

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

5.0 Potential Environmental Impacts

5.1. Transfer/Recycling Facilities

In the instance of supporting facilities – Transfer/Recycling Facilities for Belize City, San Pedro, and Caye Caulker, a more simplified approach was taken and the issues were dealt with collectively. Areas that were addressed are:

- Air Quality/ Odor
- Soils and Terrain
- Surface Water
- Ground water
- Vegetation and Wildlife
- Sensitive Habitats
- Current and Proposed Land Uses
- Traffic
- Disturbances (Noise, Pests, Dust, Aesthetics, etc.)
- Historic Resources
- Ongoing Operations of the Site over the design life

5.1.1 Belize City: Miles 3 Site

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 sources 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.



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

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.

Leachate also poses an environmental risk, particularly to surface water. 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 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.



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

The proliferation of vermin and other pest is serious public health concern in particular when one considers that the Island 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.

A recent study conducted by ETEISA indicated that both surface and ground water was being contaminated by leachate produced at the Dump. There exists the possibility that the 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 odors 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.



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

5.1.3 Caye Caulker

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 usually 12-18 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.

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.

5.2 Regional Sanitary Landfill: Mile 22 Site

5.2.1 Introduction

The evaluation of environmental and related socio-economic impacts related to the development and operation of the proposed Sanitary Landfill facility at the site designated as Mile 22 has been prepared through the examination of individual environmental components that are potentially affected by the proposed activities. This examination assesses the following:



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

- How, likely is the impact is to occur (likelihood or probability);
- What is the magnitude of the impact if it does occur, and whether it is positive or negative (significance);
- What is the timeframe over which the impact is likely to be experienced (long-term, short-term);
- Whether the impact can be reduced (mitigation); and
- Whether the impact can be prevented.

The environmental components to be considered are as presented below:

- Air Quality/ Odor
- Soils and Terrain
- Surface Water
- Ground water
- Vegetation and Wildlife
- Sensitive Habitats
- Current and Proposed Land Uses
- Traffic
- Disturbances (Noise, Pests, Dust, Aesthetics, etc.)
- Historic Resources
- Ongoing Operations of the Site over the design life

Table 5.1 identifies the potential environmental impacts stemming from the proposed landfill project, for construction, operations and post-closure phases, for each of the above environmental components.

The remainder of this Section presents a discussion of impacts for each environmental component, in terms of the potential impact, the proposed mitigation to prevent/reduce adverse impacts, and anticipated *residual* impacts (i.e., the degree of impact and issues remaining after mitigation has been implemented). The significance of the anticipated residual impacts is then



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

assessed. Table 5.2 contains a summary of the impact and recommended mitigation measures.

5.2.2 AIR QUALITY

5.2.2.1 Potential Impacts

- The generation and release of landfill gas from the fill site;
- Landfill odors reaching residential developments; and
- Smoke and dust from fires and the activities of on-site machinery at the landfill site.

Without mitigation, there is the potential for odors from waste material in the landfill to reach future adjacent residential lands to the south west of the landfill site when days are calm. Landfill gas (chiefly carbon dioxide and methane) is normally produced as a result of decay processes in any sanitary landfill facility and again can migrate under calm weather conditions.

Also smoke from fires and dust from the activities of machinery at the landfill are other possible irritants to nearby human populations.

5.2.2.2 Proposed Mitigation and Residual Impacts

5.2.2.2.1 Landfill Gas

Landfill gas is a product of all municipal solid waste landfills, and occurs as a natural consequence of the microbial breakdown of the waste material. The flaring of landfill gas (or, if in sufficient quantities, its use as an energy supply) are accepted practices in contemporary landfill operation when the site is in very close proximity to urban development. At remote sites the normal



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

practice is to allow the gas to vent to the atmosphere and be taken up by vegetation. Landfill gas contains primarily methane and carbon dioxide, with smaller amounts of hydrogen and various trace chemicals in small quantities. At an early stage of degradation, the proportion of carbon dioxide is high, but as a landfill ages, the process gives off a progressively higher proportion of methane. The planning of a large municipal landfill usually has some future provisions for landfill gas collection and possibly flaring. Flaring will burn the produced methane, converting it to carbon dioxide, heat and water vapor. Neither methane nor carbon dioxide are particularly harmful, although both are “greenhouse” gases, implicated as contributors to global warming.

The actual quantities for a landfill of this size, however, are very small compared to the emissions from diesel engines and automobiles along the Western Highway for example.

A portion of gases that would vent to the surface from a municipal waste landfill, would be absorbed by the green foliage of broad leaf plants in the buffer zones. With the natural buffers and state of the surrounding areas this would reduce the problems offsite, at the Mile 22 Site. Subsequent flaring of landfill gas, albeit an expensive and complex operation, could provide small environmental benefits but this process is not economically justified at the Mile 22 site.



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT: MILE 22

**Table 5.1
List of Potential Impacts**

Air Quality	<ul style="list-style-type: none"> • generation of landfill gas from the landfill site • landfill odours • smoke and dust from fires and the activities of on-site machinery at the landfill site
Soils and Terrain	<ul style="list-style-type: none"> • erosion of bare slopes during construction and operational phases • slope erosion in post-closure condition
Surface Water	<ul style="list-style-type: none"> • Introduction of contaminants from surface runoff water from landfill to adjacent surface waters • Introduction of sediment into adjacent surface waters
Groundwater	<ul style="list-style-type: none"> • leakage of leachate from landfill cells into ground water, affecting ground water quality, well water, and potentially surface water at discharge points
Vegetation and Wildlife	<ul style="list-style-type: none"> • loss of habitat for wildlife; • loss of vegetation of potential commercial value; • disruption of wildlife dispersion; • loss of habitat for rare or endangered species;
Current and Proposed Land Uses	<ul style="list-style-type: none"> • conflict of landfill siting and operation with future land uses
Traffic	<ul style="list-style-type: none"> • Increase in truck traffic on the Western Highway, with consequent reduction in traffic safety and efficiency • safety risk due to trucks entering or exiting the landfill access road at mile 22 • damage to highway from increased truck traffic
Disturbances	<ul style="list-style-type: none"> • disturbance from noise of machinery in landfill • disturbance from pest populations attracted to the landfill • litter and dust generated at the landfill • increased illegal dumping along access road.
Historical Resources	<ul style="list-style-type: none"> • loss of possible artifacts with historical/archaeological importance due to construction and related activities
Operations	<ul style="list-style-type: none"> • If proper site operations are not achieved all above impacts could be compounded.
Other Factors	<ul style="list-style-type: none"> • Improvement of environmental problems at existing landfills in surrounding communities

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT: MILE 22

Table 5.2

Key mitigation measures recommended to avoid or minimize potential impacts
(see also Environmental Mitigation, Section 6)

Potential Impact	Recommended Mitigation Measures
<p><i>Air Quality</i></p> <ul style="list-style-type: none"> • generation of landfill gas (LFG) from the landfill site • landfill odors • smoke and dust from fires and on-site machinery 	<ul style="list-style-type: none"> • buffer zones to be revegetated with broad leaf trees/plants • gas collection wells to be installed if monitoring systems indicate significant LFG production • on-site and other enclosed structures to be monitored regularly • working face of the landfill to be confined to the extent possible • daily cover to be applied to the working face • intermediate cover to be applied to cells not actively worked for more than 1-2 weeks • final cover to be applied to all areas that have been filled • waste to be compacted in lifts of limited thickness • all incoming vehicles to be covered • equipment to be maintained in proper running order • water to be applied to internal access roads when necessary • internal permanent access roads to be compacted and/or gravelled • fire prevention and contingency measures (see Environmental Mitigation plan)
<p><i>Soils and Terrain</i></p> <ul style="list-style-type: none"> • erosion of bare slopes during construction and operational phases 	<ul style="list-style-type: none"> • contouring of landfill and surface water diversion channels to be constructed so surface water run-on diverted around site perimeter • surface water flows to be maintained as natural pre-development levels (instantaneous) • drainage channels and storm ponds to contain 1-hour 1-in-100-year return storm event during normal operating conditions • runoff system to direct surface runoff away from areas where active landfilling in progress • drainage courses designed to keep velocities to reasonable level • culverts and rip rap to be used to limit soil erosion in drainage channels • run-off from non-contact areas to be diverted to retention pond system • number of exposed slopes and cumulative surface area to be kept to minimum
<p><i>Surface Water</i></p> <ul style="list-style-type: none"> • introduction of contaminants from surface runoff water from landfill to adjacent surface waters 	<ul style="list-style-type: none"> • landfill leachate not to discharge into non-contact water • non-contact water not to contact waste material • water collecting in open face of landfill to be retained, managed as leachate • no leachate to be released from treatment pond area until determined suitable for release • special containment measures for special wastes and recyclables storage areas

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT: MILE 22

Table 5.2

Key mitigation measures recommended to avoid or minimize potential impacts
(see also Environmental Mitigation, Section 6)

Potential Impact	Recommended Mitigation Measures
<p>Ground water</p> <ul style="list-style-type: none"> - leakage of leachate from landfill cells into ground water, affecting ground water quality 	<ul style="list-style-type: none"> - leachate containment system to be composed of thick, impermeable clay layer for each landfill cell - appropriate thickening of clay liner to be taken if permeable sand and gravel lenses exposed - leachate accumulating in each cell to drain via leachate collection system - on-site leachate retention system to facilitate anaerobic and aerobic natural treatment - each closed cell to be capped to curb leachate production
<p>Vegetation and Wildlife</p> <ul style="list-style-type: none"> - loss of habitat for wildlife - disruption of wildlife dispersion - loss of habitat for rare or endangered species 	<ul style="list-style-type: none"> - buffer zones to have an indigenous tree planting program - buffer zone to be established/maintained on all sides of the landfill site (50 m) - buffer zone to be established/maintained on all sides of the landfill site (50 m) - no fencing around buffer zone or landfill site - suitable vegetation and contouring appropriate for wildlife dispersion in post-closure phase - no mitigation required
<p>Current and Proposed Land Uses</p> <ul style="list-style-type: none"> - conflict of landfill siting and operation proposed land uses 	<ul style="list-style-type: none"> - consideration of landfill activities if plans for new residential areas are implemented in future
<p>Traffic</p> <ul style="list-style-type: none"> - reduction in traffic safety and efficiency - safety risk due to trucks accessing landfill site - damage to highway from increased truck traffic 	<ul style="list-style-type: none"> - access point at Mile 22 to be positioned so traffic visibility maximized each direction - extra turn lanes at access point, paved shoulder lanes - possible mud track from access road.

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT: MILE 22

Table 5.2

Key mitigation measures recommended to avoid or minimize potential impacts (see also Environmental Mitigation, Section 6)

Potential Impact	Recommended Mitigation Measures
<p><i>Disturbances:</i></p> <ul style="list-style-type: none"> - disturbance from noise of machinery - disturbance from pests, litter and dust generated at landfill - visual impacts from landfill 	<ul style="list-style-type: none"> - treed buffer zone to be established/maintained on all sides of the landfill site (50 m) - working face of the landfill to be confined to the extent possible - daily cover to be applied to the working face - intermediate cover to be applied to cells not actively worked for more than 1-2 weeks - final cover to be applied to all areas that have been filled - waste to be compacted in lifts of limited thickness - all incoming vehicles to be covered - dust suppression measures to be utilized - treed buffer zone to be established/maintained on all sides of the landfill site (50 m) - recontouring and suitable re-vegetation in post-closure phase, compatible with surrounding landscapes
<p><i>Historical Resources</i></p> <ul style="list-style-type: none"> - loss of historical/archaeological artifacts 	<ul style="list-style-type: none"> - Department of Archaeology to be informed if artifacts of potential significance are encountered, work at that location to stop to allow assessment and recovery if warranted
<p><i>Other Factors</i></p> <ul style="list-style-type: none"> - reduction in illicit waste dumping - improvement of environmental problems at existing landfills - Construction of Transfer Stations 	<ul style="list-style-type: none"> - Implementation of Solid Waste Management Plan - use of excess cover material at Mile 22 facility for use in reclaiming other landfills where odors, pests and pollution are problematic - Without transfer stations, site will not operate properly.

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

5.2.2.3 Dust and Smoke

The facility may create some dust resulting from vehicle movements; however there is provision for dust suppression in the design and operating plan. This involves the gravel surfacing of the access road and service roads within the site, as well as using water to suppress dust that does arise. The timeframe of the impact will be short as most of it will occur during the construction phase, and the dust issue during the operational phase is mitigable. This site will be very remote from development at the initial construction phase and should not need mitigation efforts.

Fires do occur at landfills, requiring vigilance to extinguish them quickly. Fires are usually the result of hot loads being received at landfills. These hot portions can be barbecue briquettes, smouldering vegetation, etc. With the use of transfer stations for a large portion of the MSW waste the hot loads should be greatly reduced. Loads that are directly hauled to the site could also pose a problem and site operational staff should be on the lookout for these wastes. Ideally, when a hot load is encountered it should be isolated in an open area and extinguished with water before being considered for incorporation in the fill area. Clearly, smoke irritation can be avoided through the prevention of fires at the landfill.

The Environmental Mitigation plan in this EIA sets out fire prevention procedures which should be adhered to at all times throughout the operational life of the landfill. Good communications with neighbouring facilities and surveillance for fires and dust by the landfill operating staff can prevent significant problems from occurring. Quick reaction to any observed smoldering loads will also reduce these problems.



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

5.2.2.4 Odor

Odors from decaying waste material are produced at sanitary landfills, particularly when waste high in organic material (e.g., animal waste, domestic waste, faecal waste) is disposed. It is noted that there is no existing development located within four to five kilometers downwind of the site from the proposed landfill. However, it is possible and quite feasible to prevent odors from being a problem to downwind neighbouring residents and facilities by applying adequate cover material sufficiently frequently and effectively. There is an ample supply of soil (clay, silt, sand and mixtures thereof) existing on the site, which can be used as cover material. The Environmental Mitigation plan in this EIA Report sets out the methods for applying daily cover, intermediate cover (when an individual cell is non-active for a period of time), and final cover (when the cell or landfill is permanently closed). Additionally, it is recommended that the active face (area of uncovered wastes placed during the daily operation) of the landfill at any given time be minimized. It is absolutely essential that even at remote sites the above provisions be implemented at the landfill facility, if problems with odors impinging on neighboring facilities are to be avoided. The current landfill at Mile 3.5 of the Western Highway, as currently operated, presents a readily observable odor problem for about 500 meters downwind. This is because the landfill is being operated as an area fill and cover material is not being applied regularly or adequately.

The operations at the Mile 22 site would not be a pure area fill, but rather a combination of area and trench fill operation. The abundance of on-site cover material and the site layout would allow regular covering of wastes. This allows better control of the site and would minimize the extent of the open areas of wastes. This would reduce or eliminate the problems of odor, litter dispersion, animal scavengers and pests including disease vectors.



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

Apart from this, good communications with future development and monitoring of odors by the landfill operating staff can help to prevent significant problems from occurring.

5.2.3 SOILS AND TERRAIN

5.2.3.1 Potential Impacts

- The erosion of bare slopes during construction and operational phases
- The potential for ongoing slope erosion in post-closure condition

In any landfill or similar operation, there is the potential for soils to erode or lose stability when surface water drains over them. Particulate matter may be carried offsite in surface runoff, with consequent effects on surface water quality, unless provisions are made through a storm retention pond to control this.

5.2.3.2 Proposed Mitigation and Residual Impacts

A large northerly portion of the site has already been the subject of severe erosion in the form of washed surfaces and incised gullies. This will require remediation during the initial site construction period.

The key to avoiding erosion problems is to reduce water flow over bare, erodible soils, and particularly reducing the velocity of water as it drains over the terrain or through drainage courses. This can be accomplished using effective contouring to reduce slope grades, ditch blocks to reduce runoff velocities and prompt and effective re-vegetation of bare ground whenever possible, which stabilizes the soil and helps to reduce run-off water velocities. Contouring of the landfill facility and surface water

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

diversion channels shall be constructed so that surface water run-on in the event of severe storm events is directed to the on-site storm pond. The concept shall be based on maintaining surface water flows that are no more, in terms of instantaneous flows, than what would be considered as the natural undisturbed site conditions. The storm runoff system shall be composed of use of the existing small intermittent creek, constructed drainage channels and a large storm pond such that will handle at least a one hour, 1-in-100-year return storm event.

All new and existing storm drainage courses shall be constructed to keep velocities to a reasonable level and the use of culverts, ditch blocks and rip rap will be undertaken to limit soil erosion in drainage channels. As the development and operation of the landfill progresses, the number of slopes that will be exposed at any given time, and their cumulative surface area, shall be kept to a minimum. For the post-operational phase, the landfill shall be capped, contoured, and vegetated appropriately, with full attention to providing effective drainage and erosion prevention. All slopes on finished areas will be limited to a slope no steeper than 1 vertical to 6 horizontal, in order to limit soil erosion. This can be compared to normal sites that have steeper slopes in the range of 1 to 3.

It is expected that if these measures including the storm pond are put into effect, the landfill may be constructed, operated and decommissioned with no significant adverse effects to soils or to surface water through the effects of soil erosion.



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

5.2.4 SURFACE WATER

5.2.4.1 Potential Impacts

- The introduction of contaminants to surface runoff water that has been in contact with wastes from the landfill to adjacent offsite surface waters. One concern that was raised during public meetings is the possibility that contaminants from the waste might enter surface runoff water from the landfill and reach major surface water courses such as the Belize River.

5.2.4.2 Proposed Mitigation and Residual Impacts

A number of measures are proposed as part of the Environmental Mitigation and Monitoring plans to ensure that surface water quality in the watershed surrounding the proposed landfill will not be adversely affected. Some of the key features are as follows.

- All landfill surface runoff will be directed to a large on-site holding pond where it will undergo natural aerobic stabilization and sedimentation. These ponds will be sized to handle a 1/100 year 1 hour return storm event, during normal operations of the landfill.
- Only surface water that has **not** come into contact with the waste material (i.e., noncontact surface water) will be allowed to directly enter the storm water holding pond.
- All contact water will be conveyed to the leachate retention and treatment ponds described in following sections. In the initial stages of operation of each landfill cell the surface run-off will be diverted into the leachate collection and treatment system, until it can be adequately handled as clean water.

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

- During construction, appropriate measures including provision of berms, silt traps, etc., will be taken to ensure that significant amounts of sediments do not impact adjacent watercourses.
- Upon closure of the landfill, the surfaces will be contoured and re-vegetated in such a way as to prevent erosion and resulting sedimentation of adjacent surface waters.

Because only the **non-contact** surface water or treated leachate will be allowed to directly enter the surface water holding pond, it will represent a similar water quality to what is currently running into adjacent drainage from the site today, apart from higher suspended solids (from the work and landfilling activities). The retention of the surface runoff in the pond will allow an opportunity for sedimentation and removal of suspended particulate material.

Regular monitoring of surface water quality at key locations shall be conducted at critical points in the watershed throughout the construction and operational life of the landfill. This will include not only points immediately adjacent to the site, but also in the surrounding creeks, lagoons, and the 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 are anticipated.

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

5.2.5 GROUND WATER

5.2.5.1 Potential Impacts

- The leachate from landfill cells may leak into ground water, affecting groundwater quality, well water, and potentially surface water at discharge points

A potential impact that must be mitigated at many sanitary landfill sites is the possibility that leachate from the waste cell is allowed to enter the ground water underlying the site. This could have long-term adverse effects on ground water quality, well water quality, and surface water quality stemming from discharge of the ground water to the surface water. It is noted that there are no known active wells within about 4 kilometers of the Mile 22 landfill site. The closest being the Jih Chan well.

Three on-site bore holes each to 15 meters (50 feet) did not initially encounter any ground water at this site. Two of these boreholes were at the lowest elevations of the site. Subsequent elevation observations indicate a ground water level of approximately 10-11 meters above sea level. This is not a true level of ground water but an indication of the pressure in the deeper aquifer.

5.2.5.2 Proposed Mitigation and Residual Impacts

A normal mitigative practice in landfill operation is to provide a liner – either natural or synthetic - to contain the leachate. The leachate is collected via a system of pipes and pumps where necessary, and segregated for treatment. A natural liner normally consists of impermeable clay.

The proposed sanitary landfill at the Mile 22 site has been selected partly to take advantage of the significant depths of impermeable clay found in the

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

borehole program, which will act as a natural liner, preventing percolation of leachate into potentially a much deeper groundwater regime.

In the proposed design of the facility, the leachate will be collected from each cell and will be conveyed by gravity, to a series of three leachate ponds, which will also be lined with HDPE or constructed using the native impermeable clays. Leachate will undergo natural anaerobic treatment in these cells followed by aerobic (oxidative) treatment, before draining to a large pond. Here, the water will be allowed to evaporate but in addition, will undergo further purification through the effect of natural wetland vegetation (which will tend to assimilate nitrates and phosphates, heavy metals, etc.). No leachate shall be released from the pond area until analyses for basic parameters have been completed and it has been determined suitable for release.

The leachate cells will be sized to also accommodate the incident rainfall from a 1- hour 1/100 year return storm event during normal operating conditions, plus the amount of leachate produced in a 40-day period. While average rainfall data and evaporation rates indicate that at most times of the year, evaporation will occur at a rate to avoid overflow from the pond, the water in the pond can also be removed by pumping for use on roads or re-circulating in the waste pile. The re-circulation of leachate through the landfill wastes is proposed for this site. This process for landfill operation is commonly referred to as a “Bio-Reactor” landfill. The re-circulation of leachate through the wastes speeds up the overall decomposition of organics by providing adequate moisture for the bio-degradation process.

The waste stream will be screened at the transfer stations to remove household and other hazardous materials such as batteries, solvents, used oil, chemicals, etc., which normally contribute high levels of contaminants



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

such as heavy metals and toxic organics to the waste stream. (These need to be handled as an aspect of the overall Waste Management Plan).

In the post-operational phase, an impermeable 0.5m layer of clay or similar material will be placed on top of the closed cells, to curtail the percolation of water into the cell and hence the ongoing production of leachate.

With the groundwater protection that will be provided by the natural clay at the site, with the leachate collection and management system in effect, with the screening of the incoming solid waste stream, and with the proper closure of each cell so as to curtail the production of leachate, as well as other measures outlined in the Environmental Mitigation and Monitoring plans, no significant effects on ground water is anticipated.

5.2.6 VEGETATION AND WILDLIFE

5.2.6.1 Potential Impacts

- The loss of habitat for wildlife;
- The loss of vegetation of potential commercial value;
- The disruption of wildlife;
- The loss or disturbance of habitat for rare or endangered species; and
- The loss of critical or sensitive habitats.

The development of a proper 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.

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

5.2.6.2 Proposed Mitigation and Residual Impacts

The current design for the landfill site incorporates an undisturbed buffer zone of 50 meters to be established around the site using existing and in some places planted trees and other vegetation, in order to reduce the effects of noise and other disturbance to surrounding human and wildlife populations. In addition, a 100 meter buffer will be placed around the onsite creeks. The site will not be fenced initially, so as to facilitate wildlife dispersion through the buffer zone areas. If problems with pests (e.g., feral cats and dogs) become a concern, however, there will be provision to erect a fence around the area as it is being used.

Additionally, favourable contouring and re-vegetation of the decommissioned landfill shall be conducted so as to promote its value as habitat. Suggested vegetation plans include restoring it to be similar to surrounding landscapes. The buffer zones will have additional trees planted in them as required to increase the vegetation coverage around the site perimeter.

The Mitigation Plan recommends that the Solid Waste Management Authority (SWMA) consider the future 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. This could be done in coordination with the Tropical Education Centre, to complement its theme of biodiversity and conservation. While a small loss of habitat will occur for a time due to the development of the landfill facility, the vegetation communities that currently exist there (i.e., pine savannah, thicket hardwood trees) are well represented on the coastal plains of Belize. This will not represent a significant loss in terms of habitat for plants or animals, nor for commercially important plants/animals. In addition, a large portion of the site has already been significantly

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

diminished of habitat due to past excavation activities and most recent use as a temporary log storage area for logging activities in the immediate area. It would appear to be of less value for wildlife habitat compared to the surrounding areas.

The proposed plan will offer the option of returning the land to an equal or higher value for habitation than present conditions, through favorable contouring and re-vegetation to promote its value for habitat and wildlife dispersion. 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.

5.2.7 CURRENT AND PROPOSED LAND USES

5.2.7.1 Potential Impact

- The conflict of landfill siting and operation with current or proposed land uses

5.2.7.2 Proposed Mitigation and Residual Impacts

The land which has been proposed for the Mile 22 landfill facility is privately owned and presently unused. The landowners have shown interest with the proposed use of the two blocks of land as a sanitary landfill. No additional mitigation is therefore required.

While there have been several proposals for residential development in the vicinity of the proposed landfill, the implementation of these plans has not moved to the point where irresolvable land use conflicts are inevitable. Some surveying posts in the Olympic development area to the east have been seen in the field but these have not been confirmed by development plans.



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

When new development plans are considered for adjacent properties, the regulatory agency should ensure that they are done so as to avoid land use or other conflicts involving the landfill facility.

5.2.8 TRAFFIC

5.2.8.1 Potential Impacts

- An increase in truck traffic on the Western Highway, with consequent reduction in traffic safety and efficiency;
- The safety risk due to trucks entering or exiting the access road to the distant landfill site; and
- Possible damage to highway from increased truck traffic

5.2.8.2 Proposed Mitigation and Residual Impacts

With the waste transfer stations that are proposed in the SWMP in place, the transfer 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 heavy 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 approximately 7.5-10%, based on the data obtained from Mile 35, some eight miles (13 km) to the west. The increase in heavy traffic, from about 360 vehicles per day to about 380-400 vehicles per day is very small and would pose an almost insignificant threat to safety, provided that the timing of waste management vehicle traffic is more or less distributed in time over the course of any day, or days during the working week.

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

Although no data on traffic densities by hour of the day were available, the Western Highway from Belize City to Belmopan is rather heavily used in the morning and evening periods, as those who live in Belize City and work in Belmopan commute. It is recommended that the traffic densities be monitored at intervals to ascertain that waste management vehicles travelling to and from the Mile 22 Sanitary Landfill facility are not posing a safety or traffic flow problem on the Western Highway.

The location of the landfill access point, at the beginning a long stretch of straight highway with no substantial visual obstructions for more than 1 mile to the west with a lesser distance of 300 – 500m to the east. Adequate controls and signage (i.e., suitable speed limit, and no-passing zone) will be installed at the appropriate points east and west of the Sanitary Landfill access point.

In the case that the alternative access road is selected, a 400-500m service road to the east of the existing junction will be required. This is needed to provide adequate site distance to the west.

The Environmental Mitigation plan calls for turn lanes at the Sanitary Landfill access point, in the form of paved shoulder lanes both eastbound and westbound and the access point to be set at right angles to the Western Highway. A free right turn lane will be presented in the design for traffic entering the access road from the east. In the landfill site itself, an area will be excavated and set aside for the wet weather disposal of wastes. This area will reduce the tracking of mud onto the access road. The distance between the landfill site and the Western highway is sufficient that all tracking of mud will be on the access road and not carried over to the Highway. It is proposed that the access road be a high standard gravel road initially and this could have some tracking of mud onto the Western Highway during rainy period unless a portion of the access road at the junction is paved.



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

With the above mitigation measures in place, there should not be a significant reduction in traffic safety or efficiency of traffic flow as a result of the operation of the landfill facility.

5.2.9 DISTURBANCES

5.2.9.1 Potential Impacts

- The disturbance of adjacent facilities from noise of machinery in landfill;
- The disturbance of adjacent facilities from pest populations attracted to the landfill;
- Litter and dust generated at the landfill and distributed to neighbouring properties; and
- Visual impacts from landfill or litter.

The problems of noise, pests, litter and visual impact are all familiar problems associated with landfill or other related waste management facilities that are improperly operated. The future Black Orchid Garden development plus the Jih Chan subdivision when fully developed are the potential receptors of noise, pest, litter, and visual impacts from the landfill construction or operations. If additional plans for residential developments are realized during the life of the facility, they will also need to be taken into account as potential receptors.

5.2.9.2 Proposed Mitigation and Residual Impacts

While noise, pests, litter and visual impacts are potential problems of landfill operations, there are operational means of addressing all of them, and the difference between a well-run facility and a poorly operated one is often manifested by the frequency of complaints about these disturbances.



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

The Environmental Mitigation plan in this EIA Report sets out a number of ways for managing the above potential disturbances. They are summarized below. While some degree of machinery noise may be heard in surrounding areas, the Re-vegetation and maintenance of a treed buffer zone of 50 meters around the site will serve to reduce the noise levels heard beyond the site. Normally this is reduced to zero at about one kilometer distance.

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

As outlined above, the 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. The existing Mile 3 - 3.5 landfill, for example, is frequented by numerous vultures who feed on the waste organic materials. However, the Mile 3-3.5 site is operated as an "area fill" in which there is a large surface of exposed waste to which very little or no cover material is applied. As a result, the birds are attracted to the odor of the decaying material. These birds can at most times be seen circling above the landfill and/or on the landfill feeding on the waste.

Effective and regular application of cover material as specified in the Environmental Mitigation plan, however, should reduce the attraction of these and other pests and animal scavengers to levels that are not a nuisance to surrounding areas. In addition, the working face of the landfill should be confined as much as possible, reducing the amount of fresh waste exposed to the air. Finally, compaction of the waste in the landfill serves not only to reduce odor and pest problems, but to minimize the escape of windblown litter.



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

To control litter, all incoming vehicles should 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 at its periphery. This crew should also clean the access road ditches adjacent to the site on a regular basis. It is recommended that all of the above problems be monitored by visual or other inspection by landfill staff on a regular basis, and that good communications be maintained with the surrounding neighbours and a Community Advisory Committee, where they exist. In this way, emerging problems can be addressed promptly so as to prevent serious disturbances.

In terms of aesthetics, the treed buffer zone will minimize visual impact from the perspective of adjacent areas during construction and operations. After landfill closure, the landfill will be re-contoured and re-vegetated such as to provide an acceptable visual presentation, using graded slopes and suitable species of grass or other vegetation.

In addition, it is recommended that the operator of the landfill post a BZ\$100,000 performance security, that can be accessed by the Department of Environment, if any remedial actions related to poor operational procedures are required.

With the measures of the Environmental Mitigation and Monitoring plans fully implemented, it should be possible to prevent significant adverse impacts in the form of disturbances to neighbouring institutions or residences.



BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

5.2.10 HISTORICAL RESOURCES

5.2.10.1 Potential Impacts

- The loss of artefacts of historical/archaeological importance due to construction and related activities.
- Construction, clearing and related activities could result in the loss or damage of buried or surface artefacts of potential historical importance.

5.2.10.2 Proposed Mitigation and Residual Impacts

Consultation with the Institute of Archaeology indicated that the area in which the proposed site is located lies in forest, pine savannah and wetland country and not known for the existence of caves (which are richly endowed with historical artefacts in Belize). Furthermore, because the site is far from any major river, artefacts that are typically found on historic river routes would not be encountered there. These factors, together with the fact that much of the surface layers at the site have already been removed or disturbed by quarrying activities makes it unlikely that historic artifacts would be found on the site.

While it is not likely that any historic artifacts would be found at the site, “mounds” containing Mayan cultural remains are sometimes found away from caves, river routes and other indicators of high archaeological potential. The site has been traversed by many persons on the project team without observations of any such remains.

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

If mounds, clayworks or other artifacts of possible historical importance are found on the site during clearing or construction, however, the articles shall be left, work in the immediate area should halt temporarily, and the Institute of Archaeology contacted to determine the potential importance and the recommended action. Given the above, it is not anticipated that any significant loss or damage to historical resources will result from the development of the proposed landfill.

5.2.11 Other Factors

Provided that the general recommendations of the Environmental Mitigation and Monitoring Plans of this EIA Report and the Solid Waste Management Plan are implemented, the loss resulting from the use of the site under consideration as a new regional landfill facility would be outweighed by the environmental benefits such as improved waste disposal system for Belize, resulting in less litter, odor and pests. One positive feature of using the Mile 22 site for a regional sanitary landfill is the abundance of cover material. This material could be used not only for daily, intermediate and final cover at the site, but also for reclaiming existing problem landfills and dumps, such as the one at Mile 3-3.5 of the Western Highway and as base material for the sites at San Pedro and Caye Caulker composting facility.

Risks of significant adverse impacts to other components of the environment, after mitigation, are judged to be low.

