DRAFT ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

MARUDI MOUNTAIN GOLD MINE

FOR

ROMANEX GUYANA EXPLORATION LIMITED

GROUND STRUCTURES ENGINEERING CONSULTANTS INC
LOT GSEC, LILIENDAAL, GEORGETOWN
GUYANA

2018

1.0 EXECUTIVE SUMMARY

Romanex Guyana Exploration Limited (RGEL) Marudi Mountain Mining License encompasses an area of 5,577 hectares (ha.) located in the Rupununi District, in southwestern Guyana. The area is approximately 155 kilometers south-southeast of Lethem and 50 kilometers south-southeast of the Amerindian village of Aishalton. A Mining License was granted for the concession by the Guyana Geology and Mines Commission (GGMC), however large-scale operations at the site were precluded by invasion of the concession by several medium and small-scale miners. The Ministry of Natural Resources mediated the dispute between RGEL and these miners. One of the mandates of the mediation process was the performance of an Environmental and Social Impact Assessment (ESIA) for the property. The performance of this ESIA is reflective of RGEL adherence to the conciliation process and is intended to support RGEL Environmental Permit Application in support of the Mining License under regulations established by the GGMC.

Gold has been known to occur in the Marudi Mountain area since 1934. Ore reserves calculation for the property, indicate that at least 3.1 million metric (MM) tonnes of hard rock ore grade material exist in the main body of mineralization at the Marudi Concession with an average gold content of 2.89 grams of gold per tonne. This is the equivalent of 275,000 ounces of gold. In addition to these hard rock resources, a significant volume of material exists on the property of either saprolite or colluvial material that contains more than 1 gram of gold per tonne but has not been thoroughly sampled due to the loose nature of the material. This volume of this material is estimated at 750,000 to 1,200,000 tonnes containing the equivalent of 25,000 to 40,000 additional ounces of gold.

This ESIA has been prepared to conform to guidelines established by the Guyana Environmental Protection Agency and as detailed in the EPA publication titled Environmental Impact Assessment Guidelines, Volume 3 Mining, Version 1, August 2000. The ESIA has been prepared in a modular structure with each environmental variable being covered by a single chapter. Environmental management measures are encapsulated within each module, confirming to the EPA "Guidelines for Preparing Environmental Management Plans". The management measures, in each module, identify feasible and cost-effective measures to reduce potentially adverse environmental impacts to acceptable levels. The general regulatory framework for mining projects and alternative analyses precede presentation of baseline data, impact assessment and management measures.

This ESIA considers the Project Area of Influence to be the area which will experience direct environmental and social impacts because of the project. Direct physical environmental impacts are related to the environmental pathways. The physical pathways for this project are air and water. The project Area of Influence, for physical environmental impacts, therefore extends to the limits of the watershed around the project area. The Project area of Influence is also defined based on likely socio-economic and socio-cultural impacts and considered the role of third parties including the regional administration and Central Government and groups which may be affected by the project because of their disadvantaged or vulnerable status. The Project area of Influence consequently incorporate all communities within the watershed and other communities close to the proposed mine and include Kuraudanawa/Krowdar Village, Achuwib, Aishalton, Awaruwaunau, Parabara and Shea villages, which are indigenous communities in the South Rupununi which are in closest proximity to the mine site.

The likely impacts of the project were considered for all environmental and social components identified in the Scope and Terms for the project, prepared by the Guyana Environmental Protection Agency (EPA). Baseline information were drawn from both desk study and from field surveys and incorporated additional work conducted previously within the Marudi Concession. The impact assessment and prediction also considered the additional possibility of impact interactions that is between different impacts of the project, or between project impacts and the impacts of other projects, including illegal artisanal mining which may result in one or more additional impacts. The ESIA identifies reasonable alternatives in terms of project design, technology, location, size and scale, considered by the developer, which are relevant to the proposed project and its specific characteristics and indicates the main reasons for selecting the chosen alternative.

The ESIA identified project stakeholders as individuals and organizations actively involved in the project whose interests may be affected because of the project. Stakeholders were considered in achieving project goals since their participation and support would be crucial to the success of the project. The ESIA defines key stakeholders as those

who can significantly influence or are important to the success of an activity. Secondary stakeholders are defined as all other individuals or institutions with a stake, interest or intermediary role in the project. Stakeholders were identified based on the construction of a stakeholder matrix where stakeholders are plotted against two variables. These variables were the level of stake in the outcomes of the project against the resources of the stakeholder and the importance of the stakeholder against the influence of the stakeholder.

The ESIA is guided by several international policies and local legislations and regulations, developed to ensure sound management of the environment. National Policies, Regulations and Legislations which are relevant to the deliberations of this ESIA include The National Environmental Action Plan, The Environmental Protection Act 1996, The Environmental Protection (Authorizations) Regulations 2000, The Environmental Impact Assessment Guidelines, The Environmental Protection (Hazardous Wastes Management) Regulations, 2000, The Environmental Protection Air Quality Regulations 2000, The Environmental Protection Water Quality Regulations 200, The Gold Board Act (1981), The Gold Board (Amendment) Act (1994), The Guyana Geology and Mines Commission Act of 1979 and Mining Act of 198 and The Mining (Amendment) Regulations 2005 including the Requirements for Environmental Management for Large Scale Mining and the General Requirements Applicable to Mining.

International convention and standards incorporated into this ESIA include The World Bank Water Quality Standards, The Basel Convention on the Trans-boundary Movement of Hazardous Waste and their Disposal, WHO Guidelines, The Convention on Biological Diversity, The Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), The Convention on the Protection of World Cultural and Natural Heritage, 1972, the Protocol concerning pollution from Land-Based Sources and Activities (LBS); Protocol concerning Specially Protected Areas and Wildlife (SPAW); Rio Declaration; Agenda 21; UN Framework Convention on Climate Change (UNFCCC) and The Treaty on Cooperation for the Development of the Amazon Basin.

The ESIA considers development of the Marudi Mountain concession into a large-scale mine for the recovery of gold bearing ore and for recovery of that gold. The ore will be recovered in two phases; removal of gold bearing saprolite and colluvium and mining of hard-rock resources. The mining and mineral processing operations will be preceded by preliminary works at the site. The preliminary phase will entail site clearing and construction of site facilities. Facilities to be constructed during the preliminary phase will include living quarters and office areas. Timber and other vegetative material not suitable for use as construction material will be burned or buried on site during the mining operation.

Soft rock material will be mined by traditional truck and shovel operations. Hard rock will also be mined by traditional truck and shovel operations generally below the area of saprolite (soft rock) mining. In addition, light blasting will also be used, if required, to loosen the rock. Ore will either be stockpiled or hauled directly to the processing plant. Soft rock ore will be fed into the wash plant for beneficiation by gravity. Single size fractions will be sent to a gravity separator. Coarse fractions will be fed into jigs and then on to coarse sluice boxes. Finer fractions will be fed through either jigs or centrifugal concentrators. The tailings from the fine circuit will be sent over long sluices, while the concentrate will either be cleaned up by hand or tabled to create a concentrate for smelting.

A combination of gravity and froth flotation will be used to extract gold from hard-rock ore. Hard rock ore will be crushed and fed to a SAG or ball mill to reduce the material to a relatively coarse grind. The ground material will pass through the gravity circuit. After gravity concentration, the residual material will pass to the flotation circuit where it will contact pine oil and air bubbles in an agitated tank. The gold will adhere to the pine oil which will coat the bubbles. The bubbles will then rise to the surface of the tank bringing gold with them. The particles of gold will then be scraped off the surface as foam. The foam would be collected and smelted to recover the gold. No mercury or cyanide will be used in the recovery operation.

Tailings would be collected in a pond designed to prohibit the escape of fine material to surface water. The pond will be created by constructing a saddle dike on one side of a valley located within the concession. The pond will encompass the headwaters of two streams in the concession. The tailings pond would be designed to contain all ore material generated during the life of the operation. Water from the pond will be recycled for plant process water.

Operations will be undertaken to minimize the footprint of the mine. Exploited and mined out areas will be subject to continuous reclamation. After cessation of all operations the area would be rehabilitated so that all surfaces drain naturally, blend with the natural terrain, and are left in a condition that will facilitate natural revegetation.

Consultations were held with all primary stakeholders. Consultations with state/sectoral agencies and NGOs were held in the Roraima Duke Lodge under the auspices of the Ministry of Natural Resources. This consultation was preceded by a letter to all stakeholders requesting submission of issues and concerns to be considered by the ESIA. Focused consultations were held with residents of communities within the project area of influence. All consultations were initiated with a detailed description of the project and its anticipated environmental and social impacts. Stakeholders were subsequently invited to identify issues and concerns for inclusion into the impact assessment and management measures for the facility.

The proposed mine pit is close to the headwaters of several creeks. These creeks flow from the headwater southwards to the Kuyuwini River which is a major source of flow in that reach of the Essequibo River. Practically no data are available on groundwater resources in mine site area. Monitoring wells were installed at the site in 2009 and 2018 to recover groundwater samples for analyses. Wells were screened in the alluvial, saprolite and bedrock at the site in 2018. Hydraulic conductivities for alluvials and saprolite were determined by performing insitu permeability test in each well. Hydraulic conductivities for bedrock was determined by performing Packer tests. Both surface and groundwater samples were recovered for analyses in 2009 and 2018.

Surface water quality may be impacted by construction, operation and closure of the mine site. Sediment discharge from cleared areas has the potential to reduce water quality in streams and creeks adjacent to cleared areas. The clearing of vegetation will reduce interception and may result in increased discharge to streams and creeks around the construction area and increased water levels in these streams and creeks. Surface water quality may be negatively impacted during construction of the mine site by accidental discharges of fuels, oils and grease. Culverts constructed through roads may modify the natural flow of surface water and concentrate flows at certain points and may increase the speed of surface water flow. Land clearing and earthmoving activities may increase the potential for erosion and increased sediment transport to waterways and sedimentation of these waterways. Flow may be curtailed in some segments of creeks due to development of the tailings pond and other mine facilities.

Impermeable liners in the tailings pond area may reduce recharge to groundwater. Withdrawals from wells, drilled for the operation are unlikely to have any impacts on the availability of groundwater. Spills of fuel and oils from equipment and from fuel storage and service areas can flow to the underlying aquifer and potentially impact groundwater quality. Precipitation may induce leaching of chemicals from waste rock and saprolite stockpiles at the project site. Infiltration of wastewater from the tailings and waste management areas along with leaching of minerals into solution in the mine can have potential negative impacts on groundwater quality. Extensive groundwater dewatering to facilitate mine pit operations will disrupt the existing groundwater flow regime and result in groundwater flow into the mine from areas surrounding the mine footprint. Potential spills or discharges of chemicals used in the mineral processing operations may result in impacts to groundwater.

The Project area is in the Karawaimentau-Marudi Mountain Range. The range is separated into three portions by deep transverse valleys. The greatest development of Marudi Group rocks occurs as an enclave within the South Savanna Granite. Most of the rocks are derived from the same sediments. The oldest rocks in the region are inferred to be formed from siliceous and felspathic sediments. Biotite, schists and biotite garnet schists have developed from the more argillaceous members while the meta-siltstones and impure quartzites have been derived from arenaceous members. Narrow bands of phyllites occur locally varying from dull red to pale yellow but owing to the ease with which they decompose, they are seldom seen within the area. The soil types in the area are Fp, Li and Mp soils. Sediment quality for the area was established in both 2009 and 2018 by recovering sediment samples from points coincident with the points at which surface water samples were recovered.

Site activities may result in soil degradation since minerals necessary to support the ecosystem may be depleted by construction activities. Site clearing can potentially result in soil loss through increased soil erosion. Soil erosion may also occur if construction activity blocks natural water courses. The movement of heavy equipment may cause rutting and compaction of susceptible soils. Topsoil mixing may potentially occur during mine site operations. Soil

may be contaminated by accidental releases of fuels, oils, grease and other hazardous materials. If not properly managed, wastes could lead to contamination of soils, as well as generation of odors, attraction of vermin, and creation of human health and safety hazards.

Mining and spoil disposal will result in an alteration of the stratification of the unconsolidated soils at the site. Excavated slopes may result in increased erosion, greater and more rapid runoff, may pose risks to wildlife and may expose potentially reactive, naturally occurring materials. Water saturation can trigger slope failure. Fill materials may in some cases also be subject to rapid disintegration, or to decomposition, yielding acids and releasing potentially toxic metals. Slope failure can result in direct release or direct exposure of these materials to the surrounding environment.

Fugitive dust and products of combustion will be emitted during all phases of the operation. Larger particles of dust can affect the nasal passages, cause irritated and congested nose and may cause an irritant cough. Stripping topsoil and overburden will generate dust when undertaken in the dry season. Dust emissions from blasting, loading and unloading of haul trucks, haul roads, milling equipment, material stock piles and other fugitive dust generating operations would occur over the duration of the operation. Blasting may generate fumes from incomplete combustion of the chemical explosives and dust clouds from the fracturing of blasted materials.

Guyana is in the Equatorial Trough Zone (ETZ) and its weather and climate are influenced primarily by the seasonal shifts of the ETZ and its associated rain-bands called the Inter Tropical Convergence Zone (ITCZ). Secondary influences on the climate are of Pacific origin. Formation of El Niño and La Niña can disturb the regular location of the ITCZ which may result in higher or lower than normal rainfall at specific locations. The El Niño/La Niña is primarily responsible for inter-annual variation in rainfall.

Approximately 65 ha of tropical forest will be cleared for the mines, widened roadway and related facilities. The project may result in a yearly increase in the global CO_2 emissions by amounts ranging up to approximately 22,315 tonnes. The vertical surfaces of mine pits and buildings would be added to the natural landscape. Exposed land surfaces have greater heat conduction, and more heat storage than the natural land covers they replace. Heat energy would also be added at the mine site by the operation of mining equipment and power generation. The mine site area may therefore become warmer than surrounding areas. There is a theoretical potential for increased local rainfall due to the combined effect of particulate air pollution and increased convectional uplift due to increased surface temperature. Mining operations will move, break, and grind large quantities of rock, all energy-intensive activities. Energy generation at the mine site will be based on the consumption of fossil fuel which will release carbon dioxide (CO_2), a prominent greenhouse gas (GHG) to the atmosphere. Subsequent mineral processing will add to CO_2 emissions.

Biodiversity surveys were conducted in 2017 and 2018 to update the biodiversity data compiled during 2009. The objective of the biodiversity baseline surveys was to determine the existence of potentially sensitive habitats and species within the mining concession. Species recorded during the surveys were compared with the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species for Guyana to determine and classify species that are threatened, that is, species listed as Critically Endangered, Endangered or Vulnerable.

The 2017- 2018 floral surveys consisted of both terrestrial forest inventory (FI) and a floristic survey. Vascular plants species such as shrubs, herbs, and lianas (Pteridophytes and Angiosperms), not included in the FI, were recorded during the floristic survey. Five sample plots were used for both wet and dry season surveys.

The 2017- 2018 faunal surveys utilized live-capture traps and mist netting for volant mammals and birds. Active searches were undertaken to obtain information on herpetofauna and macro-invertebrates. Hook and line were used to capture middle sized and large fish and gill nets and seines for smaller sized fish. Active searches were used for benthic organisms. Faunal plots were established in the general vicinity of the floral plots during all surveys. Different vertebrate groups were sampled at discrete intervals along main transects to avoid and/or minimize interference between methodologies and sampling of different terrestrial vertebrate groups. Additional

sampling was undertaken in sections of each transect which exhibited micro-habitat cues or features for the vertebrate group surveyed.

A total of 79 plant species representing 40 families were recorded by both the wet and dry season surveys of 2017 - 2018. Leguminosae, Chrysobalanaceae, Sapotaceae and Palmae were the most abundant families recorded within the mixed forest during the survey. The wet season survey of 2017 documented 17 non-volant mammalian species, 22 species of bats, 16 species of amphibians, 14 reptilian species, 174 bird species, 14 species of fish and a diversity of both terrestrial and aquatic invertebrates. The dry season survey of 2018 documented 13 non-volant mammalian species, 10 species of bats, 28 species of amphibians, 10 reptilian species, 161 bird species, 17 species of fish and a diversity of terrestrial and aquatic invertebrates. No known Critically Endangered, Endangered or Vulnerable species were recorded by the surveys.

Dust and combustion emissions generated by equipment during the clearing for mine site facilities may cause injury to plants under ambient conditions of exposure. Cutting of large tracts will make plant regeneration difficult. Enhanced leaching, occasioned by clearing, can deplete the soil of nutrients. Increased human presence may lead to increased impacts on flora through harvesting, collecting, disturbance, and other activities by construction workers. Weeds may be introduced into the project area if the project uses plant and equipment, with soil and weeds from other locations.

Widening of the access road and clearing of the area will fragment the area and can potentially impact wildlife since some animal species depend on the existence of other plant and animal species within the habitat for nutrients/food and cover. Facilities and other works may form temporary barriers to the movement of animals. Isolation, by fragmentation, may lead to local decline of species, or genetic effects such as inbreeding. The physical disturbance and noise produced by construction equipment may impose additional stresses upon wildlife and may lead to increased migration. Increased human presence may increase impacts on fauna through harvesting, collecting, hunting, fishing, disturbance, and other activities. Animals introduced to the mine site may pose threats to the biodiversity of the mine site.

The construction of the mine and associated infrastructure will result in the loss of various stream habitats within the concession area. Surface runoff from cleared areas may introduce additional nutrient loads to streams. Higher nutrient levels can potentially result in eutrophication. Pollution by contaminated surface runoff can also impact water quality in the streams and lead to denitrification and increased oxygen consumption resulting in an environment less conducive to the survival of fishes. Discharge to water management ponds will contain sediments which will result in decreased transparency and a reduction of light available to aquatic plants, a primary food source for aquatic organisms.

Ecosystem services within the project footprint include freshwater, construction materials, medicinal plants, fuel wood and food (fish and meat). Several provisioning services provided by ecosystems will be impacted in the project area. Clearing of the mine site will remove food and fiber included in the vast range of food products derived from plants, animals, microbes and many other products derived from ecosystems. Fuel including wood and other biological materials which serve as sources of energy would also be removed by site clearing operations. Regulating services provided by ecosystem processes will also be impacted by the project. Emissions associated with the operation of plant and equipment at the site may pose added stresses on ecosystem services required to generate clean air. Changes in land cover at the mine site may affect both temperature and precipitation. The timing and magnitude of runoff, flooding, and aquifer recharge may be impacted by changes in land cover. The removal of vegetative cover may reduce soil retention and increase the likelihood of landslides. Ecosystems serve to regulate human diseases and aid biological control. These functions may be impacted by site clearance for construction and operation of the mine site.

This project is in a remote and rural area. The area is populated primarily by Indigenous Peoples. The project can create important employment opportunities for Indigenous Peoples and may help to fulfil their social and economic aspirations. The socio-economic baseline was developed to create a profile of the communities in and within the project Area of Influence (AOI). The AOI incorporates all communities within the watershed and other

communities close to the proposed mine. The baseline was compiled based on consultations and field work with stakeholders within the project AOI and incorporates data provided by stakeholders outside of the AOI.

Potential social changes associated with mining include land use changes, growth inducement, income generation, education and training, capacity strengthening, improvement of public infrastructure, education, health, and welfare, uncontrolled influx of people, disruption of societal organization, loss of traditional values and norms and changes in life style and livelihood.

Conflicting positions of the indigenous groups and the Government, related to issuance of land, may result in open protests and hostility towards RGEL. Mining may require withdrawal of water from surface water systems around the project area. Water is a critical resource particularly for communities which obtain water from rivers, and creeks. Conflicts may develop between RGEL and communities if water withdrawal for project needs results in water shortages downstream. Tension currently existing between artisanal and small-scale miners (ASM) and RGEL over competition for the exact resources may be exacerbated after commencement of mining operations by RGEL. Most persons within the AOI do not possess the technical certification required by a project of this nature. Failure to satisfy employment expectations may become a source of conflict.

RGEL will develop training programs for members of these communities to enable them to take up skilled employment. If possible RGEL will partner with the local/regional authority to provide training programs by coordinating skills training or extension programs to help train the local workforce and will also work with government to expand training programs into the area or make them more consistent with the needs of mine site.

Environmental Management Plans (EMPs) have been developed to manage the impacts to all environmental media. Each Environmental Management Plan was developed to mitigate the potential negative impacts and risks and to enhance the potential positive impacts of the proposed action. In addition, monitoring programs have been developed for all environmental media for all phases of the proposed operations. The monitoring programs will provide data which would serve as the basis to determine the environmental performance of the operation. The facility will be monitored to confirm its adherence to sound environmental management practices and contractually established operational standards. Monitoring will be conducted during the construction and operation phases of the project. The monitoring program is designed to ensure that the trends for specific parameters are tracked. It will also provide information on compliance with legislations, guidelines and contractual requirements for the construction and operation of the facility.

GLOSSARY OF TERMS

Alluvial Gold - Gold deposited by flowing water.
Amalgam - Gold or silver mixed with mercury.
Amalgamation - A process that separates gold (or silver) from ore. Ore is crushed in a mercury-water solution and subjected to violent agitation, which breaks up the mercury into minute particles that adhere to the gold. When the gold has partially separated from the mercury, the remaining mass is heated in a retort. The mercury vaporizes and is condensed to use again. The gold is now almost pure and is cast into bars.
Assay Office - A place that evaluated or chemically tested and analyzed the mineral content of ore to determine the nature and proportion of the ingredients.
Adit - A mine entrance that is horizontal or inclined.
Auriferous - Gold-bearing.
Barren pond - Storage pond for solution from which gold has been extracted.
Base Gold - Gold alloy.
Bund - A low embankment often constructed around potential spillage areas to reduce the risk of environmental contamination. It is important these structures can retain the volume of any potential spillage.
Bullion - Unprocessed gold or silver, before coinage or minting. Usually melted into bricks or bars for easy storage.
Carat - (1) One 24th part of pure gold. (2) It's also a unit of weight equal to about 0.2 grams used to weigh precious gems.
Decant - The removal of solution from a tailings storage facility after solids have been allowed to settle.
Dredging - A gold mining method in which a barge or boat equipped with machinery scoops the gold-bearing gravel from the river beds. The gravel is then processed by washing or sluicing.
Drift - A horizontal tunnel leading from the main bore or shaft of a mine.
Dust - Minute particles of gold taken by placer mining and used as money.
Eh - Reduction potential (in units of volts or millivolts)—a measure of how oxidizing or reducing a system is (more positive values tend to indicate oxidizing environments, more negative values reducing).
EMS - Environmental Management System
Freeboard - The distance between the crest of a pond or impoundment and the level of contained solution.
Gangue - Unwanted rock found during gold mining.
Gold - A heavy yellow metallic chemical element; a precious metal used in coins, jewelry
Gravels - A loose mixture of small pebbles and rock fragments like coarse sand that contain gold particles; also called placer deposits.
HACCP - Hazard Analysis at Critical Control Points—a formal procedure designed to identify the hazards associated with particular stages in a given process.
Hardrock (Quartz) Mining - The underground method of mining accomplished by sinking a shaft deep into ground containing a vein or ore pocket, with drifts (tunnels) radiating out on various levels.
Hydraulic Mining (Hydraulicking) - A method of mining whereby water under pressure is directed at hillsides of soft gravels through a hose with a nozzle called a monitor or giant, causing mud to run down into long lines of sluice boxes.
Lixiviants - Chemical leaching agents.
Lode - An underground vein bearing gold or other precious metal.
Mercury - See Quicksilver
Metallurgy - The science of separating metals from their ores and preparing them for use by refining, etc., developed from alchemy of the Middle Ages.
Mixing Zone - A predefined area beyond an outfall or discharge point in which the applicable jurisdiction or regulatory agency permits water quality criteria to be exceeded. Beyond the mixing zone boundary, applicable water quality criteria for the protection of aquatic life must be observed.
Ore - Rock containing enough precious metal to make it worth mining.
Overburden - Material, like dirt and rock, covering the gold-bearing veins or gravel that was removed by hydraulicking.
Panning - A simple but slow method of mining. Gravels from the stream bed are washed in a pan, causing lighter materials to spill over the side and heavier gold-bearing particles to settle to the bottom.
Pay Dirt - Expression describing gold-rich ore, sand, or gravel taken from claims. The claim became "pay dirt" when the miner realized a profit after his expenses had been covered.

Ph - The measure of acidity (or alkalinity) defined as being the negative log (to base 10) of the free hydrogen ion concentration. The pH scale ranges from 0 to 14; a pH of 7 is neutral, less than 7 acidic and more than 7 alkaline.
Phreatic Surface - The surface between the zone of saturation and the zone of aeration; ground water table.
Process Solution - Solutions used to leach gold, barren leach solution from heap leaching, mill tailings, tailings return water and carbon stripping solution.
Placer - A deposit of gravel or sand containing particles of gold that can be washed out. Usually eroded from the hills or deposited by a river.
Placer Mining - Mining on the surface. A process of extracting surface gold from ore-bearing gravels by panning, dredging, and sluicing.
Pocket - A small but rich concentration of gold in a quartz vein, or gold-bearing gravel in a hole or low spot in a stream bed.
Quartz - A common, hard mineral, often with brilliant crystals, generally found in large masses or veins.
Quicksilver - Mercury (*Hg*.): a heavy, silver-white metallic chemical element, liquid at ordinary temperatures. Used to help capture gold particles in sluicing when placed at the riffles or ribs in the box.
Retort - A high-temperature furnace used in refining gold. Amalgam is super-heated so the mercury is vaporized and saved, and the gold is formed into bars.
Riffles - The wooden ribs or slats placed on the bottom of rockers, long toms and sluice boxes to capture the heavy gold particles while the lighter material is washed away.
Slimes - The finest particles suspended in a tailings slurry.
Sluice Box - A box with a sloping trough or inclined flume where heavy gold-bearing particles are caught by riffles or slats.
Stamp Mill - A mill built to break up and grind gold-bearing ore, saving the gold by amalgamation. A mill could have any number of "stamps".
Stamps - Metal arms at a stamp mill that raised and lowered like battering rams to crush the ore so the gold could be extracted.
Stakeholder - Stakeholders are individuals and groups that have interest in activities of a mine, or who are or may reasonably be affected by those activities. The term is applied differently depending on the specific nature of the issue to be addressed, and can require considerable flexibility and judgment.
Surface Water(s) - Any natural water body occurring on the surface, including but not limited to rivers, creeks, streams, lakes, marshes, and marine waters.
Tailings - Waste material left after gold-bearing ore is processed. Material rejected from a mill after the recoverable valuable minerals have been extracted.
Tailing Storage Facility (TSF) - An impoundment used to place mill effluent containing the leached ore in a water slurry. The solids remain in the TSF for disposal and the water may be recycled back to the mill for reuse or may be treated and discharged.
Troy Ounce - Based on the ancient unit of measure, the grain, and used to measure gold. The troy ounce contains 480 grains, while the avoirdupois ounce contains 437.5 grains. Therefore, a troy ounce equals 1.097 avoirdupois ounces. Also, a troy ounce equals 20 pennyweight (DWT).
Vein - Route followed by gold from the lower depth of the earth towards the surface.
Worked Out - A claim, mine, or area that has been thoroughly mined of all gold that is profitable to mine.
TSF - Tailings storage facility
Volatilization - Release of gaseous phase of a chemical.

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1.0 INTRODUCTION

This report presents the results of an Environmental and Social Impact Assessment (ESIA) undertaken for development of an open pit mine by Romanex Guyana Exploration Ltd (RGEL) in the South Rupununi. The area to be developed into the mine is situated in the Rupununi Mining District and is defined by the GGMC as follows:

> *A rectangular block of State Land in the Rupununi (No. 6) Mining District, being eastern portion of Marudi Mountain and including the headwaters of Peace, Pancake, Locust, Ashburner and Toucan Creeks, the Marudi Mountain Mine Compound and the headwaters of Totowau Creek as shown on topographic sheet 77 (Marudi) and contained within the following boundaries:- Commencing at a point A located 3900 feet (1189 m) bearing 85^{o} from the peak of Bat Mountain, thence in straight line bearing 325^{o} (T) for a distance of 30000 feet (9150 m) to a point B near the headwaters of Totowau Creek passing through a point on Success Creek, 200 feet upstream from its junction with Kimberley Creek and approximately 15400 feet from A thence bearing 55^{0} (T) in a straight line for a distance of 20000 feet (6096 m) to point C approximately 3500 feet downriver from the source of an unnamed creek flowing westward to the Totowau thence in a straight line bearing 145^{o} (T) for a total distance of 30000 feet (9150 m) to point D at the source of a right bank tributary of Quata Creek entering it 10.5 miles up, crossing a mountain peak located about 9000 feet from C and 4000 feet southeast of the main Mapuerwautau Mountain and crossing the Bacaba Creek about 10500 feet upriver from its junction with Quata Creek and 11500 feet (4420 m) from point D; thence for 20000 feet (6096 m) bearing 235^{o} (T) to point of commencement and containing an area of 13,774 acres (5577 ha) save and except all lands already lawfully held and occupied.*

The proposed mine site is located approximately 140 kilometres southeast of the administrative center of Region 9, Lethem. The location of the proposed mine site relative to that administrative center is shown on Figure 1. The extent of the concession under consideration by this ESIA is shown on Figure 2.

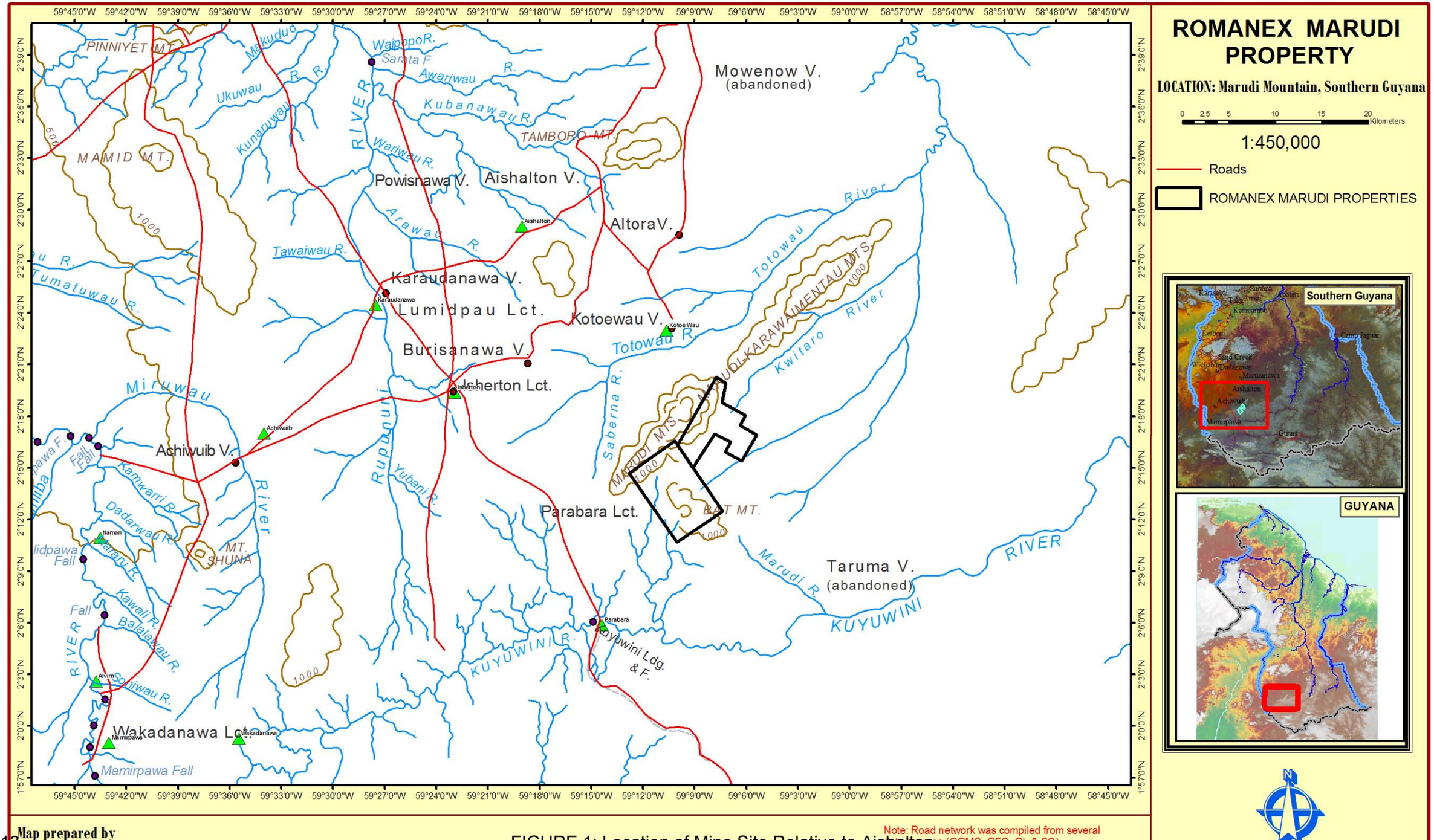
1.1 Purpose of and Need for Action

An Environmental Impact Assessment was undertaken for this property in 2003. The property was, however, not developed into a mine. An Environmental and Social Impact Assessment was undertaken to address environmental and social concerns related to the mining of alluvial deposits within the exact concession in 2010. This ESIA was undertaken by REXMA under license by RGEL and considered environmental and social consequences related to the mining of alluvial deposits in the flats of Capodilla and Toucan Creeks, July Creek, Locust Creek, Peace Creek, Paunch Creek and Rice Creek.

REXMA opted against implementation of the alluvial mining project. The property was subsequently invaded by illegal miners who mined all the alluvial deposits within the creeks and their adjacent flood plains. These miners have also mined several areas away from the creek and their flood plains including Mazoa Hill. Illegal mining has resulted in sediment discharge to practically all the waterways within the concession. Several of the waterways extend beyond the concession limits. Sediment discharges have consequently progressed beyond the concession limits. Neither the EIA done by RGEL nor the ESIA done by REXMA/Romanex planned to use any reagents in the gold recovery process. Illegal miners have indiscriminately used mercury to recover gold. This practice may have led to increased levels of mercury in soil, groundwater and surface water within the RGEL concession.

RGEL intends to proceed with the development of a gold mining operation in the Marudi Mountain Concession. Intrusion of illegal miners have however prevented this. A conciliation process was consequently initiated by the GGMC to ensure RGEL continues to hold all rights to the concessions. RGEL has agreed to conduct another ESIA for the property as part of the conciliation process.

The performance of this ESIA is reflective of RGEL adherence to the conciliation process and is intended to support RGEL Environmental Permit Application in support of the Mining License under regulations established by the GGMC.



Map prepared by
Ground Structures Engineering Consultants

FIGURE 1: Location of Mine Site Relative to Aishalton

Note: Road network was compiled from several sources (GGMC, GFC, GL & SC).
This map in no way seeks to indicate road conditions.

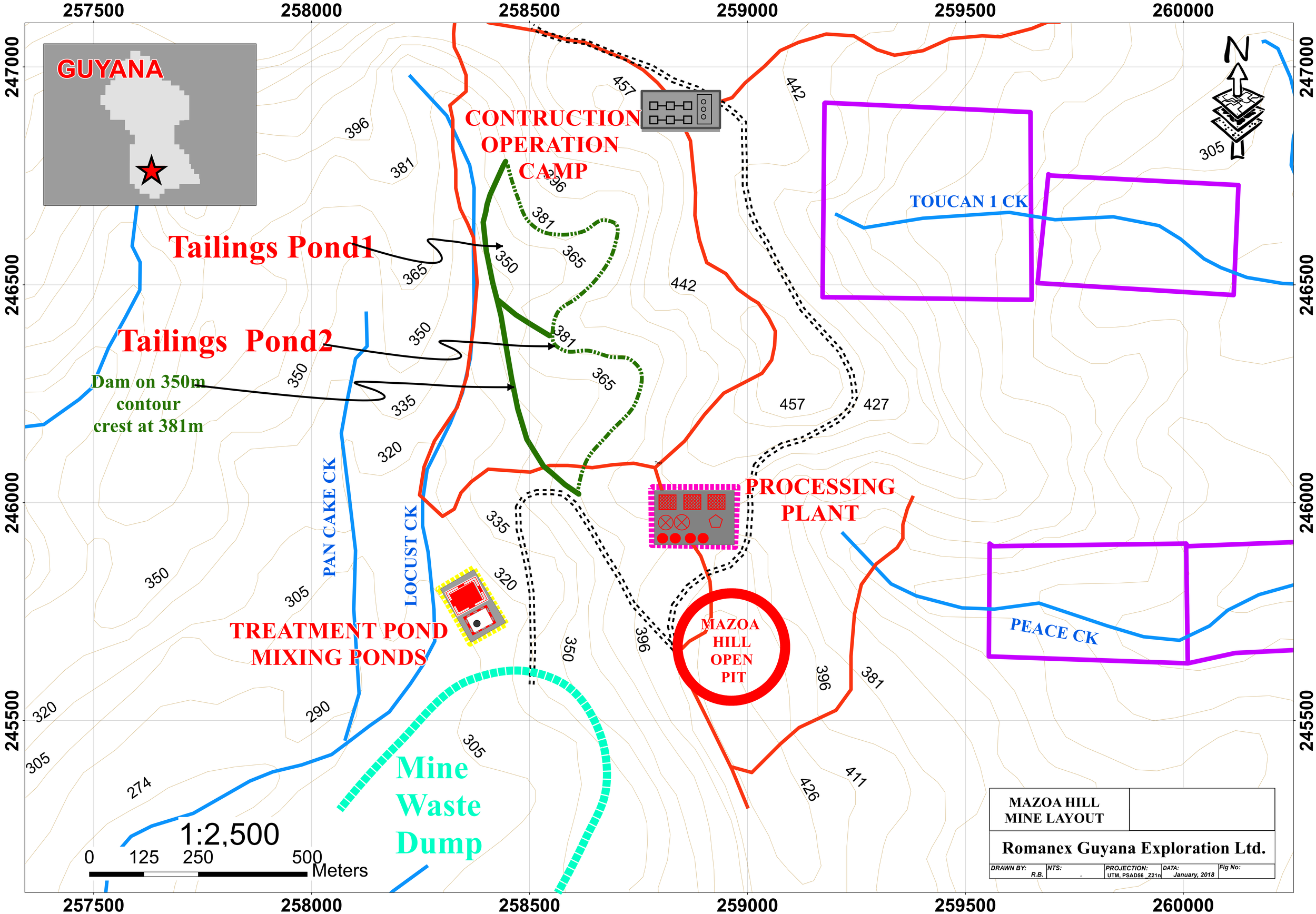


Figure 2: Extent of Area to be Developed into Mine Site

One of the conditions of a Mining License is that RGEL obtain an Environmental Permit. In support of the Mining License, RGEL is required to submit a feasibility study for the approval of GGMC. The feasibility study must include an Environmental and Social Impact Assessment for any mining operation to be undertaken at the property. The Mining License will supersede the Prospecting License in accordance with the terms of the Mining License initially issued by the GGMC.

The section of the area proposed for development, within the area identified on Figure 2, consists of Mazoa Hill and of alluvial/eluvial/colluvial deposits adjacent to several streams in the concession. The mine will be operated in accordance with the GGMC Mining License and the Guyana Environmental Protection Agency (EPA) guidelines.

The quantity and grade of gold recoverable on the property have convinced RGEL to undertake the ESIA and feasibility study to support the mining license and to commence with the development of a mine at the Marudi Concession in accordance with the regulations of the Guyana Geology and Mines Commission. Further, exploration work has verified that gold is present in adequate quantities and is of reasonable grade to warrant the establishment of an open pit mine and mineral processing operations at the site.

The purpose of the proposed action is therefore to convert the current operations into a functional mine. To attain the objectives of the proposed action a surface mine and mineral processing operation for the recovery of gold will be undertaken in the area.

1.2 Background

Gold has been known to occur in the Marudi Area since 1934, when government geologists became aware of artisanal mining in the district. The deposit has been exploited continuously by artisanal miners since that time. Production from the concession area is unknown but estimate inferred from the size of old workings and the observed grades of material range to over 100,000 ounces of gold. Several companies including Rupununi Gold Mining, NorMan Mines Ltd., Noranda, GUYMINE, Eastern Caribbean Mining Development Ltd and Sutton Resources have explored the property over the years.

The mineralized zones at Marudi are contained within a belt of ancient metamorphosed volcanics, metavolcanic sediments, and chemical precipitates that are now folded into a complex pattern. Among this rock sequence is one unit which is interpreted to be a chemical precipitate high in iron and silica, referred to as banded iron formation or BIF. This unit has been subsequently fractured and mineralized by the passage of metamorphic fluids which re-mobilized and precipitated gold, silica, sodium, calcium and other salts. This has led to a large mineralized mass of material high in silica and iron containing economic values of gold.

Ore reserves calculation for the property, indicate that at least 3.1 million metric (MM) tonnes of hard rock ore grade material exist in the main body of mineralization at the Marudi Concession with an average gold content of 2.89 grams of gold per tonne. This is the equivalent of 275,000 ounces of gold. Further anomalous zones occur on the property that are not yet fully explored and will contribute to the reserves in the future after additional exploration. In addition to these hard rock resources, a significant volume of material exists on the property of either saprolite or colluvial material that contains more than 1 gram of gold per tonne but has not been thoroughly sampled due to the loose nature of the material. This volume of this material is estimated at 750,000 to 1,200,000 tonnes containing the equivalent of 25,000 to 40,000 additional ounces of gold.

1.3 Project Area of Influence

This ESIA considers the Project Area of Influence to be the area which will experience direct environmental and social impacts because of the project. Direct physical environmental impacts are related to the environmental pathways. The physical pathways for this project are air and water. The project Area of Influence, for physical environmental impacts, therefore extends to the limits of the watershed around the project area.

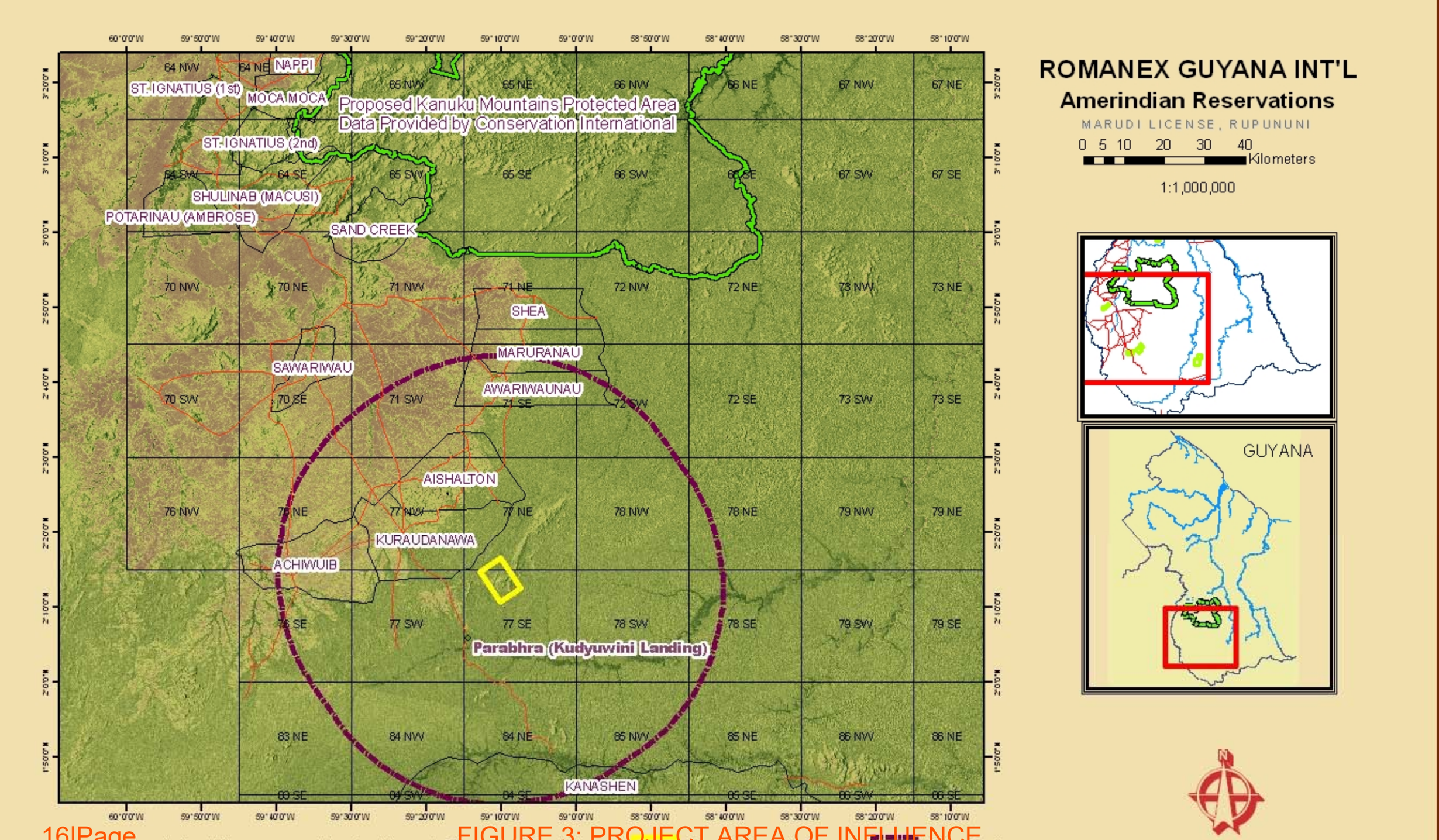


FIGURE 3: PROJECT AREA OF INFLUENCE

Emissions to air are not expected to result in increased concentrations in ambient air outside of the watershed surrounding the project. If, however, screen modeling of air emissions indicates effects beyond the limits of the watershed the Project Area of Influence will be extended to capture those impacts.

The Project area of Influence is also defined based on likely socio-economic and socio-cultural impacts and considered the role of third parties including the regional administration and Central Government and groups which may be affected by the project because of their disadvantaged or vulnerable status. Socio-economic and socio-cultural impacts will be a function of access to the mine site and from opportunities created for participation of communities close to the mine. The Project area of Influence consequently incorporate all communities within the watershed and other communities close to the proposed mine and include Kuraudanawa/Krowdar Village, Achuwib, Aishalton, Awaruwaunau, Parabara and Shea villages, which are indigenous communities in the South Rupununi which are in closest proximity to the mine site. These communities may serve as sources of employment for the Project and are therefore included in the Project Area of Influence.

The project Area of Influence is shown as Figure 3.

1.4 Scope of Environmental and Social Impact Assessment

This ESIA has been prepared to conform to guidelines established by the Guyana Environmental Protection Agency and as detailed in the EPA publication titled Environmental Impact Assessment Guidelines, Volume 3 Mining, Version 1, August 2000. In accordance with those guidelines this ESIA is comprised of three components, the Environmental Baseline Study, The Environmental and Social Assessment and the Environmental and Social Impact Management Plan. The baseline detailed herein is a record of the present quality of the physical, biological and socio-economic and socio-cultural variables within the project area of influence. The existing environment is described only for those aspects of the physical, biological, social and economic environment within the study area that are relevant to the project.

The Environmental and Social Impact Assessment identifies and assesses the impacts of the proposed action and its alternatives taking into consideration the measures that are proposed to mitigate and/or enhance the probable impacts. The assessment identifies the project-environment interactions during design, construction and operation and after closure of the operation.

1.5 ESIA Study Team

The Environmental and Social Impact Assessment was undertaken by Ground Structures Engineering Consultants Inc (GSEC). The study team assembled for this assignment consists of individuals who are recognized experts in conducting environmental and social impact assessments in Guyana. This collaboration has resulted in the creation of a unique group of professionals, all of whom have the necessary range and depth of experience and a thorough understanding of local conditions to conduct the ESIAs to World Bank, IFC, IDB and Guyana EPA Standards.

Charles P. Ceres, GSEC Project Director, is the Managing Principal of Ground Structures Engineering Consultants Ltd. of Guyana. He served as the Project Director and provided strategic guidance to the team and was responsible for project co-ordination and logistics. Charles oversaw the fieldwork and baseline studies. Charles has also managed several EIAs and EAs in Guyana and has served as a consultant to the Guyana Environmental Protection Agency.

Jewel Liddell, Biodiversity Lead Specialist, led the biodiversity and ecological aspects of the assignment. Ms. Liddell professional experience with biological, environmental, and geographic studies span a period greater than 20 years. She has become a specialist in South American biodiversity and ecosystems studies, with expertise in the development of baselines, impact assessments, management plans, as well as field implementation, monitoring, and auditing. Ms. Liddell has examined the impacts of mining projects on ecosystems and local stakeholders.

Vanessa Williams, Social Specialist, developed parameters for characterization of the socioeconomic and sociocultural baselines. She conducted the socio-economic and socio-cultural impact assessments. Since joining

GSEC, Vanessa has focused on the identification, mitigation and compensation of social impacts and risks which has included leading social audits, developing social management plans and ensuring compliance of existing plans with international best practice. Prior to joining GSEC, Vanessa worked for 2 years in Belize on social sector management projects. Vanessa has worked with indigenous and peasant communities doing project design and evaluation work on agricultural development, biodiversity conservation and natural resources management projects.

Raeburn Jones is a former assistant commissioner of forest in Guyana. Raeburn has several years of experience both in the forestry and environmental areas in Guyana. His responsibilities included developing protocols for baseline definition of forest resources and the development of management and mitigation plans to minimize impacts on these resources.

Corren Paul, Zestnelia Kennedy, **Jamarcy Lynch and Akesha Adonis** Biodiversity Specialists GSEC, are qualified biodiversity specialists with credentials and experience in Guyana. Ms. Paul, Kennedy, Lynch and Adonis worked closely with Ms. Liddell and Mr. Jones to cover biodiversity issues related to both baseline characterization and management and mitigation plans.

1.6 ESIA Organization

The ESIA has been prepared in a modular structure with each environmental variable being covered by a single chapter. Environmental management measures are encapsulated within each module, confirming to the EPA "Guidelines for Preparing Environmental Management Plans". The management measures, in each module, identify feasible and cost-effective measures to reduce potentially adverse environmental impacts to acceptable levels including operational procedures to avoid environmental risks during operations as well as emergency and contingency plans in the event of accidents during operations.

The general regulatory framework for mining projects and alternative analyses precede presentation of baseline data, impact assessment and management measures for each environmental variable. The ESIA will be developed in the following sequence:

Chapter 2 details the impact prediction and evaluation methods of this ESIA
Chapter 3 identifies and discusses alternatives to the Proposed Action
Chapter 4 details the Stakeholder Identification and Public Consultation Process
Chapter 5 details the Legislative and Regulatory Framework applicable to Mining Projects in Guyana
Chapter 6 identifies the various phases and details the components of the Proposed Action.
Chapter 7 addresses issues related to water resources including the Legal and Institutional Framework, baseline compilation, impact prediction and evaluation, and the environmental management and mitigation to be implemented for water resources
Chapter 8 addresses issues related to soil, land and geology including the Legal and Institutional Framework, baseline compilation, impact prediction and evaluation, and the environmental management and mitigation to be implemented for soil, land and geology
Chapter 9 addresses issues related to air quality including the Legal and Institutional Framework, baseline compilation, impact prediction and evaluation, and the environmental management and mitigation to be implemented for air quality
Chapter 10 addresses issues related to climate and climate change, the Legal and Institutional Framework, baseline compilation, impact prediction and evaluation, and the environmental management and mitigation to be implemented for climate and climate change
Chapter 11 addresses issues related to biological resources including the Legal and Institutional Framework, baseline compilation, impact prediction and evaluation, and the environmental management and mitigation to be implemented for biological resources
Chapter 12 addresses issues related to ecosystem services including the Legal and Institutional Framework, baseline compilation, impact prediction and evaluation, and the environmental management and mitigation to be implemented for ecosystem services

Chapter 13 addresses issues related to noise and vibration including the Legal and Institutional Framework, baseline compilation, impact prediction and evaluation, and the environmental management and mitigation to be implemented for noise and vibrations
Chapter 14 addresses issues related to landscape and visual resources including the Legal and Institutional Framework, baseline compilation, impact prediction and evaluation, and the environmental management and mitigation to be implemented for landscape and visual resources
Chapter 15 addresses issues related to socio-economic and socio-cultural resources including the Legal and Institutional Framework, baseline compilation, impact prediction and evaluation, and the environmental management and mitigation to be implemented for socio-economic and socio-cultural resources
Chapter 16 examines the risks and risks assessment associated with the proposed action and details steps required to minimize those risks
Chapter 17 examines the cumulative effects of the proposed action
Chapter 18 details a preliminary closure plan for the site
Chapter 19 outlines the Institutional framework for project execution and supervision
Chapter 20 details the results of discussions with agencies and NGOs.

2.0 IMPACT PREDICTION AND EVALUATION

This ESIA defines direct impacts as environmental changes directly associated with project activities. Typical of these would be changes of topography, erosion and dust emissions. Indirect impacts are defined as environmental changes not directly associated with project activities which occur at a distance from the project because of complex pathways. Indirect impacts are referred to as second or third level impacts, or secondary impacts. This ESIA also considers induced development impacts, including possible increases in population and related environmental impacts and cross media impacts.

The likely impacts of the project were considered for all environmental and social components identified in the Scope and Terms for the project, prepared by the Guyana Environmental Protection Agency (EPA). Baseline information were drawn from both desk study and from field surveys and incorporated additional work conducted previously within the Marudi Concession.

Impact significance was defined based on evaluations of several significance attributes. These attributes have gained common acceptance (although definitions may vary) as a means of identifying and measuring various aspects of an impact, and collectively assist in evaluating impact significance.

The categorization of impacts into positive or negative (adverse) impacts is not necessarily simple as project impacts may have both positive and negative effects, for example, one group may benefit while another is disadvantaged or the impact may be positive socio-economically but not ecologically. Impact magnitude measures the severity of environmental effects. Effects range from minor or inconsequential with little significance to major or catastrophic with significant adverse environmental effects, which may be unacceptable. When considering the magnitude of potential impacts, the mine development was considered within the context of regional development and the extent to which the project could trigger or contribute to any cumulative effects.

Reversibility, in this ESIA, refers to the environmental recovery once an impact has occurred. Irreversible environmental impacts are commonly considered more significant than those that are reversible. Irreversible changes always command attention because they signal a loss of future options. Species extinction, severe soil erosion, destruction of ancient rain forest, and other habitat destruction are examples of irreversible changes. Change in land use by providing access to remote areas is also virtually impossible to reverse once land use changes commence such as conversion of forest areas to agricultural land.

Duration, within this ESIA, considers the period over which an environmental effect occurs. Long-term environmental effects may be significant. Short-term environmental effects may also be significant, especially if the short-term effects negatively affect public perception of a project. Consideration is given to negative impacts that may develop over time including consideration of acid rock drainage and human health impairment associated with exposure to trace metals released by mining activities. Frequency is closely related to the duration of the environmental effect. The frequency of effects and the potential of the environment to recover from these effects are important. If an activity is intermittent, for example, it may allow for environmental recovery during inactive periods.

This ESIA defines geographic extent as how far an effect propagates. Localized adverse environmental effects may not be significant, while widespread effects may. Geographic extent considers the extent to which environmental effects, caused by the project, may occur in areas far removed from it.

Likelihood, in this ESIA is defined as the probability of an impact occurring. Two criteria are considered when examining likelihood: (1) probability of occurrence: is there is a high, medium or low probability that a particular significant environmental impact will occur. (2) certainty of significance: the level of uncertainty associated with the environmental assessment, often termed as 'confidence limits. If confidence limits are high and impacts are evaluated as significant, there is a high degree of certainty that conclusions are accurate and environmental impacts are significant. If confidence limits are low, there is a high degree of uncertainty about the accuracy of conclusions, and it will be difficult to decide whether significant environmental effects are likely or not.

The impact assessment and prediction also considered the additional possibility of impact interactions that is between different impacts of the project, or between project impacts and the impacts of other projects, including illegal artisanal mining which may result in one or more additional impacts.

The impact assessment, in this ESIA is based on the following:

- An understanding of the nature of the proposed project, including project design, construction activities and timing, and decommissioning
- Information about the relevant receptors and the receptors response to changes/disturbances
- The effectiveness of mitigation measure for similar projects
- The impacts of the project on other environmental and social components that may interact
- Existing and previously approved projects which can contribute to cumulative impacts

Both qualitative and quantitative methods were used to determine the magnitude of impacts (severity), duration, reversibility/irreversibility and geographic extent in addition to the frequency of impacts. Qualitative assessments employ ratings such as neutral, slight, moderate or large and are applied to both negative and positive impacts. Qualitative assessments are used where quantitative assessments are difficult or impossible, for instance in landscape, archaeological, and biodiversity assessment. Quantitative assessments involve measurement or calculation of numerical values, e.g. of the level of a pollutant in relation to a statutory threshold value.

Information on potential impacts from the construction and operation of the Project was obtained from various sources, including consultation with the EPA, the public consultations process, ESIAs for similar projects in Guyana and worldwide; literature, research, and independent modeling and analysis. The Project team used professional judgment, fieldwork, and desktop analysis to identify potential impacts and their interactions. The methodology which was used to identify and assess the potential physical and social impacts of the proposed Project is described in the following sections.

2.1 Assessment of Environmental Impacts

The assessment of impacts to each environmental component followed the following sequence:

- Characterization of the baseline for that specific environmental component before the Project is undertaken
- Identification of the sources of impacts and the impacts themselves, on that specific environmental component, during the construction, operation and closure phases of the Project
- Rating of the impacts, on that specific environmental component, before any mitigation (for negative impacts) or enhancement (for positive impacts) is implemented
- Recommended mitigation and enhancement measures, on that specific environmental component, to address the impact and
- Rating of the impacts after mitigation, on that specific environmental component, to produce a "residual" impact rating.

2.2 Rating of Environmental Impacts

Potential environmental impacts were rated to:

- Provide a basis for prioritization of impacts to be dealt with
- Provide a method of assessing the effectiveness of proposed mitigation measures and
- Provide a scale which shows the level of impact both before and after a proposed mitigation measure has been applied.

A consistent system for rating impacts was used to apply analytical rigor to the assessment and rating process. However, outcomes related to reduction of major negative impacts or enhancement of positive impacts is dependent on the selection, applicability, implementation and effectiveness of mitigation measures for the proposed Project.

2.3 Criteria for Rating the Impacts

Impacts were rated as the product of three elements: (1) the duration of the potential impact and (2) the severity (magnitude) of the impact and (3) its geographical extent. The overall rating of the impacts was determined based on Table 1 This matrix acts as a guide and there may be situations where its rigid application is inappropriate and where the perceptions of stakeholders and their feedback played a more significant role. For specific impacts where this is the case, the rating is clearly explained in the evaluation of the impact.

2.3.1 Severity and Enhancement Criteria

The severity or enhancement of each impact was rated using the criteria identified in Tables 2 and 3. Colors are used to assist the reader in reviewing the impacts and their relative magnitude.

Table 1: Rating Matrix

DURATION	MAGNITUDE	EXTENT			
		LOCAL	REGIONAL	TERRITORIAL	NATIONAL
Short-Term	Low	Low	Low	Moderate	Moderate
Short-Term	Moderate/High	Low	Moderate	Moderate	Moderate
Medium-Term	Low	Moderate	Moderate	Moderate	Moderate
Medium-Term	Moderate/High	Moderate	Moderate	Moderate	High
Long-Term	Low	Moderate	Moderate	High	High
Long-Term	Moderate/High	Moderate	High	High	High
Long-Term	Moderate/High	Moderate	High	High	High

Table 2: Severity Criteria: Negative Social/Health and Environmental Impacts

Magnitude	Negative Social/Health Impacts					Negative Environmental Impacts
	Duration	Geographic Extent	Ability to Adapt	Socio-Cultural Effects	Health Effects	
Low	Short-term < 1 year Low Frequency	Local	Those affected will be able to adapt to the changes with relative ease, and maintain pre-impact livelihoods, culture, quality of life and health.	Inconvenience but with no consequence on long-term livelihood, culture, quality of life, resources, infrastructure and services.	Event resulting in annoyance, minor injury or illness that does not require hospitalizatio n.	Affects environmental conditions, species and habitats over a short period of time, is localized and reversible.
Moderate	Medium-term 1-6 years Medium to Intermittent Frequency	Regional	Those affected will be able to adapt to the change with some difficulty and, and maintain pre-impact livelihoods, culture, quality of life and health but only with a degree of support.	Primary and secondary impacts on livelihoods, culture, quality of life, resources, infrastructure and services.	Event resulting in moderate injuries or illness, which may require hospitalizatio n.	Affects environmental conditions, species and habitats in short and medium-term. Ecosystem integrity will not be adversely affected in the long-term, but the effect is likely to be significant in the short or medium term to some species or rceptors. The area/region may be able to recover through natural regeneration and restoration.
High	Long-term/Irreversible > 6 years Constant Frequency	Territorial	Those affected will not be able to adapt to the changes and maintain pre-impact livelihood.	Widespread and diverse primary and secondary impacts likely to be impossible to reverse or compensate for.	Catastrophic event resulting in loss of life, severe injuries or chronic illness requiring hospitalizatio n.	Affects Environment conditions, species and habitats for the long-term (over the life of the project) may substantially alter the local and regional ecosystem and natural resources, and may affect sustainability. Regeneration to its former state would not occur without intervention.

						Affects environmental conditions or media over the long-term, has local and regional affects and/or is irreversible.

Table 3: Enhancement Criteria: Positive Social/ Health and Environmental Impacts/Effects

Enhancement	Positive Social/Health Impacts				Positive Environmental Impacts			
	Duration	Extent	Degree of Change	Focus/Sensitivity	Duration	Extent	Degree of Change	Focus/Sensitivity
High Level of enhancement	Benefits will be lasting and sustained over the long-term i.e: > 7 years	National	Direct benefits to individuals and communities will provide significant opportunities for leveraging secondary benefits and significantly improving livelihoods for themselves and others.	Benefits will pertain to vulnerable groups and those that would have otherwise been 'losers' as a result of the project.	Benefits will be sustained over the long-term.	Benefits will extend beyond local environment (i.e., linkage of fragmented habitat, e.g., regional corridor)	Direct benefits to species or resources will provide significant opportunities for sustainability.	Benefits will pertain to species, habitats and natural resources that are degraded or are sensitive, rare or in need of protection.
Moderate Level of enhancement	Benefits will be felt for a medium period of time (1 to 7 years) or be intermittent over the longer term.	Territorial	Moderate benefits to individuals and communities which will provide some opportunities for furthering themselves and	Benefits will possibly pertain to vulnerable groups and those that would have otherwise been 'losers' as a result of the project.	Benefits will be measurable in the short-term and possibly longer.	Benefits to many species, habitats and natural resources in the local environment and beyond.	Direct benefits to species, habitats and natural resources that may provide some opportunities for sustainability.	Benefits will pertain to species, habitats and natural resources that have some level of degradation, sensitivity or rarity.

			improving livelihoods.					
Low Level of enhancement	Benefits will be short-term (up to one year).	Regional	Some benefits to individuals and communities potentially improving opportunities for furthering themselves and improving livelihoods.	Benefits will not pertain to vulnerable groups and will only benefit those that would have otherwise benefited from the project.	Benefits will be short-term.	Benefits to a few species associated with the habitat and resources in the local environment.	Benefits to a few species, habitats and natural resources that may provide minor opportunities for sustainability.	Benefits will pertain to species, habitats and natural resources that are not sensitive or rare.

3.0 DESCRIPTION OF ALTERNATIVES

This section reviews the factors which resulted in the selection of the primary alternative for the operation of an open pit mine within the Marudi Concession. This section further identifies reasonable alternatives in terms of project design, technology, location, size and scale studied by the developer, which are relevant to the proposed project and its specific characteristics and indicates the main reasons for selecting the chosen alternative.

3.1 No Project Alternative

The "No Project" alternative is not considered viable to RGEL, as it would result in the foregoing of economic benefits to Guyana derived from the revenues of the gold production and creation of direct and indirect employment by the project. This alternative would also lead to the necessity to further explore other concessions and would not leverage the findings of the exploration and prospecting carried out in the Property to date, thus resulting in greater environmental impacts in areas presently not subject to such activities. The No-Project alternative will also exacerbate the problems created by illegal miners currently operating within the concession and would be counter to the GGMC planned objective to ensure mining occurs in an environmentally sound manner.

3.2 Mine and Infrastructure Location

Exploration activities within the Concession have identified and delineated the existence of a viable resource in the area. There is no alternative location for the project in the immediate vicinity of this concession due to absence of other significant gold bearing resources elsewhere within the Concession. The sites chosen for the support facilities have been guided by topography and the principles of minimizing the affected area and concentrating the impacts to a single zone within the concession.

3.3 Mining and Beneficiation Processes

RGEL will utilize Good International Industry Practices (GIIP) for all mining and beneficiation processes. This will include beneficiation of gold utilizing no chemical reagents. Progressive reclamation will also occur as mining progresses. Alternatives for beneficiation entails the use of chemical reagents and the discharge of residual levels of chemical reagents to the environment based on Best Management Practices (BMPs) or discharge of chemical reagents at elevated levels if BMPs are not utilized.

Mercury amalgamation (Hg) is the method-of-choice for small and medium scale miners in Guyana. Mercury amalgamation is effective only for gold particles larger than 60-70 microns. For mercury amalgamation to be effective the gold particles must have a clean surface available, the mercury must be put in direct contact with the gold particle, the mercury must be clean enough, the gold must be already liberated from the matrix and the gold must have its surface exposed to adhere to the mercury.

There has been increased recognition of the harmful impact of mercury on human health and ecosystems and the Guyana Geology and Mines Commission has mandated that mercury use be discontinued. Mercury use will result in impacts to the health of employees and local people and poses threats to the environment. Mercury use is also likely to increase insurance risks and liabilities. In addition, viable alternatives to mercury now exist since mercury is ineffective at recovering gold less than 70 microns in size. Mercury amalgamation can result in significantly greater impacts on the environment in addition to replicating the impacts of the proposed action on biodiversity.

Chlorine can also be used to recover gold. As noted by WWF-Guianas (www.wwfguianas.org), a basic version of chlorination could replace amalgamation and cyanide. Two common chemicals are required for chemical leaching; 14-16% sodium hypochlorite NaOCl and 30% strength hydrochloric acid. Bleach (sodium hypochorite solution) forms comparatively stable trihalomethanes (THMs) and haloacetic acids (HAAs) which are claimed to be carcinogenic and may pose other health risks to mine site employees.

The environmental impacts of alternative beneficiation and mining methods will consequently result in greater environmental impacts and validate the choice of this option for recovery of gold at this location.
RGEL utilization of GIIP for all mining and beneficiation processes will incorporate appropriate Environment, Health and Safety Guidelines in the final design of all facilities and processes. Mercury amalgamation and chemical leaching will not conform to GIIP as these practices are likely to create health and environmental impacts.

3.4 Alternative Tailing Management Facilities

The purpose of a tailings impoundment is to contain fine-grained tailings, often with a secondary or co-purpose of conserving water for use in the mine and mill. This must be accomplished in a cost-effective manner that provides long-term stability of the embankment structure and the impounded tailings coupled with long-term protection of the environment. The design of any tailings embankment and impoundment must be balanced against three interests, cost, stability, and environmental performance, with situation-specific conditions establishing the balance at each stage of the process. The long-term costs of tailings disposal depend in part on mechanical stability and environmental integrity since stable and environmentally acceptable structures are cost effective.

Two basic types of structures are used to retain tailings, raised embankment and retention dams. Either type of structure, raised embankments or retention dams, can be used to form tailings impoundments. The four main types of impoundments include the Ring-Dike, In-Pit, Specially Dug Pit, and variations of the Valley design. The design choice is primarily dependent upon natural topography, site conditions, and economic factors. Costs are directly related to the amount of fill material used in the dam or embankment. Major savings are realized by minimizing the size of the dam and by maximizing the use of local materials, particularly the tailings themselves.

Impoundment of slurry tailings is the most common method of disposal. Impoundments are favored because they are economically attractive and relatively easy to operate. Tailings impoundments are designed to perform several functions, including treatment functions. These functions include

- Removal of suspended solids by sedimentation
- Precipitation of heavy metals as hydroxides
- Permanent containment of settled tailings
- Equalization of wastewater quality
- Stabilization of some oxidizable constituents (e.g., thiosalts and flotation reagents)
- Storage and stabilization of process recycle water
- Incidental flow balancing of storm water flows

One disposal option is dewatering of the tailings (thickened to 60 percent pulp density or more) or dried (to moisture contents of 25 percent or below) prior to disposal. Advantages of this option include minimizing seepage volumes and land needed for an impoundment and simultaneous tailings deposition and reclamation. The efficiency and applicability of using thickened or dry tailings depends on the ore grind and concentrations of gypsum and clay as well as the availability of alternative methods. These methods are prohibitively expensive due to additional equipment and energy costs.

Tailings can also be used to backfill former open-pit mines. In active pits, embankments will be required to keep the tailings away from active areas. However, seepage from the tailings can adversely affect the stability of the pit walls or embankments and disposal of tailings into active pits is typically not practiced.

Tailings may also be disposed underwater in rivers. Underwater disposal sometimes prevents the oxidation of sulfide minerals in tailings, thus inhibiting acid generation. Subaqueous disposal is most often used in areas with high precipitation, steep terrain, or high seismicity. This method is however limited to coarse tailings that can settle quickly. High pH tailings can modify the acidity of the river resulting in environmental degradation.

Since mine tailings are usually in slurry form, disposal of slurry tailings in impoundments made of local materials is the most common and economical method of disposal. It is economically advantageous to use natural or man-made depressions to contain tailings. The advantages include reduced dam size, since the sides of the valley or

other depression serve to contain tailings. In addition, tailings in man-made or natural depressions present less relief for air dispersion of tailings material. In addition, man-made depressions can be constructed singly, allowing for the tailings to be contained behind a single dam or embankment. The man-made depressions, created by excavations for ore, will be reclaimed by the tailings disposal operation and will provide less relief for wind-blown emissions from the tailings pond surface.

The design of the tailings disposal option selected for this project will provide the best balance of cost, stability, and environmental performance. This option presents major savings to the project by eliminating the need for a tailings dam and by maximizing the use of materials already at the site, particularly the tailings for progressive site reclamation.

3.5 Access/Transport Mode

Access to the project and transportation of materials and products is possible by three primary modes: overland, river, or air. Air transport will be used as one of the transportation mode for personnel to and from the mine. This will reduce the number of persons and vehicles/vessels travelling along the access road and will keep the camp as an "offshore operation". The primary mode of transport of materials and supplies to the mine and product from the mine will be overland by truck from the mine.

To avoid impacts of constructing an entirely new road, the route for overland transport was selected based on the availability of existing roads that extend from Lethem to the project area. There are very few existing roads in the region, limiting the selection to the road initially constructed to the mine site.

4.0 STAKEHOLDER IDENTIFICATION AND CONSULTATION

Project stakeholders are individuals and organizations who would be actively involved in the project, or whose interests may be affected because of the project execution. Stakeholder analysis results in the development of cooperation between the stakeholder and the project team and, ultimately, assures successful project outcomes. Stakeholders were considered in achieving project goals since their participation and support would be crucial to the success of the project. A stakeholder analysis was conducted to identify individuals or groups which are likely to be affected by the project. Stakeholders were then sorted according to how much they can affect the action and how much the action can affect them. The information was subsequently used to assess how the interests of those stakeholders was best addressed by the project.

This ESIA defines a stakeholder as any person or organization, who can be positively or negatively impacted by, or cause an impact on the actions of the Project and includes individuals, government and non-Governmental organizations. Those individuals and groups can be ultimately affected by project activities, either as beneficiaries (positively impacted) or disbeneficiaries (adversely impacted).

Key stakeholders are defined as those who can significantly influence or are important to the success of an activity. Secondary stakeholders are all other individuals or institutions with a stake, interest or intermediary role in the project. Stakeholders were identified based on the construction of a stakeholder matrix where stakeholders are plotted against two variables. These variables were the level of stake in the outcomes of the project against the resources of the stakeholder and the importance of the stakeholder against the influence of the stakeholder. The matrix is demonstrated In Figure 4.

Figure 4 - Stakeholder Classification Matrix

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="4">IMPORTANCE OF STAKEHOLDERS</td></tr>
<tr><td>Unknown</td><td>Little/No Importance</td><td>Some Importance</td><td>Significant Importance</td></tr>
<tr><td rowspan="4">INFLUENCE OF STAKEHOLDER</td><td>Significant Influence</td><td colspan="2" rowspan="2">C</td><td colspan="2" rowspan="2">A</td></tr>
<tr><td>Somewhat Influence</td></tr>
<tr><td>Little or No Influence</td><td colspan="2" rowspan="2">D</td><td colspan="2" rowspan="2">B</td></tr>
<tr><td>Unknown</td></tr>
</table>

In the matrix Box A include stakeholders with a high degree of influence on the project, who are also of high importance for its success. These include senior government officials, politicians or trade unions. Box B are stakeholders of high importance to the success of the project, but with low influence. This implies that they will require special initiatives if their interests are to be protected and include traditionally marginalized groups (e.g. Indigenous people, youth, seniors), who might be beneficiaries of a new service, but who have little 'voice' in its development. Box C are stakeholders with high influence, who can affect the project outcomes, but whose interests are not necessarily aligned with the overall goals of the project. These include the Guyana Geology and Mines Commission, the Environmental Protection Agency, Conservation International and World Wildlife Fund. These stakeholders may be a source of significant risk, and they will need careful monitoring and management and Box D are stakeholders such as the Guyana Revenue Authority, have low influence on, or importance to the project objectives but require limited monitoring or evaluation, but are of low priority.

Correspondence was sent to several Government and Non-Governmental organisations to solicit their comments and concerns related to the proposed project. The correspondence identified the project area as being approximately 5577 hectares (ha) and its location in the South Rupununi Mining District, approximately 155 kilometers south–south east of Lethem, and 50 kilometers south–south east of Aishalton and solicited any information in stakeholder possession related to:

- forestry concessions, forest types and timber extracted from the area and its vicinity
- the proximity of indigenous communities
- mining operation now and formerly operating in the area
- the likely presence of archaeological resources in the area

- site geology
- hydrogeology
- surface water hydrology
- biological resources in the area including the presence of any unique ecosystems, natural habitat or endangered species
- historical association of the area with Indigenous Peoples
- permanent or transient uses of the area by Indigenous Peoples
- chemical properties of the site soils
- risk of natural hazards (e.g. flooding) and subsidence and
- local meteorological conditions
- historical human activities within proximity of the study area,
- persons who engage in these activities
- any artifacts related to those activities
- people who have constantly lived in the area
- people who recently moved into the area
- people who enter the area periodically
- Land use patterns such as agriculture, forestry and mining within and around the proposed mine site
- schools, medical facilities, communications/transport networks and markets
- public health, health risks and diseases in the vicinity of the project

In accordance with Good International Industry Practice (GIIP) these stakeholders were requested to provide any information in their possession and were also invited to a meeting to identify issues for inclusion in the ESIA document. A copy of the correspondence is presented in the Appendix.

5.0 LEGISLATIVE AND REGULATORY FRAMEWORK FOR MINING PROJECTS

5.1 Environmental Impact Assessment Process

Environmental approval for the project will be guided by adherence to several pieces of legislation and an associated regulatory framework during construction, operation and closure of the mine and associated facilities. The legislative and regulatory framework incorporate national legislation, policies, and regulations in addition to regional and international guidelines to which Guyana is a signatory. The environmental and social impact assessment process for development, operation and closure of this mine will be undertaken in accordance with the legislative and regulatory framework which follows.

5.1.1 National Policies, Regulations and Legislations

5.1.1.1 National Environmental Action Plan

The National Environment Action Plan (NEAP), developed in 1994, outlines the Government of Guyana main environmental policy objectives for sound management of the environment and natural resources. Twelve policy objectives are outlined in the NEAP. One of the policy objectives calls for the Government of Guyana to require that environmental assessments are undertaken for proposed development activities that may significantly affect the environment. In keeping with this environmental policy objective, the Environmental Protection Act (EP Act) was made law in June 1996 and outlined the legal framework for undertaking environmental impact assessments. The EP Act established the Environmental Protection Agency (EPA) and established a legal process to undertake sustainable and effective management of the environment and its natural resources.

The NEAP was updated in 2000. It states Guyana's Policy position as 'sustainable development that integrates economic, environmental and social values during planning, and recognizes the need to distribute benefits equitably across socio-economic strata and gender upon implementation.' The main goals of protecting the environment are defined in the plan as:

1. The prevention or control of pollution to maintain the integrity of the land and the natural purity of the air and water resources
2. The general preservation and conservation of ecological integrity and the protection of natural habitats and fragile ecosystems
3. Ensuring sustainability through best practice of the management and use of natural resources for economic development.

5.1.1.2 Environmental Protection Act 1996

The Environmental Protection Act, which established the Environmental Protection Agency (EPA), provides for the management, conservation, protection and improvement of the environment. It outlines provisions to prevent or control pollution, to assess the impact of economic development on the environment and to enable the sustainable use of natural resources. The EP Act mandates the performance of Environmental Impact Assessments for projects which are likely to have significant impacts on the environment.

This Act was amended in 2005 to include a section on record keeping and monitoring. The EP Act now mandates the EPA to require that any person who releases or engages in the handling of hazardous substances or contaminants to:

1. Sample and analyze such contaminant or hazardous substance, or material contaminated by that person for specific constituents or characteristics;
2. Install, use and maintain monitoring equipment, and implement environmental audit procedures as may be specified in any environmental authorization issued pursuant to this Act;
3. Establish and maintain records regarding such sampling, monitoring, and environmental auditing activities;

4. Establish and maintain records regarding pollution control equipment on the premises (including records on control equipment parameters, production variables and other indirect data when direct monitoring is not required);
5. Submit reports including compliance reports; and
6. Provide such other information as the authority may require.

Five (5) regulations were enacted in 2000 under the Environmental Protection Act. These are:

1. The Environmental Protection Air Quality Regulations
2. The Environmental Protection Water Quality Regulations
3. The Environmental Protection Noise Management Regulations
4. The Environmental Protection Hazardous Wastes Management Regulations
5. The Environmental Protection Authorizations Regulations

5.1.1.3 Environmental Protection (Authorizations) Regulations 2000

This regulation mandates that records be kept of all environmental monitoring (not less than 3 years), sampling procedures, maintenance and calibration procedures and all problems and malfunctions. These records should be made available to the EPA. The record must provide information such as:

Steps to avoid, minimize, mitigate and compensate for impacts
Records of monitoring information such as date, place and time of measurement etc.
Proper maintenance of facilities and appropriate quality assurance procedures;

5.1.1.4 Role of EPA in EIAs

The EP Act mandated four functions for the EPA as related to environmental assessments. These four functions are:

1. To take such steps as are necessary for the effective management of the natural environment to ensure conservation, protection and sustainable use of natural resources;
2. To promote the participation of members of the public in the process of integrating environmental concerns in planning for development on a sustainable basis;
3. To ensure that any development activity which may cause an adverse effect on the natural environment be assessed before such activity is commenced and that such adverse effect is considered in deciding if such activity should be authorized.
4. To coordinate environmental management activities of all persons, organizations and activities.

The Agency is mandated to be guided by several principles of environmental management as part of this process. These principles are:

1. The "polluter pays principle"- the polluter should bear the cost of measures to reduce pollution
2. The "precautionary principle"- where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation.
3. The "strict liability" legal principle: any person who contravenes this Act or regulations shall be liable to the penalties prescribed thereafter;
4. The "avoidance" principle: it is preferable to avoid environmental damage, as it can be impossible or more expensive to repair rather that prevent damage;
5. The "state of technology" principle: measures protecting the environment are restricted by what is technologically feasible and as technology improves, the improved technology should be used to prevent and repair environmental damage.

5.1.1.5 The EIA Process

The EPA has indicated that an EIA, (herein referred to as an ESIA), must be conducted for this project. The ESIA must conform to the EIA process established by the Guyana EPA. In accordance with the EIA process the EPA has published, at RGEL cost, a notice of the project in at least one daily newpapers and has made a non-technical summary of the project available to members of the public. Members of the public have had more than twenty-eight days from the date of publication to make written submission to the Agency setting out those questions and matters which they require to be answered or considered in the environmental impact assessment. The EPA has consulted with Ground Structures Engineering Consultants Inc. (GSEC), the firm chosen to carry out the environmental impact assessment, to set the terms and scope of the environmental impact assessment considering all submissions made by members of the public.

During performance of the ESIA both the developer and GSEC consulted members of the public, interested bodies and organizations and provided to members of the public on request, and at no more than the reasonable cost of photocopying, copies of information obtained for the ESIA. In accordance with the EP Act the ESIA included the identification, description and evaluation of the direct and indirect effects of the proposed project on the environmental including

- human beings
- flora and fauna and species habitats
- water
- soil
- air and climatic factors
- material assets, the cultural heritage and the landscape
- natural resources, including how much of a particular resource is degraded or eliminated, and how quickly the natural system may deteriorate
- the ecological balance and ecosystems
- the interaction between the factors listed above
- other environmental factor which needs to be taken into account or which the EPA required to be included
- the need to protect and improve human health and living conditions and
- the need to preserve the stability of ecosystems as well as the diversity of species.

Further to ensure compliance with the EP Act, this ESIA contains the following information

- a description of the project, including in particular the geographical area involved, the physical characteristics of the whole project and the land-use requirements during the construction and operational phases, including plans, drawings, and models
- the main characteristics of the production process, including the nature and quantity of the materials used, plans, drawings and models
- an estimate, by type and quantity, of expected contaminants, residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation resulting from the operation of the proposed project
- the length of time of the project.
- an outline of the main alternatives studied by the developer and an indication of the main reasons for his choice, taking into account the environmental factors
- a description of the likely significant effects of the proposed project on the environment resulting from
    - the existence of the project
    - the use of natural resources
    - the emission of contaminants, the creation of nuisances and the elimination of waste, and
- a description of the forecasting methods used to assess the effects on the environment.
- an indication of any difficulties (technical deficiencies or lack of knowledge or expertise) encountered by the developer in compiling the required information
- a description of the best available technology

- a description of any hazards or dangers which may arise from the project and an assessment of the risk to the environment
- a description of the measures which will be used to mitigate any adverse effects
- a statement of reasonable alternatives (if any) and reasons for their rejection
- a statement of the degree of irreversible damage, and an explanation of how it is assessed
- an emergency response plan for containing and cleaning up any pollution or spill of any contaminant
- a programme for rehabilitation and restoration of the environment

After completion, the ESIA will be submitted to the EPA for evaluation and recommendations. A notice will be published, by RGEL, in at least one daily newspaper confirming that the ESIA has been submitted to the agency. Members of the public shall have sixty days from the date of publication of that notice to make submissions to the Agency as they consider appropriate.

Concurrently, the EPA shall submit the ESIA to the Environmental Assessment Board for its consideration and recommendation as to whether the environmental impact assessment and the environmental impact statement are acceptable.

5.1.1.6 Environmental Impact Assessment Guidelines

The Environmental Protection Agency (EPA) in collaboration with the Environmental Assessment Board (EAB) has produced guidelines for conducting Environmental Impact Assessments (EIA) for Mining Projects in Guyana. The guidelines are intended to compliment those in Section IV of the Environmental Protection Act, 1996 (EP Act). In accordance with these guidelines, this ESIA consist of three components; Environmental Baseline Study, Environmental Assessment and Environmental Impact Statement. The Environmental Baseline Study records the quality of the environment within the area of influence before the project is implemented. The data is analyzed in the environmental assessment and is used to predict and quantify impacts.

The Environmental Assessment (EA) is the identification and assessment of impacts of the proposed project and of its alternatives. The EA considers mitigation measures to offset negative impacts and assesses the impact of implementing these measures on the environment. The Environmental Impact Statement is a summary of the findings of the Environmental Baseline Study and the Environmental Assessment and includes an Environmental Management Plan.

5.1.1.7 Gold Board Act (1981)

This Act provided for the establishment, constitution, and functions of the Guyana Gold Board and for matters connected therewith. The functions of the board, as defined by the Act, include to carry on the business of trading in gold, to secure, always, an adequate supply of gold and to ensure its equitable distribution in Guyana at fair prices, subject to this Act, to purchase all gold produced in Guyana, subject to this Act, to sell all gold in Guyana and to sell gold outside Guyana and to engage in other related commercial or industrial activities. The act further mandates that no person shall sell any gold to, or purchase any gold from, any person other than the Board or any agent authorized in writing by the Board or export any gold. The Act also allows the Board to authorize a person to have in his possession or to sell or export such quantity of gold as the Board may allow subject to such conditions as the Board may think fit to impose.

5.1.1.8 Gold Board (Amendment) Act (1994)

This Act amended the Guyana Gold Board Act 1981. Section 2 of the Gold Board Act was amended for the word "claim" to have the same meaning as assigned to it by the Mining Act 1989. This amendment repealed Section 6 of the Gold Board Act and substituted it with the requirement for every producer who possesses gold, won or obtained during operations as a producer, before the date of coming into operation of the Guyana Gold Board (Amendment) Act 1994, to sell such gold to the Board or to any agent authorized in writing by the Board. The amendment further mandated that every producer who wins or obtains gold during operations as a producer shall, within twenty-eight days after his winning or obtaining such gold and within twenty-four hours of conveying such

gold to Georgetown or any other place determined by the Minister by notice in the official Gazette, or such longer period as the Board may allow, sell such gold to the Board or to any agent authorized in writing by the Board.

5.1.1.9 Guyana Geology and Mines Commission Act of 1979 and Mining Act of 1989

The Guyana Geology and Mines Commission, established by the GGMC Act 1979 is responsible for the implementation of the Mining Act 1989, which established the legal framework for the utilization of mineral resources in Guyana. The Act makes provision for a system of mineral agreements and licences for regulating prospecting. It gives the Commission the responsibility to establish regulations for mining and quarrying operations. A mining licence is required to mine any mineral and is issued at the discretion of the Commissioner of the GGMC based on agreement of the Minister responsible for mining. In addition, the act makes provisions for the disposal of sanitary waste and the storage of poisonous substances in mining areas.

Sections 76 and 77 of the Mining Act of 1989 details provisions for regulations related to safety in mines or quarries or in prospecting, mining or quarrying operations and the welfare of workers. The Guyana Geology and Mines Commission is currently developing a document on Occupational Health and Safety in Mines. The provisions of this act are superseded by the Mining Act 1989 if inconsistencies prevail.

5.1.1.10 The Mining (Amendment) Regulations 2005

The GGMC amended its mining regulations in 2005. RGEL holds a Mining Licence issued by the Guyana Geology & Mines Commission (GGMC). GGMC is responsible for enforcing the provisions in this regulation. Environmental provisions applicable to current mining operations are detailed in the Mining (Amendment) Regulations 2005. The Mining (Amendment) regulations 2005 contain mandates for several areas. The mandates which are applicable to this project are as follows:

1. Requirements for Environmental Management for Large Scale Mining
2. General Requirements
3. Protected Areas
4. Pollution Control

5.1.1.10.1 Requirements for Environmental Management for Large Scale Mining

There are specific requirements for environmental management of large scale mining operations. Every person who proposes to dispose of effluent is required before commencing any action related thereto, to apply either personally or in writing to the Commission for a permit and to submit with such application, the prescribed fee and a description in summary of the activities including information on:

- the site, design or process, site characteristics and layout, distance to water bodies, ground water regime and mode of tailings disposal
- possible effects on the environment and
- a simplified description of the activity.

Where the Commission is satisfied with an application that the proposed use does not significantly affect the environment and that the requirements of these Regulations have been complied with, together with the requirements of the Environmental Protection Act 1996 and the recommendations of the EPA, it shall grant the permit applied for on such terms and conditions and in such form as the Commission may from time to time determine.

The Commission may refuse to grant a permit under this regulation where it has reason to believe that the application is based on false or misleading information or after consultation with the EPA, it is satisfied that the preservation and character of the environment, including flora and fauna will be adversely affected. If the Commission, after consultation with the EPA is satisfied that there have been material changes in the circumstances that existed at the time the permit was granted, the Commission shall convey this in writing to the permit holder

and advise that a new permit must be applied for and the current permit will remain valid only up to a stipulated date.

A person to whom a permit has been granted in accordance with this regulation can apply to the Commission to vary or modify the permit stating clearly the reasons and the Commission may issue a written warning to the permit holder and manager of the operation for any breach of provisions of these regulations or any terms and conditions subject to which the permit is granted. The Commission may suspend a permit for a breach of any provision of these regulations or for any term or condition subject to which the permit is granted.

The Commission is required, on suspending a permit to notify the holder in writing stating the breach that gave rise to the suspension, requiring the holder of the permit to remedy the breach, stating the time within which the breach is to be remedied and stating whether the permit is to be returned within a specific time to the Commission.

Where the Commission cancels a permit, the Commission is required as soon as practicable thereafter, to notify in writing the person to whom the permit or certificate was granted of the cancellation. The notice shall state the reason for the cancellation, and such cancellation shall take effect on receipt of the notice by the addressee. Any person who is aggrieved by a decision of the Commission shall within twenty-eight days of the decision, appeal in writing against such decision to the Minister. The Minister after examining all relevant information on the matter appealed shall issue an appropriate order.

A permit is mandated not to be transferable except with the permission of the Commissioner and where the Commissioner authorizes the transfer of such a permit, he may vary the conditions already imposed on the permit or he may impose such other conditions as he may consider appropriate. The Commission, EPA, the mining associations and educational training institutions shall in accordance with the curricula approved by the Commission jointly or singularly provide training and certification courses for miners on environmental hazards in mining activities.

Every holder of Mining licence, Prospecting Permit or Mining Permit is also mandated to lodge an Environmental Bond in favor of the Commission, in an amount to be determined by the commissioner. The Environmental Bond or part thereof, shall be used by the Commission to restore the environment where restoration of the said area was not done to the satisfaction of the Commissioner provided that the Commission shall retain no third party to carry out such restoration before the miner has been given three months from the date restoration becomes due to restore the area.

The regulations also mandate preparation of a closure plan before any new prospecting or mining licence is issued by the Commission and the closure plan must be approved by the Commission before a new prospecting or mining licence, is issued by the Commission to an operator.

The reclamation and closure plan is required to include measures for the backfilling of placer mine pits, where applicable and appropriate, the stripping and stockpiling of topsoil for use in reclamation, the replacement of topsoil and vegetation of disturbed lands and the restoration of water courses, where appropriate. Holders of Prospecting and Mining Licences are required to prepare a contingency and emergency response plan in accordance with the Code of Practice. The contingency and emergency response plans must set out provisions for hazards in mining operations including practical mechanisms to respond to spills of hazardous substances. Any person who contravenes this regulation commits an offence and holders of prospecting and mining licences and medium scale permits are required to ensure that all relevant information of the contingency and emergency response plan are communicated to employees and independent contractors, and shall include information on first person response, notification procedures, location of clean-up equipment, an analysis of potential accidents and responses and materials safety data sheets for all materials which could be spilled.

5.1.1.10.2 General Requirements Applicable to Mining

The general requirements of the regulations stipulate that the Commissioner shall determine the number of dredges or mining operations which shall be permitted to dredge or mine in any area which may already be or likely to be

affected by tailings discharge and to also direct the method of mining permissible in the areas affected or likely to be affected by tailings discharge if necessary. The basis for the commissioner determination is the percentage of clay content found in the overburden or deposit or the total load of clay which may be released in the tailings and shall be made from results of sampling and tests done by officers of the Commission. The regulations also permit The Nephelometric Turbidity Units (NTU) value at the affected area to be stipulated by the Commissioner from time to time and operators of land operations are mandated to discharge tailings into a tailings pond or into a river, creek or stream where the critical turbidity has not exceeded 30 NTU. In addition, operators of river operations are required to discharge tailings into a tailings pond on land or to a river, creek or stream where the critical turbidity has not exceeded 30 NTU or in any other manner as approved by the Commissioner.

Discharges from tailings ponds are required to be released underwater through a conduit at a minimum depth specified by the Commissioner. Where any operation exceeds either of the stipulated limits, the operator shall be cited for such breach and be given twenty-four hours within which to rectify same and operators are required to keep a daily record of the readings of the total suspended solids or Nephelometric Turbidity Units (NTU) in grab samples of the discharge. All readings forming part the daily record shall be taken approximately twenty-four hours after the previous reading.

Prior to the commencement of mining in any area, a miner is required, if the miner considers that the area has been environmentally damaged, to request in writing an inspection of such areas by the Commissioner or an officer appointed in writing by the Commissioner.

Tailings dam or water retaining dams higher than 16 feet or six metres must be inspected annually by a qualified civil, mining or geotechnical engineer registered with the Commission and approved by a recognized engineering body. The reports of such inspections are required to be kept on file and be available for review by inspectors of the Commission and every tailings pond shall be equipped with emergency spillways that pass the flows from the probable maximum flood to prevent overtopping of dams under extreme rainfall or runoff rainfall.

The regulations stipulate that no compensation shall be paid to a holder of a permit where the decision to cancel the permit was necessary for the purposes of protecting and conserving the environment, any animal or plant or because of an unforeseeable change in circumstances based on which the permit was granted.

5.1.1.11 Mining Regulations

The regulations contain provisions for the sanitary management of human waste and for burial of animals and any person who expires at the mine. These regulations prohibit the hiring of females, and underage boys and restrict persons permitted to work underground.

The royalty payable on gold is detailed in the regulations in addition to the rights and expectations of lessees and tributors. The regulations places restrictions on individuals eligible to be employed as laborers in mining districts and mandate that each person, who is not an Amerindian, who works as an employee in a mining district shall be registered. The employer at a mine site is mandated to keep medicines and medical supplies for the use of mine employees and in instances where the number of employees exceed 50 the employer is compelled to employ a sicknurse or dispenser and prohibits employers from punishing employees.

The regulations further mandate the keeping of record of gold, valuable minerals and precious stones, payment of royalty on gold, valuable minerals and precious stones, sale and purchase of gold, valuable minerals and precious stones and on the export of precious Stones.

Part XXII of the regulations applies to the rights, privileges and restriction on Amerindians and the miscellaneous provisions provide for disposal of forfeited gold, valuable minerals and precious stones.

5.1.1.11.1 Environmental Provisions for Mining

The environmental provisions of Cap 65:01, as inferred from those regulations, relate to the management of mine operation effluents. The provisions for construction of dams can be interpreted as being related to the construction of tailings, detention and sediment control structures.

5.1.1.11.2 General Monitoring Requirements

The Mining Regulations require that "environmental effects monitoring" should be conducted for every mine, including new mines. An "environmental effects monitoring program" is required to be submitted to the GGMC for approval as part of the Environmental Management Plan.

5.1.2 INTERNATIONAL AND REGIONAL POLICY

5.1.2.1 Rio Declaration

The Rio Declaration on Environment and Development was one of five (5) documents that resulted from the Earth Summit in Rio de Janeiro in 1992. The other documents which apply to this project are:

- Agenda 21
- United Nations Framework Convention on Climate Change
- United Nations Convention on Biological Diversity

The Rio Declaration consisted of 27 principles intended to guide sustainable development around the world. It confirms the responsibilities of all countries including Guyana to among other principles:

- Use the precautionary approach to prevent environmental degradation (Principle 15)
- Undertake activities having environmental impacts with full public participation (Principle 10)
- Include Indigenous People and their communities in development projects (Principle 22)

Guyana practices sustainable development guided by the Rio Declaration and developed and implemented guidelines for conducting Environmental Impact Assessments, which will be used to guide this project.

5.1.2.2 Agenda 21

Agenda 21 arose from the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992. It outlines several environmental policies and management issues for a more sustainable pattern of development in the 21st century. Four major areas of political action were identified in Agenda 21; social and economic development, natural resources, fragile ecosystems, major organizations and groups of people and means of implementation (Selman, 1996). Further, twenty-seven (27) environmental principles for the protection of environmental resources were outlined as the Agenda 21 action programs. One of its principles which states that environmental impact assessment should be a national instrument and shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority is applicable to this project (Principle 17). This global principle guided the development of a national policy on environmental impact assessment.

The UNCED Conference also initiated global statements on key environmental issues. These included the Framework Convention on Climate Change and the Convention on Biological Diversity which Guyana has ratified. Guyana must therefore consider these global agreements during environmental impact assessment for developmental projects.

5.1.2.3 Treaty on Cooperation for the Development of the Amazon Basin

The Treaty on Cooperation for the Development of the Amazon Basin was established in 1978 to promote the harmonious development of the Amazon Region and to undertake joint action and efforts to promote the harmonious development of the Amazonian territories in such a way that joint actions produce equitable and mutually beneficial results and achieve the preservation of the environment, conservation and rational utilization of the natural resources.

Six sub-committees were set up to initiate, implement and address issues as it relates to the implementation of the Amazonian Treaty. These include the following: Health, Transportation, Education, Infrastructure, Tourism, Environment, Science and Technology and Indigenous Affairs.

The area proposed for the development of this project is considered part of the Amazon Basin and this treaty would be applicable to the development. The environmental conditions and agreements place emphasis on the Government of Guyana as a signatory to these treaties to put specific measures in place for compliance. The enactment of the Environmental Protection Act and its regulations have established the institutional and regulatory measures for the implementation of the treaty some of which forms part of the environmental impact assessment requirements.

6.0 DESCRIPTION OF THE PROPOSED ACTION

6.1 Proposed Action

The proposed action, addressed by this Environmental and Social Impact Assessment (ESIA), is the operation of a mining and mineral processing operation for the recovery of gold on the concession granted to Romanex Guyana Exploration Limited (RGEL). The concession is located on the rectangular block of Land in the Rupununi Mining District and includes the headwaters of Peace, Pancake, Locust, Ashburner and Toucan Creeks, the Marudi Mountain Mine Compound and the headwaters of Totowau Creek. The mining operation will be undertaken based on surface mining methods. Ore recovery will be concentrated in an open pit mine sited on Mazoa Hill and in eluvial/colluvial deposits adjacent to several streams in the concession.

The project will be exploited in two phases:

Phase 1 Removal of gold bearing saprolite and colluvium
Phase 2 Mining of hard-rock resources.

6.2 Preliminary Works

Preliminary works will consist of the clearing of the forested area for development into a surface mine. The forest will be cleared using conventional methods. Chainsaws will be used for felling large trees. The underbrush will be cleared by hand cutting. Felled timber will be used for construction purposes on site to enlarge the existing mining camp and camp facilities. Among the facilities to be constructed with timber are the living quarters and office areas for the project. Surplus timber will be stockpiled for future use. Timber and other vegetative material not suitable for use as construction material will be burned or buried on site during the mining operation. The preliminary phase, entailing site clearing and construction of site facilities, will be completed in approximately six months. The work force during this phase will vary from 25 men initially to 85 men in the latter stages of construction.

Mining will be preceded by significant site preparation works. In all areas to be mined, the surface layer of soil will be pushed to stockpiles and saved for future reclamation. Prior to removal of any surficial soil, timber which is felled, because it occurs on the resource or poses a hazard to worker safety, will be branched and cut to useable lengths and stockpiled for construction use related to the mining operation.

6.3 Mining

Soft rock material will be mined by traditional truck and shovel operations. Tractors and excavators will loosen and excavate the material, and the material will be loaded onto trucks by either excavators or wheel loaders. The material will be hauled to a stockpile area adjacent to the processing plant. Hard rock will also be mined by traditional truck and shovel operations generally below the area of saprolite (soft rock) mining. Hard rock material will be ripped with tractors equipped with rippers. In addition, light blasting with a 3-5 meter centers drill pattern will also be used, if required, to loosen the rock. Hard rock will be loaded onto trucks by either excavators or wheel loaders.

Ore will either be stockpiled or hauled directly to the processing plant. Haul roads will be constructed, using waste rock and saprolite after processing for mineral recovery, to ensure minimum damage to forested areas and to ensure that streams crossings are kept to only the number absolutely required. Haul roads will be cleared of all trees and vegetation. Spoil pile and stockpile areas would be located and arranged to preserve trees and vegetation to the maximum practicable extent. During the overburden removal and ore recovery exercises and when weather and ground conditions permit, all deep ruts caused by mining equipment that are hazardous to the movement of equipment would be corrected. Damage to creeks and roads due to mining equipment would also be corrected.

6.4 Processing

6.4.1 Phase One – Soft Rock and Gravity Concentration

Ore will be fed directly to the wash plant by truck or will be moved from the stockpile to the wash plant by truck. In the wash plant the ore will be beneficiated by gravity. The wash plant will wash the ore to free it into a slurry and to break up any loose rock. Material larger than 25 mm in diameter will be used for either construction purposes or stockpiled to be re-processed in the second phase (Hard Rock Mining) of the operation. Material between 4 mm and 25 mm will be sampled as it leaves the plant and a record kept of gold content. This material will also be used for construction or stockpiled for future processing based on gold grade determined by sampling. Material less than 4 mm in size will be passed through various screens or cyclones to insure proper size fractionation and separation. Single size fractions will be sent to a gravity separator. Coarse fractions will be fed into jigs and then on to coarse sluice boxes. Finer fractions will be fed through either jigs or centrifugal concentrators. The tailings from the fine circuit will be sent over long sluices, while the concentrate will either be cleaned up by hand or tabled to create a concentrate for smelting. No mercury or cyanide will be used in the recovery operation.

6.4.2 Phase Two – Hard Rock Gravity Plus Flotation

Test work has indicated that a concentrate containing approximately 91% of the contained gold can be produced by froth flotation. A combination of gravity and froth flotation will therefore be used to extract gold from hard-rock ore. A crusher will be added to the circuit to convert the mill, used to process soft rock ore during Phase one, to handle the harder Phase Two ore. The crusher will reduce the size of material arriving at the stockpile from the mine. Hard rock and suitable material stockpiled from the gravity beneficiation process will be crushed and fed to a SAG or ball mill to reduce the material to a relatively coarse grind. The ground material will contain approximately 40% of material finer than the ASTM No. 200 sieve. The material will then be passed through the original gravity circuit.

After gravity concentration of the ground ore, the residual material will pass to the flotation circuit. In the flotation circuit, ground ore will come into contact with pine oil and air bubbles in an agitated tank. The gold will adhere to the pine oil which will coat the bubbles. The bubbles will then rise to the surface of the tank bringing gold with them. The particles of gold will then be scraped off the surface as foam. The foam would be collected and smelted to recover the gold.

The reagents employed in flotation are generally interfacial surface tension modifiers, surface chemistry modifiers, and/or flocculants. Usually they are classified under five headings: collectors (known as flotation promoters), frothers, modifiers, activators and depressants. Collectors are reagents that coat and/or react with mineral surfaces and make them water repellent or attachable to air bubbles. Frothers are surface active reagents that aid in the formation and stabilisation of air-induced flotation froths. The commonly employed frothing agents are alcohols which are only slightly soluble in water, or the more modern frothers, which are generally varieties of polyethers or polyglycol ethers that are completely miscible with water.

A pH modifier such as lime may be added to the processing circuit if required. Silicates and the phosphates, which also act as modifiers, to control the effect of cationic and anionic impurities in flotation water may also be used if required.

6.4.3 Tailings Management

Tailings, from the operations, would be collected in a pond designed to prohibit the escape of fine material to surface water. The pond will be in a natural valley located on the property. A diversion ditch will be constructed around the pond to prevent runoff from entering it. The pond will be created by constructing a saddle dike on one side of a valley located within the concession. The tailings pond would be designed to contain all material generated during the life of the operation. It will be designed for a twenty-year life. It will have a surface area of 300,000 m^2 and will be designed for a capacity of approximately 3 million metric tons. Water from the pond will be recycled for plant process water and will also be utilized in the recovery processes. Preventative measures to be adapted for

integrity of the ponds will include adequate bunding and appropriate geotechnical and architectural design of the impoundment area to preclude release of process water into the environment. The pond will encompass the headwaters of two streams in the concession.

6.4.4 Reclamation

During the mine life and after cessation of operations, care will be taken to minimize the footprint of the mine. As exploitation ceases in areas, these areas will be subject to ongoing reclamation. Excavated areas will either be back-filled or provided with inflows and outflows to permit them to become aerated lakes. Roads will be maintained with culverts to inhibit the creation of stagnant pools. On abandonment, all materials and debris would be removed from stockpile locations. After cessation of all operations, the area would be rehabilitated, as required, so that all surfaces drain naturally, blend with the natural terrain, and are left in a condition that will facilitate natural revegetation, provide for proper drainage, and prevent erosion to provide a base for conversion to useful habitat or agricultural lands.

6.5 Support Services

Support services such as equipment maintenance, provision of project housing and other services activities would be performed to reduce accidental spillage of solid matter, contaminants, debris, and other objectionable pollutants and wastes into waterways in the project area. Such pollutants and wastes include, but are not restricted to, refuse, garbage, cement, concrete, oil and grease, and other petroleum products. All water discharges from the area will be done in a manner to ensure minimal discharge of sediments to any waterway. Excavated soil will not be stockpiled or deposited near or on the banks of waterways where they can be washed away by storm runoff.

6.5.1 Site Utilities Supply

A well will be drilled on site to provide potable water for use by project personnel. The water quality analyses of groundwater samples from the mine site area indicate that groundwater quality satisfies Ontario Drinking Water Standards. Groundwater will consequently not be treated prior to use. Electric generators providing total power output capacity in excess of 500 kilowatts will be provided for use of onsite personnel and for the operation of the processing plant. The layout of the mine site inclusive of the open pit, tailings pond, sedimentation pond, processing plant and personnel accommodation is shown on Figure 5.

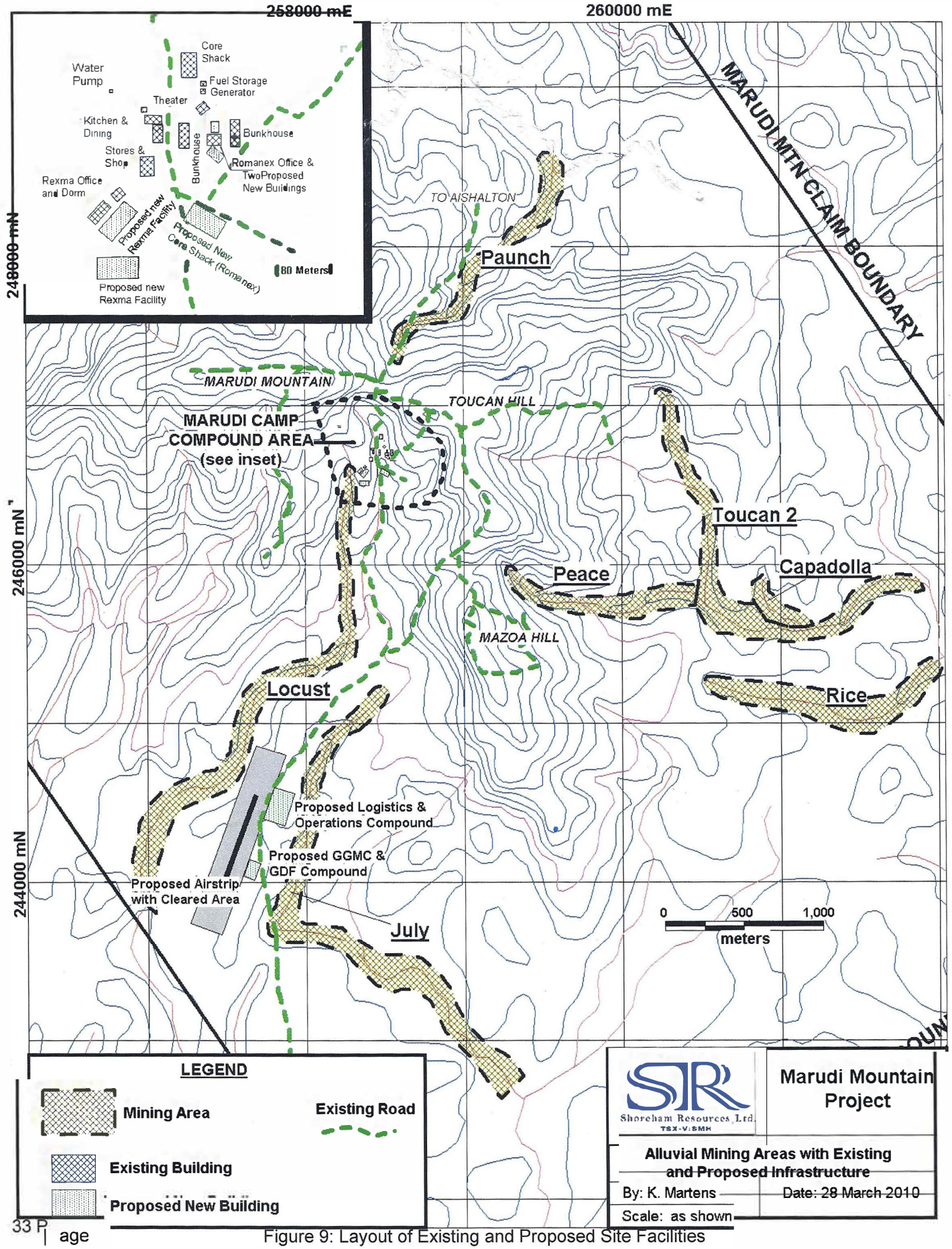


Figure 9: Layout of Existing and Proposed Site Facilities

Figure 5: Mine Site Layout

7.0 WATER RESOURCES

7.1 Introduction

This chapter defines the regulatory framework and baseline data for water resources for the proposed action and identifies project impacts on the water resources environment including water quantity, water quality and fluvial geomorphology. The methodology used to rate the environmental impacts on water resources replicates that outlined in Chapter 5. The chapter further outlines environmental management actions to mitigate impacts on water resources.

7.2 Policy Legislative and Regulatory Framework

7.2.1 Environmental Protection Water Quality Regulations 2000

These regulations require registration and environmental authorization of any person whose construction, installation, operation, modification or extension of any facility cause the discharge of effluents. These regulations cover parameter limits of effluent discharges, new sources of effluent discharges, fees for registration and environmental authorization, sampling points, records and reports and general provisions for the registration of water effluent, biological integrity, spills or accidental discharges and standard methods of analysis. Guidelines on the discharge of effluents and disposal of sludge are detailed in these regulations.

In accordance with these regulations the EPA was mandated to establish parameter limits for concentration of constituents of effluent which can be discharged into any inland or coastal waters or lands of Guyana for Ammonical Nitrogen, Sulphate, Chloride, Cobalt, Colour, Detergents, Anionic, Fluoride (as F), Molybdenum, Phosphate 9 as P, Polychlorinated Biphenyls, Selenium, Silver, Beryllium, Vanadium, Radioactive Material, Nitrate Nitrogen, Temperature, Pesticides, Fungicides, Herbicides, Insecticides, Rodenticides, Fumigants or any other Biocides or any other Chlorinated Hydrocarbons. Standards were also to be established for any substance that either by itself or in combination with other waste or refuse may give rise to any gas, fume or odour or substance which causes or is likely to cause pollution. The Guyana National Bureau of Standards (GNBS), along with the EPA, have developed interim industrial effluent standards which, however, are not specific to mining.

7.2.2 EPA EIA Guidelines Mining Version 1, August 2000 Water Quality

In addition to the mandates for effluent discharge to the environment, the EPA has established guidelines for water quality monitoring parameters associated with mining. Since this is a mining project these standards are applicable to all phases of the project. These guidelines mandate that both surface and groundwater associated with mining operations be analyzed for pH, TDS, TSS, turbidity, conductivity, organic compounds (phenol and oil and grease), major anions (Ca, Mg, Na, K), nutrients (TKN, total ammonia, phosphate, nitrate + nitrite), trace metals (Al, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Sb, Zn). The EPA further dictates that concentration levels of these substances shall not exceed levels of environmental concern (normally set as levels to protect aquatic species). The EPA also reserves the right to request analyses to determine bacteriological levels (coliforms, fecal coliforms and standard plate counts), rare earth elements, radioactive elements and other trace metals.

7.2.3 The Mining (Amendment) Regulations 2005

The GGMC amended its mining regulations in 2005. Several of those regulations apply to water resources. Anyone who proposes to dispose of effluent is required before commencing any disposal action to apply to the GGMC for a permit with the associated fees and a description of the proposed discharge including the site, design or process; site characteristics and layout; distance to water bodies; ground water regime and mode of tailings disposal, possible effects on the environment and a simplified description of the activity. The GGMC will grant a permit only after it is satisfied that the proposed activity will not significantly affect the environment and that the requirements of both these Regulations and the requirements of the Environmental Protection Act 1996 have been complied with.

GGMC may refuse to issue a permit, under this regulation, where it has reason to believe that the application is based on false or misleading information or it is satisfied, after consultation with the EPA, that the preservation and character of the environment will be adversely affected. If the Commission, after consultation with the EPA is satisfied that there have been material changes in the circumstances that existed at the time the permit was granted, the Commission shall convey this in writing to the permit holder and advise that a new permit must be applied for and the current permit will remain valid only up to a stipulated date. A person to whom a permit has been granted in accordance with these regulations can apply to the GGMC to vary or modify the permit with clearly stated reasons.

The GGMC may issue a written warning to the permit holder and mines manager for any breach of the provisions of these regulations or of any terms and conditions under which the permit was granted. The Commission may suspend a permit for a breach of any provision of these regulations or for any term or condition subject to which the permit is granted. The Commission is required, on suspending a permit to notify the holder, in writing, stating the breach that gave rise to the suspension, requiring the holder of the permit to remedy the breach, stating the time within which the breach is to be remedied and stating whether the permit is to be returned within a specific time to the Commission.

Where the Commission cancels a permit, the Commission is required as soon as practicable thereafter, to notify in writing the person to whom the permit or certificate was granted of the cancellation. The notice shall state the reason for the cancellation, and such cancellation shall take effect on receipt of the notice by the addressee. Any person who is aggrieved by a decision of the Commission shall within twenty-eight days of the decision, appeal in writing against such decision to the Minister. The Minister after examining all relevant information on the matter, appealed, shall issue an appropriate order. A permit is mandated not to be transferable except with the permission of the Commissioner and where the Commissioner authorizes the transfer of such a permit, he may vary the conditions already imposed on the permit or he may impose such other conditions as he may consider appropriate.

7.2.3.1 General Requirements

The GGMC Commissioner is required under the general requirements of the Mining Amendment, 2005, to determine the number of dredges or mining operations which shall be permitted to dredge or mine in any area which may already be or likely to be affected by tailings discharge and to also direct the method of mining permissible in the areas affected or likely to be affected by tailings discharge if necessary. The basis for the commissioner determination is the percentage of clay content found in the overburden or deposit or the total load of clay which may be released in the tailings and shall be made from results of sampling and tests done by officers of the GGMC. The regulations also permit The Nephelometric Turbidity Units (NTU) value at the affected area to be stipulated by the Commissioner from time to time. Land operations are mandated to discharge tailings into a tailings pond or into a river, creek or stream where the critical turbidity has not exceeded 30 NTU. In addition, operators of river operations are required to discharge tailings into a tailings pond on land or to a river, creek or stream where the critical turbidity has not exceeded 30 NTU or in any other manner as approved by the Commissioner.

Operators are also required to ensure that discharges from tailings ponds or dredges into any river or creek shall not exceed either 100 mg/l of total suspended solids (TSS) or 50 Nephelometric Turbidity Units (NTU). The Commissioner is authorized to stipulate the limits for chemical contamination from time to time. Discharges from tailings ponds and river dredge are required to be released underwater through a conduit at a minimum depth specified by the Commissioner. Where any operation exceeds either of the stipulated limits, the operator shall be cited for such breach and be given twenty-four hours within which to rectify same and operators are required to keep a daily record of the readings of the total suspended solids or Nephelometric Turbidity Units (NTU) in grab samples of the discharge. All readings forming part the daily record shall be taken approximately twenty-four hours after the previous reading.

Where settling ponds are used as parts of the mine drainage system, channels discharging into the river must be culverted, and where necessary the slopes must be protected from erosion. Approved devices, chemical procedures or ponds must be used to remove settleable solids from tailings discharges from on-land mines. Every settling pond

must have a minimum water residence time equivalent to the aggregate volume of slurry processed or water used in each sluice box or mine processing device in any continuous two-hour period with discharge being in accordance with the effluent limits. Operators are also restricted from disposing of petroleum products or any matter containing tars, oil, grease or any poisonous substances directly on the surface of the land or in a river or creek.

Prior to the commencement of mining in any area, a miner is required, if the miner considers that the area has been environmentally damaged, to request in writing an inspection of such areas by the Commissioner or an officer appointed in writing by the Commissioner.

The regulations require that information in relation to the disposal of effluent shall be provided by the applicant, to the Commission, on the site of the disposal, the amount of the disposal and the possible effects on the environment.

Among the general requirements is that tailings dam or water retaining dams higher than 16 feet or six metres be inspected annually by a qualified civil, mining or geotechnical engineer registered with the Commission and approved by a recognized engineering body. The inspection reports must be kept on file and be available for review by inspectors of the Commission. Every tailings pond shall be equipped with emergency spillways that pass the flows from the probable maximum flood to prevent overtopping of dams under extreme rainfall or runoff rainfall.

The regulations stipulate that no compensation shall be paid to a holder of a permit where the decision to cancel the permit was necessary for the purposes of protecting and conserving the environment, any animal or plant or by reason of an unforeseeable change in circumstances based on which the permit was granted.

7.2.4 Mining Regulations – Water Resources Provisions

The environmental provisions of Cap 65:01, as inferred from those regulations, relate to the management of mine operation effluents. The provisions for construction of dams can be interpreted as being related to the construction of tailings, detention and sediment control structures.

In accordance with Part VIII 60 (a) a dam can be constructed on state land as part of a mining operation. There is also a mandate that no one shall deposit any earth, stone, gravel, debris or tailings on a claim held by another person without their consent. This regulation also mandates that any area of water containing poisonous or injurious chemical solutions used in the treatment of gold or other minerals must be fenced to prevent inadvertent access thereto, and notice boards shall be erected in suitable places warning persons not to make use of such water. In addition, in no case shall water containing any poisonous or injurious chemical solutions be permitted by a claim holder or his agents to knowingly escape or enter any river, creek, race, lake, reservoir, or any stagnant water without having been previously rendered innocuous.

Additional provisions of the regulations which are inferred to relate to the utilization and impacts on water resources stipulate that a person may hold, at the same time, on any water-course which is not navigable, claims extending from the point where such water-course ceases to be navigable to its source and no claim other than a dredging concession or river location shall include the bed of a navigable river or water-course. In addition, no person holding a claim on either bank of a navigable water-course shall prevent free navigation and passage thereon and every holder of a claim shall be entitled to the free use of water naturally flowing through or past his claim, and not already lawfully appropriated in such manner as may, in the opinion of the commissioner or of the mines officer, subject to the approval of the Commissioner, be necessary for the proper working thereof.

Additional regulations related to water resources, is a mandate that no person shall back the water of any river, creek or water-course upon any claim or cause any claim to be flooded, either willfully or by neglect through the construction of any dam or stop-off, or in any other way and permits the Minister to grant to any person a licence, with such terms and conditions as he may think proper to take direct and use any water from any river, creek, tributary, stream, lake or pool, situated upon or flowing through any State lands for the purpose of supplying with water any machine or any engine or machinery employed and for mining purposes provided that such works shall not interfere with existing rights. Every water-race shall have a point to be specified by the commissioner or mines

officer at which water shall be taken from the river, creek, or other source, but in no case, shall such river, creek, or other source be included in or form part of any water-race or pipe for the conveyance of water.

The final water resources provision states that in case any holder of a licence under this regulation fails to make a reasonable use of the advantages allowed to him by his licence or if he takes water in excess of a reasonable quantity or if he wastes water or if he fails to comply with the condition under which his licence was granted the Minister may cancel his licence and every person who willfully or negligently causes the water of any well or reservoir on or near any claim, or of any creek used for drinking purposes and set apart by the mines officer for that purpose, to become contaminated shall be guilty of a breach of the regulations.

Limits on effluent disposal are covered by the requirement that in no case shall water containing any poisonous or injurious chemical solution be permitted to escape or enter any river, creek, race, lake, reservoir, or any stagnant water without having been previously rendered innocuous.

7.2.5 World Bank Water Quality Standards

Tolerable limits have not been established by the EPA for water quality for construction or mining operations which would be applicable to this project. The 2007 IFC EHS guidelines limits for the mining and milling industries would therefore be applied to this project. These limits for liquid effluents and residual heavy metals are detailed below.

7.2.5.1 Liquid Effluents

The following limits for effluent discharged to receiving waters from tailings impoundment, mine drainage, sedimentation basins, sewage systems and storm water drainage are considered applicable to this project.

pH	6 to 9
BOD5	50 mg/l
Oil and Grease	10 mg/l
Total Suspended Solids	50 mg/l
Temperature-at the edge of a designated mixing zone: receiving waters, Max 3°C if receiving waters >28°C	Max.5°C above ambient temperature of

7.2.5.2 Residual Heavy Metals

The following recommended target limits, which are expected to pose no risk for significant adverse impact to aquatic biota or humans will be applied to this project.

Arsenic	1.0 mg/l
Cadmium	0.1 mg/l
Chromium, Hexavalent	0.05 mg/l
Chromium, Total	1.0 mg/l
Copper	0.3 mg/l
Iron, Total	2 mg/l
Lead	0.6 mg/l
Mercury	0.002 mg/l
Nickel	0.5 mg/l
Zinc	1.0mg/l

If natural concentrations exceed these levels, the discharge will be allowed to contain concentrations up to natural background levels. Concentrations up to 110% of natural background would be acceptable if no significant adverse impact can be demonstrated.

7.3 Baseline

7.3.1 Surface Water

A hydrological map of the area to be mined is shown as Figure 6. The drainage basin for the Kuyuwini River, which encompasses the area to be mined, is shown on Figure 7. The proposed mine pit would be located on Mazoa Hill, close to the headwaters of several creeks. These creeks flow from the headwater southwards to the Kuyuwini River which is the primary drainage conduit for the area. The catchment area to be mined is located on a catchment whose north and west limits are defined by the Marudi Mountains.

Soils present at ground surface have variable infiltration rates. Some of the precipitation on the ground surface will report to groundwater. Surface water flows in the creeks within the area are consequently highly likely to be a combination of groundwater discharge to surface water bodies and direct surface runoff, with flows in the dry season being primarily due to groundwater discharge to surface water.

7.3.1.1 Catchment Area and Flow Volumes

The primary creeks within proximity to the proposed open pit mine are Capodilla, Locust, July, Peace, Paunch, Rice and Toucan. The meteorological department has no monitored streamflow values for any of these creeks. The catchment area for each creek was approximated from a 1:50,000 topographic map of the area and are summarized in Table 4.

Table 4: Summary of Catchment Area for Creeks in Mine Site Vicinity

Creek	Catchment Area (km^2)
Capodilla	0.20
Locust	2.50
July	2.34
Peace	0.53
Paunch	1.07
Rice	0.78
Toucan	1.12

No data is available for precipitation runoff in the project area. Montreal Engineering Company Limited (1976) determined an average runoff of 2.5 ft^3 per sec per square mile (0.000274 m^3 per sec per hectare) for the area. That value was used to develop average flows in each creek based on their catchment areas. The report also documented flow variations in the Essequibo River up to King William IV Falls. The peak, average and minimum daily flows in the Essequibo River at King William IV Falls equate to 130, 50 and 8 ft^3/sec. respectively. The Kuyuwini is a major source of flow in that reach of the Essequibo. It was consequently inferred that the flow variations in the Essequibo would also be reflective of peak, average and minimum runoff from the drainage basin. Based on that assumption the peak, average and minimum flows in the creeks are inferred to be as detailed in Table 5 below.

Table 5: Summary of Inferred Peak, Average and Minimum Flows in Targeted Creeks

Creek	Inferred Flow (m^3/sec)		
	Peak	Average	Minimum
Capodilla	1.42E-04	5.48E-05	8.77E-06
Locust	1.78E-03	6.85E-04	1.10E-04
July	1.67E-03	6.41E-04	1.03E-04
Peace	3.78E-04	1.45E-04	2.32E-05
Paunch	7.62E-04	2.93E-04	4.69E-05
Rice	5.56E-04	2.14E-04	3.42E-05
Toucan	7.98E-04	3.07E-04	4.91E-05

The flows in Table 5 are reflective of undeveloped conditions. The illegal miners, within the concessions, have mined all the creeks and associated flood plains detailed in Table 5. This has resulted in significant increases in

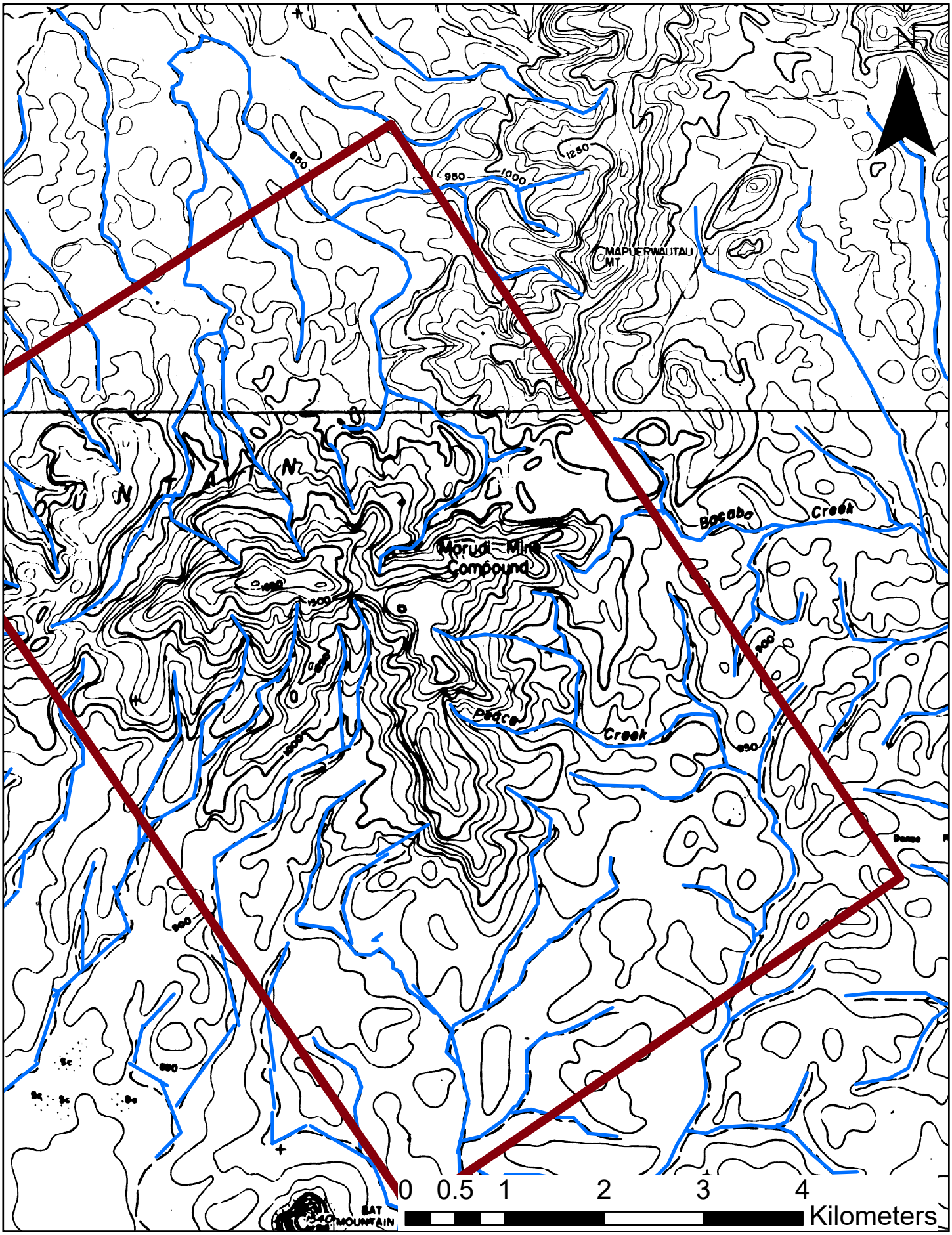


Figure 6: Hydrologic Map of Concession

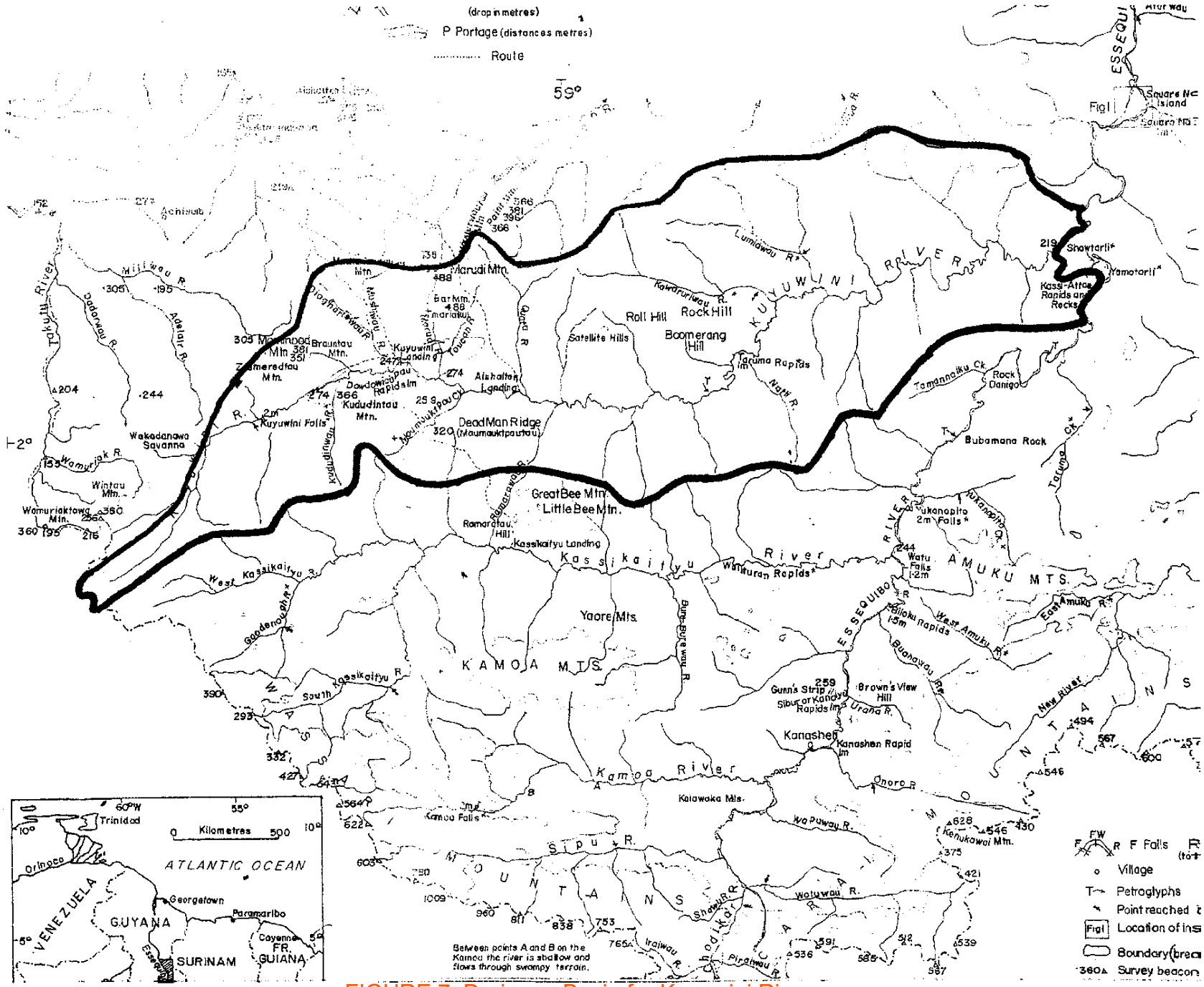


FIGURE 7: Drainage Basin for Kuyuwini River

the volume of sediment within each creek. The catchment area of each creek however has remained the same. The creeks will consequently continue to drain the inferred flow detailed in Table 5, however the flood plain of each creek has extended beyond those existing prior to the onset of the illegal mining operation.

7.3.2 Surface Water Quality

Baseline surface water quality for the area was developed for the ESIA conducted in 2009. Surface water samples were recovered in 2009 and analysed for the presence of EPA targeted pollutants. During August and October 2009, surface water samples were recovered from points coincident with the intersection of Capodilla and Peace Creeks (SW-1), Locust and July Creek (SW-2) and from Paunch Creek (SW-3). Surface water samples were recovered from these exact locations in January and May 2018 to determine if there were any impacts on surface water quality associated with the illegal mining operations. The water quality data for 2009 is representative of conditions prior to the commencement of mining operations.

Surface water samples, recovered in both 2009 and 2018 were analysed by ACCUTEST/EXOVA/ EUROFINS laboratories in Ottawa, Ontario, Canada to determine the concentration of parameters mandated in the EPA guidelines for Environmental Impact Assessment for the Mining Sector. The results of analytical tests on surface water samples, recovered in 2009, are detailed in Tables 6 and 7. The results of analytical tests on surface water samples, recovered in 2018, are detailed in Tables 8 and 9. The USEPA drinking water standards for various compounds are also listed in the tables for comparison.

Table 6: Results of 2009 Analytical Tests on Surface Water Samples

LAB ID:			**735006**	**735007**	**735008**	**USEPA Drinking Water Standard**
Sample Date:			**2009-08-01**	**2009-08-01**	**2009-08-01**	
Sample ID:			**SW1**	**SW2**	**SW3**	
PARAMETER	**UNITS**	**MRL**				
Acidity as $CaCO_3$	mg/L	1	<5	<5	<5	-
Alkalinity as $CaCO_3$	mg/L	5	20	29	11	
Chloride	mg/L	1	2	1	1	250
Conductivity	uS/cm	5	44	58	37	
Fluoride	mg/L	0.10	<0.10	<0.10	<0.10	2.0
Ph			7.43	7.49	7.21	6.5 – 8.5
Phenols	mg/L	0.001	<0.001	<0.001	<0.001	
Sulphate	mg/L	1	<3	<3	<3	250
Total Dissolved Solids (COND - CALC)	mg/L	5	29	38	24	500
Total Suspended Solids	mg/L	2	379	248	2640	
Turbidity	NTU	0.1	>100	>100	>100	
HCO_3 as $CaCO_3$	mg/L	5	20	29	11	
Aluminum	mg/L	0.1	4.5	5.0	75.6	0.05 – 0.2
Antimony	mg/L	0.01	<0.01	<0.01	<0.01	0.006
Arsenic	mg/L	0.05	<0.05	<0.05	<0.05	0.010
Cadmium	mg/L	0.01	<0.01	<0.01	<0.01	0.005
Calcium	mg/L	1	1	<1	2	-
Chromium	mg/L	0.05	<0.05	<0.05	0.18	0.1
Cobalt	mg/L	0.01	0.01	0.01	0.08	-
Copper	mg/L	0.01	0.01	0.02	0.26	1.0
Iron	mg/L	0.1	13.3	19.2	275	0.3
Lead	mg/L	0.01	<0.01	<0.01	0.02	0.015

Magnesium	mg/L	1	<1	<1	4	
Manganese	mg/L	0.01	0.88	1.18	2.81	0.05
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	0.002
Molybdenum	mg/L	0.01	<0.01	<0.01	<0.01	
Nickel	mg/L	0.01	<0.01	<0.01	<0.01	
Potassium	mg/L	1	<1	<1	<1	
Sodium	mg/L	2	<2	<2	<2	
Selenium	mg/L	0.05	<0.05	<0.05	<0.05	0.05
Zinc	mg/L	0.05	<0.05	<0.05	0.15	
Oil & Grease						
Oil & Grease – Mineral	mg/L	1	<1	<1	<1	
Oil & Grease - Non-mineral	mg/L	1	<1	<1	<1	
Oil & Grease – Total	mg/L	1	<1	<1	<1	

Table 7: Results of 2009 Analytical Tests on Surface Water Samples

LAB ID:			751286	751287	751288	**USEPA Drinking Water Standard**
Sample Date:			2009-10-13	2009-10-13	2009-10-13	
Sample ID:			SW1	SW2	SW3	
PARAMETER	**UNITS**	**MRL**				
Acidity as CaCO3	mg/L	5	<5	<5	<5	-
Alkalinity as CaCO3	mg/L	5	31	14	30	
Chloride	mg/L	1	1	1	2	250
Conductivity	uS/cm	5	71	35	64	
Fluoride	mg/L	0.10	<0.10	<0.10	<0.10	2.0
N-NH3 (Ammonia)	mg/L	0.02	0.02	<0.02	0.04	
N-NO2 (Nitrite)	mg/L	0.10	<0.10	<0.10	<0.10	
N-NO3 (Nitrate)	mg/L	0.10	0.15	0.14	0.13	
pH			7.75	7.15	7.65	6.5 – 8.5
Phenols	mg/L	0.001	<0.001	<0.001	<0.001	
Sulphate	mg/L	1	1	<1	2	
Total Dissolved Solids (COND - CALC)	mg/L	5	46	23	42	500
Total Kjeldahl Nitrogen	mg/L	0.10	0.19	0.12	0.16	
Total Phosphorus	mg/L	0.01	0.02	<0.01	3.43	
Total Suspended Solids	mg/L	2	44	4	5260	
Turbidity	NTU	0.1	27.0	1.3	>100	
HCO3 as CaCO3	mg/L	5	31	14	30	
Calcium	mg/L	1	5	2	5	
Magnesium	mg/L	1	3	1	2	
Potassium	mg/L	1	<1	<1	<1	
Sodium	mg/L	2	<2	<2	2	
Aluminum	mg/L	0.01	0.94	0.02	19.3	0.05 – 0.2
Antimony	mg/L	0.0001	<0.0001	<0.0001	<0.01	
Arsenic	mg/L	0.001	<0.001	<0.001	<0.05	0.010
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.01	0.005
Chromium	mg/L	0.001	0.002	0.001	<0.05	0.10
Cobalt	mg/L	0.0002	0.0003	0.0005	0.02	
Copper	mg/L	0.001	0.001	<0.001	0.05	1.0
Iron	mg/L	0.03	1.35	0.27	42.8	0.3

Lead	mg/L	0.001	<0.001	<0.001	0.01	0.015
Manganese	mg/L	0.01	0.07	0.21	0.65	0.05
Mercury	mg/L	0.0001	<0.0001	<0.0001	0.0003	0.002
Molybdenum	mg/L	0.005	<0.005	<0.005	<0.01	
Nickel	mg/L	0.005	<0.005	<0.005	0.02	
Selenium	mg/L	0.001	<0.001	<0.001	<0.05	0.05
Zinc	mg/L	0.01	<0.01	<0.01	0.06	5
Oil & Grease						
Oil & Grease – Mineral	mg/L	1	<1	<1	<1	
Oil & Grease - Non-mineral	mg/L	1	540	<1	<1	
Oil & Grease – Total	mg/L	1	540	<1	<1	

Table 8: Results of 2018 Analytical Tests on Dry Season Surface Water Samples

LIMS #				**1343669**	**1343670**	**1343671**
Sample ID				**SW-1**	**SW-2**	**SW-3**
Sample Date				**2018-01-24**	**2018-01-24**	**2018-01-24**
Analyte	**Units**	**Analytical Method**	**MRL**			
Ag	mg/L	EPA 200.8	0.0001	<0.0001	<0.0001	<0.0001
Al (dissolved)	mg/L	EPA 200.8	0.01	0.22	0.72	0.76
As	mg/L	EPA 200.8	0.001	<0.001	<0.001	<0.001
B	mg/L	EPA 200.8	0.01	<0.01	<0.01	<0.01
Ba	mg/L	EPA 200.8	0.01	0.09	0.04	<0.01
Be	mg/L	EPA 200.8	0.0005	<0.0005	<0.0005	<0.0005
Br	mg/L	SM 4110	0.25	<0.25	<0.25	<0.25
Ca	mg/L	M SM3120B-3500C	1	3	3	9
Cd	mg/L	EPA 200.8	0.0001	<0.0001	<0.0001	<0.0001
Cl	mg/L	SM 4110	1	2	2	2
Co	mg/L	EPA 200.8	0.0002	0.0013	0.0005	0.0004
Conductivity	uS/cm	C SM4500-H+B	5	52	46	92
Cr	mg/L	EPA 200.8	0.001	<0.001	0.001	<0.001
Cu	mg/L	EPA 200.8	0.001	<0.001	<0.001	0.002
Cyanide (free)	mg/L	C SM4500-CNC	0.005	<0.005	<0.005	<0.005
Cyanide (total)	mg/L	C SM4500-CNC	0.005	<0.005	<0.005	<0.005
F	mg/L	C SM4500-H+B	0.1	<0.10	<0.10	<0.10
Fe	mg/L	EPA 200.8	0.03	0.44	1.71	1.57
Hg	mg/L	M SM3112B-3500B	0.0001	<0.0001	<0.0001	<0.0001
K	mg/L	M SM3120B-3500C	1	2	2	<1
Mg	mg/L	M SM3120B-3500C	1	2	2	4
Mn	mg/L	EPA 200.8	0.01	1.38	0.11	0.04
Mo	mg/L	EPA 200.8	0.005	<0.005	<0.005	<0.005
Na	mg/L	M SM3120B-3500C	2	2	3	3
Ni	mg/L	EPA 200.8	0.005	<0.005	<0.005	<0.005
N-NH3	mg/L	SUBCONTRACT-SA-INORG	0.02	0.13	0.13	0.15
N-NO2	mg/L	C SM4500-NO3-F	0.1	<0.10	<0.10	<0.10
N-NO3	mg/L	C SM4500-NO3-F	0.1	<0.10	<0.10	<0.10
Oil & Grease - Mineral	mg/L	C SM5520B	1	<1	<1	<1
Oil & Grease - Non-mineral	mg/L	C SM5520B	1	<1	<1	<1
Oil & Grease - Total	mg/L	C SM5520B	1	<1	<1	<1

O-PO4	mg/L	C SM4500-PF	0.03	<0.03	<0.03	<0.03
Pb	mg/L	EPA 200.8	0.001	<0.001	<0.001	<0.001
pH		C SM4500-H+B	1	7.54	7.18	7.72
Phenols	mg/L	SUBCONTRACT-SA-INORG	1	<0.001	0.002	<0.001
Sb	mg/L	EPA 200.8	0.0005	<0.0005	<0.0005	<0.0005
Se	mg/L	EPA 200.8	0.001	<0.001	<0.001	<0.001
Si	mg/L	M SM3120B-3500C	0.1	7.1	7.3	18.3
SO4	mg/L	SM 4110	1	2	<1	<1
Sr	mg/L	EPA 200.8	0.001	0.016	0.025	0.021
TDS (COND - CALC)	mg/L	C SM2540	1	34	30	60
Ti	mg/L	EPA 200.8	0.01	<0.01	0.03	0.03
Tl	mg/L	EPA 200.8	0.0001	<0.0001	<0.0001	<0.0001
Total Kjeldahl Nitrogen	mg/L	SUBCONTRACT-SA-INORG	0.8	0.9	1.1	0.9
Total Suspended Solids	mg/L	C SM2540	2	68	16	9
Turbidity	NTU	C SM2130B	0.1	14.3	12.1	24.2
V	mg/L	EPA 200.8	0.001	0.001	0.002	0.005
Zn	mg/L	EPA 200.8	0.01	<0.01	<0.01	<0.01

Table 9: Results of 2018 Analytical Tests on Wet Season Surface Water Samples

LIMS #				**1360498**	**1360499**	**1360500**
Sample ID				**SW-1 (July Creek)**	**SW-2 (Rice Creek)**	**SW-3 (Paunch Creek)**
Sample Date				**2018-05-07**	**2018-05-07**	**2018-05-07**
Analyte	**Units**	**Analytical Method**	**MRL**			
Ag	mg/L	EPA 200.8	0.0001	<0.0001	<0.0001	<0.0001
Al (dissolved)	mg/L	EPA 200.8	0.01	0.18	0.52	0.61
As	mg/L	EPA 200.8	0.001	<0.001	<0.001	<0.001
B	mg/L	EPA 200.8	0.01	<0.01	<0.01	<0.01
Ba	mg/L	EPA 200.8	0.01	0.02	0.07	0.08
Be	mg/L	EPA 200.8	0.0005	<0.0005	<0.0005	<0.0005
Br	mg/L	SM 4110	0.25	<0.25	<0.25	<0.25
Ca	mg/L	M SM3120B-3500C	1	7	4	3
Cd	mg/L	EPA 200.8	0.0001	<0.0001	<0.0001	<0.0001
Cl	mg/L	SM 4110	1	2	2	2
Co	mg/L	EPA 200.8	0.0002	0.0005	0.0002	0.0009
Conductivity	uS/cm	SM2320,2510,4500H/F	5	77	62	44
Cr	mg/L	EPA 200.8	0.001	<0.001	<0.001	0.003
Cu	mg/L	EPA 200.8	0.001	0.002	<0.001	0.002
Cyanide (free)	mg/L	C SM4500-CNC	0.005	<0.005	<0.005	<0.005
Cyanide (total)	mg/L	C SM4500-CNC	0.005	<0.005	<0.005	<0.005
F	mg/L	SM2320,2510,4500H/F	0.1	<0.10	<0.10	<0.10
Fe	mg/L	EPA 200.8	0.03	1.74	1.54	2.75
Hg	mg/L	M SM3112B-3500B	0.0001	<0.0001	<0.0001	<0.0001
K	mg/L	M SM3120B-3500C	1	1	3	2
Mg	mg/L	M SM3120B-3500C	1	4	1	2
Mn	mg/L	EPA 200.8	0.01	0.09	0.12	0.11
Mo	mg/L	EPA 200.8	0.005	<0.005	<0.005	<0.005
Na	mg/L	M SM3120B-3500C	2	2	<2	4
Ni	mg/L	EPA 200.8	0.005	<0.005	<0.005	<0.005

N-NH3	mg/L	POINTECLAIRE	0.05	0.12	0.3	0.14
N-NO2	mg/L	SM 4110	0.1	<0.10	<0.10	<0.10
N-NO3	mg/L	SM 4110	0.1	0.16	<0.10	<0.10
Oil & Grease – Mineral	mg/L	C SM5520B	1	<1	1	<1
Oil & Grease - Non-mineral	mg/L	C SM5520B	1	1	1	<1
Oil & Grease – Total	mg/L	C SM5520B	1	1	2	<1
O-PO4	mg/L	POINTECLAIRE	0.03	<0.03	<0.03	<0.03
Pb	mg/L	EPA 200.8	0.001	<0.001	<0.001	0.001
pH		SM2320,2510,4500H/F	1	7.55	7.5	6.85
Phenols	mg/L	POINTECLAIRE	0.001	<0.001	<0.001	<0.001
Sb	mg/L	EPA 200.8	0.0005	<0.0005	<0.0005	<0.0005
Se	mg/L	EPA 200.8	0.001	<0.001	<0.001	<0.001
Si	mg/L	M SM3120B-3500C	0.1	11.8	3.3	8.8
SO4	mg/L	SM 4110	1	<1	<1	<1
Sr	mg/L	EPA 200.8	0.001	0.024	0.043	0.032
TDS (COND - CALC)	mg/L	C SM2540	1	50	40	29
Ti	mg/L	EPA 200.8	0.01	0.01	0.02	0.04
Tl	mg/L	EPA 200.8	0.0001	<0.0001	<0.0001	<0.0001
Total Kjeldahl Nitrogen	mg/L	POINTECLAIRE	0.8	<0.8	0.9	1.2
Total Suspended Solids	mg/L	C SM2540	2	13	24	76
Turbidity	NTU	C SM2130B	0.1	41.9	36.6	28.1
V	mg/L	EPA 200.8	0.001	0.003	0.001	0.004
Zn	mg/L	EPA 200.8	0.01	<0.01	<0.01	<0.01

7.4 Groundwater Resources

Practically no data are available on groundwater resources in mine site area. Three monitoring wells were installed at the site, in 2009, in proximity to the points at which the surface water samples were recovered. All wells were screened in the alluvial deposits at the site. One well (MW-1) was installed close to the intersection of Capodilla and Peace Creeks. The second well, (MW-2), was installed close to the intersection of Locust and July creeks and the third well, (MW-3), was installed near Paunch Creek. Groundwater was encountered at all monitoring wells. The depth to groundwater ranged from approximately 1.8 m at MW-3 to 3.0 m. at MW-1.

The horizontal flow gradient, in the alluvial deposits in 2009, was inferred by approximating ground surface elevations from topographic maps for the area. The horizontal flow gradients determined from inferred groundwater levels at the monitoring wells ranged from 0.208 to 0.357 in 2009. This high gradient recorded at that time were probably attributable to the pronounced slopes near the mine site. Regional groundwater flow is primarily to the south-southeast.

The hydraulic conductivity of the alluvials was determined by performing a rising head permeability test in each well. The hydraulic conductivity was determined to be approximately $5.8X10^{-3}$ m/sec. While the lateral extent of groundwater is not known, the hydraulic conductivity indicates that the formation may yield water.

During late 2017, well nests were installed at 5 locations at the mine site. Three wells were installed at each location and were screened in the alluvials, saprolite and bedrock at each location to infer vertical flow gradients between the geologic formations occurring at the site. Locations of the well nests are shown on Figure 8. The coordinates of each well nest and the response zone in which individual wells were screened are detailed in Table 10. Each well in alluvial and saprolite consisted of a standpipe piezometer, comprised of 3 m of No 10 Slotted PVC screen surrounded by a sand pack with flush PVC piping extending to the ground surface.

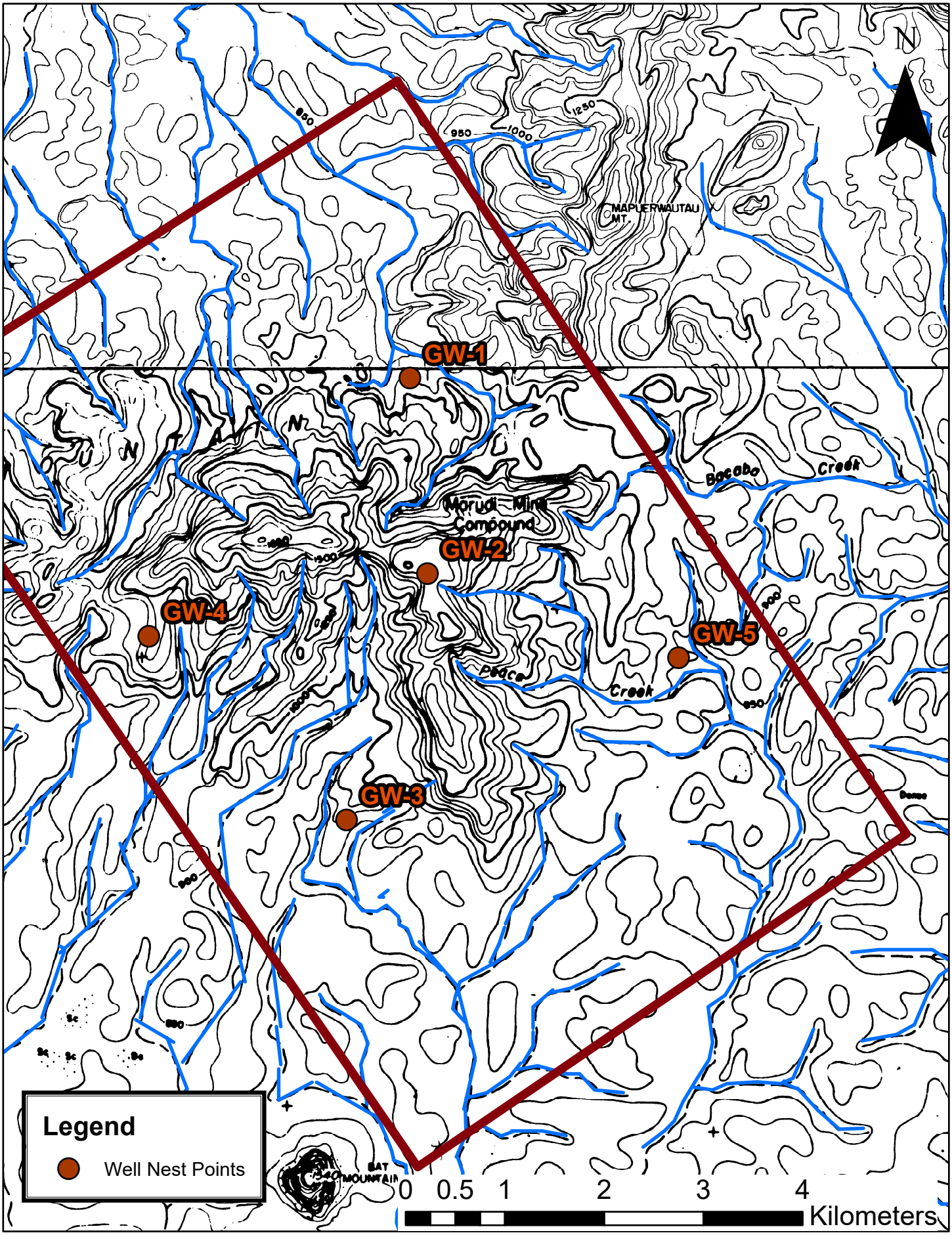


Figure 8: Well Nest Location Map

Table 10: Coordinates, Response Zone and Depth of Groundwater Wells

Monitoring Well ID	Measured Coordinates		Well Depth (m)	Response Zone
	Northing (m)	Easting (m)		
MW17-142	0246947	0258390	40.5	Bedrock
MW17-143	0246947	0258388	15.7	Saprolite
MW17-144	0246945	0258390	6.0	Alluvials
MW17-145	0245920	0258052	40.38	Bedrock
MW17-146	0245920	0258053	15.0	Saprolite
MW17-147	0245920	0258053	5.70	Alluvials
MW17-148	0244667	0257905	30.7	Bedrock
MW17-149	0244665	0257905	15.0	Saprolite
MW17-150	0244664	0257905	14.20	Alluvials
MW17-151	0246560	0260421	40.38	Bedrock
MW17-152	0246558	0260421	18.0	Saprolite
MW17-153	0246559	0260421	6.0	Alluvials
MW17-154	0247829	0258996	21.0	Bedrock
MW17-155	0247829	0258995	12.0	Saprolite
MW17-156	0247829	0258994	4.0	Alluvials

The stratigraphic profile at the site consists of a zone of residual soil which has been completely weathered to soil with no remaining structure of the rocks from which the soils were formed being visible. There is some laterite, a more specific sub-grouping of residual soil where secondary iron or aluminium oxides form, present at some location at the site. The residual soil is underlain by saprolite. The saprolite is representative of a portion of the weathered profile which has retained the original fabric and structure of the parent rock. Saprolite differs from weathered rock in degree of alteration. It is material that is sufficiently broken down that it can be augered through or dug with a shovel yet is retains the original rock structure (Anderson & Anderson, 2010). The retention of the rock structure implies that the saprolite has undergone no strain. The saprolite is underlain by weathered rock or saprock which constitutes the transition zone between saprolite and bedrock. In this zone intact rock material is present in a discontinuous framework separated by soil-like material. Typically, saprock is defined as having a rock content of 50 % or more. The rock material can be present in various states of weathering from highly weathered to fresh. Significant zones of soil like material can be encountered within a saprock zone due to preferential local weathering. The saprock is underlain by a stratum of intact rock with no indication of weathering.

Tests were conducted, during the field program, to determine the hydraulic conductivity of each geologic formation at the site. Packer (Lugeon) tests were conducted in bedrock. Slug Tests were performed in both the alluvials and saprolite deposit at all locations. The slug test consisted of displacing the water in the well by several feet and monitoring the return of the water level to its pretest level over time. The Packer Test consisted of isolating a section of the borehole using inflatable packers and injecting water into the isolated section and recording the water losses into the rock over time. Groundwater levels were recorded at all wells at the same time to provide data on vertical and horizontal flow gradients. Groundwater levels in wells were reduced to elevation values based on the ground surface elevations obtained by GPS.

Groundwater was recorded in wells, in the alluvial deposit, at a single location in the dry season and at two wells in the wet season. The data was inadequate to develop potentiometric maps for the alluvial deposit at the site. Groundwater elevations recorded in the alluvial stratum are detailed in Tables 11 and 12 for the dry and wet season respectively.

Table 11: Summary of Groundwater Elevation in Alluvials – 2018 Dry Season

Monitoring Well ID	Coordinates		Response Formation	Ground Surface Elevation (m)	Groundwater Elevation(m)
	Northing (m)	Easting(m)			
MW17-144	0246945	0258390	Alluvials	370.73	Dry
MW17-147	0245920	0258053	Alluvials	310.06	Dry
MW17-150	0244664	0257905	Alluvials	283.84	Dry
MW17-153	0246559	0260421	Alluvials	284.76	280.68
MW17-156	0247829	0258994	Alluvials	312.20	Dry

Table 12: Summary of Groundwater Elevation in Alluvials – 2018 Wet Season

Monitoring Well ID	Coordinates		Response Formation	Ground Surface Elevation (m)	Groundwater Elevation(m)
	Northing (m)	Easting(m)			
MW17-144	0246945	0258390	Alluvials	370.73	366.08
MW17-147	0245920	0258053	Alluvials	310.06	Dry
MW17-150	0244664	0257905	Alluvials	283.84	Dry
MW17-153	0246559	0260421	Alluvials	284.76	281.49
MW17-156	0247829	0258994	Alluvials	312.20	Dry

Groundwater levels in the saprolite and bedrock formations were used to develop potentiometric maps for the saprolite stratum and bedrock at the site in the dry and wet seasons. The data used for the saprolite stratum and bedrock are presented in Tables 13 thru 16. The associated potentiometric maps developed based on the information in Tables 13 thru 16 are shown depicted on Figures 9 thru 12. All potentiometric level maps were developed by extrapolation between points where groundwater elevations were recorded. It should be established that the data may not be exactly accurate because of the distance between ground water level measurements and the relatively low number of values.

Table 13: Summary of Groundwater Elevation in Saprolite – 2018 Dry Season

Monitoring Well ID	Coordinates		Response Zone	Ground Elevation (m)	Groundwater Elevation (m)
	Northing(m)	Easting (m)			
MW17-143	0246947	0258388	Saprolite	370.73	364.43
MW17-146	0245920	0258053	Saprolite	310.06	303.66
MW17-149	0244665	0257905	Saprolite	283.84	279.22
MW17-152	0246558	0260421	Saprolite	284.76	279.42
MW17-155	0247829	0258995	Saprolite	312.20	Dry

Table 14: Summary of Groundwater Elevation in Saprolite – 2018 Wet Season

Monitoring Well ID	Coordinates		Response Zone	Ground Elevation (m)	Groundwater Elevation (m)
	Northing(m)	Easting (m)			
MW17-143	0246947	0258388	Saprolite	370.73	365.04
MW17-146	0245920	0258053	Saprolite	310.06	304.21
MW17-149	0244665	0257905	Saprolite	283.84	279.76
MW17-152	0246558	0260421	Saprolite	284.76	281.41
MW17-155	0247829	0258995	Saprolite	312.20	300.43

Table 15: Summary of Groundwater Elevation in Bedrock – 2018 Dry Season

Monitoring Well ID	Coordinates		Response Zone	Ground Elevation (m)	Groundwater Elevation (m)
	Northing(m)	Easting (m)			
MW17-142	0246947	0258390	Bedrock	370.73	364.78
MW17-145	0245920	0258052	Bedrock	310.06	303.69
MW17-148	0244667	0257905	Bedrock	283.84	279.17
MW17-151	0246560	0260421	Bedrock	284.76	279.25
MW17-154	0247829	0258996	Bedrock	312.20	300.20

Table 16: Summary of Groundwater Elevation in Bedrock – 2018 Wet Season

Monitoring Well ID	Coordinates		Response Zone	Ground Elevation (m)	Groundwater Elevation (m)
	Northing(m)	Easting (m)			
MW17-142	0246947	0258390	Bedrock	370.73	365.81
MW17-145	0245920	0258052	Bedrock	310.06	304.22
MW17-148	0244667	0257905	Bedrock	283.84	279.22
MW17-151	0246560	0260421	Bedrock	284.76	281.12
MW17-154	0247829	0258996	Bedrock	312.20	300.47

Figure 9 - Dry Season Potentiometric Map for Saprolite Zone

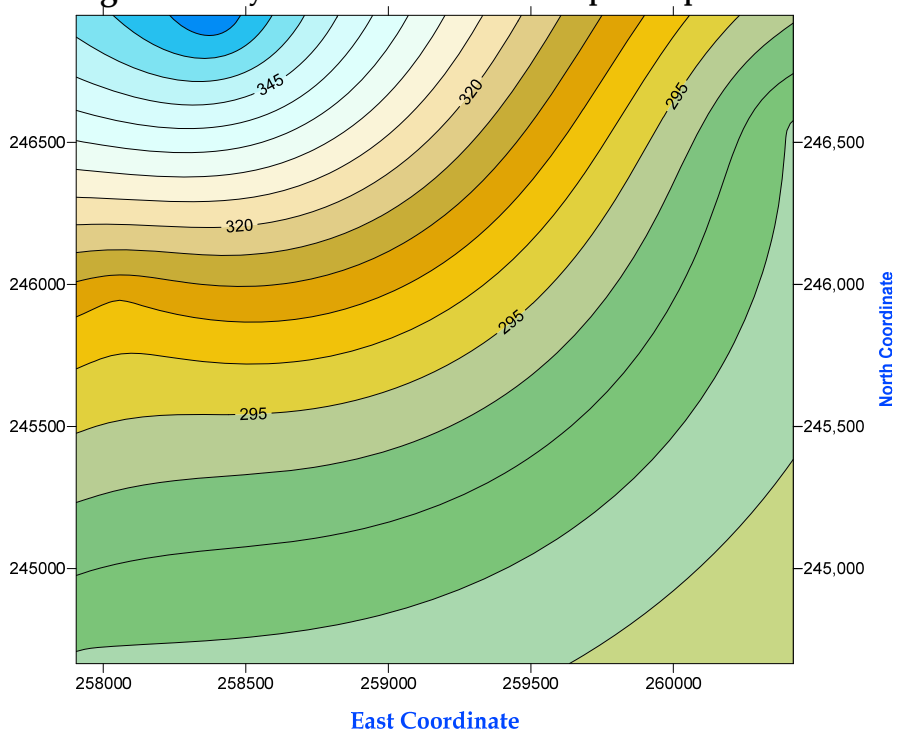


Figure 10 - Wet Season Potentiometric Map for Saprolite Zone

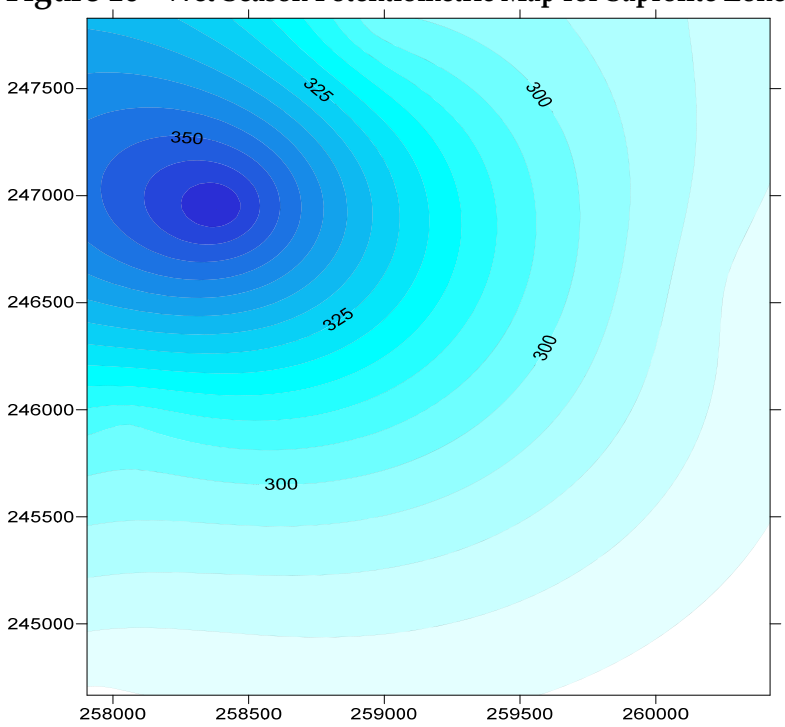


Figure 11 - Dry Season Potentiometric Map for Bedrock Zone

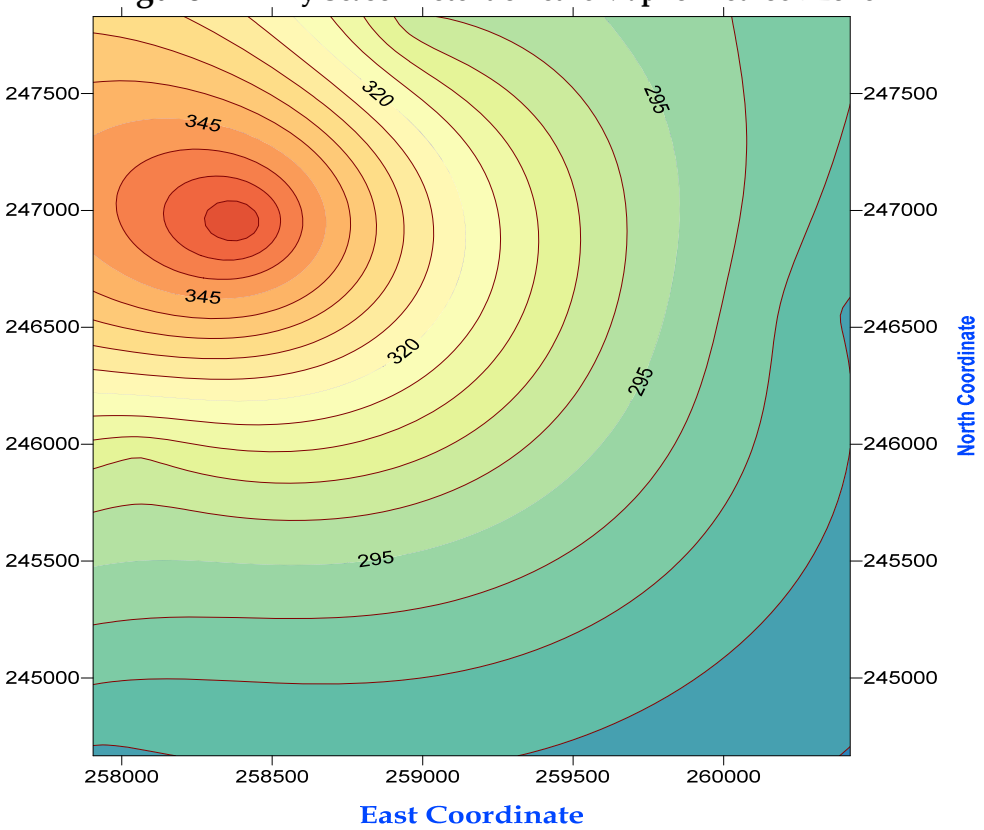
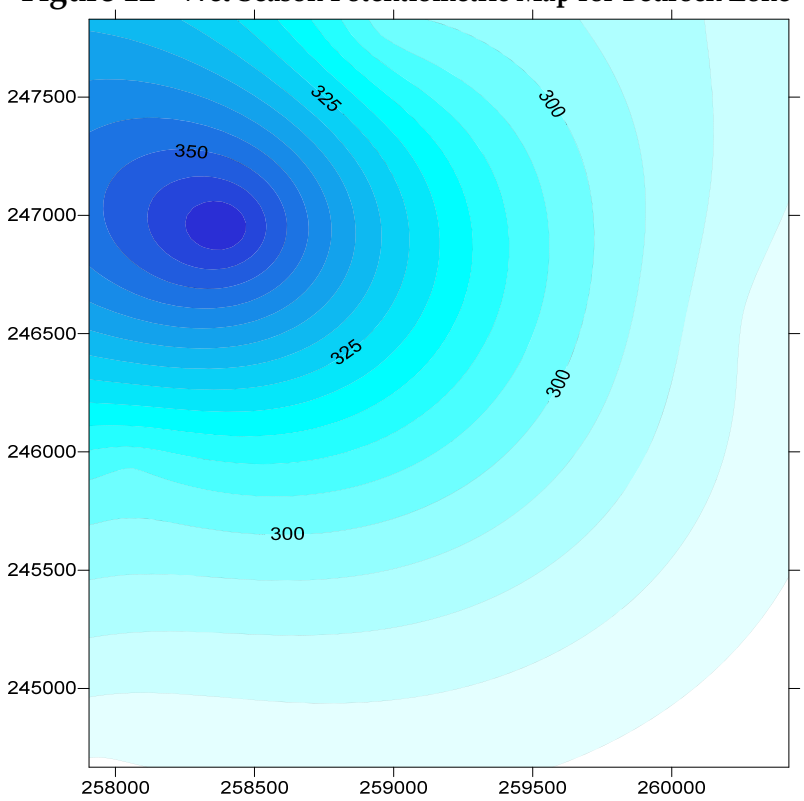


Figure 12 - Wet Season Potentiometric Map for Bedrock Zone



In all instances where groundwater levels were recorded in the alluvials, saprolite and bedrock formations, the groundwater elevations in the alluvials exceeded those recorded for both saprolite and bedrock which is indicative of a vertically downwards flow gradient from the alluvials into both saprolite and bedrock. There was little discernible difference in groundwater elevations in the saprolite formation and bedrock when these were simultaneously recorded.

While no discernible confining layer was encountered at the interface between the alluvials and saprolite the variation in groundwater levels between these two formations is probably reflective of the base of the alluvial deposit itself serving as a confining layer between the two formations.

Groundwater levels in the saprolite and bedrock differed only very slightly at the same well nest. Similarly, no discernible confining layer was encountered at the interface between the saprolite and bedrock. The slight variation in groundwater levels between these two formations is probably indicative of the sensitivity of the measurements and not indicative of differing flow regimes in these formations. Since the groundwater elevations were all relatively equal at each well nest in the saprolite and bedrock, these two formations are hydraulically interconnected.

The horizontal flow gradients were computed by identifying potentiometric lines that were farthest and closest apart. Since horizontal flow occur perpendicular to the potentiometric lines, maximum and minimum hydraulic gradients respectively will occur perpendicular to the closest and farthest spaced potentiometric lines. The maximum and minimum horizontal flow gradient equate to approximately 0.0085 and 0.0043.

The potentiometric maps all indicate that flow is from the northwestern section of the mine site towards the southeastern side of the site. Hydraulic conductivity values for the alluvials, saprolite and bedrock are summarized in Table 17. No values were computed for the bedrock since no discharge to the formation was recorded while performing the Packer Tests.

Table 17: Summary of Hydraulic Conductivity

Monitoring Well ID	Measured Coordinates		Response Zone	Hydraulic Conductivity (cm/sec)
	Northing (m)	Easting(m)		
MW17-144	0246945	0258390	Alluvials	2.251 E- 04
MW17-147	0245920	0258053	Alluvials	
MW17-150	0244664	0257905	Alluvials	
MW17-153	0246559	0260421	Alluvials	3.675 E- 04
MW17-156	0247829	0258994	Alluvials	
MW17-143	0246947	0258388	Saprolite	2.911 E- 05
MW17-146	0245920	0258053	Saprolite	9.084 E- 06
MW17-149	0244665	0257905	Saprolite	2.872 E – 04
MW17-152	0246558	0260421	Saprolite	2.668 E – 05
MW17-155	0247829	0258995	Saprolite	1.532 E – 04
MW17-142	0246947	0258390	Bedrock	No Take
MW17-145	0245920	0258052	Bedrock	No Take
MW17-148	0244667	0257905	Bedrock	No Take
MW17-151	0246560	0260421	Bedrock	No Take
MW17-154	0247829	0258996	Bedrock	No Take

The hydraulic conductivity of the alluvial soils at the site equates to approximately 10^{-4} cm/sec. The hydraulic conductivity of the saprolite stratum at the site equates to approximately 10^{-5} cm/sec and the hydraulic conductivity of the bedrock equates to approximately 0.0 cm/sec.

7.4.1 Groundwater Quality

Groundwater samples were recovered, twice in 2009, from the site to track temporal variations in groundwater quality. All samples were recovered in accordance with the USEPA RCRA Groundwater Monitoring Technical Enforcement Guidance Document. Results of analyses on the groundwater samples, recovered in 2009, are presented in Table 18 and 19.

Table 18: Results of Analytical Tests on Groundwater Samples

LAB ID:			735009	735010	735011
Sample Date:			2009-08-01	2009-08-01	2009-08-01
Sample ID:			MW1	MW2	MW3
PARAMETER	**UNITS**	**MRL**			
Acidity as CaCO3	mg/L	1	<5	<5	<5
Alkalinity as CaCO3	mg/L	5	37	21	33
Chloride	mg/L	1	4	3	5
Conductivity	uS/cm	5	88	45	62
Fluoride	mg/L	0.10	<0.10	<0.10	<0.10
N-NH3 (Ammonia)	mg/L	0.02	0.21	<0.02	0.16
N-NO2 (Nitrite)	mg/L	0.10	<0.10	<0.10	<0.10
N-NO3 (Nitrate)	mg/L	0.10	<0.10	0.14	<0.10
Total Kjeldahl Nitrogen	mg/L	0.10	0.61	<0.10	0.42
Ph			7.15	6.70	6.85
Phenols	mg/L	0.001	<0.001	<0.001	<0.001
Sulphate	mg/L	1	<3	<3	<3
Total Dissolved Solids (COND - CALC)	mg/L	5	57	29	46
Total Suspended Solids	mg/L	2	62800	1030	34500

Turbidity	NTU	0.1	>100	>100	>100
HCO3 as CaCO3	mg/L	5	37	21	29
Aluminum	mg/L	0.1	1050	5.3	453.0
Antimony	mg/L	0.01	0.02	<0.01	<0.01
Arsenic	mg/L	0.05	<0.05	<0.05	<0.05
Cadmium	mg/L	0.01	0.01	<0.01	<0.01
Calcium	mg/L	1	1	<1	12
Chromium	mg/L	0.05	1.70	<0.05	<0.05
Cobalt	mg/L	0.01	1.16	<0.01	1.23
Copper	mg/L	0.01	7.59	0.02	3.24
Iron	mg/L	0.1	4010	14.1	1853
Lead	mg/L	0.01	2.49	<0.01	3.21
Magnesium	mg/L	1	<1	<1	<1
Manganese	mg/L	0.01	72.8	0.42	24.30
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.01	0.03	<0.01	<0.01
Nickel	mg/L	0.01	1.72	<0.01	<0.01
Potassium	mg/L	1	<1	<1	<1
Selenium	mg/L	0.05	<0.05	<0.05	<0.05
Sodium	mg/L	2	<2	<2	<2
Zinc	mg/L	0.05	2.42	0.06	1.14
Oil & Grease					
Oil & Grease – Mineral	mg/L	1	<1	<1	<1
Oil & Grease - Non-mineral	mg/L	4	<4	<4	<4
Oil & Grease – Total	mg/L	5	<5	<5	<5

Table 19: Results of Analytical Tests on Groundwater Samples

LAB ID:			751289	751290	751291
Sample Date:			2009-10-13	2009-10-13	2009-10-13
Sample ID:			GW1	GW2	GW3
PARAMETER	**UNITS**	**MRL**			
Acidity as CaCO3	mg/L	5	<5	<5	<5
Alkalinity as CaCO3	mg/L	5	25	31	119
Chloride	mg/L	1	3	3	3
Conductivity	uS/cm	5	52	61	267
Fluoride	mg/L	0.10	<0.10	0.11	0.14
N-NH3 (Ammonia)	mg/L	0.02	0.12	0.30	13.7
N-NO2 (Nitrite)	mg/L	0.10	<0.10	<0.10	<0.10
N-NO3 (Nitrate)	mg/L	0.10	<0.10	<0.10	<0.10
Ph			6.51	6.90	7.43
Phenols	mg/L	0.001	<0.001	<0.001	<0.001
Sulphate	mg/L	1	<1	<1	<1
Total Dissolved Solids (COND - CALC)	mg/L	5	34	40	174
Total Kjeldahl Nitrogen	mg/L	0.10	0.38	0.42	15.2
Total Phosphorus	mg/L	0.01	<0.01	<0.05	<0.05
Total Suspended Solids	mg/L	2	15100	3600	13600
Turbidity	NTU	0.1	>100	>100	>100
HCO3 as CaCO3	mg/L	5	25	31	119
Calcium	mg/L	1	<1	2	4
Magnesium	mg/L	1	<1	<1	2
Potassium	mg/L	1	<1	<1	2

Sodium	mg/L	2	<2	2	<2
Aluminum	mg/L	0.01	1.97	0.05	0.50
Antimony	mg/L	0.0001	<0.0001	<0.0001	<0.0001
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.003	0.001	0.003
Cobalt	mg/L	0.0002	0.0092	0.0097	0.0115
Copper	mg/L	0.001	0.003	<0.001	0.001
Iron	mg/L	0.03	1.49	1.50	0.64
Lead	mg/L	0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.01	0.69	2.90	3.29
Mercury	mg/L	0.0001	0.0010	<0.0001	0.0230
Molybdenum	mg/L	0.005	<0.005	<0.005	<0.005
Nickel	mg/L	0.005	<0.005	<0.005	<0.005
Selenium	mg/L	0.001	<0.001	<0.001	0.002
Zinc	mg/L	0.01	<0.01	<0.01	<0.01
Oil & Grease					
Oil & Grease – Mineral	mg/L	1	<1	<1	<1
Oil & Grease - Non-mineral	mg/L	1	<1	<1	<1
Oil & Grease – Total	mg/L	1	<1	<1	<1

Groundwater samples were recovered from each well nest in 2018, based on the vertical flow gradients and in accordance with the USEPA RCRA Groundwater Monitoring Technical Enforcement Guidance Document. The groundwater samples were analysed to determine the presence and concentration of chemicals mandated by the EPA guidelines for mining projects. Tables 20 and 21 present the results of the analyses conducted on ground water samples recovered in 2018.

7.5 Impact Prediction and Evaluation

7.5.1 Surface Water

7.5.1.1 Construction Phase

Sediment discharge from cleared areas has the potential to reduce water quality in streams and creeks adjacent to cleared areas. These are moderate impacts (long-term, high severity, regional extent). The construction duration is likely to be relatively short. An Erosion and Sediment Control Plan will be implemented to mitigate potential impacts to water quality from erosion. The mitigation measures will result in low impacts (short-term, low severity, local extent).

The clearing of vegetation will reduce interception and may result in increased discharge to streams and creeks around the construction area and increased water levels in these streams and creeks. These are moderate impacts (medium-term, moderate severity, local extent). Increased water levels in the streams and creeks are unlikely to exceed typical wet season levels. These impacts will be mitigated by undertaking most of the construction activities, which may result in increases in stormwater runoff, in the dry season. These mitigation measures will result in low impacts (short-term, low severity, local extent).

Table 20: Results of Test on Groundwater Samples Recovered in 2018 Dry Season

LIMS #				1343757	1343758	1343759	1343760	1343761
Sample ID				MW17-154	MW17-149	MW17-151	MW17-145	MW17-142
Sample Date				2018-01-24	2018-01-24	2018-01-24	2018-01-24	2018-01-24
Analyte	Units	Analytical Method	MRL					
Ag	mg/L	EPA 200.8	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Al (dissolved)	mg/L	EPA 200.8	0.01	0.03	0.11	1.29	0.19	0.04
Alkalinity as CaCO3	mg/L	C SM4500-H+B	5	53	45	49	49	68
As	mg/L	EPA 200.8	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
B	mg/L	EPA 200.8	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ba	mg/L	EPA 200.8	0.01	0.1	0.11	0.14	0.13	0.15
Be	mg/L	EPA 200.8	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Br	mg/L	SM 4110	0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Ca	mg/L	M SM3120B-3500C	1	16	10	10	12	3
Cd	mg/L	EPA 200.8	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cl	mg/L	SM 4110	1	3	4	5	3	2
Co	mg/L	EPA 200.8	0.0002	0.0026	0.0006	0.0009	0.001	0.001
Conductivity	uS/cm	C SM4500-H+B	5	108	97	111	109	137
Cr	mg/L	EPA 200.8	0.001	<0.001	<0.001	0.002	<0.001	<0.001
Cu	mg/L	EPA 200.8	0.001	0.004	0.007	0.007	0.004	0.007
F	mg/L	C SM4500-H+B	0.1	<0.10	<0.10	0.14	<0.10	<0.10
Fe	mg/L	EPA 200.8	0.03	2.15	2.94	2.55	1.03	0.45
HCO3 as CaCO3	mg/L	SM 2320B	1	53	45	49	49	68
Hg	mg/L	M SM3112B-3500B	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	mg/L	M SM3120B-3500C	1	<1	2	6	1	2
Mg	mg/L	M SM3120B-3500C	1	2	<1	3	3	2
Mn	mg/L	EPA 200.8	0.01	0.41	0.2	0.15	0.18	0.36
Mo	mg/L	EPA 200.8	0.005	<0.005	<0.005	<0.005	0.006	<0.005
Na	mg/L	M SM3120B-3500C	2	3	5	8	6	5
Ni	mg/L	EPA 200.8	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
N-NH3	mg/L	SUBCONTRACT-PC-INORG	0.02	0.17	0.34	0.3	0.15	0.15
N-NO2	mg/L	C SM4500-NO3-F	0.1	<0.10	<0.10	<0.10	<0.10	<0.10
N-NO3	mg/L	C SM4500-NO3-F	0.1	<0.10	<0.10	<0.10	<0.10	0.82
Oil & Grease - Mineral	mg/L	C SM5520B	1	<1	<1	<1	<1	<1
Oil & Grease - Non-mineral	mg/L	C SM5520B	1	<1	<1	<1	1	<1

Oil & Grease – Total	mg/L	C SM5520B	1	<1	<1	<1	1	<1
Pb	mg/L	EPA 200.8	0.001	0.001	0.003	0.001	<0.001	0.001
Ph		C SM4500-H+B	1	7.43	7.56	7.73	7.61	7.28
Phenols	mg/L	SUBCONTRACT-SA-INORG	1	<0.001	<0.001	0.002	0.002	<0.001
PO4	mg/L	C SM4500-PF	0.03	<0.03	0.15	<0.03	0.09	<0.03
Sb	mg/L	EPA 200.8	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Se	mg/L	EPA 200.8	0.001	<0.001	<0.001	<0.001	<0.001	0.001
Si	mg/L	M SM3120B-3500C	0.1	8.3	2.9	4.5	10	7.8
SO4	mg/L	SM 4110	1	2	2	2	4	2
Sr	mg/L	EPA 200.8	0.001	0.029	0.02	0.05	0.032	0.02
TDS (COND - CALC)	mg/L	C SM2540	1	70	63	72	71	89
Ti	mg/L	EPA 200.8	0.01	<0.01	<0.01	0.08	<0.01	<0.01
Tl	mg/L	EPA 200.8	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Total Kjeldahl Nitrogen	mg/L	SUBCONTRACT-PC-INORG	0.8	1.3	2.7	2.8	1.6	1.8
Total Suspended Solids	mg/L	C SM2540	2	53	82	294	78	199
Turbidity	NTU	C SM2130B	0.1	33	44.8	>100	41.9	75.2
V	mg/L	EPA 200.8	0.001	<0.001	<0.001	0.004	0.001	0.001
Zn	mg/L	EPA 200.8	0.01	0.03	0.05	0.02	0.04	0.01

Table 21: Results of Test on Groundwater Samples Recovered in 2018 Wet Season

LIMS #				**1360493**	**1360494**	**1360495**	**1360496**	**1360497**
Sample ID				**MW17-142**	**MW17-155**	**MW17-151**	**MW17-145**	**MW17-148**
Sample Date				**2018-05-07**	**2018-05-07**	**2018-05-07**	**2018-05-07**	**2018-05-07**
Analyte	**Units**	**Analytical Method**	**MRL**					
Ag	mg/L	EPA 200.8	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Al (dissolved)	mg/L	EPA 200.8	0.01	0.47	0.01	0.45	0.02	0.04
Alkalinity as CaCO3	mg/L	SM2320,2510,4500H/F	5	65	12	61	52	39
As	mg/L	EPA 200.8	0.001	<0.001	<0.001	0.001	<0.001	<0.001
B	mg/L	EPA 200.8	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ba	mg/L	EPA 200.8	0.01	0.13	0.13		0.13	0.03
						0.59		
Be	mg/L	EPA 200.8	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Br	mg/L	SM 4110	0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Ca	mg/L	M SM3120B-3500C	1	16	3	10	14	8

Cd	mg/L	EPA 200.8	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cl	mg/L	SM 4110	1	4	1	3	3	1
Co	mg/L	EPA 200.8	0.0002	0.0009	0.0002	0.0228	<0.0002	0.0003
Conductivity	uS/cm	SM2320,2510,4500H/F	5	150	40	148	120	86
Cr	mg/L	EPA 200.8	0.001	0.002	0.001	0.004	<0.001	0.001
Cu	mg/L	EPA 200.8	0.001	0.002	0.002	0.007	<0.001	<0.001
F	mg/L	SM2320,2510,4500H/F	0.1	0.18	<0.10	<0.10	<0.10	<0.10
Fe	mg/L	EPA 200.8	0.03	2.93	0.05	7.09	0.43	0.28
HCO3 as CaCO3	mg/L	SM 2320B	1	65	12	61	52	39
Hg	mg/L	M SM3112B-3500B	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	mg/L	M SM3120B-3500C	1	8	2	<1	1	<1
Mg	mg/L	M SM3120B-3500C	1	3	1	3	3	<1
Mn	mg/L	EPA 200.8	0.01	0.09	0.04	1.8	0.12	0.02
Mo	mg/L	EPA 200.8	0.005	<0.005	<0.005	<0.005	0.01	<0.005
Na	mg/L	M SM3120B-3500C	2	6	<2	20	6	<2
Ni	mg/L	EPA 200.8	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
N-NH3	mg/L	POINTECLAIRE	0.02	0.17	0.15	0.5	0.17	0.16
N-NO2	mg/L	SM 4110	0.1	<0.10	<0.10	<0.10	<0.10	<0.10
N-NO3	mg/L	SM 4110	0.1	0.28	0.76	<0.10	0.18	<0.10
Oil & Grease – Mineral	mg/L	C SM5520B	1	<1	<1	1	<1	<1
Oil & Grease - Non-mineral	mg/L	C SM5520B	1	1	1	1	1	1
Oil & Grease – Total	mg/L	C SM5520B	1	1	1	2	1	1
Pb	mg/L	EPA 200.8	0.001	<0.001	<0.001	0.001	<0.001	0.001
pH		SM2320,2510,4500H/F	1	7.83	6.54	7.06	7.7	6.71
Phenols	mg/L	POINTECLAIRE	0.001	<0.001	0.001	<0.001	<0.001	<0.001
PO4	mg/L	C SM4500-PF	0.03	<0.03	<0.03	<0.03	0.12	<0.03
Sb	mg/L	EPA 200.8	0.0005	0.0006	<0.0005	<0.0005	<0.0005	<0.0005
Se	mg/L	EPA 200.8	0.001	<0.001	<0.001	0.005	<0.001	<0.001
Si	mg/L	M SM3120B-3500C	0.1	6.5	7.1	6.9	10	4.1
SO4	mg/L	SM 4110	1	<1	<1	17	3	2
Sr	mg/L	EPA 200.8	0.001	0.046	0.015	0.035	0.033	0.024
TDS (COND - CALC)	mg/L	C SM2540	1	98	26	96	78	56
Ti	mg/L	EPA 200.8	0.01	0.11	<0.01	0.04	<0.01	0.01
Tl	mg/L	EPA 200.8	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Surface water quality may be negatively impacted during construction of the mine site by accidental discharges of fuels, oils and grease from construction equipment. These are high impacts (medium-term, high severity, regional extent). The potential for accidentals spills of fuels, oils and grease and the associated contamination of surface waters will be minimized by implementation of a Spill Prevention and Contingency Plan. This Plan details measures which will be implemented to prevent, and if necessary, contain spills of fuels, oils, or other contaminants. Such measures will include siting of fuel containment tanks on impervious bases located within a bunded impermeable enclosure designed to hold 110 percent of the contents of the largest tank and channeling stormwater discharge from fuel storage areas to an oil-water separator prior to being discharged to surface water. Implementation of these mitigation measures will effectively remove any potential impacts to surface water quality. The residual impacts will consequently be low (short-term, low severity, local extent).

Road construction activities may include placing culverts at several stream crossings. Culverts constructed through the roads will modify the natural flow of surface water and concentrate flows at certain points and may increase the speed of surface water flow. These changes may potentially result in flooding and increased sediment discharge to streams near roads. These are high (long-term, high severity, regional extent) impacts. These impacts will be mitigated by designing culvert sizes to pass the natural surface water flows. Culverts will also be lined with grass and/or, riprap, where necessary. Flow volumes will be determined as part of the hydrological monitoring program to be undertaken during design works at the site. This will result in low residual impacts (short-term, low severity, local extent)

Land clearing and earthmoving activities associated with development of the mine infrastructure, including the tailings and water management ponds may increase the potential for erosion and the associated increased sediment transport to waterways and sedimentation of these waterways in the Project area. Streams in the Project area have historically been adversely impacted by sedimentation from artisanal miners. Construction activities will pose increased risks of added sediment discharge to these streams. The potential for increased sediment discharge to surface water because of construction activities is a high impact (medium term, high severity, regional extent). The potential for sediment discharge to waterways will be minimized or avoided by the implementation of best management practices such as:

- optimization/minimization of vegetation clearance,
- revegetation of disturbed areas (even if temporary),
- Use of storm runoff retention ponds and silt fences, etc.

Implementation of these mitigation measures will result in low residual impacts (short-term, low severity, local extent).

Upstream and downstream segments of streams will be affected, and flow may be curtailed in some segments due to development of the tailings pond and other mine facilities. During construction, diversion channels will be provided for stormwater runoff. These channels will discharge to existing surface waters. The diversion channels will receive runoff from soil waste piles and will discharge to several creeks. Retention ponds and other detention storage/sedimentation facilities will be installed to ensure that stormwater discharges do not degrade the water quality. This will result in low impacts (short-term, moderate severity, local extent).

7.5.1.2 Operation Phase

Common effluents during mining and processing operations will include:

- Process effluent - water which has contacted process materials or results from the production or use of raw material, intermediate product, finished product, by-product, waste product or wastewater. It can also include blow-down water, effluent that results from plant cleaning or maintenance operations, and any effluent that contacts cooling water or storm water (www.ec.gc.ca). Process effluent maybe discharged from a mine site to the environment as one or a combination of the following:
    - decanted effluent from an engineered impoundment area (e.g. tailings pond);

  - decanted effluent from a polishing pond or clarification pond typically situated down-stream of a tailings pond; and
  - treated effluent from an effluent treatment plant.

- Cooling water used to remove heat from equipment, process operations and materials. Typically, spent cooling water would be combined with other effluent streams such as a tailings slurry discharge to a tailings pond (e.g. process effluent) or mine water stream, prior to discharge to the environment.

- Mine water resulting from the dewatering of the mine pit. It would be pumped from the mine and either added to the process water supply or discharged through settling ponds or combined with process effluent.

- Seepage water from the tailings ponds and waste rock dumps

- Storm water from surface runoff from rainfall and natural drainage. Storm water discharges will include drainage from mine and mill sites, drainage collection ponds, material handling areas, raw material storage sites, and waste disposal areas, including waste rock and overburden dumps. Typically, stormwater drainage is diffuse with a large number of discharge points to the environment.

- Other effluent streams at the mine site will include sanitary wastewater discharges, emergency overflows from wastewater impoundment ponds, and backwash waters from potable water treatment plants.

Several potential surface water impacts are attributed to gold mining activities, including increased sediment loads and low pH due to acid mine drainage (AMD). Chemicals such as lime and other caustic chemicals may be used during the mining operations and can impact surface water bodies via accidental spills, releases, or leachate associated with waste rock stockpiles from the processing operations.

Several chemicals including lime will be used during mineral processing. Potential spills or discharges of chemicals used in the mineral processing operations may result in high impacts to surface water (medium term, high severity, regional extent). Best Management Practices (BMPs) during the transportation, handling, storage, use of and destruction/safe disposal of these chemicals would be implemented during mine site operations to minimize these potential impacts. Implementation of these mitigation measures (i.e., BMPs) will result in low impacts (short-term, low severity, local extent) to surface water.

Precipitation may induce leaching of chemicals from waste rock and saprolite stockpiles at the Project site. In the event of significant storm events, these stockpiles may become saturated, causing slope failures. Stormwater discharge from stockpiles containing water-soluble chemicals and/or heavy metals and sediment discharge to surface water from slope failures can potentially result in degradation of surface water quality. These are considered high impacts (medium term, moderate severity, regional extent). Perimeter drainage channels will be installed around waste stockpiles to collect stormwater runoff. Stormwater from the perimeter drainage system will be discharged to a water management pond before final discharge to surface water. Additional mitigation measures to preclude impacts on surface water quality will include the following:

- Periodic monitoring of the physical integrity of the waste rock and saprolite stockpiles during operations to minimize the potential for discharges due to slope failures.

Implementation of these mitigation measures will result in low impacts (short-term, low severity, local extent).

Several creeks are near to the proposed mine pit and tailings pond. Flow into creeks downstream of the mine pit and tailings pond will be altered and/or reduced after these facilities become operational, resulting in reduced flows in the downstream section of these creeks. The modification of hydrologic flow patterns in creeks is considered a moderate impact (long-term, moderate severity, regional extent). Mitigation of this impact will be achieved by directing discharge from the tailings pond, if they meet effluent discharge limits and water quality standards, to the section of the creeks downstream of the tailings pond. Mitigation measures will result in low impacts (medium-term, low severity, local extent).

Breaches and overtopping of the tailings pond will result in high impacts (long-term, high severity, regional extent) to surface water quality. These impacts will be mitigated by utilization of BMPs during design, construction and operation of these facilities, including monitoring of dam integrity. Implementation of BMPs will result in low impacts (short-term, low severity, local extent).

Water quality may be potentially impacted by wastewater discharges from the onsite sewer system, domestic wastewater and/or by stormwater runoff from developed areas (i.e., workshops, equipment storage and service areas, etc.). Discharge of wastewater from these areas to surface water may impair surface water quality by causing changes to physical, chemical and biological properties within the receiving waters. These potential wastewater discharges are high impacts (long-term, high severity, regional extent). Mitigation measures will include the following:

- Proper design, use and maintenance (including regular de-sludging) of plant sewer systems and/or individual septic tank systems (e.g., septic tanks and leach fields consisting of gravel infiltration beds)
- Septic tanks would be designed in accordance with the Guyana Septic Tank Standard developed in 2008
- Proper disposal of sludge (i.e., in a secure landfill) and
- Stormwater runoff from developed areas will be channeled through several oil-water separators prior to discharge to surface water
- Monitoring of the effluent from the oil-water separators to ensure that the discharged stormwater meets effluent discharge/water quality standards prior to discharge into surface water.

Implementation of these mitigation measures will result in low impacts (short-term, low severity, local extent).

Wastewater from operations will consist of water from mine dewatering and slurry/tailings from the mineral processing operations. Water from mine dewatering will be discharged to surface water after passing through a water management pond to ensure the attainment of discharge effluent/water quality standards. This water will be subject to conditions detailed in the Erosion and Sediment Control Plan to minimize sediment discharge to surface water during operations. The potential discharge of water from the pit dewatering is a low impact (medium term, low severity, local extent). No mitigation measures are proposed.

Wastewater from the processing operations (i.e., slurry/tailings) will be transferred to the tailings pond. The tailings pond will be constructed with an impermeable liner system to minimize potential leakage to surface or groundwater. Potential release of tailings water to groundwater is a minor impact (short-term, low severity, local extent).

Surface spills and releases of fuels, oils and grease from mining equipment and/or the failure of fuel containment facilities (i.e., the tank farm) during the operations phase are high impacts (medium-term, high severity, regional extent). Mitigation measures will include the following:

- Implementation of spill containment, control and prevention measures during transport and refuelling operations as well as during all vehicle and mining equipment maintenance and repair and
- Channeling stormwater discharge from fuel storage areas to an oil-water separator prior to being discharged to surface water.

Implementation of these mitigation measures will result in low impacts (short-term, low severity, local extent) on surface water quality during operation.

Operation of the mine site and its ancillary facilities will generate solid wastes, including soil, paper, metal, trash, scrap, rubble, domestic and hazardous wastes. If not properly managed, these wastes could lead to contamination of surface and groundwater. This impact is rated as high (long-term, moderate severity, regional extent). The Project will minimize and mitigate these potential impacts by developing and implementing waste management plans for each type of solid waste generated by the operation phase of the Project. Reuse and recycling would be preferred over disposal to the extent practicable. Under proper management, the residual impact on surface and groundwater associated with improper waste disposal would be low (short-term, low severity, local extent).

7.5.1.2.1 Fuel Spill Modeling

The model of the fuel oil assumed that the spill resulted from rupture and total loss of the contents of a 50,000 gallons diesel fuel tank stored immediately adjacent to Rice Creek. The accidental spill scenario assumed that the diesel fuel breached the containment facility and all 50,000 gallons spilled over the bank into the creek in one hour. The diesel was modeled as a both conservative substance (no decay or evaporation) and based on degradation due to evaporation and biological decay.

The model assumed one dimensional transport and involved instantaneous injection (or spill) of 156,411 kg of diesel in the channel of Rice creek. The channel cross-section of 3.54 m^2, average flow velocity of 0.332 m/s and a dispersion coefficient of 0.07 m^2/s was considered by the analyses. The parameters were used to examine the impact of the spill with distance from the source. Figure 13 depicts the evolution of the diesel contaminant plume at times 20, 40 and 60 seconds after the spill. Results of the model indicate decay in concentrations with increased time and distance. Below trace concentrations were indicated by the model at distances ranging from 0.25 to 1.3 km from the spill, 1 hour after the spill. The rapid decrease in concentration is due to primarily high velocity and steepness of the creek near the mine site. High velocity and elevated slopes accelerates the movement downriver.

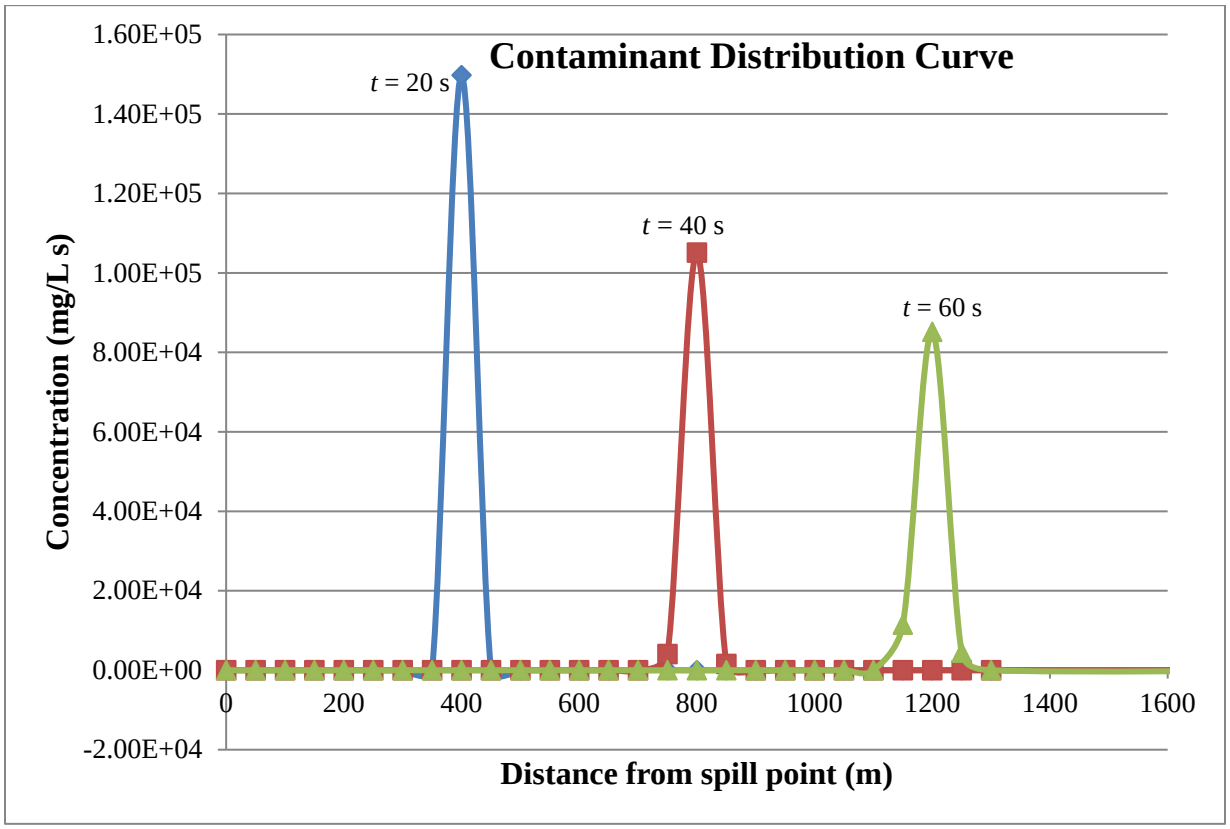


Figure 13 - Diesel Concentration with Distance and Time in Rice Creek Based on Hypothetical Spill

A diesel oil spill into the creek may affect the banks (where staining may coat plants or be ingested by wildlife), the benthos (where sediments may become contaminated and organisms become physically fouled), the water surface (where birds and sea creatures may become contaminated by contacting the oil), and the water column (where aquatic organisms may ingest dissolved hydrocarbons causing narcosis in high concentrations and durations of exposure). If the assumed accidental fuel spill occurred, Rice Creek would experience concentrations as high as 3.01 x 10^5 mg/l at the initial spill location and 41.3 mg/l at a located 1.3 km downstream. At these concentrations, humans, fish, invertebrates, mammals, and birds in the river may be at risk. These are high impacts (medium-term, high severity, regional extent).

These impacts will be mitigated by strict adherence to the Environmental Monitoring Plan, specifically to include frequent monitoring and inspection of fuel storage tanks. The Spill Prevention and Cleanup Control and Emergency Response Plans will include aggressive alerts, education, and cleanup activities. In addition, discharges/drainage from these areas would be directed to the tailing ponds, if practical or to a separate emergency containment pond. The emergency containment pond will act as a fail-safe mechanism and will complement the Best Management Practice (BMP), Environmental Monitoring Plan (EMP) and the Spill Prevention and Clean-up Control and Emergency Response Plans proposed for implementation to mitigate impacts from spills. Application of these mitigation measures to contain and localize potential spills will result in a rating of minor impact (short-term, low severity, local extent).

7.5.1.3 Closure Phase

Failure of the tailings pond may significantly impact surface water and groundwater quality near to the Project area. The failure of the tailings dams after completion of mining activities is a potentially high impact (long-term, high severity, regional extent). The following mitigation measures will be implemented to minimize the likelihood of tailings pond failure:

- Post-closure monitoring of the stability of the tailings pond and
- Periodic monitoring of surface and groundwater conditions near the pond.

Implementation of these measures will result in low impacts (short-term, low severity, local extent).

The dismantling and cleanup of fuel storage tanks, hazardous waste receptacles, and other accumulated materials during closure could lead to spills which could contaminate surface water. Spills associated with closure activities will generate moderate impacts (medium term, medium severity, regional extent). Mitigation of these potential impacts will be achieved by adhering to a mine closure plan that specifies appropriate and specific procedures for dismantling/decommissioning mining infrastructure.

7.5.1.3.1 Acid Mine Drainage

Acid generation may occur if sulphide-rich materials present in waste rock, mine openings, pit walls and tailings are exposed to and react with, oxygen and water to form sulphuric acids. Sulphuric acid generated by this process will easily dissolve metals such as iron and aluminium present in soils at the site. The process would be accelerated by the preence of acid-ingesting bacteria. Acid mine drainage (AMD) will result in low pH values and elevated concentrations of dissolved metals in surface water since the solubility of metals is pH dependent and for most metals the solubility increases with a decrease in pH value.

Dissolved metals in AMD will discolor water and stains exposed rocks and streambeds. AMD, if it occurs, will persist in the environment. Acid-generating soil and rock at the mine site will generate high impacts (long-term, moderate severity, regional extent) to surface and aquatic life. These impacts will continue until there are no remaining sulphides.

AMD will be mitigated by conducting tests and analyses on mine waste to predict the waste potential to generate acid drainage. Analyses will include simple calculations involving the balance of acid-generating minerals (e.g. pyrite) against the existence of neutralizing minerals (e.g. calcium carbonate) supported by complex laboratory tests (e.g. kinetic testing). Soils determined to be potentially acid generating will be covered by a 30 cm thick layer of non-acid generating soils to preclude water contacting AMD generating soils. The mitigation measures will result in low impacts (short-term, low severity, local extent).

7.5.2 Groundwater Quality

7.5.2.1 Construction Phase

Impermeable liners may be placed over the base of the tailings pond during construction. The impermeable liners will reduce recharge to groundwater. However, the project foot print is quite small in comparison to the area available for groundwater recharge. The impacts of reduced groundwater recharge, occasioned by the impermeable liner, would therefore be low (short-term, low severity, local extent).

Wells will be drilled on site to provide water for drinking/cooking. These wells will be located some distance from and at higher elevations than the mining operations and sewerage management facilities. Withdrawals from wells are unlikely to have any impacts on the availability of groundwater since there are no other withdrawals in the area. This coupled with the increased infiltration potential because of increased areas of exposed ground cover to rainfall will facilitate ground water recharge and minimize potential impacts on groundwater quantity. This would therefore result in low impacts (long-term, low severity, regional extent).

Spills of fuel and oils from equipment and from fuel storage and service areas can flow to the underlying aquifer and potentially impact groundwater quality. This will result in high impacts (long term, high severity, regional extent) to groundwater quality. Potential contamination of the underlying aquifer will be minimized by installing drip pans on all equipment, enforcing a program to check for equipment leaks and implementation of the SPCP. The SPCP will detail plans for utilization of sorbents, biological agents, chemical dispersants and gelling agents. All fuel will be stored within containment walls designed to contain 110 percent of the tank contents. Implementation of these mitigation measures will result in low residual impacts (short-term, low severity, local extent) to groundwater quality.

Dewatering may be required during construction of foundations for project infrastructure. Surface spills of fuels into foundation excavations may result in localized impacts to shallow groundwater at the project site. Dewatering activities will, however, capture any petroleum-related releases to groundwater. The potential impact to groundwater during the construction phase is consequently considered to be low (short-term, low severity, local extent). Nevertheless, potential impacts to groundwater quality related to surface spills will be mitigated using secondary containment structures around above ground storage tanks containing fuel oil and the maintenance of spill containment equipment near refueling areas.

7.5.2.2 Operation Phase

Precipitation may induce leaching of chemicals from waste rock and saprolite stockpiles at the project site. Leaching of the waste rock and saprolite stockpiles can potentially result in degradation of groundwater quality if no impermeable liner is installed below these facilities. The presence of groundwater at shallow depths and potential leaching of contaminants into groundwater is considered a high impact (long-term, high severity, regional extent). This potential impact will be mitigated by installation of an impermeable barrier under the waste rock and saprolite stockpiles. These mitigation measures will result in low impacts (short-term, low severity, local extent).

Infiltration of wastewater from the tailings and waste management areas along with leaching of minerals into solution in the mine can have potential negative impacts on groundwater quality. These are high impacts (long-term, high severity, regional extent). Mitigation of these potential impacts will be achieved by installing impervious liners below the tailings pond and waste management areas and by directing water from the mine to a water management pond. Implementation of these mitigation measures will result in low impacts (short-term, low severity, local extent).

Extensive groundwater dewatering will be required to facilitate mine pit operations. This will disrupt the existing groundwater flow regime and result in groundwater flow into the mine from areas surrounding the mine footprint. This may also include surface water from the creeks in the areas because these may be hydraulically connected to shallow groundwater near to the open pit mine. Based on the remote location of the project site and lack of any

known water supply wells, the groundwater dewatering is considered to be a moderate impact (medium term, low severity, regional extent). No mitigation measures are proposed.

Several chemicals including lime will be used during mineral processing. Potential spills or discharges of chemicals used in the mineral processing operations may result in high impacts to groundwater (long term, high severity, regional extent). Best Management Practices (BMPs) during the transportation, handling, storage, and use of these chemicals will be implemented during operations to minimize these potential impacts. Implementation of these mitigation measures (i.e., BMPs) will result in low impacts (short-term, low severity, local extent) to groundwater.

7.5.2.3 Closure Phase

Failure of the tailings pond may significantly impact groundwater quality near the Project area. The failure of the tailings dams after completion of mining activities is a potentially high impact (long-term, high severity, regional extent). The following mitigation measures will be implemented to minimize the likelihood of tailings pond failure.

- Post-closure monitoring of the stability of the tailings pond and
- Periodic monitoring of surface and groundwater conditions in the vicinity of the pond.

Implementation of these measures will result in low impacts (short-term, low severity, local extent).

In addition, the dismantling and cleanup of fuel storage tanks, hazardous waste receptacles, and other accumulated materials during closure could lead to spills which could contaminate groundwater. Potential spills associated with these closure activities are moderate impacts (medium term, moderate severity, regional extent). Mitigation of these potential impacts will be achieved by adhering to a mine closure plan that specifies appropriate and specific procedures for dismantling/decommissioning mining infrastructure.

7.5.2.3.1 Water Balance

Mining activities will alter the local water balance and has the potential to also alter the regional water balance. Changes in water balance are a function of the climatic setting and the local hydrology in addition to the depth of the mine and the dewatering required. Changes in the local water balance will result from changes in landform and land cover and because of discontinued mine dewatering after mine closure. This will be reflected by rebound in water levels after pumping ceases. Mining activities may have resulted in development in a new ecological equilibrium at the site in response to the changed water balance during mine operation. This ecological equilibrium will be impacted by the new water balance. These are moderate impacts (long-term, moderate severity, regional extent).

7.6 Environmental Management Plan

All contaminated water will be directed to a water management pond. Liquid-based process wastewater will be channeled to the tailings pond. All water retention facilities will be provided with adequate capacity to contain the design rainfall event and to eliminate the likelihood and frequency of spills that may impact downstream waters and groundwater quality.

Site clearing operations will progress in a gradual and phased manner to ensure there are no large increases in sediment discharge. Sediment control structures will be used to prevent the inflow of sediment to surface water. These control practices will include sediment traps and screens to control run-off and sedimentation. Surface runoff from the workshop and other vehicle service areas will be channeled to oil/water separators. All water from the oil/water separators will be skimmed prior to discharge. The operations will monitor discharges to surface water upgradient and down gradient of the site.

Table 22: Summary of Water Resources Impacts

Project Phase	Impacts		Project Impacts Rating	Mitigation Measures	Impact Rating after Mitigation
Water Resources – Surface Water					
Construction	Reduce Water Quality in Creeks and Streams	*Source* Construction of plant site Construction of road Vegetation Clearance *Vulnerability* Steep Area Highly erodible soils	Moderate (long-term, high severity, regional extent).	Implementation of an Erosion and Sediment Control Plan	Low (short-term, low severity, local extent).
	Increased Water Levels in Streams	*Source* Vegetation clearance increased discharge volume. *Vulnerability* Peace, Paunch, July, Locust Creeks Kuyuwini River	Moderate (medium-term, moderate severity, local extent)	Vegetation clearance will be undertaken in the dry season.	Low (short-term, low severity, local extent).
	Surface Water Contamination	*Source* accidental discharges of fuels, oils and grease from construction equipment *Vulnerability* Peace, Paunch, July, Locust Creeks Kuyuwini River	High (medium-term, high severity, regional extent).	Implementation of a Spill Prevention and Contingency Plan with to prevent, and if necessary, contain spills of fuels, oils, or other contaminants.	Low (short-term, low severity, local extent).
	Modification and concentration of flow	*Source* Culvert Installation *Vulnerability* Access roads within and to Project	High (long-term, high severity, regional extent) impacts.	Flow volumes determined as part of the hydrological study for project and culverts sized to pass the natural surface water flows and lined with grass and/or, riprap.	Low (short-term, low severity, local extent).
Operation	Lowered Surface water Quality	*Source* Spills or discharges of chemicals used in the mineral processing *Vulnerability* Peace, Paunch, July, Locust Creeks Kuyuwini River	High (medium term, high severity, regional extent).	Implementation of Best Management Practices (BMPs) during transport, handling, storage, use and destruction/ disposal of these chemicals.	Low (short-term, low severity, local extent)
	Leaching of Chemicals into solution	*Source* Waste rock and saprolite stockpiles	High (medium term, moderate severity, regional extent).	Installation of perimeter drainage channels around waste stockpiles and	Low (short-term, low severity, local extent)

		Vulnerability Peace, Paunch, July, Locust Creeks Kuyuwini River		discharge of stormwater from perimeter drains to a water management pond.	
	Altered/reduced stream flows	*Source* Creation of mine pit *Vulnerability* Peace, Paunch, July, Locust Creeks Kuyuwini River	Moderate (long-term, moderate severity, regional extent).	Discharge of clean water discharge from the tailings pond to downstream sections	Low (short-term, low severity, local extent).
	Impaired Surface water Quality	*Source* Breach/ Overtopping of the tailings pond Wastewater Discharge Onsite Sewerage system Discharge Discharge from Workshops *Vulnerability* Peace, Paunch, July, Locust Creeks Kuyuwini River Physical stability of Surface Water Chemical Stability of Surface Water Biological Stability of Surface Water	High (long-term, high severity, regional extent)	Utilization of BMPs during design, construction and operation and monitoring of dam integrity.	Low (short-term, low severity, local extent)
Closure	Impaired Ground water Quality Ground and Surface Water contamination	*Source* Improper disposal of solid wastes (soil, paper, metal, trash, scrap, rubble, domestic wastes) and hazardous wastes.	High (long-term, medium severity, regional extent).	Development and implementation of waste management plans for each type of waste generated with emphasis on reuse and recycling.	Low (short-term, low severity, local extent).
Water Resources – Groundwater					
Construction	Reduced Groundwater Recharge	*Source* Impermeable liners on base of the tailings pond. *Vulnerability* Groundwater	Low (short-term, low severity, local extent).		Low (short-term, low severity, local extent).
	Availability	*Source* Pumping of wells	Low (long-term, low severity, regional extent).		Low (long-term, low severity, regional extent)
	Groundwater Quality	*Source* Spills of fuel and oils to groundwater	High (long term, high severity, regional extent)	Installation of drip pans, program to check for equipment leaks	Low (short-term, low severity, local extent).

		Vulnerability Underlying aquifers		Implementation of the Spill Prevention & Contingency Plan.	
Operation	Groundwater Quality	*Source* Precipitation and leaching of chemicals from waste rock and saprolite stockpiles	High (long-term, high severity, regional extent).	Installation of an impermeable barrier under the waste rock and saprolite stockpiles.	Low (short-term, low severity, local extent).

The Tailings pond will be designed for the critical rainfall event. The top of the tailings pond will sit above surrounding ground level and will preclude runoff from the surrounding area from entering the pond. The pond would be provided with a minimum operating freeboard of 3 m which will allow for adequate containment of precipitation associated with the design rainfall event.

Since water can exit the tailings pond as seepage through its embankment, seepage controls will be provided in the design to maintain embankment stability, to decrease water losses and maintain water-quality at the site. Drains will be provided for seepage collection and all seepage collected in these drains will be pumped back into the process stream.

Precipitation data, topographic maps and stream flow measurements will be used during design of the ponds to prepare hydrographs and frequency curves for use in estimating volumes of precipitation. Precipitation data from wet and dry years will be used to provide minimum, average, and maximum precipitation volumes to determine storage capacity for each pond. The design of each pond will include capacity to store precipitation incident on the pond during rainfall. Surface runoff from other areas of the site will be channeled away from the tailings pond. The tailings and water management ponds will both be provided with impervious liners, if required, to preclude groundwater contamination.

All storm water runoff will be channeled to the water management pond. Discharge from the water management pond will be via a spillway and will be channeled through a sediment control structure to remove sediment prior to discharge to surface water bodies in the site area. In some instances, water from the water management pond will be discharged to augment water in the process circuit. No direct discharge to surface water would be permitted from any of the ponds that constitute a part of the process circuit. The mine will be developed to ensure minimum disturbance to streams and creeks in the area. In instances where this cannot be avoided, streams/creeks will be diverted to ensure flow to downstream sections.

The design of the onsite sewage treatment facilities will comply with the applicable requirements of the 2008 Guyana Septic Tank Standard. Although not specific to mining, the GNBS and EPA have jointly developed interim industrial effluent standard which will be met by the Project.

The World Bank OP 4.37 – Safety of Dams Requirements for Design and Review or similar guidance would be applied to the design, construction, operation, instrumentation and monitoring of the tailings dam. The tailings pond will be designed to ensure stability of its embankment. Stability analysis will be performed of the embankment cross-section to optimize the structure with respect to cost and other objectives while maintaining reliability. Flow nets or an appropriate numerical method will be used to estimate seepage direction and volume and pore pressures at points within the embankment. A flow net is a graphical solution of Darcy's law to show steady state flow through porous media and is used to compute ground water flow. Finite-element and other analysis are also appropriate for predicting seepage direction and volume.

The analyses of the tailings pond embankment stability will consider the following failure modes:

- rotational slide
- overtopping
- foundation failure
- erosion
- piping
- liquefaction

Data for the analyses will be generated by conducting a detailed geotechnical investigation in the area proposed for the tailings pond and on materials identified for use as fill for tailings pond construction. The objective of the investigation will be to determine the geotechnical and hydrogeological conditions and characteristics of the subsurface soil and rock units as they affect the design of the structure.

The investigations will include the installation of vertical boreholes through overburden units and bedrock, soil sampling, rock coring, field testing of soil and rock samples, and laboratory testing of the recovered soil and rock samples.

The initial design of the tailings dam and other earth structures will be submitted to the EPA for review. The final design of the tailings pond will be submitted to both GGMC and the EPA for approval prior to project start up and the use of these facilities.

RGEL will develop a site-specific Tailings Management Plan as part of the final design phase of the Project. The tailings management strategies will consider how tailings are to be handled and disposed of during operation, in addition to permanent storage after decommissioning. Strategies will be developed in full consideration of the site topography, downstream receptors and the physical nature of tailings (e.g. projected volume, grain size distribution, density, water content, among other issues).

The Tailing Management Plan (TMP) development will explicitly include review and consideration of the lessons learned from the Omai Mines incident due to the high sensitivity of many stakeholders to this issue. The TMP would include a synthesis of these lessons and the steps to be taken to mitigate, and where possible, to avoid identified weaknesses of the Omai management system.

The TMP will include details on the management organization and roles, as well as the required qualifications and competencies for tailings operators and a training plan. The TMP will include an Operating Manual and Contingency Plan, both written in clear and concise language.

Recommended tailings management strategies will include:

- Design, operation, and maintenance of structures according to specifications of ICOLD3 and ANCOLD4, or other internationally recognized standards based on a risk assessment strategy
- Appropriate independent review will be undertaken at design and construction stages with ongoing monitoring of both the physical structure and water quality, during operation and decommissioning
- Where structures are located in areas where there is a risk of high seismic loadings, the independent review will include a check on the maximum design earthquake assumptions and the stability of the structure to ensure that the design is such that during seismic events there should be no uncontrolled release of tailings
- Design of tailings storage facilities will take into account the specific risks/hazards associated with geotechnical stability or hydraulic failure and the associated risks to downstream economic assets, ecosystems and human health and safety
- Environmental considerations will also consider emergency preparedness and response planning and containment/mitigation measures in case of catastrophic release of tailings or supernatant waters
- Any diversion drains, ditches, and stream channels to divert water from surrounding catchment areas away from the tailings structure will be built to the flood event recurrence interval standards
- Seepage management and related stability analysis will be a key consideration in design and operation of tailings storage facilities. This is likely to require a specific piezometer based monitoring system for seepage water levels within the structure wall and downstream of it, which will be maintained throughout its life cycle
- Consideration of zero discharge tailings facilities and completion of a full water balance and risk assessment for the mine process circuit including storage reservoirs and tailings dams
- Consideration of use of natural or synthetic liners to minimize risks
- Design specification will take into consideration the probable maximum flood event and the required freeboard to safely contain it (depending on site specific risks) across the planned life of the tailings dam, including its decommissioned phase
- Where potential liquefaction risks exist, including risks associated with seismic behavior, the design specification will take into consideration the maximum design earthquake
- On-land disposal in a system that can isolate acid leachate-generating material from oxidation or percolating water, such as a tailings impoundment with dam and subsequent dewatering and capping. On-

land disposal alternatives will be designed, constructed and operated according to internationally recognized geotechnical safety standards and
- Riverine (e.g. rivers, lakes, and lagoons) disposal is not considered good international industry practice and will not be considered by the Project.

To reduce the use of the TMA by wildlife, the following criteria will be applied (after Donato et al., 2007):

- Reduce supernatant area
- Thicken tailings to prevent supernatant formation
- Screen decant ponds
- Remove nearby vegetation surrounding or overhanging water
- Remove standing trees and logs within TMA
- Avoid supernatant resting against dam walls
- Avoid uneven dam floors that form islands and
- Avoid the formation of shallow flats.

The TMA will be designed for the critical rainfall event. The top of the TMA would be situated above surrounding ground level to prohibit runoff from the surrounding area from entering the pond. The TMA would be provided with a minimum operating freeboard of 3 m which should allow for adequate containment of precipitation associated with the design rainfall event.

7.6.1 Fuel Oil Management

Spills of fuel oil could result in surface and groundwater contamination. Fuel oil storage areas will be located well away from areas of fire hazard such as where welding operations will be performed. All fuel will be barged and/or trucked to site by secure fuel trucks and transferred into fuel storage tanks that are founded on impervious concrete surfaces. The fuel tanks will be housed within bunded enclosures. The enclosures will be sized to retain the contents of 120% of the largest tank in the event of tank failure. Discharge from fuel storage areas will be channeled to oil-water separators prior to being discharged to surface water.

Indiscriminate dumping of waste oil will not be permitted under any circumstances. Waste oil will be stored in approved containers at designated points around the Project site. All locations will be selected based on factors such as proximity to water, migration routes, fire risks and access. Waste oil storage areas will be provided with secondary containment to deal effectively with any leakage or spillage. Liquids, spent oils, fuels and lubricants will be collected and returned in drums to oil companies and/or to Bosai for fueling of their calcination operations.

7.6.2 Spill Contingency Plan

The spill contingency plan prepared for the project consists of two distinct plans; the Emergency Response Plan (ERP) and the Spill Prevention and Cleanup Control (SPCC) Plan. The elements of each plan are detailed below.

7.6.2.1 Emergency Response Plans

The objective of the Emergency Response Plan (ERP) is the protection of the communities and the environment in the project area of influence through the development of emergency response strategies and capabilities. This Emergency Response Plan details measures to respond to potential releases of tailings, process chemicals, process wastewater, fuel oils and/or other hazardous material. In addition, it details emergency response procedures for potential release of hazardous material which is being transported to the site.

Examination of the proposed project has identified several possible scenarios which may require the activation of emergency response procedure. Emergency response actions will be needed for the following:

- Spills of fuel oil or other hazardous material during road transport to the site
- Releases of fuel oil or other hazardous material during unloading and mixing

- Releases of fuel oil or other hazardous material during fires and explosions
- Release of fuel oil or other hazardous material due to pipe, valve and tank ruptures
- Overtopping of tailings and water management ponds
- Failure of embankment of the tailings and/or water management pond
- Power outages and pump failures
- Uncontrolled seepage through the embankment of tailings and/or water management pond.

This ERP describes specific response actions, as appropriate for each emergency situations identified above. The response actions include clearing site personnel from the area of exposure, notification to operational, management and response personnel, use of antidotes and first aid measures for chemical exposure, control of releases at their source, containment of releases, assessment of the release and mitigation, procedures to examine the cause of the release, and implementation of measures to prevent reoccurrence of releases.

The company will maintain an Emergency Response Center at the site. A primary and alternate Emergency Response Coordinator will be located at the site. The coordinators will have explicit authority to commit the resources necessary to implement the ERP. Emergency response teams would be identified and would be appropriately trained and prepared. After the commencement of construction, this ERP shall be extended to include call-out procedures and 24-hour contact information for the coordinators and response team members.

All personnel involved in mineral processing and process chemical management would be trained to recognize and respond to situations which can result in releases to the environment. The training will include identification of procedures to be followed if a chemical release is discovered, including notification of the appropriate site personnel, measures to assure worker safety, and methods to stop or contain the release, if possible.

The following list of equipment and supplies will be provided for response to emergencies.

- Earthmoving Equipment
- Mobile Generators
- Sand and Gravel
- Sand Bags
- Pumps
- Pipes
- Booms
- Absorbents

If there is a slowly developing emergency or unusual situation, where an emergency is not imminent, but could occur if no action is taken, (e.g prolonged and unseasonal rainfall and possible overtopping of the tailings/water management pond) the EPA, GGMC and Ministry of Natural Resources (MNR) will be notified. The Regional Democratic Council of Region 9 and Para Bara Village will be notified of the potential problem and will be kept advised of the situation. During these contacts, the agencies will be requested to indicate if there are any immediate actions that can be taken to reduce the risk of the emergency and if necessary, preventative actions will be implemented. An Emergency Response Coordinator will be assigned the task to continuously monitor the situation and to coordinate emergency action if required.

If an emergency is imminent, but has not yet begun, (e.g. failure of the outer section of tailings/water management pond embankment, but no releases) media houses in Region 9 and nationally would be alerted to inform residents of surrounding area and steps will be initiated to immediately advise communities and persons near the emergency to evacuate due to the potential release. The EPA, GGMC and MNR will be notified. A single Emergency Response Coordinator will be tasked with responding to the potential release to minimize disparate utilization of resources. Equipment and personnel will be deployed to the maximum extent necessary to prevent potential release to the environment.

If there is a release of fuel oil or other hazardous material, all persons and communities downstream and downwind from that release will be notified immediately and efforts will be coordinated with others to reduce impacts

associated with the release. The EPA, the GGMC and MNR will be immediately notified. If a spill of fuel oil or other hazardous material/waste enters waters adjacent to the access/haul roads, Para Bara Village and Guyana Water Inc. (GWI) will be added to the entities notified. An alternate water source will be provided to Para Bara Village until analytical tests confirm that the water has again attained potable water quality standards.

All transport vehicles will be fitted with absorbent material and vehicle operators will be provided with a radio to maintain contact with the emergency response center. If there is a spill/leak of fuel oil or other hazardous material onto roadways during transportation to/from the site, prompt action will be taken to contain the leak or spillage. All combustibles/ignition sources such as running engine, likely to result in fires, will be removed from the vicinity of the spill and anyone in the area will be advised to stay upwind of the spill. Absorbent material in the transport vehicle will be used to cover small spills. The vehicle operator will immediately notify the Emergency Response Center which will assign an Emergency Response Coordinator to respond to the emergency.

A berm will be constructed around the spill area to control runoff to surface water. All soils impacted by the spills will be excavated from the spill area and disposed in accordance with the hazardous waste management procedures. In the events of spills to surface waters, fauna will be trapped and will be relocated to areas within proximity of the site, which are the same ecologically as the spill area. Fishes will be trapped with nets and animals will be snared in traps designed to ensure that animals are not injured during trapping. The relocation of fauna impacted by accidental spills is expected to be a very infrequent occurrence and will have insignificant impacts on the areas to which the fauna is relocated. Spills of fuel oil will be responded to by the addition of surfactants and by retrievals with skimmers. Other chemicals, which cannot be recovered manually, chemically or by mechanical means will be allowed to naturally degrade by dilution and dispersion. During the degradation process water quality would be monitored in the spilled area. After monitoring determines that water quality has attained acceptable standards, sensitive fauna will be allowed to naturally reenter the area.
If an earthquake is felt in the vicinity, visual inspections shall be conducted of the tailings and water management facilities, process vessels and pipe network, and containment facilities for chemicals and fuel, and sewerage management facilities immediately after. If damage has occurred but is judged not serious enough to cause failure of any facility, the nature, location, and extent of the damage, as well as the potential for failure will be quickly observed. The EPA, GGMC and MNR will be contacted and a description of damage, including the location, extent and rate and the associated effects on adjoining structures, prevailing weather conditions, and other pertinent facts will be provided.

If any of these facilities is damaged to the extent that a potential release to the environment is possible, the emergency imminent procedures will be immediately implemented. A close watch will be kept on the facilities for the next two to four weeks as some damage may not show up immediately after the event. If there is overtopping of ponds, power outages and pump failures, uncontrolled seepage from the tailings or water management pond, and/or leaks from process vessels, all persons and communities downstream from the site will be notified immediately and efforts will be coordinated with others downstream to try and reduce impacts, if applicable. The EPA, the GGMC and MNR will be immediately notified. The Emergency Response Center will assign an Emergency Response Coordinator to respond to the emergency. Emergency response procedures will replicate those for a spill during transportation of fuel oil or other hazardous materials to the site.

Any time levels in the water management ponds exceed the design levels, these facilities will be inspected daily. If the water surface level rises to within 0.25 m of the crest of the facility the following will be immediately implemented:

- contact EPA, GGMC and MNR
- discharge excess water from these facilities to surface water through sediment control structure
- monitor the receiving surface water body for sediment and chemical contamination
- notify downstream residents of the discharge, and perform the discharge in stages to reduce sediment and chemical inflows
- provide water to residents downstream of the discharge until water quality in the receiving waters returns to an acceptable standard.

7.6.3 Spill Prevention and Cleanup Contingency Plan

This Spill Prevention and Cleanup Contingency (SPCC) Plan will become effective coincident with the commencement of construction activities at the mine. Emergency Response Coordinators will have authority to expend funds and recruit employees to implement the Spill Prevention and Cleanup Contingency Plan. The SPCC Plan addresses the following:

- Operating procedures to prevent oil spills
- Control measures which will be installed to prevent a spill from reaching navigable waters and
- Countermeasures to contain, clean up, and mitigate the effects of any spill which discharges to surface or ground water.

This SPCCP also sets out an organized, planned, and coordinated course of action to be followed in case of a fire, explosion, or release of hazardous material which could threaten human health or the environment. The SPCC Plan would be implemented for on-site, as well as off-site releases that could threaten human health and the environment, even if the Emergency Response Coordinator does not believe that the spill will leave the site. The Plan deals with threats to facility personnel, as well as with threats to people outside the facility.

After the completion of construction works at the site, a site plan detailing the physical layout and a facility diagram will be appended to this SPCCP. The appended information shall include contact list and phone numbers for the Emergency Response Coordinator(s), the EPA, cleanup contractors, and other appropriate national and local agencies who will be contacted in case of a discharge. The SPCCP shall also be expanded to include a prediction of the direction, rate of flow, and total quantity of fuel oil/hazardous material which may be discharged after a Hazard Assessment has been conducted for the process equipment failure.

An internal communication or alarm system capable of providing emergency instructions shall be maintained at the mine site together with a device capable of summoning external assistance (telephone or two-way radio). Portable fire extinguishers, fire control equipment, spill control equipment, and decontamination equipment will also be maintained at this location.

All fuel storage areas shall be founded on impervious surface and be sited in containment facilities designed to retain 120% of the tank contents. The containment may be either dikes, berms, retaining walls or curbs. Discharge from the containment area shall be directed into gutters which flow to oil-water separators prior to release to the environment. Water discharges to the environment shall be monitored to ensure adherence to water quality. If there is a discharge from the fuel storage area to the environment, an Emergency Response Coordinator shall respond to that discharge and an alternate source of water will be provided to persons located downstream of the discharge.

Spills of fuel oils will be cleaned by mechanical methods, chemical dispersants, gelling agent or biological agents. The specific method to be used will depend on the quantity and location of the spill. Mechanical cleanup, using booms and skimmers, will be used to recover spills to surface water. Containment booms would be used to control the spread of spilled product and to concentrate the product in thicker surface layers to make recovery easier. In addition, booms will be used to divert and channel oil slicks along desired paths, making them easier to remove from the surface of the water. Skimmers would be used to recover spilled oil from the surface of the water. Skimmers will be either self-propelled or operated from the bank of streams/creeks. Chemicals dispersants will be used to accelerate the breakup of fuel oil and refined product spills to surface water. Dispersants would be applied immediately following a spill, before the lightest materials in the oil have evaporated. The use of dispersants in freshwater would be authorized by the Emergency Response Coordinator only if it does not pose any threat to human health or the environment. Gelling agent will be used to respond to small spills of fuel oil. Gelling agents will be applied by hand to small spills and would be left to mix on their own. The gelled oil would be removed from surface water using skimmers. Biological agents will be used to mitigate the impacts of spills of crude oil and refined products to surface water and to soils.

Surface water samples will be recovered from the impacted areas after cleanup to ensure that residual levels of hydrocarbons and other fuel oil constituents do not exceed tolerable limits. If surface water quality has not been

attained, monitoring will be continued. Persons downstream of the spill will continue to be provided with clean water until water in the affected area again attains acceptable water quality.

If the discharge of fuel oil results in contamination of the aquifer, a detailed investigation will be conducted to define the contaminant plume. A plan to clean-up the aquifer will be prepared after the delineation of the plume. The contaminated groundwater will be treated and would be re-injected into the aquifer. Treatment will cease when analyses of groundwater samples indicate acceptable groundwater quality.

The SPCC Plan will be reviewed, and be immediately amended whenever the following situations apply:

- applicable regulations are revised
- the plan fails in an emergency
- the facility changes its design, construction, operation, maintenance, or other circumstances in a way that materially increases the potential for fires, explosions, or releases
- the list of emergency coordinators changes
- the list of emergency equipment changes.

7.6.4 Catchment Area Management

The concession will be managed to ensure minimal impacts to the watershed. The objective of the catchment management plan is to maintain, as closely as possible, the pre-project hydrological runoff characteristics of the watershed in which the project is located. The catchment management plan addresses the protection and conservation of the local natural resources and contains measures for safeguarding water for future development. The plan will also ensure that water quality and security of water supply is provided to transient people and communities who use waters from creeks flowing through the concession.

All forest cover outside of the area cleared for the mine site operation will be maintained to control run-off, to limit erosion, to minimize sediment and nutrient supplies, to maximize infiltration and to maintain pre-project rates of evapotranspiration. The adoption of sound catchment management practices for the area will reduce the inflow of debris and other material from both point and diffuse sources into the waters of the creeks and their tributaries, thereby ensuring the maintenance of water quality both upstream and downstream of the project.

7.7 Monitoring Plan

Water samples will be recovered for analytical tests, from discharge points downstream of the tailings and water management ponds, weekly for the first year of operation and twice per month after that time. The sampling results would be used to determine if there are any changes in surface water quality associated with these discharges.

Effluent from the sewage treatment systems would be sampled weekly at the discharge point(s) and tested for total coliform bacteria, BOD_5, COD, pH, total N, total P, oil & grease, and TSS and these will be compared against IFC General EHS Guidelines indicator values for treated sewage discharges. Monitoring of effluent from oil-water separators would also be conducted weekly to ensure that discharged stormwater meets effluent discharge/water quality standards prior to discharge into surface water.

Surface water samples would be collected in streams/creeks in proximity of the operations on a quarterly basis (i.e., four times each year). Statistical evaluation of the data would be performed to determine if sampling should be conducted at more frequent intervals. Stream flow data would be collected at each surface water sampling event as part of the sampling protocol. Surface water monitoring data would be compared to the IFC/World Bank Standards (IFC/World Bank Environmental, Health and Safety Guidelines for Mining, December 10, 2007) to assess potential impacts of the mining operations. These levels should be achieved, without dilution, at least 95 percent of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours.

Groundwater monitoring wells would be installed both up-gradient and down-gradient of the tailings and water management pond. Samples would be collected from these wells on a monthly basis and analyzed for the presence

of heavy metals. Three additional permanent groundwater monitoring wells would be installed on the perimeter of the operations area. Groundwater sampling would be conducted at each perimeter well on a yearly basis and samples would be analyzed for the presence and concentration of parameters of the World Health Organization (WHO) guideline values provided in Guidelines for Drinking Water Quality Incorporating First and Second Addenda to Third Edition, Volume 1, Recommendations, 2006 to assess for potential impacts from the mining operations. For cases where the baseline conditions exceed IFC/World Bank or WHO standards, the surface water and groundwater parameters should not show a statistically significant increase over the baseline levels.

Runoff from the stockpiles would be monitored for water quality. Samples would be collected from the leachate collection/perimeter drainage system and analyzed for the presence and concentration of appropriate parameters to assess whether the leachate can be discharged directly into the diversion channel system or whether it must be pumped to the water management pond for treatment prior to discharge to surface water.

7.7.1 Tailings and Water Management Dam Integrity Monitoring

Monitoring and preventive maintenance would be undertaken to assure optimal performance of the tailings and water management ponds. Monitoring would consist of visual observation of the tailings embankment, and the monitoring of piezometers and other instrumentation installed to assess the performance of these facilities. RGEL would retain an independent expert firm to monitor the performance of the Tailings pond during the project operation phase.

The tailings and water management ponds would be monitored on a weekly basis, at a minimum, or as dictated by the EPA/GGMC to visually determine their structural integrity. The ponds would also be inspected to determine seepage through embankment cross-sections and to ensure that adequate freeboard exist for their continued use. This is likely to require a specific piezometer-based monitoring system for seepage water levels within the dams and downstream of them, which would be maintained throughout their life cycle.

Visual inspections and monitoring of dam embankment structural stability using settlement plates, slope inclinometers and pore water pressure measurements would be conducted to assess the stability of the dams. Soil strength gains associated with consolidation of the fill and the widened cross-section of the embankments due to tailings deposition would also be factored into the periodic evaluation of the impoundment stability.

Preventive maintenance would be undertaken at all potential trouble spots observed during visual inspection. The preventative maintenance would be geared primarily to ensure the stability of the structure and to control seepage through the embankment cross-section. A beach would be maintained immediately adjacent to the upstream slope of the embankments to increase the length of the seepage path and the stability of the embankment slope.

Measurements and monitoring would be made after the occurrence of unusual conditions such as heavy surface runoff or peak floods. If the characteristics of the tailings and the construction method change substantially over the time the Tailings pond is in use, these changes may alter the conditions governing the stability of the embankment. Changes could occur in crest levels, water levels, embankment slopes, cross-section geometry, seepage conditions, and material characteristics. A continuous program of inspection and maintenance would therefore be undertaken from the beginning of deposition throughout the life of the dam. Through careful monitoring, areas of concern would be noted and quickly repaired, thereby preventing failure.

Visual monitoring would be done to identify typical distress signals associated with tailings dam operation, such as cracking, wet spots on the downstream face, and critical settlement. The visual observations would be supplemented by instrumentation to enable an accurate interpretation of the extent of any problem likely to occur. The instrumentation, inclusive of piezometers, settlement plates and inclinometers, would be used to show developing trends in the behavior of the tailings and water management ponds.

The instrumentation would be installed in the embankment and its foundation to monitor changes which are critical to the embankment stability, and to predict unstable conditions. Instruments would be installed to measure pore water pressures, seepage flows, embankment movements, and total pressures. Pore water pressure in soils would

be measured with piezometers. Seepage flow emerging downstream from the embankment, would be collected and directed to a weir for flow measurements. Seepage flows would be used to indicate when significant changes occur and to permit an evaluation of potential problems from piping.

Markers would be installed on the embankment surface and would be aligned in a straight line-of-sight to permit rapid detection of horizontal movement during surveys. In instances where cracks are visible on the embankment surface, successive measurements between two stakes spaced either side of the crack should indicate any widening and acceleration in separation rate.

Slope indicators would be used to measure horizontal movement of the embankment. The slope indicators work by telescoping cylindrical casing into the embankment during construction. A sensing element is lowered down grooves inside the casing and measures the slope of the casing in two directions at right angles. From the measured slopes, the horizontal movements occurring over the length of the casing can be calculated. Settlement would be measured by leveling of temporary benchmarks.

The frequency of monitoring would depend on previous observations and on the critical nature of the parameters. The frequency of monitoring would be more pronounced during and immediately after construction. When records indicate that conditions are relatively stable, the frequency of monitoring would be extended. Monitoring audits would include water balance, freeboard, and deposition plans.

7.7.2 Post-Closure Monitoring

Post closure monitoring of the Tailings Pond would be conducted to ensure the integrity of the embankment cross-section and to verify that surface water and groundwater are not being impacted by releases from the Tailings Pond. The chemical concentration and water content of tailings would be monitored to determine when these parameters are within acceptable limits.

Post closure monitoring of the Tailings Pond would also include the collection of surface water and groundwater samples from locations near the Tailings Pond on a quarterly basis. Both surface and groundwater samples will be analyzed for parameters mandated by the EPA. Minimum parameters for which both surface and groundwater will be analyzed are detailed in Table 23. Sampling would be conducted for a period of five years after mine closure, at a minimum. Additional monitoring beyond five years may be required depending on the results of a risk analysis.

Table 23: IFC effluent guideline values for the mining sector.

Pollutant	Units	IFC Guideline Value
Total Suspended Solids	mg/L	50
Ph	S.U.	6-9
COD	mg/L	150
BOD5	mg/L	50
Oil and Grease	mg/L	10
Arsenic	mg/L	0.1
Cadmium	mg/L	0.05
Chromium (VI)	mg/L	0.1
Copper	mg/L	0.3
Cyanide	mg/L	1
Cyanide, Free	mg/L	0.1
Cyanide, Weak Acid Dissociable	mg/L	0.5
Iron (total)	mg/L	2.0
Lead	mg/L	0.2
Mercury	mg/L	0.002
Nickel	mg/L	0.5
Phenols	mg/L	0.5
Zinc	mg/L	0.5

Temperature	°C	<3 degree differential
Note: Metals concentration represent total metals.		

Monitoring of the tailings would be discontinued only after both chemical concentrations and tailings moisture content are within acceptable limits and only after the safety factor of embankment cross-section is determined to exceed 1.5. This safety factor is based on the soil strength gains over time due to compaction and the widened embankment footprint based on deposition of the coarse fraction of the tailings adjacent to the dam.

Closed facilities will be inspected, and annual reports provided to evaluate the success of progressive reclamation. Reclamation monitoring would be coordinated with the EPA and GFC. Reclamation success will be evaluated both in terms of vegetation and erosion. The existing monitoring programs for surface and groundwater will continue in accordance with the proposed monitoring plans. Monitoring would be modified to address progressive reclamation as it proceeds.

8.0 SOIL LAND AND GEOLOGY

8.1 Introduction

Land and soil are often considered to be the same thing, but there are important differences between these terms. Land is the terrestrial part of the earth's surface, and people think of land in terms of what they can do with it. Land is an area or location where we can live and carry out activities for subsistence or wealth-creating employment, leisure activities and other lifestyle choices.

Where soil occurs, it is the top layer of the terrestrial part of the surface of the earth (i.e. land). Soil contributes towards terrestrial ecosystem services that people rely upon when they use land for food, shelter and biomass production and these are central to social, economic and environmental sustainability. Soil is a component/subsystem of terrestrial ecosystems, providing a growing medium for flora and a habitat for fauna. Soil is one of the main environmental receptors of development impacts.

Geology is a vast and complex subject, and only a few aspects of key relevance to ESIA will be considered here. Surface geology concerns superficial deposits while solid geology only concerns pre-superficial formations.

8.2 Policy, Legislative and Regulatory Framework

8.2.1 Town and Country Planning Act Chapter 20:01

Provisions are made in this Act for the orderly and progressive development of land (which is specifically defined), cities, Towns and other areas, be they urban or rural, for their preservation and improvement and for other related matters. The prescribed authority, responsible for effecting the provisions of the Act is the Central Housing and Planning Authority established under the Housing Act Chapter 36:20. The Central Housing and Planning Authority will be required to provide consent for the development and regulation of any new settlement associated with the mine site operations.

8.2.2 Environmental Protection (Hazardous Wastes Management) Regulations, 2000

These regulations outline the rules and procedures to transport, store, treat and dispose of hazardous wastes. There are no regulations for the management of hazardous substances. These regulations are intended to ensure, through the environmental authorization process, that all operations that generate, transport, treat, store and dispose of hazardous wastes are managed in a manner that protects human health and the environment. The regulations allow for the provision of information on the types of facilities and quantity of hazardous waste generated, treatment standards and efforts to reduce the waste generated. An emergency preparedness plan is required for anyone who operates a hazardous waste facility. For the purposes of that regulation, hazardous material/waste is regarded as the following:

- Explosives
- Flammable liquids
- Flammable solids or waste solids other than explosives which may be readily combustible
- Oxidising substances
- Organic peroxides
- Poisonous substances
- Infectious substances
- Corrosives
- Toxic gases
- Toxic substances which if inhaled or ingested may cause delayed or chronic effects
- Ecotoxic substances which if released may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon systems
- Materials capable, after disposal, of yielding another material which possesses any of the characteristics specified above

A larger proportion of the hazardous material identified above will not be utilized by this project. The fuel used to power equipment can however be classified as a hazardous material. The hazardous wastes regulations will therefore apply to fuel oil/used oils at the project site.

8.2.3 Protocol Concerning Pollution from Land-Based Sources and Activities (LBS)

The Protocol requires contracting parties to develop and implement programs, plans and measures to prevent, reduce or control pollution of the Convention areas from land-based sources and activities. Parties are required to address the source categories, activities and pollutants of concern listed in Annex 1 to the Convention. Extractive industries and mining are identified as priority source categories and activities. Heavy metals and compounds, cyanides and fluorides are listed as primary pollutants of concern. Annex II identifies factors to be used to determine effluent and emission limitations and/or management practices.

Possible landbased sources of pollution at the site will include fuel storage tanks and leaks from mining equipment. In accordance with this protocol, the project proponent shall develop and implement programs, plans and measures to prevent, reduce and/or control pollution of the project area from land-based sources and activities.

8.2.4 Basel Convention on the Transboundary Movement of Hazardous Waste and their Disposal

The Basel Convention aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes. Guyana is a party to this convention which came into force in 1992. It was designed specifically to prevent transfer of hazardous waste from developed to less developed countries (LDCs). The Convention is also intended to minimize the amount and toxicity of wastes generated. This ensures that toxic waste is managed as close as possible to the source of generation. Examples of hazardous waste as defined by the convention are:

- Wastes from the manufacture, formulation and use of wood preserving chemicals
- Waste pharmaceuticals, drugs and medicines
- Wastes from the production, formulation and use of organic solvents
- Waste mineral oils unfit for their originally intended use
- Waste oils/water, hydrocarbons/water mixtures, emulsions
- Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish

Consequent to this convention Guyana developed regulations on environmental protection. One of these regulations focuses on the management of hazardous wastes.

8.3 Baseline

8.3.1 Geology

The Project area is located in the Karawaimentau-Marudi Mountain Range. The Karawaimentau-Marudi Mountain Range forms a very marked topographic unit. It stretches for about 20 miles in a NNE-SSW direction and is generally about 880 feet above the surrounding country. These mountains, together with a few similar but rather restricted masses support a region of thickly forested country which stands out in marked contrast with the extensive savannas to the west and south. The range is separated into three portions by deep transverse valleys, Karawaimentau in the northeast being the highest portion at about 1800 feet above sea level. Mapuemautau forms the central portion of the range, at about 1200 feet above sea level, while the Marudi-Mazoa portion in the southwest is almost as high as the Karawaimehtau region. Most of the creeks in the area have their sources in the range. These creeks have very steep gradients in their upper reaches and cut downwards very rapidly.

The greatest development of Marudi Group rocks occurs as an enclave within the South Savanna Granite. (*Report No.26, Institute of Geological Sciences by Jevan P. Berrange 1973 titled "A Synopsis of the Geology of Southern Guyana"*). The Marudi schist belt extends for about 20 miles in a NE-SW direction but is seldom more than 5 miles wide in the Marudi Mountain area. Most of the rocks are derived from the same sediments. The oldest rocks in the region are

inferred to be formed from siliceous and felspathic sediments, which after consolidation, were intruded by a series of dolerite dykes. The rocks of the enclave then suffered low grade regional metamorphism which converted the sediments into a series of schists, while the dolerites were changed to amphibolites. The dominant direction of foliation imparted to the rocks during metamorphism was NE-SW.

The next major event in the area was the emplacement of the South Savanna Granite, accompanied by the development of muscovite schists and quartzo-felspathic veins. Flow banding developed in the gneisses near the granite margins, while there is some evidence in the enclave of northwest fracturing. Intensive silicification associated with the emplacement of the granite produced lenses of quartzites aligned generally in a NE direction though a few minor occurrences trend NW. A period elapsed between the introduction of the South Savanna Granite and the intrusion of the Marudi Granodiorite. This was intruded into the shear zone at Marudi Mountain within which the auriferous quartz veins occur. Further movements along the shear zone caused shearing of the quartz veins and the production of cataclastic foliation in the adjacent granodiorite.

The rocks of this Group are usually easily eroded, producing a flat monotonous country which is often swampy and consequently outcrops are restricted to creek beds. Biotite, schists and biotite garnet schists have developed from the more argillaceous members while the meta-siltstones and impure quartzites have been derived from arenaceous members. Narrow bands of phyllites occur locally varying from dull red to pale yellow but owing to the ease with which they decompose, they are seldom seen within the area.

Nowhere in the Marudi Mountain can the original unmetarmorphosed sediments be seen, but in some of the low grade metasediments the rather poorly sorted nature of the rocks is demonstrable. Low grade regional metamorphism has produced biotite-albite-schists in which coarse grains of albite, quart: and iron oxides up to 2 mm across, are set in fine- grained quartz, biotite, and muscovite. Thin sections reveal a second generation of felspars with poikiloblastic albite and poorly formed microcline. There is only a partial alignment of small brown flakes of biotite and muscovite.

8.3.2 Soils

The tropical conditions of the study area have produced an environment dominated by chemical weathering. The surficial soil is generally a saprolitic clay material that retains some elements of the original bedrock structure. Natural slopes in the area range from being relatively mild to steep. There is some evidence of slope failure in the area, which is very likely associated with the development of saturated conditions during the wet season.

The soil types on the proposed Project site include three soil map units (see Figure 14). Fp Soils are brown, red and yellow deep moderately well drained clay and loam soils encountered in areas of undulating pediplanes with round rises and some dissection. These are tertiary soils derived mainly from transported deposits and overlie granite and gneisses in the area.

Li soils are variable stony and immature shallow and mainly excessively drained soils which occur in mountainous and hilly areas (Braun et. al, 1964). These soils are residual materials derived mainly from weathering of granite, gneisses and schists which are present in the area.

Mp soils are brown and dark brown, deep well drained sandy loam and clay soils or red deep well and moderately well drained clay loam soils which occur in areas of gently sloping but sometimes dissected mountain and hill pediments. These soils are sub-recent to recent outwash materials related to a variable solid geology including some basic rocks.

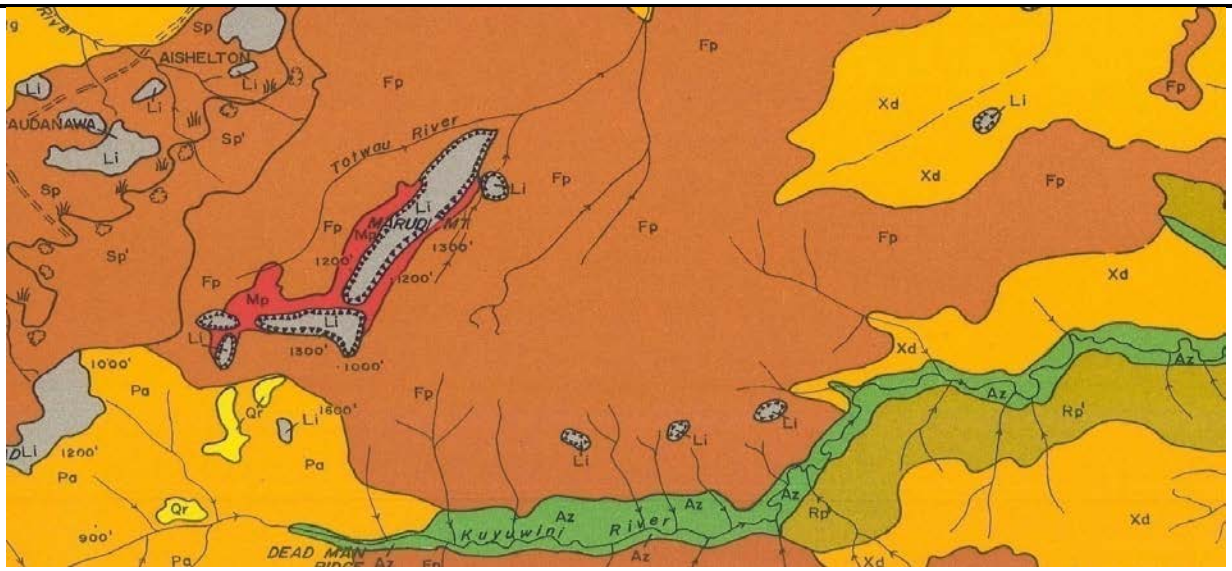


Figure 14 - Soil Map of Project Area (Braun, E.H. G., Derting, J., Suggett, G.R.. Year: 1964.)

8.3.3 Seismic Activity

Seismicity in the northern part of the South America continent is largely controlled by plate boundary events occurring along the southern rim of the Caribbean Basin. Major earthquakes frequently occur along the plate boundary between the South American and Caribbean Plates. Figures 15 and 16 respectively show the distribution of historical deep seated and shallow earthquakes occurring around the Caribbean Basin. These figures demonstrate that earthquake activity is concentrated in a circular pattern around the perimeter of the Caribbean tectonic plate.

Guyana is located within the South American tectonic plate. The project site is located more than 500 km from the Caribbean and South American plate boundary. A search was conducted of the National Oceanic and Atmospheric Administration Earthquake database, which includes data on a half-million earthquakes dating back to 2100 B.C. The results of that search are shown as Figure 17.

That search revealed that three events have occurred within recorded history within 200 km of the project area. One of these events occurred in Guyana, in 1964, at a point defined by 2.64° North and 59.62° West at a depth of 50 km and with a magnitude of 4.50 which is within 50 km of the project area. The second event occurred almost immediately west of that point in Brazil at a point defined by 2.68° North and 60.12° West. The depth of that event was not recorded. The magnitude of that event was reported as being 4.90.

Figure 15 - Deep and Intermediate Depth Seismicity, 1901-1993 (from OAS CDMP, 2001)

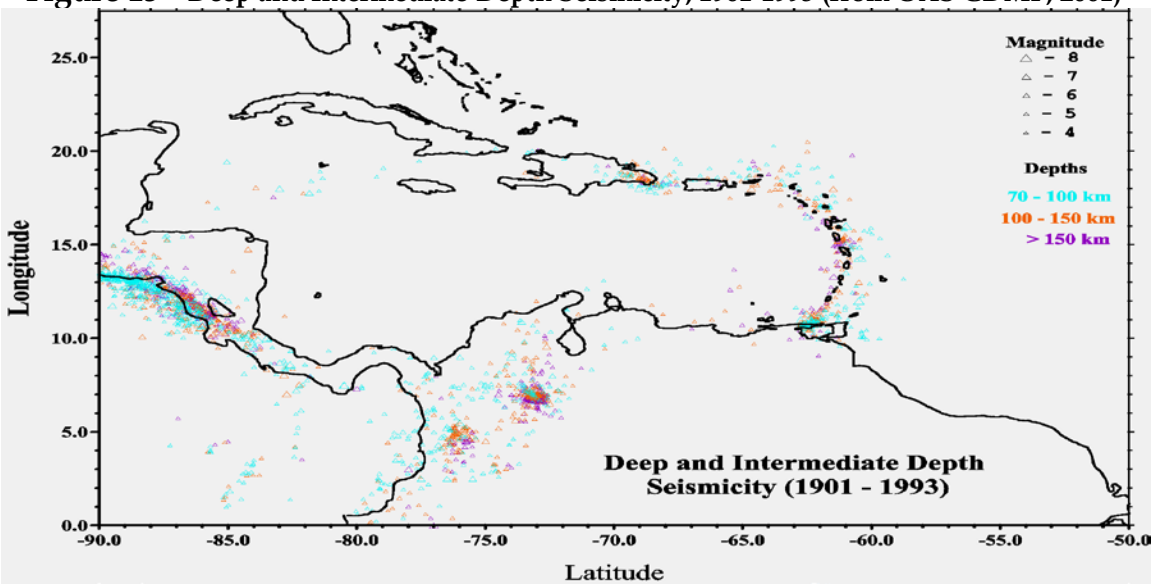
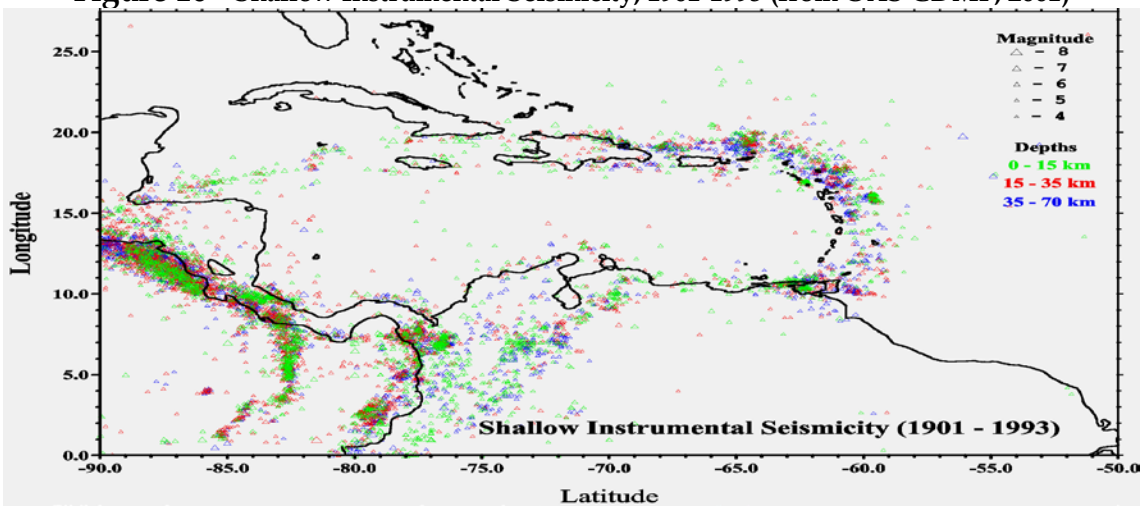


Figure 16 - Shallow Instrumental Seismicity, 1901-1993 (from OAS CDMP, 2001)



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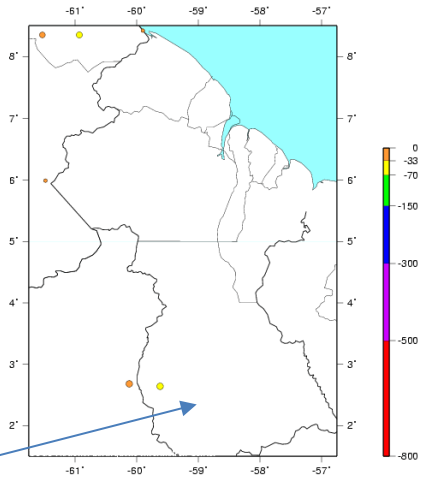


Figure 17 - Earthquake Location within and around Guyana

Mine Site

8.3.4 Sediment Quality

Sediment samples were recovered from the points coincident with the points at which surface water samples were recovered in both 2009 and 2018 and concurrently with the surface water samples. The results of the analyses on sediment samples, recovered in 2009 are detailed in Tables 24 and 25.

Table 24: Results of 2009 Analyses on Sediment Samples

LAB ID:			**735012**	**735013**	**735014**
Sample Date:			**2009-08-01**	**2009-08-01**	**2009-08-01**
Sample ID:			**S1**	**S2**	**S3**
PARAMETER	**UNITS**	**MRL**			
Total Organic Carbon	%	0.01	1.23	0.16	0.86
Loss on Ignition	%	0.01	3.48	5.21	4.26
Aluminum	ug/g	1	3450	14000	12584
Arsenic	ug/g	1	2	4	2
Antimony	ug/g	1	<1	<1	<1
Calcium	ug/g	100	5500	3200	4400
Cadmium	ug/g	0.5	<0.5	<0.5	<0.5
Chromium	ug/g	1	19	43	43
Cobalt	ug/g	1	5	30	30
Copper	ug/g	1	13	48	48
Iron	ug/g	1	13700	48500	55500
Lead	ug/g	1	5	14	9
Magnesium	ug/g	100	1800	2100	1600
Manganese	ug/g	1	125	3300	2168
Mercury	ug/g	0.1	0.3	0.2	0.2
Molybdenum	ug/g	1	<1	<1	<1
Nickel	ug/g	1	<1	10	15
Potassium	ug/g	100	127	103	90
Selenium	ug/g	1	<1	<1	<1
Sodium	ug/g	100	1000	1200	900
Zinc	ug/g	1	9	35	42

Table 25: Results of 2009 Analyses on Sediment Samples

LAB ID:			751283	751284	751285
Sample Date:			2009-10-12	2009-10-12	2009-10-12
Sample ID:			SD1	SD2	SD3
PARAMETER	**UNITS**	**MRL**			
Loss on Ignition (@550C)	%	0.1	3.2	2.4	4.0
Total Organic Carbon	%	0.01	0.34	0.43	0.44
Calcium	ug/g	100	797	458	527
Magnesium	ug/g	100	4360	1500	1510
Potassium	ug/g	100	2460	981	1480
Sodium	ug/g	100	<100	<100	<100
Aluminum	ug/g	1	9950	7460	12500
Antimony	ug/g	1	<1	<1	<1
Arsenic	ug/g	1	1	3	3
Cadmium	ug/g	0.5	<0.5	<0.5	<0.5
Chromium	ug/g	1	97	80	61
Cobalt	ug/g	1	12	19	25
Copper	ug/g	1	31	36	63

Iron	ug/g	1	25400	47400	56600
Lead	ug/g	1	6	13	11
Manganese	ug/g	1	416	1140	713
Mercury	ug/g	0.1	<0.1	<0.1	<0.1
Molybdenum	ug/g	1	<1	2	<1
Nickel	ug/g	1	32	24	20
Selenium	ug/g	1	<1	<1	<1
Zinc	ug/g	1	38	34	53

The results of analytical tests on sediment samples recovered in 2018 are detailed on Tables 26 and 27.

Table 26: Results of 2018 Dry Season Analyses on Sediment Samples

LIMS #				**1343672**	**1343673**	**1343674**
Sample ID				**SW-1**	**SW-2**	**SW-3**
Sample Date				**2018-01-24**	**2018-01-24**	**2018-01-24**
Analyte	**Units**	**Analytical Method**	**MRL**			
Ag	ug/g	EPA 200.8	0.2	<0.2	<0.2	<0.2
Al	ug/g	EPA 200.8	10	6980	2850	6470
As	ug/g	EPA 200.8	1	5	<1	<1
Ba	ug/g	EPA 200.8	1	264	17	37
Be	ug/g	EPA 200.8	1	<1	<1	<1
Ca	ug/g	M SM3120B-3050B	50	250	100	220
Cd	ug/g	EPA 200.8	0.5	<0.5	<0.5	<0.5
Co	ug/g	EPA 200.8	1	39	1	9
Cr	ug/g	EPA 200.8	1	52	11	28
Cu	ug/g	EPA 200.8	1	50	2	21
Fe	ug/g	EPA 200.8	10	61700		31600
Hg	ug/g	M SM3112B-3500B	0.1	<0.1	<0.1	<0.1
K	ug/g	M SM3120B-3050B	50	270	70	130
Loss on Ignition (@550C)	%	Ag Soil	0.1	3.7	1.4	3.2
Mg	ug/g	M SM3120B-3050B	50	160	90	120
Mn	ug/g	EPA 200.8	1	3640	40	898
Mo	ug/g	EPA 200.8	1	2	<1	<1
Na	ug/g	M SM3120B-3050B	100	<100	<100	<100
Ni	ug/g	EPA 200.8	1	11	2	6
Oil & Grease – Mineral	ug/g	C SM5520D	100	<100	<100	<100
Oil & Grease - Non-mineral	ug/g	C SM5520D	100	200	200	100
Oil & Grease – Total	ug/g	C SM5520D	100	200	200	100
Organic Matter (@350C)	%	Ag Soil	0.1	1.4	0.4	1.7
Pb	ug/g	EPA 200.8	1	22	4	5
Sb	ug/g	EPA 200.8	1	<1	<1	<1
Se	ug/g	EPA 200.8	1	<1	<1	<1
Sr	ug/g	EPA 200.8	1	3	2	3
Tl	ug/g	EPA 200.8	1	<1	<1	<1
TOC	%	SUB-PETRO LABS	0.01	0.03	0.06	0.07
V	ug/g	EPA 200.8	2	140	15	56
Zn	ug/g	EPA 200.8	2	30	5	14

Table 27: Results of 2018 Wet Season Analyses on Sediment Samples

LIMS #				**1360501**	**1360502**	**1360503**
Sample ID				**SW-1**	**SW-2**	**SW-3**
Sample Date				**2018-05-07**	**2018-05-07**	**2018-05-07**
Analyte	**Units**	**Analytical Method**	**MRL**			
Ag	ug/g	EPA 200.8	0.2	<0.2	<0.2	<0.2
Al	ug/g	EPA 200.8	5	12800	9170	1160
As	ug/g	EPA 200.8	1	<1	1	<1
Ba	ug/g	EPA 200.8	1	51	24	14

Be	ug/g	EPA 200.8	1	<1	<1	<1
Ca	ug/g	M SM3120B-3050B	50	600	300	200
Cd	ug/g	EPA 200.8	0.5	<0.5	<0.5	<0.5
Co	ug/g	EPA 200.8	1	17	3	<1
Cr	ug/g	EPA 200.8	1	37	18	11
Cu	ug/g	EPA 200.8	1	41	12	1
Fe	ug/g	EPA 200.8	5	52100	28700	2350
Hg	ug/g	M SM3112B-3500B	0.1	<0.1	<0.1	<0.1
K	ug/g	M SM3120B-3050B	50	300	200	<100
Loss on Ignition (@550C)	%	Ag Soil	0.1	5	3.6	0.4
Mg	ug/g	M SM3120B-3050B	50	400	200	100
Mn	ug/g	EPA 200.8	1	1070	156	25
Mo	ug/g	EPA 200.8	1	<1	<1	<1
Na	ug/g	M SM3120B-3050B	100	<100	<100	<100
Ni	ug/g	EPA 200.8	1	9	3	4
Oil & Grease - Mineral	ug/g	C SM5520D	100	1100	<100	<100
Oil & Grease - Non-mineral	ug/g	C SM5520D	100	1100	<100	<100
Oil & Grease - Total	ug/g	C SM5520D	100	2200	<100	<100
Organic Matter (@350C)	%	Ag Soil	0.1	3.3	2.2	0.3
Pb	ug/g	EPA 200.8	1	10	5	1
Sb	ug/g	EPA 200.8	1	<1	<1	<1
Se	ug/g	EPA 200.8	1	<1	<1	<1
Sr	ug/g	EPA 200.8	1	5	3	2
Tl	ug/g	EPA 200.8	1	<1	<1	<1
TOC	ug/g	SUB-PETRO LABS	0.01	1100	405	201
V	ug/g	EPA 200.8	2	105	51	5
Zn	ug/g	EPA 200.8	2	28	9	2

8.4 Impact Prediction and Evaluation

8.4.1 Soils

8.4.1.1 Construction

Potential impacts to soil could result from widening of the access road from Aishalton to Marudi, from vegetation clearance of the mine site and infrastructure area footprints and creek flats to be mined and from excavation for creek diversions. Soil is a complex ecosystem. A single cubic meter of soil may contain millions of living things, including small rodents, insects, worms, algae, fungi, and bacteria. These organisms are important for mixing and aerating the soil particles. They also help release or convert nutrients in soils into forms that are useful for plants. These soils, developed on highly leached bedrock, are nutrient poor and have low fertility. The development and maintenance of the terrestrial ecosystems, in the project area depend upon the surficial soils as basic components of the system. Interactions between physical and biochemical processes have operated over variable time scales (hundreds to thousands of years) and space (from less than 1 m^2 to thousands of square kilometers) to produce the soil which provide support to complex ecosystems. In addition, continued weathering of minerals in soils at the site continues to release chemicals which are used by a variety of organisms, including plants to build soils.

Construction activities will result in soil degradation since minerals necessary to support the ecosystem may be depleted by construction activities. These are moderate impacts (long-term; moderate severity, local extent). These impacts will be mitigated by confining clearing and excavation activities only to those areas required for execution of the project. The mitigation measures will result in low impacts (short-term, low severity, local extent).

Site clearing, and access road diversion and construction can potentially result in soil loss through increased soil erosion. Roads and other transport lines in the terrain may result in increased soil erosion since the roads may transport water, mimicking a river. This area is subject to periods of heavy rainfall and the amount of water may be extensive and may increase erosion on roads and surrounding areas. At road curves, the water will continue straight forward and create large gullies and possible cover large areas with eroded matter. Soil erosion may also

occur if construction activity blocks natural water courses. Site clearing and access road maintenance/widening and construction can consequently potentially result in increased soil erosion. These impacts could be pronounced in areas of significantly steep slopes and where the soils erosion potential is severe or very severe. Slopes on the access roadway and in cleared areas will be maintained at relatively mild slopes. Therefore, the impact of the proposed Project construction on soils would be moderate (medium-term, moderate severity, local extent).

The likelihood of soil erosion will be minimized or avoided by the implementation of the following mitigation measures:

- Implementation of best management practices (Storm Water Management Plan) for soil erosion
- Implementation of site reclamation activities
- Installation of channel control structures
- Implementation of an Interim Reclamation Plan following clearance activities and
- Implementation of a long-term Reclamation Plan for disturbed areas.

These mitigation measures will result in low impacts (short-term, low severity, local extent).

The movement of heavy equipment may cause rutting and compaction of susceptible soils. Near surface soil compaction will reduce the ability of the soil to absorb water. Furthermore, water already in the soil will become more tightly held and, thus, less available to plants and animals. Compaction will also change the variability of soil temperature. This effect would be most apparent near the surface, where the soil becomes hotter during the day and colder at night. Heavy earthmoving equipment will also increase mechanical erosion and facilitate wind and water erosion of soil materials loosened by their passage. Runoff from cleared areas can be as much as eight times greater than runoff from adjacent, vegetated areas with associated increase in soil erosion. The construction and mining operations will be restricted to mineralized areas, compaction, rutting and erosion would therefore be localized to these areas. These impacts to soil resources are expected to be low (short-term, low severity, local extent). No mitigation would be required.

Topsoil mixing may potentially occur during access road construction, excavation, mine site preparation and during landscaping. The mixing of the topsoil or surface soil with the subsoil from these activities could result in a loss of soil fertility and the loss of viable seeds present (topsoil seedbank) in the topsoil. Soil development is a complex process. The rock and hydrologic cycles have interacted at the project site to produce weathered rock materials that are basic ingredients of soils. Weathering is the physical and chemical breakdown of minerals and rocks and the first step in soil development. Weathered rock is further modified into soil by the activity of soil organisms. The common master, or prominent, soil horizons are the O and A horizons. The O Horizon and A Horizon contain highly concentrated organic material, such as decomposing plants. The difference between these two layers is reflected by the amount of organic material present in each. In general, the O Horizon consists almost entirely of plant litter and other organic material, whereas the underlying A Horizon contains a good deal of both organic and mineral material. Below the O or A horizons, some soils have an E horizon, or zone of leaching, a light-colored layer that is leached of iron-bearing components. This horizon is light in color because it contains less organic material than the O and A horizons and little inorganic coloring material, such as iron oxides.

The mixing of the O Horizon and A-Horzon soils with less organic matter from the active leaching zones underlying these soils will result in a loss of soil fertility and the loss of viable seeds present (topsoil seedbank) in the O-Horizon Soils. This will result in moderate impacts (long-term, medium severity; local extent).

To prevent topsoil mixing and the associated loss of viable seed banks, the following mitigation measures will be implemented:

- Topsoil will be segregated from subsurface layers during construction activities
- Topsoil will be stored separately from other overburden materials
- Topsoil will be replaced following mining activities

Implementation of these mitigation measures will result in low impacts (short-term, low severity, local extent).

8.4.1.2 Operation Phase

Mining operation will increase soil erosion within the footprint of operational areas. In the operational phase risks of erosion would exist if maintenance routines are inadequate, or if the location of the road has not been considered carefully. The area is subject to intense precipitation events and large seasonal variations in rainfall intensity which will increase the likelihood of severe erosion. The operational phase can therefore result in increased soil erosion. Areas cleared of vegetation for the mine site will be terraced and will be planted with trees and provided with catch water drains, and small ponds to reduce soil erosion These actions will minimize surface water discharge during precipitation events. The minimization of surface water discharge coupled with implementation of best management practices in the Storm Water Management Plan will result in insignificant soil loss due to erosion resulting in low impacts (short-term, low severity; local extent).

During operations, soil may be contaminated by accidental releases of fuels, oils, grease and other hazardous materials from equipment and/or from the failure of fuel/hazardous material containment areas. These are moderate impacts (medium term, medium severity, local extent). The potential for accidental spills of fuels and other hazardous materials and associated soil contamination will be minimized or avoided by the implementation of a Spill Prevention and Contingency Plan (SPCP). Management measures detailed in this plan includes siting of fuel containment tanks on impervious bases located within a bunded impermeable enclosure designed to hold 110 percent of the contents of the largest tank. Implementation of these mitigation measures would result in low impacts (short-term, low severity, local extent) on soil during construction.

Operation of the mine site and its ancillary facilities will generate solid wastes, including soil, paper, metal, trash, scrap, rubble, domestic wastes, and hazardous wastes. If not properly managed, these wastes could lead to contamination of soils, as well as generation of odors, attraction of vermin, and creation of human health and safety hazards. This impact is rated as high (long-term, medium severity, local extent). The Project will minimize and mitigate these potential impacts by developing and implementing waste management plans for each type of solid waste generated by the operation phase of the Project. Reuse and recycling would be preferred over disposal to the extent practicable. Under proper management, the residual impact, to soils, associated with solid waste generation will be low (short-term, low severity, local extent).

8.4.1.3 Closure Phase

During closure operations, the mine pit will be contoured to restrict erosion and creek flats will be revegetated. There may be increased erosion during the restoration exercise. These are moderate impacts (short-term, moderate severity, local extent). Increased erosion is also likely to occur to creeks around developed areas during site restoration exercise. These are moderate impacts (short-term, moderate severity, local extent). Both impacts will be mitigated by using silt fences around working areas during restoration. The implementation of mitigation measures will result in low residual impacts (short-term, low severity, local extent).
During closure operations, the footprint of the mine site and infrastructure areas will be contoured to fit into the surrounding topography and creeks will be restored to former alignments, where possible. All areas initially cleared will be revegetated. In addition, soil conservation measures such as contour plowing of the upper sections of cleared areas will be used to improve the humidity of the soil and it ability to sustain vegetation.

8.4.2 Land

The primary land use activities in the area are mining and forestry. The land, within the project footprint, will be initially used for mining and will be reconverted to forestry after mine closure. The project will result in no impacts on land use. These impacts will not be mitigated.

8.4.3 Geology

8.4.3.1 Construction Phase

The stratigraphic profile at the site consists of a zone of residual soil which has been completely weathered to soil with no remaining structure of the rocks from which the soils were formed, being visible. There is some laterite, a more specific sub-grouping of residual soil where secondary iron or aluminium oxides form, present at some locations at the site. The residual soil is underlain by saprolite. The saprolite is representative of a portion of the weathered profile which has retained the original fabric and structure of the parent rock. Saprolite differs from weathered rock in its degree of alteration. It is material that is sufficiently broken down that it can be augered through or dug with a shovel yet is retains the original rock structure (Anderson & Anderson, 2010). The retention of the rock structure implies that the saprolite has undergone no strain. The saprolite is underlain by weathered rock or Saprock which constitutes the transition zone between saprolite and bedrock. In this zone intact rock material is present in a discontinuous framework separated by soil-like material. Typically, saprock is defined by having a rock content of 50 % or more. The rock material can be present in various states of weathering from highly weathered to fresh. Significant zones of soil like material can be encountered within a saprock zone due to preferential local weathering. The saprock is underlain by a stratum of intact rock with no indication of weathering. Surficial soils, represented only by a part of the residual soils at the site, will be removed over that area of the site which has been identified for the above facilities. Removal of these surficial residual soils will result in low impacts (long-term, low severity, local extent). No mitigation would be needed. The construction works will not alter the stratigraphic profile at the site. Construction work will consequently have no impacts on the geology of the area.

8.4.3.2 Operation Phase

During mining, soil and rock would be excavated from the mine pit area. The present geologic profile of the area consists of a stratum residual soil material derived from weathered acid crystalline rocks (granite, schist, dolerite, granodiorite, and phyllite) underlain by sedimentary, metamorphic and intrusive rocks. Mining will not segregate soils based on the depths at which these soils are encountered when the overburden material is disposed in the spoil piles. Mining and spoil disposal will result in an alteration of the stratification of the unconsolidated soils at the site. Additionally, several pits may be created by excavation operations. Spoil disposal and ore stockpiles may result in filling of depressed areas and creation of elevated areas. The pits, spoil and ore stockpiles will alter the topography, slope relief intensity, degree of shaping and exposure of the area. These are moderate impacts (long-term, low severity, local extent). These impacts will not be mitigated.

Mining will create both cut and fill slopes. Cut slopes will be created by the removal of waste rock and/or ore and are usually steep slopes surrounding the mine pit excavation. Excavated slopes may result in increased erosion, greater and more rapid runoff, may pose risks to wildlife and may expose potentially reactive, naturally occurring materials. Dumping of overburden soils, tailings, waste rock, or other materials creates new fill slopes. Water saturation can trigger slope failure. Fill materials may in some cases also be subject to rapid disintegration, or to decomposition, yielding acids and releasing potentially toxic metals. Slope failure can result in direct release or direct exposure of these materials to the surrounding environment.

Mining may also trigger landslides through natural soil and rock masses. This commonly occurs in pit walls but may also occur along access and haulage roads, particularly where these involve excavations into steep hillsides. Many natural slopes in mountainous terrain are only marginally stable and require only a relatively minor change to become unstable. Merely clearing vegetation or excavating a trench may, in some instances, be sufficient to destabilize an entire mountain slope. Failure of cut/fill slopes will create high impacts (medium term, high severity, local extent).

These potential impacts will be mitigated by detailed geotechnical engineering investigations to analyze the stability of cut and fill slopes and by designing both cut and fill slopes to consider both undrained and effective stress conditions including variation of phreatic surfaces with slope saturation. These mitigation measures will result in low impacts (short-term, low severity, local extent).

8.4.3.3 Closure

Closure will have no impacts on geology. No mitigation is required.

Table 28: Summary of Soil, Land and Geology Impacts

Soils, Land and Geology					
Soils					
Project Phase	**Impacts**		**Project Impacts Rating**	**Mitigation Measures**	**Impact Rating after Mitigation**
Construction	Soil Degradation by mineral depletion	*Source* Construction activities *Vulnerability* Fertile Soils in project area	Moderate (medium-term; moderate severity, local extent).	Confining clearing and excavation activities to only areas required for project.	Low (short-term, low severity, local extent).
	Soil Loss by Erosion	*Source* Site clearing access road diversion access road construction *Vulnerability* Steep Areas Site and Access Roads	Moderate (medium-term, moderate severity, local extent).	Implementation of best management practices (Storm Water Management Plan) for soil erosion. Implementation of site reclamation activities Installation of channel control structures Implementation of an Interim Reclamation Plan following clearance activities and Implementation of a long-term Reclamation Plan for disturbed areas.	Low (short-term, low severity, local extent).
	Soil Rutting /Compaction Increases mechanical erosion Increased wind and water erosion	*Source* Heavy equipment movement *Vulnerability* Near surface soils Water absorption capacity Water availability for animals and plants. Variability of soil temperature	Moderate (Medium-term, moderate severity, local extent).	Restriction to mineralized areas	Low (short-term, low severity, local extent).
	Topsoil mixing Reduced soil Fertility Loss of Seed banks	*Source* Access road construction	Moderate (long-term, medium severity; local extent)	Topsoil will be segregated from subsurface layers	Low (short-term, low severity, local extent).

		Excavation Mine Site Preparation Landscaping *Vulnerability* Site soils		during construction activities Topsoil will be stored separately from other overburden materials Topsoil will be replaced following mining activities	
Operation	Increased Soil Erosion	*Source* Inadequate maintenance routines Improper road location intense precipitation events *Vulnerability* Water Quality Steep Terrain	Moderate (short-term, moderate severity; local extent).	Terracing of cleared areas for the mine site Tree planting Provision of catch water drains and small ponds Implementation of Storm Water Management Plan	Low (short-term, low severity; local extent).
	Soil Contamination	*Source* Accidental releases of fuels, oils, grease and other hazardous materials from equipment.	Moderate (medium term, medium severity, local extent).	Implementation of a Spill Prevention and Contingency Plan (SPCP) including siting fuel containment tanks on impervious bases. Implementation of waste management plans for each type of solid waste generated by the operation phase of the Project.	Low (short-term, low severity, local extent)
Closure	*Erosion*	*Source* Site recontouring *Vulnerability* Surrounding Creeks Access Roads	Moderate (short-term, medium severity, local extent).	Revegetation of cleared areas Installation of silt fences around working areas	Low (short-term, low severity, local extent).
Geology					
	Altered stratigraphic profile at the site	*Source* Surficial soils	Low (long-term, low severity, local extent)	No mitigation would be needed.	Low (long-term, low severity, local extent)
	Slope Instability	*Source* Cut and fill slopes created by mining	High	Performance of detailed geotechnical engineering	Low (short-term, low severity, local extent)

		Water saturation can trigger slope failure. *Vulnerability* Wildlife Potentially reactive naturally occurring materials	(medium term, moderate severity, local extent)	investigations to analyze the stability of cut and fill slopes Designing cut and fill slopes to consider both undrained and effective stress conditions	

8.5 Environmental Management Plan

8.5.1 Soils Management

Soils will be protected from contamination and erosion during all Project activities. Soil erosion measures are detailed in the Erosion and Sediment Control Plan. Soil will not be allowed to become a contaminant itself by entrainment in runoff or wind. Topsoil and organic matter will be separated from subsoils and will not be intermixed. Topsoil and organic matter will be stockpiled and protected from rainfall and sunlight. Stockpiled materials will be reutilized in progressive restoration works as soon as practicable to avoid losses of organic matter through oxidation. No topsoil will be removed from any area outside the mining limits unless approved by the EPA.

Soils in temporary work areas will be decompacted by disking, plowing, ripping, or other mechanical means. Soils will be protected from contamination as detailed in the Spill Prevention and Control Plan. Contaminated soil will be remediated by in situ or ex situ means as appropriate.

In the event of chemical spills, soil samples will be recovered from the impacted areas after cleanup to ensure that residual levels of hydrocarbons and other fuel oil constituents do not exceed tolerable limits. If these limits are exceeded in soil, additional soil will be removed from the spill area until the residual levels fall below tolerable limits. The soil excavated from the area shall be disposed in accordance with the Hazardous Waste Management protocol.

8.5.2 Erosion and Sediment Control Plan

Mining will be undertaken with long-term erosion and sediment control as a primary consideration. Mining operations conducted during the rainy season will be clearly demonstrated, to the satisfaction of the EPA, that at no stage of the operations will there be any substantial risk of increased sediment discharge from the site. When mining occurs in the rainy season, the smallest practicable area of erodible land will be exposed during mining operations and the time of exposure shall be minimized. Natural features, including vegetation, terrain, watercourses and similar resources shall be preserved wherever possible. Limits of mining shall be clearly defined and marked to prevent damage by mining equipment.

Site clearing operations will progress in a gradual and phased manner to ensure there are no large increases in sediment discharge. Sediment control structures will be used to prevent the inflow of sediment to surface water. These control practices will include sediment traps and screens to control run-off and sedimentation from active mining and developed areas.

Permanent vegetation and structures for erosion and sediment control shall be installed as soon as possible. Adequate provision shall be made for long-term maintenance of permanent erosion and sediment control structures and vegetation. No topsoil shall be removed from the area outside the mining limits unless approved by the EPA. Topsoil overburden shall be stockpiled and redistributed to provide a suitable base for seeding and planting. Runoff from the stockpiled area shall be controlled to prevent erosion and resultant sedimentation of receiving waters. Runoff shall not be discharged from the site in quantities or at velocities substantially above those which occurred before grading.

Waste rock and soil from the mining and mineral processing operations will be disposed in spoil piles located in the mined-out areas. All spoilpiles would be surrounded by a soil containment berm to preclude the easy flow of surface runoff and sediment from stockpiles. The containment berms would be constructed of soil pervious enough to enable the passage of surface runoff water while trapping sediment contained in that runoff. The height and slope of each spoilpile would be such that foundation and slope failures do not occur.

Stormwater runoff and water from the mining operations would both be channeled to temporary sedimentation ponds. Those ponds would be designed to provide a detention time of 48 hours. Discharge from the sediment

pond would be via a spillway and would be channeled through a sediment control structure constructed of a matrix of stone, sand and grass to remove sediment prior to discharge to surface water bodies in the site area.

Mining would proceed in such a manner as to minimize disturbance to streams in the area. In instances where this cannot be avoided, sediment control structures and practices would be used to prevent the inflow of sediment to surface water. These control practices would include sediment traps or screens to control run-off and sedimentation.

Sumps would be excavated on the floor of the mine and all groundwater flow and precipitation would be channeled into sumps. Measures would be implemented to prevent surface runoff from entering the open pit and from adding to the volume of groundwater inflow and direct precipitation.

Erosion control operations would be performed under favorable weather conditions. When excessive moisture or other unsatisfactory conditions prevail, the work would be stopped. Erosion control materials will not be applied in adverse weather conditions which could affect their performance. Erosion control will be accomplished by using one of the following:

- Erosion control blankets
- Geotextile fabric
- Seeding

Before placing erosion control blankets the subgrade will be graded smooth with no depressions or void areas and would be free from obstructions, such as tree roots, projecting stones or other foreign matter. No vehicles will be permitted directly on the blankets. Before geotextile fabric is placed, the subgrade shall be compacted and graded level with no depressions, voids, soft or uncompacted areas and shall be free from obstructions, such as tree roots, projecting stones or other foreign matter. Seeding shall then be applied to the areas.

8.5.3 Overburden Management

To minimize excessive land consumption and the associated clearing of forested areas, spoil piles will be located in mined out areas in the open pit. Initially spoils will be disposed in above ground areas determined to be free of economic grade ore. However, as mining progresses, spoils will be disposed in mined out areas as part of the progressive reclamation. Spoil piles will be periodically watered to minimize dust emission. In addition, all spoil piles will be surrounded by a soil containment berm to preclude the easy flow of surface runoff and sediment. The containment berm will be constructed of soil pervious enough to enable the passage of surface runoff water while trapping sediment contained in that runoff. The height and slopes of each spoil pile will be such that foundation and slope failures do not occur. Spoil piles will be seeded and revegetated after closure.

8.5.4 Land Reclamation

Land reclamation will reduce negative perceptions and impacts associated with open pit mining. All open-pit and spoil pile areas will be regraded to fit into the surrounding topography. Erosion controls would be applied around regraded areas to minimize soil loss prior to vegetation taking hold. Minimum compactive effort will be exercised during regrading to ensure that the soil compaction does not prevent stormwater infiltration. This will ensure the soil would be able to fulfill its diverse functions as a water reservoir, a biotope for plants and animals, and a basis of agricultural production. Regraded areas will be covered by humus to enhance conditions for revegetation. All streams that were temporarily diverted during the mining operations will be restored to their channels and cross-sections and berms will be provided adjacent to the reclaimed channels to preclude the easy flow of sediment into the restored waterways.

8.5.5 Mine Waste Geochemical Characterization

The Mining operations will prepare and implement ore and waste geochemical characterization methods for proper routing of Potentially Acid Generating (PAG) materials and Acid Reduction Detection (ARD) management programs that include the following elements:

- Conducting a comprehensive series of accelerated leaching tests from feasibility study stage onwards, to evaluate the potential for ARD in all formations to be disturbed or otherwise exposed by the mine according to internationally recognized methodologies
- Conducting comprehensive ARD/metals leaching (ML) testing/mapping on an ongoing basis with decreasing block size as formations are transferred from long to medium and short term mining plans
- Implementation of ARD and ML preventive actions to minimize ARD including:
    - Limiting exposure of PAG materials by phasing of development and construction, together with covering, and/or segregating runoff for treatment and
    - Implementation of water management techniques such as diverting clean runoff away from PAG materials, and segregating "dirty" runoff from PAG materials for subsequent treatment; grading PAG material piles to avoid ponding and infiltration; and removing pit water promptly to minimize acid generation.

- Controlled placement of PAG materials (including wastes) to provide permanent conditions that avoid contact with oxygen or water including:

    - Submerging and/or flooding of PAG materials by placing PAG materials in an anoxic (oxygen free) environment, typically below a water cover
    - Isolating PAG materials above the water table with an impermeable cover to limit infiltration and exposure to air and
    - Blending of PAG materials with non-PAG or alkaline materials to neutralize acid generation, as appropriate. Blending would be based on full characterization of each of the blended materials, the ratio of alkaline materials to acid generating materials, the case histories of failed operations, and the need for static and long- term kinetic tests.

8.5.6 Explosives Management

Explosives will be stored in a magazine manuafactured to conform to U.S. Government specifications. The Explosive magazine would be designed to be bullet, fire, weather and theft resistant. It would be manufactured from high quality heavy gauge steel with plywood or hardwood lined interiors and would be properly ventilated.

Placards will be posted on or near each magazine door, specifying explosive and personnel limits and general safety precautions that would be observed during work in the magazine. Vegetation around the magazine would be controlled to minimize potential damage. At least two fire extinguishers would be provided and maintained for immediate use by personnel working around the magazine. The purpose of these fire extinguishers would be to fight small external fires or magazine fires that do not involve explosives.

Explosives would be stored on shelves in the magazine. Explosives and explosives containers in storage would be positioned safely and securely. If explosives containers are stacked, they will be placed in stable arrays. Load limits will be established for shelves in the magazine. Materials will not be left suspended by booms, cranes, or hoists in the magazine.

Stored explosives will be segregated by lot designation. Stacks of explosives would be arranged so that air freely circulates to all parts of the stack. To prevent moisture accumulation, pallets would be used to ensure that containers are not stacked directly on the magazine floor. Aisles shall be wide enough to accommodate inspection, inventory, sampling, and materials handling operations in the magazine. Unobstructed aisles will be maintained to permit rapid exit of personnel.

The magazine will be locked always except when permissible operations are in progress or when opened for ventilation. Personnel will be present whenever the magazine is open for ventilation. All exit doors will be unlocked and open when personnel are working in the magazine.

The explosive magazine will be inventoried annually to determine the total weight of explosives present and to remove and destroy materials that are not properly identified or labeled.

Empty containers, tools, conveyors, lift trucks, skids, etc. would not be stored in the magazine. Combustible materials such as packing materials and boxes will not be stored in the magazine. Flammable liquids will not be stored or used in the magazine unless the liquid is an explosive or is needed as an explosives-wetting agent, or is an integral part of an explosives device.

Operations in and around the magazine will be prohibited when an electrical storm is in progress and minimized when it is evident that such a storm is approaching. Explosives handling operations will not be performed when magazine entranceways do not provide adequate footing. No operation involving hazardous materials will be permitted in the magazine. Only one container of explosives will be opened at one time in a magazine.

8.6 Monitoring Plan

The removal, storage, and reutilization of topsoil and organic matter would be registered and documented. The removal, storage, treatment, and final disposition of contaminated soils would also be registered and documented.

8.6.1 Mine Waste Stockpiles Monitoring

The waste rock stockpiles would be monitored on a weekly basis to determine the integrity of the containment berm around the perimeter of the stockpiles. The monitoring events would include an evaluation of the height and slopes of the stockpiles to ensure that they do not exceed the tolerable limits. Potential changes in geotechnical properties due to chemical or biologically catalyzed weathering would be considered and monitored as these can reduce the geotechnical stability of the stockpiles.

8.6.2 Hazardous Material Monitoring

Inventories of hazardous material would be monitored to ensure all material is used for the purposes intended. Waste containment areas would be monitored to ensure that the impervious surface upon which they are sited is not breached. The area would be monitored to determine that incompatible chemicals are not stored together and that stormwater discharges from the area are channeled to the water management pond. Hazardous material inventory data would be reported to the GGMC and made available to interested stakeholders.

8.6.3 Solid Waste Monitoring

The solid waste disposal operation would be monitored to determine the effectiveness of the recycling, composting and disposal operations. Manifests would be developed to ensure proper disposal of septic tank waste.

8.7 Progressive Monitoring of Land Reclamation

As part of the reclamation program, a record would be maintained of all spontaneous and natural regrowth after clearing and the conditions contributing that that regrowth. The record would note plant species, soil type, weather conditions during the period, drainage conditions etc. The records would be used to examine parameters considered necessary for the successful establishment of plant cover after reclamation.

Land reclamation areas would be monitored to ensure that compaction of the ground surface does not preclude the infiltration of precipitation. The humus from the composting operation would also be monitored to ensure its use in the land reclamation. The growth of any trees planted for revegetation would be monitored. Substitute plant types would be identified if the growth rates are unacceptable.

9.0 AIR QUALITY

Development has the potential to alter air pollutants concentrations from the baseline situation and may affect people, plants, animals, materials and buildings. Development also has the potential to create a local dust nuisance due to earth-moving and materials-handling operations during periods of dry weather if appropriate mitigation measures are not managed successfully. Combustion engines may give rise to both routine and non-routine pollutant emissions. Non-routine emissions may include accidental releases.

9.1 Policy, Legislative and Regulatory Framework

9.1.1 Environmental Protection Air Quality Regulations 2000

Environmental Protection (air quality) regulations were developed in 2000 under the Environmental Protection Act 1996. In accordance with these regulations anyone who emits any air contaminant in the construction, installation, operation, modification or extension of any facility related to industry, commerce, agriculture or any institution shall apply to the EPA for an environmental authorization and shall apply to the EPA at least one hundred and eighty days before the date on which the emission is to commence. In accordance with the regulations the EPA shall establish parameter limits with respect to emission of smoke, solid particles, sulfuric acid mist or sulfuric trioxide, fluoride compounds, hydrogen chloride, chlorine, hydrogen sulfide, nitric acid or oxides of nitrogen and carbon monoxide. No parameters limits have been mandated to date.

9.1.2 WHO Guidelines

The WHO guideline values are based on the lowest concentration a pollutant has been shown to produce adverse health effects or the level at which no observed health effect has been demonstrated, plus a margin of protection to safeguard sensitive groups within the population. Sensitive groups include people with asthma, those with pre-existing heart and lung diseases, the elderly, infants, and pregnant women and their unborn babies. Some pollutants, notably carcinogenic pollutants (e.g. arsenic, benzene, chromium, polycyclic aromatic hydrocarbons (PAHs) and vinyl chloride) have not been given a guideline value. Instead, exposure-effect information is provided, giving guidance to risk managers about the major health impact for short- and long-term exposure to various levels of this pollutant.

The WHO guideline values are based on health considerations alone, and do not consider the technical feasibility or the economic, political and social dimensions of attainment. In the absence of parameters limits, this project proposes to adhere to WHO Ambient Air Quality (2007) and World Bank Guidelines. The WHO ambient air quality guidelines are detailed in Table 29.

Table 29: WHO Air Quality Guidelines (Note: UR = excess risk of dying from cancer following lifetime exposure.)

Pollutant	Averaging time	Guideline Value
Nitrogen dioxide	1 h	200 µg/m³
	Annual	40 µg/m³
Sulphur dioxide	10 min	500 µg/m³
	1 h	–
	3 h	–
	24 h	20 µg/m³
PM2.5	24 h	25 µg/m³
	Annual	10 µg/m³
PM10	24 h	50 µg/m³
	Annual	20 µg/m³
Carbon monoxide	15 min	100 mg/m³
	30 min	60 mg/m³
	1 h	30 mg/m³
	8 h	10 mg/m³
Ozone	8 h	100 µg/m³
Benzene	Annual	–
	UR/lifetimen	6×10^{-6} (µg/m³)
Dichloromethane	24 h	3 mg/m³
Formaldehyde	30 min	0.1 mg/m³
PAHso	UR/lifetimen	8.7×10^{-5} (µg/m³)
	Annual	–
Styrene	1 week	0.26 mg/m³
Tetrachloroethylene	Annual	0.25 mg/m³
Toluene	1 week	0.26 mg/m³
Trichloethylene	UR/lifetimen	4.3×10^{-7} (µg/m³)
Arsenic	UR/lifetimen	1.5×10^{-3} (µg/m³)
	Annual	–
Cadmium	Annual	5 µg/m³
Chromium	UR/lifetimen	0.04 µg/m³
Lead	Rolling 3 months	–
	Annual	0.5 µg/m³
Manganese	Annual	0.15 µg/m³
Mercury	Annual	1.0 µg/m³
Nickel	UR/lifetimen	3.8×10^{-4} (µg/m³)
	Annual	–

9.1.3 World Bank Air Quality Guidelines

The World Bank guidelines limit concentrations of contaminants in ambient air, measured at the project property boundary to the following limits:

Particulate matter (<10 mm)	
Annual Arithmetic Mean	100 mg/m³
Maximum 24-hour Average	500 mg/m³
Nitrogen Oxides as NO_2	
Annual Arithmetic Mean	100 mg/m³
Maximum 24-hour Average	200 mg/m³
Sulphur Dioxide	

Annual Arithmetic Mean	100 mg/m^3
Maximum 24-hour Average	500 mg/m^3

9.1.3.1 Workplace Air Quality

Arsenic	0.05 mg/m^3
Carbon Monoxide	29 mg/m^3
Copper	1 mg/m^3
Free Silica	5 mg/m^3
Hydrogen Cyanide	11 mg/m^3
Hydrogen Sulphide	14 mg/m^3
Lead, Dust and Fumes, as Pb	0.15 mg/m^3
Nitrogen Dioxide	6 mg/m^3
Particulate (Inert of nuisance dusts)	10 mg/m^3
Sulphur Dioxide	5 mg/m^3

If warranted, emission modeling will be conducted to determine whether the most stringent of these air quality standards will be exceeded. If these standards are exceeded mitigation measures will be identified to minimize impacts associated therewith.

9.1.4 Air quality Guidelines for Vegetation and Ecosystems

The effect of air pollution on vegetation and ecosystems is a relatively complex and evolving area. Critical loads for deposition onto sensitive ecosystems have been specified by the United Nations Economic Commission for Europe (UNECE). Exceedance of a critical load is used as an indication of the potential for harmful effects to occur. The UK Air Pollution Information System (APIS) provides guidance loads and levels. Examples of critical levels and the source of the limit value are shown in Table 30.

Substances released to air are not assessed for deposition to ground unless they contribute to acidification and eutrophication or they are highly toxic, bio-accumulative or persistent. There are no well-defined critical loads for heavy metals.

Table 30: Critical levels for key pollutants (APIS 2016)

Pollutant	*Receptor*	*Time period*	*Critical level*
NO_x	All	Annual mean	30 µg/m^3
NO_x	All	24-hour mean	75 µg/m^3
SO_2	Crops	Annual mean	30 µg/m^3
SO_2	Forests and natural vegetation	Annual mean	20 µg/m^3
O_3	Crops	AOT40, May to July	3,000 ppb hours
O_3	Semi-natural vegetation dominated by annuals	AOT40, May to July	3,000 ppb hours
Ammonia	Other vegetation	Annual mean	3 µg/m^3 (with an uncertainty range of 2–4 µg/m^3)

9.2 Baseline

During the well installation program, the level of PM_{10}, and $PM_{2.5}$ were recorded, in ambient air, at several locations within the concession. The locations and levels of PM_{10}, and $PM_{2.5}$ recorded at detailed in Table 31.

Table 31: Levels of PM10 and PM2.5 within Concession

Location		Concentration (µg/m3)	
Eastings	Northings	$PM_{2.5}$	PM_{10}
258453	246683	4.2	6.4
258455	246736	4.7	6.5
258482	246683	4.2	7
258963	247811	6.3	13.9
258984	247873	6.5	10.9
258995	247828	5.8	15.7
258389	246941	4.5	5
258395	246956	4.4	5.3
258401	246970	3.9	6.2
257881	244707	5.3	9.3
257904	244687	5.4	9
257925	244670	5.3	7.9
258041	245919	8.1	13.6
258075	245959	7.9	9.9
258109	245967	7.6	9.6
260409	246560	4.2	8.1
260363	246559	4.5	5.1
260515	246540	4.1	6

There are no major industries in the area. Aerial emissions in the Project area are directly related to the emission of gases by rotting trees and other vegetative matter. Airborne discharges and particulate matter are not monitored in the area. However, typical guidelines for sulphur emissions specify two levels of allowable emissions. If the region is unpolluted the maximum allowable emissions should not exceed 500 tonnes per day (tpd). If the region is polluted the maximum allowable emissions should not exceed 100 tpd. This criterion is not expected to be exceeded by current aerial emissions.

9.3 Impact Prediction and Evaluation

9.3.1 Construction and Operation Phases

Construction works will result in emissions of fugitive dust and products of combustion. Dust generated would be a function of construction activities, soil type, moisture content, wind speed, frequency of precipitation, vehicle traffic and vehicle type. Dust is broadly defined as small solid particles created by the break-up of larger particles. Depending on their size, dust particles can become hazardous to worker health, particularly when suspended in air. The largest size particle that can be suspended in air for long periods of time from wind velocity acting upon it is about 60 micrometers (µm), which is about the thickness of a human hair. Particles ranging from about 60 to 2,000 µm can also become suspended in air, but they only reach heights up to approximately three feet above the ground before they fall back to the surface. Particles larger than about 2,000 µm generally creep or roll along the surface due to wind velocity acting upon them. These larger particles of dust can affect the nasal passages, causing an irritated and congested nose, and might also cause an irritant cough should they deposit in the throat. Smaller airborne particles of dust, which can remain suspended in air for hours, pose a risk to the respiratory system when inhaled. In general, the smaller the aerodynamic diameter of the inhaled dust particle, the more likely it will be deposited more deeply in the respiratory tract.

Fugitive emissions would be greater during dry periods. Dust emissions from roads would occur for the duration of both the construction and operation phases. The site is approximately 25 km from the nearest settlement. The

impacts to air quality would therefore be low (medium term, low severity, local extent). These impacts will be mitigated by employing the following measures:

- Minimizing drop heights from excavation equipment
- Limiting vehicle speed to a maximum 30 km/hr.
- Employing dust suppression techniques such as applying water or non-toxic chemicals
- Maintaining construction equipment according to manufacturer's specifications
- Providing facemasks with dust removal filters
- Conducting periodic medical checks of employees for effects of dust exposure
- Providing goggles and eye wash lotion for dust-induced eye irritation.

Implementation of the mitigation measures will result in low impacts (short-term, low severity, local extent).

Combustion emissions would result from chainsaw operations and the use of diesel and/or gasoline fired heavy duty equipment. Products of combustion will include: Benzene, $PM_{10,}$ $PM_{2.5}$, carbon monoxide, NO_x, SO_2, VOCs – a precursor of ozone and hydrocarbons. Ozone, sulfur dioxide, fine particulates, and nitrogen dioxide have both acute and chronic health effects. Carbon monoxide has acute effects only, whereas lead, being a toxic metal, has chronic effects (at ambient air levels). Ozone is a strong oxidizer that affects the respiratory system and may lead to damage of lung tissues. It acute effects include cough and chest pain, eye irritation, headaches, lung function losses, and asthma attacks. The acute effects of sulfur dioxide include irritation and restriction of air passages. There is reduced mucus clearance from the restricted air passages and chest tightness. Under normal conditions, the lung passages are open, however, the lung passages constrict in a response to SO_2. This constriction further aggravates other health conditions. Sulfur dioxide also causes immune system suppression and increases the probability of bronchitis. There are some indications that chronic exposure to sulfur dioxide may also act as a cancer promoter in addition to an immune system suppressor.

Exposure to elevated concentrations of fine particulates increases mortality rate, increases incidence of asthma and bronchitis, and rates of infection in the respiratory system. Particulates also directly irritate the respiratory tract, constrict airways, and interfere with the mucus lining of the lung passages. The chronic effects of fine particulates include loss of lung capacity and lung damage, resulting from scarring caused when fine particulates are not cleared from the lung passages or alveoli. Fine particulates also act as carriers for toxic contaminants and heavy metals particularly when the contaminants exist in a fume or a vapor state and condense onto the fine particulates. In the alveolar regions, heavy metals may be absorbed into the blood and circulated to other parts of the body. Particulates, and fine particulate fractions, are also responsible for visibility reduction.

The acute effects of nitrogen dioxide are both direct and indirect. The direct effects are damages to the cell membranes in the lung tissues as well as constriction of the airway passages. Asthmatics are affected by these acute effects. The indirect effects are that nitrogen dioxide causes edema, or a filling of the intercellular spaces with fluid, which may develop into local areas of infection.

Carbon monoxide affects health through binding with hemoglobin in the blood. Hemoglobin is the oxygen-carrying protein that is responsible for the oxygen and CO_2 exchanges necessary for life. When CO binds to hemoglobin, the blood loses its ability to transmit vital oxygen to all tissues of the body. At high levels of carbon monoxide, the potential exists for asphyxiation. In addition, Carbon Monoxide causes impairment of performance, slow reflexes, fatigue, and headaches due to the lack of oxygen in the brain. Carbon Monoxide also results in aggravated heart and lung disease symptoms as well as impairments in the central nervous system and brain functions.

Aromatic compounds such as benzene, directly affect the central nervous system by asphyxiation resulting from the loss of oxygen to the brain.

The impacts to air quality of combustion emissions were assessed using the USEPA Screen 3 Model. This model estimates the air quality impact of stationary sources. This model was used since no database exists to conduct an alternative analysis of air quality impacts. A list identifying equipment, number of pieces, manufactuers and capacity which will generate emissions during both construction and operation is presented in Table 32.

Table 32: Summary of Emission Generating Construction Equipment

Type	No	Make	Horsepower
Track loader	1	Caterpillar	69
Wheel loader	1	Caterpillar	210
Motor Grader	1	Caterpillar	145
Excavator	1	Doosan	149
Track Dozer	1	Caterpillar	238
Excavator	4	Caterpillar	200
Excavator	1	Caterpillar	160
Excavator	2	Caterpillar	417
Excavator	1	Doosan	149
Track Dozer	1	Caterpillar	330
Track Dozer	2	Caterpillar	359
Articulated Truck	3	Caterpillar	452
Wheel loader	1	Caterpillar	386
Track loader	1	Caterpillar	275
Hydraulic Shovel	1	Caterpillar	1043
Rotary Drill	1	Caterpillar	542
Diamond Drill	2	Hydrocore	137
Diamond Drill	1	Longyear	150
Stoper Drill	2	Crowder	60
Telehandler	1	Caterpillar	142
Crane	1	Terex	462
Dumping Truck	1	Bedford	98
Dumping Truck	3	Bedford	206
Light Towers	16	Generac	13
Pumps	2	Izuzu	86
Pumps	2	Izuzu	68
Pumps	4	Pioneer	100
Pumps	4	Pioneer	150
Pumps	2	Pioneer	300
Compressor	2	Atlas Copco	115

Source emissions to air were estimated using the USEPA AP-42 emission factors. It was assumed that at the peak of activity all equipment listed above would be operational. To generate conservative estimates of emissions, each piece of equipment was assumed to burn diesel fuel in two shifts of 10 hours each. The USEPA AP-42 Emission Factors for diesel industrial engines were then used to estimate emissions from construction equipment. The total daily emissions and unit emissions are detailed in Table 33.

Table 33: Emissions from Equipment – Construction and Operational Phases

Pollutant	Total Daily Emissions (kg)	Emission Rate (g/s-m2)
NO_x	15860.52863	0.088114048
CO	3417.688106	0.018987156
SO_x	1048.84141	0.005826897
PM_{10}	1125.585903	0.006253255
CO_2	588374.4493	3.268746941

Aldehydes	236.8846696	0.001316026
Benzene	1.212948253	6.7386E-06
Toluene	0.531721153	2.95401E-06
Xylenes	0.37051474	2.05842E-06
Propylene	3.354133433	1.86341E-05
1,3 Butadiene	0.050832022	2.824E-07
Formaldhyde	1.534061027	8.52256E-06
Acetaldehyde	0.997139668	5.53966E-06
Acrolein	0.120254784	6.68082E-07
Total Polycyclic Aromatic Hydrocarbons	4.26888E-07	0.218408689

The analyses assumed that the emissions were from an area source approximately 50 m wide and 50 m long, with a height of 0.5 m to correspond to the exhaust height of most of the equipment. The variation in concentrations was computed using NO_x as the trace constituent. The concentration of NO_x was determined for distances ranging from 5 m to 2500 m from the emission source. The analyses indicated very minor impacts on air quality ranging from a change in NO_x concentration of approximately 373000 ug/m^3 at a distance of 5.0 m, to 36070 ug/m^3 at 2500 m. The distribution of the concentrations of NO_x over distance is shown in Figure 18.

These emissions would be short-term and would be near construction and mining operations only. The impacts to air quality would therefore be moderate (short-term, moderate severity, local extent). These impacts will be mitigated by maintaining construction equipment according to manufacturer's specifications. Emissions from Internal Combustion Engines (ICE) will be minimized by managing both the operating conditions and selecting appropriately designed ICEs. ICEs to be used for this project will have air-to-fuel ratios which will reduce CO and hydrocarbon emissions. ICEs used for this project will have ratios generally less than or equal to 1.0. Spark timing of ICEs will also be changed to reduce engine temperatures and the associated NOx emissions. This may also result in marginal reduction of hydrocarbon emissions. ICEs selected for this project will also have low compression ratios which will result in significant reduction in both oxides of nitrogen and hydrocarbons emissions. Implementation of the mitigation measures will result in low impacts (short-term, low severity, local extent).

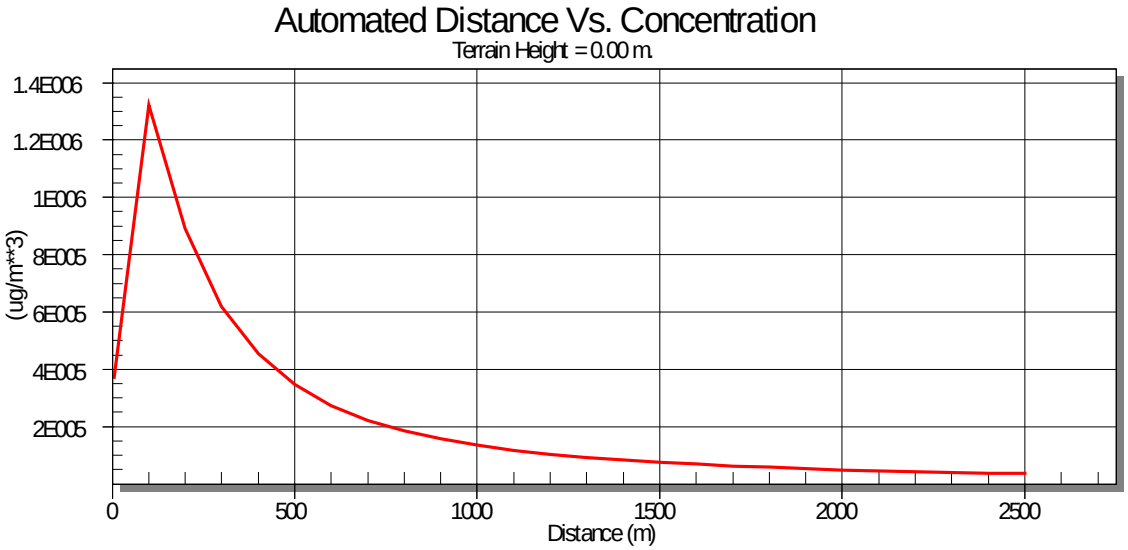


Figure 18 - Distribution of NOx concentration with Distance

The operation phase of the project will see the generation of dust and combustion emissions from:

- Stripping of topsoil and overburden
- Drilling and explosive Blasting
- Loading and unloading of haul trucks.
- Transport/haulage of extracted ore from the mine pit to the processing facility

- Crushing, screening, milling, classifying ore materials
- Vehicles traversing site roads
- Wind erosion of stockpiles and spoil piles
- Operation of heavy duty equipment

Stripping topsoil and overburden will generate dust when undertaken in the dry season. Dust emissions from blasting, loading and unloading of haul trucks, haul roads, milling equipment, material stock piles and other fugitive dust generating operations would occur over the duration of the operation. This will result in moderate impacts (medium term, moderate severity, local extent). Dust and other emissions from haul roads and other sources will be mitigated by employing the following measures:

- Minimizing drop heights from vehicles
- Limiting vehicle speed
- Employing dust suppression technique such as applying water or non-toxic chemicals
- Maintaining construction equipment according to manufacturer's specifications

Implementation of these mitigation measures will result in low impacts (short-term, low severity, local extent).

Dust would be emitted from the access road surface and from unsurfaced areas within the facility during operation. Equipment traversing the road will emit products of combustion. Equipment passage over the access road will be intermittent. The impacts to air quality would therefore be moderate (short-term, moderate severity, local extent). These impacts will be mitigated by employing the following measures:

- Limiting vehicle speed
- Employing dust suppression techniques
- Maintaining equipment in accordance with manufacturer's specifications

Implementation of the mitigation measures will result in low impacts (short-term, low severity, local extent).

Overburden drilling will generate respirable dust that can affect workers at the mine site. Overburden removal by mobile excavation equipment such as bulldozers, front-end loaders, and haulage trucks will be dusty, particularly under dry and windy conditions. These are moderate impacts (medium term, moderate severity, local extent). These impacts will be mitigated by having equipment outfitted with tightly enclosed cabs with dust filtration systems to lower the dust exposure of both drill and mobile equipment operators. The mitigation measures will result in low residual impacts (short-term, low severity, local extent).

Operation of the mine site and its ancillary facilities will generate solid wastes, including soil, paper, metal, trash, scrap, rubble, domestic wastes, and hazardous wastes. If not properly managed, these wastes would generate odors. This impact is rated as moderate (long-term, moderate severity, local extent). The Project will minimize and mitigate these potential impacts by developing and implementing waste management plans for each type of solid waste anticipated to be generated by the operation phase of the Project. Reuse and recycling would be preferred over disposal to the extent practicable. Under proper management, the residual impact associated with odor generation would be low (short-term, low severity, local extent).

9.3.1.1 Power Generation

Operation of the mine site will require a substantial supply of electrical energy and would be provided by an installed capacity of approximately 2.5 MW. That power would be provided by several diesel-powered generators. A summary of the generation capacity proposed for the mine site is detailed in Table 34.

Table 34: Generators Proposed to be Deployed to Mine Site

Type	Quantity	Manufacturer	Model	Engine size
Generator	2	ECI Guyana	QOP45	45 KvA
Generator	2	ECI Guyana	QOP24	24 KvA
Generator	1	Isuzu	28	28 KvA
Generator	1	ECI Guyana	QP16	16 KvA
Generator	3	ECI Guyana	QOP200	200 KvA
Generator	2	ECI Guyana	QOP75	75 KvA
Generator	3	ECI Guyana	QOP513	513 KvA

The generators will be fueled by heavy fuel oil, and the heat from the exhaust of the generators will be used to preheat the fuel oil to increase combustion efficiencies. Based on these parameters, an air quality screening model was utilized to examine the impacts of the proposed power generating facility. The model assumed that the exhaust would be combined into a single, 30-meter high stack and that the effect of pre-heating the fuel would reduce the exhaust temperature from 767 Kelvin (K) to 460 K. The generation configuration was assumed equivalent to three of the QP513 Generators. Stack characteristics for the single stack, for three engines, are shown in Table 35.

Table 35: Estimated Stack Parameters for Generators

Description	Height (m)	Inner Diameter (m)	Exhaust Velocity (m/s)	Exhaust Flow (m^3/s)	Exhaust Temperature (K)	Heat Input (MMBTU/hr)
3 Units	30.00	1.5	0.82	1.45	460.0	1.77

The assessment was conducted assuming that the power generation units would comply with the air quality sections of the IFC Environmental, Health, and Safety General Guidelines. In accordance with the general guidelines, it was assumed that the stack would be constructed in accordance with Good International Industry Practice (GIIP) guidelines and would therefore not be subject to aerodynamic downwash from nearby buildings and structures. Emission rates were calculated based on the general guideline recommendations of the IFC Environmental, Health, and Safety General Guidelines.

Emissions calculated for SO_2, NO_x, and PM for the 3 units and the low and high range of the modeled emission rates for the generators are shown in Table 36.

Table 36: Modeled Emission Rates for Generators

Description	Exhaust Flow (m^3/s)	Units	PM Low	PM High	NOx Low	NOx High	SO_2 Low	SO_2 High
3 Units	1.45	ugm^3/s	0.1035	5.289	281.4	973.2	365.8	1265

Receptors were placed out to 50 km from the mine site, and maximum concentrations were identified for comparison to IFC standards. The IFC general guidelines defer to "...national legislated standards, or in their absence, the current WHO Air Quality Guidelines or other internationally recognized sources". For this assessment, modeled impacts were compared to the WHO Air Quality Guidelines; additionally, all particulate emissions were assumed to be $PM_{2.5}$. Due to the remote nature of this facility, no background concentrations were added to the modeled impacts. Additional emissions will come from non-stationary sources such as vehicles, machinery, and portable pumps and generators.

Table 37 presents the results of the modeling and demonstrates that the maximum impacts of the power generating units (3 units, both low and high emission rates) meet all of the WHO guideline values.

Table 37: Model Results-- Emission Rates for Generators

SO_2

Avg. Period	Description	Model Prediction (ug/m³)	WHO Guidelines (mg/m³)
24-hr	Low	365.8	350
	High	1265	

NO_2

Avg. Period	Description	Model Prediction (ug/m³)	WHO Guidelines (mg/m³)
24-hr	Low	281.4	200
	High	973.2	

PM

Avg. Period	Description	Model Prediction (ug/m³)	WHO Guidelines (mg/m³)
24-hr	Low	54.5	50
	High	25.8	

9.3.1.2 Blasting

Blasting may generate fumes from incomplete combustion of the chemical explosives and dust clouds from the fracturing of blasted materials. Blasts will be designed to prevent peak particles velocity from exceeding 2 mm/s for more than 5% of the total number of blasts or 10 mm/s at any time and the mine would be designed in a series of benches to limit the size of the overburden blasts to an acceptable level. Blasting will only be undertaken after an assessment of meteorological conditions prior to blasting. If weather inversion conditions are detected; and/or wind speeds are greater than 10 m/s no blasting will be undertaken. Flyrock may also be generated by blasting operations. Blasting procedures will be designed to keep flyrock to a minimum and contained within the mine pit. If flyrock extends beyond the pit a thorough assessment will be carried out to try to determine the cause. Implementation of the mitigation measures will result in low impacts (short-term, low severity, local extent).

9.3.2 Closure

Impacts to air will result from dust and combustion emissions generated by equipment during site restoration. Dust generated would be a function of closure operations, soil type, moisture content, wind speed and frequency of precipitation. Fugitive emissions would be greater during dry periods. The site is approximately 25 km from the nearest settlement. The impacts to air quality would therefore be moderate (medium-term, moderate severity, local extent). These impacts will be mitigated by employing the following measures:

- Minimizing drop heights from excavation equipment
- Employing dust suppression technique such as applying water or non-toxic chemicals
- Maintaining construction equipment according to manufacturer's specifications
- Providing facemasks with dust removal filters
- Providing goggles and eye wash lotion for dust-induced eye irritation.

Implementation of the mitigation measures will result in low impacts (short term, low severity, local extent).

Table 38: Summary of Air Quality Impacts

Air Quality					
Construction	Increased emissions of fugitive dust and products of combustion	*Source* Land clearing loading and unloading of trucks excavation and grading Construction of roads, tailings and water management ponds and stockpiles Emissions from chainsaws Use of diesel and/or gasoline fired heavy duty equipment *Vulnerability* Vegetation in proximity to work Workmen at the site	Low (medium term, low severity, local extent)	Cover trucks to minimize particulate emission Minimize drop heights from vehicles Scheduling land clearing activities to less windy days Limiting vehicle speed to a maximum 30 km/hr Employing dust suppression technique Avoiding open burning of wastes Maintaining construction equipment according to manufacturer's specifications.	Low (short-term, low severity, local extent)
	Loss of sequestration capacity	*Source* Clearing of vegetation *Vulnerability* Loss of carbon sequestration capacity of vegetation in affected areas	High (long-term medium Severity, Regional extent)	Phased clearing of the areas to be cleared Long term restoration of the forest cover through mine restoration and re-vegetation.	Low (Long-term, low severity, local extent)
Operation	Increases in dust and combustion emissions	*Source* Drilling and Explosive Blasting Vehicles traversing site roads Wind erosion of stockpiles and spoil piles The operation of heavy duty equipment *Vulnerability* Vegetation in proximity to work Workmen at the site	Low (Long-term, Low Severity, Local Extent)	Implement Blast Management Plan and dust management procedures. Cover trucks to minimize particulate emission Minimize drop heights from vehicles Limiting vehicle speed to a maximum 30 km/hr Employing dust suppression technique Maintaining construction equipment according to manufacturer's specifications Providing facemasks with dust removal filters Conducting periodic medical checks of employees Providing goggles and eye wash lotion	Low (Short-term, low severity, local extent).

9.4 Environmental Management Plan

Fugitive dust emissions from dry surfaces of construction sites, roadways, work areas, tailings facilities, waste dumps, stockpiles and other exposed areas will be minimized by the following:

- Dust suppression techniques (e.g. wetting down, use of all-weather surfaces, use of agglomeration additives) for roads and work areas, optimization of traffic patterns, and reduction of travel speeds
- Revegatating or covering exposed soils and other erodible materials promptly
- Clearing and opening up new areas only when absolutely necessary
- Enclosing dusty materials storage areas by installing efficient dust suppression equipment in these areas
- Loading, transfer, and discharge of materials will take place with a minimum height of fall, and will be shielded against the wind, and
- Conveyor systems for dusty materials will be covered and equipped with measures for cleaning return belts
- Maintaining a vegetated buffer zone on the project boundary

Water would be used as the primary dust suppressant. Other suppressants may include surfactants, petroleum emulsions, polymers, and adhesives. Selection of the preferred agent for use will depend on conditions at the mine site. Performance of each dust control agent would be evaluated based on control efficiency which compares the dust concentration of a treated road surface to that of an untreated or uncontrolled road surface. Equipment to be used for the application of the dust suppressants will include a road grader equipped with scarifiers, a compactor, and a water truck for distribution of the suppressant to the road surface. Water will be periodically sprinkled on roads, other conveying routes, stock piles and spoil piles to control dust emissions.

Other emissions to air would include NOx, CO, VOCs, SO_2, PM_{10}, $PM_{2.5}$, and hazardous air pollutants (HAPs) from the operation of gasoline and diesel fired equipment. These emissions would be reduced to minimum levels by following the protocols of the manufacturer for equipment use and maintenance.

9.5 Monitoring Plan

Vehicles and non-stationary equipment would be visually monitored to identify any vehicles or equipment with visible particulate emissions that should be repaired or maintained.

Emissions from the generator house stack would be tested annually for NOx and PM, with fuel testing for SO_2, to ensure emissions guidelines are met. After three years, the testing frequency may be relaxed to every 2-3 years if the annual testing produces consistent results.

Roads and roadside vegetation would be monitored to ensure that excessive dust is not emitted by vehicle traffic, construction, and maintenance activities. Dust emissions from the stockpiles would be visually monitored and corrective action implemented, if required. Corrective actions may include wetting down or covering the stockpiles to reduce dust emissions.

RGEL would establish an automated meteorological station to measure rainfall, temperature (maximum and minimum), humidity, evaporation, wind speed and direction, and hours of sunshine.

10.0 CLIMATE AND CLIMATE CHANGE

Climate change is often referred to as the most serious environmental challenge facing humanity. It is also a political, social and economic challenge which requires action at global, national, local and individual scales. The first legally binding agreement to take urgent global action to address climate change was reached at the UN Climate Conference in Paris in December 2015, where 195 countries committed to (UN 2015 Art 2, 1a and 1b):

> *holding the increase in global temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change, and increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a way that does not limit food production.*

Environmental and Social Impact Assessments (ESIAs) play an important role in helping to meet the commitments made in Paris. It can help to ensure that new projects do not exacerbate climate change and that they adapt to be more resilient to the consequences.

10.1 Policy, Legislative and Regulatory Framework

10.1.1 Green State Development Strategy and Financing Mechanisms

Guyana is committed to developing a green economy to ensure the sustainable management of natural resources and balance economic growth with preservation of the country's environmental treasures for generations to come. Guyana's commitment to green growth has been demonstrated by its pioneering environmental international partnerships and its status as a signatory to the Paris Agreement on Climate Change. Numerous national documents reflect principles that support the green economy, including the country´s National Determined Contribution (NDC), the Low Carbon Development Strategy, Climate Resilience Strategy Action Plan (CRSAP), Guyana's renewable energy transition plan, Climate change resilience strategy and adaptation plan, National Strategy for Biodiversity Conservation and National Adaptation Strategy for the Agricultural Sector.

The Green State Development Strategy (GSDS) considers and puts emphasis on the balance between the three dimensions of sustainable development: economic, social and environmental to ensure comprehensive implementation of the 2030 Agenda and SDGs. The objectives are:

i)Social cohesion and inclusion: human rights, multi-ethnicity and gender equality, non-discrimination and protection of vulnerable and marginalized population groups
ii)Well-being, education and quality of life: moral fabric, improving quality of living for all Guyanese, promoting sustainable lifestyles and protection of the environment
iii)Sustainable use of biodiversity and increased resource efficiency: acknowledging the role that nature plays in Guyana's economic and social structure, and decoupling economic growth from environmental degradation
iv)Decarbonisation and climate resilience: aiming for a transition to a 100% renewable country by 2025.
v)Sustainable finance: redirecting and mobilising investments: economic output and production have to develop while reducing the impact on environment, such as redirecting investment to sustainable infrastructure and green economic sectors
vi)Good governance, decentralisation and participatory processes: ensuring transparency and sharing services and decision-making to the population; engaging civil society and creating a space for citizen participation

The GSDS proposes that focus be placed on conducting a long-term resource management plan for the non-renewable extractive sectors with the explicit goal of optimising generated wealth to support stable and balanced economic growth. This will include an assessment of the long-term price scenarios for major commodities; the extent of the extractable resource given economic, social and environmental constraints; and the role of a sovereign wealth fund in smoothing the fiscal impact of price fluctuations and facilitating the reinvestment of mineral wealth into Guyana's broader economic development.

It also proposes to identify and assess opportunities to improve the productivity of and reduce the waste produced by extractive activities; to minimise and rehabilitate their impacts on the natural environment whether through the clearing of natural environments for production, or the damage to surrounding natural environments through air, soil, water and other forms of contamination. These activities must be inclusive, through the participation of local communities both in economic gains and in decisions that affect their social and cultural heritage.

The GSDS proposes to place emphasis on increased use of green technologies with lower carbon intensity, whether this be from an increase in energy efficiency, fuel switching or other means. The GSDS will consider existing extractive technologies used globally as well as promising areas for research and development. It would also include a strategy to leverage human capital available throughout Guyana and in its Diaspora.

Further the GSDS proposes to promote a suite of regulations, economic instruments, support programmes, voluntary agreements, and others to facilitate long-term efficient resource use/extraction, and to improve the economic, social and environmental sustainability of that extraction. This will require identification of the infrastructure, skills and institutions to support this transformation. It will need to examine both large and small-scale operations.

10.1.2 Low Carbon Development Strategy (LCDS)

The second draft of the Guyana Low Carbon Development Strategy (LCDS), prepared by the Office of Climate Change in the office of the President details a framework for "Transforming Guyana's Economy While Combating Climate Change". The draft was prepared based on extensive stakeholder consultations over a four-month period in which over 10% of the Guyana population is claimed to have participated.

The LCDS indicates that Guyana "supports international proposals to cut greenhouse gas emissions from deforestation and forest degradation in half by 2020 and make the global forestry sector carbon neutral by 2030 – where emissions from deforestation and forest degradation are balanced by new forest growth." The LCDS recognizes the Guyana must "Reform existing forest-dependent sectors, including forestry and mining, where necessary, so that these sectors can operate at the standards necessary to sustainably protect Guyana's forest."

The LCDS has therefore identified the tasks of the GGMC as "regulating all activities in the mineral sector. It regulates the extraction of minerals from small, medium and large-scale mining operations, and provides advice to the Government on appropriate mineral policy matters so that Guyana's mineral resources can be rationally developed and utilized". The LCDS further recognizes that "Mining is one of the major contributors to Guyana's existing (low) deforestation and degradation rates. The Government has been working with the mining sector to identify ways to embark on wide-ranging reform of the mining regulations and their enforcement to ensure that mining operations promote higher standards of environmental sustainability alongside economic development. In doing so, possible payments from REDD+ will be factored into policy-making. Where necessary, compensation will be provided to those whose livelihoods have been impacted negatively because of REDD+ related activities." It was recently proposed by the GGMC, because of the LCDS, that the use of mercury in mining be curtailed entirely. A two-year period has been identified for enactment of the mercury ban.

Guyana and Norway, subsequent to publication of the initial LCDS document, signed a Memorandum of Understanding related to reduction in emissions thru deforestation and degradation. The agreement indicates that Norway would provide Guyana with result-based payments for forest climate services. Norway payments will total US $250 million over the period 2010 – 2015 and would be based on performance as related to reductions in deforestation and degradation. "The Governments of Norway and Guyana believe that this can provide the world with a working example of how REDD+ might operate for a High Forest Low Deforestation (HFLD) country."

10.1.3 UN Framework Convention on Climate Change (UNFCCC)

UNFCCC was entered into force in 1994 to achieve stabilization of greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system. Further, it required that acceptable

levels of greenhouse gas (GHG) be achieved within a time frame that is sufficient to allow ecosystems to adapt naturally to climate change.

Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the earth's surface, atmosphere and clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the earth's atmosphere. Fluorinated gases were also covered under the Kyoto Protocol.

In keeping with the provisions of the Convention, a national climate change committee was established, and a national inventory of Greenhouses Gases was prepared for base-year 1994. Aspects related to technology transfer, capacity building requirements, vulnerability assessment and adaptation measures were compiled.

10.2 Baseline

Guyana is located in the Equatorial Trough Zone (ETZ) and its weather and climate are influenced primarily by the seasonal shifts of the ETZ and its associated rain-bands called the Inter Tropical Convergence Zone (ITCZ). Secondary influences on the climate are of Pacific origin. Formation of El Niño and La Niña can disturb the regular location of the ITCZ which may result in higher or lower than normal rainfall at specific locations. The El Niño/La Niña is primarily responsible for inter-annual variation in rainfall.

Romanex has collected rainfall and temperature data over the period January 2000 to June 2003. Daily rainfall data was compiled from that record and total monthly rainfall and maximum and minimum rainfall recorded over the period were developed. Maximum and minimum temperatures were also noted for the period of record. The maximum, minimum and average temperatures over the period of record were 30, 19 and 25°C respectively. Estimates of rainfall with return periods of 10, 20, 50 and 100 years were computed from data. It should be noted that these values are not based on an extensive record but on Exceedance probabilities computed from the length of record available for the site. In fact, rainfall magnitudes greater than 10 cm in twenty-four hours were exceeded four times and a magnitude greater than 12.5 cm in twenty-four hours was exceeded over the period of record. Figures 19 thru 21 summarize recorded monthly rainfall and maximum and minimum daily rainfall recorded for each month of the period of record.

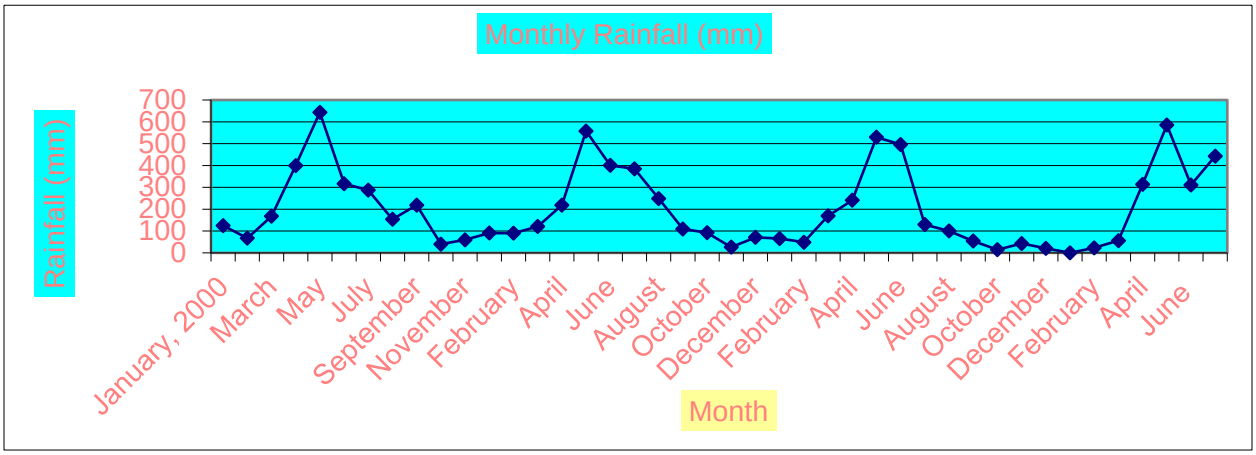


Figure 19 - Monthly Rainfall January 2000 – July 2003

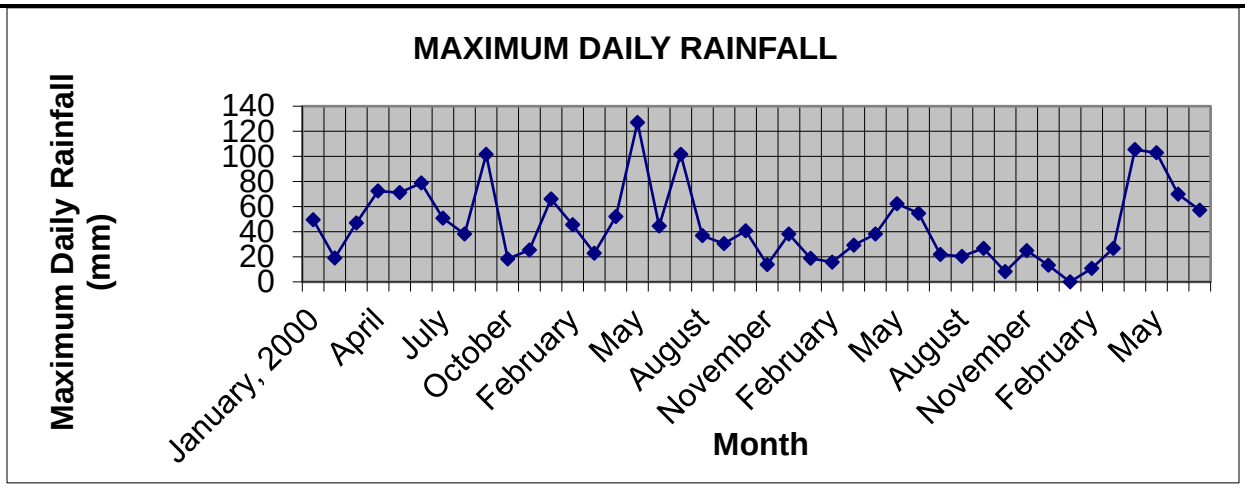


Figure 20 - Maximum Daily Rainfall/Month (January 2000 – July 2003)

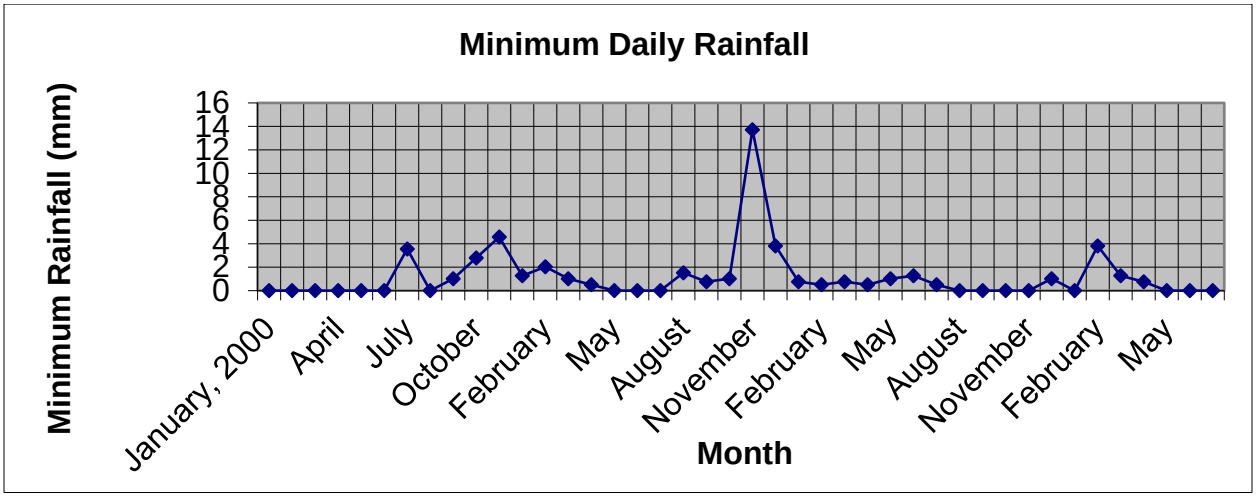
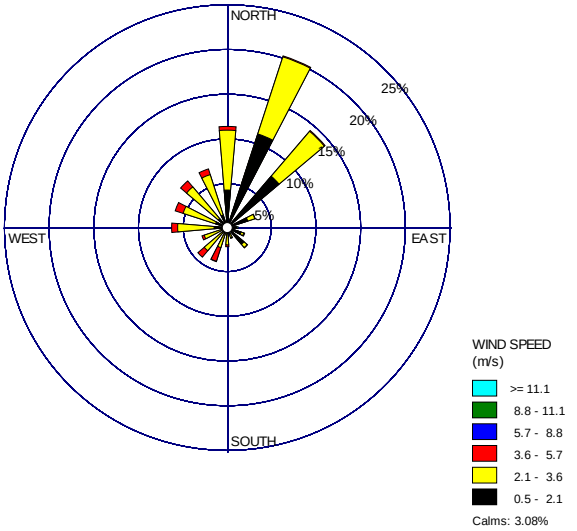


Figure 21 - Minimum Daily Rainfall/Month (January 2000 – July 2003)

An automated weather station was installed at the mining concession in August 2009 to develop baseline data. The weather station has provided an automated record of minimum and maximum temperatures, total rainfall, rainfall rate, maximum and average wind speeds and direction, barometric pressure, humidity, solar radiation and several other parameters at one-hour intervals since that time. A wind rose (Figure 22) generated from the weather station indicates the prevailing winds to be primarily from the East-North East. The additional data acquired by the weather station is inadequate to infer specific weather trends.

Figure 22 - Wind Rose for Project Area



The Government of Guyana through its Ministry of Agriculture prepared its Second National Communication to the UNFCCC. The SNC details trends in Greenhouse Gas emissions from base year 1990 up to 2004. The report concluded "For the period examined (1990-2004), there are no real apparent trends in GHG emissions" and goes on to state "CO2 emissions (Reference) range between 1,246 Gg (1992) and 1,813 Gg (1998), whereas GHG Removals (Forestry) vary between 65,318 Gg (1990) and 59,333 Gg (2004). However, when compared to the Initial National Communication (INC) of Guyana, GHG removals from the Land Use, Land-Use Change, and Forestry (LULUCF) sector was - 29,195 Gg for the year 1994. This change is due to the fact that for the sub-module on Changes in Forests and Other Woody Biomass Stocks, 15 % of the entire forest area (16.45 million hectares) of Guyana is now considered to be anthropogenically impacted, whereas for the INC only part of the forest area (2.273 million hectares: 13.8 %) was considered as being affected by human activities. The categorization of forest classes was also changed from moist dry, and moist, to essentially moist."

The report also examined non-carbon dioxide emissions and goes on to state "The non-CO_2 gases emissions are also remarkably stable from year to year. CH_4 emissions vary between 44 Gg (2002) and 56 Gg (2003). N_20 emissions remain stable at around 1 Gg for all years. CO however ranges from 205 Gg (1995) to 254 Gg (1990-1994). Finally, NMVOC emissions vary between 24 Gg (2000) and 30 Gg (1992-1994)".

The Guyana Forestry Commission (GFC, Nov 13, 2009) details total sequestered carbon as tree biomass in Guyana. The concession is characterized by mixed forest vegetation, stratified by topography. The mixed forest strata of the concession depicted in the GFC vegetation map includes Forest on Steep Hills in South of Guyana and Mixed Forest South of Guyana.

A floral survey was conducted of the concession to determine the biomass likely to be impacted by the project. Among data recorded by the survey were plot composition (plot number, species diameter at breast height (DBH)), plot attributes (including location and soil type), and taxa specific and tree attributes. Plots Timber volumes were computed for each transect area and then extrapolated over the plot to determine the volume of wood available within the concession. Timber volume were estimated using the following formula (Adopted from the GFC Metrification Manual for Timber Species, 1999):

$$Timeber\ Volume\ (m^3) = 0.7854 \times D^2 L \times 0.0001$$

Where
D = Diameter at Breast Height (DBH) (m)
L = Log Length (m)

Biomass estimates were developed based on the pan-tropical biomass equation of Chave et al (2005). The Chave et al (2005) biomass allometric model was validated as applicable for use in the Guyana context in Alder and van Kuijk (2009) baseline assessment of forest carbon in Guyana. Biomass estimates were calculated strictly for trees with diameter at breast height (DBH) greater than 5 cm and for saplings with DBH less than 5 cm. Carbon accounting estimates were expressed both in tonnes carbon per ha, ($tC\ ha^{-1}$) or tonnes of carbon dioxide-equivalent per ha, ($tCO_2\text{-}e\ ha^{-1}$). The conversion factor of 0.5 for biomass to carbon, which was recommended by the Intergovernmental Panel on Climate Change (IPCC) (2006) was used. The CO_2-equivalent, tonnes of carbon was determined by multiplying the ratio of 44/12, which is the ratio of the atomic weights of Carbon Dioxide (CO_2) to Carbon (C).

Wood densities were derived species by species from the database of Zanne et al (2009). These are available for 134 Guyanese species, including all common forest trees. For species with unknown wood density a weighted average wood density of 0.66 g/cm^3 was utilized as recommended by ter Steege (2001).

Below ground tree (root) biomass was calculated as a root:shoot (R:S) ratio relative to above ground biomass. This method is implicit in the IPCC (2006) equations for forest biomass calculations. The following root:shoot ratios adopted from Steege (2001) were utilized for the forest types encountered within this concession:

Mixed Forest R:S ratio = 0.220

Necromass (dead wood and litter) was estimated using an expansion factor of 8.6 % (adopted from Steege (2001)) relative to tree biomass. The total volume of biomass per hectare within the concession is presented in Table 39 for both the wet and dry season.

Table 39: Biomass per Hectare for Areas Sampled

`	Wet Season						Dry Season					
	(tonne Carbon/hectare)					Total Carbon Dioxide Equivalent	(tonne Carbon/hectare)					Total Carbon Dioxide Equivalent
Parameter	Above Ground Biomass	Below Ground Biomass	Saplings Biomass	Dead wood and Litter Biomass	Total Carbon Pool		Above Ground Biomass	Below Ground Biomass	Saplings Biomass.	Dead wood and Litter Biomass	Total Carbon pools	
Total	42.03	9.88	2.07	2.91	56.88	208.56	42.03	9.88	2.07	2.91	56.88	208.56

10.3 Impact Prediction and Evaluation

The GFC data was used ahead of the guidelines detailed in Chapter 4 of the *Guidelines (2003) on Land Use Land Use Change and Forestry (LULUCF)* since the data available for Guyana will only allow computation of Tier I levels and the Tier I levels neglects the below ground biomass.

Further the GFC data does not allow for determination of yearly sequestration rates. Studies by Reforest the Tropics Inc have indicated that one hectare of tropical forest has the potential to sequester between 8 and 12 tons of Carbon Dioxide (CO_2) annually. Approximately 65 ha of tropical forest will be cleared for the mines, widened roadway and related facilities. Consequently between 520 and 780 tons/year of CO_2 will no longer be sequestered by the forest. In addition, the project will also generate approximately 21,535 tonnes of CO_2 each year due to emissions from construction and other fossil fuel equipment. The project will therefore result in a yearly increase in the global CO_2 emissions by amounts ranging up to approximately 22,315 tonnes.

Loss of sequestration capacity is a moderate impact (long-term, moderate severity, regional extent). This impact will be mitigated by phased clearing of the areas to be mined such that all areas would not be cleared at once. In addition, mined out areas will be revegetated after mining is completed. This will result in long term restoration of the forest cover allowing the mined-out areas to again serve as a carbon sink. The mitigation measures will result in low impacts (short-term, low severity, local extent).

Mining can alter the local climate in many ways. Exposed rock, roads, and buildings will replace natural vegetation at several locations within the mine footprint. The vertical surfaces of mine pits and buildings would also be added to the natural landscape. Exposed land surfaces have greater heat conduction, and more heat storage than the natural land covers they replace. Heat energy would also be added at the mine site by the operation of mining equipment and power generation. Evaporation and transpiration from various natural surfaces existing prior to mine site creation would have acted to cool the land surface and local atmosphere. Drainage systems created for mine site operations will rapidly remove surface water from the site making less water available for cooling. The mine site area will therefore become warmer than surrounding areas. This is a moderate impact (long-term, moderate severity, local extent). These impacts will be mitigated by minimizing the areas of exposed rocks and building. This will result in low impacts (medium-term, low severity, local extent).

There is a theoretical potential for increased local rainfall due to the combined effect of particulate air pollution and increased convectional uplift due to increased surface temperature. Particulate air pollution may enhance rainfall by increasing the number of condensation nuclei. The incremental temperature increase may add to convection currents over the mine area. These are moderate impacts (medium term, moderate severity, regional extent). These impacts will be mitigated by taking steps to minimize particulate emissions to air. This will result in low impacts (short-term, low severity, local extent).

Mining operations will move, break, and grind large quantities of rock, all energy-intensive activities. Energy generation at the mine site will be based on the consumption of fossil fuel which will release carbon dioxide (CO_2), a prominent greenhouse gas (GHG) to the atmosphere. Subsequent mineral processing will add to CO_2 emissions. These are moderate impacts (long-term, moderate severity, national extent). Greenhouse gas emissions will be reduced by minimizing waiting times of mine equipment, reducing rolling resistance, and optimizing fuel efficiency. The mitigation measures will result in low impacts (long-term, low severity, regional extent).

10.4 Environmental Management Plan

Climate change will be mitigated by employing a resource hierarchy for energy at all stages of the project (construction, operation, and decommissioning) and through the supply chains and will include:

- adopting alternatives to avoid GHG emissions where possible.
- minimizing energy use though energy-efficient design and energy conservation.
- employ renewables (non-fossil fuel sources) and low-carbon materials to the maxiu.
- employ sources with co-benefits such as combined heat and power stations.

This would minimize project impacts, which can adversely affect climate change.

Mitigation will also include offsetting measures, where possible, such as enhancement of natural carbon sinks by retaining vegetated areas to the maximum extent possible and by considering carbon management programmes or clean technology such as renewable energy schemes for residential and other facilities.

10.5 Monitoring Plan

The carbon balance of the project will be monitored throughout the project life and decommissioning. The project will also monitor Guyana's changing global and national commitments to climate change reduction targets under the evolving provisions of the Paris Agreement 2015 to determine the impacts of its greenhouse gas emission on these targets.

Table 40: Summary of Climate and Climate Change Impacts

Project Phase	Impacts		Project Impacts Rating	Mitigation Measures	Impact Rating after Mitigation
Climate and Climate Change					
Construction	Loss of sequestration capacity	*Source* Vegetation Clearing *Vulnerability* Vegetated Areas	Moderate (long-term, medium severity, Local extent)	Phased vegetation clearing Revegetation of mined out areas	Low (short-term, low severity, local extent).
	Increased Local Rainfall	*Source* Particulate air pollution increase convectional uplift due to increased surface temperature. *Vulnerability* Areas adjoining Mine Site	Moderate (medium term, moderate severity, local extent).	Implementation of BMP to minimize particulate emissions to air	Low (short-term, low severity, local extent).
Operation	Increases CO_2 emissions	*Source* Energy generation Mineral Processing *Vulnerability* Areas adjoining Mine Site	Moderate (long-term, moderate severity, national extent).	Reduced and minimization of equipment waiting times, Reduced rolling resistance by proper maintenance Optimizing fuel efficiency	Low (long-term, low severity, regional extent)

11.0 BIOLOGICAL RESOURCES

There is growing recognition that human activities influence ecosystem services, which in turn affect biodiversity and the values associated with wildlife. Biological resources must therefore be considered by ESIAs to demonstrate that development will not irreparably harm the environment or its capacity to provide ecosystem services for current or future generations.

11.1 Policy, Legislative and Regulatory Framework

11.1.1 Protected Areas

The Act mandates that no person shall conduct mining and quarrying activities in areas within 20 metres of the low water mark of a river bank except for access of dredges from the river. Mining or quarrying is forbidden in specified nature reserves, parks where resource extraction is prohibited and in buffer areas if not expressly approved by the Commission and all parties likely to be affected by the activity must be notified. In addition, no dry mining or excavation shall be conducted in any watershed without prior permission from the Commissioner.

The Regulations made under The Mining Act (No. 20 of 1989) part XXVII 1 (a) states that there is a restriction to mining and quarrying activities in areas within 20 metres of the low water mark of a river bank except for access of dredges from the river. Restrictions are also placed on mining or quarrying in specified nature reserves and parks where resource extraction is prohibited. Mining can only occur in buffer areas if approval is obtained from the Commission and parties likely to be affected by the activity are informed.

11.1.2 Wild Birds Protection Act Chapter 71:01

The Act has stipulations for the protection of certain wild birds. Wild birds are defined in the schedule of the Act. Certain wild birds are protected absolutely. It is an offence to wound, kill, expose for sale, and offer for sale or export wild birds that are absolutely prohibited. However, there are some wild birds that are not so protected; they receive protection only during a prescribed closed season. However, it is not an offence to wound or kill any wild bird to procure food if done ten miles or more from a plantation.

There are no provisions for the protection of wild birds relative to mining operations however conservation of biological resources is applicable to the project. The company will therefore conform to the provisions of this act.

11.1.3 Wildlife Conservation and Management Act (2016)

This Act provides for the protection, conservation, management, sustainable use, internal and external trade of Guyana's wildlife. It established and incorporated the Guyana Wildlife Conservation and Management Commission and identifies the power of the Minister to give directions to the Commission. The functions of the Commission and duties of the Commission are detailed in the Act which established a Wildlife Scientific Committee and detailed the functions of Wildlife Scientific Committee. The Act recognizes the Guyana Wildlife Conservation and Management Commission as the CITES Management Authority for Guyana. The mandate of the Commission, according to the act, includes development and recommendation of strategies in the field of conservation, management and sustainable use of species of wildlife, consulting with the Wildlife Scientific Committee on the scientific aspects of the conservation, management and sustainable use of species of wildlife, developing, implementing and monitoring collaborative arrangements for the conservation, management and sustainable use of wildlife and coordinating in consultation with stakeholders, the establishment and maintenance of wildlife conservation and management plans and programs. This project involves no trade in wildlife. The sole aspect of this Act applicable to this project relates to the plans for the management of the biological resources located within the mine site area.

11.1.4 National Biodiversity Action Plan

The National Biodiversity Action Plan (NBAP) was prepared in 1999 to integrate the implementation of the Convention on Biological Diversity into national development. The overall goal of the NBAP was "to promote and achieve the conservation of Guyana's biodiversity, to use its components in a sustainable way, and to encourage the fair and equitable sharing of benefits arising out of the use of Guyana's biodiversity". The stated objectives of the plan were to:

1. Evaluate the state of capacity nationally to achieve the above goal
2. Identify gaps and needs relating to achieving the above goal
3. Propose actions to achieve this goal and close the gaps
4. Develop activities in a number of priority areas relating to the overall goal
5. Identify the roles and responsibilities of the various stakeholder groups in the implementation of the plan
6. Increase public awareness of biodiversity.

The plan included several program areas partitioned under two phases with various actions for execution. Phase 1 identified foundation programs that are essential for sustainable biodiversity planning and management. This included Human Resources and Institutional Capacity Building. Phase 2 on the other hand, consolidated phase 1 and initiated additional interventions for the second cycle of the plan. The program area for the additional interventions included a Biodiversity Action Plan.

This plan entered its second cycle in 2007 to focus mainly on conservation and sustainable use of biodiversity and sharing of benefits. It retained as its cornerstone the goal and seven objectives from the previous plan. Four thematic natural resource areas are listed as requiring attention. These are:

1. Forests
2. Agriculture
3. Coastal resources
4. Marine resources

The mining operation and access roads in forested areas will impinge on biological diversity. Therefore, according to NBAP 1 consideration should be given to the adoption of the four approaches stated below when planning for management of biodiversity.

1. The Participatory Approach which recognizes that conservation and responsible use of biodiversity requires commitment and collaboration from agencies, individuals etc. that impact/use biodiversity through their activities

2. The Cyclical/adaptive Planning Approach which is cyclic in nature and adaptive to change in circumstances and national policy

3. The Ecosystem Approach to biodiversity planning and management is based on the linking of the social, economic and environmental aspects of biodiversity management

4. The Precautionary Principle which according to the Convention on Biological Diversity is "where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimise such a threat." This principle has been incorporated into the Environmental Protection Act

11.1.5 Forest Act 2008

The Forest Act 2008 consolidates and amends the law on forests. It governs all activities that are carried out in the forest including mining and associated activities. Under this Act, no person shall engage in the following unless a mineral prospecting or mining licence has been granted under the Mining Act 1989:

- Enter and occupy state forest
- Cut, damage or take any forest produce or carry on any kind of forest operation
- Carry out any kind of exploratory operation in a state forest

The Guyana Forestry Commission with the approval of the Minister is vested with the power for carrying out the purposes of the Act. This project will entail mining within forested areas, the Forest Act 2008 will therefore apply to the operations.

11.1.6 Guyana Forestry Commission Act 2007

The Guyana Forestry Commission Act 1979 was repealed and replaced by the Guyana Forestry Commission Act 2007. The functions of the Commission as defined in the act include:

- To provide advice on various forest related issues and on formulation of forest policy
- To prepare plans, codes of practice, and guidelines for the conservation and management of forests
- To research, collate, analyse, prepare and disseminate data, statistics and other information about forests and all aspects of forestry including forest ecology and the use of forest produce
- To inspect, certify and accredit services for quality control of forest produce.

11.1.7 Code of Practice for Timber Harvesting 2002

The Code of Practice for Forest Operation was developed by the Guyana forestry Commission (GFC) for Timber Sales Agreement (GFC) and Wood Cutting Leases WCLs. It provides guidelines and standards on what constitutes satisfactory road building and other related forestry activities. One important component of this project is upgrading an access road to the mine site. This road will at a minimum confirm to GFC Road Planning as outlined in Chapter five (5) of the Code of Practice.

11.1.8 Convention on Biological Diversity

Guyana ratified this Convention on August 12, 1992. It was entered into force on November 12, 1997. The National Focal Point and the Implementing Agency is the Environmental Protection Agency. The objectives of the Convention include the conservation of biological diversity (defined as the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexities of which they are part including diversity within species, between species and of ecosystems), the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

The provisions of the Convention apply to areas within the limits of national jurisdiction of contracting parties. Contracting parties are required under Article 7 of the Convention to identify processes and activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity and to monitor their effects through sampling and other techniques. Parties are, also as far as is possible and as appropriate, required to establish protected areas or areas where special measures need to be taken to conserve biological diversity. In areas adjacent to these protected areas, environmentally sound and sustainable development should also be promoted. Article 8 requires that degraded ecosystems be rehabilitated and restored and the recovery of threatened species be done through the development and implementation of plans or management strategies. Contracting parties are also required to regulate or manage relevant processes or activities where a significant adverse effect on biological diversity has been determined.

Article 10 of the Convention supports the integration of conservation and sustainable use of biological resources in national decision-making and the support of local populations to develop and implement remedial action in degraded areas where biological diversity has been reduced. The avoidance or minimizing of adverse transboundary effects is also considered important and should be addressed by the introduction of environmental impact assessments of proposed projects that are likely to have significant adverse impacts on biological diversity. Artcle 10 also requires the exchange of information and consultation on activities likely to significantly adversely affect the biological diversity of other States and notification to such States of imminent or grave danger to biological diversity within areas under the jurisdiction of such States.

In observance of the Convention, Guyana established the Environmental Protection Agency in 1996, to coordinate and implement a programme for the conservation of biological diversity. A National Biodiversity Action Plan was also developed with stakeholders.

This project could potentially impact the biodiversity of the area to be exploited. The project will consequently be executed to satisfy the objectives of the Convention to conserve biological diversity to ensure sustainable use of the ecosystem components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

11.1.9 Protocol Concerning Specially Protected Areas and Wildlife (SPAW)

The SPAW Protocol, used as a means of regionalizing global conventions such as the CBD, utilizes an ecosystem approach to conservation by protecting rare and fragile ecosystems and the endangered species it houses. Through its Caribbean Regional Coordinating Unit, assistance is given for the establishment of protected areas to ensure attainment of the objectives of the SPAW Program to significantly increase the number and improve the management of national protected areas and species in the region and assist the Governments of the region, on request, to develop guidelines for the establishment and management of such areas.

The Protocol extends to the Convention Areas as well as water courses extending up to the fresh water limit or watersheds designated by the parties. It urges when necessary, the establishment of protected areas in instances where it is necessary to protect:

- representative types of coastal and marine ecosystems of adequate size to ensure their long-term viability and to maintain biological and genetic diversity
- habitats and their associated ecosystems critical to the survival and recovery of endangered, threatened or endemic species of flora or fauna
- the productivity of ecosystems and natural resources that provide economic or social benefits and upon which the welfare of local inhabitants is dependent and
- areas of special biological, ecological, educational, scientific, historic, cultural, recreational, archaeological, aesthetic, or economic value, including, in particular, areas whose ecological and biological processes are essential to the functioning of the Wider Caribbean ecosystems.

In the application of protection measures, each party is urged to progressively take such measures in accordance with its national laws and international law as are appropriate for:

- the regulation or prohibition of the dumping or discharge of wastes and other substances that may endanger protected areas
- the regulation or prohibition of coastal disposal or discharges causing pollution, emanating from coastal establishments and developments, outfall structures or any other sources within their territories
- the regulation or prohibition of fishing, hunting, taking or harvesting of endangered or threatened species of fauna and flora and their parts or products
- the prohibition of activities that result in the destruction of endangered or threatened species of fauna or flora and their parts and products, and the regulation of any other activity likely to harm or disturb such species, their habitats or associated ecosystems

- the regulation or prohibition of any activity involving a modification of the profile of the soil that could affect watersheds, denudation and other forms of degradation of watersheds, or the exploration or exploitation of the subsoil of the land part of a marine protected area
- the regulation or prohibition of industrial activities and of other activities which are not compatible with the uses that have been envisaged for the area by national measures and/or environmental impact assessments pursuant to Article 13
- any other measure aimed at conserving, protecting or restoring natural processes, ecosystems or populations for which the protected areas were established.

If any rare or fragile ecosystems are encountered within the area being exploited the ecosystem approach to conservation will be utilized to manage that rare or fragile ecosystem.

11.1.10 Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)

This convention was established in 1972 to control international trade of live and dead animals and plants through the issuing of permits/certificates for such trade. Requirements for the establishment of Scientific and Management authorities; regulation of trade in specific species via permits and certificates and maintenance of records of trade are detailed in the convention. The legal obligation under this convention was established in the Species Protection Regulations of 1999 under the Environmental Protection Act.

11.2 Baseline

11.2.1 Biological Resources

Biodiversity surveys were conducted in 2017 and 2018 to update the biodiversity data compiled during 2009. The wet season biodiversity survey was undertaken in April-May of 2017. The dry season biodiversity survey was undertaken in January of 2018.

The objective of the biodiversity baseline surveys was to determine the existence of potentially sensitive habitats and species within the mining concession. Species recorded during the surveys were compared with the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species for Guyana to determine and classify species that are threatened, that is, species listed as Critically Endangered, Endangered or Vulnerable. The IUCN defines species according to their likelihood of extinction and produces a Red List, which includes internationally recognized flora and fauna. The criteria for the IUCN classification are provided in Table 41.

Table 41: IUCN Red List Classification

IUCN CLASSIFICATION	DESCRIPTION
EXTINCT (E)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), and throughout its historic range have failed to record an individual.
EXTINCT IN THE WILD (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual.
CRITICALLY ENDANGERED (CR)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see 2001 IUCN Redlist Categories and Criteria Version 3.1), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

IUCN CLASSIFICATION	DESCRIPTION
ENDANGERED (EN)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see 2001 IUCN Redlist Categories and Criteria Version 3.1), and it is therefore considered to be facing a very high risk of extinction in the wild.
VULNERABLE (VU)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see 2001 IUCN Redlist Categories and Criteria Version 3.1), and it is therefore considered to be facing a high risk of extinction in the wild.
NEAR THREATENED (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
LEAST CONCERN (LC)	A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
DATA DEFICIENT (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat.
NOT EVALUATED (NE)	A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

The information obtained by the surveys were used to consider biodiversity within the concession at the following levels of scale, presented in increasing order of detail as follows:

- Regions/Biogeographic Provinces
- Landscapes/Eco regions
- Habitats and Species

11.2.1.1 Regional and Biogeographic Context

Guyana is situated in the neo-tropical bio-geographical province of northeastern South America and is home to a vast expanse of primary tropical forest, freshwater and other unique ecosystems. Guyana, being part of the Guiana Shield (a geomorphologic complex region), forms part of the Amazon Biome. Four main biogeographical units are distinguished within Guyana (FAO, 2015). These include:

1. The northern coastal belt, consisting of low-lying alluvium with a varying width up to a maximum of 65 km in land (in the east)
2. The lowland region of undulating forest land covering most of the northern and central parts of the country, generally with an elevation below 150 m
3. The Pakaraima mountain region in the west, an elevated table land of sandstone escarpments between 300 and 1200 m in elevation and
4. The southern uplands consisting of a vast area mostly over 150 m in elevation covered with undulating forest land.

The Marudi concession is in the Upper Takutu-Upper Essequibo southern uplands which consist of a vast area of undulating terrain covered with tall evergreen ombrophilous forest. This region forms part of the Guiana Highlands which commence in Venezuela, east of the Orinoco and extend across much of west-central Guyana and into the northern Roraima state in Brazil. This southern upland and by extension Guyana is part of the Guiana Shield region as defined by regional studies by Hollowell and Reynolds (2005).

The Guiana Shield located in northeastern South America includes the large mountain systems that form the watershed between the Amazon and Orinoco Rivers. The Shield accounts for more than 25 % of tropical forests remaining in the world. Its diverse landscapes have been recognized for their biological endemism, unique ecosystems, pristine forests and cultural diversity. Figure 23 depicts the general location of the concession in relation to the Guiana Shield Region.

The lowlands of the Guiana Shield are biogeographically distinct from the Guiana Shield highlands which include the Tepui formations characterized by relatively high levels of endemism (Hollowell and Reynolds, 2005). Biogeographically, the lowlands of the Guiana Shield are much more closely related to the forested lowlands of the Amazon Basin and are often included under broader definitions of Amazonia due to their overriding similarities. One such similarity, according to ter Steege (2000), is that the lowland rainforests on brown sandy soils, loams, or laterites form the major vegetation type of the Amazon Valley and the Guiana Shield. The Amazon Basin, spanning 6.7 million km^2, is the single largest remaining tropical rainforest in the world and is home to at least 10% of the world's known biodiversity.

The vertebrate faunal diversity of the Shield's lowland forests is comprised largely of widespread species found across the lowland humid forests of the Amazon Basin and the watersheds of the Guiana Shield. In contrast, Guiana vertebrate endemics are generally restricted to the highlands of the Guiana Shield, especially at elevations greater than 1,500 m, or to the savanna and dry forest ecosystems (Hollowell and Reynolds, 2005).

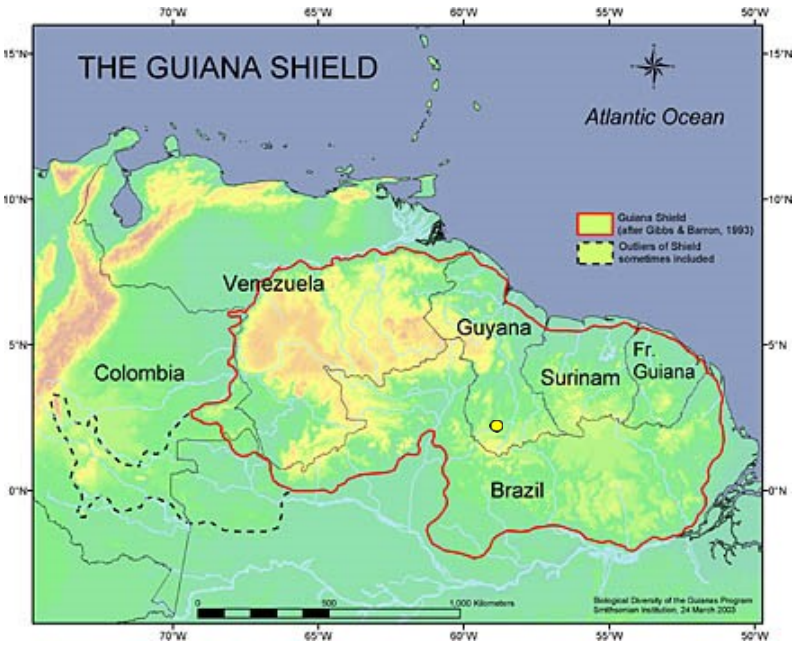
According to ter Steege and Zondervan (2000), the forest of the Guiana Shield comprises of five major forest regions:

1. Forests in the coastal plain (Venezuela – Guyana – Suriname – French Guiana)
2. Forest in the North-West District of Guyana and lowland Venezuelan Guyana
3. Forests of the White Sands Formation (Guyana-Suriname-French Guyana)
4. Forests in the Pakaraima-Central Guiana Upland region (Guyana-Venezuela-Brazil)
5. Forests of the southern peneplain (Guyana-Suriname-French Guiana-Brazil)

The Marudi Concession lies south of the Rupununi River within the Guiana Shield forest region of the southern peneplain with elevations ranging between 300 – 1200 m. According to ter Steege (2000), this forest region is found on soils developed on the crystalline shield, such as granites and greenstones and on pockets of Plio-pleistocene sediments. Rainforest of the region fringe the savannahs and are characterized by a high abundance of *Goupia glabra, Couratari, Sclerolobium, Parinari, Apeiba, Peltogyne, Catostemma, Spondias mombin* and *Anacardium giganteum.*

The forest south of the Kuyuwini River and east of New River is distinguished by a dominance of *Geissospermum sericeum*, *Eschweilera* cf. *pedicellata, Lecythis corrugata, Pouteria coriacea* and *Pourouma spp*. Other notable species of this region are *Parkia, Ficus, Sclerolobium, Trichilia, Parkia, Parinari* and *Goupia*. *Eperua falcata* are characteristic of late secondary forest while *Pterocarpus* and *Macrolobium acaciifolium* are common in forests along the rivers in this area. Forests along the foothills and middle slopes of the Kanuku Mountains are characterised by *Cordia alliodora, Centrolobium paraense, Apeiba schomburgkii, Acacia polyphylla, Pithecellobium* s.l., *Peltogyne pubescens, Manilkara* spp., *Cassia multijuga* and *Vitex* spp. *Manikara* dominates the higher areas, while in the low forest/woodland *Erythroxylum* and *Clusia* dominates on slopes with bare rock.

Figure 23 - General Location of Marudi Concession in Relation to the Guiana Shield Region



KEY

Guiana Shield Region

Outliers of the Guiana Shield (sometimes included)

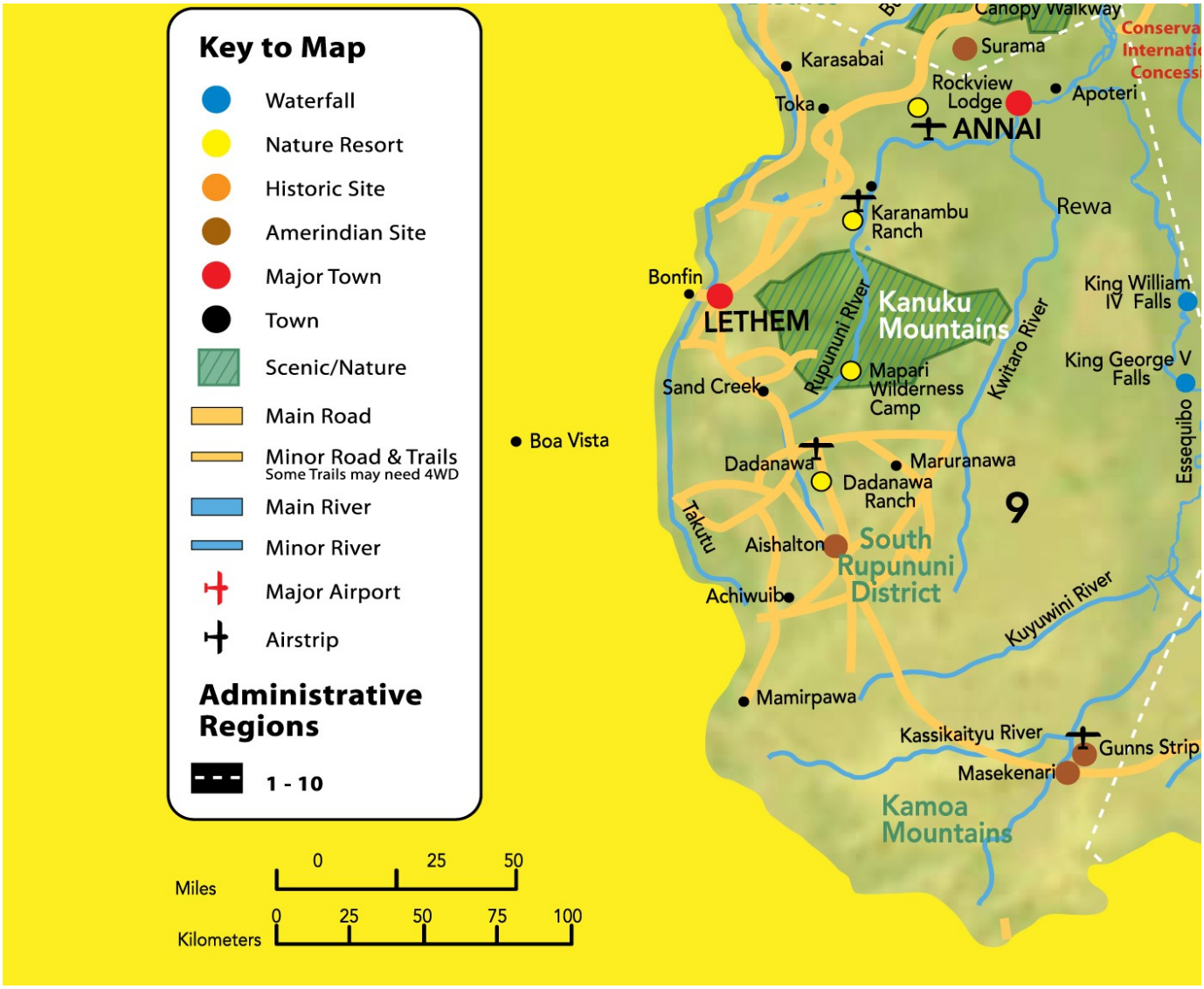
General Area of Marudi Concession

The South Rupununi Savannah varies in terrain from flat to dissected and undulating in some places. It is characterized by rock outcrops with a typical 'rock vegetation'. The species present on the smallest rock plates are: *Cereus hexagonus, Melocactus smithii, Cnidoscolus urens, Cyrtopodium glutiniferum* and *Portulaca sedifolia.*

These species are found abundantly in almost every dry forest type (non-flooded forest) in this region. Most of these species belong to the genera of the 'Lowland Guianas Dominants' (ter Steege and Zondervan, 2000).

The Kwitaro and Kuyuwini Rivers are the main source of drainage for this concession. Both rivers are located on the right bank of Essequibo River which is the main drainage conduit of the landscape region of the concession. The Essequibo and its main tributaries, the Rupununi, Mazaruni, and Cuyuni, drains about a third of Guyana. The

Figure 24 - The Major Rivers Surrounding Marudi



(Adapted from http://georgetown-guyana.com/files/2011/02/MapofGuyana.jpg)

Essequibo River basin occupies an area of approximately 69,300 sq.km (26,757sq.mi) and flows to the north for 1,014 kilometers (630 mi) and has its origins in the Acarai Mountains near the Brazil-Guyana border. The Marudi concession lies south of the Kwitaro and west of the Essequibo Rivers respectively.

The Essequibo River and the seasonally flooded Rupununi savannas of southwestern Guyana serve as biological corridors for aquatic biota, directly linking the Amazon Basin and the watersheds north of the Guiana Shield (Watkins et al., 2004). The Essequibo River therefore serves as a biological corridor directly linking the Amazon Basin and the watersheds north of the Guiana Shield.

Based on the analyses of a large scale national forest inventory carried out in Guyana's forest ter Steege (2000) identified five preliminary national forest regions, which are geographically separated as depicted in Figure 25**:**

1. The Southern Wet Forest
2. The Southern Dry Forest
3. The Pakaraimas Mountains Wet Forest
4. The Central Guyana Wet Forest and

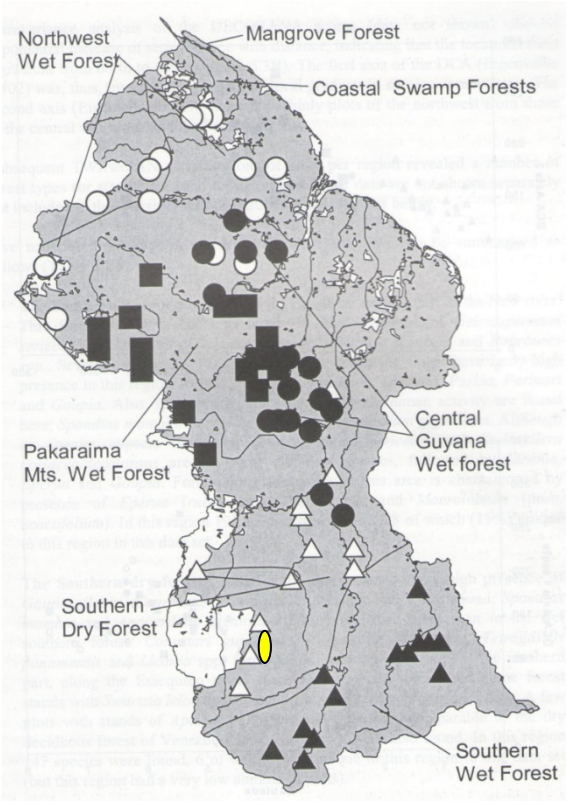
5. The Northwest Guyana Wet Forest

The Upper Essequibo River basin lies within the southern wet forest and the southern dry Forest and is Guyana's largest source of fresh water. It anchors an aquatic system that features the highest recorded freshwater fish diversity in the world. The area is also home to numerous endangered species, such as the tapir, cock-of-the-rock, harpy eagle, black caiman, giant armadillo, giant river otter and the giant river turtle.

The southern wet forest and the southern dry forest are situated on ground water laterites, truncated phase of red yellow latosols and reddish brown lateritic high base status (pedimentary phase) soil formation and is characterized by high abundance of *Goupia glabra, Couratari, Sclerolobium, Parinari, Apeiba, Peltogyne, Catostemma, Spondias mombin* and *Anacardium giganteum* in the higher elevations, while in the lower reaches the forest is characterised by *Cordia alliodora, Centrolobium paraense, Apeiba schomburgkii, Acacia polyphylla, Pithecellobium*, *Peltogyne pubescens, Manilkara* spp., *Cassia multijuga* and *Vitex* spp. *Manikara* dominates the higher areas, while in the Low forest/woodland *Erythroxylum* and *Clusia* dominates on slopes with bare rock.

The forest ecosystems of the Upper Essequibo River basin are dominated by dense forests which are interlocked among aquatic environments in the form of rivers and creeks. Forest ecosystems along the rivers and in the valleys are seasonally flooded and provide habitats for aquatic biota during the wet season. The valley slopes, hill slopes, and ridge tops support forests vegetation tolerant to non-seasonally flooded forest conditions. The river ecosystems are integrated through surface and groundwater hydrological processes. The surface waters of the region are generally considered 'blackwaters' with low pH, high contents of tannins and organic acids from the breakdown of leaf litter, low conductivity and suspended sediments. The Basin supports a large diversity of widespread low-land humid forest fauna typical of the neotropics, the Guiana Shield and Amazonia lowlands, and the lowlands forest regions of Guyana.
The Upper Essequibo River basins are known for its timber and mineral resources. The Marudi Mountain areas have been historical mined on a subsistence level.

Figure 25 - MAP OF THE NATIONAL FOREST REGIONS OF GUYANA



Map sourced from; Plant Diversity of Guyana; Tropenbos Series 18; Edited by ter Steege (2000)

LEGEND
▲ *Southern Wet Forest*
○ *Northwest Guyana Wet Forests*
● *Central Guyana Wet Forest*
■ *Pakaraima Mountains Wet Forests*
△ *Southern Dry Forest; Light grey areas: area under forest cover*
◯ General area of the Marudi concession

11.2.1.2 Habitats and Species

Based on the vegetation map of Figure 26, produced by the Guyana Forestry Commission (GFC) 2016, the concession is characterized by mixed forest vegetation, stratified by topography. The mixed forest strata of the concession depicted in the GFC vegetation map include:

- Forest on Steep Hills in South of Guyana
- Mixed Forest South of Guyana

Mixed forest vegetation typically occurs on well-drained soils from the flat plain to broken areas on brown sand, loam or red earth. In the lowland region of Guyana, mixed forest vegetation occurs from the Venezuelan border to the Demerara River in the east and from the coastal belt south to the Pakaraima Mountains. This large area is practically covered by the *Eschweilera/Licania* association. The other association occurring is *Eschweilera/Dicymbe*, which can be considered as a transition between the *Dicymbe* forests of the Pakaraima region and the lowland forests. Mixed forests of Marudi are generally classified as follows:

> **Mixed rainforest in south Guyana:** Dry (deciduous) forest types fringe the savannahs in south Guyana. Most of the dry forest stands show high presence of *Goupia glabra, Couratari, Sclerolobium, Parinari, Apeiba, Peltogyne, Catostemma, Spondias mombin* and *Anacardium giganteum*. South of the Kuyuwini River to east of the New River the forest is characterised by a high presence of *Geissospermum sericeum*, *Eschweilera* cf. *pedicellata, Lecythis corrugata, Pouteria coriacea* and *Pourouma* spp. Several other taxa, characteristic of late secondary forest, have high presence in this region: *Parkia, Ficus, Sclerolobium, Trichilia, Parkia, Parinari* and *Goupia*. *Eperua falcata, Pterocarpus* and *Macrolobium acaciifolium* are common in forests along the rivers in this area.
>
> **Forest on steep hills in south Guyana:** Forests along the foothills and middle slopes of the Kanuku Mountains are characterised by *Cordia alliodora*, *Centrolobium paraense, Apeiba schomburgkii, Acacia polyphylla, Pithecellobium s.l., Peltogyne pubescens*, Manilkara spp., *Cassia multijuga* and *Vitex spp*. *Manikara* dominates the higher areas. Low forest/woodland with *Erythroxylum* and *Clusia* on slopes with bare rock is also common.

The South Rupununi Savannah, in particular, has rock outcrops with a typical 'rock vegetation'. The species present on the smallest rock plates are: *Cereus hexagonus, Melocactus smithii, Cnidoscolus urens, Cyrtopodium glutiniferum* and *Portulaca sedifolia*.

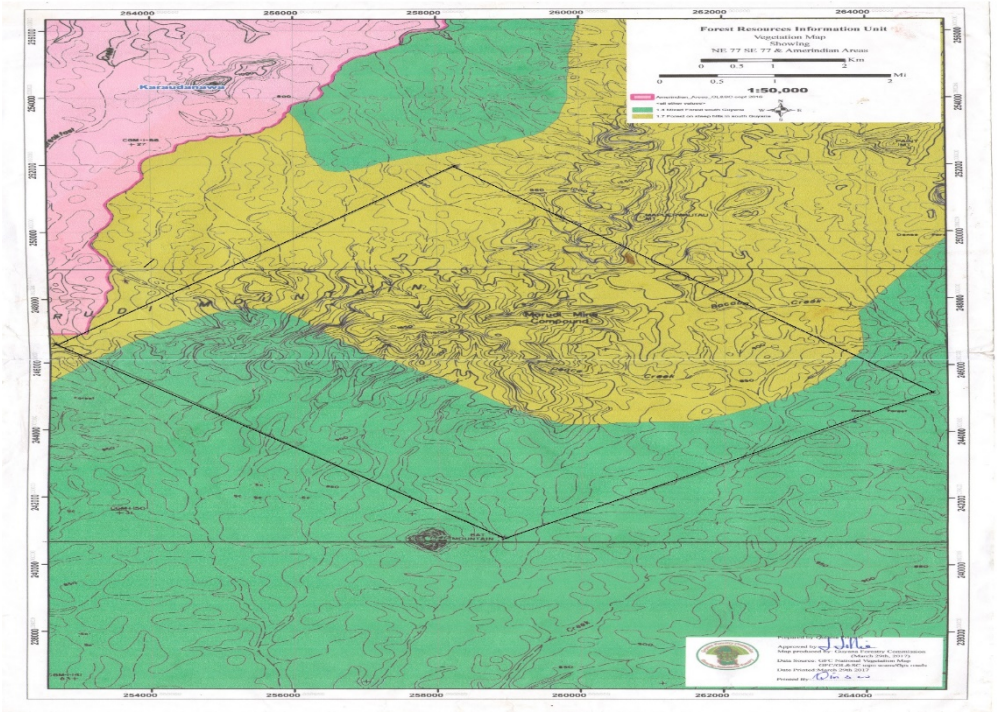


Figure 26 - GFC Vegetation Map Identifying Forest Types within Concession

11.2.2 2009 Biodiversity Survey Methodology

11.2.2.1 Terrestrial Resources

The 2009 floral survey incorporated several transects and subplots. Each transect was approximately 1 km long with 50m x 50m subplots at every 100 m on each transect, creating a herring bone formation. Squares 10 m x 10 m were established within each 50m x 50m main plot. All trees with 20 cm diameter at breast height (DBH) and above were recorded within the main (50m x 50 m) main plot. Trees and saplings, less than 19.9 cm DBH, were measured in each sub plots. Table 42 below identifies the terrestrial sample locations used for the 2009 surveys with corresponding GPS coordinates. In several instances GPS Coordinates could not be obtained due to cloud and or forest cover.

During the 2009 surveys, avifaunal species were identified and counted by visual encounter and auditory surveys and point counts. Binoculars, spotting telescope and audio playbacks were also used. Focus was placed mainly on dawn song and sunset flight sessions when species are most active. Night spotting was also conducted for nocturnal species. Avifaunal surveys were conducted between 05:00 – 07:00 hrs. and 16:00 – 21:00 hrs. daily. Species were identified by visual encounter surveys (VES), vocalization (mainly dawn song and sunset flight sessions when species are most active), night spotting and opportunistic sightings.

During both the wet and dry season surveys of 2009, mammals were identified by visual encounter surveys (VES), by track and scat identification, and by opportunistic sightings. Mammalian surveys were conducted between 05:00 – 07:00 hrs. and 16:00 – 21:00 hrs. daily. Herpetofaunal surveys were conducted between 06:00 – 08:00 hrs, 11:00 – 13:00 hrs and 19:00 – 23:00 hrs daily. Invertebrate sampling was conducted during the periods corresponding to the herpetofaunal surveys, as well as opportunistically.

Table 42: 2009 Terrestrial Sample Plot Locations – 2009 Surveys

SITE	COORDINATES	DESCRIPTION
TERRESTRIAL		
Transect 1, Plot 1	N02o 11.45.2', W059o 10.53.1' N02o 11.48.3' W059o	Floodplain mix forest, sand and pegasse sediment
Transect 1, Plot 2	N02o 11.53.8' W059o 10.49.0' N02o 11.55.9' W059o 10.48.9'	Floodplain mix forest, sand and pegasse sediment
Transect 1, Plot 3	N02o 12.03.9' W059o 10.52.9' N02o 12.04.7' W059o 10.55.2'	Floodplain mix forest, sand and pegasse sediment
Transect 1, Plot 4	N02o 12'10.3' W059o 10.50.1' N02o 12'11.7' W059o 10.48.2'	Floodplain mix forest, sand and pegasse sediment
Transect 1, Plot 5	N02o 12.18.3' W059o 10.48.1' N02o 12.20.1' W059o 10.49.3'	Laterite soil
Transect 1, Plot 6	N02o 13.02.2' W059o 1024.1'	Laterite soil
Transect 2, Plot 1	N02o 13'56.9' W059o 11'49.3'	Laterite and loam soils
Transect 2, Plot 2	N02o 13'57.3' W059o 11'46.2' N02o 13'57.9' W059o 11'40.8'	Laterite and loam soils
Transect 2, Plot 3	N02o 13'56.4' W059o 11'36.5'	Laterite and loam soils
Transect 2, Plot 4	N02o 13'57.2' W059o 11'26.6'	Laterite and loam soils
Transect 3, Plot 1 - 4	No readings	
Transect 4, Plot 1	N02o 12'59.8' W059o 08'53.3'	
Transect 4, Plot 2	No readings	
Transect 5, Plot 1 - 2	No readings	
Transect 6, Plot 1 - 2	No readings	
Transect 7, Plot 1 - 2	No readings	
Transect 8, Plot 1 - 4	No readings	

*No readings were as a result of forest cover and/or cloud cover

Herpetofauna were identified using visual encounter surveys (VES), vocalization for frogs and opportunistic sightings. Species abundance was relatively low in the dry season as compared with the wet season, probably due to the lack of water within the area. Most amphibian species were identified at Capadolla Creek and Locust Creek area which is parallel to the airstrip while reptiles were identified mostly around the camp.

Macro-invertebrates were sampled using visual encounter surveys (VES), leaf litter sampling and dip netting. The eight (8) plant transects were used to sample the macroinvertebrates within the concession area.

11.2.2.2 Aquatic Resources

The fish fauna at the Marudi Concession was sampled at six locations in 2009, namely Rice Creek, Capodilla Creek, Peace Creek, Locust Creek, Toucan Creek and July Creek. Methodology for sampling consisted mainly of utilising seines and hook and line. Icthyofaunal sampling was conducted between 05:00 – 16:00 hrs daily. Nocturnal sampling was also conducted along Locust Creek between 19:00 – 21:00 hrs. Sampling was conducted at 200 m intervals along each creek. Practically no GPS coordinates were obtainable for the sampled points due to cloud/forest cover. Paunch Creek was surveyed for aquatic species. However, no fish species were observed, since Paunch Creek was dry during the period when the sampling program was undertaken. The locations of aquatic sample plots, used for 2009 surveys, are identified in Table 43.

Table 43: Aquatic Sample Plots

AQUATIC		
Rice Creek	N02o 13.01.3' W059o 08.57.6'	White clay and sand
Pease Creek Mouth	N02o 13'19.9' W059o 09'10.1"	
Locust and Capadula Creek	No readings	Red clay and loam
July Creek	No readings	Rocks
Paunch Creek	No readings	
Mouth of Locust Creek	No readings	

11.2.3 2009 Biodiversity Survey Results

11.2.3.1 Floral Composition

The 2009 floral survey indicated that the trees were mostly between 20 and 30 m high with canopy trees reaching 40 m. In the transition zone between the savannah and the wet forest the vegetation possessed a species composition that is comparable to that of bush islands but the trees were lower and mostly semi-deciduous. The floral assessment identified 115 species of plants occurring in the area (see Table 44). There was no species variation from Wet to Dry season, except for those trees that were fruiting or flowering.

The locally protected species encountered by the 2009 assessment was Bulletwood, *Manilkara bidentata*. Species identified within this area are common to fairly common to this area and within the laterite mix and swamp forest biogeographic province of Guyana.

Table 44: 2009 Floral Assessment at Marudi Mountain, Guyana

Local Name	Family	Scientific Name	Comment
Aeroids	-	*Philodendron fragrantissimum*	
Antwood	Boraginaceae	*Codia nodosa*	Medicinal properties
Aromata	Papilionoidae	*Clathrotropis macrocurpa*	Timber & Medicine. Serves as a source of nitrogen for the forest soil since it is a legume and the roots nodulate which provides an ideal environment for nitrogen fixing bacteria (Rhizobium spp).
Asepoko	Sapotaceae	*Pouteria guianensis*	This timber species has a fleshy fruit which provide food mainly for monkeys and large fruit eating birds; and also some species of turtles.
Bactris Palm	Palmae/Arecaceae	*Batris spp*	
Bambocaceae	-	-	
Baradan	Lauraceae	*Octotea tomentella*	
Baramalli	-	*Casostoma commune*	
Bauhinia	-	-	
Black kakaralli	Lecythidaceae	*Eshweileria subglandulosa*	Timber. Provides food for animals such as monkeys, agoutis, etc. The fruit is a very hard pyxidium in which these animals can penetrate.
Black Yari Yari	-	*Guatteria foliosa*	
Bloodwood	Guttifeferae	*Vismia macrophylla*	
Broad Leaf Kakaralli	-	-	Timber & firewood
Broad Leaf Melastome	-	-	
Brown Whitey	-	-	
Bulletwood	Sapotaceae	*Manilkara bidentate*	
Burada	-	*Parinari campestris*	
Buru Palm	-	-	
Butter Wood	Quassia	-	
Clusia	-	*Clusia sp.*	
Cocoa	Ericaceae	*Thibaudia Formosa*	
Congo Pump	Moraceae	*Cecropia peltat*	The hollow stem of the seedling provide a nesting place for Aztec ants which forge a mutual relationship with the plant. Medicinal.
Counta	-	-	
Countabali	Chrysobalanaceae	*Licania alba*	
Crabwood	-	*Carapa guianensis*	Timber, medicine & NTF. The seeds serve as a food source for animals (hoarding rodents, monkeys and deer).
Dalibana	Palmae	*Genonoma baculifera*	
Dogseed	Apocyanaceae	*Tabernaemontana disticha*	
Duka	Anacaradiaceae	*Tapirira obtuse*	

Duru	Tiliaceae	*Apeaba petoumo*	Timber & firewood
Elizebetha	-	-	
Epiphytes	-	-	
Fatpork	Chrysobalanceae		
Ferns	-	-	
Ficus	-	-	
Fine Bamboo	-	-	
Fine Leaf Kerati	Lauraceae	*Ocotea oblonga*	
Fine Leaf Counta	-	-	
Fine Leaf Kakaralli	Lecythidaceae	*Eshweileria wachenheimii*	Timber. Provides food for animals such as monkeys, agoutis, etc. The fruit is a very hard pyxidium in which these animals can penetrate.
Fowl Cup	-	-	
Fukadi	Combretaceae	*Terminalia decandrum*	
Futui	Bignoniaceae	*Jacaranda copaia*	
Guava family	Mrythaceae	-	Timber. Provides food for animals such as monkeys, agoutis, etc. The fruit is a very hard pyxidium in which these animals can penetrate.
Haritibana	Musaceae	*Heliconia acuminata*	
Haritibana	Musaceae	*Heliconia pesittacarum*	
Hayawaballi	Burseraceae	*Tetragastric altissima*	
Helicionias	-	*Helicionius sp.*	Dominant species along Transect 1
Hiawa	Burseraceae	*Protium polybotryum*	NTFP & Timber
Hill dalli	Myristicaceae	*Virola michelii*	
Hububalli	Anacaradiaceae	*Loxoptergium sagotti*	
Hubudi	Anacaradiaceae	*Amacardium giganteum*	
Kabakalli	Celastraceae	*Goupia giabra*	
Kamakuti	Bombacaceae	*Bombax flaviflorum*	
Karamani	-	-	
Karohoro	Araliaceae	*Schefflera decaphylla*	
Kerati	Lauraceae	*Aniba cf. guianensis*	
Kirikua	Myristicaceae	*Iryanthera lancifolia*	
Kokorite	Palmae	*Attalea regia*	
Kokriteaballi	Sapotaceae	*Pouteria cuspidata*	
Korokai	Burseraceae	*Protium decandrum*	
Letter Wood	Moraceae	*Broimum guianensis*	
Lianas	-	-	
Lu	Palmae	*Oenocarpus bacaba*	
Maho	Sterculiaceae	*Sterculia rugosa*	Medicinal properties.
Makorakun	-	*Inga sp.*	
Manicole	Palmae	*Euterpe prectoria*	Food
Mara mara	Rubiaceae	-	
Match Wood	-	-	
Melostomes	Melastomataceae	*Aciotis spp Clidemia spp*	Some species of melostomes has galls on the stem in which ants colonise. Medicinal.
Monkey Bush - Duni	Apeiba Echinata	-	
Monkey Ladder	Leguminosae-caesalp	*Bauhinia guianensis*	Medicine
Monkey Pot	-	*Lecythis zabacujo*	Provides food for animals such as monkeys, agoutis, etc. Timber.
Mukru	Caesalinioideae	*Ischnosiphon arouma*	Medicinal properties
Munuri bush	Monimiaceae	*Spiaruma guianensis*	
Nibi	Araceae	*Heteropsis flexuosa*	Mixed forest type, craft material
Orchids	Orchidaceae	-	
Parkia	Leguminosae	*Parkia nitida, P. pendula*	
Piper	Piperaceae	-	
Plum	Anacaradiaceae	*Spondias mmbin*	
Red Cedar	-	-	

Rubber tree	Euphurobiaceae	*Sapium jenmanii*	
Sand baromalli	Bombacaceae	*Castostema flagrams*	
Sedges	-	-	
Shibadeen	Apocyanaceae	*Aspidosperma cruentum*	
Shirada	Mimosoidae	*Inga lateriflora*	
Silverbali	Lauraceae	*Licaria canella*	
Silverballi	-	*Ocotea spp.*	
Simarupa	Simaroubaceae	*Quassia simaruba*	
Smilax	-	-	
Smooth leaf kakaralli	Lecythidaceae	*Eschweilera coriacea*	
Sorodani	-	-	
Sauri	Annacardiaceae	*Caryocar nuciferum*	
Sourie Skin Silverballi	-	-	
Spiny Bamboo	-	-	
Spiny Palm	-	*Attalea sp.*	
Stilt Root Palm	-	*Catoblastus sp.*	
Surandan	Euphurobiaceae	*Hyeronima alshorneodes*	
Swartzia	-	*Swartzia schomburgkii*	
Takagalia	-	-	
Tatabu	-	-	
Tattaboo	-	-	
Turu Palm	Palmae	*Jesinia bataua*	Roofing material and Craft
Wabaima	-	-	
Wadara	Lecythidaceae	*Couratair guianensis*	
Wakakusa	Mimosoidae	*Inga alba*	
Wakaradan	Melastomataceae	*Miconia of ruticalyx*	
Whitey	-	*Inga sp.*	Serves as a source of nitrogen for the forest soil since it is a legume and the roots nodulate which provides an ideal environment for nitrogen fixing bacteria (Rhizobium spp). The seed of this tree also serves as a food source for animals(mainly rodents,monkeys and birds). Timber.
Wild Banana	Sprelipiaceae	-	
Wild Cocoa	Bombacaceae	*Pachira aquatic*	Medicinal
Wild Ginger	Lauraceae	*Ocotea splendens*	
Wild Sorrel	-	-	Medicinal: cold, sores, itches
Woody Palm	-	-	
Yari Yari	Meliaceae	*Trishila sp.*	The fruits are eaten by monkey and most importantly cotingoid birds. NTFP.
Yarula	Apocyanaceae	*Aspidosperma excelsum*	
Yellow Flower	Rubiaceae	-	

11.2.3.2 Avifauna

A total of 155 species of avifauna from 37 families was documented during the 2009 wet season. A total of 130 species within 37 families were identified during the 2009 dry season. Six (6) waterbirds were observed within the study area, namely *Phalacrocorax brasilianus, Mesembrinibis cayenninsis, Aramides cajanea, Megaceryly torquata, Chloroceryle amazona, Megarynchus pitangua, Philphydor lictor* and *Atticora fasciata*. Four (4) migrants were observed in the area during the wet season. These are *Tyrannus tyrannus, Tyrannus dominicensis, Elanoides forficatus* and *Ictinia plumbea*. Nine (9) species of avifauna endemic to the Guiana Shield, namely, *Perissocephalus tricolor, Procnias albus, Monasa atra, Pteroglossus viridis, Selenidera culik, Ramphastos tucanus, Xiphorpynchuss pardalotus, Myromotherula gutturalis and Myrmeciza ferruginea* were also recorded by the 2009 surveys.

Two migrant species were observed in the area during the 2009 dry season, namely, *Elanoides forficatus and Ictinia plumbea;* while *Aramides cajanea, Megarynchus pitangua, Tachycineta albiventer* and *Atticora fasciata* were noted as wetland birds. Ten species of Guianan Shield Endemics were also observed, namely, *Touit batavicus, Gypopsitta caica,*

Monasa atra, Ramphastos tucanus, Myrmotherula guttata, Myrmeciza ferruginea, Corapipo gutturalis, Tyranneutes virescens and Cyanicterus cyanicterus.

An individual Harpy Eagle, *Harpia harpyja*, was recorded in the area during the 2009 wet season. The Harpy Eagle was, however, not observed in the area during the 2009 dry season. There was no evidence of this bird nesting in the project area. Forests supporting these eagles are usually less than 90 m in height and undisturbed forests are ideally suited to their needs; but they can occur in secondary growth forests and minimally disturbed areas. The available evidence suggests that the Harpy Eagle is based at Bat Mountain and comes over to the project area to forage for food. The presence of sloths acts as further evidence of the Harpy Eagle foraging in the area. This bird is considered globally near-threatened by IUCN and are CITES Appendix I species.

The area provides a feeding ground for numerous parrot species in 2009. These birds were noted feeding on the *Pouteria cuspidata*, Ficus spp. and Inga sp. The small melastomes, which were fruiting at the time, acted as a food source also for the birds in the area. All birds, except for the Harpy Eagle, are common to fairly common to Guyana. A summary of avifauna recorded by the 2009 surveys is detailed in Table 45.

Table 45: 2009 Assessment of Avifauna at Marudi Mountain, Guyana

Abundance Codes:
C - more than 20 individuals encountered daily in prime habitat and season (Common)
F - 5-20 individuals encountered daily in prime habitat and season (Fairly Common)
U - present in small numbers (fewer than 5 individuals per day) and not encountered daily even in prime habitat and season (Uncommon)
S - present in small numbers (a pair or less) andnot encountered daily even in prime habitat and season (Scarce)

Common Name	Scientific Name	Abundance	Observed in Wet Season	Observed in Dry Season
Tinamous – Tinamidae				
Little Tinamou	*Crypturellus soui*	F	Yes	No
Red-legged Tinamou	*Crypturellus erythropus*	F	Yes	No
Great Tinamou	*Tinamos major*	F	No	Yes
Cormorants – Phalacrocoracidae				
Neotropic Cormorant	*Phalacrocorax brasilianus*	U	Yes	No
Ibises – Threskiornithidae				
Green Ibis	*Mesembrinibis cayenninsis*	U	Yes	No
Vultures – Catharidae				
Black Vulture	*Coragyps atratus*	F	Yes	Yes
King Vulture	*Saroramphus papa*	F	No	Yes
Turkey Vulture	*Cathartes aura*	F	Yes	No
Greater Yellow-headed Vulture	*Cathartes melambrotus*	F	Yes	No
Hawks, Eagles – Accipitridae				
Swallow-tailed Kite	*Elanoides forficatus*	U	Yes	Yes
Plumbeous Kite	*Ictinia plumbea*	F	Yes	Yes
Crane Hawk	*Geranospiza caerulescens*	U	Yes	No
Gray Hawk	*Asturina nitida*	U	Yes	Yes
Great Black-Hawk	*Buteuogallus urubitinga*	U	Yes	No
Roadside Hawk	*Buteo magnirostris*	U	Yes	No
Harpy Eagle	*Harpia harpyja*	R	Yes	No
Falcons, Caracaras – Falconidae				
Collared Forest-Falcon	*Micrastur semitorquatus*	F	No	Yes
Black Caracara	*Daptrius ater*	U	Yes	Yes
Red-throated Caracara	*Ibycter americanus*	U	Yes	Yes
Yellow-headed Caracara	*Milvago chimachima*	U	Yes	Yes
Crested Caracara	*Caracara plancus*	F	No	Yes
Laughing Falcon	*Herpetotheres cachinnans*	U	Yes	Yes
Bat Falcon	*Falco rufigularis*	F	Yes	Yes
Curassows, Guans – Cracidae				
Little Chachalaca	*Ortalis motmot*	F	Yes	Yes
Spix's Guan	*Penelope jacquacs*	F	Yes	Yes

Blue-thoated Piping-Guan	*Pipile cumanensis*	F	Yes	No
Black Curassow	*Crax alector*	F	Yes	Yes
Rails – Rallidae				
Gray-necked Wood-Rail	*Aramides cajanea*	U	Yes	Yes
Sunbitterns – Eurypygidae				
Sunbitterns	*Eurypyga helias*	U	Yes	No
Trumpeters – Psophidae				
Gray-winged Trumpeter	*Psophia crepitans*	F	Yes	Yes
Pigeons, Doves – Columbidae				
Scaled Pigeon	*Patagionenas specious*	F	Yes	Yes
Pale-vented Pigeon	*Patagionenas cayennensis*	F	Yes	Yes
Plumbeous Pigeon	*Patagionenas plumbea*	F	Yes	No
White-tipped Dove	*Leptotila verreauxi*	F	Yes	Yes
Common Ground Dove	*Columbina passerina*	S	No	Yes
Gray-fronted Dove	*Leptotila rufaxilla*	F	Yes	No
Parrots – Psittacidae				
Red -bellied Macaw	*Orthopsittaca manilata*	F	Yes	No
Red-and-Green Macaw	*Ara chloropterus*	U	Yes	Yes
Green-rumped Parrotlet	*Forpus passerines*	A	No	Yes
Golden-winged Parakeet	*Brotogeris chrysoptera*	F	Yes	Yes
Lilac-tailed Parrotlet	*Touit batavicus*	U	No	Yes
Black-headed Parrot	*Pionites melanocephalus*	U	Yes	Yes
Caica Parrot	*Gypopsitta caica*	S	No	Yes
Blue-headed Parrot	*Pionus menstruus*	C	Yes	Yes
Dusky Parrot	*Pionus fuscus*	U	Yes	Yes
Yello-crowned Parrot	*Amazona ochrocephala*	C	Yes	Yes
Orange-winged Parrot	*Amazona amazonica*	C	Yes	Yes
Mealy Parrot	*Amazona farinosa*	C	Yes	Yes
Red-fan Parrot	*Deroptyus accipitrinus*	F	Yes	Yes
Cuckoos – Cuculidae				
Squirrel Cuckoo	*Piaya cayana*	C	Yes	Yes
Striped Cuckoo	*Tapera naevia*	S	No	Yes
Greater Ani	*Crotophaga major*	U	No	Yes
Smoothed-billed Ani	*Crotophaga ani*	C	Yes	Yes
Potoos – Nyctibccdae				
Great Potoo	*Nyctibius grandis*	U	Yes	Yes
Swifts – Apodidae				
Short-tailed Swift	*Chaetura brachyuran*	C	Yes	Yes
Band-rumped Swift	*Caetura spinicauda*	C	Yes	No
Gray-Rumped Swift	*Chaetura cinereiventris*	C	Yes	No
Fork-Tailed Palm-Swift	*Tachornis squamate*	C	Yes	No
White-collared Swift	*Sterptoprocne zonaris*	F	No	Yes
Hummingbirds – Trochilidae				
Long-tailed Hermit	*Phaethornis supercilliosus*	C	Yes	Yes
Reddish Hermit	*Phaethornis ruber*	C	Yes	Yes
Gray-breasted Sabrewing	*Campylopterus laripennis*	U	No	Yes
Little Hemit	*Phaethornis longuemareus*	F	Yes	No
Blue-fronted Lancebill	*Doryfera johannae*	F	Yes	No
White-necked Jacobin	*Florisuga mellivora*	F	Yes	No
Black-throated Mango	*Anthracothorax nigricollis*	F	Yes	No
Blue-chinned Sapphire	*Chlorestes notate*	F	Yes	No
Fork-tailed Woodnymph	*Thalurania furcate*	F	Yes	No
White - chested Emerald	*Amazilia brevirostris*	F	Yes	Yes
Glitering - throated Emerald	*Amazilia fimbriate*	F	Yes	No
Plain-bellied Emerald	*Amazilia leucogaster*	F	Yes	No
Crimson Topaz	*Topaza pella*	F	Yes	No
Trogons – Trogonidae				
White - tailed Trogon	*Trogon viridis*	C	Yes	Yes

Violaceous Trogon	*Trogon violaceus*	C	Yes	Yes
Black - tailed Trogon	*Trogon melanurus*	F	No	Yes
Kingfishers – Alcedinidae				
Ringed Kingfisher	*Megaceryly torquata*	F	Yes	No
Amazon Kingfisher	*Chloroceryle amazon*	F	Yes	No
Puffbirds – Bucconidae				
Black Nunbird	*Monasa atra*	C	Yes	Yes
Swallow-wing Puff Bird	*Chelidoptera tenebrosa*	C	Yes	Yes
Jacamars – Galbulidae				
Great Jacamar	*Jacamarops aureus*	F	Yes	No
Paradise Jacamar	*Galbula dea*	U	No	Yes
Toucans – Ramphastidae				
Green Aracari	*Pteroglossus viridis*	F	Yes	No
Black - necked Aracari	*Pteroglossus aracari*	F	Yes	Yes
Guianan Toucanet	*Selenidera culik*	F	Yes	No
Channel - billed Toucans	*Ramphastos vitellinus*	C	Yes	Yes
Red-billed Toucan	*Ramphastos tucanus*	C	Yes	Yes
Woodpeckers – Picidae				
Lineated Woodpecker	*Dryocopus lineatus*	C	Yes	No
Yellow-tufted Woodpecker	*Melanerpes cruentatus*	C	Yes	Yes
Chestnut Woodpecker	*Celeus elegans*	F	Yes	No
Cream-colored Woodpecker	*Celeus flavus*	F	Yes	Yes
Ringed Woodpecker	*Celeus torquatus*	F	Yes	Yes
Red-necked Woodpecker	*Campephilus rubricollis*	C	Yes	Yes
Crimson-crested Woodpecker	*Campephilus melanoleucos*	C	Yes	No
Ovenbirds – Furnariidae				
Rufous-tailed Foliage-gleaner	*Philydor ruficaudatum*	F	Yes	No
Woodcreepers – Dendrocolaptidae				
Plain-brown Woodcreeper	*Dendrocincla fuliginosa*	F	Yes	Yes
Wedge-billed Woodcreeper	*Glyphorynchus spirurus*	F	Yes	Yes
Amazonian - barred Woodcreeper	*Dendrocolaptes certthia*	F	Yes	No
Straight-billed Woodcreeper	*Xiphorhynchus picus*	F	Yes	Yes
Chestnut-rumped Woodcreeper	*Xiphorpynchuss pardalotus*	F	Yes	No
Typical Antbirds – Thamnophilidae				
Great Antshrike	*Taraba major*	U	No	Yes
Black-crested Antshrike	*Sakesphorus Canadensis*	F	Yes	Yes
Barred Antshrike	*Thamnophilus doliatus*	F	Yes	Yes
Pygmy Antwren	*Myrmotherula brachyuran*	F	Yes	No
Rufous-bellied Antwren	*Myrmotherula guttata*	U	No	Yes
Warbling Antbird	*Hypocnemis cantator*	U	No	Yes
Brown-bellied Antwren	*Myromotherula gutturalis*	F	Yes	No
Ash-winged Antwren	*Terenura spodioptila*	F	Yes	No
Gray Antbird	*Cercomacra cinerascens*	F	Yes	No
Dusky Antbird	*Cercomacra tyrannina*	F	Yes	No
Blackish Antbird	*Ceromacra nigrescens*	F	Yes	No
White-browed Antbird	*Myrmoborus leucophrys*	F	Yes	No
Black-chinned Antbird	*Hypocnemoides melanopogon*	F	Yes	No
Silvered Antbird	*Sclateria naevia*	F	Yes	No
Spot-winged Antbird	*Schistocichla leucostigma*	F	Yes	No
White-bellied Antbird	*Myrmeciza longipes*	F	Yes	No
Ferruginous-backed Antbird	*Myrmeciza ferruginea*	F	Yes	Yes
Black-throated Antbird	*Myrmeciza atrothorax*	F	Yes	No
White-plumed Antbird	*Pithys albifrons*	F	Yes	Yes
Ground Antbirds / Formicariidae				
Spotted Antpitta	*Hylopezus macularius*	S	No	Yes
Tyrant Flycatchers – Tyrannidae				
Yellow-bellied Elaenia	*Elaenia flavogaster*	F	No	Yes
Greenish Elaenia	*Myiopagis viridicata*	F	Yes	No

Forest Elaenia	*Myiopagis gaimardii*	F	Yes	No
Yellow Tyrannulet	*Capseimpis flaveola*	F	Yes	Yes
Pale-eyed Pygmy-Tyrant	*Atalotriccus pilaris*	F	Yes	Yes
Common Tody-Flycatcher	*Todirostrum cinereum*	F	No	Yes
Boat-billed Flycatcher	*Megarynchus pitangua*	F	Yes	Yes
Dusky-chested Flycatcher	*Myiozetetes luteiventris*	F	Yes	Yes
Rusty-margined Flycatcher	*Myiozetetes cayanensis*	F	Yes	Yes
Streaked Flycatcher	*Myiodynastes maculates*	F	No	Yes
Grey-capped Flycatcher	*Myiozetetes granadensis*	F	Yes	No
Yellow-throated Flycatcher	*Conopias parvus*	F	Yes	No
Piratic Flycatcher	*Legatus leucophaius*	F	Yes	Yes
Dusky-capped Flycatcher	*Myiarchus tuberculifer*	U	No	Yes
Sulphury Flycatcher	*Tyrannopsis sulphurea*	F	Yes	No
Brown-crested Flycatcher	*Myiarchus tyrannulus*	F	Yes	Yes
Social Flycatcher	*Myiozetetes similis*	F	Yes	No
Lesser Kiskadee	*Philphydor lector*	F	Yes	No
Great Kiskadee	*Pitangus sulphuratus*	F	Yes	Yes
White-throated Kingbird	*Tyrannus albogularis*	F	Yes	No
Tropical Kingbird	*Tyrannus melancholicus*	F	Yes	Yes
Eastern Kingbird	*Tyrannus tyrannus*	F	Yes	No
Gray Kingbird	*Tyrannus dominicensis*	F	Yes	No
Mourners, Becards, Tityras - Incertae Sedis				
Cinereous Becard	*Pachyramphus rufus*	S	No	Yes
Black-tailed Tityra	*Tityra cayana*	U	Yes	Yes
Cinnamon Attila	*Attilla cinnamomeus*	U	Yes	Yes
Bright-rumped Atilla	*Attilla spadiceus*	U	Yes	No
Cotingas – Cotingidae				
Guianan Red-Cotinga	*Phoenicircus carnifex*	F	Yes	No
Purple-throated Fruitcrow	*Querula purpurata*	F	Yes	Yes
Capuchinbird	*Perissocephalus tricolor*	U	Yes	No
White Bellbird	*Procnias albus*	U	Yes	No
Screaming Piha	*Lipaugus vociferans*	F	Yes	Yes
Manakins – Pipridae				
White-throated Manakin	*Corapipo gutturalis*	U	No	Yes
Blue-backed Manakin	*Chiroxiphia pareola*	U	No	Yes
White-bearded Manakin	*Manacus manacus*	F	Yes	No
White-crowned Manakin	*Pipra pipra*	F	Yes	No
Golden-headed Manakin	*Pipra erythrocephala*	F	Yes	Yes
Tiny Tyrant-Manakin	*Tyranneutes virescens*	U	No	Yes
Saffron-crested Tyrant-Manakin	*Neopelma chryoscephalum*	F	Yes	Yes
Vireos – Vireonidae				
Red-eyed Vireo	*Vireo olivaceus*	F	Yes	Yes
Swallows – Hirundinidae				
Brown-chested Martin	*Progne tapera*	U	No	Yes
White-winged Swallow	*Tachycineta albiventer*	U	No	Yes
Blue-and-White Swallow	*Notiochelidon cyanoleuca*	F	Yes	No
White-banded Swallow	*Atticora fasciata*	F	Yes	Yes
Wrens – Troglodytidae				
Coraya Wren	*Thryothorus coraya*	F	Yes	Yes
Buff-breasted Wren	*Thryothorus leucotis*	F	Yes	Yes
Southern House-Wren	*Troglodytes musculus*	F	Yes	Yes
Musician Wren	*Cyphorhinus arada*	U	No	Yes
Thrushes / Turdidae				
Bare-eyed Thrush	*Turdus nudigensis*	U	No	Yes
White-necked Thrush	*Turdus albicollis*	U	No	Yes
Pale-eyed Thrush	*Turdus leucops*	U	Yes	No
Tanagers – Tharupidae				
White-shouldered Tanager	*Tachyphonus luctuosus*	U	No	Yes

White-lined Tanager	*Tachyphonus rufus*	F	Yes	Yes
Silver-beaked Tanager	*Ramphocelus carbo*	F	Yes	Yes
Blue-gray Tanager	*Thraupis episcopus*	F	Yes	Yes
Turquiose Tanager	*Tanagra Mexicana*	F	Yes	Yes
Palm Tanager	*Thraupis palmarum*	F	Yes	Yes
Blue-gray Tanager	*Thraupis episcopus*	U	No	Yes
Blue Dacnis	*Dacnis cayana*	U	No	Yes
Green Honeycreeper	*Chlorophanes spiza*	U	No	Yes
Spotted Tanager	*Tanagra punctate*	F	Yes	No
Purple Honeycreeper	*Cyanerpes caeruleus caerulus*	F	Yes	Yes
Red-legged Honeycreeper	*Cyanerpes cyaneus*	U	No	Yes
Bananaquit	*Coereba flaveola*	F	Yes	Yes
Cardueline Finches – Fringillidae				
Violaceous Euphonia	*Euphonia violacea*	F	Yes	Yes
Emberizine Finches – Emberizidae				
Blue-black Grasssquit	*Volatina jacarina*	F	No	Yes
Ruddy-breasted Seedeater	*Sporophila minuta*	F	No	Yes
Chestnut-bellied Seedeater	*Sporophila castaneiventris*	F	Yes	Yes
Grosbeaks, Saltators / Cardinalidae				
Buff-throated Saltator	*Salator maximus*	S	No	Yes
Yellow-green Grosbeak	*Caryothraustes Canadensis*	F	No	Yes
Blue-black Grosbeak	*Cyanocompsa cyanoides*	S	No	Yes
New World Blackbirds - Icteridae				
Moriche Oriole	*Icterus chrysocephalus*	F	Yes	No
Yellow Oriole	*Icterus nigrogularis*	F	Yes	No
Yellow-rumped Cacique	*Cacicus cela*	C	Yes	No
Crested Oropendola	*Psarocolius decumanus*	C	Yes	Yes
Green Oropendola	*Psarocolius viridis*	C	Yes	Yes

11.2.3.3 Mammals

The 2009 mammalian surveys recorded a decrease in species richness from Wet to Dry season, possibly due to lack of water and associated unavailability of food within the area and migration to other locations where water was available. Increase human activity within the area may have also contributed to migration to other areas. The Wet Season documented 17 species of mammals as compared with 11 species during the Dry Season (Table 46).

Table 46: 2009 Mammalian Assessment at Marudi Mountain, Guyana

Abundance Codes:
U – small numbers recorded, but not encountered daily (uncommon)
F – less than 5 individuals recorded daily (fairly common)
C – observed between one to ten individuals daily (common)
A – observed more than ten individuals daily (abundant)
R – observed less than once a day (rare)
O – observed once (status unknown)

Local Name	Scientific Name	Abundance	Present in Wet Season	Present in Dry Season
Common Porcupine	*Coendou prehensilis*	F	yes	No
Tapir	*Tapirus terrestris*	U	yes	Yes
Agouti	*Dasyprocta leporinus*	C	yes	Yes
Red Brocket Deer	*Mazama Americana*	U	yes	Yes
Labba	*Agouti paca*	C	yes	Yes
Jaguar	*Panthera once*	U	yes	Yes
Guianan Squirrel	*Sciurus aestuans*	C	yes	No
Collared Peccary	*Pecari tajacu*	U	yes	No
Giant Armadillo	*Priodontes maximus*	C	yes	No
Nine banded Armadillo	*Dasypus novemcinctus*	C	yes	No
Black Spider Monkey	*Ateles paniscus*	C	yes	Yes
Common Squirrel Monkey	*Saimiri scurries*	C	yes	Yes
Guiana bearded Saki	*Chiropotes chiropetes*	C	yes	Yes

Sloth	*Bradypus tridactylus*	R	yes	No
Cuvier's Terrestrial Spiny Rat	*Proechimys cuvieri*	C	yes	No
Common Opossum	*Didelphis marsupialis*	C	yes	No
Howler Monkey	*Alouatta seniculus*	C	yes	Yes
Savannah Deer	*Odocoileus virginianus*	C	No	Yes
Tayra	*Eira barbara*	U	No	Yes

11.2.3.4 Herpetofauna

The 2009 survey identified 24 species of herpetofauna from 13 species of amphibians and 11 species of reptiles in the wet season. A total of 12 species of herpetofauna, with seven (7) species of amphibians and five (5) species of reptiles were identified in the dry season (Table 47). Many of the species encountered are common to the wider geographic area and Guyana.

Table 47: 2009 Herpetofaunal Assessment at Marudi Mountain, Guyana

Abundance Codes:
U – small numbers recorded, but not encountered daily (uncommon)
F – less than 5 individuals recorded daily (fairly common)
C – observed between one to ten individuals daily (common)
A – observed more than ten individuals daily (abundant)
R – observed less than once a day (rare)
O – observed once (status unknown)

Local Name	Scientific Name	Abundance	Present in Wet Season	Present in Dry Season
Amphibians				
Brilliant-thighed poison frog	*Allobates femoralis*	F	Yes	Yes
Three-stripped poison arrow frog	*Ameerega trivittata*	C	Yes	No
Knudsen's thin-toed frog	*Leptodactylus knudensi*	U	Yes	No
Werner's Toad	*Rhaebo nasicus*	C	Yes	No
Knudsen's thin-toed frog	*Leptodactylus knudensi*	C	Yes	No
Lutz's thin-toed frog	*Leptodactylus lutzi*	U	Yes	No
-	*Hyla punctate*	O	Yes	No
-	*Bufo complexe margaritifer*	A	Yes	No
-	*Eleutherodactylus chiastonotus*	U	Yes	No
Peter's thin-toed frog	*Leptodactylus petersii*	C	Yes	No
-	*Osteocephalus spp.*	C	Yes	No
-	*Hypsiboas raniceps*	C	Yes	No
-	*Hypsiboas boans*	F	Yes	No
-	*Scinax rubra*	U	No	Yes
-	*Leptodactylus mystaceus*	U	No	Yes
Giant Toad	*Rhinella marinus*	U	No	Yes
Map treefrog	*Hypsiboas geographica*	U	No	Yes
Giant Monkey Toad	*Phyllomedusa bicolor*	U	No	Yes
Spotted Toad	*Rhaebo guttatus*	U	No	Yes
Reptiles				
Grooved side neck turtle	*Platemys platycephala*	U	Yes	No
-	*Gonatodes humeralis*	F	Yes	Yes
-	*Leposoma percarinatum*	C	Yes	Yes
Plica Lizard	*Plica plica*	F	Yes	No
-	*Anolis fuscoauratus*	F	Yes	Yes
Green-garden Lizard	*Ameiva ameiva*	A	Yes	Yes
-	*Kentropyx calcarata*	A	Yes	Yes
Bushmaster	*Lachesis muta*	R	Yes	No
Labaria	*Bothrops atrox*	U	Yes	No
Parrot Snake	*Leptophis ahaetulla*	U	Yes	No
Northern Tegu Lizard/Salipenter	*Tupinambis teguixin*	U	Yes	No

11.2.3.5 Macroinvertebrates

A total of 20 families/orders of macro-invertebrates were identified in the area during the wet season and a total of 8 families/orders of macro-invertebrates were identified during the dry season of 2009 (Table 48). Most of the families and/or orders were present at all sampling sites, except for the Annelidae, Diptera and Scorpiones.

Table 48: 2009 Assessment of Macroinvertebrates at Marudi Mountain, Guyana

Abundance Codes:
U – small numbers recorded, but not encountered daily (uncommon)
F – less than 5 individuals recorded daily (fairly common)
C – observed between one to ten individuals daily (common)
A – observed more than ten individuals daily (abundant)
R – observed less than once a day (rare)
O – observed once (status unknown

Common Name	Family/Order	Species	Abundance	Observed in Wet Season	Observed in Dry Season
Segmented worms	Annelidae	-	C	Yes	No
Spiders	Aranae	-	A	Yes	Yes
Cockroaches	Blattidae	-	A	Yes	No
Beetles	Coleoptera	-	A	Yes	Yes
Millipedes	Diplopoda	-	F	Yes	No
True flies	Diptera	Cowfly	F	Yes	Yes
True bugs	Hemiptera	-	C	Yes	No
Water threaders	Hydrometridae	-	C	Yes	No
Ants & Bees	Hymenoptera	Leaf cutters ants, Red ants, Bees, Wasps	A	Yes	Yes
Butterflies	Lepidoptera	Papalio: Ascolins sp Eurytides: Molops sp. Dismorphia: Pinthaeus sp., Amphione sp. Archonias: Bellona hyrnetho Melinaea: Marsaeus messenina, Marsaeus mothome Thyridia: Aedesia sp Philaetheia: Dido sp. Dryus: Julia sp. Heliconias: Numata idalion, Numata sp. Messene sp., Doris sp., Melponene bellula Pierella: Hyalinus sp. Euptychia: Mollis sp., Binocula sp., Cephus sp., Ocypete sp., Lea sp., Tricolor sp. Morphidae: Rhetenor sp,, Ggranadensis sp., Deidamia deidamia Marpesia: Corinna sp., Catonephele antione, Adelpha phylaca Prepona: Demophon sp Lycaenidae: Theocritus sp., Phaleros sp., Orgia sp. Riodinidae: Emesis Lucinda, Euselasia issoria, Semomesia capanoca, Eurybia donna, Thermone pais, Amarynthis meneria, Stalachtis calliope	A	Yes	Yes
Moths	Lepidoptera	-	F	Yes	No
Dragonflies & Damselflies	Odonata	-	F	Yes	Yes
Grasshopper & Cricket	Orthoptera	-	F	Yes	Yes
Stick insects	Plasmidae	-	F	Yes	No

Scorpion	Scorpiones	-	F	Yes	No
Mosquitos	Culicidae	-	A	Yes	No
Fireflies	Lampyridae	-	U	Yes	No
Crab	Decapoda-Brachyura	-	U	Yes	No
Shrimp	Decapoda-Caridea	-	U	Yes	No
Snails	Gastropoda	-	U	Yes	No
Katydids	Tettigoniidae	-	U	Yes	No

All families/orders were abundant or fairly common at each site, except for the Crab, Shrimp and Fireflies. The most abundant orders/families were Aranae, Hydrometridae, and Lepidoptera, with Lepidoptera being the largest with 39 species of butterflies, followed by Aranae which contained 10 species of spider including touranchellas.

Coleopteran, Hymenoptera and Odonata each consisted of five species, including several significantly large long horn beetle and jewel beetles, the leaf-cutters, and dragonflies and damselflies respectively.

Sampling during the start of the wet season and the presence of significant fruiting and flowering plants within the area probably accounts for the significant presence and observation of Lepidotera and other families in the wet season. The low number documented in the dry season is probably due to little water being available within the area for breeding and feeding activities. Fruiting trees were limited in the area during the dry season.

11.2.4 Aquatic Resources

11.2.4.1 Fishes

During the 2009 surveys, the creeks contained little water to support icthyofaunal life. Only Locust Creek which ran adjacent to the Camp, and Peace Creek had a few centimeters of water during the dry season with the depth of water in Locust Creek being approximately 1 m. All creeks were sediment free in 2009 except for some areas along Locust Creek.

A total of four (4) species of fishes were documented during the 2009 dry season as compared to a single species documented during the 2009 wet season. The depth of water in the creeks probably resulted in the low number of species observed. There may be several reasons a greater number of species, (3), were recorded during the dry season including the fact that during the dry season the water levels were significantly lower which prevented migration of some species within the area to other creeks and waterways. Fishes recorded by the 2009 surveys are detailed in Table 49.

Table 49: 2009 Assessment of Fishes at Marudi Mountain, Guyana

Abundance Codes:
U – small numbers recorded, but not encountered daily (uncommon)
F – less than 5 individuals recorded daily (fairly common)
C – observed between one to ten individuals daily (common)
A – observed more than ten individuals daily (abundant)
R – observed less than once a day (rare)
O – observed once (status unknown)

Local Name	Scientific Name	Abundance	Observed in Wet Season	Observed in Dry Season
-	*Aphyocharax erythrurus*	O	Yes	No
Yarrow	*Hoploerythrinus unitaeniatus*	U	No	Yes
Huri	*Hoplias marabalicus*	U	No	Yes
Kassie	*Rhamdia holomelas*	U	No	Yes
-	*Astyanax spp.*	U	No	Yes

11.2.4.2 2017-2018 Biodiversity Survey Methodology

Terrestrial and Aquatic plots for the 2017 - 2018 surveys were selected based on the topography (vegetation type, habitat characteristics), the level of disturbance and accessibility. The exact locations were used for both the wet and dry season surveys to determine whether there were temporal variations in the areas surveyed. The location

and habitat description of each terrestrial and aquatic sample plots utilized for the 2017-2018 surveys are described in Table 49 and 50 respectively.

11.2.5 2017-2018 Methodology

During 2017 – 2018, floral and faunal data were collected to identify sensitive species based on the IUCN RED LIST of species and CITES Appendix.

11.2.5.1 Floral Survey

The floral surveys consisted of a terrestrial forest inventory (FI) and a floristic survey. Floristic surveys were conducted in the plots established for the FI. Vascular plants species such as shrubs, herbs, and lianas (Pteridophytes and Angiosperms), not included in the FI, were recorded during the floristic survey. Five sample plots were established for the floral survey in 2017 - 2018. A cluster of 5 circular plots were established in each sample plot. The circles were established in the pattern shown in Figure 27 below. The center to center distance of each of the larger circle was set at 100 m. Each circle or the main plot had a radius of 18 m. A smaller inner circle with a radius of 8 m was established concentric with the larger circle as depicted in Figure 28.

All trees (including standing dead trees) of 20 cm DBH and above were recorded over the main circle plot. Floral information recorded per plot included:

- Location (UTM Coordinate (Easting and Northing) of each sample plot and site elevation
- Type of environment and physiographic position of subplot and soil type
- Plant species scientific name and common name
- Estimated height of commercial of timber, for DBH of 35 cm and above
- Seasonal variations of Taxa (family and species)
- Species number and Habitat variations (leaf litter thickness, number of seedlings, plant species fruiting or flowering, etc).

Volumes were estimated for each plot of mature trees with DBH of 35 cm and above to estimate the volume of commercial and cultural use timber of the area. Data was collected and analyzed using the DAFOR ranking system. This method of evaluation involves assigning species as dominant, abundant, frequent, occasional or rare. Plants in each survey plot were determined as belonging to one of three strata. These were respectively Strata A: all mature trees greater with DBH equal to or greater than 20 cm, Strata B: Shrubs Layer Smaller Woody Stems; and Strata C the Ground Layer Seedlings/herbaceous stems.

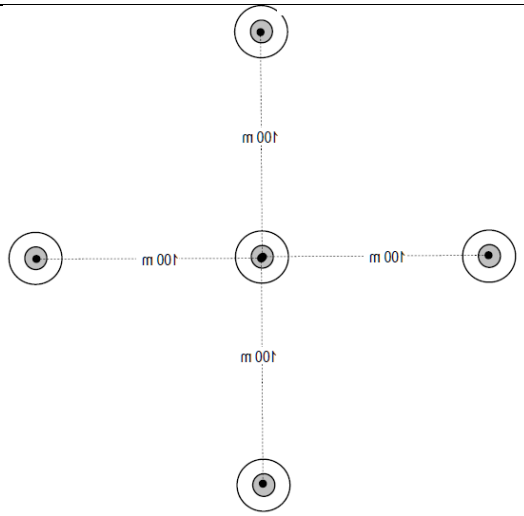


Figure 27 - Cluster of Circular Sample Plots

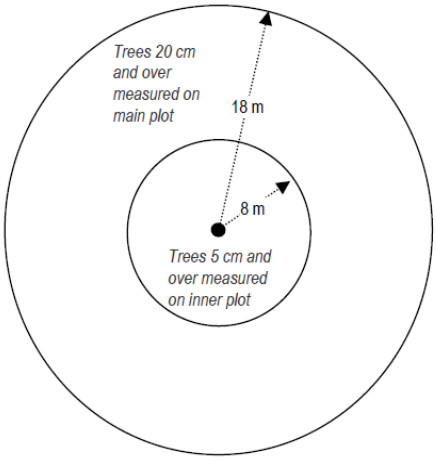


Figure 28 - Main Circle Plot Design

Floral data recorded on data sheets included plot composition (plot number, species diameter at breast height (DBH)), plot attributes (including location and soil type), and taxa specific and tree attributes. Unknown varieties were sampled, preserved and returned to Georgetown for identification. Each plot was classified as primary or secondary growth to allow inferences to be drawn about the degree of disturbance within each plot.
Timber volume were estimated using the following formula (Adopted from the GFC Metrification Manual for Timber Species, 1999):

Timber Volume (m^3) = $0.7854*D^2L*0.0001$

Where D = Diameter at Breast Height (DBH)
L = log length

Biomass estimates were developed based on the pan-tropical biomass equation of Chave et al (2005). The Chave et al (2005) biomass allometric model was validated as applicable for use in the Guyana context in Alder and van Kuijk (2009) baseline assessment of forest carbon in Guyana. Biomass estimates were calculated strictly for trees with DBH greater than 5 cm and for saplings with BDH less than 5 cm. Carbon accounting estimates were expressed both in tonnes carbon per ha, ($tC\ ha^{-1}$) or tonnes of carbon dioxide-equivalent per ha, ($tCO_2\text{-}e\ ha^{-1}$). The IPCC (2006) recommended conversion factor of 0.5 for biomass to carbon was used. The CO_2-equivalent, tonnes of carbon was determined by multiplying by the ratio of 44/12, which is the ratio of the atomic weights of Carbon Dioxide (CO_2)

to Carbon (C).

The Chave et. Al. (2005) model is as follows:

AGB = wood density (g/cm^3) x exp(-1.499 + 2.148ln(DBH) + 0.207(ln(DBH))^2 – 0.0281(ln(DBH))^3)

Wood densities were derived species by species from the database of Zanne et al (2009). These are available for 134 Guyanese species, including all common forest trees. For species with unknown wood density a weighted average wood density of 0.66 g/cm^3 was utilized as recommended by ter Steege (2001). Below ground tree (root) biomass was calculated as a root:shoot (R:S) ratio relative to above ground biomass. This method is implicit in the IPCC (2006) equations for forest biomass calculations. The following root:shoot ratios adopted from Steege (2001) were utilized for the forest types encountered within this concesssion:

Mixed Forest R:S ratio = 0.220

Necromass (dead wood and litter) was estimated using an expansion factor of 8.6 % (adopted from Steege (2001)) relative to tree biomass.

The volume of commercial and cultural use timber reported reflects the volumes computed over the transect area only. These volumes were extrapolated over the plot to determine the volume of wood available within each plot.

11.2.5.2 Faunal Surveys

The faunal surveys utilized live-capture traps and mist netting for volant mammals and birds. Active searches were undertaken mainly to obtain information on herpetofauna and macro-invertebrates. Hook and line were used to capture middle sized and large fish and gill nets and seines for smaller sized fish. Active searches were used for benthic organisms.

Faunal plots were established in the general vicinity of the floral plots during all surveys. At each plot, a main forest transect approximately 2 km in length was established for the sampling of avifauna, mammals and herpetofauna. Different vertebrate groups were sampled at discrete intervals along the main transect to avoid and/or minimize interference between methodologies and sampling of different terrestrial vertebrate groups. Additional sampling was undertaken in sections of each transect which exhibited micro-habitat cues or features for the vertebrate group surveyed. The techniques utilized for the faunal surveys are presented in the following sections.

11.2.5.2.1 Non-Volant Mammals

Transects were selected based on soil and forest types. To ensure exhaustive survey of both large and small mammals, several census techniques were conducted each day along the transects to determine species presence, distribution and relative abundance. These techniques included trapping, Visual Encounter Surveys (VES), Auditory Encounter Surveys (AES), track identification and opportunistic sighting. At each site three days of survey were undertaken by a principal investigator, three observers and two field assistants.

Visual Encounter and Auditory Encounter surveys and track identification were executed by walking the transects from 5:00 hr – 7:00 hr and from 17:30 hr –8:30 hr, or longer periods, each day, depending on the amount of wildlife activities present. Tracks were identified by local guides. All evidence in the form of non-volant mammal carcasses, footprints, resting sites and feeding ground were recorded during these searches. Tracks, scratch marks and actual sightings were photographed and/or recorded.

Camera traps were placed along the transects at points on obvious wildlife trails, with creek beds along the trails being given preference. Camera traps were stationed at these locations for ten days during the wet season survey and for eight days during the dry season survey.

Small mammals were targeted with baited traps which were placed at strategic locations along the transect on the first day at each new site. Traps were checked in the evening for captures and were retrieved on the last day of

survey for each transect. Three sizes of folding live traps were used ((6 x 6 x 16"), (6 x 6 x 26") and (28x 12x 12")) and baited with sardines, sunflower seeds, nut butter and bread.

The numbers of daily sightings of individuals per species for each site was recorded and was used to determine the relative abundance of all species as follows:

- C: Common, more than 5 individuals encountered daily, observed on at least 90% of days at each site
- F: Fairly common, fewer than 5 individuals encountered daily, observed on at least 50% of days at each site
- U: Uncommon, small numbers of individuals encountered, observed on fewer than 25% of days

11.2.5.2.2 Volant Mammals – Bats

Mist nets locations were determined by considering the forest structure of each site, openness of the understory, forest type, potential roosting, accessibility and possible foraging sites as evidenced by possible food sources such as insects, fruits and flowering plants. A total of twelve understory mist nets (Dimensions 12 x 2.5m, mesh size 36 mm and four pockets) were installed in each of the five transects. The nets were placed in a perpendicular manner to increase and optimize the sample effort in the area.

Nets were opened from 17:00 hrs to 23:00 hrs. daily for each of the three (3) days per site. Nets were checked every half hour to an hour for captured individuals. After removal, bats were identified using "Field Key to the Bats of the Guianan Sub-Region, (Lim and Engstrom from the Royal Ontario Museum). Forearm, reproductive and other measurements were taken to aid identification where necessary. Photographs of collected species were also taken. Unidentified specimens were placed in individual cloth bags and transported to camps to facilitate further identification and were then released.

11.2.5.2.3 Birds

Visual Encounter Surveys (VES) and Auditory Encounter Surveys (AES) were conducted along a 2 km transect of each survey plot to determine species presence, distribution and relative abundance. Transects were walked, each day, from 07:30 hrs to 09:30 hrs and again from 15:00 hrs to 17:30 hrs, or longer depending on the amount of wildlife activities present. Field identification was done using Birds of Northern South America; Vol 2 (Install *et al*. 2006) and Birds of South America: Non-Passerines (Erize *et al*. 2006). Vocal identifications of many of the cryptic and canopy bird species were verified by using playback of pre-recorded bird songs, via an Olympus WS-823 digital recorder. Mist-netting was conducted at all 3 survey sites. Nets were opened from 07:30 hrs to 14:30 hrs. All birds caught were photographed, identified and released within 50 meters from where they were caught.

11.2.5.2.4 Herpetofauna – Amphibians and Reptiles

Visual Encounter Surveys (VES) and Auditory Encounter Surveys (AES) were conducted along a 2 km transect at each survey plot to determine species presence, distribution and relative abundance. Patch sampling or area searches of habitats (micro-habitats and habitat-patches of the reptiles and amphibians, for example, small pools and wet areas) were conducted during the day and night. Nocturnal VES and AES survey were conducted at 18:00 hrs and 20:00 hrs for approximately 1.5 to 2 hours via transect walks along the main road and secondary trails, focusing on wet areas. Hand held torch lights and headlamps were used to search for reptiles and amphibians. Caimans were typically located by their eye-shine first and approached to confirm identification and possibly photographed. A digital voice recorder was also used as a playback tool of pre-recorded anuran calls to assist the survey team to identify species. General searches for amphibians and reptiles around the campsites were also conducted and opportunistic observations recorded.

11.2.5.2.5 Macro-Invertebrates

The macro-invertebrate survey methodology included visual observations, timed searches, destructive sampling and litter leaf searches. Visual observations were done by walking at a uniform pace along the main transect and recording macro-invertebrates observed within 5 m on either side of transects. This method facilitated the sampling of diurnal lepidopteras and ground dwelling macro-invertebrates, flying and perching macro-invertebrates. Timed

searches were conducted for 40 minutes along the main transects at nights from 10:00 -12:00 pm and during the twilight from 16:30 to 18:00 hrs. This was done to survey nocturnal macro invertebrates. Destructive sampling was also used to survey macro invertebrates that conceal themselves under dead wood, tree buttresses and rocks. Leaf litter searches were conducted along the main transect and open trails and roads to sample terrestrial macro-invertebrates that conceal themselves under tree buttresses, rocks and dead wood.

Benthic macro-invertebrates were actively sampled by using kick nets. Sample locations were placed at approximately 50 m intervals, beginning downstream and moving upstream. Stream beds substrates and water vegetation were aggressively disturbed to drive organisms into the nets. Micro-invertebrates were recorded, when encountered, in all transects. Macro Invertebrates were classified to the taxa Order due to the difficulty of identifying and classifying them to the species level.

11.2.5.2.6 Fish and Benthic Organisms

The aquatic survey encompassed both benthic population and fish diversity. Approximately 3 days were spent at each of the sampling sites during the wet season survey and 2 days during the dry season survey. To ensure that the sites were exhaustively sampled different sampling gears were used, to capture both benthic and fish population. The gears used at the sampling sites differed based on the environment and the width and depth of the water body.

A total of seven (7) water channel were located, however, three of the streams closest to each other was considered as one survey site. Four sampling sites were developed. Sampling method was executed based on the size of the water body. In larger channels gillnets were used, however, smaller sites only facilitated the smaller equipment. The sampling included

- Cast Nets and Gillnets; set out based on the depth, width and velocity of the water body. In areas where gillnets were used, these nets were checked every morning at 8:00 am and afternoon at 5:00 pm
- Dip Nets; used in all stream types to capture both benthic organisms and small fish populations. For extremely congested sites, the streams were sampled to the farthest extent possible, based on the width of the stream and quantity of water
- Hook and line fishing; based on the velocity of the water and the depth. Approximately 2 hours of fishing was done on each aquatic transect
- Spring Hooks; used in extremely deep ponds to compliment the other sampling since the water depth prevented the researcher and assistants from entering the water. Drag sienes were used where stream width exceeded 1 m and stream depths were less than 1 m.

11.2.6 2017- 2018 Biodiversity Surveys Results

The forest within the concession is home to a variety of vegetation that are used for commercial as well as domestic purposes. Several fruiting trees were identified during each survey. Fruiting trees included Ants bush (*Cordia nodosa*), Barakaro (*Ormosia coccinea*), Bulletwood (*Manilkara bidentata*), Crabwood (*Carapa guianensis*), Dallibana (*Geonoma baculifera*), Dukuria (*Sacoglottis aff. Cydonioides*), Fig tree (*Ficus guianensis*), Haiawaballi (*Tetragastris altissima*), Kamahora (*Pouteria venosa*), Kamakuti (*Bombax flaviflorum*), Kokoritiballi (*Pouteria cuspidata*), Kurokai (*Protium heptaphyllum*) and Whitey (*Inga jenmanii*).

The concession has experienced significant disturbance and habitat degradation which has created a modified habitat. No species or habitat of major concern was documented during the survey. Species recorded within the concession are widespread throughout their ranges within Guyana, the Guiana Shield and Amazonia.

11.2.6.1 Flora

A total of 79 plant species representing 40 families were recorded during the wet season survey of 2017. Leguminosae, Chrysobalanaceae, Sapotaceae and Palmae were the most abundant families recorded within the mixed forest during the survey. *Ormosia coccinea* was the most frequently encountered species of the family

Leguminosae (also referred to as Fabaceae), while *Sclerolobium micropetalum* and *Peltogyne venosa* were rarely encountered.

A total of 79 plant species representing 40 families were also recorded during the dry season survey of 2018. Leguminosae, Chrysobalanaceae, Sapotaceae and Palmae were also the most abundant families recorded within the mixed forest during the survey. *Ormosia coccinea* was the most frequently encountered species of the family Leguminosae (also referred to as Fabaceae), while *Sclerolobium micropetalum* and *Peltogyne venosa* were rarely encountered. There was no species composition variation from the wet to dry season, however, there was a variation with respect to flowering and fruiting plant.

Frequently encountered species of the family Chrysobalanaceae included *Alexa imperatricis, Licania guianensis, Licania heteromorpha,* and *Couepia exflexa,* however, *Licania alba* and *Parinari campestris* were rarely encountered. The Mixed Forest was dominated by the species *Panicum pilosum* of the Gramineae family, *Pityrogramma spp*. of the Adiantiaceae family and *Sloanea cf. guianensis* of the Elaeocarpaceae family.

True Guyana endemics Common Baromalli (*Catostemma commune*) and Marishiballi *(Licania densiflora)* were frequently encountered within the mixed forest during the wet season survey of 2017, while Guiana Shield endemic Black Kakaralli (*Eschweilera sagotiana*) was determined to be frequent to occasional. The floral survey recorded Wadara (*Couratari guianensis*), which is listed as vulnerable species (CITIES). The Guava Skin Kakaralli (*Eschweilera alata*) and Okokonshi (*Quiina indigofera)*, are listed as Rare Plants by the IUCN Red List. Floral species recorded by the 2017-2018 surveys are detailed in Table 51.

Table 51: Floral Species Recorded During 2017- 2018 Surveys

Common Name	Scientific Name	Family Name	Recorded in 2017 Wet Season	Recorded in 2018 Dry Season
Fern	*Pityrogramma spp.*	Adiantiaceae	Yes	Yes
Arara broad leaf	*Unonopsis spp.*	Annonaceae	Yes	Yes
Black Yari Yari	*Guatteria punctate*	Annonaceae	Yes	Yes
White Yari Yari	*Duguetia pauciflora*	Annonaceae	Yes	Yes
Dog stone	*Tabenaemontana undulata*	Apocynaceae	Yes	Yes
Dukali*	*Parahancornia fasciculate*	Apocynaceae	Yes	Yes
Yarula	*Swartzia jenmani*	Apocynaceae	Yes	Yes
Yarula (Black)	*Aspidosperma excelsum*	Apocynaceae	Yes	Yes
Matchwood	*Schefflera morototonii*	Araliaceae	Yes	Yes
Nibi	*Heteropsis flexuosa*	Areacaceae	Yes	Yes
Understorey palm	*Bactris spp*	Areacaceae	Yes	Yes
Manicole	*Euterpe oleracea*	Arecaceae	Yes	Yes
Turu	*Jessenia bataua*	Arecaceae	Yes	Yes
Common Baromalli*	*Catostemma commune*	Bombacaceae	Yes	Yes
Ants bush	*Cordia nodose*	Boraginaceae	Yes	Yes
Duka*	*Protium decandrum*	Burseraceae	Yes	Yes
Haiawballi	*Protium tenuifolium*	Burseraceae	Yes	Yes
Kurokai*	*Protium heptaphyllum*	Burseraceae	Yes	Yes
Ulu	*Trattinnickia burserifolia*	Burseraceae	Yes	Yes
Kabukalli*	*Goupia glabra*	Celastraceae	Yes	Yes
Burada*	*Parinari campestris*	Chrysobalanaceae	Yes	Yes
Fine Leaf Counter*	*Licania sp.*	Chrysobalanaceae	Yes	Yes
Kairiballi	*Licania heteromorpha*	Chrysobalanaceae	Yes	Yes
Kauta*	*Licania guianensis*	Chrysobalanaceae	Yes	Yes
Kautaballi	*Licania alba*	Chrysobalanaceae	Yes	Yes
Marishiballi*	*Licania densiflora*	Chrysobalanaceae	Yes	Yes
Fukadi*	*Terminalia Amazonia*	Combretaceae	Yes	Yes

Conga Cane	*Costus Arabicus L.*	Costaceae	Yes	Yes
Waiaballi	*Tapura guianensis*	Dichapetalaceae	Yes	Yes
Aruadan	*Sloanea cf. guianensis*	Elaeocarpaceae	Yes	Yes
Haiahaia	*Sapium Jenmanii*	Euphorbiaceae	Yes	Yes
Iron Mary	*Chaetocarpus schomburgkianus*	Euphorbiaceae	Yes	Yes
Mabwa	*Sapium jenmanii*	Euphorbiaceae	Yes	Yes
Swizzle Stick	*Mabea Piriri Aubl*	Euphorbiaceae	Yes	Yes
Aromata*	*Clathrotropis spp.*	Fabaceae	Yes	Yes
Darina*	*Hymenolobium flavum*	Fabaceae	Yes	Yes
Bamboo	*Panicum pilosum*	Gramineae	Yes	Yes
Asashi	*Rheedia acuminate*	Guttiferae	Yes	Yes
Dukuria *	*Sacoglottis aff. Cydonioides*	Humiriaceae	Yes	Yes
Muharoko	*Eleutherine Bulbosa*	Iridaceae	Yes	Yes
Baradan*	*Ocotea tomentella*	Lauraceae	Yes	Yes
Brown silverballi	*Aniba cf. riparia*	Lauraceae	Yes	Yes
Ginger gale silverballi	*Aniba cf. guianensis*	Lauraceae	Yes	Yes
Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	Yes	Yes
Yellow Silverballi*	*Aniba ovalifolia*	Lauraceae	Yes	Yes
Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	Yes	Yes
Guava Skin Kakaralli*	*Eschweilera alata*	Lecythidaceae	Yes	Yes
Monkey Pot*	*Lecythis zabucajo*	Lecythidaceae	Yes	Yes
Wadara*	*Couratari guianensis*	Lecythidaceae	Yes	Yes
White Kakaralli	*Eshweilera wachenheimii*	Lecythidaceae	Yes	Yes
Rose of the Mountain	*Brownea latifolia*	Leguminosae– Caesalp	Yes	Yes
Maporokon*	*Inga alba*	Leguminosae– Mimos	Yes	Yes
Warakosa	*Inga thibaudiana*	Leguminosae– Mimos	Yes	Yes
Tatabu*	*Diplotropis purpurea*	Leguminosae– Papil	Yes	Yes
Kaditiri	*Sclerolobium micropetalum*	Leguminosae-caesalp	Yes	Yes
Whitey	*Inga jenmanii*	Leguminosae-mimos	Yes	Yes
Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	Yes	Yes
Tonka Bean *	*Dipteryx oradata*	Leguminosae-Papil	Yes	Yes
Purple Heart	*Peltogyne Venosa*	Leguminosea- Caesalp	Yes	Yes
Mokru	*Ischnosiphon arouma*	Marantaceae	Yes	Yes
Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	Yes	Yes
Wakaradan	*Miconia cf. ruficalyx*	Melastomataceae	Yes	Yes
Crabwood*	*Carapa guianensis*	Meliaceae	Yes	Yes
Red Cedar	*Cedrela oradata*	Meliaceae	Yes	Yes
Muniridan*	*Siparuna guianensis*	Monimiaceae	Yes	Yes
Cowwood*	*Bagassa guianense*	Moraceae	Yes	Yes
Letterwood *	*Brosiumum guianense*	Moraceae	Yes	Yes
Heliconia	*Heliconia spathocircinata*	Musaceae	Yes	Yes
Wild Banana	*Heliconia Spathocircinata*	Musaceae	Yes	Yes
Hill Dalli *	*Virola sebifera*	Myristicaceae	Yes	Yes
Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae	Yes	Yes
Quackoo	*Marlierea montana*	Myrtaceae	Yes	Yes
Turtle Cherry	*Eugenia patrissi*	Myrtaceae	Yes	Yes
Buba	*Socratea exorrhiza*	Palmae	Yes	Yes
Dallibana	*Geonoma baculifera*	Palmae	Yes	Yes
Kokerite	*Maximiliana maripa*	Palmae	Yes	Yes
Masoa plimpla	*Bactris major*	Palmae	Yes	Yes

White seed	*Bactris oligoclada*	Palmae	Yes	Yes
Widi	*Astrocaryum gynacanthum*	Palmae	Yes	Yes
Yuruwe	*Bactris humilis*	Palmae	Yes	Yes
Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	Yes	Yes
Mamuriballi	*Quinna indigofera*	Quiinaceae	Yes	Yes
Okokonshi	*Quiina indigofera*	Quiinaceae	Yes	Yes
Komaramara	*Duroia eriopila l.f. var. eriopila*	Rubiaceae	Yes	Yes
Sinkola	*Cinchona sp.*	Rubiaceae	Yes	Yes
Kulishiri Black	*Cupania hirsute*	Sapindaceae	Yes	Yes
Sand Mora*	*Talisia cf. guianensis*	Sapindaceae	Yes	Yes
Asepoko*	*Pouteria guianensis*	Sapotaceae	Yes	Yes
Bartaballi	*Pouteria durlandii*	Sapotaceae	Yes	Yes
Bulletwood*	*Manilkara bidentate*	Sapotaceae	Yes	Yes
Kamahora	*Pouteria venosa*	Sapotaceae	Yes	Yes
Kokoritiballi	*Pouteria cuspidate*	Sapotaceae	Yes	Yes
Limonaballi*	*Chrysophyllum pomiferum*	Sapotaceae	Yes	Yes
Suya*	*Pouteria specious*	Sapotaceae	Yes	Yes
Ubudiablli	*Chrysophyllum sanguinolentum*	Sapotaceae	Yes	Yes
Kamakuti	*Bombax flaviflorum*	Sterculiaceae	Yes	Yes
Maho*	*Sterculia pruriens*	Sterculiaceae	Yes	Yes
Duru	*Apeiba echinate*	Tiliaceae	Yes	Yes
Adebero	*Paypayrola longifolia*	Violaceae	Yes	Yes

Table 52: Flowering and Fruitng Plants Recorded by Surveys

Common Name	Scientific Name	Family Name	Fruiting 2017	Flowering 2017	Fruiting 2018	Flowering 2018
Ants bush	*Cordia nodose*	Boraginaceae	Yes			
Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	Yes			
Black Yari Yari	*Guatteria punctate*	Annonaceae	Yes			
Bulletwood*	*Manilkara bidentate*	Sapotaceae	Yes			
Crabwood*	*Carapa guianensis*	Meliaceae	Yes			
Dallibana	*Geonoma baculifera*	Palmae	Yes			
Dukuria*	*Sacoglottis aff. Cydonioides*	Humiriaceae	Yes			
Fig tree	*Ficus guianensis*	Moraceae	Yes			
Granny backbone	*Curarea candicans*	Menispermaceae				Yes
Guava Skin Kakaralli*	*Eschweilera alata*	Lecythidaceae				Yes
Haiawaballi	*Tetragastris altissima*	Burseraceae	Yes			Yes
Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae			Yes	
Hill Corkwood*	*Pterocarpus rohrii*	Papilionaceae			Yes	
Hill Dalli *	*Virola sebifera*	Myristicaceae			Yes	
Kamahora	*Pouteria venosa*	Sapotaceae	Yes			Yes
Kamakuti	*Bombax flaviflorum*	Sterculiaceae		Yes		
Kauta*	*Licania guianensis*	Chrysobalanaceae			Yes	
Kirikaua	*Iryanthera lancifolia*	Myristicaceae				Yes
Kokoritiballi*	*Pouteria cuspidate*	Sapotaceae	Yes			Yes
Kurokai*	*Protium heptaphyllum*	Burseraceae	Yes			Yes
Lu	*Oenocarpus bacaba*	Arecaceae			Yes	
Monkey Pot*	*Lecythis zabucajo*	Lecythidaceae				Yes
Monkey Syrup	*Maripa scandens*	Convolvulaceae				Yes
Sand Baromalli	*Catostemma commune*	Bombacaceae				Yes

Shibadan*	*Aspidosperma cruentum*	Apocynaceae			Yes	
Suya*	*Pouteria specious*	Sapotaceae			Yes	
Ulu	*Trattinnickia burserifolia*	Burseraceae			Yes	
White Yari Yari	*Duguetia pauciflora*	Annonaceae	Yes			
Whitey	*Inga jenmanii*	Leguminosae-mimos		Yes		
Widi	*Astrocaryum gynacanthum*	Palmae				Yes
Wild star apple	*Couma rigida*	Apocynaceae	Yes			
Wina*	*Lecythis corrugate*	Lecythidaceae				Yes

Table 53: Volume of all Timber Species within Surveyed Plots

Common Names	Scientific Name	Family Names	Volume (m^3)	Harvestable Volume (m^3)
Arara broad leaf	*Unonopsis spp.*	Annonaceae	4.68	0.00
Aromata*	*Clathrotropis spp.*	Fabaceae	0.30	0.30
Asashi	*Rheedia acuminate*	Guttiferae	0.31	0.00
Asepoko*	*Pouteria guianensis*	Sapotaceae	7.21	3.99
Baradan*	*Ocotea tomentella*	Lauraceae	1.18	1.18
Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	37.28	33.80
Bat Seed*	*Andira surinamensis*	Leguminosae	7.09	2.95
Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	28.72	0.00
Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	17.66	16.33
Brown Silverballi *	*Aniba riparia*	Lauraceae	1.74	1.74
Bulletwood*	*Manilkara bidentate*	Sapotaceae	102.46	67.23
Burada*	*Parinari campestris*	Chrysobalanaceae	2.02	0.48
Common Baromalli*	*Catostemma commune*	Bombacaceae	14.31	11.94
Cowwood*	*Bagassa guianense*	Moraceae	8.44	7.99
Crabwood*	*Carapa guianensis*	Meliaceae	16.39	15.39
Dalli hill*	*Virola sebifera*	Myristicaceae	7.94	8.48
Darina*	*Hymenolobium flavum*	Fabaceae	1.32	1.32
Duka*	*Protium decandrum*	Burseraceae	6.05	3.71
Dukali*	*Parahancornia fasciculata*	Apocynaceae	0.90	0.53
Dukuria *	*Sacoglottis aff. Cydonioides*	Humiriaceae	0.89	0.89
Duru	*Apeiba echinate*	Tiliaceae	3.27	0.00
Fine Leaf Counter*	*Licania sp.*	Chrysobalanaceae	8.98	6.97
Fukadi*	*Terminalia Amazonia*	Combretaceae	0.98	0.98
Guava Skin Kakaralli*	*Eschweilera alata*	Lecythidaceae	3.04	0.00
Haiawa*	*Protium decandrum*	Burseraceae	0.68	0.68
Haiawaballi	*Protium tenuifolium*	Burseraceae	1.79	0.00
Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae	18.84	0.00
Hill Corkwood*	*Pterocarpus rohrii*	Papilionaceae	0.79	0.79
Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	12.27	8.85
Kabukalli*	*Goupia glabra*	Celastraceae	15.99	1.98
Kaditiri	*Sclerolobium micropetalum*	Leguminosae-caesalp	1.34	0.80
Kamahora	*Pouteria venosa*	Sapotaceae	6.70	0.00
Kamakuti	*Bombax flaviflorum*	Sterculiaceae	2.10	0.00
Kauta*	*Licania guianensis*	Chrysobalanaceae	2.41	0.85
Kereti(White silverballi)*	*Ocotea cannliculata*	Lauraceae	12.48	6.61
Kokerite	*Maximiliana maripa*	Palmae	8.75	0.00
Kokoritiballi*	*Pouteria cuspidate*	Sapotaceae	35.14	33.70
Kurokai*	*Protium heptaphyllum*	Burseraceae	14.40	9.11
Letterwood *	*Brosiumum guianense*	Moraceae	4.33	4.13
Limonaballi*	*Chrysophyllum pomiferum*	Sapotaceae	10.04	9.25

Maho*	*Sterculia pruriens*	Sterculiaceae	29.28	25.50
Mamuriballi	*Quinna indigofera*	Quiinaceae	38.67	0.00
Maporokon*	*Inga alba*	Leguminosae - Mimos	22.27	7.80
Marishiballi*	*Licania densiflora*	Chrysobalanaceae	73.28	54.11
Matchwood*	*Scherfflera morototoni*	Araliaceae	7.24	5.19
Monkey Pot*	*Lecythis zabucajo*	Lecythidaceae	4.44	4.12
Red Cedar*	*Cedrela oradata*	Meliaceae	2.18	2.18
Rose of the Mountain	*Brownea latifolia*	Leguminosae - Caesalp	1.13	1.13
Sand Mora*	*Talisia cf. guianensis*	Sapindaceae	1.43	1.43
Shibadan*	*Aspidosperma cruentum*	Apocynaceae	19.12	16.84
Simarupa*	*Quaassia simaruba*	Simaroubaceae	5.21	5.21
Sinkola	*Cinchona sp.*		8.96	0.00
Suya*	*Pouteria specious*	Sapotaceae	5.55	5.30
Tatabu*	*Diplotropis purpurea*	Leguminosae - Papil	3.69	3.69
Tonka Bean *	*Dipteryx oradata*	Leguminosae-Papil	2.15	2.15
Turtle Cherry	*Eugenia patrissi*	Myrtaceae	0.45	0.00
Turu	*Jessenia bataua*	Arecaceae	2.70	0.00
Ubudiablli	*Chrysophyllum sanguinolentum*	Sapotaceae	21.83	0.00
Ulu*	*Chaetocarpus schomburgkianus*	Euphorbiaceae	0.31	0.31
Unknown			5.64	0.00
Wadara*	*Couratari guianensis*	Lecythidaceae	72.89	71.88
Wakaradan*	*Miconia cf. ruficalyx*	Melastomataceae	1.44	1.44
Warakaioro	*Laetia procera*	Flacourtiaceae	0.86	0.00
Warakosa	*Inga thibaudiana*	Leguminosae - Mimos	1.02	0.00
White Kakaralli*	*Eshweilera wachenheimii*	Lecythidaceae	0.20	0.20
Widi	*Astrocaryum gynacanthum*	Palmae	0.20	0.00
Wild Guava*	*Eshweilera alata*	Lecythidaceae	2.64	0.68
Yarula	*Swartzia jenmani*	Apocynaceae	0.58	0.00
Yarula (Black)	*Aspidosperma excelsum*	Apocynaceae	9.50	0.00
Yellow Silverballi*	*Aniba ovalifolia*	Lauraceae	1.39	1.39
Total (m3)			**777.45**	**473.51**

Table 54: Volume of Commercial Timber per Species within Surveyed Plots.

Common Name	Species Name	Total Standing Volume (m^3/ha)	Harvestable Volume (m^3/ha)
Aromata*	*Clathrotropis spp.*	0.30	0.30
Asepoko*	*Pouteria guianensis*	7.21	3.99
Baradan*	*Ocotea tomentella*	1.18	1.18
Barakaro*	*Ormosia coccinea*	37.28	33.80
Bat Seed*	*Andira surinamensis*	7.09	2.95
Black Kakaralli*	*Eshweilera sagotiana*	17.66	16.33
Brown Silverballi *	*Aniba riparia*	1.74	1.74
Bulletwood*	*Manilkara bidentata*	102.46	67.23
Burada*	*Parinari campestris*	2.02	0.48
Common Baromalli*	*Catostemma commune*	14.31	11.94
Cowwood*	*Bagassa guianense*	8.44	7.99
Crabwood*	*Carapa guianensis*	16.39	15.39
Dalli hill*	*Virola sebifera*	7.94	7.69
Darina*	*Hymenolobium flavum*	1.32	1.32
Duka*	*Protium decandrum*	6.05	3.71
Dukali*	*Parahancornia fasciculata*	0.90	0.53
Dukuria *	*Sacoglottis aff. Cydonioides*	0.89	0.89

Fine Leaf Counter*	*Licania sp.*	8.98	6.97
Fukadi*	*Terminalia amazonia*	0.98	0.98
Guava Skin Kakaralli*	*Eschweilera alata*	3.04	0.00
Haiawa*	*Protium decandrum*	0.68	0.68
Hill Corkwood*	*Pterocarpus rohrii*	0.79	0.79
Itikiboroballi*	*Swartzia benthamiana*	12.27	8.85
Kabukalli*	*Goupia glabra*	15.99	1.98
Kauta*	*Licania guianensis*	2.41	0.85
Kereti (White silverballi)*	*Ocotea cannliculata*	12.48	6.61
Kokoritiballi*	*Pouteria cuspidata*	35.14	33.70
Kurokai*	*Protium heptaphyllum*	14.40	9.11
Letterwood *	*Brosiumum guianense*	4.33	4.13
Limonaballi*	*Chrysophyllum pomiferum*	10.04	9.25
Maho*	*Sterculia pruriens*	29.28	25.50
Maporokon*	*Inga alba*	22.27	7.80
Marishiballi*	*Licania densiflora*	73.28	54.11
Matchwood*	*Scherfflera morototoni*	7.24	5.19
Monkey Pot*	*Lecythis zabucajo*	4.44	4.12
Red Cedar*	*Cedrela oradata*	2.18	2.18
Rose of the Mountain*	*Brownea latifolia*	1.13	1.13
Sand Mora*	*Talisia cf. guianesis*	1.43	1.43
Shibadan*	*Aspidosperma cruentum*	19.12	16.84
Simarupa*	*Quaassia simaruba*	5.21	5.21
Suya*	*Pouteria specious*	5.55	5.30
Tatabu*	*Diplotropis purpurea*	3.69	3.69
Tonka Bean *	*Dipteryx oradata*	2.15	2.15
Ulu*	*Chaetocarpus schomburgkianus*	0.31	0.31
Wadara*	*Couratari guianensis*	72.89	71.88
Wakaradan*	*Miconia cf. ruficalyx*	1.44	1.44
White Kakaralli*	*Eshweilera wachenheimii*	0.20	0.20
Wild Guava*	*Eshweilera alata*	2.64	0.68
Yellow Silverballi*	*Aniba ovalifolia*	1.39	1.39
Total (m^3)		**610.56**	**471.92**

11.2.6.2 Fauna

The wet season survey of 2017 documented 17 non-volant mammalian species, 22 species of bats, 16 species of amphibians, 14 reptilian species, 174 bird species, 14 species of fish and a diversity of both terrestrial and aquatic invertebrates. No known Critically Endangered, Endangered or Vulnerable species were recorded by the 2017 survey.

The 17 non-volant species recorded by the 2017 wet season survey were represented 6 orders, 10 family and a total of 140 individuals. The Jaguar (*Panthera onca*) is listed as Near Threatened while the tapir (*Tapirus terrestris*), giant armadillo (*Priodontes maximus*) and black spider monkey (*Ateles paniscus)* are all listed as vulnerable by the IUCN REDLIST.

A total of 22 Bat species represented by 4 families and a total of 132 individuals were recorded during the wet season survey of 2017. All identified species are classified as species of 'Least Concern' (L/C) by the IUCN RED LIST. None of the array of Chiropteran species surveyed during this baseline study, are identified as species endemic/restricted to Guiana.

A total of 174 bird species represented by 43 families and 1289 individuals were recorded by the 2017 wet season survey. The *Ramphastos tucanus (*White-throated Toucan), *Ramphastos vitellinus (*Channel-billed Toucan) and the

*Myrmotherula surinamensis (*Guianan Streaked Antwren) are listed as Vulnerable. *Spizaetus ornatus (*Ornate Hawk-Eagle), *Amazona farinose (*Mealy Parrot), *Pionopsitta caica (*Caica Parrot) and *Hypocnemis cantator (*Guianan Warbling Antbird) are listed as Near Threatened. A diverse amount of bird species recorded during the survey is endemic to the Guiana Shield and are restricted to the Guianas and adjacent Venezuela and Brazil

The 2017 wet season herpetofauna survey, recorded a total four hundred and seventy-four (474) individuals of 35 species of amphibians represented by 7 families and forty-eight (48) individuals of 17 species of reptiles representing eight families. The IUCN Red List of Threatened species lists the yellow-footed tortoise as Vulnerable. Biogeographically, all amphibian and reptile species recorded within the 2017 wet season survey are widespread throughout Guyana and the wider Amazonian region. They can be found in tropical moist forest in and other biogeographic provinces throughout the Guianas.

The 2017 wet season survey documented a total of 12 orders of terrestrial macro-invertebrates and one hundred and twelve (112) benthic organisms representing two (2) families and 4 species. No critically endangered, endangered, endemic or migratory fish species were documented during the wet season survey of 2017.

A total of one hundred and sixty (160) individual fishes with twenty-five (25) species representing eleven (11) families were recorded in the 2017 wet season survey. None, of the species collected, are listed under the IUCN and CITES list.

The dry season survey of 2018 documented 13 non-volant mammalian species, 10 species of bats, 28 species of amphibians, 10 reptilian species, 161 bird species, 17 species of fish and a diversity of terrestrial and aquatic invertebrates. No known Critically Endangered, Endangered or Vulnerable species were recorded by the 2018 dry season survey.

The 2018 dry season survey documented a total of thirteen (13) non volant mammals in the concession. These 13 species were represented by 5 orders, 8 families and a total of 134 individuals. The Jaguar *(Panthera onca)* is listed as Near Threatened while the black spider monkey *(Ateles paniscus)* is listed as vulnerable by the IUCN REDLIST.

A total of 10 Bat species represented by 2 families and a total of 31 individuals were recorded during the dry season survey of 2018. All identified species were classified as species of 'Least Concern' (L/C) by the IUCN RED LIST. None of the Chiropteran species recorded by this survey were identified as species endemic/ restricted to Guiana.

A total of 161 bird species represented by 45 families and 763 individuals were recorded by the 2018 dry season survey. The *Ramphastos tucanus* (White-throated Toucan), *Ramphastos vitellinus* (Channel-billed Toucan) and the *Myrmotherula surinamensis* (Guianan Streaked Antwren) are listed as Vulnerable while *Pionopsitta caica* (Caica Parrot), *Hypocnemis cantator* (Guianan Warbling Antbird), *Psophia crepitans* (Grey-winged trumpeter) and *Tinamus major* (Great Tinamou) are listed as Near Threatened. A diverse amount of bird species recorded during the survey are endemic to the Guiana Shield and are restricted to the Guianas and adjacent Venezuela and Brazil

The herpetofauna survey, conducted during the 2018 dry season, recorded a total of three hundred and nineteen (319) individuals of 28 species of amphibians representing 5 families and one hundred and six (106) individuals of 10 species of reptiles representing 8 families. No species recorded is identified as threatened or vulnerable under the IUCN Red List of Threatened species. Biogeographically, all amphibian and reptile species recorded within this survey are widespread throughout Guyana and the wider Amazonian region. They can be found in tropical moist forest in and other biogeographic provinces throughout the Guianas.

The 2018 dry season survey documented a total of 12 orders of terrestrial macro-invertebrates and sixty-two (62) benthic organisms representing two (2) families. No critically endangered, endangered, endemic or migratory species were documented during the dry season survey of 2018.

A total of one hundred and nine (109) individual fishes of seventeen (17) species representing nine (9) families were recorded in the 2018 dry season survey. None of the species are listed under the IUCN and CITES list.

11.2.6.2.1 Non-Volant Mammals

The 2017 wet season survey documented a total of seventeen (17) non-volant mammals. These 17 species were represented by 6 orders, 10 families and a total of 140 individuals. The most diverse Order Rodentia was represented by three families; Chalamyphoridae, Cuniculidae, Dasypodidae with 4 species; primates were represented by two families; Atelidae and Cebidae and 4 species followed by Ungulates with with two families; Cervidae and Tapiridae were represented by 3 species; Carnivora by two families; Procyonidae with 1 species and Felidae with 2 species, Pilosa represented by one species; Bradypodidae with 1 species and Didelphidae represented by one species.

The 2018 dry season survey documented a total of thirteen (13) non-volant mammals. These 13 species were represented 6 orders, 8 families and a total of 134 individuals. The most diverse order was the Rodentia represented by three families; Cuniculidae, Dasypodidae and Muridae, with 4 species followed by Primata represented by two families; Atelidae and Cebidae with 4 species; Ungulates were represented by two families Cervidae, Tapiridae and 3 species; Carnivora represented by two family; Felidae and Procyonidae with 3 species, Pilosa represented by one species; Bradypodidae with 1 species and Didelphidae represented by one species.

The IUCN Redlist identifies a list of species and their endangered status. Among the species recorded by the surveys is the Jaguar (*Panthera onca*) which is listed as Near Threatened, and the tapir (*Tapirus terrestris*), giant armadillo (*Priodontes maximus*) and black spider monkey (*Ateles paniscus);* all listed as vulnerable. The jaguar and the giant armadillo are both classed as Appendix 1 since they are fully protected at the national level across most of their range, with their hunting prohibited. The other mammals documented by the surveys are included in IUCN Appendices II and III.

Table 55: Non-Volant Mammals Recorded by the Surveys

COMMON NAMES	SPECIES NAME	FAMILY NAME	Recorded During 2017 Wet Season Survey	Recorded During 2018 Dry Season Survey
Red howler monkey	*Alouatta macconnelli*	Atelidae	Yes	Yes
Black spider monkey	*Ateles paniscus*	Atelidae	Yes	Yes
Three toed sloth	*Bradypus tridactylus*	Bradypodidae	Yes	No
Squirrel monkey	*Saimiri sciureus*	Cebidae	Yes	Yes
Golden hand tamrin	*Saguinus midas*	Cebidae	Yes	Yes
Gray brocket deer	*Mazama gouazoubira*	Cervidae	Yes	No
Red brocket deer	*mazama americana*	Cervidae	Yes	No
Giant armadillo	*Priodontes maximus*	Chalamyphoridae	Yes	No
Labba	*Cuniculus paca*	Cuniculidae	Yes	Yes
Nine banded armadillo	*Dasypus novemcinctus*	Dasypodidae	Yes	Yes
Red rump agouti	*Dasyprocta leporine*	Dasyproctidae	Yes	Yes
Opossum		Didelphidae	Yes	Yes
Four eyed opossum	*Philander opossum sp*	Didelphidae	Yes	No
Jaguar	*panthera once*	Felidae	Yes	Yes
Ocelot	*leopardus paradalis*	Felidae	Yes	Yes
Kinkajou	*Potos flavus*	Procyonidae	Yes	Yes
Bush cow/Tapir	*tapirus terrestris*	Tapiridae	Yes	No

11.2.6.2.2 Volant mammals - Bats

The 2017 wet season survey identified a total of 22 Bat species represented by 4 families and a total of 132 individuals. The most diverse family was the Phyllostomidae with 19 families followed by Emballonuridae with one species, *Centronycteris maximiliani*, Molossidae represented by one species, *Molossus ater* and Mormoopidae also represented by one species, *Ptero notus parnellii*. The 2018 dry season survey identified a total of 10 Bat species

represented by 2 families and a total of 31 individuals. The most diverse family was the Phyllostomidae with 9 species followed by Mormoopidae with one species.

There is a large distribution of Chiropteran species in the Guiana Sub-region. Based on a review of species richness and biogeography of Bats (Chiroptera) from Guiana Shield, 148 species of Bats have been documented of which six (6) are endemic to Guiana sub-region (Lim, Tavares, 2012). However, among the array of Chiropteran species surveyed during this baseline study, none were identified as species endemic/ restricted to Guiana

The Chiropteran population observed by the 2017-2018 surveys are all classified by the IUCN RED LIST as species of Least Concern' (L/C). The Bats surveyed are not identified by the CITES Appendix I, II or III.

Table 56: Volant Mammals Recorded by the Surveys

Common Name	Scientific Name	Family Name	Recorded by Wet Season Survey	Recorded by dry Season Survey
Shaggy Bat	*Centronycteris maximiliani*	Emballonuridae	Yes	No
Black Mastiff Bat	*Molossus ater*	Molossidae	Yes	No
Mouthstached Bat	*Pteronotus parnellii*	Mormoopidae	Yes	Yes
Dark Fruit Eating Bat	*Artibeus obscurus*	Phyllostomidae	Yes	Yes
Seba's Short tailed Bat	*Carollia perspicillata*	Phyllostomidae	Yes	Yes
Flat-Faced Fruit Eating Bat	*Artibeus planirostris*	Phyllostomidae	Yes	Yes
Pallas's Long tongued Bat	*Glossophaga soricina*	Phyllostomidae	Yes	Yes
Vampyressa Yellow Earred Bat	*Mesophylla macconnelli*	Phyllostomidae	Yes	Yes
Wooly False Vampire Bat	*Chrotopterus auritus*	Phyllostomidae	Yes	No
Frog Eatting Bat	*Trachops cirrhosus*	Phyllostomidae	Yes	No
Round Earred Bat	*Tonatia saurophila*	Phyllostomidae	Yes	No
Davies's Big Earred Bat	*Micronycteris daviesi*	Phyllostomidae	Yes	No
Short tailed Fruit Bat	*Carollia brevicauda*	Phyllostomidae	Yes	Yes
Pale Face Bat	*Phyllostomus discolor*	Phyllostomidae	Yes	No
Dwarf Little Fruit Bat	*Rhinophylla pumilio*	Phyllostomidae	Yes	No
Little White Shouldered Bat	*Ametrida centurio*	Phyllostomidae	Yes	Yes
Gervais's Fruit-eating Bat	*Artibeus cinereus*	Phyllostomidae	Yes	No
Niceforo's Big-eared Bat	*Trinycteris nicefori*	Phyllostomidae	Yes	No
Dwarf Fruit-eating Bat	*Artibeus gnomus*	Phyllostomidae	Yes	No
Lesser Long tailed Bat	*Choeroniscus minor*	Phyllostomidae	Yes	Yes
Lesser Spear-nosed Bat	*Phyllostomus elongates*	Phyllostomidae	Yes	Yes
Great Fruit-eating Bat	*Artibeus lituratus*	Phyllostomidae	Yes	No

11.2.6.2.3 Birds

The 2017 wet season survey recorded a total of 174 bird species represented by 43 families and 1289 individuals. The most diverse families were tyrant flycatchers (Tyrannidae, 21 species), followed by Antbirds (Thamnophilidae, 15 species), tanagers (Thraupidae 15 species), parrots (Psittacidae, 14 species), hummingbirds (Trochilidae 6 species), woodpeckers (Picidae 9 species), woodcreepers (Dendrocolaptidae x species), toucans (Ramphastidae 4 species), birds of prey (6 species), cotingas (Cotingidae 6 species), trogons (Trogonidae 3 species), pigeons (Columbidae 5 species), and the Cracids (3 species).

The 2018 dry season survey recorded a total of 161 bird species represented by 45 families and 763 individuals. The most diverse families were antbirds (Thamnophilidae, 18 species), followed by tyrant flycatchers (Tyrannidae, 15 species), parrots (Psittacidae, 14 species), tanagers (Thraupidae 13 species), woodpeckers (Picidae 6 species), cotingas (Cotingidae 6 species), hummingbirds (Trochilidae 5 species), toucans (Ramphastidae 5 species), manakins (Pipridae 5 species), Orioles; grackles; cowbirds; doves (Icteridae 4 species), pigeons (Columbidae 4 species), jacamar (Galbulidae 4 species) and hawk; kite (Accipitridae 4 species).

The *Ramphastos tucanus* (White-throated Toucan), *Ramphastos vitellinus* (Channel-billed Toucan) and the *Myrmotherula surinamensis* (Guianan Streaked Antwren) are listed as Vulnerable. *Spizaetus ornatus* (Ornate Hawk-Eagle), *Amazona farinose* (Mealy Parrot), *Pionopsitta caica* (Caica Parrot) and *Hypocnemis cantator* (Guianan Warbling Antbird) are listed as Near Threatened. All Psitticines, Toucans and Cracids recorded in the survey are listed as CITES Appendix II species.

The Harpy Eagle (*Harpia harpyja*) and the Ornate Hawk-Eagle (*Spizaetus ornatus*) are two of the charismatic species in the forest. These raptors are considered as rare and are listed as an endangered, rare or threatened species of status CITES Appendix II.

Species endemic to the Guianan Shield recorded by the surveys, restricted to the Guianas and adjacent Venezuela and Brazil, include the Marail Guan (*Penelope marail*), Caica Parrot (*Pionopsitta caica*), Dusky Parrot (*Pionus fuscus*), Guianan Trogon (*Trogon violaceus*), Black Nunbird (*Monasa atra*), Guianan Toucanet (*Selenidera culik*), Black-spotted Barbet (*Capito niger*), Brown-bellied Antwren (*Myrmotherula gutturalis*), Todd's Antwren (*Herpsilochmus stictocephalus*), Spot-tailed Antwren (*Herpsilochmus sticturus*), Guianan Warbling Antbird (*Hypocnemis cantator*), Rufous-throated Antbird (*Gymnopithys rufigula*), Ferruginous-backed Antbird (*Myrmeciza ferruginea*), Black-headed Antbird (*Percnostola rufifrons*), Brown-bellied Antwren (*Epinecrophylla gutturalis*), Yellow-throated Flycatcher (*Conopias parva*), Painted Tody-Flycather (*Todirostrum pictum*), Tiny Tyrant-Manakin (*Tyranneutes virescens*), White Bell-Bird (*Procnias albus*), Capuchinbird (*Perissocephalus tricolor*) and Guianan Red-Cotinga (*Phoenicircus carnifex*); (Vol. 1, *Install et al*, 2006 and *Erize et al*. 2006).

Two species recorded by the surveys are exclusively distributed north of the Amazon; Chestnut-rumped Woodcreeper (*Xiphorhynchus pardalotus*) and Cayenne Jay (*Cyanocorax cayanus*); (Vol. 1, *Install et al*, 2006 and *Erize et al*. 2006).

Table 57: Birds Species Recorded by the Surveys

Common Name	Scientific Name	Family Name	Recorded by 2017 Wet Season Survey	Recorded by 2018 Dry Season Survey
Harpy Eagle	*Harpia hapyja*	Accipitridae	Yes	No
Ornate Hawk-Eagle	*Spizaetus ornatus*	Accipitridae	Yes	No
Swallow-tailed Kite	*Elanides forficatus*	Accipitridae	Yes	Yes
Plumbeous Kite	*Ictinia plumbea*	Accipitridae	Yes	Yes
Gray-lined Hawk	*Buteo nitidus*	Accipitridae	Yes	No
Short-tailed Hawk	*Buteo brachyurus*	Accipitridae	Yes	No
Amazon Kingfisher	*Chloroceryle amazona*	Alcedinidae	Yes	No
Green Kingfisher	*Chloroceryle americana*	Alcedinidae	Yes	Yes
Gray-rumped Swift	*Chaetura cinereiventris*	Apodidae	Yes	No
Swift	*Chaetura sp*	Apodidae	Yes	No
Cattle Egret	*Bubulcus ibis*	Ardidae	Yes	No
Black Nunbird	*Monasa atra*	Bucconidae	Yes	Yes
Puffbird	*Notharchus sp*	Bucconidae	Yes	Yes
Black-spotted Barbet	*Capito niger*	Capitonidae	Yes	Yes
Common Paraque	*Nyctidromus albicollis*	Caprimulgidae	Yes	No
Blackish Nightjar	*Caprimulgus nigrescens*	Caprimulgidae	Yes	Yes
Yellow-green Grosbeak	*Caryothraustes canadensis*	Cardinalidae	Yes	Yes
Slate-colored Grosbeak	*Saltator grossus*	Cardinalidae	Yes	Yes
Blue-black Grosbeak	*Cyanocompsa cyanoides*	Cardinalidae	Yes	Yes
Greater Yellow-headed Vulture	*Catharthes melambrotus*	Cathartidae	Yes	No
Black Vulture	*Coragyps atratus*	Cathartidae	Yes	Yes
King Vulture	*Sarcoramphus papa*	Cathartidae	Yes	Yes
Ruddy Pigeon	*Patagioenas subvinacea*	Columbidae	Yes	No
Plumbeous Pigeon	*Columba plumbea*	Columbidae	Yes	Yes
Gray-fronted Dove	*Leptotila rufaxilla*	Columbidae	Yes	Yes

Common Ground-Dove	*Columbina passerina*	Columbidae	Yes	Yes
Ruddy Quail-Dove	*Geotrygon montana*	Columbidae	Yes	Yes
White Bell-bird	*Procnias alba*	Cotingidae	Yes	No
Screaming Piha	*Lipaugus vociferans*	Cotingidae	Yes	Yes
Capuchin Bird	*Perissocephalus tricolor*	Cotingidae	Yes	Yes
Purple-throated Fruitcrow	*Querula pururata*	Cotingidae	Yes	Yes
Guianan Red-Cotinga	*Phoenicircus carnifex*	Cotingidae	Yes	Yes
Crimson Fruitcrow	*Haematoderus militaris*	Cotingidae	Yes	No
Cayenne Jay	*Cyanocorax cayanus*	Corvidae	Yes	Yes
Marail Guan	*Penelope marail*	Cracidae	Yes	Yes
Spix's Guan	*Penelope jacquacu*	Cracidae	Yes	No
Little Chacalaca	*Ortalis motmot*	Cracidae	Yes	No
Squirrel Cuckoo	*Piaya cayana*	Cuculidae	Yes	Yes
Smooth-billed Ani	*Crotophaga ani*	Cuculidae	Yes	Yes
Buff-throated Woodcreeper	*Xiphorhynchus guttatus*	Dendrocolaptidae	Yes	Yes
Wedge-billed Woodcreeper	*Glyphorynchus spirurus*	Dendrocolaptidae	Yes	Yes
Chestnut-rumped Woodcreeper	*Xiphorhynchus pardalotus*	Dendrocolaptidae	Yes	Yes
Lineated Woodcreeper	*Lepidocolaptes souleyetii*	Dendrocolaptidae	Yes	No
Blue-black Grassquit	*Volatinia jacarina*	Emberizidae	Yes	Yes
gray seedeater	*Sporophila intermedia*	Emberizidae	Yes	No
Red-throated Caracara	*Ibycter americanus*	Falconidae	Yes	Yes
Bat Falcon	*Falco rufigularis*	Falconidae	Yes	No
Black-faced Antthrush	*Formicarius analis*	Formicariidae	Yes	Yes
Rufous-capped Antthrush	*Formicarius colma*	Formicariidae	Yes	Yes
Violaceous Euphonia	*Euphonia violacea*	Fringillidae	Yes	Yes
Golden-sided Euphonia	*Euphonia cayennensis*	Fringillidae	Yes	No
Finsch's Euphonia	*Euphonia finschi*	Fringillidae	Yes	Yes
Great Jacamar	*Jacamerops aureus*	Galbulidae	Yes	Yes
Yellow-billed Jacamar	*Galbula albirostris*	Galbulidae	Yes	Yes
Green-tailed Jacamar	*Galbula galbula*	Galbulidae	Yes	Yes
Paradise Jacamar	*Galbula dea*	Galbulidae	Yes	Yes
Spotted Antpitta	*Hylopezus macularis*	Grallaridae	Yes	Yes
Thrush-like Antpitta	*Myrmothera campanisoma*	Grallaridae	Yes	Yes
Gray-breasted Martin	*Progne chalybea*	Hirundinidae	Yes	Yes
Red-rumped Cacique	*Cacicus haemorrhous*	Icteridae	Yes	Yes
Green Oropendola	*Psarocolius viridis*	Icteridae	Yes	Yes
Crested Oropendola	*Psarocolius decumanus*	Icteridae	Yes	Yes
Giant Cowbird	*Molothrus oryzivorus*	Icteridae	Yes	Yes
Blue-crowned Motmot	*Momotus momota*	Momotidae	Yes	Yes
Common Potoo	*Nyctibius nyctibius*	Nyctibidae	Yes	Yes
Marbled Wood-Quail	*Odontophorus gujanensis*	Odontophoridae	Yes	Yes
Riverbank Warbler	*Myiothlypis rivularis*	Parulidae	Yes	No
Piculet species	*Picumnus sp*	Picidae	Yes	No
Golden-Olive Woodpecker	*Piculus rubiginosus*	Picidae	Yes	No
Yellow-tufted Woodpecker	*Melanerpes cruentatus*	Picidae	Yes	Yes
Yellow-throated Woodpecker	*Piculus flavigula*	Picidae	Yes	Yes
Red-necked Woodpecker	*Campephilus rubricollis*	Picidae	Yes	Yes
Chestnut Woodpecker	*Celeus elegans*	Picidae	Yes	Yes
Waved Woodpecker	*Celeus undatus*	Picidae	Yes	No
Cream-colored Woodpecker	*Celeus flavus*	Picidae	Yes	No
Lineated Woodpecker	*Dryocopus lineatus*	Picidae	Yes	Yes
White-crowned manakin	*Pipra pipra*	Pipridae	Yes	Yes

Golden-headed Manakin	*Pipra erythrocephala*	Pipridae	Yes	Yes
Tiny Tyrant-Manakin	*Tyranneutes virescens*	Pipridae	Yes	Yes
Long-billed Gnatwren	*Ramphocaenus melanurus*	Polioptilidae	Yes	Yes
Red-and-Green Macaw	*Ara chloropterus*	Psittacidae	Yes	Yes
Scarlet Macaw	*Ara macao*	Psittacidae	Yes	Yes
Blue-and-Gold Macaw	*Ara ararauna*	Psittacidae	Yes	Yes
Mealy Parrot	*Amazona farinose*	Psittacidae	Yes	No
Orange-winged Parrot	*Amazona amazonica*	Psittacidae	Yes	No
Red-Fan Parrot	*Deroptyus accipitrinus*	Psittacidae	Yes	Yes
Blue-headed Parrot	*Pionus menstruus*	Psittacidae	Yes	Yes
Caica Parrot	*Pionopsitta caica*	Psittacidae	Yes	Yes
Dusky Parrot	*Pionus fuscus*	Psittacidae	Yes	Yes
Painted Parakeet	*Pyrrhura picta*	Psittacidae	Yes	Yes
Golden-winged Parakeet	*Brotogeris chrysoptera*	Psittacidae	Yes	Yes
Dusky-billed Parakeet	*Forpus sclateri*	Psittacidae	Yes	Yes
White-eyed Parakeet	*Psittacara leucophthalmus*	Psittacidae	Yes	No
Fiery-shouldered Parakeet	*Pyrrhura egregia*	Psittacidae	Yes	No
White-throated Toucan	*Ramphastos tucanus*	Ramphastidae	Yes	Yes
Channel-billed Toucan	*Ramphastos vitellinus*	Ramphastidae	Yes	Yes
Black-necked Aracari	*Pteroglossus aracari*	Ramphastidae	Yes	Yes
Guianan Toucanet	*Selenidera culik*	Ramphastidae	Yes	Yes
Toco Toucan	*Ramphastos toco*	Ramphastidae	Yes	No
Spotted Sandpiper	*Actitis macularius*	Scolopacidae	Yes	Yes
Spectacled Owl	*Pulsatrix perspicilata*	Strigidae	Yes	No
Northern Tawny-bellied Screech-Owl	*Megascops watsonii*	Strigidae	Yes	No
Amazonian Pygmy-Owl	*Glaucidium hardyi*	Strigidae	Yes	Yes
Todd's Antwren	*Herpsilochmus stictocephalus*	Thamnophilidae	Yes	Yes
Spot-tailed Antwren	*Herpsilochmus sticturus*	Thamnophilidae	Yes	Yes
White-flanked Antwren	*Myrmotherula axillaris*	Thamnophilidae	Yes	Yes
Long-winged Antwren	*Myrmotherula longipennis*	Thamnophilidae	Yes	No
Ferruginous-backed Antbird	*Myrmeciza ferruginea*	Thamnophilidae	Yes	Yes
White-plumed Antbid	*Pithys albifrons*	Thamnophilidae	Yes	Yes
Guianan Warbling Antbird	*Hypocnemis cantator*	Thamnophilidae	Yes	Yes
Gray Antbird	*Cercomacra cinerascens*	Thamnophilidae	Yes	Yes
Dusky Antbird	*Cercomacra tyrannina*	Thamnophilidae	Yes	Yes
Black-headed Antbird	*Percnostola rufifrons*	Thamnophilidae	Yes	Yes
Mouse-colored Antshrike	*Thamnophilus murinus*	Thamnophilidae	Yes	Yes
Fasciated Antshrike	*Cymbilaimus lineatus*	Thamnophilidae	Yes	Yes
Cinereous Antshrike	*Thamnomanes caesius*	Thamnophilidae	Yes	Yes
Palm Tanager	*Thraupis palmarum*	Thraupidae	Yes	Yes
Blue-grey Tanager	*Thraupis episcopus*	Thraupidae	Yes	Yes
Silver-beaked Tanager	*Ramphocelus carbo*	Thraupidae	Yes	Yes
Red-billed Pied Tanager	*Lamprospiza melanoleuca*	Thraupidae	Yes	No
Fulvous-crested Tanager	*Tachyphonus surinamus*	Thraupidae	Yes	Yes
Torquoise Tanager	*Tangara Mexicana*	Thraupidae	Yes	Yes
Bay-headed Tanager	*Tangara gyrola*	Thraupidae	Yes	Yes
Spotted Tanager	*Tangara punctate*	Thraupidae	Yes	Yes
Opal-rumped Tanager	*Tangara velia*	Thraupidae	Yes	Yes
Tanager	*Tangara sp*	Thraupidae	Yes	No
Blue-backed Tanager	*Cyanicterus cyanicterus*	Thraupidae	Yes	Yes
Yellow-backed Tanager	*Hemithraupis flavicollis*	Thraupidae	Yes	Yes

Purple Honeycreeper	*Cyanerpes caeruleus*	Thraupidae	Yes	Yes
Red-legged Honeycreeper	*Cyanerpes cyaneus*	Thraupidae	Yes	Yes
Green Honeycreeper	*Chlorophanes spiza*	Thraupidae	Yes	Yes
Variegated Tinamou	*Crypturellus variegatus*	Tinamidae	Yes	Yes
Little Tinamou	*Cryptturellus soui*	Tinamidae	Yes	No
Reddish Hermit	*Phaethornis ruber*	Trochilidae	Yes	Yes
Eastern Long-tailed Hermit	*Phaethornis superciliosus*	Trochilidae	Yes	Yes
Straight-billed Hermit	*Phaethornis bourceri*	Trochilidae	Yes	Yes
Black-eared Fairy	*Heliothryx auritus*	Trochilidae	Yes	No
Grey-breasted Sabrewing	*Campylopterus largipennis*	Trochilidae	Yes	No
Fork-tailed Woodnymph	*Thalurania furcate*	Trochilidae	Yes	Yes
Coraya Wren	*Thryothorus coraya*	Troglotidae	Yes	Yes
White-breasted Wood-wren	*Henicorhina leucosticta*	Troglotidae	Yes	Yes
Buff-breasted Wren	*Camplyorhynchus griseus*	Troglotidae	Yes	Yes
House Wren	*Troglodytes aedon*	Troglotidae	Yes	No
Guianan Trogon	*Trogon violaceus*	Trogonidae	Yes	Yes
Green-backed Trogon	*Trogon viridis*	Trogonidae	Yes	Yes
Black-tailed Trogon	*Trogon melanurus*	Trogonidae	Yes	Yes
Cocoa Thrush	*Turdus fumigatus*	Turdidae	Yes	Yes
Helmented Pygmy-Tyrant	*Lophotriccus galeatus*	Tyrannidae	Yes	Yes
Double-banded Pygmy-Tyrant	*Lophotriccus vitosus*	Tyrannidae	Yes	No
Short-tailed Pygmy-Tyrant	*Myiornis ecaudatus*	Tyrannidae	Yes	No
Tropical Kingbird	*Tyrannus melancholicus*	Tyrannidae	Yes	Yes
Yellow-crowned Tyrannulet	*Tyrannulus elatus*	Tyrannidae	Yes	Yes
White-lored Tyrannulet	*Ornithion inerme*	Tyrannidae	Yes	No
Yellow-throated Flycatcher	*Conopias parvus*	Tyrannidae	Yes	Yes
Rusty-margined Flycatcher	*Myiozetetes cayanensis*	Tyrannidae	Yes	No
Whiskered Flycatcher	*Myiobius barbatus*	Tyrannidae	Yes	Yes
Streaked Flycatcher	*Myiodynastes maculatus*	Tyrannidae	Yes	Yes
Painted Tody-Flycatcher	*Todirostrum pictum*	Tyrannidae	Yes	No
Common Tody-Flycatcher	*Todirostrum cinereum*	Tyrannidae	Yes	No
Fork-tailed Flycatcher	*Tyrannus savanna*	Tyrannidae	Yes	Yes
Bright-rumped Attila	*Attila spadiceus*	Tyrannidae	Yes	Yes
Black-capped Becard	*Pachyramphus marginatus*	Tyrannidae	Yes	No
Black-tailed Tityra	*Tityra cayana*	Tyrannidae	Yes	Yes
Grayish Mourner	*Rhytipterna simplex*	Tyrannidae	Yes	Yes
Buff-cheeked Greenlet	*Hylophilus musicicapinus*	Vireonidae	Yes	Yes
Slaty-capped Shrike-Vireo	*Vireolanius leucotis*	Vireonidae	Yes	No
Slate-coloured Hawk	*Buteogallus schistaceus*	Accipitridae	No	Yes
Band-rumped Swift	*Chaetura spinicauda*	Apodidae	No	Yes
Turkey Vulture	*Cathartes aura*	Cathartidae	No	Yes
Spangled Cotinga	*Cotinga cayana*	Cotingidae	No	Yes
Purple-throated Cotinga	*Porphyrolaema porphyrolaema*	Cotingidae	No	Yes
Unknown	*Pipile sp.*	Cracidae	No	Yes
Rufous-vented Chachalaca	*Ortalis ruficauda*	Cracidae	No	Yes
Chestnut-crowned Foliage-gleaner	*Automolus rufipileatus*	Furnariidae	No	Yes
Little Long-tailed Woodcreeper	*Deconychura typical*	Furnariidae	No	Yes
Salty-backed forest Falcon	*Micrastur mirandollei*	Falconidae	No	Yes
Stripe-headed Brush Finch	*Arremon torquatus*	Passerellidae	No	Yes
Golden-collared Woodpecker	*Veniliornis cassini*	Picidae	No	Yes

Collared Gnatwren	*Microbates collaris*	Polioptilidae	No	Yes
Sapphire-rumped Parrotlet	*Touit purpuratus*	Psittacidae	No	Yes
Tepui Parrotlet	*Nannopsittaca panychlora*	Psittacidae	No	Yes
Grey-winged trumpeter	*Psophia crepitans*	Psophiidae	No	Yes
Green Aracari	*Petroglossus viridis*	Ramphastidae	No	Yes
Solitary Sandpiper	*Tringa solitaria*	Scolopacidae	No	Yes
Guianan Streaked Antwren	*Myrmotherula surinamensis*	Thamnophilidae	No	Yes
Amazonian-streaked Antwren	*Myrmotherula mulyostiata*	Thamnophilidae	No	Yes
White browed Antbird	*Myrmoborus leucophrys*	Thamnophilidae	No	Yes
Scale-backed Antbird	*Hylophylax poecilinota*	Thamnophilidae	No	Yes
Guira Tanager	*Hemithraupis guira*	Thraupidae	No	Yes
Flame-crested Tanager	*Islerothraupis cristata*	Thraupidae	No	Yes
Cinereous Tinamou	*Crypturellus cinereus*	Tinamidae	No	Yes
Great Tinamou	*Tinamus major*	Tinamidae	No	Yes
White-necked Thrush	*Turdus albicollis*	Turdidae	No	Yes
Cocoa Thrush	*Turdus fumigatus*	Turdidae	No	Yes
Piratic Flycatcher	*Legatus leucophaius*	Tyrannidae	No	Yes
Streak Flycatcher	*Myiodynastes difficillis*	Tyrannidae	No	Yes
Tawny-crowned Greenlet	*Tunchiornisochraceiceps*	Vireonidae	No	Yes
Lemon-chested Greenlet	*Hylophilus griseiventris*	Vireonidae	No	Yes

11.2.6.2.4 Herpetofauna – Amphibians and Reptiles

Four hundred and seventy-four (474) individuals representing 35 species of amphibians and 7 families were recorded by the 2017 wet season survey. Most species belonged to the families Hylidae, Leptodactylidae and the Poison-frogs (Aromobatidae and Dendrobatidae). The tree-frogs (Hylidae) with 16 species was most abundant, followed by the Poison-arrow frogs with 8 species, the Leptodactylidae with 6 species, Bufonidae (toads) with 3 species, and single representatives of the family Microhylidae.

The 2017 wet season survey recorded forty-eight (48) individuals of 17 species of reptiles representing eight families and three orders. One species of crocodile, 10 species of lizards, 4 species of snakes and 2 species of Turtles were recorded by the 2017 wet season survey. The lizards belong to four families, and the snakes belong to two families; with two species in the family Colubridae (typical snakes) and two in the family Boidae (constrictors). Both families of snakes are non-venomous.

Three hundred and nineteen (319) individuals of 28 species of amphibians representing 5 families were recorded during the 2018 dry season survey. Most species belonged to the families Hylidae and Leptodactylidae. The tree-frogs (Hylidae) with 13 species were most abundant, followed by the Leptodactylidae with 8 species, Bufonidae (toads) with 4 species, Dendrobatidae (poison frogs) with 2 species and a single representative of the family Aromobatidae.

The 2018 dry season survey recorded one hundred and six (106) individuals of 10 species of reptiles representing eight families and one Order.

No endangered, rare or threatened species of amphibians were documented by either survey. The brilliant-thigh poison frog (*Ameerega femoralis*) and the *Ameerega trivittata* are collected for the pet trade and are CITES Appendix II listed species, however, their IUCN status is rated as Least Concern. The IUCN Red List of Threatened species lists the yellow-footed tortoise as Vulnerable. The dwarf caiman is listed as IUCN Lower Risk/conservation dependent. All species are CITES Appendix II listed, regulating their international trade.

Biogeographically, all amphibian and reptile species recorded within this survey are widespread throughout Guyana and the wider Amazonian region. They can be found in tropical moist forest and in other biogeographic provinces throughout the Guianas (Kok and Kalamandeen, 2008; Avila Pires, 1995; Starace, 1998; Lescure and Marty, 2000; Smithsonian Institute, 2000; Donnelly *et al*., 1998; Senaris *et al*., 2008).

Table 58: Herpetofaunal Species Recorded by the Surveys

Common Name	Scientific Name	Family Name	Recorded by 2017 Wet Season Survey	Recorded by 2018 dry Season Survey
Frogs				
Three-striped Poison Frog	*Ameerega trivittata*	Aromobatidae	Yes	No
Brilliant-thighed Poison Frog	*Allobates femoralis*	Aromobatidae	Yes	Yes
Unknown	*Colostethus sp1*	Dendrobatidae	Yes	No
Unknown	*Colostethus sp2*	Dendrobatidae	Yes	No
Unknown	*Colostethus baeobatrachus*	Dendrobatidae	Yes	Yes
Unknown	*Colostethus degranvillei*	Dendrobatidae	Yes	No
Unknown	*Epidobates hahneli*	Dendrobatidae	Yes	Yes
Unknown	*Ameerega flavopicta*	Dendrobatidae	Yes	No
Cane Toad	*Rhinella murinus*	Bufonidae	Yes	Yes
Smooth-backed Toad	*Rhinella guttatus*	Bufonidae	Yes	Yes
Unknown	*Rhinella nasicus*	Bufonidae	Yes	No
Unknown	*Eleuthrodactylus sp1*	Leptodactylidae	Yes	No
Unknown	*Leptodactylus fuscus*	Leptodactylidae	Yes	No
Knudsen's thin-toed Frog	*Leptodactylus knudseni*	Leptodactylidae	Yes	No
Amazonian White-lipped Frog	*Leptodactylus mystaceus*	Leptodactylidae	Yes	Yes
Unknown	*Leptodactylus pentadactylus*	Leptodactylidae	Yes	Yes
Unknown	*Lithodytes sp*	Leptodactylidae	Yes	No
Unknown	*Physalemus cuvieri*	Leiuperidae	Yes	No
Gladiator Tree-Frog	*Hypsiboas boans*	Hylidae	Yes	Yes
Unknown	*Hypsiboas crepitans*	Hylidae	Yes	No
Chaco Treefrog	*Hypsiboas raniceps*	Hylidae	Yes	No
Troschel's Treefrog	*Hypsiboas calcarata*	Hylidae	Yes	Yes
Map Treefrog	*Hypsiboas goegraphica*	Hylidae	Yes	No
Unknown	*Dendropsophus minutus*	Hylidae	Yes	Yes
Unknown	*Hypsiboas leucophyllata*	Hylidae	Yes	Yes
Slender-legged Treefrog	*Osteocephalus oophagus*	Hylidae	Yes	No
Manaus Slender-legged Treefrog	*Osteocephalus taurinus*	Hylidae	Yes	No
Treefrog	*Osteocephalus sp*	Hylidae	Yes	No
Surinam casque-headed Treefrog	*Phrynohyas coracea*	Hylidae	Yes	No
Giant Waxy Monkey Tree Frog	*Phyllomedusa bicolor*	Hylidae	Yes	Yes
Monkey Tree Frog	*Phyllomedusa sp*	Hylidae	Yes	Yes
Red snouted Treefrog	*Scinax ruber*	Hylidae	Yes	Yes
Boeseman's snouted Treefrog	*Scinax bosemani*	Hylidae	Yes	Yes
Treefrog	*Hypsiboas sp*	Hylidae	Yes	Yes
Microhylid Frog	*Chiasmocleis sp*	Microhylidae	Yes	No
Common lesser toad	*Rhinella granulosa*	Bufonidae	No	Yes
Common toad	*Rhinella margaritifier*	Bufonidae	No	Yes
Unknown	*Eleutherodactylus inguinalis*	Leptodactylidae	No	Yes
Unknown	*Eleutherodactylus zeuctotylus*	Leptodactylidae	No	Yes
Lowland Tropical Bullfrog	*Adenomera andreae*	Leptodactylidae	No	Yes
Napo Tropical Bullfrog	*Adenomera hylaedactyla*	Leptodactylidae	No	Yes
Peters thin-toed Frog	*Leptodactylus petersii*	Leptodactylidae	No	Yes

Unknown	Leptodactylus longirostris	Leptodactylidae	No	Yes
Unknown	*Dendropsophus brevifrons*	Hylidae	No	Yes
Gunther's banded frog	*Hypsiboas fasciatus*	Hylidae	No	Yes
Orange legged leaf frog	*Phyllomedusa hypochondrialis*	Hylidae	No	Yes
Polka-dot Treefrog	*Hypsiboas punctatus*	Hylidae	No	Yes
Demerara Falls Treefrog	*Hypsiboas cinerascens*	Hylidae	No	Yes
Lizards				
Turnip-tailed Lizard	*Thecadactylus rapicauda*	Gekkonidae	Yes	No
Unkown	*Gonatodes sp*	Gekkonidae	Yes	Yes
Forest Gekko	*Gonatodes humeralis*	Gekkonidae	Yes	No
Unkown	*Anolis planiceps*	Polychoritade	Yes	No
Skink Lizard	*Mabuya mabuya*	Scinidae	Yes	No
Green Garden Lizard	*Ameiva ameiva*	Teiidae	Yes	Yes
Forest Racer Lizard	*Kentropyx calcarata*	Teiidae	Yes	No
Forest Racer Lizard	*Kentropyx striata*	Teiidae	Yes	No
Unkown	*Leposoma sp*	Gymnophthalmidae	Yes	No
Water Lizard	*Neusticurus sp*	Gymnophthalmidae	Yes	No
Unknown	*Hemidactylus sp*	Gekkonidae	No	Yes
Unknown	*Anolis sp*	Polychoritade	No	Yes
Unknown	*Mabuya nigropunctata*	Scinicidae	No	Yes
Unknown	*Tropidurus sp*	Tropiduridae	No	Yes
Forest Racer Lizard	*Kentropyx sp*	Teiidae	No	Yes
Caimans				
Dwarf Caiman	*Paleosuchus sp*	*Alligatoridae*	Yes	*No*
Snakes				
Amazon Tree Boa	*Corallus hortulanus*	Boidae	Yes	No
Rainbow Boa	*Epicrates cenchria*	Boidae	Yes	No
parrot snake'	*Philodryas viridissimus*	Colubridae	Yes	No
Unkown	*Drymoluber sp*	Colubridae	Yes	No
Tree boa	*Corallus caninus*	Boidae	No	Yes
Bush master	*Lachesis muta*	Viperidae	No	Yes
Horsewhip snake	*Oxybelis aenus*	Colubridae	No	Yes
Turtles				
Painted Turtle	*Rhynoclemmys punctularia*	Geoemydidae	Yes	No
Yellow-footed Tortoise	*Chelonoides denticulata*	Testunidae	Yes	No

11.2.6.2.5 Macro-Invertebrates

The 2017 wet season survey documented a total of 12 orders of terrestrial macro invertebrates. These orders included Dictyoptera (cockroaches), Isoptera (termites), Hymenoptera (ants), Araneae (spiders), Haplotaxida (earth worm), Spirobolida (yellow banded millipedes), Orthoptera (grasshopper and crickets), Hemiptera (True bugs), Coleoptera (beetle), Odonata (Dragon flies), Spirostreptida (millipedes) and Diptera (true flies (cow flies)). The orders Lepidoptera and hymenoptera were classified to species while the other orders were identified to the order taxa due to the difficulty of identifying and classifying invertebrates to the species level. The most abundant orders were the Araneae, Hymenoptera, Isoptera, Lepidoptera and odonata.

The 2018 dry season survey documented a total of 10 orders of terrestrial macro invertebrates. These orders included Hymenoptera (ants), Araneae (spiders), Haplotaxida (earth worm), Orthoptera (grasshopper and crickets), Hemiptera (True bugs), Lepidoptera (butterflies & moths), Coleoptera (beetles), Odonata (insects), Decapoda (Crabs; Shrimp) and Gastropoda (snails). The orders Lepidoptera and hymenoptera were classified to

species while the other orders were identified to the order taxa due to the difficulty of identifying and classifying invertebrates to the species level. The most abundant order was Lepidoptera.

Four (4) species of benthic organisms were collected, including Shrimp and Crab of the order Decapoda and Snails and Kreketae of the order Gastropoda. The most dominant organism collected was shrimp, which was represented by fifty-eight (58) individuals. Snails were the second most dominant organism, represented by forty (40) individuals.

The species documented by these surveys face no threats of endangerment or extinction when checked against both the IUCN RED List of Threatened Species and the CITES watch list.

Table 59: Macro-Invertebrates Recorded During the Surveys

Common Name	ORDER	Scientific Name	Family	Recorded by 2017 Wet Season Survey	Recorded by 2018 dry Season Survey
Terrestrial Macro-Invertebrates					
Penelope's Ringlet	Lepidoptera	*Cissia Penelope*	Nymphalidae	Yes	Yes
Orange-spotted Tiger Clearwing	Lepidoptera	*Mechanitis polymnia*		Yes	Yes
Hermes satyr	Lepidoptera	*Hermeuptychia Hermes*	Nymphalidae	Yes	No
	Lepidoptera	*Peropthalma lasus*	Riodinidae	Yes	No
	Lepidoptera	*Pierella*	Nymphalidae	Yes	No
	Lepidoptera	*Heliconius*	Nymphalidae	Yes	No
Morpho	Lepidoptera	*Morpho menelaus*	Nymphalidae	Yes	No
Uncertain owlet	Lepidoptera	*Bia actorion*	Nymphalidae	Yes	No
eighty-eights	Lepidoptera	*Diaethria*	Nymphalidae	Yes	Yes
Tigerwing	Lepidoptera	*mechanitis*	Nymphalidae	Yes	Yes
Doris longwing	Lepidoptera	*Heliconius doris*	Nymphalidae	Yes	No
bushfoots butterfly	Lepidoptera	*Neruda metharme metharme*	Nymphalidae	Yes	No
tiger butterfly	Lepidoptera		riodinidae	Yes	Yes
Sara longwing	Lepidoptera	*Heliconius sara*	Nymphalidae	Yes	No
False Giant Swallowtail	Lepidoptera	*Papilio thoas*	Papilionidae	Yes	No
Tiger Mimic Queen	Lepidoptera	*Lycorea halia*	Nymphalidae	Yes	Yes
Orange tiger	Lepidoptera	*Dryadula phaetusa*	Nymphalidae	Yes	No
Flame	Lepidoptera	*Dryas iulia*	Nymphalidae	Yes	Yes
	Lepidoptera	*Cissia*	Nymphalidae	Yes	No
gladiater bird eating spider	Araneae	*Theraphosa blondi*	Theraphosidae	Yes	No
Bullet ant	Hymenoptera	*Paraponera clavate*	Formicidae	Yes	Yes
Leaf cutting ants	Hymenoptera	*Atta cephalotes*	Formicidae	Yes	Yes
Army ants	Hymenoptera	*Eciton burchellii*	Formicidae	Yes	Yes
Big eyed ants	Hymenoptera	*Gigantiops destructor*	Formicidae	Yes	Yes
Earth worm	Haplotaxida	*lumbricus terrestris*	Lumbricidae	Yes	Yes

Yellow-banded Millipede	Spirobolida	*Anadenobolus monilicornis*	Rhinocricidae	Yes	No
Grasshopper and crickets	Orthoptera			Yes	Yes
Millipedes	Spirostreptida			Yes	No
Beetle	Coleoptera			Yes	Yes
Dragon flies	Odonata			Yes	Yes
Cockroaches	Dictyoptera			Yes	No
Bees and wasps	Hymenoptera			Yes	Yes
True Bugs	Hemiptera			Yes	Yes
Spiders	Araneae			Yes	Yes
True Flies (cow fly)	Diptera			Yes	No
Benthic Invertebrates					
Crab	Decapoda			Yes	Yes
Shrimp	Decapoda			Yes	Yes
Kreketae	Gastropoda			Yes	No
Snail	Gastropoda			Yes	Yes

11.2.6.2.6 Fish

The 2017 wet season survey documented one hundred and sixty (160) individuals represented by twenty-five (25) species and eleven (11) families. The 2018 dry season survey documented one hundred and nine (109) individuals represented by seventeen (17) species and nine (9) families.

The most dominant species, in the 2017 wet season, was *Guianacara dacrya* (Cichlidae, 33 individuals) followed by *Astyanax bimaculatus* (Characidae, 31 individuals), *Hoplias malabaricus, Callichthys callichthys, Erythrinus erythrinus, Megalechis thoracata, Moenkhausia dichrouia, Pimelodella spp, Hypostomus spp, Rinelorocaria spp, Hemiodus unimaculatus, Anablepsoides spp and Callichthys spp* all these species represented one (1) individual.

The most dominant species, in the 2018 dry season, was *Hyphessobrycon serape (*Characidae, 34 individuals) followed by *Guianacara dacrya (*Cichlidae, 18 individuals), *Aequidens potaroensis (*Cichlidae, 17 individuals), *Bryconops melanurus (*Characidae, 10 individuals), *Crenicichla alta (*Cichlidae, 7 individuals), *Hoplias malabaricus (*Erythrinidae, 4 individuals), *Pyrrhulina semifasciata (*Lesbiasinidae, 4 individuals), *Erythrinus erythrinus (*Erythrinidae, 2 individuals), *Curimatella immaculate (*Curimatidae, 2 individuals), *Poptella spp (*Characidae, 2 individuals), *Hypostomus spp (*Loricariidae, 2 individuals), *Gymnotus coropinae (*Gymnotiformes, 2 individuals). *Rhamdia quelen, Moenkhausia dichrouia, Leporinus friderici, Pimelodella spp and Hoplias aimara* were all represented one (1) individual. None of the species recored is listed under the IUCN and CITES list.

Table 60: Fish Species Recorded During the 2017- 2018 Surveys

Common Name	Scientific Name	FAMILY	Recorded by 2017 Wet Season Survey	Recorded by 2018 Dry Season Survey
Daray	*Leporinus friderici*	Anostomidae	Yes	Yes
Aquarium Fish	*Anablepsoides spp*	Aplocheilidae	Yes	No
Smoke Hassa	*Callichthys callichthys*	Callichthyidae	Yes	No
Smoke Hassa	*Megalechis thoracata*	Callichthyidae	Yes	No
Cat Fish	*Callichthys spp*	Callichthyidae	Yes	No
Celebae	*Hyphessobrycon serpae*	Characidae	Yes	Yes
Silver Belly	*Astyanax bimaculatus*	Characidae	Yes	No
Celebae	*Phenacogaster pectinatus*	Characidae	Yes	No
Band Tail Tetra	*Moenkhausia dichrouia*	Characidae	Yes	Yes
Silver Dollar	*Poptella spp*	Characidae	Yes	Yes
Sun Fish	*Crenicichla alta*	Cichlidae	Yes	Yes
Patwa	*Aequidens potaroensis*	Cichlidae	Yes	Yes
Patwa	*Guianacara dacrya*	Cichlidae	Yes	Yes

Coroor	*Curimatella immaculata*	Curimatidae	Yes	Yes
Yarrow	*Erythrinus erythrinus*	Erythrinidae	Yes	Yes
Huri	*Hoplias malabaricus*	Erythrinidae	Yes	Yes
Haimara	*Hoplias aimara*	Erythrinidae	Yes	Yes
	Hemiodus unimaculatus	Hemiodontidae	Yes	No
Cassie	*Rhamdia quelen*	Heptapteridae	Yes	Yes
Cassie	*Pimelodella spp*	Heptapteridae	Yes	Yes
Cassie	*Pimelodella cristata*	Heptapteridae	Yes	No
Aquarium Fish	*Pyrrhulina stoli*	Lesbiasinidae	Yes	No
Smoke Hassa	*Hypostomus taphorni*	Loricariidae	Yes	No
Smoke Hassa	*Hypostomus spp*	Loricariidae	Yes	Yes
Banjaman	*Rinelorocaria spp*	Loricariidae	Yes	No
Aquarium Fish	*Pyrrhulina semifasciata*	Lesbiasinidae	No	Yes
Banded knife Fish	*Gymnotus coropinae*	Gymnotidae	No	Yes
Tail-light Tetra	*Bryconops melanurus*	Characidae	No	Yes

11.2.6.3 Threatened Species

The local conservation status of species within Guyana is set out in the First Schedule of the Wildlife Management and Conservation Regulations, 2013. The First Schedule of the Regulations classifies threatened wildlife as Vulnerable (V), Endangered (EN) and Critically Endangered (CR), as guided by the criteria of the IUCN Red List of Threatened Species occurring in Guyana. Taxa in any of these three categories are collectively referred to as 'threatened'. The IUCN Red List species was therefore used in this analysis. Threatened and Near Threatened (NT) species of international concern recorded within the concession is provided in Table 61.

Table 61: Threatened and Near Threatened (NT) Species of International Concern

MAMMALS	**COMMON NAMES**	**IUCN**
Priodontes maximus	Giant Armadillo	**Vu**
Tapirus terrestris	Brasilian Tapir	**V**
Ateles paniscus	Black spider monkey	**V**
Pantera Onca	Jaguar	**V**
BIRDS		**NT**
Spizaetus ornatus	Ornate Hawk-Eagle	**NT**
Amazona farinosa	Mealy Parrot	**NT**
Harpia harpyja	Harpy Eagle	**NT**
Pionopsitta caica	Caica Parrot	**NT**
Hypocnemis cantator	Guianan Warbling Antbird	**NT**
Ramphastos tucanus	White-throated Toucan	**V**
Crax alector	Black Curassow	**V**
Ramphastos vitellinus	Channel-billed Toucan	**V**
Myrmotherula surinamensis	Guianan Streaked Antwren	**V**
Psophia crepitans	Grey-winged trumpeter	**NT**
Tinamus major	Great Tinamou	**NT**
HERPETOFAUNA		
Chelonoidis denticulata	Yellow-footed Tortoise	**V**

Psophia crepitans occurs through Brazil north of the Amazon, west to the Rio Negro, through the Guianan shield forests (French Guiana, Suriname and Guyana) and South-west Venezuela. This species is considered near threatened due to increased deforestation in the Amazon basin as land is cleared for cattle ranching and soy production, facilitated by expansion of the road network (Soares-Filho et al. 2006; Bird et al. 2011). It is also declining because of hunting pressure.

Tinamus major is found east of Venezuela through Guyana, Suriname and French Guiana to north-east Brazil (del Hoyo *et al.* 1992). This species is considered near threatened due to habitat loss across its large range, as a result of accelerating deforestation in Amazonia. It is likely to be sensitive to forest degradation, both through a reduction in forest quality and because logging roads facilitate access to forests by hunters, who prize this species as game (del Hoyo *et al.* 1992; Peres 2000; A. Lees *in litt.* 2011).

P. Brasiliensis is endemic to the rainforests and wetlands of South America. The northern extent of its range occurs near, but does not include, the Caribbean Sea, and the southern extent of its range reaches Argentina. Most of the animals are found in the Brazilian Amazon and the regions immediately bordering this area. In Guyana, there are several known localities with stable giant otter populations in the Rupununi Region such as; Bat Creek, Lower Rewa River, Upper Rewa River, Karanambo, Upper Rupununi River (Duplaix, 2002).

Tapirus terrestris (Brasilian Tapir) is found in lowland regions of northern and central South America, from Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Suriname, and Venezuela. This species is considered to be Vulnerable due to an ongoing population reduction as a result of habitat loss, illegal hunting and competition with livestock. Lowland tapir populations seem unlikely to persist anywhere humans occur at densities any greater than 1/km^2. Even where habitats remain, populations are reduced and dispersed due to the effects of hunting. This is greatly amplified around increasing human populations and settlements within its habitat range.

Priodontes maximus (Giant Armadillo), the largest of all armadillo species, ranges from northern Venezuela (east of the Andes) and the Guianas (French Guiana, Guyana, and Suriname), south to Paraguay, and northern Argentina Although widespread, *Priodontes maximus* is listed as Vulnerable since it is rare over its entire range. Population decline of *Priodontes maximus* is based on habitat loss and over-hunting.

Panthera onca (Jaguar) is the largest cat of the Americas, and the only living representative of the genus Panthera found in the New World. The jaguar is considered to be Near Threatened due to habitat loss, poaching of prey and fragmentation of populations across portions of its range. Much of the jaguar's remaining habitat is the rainforest of the Amazon basin. The jaguar is still an abundant species, but is threatened by habitat loss and persecution.

Ateles paniscus (Black spider monkey) occurs north of the Rio Amazon, east of the Rios Negro and Branco. In Guyana, it is known from the far south and from the east of the River Essequibo, and east from there through Suriname and French Guiana, excluding the lowland coastal plains, but throughout adequate habitat and into the states of Amapá, Pará (north of the Rio Amazonas), and Amazonas, Brazil. Although habitat loss is not as severe in the more northerly part of the range of *A. paniscus*, hunting remains a threat across the range and is taking place even within protected areas.

The bird species *Hypocnemis cantator (*Warbling Antbird), *Spizaetus ornatus* (Ornate Hawk-Eagle), *Amazona farinosa* (Mealy Parrot), *Harpia hapyja* (Harpy Eagle), and *Pionopsitta caica* (Caica Parrot) are listed as Near Threatened by the IUCN Red List. Based on a model of future deforestation in the Amazon basin, it is suspected that the population of these bird species will decline rapidly over the next three generations. These birds have therefore been listed as Near Threatened.

Harpia harpyja (Harpy Eagle)is sparsely distributed and generally rare throughout its extensive range in south Mexico, Guatemala, Belize (recently confirmed, Honduras, Nicaragua, Costa Rica, Panama, Colombia, Venezuela, Guyana, Suriname, French Guiana, Ecuador, Peru, Bolivia, Brazil, Paraguay and north-east Argentina. It is thought to be locally or regionally extinct in large parts of its former range, notably most of central and north Central America and possibly Rio Grande do Sul, Brazil (Bierregaard 1994a, Bierregaard et al. 1995), but recent records suggest that the population in the southern Atlantic forests may be migratory (Galetti et al. 1997b).

*Hypocnemis cantator (*Warbling Antbird) occurs in the Guyana Shield of northern South America, and is generally fairly common. Its distribution just reaches extreme east-central Venezuela, where it is found in north-western Bolívar. It ranges from there through Suriname, Guyana and French Guiana, being especially frequent in the latter two, to north-east Amazonian Brazil, where it ranges from the lower Rio Negro eastwards to Amapá. The primary threat to this species is accelerating deforestation in the Amazon basin as land is cleared for cattle ranching and soy

production, facilitated by expansion of the road network. It is thought likely to be particularly susceptible to forest fragmentation. This species is suspected to lose 27.6 - 45.5% of suitable habitat within its distribution over three generations (56 years) based on a model of Amazonian deforestation (Soares-Filho et al. 2006, Bird et al. 2011). However, losses outside Amazonia are judged to be likely to be lower (A. Lees in litt. 2011), so the species is therefore suspected to decline by 25-30% over three generations.

Spizaetus ornatus (Ornate Hawk-Eagle) mainly occurs in humid forests and ranges through most of the Neotropics. The nominate subspecies *ornatus* occurs from east Colombia east through Venezuela, where it is slightly more frequent but still uncommon It is uncommon to rare in Guyana, Suriname, French Guiana and Trinidad and Tobago. The taxon's range extends south through east Ecuador, north-east Peru and north-east Bolivia. It reaches south Brazil, where it has declined in areas of heavy deforestation, and further south to Paraguay. The primary threat to this species is accelerating deforestation in the Amazon basin, through which it is projected to lose up to 40% of its habitat. It is also susceptible to hunting and persecution, but is comfortable traversing fragmented landscapes and has a huge range.

*Amazona farinose (*Mealy Parrot) is widespread from eastern Panama, south and east through Colombia, Venezuela, Guyana, Suriname, French Guiana, Ecuador, Peru, Bolivia and Brazil. Large populations are said to persist in the less disturbed parts of its range. This species inhabits extensive tracts of lowland tropical evergreen forest, also occurring in palm stands, deciduous and gallery woodland and secondary growth near forest. The primary threat to this species is accelerating deforestation in the Amazon Basin as land is cleared for cattle ranching and soy production, facilitated by expansion of the road network.

The *Ramphastos tucanus* (White-throated Toucan), *Crax alector* (Black Curassow), *Ramphastos vitellinus* (Channel-billed Toucan), and *Myrmotherula surinamensis* (Guianan Streaked Antwren) are listed as Vulnerable. *Ramphastos tucanus* occurs in lowland tropical forest, especially old riverbeds, late stage successional forest, and mature forest near water. It has a wide range, from eastern Venezuela through Guyana, Suriname and French Guiana, east of the Rio Negro in northeast Brazil and also south of the Amazon in northern Pará and Maranhão states. The primary threat to this species is accelerating deforestation in the Amazon basin as land is cleared for cattle ranching and soy production, facilitated by expansion of the road network. It is also declining as a result of hunting pressure.

Ramphastos vitellinus (White-throated Toucan*)* inhabits forested lowlands, most often near water, forest edge, swamp forest, clearings, riverine forest, and patches in savannas, cerrado and riverine forest, up to 1,700 m. It is much less common in secondary and selectively cut forest. It has an extensive range from easternmost Colombia, east through Venezuela, Trinidad and Tobago, Guyana, Suriname and French Guiana, to northern Amazonian Brazil (Amazonas, Roraima, Pará and Amapá states). The primary threat to this species is accelerating deforestation in the Amazon basin as land is cleared for cattle ranching and soy production, facilitated by expansion of the road network. It is also declining as a result of hunting pressure.
Myrmotherula surinamensis has a large range in the Guyana Shield region and is generally uncommon to fairly common. In south Venezuela, it occurs in southern Delta Amacuro, Bolívar (where it is uncommon and local) and Amazonas, including presence in Yapacana National Park, Duida National Park, La Neblina National Park and Alto Orinoco-Casiquiare Biosphere Reserve. It is found across Suriname, Guyana and French Guiana, being frequent in the latter two. In north Brazil, it ranges from eastern Roraima eastwards as far as Amapá. The species is an understorey and middle storey species of Amazonian lowland seasonally flooded forest, permanently flooded forest and shrubby secondary growth, occurring up to 550 m. The primary threat to this species is accelerating deforestation in the Amazon basin as land is cleared for cattle ranching and soy production, facilitated by expansion of the road network. It is thought that it may be particularly susceptible to forest fragmentation.

Guyana has no listed critically endangered or endangered terrestrial or freshwater vertebrates. The only fish and non-avian reptiles listed as endangered or critically endangered by the IUCN for Guyana are marine species that are not present within the Cuyuni-Mazaruni Basin. No endangered or critically endangered amphibians are known to occur in Guyana.

11.3 Impact Prediction and Evaluation

11.3.1 Construction Impacts

11.3.1.1 Floral Resources

Dust and combustion emissions generated by equipment during the clearing for mine site facilities may cause injury to plants under ambient conditions of exposure. Pollutants confirmed to cause injury to plants include NO_2, and particulate matter both of which would be generated by equipment operations at this site. Plant injury would depend on physical and biological factors. Plants consist of four organs: roots, stems, leaves, and reproductive structures. The leaf is the principal target for damage, as it is the organ involved in gas exchange, and its damage would be most obvious. The upper surface of a leaf is overlain by a waxy layer referred to as the cutin. Below the cutin is a layer of colorless cells; the upper epidermis. Both the cutin and the upper epidermis protect the leaf from desiccation and mechanical injury. Located beneath the upper epidermis is a layer of photosynthetically active cells. Next are a mass of irregularly shaped and loosely arranged cells. The loose arrangement provides for large intercellular spaces in which gas exchange is facilitated. The lower surface of the leaf is bounded by the lower epidermis, which also functions to protect the leaf.

Emission impacts upon plants may include changes in leaf structure, which may include chlorophyll destruction (chlorosis), tissue death (necrosis), and pigment formation. Visible symptom patterns may result from either acute or chronic exposures. Acute injury may result from brief exposures (several hours) to elevated levels of a pollutant. Tissue necrosis is generally the dominant symptom pattern from acute exposures. Chronic plant injury may result from intermittent or long-term exposures to relatively low pollutant concentrations, with chlorophyll destruction or chlorosis as the principal symptom of injury. These are moderate impacts (long-term, moderate severity, local extent).

These impacts will be mitigated by employing the following measures:

- Employing dust suppression technique such as applying water or non-toxic chemicals
- Maintaining construction equipment according to manufacturer's specifications

These mitigation measures will result in low impacts (short-term, low severity, local extent).

Construction works will include clearing the mine footprint and areas for camp site facilities. The access road may also be widened from its current average width. The areas occupied by the access road corridor, the areas to be mined together with the areas for other mine site facilities will be subtracted from the total area available to flora. Cutting of large tracts will make plant regeneration difficult. This difficulty arises since nutrients, contained in the biomass can be washed away by rainwater after clearing. In addition, enhanced leaching, occasioned by clearing, can deplete the soil of nutrients. The absence of nutrients may result in any new vegetation consisting mainly of grass species. Aggressive grass species and shrubs will effectively prevent seed-bearing plants from finding satisfactory living conditions. These grasses serve as a food source for a significant population of birds. The surrounding area is the same ecologically as the cleared area and the area to be cleared is a very small percentage of the total area. Clearing will consequently result in only low impacts (short-term, low severity, local extent) on the overall area.

Access roads will cut an existing ecosystem into two parts. The two parts created by the road may potentially have less value than the initial whole ecosystem, since ecosystems are characterized by complex, interdependent relationships between component species and their physical environment. The access road may potentially fragment the area into weaker ecological sub-units and may make the entire area vulnerable to invasion and degradation. This is a moderate impact (long-term, moderate severity, regional extent). This impact will be mitigated by minimizing the width of access roads. The mitigation measures will result in low residual impacts (short-term, low severity, regional extent).

It is estimated that approximately 65 ha of land will be cleared for the mine site and associated infrastructure. The loss of terrestrial habitats and flora is unavoidable within the project footprint area. Activities related to exploration

and artisanal mining has resulted in large tracts of the project footprint area being secondary growth areas. None of the terrestrial habitats in the project area have been identified as critical habitat. None of the plant species known to be present in the project area are known to be threatened locally or to be restricted-range endemic. The loss of terrestrial habitats in the project area is a high impact (medium-term, high severity, local extent). With appropriate mitigations such as strict minimization of clearing and progressive restoration, the impact rating is low (medium-term, low severity, local extent).

The construction works will lead to increased human population and increased levels of general activity in the area. The increased human presence has the potential to lead to increased impacts on flora through harvesting, collecting, disturbance, and other activities by construction workers. This impact is considered high (long-term, high severity, regional extent). The company will enforce a policy of no harvesting of flora resources to ensure that no flora are harvested from the area or brought into the area. Implementation of these measures will result in low residual impacts (short-term, low severity, regional extent).

Weeds may be introduced into the project area during construction if the project uses plant and equipment, with soil and weeds from locations at which the equipment and plant were previously used. These are high impacts (long-term, high severity, local extent). These impacts will be mitigated by taking steps to ensure that all equipment, previously used at other locations, are free of all soils and weeds. This will result in low impacts (short-term, low severity, local extent).

11.3.1.2 Faunal Resources

Widening of the access road and clearing of the area, for workshop and laboratory facilities, will fragment the area and can potentially impact wildlife since some animal species depend on the existence of other plant and animal species within the habitat for nutrients/food, cover, etc. The areas to be cleared are relatively small in comparison to the available area. Clearing and encroachment will alter several of the physical conditions including light, humidity and temperature. The installation of facilities and other construction works will form temporary barriers to the movement of animals, including access to water bodies. These are moderate impacts (short-term, moderate severity, local extent). These impacts will be mitigated by minimizing the area cleared for the facilities and by maintaining wildlife corridors within the cleared areas. The implementation of the proposed mitigation measures will result in low residual impacts (short-term, low severity, local extent).

The habitat will also become fragmented if the area of land is broken up into smaller and smaller patches. This will make dispersal by native species from one patch to another difficult or impossible and may cut off migratory routes. Isolation may lead to local decline of species, or genetic effects such as inbreeding. Species that require large patches of forest may simply disappear. These are moderate impacts (medium-term, medium severity, local extent). These impacts will be mitigated by ensuring that a single continuous area, with small patches of vegetation, is cleared for the mine site facilities. This will result in low impacts (short-term, low severity, local extent).

The physical disturbance and noise produced by construction equipment may impose additional stresses upon wildlife and may lead to increased migration. While disturbances may be stressful for some wildlife, other species may easily adapt to and thrive successfully in the area owing to the phenomenon of habituation. These are potentially moderate impacts (long-term, high severity, local extent). These impacts will be mitigated by ensuring that noise levels are maintained at the lowest possible and are in accordance with EPA Noise Guidelines. The mitigation measures will result in low impacts (long-term, low severity, local extent).

The construction works will lead to increased human population and increased levels of general activity in the area. The increased human presence has the potential to lead to increased impacts on fauna through harvesting, collecting, hunting, fishing, disturbance, and other activities by construction workers. This impact is considered high (long-term, high severity, regional extent). The company will enforce a policy of no hunting and fishing by its employees and will also implement measures to ensure that no fauna is harvested from the area or brought into the area. Implementation of these measures will result in low residual impacts (short-term, low severity, regional extent).

Animals introduced to the mine site may pose threats to the biodiversity of the mine site. Introduction of household pets including dogs, cats and other pets, to the project area, may kill many native birds and small animals. Feral dogs and cats are particularly damaging in this regard. These are high impacts (long-term, high severity, local extent). These impacts will be mitigated by the company incorporation into its policy of bans on introduction of pets to the mine site. This will result in low impacts (short-term, low severity, local extent).

Some loss of small and/or slow-moving fauna will inevitably occur during land clearing and earthmoving activity. None of the invertebrate, amphibian, non-avian reptile or small mammal species determined to be present in the project area is known to be threatened or endemic. More mobile fauna including large mammals and adult birds will very likely flee the area well in advance of any land clearing operations. The surrounding area is large enough to absorb fauna fleeing cleared areas. The loss of terrestrial fauna in the project area is estimated to be a moderate impact (medium-term, moderate severity, local extent) since the area has been disturbed by artisanal mining and exploration activities. This impact will be mitigated by minimization of the areas cleared. The residual impact will consequently be low (short-term, low severity, local extent).

11.3.1.3 Aquatic Resources

The construction of the mine and associated infrastructure will result in the loss of various stream habitats within the concession area. Several of these habitats have already been affected by historical exploration and mining activities at the site as well as by ASM activities in the area. Surveys have not identified any critical aquatic habitats. Similar aquatic habitats are common in the region. Loss of aquatic habitats in the open pit area, tailings pond, and other areas where major conversion of the land surface is required will be unavoidable due to the nature of the activities. These are moderate impacts (long-term, moderate severity, local extent).

These impacts would be mitigated during the construction stage of the project by constructing the water management impoundments at a rate slow enough to allow aquatic organisms to relocate outside of the footprint of the ponds. Construction will progress in the flow direction of streams to further enhance this possibility. Further retention ponds and other detention storage/sedimentation facilities will be installed to ensure that stormwater discharges do not degrade the habitat structure of the receiving bodies. None of the aquatic fauna identified in the streams or creeks within the project area are known to be threatened or restricted-range endemic. The mitigation measures will result in low impacts (short-term, low severity, local extent).

The loss of aquatic habitat in the concession area is a potentially high impact (long-term, moderate severity, local extent). These impacts will be mitigated by minimizing the extent of areas cleared for diversion channels and by installing bypass structures, where possible, to facilitate flow in the downstream section of streams which have been diverted. Application of these mitigation measures will result in low residual impacts (short-term, low severity, local extent) on aquatic habitats.

Surface runoff from cleared areas may introduce additional nutrient loads to streams. Higher nutrient levels can potentially result in eutrophication. Pollution by contaminated surface runoff can also impact water quality in the streams and lead to denitrification and increased oxygen consumption resulting in an environment less conducive to the survival of fishes. Contaminants could be ingested by aquatic organisms causing reproductive impairment, stunted growth, and other physiological effects. Also, as contaminants naturally break down, they use dissolved oxygen, sometimes significantly reducing the dissolved oxygen content of the water, which can lower spawning success for many fish species and reduce overall habitat suitability for many aquatic organisms. During construction, there could be hydrocarbon contamination of the aquatic systems from accidental spills of lubricants and fuel. Hydrocarbons introduced into aquatic environments may change aquatic plant and animal growth, mortality and communities. These are potentially high impacts (long-term, high severity, regional extent).

Discharge to water management ponds will contain sediments which will result in decreased transparency and a reduction of light available to aquatic plants, a primary food source for aquatic organisms. Further, the suspended sediment will ultimately settle onto instream habitat features (e.g., downed wood, gravel, etc.) or the bottom substrate causing embeddedness, which will decrease the value of instream habitat for macroinvertebrates and fish. Specifically, increases in embeddedness levels decrease the space between substrate particles and limit the available area and cover for small fish, macroinvertebrates, and periphyton.

The adverse effects of increased levels of fine sediments on fish include: increased mortality caused by gill damage; increased predation due to sedimentation of shelter; increased susceptibility to disease; impaired developmental rates, reduction of suitable spawning habitat, reduced spawning success, modification of migration patterns, impairment of visual feeders, and reduction of light penetration, which impedes primary production, reduces food availability, and alters food webs. These are high impacts (long-term, moderate severity, local extent).

These impacts will be mitigated by implemenatation of an Erosion and Sediment Control Plan and by channeling contaminated runoff to oil-water separators prior to discharge to streams/creeks. The mitigation measures will result in low impacts (short-term, low severity, local extent).

11.3.2 Operation Impacts

11.3.2.1 Floral Resources

The removal of vegetation for mine site operations will alter the availability of food and shelter for wildlife. Mining may impact biodiversity by changing species composition and structure and may provide access to previously isolated areas thereby enabling exploitation of biological resources from the area. Imported species including weedy plants and insect pests may thrive while native species may decline. Improved access to the mine site areas may result in increased hunting, logging and land development.

Mining can potentially reduce biodiversity either directly, through activities which remove, damage or modify habitats, or indirectly where changes caused by project activities may create situations where species or their habitats can be damaged by activities other than those directly associated with mining. Examples of such indirect impacts include proliferation of weeds attracted to areas disturbed by mining, and exploitation of timber in forests made accessible by construction of mine site infrastructure.

During the operations, areas to be mined will be cleared of vegetation. Clearing of areas to be mined will make plant regeneration difficult since nutrients, contained in the biomass, can be washed away after clearing. The surrounding area is the same ecologically as the cleared area and the area cleared is a very small percentage of the total area. Clearing will consequently result in only moderate impacts (medium-term, moderate severity, local extent) on the overall area. The potential impacts will be mitigated by revegetating the area after the completion of the mining operation. This would therefore result in low residual impacts (medium-term, low severity, local extent).

Emission impacts upon plants may include changes in leaf structure, which may include chlorophyll destruction (chlorosis), tissue death (necrosis), and pigment formation. Visible symptom patterns may result from either acute or chronic exposures. Acute injury may result from brief exposures (several hours) to elevated levels of a pollutant. Tissue necrosis is generally the dominant symptom pattern from acute exposures. Chronic plant injury may result from intermittent or long-term exposures to relatively low pollutant concentrations, with chlorophyll destruction or chlorosis as the principal symptom of injury. These are moderate impacts (long-term, moderate severity, local extent).

These impacts will be mitigated by employing the following measures:

- Employing dust suppression technique such as applying water or non-toxic chemicals
- Maintaining construction equipment according to manufacturer's specifications

These mitigation measures will result in low impacts (short-term, low severity, local extent).

Traffic on the access road and mine service roads during the operation phase would impact the early succession/edge and secondary forest habitats located along these roads by increasing dust, which will settle on vegetation. Dust accumulation on plants has been found to impair biological functions including metabolism and photosynthesis, stunt growth, make them more susceptible to disease, and even cause mortality. Road dust may deposit on vegetation up to one kilometre away from the generation site and may contain pollutants or chemicals that can alter the permeability of the leaves or the pH of the leaves' surfaces (Farmer, 1993). Given the limited

geographic scope of this impact, the impact of dust accumulation on plants would be low (medium term, low severity, local extent). Wetting roads during the dry seasons would reduce this impact to low (short-term, low severity, local extent).

The project may use equipment that were previously used on other projects. Soil pathogens, insects and fungi can be introduced from these items unless stringent measures are taken to avoid this possibility. These are moderate impacts (long-term, high severity, local extent). These impacts will be mitigated by having all equipment fumigated prior to deployment to the mine site. This will result in low impacts (short-term, low severity, local extent).

The movement of people, equipment, and materials to the mine has the potential to cause the introduction of alien invasive species of plants. The disturbance and clearing of natural habitats can also promote the growth or colonization of alien invasive species. This impact is rated as moderate (long-term, moderate severity, local extent). These impacts will be mitigated by implementation of the following mitigation measures:

- Monitoring of biodiversity and,
- Control of invasive species.

Implementation of these measures will result in low impacts (short-term, low severity, local extent).

11.3.2.2 Faunal Resources

During operation additional loss of habitats will not affect any threatened or restricted-range endemic species of fauna since much of the fauna will have likely already left the affected habitats due to disturbance during the construction phase. This impact is rated as moderate (medium term, moderate severity, local extent). These impacts will be minimized by implementation of the following:

- Minimization of the Project footprint and,
- Initiating restoration as soon as practicable in temporary work areas.

Implementation of these measures will result in low residual impacts (medium term, low severity, local extent).

Most of the larger animals would have already abandoned the area during the construction phase. Only small fauna accustomed to disturbed environments are likely to remain in or enter mining areas and other work sites during the operation phase. It is likely that small numbers of small animals such as amphibians and snakes will experience mortality due to equipment and vehicle use. The loss of terrestrial fauna during the mining operations phase is rated as moderate (long-term, moderate severity, local extent). These impacts will be mitigated by implementation of the following:

- Minimization of the Project footprint and
- Performance of preclearance surveys.

The movement of people, equipment, and materials to the mine has the potential to cause the introduction of alien invasive species of animals. This impact is rated as moderate (long-term, moderate severity, local extent). These impacts will be mitigated by implementation of the following mitigation measures:

- Monitoring of biodiversity and
- Control of invasive species.

Implementation of these measures will result in low impacts (short-term, low severity, local extent).

During operation of the mine, wildlife may move away from the area. This displacement will increase competition with wildlife on the periphery of the area. This is a moderate impact (medium term, moderate severity, local extent). This impact cannot be mitigated.

The physical disturbance and noise produced by mining equipment may impose additional stresses upon wildlife and may lead to increased migration. While disturbances may be stressful for some wildlife, other species may easily adapt to and thrive successfully in the area owing to the phenomenon of habituation. These are potentially high impacts (long-term, high severity, local extent). These impacts will be mitigated by minimizing the extent of the cleared areas and by ensuring that noise levels are maintained at the lowest possible. The mitigation measures will result in moderate impacts (medium term, moderate severity, local extent).

Most animal species follow established patterns in their daily and seasonal movements. The areas through which animals travel on their way to and from feeding, breeding and birthing grounds, and between their seasonal ranges, are known as corridors. If the mine service roads and widened access road intersects or blocks wildlife corridors, animals may cease use of the corridor since animals are reluctant to cross open spaces and may be hit by vehicles using the roads. This may result in potential increase in animal mortality because of collisions with vehicles, or a delay in migration in search of food and for breeding and birthing. These are moderate impacts (long-term, moderate severity, local extent). These impacts will be mitigated by conducting an assessment after the roads are cleared to identify corridors and signs will be posted notifying drivers of the existence of these corridors and speed restrictions will be placed on the roads near the corridors. The mitigation measures will result in low impacts (short-term, low severity, local extent).

Wildlife species live in communities that depend on each other. Survival of these species depends on soil conditions, local climate, altitude, and other features of the local habitat. Mining operations will result in direct and indirect impacts to wildlife. The impacts will stem primarily from disturbing, removing, and redistributing the land surface. Most of these impacts would be short-term and would be confined to the mine site. Mining operations will displace and possibly destroy wildlife in areas to be excavated and to be used for disposal of mine wastes. The mobile wildlife species, like game animals, birds, and predators will leave these areas, however, the more sedentary animals, like invertebrates, many reptiles, burrowing rodents, and small mammals, may be more severely affected.

Some animals would be attracted to the open spaces created by the mine and service roads for protection from predators, good food supplies and better travel conditions. This may potentially lead to accidental death and poaching. These are moderate impacts (long-term, moderate severity, local extent). These impacts will be mitigated by constraining the areas cleared for the mine and service roads to the narrowest width possible and by lowering the vertical alignment. Service roads will also be designed to minimize cuts and fills and will have relatively flat side slopes with minimal clearing of existing vegetation. The narrower rights-of-way and lower vertical alignment will make crossing easier for animals and will provide longer sight lines for drivers resulting in less frequent collisions with animals. The mitigation measures will result in low impacts (short-term, low severity, local extent).

11.3.2.3 Aquatic Resources

The operation of the mine and associated infrastructure will impact various stream habitats within the concession area. These habitats will have already been affected by construction phase activities, but the initiation of mining operations will bring additional impacts to these affected aquatic habitats. Impacts to aquatic habitats associated with the operation of the open pit area, the tailings pond and other areas where major conversion of the land surface occurs will be unavoidable due to the nature of the activities. Upstream and downstream segments of streams will be affected. Water discharged from the diversion channels surrounding the waste stockpile areas will affect downstream receiving bodies and their aquatic fauna.

The loss of aquatic habitats in the concession area is a high impact (long-term, high severity, regional extent). Mining operations will include relocation of streams. Several of these streams may contain fish, aquatic invertebrates and amphibians. The relocation of these streams may result in loss of these aquatic resources. This will reduce food supplies for predators which feed on these aquatic resources which may result in the reduction or disappearance of these predators. These are high impacts (long-term, high severity, regional extent). These impacts will be mitigated by minimizing the number and longitudinal extent of streams to be relocated. The mitigation measures will result in moderate impacts (short-term, moderate severity, local extent).

Some wildlife species depend on vegetation growing in natural drainages. This vegetation provides essential food, nesting sites, and cover for escape from predators. Mining activity may destroy vegetation near streams and reduce the quality and quantity of habitat essential for waterfowl, birds, and other terrestrial species. These are moderate impacts (long-term, moderate severity, local extent). These impacts will be mitigated by assessing the area and the alignment of streams to be diverted before the start of work. The work, on both areas to be cleared and streams to be diverted, will be conducted in a phased manner to identify and manage the potential environmental impacts to preclude these impacts from being realized. The mitigation measures will result in low impacts (short-term, low severity, local extent).

11.3.3 Closure Impacts

Acid generation may occur if sulphide rich materials, present in mine openings, pit walls, waste rock and tailings, are exposed to and react with oxygen and water to form sulphuric acids. Sulphuric acid generated by this process will easily dissolve metals such as iron and aluminium present in soils at the site. The process is accelerated by the preence of acid-ingesting bacteria. Acid mine drainage (AMD) will result in low pH values and elevated concentrations of dissolved metals in surface water since the solubility of metals is pH dependent and for most metals the solubility increases with a decrease in pH value.

While small amounts of metals are considered essential for the survival of many organisms, large quantities are often toxic. Few terrestrial and aquatic species are known to be naturally tolerant of heavy metals, although some have adapted over time. Many fish are highly sensitive to even mildly acidic waters and cannot breed at pH levels below 5. Some may die if the pH level is less than 6 (Ripley et al. 1996). In general, the number of plant and animal species decreases as the aqueous concentration of heavy metals increases. Some taxa are known to be more sensitive to the presence of heavy metals. This is particularly the case for species living in freshwater aquatic habitats. Furthermore, juvenile fish are more sensitive than adult fish, and the presence of heavy metals may affect the critical reproductive and growth stages of fish. These are high impacts (long-term, high severity, regional extent). These impacts will be mitigated by applying a non-reactive cap to all acid generating areas. The mitigatiom measures will result in low residual imapcts (short-term, low severity, local extent).

Weeds may be introduced to the mine site during site reclamation. Weed introduction can occur by seed contaminated with seeds of weeds which is quite common, even in commercial seed supplies. Weeds may also be introduced by plant and equipment relocated from other areas. These are high impacts (long-term, high severity, local extent). These impacts will be mitigated by requesting that all seed suppliers certify that seeds supplied are weed free. Seedlings would also be closely monitored for signs of unwanted species. In addition, any non-native species being considered for mine rehabilitation would be carefully tried and closely monitored prior to its introduction. This will result in low residual impacts (short-term, low severity, local extent).

11.4 Environmental Management Plan

11.4.1 Terrestrial Resources

Temporary and permanent alteration of terrestrial habitats will be minimized to the extent feasible and be consistent with the requirement to protect and preserve critical habitat. Recommended management strategies will include:

- Siting site roads and facilities in locations that avoid impacts to critical terrestrial habitat, and planning exploration and construction activities to avoid sensitive times of the year
- Minimizing disturbance to vegetation and soils
- Implementation of mitigation measures appropriate for the type of habitat and potential impacts including, for example, post-operation restoration (which may include baseline inventories, evaluations, and eventual rescue of species), offset of losses, or compensation of direct users

Table 62: Summary of Biological Resources Impacts

Biological Resources – Terrestrial					
Construction	**Land consumption and loss of terrestrial habitat**	*Source* Clearing for the open pit, tailings and water management ponds and other site facilities Clearing for access road *Vulnerability* Displacement of wildlife Nutrients in Biomass and Soil Mortality and injuries of wildlife due to interaction with vehicles Mortality and injuries of wildlife due to increased interaction with vehicles	Low (Medium-term, Low Severity, Local extent)	None Provided. The surrounding area is exactly the same ecologically as the cleared area and the area cleared is a very small percentage of the total area.	Low (Medium-term, Low Severity, Local extent)
	Habitat Degradation	*Source* Traffic resulting in dust covered vegetation. Fragmentation caused by roads *Vulnerability* Vegetation in access road vicinity Displacement of wildlife. Mortality and injuries of wildlife due to interaction with vehicles.	High (Medium Term, High Severity Local extent)	Wet roads during the dry seasons. Minimize road width Limit speeds on roads Implementation of a weed management program to control the spread of invasive and exotic species	Low (Medium-term, Low Severity, Local extent)
	Increased Erosion and Disturbance of Soils	*Source* Site preparation and construction of Roads, Tailings and Water Management Ponds. Vegetation clearing for Site access and for construction. *Vulnerability:* Disruption of nutrient cycles and destruction of soils. Formation of gullies and increased sediment loads to aquatic systems. Pollution of surface waters due to erosion.	High (Long-term, High Severity Local Extent)	Implementation of Best Management Practices	Low (Medium-term, Low Severity, Local extent)

Construction	**Mortality and Disturbance of Wildlife**	*Source:* Site preparation and construction of Roads, Tailings and Water Management Ponds. More workers on site and noise from equipment. Hunting by workers *Vulnerability:* Displacement of wildlife. Higher mortality and injuries of wildlife due to increased interaction with vehicles and hunting.	Moderate (Medium Term, Moderate Severity, Local extent).	Minimizing cleared areas Slow and phased clearing to enable migration of wildlife Maintenance of wildlife corridors in cleared areas Ban on hunting and fishing by company employees Controlled access of non-indigenous persons to mining concession Minimization of noise emissions	Low (Medium-term, Low Severity, Local extent)
`Operation	**Habitat degradation**	*Source* Dust accumulation on plants Physical disturbance and noise from equipment operation Blockage/intersection of wildlife corridors Traffic on roads *Vulnerability* Early succession/edge and secondary forest habitats located along roads Displacement of wildlife and increased competition with wildlife on the perimeter of project area Increased migration of wildlife Animals on their way to and from feeding, breeding and birthing grounds, and between seasonal ranges Animals attracted to access roads open spaces for protection from predators, food supplies and better travel conditions Higher mortality and injuries of wildlife due to increased interaction with vehicles and hunting	Moderate (Long-term Moderate Severity, Local extent)	Wetting roads during the dry seasons Minimize extent of the cleared areas Utilize Best Working Practices for noise Identification and flagging of migration corridors Posting signs notifying drivers of the existence of these corridors Speed restrictions on the access road in the vicinity of the corridors Constrain width of access road Lowered the vertical alignment to maximize line of sight. Design access roads to minimize cuts and fills and with flat side slopes. Hunting and fishing ban for employees	Low (Medium-term, Low Severity, Local extent)

Closure	**Habitat Degradation**	*Source* Encroachment by aggressive and unwanted plant species (pests) Acid Mine Drainage *Vulnerability* Native vegetation species and natural ecosystem Historical fire regimes, Soil nutrient regimes, Increased soil erosion Elimination/alteration of natural vegetative strata.	Moderate (Long-term Moderate Severity, Local extent)	Implementation of weed management program Determination of acid generating potential Placing acid generating material above the water table to isolate the material from contact with water Capping acid generating materials with clay or other materials to reduce permeability	Low (Medium-term, Low Severity, Local extent).
Construction	**Loss of aquatic habitat and fauna**	*Source* Diversion/drainage of streams for haul roads Impoundment of Tailings and Water management ponds Constriction of surface water flows at culverts and other road crossings may create currents too fast for some fish species to survive. Culverts on access road may act as barriers to movement of some aquatic species Restricted migration of fish Sediment discharge to waterways Accidental spills of lubricants and fuel *Vulnerability* Fish breeding areas. Dissolved oxygen levels. Nutrient loads to waterways. Reproductive impairment, stunted growth, and other physiological effects. Spawning success for fish species Reduction of habitat suitability for many aquatic organisms	High (Medium-term, High Severity Local Extent)	Implementation of Erosion and Sediment Control Plan Channelling contaminated runoff to oil-water separators prior to discharge to streams/creeks Bridging areas of standing water Designing culverts to enable the passage of migratory aquatic species by incorporating baffles to slow flows Setting culvert bottoms below the level of the stream bed. Designing culvert gradients to ensure that streambed gradients existing prior to construction are maintained to the maximum extent practicable	Low (Short-term, Moderate Severity, Local Extent).

Operation	**Degradation of aquatic habitat and water quality**	*Source* Absorption of creeks/streams within tailings and water management ponds Process discharge to tailings and water management ponds Sediment discharged in process wastewater Hydrocarbon contamination of aquatic environment from accidental spills of lubricants and fuel *Vulnerability* Fishes and other aquatic organisms trapped within tailings and water management ponds. Decreased transparency and reduction of light available to aquatic plants. Suspended sediment settlement onto instream habitat features (e.g., downed wood, gravel, etc.) or bottom substrate. Reduction in available area and cover for small fish, macroinvertebrates, and periphyton. Increased mortality caused by gill damage. Increased predation due to sedimentation of shelter. Increased susceptibility to disease. Impaired developmental rates. Reduction of suitable spawning habitat and reduced spawning success. Modification of migration patterns. Impairment of visual feeders. Reduction of light penetration.	High (Long-term, High Severity, Local extent)	Construction of impoundment at a rate slow enough and in direction of stream flow to allow aquatic organisms to relocate outside of the footprint of the ponds. Implementation of the Spill Contingency Plan Implementation of Erosion and Sediment Control Plan	Moderate (Long-term, moderate Severity – medium; Local extent)

- Avoiding or minimizing the creation of barriers to wildlife movement, or threats to migratory species (such as birds) and providing alternative migration routes when the creation of barriers cannot be avoided
- Planning and avoiding sensitive areas and implementing buffer zones
- Conducting activities such that the risk of landslides, debris or mud flows and bank or alluvial fan destabilization is minimized
- Implementing soil conservation measures (e.g. segregation, proper placement and stockpiling of clean soils and overburden material for existing site remediation); key factors such as placement, location, design, duration, coverage, reuse, and single handling will be considered
- Where topsoil is pre-stripped, it will be stored for future site rehabilitation activities. Topsoil management will include maintenance of soil integrity in readiness for future use. Storage areas will be temporarily protected or vegetated to prevent erosion
- Conserving the quality and composition of growth medium for use (e.g. for capping) during site reclamation and closure activities
- Ensuring that the growth medium is sufficient to support native plant species appropriate for the local climate and consistent with proposed future land uses. Overall thickness of the growth medium will be consistent with surrounding undisturbed areas and future land use and
- Managed vegetation growth along site roads and at permanent above-ground facilities. Removal of invasive plant species and replanting of native species. Vegetation control will employ biological, mechanical and thermal vegetation control measures and avoid the use of chemical herbicides as much as possible.

If it is demonstrated that the use of herbicides is required to control vegetation growth along site roads or at facilities, then personnel will be trained in their use.

The Project footprint would optimize the use of areas which were previously cleared for earlier exploration and mining operations and clearing would be minimized to the extent practicable.

The area will be revegetated with indigenous species or any other species that may be approved in writing by the Guyana Forestry Commission after completion of mining as part of the Closure Plan. Primary and secondary site roads will be identified, and site roads no longer needed would be closed to employees. The revegetation program will be tested on these closed roads to develop an appropriate revegetation program. The company will enact a policy to ensure no plants or wildlife is removed from the mine site. In addition, employees will not be permitted to bring plants and wildlife from other areas to the mine site.

New vegetation will be planted around production facilities and along site roads to mitigate the impact on terrestrial resources. Vegetated corridors will be maintained and gradually removed during construction to enable wildlife present in the area to relocate to adjacent areas. Construction rates will be monitored in relation to the time it will take for animals to move away from construction areas and construction works will be programmed, based on the results of that monitoring, to occur in a manner slow enough to ensure that animals can move to other locations. Construction of the tailings ponds will progress in the direction of stream flow to enable aquatic organisms to vacate the area. Process plant and other buildings and facilities will be sited within areas which were previously cleared for earlier mining operations. The footprint of areas identified for the tailings ponds and the open pit together with the site roads will be minimized.

Attention will be paid to vulnerable or conservation-worthy plant and animal species that will be affected and conservation measures will be enforced in consultation with the EPA. Wildlife will be restricted access to chemical-solution ponds, by erecting fences at strategic locations, if monitoring indicates significant occurrences of deaths associated with ingestion of water from the tailing pond and related water management facilities. In addition, all discharges from these facilities will be monitored to ascertain that discharges are safe for fish, as well as people. The company will restrict hunting for wildlife in the project area of influence by non-indigenous peoples. Access to the concession by non-indigenous persons, not employed by the project, will be restricted and the workforce will be educated about the consequences of hunting. RGEL will also establish a reporting mechanism for hunting incidents within the concession.

11.5 Monitoring Plan

11.5.1 Aquatic Ecology Monitoring

In addition to the monitoring of the physical and chemical quality of water in streams and rivers, RGEL would perform periodic sampling to assess trends in the abundance and diversity of the aquatic biota in all streams affected by the Project. Special attention would be given to the detection of invasive alien species.

11.6 Terrestrial Ecology Monitoring

RGEL would contract a firm to develop and implement a Biodiversity Monitoring Plan. This plan would identify the appropriate indicators, protocols, and frequencies to be followed. The results of the Biodiversity Monitoring would be reported to all interested stakeholders.

Monitoring would begin during the pre-construction phase and will continue throughout construction, operation, and abandonment until site closure has been achieved. The pre-construction phase monitoring would provide additional baseline data for comparison against monitoring results from later project phases.

Wildlife monitoring would be conducted concurrently with the vegetation monitoring. Observations would be recorded in a wildlife-sighting logbook and these would be periodically examined to determine if there have been any significant changes in species abundance and/or distribution. All collisions with wildlife on haul and site roads would be recorded. The record would note the proximity to cleared areas, the animal involved in the collision and the time of that collision etc. These records would be used to evaluate the success of the measures outlined in the Management Plan.

If endangered species are observed at any time during construction or operations, special monitoring plans would be developed to track these occurrences. A record would be maintained of all animal mortality associated with Tailings and Water Management Ponds. The location of the fatality, the time of day and the process discharge at that time would be among the parameters recorded. Additional fencing around the ponds would be installed as needed based on the results of this monitoring.

Special attention should be given to the detection of invasive alien species to preemptively identify areas were control measures are required.

12.0 ECOSYSTEM SERVICES

Ecosystem services are the direct and indirect contributions made by ecosystems to human well-being. They are classified into four types:

1. *Provisioning services* – goods or products such as food, timber and freshwater
2. *Regulating services* – contributions to human well-being arising from an ecosystem's control of natural processes, such as climate regulation, disease control, erosion prevention, water flow regulation, and protection from natural hazards
3. *Cultural services* – the non-material contributions of ecosystems to human well-being, such as recreation, spiritual values, and aesthetic enjoyment
4. *Supporting services* – the natural processes needed to maintain the other services, such as primary production, or nutrient and water cycles.

Ecosystem services have also been defined as the conditions and relationships through which natural ecosystems sustain and fulfil requirements for human life (Daily 1997). This definition emphasises the fact that human well-being is based on benefits derived from people's actual use of ecosystem services.

While some ecosystem services contribute directly to human well-being, others do so indirectly by supporting other services. For example, livestock farming provides direct value to human well-being through income or by providing meat or milk for subsistence, whereas hay production contributes indirectly by supporting livestock production. The former is referred to as "final services" and the latter as "intermediate services".

In other words, ecosystem services are "final" at "point of use", in which case it should be possible to identify a specific beneficiary, whereas for "intermediate" services it can be less straightforward to identify a particular "end-user". This does not make them any less necessary or important, but introduces a challenge from an ESIA perspective, particularly where multiple ecosystem services have multiple beneficiaries and complex "supply chains".

Supporting services are those that are necessary to produce all other ecosystem services. They differ from provisioning, regulating, and cultural services in that their impacts on people are either indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts on people. Some services, like erosion control, can be categorized as both a supporting and a regulating service, depending on the time scale and immediacy of their impact on people. For example, humans do not directly use soil formation services, although changes in this would indirectly affect people through the impact on the provisioning service of food production. Similarly, climate regulation is categorized as a regulating service since ecosystem changes can have an impact on local or global climate over time scales relevant to human decision making (decades or centuries), whereas the production of oxygen gas (through photosynthesis) is categorized as a supporting service since any impacts on the concentration of oxygen in the atmosphere would only occur over an extremely long time. Some other examples of supporting services are primary production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

12.1 Policy, Legislative and Regulatory Framework

At the Nagoya UN Biodiversity Summit in October 2010, 192 countries and the European Union agreed to a new Strategic Plan of action on biodiversity and ecosystems, with the following vision: "By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people." Parties to the Convention on Biological Diversity (CBD 2010) also agreed a shorter-term ambition to:

> take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planet's variety of life, and contributing to human well-being, and poverty eradication.

The need to safeguard essential ecosystem services was therefore central to the Strategic Plan. Parties agreed on a set of strategic goals and targets referred to as the "Aichi" targets to drive action on biodiversity and implement the plan.

Guidance on assessing impacts on ecosystem services is available from various sources: Waage (2014) provides an overview of ecosystem services methods and tools. Overall guiding principles and steps are provided by Baker and Scott (2013). More detailed instructional guidance is provided by Everard and Waters (2013) and Landsberg et al. (2013). In addition to project-level guidance, policy-level or strategic assessment guidance is also available (e.g. Geneletti 2011; Partidário and Gomes 2013; GIZ 2012). The following steps for assessing project impacts on people who use and depend on ecosystem services are in line with most current guidance:

1. Given predicted changes in ecosystems as a result of the planned development, identify the ecosystem services for which supply might change. Also identify ecosystem services for which the ability of users to access them might be affected by the planned development
2. Identify the users and beneficiaries of these services
3. If intending to comply with IFC Performance Standards, select "priority ecosystem services" (those on which beneficiaries have high levels of dependence, with limited or no available alternatives)
4. Establish the baseline for these priority ecosystem services, assuming current levels of use: will there be a sustainable relationship between supply and use in the absence of the planned development?
5. Predict project impacts on priority ecosystem services (their likely future supply, use and benefits as appropriate), using current and projected levels/relationships as the baseline
6. Mitigate project impacts on priority ecosystem services to ensure that benefits are maintained.

Ultimately, the goal is to identify the specific benefits that people derive from ecosystem services, understand their level of dependence on them and determine their ability to maintain the levels of benefit that they need through alternative means, if they lose access to the services that underpin them or if supply goes down.

The field work programmes therefore incorporated the identification of people who are highly vulnerable to changes in ecosystem service supply who might not be identified through typical social assessments.

12.2 Baseline

The ecosystem services baseline was compiled by mapping the project activities and its associated infrastructure against the area ecosystems to identify areas where biophysical and/or social changes are likely to occur because of the construction, operation and closure of the project. These changes would be reflected by alterations to the ecosystems and ecosystem service supply within the project footprint area. Ecosystem changes likely to occur due to the ability of people to access particular services and the persons likely to be affected were also identified.

Ecosystem services within the project footprint include freshwater, construction materials, medicinal plants, fuel wood and food (fish and meat). Persons within the concession, however, confirmed that very few of the resources were utilized for domestic purposes.

12.2.1 Soil

The concession, as shown on Figure 29 is located totally within the Kuyuwini River drainage basin. The mine pit will be located on Mazoa Hill. The tailings management area will be created by a valley fill and the process plant will be located north of the mine pit. The vegetation type in the entire area is the same and consists of wet and dry forest of South Guyana on Li and Mp soils.

Li soils are variable stony and immature shallow and mainly excessively drained soils which occur in mountainous and hilly areas. These soils are residual materials derived mainly from weathering of granite, gneisses and schists which are present in the area. Mp soils are brown and dark brown, deep well drained sandy loam and clay soils or red deep well and moderately well drained clay loam soils which occur in areas of gently sloping but sometimes dissected mountain and hill pediments. These soils are sub-recent to recent outwash materials related to a variable solid geology including some basic rocks.

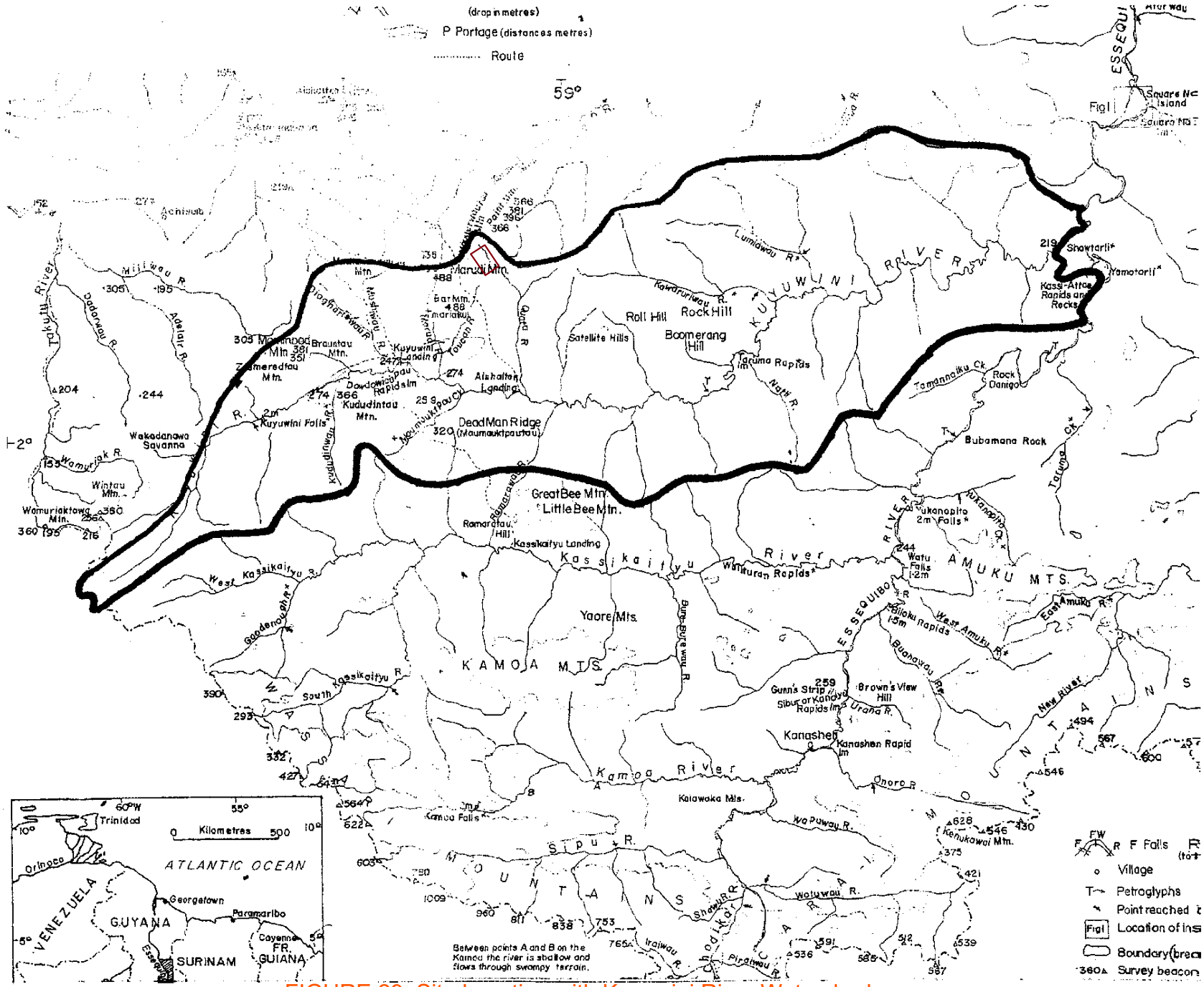


FIGURE 29: Site Location with Kuyuwini River Watershed

12.2.2 Water Resources

The layout of the facilities for the mine site, are shown on Figure 30. The airstrip would be located on an elevated strip of land between Locust and July Creeks. Romanex's logistics and operation and GGMC compounds will also be this area. The limits of the flood plains of these streams are shown on Figure 31 which also identifies the location of the mine pit on Mazoa Hill and the Marudi camp compound.

The following creeks are located within the project footprint area:

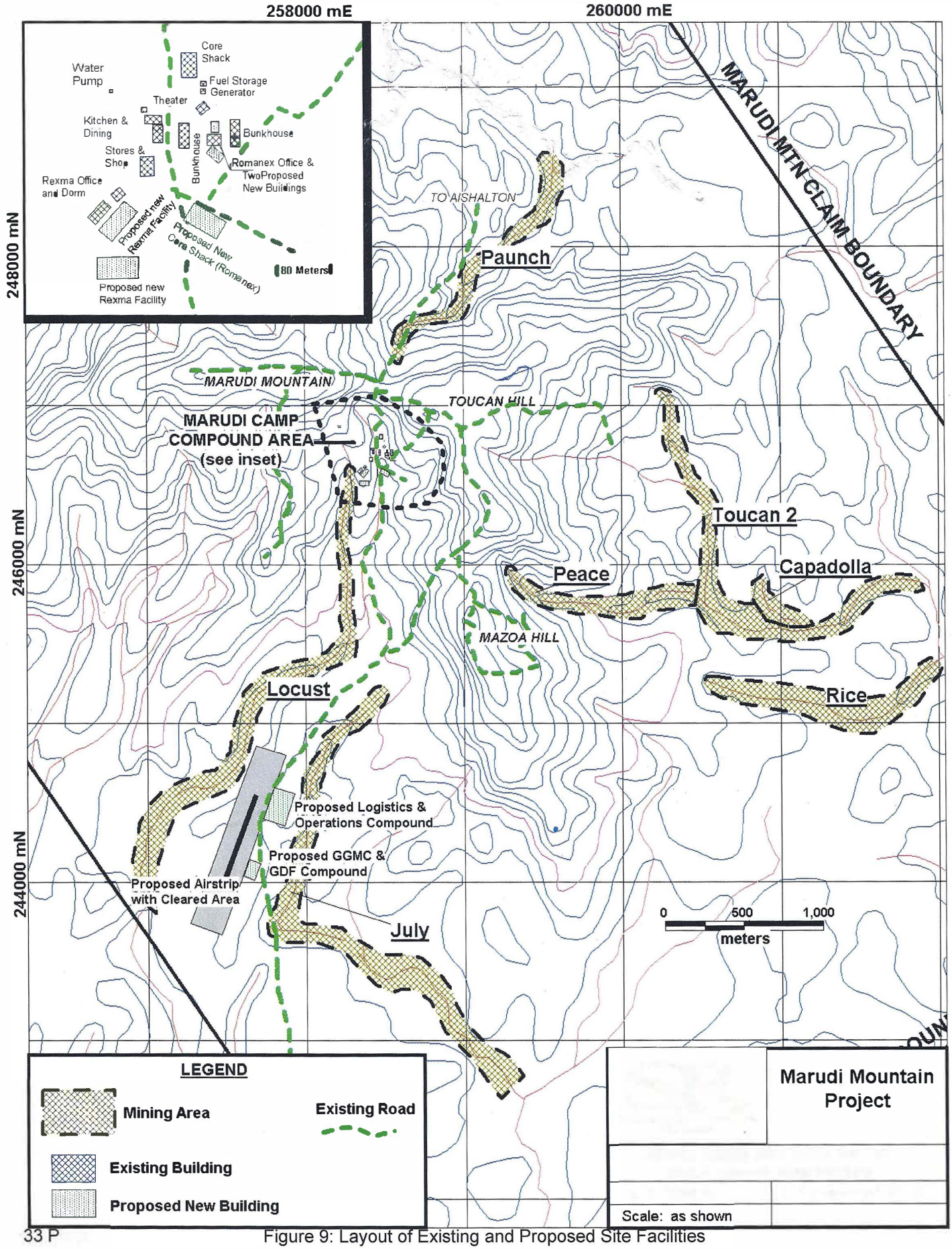
- Peace
- Toucan
- Rice
- Capodilla
- Locust
- Paunch

No one within the concession indicated that surface water was used for household purposes. Groundwater, however, is used for washing, bathing and drinking. Surface water is used solely in mining operations.

12.2.3 Forest Resources

The concession is located within an area of undulating terrain covered with tall evergreen ombrophilous forest in the Guiana Shield forest region of the Southern peneplain with elevations ranging between 300 – 1200 m. According to ter Steege (2000), this forest region is found on soils developed on the crystalline shield, such as granites and greenstones and on pockets of Plio-pleistocene sediments. Rainforests of the region fringe the savannahs and are characterized by a high abundance of *Goupia glabra, Couratari, Sclerolobium, Parinari, Apeiba, Peltogyne, Catostemma, Spondias mombin* and *Anacardium giganteum.* Other notable species of this region are *Parkia, Ficus, Sclerolobium, Trichilia, Parkia, Parinari* and *Goupia*. *Eperua falcata* are characteristic of late secondary forest while *Pterocarpus* and *Macrolobium acaciifolium* are common in forests along rivers in this area.

The baseline biodiversity assessment identified 13 species of mammals including 5 primates that are traditionally consumed for protein in hinterland regions. Hunting, however, occurs infrequently and occurs typically twice each year. Mammals harvested included *Cuniculus paca* (Labba), *Tapirus terrestris* (Lowland tapir), *Mazama sp* (Deer), *Dasypus sp* (armadillo) and *Dasyprocta leporine* (Red-rumped agouti). None of the 5 primate species recorded in the project area serve as a source of proteins for persons within the concession. Two species of birds namely, *Tinamus major* (Great Tinamou) and *Crax alector* (Powis) are used as sources of protein, however, these were not collected within the area designated for the project. Less than 0-25% of the daily protein consumed is derived from wildlife and fishing occurs only occasionally in the project area.



33 P

Figure 9: Layout of Existing and Proposed Site Facilities

Figure 30: Layout of Mine Site Facilities

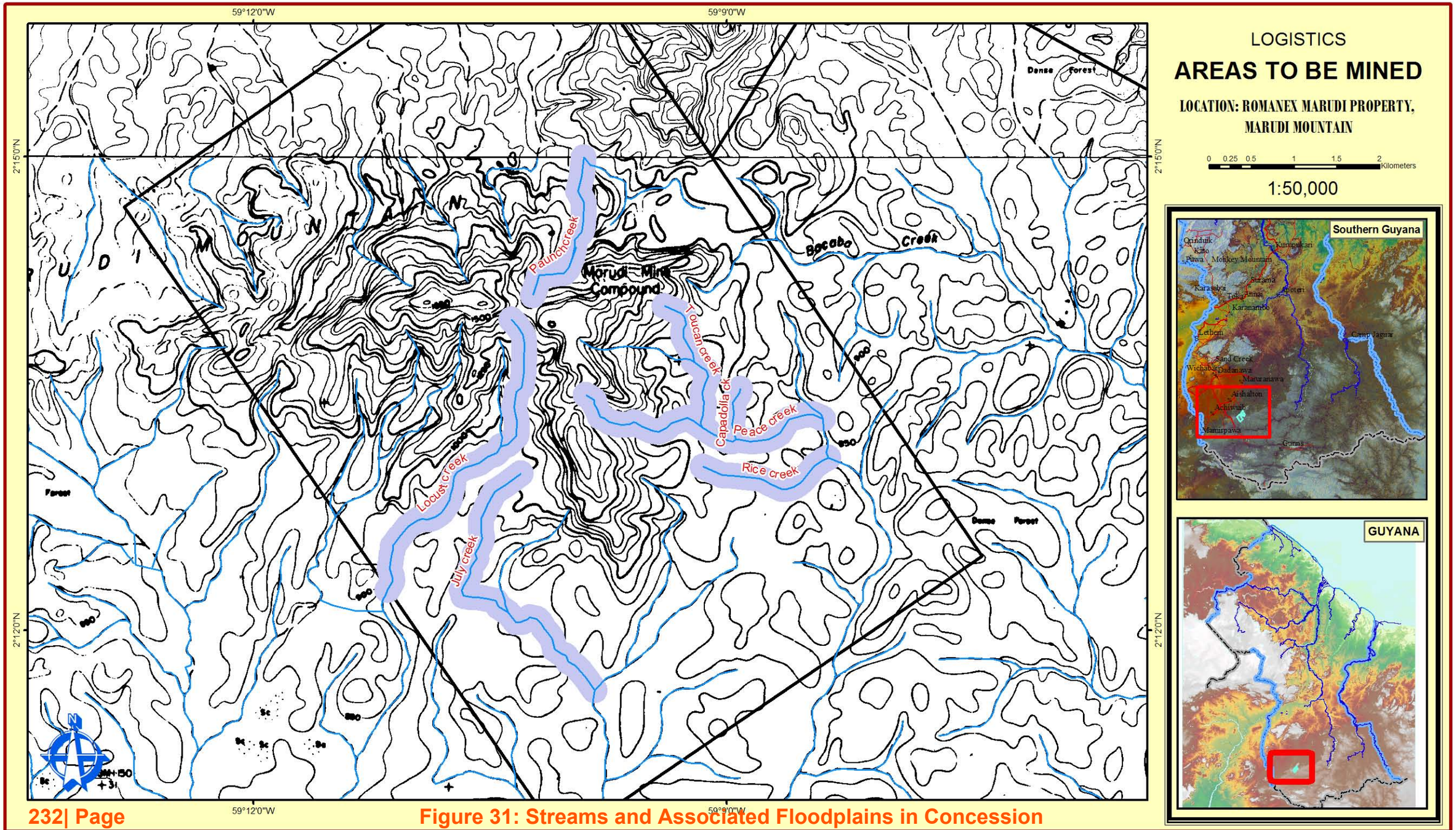


Figure 31: Streams and Associated Floodplains in Concession

Thirty-one (31) timber species with commercial value were recorded in the project area, however, none are harvested in the proposed project area. Two species are currently used as energy sources within the project footprint area. Trees are, however, not felled for fuel since fallen trees are collected for this purpose. Species collected for fuel include *Manilkara bidentata* (Bullet wood), *Licania alba* (Kauta).

Several medicinal plants were documented by the floral surveys. Species, identified as having medicinal values within the concession are *Cinchona sp* (Sinkola), *Manikara bidentata* (Bullet wood), *Clathropis spp* (Aromata), *Davilla kunthii* (Red kapadula), *Alexa imperatricis* (Locust), *Hymenaea courbaril* (Wild masala), *Pityrogramma calomelanos* (Wild maran), and *Curarea candicans* (granny backbone). Non-timber forest products were not harvested in the project area. None of the areas or species documented in the project area were used for recreation, tourism, education or cultural purposes.

12.3 Impact Prediction and Evaluation

12.3.1 Provisioning Services

Several provisioning services provided by ecosystems will be impacted in the project area. Clearing of the mine site will remove food and fiber included in the vast range of food products derived from plants, animals, microbes and many other products derived from ecosystems. Fuel including wood and other biological materials which serve as sources of energy would also be removed by site clearing operations. The associated movement of animals from cleared areas will also result in the removal of genetic resources inclusive of genes and genetic information used for animal and plant breeding and biotechnology from the mine site footprint. The biodiversity surveys identified several plants used for medicinal purposes in areas to be cleared for the mine site. These plants may contain biochemicals consisting of natural medicines, and pharmaceuticals since many medicines, biocides, food additives, such as alginates, and biological materials are derived from ecosystems. The construction and operation of the tailings and water management ponds and diversion of creeks may also reduce fresh water resources in the mine site footprint area. The linkages provided by freshwater between the different categories of ecosystem services will be altered by these changes. These are moderate impacts (medium term, moderate severity, local extent). These impacts will be mitigated by minimizing the areas cleared of vegetation and by limiting diversion of creeks to the maximum extent possible. The mitigation measures coupled to the proximity of exact provisioning services will result in low residual impacts (short-term, low severity, local extent).

12.3.2 Regulating Services

Regulating services provided by ecosystem processes will be impacted by the project. Air quality is partly maintained by ecosystems and both contribute chemicals to and extract chemicals from the atmosphere, influencing many aspects of air quality. Emissions associated with the operation of plant and equipment at the site may pose added stresses on ecosystem services required to generate clean air. These are moderate impacts (long-term, moderate severity, local extent). All emission generating equipment will be outfitted to ensure that emissions are below regulatory standards. The mitigation measures will result in low impacts (short-term low severity, local extent).

Ecosystems also regulate climate both globally and locally. Changes in land cover at the mine site may affect both temperature and precipitation. At the global scale, ecosystems play an important role in climate by either sequestering or emitting greenhouse gases. The project will generate several greenhouse gases including Carbon Dioxide, water vapor and methane from decomposition of vegetation cleared for development of the mine site. These are low impacts (long-term, low severity, local extent). These impacts will not be mitigated.

The timing and magnitude of runoff, flooding, and aquifer recharge may be impacted by changes in land cover, including alterations that change the water storage potential of the system, such as the conversion of swamps or the replacement of forests with impermeable areas such as the accommodation areas. These are moderate impacts (medium term, moderate severity, local extent). These impacts will be mitigated by minimizing cleared areas and the footprint of impermeable areas created during mine site development. This will result in low residual impacts (short-term, low severity, local extent).

The removal of vegetative cover may reduce soil retention and increase the likelihood of landslides. These are high impacts (long-term, high severity, local extent). These impacts will be mitigated by minimizing vegetation removal and by terracing cleared areas and providing surface runoff management features in cleared areas. These mitigation measures will result in moderate impacts (long-term, moderate severity, local extent).

Ecosystem services results in water purification and waste treatment since ecosystems while being a source of impurities in fresh water also helps to filter out and decompose organic wastes introduced into inland waters. Ecosystems also serve to regulate human diseases since changes in ecosystems can directly change the abundance of human pathogens and can alter the abundance of disease vectors, such as mosquitoes. Ecosystems also aid biological control since ecosystem changes affect the prevalence of crop and livestock pests and diseases and aids pollination since ecosystem changes affect the distribution, abundance, and effectiveness of pollinators. These functions will be impacted by site clearance for construction and operation of the mine site. These are high impacts (long-term, high severity, local extent). These potential impacts will be mitigated by minimizing vegetation removal. The mitigation measures will result in moderate impacts (long-term, moderate severity, local extent).

12.3.3 Cultural Services

Cultural Services are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. Ecosystems are also of aesthetic value and aid in the development of social relations since ecosystems influence the types of social relations that are established in particular cultures and many people value the sense of place that is associated with recognized features of their environment, including aspects of the ecosystem. Ecosystems also support cultural heritage values since societies place high value on the maintenance of either historically important landscapes ("cultural landscapes") or culturally significant species. The mine site area has only recently been populated and there are no records of the area being previously occupied. There is therefore very little cultural diversity, spiritual and religious values to the area since no group has any proven spiritual and religious values to ecosystems or their components of the area. The absence of historic populations has also resulted in no known traditional and formal knowledge systems related to ecosystems within the mine site footprint developed by different cultures.

The mine site area is like the surrounding area and there are no specific educational values related to ecosystems, their components and processes within the mine site footprint which provide a basis for both formal and informal education to people in the area. Further while ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture, and advertising, ecosystems with the mine site footprint are not used for any of these purposes. The impacts on cultural services will be low (short-term, low severity, local extent).

12.4 Environmental Management Plan

The project footprint is small compared to the area surrounding the project footprint which could potentially serve as sources of provisioning services, regulating services, cultural services and/or supporting services. No mitigation measures are therefore specifically proposed to mitigate ecosystem impacts. Ecosystems impacts will, however, be mitigated by the mitigation measures proposed for the other environmental media considered by this ESIA.

12.5 Monitoring Plan

The impacts on ecosystem services would be indirectly monitored by compilation of monitoring data for surface and ground water quality, biological resources and socio-economic and socio-cultural resources.

Table 63: Summary of Ecosystem Services Impacts

Project Phase	Impacts		Project Impacts Rating	Mitigation Measures	Impact Rating after Mitigation
Ecosystem Services					
Construction	Loss of Provisioning Services	*Source* Clearing of the mine site and removal of food and fiber derived from plants, and animals Loss of microbes and many other products Loss of fuel wood and other biological energy sources Removal of genes and genetic information for animal and plant breeding and biotechnology *Vulnerability* Vegetation Animals	Moderate (medium term, moderate severity, local extent).	Minimizing areas cleared of vegetation limiting diversion of creeks	Low (short-term, low severity, local extent)
	Reduced Air Quality	*Source* Plant and Equipment Operation *Vulnerability* Ecosystems maintenance Chemicals extraction from the atmosphere	Moderate (long-term, moderate severity, local extent)	BMP including proper outfitting of emission generating equipment	Low (short-term low severity, local extent).
	Increase likelihood of Landslide	*Source* Removal of vegetative cover Increased rainfall *Vulnerability* Steep Areas	High (long-term, high severity, local extent).	Minimizing vegetation removal Terracing cleared area Providing surface runoff management features in cleared areas.	Moderate (long-term, moderate severity, local extent).
	Reduced Ability to Purify Water	*Source* Vegetation Clearance *Vulnerability* Water purification Waste Treatment by ecosystems Decomposition of organic wastes Regulation of human diseases by altering abundance of disease vectors	High (long-term, high severity, local extent).	Minimizing vegetation removal.	Moderate (long-term, moderate severity, local extent).

13.0 NOISE AND VIBRATIONS

Noise is essentially unwanted sound and deals with people's subjective responses to an objective reality. It is the annoyance caused by noise that is critical in ESIA. Sound consists of pressure variations that are detectable by the healthy human ear. These pressure variations have two key characteristics: frequency and amplitude. Sound frequency refers to how quickly the air vibrates, or how close the sound waves are to each other (in cycles per second, or Hertz (Hz)). Environmental noise can be dominated by a particular frequency or it may be described as 'broad band', i.e. comprising a range of different frequencies. Most sounds in an environmental context consist of many different frequencies, although equipment such as turbines, compressors, cooling fans, or transformers can generate noise with discrete frequencies that produce distinct tonal characteristics.

Sound amplitude refers to the amount of pressure exerted by the air, which is often visualised as the height of the sound waves. Amplitude is described in units of pressure per unit area, microPascals (μPa). The amplitude is sometimes converted to sound power, in picowatts (10^{-12} watts), or sound intensity (in 10^{-12}watts/m^2). Sound intensity is subjectively felt as the loudness of sound. However, none of these measures are easy to use because of the vast range which they cover. As a result, a logarithmic scale of **decibels** (dB) is used. The sound pressure level (L_p) in decibels is given by:

$$L_p=10 \log_{10}(P/p)^2 \text{ dB}$$

where P is the amplitude of pressure fluctuations, and p is 20μPa, which is considered to be the lowest sound audible to the healthy human ear.

13.1 Policy, Legislative and Regulatory Framework

13.1.1 Environmental Protection Noise Management Regulations 2000

Under these regulations operations that emit noise in the execution of various activities such as construction, transport, industry, commerce and other institutions are required to apply to the Agency for an environmental authorization. The EPA is responsible for the establishment of standards for permissible noise levels in industry, construction and other areas. The categories for which permissible noise levels are fixed by the EPA are as follows: Residential, Institutional, Educational, Industrial, Commercial, Construction, Transportation and Recreational. The Guyana National Bureau of Standards (GNBS) and the EPA together with other relevant agencies developed Interim Guidelines for Noise Emission into the Environment. Under these guidelines, noise emissions from Industrial and Commercial sources for both day (06:00h – 18:00h) and night (18:00h – 06:00h) would be 100 and 80 decibels (Industrial) and 80 and 65 decibels (commercial) respectively at the property boundary or 15 meters from the source.

13.1.2 World Health Organization

The *Guidelines for Community Noise* (WHO 1999) are health-based guidelines that incorporate influential noise standards as part of a framework for noise management. The guidelines recommend internal and external noise levels that will prevent detrimental effects on a community, including rest, sleep, and work that requires concentration, amongst others:

- To protect the majority of people from serious annoyance during the daytime, the noise level on balconies, terraces and outdoor living areas should not exceed 55 dB LA_{eq} for a steady, continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the outdoor noise level should not exceed 50 dB LA_{eq}.

- At night, noise levels at the outside façades of the living spaces should not exceed 45 dB LA_{eq} and 60 dB LA_{max}, so that people can sleep with bedroom windows open

13.2 Baseline

During the field survey programs noise levels were recorded at several locations within the concession. The locations and associated noise levels are detailed in Table 64.

Table 64: Noise Levels within Concession

LOCATION		Noise Level (dBA)
Eastings	**Northings**	
258453	246683	59.6
258455	246736	83.3
258482	246683	66.3
258963	247811	77.7
258984	247873	72
258995	247828	62.9
258389	246941	76
258395	246956	75.4
258401	246970	74.3
257881	244707	60.7
257904	244687	62.3
257925	244670	67.7
258041	245919	77.9
258075	245959	62.4
258109	245967	67.1
260409	246560	77.8
260363	246559	72.7
260515	246540	65.4

13.3 Impact Prediction and Evaluation

13.3.1 Construction

Construction activities will produce noise levels above the WHO industrial/commercial noise level guideline value of 70 decibels (dBA) from heavy earthmoving machinery operation. Maintenance operations in workshops will generate noise levels about 72-110 dBA. Noise levels from the power generation plant will range from 90-105 dBA. Exposure to noise levels above 90 dBA can cause noise-induced hearing loss. Noise levels above the tolerable threshold of 72 decibels may result in fatigue, tiredness, low morale and decreased production levels. Primary noise receptors in the area will be individuals involved in construction activities at the site. There are no communities close to the project boundaries. Tired workers are prone to accidents which may contribute to an increase in work-related accidents. These are high impacts (medium term, high severity, local extent).

Construction phase noise will have an adverse effect on many species of wildlife that are sensitive to increased noise levels. However, many species may become habituated to frequent noise events or continuous noise levels and may return to the area. The more sensitive fauna have likely, long abandoned the project area where there is frequent disturbance from noise associated with artisanal mining and exploration.

Noise impacts will be mitigated by implementation of the following:

- Installation of soil berms as noise barriers to mitigate noise impacts adjacent to camp housing areas
- Installation of sound suppression devices (such as mufflers) on earthmoving equipment, generators etc

- Avoiding unnecessary idling of vehicles and machinery that are used intermittently
- Employing best available work practices on-site to minimize occupational noise levels and
- Provide personal protective equipment (PPE) to employees and contractors and requiring their usage under the health and safety plan.

Implementation of these measures would result in low residual impacts (short-term, low severity, local extent).

The project area is covered by soil overburden which will affect the intensity and frequency of vibrations generated by blasting since soil usually has less elasticity modulus than the rocks. The lower elastic modulus will diminish the blast wave propagation velocity. The vibration frequency will also diminish but displacement created by blasting will increase significantly as the soil overburden thickens. The magnitude of the vibrations will decrease rapidly with distance increase due to the soil overburden because a large part of the energy is used up in overcoming friction between particles and in displacing them.

Construction blasting will result in vibrations, air blast and fly rock which may cause damage to nearby structures and be a source of conflict with the artisanal miners close to the mine site. The local geology and rock geomechanics will influence vibrations generated by blasting. Vibrations will propagate in all directions if the rock is homogeneous and massive. However, if the area has a complex geological structure wave propagation will vary with direction and, consequently, give different attenuation indexes. These are moderate impacts (medium term, moderate severity, local extent). These impacts will be mitigated by designing blast to utilize the appropriate charge weight per delay, powder factor, explosive type and delay period and incorporating the appropriate geometric parameters for each blast. The mitigation measures will result in low residual impacts (short-term, low severity, local extent)

13.3.2 Operation

During mining and mineral processing operations, noise levels above the WHO industrial/commercial noise level guideline value of 70 dBA will be emitted from heavy equipment and earthmoving machines operation and from process equipment such as crushers and grinders. Periodic elevated noise levels will also be generated from blasting operations associated with mining operations. Maintenance operations in workshops and the process plant area will generate noise levels about 72-110 dBA. Noise levels from diesel power generation plants will range from 90-105 dBA. Exposure to noise levels above 90 dBA can cause noise induced hearing loss. Noise levels above the tolerable threshold of 72 dBA may result in fatigue, tiredness, low morale and decreased production levels. Tired workers are prone to accidents which may contribute to an increase in work-related accidents. These are high impacts (long-term, moderate severity, local extent).

Primary noise receptors in the area will be individuals involved in operation activities. In addition to the earthen noise barriers created to minimize impacts on the housing area, additional mitigation measures, to mitigate noise impacts to mine site employees, will consist of the following:

- Installation of sound suppression devices (such as mufflers) on earthmoving equipment and generators, as necessary
- Employing best available work practices on-site to minimize occupational noise levels
- Isolation of noise source from employees' living and dining area
- Using acoustic insulating materials such as silencers on exhaust systems
- Issuing/requiring use of PPE (e.g., ear plugs or ear muffs) especially in high noise locations
- Posting visible warning signs in areas of high noise levels instructing employees to wear ear protection
- Periodically monitoring noise levels to ensure compliance with recommended threshold levels and
- Conducting regular hearing tests and maintaining records of results for workers exposed to high noise levels.

During the operational phase of the project, noise would continue to affect surrounding habitats, but most species remaining would have either become habituated to noise during the construction phase or were otherwise pre-

adapted to higher noise levels. Implementation of these measures would result in low impacts (short-term, low severity, local extent) related to noise generated.

The project area is covered by soil overburden which will affect the intensity and frequency of vibrations generated by blasting since soil usually has less elasticity modulus than the rocks. The lower elastic modulus will diminish the blast wave propagation velocity. The vibration frequency will also diminish but displacement created by blasting will increase significantly as the soil overburden thickens. The magnitude of the vibrations will decrease rapidly with distance increase due to the soil overburden because a large part of the energy is used up in overcoming friction between particles and in displacing them.

During operations blasting will result in vibrations, air blast and fly rock which may cause damage to structures nearby and be the source of conflict with the artisanal miners close to the mine site. The local geology and rock geomechanics will influence vibrations generated by blasting. Vibrations will propagate in all directions if the rock is homogeneous and massive. However, if the area has a complex geological structure wave propagation will vary with direction and, consequently, give different attenuation indexes. These are moderate impacts (medium term, moderate severity, local extent). These impacts will be mitigated by designing blast to utilize the appropriate charge weight per delay, powder factor, explosive type and delay period and incorporating the appropriate geometric parameters for each blast. The mitigation measures will result in low residual impacts (short-term, low severity, local extent).

13.3.3 Closure

Closure activities will produce noise levels above the WHO industrial/commercial noise level guideline value of 70 decibels (dBA) from heavy earthmoving machinery operation. Noise levels above the tolerable threshold of 72 decibels may result in fatigue, tiredness, low morale and decreased production levels. Primary noise receptors in the area will be individuals involved in closure activities. Tired workers are prone to accidents which may contribute to an increase in work-related accidents. These are major impacts (medium term, high severity, local extent).

Closure phase noise will have an adverse effect on wildlife species which are sensitive to increased noise levels. However, many species may become habituated to frequent noise events or continuous noise levels and may return to the area. The more sensitive fauna has likely, long abandoned the project area where there was frequent disturbance from noise associated with former mine site operations.

Noise impacts, during closure, will be mitigated by implementation of the following:

- Installation of sound suppression devices (such as mufflers) on earthmoving equipment, generators etc
- Avoiding unnecessary idling of vehicles and machinery that are used intermittently
- Employing best available work practices on-site to minimize occupational noise levels and
- Providing personal protective equipment (PPE) to employees and contractors and requiring their usage under the health and safety plan.

Implementation of these measures would result in low residual impacts (short-term, low severity, local extent).

13.4 Environmental Management Plan

Good practice in the prevention and control of noise sources will be established based on prevailing land use and the proximity of noise receptors. Noise management strategies will include:

- Noise levels at the nearest sensitive receptor will meet the EPA noise guidelines
- Implementation of enclosure and cladding of processing plants
- Installation of proper sound barriers and /or noise containments, with enclosures and curtains at or near the source equipment (e.g. crushers, grinders, and screens)
- Installation of natural barriers at facility boundaries, such as vegetation curtains or soil berms and

Table 65: Summary of Noise and Vibration Impacts

Project Phase	Impacts		Project Impacts Rating	Mitigation Measures	Impact Rating after Mitigation
Noise and Vibrations					
Construction	**Increased Noise Levels**	*Source* Heavy-duty and earthmoving machines operation. Maintenance operations in workshops Power generation plant *Vulnerability* Wildlife receptors around area Workers	Moderate (Long-term, Moderate Severity, Local extent).	Installation of sound suppression devices Avoiding unnecessary idling of vehicles Best Available Work Practices Provide employees with noise reduction equipment	Low (Long-term, Low Severity, Local Extent)
Operation	**Increased Noise levels**	*Source* Heavy-duty and earthmoving equipment operation Process equipment such as crushers and grinders Maintenance operations in workshops and process plant Fossil fuel plant *Vulnerability* Wildlife receptors around area Workers	Moderate (Long-term, Moderate Severity, Local extent)	Installation of sound suppression devices Best Available Work Practices to minimize noise levels Isolation of noise sources from employees' living and dining area Installation of acoustic insulating materials Provide noise suppression equipment to employees Periodically monitoring noise levels Warning signs in areas of high noise levels Periodic medical hearing checks of workers	Low (Long-term, Low Severity, Local Extent)
Operation	**Airblast, Flyrock, Dust and Vibrations**	*Source* Detonation *Vulnerability* Workers Equipment Wildlife	High (Long-term, High Severity Local Extent)	Correct design of blasting rounds, Avoiding detonation of large unconfined charges Consideration of atmospheric conditions Establishment of danger zones around blast sites Minimum stand-off distance during blasting Appropriate delay intervals for charge ignition Utilization of appropriate blast patterns Confinement of the charge	Low (Long-term, Low Severity, Local Extent)

- Optimization of internal traffic routing, particularly to minimize vehicle reversing needs (reducing noise from reversing alarms) and to maximize distances to the closest sensitive receptors.

Noise emissions will be limited by appropriate soundproofing of individual pieces of equipment. Equipment exhaust systems will be fitted with mufflers. The electrical generators will be housed in closed structures with acoustic insulation that would reduce external noise levels. Additionally, all workers with potential chronic or acute noise exposures will be required to wear appropriate personal noise-protection gear.

The most significant vibrations are usually associated with blasting activities. However, vibrations may also be generated by many types of equipment. The mines will minimize significant sources of vibration by implementation of best management practices such as through adequate design of crusher foundations.

Blasting related emissions such as vibrations, airblast, overpressure, and/or fly rock) will be minimized by the following:

- Mechanical ripping where possible, to avoid or minimize the use of explosives
- Use of specific blasting plans, correct charging procedures and blasting ratios, delayed/microdelayed or electronic detonators, and specific in-situ blasting tests (the use of downhole initiation with short-delay detonators improves fragmentation and reduces ground vibrations)
- Development of blast design, including a blasting surfaces survey, to avoid overconfined charges, and a drill-hole survey to check for deviation and consequent blasting recalculations
- Implementation of ground vibration and overpressure control with appropriate drilling grids and
- Adequately designing the foundations of primary crushers and other significant sources of vibrations.

In addition, RGEL will conduct preblast inspections with the agreement of artisanal miners, of all structures close to the concession. The purpose of the preblast inspections would be to document the condition of each structure prior to its exposure to vibrations from blasting. The documentation generated by the preblast inspection will be used to verify or refute claims of damage resulting from vibrations.

The inspection procedure will document name of the structure owner, the address, date and time. This would be followed by a description of the structure, 1 floor, 2 floors, frame, painted or masonry construction, porches and foundations. Gutters and downspouts and drainage would be noted. Any low unusual ground and soil conditions would also be noted and will include lots on 1 in 3 slopes, slope failures, retaining walls inclined due to soil pressure, drainage problems and pooling of water.

The interior inspection would be conducted room by room with each room designated and described. Each wall would be inspected, noting the number of windows, doors, wall corners and ceiling corners. Window, floor and ceiling moldings would be checked for openings in mitered joints, straight joints and for separations from wall, floor or ceiling. Glass panes would be examined for cracks. Floors would be examined for openings between boards, loose, or squeaky boards, discoloration and general wear of wood. Ceilings should be examined for cracked, loose or hanging plaster, water discoloration and holes. Foundations would be checked for cracks, holes, settling and condition of mortar, if any. Gutter and downspouts will be checked for general condition and drainage. Photographs would be made of any unusual conditions that are more severe than ordinary.

A preblast survey report would be prepared for each structure with a complete description of what the inspection was able to document. It would be clearly written so that an independent examiner can readily understand what was observed.

13.5 Monitoring Plan

Noise monitoring program would be designed and conducted by trained specialists. Monitoring periods would be sufficient for statistical analysis and may last 48 hours with the use of noise monitors that would be capable of logging data continuously over this period, or hourly, or more frequently, as appropriate (or else cover differing periods within several days, including weekday and weekend workdays). The type of acoustic indices recorded

will depend on the type of noise being monitored, as established by a noise expert. Monitors would be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface (e.g., wall). In general, the noise level limit would be represented by the background or ambient noise levels that would be present in the absence of the facility or noise source(s) under investigation.

To determine compliance with airblast overpressure and ground vibration criteria RGEL will monitor every blast for airblast overpressure and ground vibration levels at four locations.

14.0 LANDSCAPE AND VISUAL RESOURCES

landscape is defined as a zone or area as perceived by local people or visitors, whose visual features and character are the result of the action of natural and/or cultural (that is, human) factors. This definition reflects the idea that landscapes evolve through time, because of action by natural forces and human beings. It also underlines that a landscape forms a whole, and its natural and cultural elements must be taken together, not separately.

Landscape character is defined as a distinct, recognizable and consistent pattern of elements in the landscape that makes one landscape different from another, rather than better or worse. Landscape character comprises combinations of landscape elements and characteristics, such as landform, geology, soils, waterbodies and catchments, trees and woodlands, boundary features and patterns, agriculture, habitats and species, settlement and development patterns, historic sites and features, recreation and access, and experiential qualities. This can also include description of social structures.

14.1 Policy, Legislative and Regulatory Framework

There are no regulations related to landscape and visual resources in Guyana. The IFC (2012) standards treat landscape under the heading of PS6 Biodiversity Conservation and Natural Resources. PS6 treats the landscape essentially as the area in which biodiversity conservation should take place, rather than as a topic of its own, for instance, for some projects, biodiversity values and ecosystem services associated with a site might be numerous. The relative importance with respect to conserving the feature as part of project operations could therefore be determined by its status in terms of these two axes: its irreplaceability in the landscape/seascape and its vulnerability in being able to remain there.

14.2 Baseline

A digital elevation map of the project area and its surroundings is shown on Figure 32. The project area ranges in elevation up to approximately 1200 m. The approach area to the mine site is in an area of undulating topography. The site itself is not visible from any of the surrounding communities since it is shielded by several mountains. Several streams originate at the crest of Marudi Mountain and flow down the mountain to the south-southeast. These streams are relatively steep, however, flow volumes are low since the site is located near to the sources of the streams. The area is heavily forested and imparts a green color to viewers on approach to the project site. The combination of the forest, steeply sloping streams and undulating topography presents a sense of tranquility to the area.

The Kwitaro and Kuyuwini Rivers are the main source of drainage for this concession. Both rivers are located on the right bank of Essequibo River which is the main drainage conduit of the landscape region of the concession. The Marudi concession lies south of the Kwitaro and west of the Essequibo Rivers.

Illegal artisanal and small-scale mining has altered both the landscape and visual resources within the concession. Several photographs of the concession area depict the landscape and visual resources within the concession. At Mazoa Hill several large angular blocks (metachert) which were broken in an excavation are now sitting on the rim of cliffs above the Locust Creek Valley. The landscape is also now draped by several covers, extended over narrow openings to subsurface workings. The fractured rock and open spaces now threaten the rock slope stability within the concession as depicted on the composited pictures of Figure 33. The visual quality of the area surrounding the concession is depicted on Figure 34. A close-up view of the exact area however identifies the presence of a landscape scarred by the mine working on one of the creeks flowing thru the area.

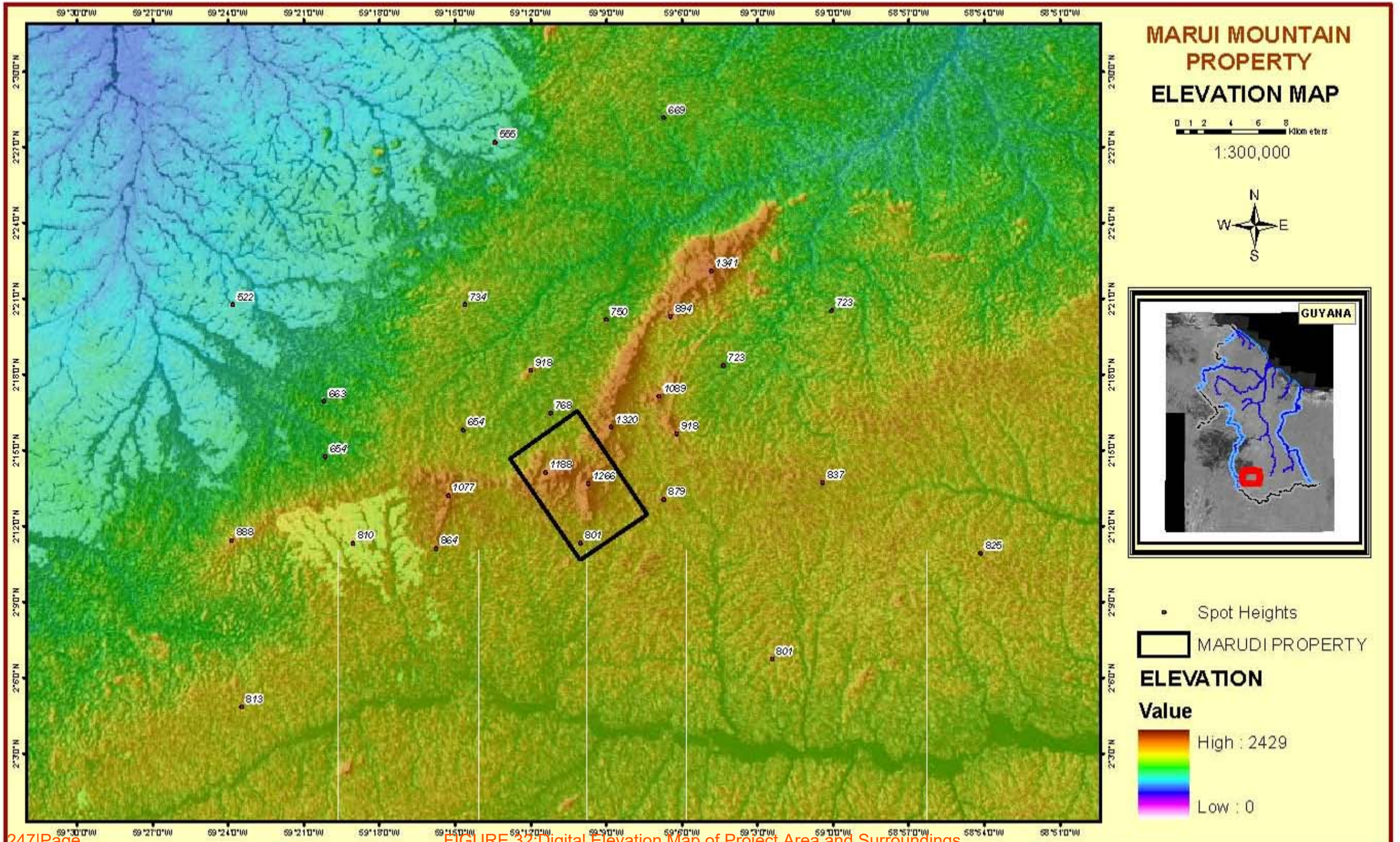


FIGURE 32:Digital Elevation Map of Project Area and Surroundings

Figure 33 - Composited Views of Concession Area

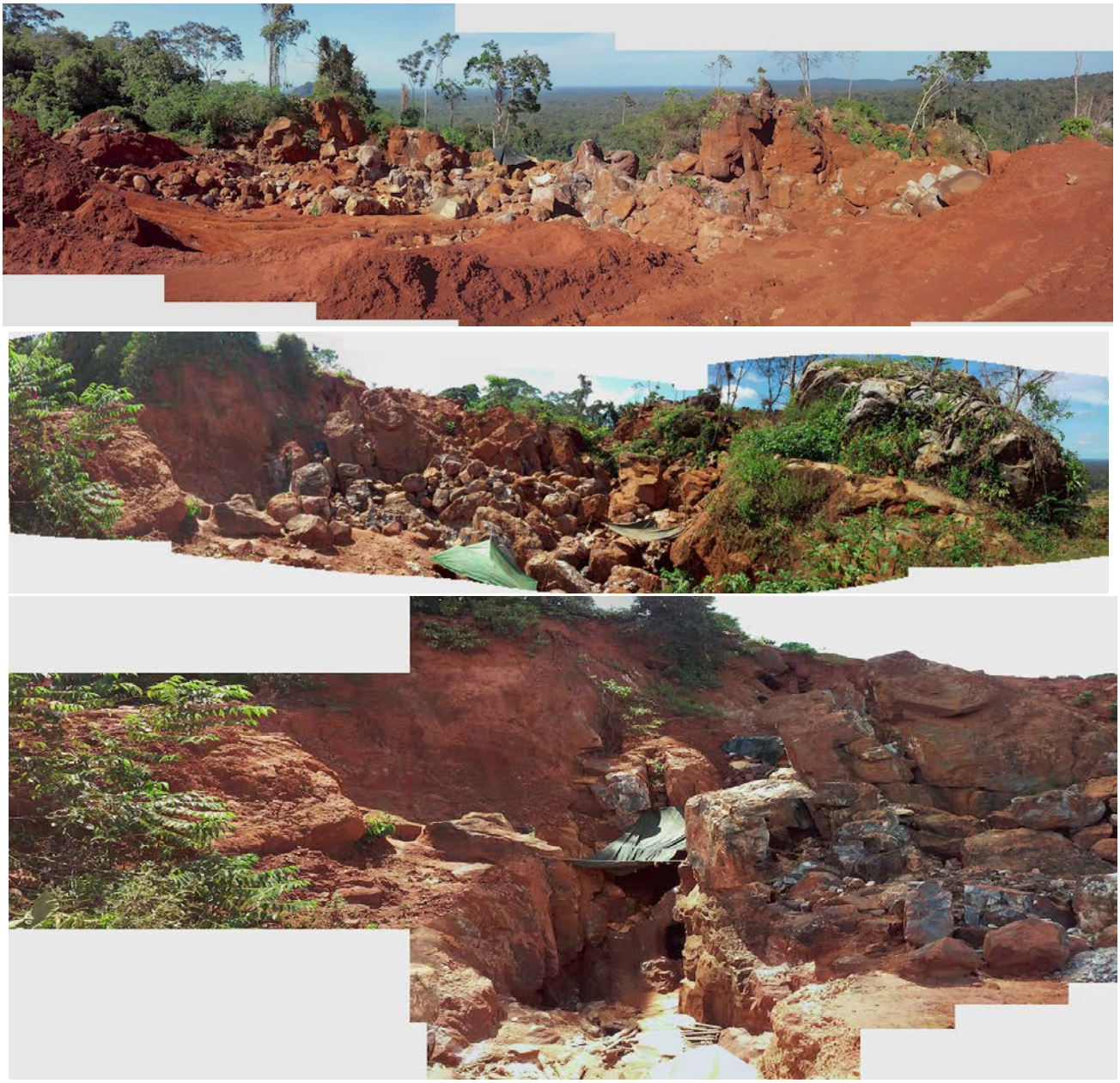


Figure 34 - Panoramic View of Concession showing Mine Working





14.3 Impact Prediction and Evaluation

14.3.1 Construction

Mining will alter the surface cover of the earth over the area to be developed into the mine. Alteration of the surface cover may cause a loss of visual amenity. Loss of visual amenity would be most noticeable during construction, when physical change occurs quickly, and at a large scale. Visual impacts will diminish public enjoyment and impair the character or quality of a natural landform. These are moderate impacts (long-term, moderate severity, local extent). Reclamation and mine closure will partly reinstate a stable and pleasing landform, however full rehabilitation of natural vegetation would occur over decades. The residual impacts after closure will therefore be low (medium term, low severity, local extent).

The project will alter the vertical dimensions of the landscape and the materials present therein. In addition, the color, reflectivity and visible emissions will be changed slightly from current levels since the operations will be

Table 66: Summary of Landscape and Visual Resources Impacts

Project Phase	Impacts		Project Impacts Rating	Mitigation Measures	Impact Rating after Mitigation
Landscape and Visual Resources					
Operation	Loss of Visual Amenity	*Source* Vegetation clearing Earthmoving Operations *Vulnerability* Members of the Public Landform	Moderate (long-term, moderate severity, local extent).	Reclamation and mine closure will reinstate a stable and pleasing landform.	Low (medium term, low severity, local extent).
	Altered Vertical dimensions and loss of color, reflectivity and visible emissions	Source Creation of Access Road Flow of traffic over roads. Clearing of greenery *Vulnerability* Members of the Public Landform	Low (medium term, low severity, regional extent).	No Mitigation would be provided since the area to be cleared is small in comparison to the overall area and would be shielded and adsorbed by the adjacent forest	Low (medium term, low severity, regional extent).

shielded by surrounding vegetation. Landscape and visual impacts will result from creation of the access road to the mine site and the flow of traffic over this road. These impacts will be low (medium term, low severity, regional extent). These impacts will not be mitigated. Additional landscape and visual impacts will result from clearing of greenery, mining and for facility construction. The scale of the area to be cleared is however relatively small in comparison to the overall area and would be shielded and adsorbed by the adjacent forest. The impacts of clearing will be moderate (long-term, low severity, local extent). These impacts will not be mitigated.

14.4 Environmental Management Plan

Mitigation measures will be implemented to prevent/avoid, reduce, and where possible offset or remedy any significant adverse landscape and visual effects. Efforts will be expended initially to prevent or avoid adverse landscape and visual effects. If adverse effects cannot be prevented they will be reduced as far as possible. Unavoidable adverse effects will be offset or remedied.

The project design will incorporate measures to minimise negative and optimise positive landscape/visual impacts. Mitigation measures will include:

- Avoiding and much as is practicable sensitive locations and sites of highly valued historic or naturalistic landscapes, and siting project facilities to minimise visibility

- Developing the site layout to ensure the location of project elements minimise impact on valued elements, characteristics and views and
- Adjusting site levels and use of structured reclamation to minimise visibility of the development
- Using appropriate design, materials and finishes to ensure built features integrate with, or enhance, their surroundings if it is possible or desirable to screen or hide the project
- Use of colors similar to background colors for site facilities such as green roofs
- Enhance the road corridor with new planting where possible using a planting palette which is consistent with the existing plants in the area
- Screening the building and other project facilities using plant where possible
- Maintaining and protecting existing vegetation wherever possible

14.5 Monitoring Plan

Monitoring will be performed to test whether the predicted effects occur and whether any unforeseen effects arise and to ensure that mitigation measures which are implemented are effective in avoiding or reducing the predicted effects.

15.0 CULTURAL HERITAGE

Culture is defined as the whole complex of distinctive spiritual, material, intellectual and emotional features that characterise a community, society or social group. It includes not only arts and literature, but also modes of life, the fundamental rights of the human being, value systems, traditions and beliefs. Cultural heritage therefore comprises these expressions of culture, described by the World Bank (1994) as "the present manifestation of the human past" and is divided into two categories:

- tangible heritage, i.e. heritage that is physical, touchable, and perceptible
- intangible, i.e. heritage that is not physical or represented by a physical object, and is of a value not precisely measurable.

Tangible cultural heritage includes, often in combination:

- Archaeological remains, both above and below ground: these include buried remains as well as standing buildings, and archaeological sites as well as individual objects and artefacts. Examples range from earthworks, burial mounds, and hill forts, to the remains of Bronze Age settlements and medieval cities
- Monuments including works of monumental sculpture and painting, inscriptions, and cave dwellings
- Historic buildings and sites connecting individual or groups both in terms of their architecture and their setting or place in the landscape
- Structures of historic and/or architectural merit including but are not limited to bridges, canals, aqueducts and irrigation systems, ancient roads, and engineered agricultural terraces
- Historic/cultural landscapes suchas as works of human beings or the combined works of nature and humans. Such areas may be of historic, aesthetic, ethnological or anthropological interest
- Movable objects, such as historic or rare books and manuscripts, paintings, sculptures, religious items, historic costumes, jewellery and textiles, fragments of monuments and archaeological materials.

In contrast to tangible heritage, which concentrates on the physical expression of cultural heritage, intangible cultural heritage encompasses spiritual and social practices and traditional activities. Intangible cultural heritage is manifested as:

- oral traditions and expressions, including language as a vehicle of the intangible cultural heritage
- performing arts
- social practices, rituals and festive events
- knowledge and practices concerning nature and the universe (including traditional medicines)
- traditional craftsmanship.

15.1 Policy, Legislative and Regulatory Framework

15.1.1 Convention on the Protection of World Cultural and Natural Heritage, 1972

The Convention Concerning the Protection of the World Cultural and Natural Heritage (the World Heritage Convention) was adopted by the General Conference of UNESCO in 1972. The Convention aims to encourage the identification, protection, and preservation of earth's cultural and natural heritage. It recognizes that nature and culture are complementary, and that cultural identity is strongly related to the natural environment in which it develops. The Convention provides for the protection of those cultural and natural 'properties' deemed to be of greatest value to humanity. It is not intended to protect all properties of great interest, importance or value, but rather a select list of the most outstanding of these from an international viewpoint. The Convention recognizes that nations have a duty to ensure the identification, protection, conservation, presentation, and transmission to future generations of their cultural and natural heritage. By adhering to the Convention, nations pledge to conserve not only the World Heritage Site(s) situated within their territories, but also to improve the protection of their national heritage. Article 1 and 2 of the convention define cultural and natural heritage as follows:

Cultural Heritage:

1. Monuments: architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding universal value from the point of view of history, art or science
2. Groups of buildings: groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of outstanding universal value from the point of view of history, art or science
3. Sites: works of man or the combined works of nature and man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view.

Natural Heritage

1. Natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view
2. Geological and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation
3. Natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty.

In accordance with this convention, The National Trust of Guyana was established to preserve Guyana's Natural/cultural Heritage.

15.1.2 Convention on Biological Diversity

The Convention on Biological Diversity 1992 notes that some cultural knowledge and practices may depend on biodiversity and its components, and therefore specifically recognises the cultural value of biodiversity alongside its ecological, genetic, social, economic, scientific, educational, recreational and aesthetic values. These cultural services should be considered in ESIA, particularly when considering linkages between cultural heritage and biodiversity, and between environmental and social impact assessment (including well-being). This is particularly so for some indigenous and other communities whose traditional and spiritual activities depend on the maintenance of particular biodiversity features.

Article 8(j) of the Convention makes provision to protect the knowledge and practices of indigenous and local communities who rely on the conservation and sustainable use of biological diversity. Article 10(c) protects and encourages customary use of biological resources in accordance with traditional cultural practices. The Convention also requires that benefits from the use, for commercial purposes, of traditional knowledge and/or practices should be shared fairly and equitably with the owners of such knowledge (Article 15(7)).

15.2 Baseline

Mining activities have been occurring in this area since the 1940s. There are however no historic buildings or sites known to be associated with mining activities. The area is not known to have served as an indigenous community. This coupled with the relatively recent presence of indigenous peoples in the area reduces the likelihood of archaeological resources being present within the project area. Several auger holes were drilled for installation of the monitoring wells. During the biodiversity surveys several individuals traversed the project area. No archaeological resources were encountered in the auger holes or observed by the biodiversity field crews.

Several pits have been excavated in the concession by illegal artisanal miners. These pits provide a clear picture of the nature of the soil structure and the upper layers of the underlying geology. No items of cultural value were observed in any of the pits examined.

Table 67: Summary of Cultural Heritage Impacts

Project Phase	Impacts		Project Impacts Rating	Mitigation Measures	Impact Rating after Mitigation
Cultural Heritage					
Construction and Operation	Destruction of Artifacts	*Source:* Excavation activities Change in Groundwater flow Regime	Moderate (Long-term, High severity, local Extent).	Preparation of Archaeological Watching brief for implementation during earth moving, excavation and blasting activities and recording of archaeological evidence. Removal and preservation of artifacts after consultations with the Guyana National Trust.	Low (short term, low severity, local extent).

15.3 Impact Prediction and Evaluation

Removal and destruction of artifacts currently in the project area will compromise the quality of these artifacts. In additions, if artifacts exist below ground in the project area, removal of the ground cover may alter the pressure required to maintain the integrity of these artifacts. Changes in water conditions may also compromise the quality of any artifacts located below ground in the project area. If artifacts are present in the area their quality may be compromised. These are moderate impacts (long-term, moderate severity, local extent). These impacts will be mitigated by preparing an archaeological watching brief for implementation during earth moving, excavation and blasting. Archaeological evidence would be recorded and artifacts should be removed or preserved in place after consultations with the Guyana National Trust. The mitigation measures will result in low impacts (short term, low severity, local extent).

15.4 Environmental Management Plan

Mitigation will be undertaken to avoid and/or prevent adverse impacts on cultural resources and will include the following:

- Employment of alternative means to achieve project goals and objectives
- Avoiding physical features, if encountered by altering facilities locations/project design measures

This will preserve cultural heritage resources in situ, since "cultural heritage assets are non-renewable resources and … their physical preservation in situ when possible should be the primary goal of cultural resource management" (HA et al. 2007).

The remaining mitigation hierarchy will be comprised of:

- reducing likely adverse impacts by reducing land-take
- repair/rectify/restore adverse impacts
- enhancing positive effects
- where adverse impacts cannot be avoided or residual impacts remain, compensate/offset wherever technically and financially feasible.

These measures will be implemented during and/or after construction, or during operation of the project.

Remedial mitigation measures will include:

- screening of a cultural heritage asset from a road development
- improving the setting of archaeological remains
- improving access and amenity to any historic sites encountered by ensuring that they are protected from damage
- implementing erosion control around cultural resources if encountered
- rerouting of vehicular and pedestrian traffic around cultural resources.

Where loss of a cultural heritage resource cannot be avoided, mitigation will consist of recording of the resource and gaining an understanding of it before its loss. This may involve an archaeological dig prior to the commencement of construction.

15.5 Monitoring Plan

The potential damage to known cultural assets caused directly by the project will be monitored. Changes in the setting (visual, acoustic, odors) of a cultural asset caused by the project will also be monitored. Potential damage to known cultural assets caused indirectly by the construction or operation of the project will also be monitored since access road improvement may increase the number of visitors that could physically damage any cultural asset and

the abandonment of the area after closure could lead to the abandonment of a cultural heritage site and to its deterioration.

If any cultural assets are discovered during monitoring, steps enacted to maintain those assets will be focused specifically on the state of conservation of cultural assets remaining in its original location.

The effects on the cultural identity of a community caused by the findings of the discovery of the cultural asset would be monitored to assess how the cultural identity of a specific community could be strengthened by the finding.

16.0 SOCIO-ECONOMIC AND SOCIO-CULTURAL RESOURCES

The Project Area of Influence (AOI), shown on Figure 3, was defined based on likely environmental impacts including socio-economic and socio-cultural impacts and considered the role of third parties including the regional administration and Central Government and groups which may be affected by the project because of their disadvantaged or vulnerable status. Socio-economic and socio-cultural impacts will be a function of access to the mine site and from opportunities created for participation of communities close to the mine.

Employment and income generation is potentially one of the greatest benefits of the project for local and wider communities. Access to good employment may be a positive catalyst for a whole range of improvements in social and health indicators. However, these improvements are based on suitable conditions of employment and recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers. Employment practices must include:

- fair treatment and non-discrimination
- good worker–management relationships
- compliance with relevant employment and labour laws
- worker protection, especially vulnerable groups such as children
- safe and healthy working conditions
- no use of forced labour.

This project is in a remote and rural area. The area is populated primarily by Indigenous Peoples. Indigenous Peoples, as social groups, are distinct from mainstream groups in national societies and are often among the most marginalized and vulnerable segments of the population. In many cases, their economic, social, and legal status limit their capacity to defend their rights to, and interests in, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development.

The project can create important employment opportunities for Indigenous Peoples and may help to fulfil their social and economic aspirations. Indigenous People issues consider:

- Respect for human rights, dignity, aspirations, culture, and natural-resource based livelihoods
- Avoidance and/or minimization of project impacts on their communities
- Promotion of sustainable development benefits and opportunities in a culturally appropriate manner
- Development of an ongoing relationship with Indigenous Peoples communities based on Informed Consultation and Participation (ICP)
- Free, Prior, and Informed Consent (FPIC) of affected communities as appropriate.

The Project area of Influence incorporate all Indigenous Peoples communities within the watershed and other communities close to the proposed mine and include Kuraudanawa/Krowdar Village, Achuwib, Aishalton, Awaruwaunau, Parabara and Shea villages, Indigenous Peoples communities in the South Rupununi which are in closest proximity to the mine site. These communities may serve as sources of employment for the Project and are therefore included in the Project Area of Influence.

16.1 Policy, Legislative and Regulatory Framework

16.1.1 United Nations Declaration on the Rights of Indigenous Peoples, 2007

In 2007, the United Nations adopted the Declaration on the Rights of Indigenous Peoples. A non-binding text, the Declaration sets out the individual and collective rights of indigenous peoples, as well as their rights to culture, identity, language, employment, health, education and other issues. The Declaration emphasized the rights of indigenous peoples to maintain and strengthen their own institutions, cultures and traditions and to pursue their development in keeping with their own needs and aspirations. It prohibits discrimination against indigenous peoples and promotes their full and effective participation in all matters that concern them, and their right to remain distinct and to pursue their own visions of economic and social development.

16.1.2 Amerindian Act No. 6 of 2006

The Amerindian Act of 2006 was assented to by the President on 14th March, 2006 and came into operation in April 2006. The Act provides for the recognition and protection of the collective rights of Amerindian Villages and Communities, mechanisms for good governance within Amerindian Villages and Communities and the granting of land to these Villages and Communities. The Act defines words used in the Act such as 'miner', 'mineral', 'mining activities' and 'traditional mining privilege'. There is a Part of the Act that provides for several matters relating to the entry and access to Amerindian Villages and Communities.

Provisions in the act govern how village lands are acquired and the rights and privileges that are attached to them. Village lands may not be disposed of except as provided in the Act. An existing Amerindian Village may have its Village lands extended on application in writing in accordance with the provisions of the Act. Amerindian Village and Village land status may be accorded an Amerindian Community on Application made, if it has been in existence for at least twenty-five (25) years and if at the time of application and for five (5) years immediately preceding its application, it consisted of at least one hundred and fifty (150) persons.

Part V of the Act deals extensively with mining and matters related to mining, including environmental issues relating to lands within the boundaries of Amerindian Villages and proximate thereto. This Part provides for allocation of lands to residents and for lease of lands within the Villages.

Mining is allowed in any river, creek, stream or other source of water within the boundaries of any village subject to prescribed conditions. Anyone who seeks to mine on Village lands without satisfying the prescribed conditions and obligations would commit an offence. One of the conditions for mining on village lands is that a miner must enter a written agreement with the Village Council. That agreement must contain terms that relate to issues such as:

- The offer of employment to residents of the Village at market rates once residents with the required skills are available
- The purchase of food and materials from the Village once available and at competitive prices
- Compliance by the miner and employees with rules made by the Village council
- The obligation of miners to take all necessary steps to avoid damage to the environment, pollution of ground water and surface water, interference with agriculture, damage or disruption of flora and fauna and disruption of residents' normal activities

The Village and miners may exercise an option to expressly cater for other matters in a written agreement. These matters may include:

- An environmental protection programme
- A waste disposal plan
- A mechanism for identifying and resolving conflict
- A health programme providing medical supplies to health workers for use in the Villages
- An education programme

Another important condition for mining in Villages is the requirements of consent from those present at a Village general meeting.

Where a large-scale miner, whether prospecting or mining, is refused consent by the Village he may still be able to prospect or mine for minerals if the Minister with responsibility for mining and the Minister of Amerindian Affairs declare that the mining activities proposed are in the public interest.

The Act provides for the payment of tribute by a miner to the Village for any minerals obtained from Village lands and the Guyana Geology and Mines Commission is mandated to transfer into a fund for that purpose, a prescribed percentage of royalties obtained from mining activities on Village lands. The Guyana Geology and Mines

Commission is obligated to notify the Village and be satisfied that the impact of mining on the Village will not be harmful before issuing any permit, licence, concession or permission over or in:

- any part of Village lands
- any land contiguous with Village lands
- any rivers, creeks or water way which pass through Village lands or any lands contiguous with Village lands

The concession is not located on lands belonging to any Amerindian Village. The mine site will, however, be accessed by a road which passes through Aishalton, an Indigenous People village. The provisions of the Act relating to miners accessing and passing through Amerindian Villages are applicable to the project.

16.1.3 Safety Provisions

Health and safety regulations are not explicitly detailed in Cap 65:01. However, the provisions of Part XIII Regulation of Mines can be interpreted as relating to regulating conditions in mines to ensure health and safety. The regulations of Mines details requirements for the employer of a mine manager and places restrictions on persons appointed manager of a mine.

16.1.3.1 Occupational Safety and Health in Mining

The Occupational Safety and Health Act, 1999 contain provisions applicable to the regulation of health and safety in mines. In 2002, a draft Mining Occupational Safety and Health Regulation was proposed by the Ministry of Labour, Human Services and Social Security with the assistance of the International Labor Organization (ILO). The mine will be required to operate in accordance with the Occupational Safety and Health Act 1999.

The OSH Regulation covers duties of employers and self-employed persons, owners of mines, manufacturers and workers. Reporting of dangerous situations and occurrences, administrative requirements such as the preparation, checking and maintenance of mine development plans, as well as those for mine operations, inspections by mine operators, minimum age of workers and the maximum duration of work shifts, and notice of death or injury are also covered. Other general areas included in the regulations are competency requirements for the supervision of workers at a mine, training for the performance of mining operations, the supervision of work done by competent workers, safe access to and egress from workplaces such as mine openings, ladders, stairways, platforms and open pit workings and general safety for working alone, protective equipment and clothing, protection from falling objects and the prohibition of substance abuse in mines.

Safety requirements for surface operations include emergency procedures and fire prevention and control strategies. The draft Regulation also addresses working environment conditions such as control of specific contaminants, noise and dust limits, vibration and heat stress, ergonomics, sanitary facilities and precautions against exposure to radon and radiation. The safe handling, storage, operation, and transport of explosives are also dealt with. Basic safety procedures for electrical safety in mines, safety requirements for machinery and plant equipment, and the operation of hoisting equipment are detailed as well as miscellaneous provisions regarding the resolution of health and safety issues and the refusal of a worker to work in particular instances.

This draft Regulation has not yet been given legal effect. This mine will have to operate under these regulations after their promulgation.

16.1.3.2 Labour Act (1942)

The Labour Act (1942) established the Department of Labour to regulate relationship between employers and employees and to settle differences between these groups. Part I of the act created the positions of Chief, Deputy and Assistant Labour Officer in addition to additional labour officers. Part II details the conciliation process in instances where a difference exists between employer and employees or between different classes of employees. Part III grants authority to the Minister to appoint an advisory committee to investigate the conditions of employment of any occupation and to make recommendations for the minimum wage to be paid to that occupation.

The advisory committee must include a representative of both the employer and employee. Parts IV and V of the act respectively detail the right of employees, duties and obligations of employers and payment of wages and deduction from wages. Part VII of the act establishes the right of the Minister to make regulations regarding the hours of work. Collective agreements are covered under Part VII of the act. All aspects of this Act are applicable to this project.

16.1.3.3 Labour (Amendment) Act (1994)

This Act amended the Labour Act by the substitution for the words '"two hundred and fifty dollars" and "ten dollars" by the words "fifteen thousand, six hundred and twenty-five dollars" and "six hundred and twenty-five dollars", respectively. The amendment further mandated where in any occupation rates of wages have not been prescribed, an employer shall pay wages to the person employed at the rate agreed upon between them, and if the employer fails to do so, he shall be liable on summary conviction to a fine of fifteen thousand six hundred and twenty-five dollars, and on a second or subsequent conviction to a fine of forty-six thousand, eight hundred and seventy-five dollars.

The Amendment also allows for any occupation in which the partial payment of wages in the form of allowances in kind is customary or desirable because of the nature of such occupation, nothing contained in the Amendment shall render illegal a contract with an employee for giving to him food, drink, a house, cottage, tenement or room, or other allowances or privilege in addition to money wages as a remuneration for his services. This part of the Amendment is particularly applicable to this project since the Project Proponent will be required to establish a man camp on site and to provide meals for persons employed on the project.

16.1.3.4 Termination of Employment and Severance Pay Act (1997)

This Act provides conditions to govern the termination of employment and grant of redundancy or severance payment to employees. Part II of the Act defines continuity of employment as beginning from and including the first day on which an employee begins to work for an employer and continuing up to and including the date of termination of employment of such employee and establishes conditions that cannot be regarded as interruptions in employment. Part III identifies conditions under which employment can be terminated and identify reasons which do not constitute good or sufficient cause for dismissal or for imposition of disciplinary action. Part IV of the Act mandates severance and redundancy paid upon termination of employment. These payments are related to the period for which the person has been employed. All aspects of this Act are applicable to this project.

16.1.3.5 Holidays with Pay Act (1995)

The Holidays with Pay Act, 1995 provides for the grant and regulation of annual holidays with pay for all categories of workers. The Act mandates that every worker is allowed a period of holidays with pay of not less than one day for each completed month of employment computed from the date of commencement of employment. Every worker who is employed on a half day basis shall have the half day counted as a day and every worker employed on a daily or an hourly basis shall be allowed a period of holidays with pay of not less than one day for every period of 20 (twenty) days or 160 (one hundred and sixty) hours worked.

16.1.3.6 Holidays with Pay (Amendment) Act (2009)

The Act repealed and re-enacted section of the Holiday with Pay Principal Act which deals with "Offences penalties and court order" and amended Section 11 which deals with the institution of prosecutions by the Chief Labour Officer and replaced the word 'holidays' with 'leave' throughout the Act.

16.1.3.7 Public Health Act Cap 145

Section 2 of the Public Health Act Cap 145 states that mining districts under the Public Health Act are understood to include mining districts established under section 4 of the Mining Act. Under Section 147, the Minister responsible for Health is enabled to make regulations generally for the sanitary control of mining districts or parts thereof, and the health and welfare of the inhabitants. Revisions to the Public Health Act including draft regulations

for mining have been made but not yet promulgated. The provisions of the Public Health Act will be factored into the employee health and safety plan for the mine site operations.

16.2 Baseline

The socio-economic baseline was developed to create a profile of the communities in and within the project Area of Influence (AOI). The project AOI was defined in Section 1.3 and as shown on Figure 3 is "the area which will experience direct environmental and social impacts because of the project. Direct physical environmental impacts are related to the environmental pathways. The physical pathways for this project are air and water. The project Area of Influence, for physical environmental impacts, therefore extends to the limits of the watershed around the project area.

Emissions to air are not expected to be experienced outside of the watershed surrounding the project. If, however, screen modeling of air emissions indicates effects beyond the limits of the watershed the Project Area of Influence will be extended to capture those impacts.

The Project area of Influence is also defined based on likely socio-economic and socio-cultural impacts and considered the role of third parties including the regional administration and Central Government and groups which may be affected by the project because of their disadvantaged or vulnerable status. Socio-economic and socio-cultural impacts will be a function of access to the mine site and from opportunities created for participation of communities close to the mine. The Project area of Influence consequently incorporate all communities within the watershed and other communities close to the proposed mine and include Kuraudanawa/Krowdar Village, Achuwib, Aishalton, Awaruwaunau, Parabara and Shea villages, which are indigenous communities in the South Rupununi which are in closest proximity to the mine site. These communities may serve as sources of employment for the Project and are therefore included in the Project Area of Influence." The zone of influence has been thus defined as the physical radius to which the project footprints or impacts may potentially extend.

The baseline was compiled based on consultations and field work with stakeholders within the project AOI and incorporates data provided by stakeholders outside of the AOI. The socioeconomic and socio-cultural baseline incorporated the following:

(i) dominant uses of land and other resources for subsistence and livelihood activities, such as farming, fishing, hunting and mining
(ii) presence of infrastructure such as schools, medical facilities, communications network/transport networks and markets
(iii) public health issues including health risks and diseases
(iv) local institutional capabilities
(v) land ownership patterns
(vi) identification and characterization of community cohesion and management and
(vii) identification of existing and proposed development plans for the study area.

The following four data collection methods were employed as an integral part of the socio-economic and socio-cultural baseline compilation:

- focused consultations with the Ministry of Amerindian Affairs and with non-governmental organizations (Guyana Organization of Indigenous Peoples, Amerindian Peoples Association and The Amerindian Action Movement of Guyana and the National Amerindian Defence Foundation) which represent the interests of indigenous peoples in Guyana
- review of data and reports compiled by indigenous people interest groups
- Interviews with representatives of the Ministry of Health
- Visits and data collection from indigenous people communities within the AOI
- Incorporation of data provided by the South Rupununi District Council (SRDC) in their correspondence to both the Guyana Environmental Protection Agency and to Ground Structures Engineering Consultants Inc.

16.2.1 Regional Context

The Marudi Mountain Mining Concession is located within Administrative Region 9, in the Rupununi Mining District, in southwestern Guyana approximately 155 kilometers south-southeast of Lethem and approximately 50 kilometers south-southeast of the Amerindian village of Aishalton. The AOI for the project includes Kuraudanawa/Krowdar Village, Achuwib, Aishalton, Awaruwaunau, Parabara and Shea villages, all located within a 60 km radius of the proposed project.

16.2.2 Access

Dirt roads prevail in the Rupununi except for areas within Lethem where asphalt roads exist. Due to the terrain and the weather patterns, access in and around the district is primarily by means of four-wheel vehicles, dirt motor-cycles, all-terrain vehicles and bicycles. The Project site is directly linked to Aishalton, the indigenous community in closest proximity to the proposed project, by a 45 km long roadway which passes through the Guyana Geology and Mines Commission check point at Bushmouth. The access road from Aishalton to the Marudi Mountain Project site is a fair-weather roadway approximately 8 m wide.

There are several airstrips in the South Rupununi, however few of these airstrips, including the one at Aishalton, are operational. Air Travel to the mine site area is facilitated primarily thru the airstrips at Aishalton and Lethem. An alternate route is by buses which operate on the Georgetown /Lethem trail. Cellular communication in the South Rupununi is provided by a lone cell tower in Aishalton.

The indigenous peoples' village of Aishalton is accessed by a 180 km long fair-weather road from Lethem which passes through Dadawana and Mountain Point. Access to areas on the Lethem-Aishalton access road can be impossible for days or weeks during the rainy season, if rainfall is intense, since intense rainfall induces elevated water levels in creeks and rivers passing adjacent to the roadway or over which the roadway passes. The roadways currently in the South Rupunini and project area are detailed on Figure 35. Aishalton is the only village within the AOI through which the access road to the mine site passes.

There is very little vehicular traffic on the road linking Lethem to Aishalton. Traffic normally equates to two four-wheel drives vehicles per day during the dry season. Passage during the wet season is impeded by elevated water levels in several rivers and may sometimes equate to as little as four vehicles per week. The current operations by RGEL at Marudi Mountain generate very little traffic on the Lethem-Aishalton Road. Traffic currently generated by RGEL consists of four-wheel drive passenger vehicles and project supply trucks. The access road is currently also used by several other mining entities operating both legally and illegally in the Marudi Mountain area.

Residents of indigenous peoples' villages in the South Rupununi use primary motorcycles for transport on the access road. A few residents of these villages use four-wheel drive vehicles to supply their shops and to transport passengers. There is no public transport network servicing the South Rupununi area.

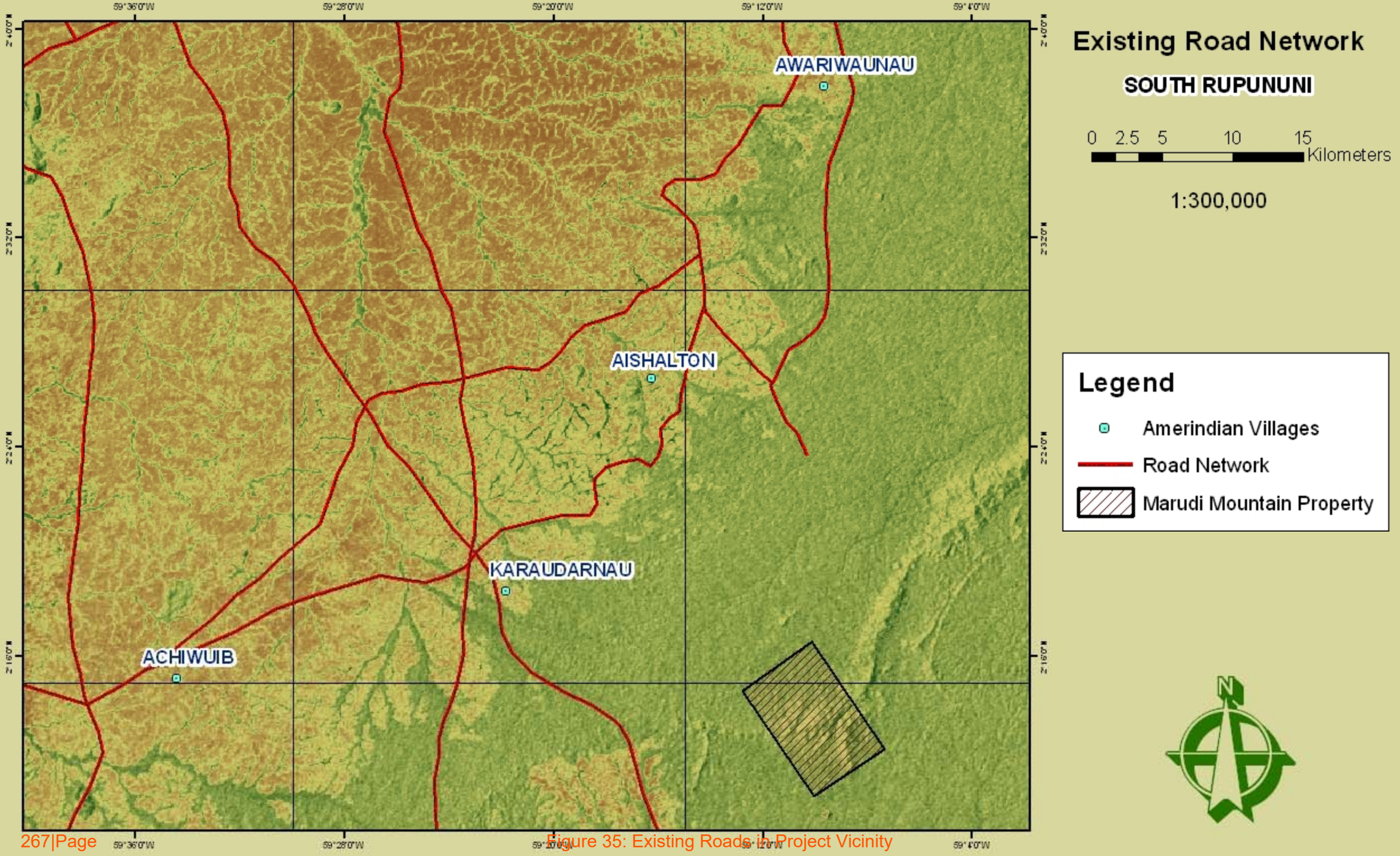


Figure 35: Existing Roads in Project Vicinity

16.3 Profile of Region 9 Upper Takutu/Upper Essequibo

Guyana has ten administrative regions. The Project is in Region 9. The regional system was designed to decentralize government functions and to provide each region with its own administrative responsibilities. Each region has a Regional Democratic Council (RDC) headed by a regional chairman. The RDC of Region 9 is based in Lethem and has three sub-regions:

- North Rupununi
- South Central
- South Rupununi

Aishalton is the administrative center of the South Rupununi Sub-Region in which the project is located.

Amerindians form the bulk of Region 9 population and are the fourth largest ethnic group in Guyana and account for 9.2 per cent of the 751,223 persons in Guyana (Guyana Census Report, 2002). Between 1980 and 2002, the Amerindian population grew from 40,343 to 68,819. This represents a significant increase of 70.6 per cent. Specifically, Amerindians account for more than three-quarters of the populations of Region 9 (89.2 percent) (Guyana Census Report, 2002).

The indigenous peoples in the South Rupununi belong primarily to the Wapishana ethnic group, the sole exception being the community of Shulinab which is populated by member of the Machusi ethnic group. Like most Amerindians, the Wapishanas are animists, that is, they believe that everything, both animate and inanimate have a spirit; spirits they believe exist and referred to as Kanaima. All residents live in small settlements. Farming, hunting and cattle rearing, historically was and continues to remain the main likelihood activities of all indigenous groups in the South Rupununi. Crops and plants cultivated by Indigenous peoples' groups include cassava, yams, sweet-potatoes, pine apples, peanuts, bananas and papaya. Indigenous peoples have traditionally and continue to hunt and fish to supplement their protein intake.

The Macushis and Wapisianas drifted from Brazil into Guyana from the beginning of the eighteenth century. Most likely, they crossed in the area of the Ireng River and began settling in the north part of the Rupununi savannahs. Later, the Wapisianas began to migrate to the south of the Kanuku Mountain. Some historians believe that they did so to avoid the slave-raiding Amerindian tribes who came from the Rio Negro and Rio Branco regions of Brazil. There is evidence that during the eighteenth and nineteenth centuries both the Macushi and Wapisiana villages erected defences against these raids. It is possible, too, that the Wapisianas moved away from the north savannahs because they and the Macushis had become enemies. In the 1780s, more Macushis and Wapisianas who were living in the Rio Branco region of Brazil fled to Guyana to escape from the Portuguese who were forcibly attempting to place them in mission settlements. Smaller groups from decimated tribes from the same region of Brazil also moved into Guyana and joined up with either the Macushis or Wapisianas after this period.

The head of a typical indigenous peoples' household is the father. Each community is governed by a Village Council comprised of a Toshao and Councilors. The Toshao is the administrative head of the village and has responsibility for maintenance of law and order. The Toshao coordinates village activities including observances of religious activities and other communal activities such as hunting and is responsible for permitting access of non-indigenous persons into the community and for hosting those persons.

Elections to fill the position of Toshao and Councilors are held every two years. Elections are supervised by the Regional Democratic Council. The Amerindian Act (2005) gives elected village officials similar powers to that of their counterparts in the local government structure in non-Amerindian areas. The functions of the Village Council are set out in the Amerindian Act (2005) as:

a. represent the Community
b. act in the best interest of the Community
c. provide advice and strategic direction to the Community
d. hold for the benefit and use of the Community all rights, titles and interests in or over Community lands

e. promote the sustainable use, protection and conservation of Community lands and the resources on those lands
f. encourage the preservation and growth of Amerindian culture
g. ensure that places and artefacts located which hold sacred or cultural values to the Community are protected and cared for
h. protect and preserve the Community's intellectual property and traditional knowledge;
i. nominate Councillors or other members of the Community to accompany the Toshao to meetings of the Regional Democratic Council, or to attend meetings on behalf of the Community; and
j. ensure that proper accounts and financial records are kept.

The Toshao receives a stipend from central Government for performing the functions mandated under the Amerindian Act.

16.4 Methodology

Data was initially acquired from secondary sources including published literature, reports and statistics. The secondary data was used to identify primary data requirements. Primary data were obtained by personal interaction with member of communities within the AOI and consisted of both informal discussions and administration of a questionnaire to community members in the Area of Influence (AOI). Communities within the AOI, their approximate distances from the project site and population are listed in Table 68.

Table 68: Population and distance from project site of Villages within Project Area of Influence

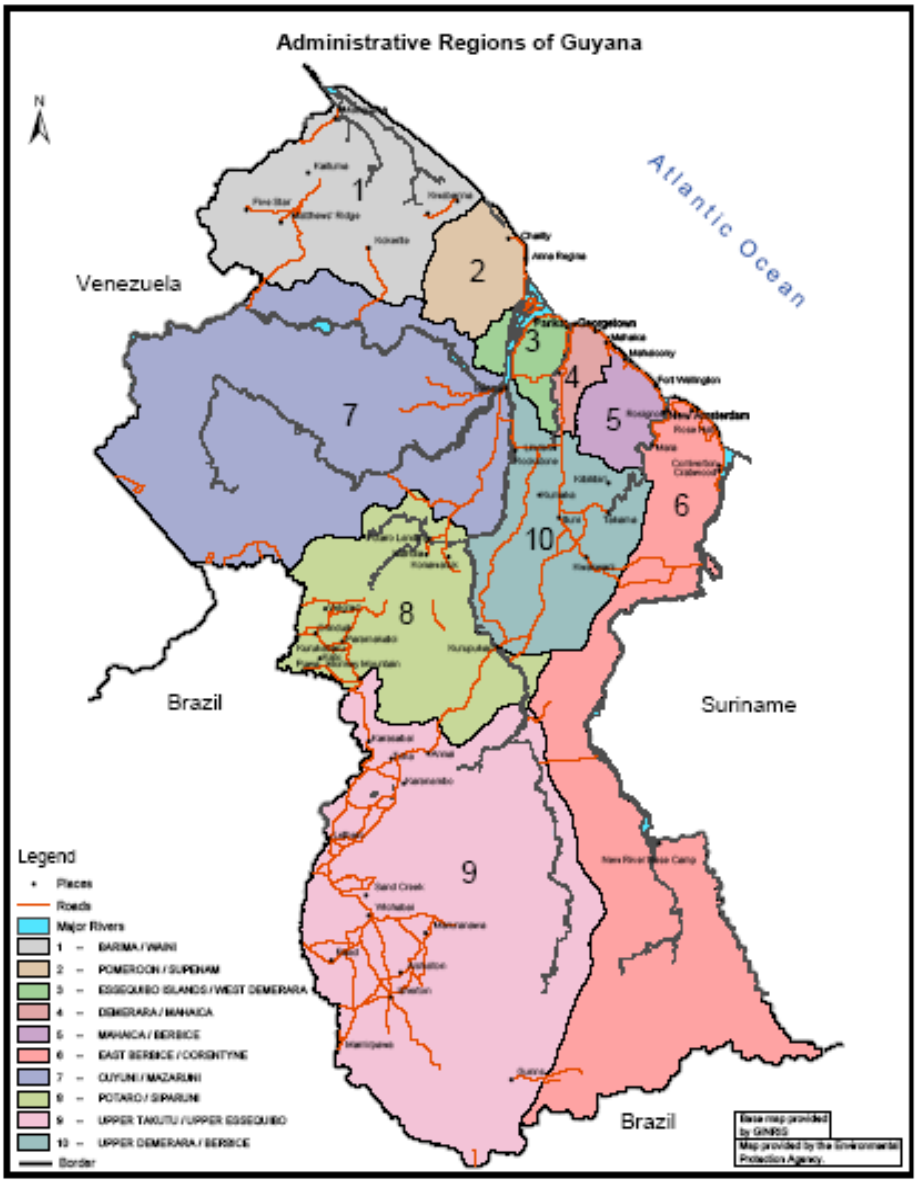
Village	Approximate Distance from Project (km)	Population
Kuraudanawa (Krowdar)	21	498
Aishalton	28	1213
Achuwib	45	500
Awariwunau	40	690
Parabara	62	171
Maruranau	47	727
Shea	54	443

The field data gathering exercise was preceded by the dispatch of correspondence to Toshaos in each community within the AOI seeking permission to enter the communities to conduct the field work. The data gathering exercise moved forward based only on that permission. The data exercise commenced in each community in the form of a meeting hosted by the Toshao. The project scope was detailed at each community meeting and persons present detailed individual concerns associated with the project. The study team members were then taken on a tour of each community. Questionnaires were subsequently randomly distributed to community members to capture persons knowledge of the project and their perception of the potential impacts (positive or negative impacts) associated therewith and measures to both ameliorate negative impacts and to enhance positive impacts and opportunities.

Compilation of the socio-economic and socio-cultural baseline was aided by focus group discussions, using the Rural Rapid Appraisal (RRA). The RRA is a multi-disciplinary approach, which uses a suite of visual methods, and semi-structured interviews to learn from the local people about their realities and challenges, especially as enunciated by interest groups, and other key stakeholders. The RRA tools aimed to capture the following:

- Anticipated social and economic impacts
- Current social and economic baseline characteristics
- Measures for mitigation of adverse impacts and enhancement of positive impacts
- Community development opportunities.

Figure 36 - Administrative Regions in Guyana



16.4.1 Community Characteristics

16.4.1.1 Awarewaunau

The titled area of Awarewaunau is 301.92 square miles. This community is located approximately 162 km from Lethem and 40 km from the Marudi project site and is home to members of the Wapishana tribe. The regional administration has indicated that this community has a population of six hundred and ninety (690) persons. The Bureau of Statistics 2012 Population Census 2012 records household size to range from three to five individuals. Figure 37 summarizes population by age and sex in this community.

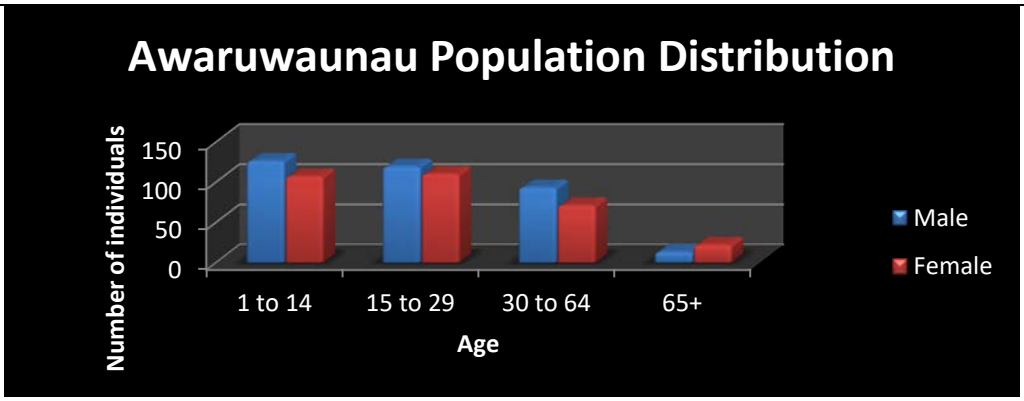


Figure 37 - Population Distribution of Awarewaunau

Houses in this community conform to the traditional styles of housing in these communities with most houses being made of thatched leaf roofs and clay-lined walls, however, there were four dwellings house constructed of concrete and with zinc roofs in this community.

16.4.1.1.1 Transportation and Communication

The village is accessed by road and trails. Commuting within and around this village is accomplished by bicycles, 4x4 vehicles, horses, cows, bullock carts, motorcycles, ATVs and by foot. Residents indicated that communications with other areas is accomplished by cellular and satellite phones. Decisions of the Toshao and Council are provided by verbal communication to residents with a village bell being used in particular ways to communicate various messages including emergency meetings, deaths, weddings and/or any dangers of which the entire community must be made aware.

16.4.1.1.2 Employment and Livelihood

Employment opportunities in Awarewaunau are a function of the primary economic activities in the villages. These economic activities include agriculture, livestock and cattle rearing, trade/industry, mining and fishing. A small percentage of persons in the village are also employed as domestic servants.

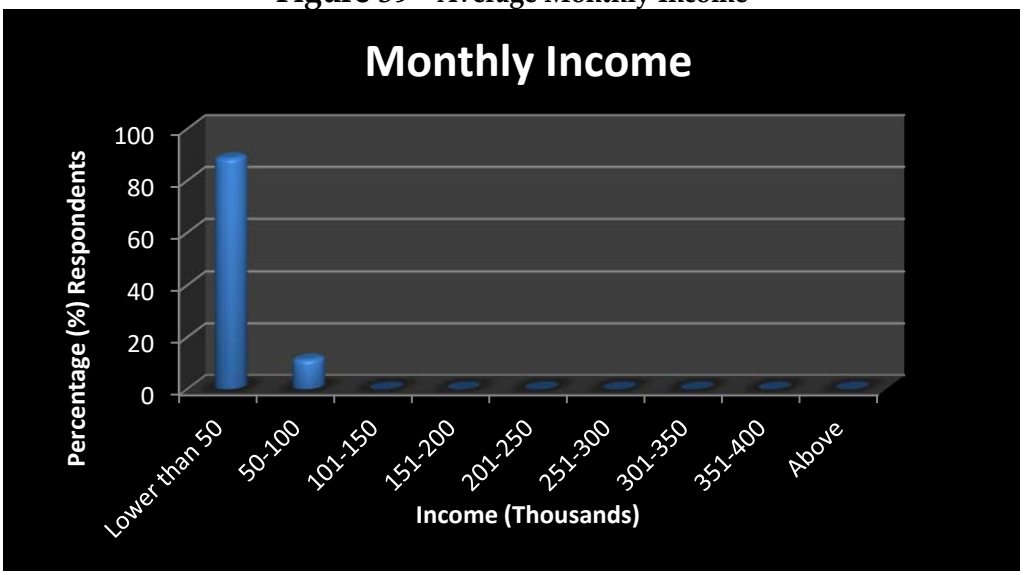
Agriculture is the primary economic activity in the village with 25.7% of the respondents indicating involvement in agriculture. Villagers farm a variety of leafy vegetables and an assortment of fruits. The second rated economic activity was livestock rearing with both pigs and chickens being reared on a small scale. Additional protein for consumption was gathered by hunting using traditional tools such as traps, bow and arrows with dogs and shotguns being used in some instances. Hunting is a common livelihood activity and is done individually or in family groups. Meat is bartered both to avoid it becoming spoiled and for agricultural produce. Cassava bread and farine are also made for personal consumption. There is a peanut factory in the village which processes peanut both for local sale and for sale to areas outside of the village.

A summary of the employment statistics for this community is demonstrated as Figure 38 and indicates that of the respondents, 17.1% are employed, 62.9% are self-employed, 14.3% are unemployed and 5.7% have been facing difficulties finding employment. The number of individuals employed (inclusive of those self-employed), is greater than the number of individuals who are unemployed. The average monthly income of most community members, as indicated by Figure 39 is lower than GYD $50,000.00.

Figure 38 - Employment Status of villagers



Figure 39 - Average Monthly Income



16.4.1.1.3 Recreation

There is a single playfield in this village which serves as a football and cricket ground and which is used to stage other community/sporting events. The playfied is also used for inter-village competitions. Vendors use areas around the playfied to sell food items and beverages whenever the field is used.

16.4.1.1.4 Education

The village has a nursery and a primary school. The nursery school has a total of thirty-five (35) pupils ranging in age from three (3) to six (6) years with all students being overseen by a single teacher. The Awarewaunau Primary school has one hundred and eighty-four (184) students who are instructed by seven (7) teachers. An active meal programme caters for all pupils and provides lunch five (5) days per week. Children above the age of 12 years, who qualify for secondary education, attends secondary school in in either Aishalton or Lethem.

16.4.1.1.5 Health Services:

The village has a single community health centre, staffed by a trained Medex. This medex attends to approximately one hundred (100) patients each month. The main illnesses, based on village health records, are malaria, respiratory infection, gastroenteritis and diarrhoea. Severe illnesses, which cannot be treated at the health centre, are referred

to Aishalton Health Centre. Patients are transported by ambulance or ATV to Aishalton, or in some cases, to Lethem by aircraft.

16.4.1.1.6 Water and Sanitation Services

Potable water use is sourced from wells (63.6% of respondents), ponds (11.4% of respondent), creeks (4.5% of respondents), rivers (2.3% of respondents), streams (4.5% of respondents), rain-water (6.8% of rtespondents) and other sources such as reservoirs (6.8% of respondents).

There are no provisions for waste management in the community. Solid wastes are disposed by individual homesteads by burning or by being placed into individuals dumps to rot. Pit latrines are commonly used by villagers.

16.4.1.1.7 Energy

There are no public utilities providing electricity in the South Rupununi. Individauls household provide their own electricity based on personal needs. Electricity is provided by several means including batteries, solar panels and generators.

16.4.1.1.8 Social and Cultural Issues

The level of health care is a major concern of villagers since travel is often required to Brazil to seek medical treatment when health care facilities in Aishalton or Lethem cannot appropriately respond. Villagers expressed desire for the project to create the following benefits:

- Development of the main access road
- Purchase of agricultural output
- Development and utilization of human resources from the village
- Appropriate renumeration for all individauls hired by the RGEL

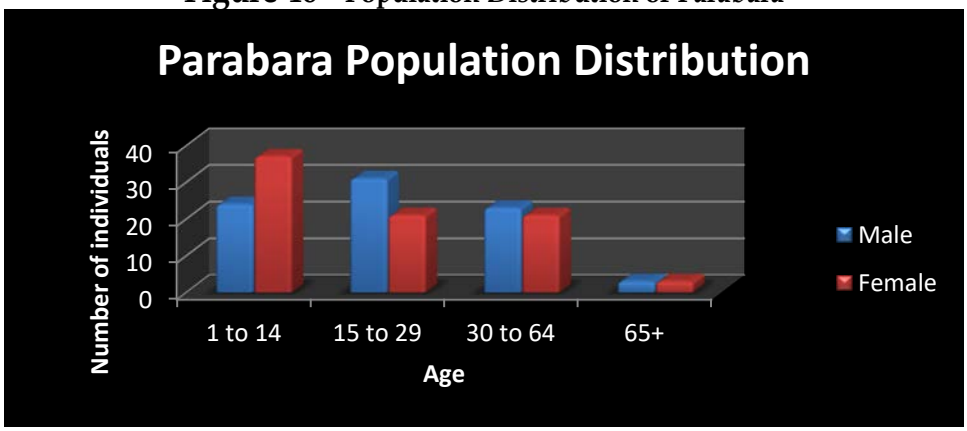
16.4.1.2 Parabara

Parabara is located approximately 247 km from Lethem, 54 km from Aishalton and approximately 62 km from the Project site. It is home to the Wapishana and Wai-Wai tribes. The 2017 Regional demographic census listed one hundred and seventy-one (171) residents for Parabara with eighty-four (84) being males and eighty-seven being females. The Bureau of Statistics Population Census 2012 lists each household to have between three (3) to five (5) individuals. The village has traditional houses of thatched leaf roofs and clay-lined walls.

16.4.1.2.1 Transportation and Communication

The village is similarly accessed by roads and trails using bicycles, 4-wheeled drive vehicles, horses, cows, bull carts, motorcycles, ATVs and by foot. Some villagers also commute by canoe on nearby rivers. Residents indicated that communications with other areas is accomplished by cellular and satellite phones. Decisions of the Toshao and Council are provided by verbal communication to residents with a village bell being used in particular ways to communicate various messages including emergency meetings, deaths, weddings and/or any dangers of which the entire community must be made aware.

Figure 40 - Population Distribution of Parabara



16.4.1.2.2 Employment and Livelihood

Residents of Parabara generate employment by partaking in agriculture, fishing and hunting. Agriculture is the major economic activity in the village and engages 44.1% of the population. Villagers plant ground provisions, peanuts and an assortment of fruits and vegetables which are sold and consumed by households. Villagers actively in hunt and fish to satisfy daily food needs.

Hunting is done individually or in family groups. In times of excess, meat is bartered and/or distributed to other villagers to prevent spoilage. Cassava bread and farine are made for personal consumption.

Emplyment status of Parabara residents is depicted in Figure 41. Approximately 49 percent of villagers are employed while approximately 27 percent are self-employed and 24 percent are experiencing difficulties obtaining employment. The average income of community members is below GYD $50,000.00 per month as demonstrated by Figure 42.

Figure 41 - Employment Profile of Parabara Residents

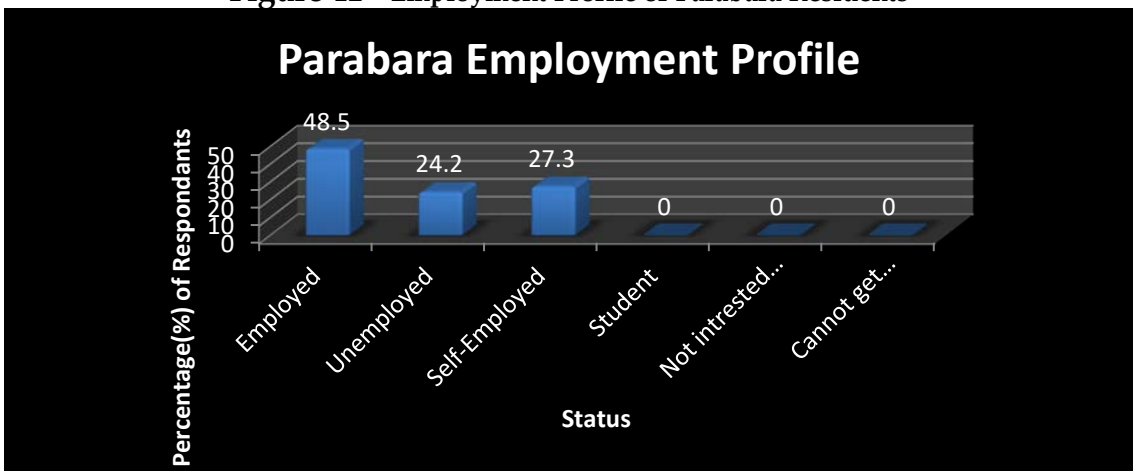
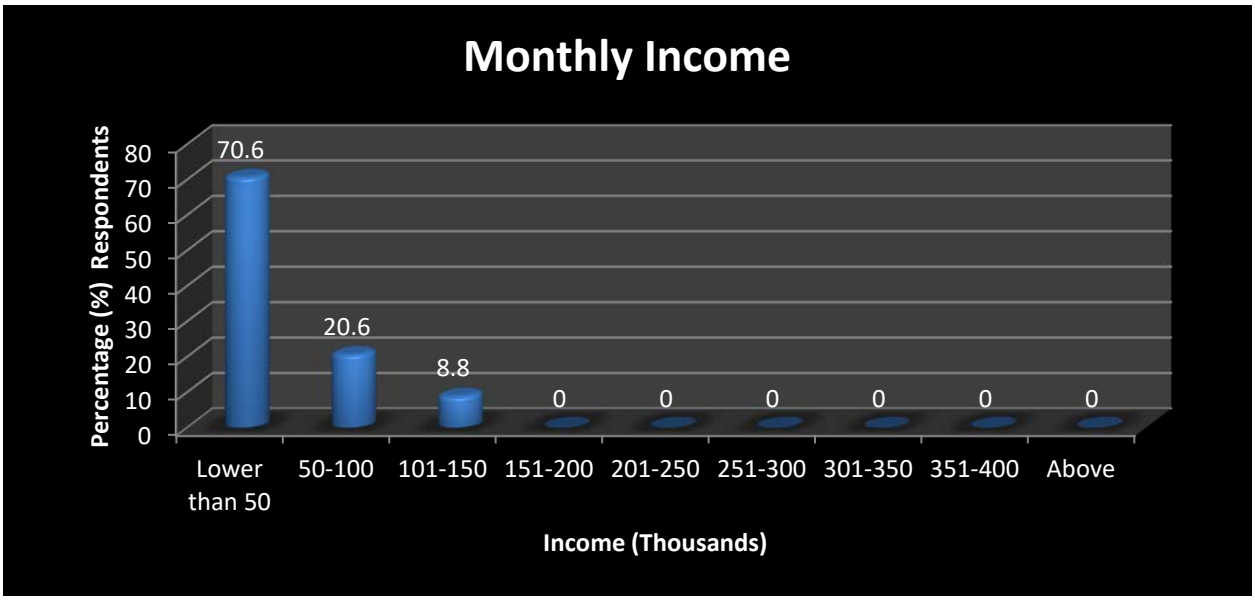


Figure 42 - Average Monthly Income



16.4.1.2.3 Recreation

There is a single playfield in this village which serves as a football and cricket ground and which is used to stage other community/sporting events. The playfied is also used for inter-village competitions. Vendors use areas around the playfied to sell food items and beverages whenever the field is used.

16.4.1.2.4 Education

The village has both a nursery and primary school. The nursery school with a complement of nine (9) student; four (4) boys and five (5) girls ageds three (3) to six (6) years is supervised by one (1) teacher. The primary school has a total of forty-four (44) students who are supervised by seven (7) teachers. An active meal programme caters for all pupils and provides lunch five (5) days per week. Children above the age of 12 years, who qualify for secondary education, attends secondary school in in either Aishalton or Lethem.

16.4.1.2.5 Health Services:

The village has a single community health centre, staffed by a trained Medex. This medex attends to approximately one hundred (100) patients each month. The top ailments, based on village health records, are malaria, diarrhoea and mercury poisoning. If there is a severe case of illness which cannot be treated at the health centre, patients are referred to Lethem via aircraft.

16.4.1.2.6 Water and Sanitation Services

Water for household use is sourced from wells (54.3%), rivers (21.7%), ponds (2.2%) and rainwater (21.7%). There are no provisions for waste management in the community. Solid waste is disposed by individuals by burning or by placement into small earth fills to rot. Villagers use pit latrines.

16.4.1.2.7 Energy

There is no electrical utility in this community. Residents self generate electricity by using batteries, solar panels and/or generators. Several villagers, however, lack access to electricity.

16.4.1.2.8 Social and Cultural Issues

The presence of mercury in fishes from rivers and streams in this community are a major concern of villagers. Villagers surmised that the presence of mercury in fishes is attributable to mining in areas upstream of their community which discharges mercury into rivers and streams draining into the Kuyuwini River. Cheap and reliable transportation is also a concern of this community since it is quite expensive to travel to and from the community which is reflected in high costs for goods in the community.

Members of this community expressed desires for development and maintenance of their access road and for the project to support community development by purchasing agricultural output from the village and to develop and utilize human resources from the village while ensuring appropriate renumeration for all individauls hired by the Project.

16.4.1.3 Aishalton

The titled 166.3 square miles area of Aishalton is located approximately 160 km from Lethem and 21 km from the Project site. It is adminsitartive center of the South Rupununi and is home to members of the Wapishana ethnic group. The Regional administration reports that its population totals one thousand two hundred and thirteen residents (1,213) residents of which six hundred and eighty (618) are males and five hundred and ninety-five (595) are females. Most homes in Aishalton are built of thatched leaf roofs and clay-lined walls, however several homes are built of concrete and wood.

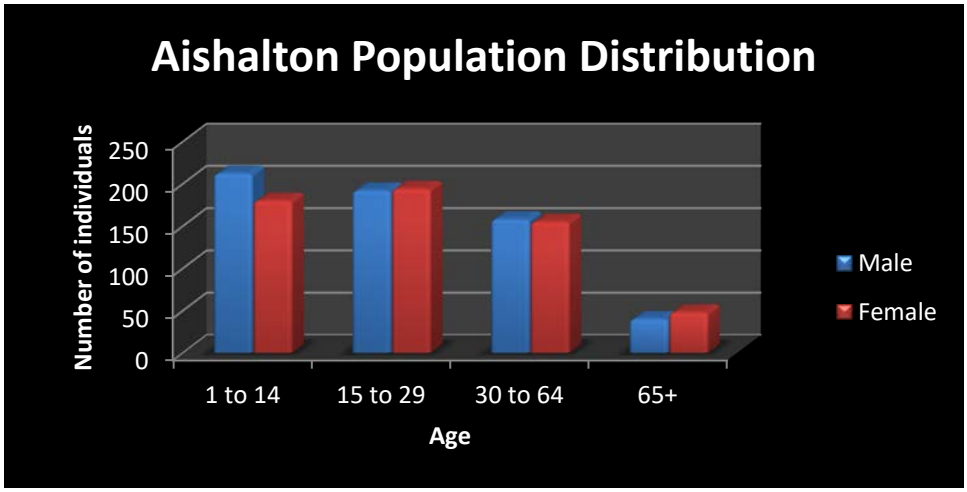


Figure 43 - Population Distribution of Aishalton

16.4.1.3.1 Transportation and Communication

Aishalton is accessed by motorcycles, bicycles, horses and 4-wheel drive vehicles. Residents commute within the village by foot on dirt tracks and trails. An airstrip, at Aishalton, also facilitates air traffic from Lethem and Georgetown. This airstrip is also used during for emergency transport of patients and for visits state officials.

The telecommunications service provider, Digicel, has installed a microwave tower at Aishalton. This tower facilitates communications between residents of Aishalton and points remote to Aishalton. In a manner common to communities in the South Rupununi, bells are used in particular ways to communicate various messages including notice of emergency meetings, deaths, weddings and/or emergency.

A FM radio station, in the community, broadcasts educational programmes, news, and community service notices and in addition to providing entertainment for villagers.

16.4.1.3.2 Employment and Livelihood

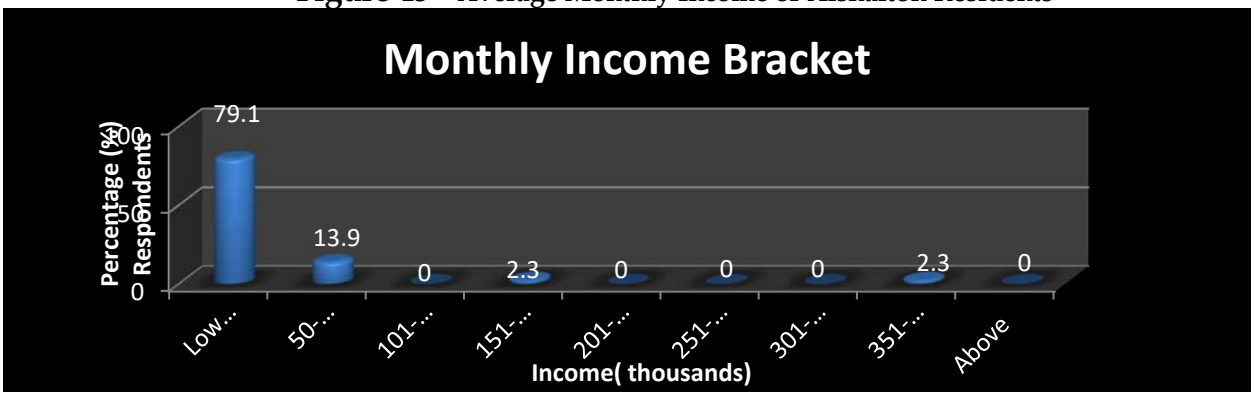
Residents of Aishalton generate income by farming, hunting, fishing and cattle rearing. Crops cultivated include cassava, banana, eshallot, callaloo, sweet pepper and ochre. Villagers use traditional farming tools including forks, shovels and cutlasses. Labba, Agouti, Deer, Wild Cow and Wild Hog are hunted and residents fish for Lukanani, Patwa, Tiger Fish and Hassar mostly in the Rupununi River during the wet season. Villagers also make cassava bread and farine for personal consumption.

Several residents also own and manage restaurants, others are employed as miners and shop-keepers with other residents working for the regional administration. The employment profile of members of Aishalton is depicted by Figure 44 and indicates that approximately nine percent of residents are employed, approximately 77% are self-employed and 14% are experiencing difficulties finding employment. The average income of most community members is below GYD $50,000.00 per month as shown by Figure 45.

Figure 44 - Employment Profile of Aishalton Residents



Figure 45 - Average Monthly Income of Aishalton Residents



16.4.1.3.3 Recreation

There is a single playfield in this village which serves as a football and cricket ground and which is used to stage other community/sporting events. The playfied is also used for inter-village competitions. Vendors use areas around the playfied to sell food items and beverages whenever the field is used.

16.4.1.3.4 Education

Aishalton has nursery, primary and secondary schools. The nursery school has a complement of fifty-one (51) students; twenty-three (23) boys and twenty-eight (28) girls who are instructed by four (4) teachers and three (3) auxiliary staff. The primary school has one hundred and sixteen (116) males and ninety (90) female students

instructed by eight (8) teachers and one (1) auxiliary staff. The secondary school has one hundred and twenty-one (121) males and one hundred and thirty-nine (139) females instructed by seventeen (17) teachers and two (2) volunteers of Project Trust. The secondary school is used by students from other villages in the South Rupununi. These students are housed in dormitory accommodations at the secondary school.

16.4.1.3.5 Security

A police station, present at Aishalton, is manned by two (2) police officers. There are infrequent crime occurrences in the village, however major crimes including assault and statutory rape sometimes occur. Police conducts patrols and outreach by All Terrain Vehicles (ATVs).

16.4.1.3.6 Health Services

A hospital in Aishalton is the major health care facility in the South Rupununi. The hospital is staffed by thirteen individuals including a single doctor and two (2) nurses. Emergency cases which cannot be handled by this hospital are transported to Lethem by a Non-Government Organizatio (NGO). The Aishalton hospital provides services to approximately one hundred and forty persons to one hundred and fifty (140-150) patients each month. Common ailments include common cold, flu, hypertension and diarrhoea.

16.4.1.3.7 Water and Sanitation Services

Potable water is sourced from wells (41.3%), ponds (5.4%), river (18.5 %), creeks (20.6%), stream (5.4%) and from rain-water (7.6%). There are no waste managememnt collection and/or disposal facilities in Aishalton. Wastes are handled individually by burning or by placing into small earth fills to rot. Pit latrines are used by most residents, however, several residents and other facilities have access to septic tanks.

16.4.1.3.8 Energy

There are no electric utilities in Aishalton. Residents of Aishalton self generate electricity using solar panels, batteries and generators.

16.4.1.3.9 Social and Cultural Issues

This community expressed major concerns about the presence of diseases, including sexually transmitted diseases (STDs) in the community and indicated that increased incidences of these diseases are related to the influx of coast-landers mining in areas around the village. The hospital at Aishalton was also reported to handle a large number of malaria cases associated with persons coming out of the Marudi Mountain area. Villagers also reported that incidences of domestic violence are prevalent in the community, however these incidences are seldom, if ever reported.

Members of this community expressed a desire for the projects to provide the following benefits:

- Purchase of agricultural output
- Development and utilization of human resources from the village
- Appropriate renumeration for all individauls hired by the RGEL

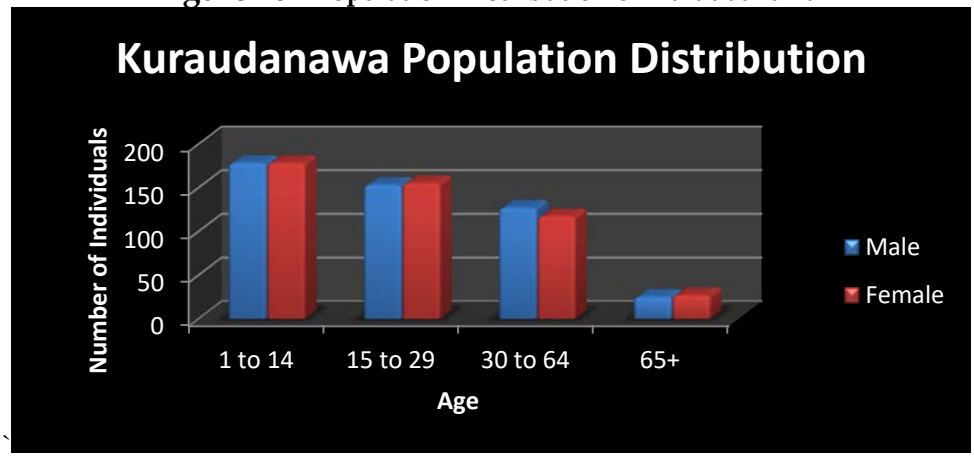
The Toshao reported that petroglypths are present within the titled area of Aishalton. He however, indicated that a request to confirm the presence of these petroglypths could only be honored if a fee was paid. The presence of petroglypths was therefore not confirmed. However, all indications are that these petroglypths were not present in the project area since no such claims were forthcoming from the Toshao.

16.4.1.4 Kuraudanawa Village

The titled area of Kuraudanawa of 301.92 square miles is located approximately 193 km from Lethem and 28 km from the Marudi project site. The village is populated primarily by members of the the Wapishana ethnic group,

however, there are small concentrations of both the Arecuma and Macusi ethnic groups resident in the village. In 2017 the Regional Administration documented a population of nine hundred and eighty-eight (988) residents; four hundred and ninety-eight (498) males and four hundred and ninety (490) females. Most homes in this community are built of thatched leaf roofs and clay-lined walls.

Figure 46 - Population Distribution of Kuraudanawa



16.4.1.4.1 Transportation and communication

The village is similarly accessed by roads and trails using bicycles, 4-wheeled drive vehicles, horses, cows, bull carts, motorcycles, ATVs and by foot. Residents indicated that communications with other areas is accomplished by cellular and satellite phones. Decisions of the Toshao and Council are provided by verbal communication to residents with a village bell being used in particular ways to communicate various messages including emergency meetings, deaths, weddings and/or any dangers of which the entire community must be made aware.

16.4.1.4.2 Employment and livelihood

Livelihood activities in this community are mainly hunting and fishing. Residents hunt mainly for Labba, Agouti, Deer and Wild Hog and fish for Lukanani, Patwa, Tiger Fish and Hassar. Several residents farm peanuts which is sold to a factory in the community to produce peanut-based products including peanut butter and roasted peanuts.

Figure 47 - Average Monthly Income of Residents

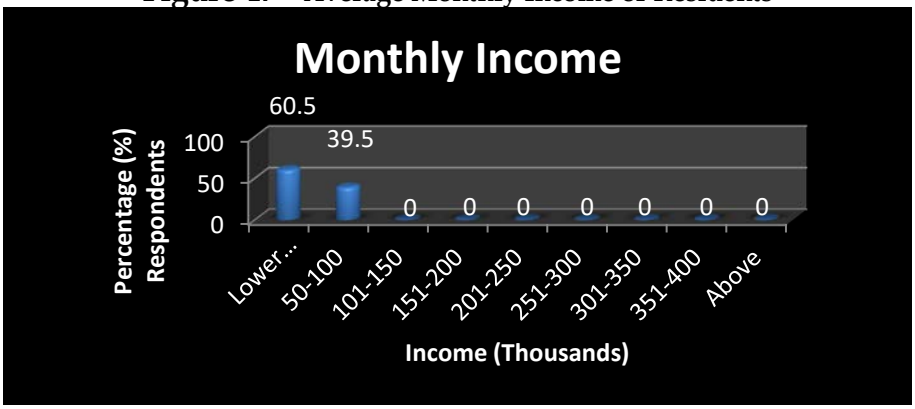


Figure 48 - Employment status of villagers



16.4.1.4.3 Recreation

There is a single playfield in this village which serves as a football and cricket ground and which is used to stage other community/sporting events. The playfied is also used for inter-village competitions. Vendors use areas around the playfied to sell food items and beverages whenever the field is used.

16.4.1.4.4 Education

There is both a nursery and primary school in this community. The nursery school has thirty-seven (37) pupils, nineteen (19) boys and eighteen (18) girls and is staffed by three (3) teachers aided by three (3) auxiliary staff members. The Primary school has a student population of two-hundred (276) and is staffed by eighth (8) teachers and an ancillary staff. There is an active hot meal programme for all pupils which provide lunch five (5) days per week. Children above the age of 12 years, who qualify for secondary education, attends secondary school in in either Aishalton or Lethem.

16.4.1.4.5 Health Services

The village has a single community health centre, staffed by a trained Medex an an assistant. The top ailments, based on village health records, are pneumonia, diabetes, high blood pressure, malaria, respiratory infection, gastroenteritis and diarrhoea. If there is a severe case of illness which cannot be treated at the health centre, patients are referred to Aishalton or to Lethem.

16.4.1.4.6 Water and Sanitation Services

The primary source of potable water in this community are several hand-dug wells spread across the community. Additional potable water sources are creeks, rivers, ponds and streams. There are no waste managememnt collection and/or disposal facilities in this community. Wastes are handled individually by burning or by placing into small earth fills to rot. All residents use pit latrines.

16.4.1.4.7 Energy

There are no electric utilities in this community. Residents self generate electricity using solar panels, batteries and generators.

16.4.1.4.8 Social and Cultural Issues

The village has experienced downsizing in the peanut production factory due to loss of its market and many villagers have discontinued their involvement in peanut farming, an activity in which they were involved for several years. Current demand for peanuts from the factory is limited to providing output for schools feeding programs in the community.

Villagers expressed desire for the project to create the following benefits:

- Development of the main access road
- Purchase of agricultural output
- Development and utilization of human resources from the village
- Appropriate renumeration for all individauls hired by the RGEL

16.4.1.5 Shea

Shea is located 100 miles south–east of Lethem, approximately 9 miles from the base of the Kanuku Mountains. The residents are primarily Wapishana who account for ninety (90%) of villagers, while the remaining 10% are of mixed descent. The regional administration indicated that the community has four hundred and forty-three residents (443); two hundred and twenty-two (222) males and two-hundred and twenty-one (221) females. Houses in this community are built of thatched leaf roofs and clay-lined walls.

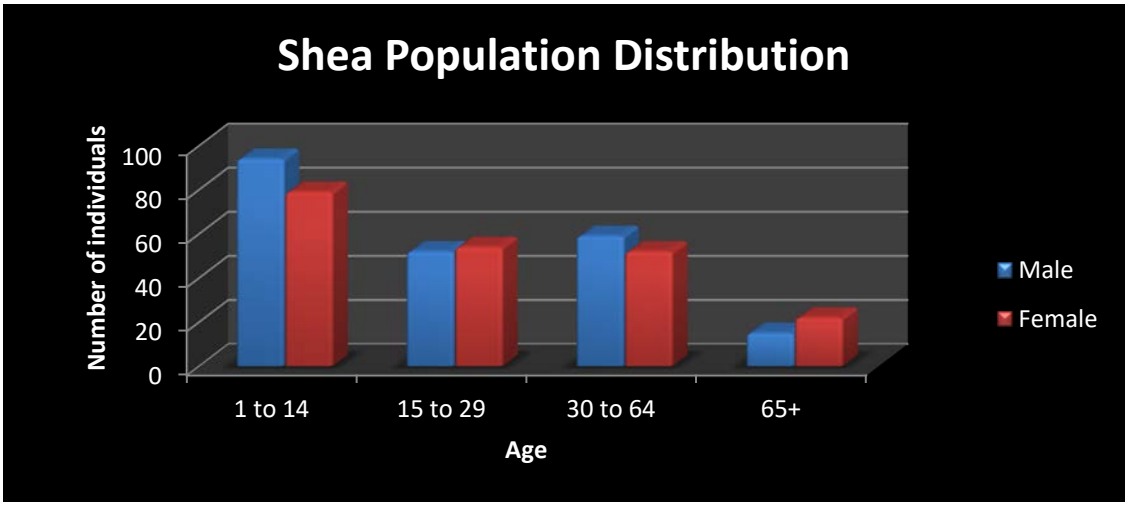


Figure 49 - Population Distribution of Shea

16.4.1.5.1 Transportation and Communication

The village is similarly accessed by roads and trails using agricultural tractors, 4-wheeled drive vehicles, motor-cycles, bicycles, horses and by feet. Residents indicated that communications with other areas is accomplished by cellular phones, however the signal strength is weak in the community. Decisions of the Toshao and Council are provided by verbal communication to residents with a village bell being used in particular ways to communicate various messages including emergency meetings, deaths, weddings and/or any dangers of which the entire community must be made aware.

16.4.1.5.2 Employment and Livelihood

Approximately fifty seven percent (56.5%) of the residents of this community are self-employed and are engaged in subsistence farming, logging, hunting and fishing and livestock rearing. Crop produced includes ground provision, fruits and vegetables, which are sold within the village and to neighbouring villages. Several residents rear chickens and pigs. Several women in the village produce and sell cassava, farine and cassareep.

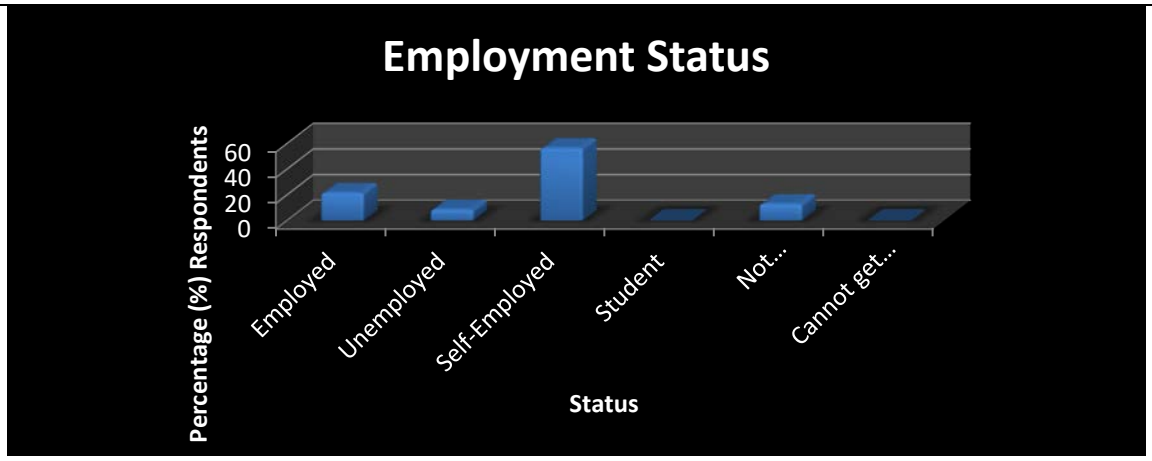


Figure 50 - Employment status of villagers

Approximately twenty two percent (21.7%0 of the residents are employed, 8.7% are unemployed, 56.5% self-employed and 13% are not interested in employment. The average monthly income of this community is less than GYD $50,000.

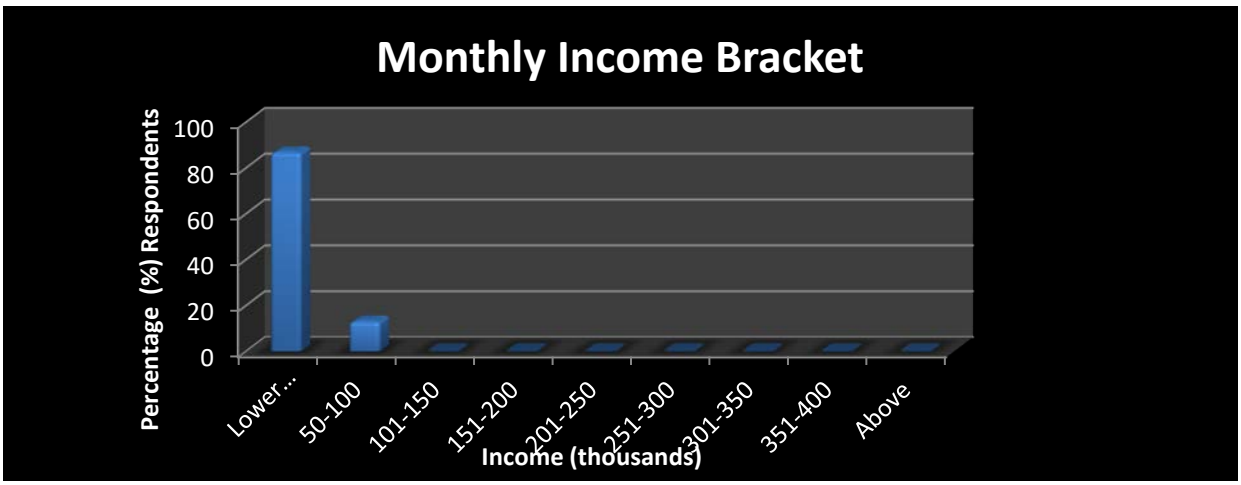


Figure 51 - Average monthly income

16.4.1.5.3 Recreation

There is a single playfield in this village which serves as a football and cricket ground and which is used to stage other community/sporting events. The playfied is also used for inter-village competitions. Vendors use areas around the playfied to sell food items and beverages whenever the field is used.

16.4.1.5.4 Education

The village has two educational facilities. A nursery school with twenty-seven (27) pupils; twelve (12) boys and fifteen (15) girls, staffed by three (3) teachers. The Primary school has one hundred and three students; 58 are males and 45 females and is staffed by eight (8) persons. An active hot meal programme for students provides lunch five (5) days per week. Students who qualify for secondary education attend school in either Aishalton or Lethem.

16.4.1.5.5 Health Services:

The village has one community health centre staffed by a trained Medex. Illnesses common in this community include diarrhoea, malaria, vomiting and occasionally minor emergencies. Severe cases which cannot be treated at the health centre are referred to Aishalton or Lethem health centre.

16.4.1.5.6 Water and Sanitation Services

Potable water is obtained from wells, river, pond, or creeks. Some residents harvest rain water. There is no central solid waste management facility in this community and individuals either burn or bury self generated waste. All homes are equipped with latrines.

16.4.1.5.7 Energy

There is no central electrical service provider in this community. Individual villagers self generfate electricity using solar panels, battery and/or generators.

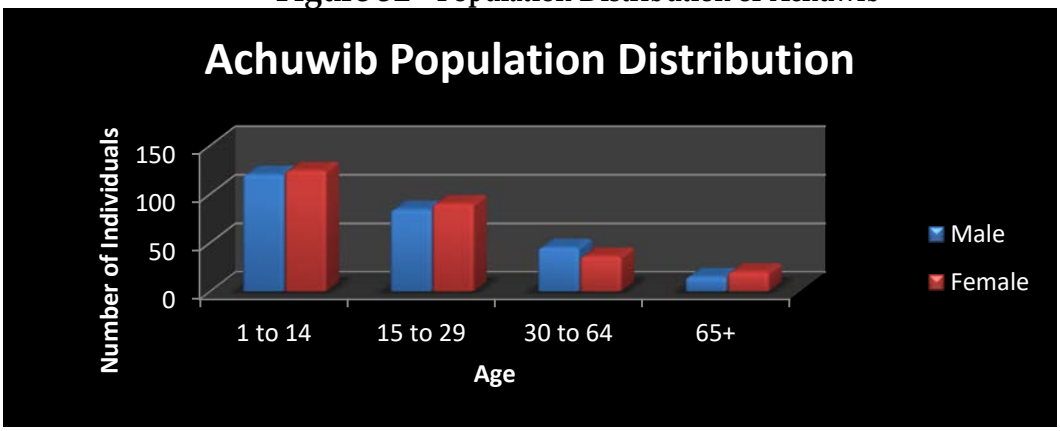
16.4.1.5.8 Social and Cultural Issues

The Toshao reported that petroglypths are present within the titled area of Shea. He however, indicated that a request to confirm the presence of these petroglypths could only be honored iof a fee was paid. The presence of petroglypths was therefore not confirmed. However, all indications are that these petroglypths were not present in the project area since no such claims were forthcoming from the Toshao. The primary social issues identified by residents of Shea was unemployment.

16.4.1.6 Achuwib

The titled area of Achuwib, totalling 166.944 square miles and is approximately 44 km from the Brazilian border and 44 km west of Aishalton. Achuwib has five hundred and seventy-seven (577) residents; two hundred and eighty-eight (288) males and two hundred and eighty-nine (289) females. The average household size of Achuwib is three to five (3- 5) persons. Approximately 90% of Achuwib residents are Wapishana, the remainder being individuals from areas in Guyana bordering the Atlantic Ocean (coast landers). Houses in this community are constructed of thatched roofs and clay-lined walls.

Figure 52 - Population Distribution of Achuwib



16.4.1.6.1 Transportation and Communication

Achuwib is similarly accessed by roads and trails using bicycles, 4-wheeled drive vehicles, horses, cows, bull carts, motorcycles, ATVs and by foot. Residents indicated that communications with other areas is accomplished by cellular and satellite phones. Decisions of the Toshao and Council are provided by verbal communication to residents with a village bell being used in particular ways to communicate various messages including emergency meetings, deaths, weddings and/or any dangers of which the entire community must be made aware.

16.4.1.6.2 Employment and Livelihood

Farming is the main economic activity in this community. Fishing and hunting are conducted solely for individual household consumption. Ten percent (10%) of Achuwib residents are Government of Guyana employees, 5% are

unemployed, 7.5% are unable to get employment and 77.5% are self-employed. Eighty percent (80%) of residents earn less than GYD$50,000 each month while 12.5% earn between GYD $50000-100000.

Figure 53 - Employment Status of Residents

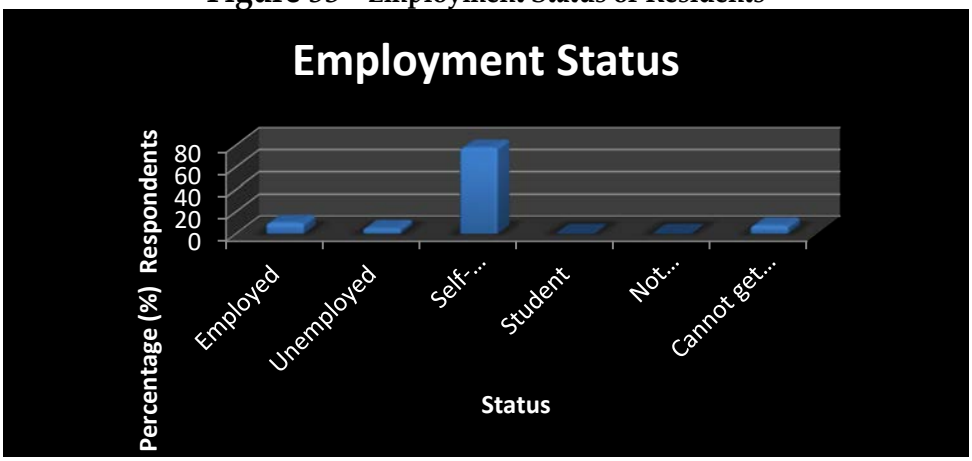
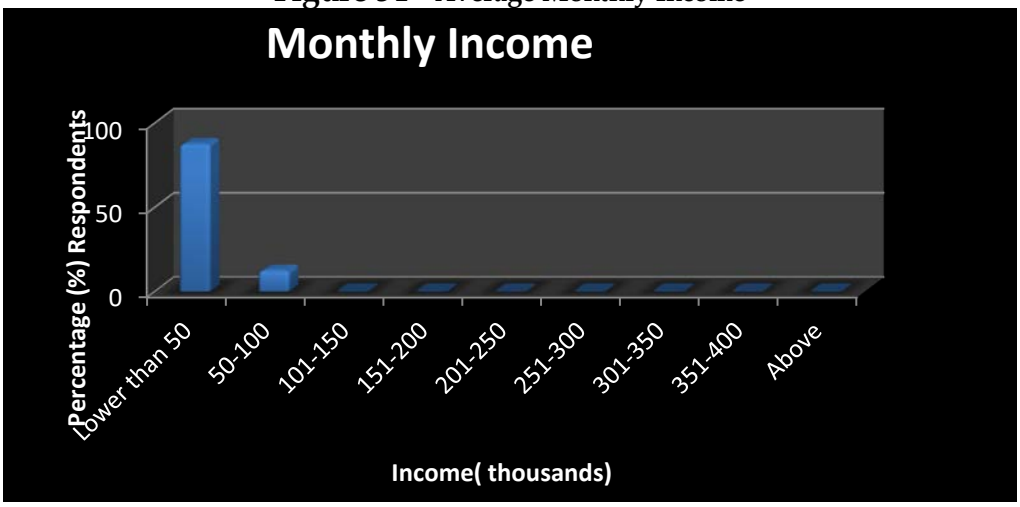


Figure 54 - Average Monthly Income



16.4.1.6.3 Recreation

There is a single playfield in this village which serves as a football and cricket ground and which is used to stage other community/sporting events. The playfied is also used for inter-village competitions. Vendors use areas around the playfied to sell food items and beverages whenever the field is used.

16.4.1.6.4 Education

Achuwib has a nursery and a primary school. The nursery school has thirty-eight (38) pupils; fifteen (15) boys and twenty (20) girls and is staffed by three (3) teachers. The Achuwib primary school has one hundred and sixty-two (162) students and is staffed by seven (7) teachers. Students from Achuwib seeking a secondary education attend school in either Aishalton or Lethem.

16.4.1.6.5 Health Services

The village has one community health centre, which is staffed by a trained Medex, who attends to patients with minor ailments and emergencies. Severe cases which cannot be treated at the health centre are referred to Aishalton or Lethem health centre.

16.4.1.6.6 Water and Sanitation Services

Potable water is obtained from wells, river, pond, or creeks. Some residents harvest rain water. There is no central solid waste management facility in this community and individuals either burn or bury self generated waste. All homes are equipped with latrines.

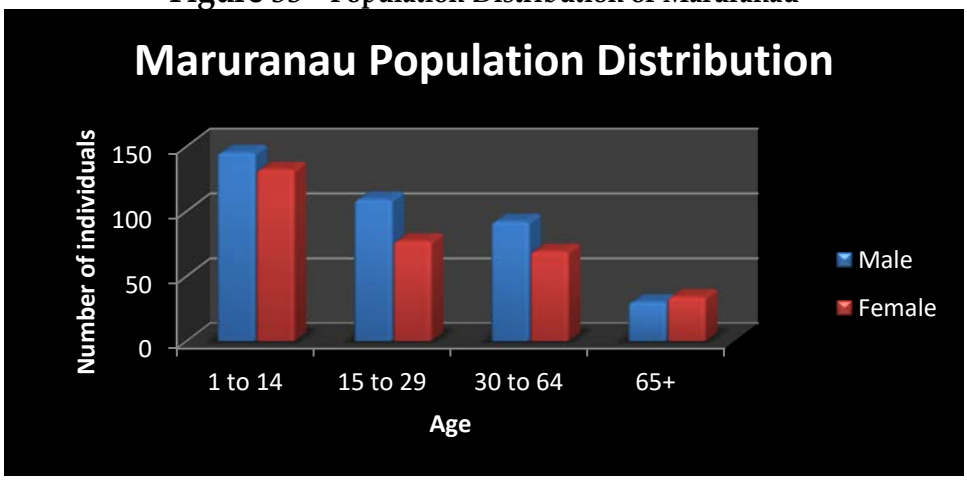
16.4.1.6.7 Energy

There is no central electrical service provider in this community. Villagers self generfate electricity using solar panels, battery and/or generators.

16.4.1.7 Maruranau Village

The titled area of Maruranau is 109.118 square miles. This village is primarily home to the Wapishanas. Maruranau has a population of seven hundred and twenty-seven (727) persons; three hundred and ninety-two (392) males and three hundred and thirty-five (335) females. Household sizes in this community range from three to five (3- 5) persons. Homes in this community are made of thatched leaf roofs and clay-lined walls.

Figure 55 - Population Distribution of Maruranau



16.4.1.7.1 Transportation and Communication

Maruranau is accessed by roads and trails using bicycles, 4-wheeled drive vehicles, horses, cows, bull carts, motorcycles, ATVs and by foot. Residents indicated that communications with other areas is accomplished by cellular phones, however the cellular signal is weak and residents must walk to strategic points to make calls. Decisions of the Toshao and Council are provided by verbal communication to residents with a village bell being used in particular ways to communicate various messages including emergency meetings, deaths, weddings and/or any dangers of which the entire community must be made aware.

16.4.1.7.2 Employment and Livelihood

Farming is the main economic activity in the village. Farmers use traditional farming tools to prepare the land. Crops planted include ground provisions, vegetables and fruits. Fishing and hunting are done solely for household consumption.

Approximately nine percent (9.3%) of the residents of Maruranau are government employees, 12.5% are unemployed, 3.1% are unable to get employment and 59.5% are self-employed. More than 85% residents earn lower than GYD$50000 per month while 6.2% earns between GYD $50000-100000 per month.

Figure 56 - Employment Status of Residents

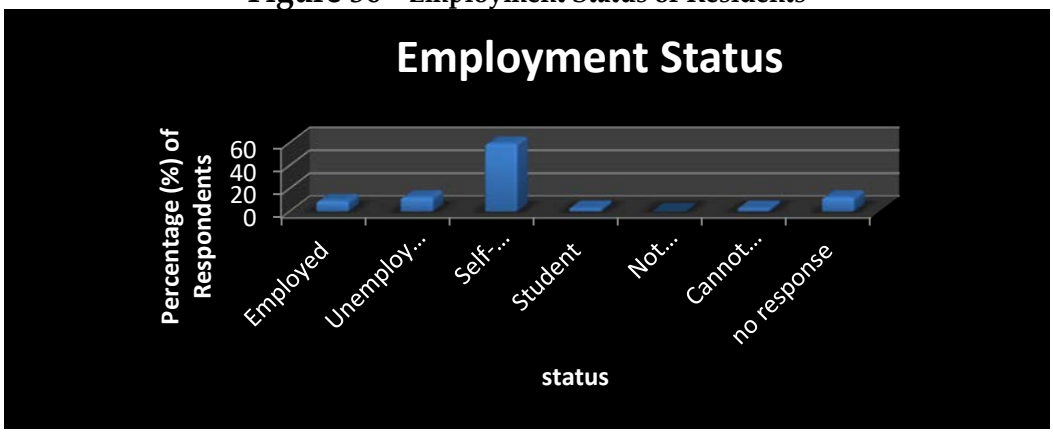
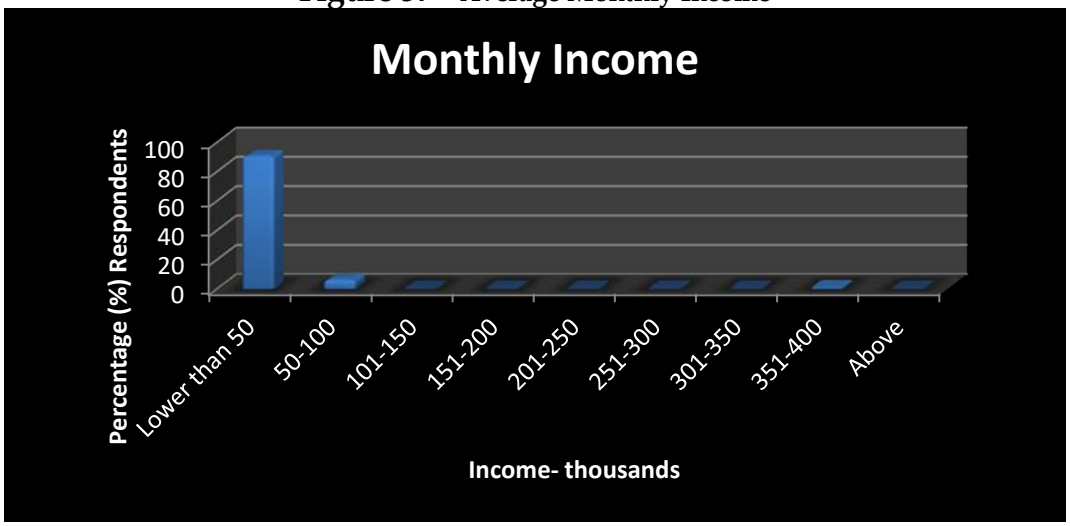


Figure 57 - Average Monthly Income



16.4.1.7.3 Recreation

There is a single playfield in this village which serves as a football and cricket ground and which is used to stage other community/sporting events. The playfied is also used for inter-village competitions. Vendors use areas around the playfied to sell food items and beverages whenever the field is used.

16.4.1.7.4 Education

Maruranau has a nursery and primary school. The nursery school has thirty (30) students aged three (3) to five (5) years of which twenty (20) are boys and ten (10) are girls. The nursery school is staffed by five persons; a head teacher, two teachers, one cleaner and one auxiliary staff. The Primary school has one hundred and sixty-two (206) students; one hundred and fourteen (114) are boys and ninety-two (92) girls and is staffed by seven (7) teachers. There is a primary top class, within the primary school, with students ranging from age (11-14) years. Students who qualify out of this program, taught by the headmaster, join other students above the age of 12 at either Aishalton or Saint Ignitus Secondary school. There is an active hot meal programme which provides lunch five (5) days per week at each school.

16.4.1.7.5 Health Services

The village has one community health centre, which is staffed by a trained Medex, who attends to patients with minor ailments and emergencies. Severe cases which cannot be treated at the health centre are referred to Aishalton or Lethem.

16.4.1.7.6 Water & Sanitation Services

Potable water is obtained from ponds, creeks, wells and by harvesting rain-water. There is no centralized waste management in this village. Individuals dispose of self-generated waste by burning or burying. Pit latrines are used by practically all households.

16.4.1.7.7 Energy

There is no central electrical service provider in this community. Individual villagers self generfate electricity using solar panels, battery and/or generators.

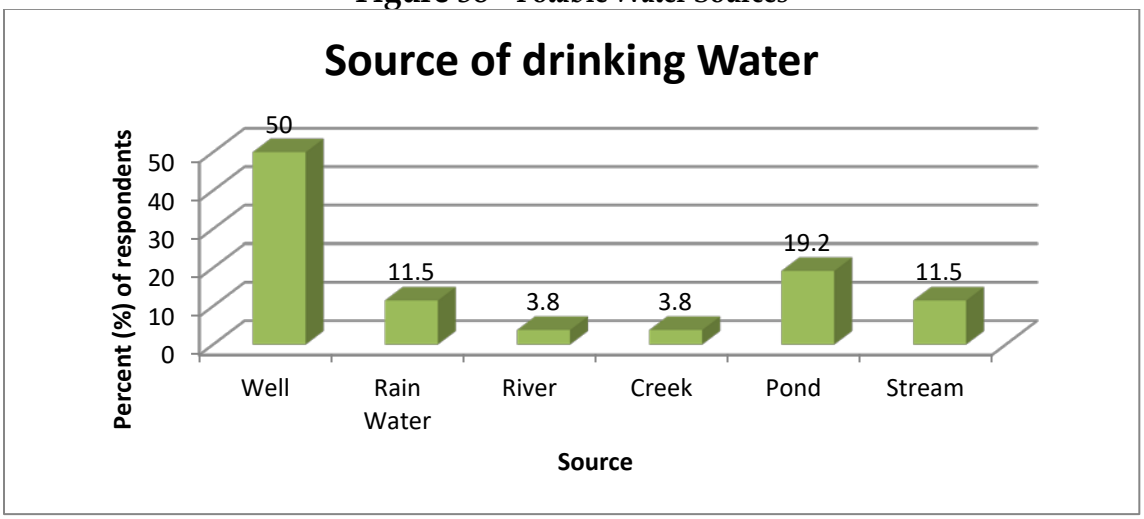
16.4.1.8 Miners

Mining in the Marudi Mountain area is monitored by the Guyana Geology and Mines Commission (GGMC). There are six (6) newly constructed shops and 7 others in various stages of construction approximately 1.6 km from the Concession area northern boundary line along the main access road. The shops were relocated to this area based on an agreement between the miners and RGEL as part of a mediation brokered by the Ministry of Natural Resources. These shops, all attached to dwelling places, serve as hubs for both social and commercial activities around the Marudi Mining Concession. These shops sell alcoholic and non-alcoholic beverages, mining supplies, clothes, spares and food. Several shops also have resident prostitutes who provide services to miners in the area.

There are no power utilities in or around the mining concession. Power is provided to buildings and camps by self-generation using both by gasoline and diesel fueled generators. Telecommunication services are available in the area through the microwave tower at Aishalton, however the signal is intermittent, and this service is not reliable.

Miners and others in areas around the mining concession obtain potable water from wells, ponds, creeks and by harvesting rainwater in tanks. Potable water sources and percentages of individuals utilizing each source are depicted on Figure 58.

Figure 58 - Potable Water Sources



Several miners, in the Project area, were interviewed to obtain information on mining methods and issues of concern related to implementation of the project. Several of the miners interviewed indicate that hammer mills are an integral part of their operation. The other miners employed both land dredging and artisanal mining (pork-knocking). A majority of the miners consulted during the baseline compilation indicated that RGEL demands a 10% tax on lands mined within the concession area. Miners, however, collectively refuse to pay. Miners all recover gold by mercury amalgamation and collectively indicated absence of knowledge of health and safety measures which should be implemented during both mining and gold recovery from amalgam. Further none of the employees are

provided with safety gear such as gloves, respirators or safety goggles. Table 69 document the individauls consulted during the baseline compilation, their locations and activities.

Table 69: Miners Consulted during Field Study

Name	Occupation	Occupational level	GPS Location	Type of ASM
Rawl Johnson	Miner	Operation Owner	21N 0258402 UTM 0245390	Hammer Milling
Timothy Hasan	Miner	Excavator operator	21N 0258402 UTM 0245390	Hammer Milling
Titus Pascal	Miner	Labourer	21N 0258402 UTM 0245390	Hammer Milling
David Brewster	Miner	Manager	21N 0258402 UTM 0245390	Land Dredging
Not stated	Miner	Labourer	21N 0257972 UTM 0245579	Land Dredging
Gilberto Olivera	Miner	Operation owner	21N 0257972 UTM 0245579	Land Dredging
Julian Douglas	Miner	Labourer		Pork knocking
Huzaifah Khan	Miner	Operation owner	21N 0258198 UTM 0245052	Hammer Milling
Gavin Wong	Miner	Manager	21N 0258195 UTM 0245066	Hammer Milling
Leon Matters	Miner	Excavator operator		Pork knocking
Michael Schaffee	Miner	Labourer	21N 0258402 UTM 0245390	Pork knocking
Eaelon Towler	Miner	Labourer		Hammer Milling
Alexis Patrick	Miner	Labourer		Land Dredging
Robert Lourinda	Miner	Labourer		Land Dredging
Dwight Coats	Miner	Operation owner		Land Dredging
Adrian Hamilton	Miner	Labourer		Hammer Milling
Steve Lamb	Miner	Manager		Hammer Milling
Hitram Madin	Miner	Labourer		Land Dredging
Cleveland	Miner	Labourer		Land Dredging

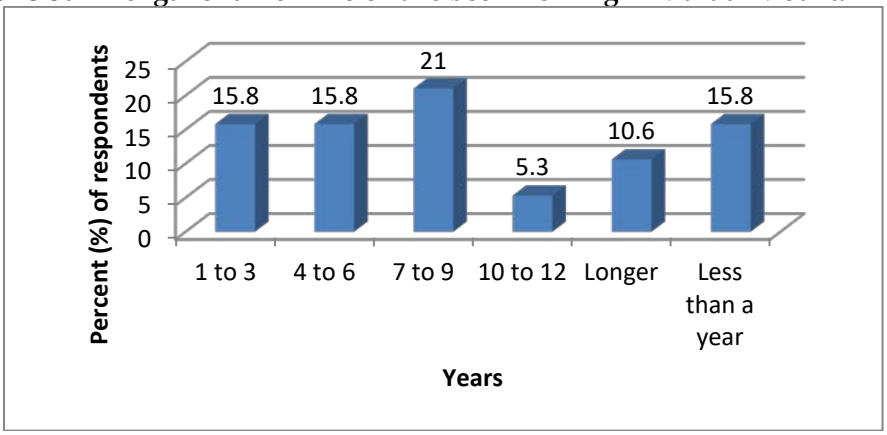
Nine miners, engaged primarily in small and medium scale alluvial mining activities, consulted during the study, are identified in Table 70.

Table 70: List of small and medium scale alluvial miners as of October 2017 provided by Romanex.

Name of Miners	GPS Position	Location	Status of work.
Francisco aka Masafum	0258089 0245460	Locust Creek	Excavator down
Elton Mc Kenzie	0258240 0246574	Pancake creek	Working
Gilberto Olivera aka Bet	0258326 0246574	Locust Creek	Working
Mary Phillip	0259657 0247972	Middle Paunch Creek	Building Reservoir
Jose Fernandez	0259275 0248672	Middle Paunch Creek	Excavator down
Adam De Souza	0258707 0249673	Lower Paunch Creek	Excavator down
Bridgo Gomes	0258674 0249714	Lower Paunch Creek	Marack engine down
Wayne Toney	0258645 0249764	Lower Paunch Creek	Working
Aubery Phoneix	0260668 0246286	Toucan Creek	Working

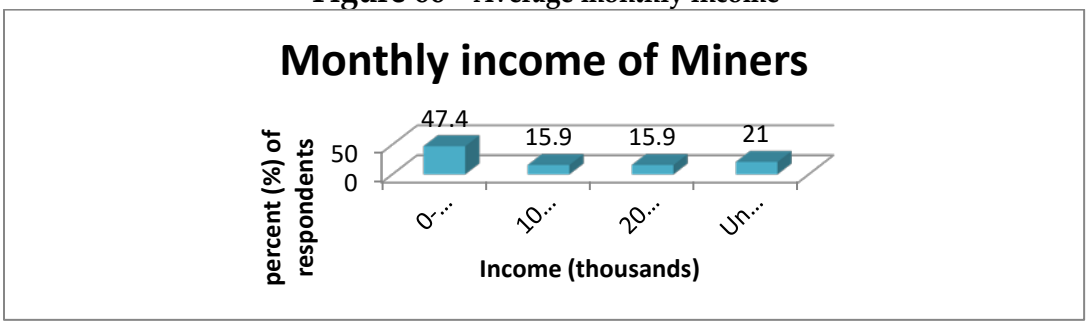
Miners collectively indicated that there has been a reduction in the number of mining operations in the area in the immediate previous 2 years. All persons interviewed have been mining for more than a decade, however, none are formally trained in safe mining practices. Most of the interviewees have worked as miners in this area for less than 10 years, some continuously while have worked others seasonally. Figure 59 shows the number of years individuals have worked in the Marudi Mountain area.

Figure 59 - Length of time miners have been working in Marudi Mountain Area



Gold recovered from the Marudi Mountain area are sold once per month to a gold buyer from Georgetown. Monthly income after expenses ranges up to $250,000.00 and is distributed as shown in Figure 60.

Figure 60 - Average monthly income



The infections most common among members of the mining community are malaria, dengue, typhoid and diarrhea. Health services are provided by the Medex located in Romanex compound. Severe cases are referred to Aishalton or Lethem hospital.

16.4.1.9 Land Use

There are three easily identifiable use classifications in the Marudi Mountain area; logging, mining and housing. The Guyana Forestry Commission and Guyana Geology and Mines Commission are the two primary Government of Guyana agencies providing oversight to forestry and mining respectively. Records available for the area indicate that lands adjoining the concession are held by Erlene Ann Francis, Romel Mc Kenzie and Stephen Lamazon respectively. These areas are held under the jurisdiction of the Guyana Geology and Mines Commission. Several miners have applied to the Guyana Forestry Commission to use their mining blocks as forestry concession.

16.5 Impact Prediction and Evaluation

Potential social changes associated with mining include land use changes, growth inducement, income generation, education and training, capacity strengthening, improvement of public infrastructure, education, health, and welfare, uncontrolled influx of people, disruption of societal organization, loss of traditional values and norms and changes in life style and livelihood. Some of these changes are a direct consequence of project operations; most are not. Some change processes are amenable to management influence; others are not.

There are several current claims for extension of indigenous titled areas in the project area with indigenous groups demanding more lands as part of their traditional and spiritual connection to the land. The Government of Guyana continues to exercise authority over much of the lands where the project is located and has agreed to allocate more land for mining in the area surrounding the project. The conflicting positions of the indigenous groups and the

Government may result in open protests and hostility towards RGEL. RGEL may find itself embroiled in these issues even though its concession was awarded before the request for extension of indigenous lands.

Several members of the communities complained about mining implications to their current livelihood. These complaints included scarcity of wildlife because of noise associated with mining and restriction of access to certain areas of the forest. These impacts are exacerbated by reduced surface water quality and reduced fishes catches because of sediment discharge to waterways around mining areas. Many of the communities are convinced that mining has compromised the quality of water available for use and has resulted in a lessened quality of life and associate mining with release of contaminants into surface water. These beliefs may lead to conflicts if adequate information is not forthcoming from RGEL on its mining operations. These are high impacts (medium-term, high severity, regional extent). RGEL will utilize new equipment rated at noise levels designed by their manufacturers and the gold recovery process will use no chemicals and will be conducted in a closed circuit to minimize discharges to the environment. This will result in low impacts (medium-term, low severity, local extent).

Mining may require withdrawal of water from surface water systems around the project area. This project is located around the head waters of streams within the watershed. Indiscriminate withdrawal of surface water will reduce water availability to points downstream of the project. Water is a critical resource particularly for communities which obtain water from rivers, and creeks. Conflicts may develop between RGEL and communities if water withdrawal for project needs results in water shortages in villages downstream. If RGEL and communities compete for water, especially during prolonged drought periods, communities may become incensed and develop resentment towards RGEl operations. These are high impacts (short-term, high severity, local extent). RGEL will recycle most of the water used in its processing operations. In addition, makeup water will be obtained from well drilled on the project site. This will result in low impacts (short-term, low severity, local extent).

Tension currently existing between artisanal and small-scale miners (ASM) and RGEL over competition for the exact resources may be exacerbated after commencement of mining operations by RGEL. This may lead to confrontation if artisanal and small-scale miners illegally enter the Project area. These are high impacts (medium-term, high severity, local extent). This has been addressed by the ongoing mediation process, initiated and implemented by the Ministry of Natural Resources (MNR). The MNR has committed to providing lands to artisanal and small-scale miners and to ensure that these miners comply with GGMC regulations. This will result in low impacts (short-term, low severity, local extent).

There is the expectation that RGEL will provide employment for the majority of persons who are unemployed in the AOI. However, most persons within the AOI do not possess the technical certification required by a project of this nature. Failure to satisfy this expectation may become a source of conflict. While mining can provide substantial employment opportunities, both directly and indirectly, the cyclical nature of the mining industry can also create challenges for workers in the various communities, as wages and personnel retention are sometimes determined by international gold prices. During periods of economic boom, wages could increase, and the demand for more work force, while in contrast, an economic downturn could result in layoff.

This will be mitigated by giving preference to people from communities within the project AOI for all open jobs. RGEL will also develop training programs for members of these communities to enable them to take up skilled employment. Training programs will include:

- Apprenticeship programs to equip residents with on-the-job experience
- Certification programs offered in conjunction with a technical school or equivalent organization
- University scholarships for community residents to study subjects that would qualify them for managerial and other skilled employment and
- Training partnerships with local or national institutions or government agencies.

If possible RGEL will partner with the local/regional authority to provide the training programs by coordinating skills training or extension programs to help train the local workforce and will also work with government to expand training programs into the area or make them more consistent with the needs of mine site. In addition, RGEL training officer will conduct basic secretarial courses in communities and computer training for employees.

The company will also provide broader training to the communities in bookkeeping, village administration and community organization, all of which provide skills useful for managing local development. RGEL will build local capacity by providing training to develop their local workforce. This training will be designed to equip employees with skills for new responsibilities within the company or to provide general livelihood skills. Employee development programs will include everything from basic literacy and numeracy to training for managerial and other skilled work. This will result in enhancement of the employment opportunities for persons within the AOI and is rated as a high impact (Long-term, moderate enhancement, regional extent).

Community members have expressed expectations related to facilities which RGEL should provide during the project. Residents are likely to demand more as the project progresses and likely to become reliant on RGEL to improve the quality of life of the community. This may result in conflicts with RGEL if these expectations are not met. Conflicts may also develop amongst communities, if one community percieves that another is receiving more resources from RGEL. These are high impacts (short-term, high severity, local extent). These impacts will be mitigated by linking community development with core business activities and will:

- Include community development considerations in corporate strategic planning
- Train and hire local employees
- Subcontract locally and train local suppliers
- Tailor infrastructure to suit community needs
- Involve employees from the outset

The mine site operation will generate local employment, build infrastructure and enhance the tax base of communities within the AOI. RGEL will address these expectations by linking community development with core business activities. RGEL will also make minor adjustments in plans or infrastructure to address community needs and will develop local suppliers of goods and services. The project will systematically link community development needs with core business operations and integrate concerns for development impact into its decision-making processes throughout the mine site operations. RGEL will also make efforts to maximize local employment and purchases and to leverage the core competencies of their businesses to promote community development. These will result in high impacts (medium term, high enhancement, regional extent).

RGEL will develop community programs to target employees and the communities in the project area of influence. Programs geared at HIV/AIDS education and prevention will be developed and implemented to reduce sick time, lower the number of employee deaths and, most importantly, help fight the spread of HIV/AIDS. Additional public health and sanitation programs will also be developed and implemented to reduce the spread of contagious disease, cut company medical costs and reduce sick time for employees and their families. The literacy, numeracy and skills development programs will make for more qualified employees, reduce costs due to employee mistakes and help employees find better jobs or income generating opportunities in the future. These are high impacts (long-term, high enhancement, regional extent).

RGEL will have a positive policy of sourcing products and services locally through subcontracts with local companies. Subcontracting locally will draw on existing resources in the area and expand opportunities for local businesses. RGEL will identify ways to promote local subcontracting while also working to avoid potential dependency of subcontractors on company purchases. Preferences for local businesses as subcontractors will form the first step of this process. These preferences would, however, be linked with mentoring and/or skills development to help local businesses win contracts with other companies in the region and country through assisting in the development of micro-enterprises linked to specific business needs. This policy may encourage community members to start companies to provide catering services, cleaning services, construction services or the production of a variety of products for both the company and other local businesses. RGEL may also offer market research support to help small businesses aim their products at a broader regional market. With skills development and market research, RGEL may transform programs to promote local subcontracting into more sustainable programs designed to build the capacity and promote the competitiveness of local businesses.

RGEL will also develop supplier development programs as a means of maximizing subcontracts to larger local firms by the following:

- Making information on purchasing policies and upcoming contracts available as early as possible to allow local businesses adequate preparation time
- Splitting contracts into smaller pieces to encourage greater local competition
- Shaping contracts to make them compatible with the capabilities of local businesses
- Offering technical assistance and training to local contractors
- Encouraging outside contractors to partner with local businesses when awarding contracts
- Assisting potential contractors in acquiring credit
- Helping local businesses write their company profiles and
- Providing guidance and directing local business owners to sources of management and administrative support services.

RGEL will also promote local contracting and/or skills building and will work to enhance capabilities of local businesses to maximize the local impacts of company purchasing and to equip local businesses to compete in regional and wider markets. RGEL will provide technical assistance, materials and/or financing to local farmers to help them grow crops needed by the company and which the company agrees to purchase. This will create further local employment and improve the incomes of local farmers. These are high impacts (long-term, high enhancement, regional extent).

The project is sited in an isolated area and will require construction of basic infrastructure such as roads, electricity and water supply. RGEL will include communities in early planning stages to help maximize community benefits from company infrastructure. RGEL will also design infrastructure development plans so they not only handle company needs but also make resources available to local communities. These are high impacts (long-term, high enhancement, regional extent).

16.5.1 Induced Development

The project will stimulate economic growth. The mine site development will require a workforce of several hundred people. The project will also provide hundreds of direct and many more indirect employment opportunities. The mine will project the image of wealth and may attract a great number of people seeking jobs to enhance their income and livelihood. The project may recruit workers from coastal areas to fill technical positions. If not effectively managed some of these individuals may move into indigenous communities. Movement of persons from the coast into indigenous communities will have implications for housing, accommodation, wages, and social life. Further increased population induced by migration into these communities will pressures available resources such as water and food and may also pose risks of increased crime. Migration may also generate clashes between culturally diverse groups if there is failure to assimilate. Newcomers may be viewed suspiciously by existing community members and would sometimes be regarded as persons with weak links to communities, and a disruptive influence on local social control, leadership, and life styles. This may alter power dynamics in the communities resulting in changes in traditional socio-economic relations among residents and within family groups. Further there may be disruptions to existing ecosystems and local communities resulting in competition for access to land and natural resources, such as water. In addition, the existing local infrastructure would be insufficient to cope with the increase in population, clean drinking water supplies may be insufficient, there will also be an absence of waste management facilities in addition to inadequate public health and educational facilities. Induced development may easily affect communities that are least prepared for an uncontrolled influx of immigrants and the rapid community changes that may result. These are high impacts (long-term, high severity, regional extent). These impacts will be mitigated by working with local indigenous communities to prevent in-migration. The company will also implement workforce recruitment and accommodation policies in collaboration with indigenous communities and provide on site accommodation for all staff. These mitigation measures will result in low impacts (short-term, low severity, local extent).

16.5.2 Economic Growth and Wealth Distribution

In addition to economic growth stimulation the project may also increase education levels, improve public health and public infrastructure. Mineral wealth is part of the natural capital of Guyana. Exploitation of that natural capital will result in the nation becoming richer (Davis and Tilton 2003). Mineral exports currently provide a significant

share of Guyana's exports. History has however, demonstrated that mineral development does not always boost a country's economic growth (Sideri and Johns 1990; Auty 1990; Ross 2001; Gelb et al. 1988). While the reasons for lack of economic growth in some oil and mineral dependent states are not entirely conclusive (Ross 1999), low levels of employment in the sector, use of mostly imported technology, high market volatility, competition with agricultural sectors and institutional corruption and mismanagement are considered as some of the contributing factors (Sideri and Johns 1990; Gelb et al. 1988; Auty 1990).

The project will provide employment in an otherwise economically marginal areas and jobs are likely to be limited in duration. Communities that come to depend on the mine to sustain their economies would be especially vulnerable to negative impacts when the mine closes. The mine site operations will however raise wage levels, potentially leading to the displacement of some community residents and existing businesses, and elevated expectations (Kuyek and Coumans 2003).

16.6 Environmental Management Plan

16.6.1 Social Management Plan

RGEL will actively discourage influx into the area and not allow outsiders to settle in the periphery of the camp. RGEL will also train its personnel on site to handle influx sensitively without conflict or security issues and would also promote and run health awareness campaigns especially on HIV and STD amongst the workers as well as local close to the project site.

The company will dialogue with the local communities to understand their expectations and create strategies to generate local employment. The company will also promote community development projects that enhance local benefits and which create skills, capacities, improve education, health and infrastructure of the local communities.

RGEL will consult and engage with artisanal miners who come into the concession and will patrol the concession boundaries to manage conflicts with small-scale and artisanal miners.

The company will train and build capacities of the workers and service providers to find economic opportunities with other industries in Guyana.

Since upgrade of the Lethem to Aishalton Road and construction of the new access road may result in increased traffic and safety risks, RGEL will estimate the volume of traffic likely during construction and operations phases and will partner with the regional government and the GGMC to promote safety and reduce risks. The company will conduct driver safety training programs, identify zones of high risks on the roads and will coordinate movement of traffic with other road users to minimize risks.

The operator will recruit unskilled employees, from communities within the project AOI, such as the cook, cleaners and security staff. RGEL will mount training programs and apprenticeships for residents, within the AOI, to boost local labor supply and will promote and reward motivated individuals who successfully graduate from the training programs. The intent is to eventually have fifty percent (50%) of the labor pool be represented by individuals from the communities within the AOI.

The Project will have open days for local suppliers and will maintain a register of local suppliers and the goods these suppliers provide. RGEL will source provisions for its canteen and kitchen from residents, within the AOI, to boost and sustain current indigenous farm practices.

Since the mining operation may deter tourism development in the Marudi Mountain area, RGEL will promote tourism visits to the site and will aid these visitors to interpret the environmental soundness of the operations.

Table 71: Summary of Social Resources Impacts

Project Phase	Impacts		Project Impacts Rating	Mitigation Measures	Impact Rating after Mitigation
Social Resources					
Construction	Reduced quality of life due to reduction in availability of food through migration of animals and fishes from project area	*Source* Noise from equipment operations Discharge of Process wastewater *Vulnerability* Animals in project area Fishes in waterways around project Community residents	Moderate (medium-term, moderate severity, local extent).	Equipment will be operated at noise levels mandated by manufacturers No chemicals will be used for gold recovery Closed circuit operation to minimize discharges to the environment.	Low (medium-term, low severity, local extent).
	Conflicts between communities and mine operator	*Source* Reduced availability of surface water *Vulnerability* Communities downstream of Mine site Plants Animals	High (Long-term, High severity, regional extent).	Water would be recycled Use wells for makeup water	Low (short-term, low severity, local extent).
Construction	**Potential influx into the Area**	*Source* Development of mine Potential employment opportunities Non streamlined recruitment process Local vendors Service providers/Prostitutes *Vulnerability* Pressure on existing resources like land, water, forest use, availability of goods and services Security influx can create security issues and increased crime Influx of people from outside could create health risks to the workers and vice versa. Influx of sex workers often leads to rise in HIV and other STD. Social interaction with other groups is likely to bring about an increase in alcohol and drug abuse, prostitution and crime. Circulation of money from wages and salaries may increase demand for alcohol, drugs and sexual services for migrant and expatriate workers.	High (Long-term, High Severity Regional extent)	Discourage influx into area for employment by having a clearly established hiring policy Conduct information dissemination campaign on hiring practices Undertake disease prevention training. Integrate communicable diseases and STD into fact sheets in H&S training for employees **and** contractors. Make HIV and STD testing and counseling available to workforce, contractors on a voluntary basis. Conduct awareness campaigns on HIV/AIDS for the workforce	Low (short-term, low Severity Regional extent)

Construction	**Increase Traffic and safety risks.**	*Source* Air and overland transport of personnel, construction materials and supplies to mine site. *Vulnerability* Local communities and artisanal miners Equipment and materials being transported Project employees	High (Long-term, High Severity Regional extent)	Enforcement of Traffic Management Plan	Minor (Severity – low; Likelihood – medium)
Construction	**Expectations/ concerns and management of local issues**	*Source* Unaddressed socioeconomic issues in Aishalton and communities in project AOI. The key issues are: Expectations of jobs/opportunities from RGEL. Expectations that project will promote local employment and community development. Benefits associated with mining and dis-benefits of mining such as deforestation or pollution which has historically been their experience. Unemployment and lack of economic opportunities for residents of Aishalton and other surrounding communities; *Vulnerability* Contentment of residents of Aishalton and surrounding communities. Good relations with Aishalton and surrounding communities.	Moderate (Long-term moderate Severity regional extent)	Dialogue with Aishalton and other surrounding communities to understand their expectations Providing employment and other opportunities to residents of Aishalton and other surrounding communities.	Minor (Severity – low; Likelihood – medium)
Construction	**Potential conflicts with artisanal miners**	*Source* Potential for artisanal miners in the area as a result of a developed mine area. *Vulnerability* Security of RGEL workers Good relations with artisanal miners	Moderate (Long-term moderate Severity, local extent)	Consultation with artisanal miners Active patrols of concession boundaries	Minor (Severity – low; Likelihood – medium)
Operation	**Reduction in employment and other induced economic benefits**	*Source* 'Boom and bust' effect. In the construction phase there is high demand for workforce as well as opportunities for local service providers. That demand will reduce in the operations phase. *Vulnerability* Local economy and employment rates Unskilled and semi skilled labor Demand for local goods and services	High (Long-term, High Severity Regional extent)	1. The company will develop sustainable strategies and diversify the skills of its workers and service providers to enable them to find economic opportunities elsewhere in the country. 2. A focused closure plan will be developed to address the issue of economic loss with appropriate mitigation measures.	Minor (Severity – low; Likelihood – medium)

	Increased Local Employment and Infrastructure Improvements	*Source* Mine Site Construction and Operation Infrastructure construction Community farmers	High (medium term, high enhancement, regional extent).	Systematically link community development with business operations integrate concerns for development impact into its decision-making processes Maximization of local employment and purchases Use core competencies to promote community development.	High (medium term, high enhancement, regional extent)
Operation	**Increased Traffic and Safety Risks**	*Source* Upgraded Road to Mine Site *Vulnerability* Trucks/other vehicles carrying equipment along the Road Artisanal miners Company employees	Moderate (Long-term moderate Severity, regional extent)	Partnership with the Government and other road users to enforce Traffic Management Plan.	Minor (Severity – low; Likelihood – medium)

RGEL will also work with communities, within the AOI, to develop a compensatory assisted area package to stem the impact of boom-bust effects related to diminished employment rates after mining at the site ceases.

16.6.2 Employee Health and Safety Plan

During the operation of the facility, emphasis will be placed on providing a safe and healthy environment for the workers. A health and safety plan will be implemented to ensure compliance with the regulations of the OHS Act 1997. Occupational Safety & Health plans will be implemented in the following areas:

- Industrial Accident prevention and management
- Occupational Hygiene
- Illness & Infectious disease prevention and management
- Sewage and Waste Disposal

16.6.2.1 Industrial Accident Prevention and Management

Industrial accident prevention and management will be implemented via the company safety program. This will commence during the construction phase and will last through the closure phase until the cessation of operations. The program will include the following:

- Hazard identification and control
- Monitoring and reporting of industrial accidents
- Training or education of employees in industrial first aid
- Industrial Accident Protocol
- Fire Safety & Preparation and
- Hazard Identification and Control

Table 73 lists potential hazards in different phases of the operations of the facility and the preventative and remedial activities necessary for their elimination and control. In addressing these hazards, the priority will be their elimination via modification in the design of equipment or process. If this is not possible or feasible and the hazard cannot be eliminated, then the employees will be provided with the necessary safety protective gear to prevent any injuries during the work process.

Table 73: Potential Hazards

Phase	Potential hazard	Protective & preventative Safety measures
1.Clearing of Site & Construction of Living Quarters: felling trees removal of topsoil & overlying vegetation assembly of building assembly of generating plant	Insect Bites Snake Bites Minor Trauma to Extremities Lacerations from use of sharp tools	Use of insect repellants Provision of snake bite kits Use of safety shoes & gloves
2.Excavation of Ore	Fugitive dust blown into eyes Inhalation of fugitive dusts High noise levels from working of heavy duty vehicles – trucks, tractors etc.	Use of clear goggles Use of dust/mist respirators Use of air plugs
3. Smelting of ore in furnaces	High temperatures	Use of heat resistant aprons/

	Minor burns to extremities	overalls Use of heat resistant gloves
4. Operation of Power generating plant	High noise levels High noise levels	Use of air muffs, Wearing of air plugs
5. Maintenance shop operations	Contact dermatitis skin irritation from exposure to grease High noise levels	Use of barrier creams & detergents on hands Use of air plugs
6. Chemical Exposure	Ingestion	Use of respirators, clear goggles, protective gloves, coveralls, washing before eating, drinking or smoking.
7. Onsite and Offsite Spill	Discharge to Groundwater Discharge to Surface water	Containment around storage areas Monitoring discharges Communication with impacted areas

Hazard identification and reporting will constitute an ongoing activity in which the employees' participation will be considered an integral part of his work functions. The OHS Act 1997 clearly stipulates the responsibilities of employees and supervisor/management in this regard. In accordance with those regulations the supervisor/manager will do the following:

- Inspect all machines and equipment for the existence of potential hazards and ensure that they are in working order
- Inform the worker of any hazards present
- Instruct the employee in the correct safe work procedure to prevent injuries and ensure that those instructions are followed
- Provide the necessary safety protective gear when required.

In accordance with OSH Act 1997 employees will be authorized to do the following:

- Cease work once a hazard is perceived
- Report the hazard to the supervisor who will in company with the safety representative inspect the condition or circumstance and determine its validity
- Obey the instruction to perform alternative work or cease work completely as directed by the supervisor
- Return to the workstation or proceed once the hazard has been adequately dealt with or eliminated

16.6.2.2 Hazard Monitoring and Reporting

The Safety Representative, elected from among the workers, will monitor hazards and work conditions. He will do the following:

- Perform Safety Inspections of operations on a regular and programmed basis (at least once per month) for the detection of unsafe conditions or any potential hazards and report these hazards to management
- Record all minor and loss time accidents in a ledger as required by the Ministry of Labor (Table 74 shows the format to be used for recording industrial accidents)
- Remit reports of industrial accidents or fatalities to the Ministry of Labor when required

Table 74: Accident Report Format

Personal injury Equipment damage
Name of person involved Dept/Area
Name of injury
Place of injury
Description of accident
Type of accident: Loss Time Minor
Foreman Signature……
Diagnosis……
Remarks…….

In addition to the abovementioned, all employees will be educated about their responsibility to participate in the creation of a healthy and safe environment by:

- reporting unsafe and hazardous conditions when detected
- performing work in a safe manner by following the correct work procedure.

16.6.2.3 Training & Education of Employees

The company will run periodic training program in:

- Basic first aid programs (all employees)
- Advanced first aid programs
- Accident investigation & reporting seminars (supervisory personnel & safety reps.)

The basic first aid program will be extended to all employees and would be geared to ensure that in the event of an accident or injury someone with first aid knowledge will always be present to render initial assistance until further medical attention can be made available. Qualified personnel will run seminars to impart the necessary theoretical as well as practical skills required. These courses will be scheduled depending on employee strength and attrition.

The advanced first aid program will constitute an upgrading course from the basic first aid program in which selected employees including supervisors and the Safety representative will be exposed to advanced first aid knowledge and techniques which will enable them to participate in the recognition and the initial management of serious injuries and illnesses e.g. Fractures, Spinal Injuries, Malaria, Typhoid fever etc.

16.6.2.4 Industrial Accident Protocol

Serious injuries will be referred to a medical practitioner and medical institution. The medical institution and practitioner will preferably be chosen from Aishalton and contact will be maintained by radio/radiophone always. In the event of an industrial accident the following protocol will be followed:

- A basic first aider will be summoned if not already present at the scene of accident
- The basic first aider will render first aid care
- The basic first aider will summon a certified medex who will administer further care if necessary and evaluate the necessity for removal to the first aid centre
- The certified medex will summon the vehicle specifically identified for this purpose and supervise the removal of the injured to the first aid station
- The employee's immediate supervisor will be informed. He will:
    - Make contact with the identified medical Practitioner and Institution and inform them of the time of arrival of the injured employee
    - Complete the accident form and forward same along with the injured to the medical institution for completion by medical practitioner

- Inform the Safety representative who will record the accident in the Industrial accident register.

A vehicle will always be available to respond to accidents. That vehicle will be equipped with four-wheel drive and will have the following equipment:

- oxygen cylinder and gas masks resuscitation equipment
- a bed and accommodation for a first aid attendant to sit alongside the injured
- a flashing light attached to warn other road users
- communication equipment.

16.6.2.5 Occupational Hygiene

The main environmental occupational hazards to which employees will be exposed during the operations phase of the mining entity are:

Dust
Noise
Heat
Fumes

16.6.2.6 Dust Exposure

The following measures will be implemented to decrease or eliminate respirable dust inhalation and prevent any adverse effects on workers:

- Provision of dust respirator with filters to employees exposed during the excavation and transportation of ore
- Siting of living quarters a convenient distance from the operations site and on the leeward side of same
- Minimal denudation of vegetation around campsite
- Chest X-Rays of all employees once yearly in order to detect any incipient pulmonary disease such as persistent coughing and/or shortness of breath.

These measures will assist in elimination or reduce further the very low risk of the development of lung impregnated disease by employees exposed to dust.

Workers in the excavation and transportation phases of the operations would be exposed to wind blown/fugitive dust being blown into the eyes and causing eye irritation and conjunctivitis. These employees will be provided with clear goggles and eye wash lotion will always be available for washing the affected eyes.

16.6.2.7 Noise

The following measures will be implemented to address worker health and safety related to noise associated with the operation:

1. Control of noise levels at source via installation of silencers on exhaust system of power generating plant
2. Provision of hearing protection to employees exposed to high noise levels: ear muffs for employees in the maintenance shops and generating plant areas
3. Earplugs for employees who operate heavy-duty machines
4. Siting of power generating plant and mining operations in locations away from the living quarters of employees
5. Warning signs in areas of high noise levels instructing employees to wear earmuffs or earplugs as required
6. Hearing conservation program for employees exposed to noise. This will consist of:

- Audiological examination before employment to establish baseline hearing capacity on initiation of employment
- Yearly audiological testing of employees exposed to high noise levels
- Acquisition of a portable sound level meter
- Measurement of sound levels in instances where it is suspected that deviations from the previous levels are occurring.

16.6.2.8 Heat

Measures to decrease the effect of increased exposure to heat will include:

- Measurement of ambient temperature levels in vicinity of generating plants
- Provision of heat shields - coating of surface of generating plant by high reflective material such as polished aluminum.

16.6.2.9 Food and Water Safety

Food and water will be provided by the mine site operator to employees. No sales of food or beverages will be permitted by vendors etc. within the mine site. A condition of employment will forbid purchasing of food, beverages etc from vendors. All food including both raw and refrigerated foods will be stored in accordance with guidelines provided by the Environmental Health Unit of the Ministry of Health. Redundancy will be provided for storage of refrigerated goods to ensure capacity exists in the event of damage or loss of any unit. All waste generated by the operation will be disposed in accordance with the Waste Management Plan.

A vector control program will be implemented over the duration of the project. Should an outbreak of flies occur, an insect exterminator would be used to control the flies at the source. Uncovered and available food wastes will not be permitted, to minimize the development of any rodent populations. Should an outbreak of rodents or other vermin occur within the area, the vermin will be exterminated by a licenced exterminator in a manner that is appropriate for the vermin in question.

All water for drinking purposes will be imported to the site from acceptable and certified drinking water sources. If groundwater is utilized for drinking water, it would be treated by chlorination and filtration to acceptable quality for potable water use. Samples of drinking water will be tested at the Government Analyst Department to ensure it conforms to drinking water standards.

16.6.2.10 Vector Control

Water in tailing and water management ponds may favor the multiplication of waterborne disease vectors such as flies, mosquitoes and other parasites and the introduction of new ones.

Pesticides that are non-toxic to humans, fish and livestock will be used for habitat and vector control. A body will be established to provide health advisory and support health services and to monitor disease vector and disease incidences.

16.7 Monitoring Plan

Since dissemination of inaccurate information on the operations can potentially generate animosity between communities in proximity to the operations, the GGMC and the Operator, a committee comprised of representatives of each community, the GGMC and RGEL will be established to provide ongoing monitoring to respond to concerns that arise in communities witin the OAI. This committee will meet quarterly or with greater frequency if circumstances dictate, to discuss issues and concerns related to the interaction of the mine and the communities. At a minimum the committee will conduct periodic stakeholder and mine management reviews. The stakeholder review will entail continuous monitoring and review of the mining operations to identify new or evolving issues.

Communities will be encouraged to report instances of infractions of the norms of indigenous society by mine site personnel and to sensitize mine site personnel to these norms. Results of environmental monitoring will be made available for review by members of adjacent communities. Members will also be informed of all incidents during operations that do not conform to sound environmental practice and specified operational environmental standards as set forth in the management, emergency response and Health and Safety plans, and of management measures implemented to prevent or remedy such occurrences and to counter their reoccurrence. Reports will be issued quarterly or upon occurrence of a violation and will be publicly and easily available from RGEL upon request.

17.0 RISKS AND RISKS MANAGEMENT

Risk is defined as exposure to the possibility of damage to humans and the natural environment because of the uncertainty associated with pursuing a course of action, in this instance the construction, operation and closure of a mine site operation in the Marudi Mountain concession.

Risk results from hazards or hazardous events. A hazard is the inherent property of an object to create damage to humans or the environment. These objects can be inherently dangerous and exposure to them can cause injury, health problems or loss of environmental quality. Hazards are both naturally occurring and created by man. Hazards may cause harm over a period through long-term exposure typically to toxic chemicals and may cause harm to humans through extended exposure at relatively low levels. These can be considered chronic hazards.

17.1 Policy, Legislative and Regulatory Framework

Guyana Environmental Protection Agency, Environmenetal Impact Assessment Guidelines Volume 3 Mining mandates that the Environmental Impact Assessment detail "a description of any hazards or dangers which may arise from the project and an assessment of the risk to the environment." It also mandates that the document "Include a review of material characteristics and hazards, credible and worst-case scenarios, evaluation of hazards and risks, potential impacts and mitigation, potential liabilities, notification plans and response plans."

United Nations Environment Programme Division of Technology, Industry and Economics document APELL for Mining, Guidance for the Mining Industry in Raising Awareness and Preparedness for Emergencies at Local Level, Section 5, Mining Hazards and Risks, Application of APELL in chronic impact situations, identifies the major risks of mine site operations to be as follows:

- Tailings dam failures - risks from tailings dams have drawn particular attention recently, following vivid media coverage of several serious accidents that have impacted communities and the environment

- Waste dumps - Waste rock dumps constitute another physical risk at mine sites. They are often major structures, consisting of large quantities of overburden or rock containing sub-economic levels of minerals. While some rock may be used in the construction of embankments, roads and even tailings dams, high stripping ratios in open pits mean that very large quantities of waste rock may be generated to produce a small quantity of metal or concentrate. Steep terrain and/or high dumps often result in dumps having very long slopes at the angle of repose for the particular material

- Transport to and from the site/loading - The mining industry is a heavy user of road, rail, sea and in some places helicopter transport, usually over long distances, to bring inputs to sites and to remove products, by-products and wastes. In fact, much of the industry's business concerns transport and handling of very large quantities of material on and off-site—most of it non-hazardous. Considerable quantities of hazardous materials are also transported in many places by the company itself, in other places by suppliers or specialist transport companies

- Pipeline failure - Pipelines carrying tailings, concentrate, fuel, or chemicals frequently traverse long distances, perhaps between parts of a large mine site or across public land. Facilities such as processing plants or heap leach pads may be several kilometres from the mine itself, and waste disposal facilities such as tailings dams may be further away, particularly in mountainous terrain. This may mean that the mine site is extensive, or consist of several small areas with pipelines, as well as haul roads, between them. Pipeline rupture is a relatively frequent event, rapidly spilling large quantities of materials. This may go undetected for some time and as secondary retention structures are not always provided, released substances enter the environment

- Spills of chemicals - Fuels and chemicals used at mining and metallurgical sites are often hazardous in nature, and may be toxic to humans and animals or plants. Virtually all are also in common use in other

industries. A relatively small number of chemicals is widely used in the industry in large quantities, and the risks associated with these are well known

- Fires and explosions - Explosives are widely stored and used at mine sites. ANFO is normally mixed at the drill hole. It is shipped as two components: ammonium nitrate (fertilizer) and fuel oil (diesel) both of which are significantly less hazardous than ANFO. Explosives are normally well controlled and stored in safe conditions in magazines which may be operated by the company or a contractor. As noted above, other flammable substances such as fuel (diesel, petrol and kerosene), and sometimes liquefied petroleum gas (LPG) are also transported and stored in large quantities, as are chemicals such as solvents, ammonia, sulphur and relatively smaller quantities of process reagents

17.2 Landslide of Tailings Management and Waste Dump Facilities

The tailings management area, water management pond and waste dumps all present threats to the environment. These threats will be manifested if there is a failure of any one of these facilities. These facilities may be subjected to slope (landslide) and foundation failures. Slope failure of the access road and/or haul road may impact the efficient functioning of mine site operations and may even result in temporary closure of mining operations.

The landslide risk assessment was conducted based on the qualitative terminology depicted in Table 75 (Lee & Jones, 2004).

Table 75: Landslide Risk Assessment – Qualitative Terminology

Qualitative Measures of Likelihood			
Level	**Descriptor**	**Description**	**Indicative Annual Probability**
A	Almost Certain	The event is expected to occur	>= 10^{-1}
B	Likely	The event will probably occur under adverse circumstances	=10^{-2}
C	Possible	The event could occur under adverse circumstances	=10^{-3}
D	Unlikely	The event might occur under adverse circumstances	=10^{-4}
E	Rare	The event is conceivable but only under exceptional circumstances	=10^{-5}
F	Not Credible	The event is inconceivable or fanciful	=10^{-6}

Qualitative Measures of Consequences to Property		
Level	**Descriptor**	**Description**
1	Catastrophic	Structure completely destroyed or large-scale damage requiring major engineering works for stabilization
2	Major	Extensive damage to most of structure or extending beyond site boundaries and requiring significant stabilization works
3	Medium	Moderate damage to some of structure or significant part of site requiring large stabilization works
4	Minor	Limited damage to part of structure or part of site requiring some reinstatement/stabilization works
5	Insignificant	Little damage

Qualitative Risk Analyses Matrix – Level of Risk to Property					
Likelihood	**Consequences to Property**				
	Catastrophic	**Major**	**Medium**	**Minor**	**Insignificant**
A – Almost Certain	VH	VH	H	H	M
B – Likely	VH	H	H	M	M – L
C – Possible	H	H	M	L – M	VL – L
D – Unlikely	M – H	M	L – M	VL – L	VL
E – Rare	M – L	L – M	VL – L	VL	VL
F - Not Credible	VL	VL	VL	VL	VL

Risk Level Implications		
Risk Level		**Implications**
VH	Very High Risk	Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risks to acceptable levels, may be too expensive and not practical
H	High Risk	Detailed investigation, planning and implementation of treatment options required to reduce risks to acceptable levels
M	Moderate Risk	Tolerable provided treatment plan is implemented to maintain or reduce risks. May be accepted. May require investigation and planning of treatment options
L	Low Risk	Usually accepted. Treatment requirements and responsibility to be defined to maintain or reduce risks.
VL	Very Low Risk	Acceptable, manage by normal slope maintenance procedures

The factors which will contribute to high risks of slope failure are as follows:

- Pronounced increases in porewater pressures in the foundation soils of the tailings and/or water managment ponds or waste dumps
- Unsustainably steep slopes in the mine and ramp access and on the site and haul roads
- Development of highly saturated soil conditions on the tailings dams slopes, waste (spoil) piles, stock piles and water management pond(s).

Slope stability failure can be triggered by one or a combination of these factors.

Risks of slope failure of the mine site facilities will be reduced by undertaking geotechnical investigations and analyses for design of these facilities. The geotechnical investigations will generate data which will be used to design the open pit slopes, mine access ramp, tailings and water management ponds and waste dumps. Slope stability analysis will consider the likelihood of slopes being saturated during the wet season.

Analyses of conceptual slope profiles for all mine site earth structure facilities will consider the following failure modes:

- rotational and block failures of the slopes
- foundation failure of slopes
- piping failure of the slopes

The analyses will examine both short and long-term load conditions for all slope configurations. Flow nets or an appropriate numerical method will be used to estimate seepage direction and volumes and pore pressures at points within each cross-section.

Analyses for all facilities considered likely to be endangered by slope failure, will examine rotational and block failures of the slopes. The assessment of mine access ramp stability will incorporate consequences associated with soil unloading. Allowances will also be made during the analyses for rises in groundwater levels in the slopes associated with flooded conditions at the base of the slope.

An extensive program of rock coring will be undertaken for development of the mine pits. The coring and the associated laboratory testing programs will develop data on rock parameters for design of that section of the open pit founded in rock. Geologic mapping will be conducted during excavation of the open pit in rock. The open pit will be designed to prevent failure planes from 'daylighting' into the cut, thus reducing the likelihood of wedge failures in the open pit.

Geotechnical investigations and analyses will also be conducted in areas identified as ore stock piles and for spoil pile locations, if outside the open pit footprint. The parameters generated by the geotechnical investigations will be

used to assess the foundation stability and slope stability for these facilities. The analyses will consider both short and long-term load conditions.

Monitoring and preventive maintenance would be undertaken to identify potential slope instability areas. Through careful monitoring, areas of concern will be noted and would be quickly repaired, to prevent slope failure. Monitoring will consist of visual observation of the slopes and the monitoring of piezometers, slope indicators and other instrumentation installed to assess the performance of these facilities.

Monitoring will also be made after the occurrence of unusual conditions such as heavy surface runoff or peak floods. The frequency of monitoring will be more pronounced during and immediately after construction and during the wet seasons. Preventive maintenance will be undertaken at all potential trouble spots observed during visual inspection. Preventative maintenance will consist of work on critical slope areas to reduce the forces which will result in slope instability.

Visual monitoring will be done to identify typical distress signals associated with slope failure, such as cracks at the crest of the slope, devegetation of the slope, wet spots on the downstream face of the slope, and critical settlement inwards of the slope crest. The visual observations will be supplemented by instrumentation to enable an accurate interpretation of the extent of any problems likely to occur. Instrumentation inclusive of piezometers, settlement plates and inclinometers will be used to show developing trends in the slopes and embankments.

Instrumentation would be installed in the tailing and water management ponds embankment and foundation to monitor changes which are critical to the structures stability, and to predict unstable conditions. Instruments will be installed to measure pore water pressures, seepage flows and embankment movements. Pore water pressures in soils will be measured with piezometers. Seepage flow emerging downstream from the embankment will be collected and directed to a weir for flow measurements. Seepage flows will be used to indicate when significant changes occur and to permit an evaluation of potential problems from piping.

Markers will be installed on the embankment crest, of the tailing and water management ponds, and would be aligned in a straight line-of-sight to permit rapid detection of horizontal movement during surveys. In instances where cracks are visible on the embankment surface, successive measurements between two stakes spaced either side of the crack will indicate any widening and acceleration in separation rate.

Slope indicators will be used, on all slopes, to measure horizontal movement. Slope settlements will be measured by leveling of temporary benchmarks.

Implementation of the design and monitoring program detailed above will ensure that slope instability is unlikely to develop, with slope instability problems likely to develop only under adverse conditions. If slope instability does develop, damage would be minor and would be limited to small areas. The slope instability would be easily corrected by the utilization of available construction techniques. The risk of slope instability would therefore be low and the design and monitoring program outlined would be adequate to manage that risk.

17.2.1 Seismic Risk Assessment

Geological features indicating the likelihood of a seismic event include the following (Kramer, 1996):

- Fracture surfaces and indicators of fracturing directly evident at ground surface inclusive of disruption of the ground surface and evidence of the movement and grinding of the two sides of a fault (slickensides, fault gouge, and fault breccia)
- Geologically mappable indicators including juxtaposition of dissimilar materials, missing or repeated strata and the truncation of strata or structures
- Topographic and geomorphic indicators including topographic scarps or triangular facets on ridges, offset streams or drainage, tilting or changes in elevation of terraces or shorelines, sag ponds and anomalous stream gradients

- Secondary geologic features inclusive of abrupt changes in groundwater levels, gradients, and chemical composition, alignment of springs or volcanic vents and the presence of hot springs
- Geophysical indicators of subsurface faulting such as steep linear gravity or magnetic gradients, differences in seismic wave velocities, and offset of seismic reflection horizons
- Geodetic indicators such as fault movement appearing in geodetic surveys as tilting and changes in the distance between fixed points

Fieldwork for the mine site area was done primarily to determine the biodiversity of the area. While a detailed examination was not conducted to discern the features detailed above, fieldwork has not detected the occurrence of any of the features indicative of the likelihood of a seismic event.

An earthquake event was recorded for Guyana, in 1964, at a point defined by 2.64° North and 59.62° West at a depth of 50 km and with a magnitude of 4.50. Additionally, as can be inferred from Figure 17, a second event occurred almost immediately west of that point in Brazil at a point defined by 2.68° North and 60.12° West. The depth of that event was not recorded. The magnitude of that event was reported as being 4.90. Strong ground motion information for Guyana from the Caribbean Disaster Management Program has also indicated the possible occurrence of horizontal ground acceleration of 45 - 70 cm/sec^2 due to an earthquake event elsewhere.

This acceleration, while quite low can result in liquefaction of the sands present at shallow depths at the project site. The integrity of structures can be compromised if the sand liquefies during an earthquake event. The geotechnical analyses will consequently examine the liquefaction susceptibility of sands at the project site. If the probability of liquefaction is estimated to be unacceptable, a program of work will be undertaken to either increase the density of the sand or to provide a mechanism for rapid drainage during a likely earthquake event.

Based on the information above the risk of failure occurring due to a seismic event is very low.

17.3 Transport and Chemical Spill Failures

Spills of chemicals and subsequent discharge to the environment will pose threats to the environment during all phases of the project. RGEL will follow the Good International Industry Practice (GIIP) to the maximum extent possible. GIIP techniques will be adopted to minimize the risk of environmental damage from accidental chemicals release. The main goals of the GIIP will be to:

- Minimize the amounts of chemicals used for gold recovery
- monitor all operations and discharges to the environment to detect any escape of chemicals and subsequent impacts of that release
- ensure a full understanding of the actual and potential hazards and environmental impacts of chemicals use
- maximize the recovery of chemicals used in mineral processing
- construct physical containment facilities to control spills or leaks of chemicals
- dispose of chemicals in a way that minimizes environmental impacts and
- keep adequate records of chemicals use.

Clear responsibility will be established for all phases of chemicals use, including transportation, storage, use and disposal.

17.3.1 Transport

Transport of chemicals will be performed to ensure protection of all communities and the environment during transport. Clear lines of responsibility will be established for all aspects of transport including the safety, security, release prevention, personnel training and emergency response procedures in event of unplanned releases. The mines manager will identify personnel responsible for each aspect of chemical transport. The transport phases will include as follows:

- packaging & labeling
- storage and security at port of entry
- transport to the operation
- unloading at the operation
- safety training
- security during transport
- emergency response during transport.

The Emergency Response Plan addresses spill response during transport to the site. All personnel involved in chemicals transport would be trained prior to the commencement of operations and would also be given periodic refresher training in the use of the equipment and in the implementation of the Emergency Response Plan.

Warning signs will be posted on all transport equipment alerting workers of the presence of chemicals and that smoking, open flames, eating and drinking are prohibited. In addition, workers will be required to wear chemical specific personal protective equipment. Security measures, such as lockouts on valves and fenced and locked storage of solids, would be provided at all transshipment points and at interim storage sites.

Storage of both solid and liquid chemicals would be separate from incompatible materials such as acids, strong oxidizers and explosives. Storage facilities will have spill containment capacity at least equal to 120% of the volume of the stored liquid and personal protective equipment and clean-up materials appropriate for the type and amount of chemicals stored would be provided at all storage locations.

High-risk sections of the route to the site, such as river and stream crossing and areas of highly pervious soil, would be identified and evaluated to determine the need for special precautions in these areas. Communities in the area will be consulted and all applicable governmental/EPA transportation related procedures. Emergency response procedures would be developed to prevent and respond to any releases during chemicals transport.

The company road safety program for all chemicals transport vehicles will include, but will not be limited to, vehicle and tire inspections, preventive maintenance, limitations on drivers' hours, tie-down procedures for solids, and procedures by which transportation can be suspended if severe weather conditions are encountered. Vehicle operators will retain records to document that these activities have been conducted. The company will also implement inventory and/or chain of custody documentation procedures to identify the loss of any chemicals material during transport.

All transport vehicles will be provided with emergency communications capability to ensure timely communication. Any spills/releases will be immediately reported to the Mines Manager who will immediately inform all potentially impacted communities, relevant government agencies and the company's designated emergency response team.

17.3.2 Handling and Storage

The company will design and construct unloading, storage and mixing facilities in accordance with GIIP and will employ quality control/quality assurance procedures and spill prevention and containment measures to protect workers and the environment during chemicals handling and storage.

All unloading and storage areas for liquid and solid chemicals would be located away from people and surface waters. Where this is not practicable, the potential for release to surface water and/or human exposure associated with the storage location would be evaluated and the operation would implement protective measures to prevent or minimize these potentials.

Unloading of all chemicals would be done on a concrete surface that can prevent leaks from contacting the environment. An automatic level indicator, high-level alarm, or integrated tank and tanker valve-shutdown device will be provided on all chemicals storage tanks to prevent overfilling. Direct observation of tank levels or use of a manual gauging rod would be done to prevent overfilling of chemicals storage tanks.

Storage areas for chemicals would be well ventilated. Measures would be put in place to minimize the potential for contact of chemicals with water. These measures will include storage in covered enclosures and off the ground or in secure containers.

The public and workers not directly involved in chemicals operations will be prohibited from accessing chemicals storage areas by a fenced boundary or by storing chemicals within a separate fenced and locked area of the plant. Chemicals would be stored separately from incompatible materials. Chemicals storage and mixing tanks would be located on a concrete surface to prevent seepage to the subsurface. Secondary containment would be employed to contain releases from these tanks as well as any precipitation that may encounter chemicals. Secondary containment used for this purpose would be constructed of concrete, plastic or other materials demonstrated to provide a competent barrier to leakage. All containment will be sized to hold 120 % of the volume of the largest tank within the containment and any piping that drains back into the containment.

Chemicals-specific first aid and emergency response equipment would be readily available for use at unloading, storage and mixing location, including oxygen and a resuscitator and appropriate personal protective equipment. An antidote for chemicals poisoning will also be available. Workers involved with unloading, storage and mixing of chemicals would be trained in the use of emergency rescue equipment and in the first aid procedures for responding to chemicals exposures.

Spill neutralization and clean-up equipment would be available for use at unloading, storage and mixing locations. This will include water for cleaning spills of liquid chemicals, shovels for cleaning up spills of solid chemicals, and chemicals to treat or neutralize chemicals and chemicals-contaminated soils, as well as chemical specific personal protective equipment. Personnel engaged in unloading, storage and mixing activities would be trained in the operation procedures to respond to chemicals spills, including notifications, clean up and detoxification.
Empty chemicals containers would not be reused on or off the mine site for any purpose other than holding chemicals.

17.3.3 Operations

All chemicals related facilities would be inspected on an established frequency sufficient to assure and document that they are functioning within design parameters. Tanks holding process solutions would be inspected for structural integrity and signs of corrosion and leakage. Secondary containments would be inspected for their integrity, the presence of fluids and their available capacity, and to assure that drains are closed and, if necessary, locked, to prevent accidental releases to the environment. Leak detection and collection systems at ponds would be inspected as required. Ponds would be periodically inspected to ensure available freeboard and the integrity of embankment.

Facility inspections would be documented on inspection forms and in log books and would include the date of the inspection, the name of the inspector, and any observed deficiencies. The nature and date of corrective actions also would be documented.

Preventive maintenance programs would be implemented to assure the continuous functioning of equipment and devices that are necessary for chemicals management. The operation would have a source of emergency power for pumps and other equipment when their primary power supply is interrupted to prevent unintentional chemicals releases and worker exposures. Back-up power generating equipment would be maintained and tested to ensure its availability if needed.

Unintentional releases will be prevented by maintaining adequate freeboard in tailings storage facilities. All facilities will be inspected and monitored to determine the accuracy of the water balance and to assure the facilities operates as designed. This will prevent an over-accumulation of water that can result in overtopping, unplanned discharge into the environment, and potential structural failure of the facility.

Tanks holding process solutions would be located on concrete to restrict seepage of spilled solution or leakage to the subsurface. Secondary containment would be provided for a potential failure of chemicals process solution

tanks, with provisions for recovery of released solution such that adverse impacts on surface or ground water are prevented.

Facilities for the management of chemicals would be constructed according to accepted engineering standards and specifications. Quality control and quality assurance programs would be implemented during construction of new facilities and modifications to existing facilities to assure their structural integrity and their ability to safely contain process solutions and solids.

The quality control and quality assurance program would address the suitability of the materials of construction and the adequacy of soil compaction for earthworks such as tank foundations and earthen liners. Quality control and quality assurance procedures would also be implemented for installation of synthetic membrane liners used in ponds, for pipes, pipe fittings, for welds and bolts on chemicals storage and process tanks, and for any other equipment containing chemicals. Records would be retained to document that the specified quality control and quality assurance procedures have been followed.

All storage areas will be bunded and will be located well away from natural drainage channels. Chemicals will be stored separately from corrosive, acidic and explosive materials. The storage area will be fenced and locked to prevent accidental entry or access by unauthorized individuals. The storage area will also be designed to be fire resistant and will be provided with adequate fire fighting capability. In addition, all vegetation will be cleared from the storage area to decrease the likelihood of fires.

An inventory will be maintained of all quantities stored and any loss will be immediately reported to the mines manager and to GGMC. The company will deploy a system to enable rapid determination of chemicals concentration in any waste water discharged from the site.

17.3.4 Worker Safety

Operators undertaking operations involving chemicals use will wear appropriate protective clothing. For respirable forms of chemicals, a full-face respirator would be worn. Since chemicals can be absorbed through skin, for liquid chemicals, workers would wear disposable coveralls, PVC gloves and waterproof boots. Workers will wash their hands before eating, drinking or smoking. Contaminated protective gear and clothing would be securely discarded or washed before being stored and re-used.

Should anyone be exposed to chemicals, effective and timely medical care will be provided. All personnel would be required to be familiar with the treatment procedures for personnel affected by chemicals exposure. All workers involved in chemicals handling would be trained to understand the hazards associated with chemicals use. Workers will also be trained to operate the facility according to systems and procedures that protect human health, the community and the environment. Training will also be provided to workers to respond to both worker exposures and environmental releases of chemicals

17.4 Pipeline Failures

Rupture of process pipelines pose threats of discharges to the environment. Pipelines would be constructed or coated with materials that are compatible with chemicals. Tanks and pipelines would be clearly identified as containing chemicals. The direction of flow would also be indicated on pipelines. Pipelines, pumps, valves and tanks would be inspected at least once monthly for evidence of leakage, presence of solution in secondary containments and integrity of the containment. Deficiencies would be noted and records would be retained documenting the inspection and the implementation of necessary corrective measures. Pipelines, pumps and valves would be inspected for deterioration and leakage. Pumps, pipelines, and chemicals treatment, destruction and regeneration equipment would be regularly maintained so that failures do not result in worker exposure or releases to the environment. Preventive maintenance activities would be documented.

Spill prevention or containment measures would be provided for pipelines transporting process solution. These measures will include secondary containment ditches, differential pressure sensing with alarms and/or automatic shutoff systems, or preventive maintenance programs with pipe thickness measurements. Tanks and pipelines

would be clearly identified as containing chemicals. Quality control and quality assurance procedures would also be implemented for installation of synthetic membrane liners used for pipes and pipe fittings.

17.5 Flood Risks

The project is in a tropical area with high annual precipitation and intense rainfall events. Various elements of the proposed mine infrastructure will be subjected to flooding risks. However, the open pit and the tailings ponds are of special concern.

17.5.1 Open Pit

Flood risks associated with the proposed Open Pit will be mainly generated by runoff from extreme rainfall event(s) in the pit and the surrounding watershed. Flooding of the open pit could be disastrous and would impact the operation in a very significant way. The pit dewatering system will be designed to handle a significant hydrological event and a surface runoff control/diversion system will be provided to minimize surface runoff from reporting into the pit area. The runoff control/diversion system will be designed to be sufficient for the extreme hydrological event.

17.5.2 Tailing Management Area

The Tailings Pond will contain tailings generated from the processing plant. Extreme floods that exceed the design criteria and intensive internal erosion can cause failure of the structure. A discharge resulting from the tailings pond failure would generate significant environmental impacts. The embankments for the tailings pond have been classified as "extreme" in terms of failure consequences and have been designed accordingly. The embankments and associated spillway(s) will be designed to handle the extreme flood without overtopping of the embankments. A regular inspection/monitoring program will be established during operations and closure to ensure that the embankments are stable in the long term.

18.0 CUMULATIVE EFFECTS

18.1 Policy, Legislative and Regulatory Framework

Cumulative impacts are mostly indirect impacts and are defined as incremental environmental changes caused by independent or repetitive activities. These impacts may occur as interactions between activities, between an activity and the environment, and across environment media. Cumulative effects can occur in many ways including (CEAA 2003; Spalding 1994):

(1) A physical or chemical constituent can be transported away from the impact source only to interact with another activity or environmental medium (e.g. soil erosion or acid rock drain-age)
(2) The gradual disturbance and loss of land and habitat, or nibbling loss (e.g. incremental land clearing as the mine advances or incremental road development into forest areas, alienating wildlife habitat clue to sensory disturbances)
(3) Spatial and temporal crowding, when too much is happening within too small an area and/or in too brief a period. Spatial crowding includes overlapping effects from separate activities (e.g. downstream confluence of effluent plumes from multiple discharge points). Temporal crowding occurs when impacts from different actions overlap or occur before the receiving environment has had time to recover (e.g. family stress due to continuous fly-in/fly-out employment)
(4) Each impact can induce further effects, sometimes called growth-inducing potential. The effects of these spin-off impacts (e.g. increase in hunting or trade of endangered species due to improved access to areas) may add to the cumulative effects near the mine. The magnitude of cumulative effects, or the impact propagation between causes and effects, can equal the sum of each individual effect (additive effects) or can result in an increased effect (synergistic effect).

There are many other examples of cumulative impacts; incremental noise from independent activities (either from one or several projects) or the cumulative effect of individual impacts on a receptor, such as human stress due to combined noise and dust exposure, or visual impacts.

Impact interactions, a subset of cumulative impacts, can occur either between the impacts of one project or between the impacts of several projects. A mineral processing plant, for example, may produce two waste water streams that individually meet relevant water quality standards, but that react in combination resulting in significant pollution levels.

The opposite to cumulative impacts are cancelling, offsetting or compensating impacts. These are also quite common. Examples include water abstraction that is offset by water discharges, or increases in traffic, offset by improvements in capacity of local roads. The objective is to generate impacts that will offset the significant adverse impacts.

18.2 Baseline

18.3 Impact Prediction and Evaluation

The poverty levels in Guyana are relatively high. However, Guyana is a natural resource rich country and there are approximately 100,000 persons who work directly or indirectly in gold and other mineral resources exploitation. Region 9 is relatively new to gold mining activities. Evidence from communities within the project AOI indicates employment in mining in addition to other subsistence livelihood activities are the main sources of livelihood in the Region.

Further evidence from communities within the project area of influence indicates significantly increased level of small and medium scale mining activities in the area. Upgrading the road to the mine site may result in more small and medium miners being able to access the area. In addition, the presence of a foreign company in the area will induce talks of a major gold strike in the area. This will result in more small and medium scale operators moving into the area. This could potentially result in a gold rush effect in the region which could have significant adverse effects on the natural environment, social and economic conditions, and community health.

The Government of Guyana, through the Guyana Geology and Mines Commission is responsible for enforcement of environmental management and other regulations in the mining sector. Enforcement of these regulations will minimize any potential impacts related to small and medium scale mining operations. These regulations will further enhance the participation of stakeholders in the economic and social development of the country by supporting and encouraging sustainable development in Region 9.

There are several small and medium scale operators in the project area. These operators all recover gold totally by mercury amalgamation. Mercury amalgamation will contribute to increased mercury levels both in soil and water in the project area. The project will expose miners to alternative, mercury free, beneficiation methods and will indirectly support the GoG efforts to eradicate mercury amalgamation in the gold mining industry.

The project will upgrade and maintain the access road from Lethem to the mine site. Small and medium-scale operators will utilize this road. While this will increase traffic volumes on the road, the presence of a primary artery to the Marudi Mountain area will eliminate the need for miners to develop alternate routes and this will minimize likely loss of flora and fauna associated with clearing other access roads to points west of the mine site.

While the Project is likely to be the major development in the Marudi Moutain region in the short term, the possible increase in small and medium scale mining activities would dramatically increase the scale of effects in the sub-region in the future. The pressure of small and medium scale operations is already a reason for concern by persons in the area with there being claims of minimized water quality. These problems, if not addressed, will be exacerbated by increased mining in the Sub-Region. The Government of Guyana is supportive of development in the region to benefit the national economy and has developed an appropriate and well structured regulatory framework to address and mitigate these concerns. However, enforcement of these regulations is weak due to limited capacity and resources.

The proposed gold mining project is a long-term project proposed for Region 9. The success of this project will encourage the development of additional mining concessions by REGL or other mining companies which could lead to greater levels of employment and extend the duration of the increased employment.

The upgraded access road may provide a conduit for other large investment projects within the Region in that it will provide access to exploitable natural resources such as timber and minerals. Currently, the road is ustilised by several medium and small-scale miners. The access may increase the economic viability of timber resources in the area. Maintenance of the access road would be critical for benefits to accrue from the proposed project and other extractive resource industries in the area and the region.

The creation of the access road may lead to migration of people to the project area to access and exploit resources to support their livelihood activities. Improved access to the project area may consequently result in increased mining, logging, agriculture and other livelihood activities such as subsistence farming, fishing, and hunting. The presence of a foreign company in the area may result in rumors of major gold finds in the area. This may lead to further proliferation of artisanal mining activities in the area, both illegal and legal operations and an increase in the number of businesses associated therewith such as shops, hotels, and brothels and the creation of other communities.

An upsurge in uncontrolled resource extraction activity and other knock on activities may have significant adverse effects on the natural environment, social and economic conditions and the overall health of the area and Region. These are major impacts (long-term, major severity, regional extent). These impacts will be managed by implementation of a Multi-Stakeholder Influx Management Committee. These measures will result in low impacts (short-term, low severity, regional extent).

18.4 Mitigation

The cumulative impacts in the area will be managed by institution of a long term, multi-stakeholder regional planning program. The planning will build consensus, collaboration and partnerships between the affected and responsible parties. Key stakeholders will be assembled into a committee which will include:

- Government of Guyana through authorities in the South Rupununi
- Residents of the Villages in the AOI
- Guyana Forestry Commission
- South Rupununi District Council
- Guyana Geology and Mines Commission
- Guyana Gold and Diamond Miners Association
- Women Miners Association
- Local WWF and CI conservation NGO offices and
- Other regional stakeholder organizations.

The committee will provide an ongoing mechanism to manage and respond to attempts by unauthorized persons to access the areas adjoining the access road and mine site to exploit resources construed to be present in those areas. This committee will meet quarterly or with greater frequency if circumstances dictate, to discuss issues and concerns related to development of the access road and mine site. At a minimum the committee will conduct periodic stakeholder and access management reviews.

18.5 Monitoring

The committee will monitor all developments within the AOI and provide feedback to regulatory agencies to ensure that all development conform to legal and regulatory requirements.

19.0 CONCEPTUAL CLOSURE PLAN

The sole precedent for closure of a mine site operation in Guyana is closure of Omai Gold Mines Limited. (OGML, 2007). This conceptual closure plan draws from that closure plan since the operation now proposed is similar to that undertaken by Omai Gold Mines. The proposed Project will include the following components:

- Open pit mine
- Ore processing plant
- Administration, warehouse, maintenance and outbuildings
- Stockpiles (ore and mine rock)
- Spoilpiles (overburden)
- Tailings Management Area(TMA)
- Laydown and materials storage facilities
- Onsite air strip and haul roads
- Onsite power infrastructure and fuel storage facilities
- Domestic and industrial waste handling facilities
- Water management facilities and drainage works and
- Power infrastructure upgrades

The facilities will be progressively closed over the duration of the mine site operations. Progressive closure will reduce the costs of reclamation since closure will be integrated with the production operations. In addition, progressive closure will result in the development of expertise on the most appropriate reclamation methods. Progressive closure will be undertaken, however without posing impediments to day-to-day operations of the site. Final closure of the mine site will be undertaken following completion of all mining operations, once treatment of site waters is no longer required, and indications that further mining of the property is not warranted.

Final closure of the facility will occur in two stages. The first stage will entail the following activities, if not undertaken during progressive closure phases:

- All fuel, chemicals, waste hydrocarbon products, and any potentially hazardous materials will be removed from this site
- Pit dewatering will cease and
- Water treatment will cease once runoff water no longer requires treatment.

During the second stage of the final closure, all equipment, machinery, and storage tanks will be removed for reuse or recycling. Where such uses are not practical, remaining materials will be disposed of at a suitable storage site. All structures will be removed and/or be demolished. Structures that are suitable for reuse or recycling will be salvaged. Structures not suitable for use will be disposed. The Tailings Pond and other water management ponds will be closed and all disturbed areas will be reclaimed, except for roads needed for access during long term monitoring.

After the major closure activities are complete, a monitoring program may be implemented including the site water quality monitoring and embankment inspections. Historical information for the site indicates that the site has been the subject of mining and mineral exploration for close to 80 years. Those activities have resulted in significant disturbance to the area, including excavations, road building, construction of infrastructure and forest clearing. A large part of the old growth timber was removed during those operations and a large part of the site is covered by secondary growth indicative of former operations at the site.

The conceptual Closure Plan is intended to ensure the "return to nature" of the mine site. After the closure process, no buildings or supporting infrastructure or facilities would remain at the site. Former operational areas will be replaced by a sustainable environment comprised of productive and diverse lake and pond ecosystems. Spoil piles, stockpiles, borrow areas etc would be vegetated with grass as well as emerging forests (primarily early stages in rainforest succession are expected to dominate the period immediately following closure). The site will be

monitored for success of the closure plan. A few routes will be left for access to points of interest for the monitoring program. These routes will be closed after successful reclamation.

19.1 Closure Objectives

The objectives of the Closure Plan are to:

1. Prevent, reduce or mitigate the adverse environmental effects associated with the Project
2. Provide for the reclamation of all affected sites and landscapes to a stable and safe condition
3. Provide for the return of all affected ecosystems to healthy and sustainable functioning
4. Reduce the need for long-term monitoring and maintenance by designing for closure and instituting progressive reclamation
5. Provide for long-term monitoring and maintenance of the sites affected by the Project as required
6. Provide for mine closure using the most current available proven technologies in a manner consistent with sustainable development.

The overall intent of the closure plan is to achieve REGL objective to restore the site and aquatic environment to a high ecological value. In addition, closure will result in the establishment of conditions that support public safety through physical stability (**Physical Stability**), it would encourage productive end land use by promotion of revegetation and promote conditions for biological stability (**Biological Stability**) in addition to ensuring that mechanisms are in place to protect water resources and the receiving environment thereby providing chemical stability (**Chemical Stability**).

Criteria/performance standards, which would function as measures of accomplishment of the closure objectives, are:

- **Physical Stability** - Preservation of protective safety measures (in a state in which the measures can be effective) throughout the post-closure monitoring period, once there has been no external human influence.
- **Biological Stability** - Effective revegetation and restoration evidenced by vegetative proliferation on 70% of the site areas intended for revegetation by the end of the post-closure monitoring period.
- **Chemical Stability** - Water quality similar or improved when compared with historic data at the end of the post-closure monitoring period, once there has been no human or related influence.

The conceptual closure plan incorporates the use of storm-water management practices and soil and wildlife conservation. The storm-water management practices will provide systems that minimize environmental damage by:

- Maximising retention time within the system by use of detention ponds
- Minimising increases in surface runoff flow and volume
- Channelling and diverting runoff
- Use of bench terraces

Soil conservation techniques to be employed to ensure closure success include

- Modifying the soil slope
- Maintaining and establishing natural vegetative cover
- Securing favorable soil conditions to facilitate vegetative growth.

Wildlife conservation techniques will include:

- Providing food resources through establishment of vegetation
- Providing habitats for wildlife through encouragement of vegetative proliferation, as well as creation of aquatic habitats
- Providing surface water and soils of good quality for wildlife consumption and use.

The mine site reclamation will be coordinated with the GGMC and the GFC.

19.2 Reforestation and Reclamation

The objectives of reforestation are to protect the soil against erosion and to restore biodiversity. The intent of the reclamation program is to develop reconstituted habitats which are ecologically functional and which can evolve naturally to the initial situation. The reclamation plan is developed based on careful planning and respect of basic rules related to fast reforestation which will provide a new forest cover rich in biodiversity. Site rehabilitation will occur as mining proceeds so that on completion of the mining process reclamation will be substantially completed. Where possible, excavations will be reforested immediately after ore recovery to minimize loss of botanical or animal biodiversity. The reforestation process will mimic the natural closure of forest gaps by pioneer trees.

The reforestation process proposed to be applied is based on the use of heliophilic species to mimic the mechanisms that close the treefall gaps during forest regeneration cycles in pristine forests. Studies of plant succession, vegetation pattern, tree growth and biomass, performed in natural pristine forests in French Guyana and Amazonian forests show that fauna recolonization and fauna succession are key mechanisms for biodiversity conservation. The reforestation process will be based on these mechanisms.

The reforestation program will commence before mining and its associated soil excavation begins at the site. Before the forest cover is removed, all useful seeds and seedlings will be collected and would be stored in a plant nursery in the mine site area. The forest cover will then be cut, and all the useful biomass would be collected, processed and stored to produce compost. Large wood stumps and trunks will also be inoculated with mushrooms. The topsoil would be removed before work commences and would be collected and stored separately. Seeds which are in the topsoil would be collected with the topsoil and stored.

A nursery would be established close to the mine site, by collecting material in the wild. The nursery would be established inside forested areas. The nursery will contain young trees of the species already present in the impacted habitat and hosting efficient indigenous ectomycorrhizal and endomycorrhizal fungi present in forest humus and nursery.

Many species of pioneer trees are sensitive to diseases and pests and as a result, many cuttings may be lost (sometimes up to 70%). The nursery would therefore be sized to overcome this problem particularly since no pesticides will be used in the nursery.

The reforestation process will begin immediately after the first area has been mined and recontoured and will be implemented by a crew specifically delegated reclamation responsibility which will start the soil rehabilitation and the revegetation process. This action will be taken to avoid soil erosion and compaction.

Borrow pits used to source material for embankment construction will be profiled and partially vegetated. Rehabilitation will commence with re-shaping of the material previously re-deposited into the mined-out areas. The water retention in surficial soil will vary from none in highly porous areas to very high in clay soils areas. The soils will therefore be intermixed to ensure uniformity of its water retention capacity. The area will then be contoured to fit into its original topography. A thick layer of the topsoil, initially stored, would then be spread over the contoured area. Micro-topography artefacts will be added, if necessary, depending on the habitat, to provide traps for floating seeds and micro-habitats for fauna. Compost will then be added to the topsoil during the revegetation and seeding process. The area will then be revegetated using seedlings and plants from the nursery.

The reclamation program will be undertaken using seedling and planting rates which are designed to establish a minimum of one leguminous plant (nitrogen source) per square metre and one non–legume plant per square metre. Nutrients will be provided by using small amounts of lime fertilizers and compost. Large cuttings from leguminous trees will be used to establish a shade cover in five to eight months. After two to three years, these short-lived plant species will contribute to the development of a litter layer. It is expected that they will age after five years and will be replaced by other species.

Stumps and logs, previously inoculated with mushrooms and stored under the canopy, would be located at strategic points to provide long term sources of organic matter and micro habitats. These stumps and logs will form fertility islets to provide organic nutrients to the topsoil. This would be particularly important in this remote area since the transportation of mineral fertilisers would be costly. The decaying wood would release fertility in the same way as in the natural treefall gaps and this kind of fertilizer is less prone to washing out by rain and flooding than the mineral fertilisers.

A containment berm will be constructed around the perimeter of each spoil pile to control erosion and the migration of solids. The spoil pile will then be graded to blend with the natural topography. A layer of saprolite will be applied to selected areas of the dump face where waste rock only is exposed. Soil will then be applied over the spoil piles and vegetated 'islands' will be planted and observed. If the "islands" indicate that the soils are adequately fertile to develop a diverse community of plants, no additional action will be taken and the vegetation will be allowed to naturally spread. If observations of the "islands" indicate very little development and spreading of vegetation, seedlings from the nursery plot will be transplanted into the spoil pile.

The mine pit will be provided with a spillway to enable discharge to surface water features around the pits. The discharge spillway will be sloped and will be covered with geotextile and rip rap (waste rock) to minimize the possibility of erosion. All power and water line will be disconnected and will be removed from the site.

All stockpile areas will be excavated back to original ground level, profiled and covered with natural organic-rich soils. Vegetated 'islands' will be planted over stockpile areas and will be observed. If the "islands" indicate that the soils are adequately fertile to develop a diverse community of plants, no additional action will be taken and the vegetation will be allowed to naturally spread. If observations of the "island" indicate very little development and spreading of vegetation, seedlings from the nursery plot will be transplanted into the stock pile.

The water management pond will be breached to reduce the pond to one-half of its designed height and a spillway will link the pond to nearby surface water features. The spillway will be covered with geotextile and rip rap (waste rock) to minimize the possibility of erosion.

All haul and access roads will be regraded, reclaimed, and closed except for agreed upon access routes. Material will be pulled from the fill portions of the roads and placed in the cut portions to aid in regrading and to match adjacent slopes and roads. All exploration roads at the mine site will be reclaimed in a similar manner to haul roads. This will include all areas outside the active mining area.

The process plant and its associated treatment facilities will be removed from the site. Concrete slabs and footings will be broken up and placed into open facilities such as ponds or will be placed on waste rock dumps in such a manner that the concrete will be incorporated into anticipated reclamation. Facility sites will be graded to blend in with existing topography, and compacted areas will be ripped and the whole area will be covered with topsoil and revegetated as detailed above. All topsoil areas will be regraded and revegetated. The primary materials to be used would be cover soil, subsoils, and non-acid generating (NAG) and acid neutralizing materials such as gravels and selected waste rock. Impervious ground covers will be installed using clays excavated from the mine pits.

The remaining areas not constructed on or of potentially AMD generating materials such as workshops, topsoil stockpiles, and some haul roads, will be covered with 12 inches of topsoil and up to an additional 12 inches of subsoil to provide a suitable substrate for vegetative growth. The subsoil will increase water storage capacity and provide a good substrate for rooting and maximize the likelihood of long-term vegetative success.

The closure plan will lead to the re-establishment of ecological processes that will allow for the development of appropriate habitats on the areas previously disturbed by mining. Where needed to provide slope and soil stabilization, permanent seed mixtures will include native species appropriate for the area. Non-invasive introduced vegetation species will be considered for their benefits to add organic matter to soils.

Closed facilities will be inspected, and annual reports provided to evaluate the success of progressive reclamation. Reclamation monitoring would be coordinated with the EPA and GFC. Reclamation success will be evaluated both in terms of vegetation and erosion. The existing monitoring programs for surface and groundwater will continue

in accordance with the proposed monitoring plans. Monitoring would be modified to address progressive reclamation as it proceeds.

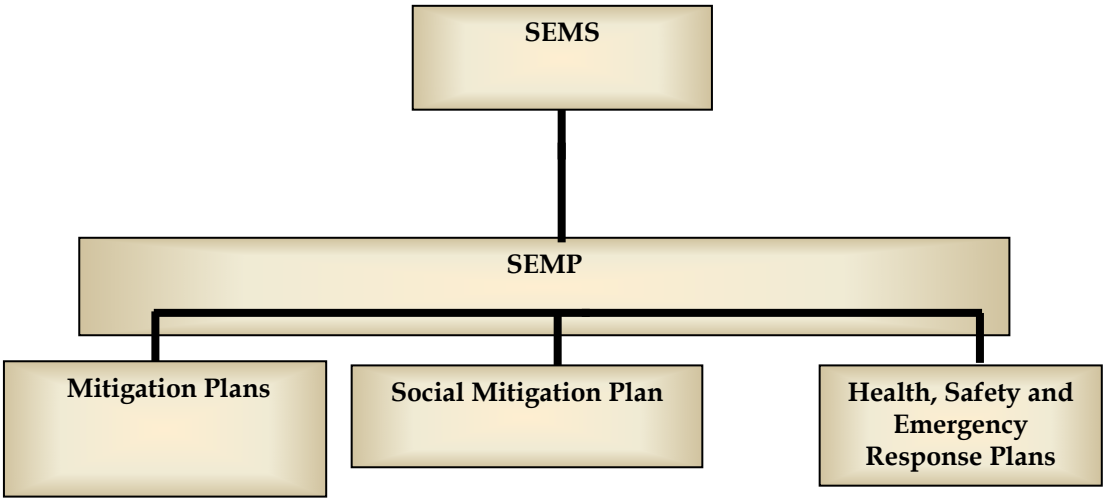
Post closure monitoring of the tailings pond will be continued to ensure the integrity of the embankment cross-section. The chemical concentration and water content of tailings will also be monitored to determine when these parameters fall within acceptable limits. Monitoring will only cease after both chemical concentrations and tailings moisture content are within acceptable limits and only after the safety factor of embankment cross-section is determined to exceed 1.5 based on the soil strength gains over time and the widened embankment footprint based on deposition of the coarse fraction of the tailings adjacent to the dam itself.

20.0 INSTITUTIONAL FRAMEWORK FOR PROJECT EXECUTION AND SUPERVISION

The Social and Environmental Management System (SEMS) provides the management framework for implementation of the mitigation measures proposed for each environmental medium. This SEMS is the backbone of the proposed mitigation measures and the adoption of this SEMS is critical for the implementation of the mitigation measures presented in this report. The SEMS is a systemic framework that will be applicable throughout the life of the project and to every phase from feasibility and construction to operation and closure.

While the mitigation measures address specific impacts identified by this ESIA, the SEMS goes beyond the mitigation measures and forms an independent and adaptive system of checks and balances that ensures that all possible environmental and social risks/impacts of the project are identified and managed beyond the scope of this ESIA and through the project life cycle. The SEMS has the following components:

1. Policy framework
2. Organizational Structure and Responsibilities for the implementation of the mitigation measures
3. Monitoring and Audits Process
4. Change Management and
5. Reporting and Disclosure.



20.1 Policy framework

RGEL and its contractors will adhere to all applicable laws, regulations, and codes of practice of Guyana applicable to Social and Environmental Sustainability, and applicable EHS Guidelines. In the event that RGEL deems full compliance with a particular standard or guideline not to be technically or economically feasible, the MNR, EPA, and GGMC would be consulted proactively such that alternative standards or practices may be developed.

A policy framework would form an integral part of a management system. The company will develop written policies on environmental, social and health & safety issues. The policies would clearly outline the mission, vision and aims of the company and the standard operating procedures (SOP) that detail how these policies will be implemented throughout the Project.

A code of conduct will be an integral part of the policy framework. The code of conduct will ensure that the intent of the policies of the company and SOPs percolate to all levels like the employees, contractors and subcontractors of the Project.

20.2 Written Management Policies

Although RGEL has not yet adopted a set of formal policies, it would adhere to the entire environment, social, health and safety and labor legislation and regulatory framework of Guyana. RGEL will develop written policies for each of the applicable Guyana standards. This will ensure that all issues that may arise during the project lifecycle can be predicted, analyzed and managed by a robust management system geared to continuous improvement.

These written policies will be designed to:

- Document principles that are compatible with social and environmental protection while allowing the operation of the facility at competitive costs
- Facilitate SOPs through the project lifecycle that will ensure compliance to its environmental and social, health & safety goals
- Promote awareness to its employees and to the general public regarding social and environmental protection.

20.3 Romanex Guyana Exploration Limited (RGEL) Code of Conduct

All Romanex Guyana Exploration Ltd (RGEL) employees, contractors, and site visitors will be required to comply with a Company Code of Conduct. The code of conduct will ensure that all the company's employees, contractors and sub-contractors are in alignment with the company's basic mission, vision, policies, and goals. This will enhance implementation of the company's written SOPs and ensure that the main message percolates to all levels and individuals associated with the project.

The code of conduct will have the following objectives:

- To ensure that all company and project personnel adopt a respectful manner towards local communities, their resources and the environment and
- To avoid and minimize adverse impacts that the behavior of company and project personnel may have on local communities and/or their resources and the environment. Such adverse impacts include social conflicts, depletion of natural resources, and impacts on native flora and fauna.

RGEL will develop their own code of conduct to reflect their own vision and objectives.

20.4 Organizational structure and Responsibilities

RGEL currently is organizationally structured for exploration activities. The ESIA consultations within the company revealed the following:

- There is lack of dedicated resources to manage environment and community/social aspects. By virtue of being a small exploration unit RGEL functions in a skeletal capacity with managers and staff taking on multiple functions
- Personnel who can take management decisions are based in primarily in Georgetown and a number of functions like hiring, HR, pay process, logistics etc. are centralized in the Georgetown office
- Stakeholder interactions are managed by various personnel mostly located in the Georgetown office. Some staff are responsible for liaising with Government departments while others interact with communities. However these duties/functions are not formalized and there is no documentation of stakeholder engagements, issues, or grievances.

To ensure effective implementation of the SEMP of this ESIA, RGEL will develop a team of trained individuals and dedicate specific resources to that team. The primary responsibility of this team of trained individuals will be to oversee the implementation of the mitigation measures and take ownership of the systems and processes of this SEMS.

Figure 61 depicts the organizational structure and personnel required for the implementation of the mitigation measures. The organization structure also depicts the specific sub-structures showing the divisions between social and environment teams that will manage and implement the mitigation measures.

The overall implementation will be done by placing both environmental and community managers at the site. This will ensure division of the tasks related to implementation of the mitigation measures amongst qualified personnel. The larger responsibility of the mitigation will rest with the Director of Sustainability and the Senior Management team while the sub teams will perform the field functions. RGEL will hire or place specialists who have experience in environmental and social issues and implementing management plans for each of the proposed positions in Figure 61.

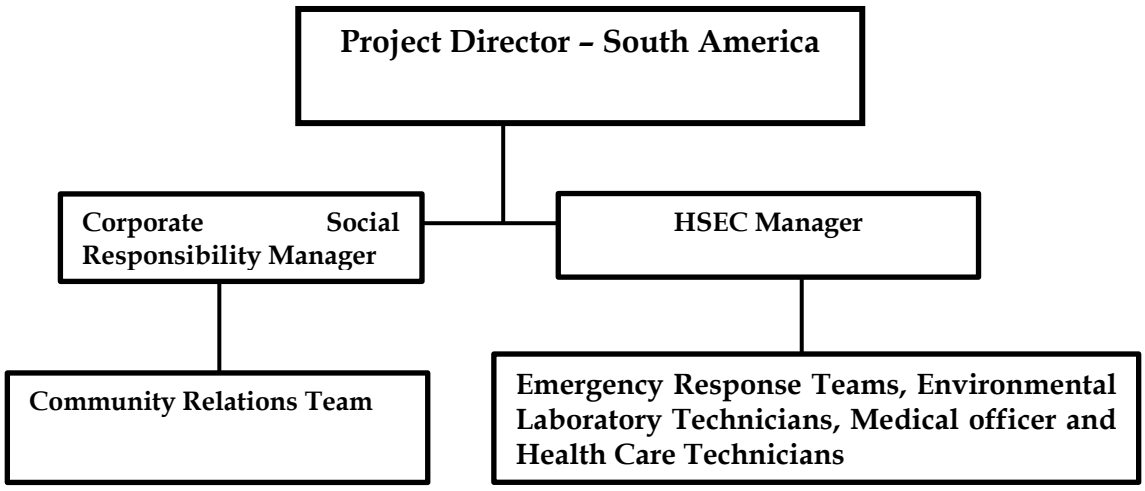


Figure 61 - Proposed Organization & Implementation Structure for the MITIGATION MEASURES

20.4.1 Project Director

The Project Director will be responsible for all sustainability matters and will be tasked with the implementation of the mitigation measures. The Director will manage and lead the Environment and Social/Community teams and ensure that the mitigation measures implementation occurs properly. The Health, Safety, Environment and Community Manager (HSEC Manager) will have direct responsibility for social/community aspects of the mitigation measures and will report directly to the Director until mining operations commence, at which time the Mines Manager – Guyana will assume the role and then report directly to the Project Director.

The Project Director will be the conduit of information and will advise and direct the senior management team of RGEL. The Senior Management team is likely to include all senior staff in Georgetown and Project Managers and other staff as appropriate. The Director will regularly report to Senior Management on the implementation issues of the mitigation measures, information on arising social and environmental issues and management of the Social and Environmental Management System (SEMS). The Director will have powers to take organizational and resourcing decisions which are necessary for maintaining a robust SEMS. Drafting of codes of conduct, written policies, managing subcontractors and ensuring compliance to all Project policies and commitments through the Project lifecycle and in cases beyond the scope of the mitigation measures will be the responsibility of this Director.

The Director will be responsible for compiling yearly reports on the status of the mitigation measures implementation and to manage the internal monitoring activities. The Director will be responsive to the environmental and social issues arising (if any) and will be proactive in identifying risks and managing these issues through the lifecycle of the project.

20.4.2 Health, Safety, Environment and Community (HSEC) Manager

A Health, Safety, Environment and Community (HSEC) Manager shall be assigned to full-time onsite duty at the Site. The HSEC Manager will report directly to the Project Director during the project build phase and will have direct responsibility for all HSEC aspects of the construction and operations, including emergency response, and will be the primary authority for day-to-day enforcement of the Environmental Management Plan (EMP) and Health, Safety, and Emergency Response Plan (HSERP).

Once Mining operations commences, the Mine Manager will direct and support the HSEC Manager by providing additional expertise and resources on an as needed basis to satisfy operational, maintenance and emergency response needs. If necessary, RGEL may retain a qualified firm to provide support to the HSEC Manager to assist with specialized training and emergency response expertise and will provide additional technical resources for operational and emergency response needs. It is anticipated that the MNRE, EPA and GGMC will review plans prepared by the operations to ensure that all concerns are appropriately addressed.

The HSEC Manager will manage all environmental and health and safety related activities and will provide training to employees and will identify equipment and resources needed to satisfactorily perform their duties and responsibilities. The EHS Manager will also provide onsite training and internal auditing of EMP and HSERP effectiveness.

20.4.3 Environmental Staff

The EHS Department will have 3 technicians whose primary duties will be to inspect the local environmental monitoring stations for water, air and soil and to collect grab samples for routine checks. They also work with the EPA and other authorities to report and assure that discharges are within guidelines.

An environmental laboratory staffed by a complement of three individuals will be located at the Project site. Individuals working in the laboratory will analyze samples of air, surface and groundwater and will serve as response team advisors in the event of emergencies. The environmental laboratory will be responsible for the analyses of samples to assess environmental compliance. The laboratory will also be responsible for collecting and packing samples for off site quality assurance tests by an independent laboratory approved by the EPA.

20.4.4 Health, Safety, and Emergency Response Staff

Medical Officers will be assigned to the Mine Site to oversee the onsite health facilities that will be equipped to attend to the needs of site residents, workers, and visitors. Two full time Health Care Technicians will be provided at the mine site to attend to minor injuries and basic first aid. Emergency Response Teams, at the site, will be comprised of employees who have been specially trained to handle potential incidents. These employees will also be responsible for maintaining the operational effectiveness of the emergency response equipment.

20.5 Monitoring and Audit process

Social and environmental monitoring programs will be implemented to address all activities that have been identified to have potentially significant impacts on social and the environmental resources during construction, normal operations, and unexpected conditions. Social and environmental monitoring activities will be based on direct and indirect indicators of emissions, effluents, and other potential sources of impacts associated with the project under a risk-based, targeted approach that addresses key indicators that are most reflective of potential impacts and risks. Monitoring will extend for a minimum period of three years after closure. Monitoring frequency for each parameter will be sufficient to provide representative data for the parameter being monitored.

Monitoring will be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data will be analyzed and reviewed/compared against operating standards so that any necessary corrective actions can be taken. The monitoring program will implement applicable sampling and analytical methods for emissions and effluents as provided in the IFC General EHS Guidelines.

The environmental monitoring program for the mine will serve as an integral part of the operation and would be implemented to generate information for environmental management and environmental information dissemination. Monitoring will be conducted during all phases of the project; specifically, the design, construction, operation and closure phases. The monitoring program will play a pivotal role in ensuring that the trends for specific parameters are tracked and will provide information on compliance with legislation and set guidelines or desirable operational limits. Review of the monitoring data will provide a basis for corrective actions and modification of activities if necessary. Sampling intensity during monitoring will depend on the time and location of the development activities and results derived from monitoring data. RGEL will conduct regular internal audits of the EMP and the Monitoring Program and will contract an independent expert firm to provide an annual external audit.

The Social Monitoring program will also have a system of internal and external monitoring. The internal monitoring would be done in house by the Community Relations Team led by the CSR Manager. Quarterly monitoring will be done of the implementation of the mitigation measures and of all community projects being funded by the company. External third party monitoring and/or audits will be facilitated by the company to ensure that the mitigation measures and its activities are meeting indicators. All issues and corrective actions raised by third party audits would be implemented.

20.6 Reporting and Disclosure

RGEL senior management will receive periodic assessments of the effectiveness of the mitigation measures, based on systematic data collection and analysis resulting from the monitoring and auditing programs. RGEL will also report externally on the implementation, monitoring, and auditing of the mitigation measures. The mitigation measures, monitoring reports, and external auditing reports will be disclosed to any interested party requesting a copy.

20.7 Change Management

RGEL recognizes that the Project design, specifications, procedures, operation parameters, and other elements will be subject to change throughout the lifetime of the Project in response to issues encountered and and/or new policies. Change Management Procedures will be developed to ensure that changes are properly reviewed and approved by persons with the required expertise prior to implementation to eliminate workplace hazards that could lead to injuries, equipment damage, production losses, project reputational impact or environmental impact. Also, the procedures will establish accountability for proper change implementation.

Change Management review procedures will address both permanent and temporary changes. Temporary change reviews and approvals will specify the duration of the change and will require review if an extension is required. Temporary changes will be considered in the same manner as permanent changes.

The mitigation measures will be reviewed and updated not less than annually and whenever the need for improvement is identified during its implementation. A complete review of the effectiveness of the mitigation measures and the need for modification considering final project design will be performed not less than 90 days before the start of operations.

Changes will be communicated to affected personnel via training and updates to digital and printed versions of the mitigation measures.

APPENDICES

DRAFT TERMS AND SCOPE
FOR
THE ENVIRONMENTAL IMPACT ASSESSMENT
FOR
ROMANEX EXPLORATION GUYANA LTD
GOLD MINING AND MINERAL PROCESSING MARUDI MOUNTAIN DEPOSIT, SOUTH RUPUNUNI SAVANNAHS

March 2018

1.0 PREAMBLE

This draft Terms and Scope - for the Environmental Impact Assessment (EIA) for the proposed Romanex Guyana Exploration Gold Mining and Mineral Processing (RGEL) Project, has been prepared in accordance with Part IV, 11 (8) of the Environmental Protection Act (EP Act.), Cap. 20:05, Laws of Guyana. It incorporates those questions and matters, received from members of the public during the mandated twenty-eight-day public comment period referred to in Part IV, 11 (7) of the EP Act.. Further this Terms and Scope has been prepared by the Environmental Protection Agency (EPA) after consultation with Ground Structures Engineering Consultants Inc. (GSEC), the firm it has approved to carry out the EIA.

This Terms and Scope sets out the requirements, both general and specific, that should be addressed by the consultant in the conduct of the EIA.

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1. INTRODUCTION

The EPA, received from Romanex Guyana Exploration Ltd. (RGEL), an application for Environmental Authorization for a proposed large-scale gold mining operation at Marudi Mountains, South Rupununi Savannahs. The application was made in accordance with section 11(1) of the EP Act Cap.20:05 and was accompanied by a summary of the project with information on:

(i) the proposed site, design, size and duration;
(ii) the possible effects on the environment; and
(iii) a non-technical explanation.

The EPA conducted a review of the application and determined in accordance with Part IV 11 (2) (b) of the EP Act Cap.20:05 that the project may significantly affect the environment and will require an EIA. The EPA consequently, and in accordance with Part IV 11 (6), of the EP Act Cap.20:05, published, at RGEL's expense, in a daily newspaper, a notice of the project and made available to members of the public the aforementioned project summary.

In accordance with Part IV 11 (4) of the EP Act Cap.20:05, this EIA will be carried out by an independent and suitably qualified firm. Ground Structures Engineering Consultants was approved by the EPA as the firm to conduct the EIA which shall:-

(a) identify, describe and evaluate the direct and indirect effects of the proposed project on the environmental including:-
    (i) human beings;
    (ii) flora and fauna and species habitats;
    (iii) water;
    (iv) soil;
    (v) air and climatic factors;
    (vi) material assets, the cultural heritage and the landscape;
    (vii) natural resources, including how much of a particular resource is degraded or eliminated, and how quickly the natural system may deteriorate;
    (viii) the ecological balance and ecosystems;
    (ix) the interaction between the factors listed above; and
    (x) any other environmental factor which needs to be taken into account or which the Agency may reasonably require to be included; and
    (xi) in accordance with Part IV, 11 (4) (b) of the EP Act Cap.20:05, the EIA must assess the project with a view to the need to protect and improve human health and living conditions and the need to preserve the stability of ecosystems as well as the diversity of species.

This Terms and Scope guides the preparation of the Environmental Impact Assessment, referred to herein as the Environmental and Social Impact Assessment (ESIA)

2.0 BACKGROUND

The RGEL Marudi Mountain Mining Licence covers an area of 5,577 hectares and is located in the Rupununi District, in southwestern Guyana, approximately 155 kilometers south-southeast of Lethem and 50kilometers south-southeast of the Amerindian Village of Aishalton (Figure 1).

Ore reserves estimates on the property, indicate that at least 3.1 MM tonnes of ore-grade material exist in the main body of mineralization at Marudi with an average good content of 2.89 grams of gold per tonne. This is the equivalent of 275,000 ounces of gold. Further anomalous zones occur on the property that are not yet fully explored and will contribute to the reserves in the future after additional exploration. In addition to these hard rock resources, a significant volume of either saprolite or colluvial material exists on the property that contains gold in excess of 1 gram per tonne but has not been thoroughly sampled due to its the loose nature. This volume of material is estimated at 750,000 to 1,200,000 tonnes containing the equivalent of 25,000 to 40,000 additional ounces of gold.

The RGEL mining project is expected to last for a period of twenty (20) years from its date of commencement. The project will entail a capital investment of approximately $85,000,000.00 USD with an annual turnover of 22,000,000.00 USD and will produce 1800 oz/mth of gold in phase 1 and 3200 oz/mth in phase 11. The preliminary phase of the project is expected to employ between 25 to 85 men per shift. After the preliminary works are completed, phase 1 activities of the project are expected to employ 110 persons for the day shift and 30 persons for the night shift. In phase 11 of the operation, 180 persons will be employed for the day shift and 60 persons for the night shift.

The project area will be exploited in two phases: phase 1 - removal of gold bearing saprolite and colluvium at the mine; and phase 2 - the subsequent mining of hard-rock resources.

Phase 1

Soft rock material will be mined by traditional truck and shovel operations. Tractors and excavators will loosen and excavate the material, and the material will be loaded on to trucks by either excavators or wheel loaders. The material will be hauled to a stockpile area adjacent to the processing plant. Hard rock mining will also be carried out by traditional truck and shovel operations generally below the area of saprolite mining. Ore will be processed by gravity beneficiation with the use of a washing plant to free the ore material into a slurry and to break up any loose rock. Material larger than 25mm in diameter will be used for either construction purposes or stockpiled to be re-processed in the second phase of the operation. Material between 4mm and 25mm will be sampled as it leaves the plant and a record kept of gold content. This material will also be used for construction or stockpiled for future processing depending on gold grade. Material less than 4mm in size will be passed through various screens or cyclones to insure proper size fractionation, and then sent to various gravity separators. Coarser fractions will pass through jigs and then on to coarse sluice boxes. Finer fractions will pass through either jigs or centrifugal concentrators. The tailings from the fine circuit will be sent over long sluices, while the concentrate will either be cleaned up by hand, or tabled to create a concentrate for smelting. No mercury will be used in beneficiation of gold. Any mercury on the property as a residue from the ore material previously handled by artisanal miners will be the reclaimed.

Phase 2

Test work has indicated that a concentrate containing approximately 91% of the contained gold can be produced by a technique called froth flotation. Apart from reagents used in the test work done, there are several other reagents which produce similar or better recovery rates. The reagent, to be used for this project will result from test work on samples of the ore. The second phase of the gold recovery process will combine gravity concentration with reagent use to treat the hard rock ores at Marudi.

A crusher will be provided inline and before the mill to handle the harder ores expected to be processed during Phase 2. Ore from this Phase and material stockpiled from the earlier gravity beneficiation phase will be crushed and fed to a SAG or ball mill to reduce the material to a relatively coarse grind (40% passing 200 mesh). The material will then be passed through the original gravity circuit. After gravity concentration of the ground ore, the material will pass to the reagent circuit. Here, the ground ore will encounter reagents in an agitated tank. The gold will be separated from the ore by the reagents prior to being recovered for smelting.

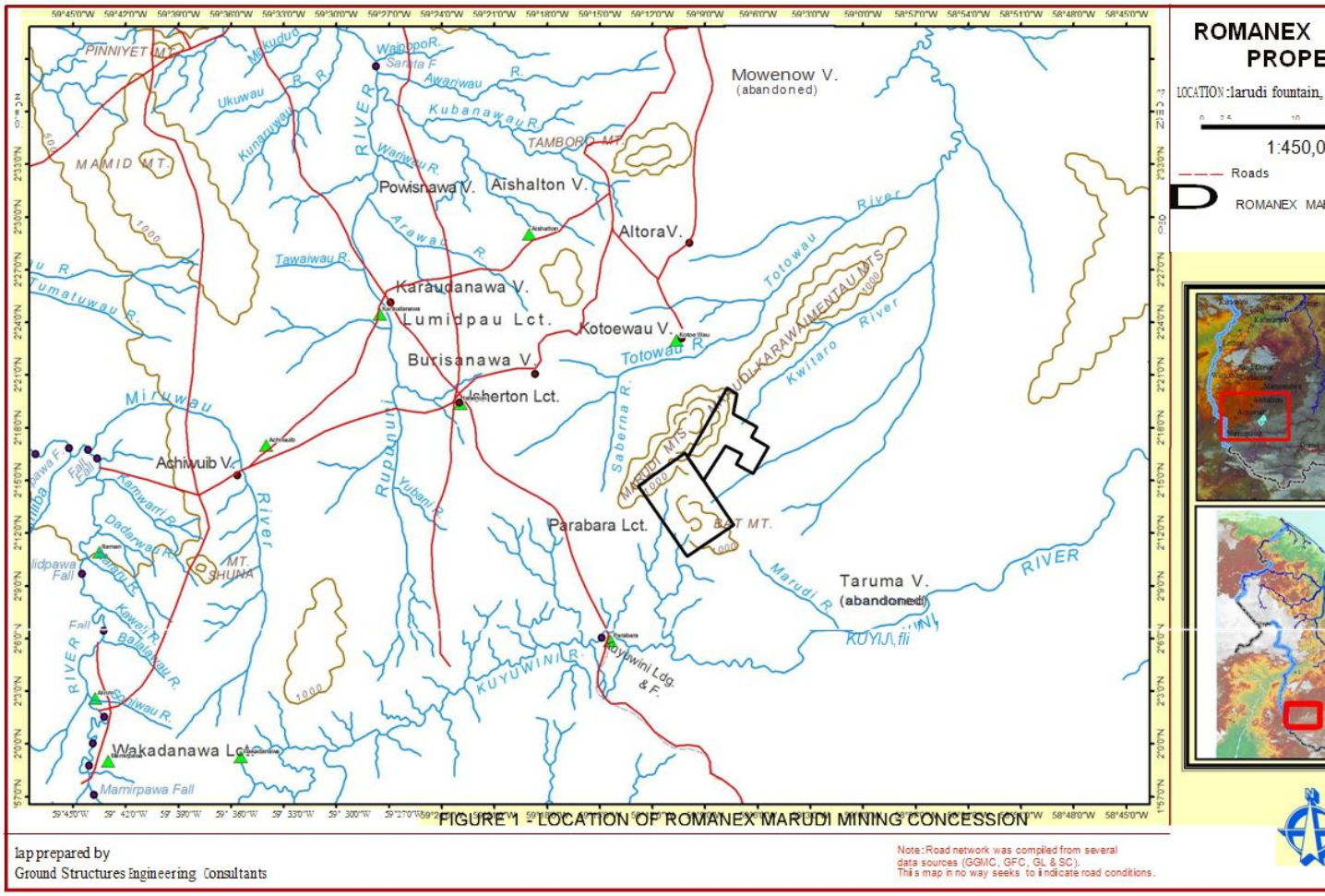
Tailings

Tailings from the operations would be collected in ponds designed to prohibit the escape of fine material to local waterways. The confinement areas would be designed to contain all material generated during the life of the operation.

Reclamation

During the mine life and after cessation of operations, care will be taken to minimize the impact or footprint of the mine. As exploitation ceases in areas, they will be subject to ongoing reclamation. Excavations will either be back-filled or provided with inflows and outflows to permit them to become aerated lakes. Roads will be maintained with culverts to inhibit the creation of stagnant pools. After cessation of all operations, all areas will be graded to a natural contour to provide a base for conversion to useful habitat or agricultural lands. Upon re-contouring, the stockpiled topsoil, and any mulch provided by stockpiled branches and forest material will be used to provide a basis for flora.

FIGURE 1: LOCATION AND ACCESS MAP OF MARUDI MOUNTAINS PROJECT SITE



Sourced: Alluvial Mining Final TOR, prepared for the Marudi Mining Project, 2009

3.0 SCOPE OF THE EIA

In accordance with Part IV (11) (5) of the EP Act Cap.20:05, every environmental impact assessment shall contain the following information:-

(a) Description of the project, including in particular:-
- (i) the geographical area involved, the physical characteristics of the whole project and the land-use requirements during the construction and operational phases, including plans, drawings, and models;
- (ii) the main characteristics of the production process, including the nature and quantity of the materials used, plans, drawings and models;
- (iii) an estimate, by type and quantity, of expected contaminants, residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation) resulting from the operation of the proposed project;
- (iv) the length of time of the project;

(b) An outline of the main alternatives studied by the developer and an indication of the main reasons for his choice, taking into account the environmental factors;

(c) A description of the likely significant effects of the proposed project on the environment resulting from:-
- (i) The existence of the project;
- (ii) The use of natural resources;

(iii) The emission of contaminants, the creation of nuisances and the elimination of waste, and a description of the forecasting methods used to assess the effects on the environment;

(d) An indication of any difficulties (technical deficiencies or lack of knowledge or expertise) encountered by the developer in compiling the required information;

(e) A description of the best available technology;

(f) A description of any hazards or dangers which may arise from the project and an assessment of the risk to the environment;

(g) A description of the measures which the proposed developer intends to use to mitigate any adverse effects and a statement of reasonable alternatives (if any) and reasons for their rejection;

(h) A statement of the degree of irreversible damage, and an explanation of how it is assessed;

(i) An emergency response plan for containing and cleaning up any pollution or spill of any contaminant;

(j) The developer's programme for rehabilitation and restoration of the environment; and

(k) A non-technical summary of the information provided under the preceding paragraphs.

4.0 REQUIREMENTS FOR THE EIA AND EIS

The Environmental Impact Statement (EIS) shall be presented in a modular format, with each component organized into standalone modules as outlined below. The general and specific requirements of the EIA and the EIS are as follows

4.1 General Requirements

(a) Mapping, as referred to in this Terms and Scope, shall be considered to be spatial data to scale, represented in digital or printed format. Mapping should be illustrated with the use of photographs, map sheets and diagrams at easily understood and appropriate scales to illustrate the spatial extent of the project and the impact area. Printed maps of the site area shall clearly indicate the layout of the facilities in the context of the immediate site, as well as relative to the wider study area. Each printed map shall be at appropriate/easily-understood scales for the overview being illustrated (e.g. 1:10 000 or 1:5000 for site plans) and shall be inserted at the point of reference in the text in the EIA. In the event that any of the maps are large and/or bulky, these should be incorporated into one of the appendices, as appropriate. All maps and figures shall adhere to the following guidelines:

- Spatial data shall be appropriately scaled;
- Map/figures shall be clearly legible and include proper legends/keys;
- Maps/figures shall be dated and the source of the datum stated;
- Maps/figures shall include an appropriate scale and a north arrow.

The use of scanned documents, texts or graphics is not acceptable.

(b) Due to the scale and nature of this intended project and the study area, the use of geographical information systems (GIS) to represent spatial data shall be required wherever practicable. Submitted data shall be presented in a working GIS project compatible with ArcView and be organised into discrete themes (i.e. shape files — point, raster and vector data). Data themes shall illustrate, but not necessarily be limited to, the following features/attributes:

- Proposed mining site and existing off-site processing plant boundaries;
- Roads (all classes);
- Built development (e.g. camps, villages etc);
- Location of existing mines and their associated infrastructure;
- Protected/Managed Areas;
- Demographics of the study area;
- Agriculture;
- Recreation;

- Topography (contour lines at appropriate intervals, preferably in metres) including derived digital elevation models (DEMs) and triangulated irregular networks (TINs);
- Sampling points for baseline data;
- Proposed monitoring stations/points;
- Intended effluent points;
- Proposed buffer zones/setback distances;
- Site layout, i.e. major building footprints and storage areas;
- Property holdings and land tenure;
- Flora, including endemic species, and faunal habitats;
- Forested areas inclusive of forest reserves and wetlands;
- Administrative areas (e.g. regional corporation);
- Water resource—rivers/streams, standing water bodies, aquifers/groundwater resources, known groundwater recharge areas, wells, watershed, etc.;
- Soil and geology; and
- Known archaeological sites and sites of historical interest.

Digital data themes or shape files should be clearly labelled/annotated with supporting metadata. Map units and distance should be set in metres and in relation to UTM Zone20 N coordinate system, WGS84 datum. The use of GIS would not otherwise exclude the use of photographs, map sheets and diagrams at easily understood and appropriate scales to illustrate the spatial extent of the project and the impacted area. Such photographs should be indexed with the map sheet to aid in the illustration process. Updated high resolution aerial and satellite imagery should be used as reference data and must be ortho-rectified so that they align perfectly with digital data themes.

4.2 Institutional and Financial Mechanisms

Examine mechanisms or arrangements which may be utilised to address the following:

(a) Restoration/rehabilitation of the exhausted mine site(s) after operations have ceased;

(b) Unexpected health and environmental consequences arising out of unforeseen circumstances.

Mechanisms for addressing compliance monitoring by regulatory agencies must also be identified and evaluated.

4.3 Stakeholder Identification and Consultation

This must be preceded by definition of the Project's Area of Influence (AOI). The area of influence must be established based on factors which the EPA considers appropriate. This is already enshrined In Part IV (11) (9) of the EP Act, which states: During the course of the environmental impact assessment the developer and the person carrying out the environmental impact assessment shall:-

(a) Consult members of the public, interested bodies and organizations;
(b) Provide to members of the public on request, and at no more than the reasonable cost of photocopying, copies of information obtained for the purpose of the environmental impact assessment.

The EPA should therefore identify the list of members of the public, interested parties and organizations to be consulted since leaving this open to the developer can be claimed to be introducing bias to the process.
The EPA has determined that the following stakeholders shall be consulted for input into the deliberations of the Environmental Impact Assessment:

- Government Ministries/Departments/Statutory Authorities;
    - The Environmental Protection Agency, (EPA);
    - The Guyana Forestry Commission (GFC);
    - The Guyana Geology and Mines Commission (GGMC);
    - The Ministry of Indigenous Peoples Affairs;
    - The Regional Democratic Council, Region #.09;
    - The Guyana Lands and Surveys Commission (GL&SC);
    - Ministry of Natural Resources;
    - Indigenous Peoples representatives groups;
    - NGOs including the World Wildlife Fund (WWF-Guianas) and Conservation International (CI – Guyana); and
    - Other appropriate local authorities in Guyana.

- Persons living within the area of influence of the project;
- Environmental experts, in biodiversity and wildlife; freshwater ecosystems; local hydrology (savannahs);
- Local and community-based organisations, environmental and other non-governmental organisations (including the Archaeological Committee);
- Local decision-making bodies e.g. South Rupununi District Council (SRDC),
- Other quarry operators in the vicinity;
- Other business interests that can be affected by the project.

The EIA shall address the concerns raised during the consultation process. The EIA report must demonstrate that public concerns have been adequately considered by suggesting possible modifications to the project proposal or by clarification of items within the document.

All public consultation results must be documented and included in the EIS which shall also contain details on the manner in which the public was notified, the groups targeted, a description of the stakeholder consultation process, a list of all stakeholders included in the process, the number of meetings held, location of the meetings, dates held, minutes of all meetings, a copy of the survey questionnaires used (if any), and the results of surveys.

4.4 Review of Existing Information

All readily available information relevant to the proposed project site and the AOI will be assembled and reviewed including local maps and management plans. The AOI will encompass the watershed and water bodies that may be possibly affected by liquid and soils waste emanating from the project operations. The review will examine documents held by the EPA, the GGMC, the GFC, the GL&SC, the Ministry of Indigenous Peoples Affairs, the Hydro-meteorological Department, other local authorities and NGOs. The review will also examine data on

environmental, economic and social variables which may include site geology, hydrogeology, surface water flow, land use in the project area and its vicinity, the proximity of indigenous communities and the likely presence of archaeological resources in the area etc. Examples of documents to be reviewed include:

- Geological publications for the area
- Forestry studies for the area
- Data on terrestrial and aquatic Resources of the area
- Indigenous groups reports
- NGOs information on the AOI, including CI- Guyana and WWF-Guianas
- Land use and topographic Maps, etc

All readily available historic baseline data for the bio-physical and socio-cultural environment must be assembled and evaluated. The historic baseline data will possibly include:

- Biological resources in the area including the presence of any unique ecosystems, natural habitat or endangered and or critically endangered species
- Historical and cultural association of the AOI with Indigenous Peoples
- Permanent or transient uses of the AOI by Indigenous Peoples
- Geological and hydrology data
- Contamination levels in soil and surface water.
- Risk of natural hazards, e.g. flooding and seismic events
- Local meteorological conditions

Historic baseline data must be compiled for socio-economic variables in the AOI including historical human activities within proximity of the study area, persons who engage in these activities and any artifacts related to those activities.

4.5 SPECIFIC REQUIREMENTS

4.5.1 Module 1 – Introduction and Background

This module will comprise:

- The project background; an outline of the environmental authorization process as required by the Environmental Protection Act; purpose of the EIA and the EIA process; and the intended use of the EIS.

- A description of the areal extent of the proposed mining site; watercourses; other property holdings, access roads, etc.; the EIA area inclusive of lands that will be directly disturbed by associated infrastructure such as, off-site processing facilities that may be expected to accommodate additional material from the subject mine.

- The definition of the EIA area informed by any other existing mining and processing operations; properly delineated and referenced in relation to the Universal Transverse Mercator (UTM) coordinate system (Zone 20 N) within the World Geodetic System 84 (WGS84) datum and described with accompanying photographs, aerial photographs and geological maps, and any other diagrams at easily understood scales to illustrate the spatial extent of the project and the potentially impacted areas and sensitive receptors.

- A detailed project description, including design, and the various phases of the proposed project covering construction and operations; historical and current state of operations and/or exploration.

- The purpose of the project; justification for its conceptualisation and implementation; detailed description of the project's phases and activities; site plan of the entire site at a scale of 1:10 000 or 1:5000 (or other appropriate level) to indicate the layout of the proposed facilities and its relationship with the study area.

- Appropriate plans at relevant scales, to facilitate comprehension of location, design, construction or operational processes, sufficient scope and detail in the project description information to allow quantitative assessment of the environmental consequences.

- Rationale demonstrating that the information is sufficient for assessment purposes if the scope of information varies among components, processes or phases of the project including information on:

    - Location to include overall positioning of the block(s) to be mined; an indication of the proposed components in relation to one another and surrounding areas; acreage to be mined, boundaries, buffer zones/setback distances, roads, rivers, streams, outfalls, and any community settlements; relationship to other mining activities in the area; location of any off-site processing sites to be utilised; and clear definition of the boundaries within which the activity is intended to occur.
    - Process Description of all phases (site preparation, extraction, storage, transportation, processing, rehabilitation, decommissioning) of the proposed mining process; flow diagrams as far as possible to illustrate the process, including, but not be limited to:
        - Type of machinery to be utilised;
        - Method and rate of extraction, off-site processing, storage and transportation;
        - Method of storage and reuse of topsoil and overburden;
        - Method of borehole testing;
        - Identification and description of the final product(s) derived including description of type and size of aggregate generated and final product/material storage arrangements.
    - Identification of staffing, support facilities and services that would be required during the different phases of the activity;
    - A description of utilities (e.g. water, electricity, telecommunications) in terms of requirements, availability, sources and plans for obtaining such;
    - Details of the on-site sewage treatment for all phases of operation, description of the proposed process and expected composition of wastewater discharges, and staging/storage, treatment and disposal processes for sewage;
    - Description of transportation requirements, equipment to be utilised and access routes;
    - Description of stormwater management strategies for stormwater runoff and containment;
    - Drainage site plans for proposed drainage network and surface runoff from effluent pits from the off-site processing plant and wider study area;
    - Waste Stream sources, composition and volumes expected e.g. domestic, process (inclusive of off-site processing plant) waste, from ancillary facilities such as, garages and wash rooms, overburden and other mining wastes; waste containment, treatment and disposal.

- Discussion of the proposed project in context of existing and/or other proposed projects or activities in the project area.

- Description of the general methodology used in the conduct of the EIA, including data collection and analysis, impact analysis, cumulative impact analysis, formulation of mitigation measures and monitoring programme, and assessment of alternatives.

- Description of the significance criteria to be used for assessing impacts on environmental and social media.

4.5.2 MODULE 2 - Legal and Regulatory Framework

This module will present and examine the general legal and or regulatory framework such as national policies and legislations relevant to the project, which are not environmental media specific, and to assess the extent to which the project is in line with these requirements. This investigation should include, but not necessarily be limited to the following:

- National environmental policy and legislation, planning and development control frameworks including protected areas and environmental quality standards with implications for the project, such as environmental protection, health and safety and land-use control;

- Regional and international agreements and conventions relevant to the project and its activities; and

- Regulatory agencies responsible for environmental protection and planning, their resources and capacity to address the issues raised by the project.

4.5.3 MODULES 3 - 14

Modules 3-10 will address specific environmental and social media relevant to the project and project area. Modules 11 -12 will focus on the impacts and risks the project will pose to the environment while Module 13 will propose a system to manage those impacts and risks. A Closure Plan for the project operation will be presented in Module 14. The specific focus of each of the modules is listed below:
Module 3: Air quality, noise, vibrations and Greenhouse gases
Module 4: Hydrology and Water resources
Module 5: Biological resources
Module 6: Geological/soil resources
Module 7: Mineral resources
Module 8: Land use
Module 9: Social and economic resources
Module 10: Cultural resources
Module 11: Cumulative Impacts
Module 12: Risk Assessment
Module 13: Environmental Management System
Module 14: Closure Plan

Further, Modules 3- 10 will each comprise the following five (5) components:
(i) Environmental setting/baseline description;
(ii) Regulatory setting specific to the particular medium;
(iii) Project impacts;
(iv) Environmental Management and Monitoring Plan; and
(v) Project alternative(s).

4.6 Environmental Setting/Baseline Description

For this component there will be a review of recent studies undertaken in the study area to determine their relevance to the current physical, biological and socio-cultural environment. Also, field studies will be undertaken to fill appropriate data gaps to enable a comprehensive description of the current physical, biological and socio-cultural environments. The data presented for this component shall be representative of the study area. The term 'representative' defines the extent to which a set of measurements taken at a collection site spatially and temporally reflects the actual conditions within the study area. Therefore, in instances where the data are being collected and reported from stations that are located off site i.e. outside the boundaries of the study area, a justification must be provided to demonstrate that the data are representative of the study area. Otherwise, the proponent will be required to provide more accurate, site-specific data. The study must include changes that may occur before the project commences in light of previous, ongoing (i.e. other operations within the defined study area) or future activities that could reasonably be determined to have a combined effect. Sufficient detail must be given to allow a clear understanding of the likely negative impacts of the proposed project and to assess the effectiveness of any proposed mitigation measures. An examination of any positive impacts should also be included to ensure as comprehensive an assessment as possible. Adequate spatial and temporal samples shall be taken to ensure a proper assessment of baseline conditions.

Baseline description shall include but not be limited to the following:

4.6.1 Air Quality

This baseline shall describe, assess and discuss:

- The wind regime of the project area, including wind speed and direction, prevailing wind conditions, seasonal variations and storm conditions as supported by representative meteorological data for the area.
- Rainfall in the areas, including seasonal variations.
- Air Temperature and Relative Humidity
- Appropriate ambient air quality parameters associated with expected emissions of this type of project including, but not limited to, the ambient concentration of total particulate matter (PM), PM 10 and 2.5, carbon monoxide (CO), oxides of Nitrogen (N0x) and Volatile Organic Compounds (VOCs).

4.6.2 Noise

The baseline shall present, assess and discuss:

- Ambient noise levels representative of the present study area supported by relevant data on:
    - Peak and average sound pressure levels.
    - Background noise levels.

- Data on ambient sound pressure level from readings taken for morning and afternoon and a range of descriptors used to ensure the respective areas are adequately characterized.

4.6.3 Geology, Land and Soils

This baseline will present:

- Geology and soil characteristics of the site including, but not limited to:
    - Subsurface stratigraphy (mapped) and a reserve assessment of the mineral resources that have been identified must be included.
    - Description supported by a map the soil types and their distribution in the study area.
    - Topography evidenced by a topographical map that shows the elevation patterns at the site and zone of impacts.
    - Soil quality baseline (extractable).
    - Geomorphology of the study area and specifically for the site wherever practicable (i.e. rates of landform change, erosion and depositional processes)

- Existing Levels of Contamination/Degradation in the Field

  This shall include but is not limited to:

    - Assessment of point and non-point sources of pollution to determine the type and extent of contamination in the area including an identification of the location of any legal or illegal gold/other mining, forestry, dumping or other activities within the project location that may be a source of pollution. Samples shall be taken where appropriate to determine pollution levels for air, water (surface and groundwater) and soil. This data shall be mapped.

4.6.4 Waste Management

This baseline will describe and assess the expected waste streams from the proposed project activities onto the land during the construction, operational and decommissioning phases of the project. This will include information on the quantity, form (liquid, solid, gas), hazard, and toxicity of each significant waste, as well as any attributes that may affect its likelihood of dispersal in the environment, as well the associated risk of causing environmental harm.

4.6.5 Water Resources

With regard to this medium, information will be provided on:

- Groundwater — including, but not limited to:
    - A discussion of the characteristics of the major aquifers and other groundwater in the study area, including groundwater quality, area and volume capacity, and specifically whether they are confined or unconfined.
    - A Map of recharge areas of aquifers, where these occur in the study area.
    - An assessment of extraction and recharge rates, where available.
    - Water quality based on parameters mandated by EPA Mining EIA guidelines.

- Surface Water Quality-including, but not limited to:
    - Assessment of ambient water quality of any natural watercourses upstream and down- stream of the site;
    - Assessment types and sources of contaminants in any streams draining from the project site into any natural watercourses;
    - Analysis of pH, total suspended solids, chemical oxygen demand, biochemical oxygen demand, and metals;
    - Analysis must include assessment of seasonal variations, and comparison of findings with acceptable water quality standards.
- Surface Hydrology and Drainage - mapping and discussion of the existing drainage patterns/characteristics of the sites and wider study area, and the dry season and wet season flow rates of the watercourses.

4.6.6 Biological Environment

For this medium the baseline shall:

- Aquatic and Terrestrial flora and fauna: characterise the biological environment to include the following:
    - Use of site-specific field surveys to assess the terrestrial and aquatic environments for impact prediction and development of mitigation and monitoring programs. The sampling regime must be scientifically rigorous and statistically significant to allow for future comparisons. Life cycles, seasonality and migration of species (where applicable) shall also be captured.
    - Flora-map and describe the existing terrestrial and aquatic vegetation.
    - Provide information on plant species and communities that are present within the study area, including information on any rare or endangered plant species and information on any specialised or unique plant communities that may be present.
    - Mapping of plant communities and the area of estimation of any community type that may be lost due to project activities.
    - Fauna of the site and their use of the surrounding environments - document and describe any species of wildlife including, but not limited to, amphibians, fish, reptiles, birds, mammals and invertebrates, that use the study area.
    - Provide a detailed habitat assessment, including identification of those of resident species of major watercourses on site, and especially those which will be altered by the project (where applicable);
    - Describe any freshwater fisheries (whether commercial, subsistence, or recreational), including the species targeted by local communities in the study area;
    - Identify and describe environmentally sensitive species and areas in the study area;
    - Identify rare, threatened, endangered and endemic species.

4.6.7 Socio-cultural Environment

The baseline will describe the socio-cultural baseline of the project-impacted areas. In order to capture a true representation of the baseline conditions, it will be useful to identify the proposed project's probable area of influence, as it relates to its potential biophysical and socio-cultural impacts. This may be achieved through the collection, reporting and analysis of appropriate and sufficient data from relevant sources (including Census data, information from Village Councils, local government, community-based organisations) and primary research. Map overlays (depicting any communities within the areas of potential impact) should be used to provide a spatial

portrayal of socio-cultural data. Field studies shall be undertaken to fully establish an appropriate social baseline, and to update information that may no longer be current. Appropriate data gathering methods shall be used commensurate with the level of detail required to determine risk to socio-cultural components.

The social baseline shall include, but not be limited to, the following information:

- Information about the traditional, existing and proposed land use in the project's area of influence identified above, and the nature, size, location and duration of their potential interactions with the environment. Land use shall be described both for amenity and aesthetics, and in terms of its importance to cultural activities
- Customs, aspiration and attitudes - indicate (by providing documentation) the acceptability of the proposed project to nearby communities and users of the area;
- Archaeological, cultural and historic value of the areas.

4.6.8 Occupation, Health and Safety Considerations

The baseline will examine Occupational health and safety issues such as:

- The safe use of explosives and machinery, personal protective equipment, emergency response plans for accidents and injuries and surveillance of workers health;
- Increased dangers from blasting, hazardous substances waste etc., to the surrounding environment (ground and surface water); these will be analysed and mitigation measures for community and occupational health and safety shall be proposed.

4.7 Specific regulatory setting

This component of each module will describe the relevant local regulations, standards and guidelines governing the specific environmental media covered by each module.

4.8 Significance criteria and project impacts, including cumulative impacts

Identify all impacts that could arise during each phase of the operation and distinguish, where applicable, between negative and positive impacts, direct and indirect impacts, immediate, short-term and long-term impacts, and cumulative impacts. To illustrate significance, direct comparisons should be made between estimates of the potential impacts and the baseline conditions for given parameters/indicators.

Describe impacts quantitatively, as far as possible, and consider those that can occur in unforeseen circumstances. The reliability of forecasts and predictions shall be indicated as appropriate. Impacts must be categorised and illustrated using an appropriate format e.g. matrices where applicable. Data from other existing activities using the same technology should be used to compare, or assist in the prediction of impacts for this proposed project, where applicable.

A method of determination of impact significance must be clearly outlined, including specific significance criteria that would allow the reader to understand the level of impact of the project on key ecological and socio-cultural components and how these levels were estimated. Areas of impact/hazards shall be illustrated in map form and those that are unavoidable or irreversible must be specifically identified. Significant changes to baseline conditions shall also be quantified where possible. A determination of impact significance shall be provided for each key environmental or socio-cultural component (by major phase or activity) after considering the application of proposed mitigation measures (i.e. rank the significance of residual effects following mitigation.

The potential impacts to be discussed include, but are not limited to, those related to:

- Human beings including, but not limited to, such aspects as:
    - Community (health, safety, socio-cultural);

- Investigate possible effects to demographic and socio-cultural profiles of the communities that would be potentially affected by the project e.g. consider neighbouring farmlands, local employment and training, local procurement, vulnerable groups (youth and elderly, handicapped, other users of the area etc.), transport, health services, security, lifestyle and culture. The potential for unplanned settlements, overloading of any community infrastructure and social conflict between workers and communities, and the potential for the project to result in displacement/relocation of community members and/or services should also be included;
- The introduction of increased dangers (e.g. fire, explosion, spills, chemical and other hazardous substances, if applicable) to the surrounding environment, including neighbouring communities;
- Infrastructure and utilities (roads, bridges, water, electricity, services, waste disposal). Consider the indirect impact of accessibility of this area to humans and the attendant demand on infrastructure and utilities;
- Impact of the project on transportation planning and traffic — discuss potential health and safety impacts due to changes in traffic conditions, such as increased volumes and increased incidence of large/heavy vehicles;
- Discuss the potential for changes to air quality that might increase human exposure to contaminants/pollution including the impacts of the increased volume of dust and the potential health impacts associated with exposure to these contaminants/pollutants.

- Flora and fauna including, but not limited to, such aspects as:

  - Impacts on terrestrial and aquatic habitat use and ecology;
  - Impacts to sensitive species such as endangered or subsistence/commercially exploited species;
  - Expected changes in the health of flora and fauna that will result from the introduction of the activity. This must include any expected changes to species count and diversity within the study area. The assumptions used for making such correlations must be explained;
  - Natural habitats - determine/estimate the degree of habitat fragmentation or degradation likely to occur both in qualitative and quantitative terms (i.e. acreage or extent of habitat fragmentation or reduction as well as the reduction in biodiversity and available ecological niches);
  - Wider impacts on terrestrial ecology of the study area, as effects are transferred along the food chain.

- Water (surface and groundwater) quality — including, but not limited to, such aspects as:

  - Effect of the mining site run off on surface water quality and the potential for contamination of groundwater from any aspect of the proposed project as it relates to the mining site;
  - The impact of the processing plant's outfall on the ambient water quality at the discharge point;
  - Impacts to the hydrology of the study area in terms of changes to groundwater recharge rates, drainage patterns, sediment loads and effects on water table (impacts should be quantified/qualified in relation to appropriate baseline parameters). Consider impacts to hydrological resources in terms of loss or impairment of resource (i.e. healthy ecological/aquatic habitat and source of potable water);The cumulative water quality effects that are likely to result from the project in combination with other existing, approved and other ancillary projects;
  - Discuss the potential for flooding as a result of the proposed activities.

- Air quality — including, but not limited to, such aspects as:

  - Dust — the generation and movement of dust off site during the mining operation;
  - Air quality as a result of exhaust emissions from machinery and equipment.
    Noise — estimate the potential for increased noise from the operations and vehicles, both unloaded and loaded, to the nearby communities and fauna. Also consider the impact of noise from the mining operations on the existing fauna;
  - Geology, soils and terrain — assess the impact of operational activities on the geological features of the site, including the type, extent and frequency of these impacts to the pre-development

topography. Assess the potential for operations to affect the stability of the substrate in terms of slope stability (i.e. vulnerability to land slippage, erosion), shear strength, porosity and compressibility. This assessment should be done in the context of baseline pre-development conditions;

- Solid waste — identify the activities of all phases of the project that may produce both hazardous and non-hazardous solid waste, and assess the possible impacts associated with the type of waste produced;

- Cumulative effects likely to result from the project in combination with other existing, approved and other ancillary projects.

- Impacts on archaeological and historical sites and cultural resources of interest, where applicable.

4.9 Environmental Management and Monitoring plan for each module

Proposed mitigation measures to reduce adverse effects and measures to enhance benefits must be clearly described. A list of all commitments for mitigation, monitoring and follow-up measures must be clearly recorded and included in an Environmental Management and Monitoring Plan.

In consideration of significant adverse impacts that were identified propose realistic, feasible measures by employing Best Available Technologies Not Entailing Excessive Cost (BATNEEC) and Best Practicable Environmental Options (BPEO) to avoid, mitigate or remedy such impacts to acceptable levels. These should satisfy, and show comparison with, local environmental, health and safety standards/guidelines and, where these are not available, international standards/guidelines shall be used. In those cases where negative impacts are known or expected to be significant, it is to the proponent benefit to follow the impact hierarchy of avoidance, minimisation, and mitigation in the project planning. Avoidance of impacts (e.g. to sensitive areas) should be the first choice and is the most beneficial to the Applicant in economic terms. If significant impacts can be avoided, the costs and delays associated with mitigation planning and permitting are also avoided. If impacts cannot be entirely avoided, it is tothe Proponent's benefit to minimise impacts for the same reasons. Mitigation is the least desirable course of action because of the costs and delays related to mitigation planning, design, permitting and implementation, as well as potential for some measure of degradation to or loss of natural resources.

Mitigation measures can be best addressed in the form of an Environmental Management Plan (EMP) that must be formulated and submitted. The EMP shall be a framework management plan for the project that seeks to manage existing health, safety and environmental issues resulting from the proposed project. The EMP must identify potential negative impacts of each phase of the project (e.g. extraction, storage, transportation, processing and rehabilitation) and describe the specific measures to be taken to avoid, manage or compensate for identified potential negative impacts. Mitigation measures shall specifically describe how existing pollution would be handled to prevent a cumulative effect with respect to the intended project.

A separate EMP will not capture the mitigation of that specific media. The management measures must fall within each module.

The EMP shall also include a table that summarises potential impacts, and describes mitigation measures that will be used. Details to be included within the management plan shall comprise, but not be limited to:

- Environmental Policy of the company and specific objectives of the plan;
- The principles that have been incorporated into the project design for pollution prevention and waste minimization;
- Plans to minimise the production or release into the environment of substances that may have an adverse effect on biota or human health;
- Management plan for the protection of important flora and fauna;
- A conceptual contingency plan that considers environmental effects associated with upset conditions such as serious malfunctions or accidents;

- Management plans for the protection of surface water quality. Management of water-related impacts, such as site run off and flooding, and how these plans will be incorporated into the project design;
- Management strategies to address community and public health and safety, inclusive of:

    - Social Impact or Community Management Plans;
    - Traffic Management Plans during the construction and operational phases;
    - Emergency Response Plan.
    - Conceptual Rehabilitation and Closure Plan - A conceptual closure plan shall be developed and shall include guidelines to minimize environmental degradation and to enhance the potential for long-term environmental restoration success. These guidelines shall address permanent protection of the environmental baseline conditions assessed and restoration of habitat compatible with native culture.
    - Monitoring programmes that will be implemented to assess the effectiveness of mitigation during the project's development and operation;
    - Plans to verify the accuracy of predictions or to determine the effectiveness of mitigation plans;
    - Identification of persons within the company responsible for executing the EMP;
    - Determination of requirements for ensuring that responses to predicted impacts are effective, and an implementation schedule (timing) for mitigation measures that must be carried out as part of the project.

- Development of a Monitoring Plan: a detailed monitoring plan must be provided for the different aspects of the project to ensure that mitigation measures are achieving their objectives. Where monitoring indicates that objectives are not being met, contingency plans to minimise adverse situations that may arise (or that have arisen) must be described. Monitoring programmes shall address the physical, biological and social impacts of the project. The parameters/indicators to be monitored and their respective frequencies of measurement must be detailed. The plan should address monitoring of the following:

    - Surface and groundwater quality (dissolved oxygen, pH, biochemical oxygen demand, chemical oxygen demand, total suspended solids, and metals);
    - Air quality (PM, CO, NO and VOCs);
    - Noise levels (measured in dBA).

Emphasis should also be placed on identifying pre-existing sources of pollution at and immediately surrounding the site where applicable.

A copy of all monitoring reports prepared in respect of the Proponents previous and present activities, where applicable, shall be made available in the Appendix of this EIS and based on these monitoring reports, it shall be determined whether predicted impacts are valid and the proposed mitigation measures are adequate or need to be re-evaluated. Include also any monitoring programs proposed to be conducted collaboratively with other stakeholders. Include in this program a description of the role and responsibilities. Devise mechanisms for sharing results, reviewing findings and adjusting programs, should monitoring identify unanticipated consequences of its operations or mitigation plans, including:

    - Corporate adaptive management strategies;
    - Consultation with regulators, public stakeholders and, if necessary, relevant management fora.

4.10 Project Alternatives

The Project Proponent is required to examine alternatives to the project design, focusing on its impact on the environment. This investigation should include, but not necessarily be limited to, the following aspects:

- Any feasible alternatives to the project design as formulated, such as the project location, sources of materials, resources, technology and management;

- The Project Proponent is required to describe the findings of any work or study undertaken to date (either by comparing potential options or selecting a preferred option such as previous option studies or preparatory assessments). This should include any issues identified during consultation with the general public, regulatory authorities, special interest groups and other key stakeholders during such studies related to the alternatives and proposed project. The reasoning for the selection of the proposed project compared to other potential options should be given;

- The Project Proponent will benchmark, where applicable, the preferred alternative against case studies of similar projects and will describe reasonable alternatives to the proposed project that would achieve similar objectives. This extends to, but is not limited to, the project alternatives such as siting, mine design, technology selection, extraction and processing techniques, treatment of effluent, operation and maintenance procedures; and

- The no action' alternative must also be considered. Provide a comparison of impacts as a result of a continuation of existing activities and conditions with those of the proposed project and action alternatives. This will demonstrate potential changes in the existing socio-cultural and environmental baseline conditions without the project. Alternatives shall be discussed in sufficient detail to clarify the reasons for preferring certain options and rejecting others. The reasons for choice of the preferred option(s) must be explained, including the following:

    - A comparison of the adverse and beneficial effects (both to the environment and community) used as the basis for selection;

    - Compliance with government policy;

    - Compliance with the principles and objectives of sustainable development;

    - The impact of significant delay or abandonment of the project before all of the proposed phases are completed.

4.11 Cumulative Impact Assessment

This description shall include an assessment of the cumulative environmental effects that are likely to result from the proposed activities in combination with other existing, approved and proposed projects in the area that could reasonably be considered to have a combined effect. The cumulative assessment must be based on an adequate understanding of the design and operation of the proposed activity, as well as other existing, approved and proposed projects. Cumulative effects shall either be described within a specific section of the EIS on cumulative effects, or be well defined within each of the report's sub-sections on potential effects, as relevant.

4.12 OTHER INFORMATION

Environmental assessment requires interdisciplinary analysis. Experts in their relevant fields should interpret information obtained and where necessary, appropriate references and technical/scientific analyses shall be provided to support such interpretations. This shall also apply to social issues, especially when dealing with sensitive matters.

An environmental impact assessment shall be submitted for public comment in accordance with Section 11 (10) of the EP Act Section 11(10) stipulates a period of not less than sixty (60) days to receive public comments and this EIA and EIS would be made available for such comments as part of an administrative record.

In order to aid the review process, the following information should be submitted to the EPA:

- Four (4) hard copies and one (1) digital copy of the EIA report to be submitted to the EPA in the first instance for preliminary review. If the EPA is not satisfied with the original submission, the documents

will be returned to the Proponent to address these concerns; If the submission is deemed acceptable, the proponent will be requested to submit a further 21 hard copies and two (2) digital copies of the EIS;
- Digital copies of the EIS should be in PDF format and the Executive Summary in Microsoft Word. Each Module/Volume of the EIS and each Appendix must be individual PDF files; all spatial and mapped data required must be provided digitally in a GIS format compatible with ArcView 9.3.

These will be copied and used for the public comment process, as well as being available to other departments/agencies that would have a critical role in the evaluation of the EIS.

5.0 EIA TEAM OF CONSULTANTS

The Environmental Impact Assessment will be undertaken by the firm Ground Structures Engineering Consultants Inc (GSEC). The study team assembled for this assignment consists of individual(s) who are recognized experts in conducting environmental impact assessments in Guyana. The group of professionals, assembled to conduct the EIA, all have the necessary range and depth of experience and a thorough understanding of local conditions to conduct the ESIAs to World Bank and Guyana EPA Standards.

Charles P. Ceres, GSEC Project Director, GSEC

Charles P. Ceres is the Managing Principal of Ground Structures Engineering Consultants Ltd. of Guyana. He will be the Project Director and will provide strategic guidance to the team and will be responsible for project co-ordination and logistics. Mr. Ceres will oversee the fieldwork and baseline studies. Mr. Ceres has been responsible for the management and execution of a wide variety of environmental projects in Guyana, the United States and the Caribbean. Mr. Ceres has also managed several EIAs and EAs in Guyana. He managed the EIA for the expansion of the Guyana Sugar Corporation Skeldon Estate and has served as a consultant to the Guyana Environmental Protection Agency. Mr. Ceres has supervised several environmental monitoring and remediation projects both in Guyana and overseas. His experience in Guyana includes supervision of the installation of groundwater monitoring equipment at Omai Gold Mines Tank Farm and the environmental audits for the privatization of Linmine and Bermine. His experience in the Northeastern United States includes supervising the installation of equipment for the remediation of soil and groundwater contamination and managing several National Pollution Discharge Elimination Systems (NPDES) installations.

In addition to definition of the regulatory/legislative framework for the project, Mr Ceres' responsibilities will include the development of management and mitigation plans to minimize impacts on environmental resources. He has served in a similar capacity on several other projects in Guyana including the Strategic Environmental Assessment for Guyana's Mining Sector and the Aurora Gold Mines Project.

Signed by:

…….
Environmental Protection Agency

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Ground Structures Engineering Consultants Inc.

1.0 BIOLOGICAL SURVEY FIELD DATA

Appendices

Fauna Field Data:

2017-2018 Transect Observation Amphibians Surveys

Scientific Names	Wet Season							Dry Season						
	Cmp	Trn1	Trn2	Trn3	Trn4	Trn5	Marudi	Cmp	Trn1	Trn2	Trn3	Trn4	Trn5	Marudi
Adenomera andreae	-	-	-	-	-	-	-	-	-	U	U	-	-	-
Adenomera hylaedactyla	-	-	-	-	-	-	-	-	-	-	U	-	-	-
Allobates femoralis	F	C	U	C	F	U	-	-	F	-	U	-	-	-
Ameerega flavopicta	U		-	U	U	U	-	-	-	-		-	-	-
Ameerega hahneli	-	C	U	-	C	U	-	-	U	-		-	-	-
Ameerega trivittata	-	C	-	-	U	-	-	-	-	-		-	-	-
Chiasmocleis sp	-	-	-	O	-	-	-	-	-	-		-	-	-
Colostethus baeobatrachus	-	U	-	-	-	-	-	-	U	-	F	-	-	-
Colostethus degranvillei	-	O	-	-	-	-	-	-	-	-		-	-	-
Colostethus sp1	-	U	-	C	-	-	-	-	-	-		-	-	-
Colostethus sp2	-	-	U	-	-	-	-	-	-	-		-	-	-
Dendropsophus brevifrons	-	-	-	-	-	-	-	U	F	-	U	-	U	-
Dendropsophus minutus	-	O	C	U	C	-	-	-	F	F	U	U	-	-
Eleutherodactylus inguinalis	-	-	-	-	-	-	F	U	U	-	F	-	-	U
Eleutherodactylus zeuctotylus	-	-	-	-	-	-	-	-	U	-	-	-	-	-
Eleuthrodactylus sp1	C	-	-	U	-	-	-	-	-	-	-	-	-	-
Hypsiboas boans	-	-	O	U	U	-	U	U	C	C	F	F	U	U
Hypsiboas calcarata	-	-	U	-	U	-	-	U	F	U	U	U	U	-
Hypsiboas cinerascens	-	-	-	-		-	-	-	-	-	-	U	-	-
Hypsiboas crepitans	-	F	U	F	U	-	-	-	-	-	-	-	-	-
Hypsiboas fasciatus	-	-	-	-	-	-	-	-	U	-	-	U	U	-
Hypsiboas geographica	-	-	U	U	U	-	-	-	-	-	-	-	-	-
Hypsiboas leucophyllata	U	C	C	-	-	-	-	-	-	-	-	U	-	-
Hypsiboas punctatus	-	-	-	-	-	-	-	-	-	U	U	-	-	-
Hypsiboas raniceps	-	U	-	-	-	-	-	-	-	-	-	-	-	-
Hypsiboas sp	-	-	-	F	F	-	C	U	U	-	-	-	-	U
Leptodactylus fuscus	-	C	-	-	U	-	-	-	-	-	-	-	-	-
Leptodactylus knudseni	-	-	U	-	-	-	-	-	-	-	-	-	-	-
Leptodactylus longirostris	-	-	-	-	-	-	-	-	-	-	F	-	-	-
Leptodactylus mystaceus	-	F	-	C	U	U	-	-	U	-	U	F	-	-
Leptodactylus pentadactylus	-	U	-	C	-	U	-	-	-		U	-	-	-

Leptodactylus petersii	-	-	-	-	-	-	-	-	-	U	U	-	-	-
Lithodytes sp	-	-	-	U	-	-	-	-	-	-	-	-	-	-
Osteocephalus oophagus	-	-	U	O	U	U	-	-	-	-	-	-	-	-
Osteocephalus sp	-	O	-	O	U	-	-	-	-	-	-	-	-	-
Osteocephalus taurinus	-	-	-	O	-	-	-	-	-	-	-	-	-	-
Phrynohyas coracea	-	-	-	O	-	-	-	-	-	-	-	-	-	-
Phyllomedusa bicolor	-	-	U	-	-	-	-	-	U			-	-	-
Phyllomedusa hypocondrialis	-	-	-	-	-	-	-	U	-	U	U	-	-	-
Phyllomedusa sp	-	-	U	-	-	-	-	-	-	-	-	-	-	-
Physalemus cuvieri	F	C	C	C	C		-	-	-	-	-	-	-	-
Rhaebo guttatus	-	-	-	-	-	O	U	-	-		F	-	-	U
Rhinella granulosa	-	-	-	-	-	-	-	-	-	U	U	-	-	-
Rhinella margaritifier	-	-	-	-	-	-	-	-	-	-	U	-	-	-
Rhinella marina	O	-	U	U	-	-	U	U	F	-	F	U	O	U
Rhinella nasicus	-	U	-	-	-	-	-	-	-	-	-	-	-	-
Scinax boesemani	-	-	U	U	U	-	-	-	-	U	U	-	-	-
Scinax ruber	-	U	-	-	-	-	-	-	U	U	U	-	-	-

Transect Observation 2017 – 2018 Reptilian Surveys

Scientific Names	**Wet Season**							**Dry Season**						
	Cmp	**Trn1**	**Trn2**	**Trn3**	**Trn4**	**Trn5**	**Marudi**	**Cmp**	**Trn1**	**Trn2**	**Trn3**	**Trn4**	**Trn5**	**Marudi**
Ameiva ameiva	-	F	-	U	U	U	C	C	C	U	A	F	-	C
Anolis planiceps	-	-	-	-	O	-	-	-	-	-	-	-	-	-
Anolis sp	-	-	O	-	-	-	-	-	U		U		-	-
Chelonoides denticulata	-	O	O	-	-	-	-	-	-	-	-	-	-	-
Corallus caninus	-	-	-	-	-	-	-	-	-	-	-	-	O	-
Corallus hortulanus	-	O	-	-	-	-	-	-	-	-	-	-	-	-
Drymoluber sp	-	-	O	-	-	-	-	-	-	-	-	-	-	-
Epicrates cenchria	-	O	-	-	-	-	-	-	-	-	-	-	-	-
Gonatodes humeralis	-	U	-	-	-	-	-	-	-	-	-	-	-	C
Gonatodes sp	-	-	-	O	-	-	U	U	-	-	U	-	-	-
Hemidactylus sp	-	-	-	-	-	-	-	-	-	-	F	-	-	-
Kentropyx calcarata	-	U	-	-	-	-	-	-	-	-	-	-	-	-
Kentropryx sp	-	-	-	-	-	-	F	U	-	-	U	-	-	C
Kentropyx striata	-	-	-	U	-	-	F	-	-	-	-	-	-	-
Lachesis muta	-	-	-	-	-	-	-	-	-	-	-	-	O	-
Leposoma sp	O	-	O	-	-	-	-	-	-	-	-	-	-	-
Mabuya mabuya	-	-	-	O	-	U	-	-	-	-	-	-	-	-
Mabuya nigropunctata	-	-	-	-	-	-	-	U	O	O	O	U	-	U
Neusticurus sp	-	-	O	-	-	-	-	-	-	-	-	-	-	-
Oxybelis aenus	-	-	-	-	-	-	-	-	-	O	-	-	-	-
Paleosuchus sp	-	-	-	O	-	-	-	-	-	-	-	-	-	-
Philodryas viridissimus	-	O	-	O	-	-	-	-	-	-	-	-	-	-
Rhynoclemmys punctularia	O	U	-	-	-	-	-	-	-	-	-	-	-	-
Thecadactylus rapicauda	-	O	-	-	-	O	-	-	-	-	-	-	-	-
Tropidurus sp	-	-	-	-	-	-	-	-	-	-	C	-	U	-

2017-2018 Transect Observations Avifauna Surveys

Scientific Name	Dry season							Wet season						
	Cmp	Trn1	Trn2	Trn3	Trn4	Trn5	Marudi	Cmp	T1	T2	T3	T4	T5	Marudi
Actitis macularius	-	-	S	S	-	S	-	-	-	-	-	S	-	-
Amazona amazonica	-	-	S	S	-	-	-	-	-	F	-	F	-	-
Amazona dufresniana	-	-	-	S	-	S	S	-	-	-	-	-	-	-
Amazona farinose	-	-	-	-	-	-	-	-	F	-	-	S	-	-
Ara ararauna	-	U	-	-	S	-	S	-	U	-	S	-	-	-
Ara chloropterus	-	-	-	S	F	F	-	-	F	F	F	-	-	S
Ara macao	-	S	S	S	S	-	-	-	-	-	S	-	-	S
Arremon torquatus	-	-	-	-	S	S	-	-	-	-	-	-	-	-
Attila spadiceus	-	S	-	-	-	S	-	-	-	-	-	U	-	-
Automolus rufipileatus	-	S	-	-	-	U	-	-	-	-	-	-	-	-
Brotogeris chrysoptera	-	U	S	F	-	F	F	-	-	-	S	F	-	-
Bubulcus ibis	-	-	-	-	-	-	-	-	-	-	S	-	-	-
Bucco capensis	-	-	S	-	-	S	-	-	-	-	-	-	-	-
Buteo brachyurus	-	-	-	-	-	-	-	-	S	-	-	-	-	-
Buteo nitidus	-	S	-	S	-	-		-	-	S	-	S	-	-
Buteogallus schistaceus	-	S	-	S	-	-	-	-	-	-	-	-	-	-
Cacicus haemorrhous	-	S	S	-	S	-	-	-	-	S	S	S	-	-
Campephilus rubricollis	-	-	-	-	S	-	-	-	S	-	S	-	-	-
Camplyorhynchus griseus	-	-	-	-	-	-	S	-	-	-	S	-	-	-
Campylopterus largipennis	-	-	-	-	-	-	-	-	-	-	S	S	-	-
Capito niger	-	-	F	U	-	-	-	-	S	-	-	S	-	-
Caprimulgus nigrescens	-	-	S	S	-	-	-	-	-	-	-	-	U	-
Caryothraustes canadensis	-	S	S	-	-	-	-	-	F	-	-	-	-	-
Cathartes aura	-	-	S	-	-	S	-	-	-	-	-	-	-	-
Catharthes melambrotus	-	-	-	-	-	-	-	-	U	-	S	-	-	F
Celeus elegans	-	U	-	-	S	-	-	-	S	-	-	-	-	-
Celeus flavus	-	-	-	-	-	-	-	-	S	S	-	-	-	-
Celeus undatus	-	-	-	-	-	-	-	-	S	-	-	-	-	-
Cercomacra cinerascens	-	F	S	S	S	-	-	-	-	U	-	U	U	-
Cercomacra tyrannina	-	U	-	S	-	S	-	-	-	U	-	U	-	S
Chaetura cinereiventris	-	-	-	-	-	-	-	-	F	-	C	-	-	-
Chaetura sp	-	-	-	-	-	-	-	-	F	-	-	-	-	-
Chaetura spinicauda	-	-	-	-	S	S	-	-	-	-	-	-	-	-
Chloroceryle amazona	-	-	-	-	-	-	-	-	-	-	S	-	-	-
Chloroceryle americana	-	-	S	S	S	U	-	-	-	S	-	S	-	-

Chlorophanes spiza	-	-	-	U	-	S	S	-	U	S	-	U	-	-
Columba plumbea	-	-	S	-	-	-	-	-	S	-	-	-	-	-
Columbina passerina	-	-	-	-	-	-	S	-	-	-	-	-	-	U
Conopias parvus	-	-	S	S	S	S	-	-	U	U	-	-	-	-
Coragyps atratus	-	S	F	U	U	U	U	-	-	-	-	F	-	F
Cotinga cayana	-	-	-	-	-	-	U	-	-	-	-	-	-	-
Crotophaga ani	-	S	U	S	F	U	U	-	-	F	-	-	-	-
Cryptturellus soui	-	-	-	-	-	-	-	-	-	-	-	-	S	S
Crypturellus cinereus	-	S	-	U	-	-	S	-	-	-	-	-	-	-
Crypturellus variegatus	-	S	-	-	-	-	-	-	S	S	S	S	-	-
Cyanerpes caeruleus	-	-	S	U	S	S	S	-	-	-	U	S	-	-
Cyanerpes cyaneus	-	-	S	-	S	-	-	-	U	-	-	-	-	-
Cyanicterus cyanicterus	-	-	S	-	S	-	-	-	F	-	-	-	-	-
Cyanocompsa cyanoides	-	S	-	S	S	-	-	-	-	-	S	-	-	-
Cyanocorax cayanus	-	-	-	-	-	-	U	-	F	U	-	-	-	-
Cymbilaimus lineatus	-	S	-	-	-	-	U	-	-	-	S	-	S	S
Deconychura typical	-	-	-	S	S	S	-	-	-	-	-	-	-	-
Dendrocolaptes certhia	-	-	S	-	S	-	S	-	-	-	-	-	-	-
Deroptyus accipitrinus	-	S	-	S	S	S	S	-	S	-	-	S	-	S
Dryocopus lineatus	-	S	-	S	-	-	-	-	S	-	S	S	-	-
Elanides forficatus	-	S	U	S	S	U	F	-	S	F	-	-	-	-
Euphonia cayennensis	-	-	-	-	-	-	-	-	-	-	-	F	-	-
Euphonia finschi	-	-	-	-	-	-	S	-	-	-	-	S	-	-
Euphonia violacea	-	S	-	S	-	S	-	-	-	-	S	S	-	-
Falco rufigularis	-	-	-	-	-	-	-	-	-	S	-	-	-	-
Formicarius analis	-	-	-	F	-	S	-	-	-	S	S	S	-	-
Formicarius colma	-	U	-	-	-	-	-	-	-	-		S	-	-
Forpus sclateri	-	-	S	U	-	-	-	-	-	-	-	S	-	-
Galbula albirostris	-	S	S	-	-	S	-	-	S	-	-	-	-	-
Galbula dea	-	F	-	S	-	-	-	-	U	-	S	-	-	-
Galbula galbula	-	S	-	-	S	-	S	-	-	-	S	-	-	-
Geotrygon montana	-	-	-	U	S	-	S	-	-	-	-	-	S	-
Glaucidium hardyi	-	S	-	-	-	S	-	-	-	-	-	-	S	-
Glyphorynchus spirurus	-	S	-	-	-	S	-	-	F	-	S	-	-	-
Gymnopithys rufigula	-	-	-	U	-	-	-	-	-	-	-	-	-	-
Haematoderus militaris	-	-	-	-	-	-	-	-	S	-	-	-	-	-
Harpia hapyja	-	-	-	-	-	-	-	-	-	-	S	-	-	-
Heliothryx auratus	-	-	-	-	-	-	-	-	S	-	-	S	S	-
Hemithraupis flavicollis	-	-	-	-	-	-	-	-	U	-	-	-	-	-

Hemithraupis guira	-	S	S	S	-	-	-	-	-	-	-	-	-	-
Henicorhina leucosticta	-	S	-	-	F	-	-	-	S	S	-	S	S	-
Herpsilochmus stictocephalus	-	-	-	S	S	S	S	-	U	S	S	U	S	-
Herpsilochmus sticturus	-	S	-	-	-	-	S	-	S	-	-	-	-	-
Hylopezus macularis	-	-	-	-	S	S	-	-	S	-	S	-	-	S
Hylophilus griseiventris	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hylophilus musicicapinus	-	-	S	-	S	-	-	-	S	S	S	S	-	-
Hylophylax poecilinota	-	-	S	-	-	S	-	-	-	-	-	-	-	-
Hypocnemis cantator	-	-	-	-	-	-	S	-	U	-	-	S	-	-
Ibycter americanus	-	S	U	S	-	-	F	-	S	S	U	-	-	F
Ictinia plumbea	-	-	-	-	S	S	-	-		C	U	S	-	-
Islerothraupis cristata	-	S	S	-	-	-	S	-	-	-	-	-	-	-
Jacamerops aureus	-	S	S	-	-	-	S	-	-	-	S	-	-	-
Lamprospiza melanoleuca	-	-	-	-	-	-	-	-	F	F	-	-	F	-
Legatus leucophaius	-	-	-	S	-	S	-	-	-	-	-	-	-	-
Leptotila rufaxilla	-	-	S	S	-	-	-	-	-	S	-	-	S	-
Lipaugus vociferans	-	U	S	F	F	S	S	-	U	F	-	U	S	F
Lophotriccus galeatus	-	-	-	-	-	-	S	-	-	S	-	U	S	-
Lophotriccus vitosus	-	-	-	-	-	-	-	-	-	-	U	S	-	-
Megascops watsonii	-	-	-	-	-	-	-	-	S	S	-	-	-	-
Melanerpes cruentatus	-	S	S	S	-	-	-	-	U	S	S	-	-	-
Micrastur mirandollei	-	S	-	-	-	S	-	-	-	-	-	-	-	-
Microbates collaris	-	S	-	-	S	S	-	-	-	-	-	-	-	-
Mionectes macconnelli	-	-	-	S	-	U	-	-	-	-	-	-	-	-
Mionectes oleaginous	-	-	-	S	S	S	-	-	-	-	-	-	-	-
Molothrus oryzivorus	-	S	-	-	S	-	S	-	-	-	S	-	-	-
Momotus momota	-	-	-	-	S	S	-	-	S	S	S	-	U	F
Monasa atra	-	S	S	F	-	F	-	-	-	-	-	S	-	S
Myiobius barbatus	-							-	-	-	-	S	-	-
Myiodynastes difficillis	-	-	S	S	-	-	-	-	-	-	U	-	-	U
Myiodynastes maculatus	-	-	S	S	-	-	-	-	-	-	S	-	-	S
Myiornis ecaudatus	-	-	-	-	-	-	-	-	S	S	-	-	-	-
Myiothlypis rivularis	-	-	-	-	-	-	-	-	-	S	-	-	-	-
Myiozetetes cayanensis	-	-	-	-	-	-	-	-	-	-	-	U	-	-
Myrmeciza ferruginea	-	S	-	-	-	S	-	-	U	S	-	-	-	-
Myrmoborus leucophrys	-	S	S	-	-	S	-	-	-	-	-	-	-	-
Myrmothera campanisoma	-	U	S	-	-	S	S	-	S	S	S	S	-	S
Myrmotherula axillaris	-	-	-	-	S	S	-	-	S	-	-	-	S	-
Myrmotherula longipennis	-	-	-	-	-	-	-	-	-	-	-	S	-	-

Myrmotherula mulyostiata	-	-	-	-	-	-	S	-	-	-	-	-	-	-
Myrmotherula surinamensis	-	-	S	-	-	S	-	-	-	-	-	-	-	-
Nannopsittaca panychlora	-	-	-	S	S	-	U	-	-	-	-	-	-	-
Notharchus sp	-	-	-	-	-	-	-	-	-	-	S	-	-	-
Nyctibius nyctibius	-	S	-	-	-	-	-	-	-	-	-	S	-	-
Nyctidromus albicollis	-	-	-	-	-	-	-	-	-	-	-	-	S	-
Odontophorus gujanensis	-	-	S	S	S	-	S	-	-	-	-	-	S	U
Ornithion inerme	-	-	-	-	-	-	-	-	S	-	-	-	-	-
Ortalis motmot	-	-	-	-	-	-	-	-	-	-	-	-	-	F
Ortalis ruficauda	-	S	-	-	-	-	S	-	-	-	-	-	-	-
Pachyramphus marginatus	-	-	-	-	-	-	-	-	U	-	-	-	-	-
Patagioenas subvinacea	-	-	-	-	-	-	-	-	S	-	-	-	-	-
Penelope jacquacu	-	-	-	-	-	-	-	-	S	-	-	-	-	U
Penelope marail	-	S	U	S	-	S	S	-	-	S	-	-	-	-
Percnostola rufifrons	-							-	S	F	S	S	S	S
Perissocephalus tricolor	-	S	S	-	-	-	U	-	-		U	-	-	-
Petroglossus viridis	-	U	-	-	S	-	-	-	-	-	-	-	-	-
Phaethornis bourceri	-	-	S	-	-	U	-	-	S	-	-	-	-	-
Phaethornis ruber	-	-	-	-	S	-	-	-	U	U	S	-	S	-
Phaethornis superciliosus	-	-	S	S	-	-	-	-	-	-	S	S	-	-
Philohydor lector	-	-	-	-	-	-	S	-	-	-	-	-	-	-
Phoenicircus carnifex	-	-	-	-	-	-	U	-	S	-	S	S	-	-
Piaya cayana	-	-	-	-	-	-	S	-	S	S	F	U	S	S
Piculus flavigula	-	S	S	S	-	-	-	-	U	S	S	-	S	-
Piculus rubiginosus	-	-	-	-	-	-	-	-	U	-	-	-	-	-
Picumnus sp	-	-	-	-	-	-	-	-	S	-	-	-	-	-
Pionopsitta caica	-	-	-	-	-	-	S	-	-	-	-	S	-	-
Pionus fuscus	-	S	S	F	S	U	F	-	-	S	-	U	-	-
Pionus menstruus	-	S	-	-	-	-	-	-	-	-	F	C	-	F
Pipra erythrocephala	-	S	-	-	U	S	S	-	S	S	-	-	-	-
Pipra pipra	-	-	-	-	-	S	-	-	S	-	-	-	-	-
Pithys albifrons	-	S	U	F	U	S	F	-	F	-	-	-	-	-
Platyrinchus coronatus	-	-	-	-	-	-	-	-	S	S	S	-	-	-
Platyrinchus platyrinchus	-	S	S	-	-	-	-	-	-	-	-	-	-	-
Porphyrolaema porphyrolaema	-	S	-	-	-	U	-	-	U	F	U	U	-	-
Procnias alba	-	-	-	-	-	-	-	-	S	-	-	-	-	-

Progne chalybea	-	-	S	S	-	S	-	-	C	F	F	-	-	-
Psarocolius decumanus	-	S	-	-	-	S	-	-	F	-	-	-	-	C
Psarocolius viridis	-	S	-	-	S	-	-	-	-	S	U	-	-	-
Psittacara leucophthalmus	-	-	-	-	-	-	-	-	U	-	-	-	-	-
Psophia crepitans	-	-	-	-	-	S	S	-	-	-	-	-	-	-
Pteroglossus aracari	-	-	S	S	-	-	-	-	F	-	S	F	-	S
Pulsatrix perspicilata	-	-	-	-	-	-	-	-	-	-	-	-	-	S
Pyrrhura egregia	-	-	-	-	-	-	-	-	U	U	-	F	-	-
Pyrrhura picta	-	-	-	-	S	-	S	-	F	-	F	C	-	F
Querula pururata	-	S	-	-	-	-	S	-	U	F	U	S	-	-
Ramphastos toco	-	-	-	-	-	-	-	-	-	-	-	-	-	S
Ramphastos tucanus	-	S	S	S	-	S	-	-	S	U	F	S	-	-
Ramphastos vitellinus	-	U	-	-	-	S	-	-	U	-	S	-	-	-
Ramphocaenus melanurus	-	-	-	S	U	-	-	-	U	-	-	S	-	-
Ramphocelus carbo	-	S	-	-	-	-	-	-	-	F	C	-	-	-
Rhytipterna simplex	-	-	-	-	-	-	-	-	S		S	-	-	-
Saltator grossus	-	-	S	-	-	S	-	-	-	S	-	S	S	-
Sarcoramphus papa	-	S	S	-	-	S	S	-	S	-	-	-	-	-
Schiffornis turdina	-	-	S	-	-	S	-	-	-	-	-	-	-	-
Selenidera culik	-	S	S	-	-	-	U	-	U	-	-	-	-	-
Spizaetus ornatus	-	-	-	-	-	-	-	-	-	S	S	-	-	-
Sporophila intermedia	-	-	-	-	-	-	-	-	-	S	-	-	-	-
Tachyphonus surinamus	-	-	-	S	-	U	-	-	S	-	-	-	-	-
Tangara gyrola	-	-	F	-	-	S	-	-	-	U	-	-	-	-
Tangara mexicana	-	-	-	U	S	-	S	-	-	F	-	S	-	-
Tangara punctate	-	-	S	-	U	S	S	-	-	F	-	-	-	-
Tangara sp	-	-	-	-	-	-	-	-	-	U	-	-	-	-
Tangara velia	-	-	S	-	U	-	U	-	F	-	-	-	-	-
Terenotriccus erythrurus	-	-	-	-	-	S	-	-	-	-	-	-	-	-
Thalurania furcate	-	S	-	-	-	-	-	-	-	S	-	S	-	-
Thamnomanes ardesiacus	-	-	-	-	-	S	-	-	-	-	-	-	-	-
Thamnomanes caesius	-	-	-	S	S	-	F	-	-	-	-	-	S	-
Thamnophilus murinus	-	U	-	-	S	-	-	-	-	U	-	-	-	-
Thraupis episcopus	-	S	-	-	-	-	S	-	F	S	S	-	-	S

Thraupis palmarum	-	-	U	-	S	-	-	-	F	S	U	U	-	U
Thryothorus coraya	-	-	S	-	-	S	-	-	S	U	-	S	-	S
Tinamus major	-	-	-	-	-	S	-	-	-	-	-	-	-	-
Tityra cayana	-	-	-	-	-	-	-	-	U	-	U	-	-	-
Todirostrum cinereum	-	-	-	-	-	-	-	-	-	-	-	S	-	-
Todirostrum pictum	-	-	-	-	-	-	-	-	-	S	-	-	-	-
Tolmomyias assimilis	-	S	U	F	S	S	-	-	-	-	-	-	-	-
Touit purpuratus	-	S	S	S	-	-	-	-	-	-	-	-	-	-
Tringa solitaria	-	S	S	-	-	-	-	-	-	-	-	-	-	-
Troglodytes aedon	-	-	-	-	-	-	-	-	-	S	-	-	-	S
Trogon melanurus	-	S	U	-	-	-	-	-	S	-	-	-	-	-
Trogon violaceus	-	-	-	-	S	-	S	-	S	-	-	-	-	-
Trogon viridis	-	-	-	S	-	S	-	-	U	S	U	-	-	-
Tunchiornis ochraceiceps	-	S	-	S	-	S	-	-	-	-	-	-	-	-
Turdus albicollis	-	-	-	-	-	-	S	-	-	-	-	-	-	-
Turdus fumigatus	-	S	-	-	-	-	S	-	S	-	-	S	-	-
Tyranneutes virescens	-	-	-	S	-	S	-	-	S	-	-	-	-	-
Tyrannulus elatus	-	S	-	S	-	-	-	-	S	-	-	-	-	-
Tyrannus melancholicus	-	-	-	-	-	S	S	-	-	U	U	F	-	F
Tyrannus savanna	-	-	-	-	-	-	S	-	-	-	S	-	-	-
Unknown	-	-	-	-	-	S	-	-	-	-	-	-	-	-
Veniliornis cassini	-	-	S	S	-	-	-	-	-	-	-	-	-	-
Vireolanius leucotis	-	-	-	-	-	-	-	-	S	-	-	-	-	-
Volatinia jacarina	-	-	-	S	S	-	-	-	-	S	-	-	-	-
Xiphorhynchus guttatus	-	-	S	-	S	-	-	-	-	F	-	U	-	U
Xiphorhynchus pardalotus	-	-	-	S	S	-	-	-	U	-	-	-	-	-

2017-2018 Transect Observations Fishes Surveys

Scientific name	Wet Season				Dry Season			
	AQS1	AQS2	AQS3	AQS4	AQS1	AQS2	AQS3	AQS4
Aequidens potaroensis	U	F	U	-	F	F	U	-
Anablepsoides spp	-	-	-	O	-	-	-	-
Astyanax bimaculatus	F	F	C	C	-	-	-	-
Bryconops melanurus	-	-	-	-	-	-	C	-
Callichthys callichthys	O	-	-	-	-	-		-
Callichthys spp	-	-	-	O	-	-		-
Crenicichla alta	F	U	U	-	-	F	U	-
Curimatella immaculata	-	-	U	-	-	-	U	-
Erythrinus erythrinus	O	-	-	-	U	-		-
Guianacara dacrya	-	-	A	-	-	-	C	-
Gymnotus coropinae	-	-	-	-	-	U		-
Hemiodus unimaculatus	-	-	O	-	-	-		-
Hoplias aimara	-	-		O	-	-	O	-
Hoplias malabaricus	O	U	O	-	O	O	U	-
Hypostomus spp					-	-	U	-
Hyphessobrycon serpae	F	-	O	O	C	-	U	U
Hypostomus taphorni	-	-	-	U	-	-		-
Leporinus friderici	-	-	U	U	-	-	O	-
Megalechis thoracata	O	-	-	-	-	-	-	-
Moenkhausia dichrouia	O	-	-	-	O	-	-	-
Phenacogaster pectinatus	O	-	U	-	-	-	-	-
Pimelodella cristata	-	-	U	-	-	-	-	-
Pimelodella spp	-	O	-	-	-	O	-	-
Poptella spp	-	-	-	-	-		U	-
Pyrrhulina semifasciata	-	-	-	-	-	U	O	-
Pyrrhulina stoli	F	-	-	-	-	-	-	-
Rhamdia quelen	O	O	-	-	-	O	-	-
Rinelorocaria spp	-	-	O	-	-	-	-	-

Transect Observations 2017-2018 Benthic Invertebrates Survey

Families/Orders	**Description**	**Frequency along Transects**	
		Wet Season	**Dry Season**
Decapoda	Crabs, shrimps and relatives	64	13
Gastropoda	Kreketaes, snails	48	30

Transect Observations 2017-2018 Volant Mammals Surveys

Scientific Names	Wet Season							Dry Season						
	Camp	**Trn1**	**Trn2**	**Trn3**	**Trn4**	**Trn5**	**Marudi**	**Camp**	**Trn1**	**Trn2**	**Trn3**	**Trn4**	**Trn5**	**Marudi**
Ametrida centurio	-	-	O	-	F	-	-	-	-	-	-	-	U	O
Artibeus cinereus	-	-	-	O	-	-	-	-	-	-	-	-	-	-
Artibeus gnomus	-	-	-	O	U	-	-	-	-	-	-	-	-	-
Artibeus lituratus	-	-	-	-	-	O	-	-	-	-	-	-	-	-
Artibeus obscurus	-	F	U	O	O	-	-	-	F	-	F	-	O	-
Artibeus planirostris	-	F	U	F	F	O	-	-	F	-	O	U	O	-
Carollia brevicauda	-	O	O	O	-	-	-	-	-	F	O	-	-	-
Carollia perspicillata	-	U	U	U	U	F	-	-	-	O	F	-	-	-
Centronycteris maximiliani	-	-	-	O	-	-	-	-	-	-	-	-	-	-
Choeroniscus minor	-	-	-	-	O	O	-	-	-	-	-	F	-	-
Chrotopterus auratus	-	-	U	-	-	-	-	-	-	-	-	-	-	-
Glossophaga soricina	-	O	-	-	-	-	-	-	-	-	-	O	O	-
Mesophylla macconnelli	-	-	O	-	-	-	-	-	-	-	-	U	-	-
Micronycteris daviesi	-	-	O	O	O	-	-	-	-	-	-	-	-	-
Molossus ater	-	-	-	-	O	-	-	-	-	-	-	-	-	-
Phyllostomus discolor	-	-	O	-	-	-	-	-	-	-	-	-	-	-
Phyllostomus elongates	-	-	-	-	-	O	-	-	-	-	U	-	-	-
Pteronotus parnellii	-	F	U	-	O	-	-	-	-	O	-	-	-	-
Rhinophylla pumilio	-	-	O	U	-	O	-	-	-	-	-	-	-	-
Tonatia saurophila	-	-	O	-	-	-	-	-	-	-	-	-	-	-
Trachops cirrhosis	-	-	O	U	O	-	-	-	-	-	-	-	-	-
Trinycteris nicefori	-	-	-	O	-	-	-	-	-	-	-	-	-	-

Transect Observation 2017-2018 Non-Volant Mammals Surveys

Scientific Name	Wet Season							Dry Season						
	Camp	**Trn1**	**Trn2**	**Trn3**	**Trn4**	**Trn5**	**Marudi**	**Camp**	**Trn1**	**Trn2**	**Trn3**	**Trn4**	**Trn5**	**Marudi**
Alouatta macconnelli	-	F	U	U	U	F	F	-	F	U	U	U	F	F
Ateles paniscus	O	-	U	-	F	U	O	-	U	-	-	F	U	-
Bradypus tridactylus	-	-	-	O	-	-	-	-	-	-	-	-	-	-
Saimiri sciureus	O	O	U	-	-	O	-	-	U	-	-	-	U	-
Saguinus midas	-	O	-	-	-	O	-	-	O	-			O	-
Mazama gouazoubira	-	U	O	-	-	-	-	-	-	-	-	-	-	-
Mazama americana	-	U	O	-	-	-	-	-	-	-	-	-	-	-
Priodontes maximus	-	O	-	U	-	F	-	-	-	-	-	-	-	-
Cuniculus paca	-	U	U	-	-	-	-	-	U	U	-	-	F	-
Dasypus novemcinctus	-	U	F	U	-	F	-	-	U	U	U	-	U	-
Dasyprocta leporine	-	F	U	U	U	F	-	-	F	U	U	U	F	-
Opossum	-	U	F	-	-	U	-	-	U	U	-	-	U	O
Philander opossum sp	-		-	-	-	O	-	-	-	-	-	-	-	-
Panthera onca	-	U	-	-	-	-	-	-	O	-	-	-	-	-
Leopardus paradalis	-		O	-	-	-	-	-	-	O	-	-	O	-
Potos flavus	-	O	O	-	-	O	O	-	F	-	-	-	-	-
Tapirus terrestris	-	U	-	-	-	-	-	-	-	-	-	-	-	-

Transect Observations 2017-2018 Macro-invertebrates Survey

Order	Description	Frequency along transects	
		Wet Season	Dry Season
Araneae	Spiders	15	5
Coleoptera	Beetles	12	12
Dictyoptera	Termites, cockroaches, mantises	13	0
Diptera	True flies	20	0
Haplotaxida	Segmented worms	7	2
Hemiptera	True bugs-aphids,cicads	17	8
Hymenoptera	Ants, bees and wasps	25	18
Lepidoptera	Butterflies, moths and skippers	36	25
Odonata	Dragon and damselfies	22	7
Orthoptera	Grasshoppers, locust, crickets, katydids	20	10
Spirobolida	Millipedes	3	0

EXAMPLE OF TIMBER VOLUMES CALCULATIONS							
Plot 1 - Transect 1							
Plot			1				
Subplot			Centre				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0258705 UTM 0243016				
Initial Altitude							
Final Altitude			296 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Clay loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume (m^3)
1	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	20	15	0.47124
2	Wadara*	*Couratari guianensis*	Lecythidaceae	G	93	20	13.5858492
3	Maho*	*Sterculia pruriens*	Sterculiaceae	G	72	20	8.1430272
4	Kokoritiballi*	*Pouteria cuspidata*	Sapotaceae	G	60	20	5.65488
5	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	27	15	0.8588349
6	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	NG	23	6	0.24928596
7	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	23	15	0.6232149
8	Hill Corkwood*	*Pterocarpus rohrii*	Papilionaceae	G	35.5	8	0.79184028
9	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	NG	27	3	0.17176698
10	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	NG	32	6	0.48254976
11	Arara broad leaf	*Unonopsis spp.*	Annonaceae	NG	35	15	1.4431725
12	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	57.5	20	5.1934575
13	Aromata*	*Clathrotropis spp.*	Fabaceae	NG	22	8	0.30410688
14	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	G	44	10	1.5205344
15	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	23	15	0.6232149
16	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	26	16	0.84948864
17	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	NG	28	8	0.49260288
18	Sinkola	*Cinchona sp.*		NG	39	5	0.5972967

19	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	23	17	0.70631022
20	Yarula (Black)	*Aspidosperma excelsum*	Apocynaceae	G	30	15	1.06029
21	Barakaro*	*Ormosia coccinea*	Leguminosae-papil	G	28.5	15	0.956911725
22	Unknown			G	31	10	0.7547694
23	Barakaro*	*Ormosia coccinea*	Leguminosae-papil	NG	36	15	1.5268176
Understory							47.06146253
1	Hill Dalli *	*Virola sebifera*	Myristicaceae				
2	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae				
3	Wakaradan	*Miconia cf. ruficalyx*	Melastomataceae				
4	Aromata*	*Clathrotropis spp.*	Fabaceae				
5	Kauta*	*Licania guianensis*	Chrysobalanaceae				
6	Kauta*	*Licania guianensis*	Chrysobalanaceae				
7	Baradan	*Ocotea tomentella*	Lauraceae				
8	Bulletwood*	*Manilkara bidentata*	Sapotaceae				
9	Maporokon*	*Inga alba*	Leguminosae - Mimos				
10	Turu	*Jessenia bataua*	Arecaceae				
11	Yuruwe	*Bactris humilis*	Palmae				
12	Yuruwe	*Bactris humilis*	Palmae				
13	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae				
14	Okokonshi	*Quiina indigofera*	Quiinaceae				
15	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae				
16	Asepoko*	*Pouteria guianensis*	Sapotaceae				
17	Manicole	*Euterpe oleracea*	Arecaceae				
18	Okokonshi	*Quiina indigofera*	Quiinaceae				
19	Asepoko*	*Pouteria guianensis*	Sapotaceae				
20	Asepoko*	*Pouteria guianensis*	Sapotaceae				
21	Yuruwe	*Bactris humilis*	Palmae				
22	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
23	Yuruwe	*Bactris humilis*	Palmae				

Plot 1- Transect 2							
Plot			1				
Subplot			E				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0258455 UTM 0242992				
Initial Altitude							
Final Altitude			289 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (subforest)			Medium				
Soil Type			Clay loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m3)
1	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	35	15	1.4431725
2	Letterwood *	*Brosiumum guianense*	Moraceae	G	49.5	15	2.886639525
3	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	33	18	1.53954108
4	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	G	22	15	0.5702004
5	Wakaradan*	*Miconia cf. ruficalyx*	Melastomataceae	G	35	15	1.4431725
6	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	30.5	14	1.02286569
7	Fine Leaf Counter*	*Licania sp.*	Chrysobalanaceae	G	29	20	1.3210428
8	Kokoritiballi*	*Pouteria cuspidata*	Sapotaceae	G	42	18	2.49380208
9	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	20	10	0.31416
10	Sinkola	*Cinchona sp.*		G	27	60	3.4353396
11	Kokoritiballi*	*Pouteria cuspidata*	Sapotaceae	G	40	15	1.88496
12	Arara broad leaf	*Unonopsis spp.*	Annonaceae	G	26	12	0.63711648
13	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	NG	20	14	0.439824
14	Maho*	*Sterculia pruriens*	Sterculiaceae	NG	20	15	0.47124
15	Matchwood	*Schefflera morototoni*	Araliaceae	G	29.8	12	0.836959939
16	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	63	10	3.1172526
17	Common Baromalli*	*Catostemma commune*	Bombacaceae	NG	25	15	0.7363125
18	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	63	10	3.1172526

19	Shibadan*	*Aspidosperma cruentum*	Apocynaceae	G	53	10	2.2061886
20	Hill Dalli*	*Virola sebifera*	Myristicaceae	G	36	15	1.5268176
21	Duru	*Apeiba echinata*	Tiliaceae	G	45	10	1.590435
22	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	36	15	1.5268176
23	Maho*	*Sterculia pruriens*	Sterculiaceae	G	38	12	1.36094112
24	Wadara*	*Couratari guianensis*	Lecythidaceae	G	82	15	7.9215444
Understory							43.8435986
1	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
2	Kauta*	*Licania guianensis*	Chrysobalanaceae				
3	Turu	*Jessenia bataua*	Arecaceae				
4	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
5	Kauta*	*Licania guianensis*	Chrysobalanaceae				
6	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
7	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
8	Kabukalli*	*Goupia glabra*	Celastraceae				
9	Waiaballi	*Tapura guianensis*	Dichapetalaceae				
10	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae				
11	Kaditiri	*Sclerolobium micropetalum*	Leguminosae-caesalp				
12	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae				
13	Kauta*	*Licania guianensis*	Chrysobalanaceae				
14	Kauta*	*Licania guianensis*	Chrysobalanaceae				
15	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
16	Bulletwood*	*Manilkara bidentata*	Sapotaceae				
17	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae				
18	Kauta*	*Licania guianensis*	Chrysobalanaceae				
19	Wadara*	*Couratari guianensis*	Lecythidaceae				
20	Yuruwe	*Bactris humilis*	Palmae				
21	Dog stone	*Tabenaemontana undulata*	Apocynaceae				
22	Kauta*	*Licania guianensis*	Chrysobalanaceae				
23	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
24	Yarula (Black)	*Aspidosperma excelsum*	Apocynaceae				
25	Manicole	*Euterpe oleracea*	Arecaceae				
26	Manicole	*Euterpe oleracea*	Arecaceae				
27	Waiaballi	*Tapura guianensis*	Dichapetalaceae				
28	Bartaballi	*Pouteria durlandii*	Sapotaceae				
29	Kauta*	*Licania guianensis*	Chrysobalanaceae				
30	Maho*	*Sterculia pruriens*	Sterculiaceae				
31	Yuruwe	*Bactris humilis*	Palmae				
32	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				

33	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
34	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
35	Dallibana	*Geonoma baculifera*	Palmae		
36	Kereti (White silvesrballi)*	*Ocotea cannliculata*	Lauraceae		
37	Wadara*	*Couratari guianensis*	Lecythidaceae		
38	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae		
39	Bartaballi	*Pouteria durlandii*	Sapotaceae		
40	Yuruwe	*Bactris humilis*	Palmae		
41	Sinkola	*Cinchona sp.*			
42	Bulletwood*	*Manilkara bidentata*	Sapotaceae		
43	Hill Dalli *	*Virola sebifera*	Myristicaceae		
44	Haiariballi	*Alexa imperatricis*	Leguminosae-papil		
45	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		
46	Waiaballi	*Tapura guianensis*	Dichapetalaceae		
47	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
48	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		

Plot 1- Transect 3							
Plot			1				
Subplot			W				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axix			21 N 0258455 UTM 0242992				
Initial Altitude							
Final Altitude			289 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (subforest)			Medium				
Soil Type			Clay loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m3)
1	Asepoko*	*Pouteria guianensis*	Sapotaceae	G	21	5	0.1731807
2	Barakaro*	*Ormosia coccinea*	Leguminosae-papil	G	34	10	0.9079224
3	Sinkola	*Cinchona sp.*		NG	21	8	0.27708912
4	Simarupa*	*Quaassia simaruba*	Simaroubaceae	G	50	20	3.927
5	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	37	15	1.6128189
6	Shibadan*	*Aspidosperma cruentum*	Apocynaceae	G	82	15	7.9215444
7	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	22	10	0.3801336
8	Limonaballi*	*Chrysophyllum pomiferum*	Sapotaceae	G	42	20	2.7708912
9	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	24.5	15	0.707154525
10	Haiawa*	*Protium decandrum*	Burseraceae	G	24	15	0.6785856
11	Duru	*Apeiba echinata*	Tiliaceae	G	33	15	1.2829509
12	Barakaro*	*Ormosia coccinea*	Leguminosae-papil	G	20	15	0.47124
13	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	22	10	0.3801336
14	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	41	18	2.37646332
15	Baradan*	*Ocotea tomentella*	Lauraceae	NG	50	6	1.1781
16	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	38	7	0.79388232
17	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	G	32	10	0.8042496
18	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	75	15	6.6268125
19	Kaditiri	*Sclerolobium micropetalum*	Leguminosae-caesalp	G	32	10	0.8042496

20	Wadara*	*Couratari guianensis*	Lecythidaceae	G	53	10	2.2061886
21	Crabwood*	*Carapa guianensis*	Meliaceae	G	23	6	0.24928596
Understory							36.52987685
1	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
2	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
3	Yuruwe	*Bactris humilis*	Palmae				
4	Muniridan*	*Siparuna guianensis*	Monimiaceae				
5	Yuruwe	*Bactris humilis*	Palmae				
6	Dog stone	*Tabenaemontana undulata*	Apocynaceae				
7	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
8	Dog stone	*Tabenaemontana undulata*	Apocynaceae				
9	Manicole	*Euterpe oleracea*	Arecaceae				
10	Manicole	*Euterpe oleracea*	Arecaceae				
11	Turu	*Jessenia bataua*	Arecaceae				
12	Maho*	*Sterculia pruriens*	Sterculiaceae				
13	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
14	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
15	Bulletwood*	*Manilkara bidentata*	Sapotaceae				
16	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae				
17	Maho*	*Sterculia pruriens*	Sterculiaceae				
18	Bamboo	*Panicum pilosum*	Gramineae				
19	Bartaballi	*Pouteria durlandii*	Sapotaceae				
20	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae				
21	Maho*	*Sterculia pruriens*	Sterculiaceae				
22	Bamboo	*Panicum pilosum*	Gramineae				
23	Bamboo	*Panicum pilosum*	Gramineae				
24	Bamboo	*Panicum pilosum*	Gramineae				
25	Bamboo	*Panicum pilosum*	Gramineae				
26	Bamboo	*Panicum pilosum*	Gramineae				
27	Bamboo	*Panicum pilosum*	Gramineae				
28	Bamboo	*Panicum pilosum*	Gramineae				
29	Bamboo	*Panicum pilosum*	Gramineae				
30	Bamboo	*Panicum pilosum*	Gramineae				
31	Bamboo	*Panicum pilosum*	Gramineae				
32	Bamboo	*Panicum pilosum*	Gramineae				
33	Bamboo	*Panicum pilosum*	Gramineae				
34	Bamboo	*Panicum pilosum*	Gramineae				
35	Bamboo	*Panicum pilosum*	Gramineae				
36	Bamboo	*Panicum pilosum*	Gramineae				

37	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
38	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
39	Okokonshi	*Quiina indigofera*	Quiinaceae		
40	Manicole	*Euterpe oleracea*	Arecaceae		
41	Kaditiri	*Sclerolobium micropetalum*	Leguminosae-caesalp		
42	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
43	Turu	*Jessenia bataua*	Arecaceae		

Plot 1- Transect 4							
Plot			1				
Subplot			N				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0258455 UTM 0242992				
Initial Altitude							
Final Altitude			289 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (subforest)			Medium				
Soil Type			Clay loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Open				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m3)
1	Kabukalli*	*Goupia glabra*	Celastraceae	G	27	18	1.03060188
2	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	G	39	15	1.7918901
3	Fine Leaf Counter*	*Licania sp.*	Chrysobalanaceae	G	31	5	0.3773847
4	Common Baromalli*	*Catostemma commune*	Bombacaceae	G	31	16	1.20763104
5	Maho*	*Sterculia pruriens*	Sterculiaceae	NG	53	15	3.3092829
6	Limonaballi*	*Chrysophyllum pomiferum*	Sapotaceae	G	57	18	4.59317628
7	Dalli hill*	*Virola sebifera*	Myristicaceae	G	29	12	0.79262568
8	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	20	15	0.47124
9	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	21	8	0.27708912
10	Wadara*	*Couratari guianensis*	Lecythidaceae	G	50	12	2.3562
11	Dalli hill*	*Virola sebifera*	Myristicaceae	G	34	15	1.3618836
12	Simarupa*	*Quaassia simaruba*	Simaroubaceae	G	33	15	1.2829509
13	Cowwood*	*Bagassa guianense*	Moraceae	G	27	15	0.8588349
Understory							19.7107911
1	Maho*	*Sterculia pruriens*	Sterculiaceae				
2	Muniridan*	*Siparuna guianensis*	Monimiaceae				
3	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
4	Kauta*	*Licania guianensis*	Chrysobalanaceae				

5	Maho*	*Sterculia pruriens*	Sterculiaceae		
6	Manicole	*Euterpe oleracea*	Arecaceae		
7	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
8	Kauta*	*Licania guianensis*	Chrysobalanaceae		
9	Manicole	*Euterpe oleracea*	Arecaceae		
10	Heliconia	*Heliconia spathocircinata*	Musaceae		
11	Okokonshi	*Quiina indigofera*	Quiinaceae		
12	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
13	Maho*	*Sterculia pruriens*	Sterculiaceae		
14	Okokonshi	*Quiina indigofera*	Quiinaceae		
15	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
16	Muniridan*	*Siparuna guianensis*	Monimiaceae		
17	Arara broad leaf	*Unonopsis spp.*	Annonaceae		
18	Manicole	*Euterpe oleracea*	Arecaceae		
19	Dallibana	*Geonoma baculifera*	Palmae		
20	Mokru	*Ischnosiphon arouma*	Marantaceae		
21	Mokru	*Ischnosiphon arouma*	Marantaceae		
22	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
23	Kauta*	*Licania guianensis*	Chrysobalanaceae		
24	Whitey	*Inga jenmanii*	Leguminosae-mimos		
25	Mokru	*Ischnosiphon arouma*	Marantaceae		
26	Common Baromalli*	*Catostemma commune*	Bombacaceae		
27	Kaditiri	*Sclerolobium micropetalum*	Leguminosae-caesalp		
28	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
29	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
30	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
31	Ubudiablli	*Chrysophyllum sanguinolentum*	Sapotaceae		
32	Kaditiri	*Sclerolobium micropetalum*	Leguminosae-caesalp		
33	Yuruwe	*Bactris humilis*	Palmae		
34	Bulletwood*	*Manilkara bidentata*	Sapotaceae		
35	Kaditiri	*Sclerolobium micropetalum*	Leguminosae-caesalp		
36	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
37	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
38	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
39	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
40	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
41	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
42	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
43	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		

44	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
45	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		

Plot 1- Transect 5							
Plot			1				
Subplot			S				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0258455 UTM 0242992				
Initial Altitude							
Final Altitude			201 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (subforest)			Medium				
Soil Type			Clay loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m3)
1	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	20	15	0.47124
2	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	G	54.5	10	2.33283435
3	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	55	16	3.801336
4	Sand Mora*	*Talisia cf. guianesis*	Sapindaceae	G	36	14	1.42502976
5	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	46	15	2.4928596
6	Barakaro*	*Ormosia coccinea*	Leguminosae-papil	G	55	16	3.801336
7	Kabukalli*	*Goupia glabra*	Celastraceae	G	28	8	0.49260288
8	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	35	15	1.4431725
Understory							16.26041109
1	Turu	*Jessenia bataua*	Arecaceae				
2	Bamboo	*Panicum pilosum*	Gramineae				
3	Bamboo	*Panicum pilosum*	Gramineae				
4	Bamboo	*Panicum pilosum*	Gramineae				
5	Bamboo	*Panicum pilosum*	Gramineae				
6	Bamboo	*Panicum pilosum*	Gramineae				
7	Bamboo	*Panicum pilosum*	Gramineae				
8	Bamboo	*Panicum pilosum*	Gramineae				
9	Bamboo	*Panicum pilosum*	Gramineae				
10	Bamboo	*Panicum pilosum*	Gramineae				

11	Bamboo	*Panicum pilosum*	Gramineae		
12	Yuruwe	*Bactris humilis*	Palmae		
13	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
14	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
15	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
16	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
17	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
18	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
19	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
20	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
21	Yarula	*Swartzia jenmani*	Apocynaceae		
22	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
23	Ginger gale silverballi	*Aniba cf. guianesis*	Lauraceae		
24	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
25	Okokonshi	*Quiina indigofera*	Quiinaceae		
26	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
27	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
28	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
29	Mokru	*Ischnosiphon arouma*	Marantaceae		
30	Dallibana	*Geonoma baculifera*	Palmae		
31	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
32	Turu	*Jessenia bataua*	Arecaceae		
33	Dallibana	*Geonoma baculifera*	Palmae		
34	Manicole	*Euterpe oleracea*	Arecaceae		
35	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
36	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
37	Okokonshi	*Quiina indigofera*	Quiinaceae		
38	Manicole	*Euterpe oleracea*	Arecaceae		
39	Mokru	*Ischnosiphon arouma*	Marantaceae		
40	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
				Total Area Sampled 1ha / 10000 sq. m	

Plot 2 - Transect 1							
Plot			1				
Subplot			Centre				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0258705 UTM 0243016				
Initial Altitude							
Final Altitude			325 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Clay loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Sinkola	*Cinchona sp.*		NG	53	8	1.76495088
2	Wadara*	*Couratari guianensis*	Lecythidaceae	G	25	8	0.36191232
3	Barakaro*	*Ormosia coccinea*	Leguminosae-papil	G	83	10	5.4106206
4	Kokerite	*Maximiliana maripa*	Palmae	G	26	8	0.42474432
5	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	24	8	0.36191232
6	Kokerite	*Maximiliana maripa*	Palmae	G	25	8	0.3927
7	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	59	10	2.7339774
8	Maporokon*	*Inga alba*	Leguminosae - Mimos	NG	39	8	0.95567472
9	Yellow Silverballi*	*Aniba ovalifolia*	Lauraceae	G	42	10	1.3854456
10	Maporokon*	*Inga alba*	Leguminosae - Mimos	G	54	12	2.74827168
11	Wadara*	*Couratari guianensis*	Lecythidaceae	G	51	8	1.63426032
12	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	90	18	11.451132
13	Kabukalli*	*Goupia glabra*	Celastraceae	G	27	8	0.45804528
14	Sinkola	*Cinchona sp.*		NG	25	8	0.3927
15	Kokerite	*Maximiliana maripa*	Palmae	G	38	12	1.36094112

16	Barakaro*	*Ormosia coccinea*	Leguminosae-papil	G	28	6	0.36945216
17	Sinkola	*Cinchona sp.*		NG	23	5	0.2077383
18	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	G	56	3	0.73890432
19	Wadara*	*Couratari guianensis*	Lecythidaceae	G	33	6	0.51318036
20	Kurokai*	*Protium heptaphyllum*	Burseraceae	G	60	15	4.24116
Understory							37.9077237
1	Manicole	*Euterpe oleracea*	Arecaceae				
2	Bartaballi	*Pouteria durlandii*	Sapotaceae				
3	Kurokai*	*Protium heptaphyllum*	Burseraceae				
4	Aruadan	*Couepia exflexa*	Chrysobalanaceae				
5	Aruadan	*Couepia exflexa*	Chrysobalanaceae				
6	Aruadan	*Couepia exflexa*	Chrysobalanaceae				
7	Aruadan	*Couepia exflexa*	Chrysobalanaceae				
8	Adebero	*Paypayrola longifolia*	Violaceae				
9	Adebero	*Paypayrola longifolia*	Violaceae				
10	Adebero	*Paypayrola longifolia*	Violaceae				
11	Adebero	*Paypayrola longifolia*	Violaceae				
12	Hill Dalli *	*Virola sebifera*	Myristicaceae				
13	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
14	Kurokai*	*Protium heptaphyllum*	Burseraceae				
15	Hill Dalli *	*Virola sebifera*	Myristicaceae				
16	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
17	Manicole	*Euterpe oleracea*	Arecaceae				
18	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
19	Waiaballi	*Tapura guianensis*	Dichapetalaceae				
20	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
21	Kurokai*	*Protium heptaphyllum*	Burseraceae				
22	Kurokai*	*Protium heptaphyllum*	Burseraceae				
23	Kurokai*	*Protium heptaphyllum*	Burseraceae				
24	Kurokai*	*Protium heptaphyllum*	Burseraceae				
25	Kurokai*	*Protium heptaphyllum*	Burseraceae				
26	Kurokai*	*Protium heptaphyllum*	Burseraceae				
27	Kurokai*	*Protium heptaphyllum*	Burseraceae				
28	Adebero	*Paypayrola longifolia*	Violaceae				
29	Adebero	*Paypayrola longifolia*	Violaceae				
30	Adebero	*Paypayrola longifolia*	Violaceae				
31	Adebero	*Paypayrola longifolia*	Violaceae				
32	Adebero	*Paypayrola longifolia*	Violaceae				
33	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				

34	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
35	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
36	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
37	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
38	Arara broad leaf	*Unonopsis spp.*	Annonaceae		
39	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
40	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
41	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
42	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
43	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
44	Aruadan	*Couepia exflexa*	Chrysobalanaceae		
45	Aruadan	*Couepia exflexa*	Chrysobalanaceae		
46	Aruadan	*Couepia exflexa*	Chrysobalanaceae		
47	Manicole	*Euterpe oleracea*	Arecaceae		
48	Manicole	*Euterpe oleracea*	Arecaceae		
49	Dallibana	*Geonoma baculifera*	Palmae		
50	Dallibana	*Geonoma baculifera*	Palmae		
51	Dallibana	*Geonoma baculifera*	Palmae		
52	Dallibana	*Geonoma baculifera*	Palmae		
53	Dallibana	*Geonoma baculifera*	Palmae		
54	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		
55	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		
56	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		
57	Asepoko*	*Pouteria guianensis*	Sapotaceae		
58	Bulletwood*	*Manilkara bidentata*	Sapotaceae		
59	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
60	Komaramara	*Duroia eriopila l.f. var. eriopila*	Rubiaceae		
61	Iron Mary	*Chaetocarpus schomburgkianus*	Euphorbiaceae		
62	Maho*	*Sterculia pruriens*	Sterculiaceae		
63	Mokru	*Ischnosiphon arouma*	Marantaceae		
64	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil		
65	Bartaballi	*Pouteria durlandii*	Sapotaceae		

Plot 2 - Transect 2							
Plot			1				
Subplot			E				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0258705 UTM 0243016				
Initial Altitude							
Final Altitude			298 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Clay loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Wild Guava*	Eshweilera alata	Lecythidaceae	NG	49	6	1.13144724
2	Wadara*	*Couratari guianensis*	Lecythidaceae	G	107	20	17.9840892
3	Wadara*	*Couratari guianensis*	Lecythidaceae	G	42	18	2.49380208
4	Kokerite	*Maximiliana maripa*	Palmae	G	26	18	0.95567472
5	Kokerite	*Maximiliana maripa*	Palmae	G	36	16	1.62860544
6	Dalli hill*	*Virola sebifera*	Myristicaceae	G	38	16	1.81458816
7	Kurokai*	*Protium heptaphyllum*	Burseraceae	G	45	8	1.272348
8	Kurokai*	*Protium heptaphyllum*	Burseraceae	G	36	8	0.81430272
9	Wadara*	*Couratari guianensis*	Lecythidaceae	G	31	15	1.1321541
10	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	31	10	0.7547694
11	Kurokai*	*Protium heptaphyllum*	Burseraceae	G	25.5	6	0.30642381
12	Maho*	*Sterculia pruriens*	Sterculiaceae	G	49	10	1.8857454
13	Barakaro*	*Ormosia coccinea*	Leguminosae-papil	G	36	15	1.5268176

14	Fine Leaf Counter*	*Licania sp.*	Chrysobalanaceae	G	39	12	1.43351208
15	Warakaioro	*Laetia procera*	Flacourtiaceae	G	33	10	0.8553006
16	Common Baromalli*	*Catostemma commune*	Bombacaceae	G	48	20	3.6191232
17	Wild Guava*	*Eshweilera alata*	Lecythidaceae	G	38	6	0.68047056
Understory							40.28917431
1	Haiariballi	*Alexa imperatricis*	Leguminosae-papil				
2	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae				
3	Kurokai*	*Protium heptaphyllum*	Burseraceae				
4	Bartaballi	*Pouteria durlandii*	Sapotaceae				
5	Asepoko*	*Pouteria guianensis*	Sapotaceae				
6	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
7	Bartaballi	*Pouteria durlandii*	Sapotaceae				
8	Dog stone	*Tabenaemontana undulata*	Apocynaceae				
9	Kurokai*	*Protium heptaphyllum*	Burseraceae				
10	Yuruwe	*Bactris humilis*	Palmae				
11	Yuruwe	*Bactris humilis*	Palmae				
12	Yuruwe	*Bactris humilis*	Palmae				
13	Yuruwe	*Bactris humilis*	Palmae				
14	Yuruwe	*Bactris humilis*	Palmae				
15	Yuruwe	*Bactris humilis*	Palmae				
16	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
17	Kurokai*	*Protium heptaphyllum*	Burseraceae				
18	Kulishiri Black	*Cupania hirsuta*	Sapindaceae				
19	Asepoko*	*Pouteria guianensis*	Sapotaceae				
20	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
21	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
22	Bulletwood*	*Manilkara bidentata*	Sapotaceae				
23	Hill Dalli *	*Virola sebifera*	Myristicaceae				
24	Hill Dalli *	*Virola sebifera*	Myristicaceae				
25	Hill Dalli *	*Virola sebifera*	Myristicaceae				
26	Hill Dalli *	*Virola sebifera*	Myristicaceae				
27	Hill Dalli *	*Virola sebifera*	Myristicaceae				
28	Hill Dalli *	*Virola sebifera*	Myristicaceae				
29	Mokru	*Ischnosiphon arouma*	Marantaceae				

30	Kurokai*	*Protium heptaphyllum*	Burseraceae		
31	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
32	Kurokai*	*Protium heptaphyllum*	Burseraceae		
33	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
34	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
35	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
36	Adebero	*Paypayrola longifolia*	Violaceae		
37	Kauta*	*Licania guianensis*	Chrysobalanaceae		
38	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
39	Kulishiri Black	*Cupania hirsuta*	Sapindaceae		
40	Adebero	*Paypayrola longifolia*	Violaceae		
41	Kauta*	*Licania guianensis*	Chrysobalanaceae		
42	Wadara*	*Couratari guianensis*	Lecythidaceae		
43	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
44	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae		
45	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
46	Waiaballi	*Tapura guianensis*	Dichapetalaceae		
47	Kauta*	*Licania guianensis*	Chrysobalanaceae		
48	Asepoko*	*Pouteria guianensis*	Sapotaceae		
49	Kokerite	*Maximiliana maripa*	Palmae		
50	Kulishiri Black	*Cupania hirsuta*	Sapindaceae		
51	Kurokai*	*Protium heptaphyllum*	Burseraceae		
52	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
53	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
54	Asepoko*	*Pouteria guianensis*	Sapotaceae		
55	Adebero	*Paypayrola longifolia*	Violaceae		

Plot 2 - Transect 3							
Plot			1				
Subplot			W				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0260142 UTM 0245114				
Initial Altitude							
Final Altitude			334 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Clay loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	NG	35	8	0.769692
2	Rose of the Mountain	*Brownea latifolia*	Leguminosae - Caesalp	G	38	10	1.1341176
3	Kokerite	*Maximiliana maripa*	Palmae	G	28	10	0.6157536
4	Maporokon*	*Inga alba*	Leguminosae - Mimos	G	38	8	0.90729408
5	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	38	7	0.79388232
6	Maporokon*	*Inga alba*	Leguminosae - Mimos	G	41	8	1.05620592
7	Barakaro*	*Ormosia coccinea*	Leguminosae-papil	G	28	5	0.3078768
8	Common Baromalli*	*Catostemma commune*	Bombacaceae	G	28	9	0.55417824
9	Common Baromalli*	*Catostemma commune*	Bombacaceae	NG	48	4	0.72382464
10	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae	G	25	10	0.490875
11	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	NG	25	6	0.294525
12	Kurokai*	*Protium heptaphyllum*	Burseraceae	NG	30	5	0.35343
13	Kurokai*	*Protium heptaphyllum*	Burseraceae	NG	26	6	0.31855824
14	Maporokon*	*Inga alba*	Leguminosae - Mimos	NG	22	10	0.3801336
15	Kokerite	*Maximiliana maripa*	Palmae	G	28	10	0.6157536
16	Maporokon*	*Inga alba*	Leguminosae - Mimos	NG	52	10	2.1237216
17	Maporokon*	*Inga alba*	Leguminosae - Mimos	NG	87	15	8.9170389

Understory					20.35686114
1	Asepoko*	*Pouteria guianensis*	Sapotaceae		
2	Adebero	*Paypayrola longifolia*	Violaceae		
3	Buba	*Socratea exorrhiza*	Palmae		
4	Whitey	*Inga jenmanii*	Leguminosae-mimos		
5	Adebero	*Paypayrola longifolia*	Violaceae		
6	Kokerite	*Maximiliana maripa*	Palmae		
7	Kulishiri Black	*Cupania hirsute*	Sapindaceae		
8	Kurokai*	*Protium heptaphyllum*	Burseraceae		
9	Kurokai*	*Protium heptaphyllum*	Burseraceae		
10	Kurokai*	*Protium heptaphyllum*	Burseraceae		
11	Asepoko*	*Pouteria guianensis*	Sapotaceae		
12	Asepoko*	*Pouteria guianensis*	Sapotaceae		
13	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
14	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
15	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
16	Arara broad leaf	*Unonopsis spp.*	Annonaceae		
17	Asepoko*	*Pouteria guianensis*	Sapotaceae		
18	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil		
19	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		
20	Maho*	*Sterculia pruriens*	Sterculiaceae		
21	Whitey	*Inga jenmanii*	Leguminosae-mimos		
22	Kokerite	*Maximiliana maripa*	Palmae		
23	Manicole	*Euterpe oleracea*	Arecaceae		
24	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
25	Kokerite	*Maximiliana maripa*	Palmae		
26	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
27	Turu	*Jessenia bataua*	Arecaceae		
28	Ulu	*Chaetocarpus schomburgkianus*	Euphorbiaceae		
29	Manicole	*Euterpe oleracea*	Arecaceae		
30	Aruadan	*Couepia exflexa*	Chrysobalanaceae		
31	Yuruwe	*Bactris humilis*	Palmae		
32	Yuruwe	*Bactris humilis*	Palmae		
33	Bartaballi	*Pouteria durlandii*	Sapotaceae		
34	Bartaballi	*Pouteria durlandii*	Sapotaceae		
35	Kurokai*	*Protium heptaphyllum*	Burseraceae		

Plot 2 - Transect 4							
Plot			1				
Subplot			N				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0260195 UTM 0245264				
Initial Altitude							
Final Altitude			308 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Clay loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Kokerite	*Maximiliana maripa*	Palmae	G	46	8	1.32952512
2	Wadara*	*Couratari guianensis*	Lecythidaceae	G	70	22	8.466612
3	Yarula (Black)	*Aspidosperma excelsum*	Apocynaceae	NG	50	8	1.5708
4	Wild Guava*	*Eshweilera alata*	Lecythidaceae	NG	24	5	0.2261952
5	Tatabu*	*Diplotropis purpurea*	Leguminosae - Papil	NG	56	15	3.6945216
6	Unknown			G	24	15	0.6785856
7	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	29	10	0.6605214
8	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	40	20	2.51328
9	Sinkola	*Cinchona sp.*		NG	42	4	0.55417824
10	Unknown			NG	53	3	0.66185658
11	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae	G	41	5	0.6601287
12	Fine Leaf Counter*	*Licania sp.*	Chrysobalanaceae	G	22	4	0.15205344
		Understory					21.16825788
1	Kurokai*	*Protium heptaphyllum*	Burseraceae				
2	Kurokai*	*Protium heptaphyllum*	Burseraceae				
3	Kurokai*	*Protium heptaphyllum*	Burseraceae				
4	Kurokai*	*Protium heptaphyllum*	Burseraceae				
5	Kurokai*	*Protium heptaphyllum*	Burseraceae				
6	White Yari Yari	*Duguetia pauciflora*	Annonaceae				

7	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
8	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
9	Kamahora	*Pouteria venosa*	Sapotaceae		
10	Kamahora	*Pouteria venosa*	Sapotaceae		
11	Kamahora	*Pouteria venosa*	Sapotaceae		
12	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
13	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
14	Dog stone	*Tabenaemontana undulata*	Apocynaceae		
15	Arara broad leaf	*Unonopsis spp.*	Annonaceae		
16	Turu	*Jessenia bataua*	Arecaceae		
17	Turu	*Jessenia bataua*	Arecaceae		
18	Bamboo	*Panicum pilosum*	Gramineae		
19	Bamboo	*Panicum pilosum*	Gramineae		
20	Bamboo	*Panicum pilosum*	Gramineae		
21	Bamboo	*Panicum pilosum*	Gramineae		
22	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
23	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
24	Black Yari Yari	*Guatteria punctata*	Annonaceae		
25	Black Yari Yari	*Guatteria punctata*	Annonaceae		
26	Aruadan	*Couepia exflexa*	Chrysobalanaceae		
27	Mokru	*Ischnosiphon arouma*	Marantaceae		
28	Mokru	*Ischnosiphon arouma*	Marantaceae		
29	Mokru	*Ischnosiphon arouma*	Marantaceae		
30	Bamboo	*Panicum pilosum*	Gramineae		
31	Bamboo	*Panicum pilosum*	Gramineae		
32	Bamboo	*Panicum pilosum*	Gramineae		
33	Common Baromalli*	*Catostemma commune*	Bombacaceae		
34	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
35	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
36	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
37	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
38	Black Yari Yari	*Guatteria punctata*	Annonaceae		
39	Black Yari Yari	*Guatteria punctata*	Annonaceae		
40	Aruadan	*Couepia exflexa*	Chrysobalanaceae		

Plot 2 - Transect 5							
Plot			[1]				
Subplot			S				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0260195 UTM 0245264				
Initial Altitude							
Final Altitude			328 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Clay loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Shibadan*	*Aspidosperma cruentum*	Apocynaceae	G	60	8	2.261952
2	Asepoko*	*Pouteria guianensis*	Sapotaceae	G	23	8	0.33238128
3	Wadara*	*Couratari guianensis*	Lecythidaceae	G	55	16	3.801336
4	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	31	5	0.3773847
5	Burada*	*Parinari lucidissima*	Chrysobalanaceae	NG	70	4	1.539384
6	Maporokon*	*Inga alba*	Leguminosae - Mimos	NG	33	8	0.68424048
7	Fine Leaf Counter*	*Licania sp.*	Chrysobalanaceae	G	38	10	1.1341176
8	Bulletwood*	*Manilkara bidentata*	Sapotaceae	NG	126	21	26.18492184
9	Matchwood	*Scherfflera morototoni*	Araliaceae	G	68	12	4.35802752
10	Kurokai*	*Protium heptaphyllum*	Burseraceae	NG	28	12	0.73890432
11	Common Baromalli*	*Catostemma commune*	Bombacaceae	G	28	18	1.10835648
12	Common Baromalli*	*Catostemma commune*	Bombacaceae	G	26	6	0.31855824
13	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	38	8	0.90729408
14	Barakaro*	*Ormosia coccinea*	Leguminosae-papil	G	35.5	12	1.18776042
15	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	28	8	0.49260288
16	Dukuria *	*Sacoglottis aff. Cydonioides*	Humiriaceae	G	35.5	9	0.890820315
17	Brown Silverballi *	*Aniba riparia*	Lauraceae	G	43	12	1.74264552
18	Barakaro*	*Ormosia coccinea*	Leguminosae-papil	G	55	20	4.75167

19	Shibadan*	*Aspidosperma cruentum*	Apocynaceae	G	37	20	2.1504252
		Understory					54.96278288
1	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
2	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
3	Bulletwood*	*Manilkara bidentata*	Sapotaceae				
4	Bulletwood*	*Manilkara bidentata*	Sapotaceae				
5	Haiariballi	*Alexa imperatricis*	Leguminosae-papil				
6	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
7	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae				
8	Aruadan	*Sloanea cf. guianensis*	Elaeocarpaceae				
9	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
10	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
11	Buba	*Socratea exorrhiza*	Palmae				
12	Kurokai*	*Protium heptaphyllum*	Burseraceae				
13	Kurokai*	*Protium heptaphyllum*	Burseraceae				
14	Kurokai*	*Protium heptaphyllum*	Burseraceae				
15	Barakaro*	*Ormosia coccinea*	Leguminosae-papil				
16	Arara broad leaf	*Unonopsis spp.*	Annonaceae				
17	Arara broad leaf	*Unonopsis spp.*	Annonaceae				
				Total Area Sampled 1ha / 10000 sq. m			

Plot 3 - Transect 1							
Plot			1				
Subplot			Centre				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0250313 UTM 0257544				
Initial Altitude							
Final Altitude			266 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Sandy loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Open				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	28	15	0.9236304
2	Fine Leaf Counter*	*Licania sp.*	Chrysobalanaceae	NG	45	8	1.272348
3	Maho*	*Sterculia pruriens*	Sterculiaceae	G	48	20	3.6191232
4	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	48	16	2.89529856
5	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	NG	42	6	0.83126736
6	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	35	10	0.962115
7	Asepoko*	*Pouteria guianensis*	Sapotaceae	NG	37	5	0.5376063
8	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	35	10	0.962115
9	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	38	8	0.90729408
10	Maho*	*Sterculia pruriens*	Sterculiaceae	G	25	8	0.3927
11	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	40	10	1.25664
12	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	25	20	0.98175
13	Crabwood*	*Carapa guianensis*	Meliaceae	G	32	6	0.48254976
14	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	30.5	12	0.87674202
15	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	21	5	0.1731807
16	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	35	20	1.92423
17	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	23	15	0.6232149
18	Suya*	*Pouteria specious*	Sapotaceae	G	63	17	5.29932942
19	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	23	10	0.4154766

20	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae	G	22	8	0.30410688
21	Letterwood *	*Brosiumum guianense*	Moraceae	NG	23	5	0.2077383
22	Fukadi*	*Terminalia amazonia*	Combretaceae	G	25	20	0.98175
23	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	25	10	0.490875
24	Burada*	*Parinari campestris*	Chrysobalanaceae	G	23	4	0.16619064
25	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	39	18	2.15026812
26	Crabwood*	*Carapa guianensis*	Meliaceae	G	45	12	1.908522
27	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	23	12	0.49857192
28	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	29.5	8	0.54679548
29	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	NG	29	6	0.39631284
Understory							32.98774248
1	Whitey	*Inga jenmanii*	Leguminosae-mimos				
2	Muniridan*	*Siparuna guianensis*	Monimiaceae				
3	Muniridan*	*Siparuna guianensis*	Monimiaceae				
4	Kauta*	*Licania guianensis*	Chrysobalanaceae				
5	Kauta*	*Licania guianensis*	Chrysobalanaceae				
6	Kauta*	*Licania guianensis*	Chrysobalanaceae				
7	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
8	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae				
9	Asashi	*Rheedia acuminata*	Guttiferae				
10	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
11	Waiaballi	*Tapura guianensis*	Dichapetalaceae				
12	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae				
13	Kurokai*	*Protium heptaphyllum*	Burseraceae				
14	Okokonshi	*Quiina indigofera*	Quiinaceae				
15	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil				
16	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae				
17	Haiawballi	*Protium tenuifolium*	Burseraceae				
18	Kurokai*	*Protium heptaphyllum*	Burseraceae				
19	Okokonshi	*Quiina indigofera*	Quiinaceae				
20	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil				
21	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae				

Plot 3 - Transect 2							
Plot			1				
Subplot			N				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0257521 UTM 0250416				
Initial Altitude							
Final Altitude			270 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Sandy loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Open				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	35	10	0.962115
2	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	32	15	1.2063744
3	Ubudiablli	*Chrysophyllum sanguinolentum*	Sapotaceae	G	67	12	4.23079272
4	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae	G	70	8	3.078768
5	Ubudiablli	*Chrysophyllum sanguinolentum*	Sapotaceae	NG	52	10	2.1237216
6	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	33	12	1.02636072
7	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	21	15	0.5195421
8	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	52	15	3.1855824
9	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	51	10	2.0428254
10	Crabwood*	*Carapa guianensis*	Meliaceae	G	30	8	0.565488
11	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	32	6	0.48254976
12	Burada*	*Parinari campestris*	Chrysobalanaceae	G	20	10	0.31416
13	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	45	5	0.7952175
14	Crabwood*	*Carapa guianensis*	Meliaceae	G	30.5	5	0.365309175
15	Warakosa	*Inga thibaudiana*	Leguminosae - Mimos	G	36	10	1.0178784

Understory					21.91668518
1	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
2	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
3	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
4	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
5	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
6	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
7	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
8	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
9	Common Baromalli*	*Catostemma commune*	Bombacaceae		
10	Common Baromalli*	*Catostemma commune*	Bombacaceae		
11	Common Baromalli*	*Catostemma commune*	Bombacaceae		
12	Buba	*Socratea exorrhiza*	Palmae		
13	Buba	*Socratea exorrhiza*	Palmae		
14	Buba	*Socratea exorrhiza*	Palmae		
15	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
16	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
17	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
18	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
19	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
20	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
21	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
22	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
23	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
24	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
25	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
26	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
27	Muniridan*	*Siparuna guianensis*	Monimiaceae		
28	Bamboo	*Panicum pilosum*	Gramineae		
29	Bamboo	*Panicum pilosum*	Gramineae		
30	Bamboo	*Panicum pilosum*	Gramineae		
31	Bamboo	*Panicum pilosum*	Gramineae		
32	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
33	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
34	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
35	Arara broad leaf	*Unonopsis spp.*	Annonaceae		
36	Arara broad leaf	*Unonopsis spp.*	Annonaceae		
37	Arara broad leaf	*Unonopsis spp.*	Annonaceae		
38	Arara broad leaf	*Unonopsis spp.*	Annonaceae		

Plot 3 - Transect 3							
Plot			1				
Subplot			S				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0257562 UTM 0250224				
Initial Altitude							
Final Altitude			241 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Sandy loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Open				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Common Baromalli*	*Catostemma commune*	Bombacaceae	G	27	15	0.8588349
2	Fine Leaf Counter*	*Licania sp.*	Chrysobalanaceae	NG	25	15	0.7363125
3	Asashi	*Rheedia acuminata*	Guttiferae	NG	20	10	0.31416
4	Bat Seed*	*Andira surinamensis*	Leguminosae	G	50	15	2.94525
5	Crabwood*	*Carapa guianensis*	Meliaceae	G	37	20	2.1504252
6	Turtle Cherry	*Eugenia patrissi*	Myrtaceae	G	24	10	0.4523904
7	Crabwood*	*Carapa guianensis*	Meliaceae	G	27	10	0.5725566
8	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	NG	24	5	0.2261952
9	Kokerite	*Maximiliana maripa*	Palmae	G	32	6	0.48254976
10	Crabwood*	*Carapa guianensis*	Meliaceae	NG	34	4	0.36316896
11	Crabwood*	*Carapa guianensis*	Meliaceae	G	22	8	0.30410688
12	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	40	10	1.25664
13	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	53	15	3.3092829
14	Wadara*	*Couratari guianensis*	Lecythidaceae	G	50	15	2.94525
15	Crabwood*	*Carapa guianensis*	Meliaceae	G	26	8	0.42474432
16	Crabwood*	*Carapa guianensis*	Meliaceae	G	27	8	0.45804528

17	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	21.5	9	0.326746035
18	Cowwood*	*Bagassa guianense*	Moraceae	G	36	5	0.5089392
19	Turu	*Jessenia bataua*	Arecaceae	G	28	8	0.49260288
20	Crabwood*	*Carapa guianensis*	Meliaceae	G	26	10	0.5309304
21	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	55	10	2.375835
22	Crabwood*	*Carapa guianensis*	Meliaceae	G	26	10	0.5309304
23	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	25	10	0.490875
24	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	29	12	0.79262568
25	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	28	10	0.6157536
26	Crabwood*	*Carapa guianensis*	Meliaceae	G	27	8	0.45804528
27	Crabwood*	*Carapa guianensis*	Meliaceae	G	52	8	1.69897728
28	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	NG	45	8	1.272348
29	Crabwood*	*Carapa guianensis*	Meliaceae	G	55	12	2.851002
30	Crabwood*	*Carapa guianensis*	Meliaceae	NG	30	6	0.424116
31	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	35	8	0.769692
32	Cowwood*	*Bagassa guianense*	Moraceae	G	37	10	1.0752126
33	Shibadan*	*Aspidosperma cruentum*	Apocynaceae	G	38	8	0.90729408
Understory							33.92183834
1	Fern	*Pityrogramma spp.*	Adiantiaceae				
2	Fern	*Pityrogramma spp.*	Adiantiaceae				
3	Fern	*Pityrogramma spp.*	Adiantiaceae				
4	Fern	*Pityrogramma spp.*	Adiantiaceae				
5	Fern	*Pityrogramma spp.*	Adiantiaceae				
6	Fern	*Pityrogramma spp.*	Adiantiaceae				
7	Bamboo	*Panicum pilosum*	Gramineae				
8	Bamboo	*Panicum pilosum*	Gramineae				
9	Bamboo	*Panicum pilosum*	Gramineae				
10	Bamboo	*Panicum pilosum*	Gramineae				
11	Bulletwood*	*Manilkara bidentata*	Sapotaceae				
12	Bulletwood*	*Manilkara bidentata*	Sapotaceae				
13	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil				
14	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae				
15	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae				
16	Muniridan*	*Siparuna guianensis*	Monimiaceae				
17	Bamboo	*Panicum pilosum*	Gramineae				
18	Kurokai*	*Protium heptaphyllum*	Burseraceae				
19	Kurokai*	*Protium heptaphyllum*	Burseraceae				
20	Kamahora	*Pouteria venosa*	Sapotaceae				
21	Kamahora	*Pouteria venosa*	Sapotaceae				

22	Kamahora	*Pouteria venosa*	Sapotaceae		

Plot 3 - Transect 4							
Plot			1				
Subplot			E				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 025655 UTM 025337				
Initial Altitude							
Final Altitude			263 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Sandy loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Darina*	*Hymenolobium flavum*	Fabaceae	NG	41	10	1.3202574
2	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	37	18	1.93538268
3	Asepoko*	*Pouteria guianensis*	Sapotaceae	NG	36	8	0.81430272
4	White Kakaralli	*Eshweilera wachenheimii*	Lecythidaceae	G	25	4	0.19635
5	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	NG	35	6	0.577269
6	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	21	10	0.3463614
7	Kabukalli*	*Goupia glabra*	Celastraceae	NG	26	5	0.2654652
8	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae	NG	51	6	1.22569524
9	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	G	43	5	0.7261023
10	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	21	4	0.13854456
11	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	NG	31	8	0.60381552
12	Fine Leaf Counter*	*Licania sp.*	Chrysobalanaceae	G	57	10	2.5517646
13	Unknown			G	95	5	3.5441175
14	Ubudiablli	*Chrysophyllum sanguinolentum*	Sapotaceae	G	82	15	7.9215444
15	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	NG	25	5	0.2454375

16	Ubudiablli	*Chrysophyllum sanguinolentum*	Sapotaceae	G	60	10	2.82744
17	Ubudiablli	*Chrysophyllum sanguinolentum*	Sapotaceae	NG	50	6	1.1781
18	Ubudiablli	*Chrysophyllum sanguinolentum*	Sapotaceae	G	71	8	3.16736112
19	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	NG	22	8	0.30410688
Understory							29.889418
1	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
2	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
3	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
4	Whitey	*Inga jenmanii*	Leguminosae-mimos				
5	Muniridan*	*Siparuna guianensis*	Monimiaceae				
6	Kurokai*	*Protium heptaphyllum*	Burseraceae				
7	Kurokai*	*Protium heptaphyllum*	Burseraceae				
8	Kurokai*	*Protium heptaphyllum*	Burseraceae				
9	Turu	*Jessenia bataua*	Arecaceae				
10	Bamboo	*Panicum pilosum*	Gramineae				
11	Bamboo	*Panicum pilosum*	Gramineae				
12	Bamboo	*Panicum pilosum*	Gramineae				
13	Bamboo	*Panicum pilosum*	Gramineae				
14	Bamboo	*Panicum pilosum*	Gramineae				
15	Mokru	*Ischnosiphon arouma*	Marantaceae				
16	Mokru	*Ischnosiphon arouma*	Marantaceae				
17	Mokru	*Ischnosiphon arouma*	Marantaceae				
18	Asepoko*	*Pouteria guianensis*	Sapotaceae				
19	Asepoko*	*Pouteria guianensis*	Sapotaceae				
20	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
21	Kurokai*	*Protium heptaphyllum*	Burseraceae				
22	Kurokai*	*Protium heptaphyllum*	Burseraceae				

Plot 3 - Transect 5							
Plot			1				
Subplot			E				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 025655 UTM 025337				
Initial Altitude							
Final Altitude			263 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Sandy loam				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	35	5	0.4810575
2	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	G	33	10	0.8553006
3	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	23	10	0.4154766
4	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	22	15	0.5702004
5	Kurokai*	*Protium heptaphyllum*	Burseraceae	NG	22	5	0.1900668
6	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	NG	30	4	0.282744
7	Bulletwood*	*Manilkara bidentata*	Sapotaceae	NG	38	5	0.5670588
8	Matchwood	*Scherfflera morototoni*	Araliaceae	NG	57	8	2.04141168
9	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	40.5	12	1.54590282
10	Crabwood*	*Carapa guianensis*	Meliaceae	NG	23	5	0.2077383
11	Crabwood*	*Carapa guianensis*	Meliaceae	G	27	8	0.45804528
12	Maho*	*Sterculia pruriens*	Sterculiaceae	G	51	8	1.63426032
13	Crabwood*	*Carapa guianensis*	Meliaceae	G	42	10	1.3854456
14	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	58	6	1.58525136
15	Wadara*	*Couratari guianensis*	Lecythidaceae	NG	40	8	1.005312
Understory							13.2252721

1	Bamboo	*Panicum pilosum*	Gramineae		
2	Bamboo	*Panicum pilosum*	Gramineae		
3	Bamboo	*Panicum pilosum*	Gramineae		
4	Mokru	*Ischnosiphon arouma*	Marantaceae		
5	Mokru	*Ischnosiphon arouma*	Marantaceae		
6	Mokru	*Ischnosiphon arouma*	Marantaceae		
7	Mokru	*Ischnosiphon arouma*	Marantaceae		
8	White Yari Yari	*Duguetia pauciflora*	Annonaceae		
9	Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		
10	Yuruwe	*Bactris humilis*	Palmae		
11	Yuruwe	*Bactris humilis*	Palmae		
12	Yuruwe	*Bactris humilis*	Palmae		
13	Yuruwe	*Bactris humilis*	Palmae		
14	Dallibana	*Geonoma baculifera*	Palmae		
15	Dallibana	*Geonoma baculifera*	Palmae		
16	Asepoko*	*Pouteria guianensis*	Sapotaceae		
17	Asepoko*	*Pouteria guianensis*	Sapotaceae		
18	Bulletwood*	*Manilkara bidentata*	Sapotaceae		
19	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae		
20	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
21	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
22	Kurokai*	*Protium heptaphyllum*	Burseraceae		
23	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae		
24	Bulletwood*	*Manilkara bidentata*	Sapotaceae		
				Total Area Sampled 1ha / 10000 sq. m	

Plot 4 - Transect 1							
Plot			1				
Subplot			Centre				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0257020 UTM 0245278				
Initial Altitude							
Final Altitude			303 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Coarse				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Laterite				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Wadara*	*Couratari guianensis*	Lecythidaceae	NG	40	8	1.005312
2	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	109	15	13.9970061
3	Arara broad leaf	*Unonopsis spp.*	Annonaceae	NG	23	12	0.49857192
4	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	G	25	10	0.490875
5	Cowwood*	*Bagassa guianense*	Moraceae	G	35	10	0.962115
6	Maho*	*Sterculia pruriens*	Sterculiaceae	G	65	15	4.9774725
7	Cowwood*	*Bagassa guianense*	Moraceae	G	54	20	4.5804528
8	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	G	29	15	0.9907821
9	Kurokai*	*Protium heptaphyllum*	Burseraceae	NG	25	10	0.490875
10	Arara broad leaf	*Unonopsis spp.*	Annonaceae	G	21	12	0.41563368
11	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	90	15	9.54261
12	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	G	26	6	0.31855824
13	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	34	15	1.3618836
14	Asepoko*	*Pouteria guianensis*	Sapotaceae	NG	35	10	0.962115
15	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	26	6	0.31855824

16	Duka*	*Protium decandrum*	Burseraceae	NG	35	8	0.769692
17	Monkey Pot*	*Lecythis zabucajo*	Lecythidaceae	NG	26	6	0.31855824
18	Asepoko*	*Pouteria guianensis*	Sapotaceae	G	38	10	1.1341176
Understory							43.135189
1	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
2	Asashi	*Rheedia acuminata*	Guttiferae				
3	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
4	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil				
5	Haiawballi	*Protium tenuifolium*	Burseraceae				
6	Brown silverballi	*Aniba cf. riparia*	Lauraceae				
7	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil				
8	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
9	Kurokai*	*Protium heptaphyllum*	Burseraceae				
10	Black Yari Yari	*Guatteria punctata*	Annonaceae				
11	Burada*	*Parinari campestris*	Chrysobalanaceae				
12	Haiariballi	*Alexa imperatricis*	Leguminosae-papil				
13	Waiaballi	*Tapura guianensis*	Dichapetalaceae				
14	Manicole	*Euterpe oleracea*	Arecaceae				
15	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
16	Masoa plimpla	*Bactris major*	Palmae				
17	Kurokai*	*Protium heptaphyllum*	Burseraceae				
18	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae				
19	Black Yari Yari	*Guatteria punctata*	Annonaceae				
20	Asepoko*	*Pouteria guianensis*	Sapotaceae				
21	Maho*	*Sterculia pruriens*	Sterculiaceae				
22	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil				

Plot 4 - Transect 2							
Plot			1				
Subplot			S				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0256937 UTM 0244841				
Initial Altitude							
Final Altitude			307 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Coarse				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Laterite				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Dukali*	*Parahancornia fasciculata*	Apocynaceae	NG	28	6	0.36945216
2	Hill Dalli *	*Virola sebifera*	Myristicaceae	G	28	8	0.49260288
3	Ubudiablli	*Chrysophyllum sanguinolentum*	Sapotaceae	G	22	10	0.3801336
4	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	28	10	0.6157536
5	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	35	15	1.4431725
6	Kurokai*	*Protium heptaphyllum*	Burseraceae	NG	50	10	1.9635
7	Yarula	*Swartzia jenmani*	Apocynaceae	NG	35	6	0.577269
8	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	G	42	10	1.3854456
9	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	NG	23	6	0.24928596
10	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	NG	86	6	3.48529104
11	Turu	*Jessenia bataua*	Arecaceae	G	28	15	0.9236304
12	Ulu	*Chaetocarpus schomburgkianus*	Euphorbiaceae	G	20	10	0.31416
13	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	G	35	5	0.4810575
		Understory					12.68075424
1	Bamboo	*Panicum pilosum*	Gramineae				

2	Bamboo	*Panicum pilosum*	Gramineae		
3	Warakosa	*Inga thibaudiana*	Leguminosae - Mimos		
4	Quackoo	*Marlierea montana*	Myrtaceae		
5	Kautaballi	Licania alba	Chrysobalanaceae		
6	Asashi	*Rheedia acuminata*	Guttiferae		
7	Okokonshi	*Quiina indigofera*	Quiinaceae		
8	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		
9	Arara broad leaf	*Unonopsis spp.*	Annonaceae		
10	Arara broad leaf	*Unonopsis spp.*	Annonaceae		
11	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
12	Kurokai*	*Protium heptaphyllum*	Burseraceae		
13	Buba	*Socratea exorrhiza*	Palmae		
14	Wild Guava*	*Eshweilera alata*	Lecythidaceae		
15	Waiaballi	*Tapura guianensis*	Dichapetalaceae		
16	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
17	Asepoko*	*Pouteria guianensis*	Sapotaceae		
18	Hill Dalli *	*Virola sebifera*	Myristicaceae		
19	Hill Dalli *	*Virola sebifera*	Myristicaceae		
20	Common Baromalli*	*Catostemma commune*	Bombacaceae		
21	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae		
22	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		
23	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		
24	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		
25	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		

Plot 4 - Transect 3							
Plot			1				
Subplot			N				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0256914 UTM 0245031				
Initial Altitude							
Final Altitude			328 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Coarse				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Laterite				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	NG	33	10	0.8553006
2	Wild Guava*	*Eshweilera alata*	Lecythidaceae	NG	31	8	0.60381552
3	Turu	*Jessenia bataua*	Arecaceae	G	25	10	0.490875
4	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	G	43	10	1.4522046
5	Maporokon*	*Inga alba*	Leguminosae - Mimos	G	42	8	1.10835648
6	Hill Dalli *	*Virola sebifera*	Myristicaceae	NG	20	8	0.251328
7	Maporokon*	*Inga alba*	Leguminosae - Mimos	G	44	7	1.06437408
8	Maporokon*	*Inga alba*	Leguminosae - Mimos	NG	22	5	0.1900668
9	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	24	10	0.4523904
10	Arara broad leaf	*Unonopsis spp.*	Annonaceae	G	23	8	0.33238128
11	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae	G	36	15	1.5268176
12	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	G	52	5	1.0618608
13	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	28	15	0.9236304
14	Maporokon*	*Inga alba*	Leguminosae - Mimos	G	44	6	0.91232064
15	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	83	15	8.1159309
16	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	30	6	0.424116
17	Widi	*Astrocaryum gynacanthum*	Palmae	NG	25	4	0.19635
18	Suya*	*Pouteria specious*	Sapotaceae	NG	23	6	0.24928596
19	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	20	6	0.188496

20	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	NG	22	3	0.11404008
21	Duka*	*Protium decandrum*	Burseraceae	NG	50	8	1.5708
Understory							22.08474114
1	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
2	Kurokai*	*Protium heptaphyllum*	Burseraceae				
3	Buba	*Socratea exorrhiza*	Palmae				
4	Wild Guava*	*Eshweilera alata*	Lecythidaceae				
5	Waiaballi	*Tapura guianensis*	Dichapetalaceae				
6	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
7	Asepoko*	*Pouteria guianensis*	Sapotaceae				
8	Hill Dalli *	*Virola sebifera*	Myristicaceae				
9	Hill Dalli *	*Virola sebifera*	Myristicaceae				
10	Common Baromalli*	*Catostemma commune*	Bombacaceae				
11	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae				
12	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
13	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				

Plot 4 - Transect 4							
Plot			1				
Subplot			W				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0256822 UTM 0244936				
Initial Altitude							
Final Altitude			328 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Coarse				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Laterite				
Topsoil Characteristic			Medium				
Type of forest canopy			Open				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Wadara*	*Couratari guianensis*	Lecythidaceae	G	38	15	1.7011764
2	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	50	5	0.98175
3	Bat Seed*	*Andira surinamensis*	Leguminosae	NG	95	10	7.088235
4	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	G	89	8	4.97692272
5	Duka*	*Protium decandrum*	Burseraceae	G	64	10	3.2169984
6	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	22	5	0.1900668
7	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	NG	22	5	0.1900668
8	Sinkola	*Cinchona sp.*		NG	42	6	0.83126736
Understory							
1	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae				
2	Turu	*Jessenia bataua*	Arecaceae				
3	Ulu	*Chaetocarpus schomburgkianus*	Euphorbiaceae				
4	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil				
5	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae				
6	Wild Guava*	*Eshweilera alata*	Lecythidaceae				

7	Turu	*Jessenia bataua*	Arecaceae		
8	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil		
9	Maporokon*	*Inga alba*	Leguminosae - Mimos		
10	Hill Dalli *	*Virola sebifera*	Myristicaceae		
11	Maporokon*	*Inga alba*	Leguminosae - Mimos		
12	Maporokon*	*Inga alba*	Leguminosae - Mimos		
13	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae		
14	Arara broad leaf	*Unonopsis spp.*	Annonaceae		
15	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae		
16	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil		
17	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae		
18	Maporokon*	*Inga alba*	Leguminosae - Mimos		
19	Bulletwood*	*Manilkara bidentata*	Sapotaceae		
20	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae		
21	Widi	*Astrocaryum gynacanthum*	Palmae		
22	Suya*	*Pouteria specious*	Sapotaceae		
23	Marishiballi*	*Licania densiflora*	Chrysobalanaceae		
24	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		
25	Duka*	*Protium decandrum*	Burseraceae		
26	Wadara*	*Couratari guianensis*	Lecythidaceae		
27	Bulletwood*	*Manilkara bidentata*	Sapotaceae		

Plot 4 - Transect 5							
Plot			1				
Subplot			E				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0257020 UTM 0244943				
Initial Altitude							
Final Altitude			358 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Coarse				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Laterite				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Asepoko*	*Pouteria guianensis*	Sapotaceae	G	38	10	1.1341176
2	Cowwood*	*Bagassa guianense*	Moraceae	NG	27	8	0.45804528
3	Dukalli*	*Parkia pendula*	Fabaceae	G	26	10	0.5309304
4	Letterwood *	*Brosiumum guianense*	Moraceae	G	34	8	0.72633792
5	Sinkola	*Cinchona sp.*		NG	35	7	0.6734805
6	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	G	54	15	3.4353396
7	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	28	10	0.6157536
8	Asepoko*	*Pouteria guianensis*	Sapotaceae	NG	38	8	0.90729408
9	Hill Dalli *	*Virola sebifera*	Myristicaceae	G	38	15	1.7011764
10	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	50	15	2.94525
11	Bulletwood*	*Manilkara bidentata*	Sapotaceae	G	25	10	0.490875
12	Common Baromalli*	*Catostemma commune*	Bombacaceae	G	36	8	0.81430272
13	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	42	10	1.3854456
14	Asepoko*	*Pouteria guianensis*	Sapotaceae	G	31	8	0.60381552
15	Kurokai*	*Protium heptaphyllum*	Burseraceae	G	22	10	0.3801336
16	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	G	28	15	0.9236304
17	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	60	18	5.089392
18	Kamakuti	*Bombax flaviflorum*	Sterculiaceae	NG	38	10	1.1341176

19	Kamakuti	*Bombax flaviflorum*	Sterculiaceae	NG	35	10	0.962115
20	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	G	22	12	0.45616032
21	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	38	10	1.1341176
22	Arara broad leaf	*Unonopsis spp.*	Annonaceae	G	35	10	0.962115
23	Common Baromalli*	*Catostemma commune*	Bombacaceae	G	24	15	0.6785856
24	Sinkola	*Cinchona sp.*		NG	22	6	0.22808016
25	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	22	8	0.30410688
Understory							28.67471838
1	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
2	Manicole	*Euterpe oleracea*	Arecaceae				
3	Manicole	*Euterpe oleracea*	Arecaceae				
4	Manicole	*Euterpe oleracea*	Arecaceae				
5	Dallibana	*Geonoma baculifera*	Palmae				
6	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
7	Kamahora	*Pouteria venosa*	Sapotaceae				
8	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae				
9	Kurokai*	*Protium heptaphyllum*	Burseraceae				
10	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
11	Muniridan*	*Siparuna guianensis*	Monimiaceae				
12	Muniridan*	*Siparuna guianensis*	Monimiaceae				
				Total Area Sampled 1ha (10000) sq. m			

Plot 5 - Transect 1							
Plot			1				
Subplot			Centre				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0257909 UTM 0247379				
Initial Altitude							
Final Altitude			500 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Laterite				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Bulletwood*	*Manilkara bidentata*	Sapotaceae	NG	69	18	6.73072092
2	Kamahora	*Pouteria venosa*	Sapotaceae	G	39.5	10	1.22542035
3	Haiawaballi	*Protium tenuifolium*	Burseraceae	G	35	16	1.539384
4	Tonka Bean *	*Dipteryx oradata*	Leguminosae-Papil	G	39	18	2.15026812
5	Mamuriballi	*Quinna indigofera*	Quiinaceae	G	160	15	30.15936
6	Kauta*	*Licania guianensis*	Chrysobalanaceae	NG	23	5	0.2077383
7	Common Baromalli*	*Catostemma commune*	Bombacaceae	NG	27	16	0.91609056
8	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	32	15	1.2063744
9	Haiawaballi	*Protium tenuifolium*	Burseraceae	NG	28	4	0.24630144
10	Kauta*	*Licania guianensis*	Chrysobalanaceae	G	27	8	0.45804528
11	Monkey pot*	*Lecythis zabucajo*	Lecythidaceae	G	81	8	4.12240752
12	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae	NG	75	15	6.6268125
13	Shibadan*	*Aspidosperma cruentum*	Apocynaceae	NG	44	15	2.2808016

14	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	48	15	2.7143424
15	Kamahora	*Pouteria venosa*	Sapotaceae	NG	36	10	1.0178784
16	Turu	*Jessenia bataua*	Arecaceae	G	22	10	0.3801336
17	Kauta*	*Licania guianensis*	Chrysobalanaceae	NG	35	6	0.577269
		Understory					62.55934839
1	Heliconia	*Heliconia spathocircinata*	Musaceae				
2	Heliconia	*Heliconia spathocircinata*	Musaceae				
3	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil				
4	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil				
5	Masoa plimpla	*Bactris major*	Palmae				
6	Masoa plimpla	*Bactris major*	Palmae				
7	Masoa plimpla	*Bactris major*	Palmae				
8	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
9	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
10	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
11	Whitey	*Inga jenmanii*	Leguminosae-mimos				
12	Kauta*	*Licania guianensis*	Chrysobalanaceae				
13	Kauta*	*Licania guianensis*	Chrysobalanaceae				
14	Bamboo	*Panicum pilosum*	Gramineae				
15	Bamboo	*Panicum pilosum*	Gramineae				
16	Bamboo	*Panicum pilosum*	Gramineae				
17	Bamboo	*Panicum pilosum*	Gramineae				

Plot 5 - Transect 2							
Plot			1				
Subplot			N				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0257885 UTM 0247468				
Initial Altitude							
Final Altitude			456 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Fine				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Laterite				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Maporokon*	*Inga alba*	Leguminosae - Mimos	NG	36	12	1.22145408
2	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	45	10	1.590435
3	Kauta*	*Licania guianensis*	Chrysobalanaceae	NG	35	8	0.769692
4	Guava Skin Kakaralli*	*Eschweilera alata*	Lecythidaceae	NG	44	20	3.0410688
5	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	36	8	0.81430272
6	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae	G	38	18	2.04141168
7	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	NG	27	7	0.40078962
8	Kamahora	*Pouteria venosa*	Sapotaceae	G	39	15	1.7918901
9	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	25	12	0.58905
10	Turu	*Jessenia bataua*	Arecaceae	G	23	10	0.4154766
11	Kabukalli*	*Goupia glabra*	Celastraceae	NG	108	15	13.7413584
12	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	73	20	8.3707932
13	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	37	12	1.29025512
14	Kamahora	*Pouteria venosa*	Sapotaceae	G	52	12	2.54846592
15	Mamuriballi	*Quinna indigofera*	Quiinaceae	G	95	12	8.505882
16	Kaditiri	*Sclerolobium micropetalum*	Leguminosae-caesalp	NG	26	10	0.5309304

17	Wadara*	*Couratari guianensis*	Lecythidaceae	G	35	15	1.4431725
Understory							49.10642814
1	Bamboo	*Panicum pilosum*	Gramineae				
2	Bamboo	*Panicum pilosum*	Gramineae				
3	Warakosa	*Inga thibaudiana*	Leguminosae - Mimos				
4	Quackoo	*Marlierea montana*	Myrtaceae				
5	Kautaballi	Licania alba	Chrysobalanaceae				
6	Asashi	*Rheedia acuminata*	Guttiferae				
7	Okokonshi	*Quiina indigofera*	Quiinaceae				
8	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
9	Arara broad leaf	*Unonopsis spp.*	Annonaceae				
10	Arara broad leaf	*Unonopsis spp.*	Annonaceae				
11	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
12	Kurokai*	*Protium heptaphyllum*	Burseraceae				
13	Buba	*Socratea exorrhiza*	Palmae				
14	Wild Guava*	*Eshweilera alata*	Lecythidaceae				
15	Waiaballi	*Tapura guianensis*	Dichapetalaceae				
16	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
17	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae				
18	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
19	Yarula (Black)	*Aspidosperma excelsum*	Apocynaceae				
20	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil				
21	Limonaballi*	*Pouteria guianensis*	Sapotaceae				
22	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae				
23	Maho*	*Sterculia pruriens*	Sterculiaceae				
24	Common Baromalli*	*Catostemma commune*	Bombacaceae				
25	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae				
26	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
27	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae				
28	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae				
29	Duka*	*Protium decandrum*	Burseraceae				

Plot 5 - Transect 3							
Plot			1				
Subplot			W				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0257806 UTM 0247342				
Initial Altitude							
Final Altitude			478 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Coarse				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Laterite				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	43	15	2.1783069
2	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	32	8	0.64339968
3	Red Cedar	*Cedrela oradata*	Meliaceae	G	43	15	2.1783069
4	Kurokai*	*Protium heptaphyllum*	Burseraceae	G	35	8	0.769692
5	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	35	8	0.769692
6	Duru	*Apeiba echinata*	Tiliaceae	NG	25	8	0.3927
7	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	42	10	1.3854456
8	Arara broad leaf	*Unonopsis spp.*	Annonaceae	G	25	8	0.3927
9	Wadara*	*Couratari guianensis*	Lecythidaceae	G	48	12	2.17147392
10	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	36	10	1.0178784
11	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	25	10	0.490875
12	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	NG	32	10	0.8042496
13	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	40	8	1.005312
14	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	NG	33	6	0.51318036
15	Yarula (Black)	*Aspidosperma excelsum*	Apocynaceae	NG	60	20	5.65488
16	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	G	45	15	2.3856525
17	Limonaballi*	*Pouteria guianensis*	Sapotaceae	NG	55	15	3.5637525
Understory							26.31749736
1	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae				

2	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae			
3	Yarula	*Swartzia jenmani*	Apocynaceae			
4	White Yari Yari	*Duguetia pauciflora*	Annonaceae			
5	Ginger gale silverballi	*Aniba cf. guianesis*	Lauraceae			
6	Dog stone	*Tabenaemontana undulata*	Apocynaceae			
7	Okokonshi	*Quiina indigofera*	Quiinaceae			
8	Marishiballi*	*Licania densiflora*	Chrysobalanaceae			
9	Dog stone	*Tabenaemontana undulata*	Apocynaceae			
10	Marishiballi*	*Licania densiflora*	Chrysobalanaceae			
11	Mokru	*Ischnosiphon arouma*	Marantaceae			
12	Dallibana	*Geonoma baculifera*	Palmae			
13	White Yari Yari	*Duguetia pauciflora*	Annonaceae			
14	Turu	*Jessenia bataua*	Arecaceae			
15	Dallibana	*Geonoma baculifera*	Palmae			
16	Manicole	*Euterpe oleracea*	Arecaceae			
17	Dog stone	*Tabenaemontana undulata*	Apocynaceae			
18	White Yari Yari	*Duguetia pauciflora*	Annonaceae			
19	Okokonshi	*Quiina indigofera*	Quiinaceae			
20	Manicole	*Euterpe oleracea*	Arecaceae			
21	Mokru	*Ischnosiphon arouma*	Marantaceae			
22	White Yari Yari	*Duguetia pauciflora*	Annonaceae			
23	Marishiballi*	*Licania densiflora*	Chrysobalanaceae			
24	Yuruwe	*Bactris humilis*	Palmae			
25	Bulletwood*	*Manilkara bidentata*	Sapotaceae			
26	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae			

Plot 5 - Transect 4			
Plot	1		
Subplot	E		
Location	Region 9		
Physiographic position			
Initial Coordinates of Axis			
Final Coordinates of Axis	21 N 0257995 UTM 0247382		
Initial Altitude			
Final Altitude	475 m		
Physiography			
Forest Type	Mix Forest		
Slope			
Soil Texture	Coarse		

State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Laterite				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	25	10	0.490875
2	Maho*	*Sterculia pruriens*	Sterculiaceae	G	62	10	3.0190776
3	Common Baromalli*	*Catostemma commune*	Bombacaceae	G	51	8	1.63426032
4	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	50	20	3.927
5	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	34	15	1.3618836
6	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	21	5	0.1731807
7	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	20	10	0.31416
8	Duka*	*Protium decandrum*	Burseraceae	G	25	10	0.490875
9	Common Baromalli*	*Catostemma commune*	Bombacaceae	G	29	8	0.52841712
10	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	26	16	0.84948864
11	Kurokai*	*Protium heptaphyllum*	Burseraceae	G	31	10	0.7547694
12	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	52	10	2.1237216
13	Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	G	31	6	0.45286164
14	Shibadan*	*Aspidosperma cruentum*	Apocynaceae	G	47	8	1.38795888
15	Letterwood *	*Brosiumum guianense*	Moraceae	G	33	6	0.51318036
16	Kauta*	*Licania guianensis*	Chrysobalanaceae	G	25	8	0.3927
17	Wadara*	*Couratari guianensis*	Lecythidaceae	G	31	15	1.1321541
18	Maho*	*Sterculia pruriens*	Sterculiaceae	G	20	15	0.47124
		Understory					20.01780396
1	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae				
2	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae				
3	Yarula	*Swartzia jenmani*	Apocynaceae				
4	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
5	Ginger gale silverballi	*Aniba cf. guianesis*	Lauraceae				
6	Dog stone	*Tabenaemontana undulata*	Apocynaceae				
7	Okokonshi	*Quiina indigofera*	Quiinaceae				
8	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
9	Dog stone	*Tabenaemontana undulata*	Apocynaceae				
10	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
11	Mokru	*Ischnosiphon arouma*	Marantaceae				
12	Dallibana	*Geonoma baculifera*	Palmae				
13	White Yari Yari	*Duguetia pauciflora*	Annonaceae				

14	Turu	*Jessenia bataua*	Arecaceae				
15	Dallibana	*Geonoma baculifera*	Palmae				
16	Manicole	*Euterpe oleracea*	Arecaceae				
17	Dog stone	*Tabenaemontana undulata*	Apocynaceae				
18	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
19	Okokonshi	*Quiina indigofera*	Quiinaceae				
20	Manicole	*Euterpe oleracea*	Arecaceae				
21	Mokru	*Ischnosiphon arouma*	Marantaceae				
22	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
23	Marishiballi*	*Licania densiflora*	Chrysobalanaceae				
24	Yuruwe	*Bactris humilis*	Palmae				
25	Bulletwood*	*Manilkara bidentata*	Sapotaceae				
26	Itikiboroballi*	*Swartzia benthamiana*	Papilionaceae				
Plot 5 - Transect 4							
Plot			1				
Subplot			S				
Location			Region 9				
Physiographic position							
Initial Coordinates of Axis							
Final Coordinates of Axis			21 N 0257995 UTM 0247382				
Initial Altitude							
Final Altitude			475 m				
Physiography							
Forest Type			Mix Forest				
Slope							
Soil Texture			Coarse				
State of Conservation			Altered				
Predominant Stratum			Tree/Arborous				
Predominant Characteristics (sub forest)			Medium				
Soil Type			Laterite				
Topsoil Characteristic			Medium				
Type of forest canopy			Closed				
Tree no.	Common Name	Scientific Name	Family Name	Risk Class	DBH(m)	Height(m)	Volume(m^3)
1	Asepoko*	*Pouteria guianensis*	Sapotaceae	G	26	6	0.31855824
2	Asepoko*	*Pouteria guianensis*	Sapotaceae	G	35	8	0.769692
3	Asepoko*	*Pouteria guianensis*	Sapotaceae	G	29	10	0.6605214
4	Kurokai*	*Protium heptaphyllum*	Burseraceae	G	27	10	0.5725566
5	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	NG	60	10	2.82744

6	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	G	24	7	0.31667328
7	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	NG	36	10	1.0178784
8	Kurokai*	*Protium heptaphyllum*	Burseraceae	NG	23	7	0.29083362
9	Kurokai*	*Protium heptaphyllum*	Burseraceae	NG	26	10	0.5309304
10	Kurokai*	*Protium heptaphyllum*	Burseraceae	NG	23	5	0.2077383
11	Kurokai*	*Protium heptaphyllum*	Burseraceae	NG	23	5	0.2077383
12	Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	G	35	10	0.962115
13	Common Baromalli*	*Catostemma commune*	Bombacaceae	G	28	10	0.6157536
14	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	24	10	0.4523904
15	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	30	10	0.70686
16	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	NG	22	10	0.3801336
17	Marishiballi*	*Licania densiflora*	Chrysobalanaceae	G	29	15	0.9907821
18	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae	NG	30	8	0.565488
19	Yarula (Black)	*Aspidosperma excelsum*	Apocynaceae	NG	44	8	1.21642752
20	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae	G	33	8	0.68424048
21	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	G	26	8	0.42474432
22	Limonaballi*	*Chrysophyllum pomiferum*	Sapotaceae	G	40	15	1.88496
23	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil	NG	31	10	0.7547694
24	Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae	NG	60	15	4.24116
		Understory					21.60038496
1	Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae				
2	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae				
3	White Yari Yari	*Duguetia pauciflora*	Annonaceae				
4	Yuruwe	*Bactris humilis*	Palmae				
5	Yuruwe	*Bactris humilis*	Palmae				
6	Fukadi*	*Terminalia amazonia*	Combretaceae				
7	Kauta*	*Licania guianensis*	Chrysobalanaceae				
8	Black Yari Yari	*Guatteria punctata*	Annonaceae				
9	Mokru	*Ischnosiphon arouma*	Marantaceae				
10	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil				
11	Buba	*Socratea exorrhiza*	Palmae				
12	Black Yari Yari	*Guatteria punctata*	Annonaceae				
13	Haiariballi	*Alexa imperatricis*	Leguminosae-papil				
14	Black Yari Yari	*Guatteria punctata*	Annonaceae				
15	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil				
16	Mokru	*Ischnosiphon arouma*	Marantaceae				
17	Mokru	*Ischnosiphon arouma*	Marantaceae				
18	Kauta*	*Licania guianensis*	Chrysobalanaceae				
19	Mokru	*Ischnosiphon arouma*	Marantaceae				

20	Mokru	*Ischnosiphon arouma*	Marantaceae		
21	Mokru	*Ischnosiphon arouma*	Marantaceae		
22	Black Yari Yari	*Guatteria punctata*	Annonaceae		
23	Black Yari Yari	*Guatteria punctata*	Annonaceae		
24	Turu	*Jessenia bataua*	Arecaceae		
25	White seed	*Bactris oligoclada*	Palmae		
26	Okokonshi	*Quiina indigofera*	Quiinaceae		
27	Muniridan*	*Siparuna guianensis*	Monimiaceae		
28	Barakaro*	*Ormosia coccinea*	Leguminosae-Papil		
29	Kauta*	*Licania guianensis*	Chrysobalanaceae		
30	Kaditiri	*Sclerolobium micropetalum*	Leguminosae-caesalp		
31	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		
32	Kereti (White silverballi)*	*Ocotea cannliculata*	Lauraceae		
33	Waiaballi	*Tapura guianensis*	Dichapetalaceae		
34	Buba	*Socratea exorrhiza*	Palmae		
35	Heliconia	*Heliconia spathocircinata*	Musaceae		
36	Okokonshi	*Quiina indigofera*	Quiinaceae		
37	Buba	*Socratea exorrhiza*	Palmae	Total Volume of Species 777.4532034 m3	
				Total area sampled = 5 ha.	50000 sq. m

Table 1: Cultural, Economic and Medicinal uses of plants documented by the Survey.

Common Name	Scientific Name	Family Name	Plant Type	Cultural, Economic and Medicinal uses
Adebero	*Paypayrola longifolia*	Violaceae	Tree	The entire plant is used as an antipyretic agent in indigenous systems of medicine. Pharmacologic studies on the bark and leaves of this plant display effective antimicrobial activity, cytotoxic function, and hypotensive effects.
Ants bush	*Cordia nodosa*	Boraginaceae	Shrub	Leaves and bark are used to treat gripes in babies, thrush, headache and diabetes.
Arara broad leaf	*Unonopsis spp.*	Annonaceae	Tree	Bark of the plant is used to treat snakebites.
Aromata	*Clathrotropis spp.*	Fabaceae	Tree	Juice from inner bark is used to treat "bush yaws". Leaves and barks are soaked in water, to use as a bath to rid the body of lice and ticks. Wood is used for heavy construction, industrial flooring, furniture and boat construction.
Aruadan	*Sloanea cf. guianensis*	Elaeocarpaceae	Tree	Bark and leaves are used in the cooking industry for flavoring.
Asashi	*Rheedia acuminata*	Guttiferae	Shrub	Wood is used for purposes such as furniture, flooring (quarter sawn), heavy construction, and general carpentry.
Asepoko	*Pouteria guianensis*	Sapotaceae	Tree	Wood is used for heavy construction, marine construction (fresh and salt water), post, spares and house framing.
Bamboo	*Panicum pilosum*	Gramineae	Shrub	Young leaves are boiled and used to treat fevers.
Baradan	*Ocotea tomentella*	Lauraceae	Tree	Wood is used for interior joinery, millwork, furniture, plywood, moulding and ship building.
Barakaro	*Ormosia coccinea*	Leguminosae-papil	Tree	Wood is used for interior and exterior joinery, veneer, furniture, wainscoting and stairs.
Bartaballi	*Pouteria durlandii*	Sapotaceae	Tree	Wood is used for exterior purposes, turned objects, window and door frames.
Bird seed	*Miconia cf. ruficalyx*	Melastomataceae	Shrub	None known.
Black kakaralli	*Eshweilera sagotiana*	Lecythidaceae	Tree	Boiled bark is used as an antiseptic. The inner bark is used as a poultice for burns, cuts and hard–boils. Wood is used for sleepers, heavy construction, industrial flooring, bridge decking, frame construction and boat construction.
Black yari yari	*Guatteria punctata*	Annonaceae	Tree	The entire plant is used for treating symptoms of menopause.
Brown silverballi	*Aniba cf. riparia*	Lauraceae	Tree	The bark is used as an aphrodisiac and to treat warts. Wood is used for heavy construction, flooring, furniture, boat construction, bridge decking and musical instruments.
Buba	*Socratea exorrhiza*	Palmae	Shrub	Boiled leaves are used to treat venereal and urinary disease.

Bullet wood	*Manilkara bidentata*	Sapotaceae	Tree	Wood is used for heavy construction, sleepers, carpentry, hydraulic works, stairs, furniture components and bridges.
Burada	*Parinari campestris*	Chrysobalanaceae	Tree	Wood is used for submerge marine construction, heavy construction, flooring, sleepers and sheep kneel.
Common baromalli	*Catostemma commune*	Bombacaceae	Tree	Wood is used for interior joinery, carpentry, veneer, flooring, pulpwood, boxes and crates. Seeds are used to treat snoring.
Conga cane	*Costus arabicus l.*	Costaceae	Herb	Roots are used to make blood cleansing tonic. Leaves are used to treat cuts, bruises and to make genital wash.
Cow wood	*Bagassa guianense*	Moraceae	Tree	Wood is used for exterior and interior joinery, cabinet work, heavy construction, ship building, moulding and carpentry.
Crab wood	*Carapa guianensis*	Meliaceae	Tree	Bark is used to treat chicken pox, measles, ulcers, malaria, stomach pains, burns and diarrhea. Seeds are used to make oil which treats cough, cold and acts as a repellant. Wood is used for interior joinery, carpentry, veneer and flooring.
Dallibana	*Geonoma baculifera*	Palmae	Shrub	The whole plant is crushed and used to treat stomach-ache and constipation.
Darina	*Hymenolobium flavum*	Fabaceae	Tree	Bark is used to treat sores.
Dog stone	*Tabenaemontana undulata*	Apocynaceae	Shrub	Juice obtained from the bark is used to treat headache and sore eyes.
Duka	*Protium decandrum*	Burseraceae	Tree	Bark is grated and used with water to treat thrush, fever, ulcers, cuts, sores and snake bites. Wood is used to make cheap furniture and frame.
Dukali	*Parahancornia fasciculata*	Apocynaceae	Tree	Wood is used for interior joinery, plywood, toys, window shutters and light construction.
Dukuria	*Sacoglottis aff. cydonioides*	Humiriaceae	Tree	Wood is used for interior joinery, plywood, toys, window shutters and light construction.
Duru	*Apeiba echinata*	Tiliaceae	Shrub	Wood is used for construction and fuel for cooking.
Fern	*Pityrogramma spp.*	Adiantiaceae	Shrub	Leaves is crushed and used as an antibiotic.
Fine leaf counter	*Licania sp.*	Chrysobalanaceae	Tree	Wood is used for heavy construction, framing, charcoal, underwater marine construction and as shingles.
Fukadi	*Terminalia amazonia*	Combretaceae	Tree	Wood is used for general construction, boat construction, cabinet work, sleepers, turnery, interior and exterior joinery.
Ginger gale silverballi	*Aniba cf. guianesis*	Lauraceae	Tree	The entire plant is used for the production of timber, traditional medicine and the perfume industry.
Guava skin kakaralli	*Eschweilera alata*	Lecythidaceae	Tree	Wood is used for heavy carpentry, industrial flooring, sleepers, marine construction, frame construction, poles and posts.

Haiawballi	*Protium tenuifolium*	Burseraceae	Tree	Wood is used for interior trimming, cabinet work, heavy construction, bridge decking, flooring interior and exterior joinery.
Haimaracushi	*Marlierea schomburgkiana*	Myrtaceae	Shrub	None known.
Heliconia	*Heliconia spathocircinata*	Musaceae	Herb	The entire plant is crushed and the juice obtained is used to treat constipation and stomachache.
Hill dalli	*Virola sebifera*	Myristicaceae	Tree	The bark is crushed in water and is used as an anti-diarrheal remedy. The sap is used to treat ulcers and skin conditions. Wood is used for moulding, plywood, coffins, framework, fiberboard, interior joinery, light carpentry, making cheap furniture, particleboard, boxes and crates.
Iron mary	*Chaetocarpus schomburgkianus*	Euphorbiaceae	Shrub	Bark is used to ward off evil spirits.
Itikiboroballi	*Swartzia benthamiana*	Papilionaceae	Tree	Leaves, bark and stems are used to treat toothache. Wood is used for interior construction, violin bow, cutlery, parquet flooring, inlay, marquetry and musical instruments.
Kabukalli	*Goupia glabra*	Celastraceae	Tree	Bark and stems are used to treat toothache, chicken pox and eczema. Bark soaked in water and consumed is used to treat and prevent malaria. Wood is used for flooring, exterior construction, cheap furniture, stairs, decking, sleepers and plywood.
Kaditiri	*Sclerolobium micropetalum*	Leguminosae-caesalp	Tree	Wood is used for light construction and furniture.
Kairiballi	*Licania heteromorpha*	Chrysobalanaceae	Tree	Inner bark is scraped and boiled to treat tuberculosis and venereal disease.
Kamahora	*Pouteria venosa*	Sapotaceae	Tree	Bark is used as an astringent. Seeds are used to treat diarrhea, heart fluttering, heartburn and chest pain. Wood is used for construction, railway ties and fencing.
Kamakuti	*Bombax flaviflorum*	Sterculiaceae	Tree	The flowers are used as an astringent and refrigerant. It is used to treat cutaneous troubles. Young roots are used in the treatment of cholera, tubercular fistula, coughs, urinary complaints, nocturnal pollution, abdominal pain due to dysentery, and impotency. The knots or the stem are used on bleeding gums. The bark is reputedly used against cholera (usually combined with many other plants), pleurisy, stings and as a diuretic. It is used in bandages for lasting fractures or given in infusion for toothache before visiting the dentist.
Kauta	*Licania guianensis*	Chrysobalanaceae	Tree	Leaves and bark are grounded and use to treat headache and fever. Wood is used for heavy construction, shingle, framing, charcoal and underwater marine construction.

Kautaballi	*Licania alba*	Chrysobalanaceae	Tree	The powder from the outer bark is used to treat ulcers and sores. Decoction from bark is used to treat snake bite. Wood is used for heavy construction, shingles, framing, charcoal and underwater marine construction.
Kereti (white silverballi)	*Ocotea cannliculata*	Lauraceae	Tree	Wood is used for light carpentry, veneer, molding, decorative fitting and plywood. Crushed bark and leaves are used as a bath to treat small pox and fever.
Kokerite	*Maximiliana maripa*	Palmae	Tree	Fruits are eaten when ripe.
Kokoritiballi	*Pouteria cuspidata*	Sapotaceae	Tree	Wood is used for heavy construction and industrial flooring.
Komaramara	*Duroia eriopila l.f. var. eriopila*	Rubiaceae	Shrub	None known.
Kulishiri black	*Cupania hirsuta*	Sapindaceae	Tree	The plant is used for treating symptoms of menopause, premenstrual syndrome, painful menstruation, acne, weakened bones and initiating labor in pregnant women.
Kurokai	*Protium heptaphyllum*	Burseraceae	Tree	Bark is used to treat burns and cuts. The exudate is used to treat arthritis. Wood is used for making furniture, house framing, plywood, interior joinery, interior fitting, veneer and light construction.
Letter wood	*Brosiumum guianense*	Moraceae	Tree	Latex from the bark is used to treat ulcers. Wood is used for purposes such as inlay work, furniture, drum sticks, umbrella handles, fishing rods, fancy articles, violin bows, cabinet work
Limonaballi	*Chrysophyllum pomiferum*	Sapotaceae	Tree	Wood is used for heavy and light construction posts.
Mabwa	*Sapium jenmanii*	Euphorbiaceae	Tree	It is used to make plywood, fiberboard, particleboard, boxes and crates. It is also used in general carpentry, millwork and utility furniture.
Maho	*Sterculia pruriens*	Sterculiaceae	Tree	Wood is used for preparing plywood, interior joinery, boxes, crates, paper pulp, black-boards, frame work and light construction.
Mamuriballi	*Quinna indigofera*	Quiinaceae	Tree	None known.
Manicole	*Euterpe oleracea*	Arecaceae	Tree	Sap is applied to cuts as well as open wounds as a hemostat and used to treat scorpion stings and hemorrhaging. Water from the stem is used as an external body wash for contraception. Palm heart is dried, grounded and used as plaster for open wounds. Decoction made from leaves, used to treat fever.
Maporokon	*Inga alba*	Leguminosae-mimos	Tree	Wood is used for utility plywood, boxes, crates, light and heavy construction.
Marishiballi	*Licania densiflora*	Chrysobalanaceae	Tree	Wood is used for heavy construction, tool handles, sleepers, industrial flooring.

Masoa plimpla	*Bactris major*	Palmae	Tree	Stems are used for wall covering.
Matchwood	*Scherfflera morototoni*	Araliaceae	Tree	Wood is used for boat construction and making cheap furniture.
Mokru	*Ischnosiphon arouma*	Marantaceae	Shrub	Leaves and stems are grounded and the juice is used to treat cuts and sores.
Monkey pot	*Lecythis zabucajo*	Lecythidaceae	Tree	Leaves, stems and bark are used to treat liver conditions. Wood is used for heavy construction, marine construction, tool handles, sleepers, industrial flooring.
Muharoko	*Eleutherine bulbosa*	Iridaceae	Tree	The red bulb is crushed and mixed with water then consume to kill intestinal parasites and worms. The sap of the bulb is mixed with salt and used as a remedy for epileptic fits. The root is used in the treatment of female infertility and haemorrhages.
Muniridan	*Siparuna guianensis*	Monimiaceae	Tree	Wood is used for heavy construction, tool handles, sleepers, industrial flooring.
Nibi	*Heteropsis flexuosa*	Areacaceae	Epiphyte	Vines are dried and used as a binding and decorate agent.
Purple heart	*Peltogyne venosa*	Leguminosea-caesalp	Tree	Wood is used for decorative finishing, cabinet work, glued laminated beams, veneer, ship construction, tool handle, carvings, furniture and heavy carpentry.
Quackoo	*Marlierea montana*	Myrtaceae	Shrub	None known.
Red cedar	*Cedrela oradata*	Meliaceae	Tree	Leaves, stems and bark are used to treat fever, earache, headache and sores. Wood is used for decorative veneer, ship and boat construction, exterior and interior joinery, preparing plywood and musical instruments.
Rose of the mountain	*Brownea latifolia*	Leguminosae-caesalp	Tree	The bark is used for treating haemorrhages, menorrahgia and menstrual pains. Flowers are used in the treatment of coughs and colds, haemorrhages, whooping cough, and tuberculosis.
Sand mora	*Talisia cf. guianesis*	Sapindaceae	Tree	None known.
Sinkola	*Cinchona sp.*	Rubiaceae	Tree	Bark soaked in cold water is used to treat malaria and bile conditions.
Suya	*Pouteria specious*	Sapotaceae	Tree	Wood is used for flooring, general construction, plywood, poles and posts.
Swizzle stick	*Mabea piriri aubl*	Euphorbiaceae	Tree	Plant is used for the treatment of venereal diseases such as gonorrhoea and syphilis but also tuberculosis or ringworm infections.
Tatabu	*Diplotropis purpurea*	Leguminosae-papil	Tree	Wood is used for decorative veneer, flooring and heavy construction.
Tonka bean	*Dipteryx oradata*	Leguminosae-papil	Tree	Bark soaked in cold water is used to treat contusions, snake bites and rheumatism. Wood is used for sleepers, bridges, flooring, marine

				construction, hydraulic works, decorative veneer, turnery and heavy construction.
Turtle cherry	*Eugenia patrissi*	Myrtaceae	Shrub	Fruits are used as a preservative in the ice-cream industry.
Turu	*Jessenia bataua*	Arecaceae	Tree	Fruits soaked is used to make tea or used as a tonic.
Ubudiablli	*Chrysophyllum sanguinolentum*	Sapotaceae	Tree	The latex obtained from the stem is applied to the wound and allowed to dry, forming a kind of protective 'skin'. Tree sap is used for making gaskets, chewing gum and as a gutta-percha substitute.
Ulu	*Trattinnickia burserifolia*	Burseraceae	Tree	Leaves are used as a stimulant, for the removal of skin laceration and treatment of tumors and leukemia. Resin is used to treat throat diseases. Wood is used for interior plywood, framework, interior joinery, light carpentry, box and crates as well as manufacturing cheap furniture.
Understorey palm	*Bactris spp.*	Areacaceae	Tree	Used for making bows and barbed arrow points.
Wadara	*Couratari guianensis*	Lecythidaceae	Tree	Inner bark in cold water is used to treat fevers. Wood is used for interior joinery, plywood, exterior joinery, cheap furniture, flooring, formworks, boxes and crates.
Waiaballi	*Tapura guianensis*	Dichapetalaceae	Tree	Leaves are used as tea to cleanse the blood and curing influenza.
Wakaradan	*Miconia cf. ruficalyx*	Melastomataceae	Tree	Leaves and stems are grounded, mixed with water and used for dandruff and other scalp conditions.
Warakosa	*Inga thibaudiana*	Leguminosae-mimos	Tree	The bark is used for treating malaria, ulcers and relieving murini ant stings.
White kakaralli	*Eshweilera wachenheimii*	Lecythidaceae	Tree	Used as a tea to cure stomach aches.
White seed	*Bactris oligoclada*	Palmae	Tree	Fruits are valuable to the market industry
White yari yari	*Duguetia pauciflora*	Annonaceae	Tree	Leaves and stems are grounded and use to treat coughs.
Whitey	*Inga jenmanii*	Leguminosae-mimos	Tree	Bark is used to treat dysentery, cuts, wounds, ulcers, mouth sores, pains, abscess, female sterility, lieshmaniasis and insect bites. Leave decoction used to treat fever.
Widi	*Astrocaryum gynacanthum*	Palmae	Tree	None known.
Wild banana	*Heliconia spathocircinata*	Musaceae	Herb	Roots are used as an astringent and diuretic. An infusion of the leaves is used to ease expulsion of the fetus at childbirth.
Wild guava	*Eshweilera alata*	Lecythidaceae	Tree	Bark is boiled to treat high blood pressure, dysentery and colic.
Yarula	*Swartzia jenmani*	Apocynaceae	Tree	None known
Yarula (black)	*Aspidosperma excelsum*	Apocynaceae	Tree	Bark is boiled and used to treat chicken pox as well as treat and prevent malaria. Juice from inner bark is used to treat eye infection.

Yellow silverballi	*Aniba ovalifolia*	Lauraceae	Tree	Wood is used for light carpentry, furniture, veneer, plywood, interior trimmings, boat construction and joinery.
Yuruwe	*Bactris humilis*	Palmae	Tree	Mesocarp has medicinal uses and the seeds are used for making creative beads.

GROUND STRUCTURES ENGINEERING CONSULTANTS INC.
GEOTECHNICAL & ENVIRONMENTAL ENGINEERS AND GROUNDWATER HYDROLOGISTS
Lot GSEC, Liliendaal, Georgetown, Guyana
Phone: 592-222-8694/7, Website: groundstructures.com
Email: charlesceres@groundstructures.com

March 12, 2018

The Commissioner
Guyana Geology and Mines Commission
Upper Brickdam
Georgetown, Guyana

Dear Mr. Dennison

RE: Environmental and Social Impact Assessment for Marudi Mountain Gold Mines

Ground Structures Engineering Consultants Inc. is currently undertaking an Environmental and Social Impact Assessment for the proposed Marudi Gold Mine Project. The project site is approximately 5577 hectares (ha) and is located in the South Rupununi Mining District, approximately 155 kilometers south–south east of Lethem, and 50 kilometers south–south east of Aishalton. The location of the concession to be mined in depicted on the attached Figures 1 and 2. As part of this exercise, data will be compiled for the concession area and its vicinity to determine the presence and proximity of the following to the proposed mine site:

- forestry concessions, forest types and timber extracted from the area and its vicinity,
- the proximity of indigenous communities
- mining operation now and formerly operating in the area and
- the likely presence of archaeological resources in the area.

Ground Structures Engineering Consultants Inc. would also, as part of the baseline study for this project be developing data on several environmental variables including:

- site geology
- hydrogeology
- surface water hydrology
- biological resources in the area including the presence of any unique ecosystems, natural habitat or endangered species
- historical association of the area with Indigenous Peoples
- permanent or transient uses of the area by Indigenous Peoples
- chemical properties of the site soils
- risk of natural hazards (e.g. flooding) and subsidence and
- local meteorological conditions
- historical human activities within proximity of the study area,
- persons who engage in these activities and
- any artifacts related to those activities
- people who have constantly lived in the area
- people who recently moved into the area and
- people who enter the area periodically
- Land use patterns such as agriculture, forestry and mining within and around the proposed mine site
- schools, medical facilities, communications/transport networks and markets
- public health, health risks and diseases in the vicinity of the project

The ESIA will be guided by Good International Industry Practice (GIIP). Accordingly, we would like to request that you provide any information in your possession related to the above or any other issue to Ground Structures Engineering Consultants Inc. for inclusion in the ESIA. We would also like to request a meeting with your organization to identify issues which you consider important for inclusion in the ESIA document.

We would consider your failure to respond to this request as being indicative of your inability to provide the data requested and also as evidence that you have no issues which you would like to have included in the Environmental and Social Impact Assessment for the Marudi Gold Mine Project.

Very Truly Yours
GROUND STRUCTURES ENGINEERING CONSULTANTS INC.

Charles P. Ceres, PE
Managing Director
Copy: Executive Director (ag) Guyana Environmental Protection Agency

GROUND STRUCTURES ENGINEERING CONSULTANTS INC.
GEOTECHNICAL & ENVIRONMENTAL ENGINEERS AND GROUNDWATER HYDROLOGISTS
Lot GSEC, Liliendaal, Georgetown, Guyana
Phone: 592-222-8694/7, Website: groundstructures.com
Email: charlesceres@groundstructures.com

March 12, 2018

The Commissioner
Guyana Forestry Commission
1 Water Street, Kingston
Georgetown

Dear Mr. Singh

RE: Environmental and Social Impact Assessment for Marudi Mountain Gold Mines

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- persons who engage in these activities and
- any artifacts related to those activities
- people who have constantly lived in the area
- people who recently moved into the area and
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Charles P. Ceres, PE
Managing Director
Copy: Executive Director (ag) Guyana Environmental Protection Agency

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Lot GSEC, Liliendaal, Georgetown, Guyana
Phone: 592-222-8694/7, Website: groundstructures.com
Email: charlesceres@groundstructures.com

March 12, 2018

The Permanent Secretary
Ministry of Indigenous Peoples Affairs
251-252 Thomas & Quamina Streets
South Cummingsburg
Georgetown, Guyana

Dear Sir/Madam

RE: Environmental and Social Impact Assessment for Marudi Mountain Gold Mines

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March 12, 2018

The Permanent Secretary
Ministry of Natural Resources
Upper Brickdam,
Georgetown, Guyana

Dear Mr. McKenzie

RE: Environmental and Social Impact Assessment for Marudi Mountain Gold Mines

Ground Structures Engineering Consultants Inc. is currently undertaking an Environmental and Social Impact Assessment for the proposed Marudi Gold Mine Project. The project site is approximately 5577 hectares (ha) and is located in the South Rupununi Mining District, approximately 155 kilometers south–south east of Lethem, and 50 kilometers south–south east of Aishalton. The location of the concession to be mined in depicted on the attached Figures 1 and 2. As part of this exercise, data will be compiled for the concession area and its vicinity to determine the presence and proximity of the following to the proposed mine site:

- forestry concessions, forest types and timber extracted from the area and its vicinity,
- the proximity of indigenous communities
- mining operation now and formerly operating in the area and
- the likely presence of archaeological resources in the area.

Ground Structures Engineering Consultants Inc. would also, as part of the baseline study for this project be developing data on several environmental variables including:

- site geology
- hydrogeology
- surface water hydrology
- biological resources in the area including the presence of any unique ecosystems, natural habitat or endangered species
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- permanent or transient uses of the area by Indigenous Peoples
- chemical properties of the site soils
- risk of natural hazards (e.g. flooding) and subsidence and
- local meteorological conditions
- historical human activities within proximity of the study area,
- persons who engage in these activities and
- any artifacts related to those activities
- people who have constantly lived in the area
- people who recently moved into the area and
- people who enter the area periodically
- Land use patterns such as agriculture, forestry and mining within and around the proposed mine site
- schools, medical facilities, communications/transport networks and markets
- public health, health risks and diseases in the vicinity of the project

The ESIA will be guided by Good International Industry Practice (GIIP). Accordingly, we would like to request that you provide any information in your possession related to the above or any other issue to Ground Structures Engineering Consultants Inc. for inclusion in the ESIA. We would also like to request a meeting with your organization to identify issues which you consider important for inclusion in the ESIA document.

We would consider your failure to respond to this request as being indicative of your inability to provide the data requested and also as evidence that you have no issues which you would like to have included in the Environmental and Social Impact Assessment for the Marudi Gold Mine Project.

Very Truly Yours
GROUND STRUCTURES ENGINEERING CONSULTANTS INC.

Charles P. Ceres, PE
Managing Director
Copy: Executive Director (ag) Guyana Environmental Protection Agency

GROUND STRUCTURES ENGINEERING CONSULTANTS INC.
GEOTECHNICAL & ENVIRONMENTAL ENGINEERS AND GROUNDWATER HYDROLOGISTS
Lot GSEC, Liliendaal, Georgetown, Guyana
Phone: 592-222-8694/7, Website: groundstructures.com
Email: charlesceres@groundstructures.com

March 12, 2018

The Commissioner
Guyana Lands and Surveys Commission
Upper Hadfield Street
Lodge, Georgetown
Guyana

Dear Mr. Benn

RE: Environmental and Social Impact Assessment for Marudi Mountain Gold Mines

Ground Structures Engineering Consultants Inc. is currently undertaking an Environmental and Social Impact Assessment for the proposed Marudi Gold Mine Project. The project site is approximately 5577 hectares (ha) and is located in the South Rupununi Mining District, approximately 155 kilometers south–south east of Lethem, and 50 kilometers south–south east of Aishalton. The location of the concession to be mined in depicted on the attached Figures 1 and 2. As part of this exercise, data will be compiled for the concession area and its vicinity to determine the presence and proximity of the following to the proposed mine site:

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Managing Director
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Lot GSEC, Liliendaal, Georgetown, Guyana
Phone: 592-222-8694/7, Website: groundstructures.com
Email: charlesceres@groundstructures.com

March 12, 2018

Mr. Kemraj Parasram
Executive Director (ag)
Environmental Protection Agency
Prashad Nagar
Georgetown, Guyana

Dear Mr. Parasram

RE: Environmental and Social Impact Assessment for Marudi Mountain Gold Mines

Ground Structures Engineering Consultants Inc. is currently undertaking an Environmental and Social Impact Assessment for the proposed Marudi Gold Mine Project. The project site is approximately 5577 hectares (ha) and is located in the South Rupununi Mining District, approximately 155 kilometers south–south east of Lethem, and 50 kilometers south–south east of Aishalton. The location of the concession to be mined in depicted on the attached Figures 1 and 2. As part of this exercise, data will be compiled for the concession area and its vicinity to determine the presence and proximity of the following to the proposed mine site:

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Charles P. Ceres, PE
Managing Director

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GEOTECHNICAL & ENVIRONMENTAL ENGINEERS AND GROUNDWATER HYDROLOGISTS
Lot GSEC, Liliendaal, Georgetown, Guyana
Phone: 592-222-8694/7, Website: groundstructures.com
Email: charlesceres@groundstructures.com

March 12, 2018

The Executive Director
Conservation International
91 Robb Street
Georgetown, Guyana

Dear Dr. Singh

RE: Environmental and Social Impact Assessment for Marudi Mountain Gold Mines

Ground Structures Engineering Consultants Inc. is currently undertaking an Environmental and Social Impact Assessment for the proposed Marudi Gold Mine Project. The project site is approximately 5577 hectares (ha) and is located in the South Rupununi Mining District, approximately 155 kilometers south–south east of Lethem, and 50 kilometers south–south east of Aishalton. The location of the concession to be mined in depicted on the attached Figures 1 and 2. As part of this exercise, data will be compiled for the concession area and its vicinity to determine the presence and proximity of the following to the proposed mine site:

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Very Truly Yours
GROUND STRUCTURES ENGINEERING CONSULTANTS INC.

Charles P. Ceres, PE
Managing Director
Copy: Executive Director (ag) Guyana Environmental Protection Agency

GROUND STRUCTURES ENGINEERING CONSULTANTS INC.
GEOTECHNICAL & ENVIRONMENTAL ENGINEERS AND GROUNDWATER HYDROLOGISTS
Lot GSEC, Liliendaal, Georgetown, Guyana
Phone: 592-222-8694/7, Website: groundstructures.com
Email: charlesceres@groundstructures.com

March 12, 2018

The Executive Director
World Wildlife Fund
285 Irving Street, Queenstown
Georgetown, Guyana

Dear Sir/Madam

RE: Environmental and Social Impact Assessment for Marudi Mountain Gold Mines

Ground Structures Engineering Consultants Inc. is currently undertaking an Environmental and Social Impact Assessment for the proposed Marudi Gold Mine Project. The project site is approximately 5577 hectares (ha) and is located in the South Rupununi Mining District, approximately 155 kilometers south–south east of Lethem, and 50 kilometers south–south east of Aishalton. The location of the concession to be mined in depicted on the attached Figures 1 and 2. As part of this exercise, data will be compiled for the concession area and its vicinity to determine the presence and proximity of the following to the proposed mine site:

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Lot GSEC, Liliendaal, Georgetown, Guyana
Phone: 592-222-8694/7, Website: groundstructures.com
Email: charlesceres@groundstructures.com

March 12, 2018

The Chief Medical Officer
Ministry of Public Health
Brickdam, Stabroek
Georgetown, Guyana

Dear Sir/Madam

RE: Environmental and Social Impact Assessment for Marudi Mountain Gold Mines

Ground Structures Engineering Consultants Inc. is currently undertaking an Environmental and Social Impact Assessment for the proposed Marudi Gold Mine Project. The project site is approximately 5577 hectares (ha) and is located in the South Rupununi Mining District, approximately 155 kilometers south–south east of Lethem, and 50 kilometers south–south east of Aishalton. The location of the concession to be mined in depicted on the attached Figures 1 and 2. As part of this exercise, data will be compiled for the concession area and its vicinity to determine the presence and proximity of the following to the proposed mine site:

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Email: charlesceres@groundstructures.com

March 12, 2018

South Rupununi District Council

Dear Sir/Madam

RE: Environmental and Social Impact Assessment for Marudi Mountain Gold Mines

Ground Structures Engineering Consultants Inc. is currently undertaking an Environmental and Social Impact Assessment for the proposed Marudi Gold Mine Project. The project site is approximately 5577 hectares (ha) and is located in the South Rupununi Mining District, approximately 155 kilometers south–south east of Lethem, and 50 kilometers south–south east of Aishalton. The location of the concession to be mined in depicted on the attached Figures 1 and 2. As part of this exercise, data will be compiled for the concession area and its vicinity to determine the presence and proximity of the following to the proposed mine site:

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March 12, 2018

The Commissioner
Guyana Geology and Mines Commission
Upper Brickdam
Georgetown, Guyana

Dear Mr. Dennison

RE: Environmental and Social Impact Assessment for Marudi Mountain Gold Mines

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