity in the composting mass before it is placed in long narrow piles (windrows). The material is aerated by turning the piles using a front-end loader. The mechanically aerated windrow method utilizes a trapezoidal-shaped pile, about 6 feet in high and 12 feet in width. The length depends on the quantity of material being composted. Runoff generated on the composting pad is routed to a temporary holding pond and either applied to the windrows or the waste disposal cells. The turning of the

windrow is the most important activity of the composting process. Without turning to provide sufficient aeration, the composting process is slowed and can result in anaerobic conditions and substandard compost quality. Moisture content should be maintained within the 45% to 65% range. The preferred pH range is between 6.5 and 8.0.

2.2 Regional Sanitary Landfill: Mile 22 Site

The Mile 22 Site is proposed as a regional sanitary landfill designed to receive solid waste from all communities along Belize Western Highway, including Ladyville and the islands of San Pedro (Ambergris Caye) and Caye Caulker. As such it is designed to comply with the waste disposal facility regulations administered by the Belize Department of the Environment (DOE). The Mile 22 Site is a privately owned parcel that is located about 3 miles northwest from the Western Highway Mile 22 mark and occupies approximately 350 acres (141hectares). An unpaved access road to the Mile 22 Site was improved by the GOB in the early 2000s with the entrance diverted to Mile 22 to allow for safer and more efficient access. Development of the Mile 22 Site into a sanitary landfill requires upgrading of the existing access road to an all weather paved road.

Part of this site was a clay and gravel source for the construction of the Western Highway. At present there are no structures on the site.

This Mile 22 landfill facility has been sized for a minimum of 20 years operation. A full environmental impact assessment study has been conducted and includes a hydro-geological investigation that determined and confirmed its suitability as a solid waste disposal site.

The engineering design concept for developing the Mile 22 Site into a sanitary landfill was carried out by Stantec (Phase 3 – Predesign Mile 22 Final Report, October 2001). The SWMA is responsible for the implementation of the Mile 22 Site. It is proposed that the

Design-Build-Operate (DBO) contracting method be employed at the Mile 22 Site. Furthermore, it is proposed that the Mile 22 Site should be operated as a bioreactor.

The proposed Mile 22 Western Highway site was selected from 15 sites as one of the best locations, based largely on geological suitability, an abundance of suitable cover material, on adequate separation from areas of large human populations, and on favourable transportation costs and efficiencies, including easy accessibility for truck traffic along a new access road at Mile 22.

3.0 ENVIRONMENTAL SETTING

3.1 Transfer/ Recycling Stations-Belize City, San Pedro & Caye Caulker

Since the objective is to remove open dumps from the offshore islands of San Pedro and Caye Caulker it will be necessary to have a transfer station in Belize City where the waste from these islands can be temporarily stored before being transported to the central landfill site at Mile 22.

The Mile 3 Open Dump site has been identified as the likely area to have the transfer station located as it will minimize cost and transportation needs in transferring wastes from the islands to Belize City. The wastes will have already been separated, bagged or bailed and ready for transportation before it leaves either San Pedro or Caye Caulker.

3.1.1 Belize City (Mile 3 and Mile 3.5)

The Belize City Mile 3 open Dump is located approximately 3 miles to the west of Belize City in a mangrove wetlands area. The central part of the Dump has the coordinates UTM 16 Q 369844 and 193494 N. The site has an approximate area of 47,000 square meters or 11.61 acres. This site is presently closed to the disposal of any solid waste material.

In June of 2007, a secondary open dump site adjacent to the mile 3 site also became operational in Belize City. The access to this site, referred to as Mile 3.5 Belize City Dump, is located about half a mile west of the previous Mile 3 site. It has an area of 4 acres. The central section of the Open Dump has the coordinates UTM 16 Q 369705 and 11934749 N. This site is located in a swampy area near mangroves. It is estimated that 448 cubic yards of solid waste is transferred from the city to this site on a daily basis. The task of collecting and transferring the wastes to the Dump site is done under the Belize Waste Control, a private entity contracted by the Belize City Council since 1992. Seven (7) backload compactor trucks, each with sixteen (16) cubic yards of capacity, are utilized to perform this task on a daily basis. Belize City is divided into two sectors, i.e. North and South Sectors with the Haulover Creek serving as the boundary. Each sector then has specific days on which waste is collected, Monday and Thursday on the North and Tuesday and Friday on the South, respectively.

Currently there are no practices employed at the site for recording the volume of solid waste being deposited at the Mile 3.5 Open Dump.

As a component of the ETEISA Report, water and leachate samples were collected from the Mile 3 and Mile 3.5 Open Dumps (See Appendix J). The water samples were collected from upstream and downstream while the leachate sample was collected from within the Dump site.

The results from the upstream samples indicated that there were no heavy metals detected from this site. Results also indicated that there was no presence of coliform bacteria detected. The laboratory data also indicates that there was no pollution from organic loading (BOD).

From the downstream results, it was confirmed there was an alkaline pH. The presence, however, of low levels of mercury and lead were detected. The findings also indicated the BOD/COD ratio to be 61.7/456=0.135, which is a value characteristic of methanogenic leachates. Coliforme bacteria were also present in this sample. High levels of iron and some manganese were also detected from this sample.

From the leachate sample, it was detected that there was low levels of heavy metals present. There was no pollution with BOD, however, COD was found to be 320mg/l. No coliforme bacteria were noted in this sample. Due to the fact that ammonia is released by the decomposition of proteins, low levels (91.2) of this substance were noted in the sample. An average amount (3,201mg/l) of total dissolved solids was recorded from this sample.

3.1.2 San Pedro

The San Pedro site is located south of Ambergris Caye and is currently being used as an open dump. This site is located within a mangrove patch on the southern end of the island. In a straight line, the site is approximately 1.86 miles south from the San Pedro Airstrip; approximately 2.7 miles north of Grand Canal; and quarter mile from the San Pedro Lagoon to the west and from the Caribbean Sea to the east. The nearest Marine Protected area to the site is the Holchan Marine Reserve, to the south. The site is located on a 26 acre parcel under a five (5) year lease agreement between the private land owner and the San Pedro Town Board. The San Pedro Town Board is the responsible entity for the management of this site. The geology of the land is typical of that associated with coralline islands. Southern Ambergris Caye is comprised of shallow layer of calcareous sands underlain by limestone bedrock. These soils are very porous and in that area the water table could be found at a depth of 12-18 inches. The surrounding vegetation is mainly dwarf red mangroves, which is common in areas of little flushing and

where nitrates and phosphates are limiting nutrients to the growth of these mangroves.

The common practice to reduce waste volume at the site is open burning.

3.1.3 Caye Caulker

The Caye Caulker dump site is located on the south-western area of the island, immediately west of the airstrip. The site is situated in an area of mangrove wetland within several small permanently inundated areas and adjacent to a canal that connects to the Caribbean Sea on the leeward side of the Island. Garbage on this site would be periodically lit to reduce its volume and sometimes fires would occur as a result of spontaneous combustion. The geology of the area is similar to that of the San Pedro dump site.

There are local operators who provide services to villagers and businesses of transporting their waste material to the dump site. The vehicles utilized to carry out these services include pickup trucks and bicycles with carts.

3.2 Regional Sanitary Landfill /Solid Waste Management Site Mile 22

The proposed solid waste site is located about 4 km due north from its existing entry point on the Western Highway. Along this route the land is open pine orchard savannah interspersed with occasional thickets along low lying drainage basins which intersect the route at various points. The site is bordered by hardwood forest to the north and by mostly broken ridge transitional forest to the east, south and west. There are no inhabited centres or farmsteads in the areas around the access road right- of-way on the landfill site and the only discernable activity now taking place near the site is selective logging. This area falls into the Belize River Drainage Basin with surface runoff draining into the Cox and Mucklehany lagoons which links up to form the Mussel Creek drainage which then

empties into the Belize River near Double Run.

Surface drainage in the general project area is dominated by runoff from the site into the Mussel Creek drainage system, where it then enters the Belize River. Surface drainage from the site is generally eastward through an onsite creek and overland flow through a network of two creeks to the Belize River.

The site is underlain by a thick layer grading from plastic clay to marl to limestone. The layers of clay are of very low hydraulic conductivity and of substantial thickness. Hence, it is extremely unlikely that contaminated water (leachate) would migrate through this material. These clays will provide a natural liner for the proposed sanitary landfill. The site also contains sufficient clay to be used for interim and final cover for the Landfill.

Wind direction is predominantly from the east and to a lesser extent the southeast, with some seasonal winds from the north, northeast and northwest. Very rarely do winds blow from the west, southwest or south.

The site lies near the edge of the Coastal Plains Savannah vegetation type. This type of vegetation is well represented in Belize on the leached, acid soils of the Pine series and as such, there will be no significant loss of forest or agricultural resource arising from clearing the area required for the landfill. Neither have any sensitive habitats for plants or wildlife been identified in the vicinity of the site. Given the poor quality of the soils in this area for arable purposes, there is limited agriculture in the vicinity of the proposed landfill site. Neither is there any other designated land use of the site at present. In the past, the site had also been partially used as a gravel quarry, which has left portions of the site in a degraded condition, further reducing its usefulness for agricultural purposes.

The closest residents are approximately 4 Km from the site. Jih Chan is approximately 2.5 miles to the SW and a small housing development at Mile 22 is about 2.5 miles to the

South East.

The Belize Zoo is situated about 7.5 miles southwest from the proposed landfill site, on the north side of the Western Highway, while The Tropical Education Centre associated with the Belize Zoo, is located about 7 miles to the southwest of the landfill site.

In terms of future land use, a major residential development and subdivision for lands situated at Mile 25 of the Western Highway was proposed several years ago, referred to as Jih Chan. It is planned to eventually provide over 6000 lots, as well as parks, retail lots, and provision for light commercial activity. Presently there are 35 houses that were built about a decade ago with no new home built for the past five years. Jih Chan is projected to remain as a very small community for several years to come. Another newly proposed residential development referred to as Black Orchid Gardens is located approximately 0.625 miles to the southeast of the Mile 22 site. Although this residential development was proposed almost a decade ago it has yet to obtain environmental clearance and the project has remained dormant for several years. In addition, construction of the infrastructure for yet another new Town had started immediately west of the Belize Zoo approximately eight years ago with no homes built on the site since then. However, just a mile away from this site a community named "Mahogany Heights," presently comprised of approximately 350 homes, has been established.

The Mile 22 site has not been proposed for any residential development, and is conveniently located to provide potential service to all of these proposed developments. The site has been field checked by the Institute of Archaeology and cleared for any potential sensitive/archaeological areas.

Because the site is distant from any major river or areas likely to contain caves, and because much of the surface layers at the site have already been removed or disturbed by quarrying activities, it is not expected that historic artifacts would be found on the site.

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4.0 PUBLIC CONCERNS

As an aspect of ensuring that adequate steps are taken to protect the environment, a series of stakeholder meetings were held prior to and after the preparation of the EIA. In addition individual discussions were held to elicit any public concerns to the Mile 22 Site. Concern was expressed that the proposed landfill might lead to contamination of surface water and ground water, either by surface runoff coming into contact with the waste or by leachate entering the surface water and possibly the Belize River.

Several questions were raised, which related to the advocacy program that was used for Mile 27 and whether the Mile 22 site assessment would allow for public input into the decision process for Mile 22. Questions were also raised regarding the role of the advocates and the Zoo in the process of changing from Mile 27 to Mile 22.

Queries were raised about the overall effect of the proposed development on both the Jih Chan and proposed Black Orchid Gardens Development. Considerable discussion was brought forward on the overall project economics of the new site, and whether a fair comparison and analyses would be made.

Residents of Jih Chan queried on the distance to the development and asked for assurance that the number of residents that would be affected by the proposed landfill site be identified.

Informal discussions with landowners after the meeting, introduced the concept of an access road into the site from Mile 22, that would serve the area well and provide access and power for the Black Orchid Gardens, Olympic Developments and Ramon lands. An existing surveyed right of way exists for this route. This logic was then used to look at two access routes into the site and the benefits and costs of each.

5.0 POTENTIAL IMPACTS AND MITIGATION

5.1 Transfer/Recycling Facilities-Belize City, San Pedro & Caye Caulker

5.1.1 Belize City (Mile 3 Site)

The present Belize City Dump is located approximately at mile 3 on the Western Highway and is accessed via a new access road located at mile 3.5. The site is adjacent to Belize Waste Control's offices and operational site and is less than ½ mile from the nearest residence. Although burning of waste is no longer intentionally practiced, this site spontaneously catches fire on a regular basis often requiring the support of the National Fire Service and Ministry of Works .

During burning residents immediately surrounding the site are subjected to the smoke generated by these fires. It is important to note that one of the main source of dioxins and furans emissions in Belize was identified as those resulting from the open burning of garbage dumps. During the months of October-February it is not uncommon for the entire Belize City to be affected by the smoke brought down as a result of an atmospheric inversion.

In addition residents and travellers are subjected to the pungent, malodorous gases released from the decomposition of the organics present within the municipal solid waste. Nearby businesses, residents and travellers on the western highway have complained of this on numerous occasions.

An assessment Conducted by ETEISA in June of 2008, indicated that the ground water and surface water on and near the site is being contaminated by leachate. Of particular concern is the presence of heavy metals, coliformes and other pollutants which are injurious to human health and the environment.

The proliferation of vermin and other pests (vultures and other scavengers) in the area is another potential negative impact of concern particularly associated with the potential spread of environmental diseases such as Malaria and Dengue.

With the rehabilitation of the site and its conversion to a transfer/recycling center much of these issues will be mitigated leading to very positive improvements to the surrounding environment.

5.1.2 San Pedro

The present solid waste disposal site in San Pedro currently receives 33.5 tons of garbage per day. A compositional analysis of this waste indicates that approximately 45% of this waste is organic with approximately 55% being inorganic. A considerable amount of plastics of all sorts and styrofoam find themselves in this waste stream.

The waste at this site is frequently lit as a means of reducing its volume. The resulting smoke and emissions has been identified as a major potential source for the accidental release of dioxins and furans. Hence, this smoke is not only a nuisance but poses a serious threat to the health of nearby residents.

The pungent and malodorous gases produced from the decomposition of the organics present in waste are also a source of potential discomfort to nearby residents and visitors to the area.

The proliferation of vermin and other pest is serious public health concern in particular when one considers that the caye is Belize's premier tourist destination. An outbreak of any of the environmental diseases could have a debilitating economic impact on the island and Belize as a whole. The proliferation of birds attracted to the dump also poses a threat to aviation because of the nearby location of the runway for San Pedro Municipal Airstrip.

The site is located on a 26 acre parcel of land being mangrove wetland dominated by dwarf red mangroves typical of southern San Pedro. The soils in this area are

comprised primarily of calcareous sandy soils underlain by limestone bedrock. Bedrock in the area is relatively at shallow depths. The water-table is a few inches down (12-18 inches).

A recent study conducted by ETEISA indicated that both surface and ground water was being contaminated by leachate produced at the Dump. There exist the possibility heavy metals and other contaminants present in the leachate could with time adversely affect the health of the surrounding environment including the Hol Chan Marine Reserve.

With the rehabilitation and conversion of the site to a Transfer/recycling Facility and non-conforming disposal site containing artificial liners for composting areas, much of the problems associated with leachate contamination and the release of smoke and other emissions will be mitigated. The impacts associated with nauseous odours from the composting of organics will be mitigated though proper management regime employing frequent turning of organics. In addition a greenbelt will be maintained around the non-conforming disposal site. The proper separation and storage of waste will also mitigate against the proliferation of vermin and pests.

It can be surmised that the conversion of the site, from a present open dump to a transfer/recycling facility and non-conforming solid waste management site will have net positive impacts to the environment of the immediate and surrounding areas. As a result the activities proposed can be classified as an environmental improvement program.

5.1.3 Caye Caulker

The present solid waste disposal site for Caye Caulker is located on the southern end of the Island on approximately two (2) acres of land immediately adjacent to the island's only airstrip. The site has a very narrow strip of vegetation

surrounding it and is very visible while approaching the island by air. Immediately west of the site is a canal or waterway that forms part of the Pelican Marina. Like San Pedro, the area is covered with a very porous calcareous sand common to coralline islands. This sand is underlain by a layer of peat followed by a limestone bedrock. The water table is usuall12-18 inches with some low lying areas inundated during high tides.

Like what is practiced with most open dumps, the garbage is periodically burnt to reduce volume. In addition sometimes fires would result due to spontaneous combustion.

Like San Pedro the smoke not only creates a nuisance to nearby residents and visitors but it also poses an unknown risk to their health as a result of the accidental release of dioxins and furans possibly released from the burning of halogenated compounds and plastics.

5.2 Regional Sanitary Landfill: Mile 22 Site

5.2.1 Air Quality

Potential air quality impacts of the development could include: generation of landfill Gas (Methane, CO_2, VOC's) from the landfill site; landfill odours reaching proposed residential developments; or smoke and dust from fires and the activities of on-site machinery at the landfill site.

Without mitigation, there is the potential for odours from waste material in the landfill to reach adjacent existing and proposed residential developments. Smoke from fires and dust from the activities of machinery at the landfill are other possible irritants to nearby human populations.

Landfill gas (mainly carbon dioxide and methane) is normally produced as a result

of the process of decay in any sanitary landfill facility. The main mitigation measure is to ensure buffers are left in a natural state and re-vegetated to provide a barrier to the movement of landfill gases. Another mitigation measure for landfill gas control, is to include the possible future installation of gas collection wells and flaring of gas if monitoring systems indicate a need.

It will be both necessary and feasible to prevent odours from being a problem to neighbouring facilities by applying adequate cover material to the landfill frequently and effectively. There is an ample supply of soil material (mainly clay, silt, sand and mixtures thereof) existing on the site, which can be used for this purpose. The Environmental Mitigation plan in this EIA Report sets out the methods for applying cover. It is also recommended that the active face of the landfill be minimized at any given time.

Air quality problems in the form of dust or vehicle emissions can be minimized by maintaining equipment in proper running order, applying water to access roads when necessary, and ensuring that all access roads are compacted and/or gravelled and stabilized or paved. Regarding smoke problems, fire prevention and contingency measures are set out in the Environmental Mitigation plan.

With the measures of the Environmental Mitigation and Monitoring plan implemented effectively, air quality impacts can be kept to insignificant levels.

5.2.2 Soils and Terrain

Potential impacts to soils and terrain include erosion of existing bare earth slopes and those developed during construction and operational phases; and slope erosion in the post-closure phase of the landfill. Particulate matter may be carried off-site in surface runoff, with consequent effects on surface water quality, unless provisions are made to avoid this.

Contouring of the landfill facility and surface water diversion channels shall be constructed so that surface water is directed to a constructed storm water pond. The concept shall be based on maintaining surface water flows exiting the pond that are no more, in terms of instantaneous flows, than what would be considered as happening during the before construction, natural site condition. For the post-operational phase, the landfill shall be capped, contoured, and vegetated appropriately, with full attention to providing effective drainage and erosion prevention. With such measures in effect, the landfill may be constructed, operated and decommissioned with no significant adverse effects from soil erosion.

5.2.3 Surface Water

One concern that was raised, is the possibility that contaminants from the waste might enter surface runoff water from the landfill and reach adjacent surface waters, including the Cox Lagoon system. A number of measures are proposed as part of the Environmental Mitigation and Monitoring plans to ensure that surface water quality is protected. All landfill surface Run-off will be directed to an on-site holding pond where it will undergo sedimentation and natural aerobic stabilization. This pond will be sized to accommodate a 1/100 year 1-hour storm event, during normal operations of the landfill. Only surface water that has **not** come into contact with the waste material (i.e., non-contact surface water) will be allowed to directly enter the holding pond. All water in contact with wastes will be conveyed to the leachate retention and treatment ponds. Once treated, the contact water, normally called leachate, could be transferred to the clean water pond.

During construction, appropriate measures including berms, silt traps, etc., will be taken to ensure sediments do not pollute adjacent watercourses. Upon closure of the landfill, the surfaces will be contoured and re-vegetated in such a way as to reduce erosion and resulting sedimentation of adjacent surface waters. Regular monitoring of surface water quality shall be conducted at critical points in the

watershed throughout the construction and operational life of the landfill, including the distant Belize River.

Provided the above measures are implemented during the construction, operations and closure phases of the landfill development, no significant adverse impacts on surrounding surface waters need be expected.

5.2.4 Ground Water

A potential impact that frequently needs to be mitigated at sanitary landfill sites is thepossibility that leachate from the waste cell is allowed to enter the ground water underlying the site. If this happens, it can have long-term adverse effects on ground water quality, and surface water quality stemming from discharge of the ground water to the surface water.

The proposed sanitary landfill at the Mile 22 Western Highway site has been selected to take advantage of the thick layer of low permeability clay that occurs on the site, which will act as a natural liner, preventing percolation of leachate into groundwater. Leachate will be collected from each cell and conveyed to a series of leachate retention and treatment ponds, where it will undergo biological treatment before draining to a large pond. (No residual liquid from the ponds shall be released into the evaporation storm pond until it has been determined suitable for release.) A secondary precaution includes that of lining the leachate collection trenches in the landfill cells with high density poly-ethylene to further impede downward movement of leachate.

In the post-operational phase, an impermeable 0.5 meter layer of clay or similar material will be placed on top of the closed areas, to curtail the percolation of water into the cell and hence reduce the production of leachate. With these and other measures in place as outlined in the Environmental Mitigation and Monitoring plans, no significant effects on the local ground water or wells are

anticipated.

5.2.5 Vegetation and Wildlife

The development of any landfill site entails clearing and re-contouring activities, as well as the operations of the facility itself. This can result in loss of habitat for wildlife and natural vegetation, as well as a tendency to act as a barrier to wildlife movement. One particular concern that has been voiced is that the proposed landfill may adversely affect wildlife movement along the corridor which has been proposed between Mile 24 and Mile 37 of the Western Highway. This corridor is actually west of the Mile 22 site.

The current design for the landfill site incorporates a non-disturbed buffer zone of 50 meters to be established around the site using existing and newly planted trees and other broadleaf vegetation, in order to reduce the effects of noise and any other disturbances to surrounding human and wildlife populations. The site will not be fenced initially, so as to facilitate wildlife dispersion through the buffer zone areas. However, if problems do arise with pests (e.g., feral cats and dogs), a fence can be erected around the actual land-filling area.

Favourable contouring and re-vegetation of the decommissioned landfill shall be conducted so as to promote its value as habitat as a result of secondary succession. This could have the advantage of preserving the area, which is consistent with the requirements of the adjacent proposed wildlife dispersion corridor. Other plans in surrounding areas could be made in the meantime, with the knowledge that this area will be restored to allow for compatible land use.

Although the site is already partially degraded as habitat due to past gravel and clay excavation activities, some further loss of habitat will occur due to the development of the landfill facility. However, the vegetation communities that currently exist there are well represented on the coastal plains of Belize, and this

will not represent a significant loss in terms of habitat for plants or animals, for commercially important plants / animals, nor for sensitive habitats.

The development of an Interpretive Centre to explain the mitigation and monitoring features of the sanitary landfill and the importance of reducing and recycling solid wastes, should be considered. This activity could be undertaken in coordination with the nearby Tropical Education Centre or other NGO's.

The proposed plan will offer the long-term option of returning the land to a higher habitat value than presently exists there. With the above mitigation in place, it is anticipated that there will be no significant adverse effects on vegetation and wildlife, and indeed in the long term there may be a net positive impact.

5.2.6 Current and Proposed Land Uses

The land which has been proposed for the Mile 22 Western Highway landfill facility is privately owned by two groups and presently unused. The landowners did not show any opposition with the proposed use as a sanitary landfill, and indicated their willingness to discuss the sale of portions of their holdings. No additional mitigation is therefore required.

While there have been several proposals for residential development in the vicinity of the proposed landfill, no development plans have been presented to date for the Mile 22 site itself.

5.2.7 Traffic

Truck traffic resulting from the operation of the regional waste management facility at Mile 22 of the Western Highway is estimated to amount to an additional 20-30 large trucks per day travelling to and from the facility. This represents an increase in total traffic of approximately 1-1.5, and of heavy traffic approximately7.5-10%, based on available data.

The increase in heavy traffic, from about 360 vehicles per day to about 380-400 vehicles per day is very small and would represent an almost insignificant increase threat to safety, provided that the timing of waste management vehicle transit is distributed over the course of any working day and during the week.

The location of the landfill access point from Mile 22 is at the beginning of a long stretch of straight highway with no substantial visual obstructions for more than 1.875 miles (3 kilometers) to the west. The easterly direction looks into a long "S" curve and sight disturbances are in the order of 975 -1625 feet (300-500 meters).

The access point from the alternative access road at approximately Mile 24 requires 500 meters of service road to be constructed parallel to the highway to improve site distances to the west.

Provision is to be made for widening the Highway to provide both eastbound and westbound turn lanes at the access point. The landfill access road of approximately 3.8 Km in length will be constructed to high quality standards (paved) along a realigned existing right of way or existing trail. The Mile 22 road will require placement of fill to raise the road bed about 1.0 to 1.5 meters, along the lowlands it crosses. Attention will be directed to the handling of storm water along the road with a series of culverts and one large concrete box culvert.

The Mile 24 road can be constructed without these large fills as it does not cross low palmetto areas.

A wet weather disposal area will be developed on site at the landfill to reduce the tracking of mud onto the access road.

With the above mitigation measures in place, there should be no significant

reduction in traffic safety or efficiency of traffic flow as a result of mud on the highway from the operation of the landfill facility, with either access road alternative.

5.2.8 Disturbances

While some degree of noise from landfill machinery may be heard in surrounding areas, the establishment and maintenance of a treed buffer zone around the site will serve to reduce noise levels beyond the site.

Dust suppression measures will be used during construction and operational phases of the landfill, for example compaction of surfaces and the use of water on internal cell access roads.

Application of daily cover material is critical in reducing the landfill's attractiveness to pests such as rodents, insects, feral dogs and cats, and birds. In addition, the working face of the landfill must be kept as small as possible, reducing the amount of fresh waste exposed to the air. Compaction of the waste in the landfill serves not only to reduce odour and pest problems, but to minimize the escape of windblown litter.

To control litter, all incoming vehicles must be covered (e.g., with netting or tarp), and site staff should be assigned as necessary to regularly retrieve litter which happens to escape from the landfill site or collect along the access road.
The treed buffer zones will also minimize visibility of the site from adjacent areas during construction and operation of the facility. After landfill closure, the landfill will be re-contoured and re-vegetated so as to provide an acceptable visual presentation.
With the measures of the Environmental Mitigation and Monitoring Plans fully implemented, it should be possible to prevent practically all disturbances to

neighbouring institutions or residences.

5.2.9 Historical Resources

Because the site is far from any major river and not in an area with abundant caves, artifacts of historical importance are not likely to be found at the proposed landfill site. Furthermore, much of the surface layers at the site have already been removed or disturbed by quarrying activities. The site has been field checked and cleared by staff from the Institute of Archaeology.

If mounds, clay-works or other artifacts of possible historical importance are found or if archaeologically significant evidence is encountered on the site during clearing or construction, the Institute of Archaeology must be contacted to determine a recommended action.

5.2.10 Other Beneficial Results

There will be considerable environmental benefit resulting from the development of the Solid Waste Master Plan (SWMP), including the regional sanitary landfill, in terms of an improved waste disposal system for Belize, resulting in less illegal dumping, litter, odour, pests or other environmental impacts.

An important environmental benefit will be the closure and rehabilitation of the dumpsite at Mile 3 that currently serves Belize City, with replacement by a transfer station to be located at the existing site.

In addition, it is planned to also close the Western Landfill site located midway between Benque Viejo and San Ignacio Towns and construct a transfer station to serve this San Ignacio, Benque region.

The closure of these two landfills will offer environmental improvements to both these existing sites.

Both Caye Caulker and San Pedro dump sites will be rehabilitated and converted to transfer/recycling stations with net positive environmental benefits to immediate and surrounding environment.

An overview of the environmental impact evaluation for transfer stations is included as Appendix H. This is presented as a generic discussion of the benefits that will derive from instituting waste transfer in place of improper landfilling. The transfer stations are also dependent on good operating procedures, but offers a much reduced and controlled work area rather than a landfill, and more limited environmental impact.

A positive feature of using the Mile 22 Western Highway site for a regional sanitary landfill is the abundance of cover material. This could be used not only for cover material for that site, but also excess materials could be backhauled to other existing disposal sites to solve problems there, notably at the Mile 3 Site near Belize City.

6.0 ENVIRONMENTAL MITIGATION

This Environmental Assessment includes a Mitigation Plan that defines design and operational measures to prevent or mitigate adverse impacts related to the construction, operation and closure phases of the proposed Mile 22 Regional Sanitary Landfill facility and supporting transfer/ recycling facilities in Belize City, San Pedro and Caye Caulker. These measures must be implemented in order to build and operate the facility in an environmentally sound fashion.

6.1 Transfer/ Recycling facilities-Belize City, San Pedro, and Caye Caulker

The plan proposes mitigation measures and related actions dealing with:

- Source separation
- Rehabilitation
- Recycling Facility
- Composting
- Transportation and Safety
- Ground and surface water protection
- Fire prevention and contingency
- Avoidance of Disturbances

6.2 Regional Sanitary Landfill: Mile 22

The plan proposes mitigation measures and related actions dealing with:

- security and access;
- traffic and safety;
- soils and terrain stability;
- surface water management;
- ground water protection;
- vegetation and wildlife habitat and dispersion;
- current and proposed land uses;
- avoidance of disturbances to proposed developments (noise, dust, pests, aesthetics);
- protection of historical resources;
- landfill gas control and management;
- fire prevention and contingency;
- closure plans;
- public consultation and awareness; and
- community involvement.

7.0 ENVIRONMENTAL MONITORING

An Environmental Monitoring plan is proposed to ensure that pollution or related problems are discovered in time to prevent or repair adverse effects, and to evaluate the success of mitigation or preventive measures set out in the design. Monitoring is proposed for the following areas:

Surface water quality (on-site and in surrounding watershed including the Belize River, Caribbean Sea);

- leachate management and ground water quality;
- landfill gas;
- odor and other public nuisances;
- historical resources; and
- traffic safety and efficiency.

The monitoring plan is to extend through the post-operational phase and will include results reporting to the Department of the Environment (DOE).

8.0 STAFFING AND TRAINING

In order that the proposed new waste disposal facility and transfer stations are operated in a satisfactory and environmentally sound fashion, trained and qualified staff should be available for various key areas, including: fire control and prevention; waste segregation and handling; leachate management; application of cover material; landfill gas collection, treatment and monitoring; leachate, ground water and surface water quality sampling procedures; dealing with the public; addressing pest problems; litter control; and awareness of relevant environmental issues. In addition it is proposed that someone trained in law be hired or retained so as to be able to provide the legal support needed by the local governments in reviewing and vetting waste collection and transportation contracts. This function is presently envisioned to be provided under the auspices of the Solid Waste Management Authority.

9.0 LEGISLATION AND INSTITUTIONAL ARRANGEMENTS

A review of the state of environmental and related legislation and institutional mechanisms in Belize, as related to the SWMP, was conducted. Recommendations are made for refinements or additions to: the Solid Waste Management Authority (SWMA) Act; the relationship between the Department of Environment (DOE) and the SWMA; the Environmental Protection Act; and the Littering and Derelict Vehicle regulations.

The Environmental Protection Act should be amended to establish regulatory mechanisms for the issuance of permits to construct and operate landfills. The Act should also empower the DOE to licence redemption depots where containers could be deposited as well as the licensing of the processing of recyclables; and the licensing of other solid waste processing facilities.

The SWMA should be responsible for regulating the operation and management of solid waste facilities; while the Department of Environment responsible for granting permits for the location, design and operational parameters of landfills and solid waste sites, for monitoring and enforcement, and for policy development. Thus in fact the SWMA is the hunter and the DOE is the game warden.

10.0 OPERATION

Proper operation of the site as a sanitary landfill is extremely important to implementing the recommended mitigation measures to avoid the corresponding impacts. To this end, it is recommended that an operational Performance Security provision be made by the designated operator, or the SWMA, over the life of the site. A $100,000 Belize Performance Security is proposed that could be accessed by the Department of Environment to rectify problems that might be attributed to non-compliance with the recommendations of this EIA.

11.0 RECOMMENDATIONS

It is recommended that the disposal component of the preferred option presented in the SWMP proceed with a regional sanitary landfill disposal facility established at the Mile 22 Western Highway site and the rehabilitation and conversion of supporting transfer/recycling facilities for Belize City (Mile 3 site), San Pedro and Caye Caulker. It should incorporate all of the mitigation features outlined in the Report including surface water management, leachate collection and treatment, treed buffer zones, landfill gas management, wet weather operations area, litter control, and contained storage for recyclables.

Other recommendations from the Solid Waste Management Plan include:

- waste transfer stations must be established at the Mile 3, Western Highway location, for wastes originating in the Belize City area and disposed at the Mile 22 sanitary landfill;
- waste transfer station to be established at the Western Sanitary Landfill for wastes originating in the Benque, San Ignacio area and disposed of at the Mile 22, Sanitary Landfill;
- waste transfer stations at the Cayes (Ambergris and Caulker) for wastes originating on these Cayes. Wastes will be shipped in specialized containers, by barge and truck and disposed of at the Mile 22, Sanitary Landfill;
- sorting of wastes to be conducted at the transfer station to remove environmentally hazardous materials and to initially recover a limited quantity of recyclable items. The level of recycling could increase in time as staff become more familiar with operations.
- institutional requirements outlined in EIA Report to be implemented, and;
- existing disposal facility at Mile 3 of the Western Highway to be suitably reclaimed, possibly using material from the Mile 22 site for cover if this proves to be economical.

Recommendations to support this EIA document include:

- consideration of the proposed adjacent wildlife dispersion corridor that crosses the Western Highway to be taken into account in developing the post-closure contouring and re-vegetation plan;
- Community Advisory Committee to be established, to facilitate involvement of neighbouring communities in the operations and monitoring of the Mile 22 disposal facility, and to participate in monitoring programs with full access to monitoring data;
- discussions to be held with representatives of NGO's, such as the Belize River Watershed Association and SWA, towards their involvement in the downstream monitoring of water quality in the Belize River;
- consideration to be given to engage members of the local community in employment opportunities at the disposal facility, or in assisting in the cleanup of existing solid waste in unauthorized locations; and
- establish an Interpretive Centre at or near the Mile 22 sanitary landfill to increase public awareness of solid waste and waste minimization issues.

To build and operate the proposed sanitary landfill facility and supporting transfer/recycling facilities in an environmentally acceptable fashion and in order to avoid complaints from neighbouring facilities/communities, the measures proposed in the Environmental Mitigation and Monitoring plans of the EIA Report must be fully implemented and evaluated on an ongoing basis.