

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

6.0 ENVIRONMENTAL MITIGATION PLAN

6.1 Introduction

The foregoing Sections in this report provide an assessment of potential Environmental impacts, as they affect surrounding air, water, soil, ecosystems, and human communities. In most cases, it is possible to reduce potential adverse impacts to insignificance, either through effective design or through sound operational management of the solid waste facilities. The following Environmental Mitigation Plan defines a set of design and operational measures to prevent or mitigate adverse impacts related to the construction, operation and closure phases of the proposed Regional mile 22 sanitary landfill facility and supporting facilities Transfer/ Recycling Facilities in Belize City (mile 3), San Pedro and Caye Caulker . These measures must be included in the site design and operational manuals in order to build and operate these facilities in an environmentally sound fashion.

6.2 Transfer/ Recycling Facilities- Belize City Mile3 Site, San Pedro and Caye Caulker

6.2.1 Traffic and Safety

1. For Belize City' s Transfer/Recycling Facility located at mile 3 on the Western Highway a new access road has been built at mile 3 ½ that would allow the site greater setback distance from the highway. This setback distance will in turn allow for safer access and improvement of the area' s aesthetics. Presently both accesses for the sites in San Pedro and Caye Caulker are adequate.
2. Adequate controls and signage shall need to be installed at the junction of access roads and other strategic points.
3. Roll-on and Roll off Containers will be sized appropriately to allow for optimum storage and safe transport to and from wharfing facilities in Belize City, San Pedro and Caye Caulker. These containers will be covered during transportation so as to prevent the release of garbage in the event a barge sinks or a container falls off as a result of inclement weather. All containers will be visibly labelled.

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6.2.2 Aesthetics / Green Belts

1. A Green Belt, consisting of thick indigenous vegetation will be grown around the perimeter of the sites in Belize City, /San Pedro and Caye Caulker to block the view of the operations occurring on the site.
2. All three sites will be remediated and the aesthetics of the Area greatly improved.
3. The active areas of these sites will be fenced to prevent litter being blown.

6.2.3 Control of Smoke, Litter, Pest and Odor

1. Open Burning of Garbage will be discontinued on all sites. The occurrence of spontaneous fires shall also be eliminated since all site will be required to be kept clean and garbage stored only on a temporary basis until there transfer to the Regional Sanitary landfill.
2. Odor from the composting of organics will be controlled through regular turning and the planting of a green belt around the sites. In addition waste will be maintained dry as much as possible and only stored temporarily. Roll-on Roll-off containers will be covered to contain odor and prevent access by vermin.
3. The working area for garbage separation and composting shall be confined as much as possible, reducing the amount of fresh water exposed to the air.
4. Site Staff shall be required to regularly retrieve litter within the site and off sites along the access roads and litter around the periphery of the sites.

6.2.4 Leachate Control and Groundwater Protection

1. Composting Sites In San Pedro and Caye Caulker will be lined with artificial plastic liners to prevent percolation of leachate into groundwater.
2. The composted waste will be turned on a regular basis to allow for more rapid breakdown and windrow covered during excessive rainy periods.
3. Composting sites will be elevated and the drainage around it designed to carry away storm water run-off away from the site.

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6.2.5 Waste Reduction and Recycling

1. Waste reduction and recycling will be actively encouraged through the implementation of a public education program.
2. Plastics will be shredded and bailed for recycling.
3. Metal containers will be crushed and compacted and sold to recyclers.
4. Bottles will be crushed and used as fill.
5. Hazardous waste such as batteries from golf cart and vehicles will be stored in a properly constructed bonded, and roofed area until transported for recycling or final disposal.

6.2.6 Fire Prevention and Contingency

1. Waste arriving at transfer/ recycling stations shall be monitored to ensure that explosive or flammable waste is separated from the other waste.
2. Site rules shall include appropriate fire prevention precautions, including restrictions on smoking and open flames on site.
3. A fire contingency plan shall be in place, and will include instructions for isolating and spreading waste in fire suppression.
4. Suitable and adequate fire fighting equipment shall be maintained on site and maintained in good working condition.

6.3 Regional Sanitary Landfill: Mile 22

6.3.1 Access, Traffic and Safety

1. The recommended point of access to the site is the new access road starting out from a point at Mile 24 on the Western Highway.
2. Adequate controls and signage (i.e., suitable speed limit, and no-passing zone) shall be installed at the appropriate points east and west of the Sanitary Landfill access road beginning point.



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3. Provision shall be made for extra turn lanes at the Sanitary Landfill access road starting point, in the form of paved shoulder lanes both eastbound and westbound. A free right turn lane for westbound traffic should be installed as part of the access road.
4. The access road shall be a paved road. The access road shall be a two lane road of sufficient width for safe and efficient movement of the trucks and machinery using it, and with wide shoulders.
5. Gravel access shall serve the administration area as well as the secure waste disposal cell and the wet weather service area.
6. An area of the waste disposal facility shall be excavated and set aside for the wet weather disposal of wastes. The wet weather disposal area shall be equipped with extra drains to provide better drainage during the rainy periods.
7. There shall be a stockpile of sand material to be used as cover in the wet weather area and a one month supply of sand will be stored on site at all times.
8. The site administration area will have night lighting for ongoing security purposes, and will also have phone service.

6.3.2 Buffer Zone

1. A buffer zone shall be maintained around all sides of the landfill site. The buffer zone shall be formed by leaving existing forest, thicket or other vegetation, and establishing new treed vegetation to fill in gaps if necessary, sufficient to provide an effective visual and noise barrier for neighbouring areas.
2. The buffer zone outlined above shall be a minimum of 50 meters in width on all sides, plus 50m on each side of the on-site creeks to provide a total of 100m buffer on these water courses.
3. No disposal or related activities or works shall be permitted within the buffer zone.
4. To allow natural use of the buffer areas by wildlife and also assist with the proposed wildlife corridor plans for the general area, it is proposed that the site shall not have a perimeter fence around the property lines. If fencing is

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required, then each area would be fenced as it is operated using t-bar posts and chain-link temporary fencing.

6.3.3 Surface Water Drainage and Erosion Control

1. Contouring of the landfill facility and surface water diversion channels shall be constructed so that surface water run-on in the event of severe storm events is diverted to the 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 site condition.
2. The storm runoff system shall be composed of drainage channels and storm pond such as will handle at least a 1-hour 1-in-100-year return storm event during normal operating conditions.
3. The storm runoff system shall direct surface runoff away from areas where active landfilling is in progress.
4. All drainage courses shall be designed to keep velocities to a reasonable level and the use of culverts and rip rap will be undertaken to limit soil erosion in drainage channels.
5. 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.
6. For the post-operational phase, the landfill shall be capped, recontoured, and vegetated appropriately, with full attention to providing effective drainage and erosion prevention.
7. All slopes on finished areas will be limited to a slope of no steeper than 1 vertical to 6 horizontal, in order to limit soil erosion.

6.3.4 Normal Cell Design and Operation

1. There are three waste disposal areas at Mile 22, each with several cells sized to accommodate 2-3 years of waste.
2. The regular solid waste disposal cells of the Sanitary Landfill facility shall be excavated such that the base of the waste cell is near or slightly above the impermeable dense white clay that underlies the site.



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3. The base grade of each cell shall be sloped to provide positive drainage, with drainage ditches constructed in each cell.
4. A leachate collection and treatment system shall be constructed at the same time as the initial cells. During the initial stages all surface or leachate or contact water should be directed to the leachate collection system. This should be continued until the leachate and surface water collection can be safely separated into their individual systems.
5. The external storm water drains shall be kept in place after cell closure to provide drainage from the capped waste cell.
6. Each area when completed will be capped with one half meter of clay and seeded with native grasses or other suitable species of vegetation, compatible with the determined final land use of the site.

6.3.5 Leachate Control and Groundwater Protection

1. A leachate containment system composed of a natural *in situ* clay to contain the predicted volumes and characteristics of leachate production in the local climate (permeability of 10^{-9} m/s), shall be included in the design of each landfill cell, including the base and sides of each cell.
2. In addition, each leachate collection trench in the landfill cells shall be lined with a 60 mil high density polyethylene liner material.
3. Opportunities for appropriate thickening of the *in situ* clay liner should be taken if permeable lenses or seams are exposed during construction.
4. The leachate accumulating in each cell shall be allowed to gravity drain from the cell to a leachate collection system leading to an on-site leachate treatment and retention system.
5. The leachate collection pipes shall be acid and corrosion resistant to leachate liquid, and be sized and designed for clean-out capabilities in future maintenance.
6. The leachate shall be removed from the containment system at intervals and in quantities as necessary to ensure that hydraulic head over the natural liner system is kept to a minimum.

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7. The leachate retention system shall be a system of retention cells designed for anaerobic treatment followed by aerobic treatment sequence, and an evaporation pond.
8. Each of the leachate retention cells shall be equipped with controlled inlet/outlet structures, and the cells shall be sized such that (i) it has at least 40 days capacity for produced leachate at the total flow condition; and (ii) it is of capacity sufficient to also hold the rainfall that would impinge on the ponds during a 1/100 year 1-hour return storm event.
9. Once the cells are at capacity, the leachate should be re-injected back into the landfill; or, after it has been fully treated, the cells may be slowly discharged into the designated storm water pond.
10. No leachate shall be released from the storm water pond area until analyses for basic parameters has been completed and it has been determined suitable for release relative to the appropriate standards under the Environmental Protection Act and its regulations.
11. The storm water pond should be suitably planted with such vegetation as will accommodate natural cleansing processes.

6.3.6 Landfill Gas

1. The presence and levels of landfill gas (LFG) are to be monitored for the first year of landfill operation, and thereafter once per year or as shown to be necessary, using the ground water monitoring wells and gas detection wells.
2. If the LFG monitoring program indicates levels of gas that are building to levels that entail a risk of igniting, leading to dangerous on-site gas levels, or affecting adjacent vegetation, gas collection wells shall be installed. The collected gas shall be vented, using acceptable standards and guidelines.
3. Measures must be in place as part of the monitoring program to detect any subsurface or surface migration of gases.
4. On-site buildings and other enclosed structures must be monitored regularly to determine whether LFG is seeping into them and introducing the risk of explosion.

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6.3.7 Control of Odor, Litter and Pests

1. The working face of the landfill shall be confined as much as possible, reducing the amount of fresh waste exposed to the air. The target area for the working face shall be 20 m x 40 m or less.
2. Daily cover (inert soil material) shall be applied once each day to the working face, to a depth of six inches (15 cm).
3. Intermediate cover shall be applied to the cells of the landfill that will not be actively worked for a period exceeding 1-2 weeks. Intermediate cover shall be applied to a depth of 1 foot (30 cm).
4. Final cover (0.5 meters thick) shall be applied to all areas that have been filled to final design grades.
5. The waste shall be compacted in lifts not exceeding 0.6 m thickness, and utilizing a steel-wheeled landfill compactor or crawler tractor, completing 2-5 passes over the total area of each lift, in order to achieve waste compaction to usual landfill densities. This measure will increase the life of the landfill, as well as facilitating the application of cover material and enhancing its efficiency in preventing the escape of odorous gases. Compaction also serves to minimize the escape of windblown litter and reduce the attraction of pests such as feral dogs and insect vectors of disease.
6. All incoming vehicles shall be covered (e.g., with netting), to avoid litter problems en route and near the landfill site. Drivers of uncovered loads should be given warnings and/or be fined.
7. Site staff shall be assigned as necessary to regularly retrieve litter both on and off sites along the access road, which happens to escape from the landfill site or collect at its periphery.
8. If vultures or other pests (e.g., feral dogs, cats, peccaries, rodents, insects) become problematic despite the above recommended measures, strategies for addressing these problems shall be considered (e.g., bird repellent tactics using visual or sound stimuli).
9. To prevent litter and illegal dumping of garbage along the length of access road guard huts/ check points will be established at the entrance and landfill site. A thicket will be issued to any vehicle containing garbage at the entrance

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of the road and the ticket collected on return having the stamp of the other guard at the landfill site as proof that the garbage arrived at the sanitary landfill.

10. It is recommended that any excess cover material at the Mile 22 after the construction of the access road be backhauled to the existing landfill at Mile 3 of the Western Highway, and used to reclaim the site, if economically feasible.

6.3.8 Smoke and Dust

1. Smoke, vehicular emissions and dust coming from the landfill shall be controlled by proper operations of the facility. This includes maintaining the landfill equipment in proper running order, and when necessary applying water to internal access roads. Internal permanent access roads shall be all-weather roads with a compacted and/or gravelled surface.

6.3.9 Fire Prevention and Contingency

1. Waste arriving at the landfill site shall be monitored to ensure that explosive, burning or smouldering waste is not accepted for disposal. Such items will be segregated and then treated on site with the available fire suppression equipment.
2. Flammable or explosive items that could pose a significant fire risk shall be removed from solid waste at the collection point and at the transfer stations.
3. Site rules shall include appropriate fire prevention precautions, including restrictions on smoking and open flames on site.
4. A fire contingency plan shall be in place, and will include instructions for isolating and spreading waste, and applying inert cover material or if appropriate, water, in such a way that any fire is smothered and contained, and that unnecessary loading of the landfill with water is avoided.
5. Suitable fire fighting equipment shall be maintained on the landfill site, and it must be maintained in proper working condition. This should consist of a self contained tank c/w gas engine and pump mounted on a trailer. The tank should remain full at all times.

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6.3.10 Historical Resources

1. If mounds, clayworks or other artifacts of possible historical importance are found on the site during clearing or construction, the articles shall be left, work in the immediate area should halt temporarily, and the Institute of Archaeology shall be contacted to determine the potential importance and the recommended action.

6.3.11 Public Consultation and Awareness, and Community Involvement

1. A Community Advisory Committee should be established, to facilitate involvement of neighbouring communities in the operations and monitoring of the Regional Mile 22 disposal facility. Once established, the Committee should meet on an ongoing and regular basis with the facility operator. The Committee should participate in monitoring programs and have full access to the monitoring data, for both on-site and off-site monitoring programs. Input from the Committee should be used to achieve continuous refinement of operational and monitoring programs for the facility.
2. Consideration should 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 concurrent with the development and operation of the disposal facility.
3. A scheme should be considered to employ scavengers who presently operate at the Mile 3 disposal site, in the sorting of solid waste at the Belize City transfer station that will be constructed at that location. This would serve not only as a source of employment for these people, but would also serve to remove recyclable and potentially hazardous materials from the solid waste stream. This, in turn, would enhance the operational life of the landfill (by reducing waste volumes to be disposed) and curb the entry of toxic/hazardous substances into the landfill. Similar considerations should be made at other transfer stations.
4. A suitable use should be determined for the trees that will be cleared to prepare the Mile 22 landfill site in the initial construction phase. Otherwise, it could be distributed to the construction workers or local people for their use (i.e., firewood, fence posts, etc.).
5. The establishment of an Interpretive Centre at or near the Mile 22 sanitary

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landfill is recommended. The purpose of the Interpretive Centre would be to increase public awareness of:

- (i) Environmentally acceptable solid waste disposal practices;
- (ii) The mitigation and monitoring programs employed at the Mile 22 Sanitary Landfill facility, including the final reclamation plan;
- (iii) The role and importance of solid waste reduction and recycling in achieving environmental sustainability;
- (iv) The technical basis for the landfill design (including display of all reports, plans, and photographs); and
- (v) A demonstration clear plastic column, that would illustrate the cross section of the landfill showing liner, leachate collection, waste and cover. Since the themes of waste reduction and environmental protection are complementary to the wildlife conservation message of the Tropical Education Centre, some thought could be given to coordinating these efforts. Even though the sites are separated by considerable distance.

6.3.12 Closure

1. At the end of the landfill's active life, the landfill site shall be capped with suitable material and re-contoured with design grades and features established to provide adequate drainage while limiting runoff velocities to minimize erosion of the cap. Such recontouring will be done in a manner that is harmonious with the surrounding landscape.
2. In designing the post-closure plan, sufficient allowance shall be given to the degree of subsidence of the landfill.
3. The land shall be revegetated appropriately, with natural vegetation according to the determined land use.
4. The type of land use for post-closure shall be determined in consultation with appropriate government agencies and public groups, including the Office of Town Planning, Department of Environment, Forestry Department, and local citizens. Consideration should be given to land use that is compatible with the proposed biological corridor for wildlife.
5. Ongoing monitoring and maintenance of the cap, the surface soil, and the vegetation shall be performed for a period of ten years or until such time as the landfill has stabilized and such proves to be no longer necessary. Landfill gas

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monitoring (and control if needed) shall continue until LFG production levels indicate that no further control or monitoring is necessary.

