

BELIZE SOLID WASTE MANAGEMENT PROJECT ENVIRONMENTAL IMPACT ASSESSMENT REVISED

10.0 Recommendations

In order for the landfill at Mile 22 to be effective, an MSW waste transfer station is required to be established concurrent with the landfill construction at the Mile 3 Western Highway location, for wastes originating in the Belize City area and disposed at the Mile 22 sanitary landfill. In addition, MSW transfer stations are contemplated for Ambergris Caye and Caye Caulker, with wastes being barged to the mainland and then trucked to the Mile 22 site. Another MSW transfer station is anticipated to be constructed at the existing Western Landfill site to serve the Benque - San Ignacio area in the near future. Sorting of the waste to remove and divert environmentally hazardous materials and recyclable items should be carried out at the transfer stations.

The following recommendations concerning the new Regional Landfill are put forward, based on the findings of the Environmental Impact Assessment.

1. The disposal component of the SWMP can proceed with a regional MSW sanitary landfill disposal facility established at the Mile 22 Western Highway site, as outlined in this Report.
2. The sanitary landfill should be designed and operated with all of the mitigative features outlined in this Report, including surface water management, leachate collection and treatment, a buffer zone, landfill gas collection management, wet weather operations area, storage for recyclables with adequate containment and other design features that will protect the surrounding environment.
3. The mitigation measures proposed in the Environmental Mitigation Plan of this EIA Report should be implemented in full.
4. The monitoring measures proposed in the Environmental Monitoring Plan of this EIA Report should be implemented in full.



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5. The institutional requirements outlined in this EIA Report should be addressed, including staffing and training needs, and legislative refinements.
6. The existing disposal facilities that are converted to MSW transfer stations should be suitably reclaimed, using soil materials to cap and seal the sites.
7. A Community Advisory Committee should be established, to facilitate involvement of neighbouring communities in the operations and monitoring of the Mile 22 disposal facility. The Committee should participate in monitoring programs and have full access to the monitoring data.
8. Discussions should be held with the Belize River Association towards developing downstream monitoring of water quality in the Belize River.
9. 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.
10. 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 MSW transfer station to be constructed at that location. Similar initiatives should be taken at the other transfer stations.
11. The buffer zones should have additional trees and shrubs placed within them to provide a uniform vegetation barrier for visual observations. In addition, the importance of the upkeep of the treed buffer to attenuate landfill gas is required.
12. The establishment of an Interpretive Centre at or near the Mile 22 sanitary landfill is highly recommended for the future. This would increase public



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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; and (iii) the role and importance of solid waste reduction and recycling in achieving environmental sustainability.

The following Schedule of Environmental Mitigation Measures (Table 10.1) summarizes the previous components of the Plan with each being presented as follows;

- general parameters,
- impact,
- mitigation measure,
- residual impacts,
- costs, implementation issues, and training requirements.

This matrix format summarizes the various potential impacts and proposed mitigation measures described in this document.



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BELIZE SOLID WASTE MANAGEMENT PROJECT
ENVIRONMENTAL IMPACT ASSESSMENT: MILE 22

Table 10.1
Schedule of Environmental Mitigation Measures for Adverse Impacts

PARAMETER	POTENTIAL IMPACT	MITIGATION MEASURE	RESIDUAL IMPACTS	COSTS IMPLICATIONS	IMPLEMENTATION ISSUES		
					STAGE	RESPONSIBILITY	TRAINING/HUMAN RESOURCES
AIR QUALITY	<ul style="list-style-type: none"> Generation of landfill gas (LFG) from the landfill site 	<ul style="list-style-type: none"> Additional planting of trees in buffer to partially absorb gases Gas collection wells to be installed if monitoring systems indicate significant LFG production On-site buildings to be monitored regularly Regular ambient condition monitoring program 	<ul style="list-style-type: none"> Landfill gas exits to atmosphere through cover materials until a collection or venting system is required 	<ul style="list-style-type: none"> Monitoring wells installed during construction after year 5 and again after year 10 Annual monitoring costs as part of operating budget Hand held monitoring equipment for atmospheric observations. 	Operating and post completion	<ul style="list-style-type: none"> Designers and subsequent site operators with data submitted to DoE to include designs and specifications Construction to properly construct and provide protection to wells Operators to ensure the wells are properly maintained and protected Additional trees to be planted in buffer areas. 	<ul style="list-style-type: none"> Operators to be trained in using gas sniffers and other air monitoring equipment.
AIR QUALITY	<ul style="list-style-type: none"> Landfill odors reaching residential or other nearby institutions 	<ul style="list-style-type: none"> 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 to final grade Waste to be compacted in lifts of limited thickness All incoming vehicles to be covered 	<ul style="list-style-type: none"> Good cover protocols will greatly reduce odors Odors should be very localized 	<ul style="list-style-type: none"> Part of daily operational costs 	During site operational life	<ul style="list-style-type: none"> Site operator to provide daily interim and final cover on an as required basis with monitoring from SWMA and DoE 	<ul style="list-style-type: none"> Staff training in landfill operations
AIR QUALITY	<ul style="list-style-type: none"> Smoke and dust from fires and on-site machinery 	<ul style="list-style-type: none"> 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) 	<ul style="list-style-type: none"> Short periods until remedial action taken 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> During site construction and operational life crews are to maintain site roads and fill areas Equipment to be serviced on regular basis 	<ul style="list-style-type: none"> Design and construction engineers, SWMA, and DoE 	<ul style="list-style-type: none"> Staff training in landfill construction and operations

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TOPOGRAPHY	<ul style="list-style-type: none"> Erosion of bare slopes in north eastern portion of site 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-off diverted around site perimeter Surface water flows to be maintained as natural pre-development levels (instantaneous) Drainage channels and storm pond 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 storm pond system Number of exposed slopes and cumulative surface area to be kept to minimum Construction of large retention pond with controlled outflow 	<ul style="list-style-type: none"> Some erosion of slopes in extreme events Need to maintain erosion control devices Construction of large retention pond with controlled outflow 	<ul style="list-style-type: none"> Part of ongoing capital and operational costs 	<ul style="list-style-type: none"> Operator required to follow designs and not to exceed grades established in landfill design Design drawings to reflect grades and facilities to provide drainage control over the entire site 	<ul style="list-style-type: none"> Site operators and monitoring by SWMA and DoE 	<ul style="list-style-type: none"> Staff training in landfill construction and operations
HYDROLOGY	<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 storm pond Water collecting in cells of landfill to be retained, managed as leachate No leachate to be released from storm pond evaporation area until determined suitable for release Special containment measures for special wastes and recyclables storage areas 	<ul style="list-style-type: none"> Small amount of contact water may escape 	<ul style="list-style-type: none"> Increased treatment costs for power (aeration of lagoon) Possible dedicated person in later stages to manage leachate system 	<ul style="list-style-type: none"> During site life both operational and post closure 	<ul style="list-style-type: none"> Site operator with monitoring from SWMA and DoE Design to provide details for stages of construction Stages to be monitored for proper timing of needs 	<ul style="list-style-type: none"> Staff training in landfill operations SWMA to develop design and operational experience in collection and treatment systems
GROUND WATER	<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 impermeable clay layer for each landfill cell Appropriate thickening of clay liner to be undertaken if permeable lenses exposed Leachate trenches to be lined with hdpe Leachate accumulating in each cell to drain via leachate collection system On-site leachate retention/treatment system to facilitate anaerobic and aerobic natural treatment Each closed cell to be capped to reduce leachate production 	<ul style="list-style-type: none"> Leachate collection and treatment must stay operational post closing of site to provide ongoing mitigation 	<ul style="list-style-type: none"> Part of ongoing operating and laboratory expenses Installation of monitoring wells as part of construction (\$250,000) 	<ul style="list-style-type: none"> All including post closure 	<ul style="list-style-type: none"> Site operator with monitoring from SWMA and DoE Design and specification of monitoring wells and their protection, along with trained supervision during construction 	<ul style="list-style-type: none"> Staff training in operations and analytical sampling and results Access to expertise from a hydrogeologist

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					STAGE	RESPONSIBILITY	TRAINING/HUMAN RESOURCES
WILDLIFE	<ul style="list-style-type: none"> Loss of habitat for wildlife 	<ul style="list-style-type: none"> Buffer zone to be established/maintained on all sides of the landfill site (50 m) Buffer zone around creek. Creek buffer 100 m total 	<ul style="list-style-type: none"> Increased activity on site 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> All 	<ul style="list-style-type: none"> Site operator to monitor 	<ul style="list-style-type: none"> N/A
WILDLIFE	<ul style="list-style-type: none"> Disruption of wildlife dispersion 	<ul style="list-style-type: none"> 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 Buffer zone around creek. Creek buffer 100 m total 	<ul style="list-style-type: none"> Access to site not controlled 	<ul style="list-style-type: none"> More security may be needed 	<ul style="list-style-type: none"> During operational stage 	<ul style="list-style-type: none"> Site Operator 	<ul style="list-style-type: none"> N/A
WILDLIFE	<ul style="list-style-type: none"> Loss of habitat for rare or endangered species 	<ul style="list-style-type: none"> No mitigation required other than providing 100 m buffer on creeks 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A
WILDLIFE	<ul style="list-style-type: none"> Loss of critical or sensitive habitats 	<ul style="list-style-type: none"> No mitigation required other than providing 100 m buffer on creeks 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A
VEGETATION	<ul style="list-style-type: none"> Loss of vegetation of potential commercial value Salvage cutting during construction 	<ul style="list-style-type: none"> Utilization of lumber removed during site clearing Onsite hardwood not economically viable 	<ul style="list-style-type: none"> Hard to reestablish trees on landfill areas, although grasses and shrubs will return 	<ul style="list-style-type: none"> Ongoing re-vegetation program as part of ongoing operations, especially in buffer zones 	<ul style="list-style-type: none"> All 	<ul style="list-style-type: none"> Site operator and local residents near site 	<ul style="list-style-type: none"> Proper design of site closure plan Maintain buffers
LAND USE AND PLANNING	<ul style="list-style-type: none"> None at present. Future possibility 	<ul style="list-style-type: none"> Consideration for interaction with new residential and recreational areas proposed in the future 	<ul style="list-style-type: none"> Landfill will exist and new development must be aware 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> All 	<ul style="list-style-type: none"> Physical Planning to be responsible for subsequent approvals 	<ul style="list-style-type: none"> Planning control to evaluate proposed use and conflicts based on other experiences
TRAFFIC	<ul style="list-style-type: none"> None at site Some at entrance road at mile 22 	<ul style="list-style-type: none"> Access point to be positioned so traffic visibility maximized each direction Extra turn lanes at access point, paved shoulder lanes No public access to facility other than main Highway access 	<ul style="list-style-type: none"> Some disturbance due to a new traffic entrance and departure point along highway at mile 22 	<ul style="list-style-type: none"> An allowance of \$680,000 has been included in project cost estimates for intersection improvements 	<ul style="list-style-type: none"> All 	<ul style="list-style-type: none"> Site design to include turn lanes and highway lane markings Mow to monitor traffic flows and patterns 	<ul style="list-style-type: none"> N/A
TRAFFIC	<ul style="list-style-type: none"> No mud on Western Highway, only on access road 	<ul style="list-style-type: none"> 1-month stockpile of sand for use as cover in wet weather area Good internal access to wet weather areas to reduce contact with clay 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Included in site operation budget 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Extra mow resources to assist with possible increase in road cleaning effort
TRAFFIC	<ul style="list-style-type: none"> Rough and unsafe road surface until access road is paved 	<ul style="list-style-type: none"> Maintenance of access road by landfill equipment 	<ul style="list-style-type: none"> Possible some mud tracked onto highway at all stages 	<ul style="list-style-type: none"> Included in site operation budget 	<ul style="list-style-type: none"> During construction will be worse Ongoing operations of site 	<ul style="list-style-type: none"> During construction engineer to monitor Ongoing monitoring both operator and mow 	<ul style="list-style-type: none"> Extra mow resources to assist with road cleaning
PHYSICAL DISTURBANCES TO NEIGHBORS	<ul style="list-style-type: none"> Future impact if development allowed 	<ul style="list-style-type: none"> N/A until development approved 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A

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OTHER FACTORS	<ul style="list-style-type: none"> Poor operation of the landfill once the site has been commissioned resulting in a series of impacts on neighbors 	<ul style="list-style-type: none"> The landfill site operator must place a \$B100,000 Performance Security that can be accessed by the DoE. 	<ul style="list-style-type: none"> Possible short term problems until remedial program underway 	<ul style="list-style-type: none"> Performance Security will cost about 2% of annual operating budget 	<ul style="list-style-type: none"> Throughout operating life of site 	<ul style="list-style-type: none"> DoE to have sole access to Performance Security and to use SWMA as agency if desired to expedite 	<ul style="list-style-type: none"> Legal assistance to write conditions of Performance Security
New Access Road	<ul style="list-style-type: none"> 3.8 Kilometers of new road construction 	<ul style="list-style-type: none"> provides designated access to site and potential for littering 	<ul style="list-style-type: none"> Littering along the road 	<ul style="list-style-type: none"> Extra time and expense to maintain and clean road right of way 	<ul style="list-style-type: none"> Ongoing 	<ul style="list-style-type: none"> Government of Belize 	<ul style="list-style-type: none"> N/A
LEGISLATION	<ul style="list-style-type: none"> Need to bring powers of DoE and SWMA into proper perspective 	<ul style="list-style-type: none"> DoE to be enforcement, approvals and policy Agency SWMA to be operations oriented in all aspects of solid waste management 	<ul style="list-style-type: none"> Possible conflicts in roles 	<ul style="list-style-type: none"> SWMA to have budget 	<ul style="list-style-type: none"> Ongoing 	<ul style="list-style-type: none"> Government of Belize 	<ul style="list-style-type: none"> Ongoing technical assistance
TRANSFER STATIONS*	<ul style="list-style-type: none"> Belize City transfer stations, Cayes System, Western Landfill and Small Village Collection are not built. System will not operate properly 	<ul style="list-style-type: none"> Ensure that the total plan is implemented asap. 	<ul style="list-style-type: none"> Landfill needs wastes to operate. Without wastes, site is inefficient 	<ul style="list-style-type: none"> Budget for landfill and ancillary functions required. 	<ul style="list-style-type: none"> Ongoing 	<ul style="list-style-type: none"> Government of Belize 	<ul style="list-style-type: none"> Total system operation required

* Although not a normal measure, without this the Waste Management Plan will not work.

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PHYSICAL DISTURBANCES TO FUTURE DEVELOPMENT	<ul style="list-style-type: none"> Disturbance of facilities from pests, litter and dust generated at landfill 	<ul style="list-style-type: none"> 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 Bird repellent tactics to be used if vultures become a problem 	<ul style="list-style-type: none"> Will still hear occasional noise when atmospheric conditions are right Dust will be short lived as operator will use on-site water or leachate for dust control 	<ul style="list-style-type: none"> Water tank included in cost estimates Landfill operating equipment in estimates includes compactor, tractor, and truck for the operation of the site Other equipment and operation expertise will be included by site operator 	<ul style="list-style-type: none"> During both construction and operational phases 	<ul style="list-style-type: none"> Site operator with monitoring from SWMA and DoE 	<ul style="list-style-type: none"> Operational manuals and training on landfill operations Landfill operational expertise exposure both to DoE and SWMA personnel
PHYSICAL DISTURBANCES TO FUTURE DEVELOPMENT	<ul style="list-style-type: none"> 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) Re-contouring and suitable re-vegetation in post-closure phase, compatible with surrounding landscapes 	<ul style="list-style-type: none"> Some residual visual messages will be there 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> During construction will be worse Ongoing operations of site 	<ul style="list-style-type: none"> Site operator to maintain buffers as required 	<ul style="list-style-type: none"> N/A
PHYSICAL DISTURBANCES TO FUTURE DEVELOPMENT	<ul style="list-style-type: none"> Selected operator may not live up to design expectations on how landfill will be operated and mitigation measures presented and approved in EIA 	<ul style="list-style-type: none"> Operator must post a performance security with DoE to ensure full compliance with environmental and site operation plan 	<ul style="list-style-type: none"> Possible short period of non compliance 	<ul style="list-style-type: none"> Performance security will cost about one percent of annual operation budget 	<ul style="list-style-type: none"> During operational life of landfill 	<ul style="list-style-type: none"> SWMA must tailor performance security requirements to meet the site operational expectations 	<ul style="list-style-type: none"> Legal assistance in preparing conditions of performance security
HISTORIC RESOURCES	<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 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A
OTHER FACTORS	<ul style="list-style-type: none"> Increase in illicit waste dumping along access road 	<ul style="list-style-type: none"> Implementation of solid waste management plan 	<ul style="list-style-type: none"> Illicit dumping will always happen 	<ul style="list-style-type: none"> Increased cost in offsite cleanups 	<ul style="list-style-type: none"> Ongoing 	<ul style="list-style-type: none"> DoE and all municipalities involved in litter control enforcement 	<ul style="list-style-type: none"> Public awareness training of all persons in Belize
OTHER FACTORS	<ul style="list-style-type: none"> Improvement of environmental problems at existing landfills 	<ul style="list-style-type: none"> Use of excess cover material at mile 22 facility for reclaiming other landfills where odors, pests and pollution are problematic Remaining existing landfills will also be reclaimed and turned into transfer stations, i.e. Cayes, Western Landfill, and Belmopan landfill 	<ul style="list-style-type: none"> Environmental problems will always occur, but programs aim to reduce through providing new facilities and enforcement 	<ul style="list-style-type: none"> Reduced costs in offsite cleanups 	<ul style="list-style-type: none"> Ongoing 	<ul style="list-style-type: none"> DoE and all municipalities involved in litter control enforcement 	<ul style="list-style-type: none"> Public awareness training of all persons in Belize

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