

## Final Environmental and Social Impact Assessment (ESIA) of the Aurora Mine Project in Guyana

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## Final Environmental and Social Impact Assessment (ESIA) of the Aurora Mine Project in Guyana

For and on behalf of  
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Approved by: Catherine Stevens

Signed:



Position: Partner

Date: 04/30/2010

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# 1

## INTRODUCTION

### 1.1

#### BACKGROUND

This Environmental and Social Impact Assessment (ESIA) report has been prepared for Guyana Goldfield's Aurora Mine Project (the Aurora Project or the Project). ERM in consortium with Ground Structures Engineering Corporation of Guyana (GSEC) was commissioned to undertake the ESIA. In terms of the project description, the ESIA was prepared on the basis of the preliminary assessment for the project (AMEC August 2009), supported by prior studies, baseline social and environmental field data collection and community engagement, and consultations with Project staff and consultants. Hence, while certain aspects of the project are well defined, others are in concept stage and may require additional analysis. Several potential additional analyses or studies envisioned have been included in the Social and Environmental Management Plan (SEMP).

The concession is located on the Cuyuni River in Administrative Region VII, Northwest Guyana. Exploration at the Aurora site began in 1911. Works completed from 1911 to 1995 included a small-scale mining operation (1940-1948). The most recent owner of the concession, an individual, acquired the property in 1995 and optioned the property to Coeur d'Alene Mines Ltd. In 1998, Guyana Goldfields acquired a 100% option on the Aurora Concession from the owner.

In 2000, the Project began exploration the site which resulted in the discovery of a number of mineralized gold zones and deposits, as well as the expansion of previously known mineralized zones. Guyana Goldfields was granted a Prospecting License (PL), under Section 30 of the Mining Act 1989, by the Guyana Geology and Mines Commission (GGMC) for a total area of 5,718.69 hectares (14,131.2 acres) encompassing the former Aurora Gold Mines on the Cuyuni River in Administrative Region VII, northwest Guyana. The project is hereinafter referred to as the Aurora project.

The construction and operation of the project requires the development of infrastructure and amenities. The project has the following major components:

1. **Aurora Mine Site**- this is the immediate operational mine area, some 5,718.69 ha in area containing the mine area, processing facilities, tailings ponds, equipment storage and maintenance facilities, fuel and chemical storage, air strip, worker camp, offices and supporting ancillary facilities;
2. **Buckhall Port**- a wharf and staging area at Buckhall on the Essequibo River will serve as the port of entry and exit for equipment, goods and services and workers for the Project; and,
3. **Access Road(s)** - connecting the Buckhall Port to the Aurora Mine Site. A portion of the extensive existing Barama Corporation forestry roads will be

utilized to reach some 131 km from Buckhall to a point east of the Aurora site. From there, the Project will construct a new road extending some 10 km south to the Cuyuni River to a barge crossing/staging area on each bank, and then an additional road (approximately 21 km) from the west bank barge crossing to the Aurora Mine Site.

## 1.2

### *PROJECT AREA OF INFLUENCE*

Due to the environmental and social context of the Project, the Project Area of Influence has been defined as three consecutively larger areas as follows (see Figure 1-1 below):

- A direct area of influence encompassing the Aurora Mine area and a 3-km wide corridor, centered on the access road, from the Aurora Mine Site across the Cuyuni River to the Barama Road and east to the Project's Buckhall port area;
- A broader indirect area of influence that takes into consideration potential interactions or impacts on the human and natural environments geographically removed or isolated from the Project and its components. The indirect area of influence determined the various villages or settlements visited under the ESIA public consultation program;<sup>1</sup> and,
- Guyana at large – while the project is located in northwestern Guyana, the magnitude and size of the project is likely to positively impact the overall socio-economic status of the country. Guyana is one of the poorest countries in the world and is ranked 103 in the 2006 United Nations Development Programme (UNDP) Human Development Report. Extensively dependent on mining industries, the need for employment and economic opportunities is the biggest concern in the country. Guyana has an unemployment rate of 11.7%. The Aurora project can be compared in size and magnitude to the gold and bauxite mine operations of Omai. Omai was a major employer and employment in Guyana was greatly affected in 2005 by both the cessation of gold mine operations due to depletion of reserves and temporary cessation of bauxite mine operations due to competition with Chinese bauxite exports. Similar to Omai in a number of respects, the Project could provide significant employment and be a driver for economic growth in the country, as well as take advantage of an existing, local skilled work force. The type, nature and degree of benefits may vary according to the project phases (i.e., exploration, feasibility, construction, operations and closure).

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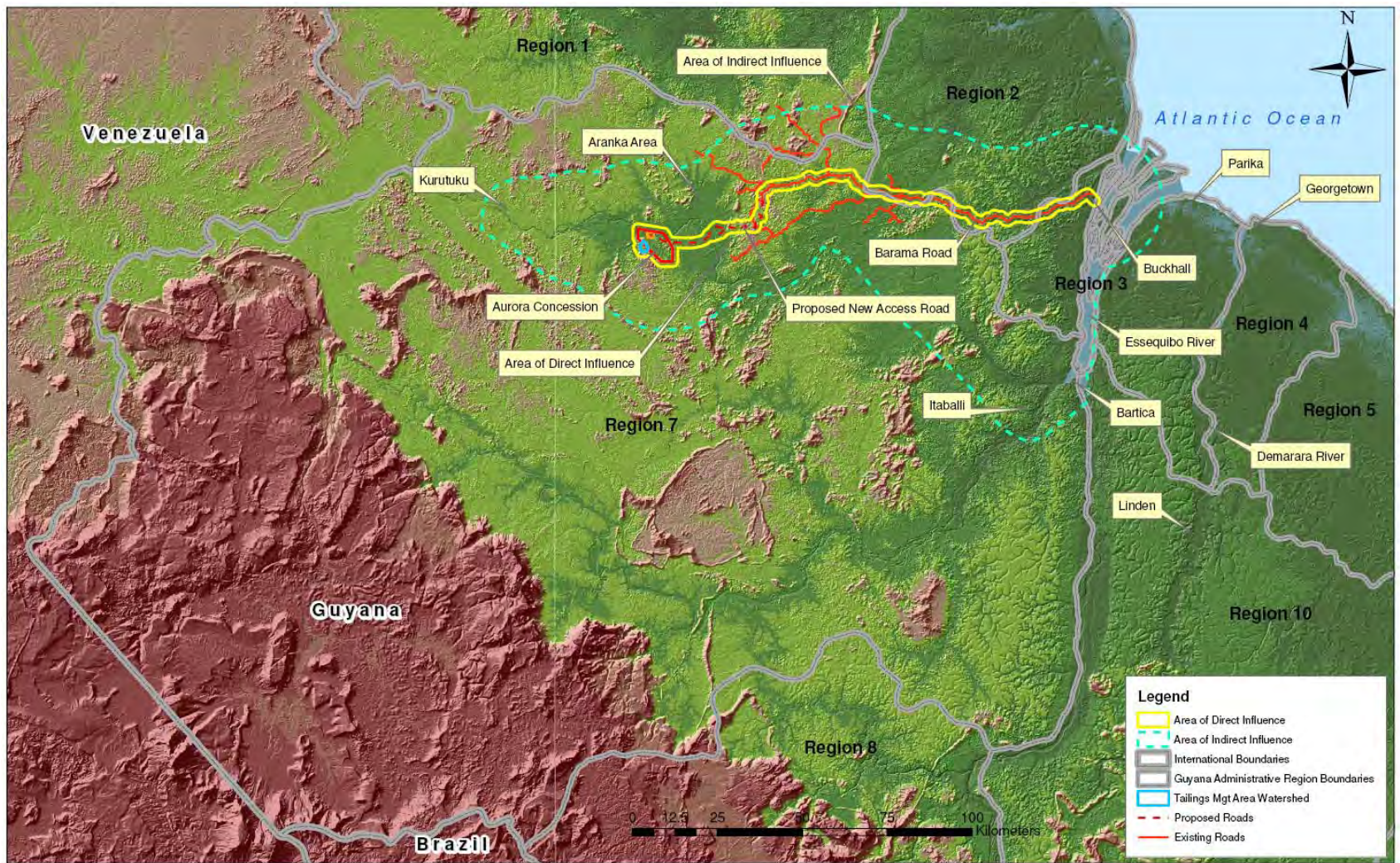
(1) There are no villages or other occupied areas in the immediate vicinity of the Aurora site as the area is for the most part uninhabited with the exception of shifting artisanal miners.

On a more localized scale, it is envisioned that at least in the early days of project development, the transportation corridor between Parika, the port on the east bank of the Essequibo and the jumping off place for access to the northwestern region, and Georgetown will serve as the primary avenue for the flow of goods and services within Guyana including labor. While the Parika to Georgetown Road corridor was not assessed under the ESIA in any detail, it is well developed, and residences, commercial enterprises and agricultural lands line the road. Potential risks and impacts from Project use should not measurably increase traffic on what is already a busy road, but it is envisioned that traffic and community health and safety management measures in the Project SEMP should be sufficient to manage potential impacts and risks in the corridor.

In the longer term, there are potential economic and employment impacts related to Project decommissioning which will affect the nation. Measures to manage and mitigate these impacts on the national economy are discussed in the impacts section of this ESIA.

More details regarding the above three levels of the Area of Influence are presented in the subsequent sections on methodology and baseline.

**Figure 1-1: Project Area of Influence** (Source:ERM, 2009)



### 1.3

#### *ESIA CONTENT ORGANIZATION*

This report is organized as follows:

*Section 2-Approach, Methodology and Limitations;*

*Section 3-Policy, Legal, Administrative Framework and Review;*

*Section 4-Project Description;*

*Section 5- Environmental Baseline;*

*Section 6- Socio-economic Baseline;*

*Section 7- key potential environmental and social impacts And Risks;*

*Section 8-Cumulative Impacts;*

*Section 9-Social and Environmental Management Systems;*

*Section 10-Environmental Management Plan;*

*Section 11-Social Management Plan; and*

*Section 12-Health, Safety and Emergency Response Plan.*

In addition, *Annex 1* contains Social Management Sub-Plans as follows:

*Part A: Artisanal Mining Management;*

*Part B: Influx Management;*

*Part C: Stakeholder Engagement Plan; and*

*Part D: Community Development Plan.*

*Annex 2* contains Biodiversity Survey Data for the Aurora Mines area, 2006-2007 and 2009.

*Annex 3* contains the *Bio-Assessment of the Cuyuni River near Aurora, Guyana, Environmental and Economic Implications* by independent biodiversity specialist Dr. Nicole Duplaix, October 2009

*Annex 4* contains the *Example Code of Conduct* to be adapted for the Project

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## 2.1

## APPROACH

The ESIA was developed using the following approach:

**Review of pre-existing project related and supporting information** - several reports had been prepared for the Aurora Project and mine area in 2006 and 2007. These included a detailed review of the environmental and social baseline in 2006, a rapid biodiversity assessment, and a high level social baseline survey. A gap assessment was conducted to determine additional studies required to update the existing baseline information commensurate with the current project development plans;

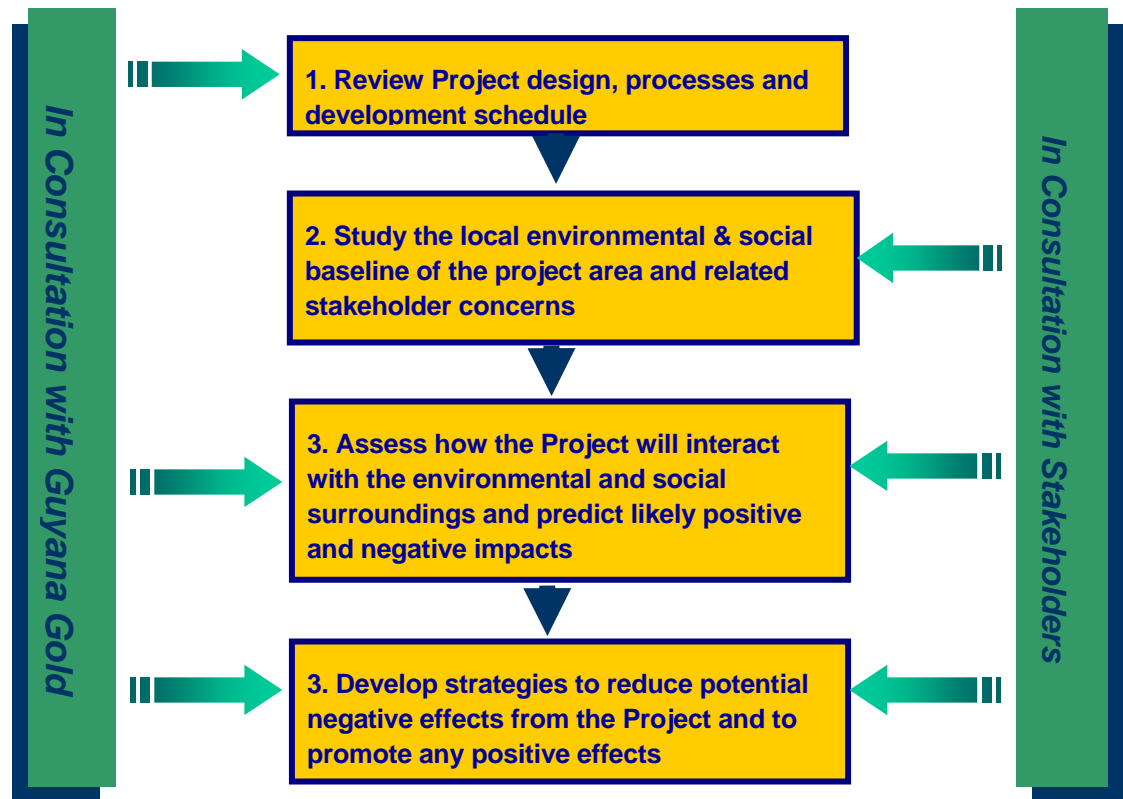
**Working with Guyana Goldfields and the Project design and engineering consultants, Amec Americas Limited (AMEC)** - ore body definition and therefore project engineering and design aspects were evolving during ESIA preparation, and the preliminary assessment, *AMEC's Technical Report on Updated Preliminary Assessment*, was completed in August 2009;

**Preparing two reports to adhere to national requirements as well as international standards** - it was determined in the spring of 2009, that in order to obtain the mining license for the Project, an EIA meeting the requirements of the EPA in Guyana had to be submitted by June 2009. Hence a separate Environmental and Social Impact Assessment (ESIA) report designed to meet Guyanese regulations was prepared and submitted in June 2009. The other requirements of the Guyanese regulatory process including a public consultation process, making the ESIA report publically available to stakeholders, and compilation of and response to comments were carried out.

This second ESIA report has been specifically written to comply with the requirements IFC's Performance Standards (PSs). Although the baseline data for both reports is largely the same, there were additional studies and stakeholder consultations carried out, and the presentation, technical content, and focus (e.g., biodiversity and the SEMP) of the ESIA is aligned with the IFC PSs.

The overall ESIA process followed is depicted in *Figure 2-1* below.

Figure 2-1 ESIA process



## 2.2

### ESIA METHODOLOGY

The methodology incorporated the following seven tasks which are described in more detail below:

- Review of existing documentation;
- Assessment of Policy, Legislative and Regulatory Framework;
- Evaluation of Historic Baseline Data;
- Determination of Scope of Assessment;
- Public Meetings;
- 2009 Field Activities and Surveys; and
- Impact Assessment and Rating.

#### 2.2.1

##### *Review of Existing Documentation*

The ESIA reviewed available historic data for the mine site and related areas. The review examined data on environmental, economic and social variables which included site geology, hydrogeology, surface water flow, biodiversity, conservation priorities, the proximity of indigenous communities, mining operations now underway and those formerly taking place in the area, and the likely presence of archaeological resources in the area. Examples of documents reviewed include:

- Geological reports for the area;
- Checklists of Plants, Fish, and Terrestrial Fauna of the Guiana Shield Region;
- 2009 IUCN Red List of Threatened Species;
- NatureServe and IUCN species distribution maps and GIS data;
- Alliance for Zero Extinction data;
- Guiana Shield Initiative studies and GIS data;
- Forestry Studies for the area;
- Data on Aquatic Resources of the area;
- Indigenous Groups reports for the mining sector;
- NGO information, including Conservation International (CI) and World Wildlife Fund (WWF);
- World Bank (IFC) guidelines on Baseline Characterization;
- World Bank (IFC) guidelines on Environmental Assessment;
- Guyana Environmental Protection Act;
- Guyana Town and Country Planning Act;
- Guyana Forestry Commission Guidelines;
- Guyana EPA Guidelines on Environmental Management Plans;
- Guyana EPA Guidelines on Human and Environmental Risk Assessment; and
- Guyana EPA Guidelines on Air Emissions Modeling.

Guidelines for the mining industry (e.g., ICMM), including those for the management of cyanide and other hazardous chemicals and standards for the construction of roads in mining areas, were also reviewed to determine their relevance to the project.

### **2.2.2 *Assessment of Policy, Legislative and Regulatory Framework***

A review of the applicable Guyanese Regulatory Framework regarding environmental and social requirements of the Project was undertaken. A comparison was made with requirements of the IFC PSs and EHS standard and based on the analysis of both frameworks, it was decided to prepare two separate reports: one adhering to Guyanese EPA requirements and the other to IFC's PSs. However, the decision to prepare a separate ESIA for the Guyana authorities was largely driven by the timing of the mining license approval process which was critical for the Project.

### **2.2.3 *Evaluation of Historic Baseline Data***

A physical, biological, and socio-economic baseline characterization had been completed for the mine site by GSEC in 2006. No baseline work had been done on

the roadway alignment or the wharf. The baseline characterization for the mine included biological field surveys, recovery and analyses of surface and groundwater samples, visits to communities within proximity of the mine site and compilation of data for the mine site and its vicinity. The baseline information was reviewed, and the additional 2009 field methodologies planned accordingly. The ESIA (2009) field studies were targeted to fill identified gaps in the existing baseline.

#### **2.2.4 *Determination of Scope of Assessment***

Based on the review and analysis of existing information, the scope of the assessment was determined, including the methodologies to be followed in the various baseline field studies such as hydrology, biodiversity, and socio-economic.

The scoping identified:

- The appropriate boundaries of the project (e.g., project area of influence);
- Major issues and concerns;
- The information necessary for decision-making;
- The significant effects and factors to be considered; and
- The scope and methodology of the assessment.

#### **2.2.5 *Public Meetings***

ERM and GSEC attended all the mandatory community stakeholder meetings chaired by the Environmental Assessment Board under the Guyana EIA legislation. An advertised public meeting was held by the EPA with a presentation of the Project and proposed activities by Guyana Goldfields in Bartica, the regional seat of Region 7, on April 29, 2009.

Concerns and issues raised by attendees at the meeting, which were few, have been incorporated into the analysis.

#### **2.2.6 *2009 Field Activities and Surveys***

Field activities and surveys were undertaken during 2009 to update the existing baseline information. The following studies and surveys were conducted by team specialists including local and international experts.

##### *Rapid Biodiversity Assessment*

To upgrade the existing baseline information, a rapid biodiversity assessment was conducted for the Project Area of Influence. The assessment utilized various data sources and methodologies including satellite imagery, literature surveys, direct observation, and where appropriate, interviews and questionnaires. Data collection for the physical environment focused on surface water hydrology, geology, topography, soil type, climate and meteorology, ambient air quality, noise and water quality, as discussed below. The biodiversity data collection focused on flora and fauna, endemic and threatened species, identification of potential sensitive habitats including wetlands, species of socioeconomic or cultural importance, migratory and congregational species, and protected areas in the region as none were present in the Project area.

The 2009 field inventory of biological resources for the Aurora mine site and environs was performed from 28 April through 5 May, 2009. During this period biological features at the mine site and its environs were characterized. This included sample collection in the case of certain plants, identification and recording. Both diurnal and nocturnal surveys were conducted. The vegetation of the Golden Square Mile, the Tailings Management Area (as identified at the time of the survey), the Water Management Pond, and the Julian Ross Itabu areas were characterized by cataloging the dominant tree and shrub species. Fish were sampled by netting and hook and line. Amphibians and reptiles were sampled by visual encounter surveys (VES) and auditory surveys. Birds were sampled by point counts and mist netting. Mammals were documented by direct and indirect observation (tracks, scat, fur, etc.) supplemented by interviews with Guyanese experts on the biodiversity of the area.

A specialized survey for giant otters, with negative results, was performed in the Cuyuni River and tributaries 13-22 October 2009 by international otter specialist Dr. Nicole Duplaix.

In addition, meetings were held in April and September, 2009, with the Guyana offices of the international conservation NGOs, the World Wildlife Fund and Conservation International, in order to share information about the project and obtain input on conservation priorities in the region.

#### *Groundwater Sampling*

In 2009, ERM subcontracted with GSEC to collect representative groundwater samples from monitoring wells located in the vicinity of the proposed Tailings Management Area (TMA), Water Management Pond (WMA), and the area proposed for open pit mining operations. The purpose of the groundwater sampling was to establish baseline groundwater conditions prior to development of the property for large-scale mining operations. Groundwater samples were collected from each monitoring well in accordance with USEPA RCRA guidelines. Groundwater samples were analyzed for metals and other constituents/parameters specified by IFC guidelines/protocols for cyanidation operations associated with the recovery of gold (i.e., Environmental, Health and Safety Guidelines for Mining,

December 10, 2007). Groundwater samples were analyzed in the laboratory by Exova Accutest of Ottawa, Canada.

#### *Surface Water/Sediment Sampling*

In 2009, ERM subcontracted with GSEC to collect surface water and sediment samples along the Cuyuni River from locations upstream, adjacent to, and downstream of the Aurora Mine site. The purpose of the surface water/sediment sampling was to establish baseline conditions along the Cuyuni River prior to development of the property for large-scale mining operations. Surface water and sediment samples were analyzed for metals and other constituents/parameters specified by IFC guidelines/protocols for cyanidation operations associated with the recovery of gold (i.e., Environmental, Health and Safety Guidelines for Mining, December 10, 2007). Surface water and sediment samples were analyzed in the laboratory by Exova Accutest, a Canadian company.

#### *Surface Water Modeling*

A comprehensive modeling approach was utilized to assess potential impacts to surface water from various discharge, spill, and release scenarios during mine construction and operation. Under this approach, a single modeling tool, GEMSS®, was utilized to quantitatively assess water resource issues related to use of the Cuyuni River. Although the range of assessments that can be conducted is extensive (e.g., fate and transport of dredged material; size and configuration of released process water, etc.), the primary objective for the ESIA was to assess the duration, spatial extent, and dilution of accidental discharges, potentially containing cyanide, to the Cuyuni River. Both small spills that may occur from time to time and catastrophic releases were assessed and modeled for the proposed project.

#### *Socio-Economic Studies*

The socio-economic baseline was updated by determining the area of influence where communities could be impacted by the Project and related activities. The study area took into consideration possible interactions with and impacts on settlements/communities due to the Project even if they were geographically far from the project.

Focused consultations were held with key stakeholders:

- Ministry of Amerindian Affairs;
- Indigenous Peoples NGOs (GOIP, APA and TAAMOG);
- WWF;
- Settlements/Communities in:
  - Aranka;
  - Kurutuku;
  - Bartica;

- Itaballi;
- Parika; and
- Buckhall.

Specifically with these small rural communities, a fact finding or information seeking exercise was undertaken through the consultations. The key objective was to assess the baseline of the communities and identify impacts (if any) that the project could potentially have on the human environment.

The main approach therefore was:

- Stakeholder ‘consultation’ focused;
- Aimed at participatory engagement of stakeholders in project conception, design and implementation; and
- An information seeking/research oriented exercise with the communities or settlements in the Project Area of Influence to facilitate profiling the socioeconomic baseline conditions of these communities and the potential impacts (if any) that might arise as a result of the Project.

The following activities were carried out in the settlements/ villages:

- Discussion with community leaders - informal discussion to understand concerns, provide information on the Project;
- Focus Group Discussions - open ended discussions with groups or sub groups within communities such as women, indigenous groups, youth, elderly people; and
- Village survey forms - these forms were completed in each village to gain basic information on the natural setting, governance, local customary and money economy, social development, infrastructure, administrative and economic conditions.

### 2.2.7 *Impact Assessment and Rating*

An impact rating system was developed for the ESIA to enable a systematic ranking of identified environmental and social impacts and presentation of a summary table which can be used by the Project to prioritise mitigations according to ranking. The impacts section presented in this report ranks impacts using the criteria presented in the following sections.

The impact rating is the product of two elements: (1) the *severity* of the potential impact and (2) the *likelihood* of the impact or “event” occurring.

### Severity and Enhancement Criteria

Firstly, the severity or enhancement of each impact was rated using the criteria identified in *Tables 2-1, 2-2, 2-3, and 2-4*. Note that colours are used to assist the reader in reviewing the impacts and their relative magnitude. As such, they should not be considered definitive.

**Table 2-2** *Severity Criteria (Negative Environmental Impacts)*

<b>Low</b>	Affects environmental conditions, species, and habitats over a short period of time, is localized and reversible.
<b>Medium</b>	Affects environmental conditions, species and habitats in the short to medium term. Ecosystems 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 receptors. The area/region may be able to recover through natural regeneration and restoration.
<b>High</b>	Affects environmental conditions, species and habitats for the long term (i.e., 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 2-3** *Severity Criteria (Negative Social or Health Impacts)*

	<i>Duration</i>	<i>Extent</i>	<i>Ability to Adapt</i>	<i>Socio-cultural Outcome</i>	<i>Health Outcome</i>
<b>Low</b>	Short-term <1 year  low frequency	Individual/ Household	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 livelihoods, culture, quality of life, resources, infrastructure and services.	Event resulting in annoyance, minor injury or illness that does not require hospitalization
<b>Medium</b>	Medium-term 1-6 years  Medium or intermittent frequency	Small number of households	Those affected will be able to adapt to change, with some difficulty, 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 many require hospitalization

	<i>Duration</i>	<i>Extent</i>	<i>Ability to Adapt</i>	<i>Socio-cultural Outcome</i>	<i>Health Outcome</i>
<b>High</b>	Long-term/ Irreversible  > 6 years  Constant frequency	Large part of/ full settlement	Those affected will not be able to adapt to changes and continue to 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 hospitalization.

**Table 2-4** *Enhancement Criteria (Positive Environmental Effects)*

	<i>Duration</i>	<i>Extent</i>	<i>Degree of Change</i>	<i>Focus/Sensitivity</i>
<b>High level of enhancement</b>	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..
<b>Medium level of enhancement</b>	Benefits will be measurable in the short term and possibly longer.	Benefits to species, habitats and natural resources in the local environment and beyond.	Moderate benefits to species, habitat, 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.
<b>Low level of enhancement</b>	Benefits will be short term.	Benefits to a few species, associated habitat, and resources in the local environment only.	Minor benefits to species, habitat, 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.

**Table 2-4** *Enhancement Criteria (Positive Social and Health Impacts)*

	<i>Duration</i>	<i>Extent</i>	<i>Degree of Change</i>	<i>Focus/ Sensitivity</i>
<i>High level of enhancement</i>	Benefits will be lasting and sustained over the long term i.e.: more than 7 years	Benefits throughout the local community and beyond to State/ National level.	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.
<i>Medium level of enhancement</i>	Benefits will be felt for a medium period of time (1 to 7 years) or be intermittent over the longer term	Benefits to many individuals and households in the local community and beyond	Moderate benefits to individuals and communities which will provide some opportunities for furthering themselves and improving livelihoods	Benefits will possibly pertain to vulnerable groups and those that might have been 'losers' from the project
<i>Low level of enhancement</i>	Benefits will be short-term (up to a year)	Benefits to a few individuals and households either in the local area and/or further afield.	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.

*Likelihood Criteria*

Likelihood categories were divided into the following:

- Low likelihood - Not known in the mining sector;
- Medium likelihood - Has occurred in mining projects; and
- High likelihood – high likelihood of the event occurring in mining projects.

*Determining the Rating*

The overall rating of the impacts was determined by using the following matrix (Table 2-5).

It should be noted that these matrices act as a guide and there may be situations where their rigid application is inappropriate and where stakeholder perceptions and feedback have a significant role to play. For specific impacts where this is the case, the rating is clearly explained in the evaluation of the impact.

**Table 2-5 Rating Matrix**

<i>Severity/Enhancement</i>	<i>Likelihood</i>		
	<i>Low</i>	<i>Medium</i>	<i>High</i>
<i>High level of enhancement</i>	Moderate	Major	Major
<i>Medium level of enhancement</i>	Minor	Moderate	Major
<i>Low level of enhancement</i>	Minor	Minor	Moderate
<i>Low severity</i>	Minor	Minor	Moderate
<i>Medium severity</i>	Minor	Moderate	Major
<i>High severity</i>	Moderate	Major	Major

### 2.3

#### *LIMITATIONS OF THE ESIA STUDY*

The ESIA study has the following limitations:

1. Timing of the study- the ESIA study was undertaken during the period March 2009 through September 2009 in parallel to the preparation of the Project pre-feasibility study prepared by AMEC. Thus the Project design details and facility location were evolving and changing during the ESIA process, with a number of key elements not yet finalized as of March 2010. In particular, the final engineering for the mine site including details for waste disposal, effluent treatment systems, road routes and road design, the Cuyuni River crossing and staging areas, and the Buckhall Port and facilities were not available. The definitive Feasibility Study for the project is scheduled to be completed in Quarter 3 of 2010.
2. The analysis and findings of this ESIA are therefore based on the status of the project description as of September 2009 (e.g., AMEC's *Technical Report on Updated Preliminary Assessment*). Any changes or additions to the project design and plans subsequent to September 2009 would not necessarily be covered under this ESIA or associated management plans;
3. Exclusion of Hydropower component- At the time of this report, the energy options available to the project were still under consideration. While the prefeasibility study is based on diesel generation of electricity, a feasibility study for a hydropower is underway and will be completed in 2010. As the feasibility of hydropower is unknown and design details were unavailable, this option was not considered in the ESIA;

4. Detailed Study of the Access Roads- At the time of writing this ESIA, the access road route connecting the Barama road to the river, the barge crossing facilities and details, and the spur road from the barge crossing to the mine site was not finalized; hence, no detailed surveys (e.g., biodiversity) were done of this route. The assessment of the approximate access road was based on information provided by the Client's survey team, existing baseline and general knowledge of the area.

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This section examines the policy, legal and administrative framework related to the mining industry in Guyana. The review focuses on the environmental and social aspects of this framework as it pertains to mining and mining activities along with project specific compliance requirements. The review begins with a general description of the national environmental institutional framework and provides an overview of the national policy and legal framework, with particular emphasis on the:

- National Development Strategy
- General National Environmental Legislation
- National Mining Legislation

The review then focuses on the international regulatory framework as it relates to the mining industry of Guyana. First, the review highlights the relevant international treaties, agreements, and conventions to which Guyana is a signatory. These international treaties, agreements, and conventions have influenced the development and implementation of several national policies and legislation related to the mining industry. Second, a detailed review of all applicable project-specific requirements and guidelines set by the International Finance Corporation (IFC) will be provided, with particular reference to:

- Performance Standards on Social and Environmental Sustainability, and,
- Environmental, Health and Safety (EHS) Guidelines.

Following the overview of the national and international policy, legal and administrative framework, a description of the required compliance mechanisms for the mining sector is provided. This section provides specific steps the project developer must take in order to comply with the national and international policy, legal, and administrative framework. The two foundational compliance mechanisms considered within this report and required by national legislation are the:

- Prospecting and Mining Licensing Process; and,
- Environmental and Social Impact Assessment Process.

The final section provides additional details on specific components of the national and international policy, legal and administrative framework. This information is provided in two comprehensive tables. The first covers national legislation, codes and draft legislation, while the second covers the applicable IFC performance standards and references to EHS guidelines. These tables are provided to supplement the overview provided throughout this chapter and to identify project

specific compliance measures prescribed by each legislation, IFC standard, or guideline.

Thus, this policy, legal and administrative framework reviews all applicable national and international policies, legislation, guidelines and standards and recommends specific actions the project developer must implement to ensure full compliance with national law, IFC Performance Standards, and EHS Guidelines.

### 3.1 NATIONAL ENVIRONMENTAL INSTITUTIONAL FRAMEWORK

The 1980 Constitution of Guyana provides the foundation for the national environmental institutional and legislative framework, stating that:

*“In the interests of the present and future generations, the State will protect and make rational use of its land, mineral and water resources, as well as its fauna and flora, and will take all appropriate measure to conserve and improve the environment”.*

Within this constitutional mandate, the Environmental Protection Act of 1996 is the primary environmental legislation in Guyana and establishes the Environmental Protection Agency (EPA) to be the primary governmental agency responsible for the management, conservation, protection and sustainable use of the environment. The Act states that the EPA shall be guided by several key principles upholding the constitutional imperative of protecting and conserving the environment. These principles include strict environmental precautions, penalties, liabilities and avoidance of environmental damage.

The Environmental Protection Act and the EPA form the basis for the environmental institutional framework of Guyana. Within this framework, each sector is administered by its corresponding ministry.

The mining sector is administered jointly by the EPA, the Guyana Geology and Mines Commission (GGMC), and the Minister of Mines. The GGMC is responsible for the promotion and administration of the mining industry, including permitting, licensing, infrastructure development, and other technical aspects of the industry. The Minister of Mines collaborates with the GGMC and is responsible for the negotiation of large scale exploration, prospecting and mining agreements.

### 3.2 NATIONAL POLICY AND LEGISLATIVE FRAMEWORK

The following section provides an overview of the relevant national strategies and legislation which make up the policy, legal and administrative framework of the mining sector in Guyana. The overview highlights specific legislation and outlines the administrative permitting and environmental and social impact assessment process. A comprehensive description of all relevant legislation is provided in *Table*

3-1, Section 3.6, which provides details on the specific provisions and, where applicable, project specific compliance requirements.

### 3.2.1 *National Development Strategy*

The Guyana National Development Strategy (NDS) 2000-2010 represents the highest level of national planning. The NDS reflects the constitutional imperative for the conservation and sustainable use of the country's natural resources, and strongly supports the EPA mandate to manage, conserve, protect and ensure the sustainable use of the environment.

In relation to the mining sector, the NDS recognizes that the mining industry has historically been one of the most significant sectors of the national economy, but also acknowledges significant constraints to the continuing development of the industry, such as an insufficient regulatory regime, lack of a competitive investment and tax system, high cost of transportation and shipping, and poor accessibility to inland services and lack of suitable labor. Within this context, the NDS includes the following goals related to the gold mining industry:

- Restructure the fiscal regime to encourage foreign investment;
- Create a system of licensed and bonded buyers of gold;
- Support environmental initiatives such as a riverbank restoration fund, incentives for regional gold processing mills, and regular regulatory compliance reviews of mining operations;
- Reorganize and restructure the GGMC and the Guyana National Resources Agency (GNRA);
- Increase industry collaboration with the Ministries of Health and Education, specifically in health, education, and malaria control initiatives; and,
- Coordinate new road construction by offering compensation or reduction in fees whenever new roads are constructed in accordance with the national road network plan, and meet specific construction and maintenance requirements.

Additionally, the Government of Guyana has published a National Environmental Action Plan (NEAP) to set out the necessary plan of action to ensure that the goals of the national development strategy related to environmental actions are fulfilled. The NEAP seeks to encourage "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." Specifically, the plan states that Guyana will seek to ensure:

- The preservation and conservation of ecological integrity and the protection of natural habitats and fragile ecosystems;
- The sustainable use of natural resources in conjunction with the proper management and environmental assessments of proposed activities; and,

- The prevention or control of pollution in order to maintain the integrity of the land and the natural purity of the air and water resources.

Therefore, where possible, the proposed project will seek to contribute to the NDS gold mining industry related goals and the general principles of the NEAP, participate in the economic and social development of the country, and carry out all activities in the most sustainable manner possible.

### 3.2.2 *National Environmental Legislation*

Within the general policy framework outlined by the NDS and NEAP, the Environmental Protection Act establishes the EPA and provides the administrative and legislative basis for:

- Requirement of environmental impact assessments, approval or rejection of projects, environmental permitting, regulations and authorizations;
- Prevention and control of pollution, including permitting, enforcement and prohibitions;
- Establishment and jurisdiction of environmental appeals tribunal;
- Procedures for investigations, prosecutions and civil proceedings;
- Environmental trust fund finances; and,
- Other administrative activities of the EPA.

The Environmental Protection Act was amended in 2000 to expand the role of the EPA and provide specific regulations for:

- Air quality,
- Water quality,
- Hazardous waste management,
- Authorizations; and,
- Noise management.

Additional legislation regarding the environment and natural resources include the following:

- Wild Birds Protection Act, Chapter 71:01
- Pesticides and Toxic Chemicals Control Act No. 13
- Public Health Act Cap 145
- Code of Practice for Timber Harvesting 2002
- Wildlife Management and Conservation Regulations (draft)
- Town and Country Planning Act 20:01

### 3.2.3 *National Mining Legislation*

In addition to the above-mentioned legislation, the mining sector is regulated by a set of specific legislation. The Mining Act forms the basis of this framework, which

is further regulated by a range of additional amendments, acts, codes and guidelines. The Mining Act establishes the legal framework for the utilization of mineral resources in Guyana. Specifically, the Act makes provisions regarding:

- Rights to and guardianship of minerals;
- Large, medium and small scale prospecting and mining;
- Prospecting licenses;
- Mining licenses;
- Royalties, penalties and other financial information;
- Mine safety, health and labor standards;
- Special provisions relating to Amerindians; and,
- Other requirements, provisions and information.

In addition to the Mining Act, the following amendments, regulations, acts, codes and guidelines further regulate the mining industry:

- The Mining (Amendment) Regulations 2005
- Mining Guidelines for Water Quality
- Occupational Health and Safety Act 1997
- Draft Mining Occupational Safety and Health Regulation 2002
- Forest Act 2008

#### *The Mining (Amendment) Regulations 2005*

The GGMC amended its mining regulations in 2005. These amended regulations together with the Mining Act 1989 are applicable to this project. GUY was granted a Prospecting Licence by the GGMC. When this ESIA satisfies both the EPA and GGMC, a mining licence will be issued for the recovery of gold in the Aurora area. GGMC would be responsible for enforcing the provisions of 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 the following:

- Use of poisonous substances;
- Requirements for environmental management for large and medium scale mining;
- Requirements for environmental management for small scale mining;
- General requirements;
- Protected areas;
- Pollution control; and,
- Offences and penalties.

Additional details are provided below for sections of the regulations that directly apply to the project.

## Use of Poisonous Substances

The poisonous substances regulations are applicable primarily to the use of mercury and cyanide in gold mining operations and stipulate that no person shall use elemental mercury or any form of mercury. These regulations present mandates for the use and storage of cyanide and require that no operation, in which cyanide or any mixture containing cyanide is used in the treatment of gold or other minerals, may be initiated until the necessary buildings, structures, rooms, appliances and other arrangements to carry on these operations have been inspected and approved by a mines officer.

The owner or manager of any claim or mine, where cyanide or any mixtures containing cyanide or any other poisonous substance are used, is mandated to enter the quantities of cyanide and other poisonous substances received and issued in a register. The Commission is required to keep registers which shall contain the following information related to cyanide permits:

- the name of the person to whom the cyanide permit is granted;
- the date that the permit was granted, expiration and renewal dates;
- the date and reason for revocation and suspension of the licence or permit and, with respect to suspensions, the time period for the suspension;
- the number of the licence or permit;
- the amount of cyanide purchased; and,
- any relevant remarks.

The regulations stipulate that any area of water containing poisonous or injurious chemical solutions used in the treatment of gold or other minerals must be fenced with posted warning signs to prevent inadvertent access. In addition, water containing any poisonous or injurious chemical solutions is not allowed to be discharged to any surface water body without having been previously rendered innocuous.

## Requirements for Environmental Management for Large Scale Mining

There are specific requirements for environmental management of large scale mining operations, including the application process for obtaining a cyanide permit. The Commission, EPA, the mining associations, and educational training institutions are obligated to provide training and certification courses for miners on the proper use of mercury and cyanide and environmental hazards associated with such use in mining activities. The Commission is also mandated by the regulations to prepare a Code of Practice that will provide further guidance on practices involving mercury use, cyanide use and disposal of effluent.

The regulations also mandate preparation of a closure plan before any new prospecting or mining licence is issued by the Commission. The reclamation and closure plan is required to include the following measures:

- Backfilling of placer mine pits, where applicable;
- Sealing or capping of shafts at closed mines in accordance with the Code of Practice or the directions of an appropriate authority at the Commission, as appropriate;
- Stripping and stockpiling of topsoil for use in reclamation; and,
- 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 response plan in accordance with the Code of Practice. The contingency and emergency response plan must set out provisions for hazards in mining operations including practical mechanisms for responding to cyanide and fuel spills, spills of other poisonous or hazardous substances, and breaches of tailings ponds.

### General Requirements

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 be affected by tailings discharge. The Commissioner will also direct the method of mining permissible in these areas, if necessary. The general requirements also stipulate that tailings must be discharged into a tailings pond or into a river, creek or stream where the critical turbidity has not exceeded 30 NTU.

Operators are also required to ensure that discharges from tailings ponds into any river or creek shall not exceed either 100 mg/L of total suspended solids (TSS) or 50 Nephelometric Turbidity Units (NTU). 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 24 hours within which to rectify the deficiency. Operators are also required to keep a daily record of the readings of the total suspended solids or NTU readings from a grab sample of the discharge and such readings shall be approximately 24 hours after the previous reading.

Where settling ponds are used as part of the mine drainage system, channels discharging into the river are required to have culverts and, where necessary, the slopes must be protected from erosion. Approved devices, chemical procedures or ponds are required to be used to remove suspended solids from tailings discharges from on-land mines. Settling ponds are required to 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.

The regulations require that all hazardous waste be sealed in barrels which are made of or lined with plastic, marked and sealed, and conveyed to an area set aside for the disposal of hazardous waste.

Tailings dams or water retaining dams higher than 16 feet (6 m) shall 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 inspection are required to be kept on file and be available for review by inspectors of the Commission. Tailings ponds shall be equipped with emergency spillways that pass the flows from the probable maximum flood so as to prevent overtopping of dams under extreme rainfall or runoff conditions.

#### Protected Areas

The regulations mandate that no person shall conduct mining activities within 20 m of the low water mark of a river bank, except for access of dredges from the river or in specified nature reserves and parks where resource extraction is prohibited or in buffer areas, without the express approval of the Commission and notification of parties likely to be affected by the activity. In addition, no dry mining or excavation shall be conducted in any watershed without prior permission from the Commissioner.

#### Pollution Control

Environmental monitoring shall be conducted for every mine including new mines. Each environmental monitoring program shall be required to be submitted to the Commission for approval as part of the Environmental Management Plan.

### 3.3

#### *INTERNATIONAL TREATIES, AGREEMENTS, AND CONVENTIONS*

The national policy, legal and administrative framework of Guyana has been significantly influenced by a set of international factors, including participation in and signing of international treaties, agreements and conventions. Such agreements require or recommend that corresponding national legislations are enacted and enforced to meet the specific guidelines of each agreement. Thus, international factors have influenced the development and implementation of specific national policies and legislation related to the mining industry, and should be taken into account by the project developer in the design and implementation of the project.

Guyana is signatory to the following international treaties, agreements and conventions particularly relevant to the mining industry:

Environment:

- Agenda 21;
- The Rio Principles;

- Basel Convention on the Transboundary Movement of Hazardous Waste and their Disposal;
- UN Framework Convention on Climate Change (UNFCCC);
- Convention on Biological Diversity (note: in observance of the Convention, Guyana established the EPA in 1996 to coordinate and implement a program for the conservation of biological diversity. A National Biodiversity Action Plan was also developed with stakeholders);
- Caribbean Environmental Programme (CEP);
- Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean;
- Protocol Concerning Pollution from Land-Based Sources and Activities (LBS);
- Protocol Concerning Specially Protected Areas and Wildlife (SPA);
- Treaty on Cooperation for the Development of the Amazon Basin; and,
- Convention on International Trade of Endangered Species;

#### Human Rights:

- International Convention on the Elimination of all Forms of Racial Discrimination;
- International Covenant on Civil and Political Rights;
- Convention on the Political Rights of Women;
- Convention on the Elimination of All Forms of Discrimination against Women;
- Convention on the Rights of the Child;
- International Convention on the Protection of the Rights of All Migrant Workers and Members of their Families;
- Convention on the Rights of Persons with Disabilities;
- ILO Core Labour Standards:
  - Freedom of association and collective bargaining (87 and 98),
  - Elimination of forced and compulsory labour (29 - 105),
  - Elimination of discrimination in respect of employment and occupation (100 and 111), and
  - Abolition of child labour (138 and 182); and
- ILO Convention on the Rights of Indigenous Peoples (Convention 169).

While not all have been ratified, the above listed treaties, agreements and conventions have provided guidelines for, or been enacted and included in, the national policy, legal and administrative framework of Guyana.

International environmental obligations have been incorporated into the NDS, NEAP, and specific legislation and guidelines such as the Environmental Protection Act and its amendments in 2000, the Mining Act and its amendments in 2005, the Mining Guidelines for Water Quality, and the Draft Mining Occupational Safety and Health Regulation 2002, among others.

International human rights obligations and norms have been incorporated into or are upheld by the Labour Act, the Amerindian Act, the Civil Law of Guyana Act, Equal Rights Act and other national legislation.

Thus, projects receiving authorization from the Guyanese EPA, GGMC or other governmental agencies should seek to comply with the relevant international guidelines, recommendations and regulations contained in the international treaties, agreements and conventions to which Guyana is signatory.

### 3.4

#### *INTERNATIONAL FINANCE CORPORATION REQUIREMENTS*

In addition to the international treaties, agreements and conventions listed above, projects receiving financing from the IFC must comply with an additional set of performance standards and EHS guidelines. A brief description of these standards and guidelines is provided to ensure that the project developer complies with all applicable standards and guidelines. Where appropriate, references to detailed compliance parameters are provided to ensure that the project developer is in compliance with specific technical requirements of the EHS guidelines for the mining industry. A comprehensive description of all relevant IFC standards and EHS guidelines and project specific compliance recommendations is provided in *Table 3-2, Section 3.6*.

The IFC has developed eight (8) performance standards for environmental and social impact assessment (Performance Standards on Social and Environmental Sustainability 2006). These standards guide the management of social and environmental risks and impacts of projects. In addition to the standards and requirements set by the national policy, legal and administrative framework, the project developer is expected to consistently meet these IFC standards throughout the life of an investment by IFC.

The performance standards that are applicable to this project are:

- Performance Standard 1: Social and Environmental Assessment and Management Systems
- Performance Standard 2: Labor and Working Conditions
- Performance Standard 3: Pollution Prevention and Abatement
- Performance Standard 4: Community Health, Safety and Security
- Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management
- Performance Standard 7: Indigenous Peoples
- Performance Standard 8: Cultural Heritage

The following section provides a brief description of each applicable standard and notes specific compliance actions necessary to meet each standard.

### *PS 1: Social and Environmental Assessment and Management Systems*

This performance standard focuses on the importance of managing social and environmental performance throughout the life of a project. It entails the thorough assessment of potential social and environmental impacts and risks from the early stages of project development, and provides order and consistency for mitigating and managing these on an ongoing basis.

The IFC mandates that a social and environmental management system appropriate to the nature and scale of the project be established and maintained. The management system shall incorporate the following elements:

- *Social and Environmental Assessment* - The social and environmental assessment should consider the potential social and environmental (including labor, health and safety) risks and impacts of the project. It should also include a description of the project and an appropriate social and environmental baseline data.
- *Management Program* - The management program should take into consideration the findings of the social and environmental assessment and consultation with affected communities. The program shall include mitigation and performance improvement measures and actions that address identified social and environmental risks and impacts.
- *Organizational Capacity and Training* - An organizational structure that defines roles, responsibilities and authority to implement the management program shall be developed. Employees and contractors with responsibility for social and environmental performance shall be trained in the requirements of the Performance Standards, Guyana's regulatory requirements and actions required under the management program.
- *Community Engagement* - The purpose of community engagement is to build and maintain constructive relationships with local communities that may be affected by risks from this project. This shall be an ongoing process which involves:
  - The disclosure of information on the risks, impacts and opportunities of the project;
  - A process of consultation so that affected communities can express their views on project risks, impacts and mitigation measures and have their concerns addressed.
  - Establishing a grievance mechanism if ongoing risks or adverse impacts are anticipated. The grievance mechanism receives and facilitates resolution of the concerns of the affected communities. The affected communities should be informed of the grievance mechanism during the engagement process.
- *Monitoring and Reporting* - The plan shall include procedures to monitor and measure the effectiveness of the management program. Mechanisms such

as inspections and audits shall be used to verify compliance toward the desired outcome.

- Compliance with all IFC EHS General Guidelines and Mining Sector Guidelines

### ***PS 2: Labor and Working Conditions***

This performance standard recognizes that the pursuit of economic growth through employment creation and income generation should be balanced with protection for basic rights of workers. Failure to establish and foster a sound worker-management relationship may undermine worker commitment and retention, and can jeopardize a project. The specific actions required by this performance standard include the following elements:

- *Working Conditions and Management of Worker Relationship* - GUY is mandated to adopt a human resources policy that sets out the company's approach to managing employees consistent with this Performance Standard. This PS mandates that upon employment, employees shall be provided with information regarding their working conditions and terms of employment and their rights to wages and benefits.
- *Protecting the Workforce* - No child below the age of 18 years will be employed in a manner that is economically exploitative and/or interferes with his/her education, health, physical, mental, moral or social development. Forced labor, which is any work or service not voluntarily performed, will not be employed.
- *Occupational Health and Safety* - A safe and healthy work environment shall be provided for workers. This considers physical, chemical, biological and radiological hazards in the various work areas.
- Compliance with IFC EHS General Guidelines and Mining Sector Guidelines.

### ***PS 3: Pollution Prevention and Abatement***

This performance standard recognizes that increased industrial activity generates increased levels of pollution to air, water and land that may threaten people and the environment. Thus, the objectives of the pollution prevention and abatement performance standard are to avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities and to promote the reduction of emissions that contribute to climate change. The specific actions required by this performance standard include the following elements:

- *General Requirements on Pollution Prevention and Abatement* - During the life-cycle of the project, pollution prevention and control technologies to avoid

or minimize adverse impacts to human health and the environment shall be considered within the realm of technical and financial feasibility.<sup>1</sup>

- *Ambient Considerations* - To address adverse project impacts on existing ambient conditions (i.e., air, soil, surface and groundwater), specific consideration will be given to existing and future land use, existing ambient conditions, and project proximity to ecologically sensitive areas.
- Promotion of strategies that avoid, minimize or reduce the release of pollutants.
- *Greenhouse Gas Emissions* - The reduction of project-related Green House Gas (GHG) emission shall be promoted. Cost-effective options to reduce or offset project-related GHG emissions include carbon financing, use of renewable energy sources, emissions offsets, etc. Quantification and monitoring of GHG emissions shall be conducted annually in accordance with internationally recognized methodologies.
- Compliance with IFC EHS General Guidelines and Mining Sector Guidelines.

#### ***PS 4: Community Health, Safety and Security***

This performance standard addresses Guyana Goldfield's responsibility to avoid or minimize the risks and impacts from project activities to community health, safety and security. The objectives of PS 4 are to avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non routine circumstances and to ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security. The specific actions required by this performance standard include the following elements:

- *Community Health and Safety Requirements* - During the life of the project, the risks and impacts to health and safety of affected community shall be evaluated and measures shall be developed to prevent or avoid risks and minimize impacts. Workers, their families and the community shall be protected from hazardous materials that may be released by the project. Adverse impacts from project activities on soil, water and other natural resources used by affected communities shall be minimized. Hazards that

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<sup>(1)</sup> Technical feasibility is based on whether the proposed measures and actions can be implemented with commercially available skills, equipment and materials, taking into consideration local factors such as climate, geography, demography, infrastructure, security, capacity and operational reliability. Financial feasibility is based on commercial considerations including the magnitude of the incremental cost of adopting such measures and actions compared to the project's investment, operating and maintenance cost and whether this incremental cost could make the project non viable.

stem from the risks and impacts from project activities shall be communicated to affected communities. Risks of security arrangements within and outside the project site will be assessed.

- Compliance with IFC EHS General Guidelines and Mining Sector Guidelines

### ***PS 6: Biodiversity Conservation and Sustainable Natural Resource Management***

This performance standard addresses how GUY can avoid or mitigate threats to biodiversity<sup>2</sup> and manage renewable natural resources. The objectives of PS 6 are to protect and conserve biodiversity and to promote the sustainable management and use of natural resources through the adoption of practices that integrate conservation needs and development priorities.

The requirements of this PS are applied to all habitats whether or not they are legally protected or have been previously disturbed. The specific actions required by this performance standard include the following elements:

- *Protection and Conservation of Biodiversity* -To avoid or minimize adverse impacts to biodiversity in the project area of influence, the following shall be done:
  - Assess the significance of impacts on all levels of biodiversity. This should include the different values attached to biodiversity by stakeholders and the impacts on ecosystem services.
  - Assess the major threats to biodiversity including habitat destruction and invasive alien species.
- Natural habitats shall not be significantly converted or degraded unless conversions are appropriately mitigated.
- The project shall not be implemented in a critical habitat unless impacts are mitigated and there is no reduction in the population of any recognized critically endangered or endangered species as defined by IUCN or national legislation.
- Compliance with IFC EHS General Guidelines and Mining Sector Guidelines.

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(<sup>2</sup>) Biodiversity refers to the variety of life in all its forms, including genetic, species and ecosystem diversity. The components of biodiversity include ecosystems and habitats, species and communities, and genes and genomes all of which have social, economic, cultural and scientific importance.

### ***PS 7: Indigenous Peoples***

This performance standard recognizes that indigenous peoples may play a role in sustainable development by promoting and managing activities as partners in development. The objectives of PS 7 are:

- To ensure that the development process fosters full respect for the dignity, human rights, aspirations, cultures and natural resource-based livelihoods of indigenous peoples;
- To avoid adverse impacts of the project on communities of indigenous peoples, or when avoidance is not feasible, to minimize, mitigate or compensate for such impacts, and to provide opportunities for development benefits in a culturally appropriate way;
- To establish and maintain an ongoing relationship with the affected indigenous peoples throughout the life of the project; and,
- To respect and preserve the culture, knowledge and practices of indigenous peoples.

The specific actions required by this performance standard include the following elements:

- *Avoidance of Adverse Impacts and Information Disclosure, Consultation and Informed Participation* - All indigenous communities within the project's area of influence that may be affected by the project shall be identified. The nature and degree of expected social, cultural and environmental impacts shall also be identified. Where avoidance is not feasible, Guyana Goldfields shall minimize, mitigate or compensate for these impacts. Their actions will be developed with full participation of affected Indigenous Peoples.
- *Development Benefits*- Opportunities for culturally appropriate development benefits for affected communities shall be identified through consultation. This shall be documented and provided in a timely manner.

### ***PS 8: Cultural Heritage***

This performance standard seeks to reduce project impacts to material cultural heritage and promote its preservation. Cultural heritage includes historic monuments and buildings, archaeological sites, shrines and other sites of religious significance.

### 3.5

#### *LEGISLATIVE REQUIREMENTS FOR THE MINING SECTOR*

The national and international policy, legal and regulatory framework suggests and describes the project-specific actions the project developer must undertake to comply with all applicable regulations, codes, and guidelines. As described above, Guyanese legislation mandates two general compliance mechanisms to ensure that all projects meet Guyanese national regulations, codes and guidelines. These mechanisms involve:

- Prospecting and Mining Licenses; and,
- Environmental and Social Impact Assessments.

These two mechanisms ensure, through application, review, approval, and monitoring, that all phases of prospecting, design, construction, operations, and closure of mining projects meet all relevant national regulations, codes and guidelines. Furthermore, by incorporating the applicable IFC Performance Standards and EHS Guidelines into these compliance mechanisms, the project developer will ensure that all activities also comply with the applicable international standards and IFC financing requirements. Although these activities form part of the same environmental permitting and authorization process prescribed and administered under Guyanese National Legislation, they are described here separately to provide an overview of the project-specific requirements of each compliance mechanism.

#### *3.5.1*

##### *Prospecting and Mining Licensing Process*

The first mechanism for ensuring compliance with the legislative framework for the mining industry in Guyana is the prospecting and mining licensing process. In Guyana, all mineral rights are owned by the State and administered by the GGMC in accordance with the Mining Act. The Act prescribes two levels of permitting for the mining industry: prospecting and mining. Prospecting licenses are required in order to begin prospecting activities. Conditions of the prospecting license include allowing for the application of a mining license at any time during its tenure. Mining licenses are required prior to the initiation of any mining operations.

The Mining Act divides prospecting and mining licenses into three groups based on the size of the concession. Small-scale claims of up to 1500ft<sup>2</sup> x 800ft<sup>2</sup> are granted to Guyanese citizens and may be located on any state land with no previous concessions. Medium-scale licenses and permits are granted for areas between 150 and 1,200 acres which can be grouped together with additional licenses or claims to form larger continuous blocks. Medium-scale licenses and claims are only granted to entities registered in Guyana, but can be transferred under private contract to other entities. Large-scale claims for areas between 500 and 12,800 acres may be granted to any entity, including companies of any nationality.

The application process for prospecting and mining licenses is administered by the GGMC, as described in the Mining Act. The project developer must apply for and acquire the appropriate prospecting or mining license in order to comply with the national legislative framework describe above. This process ensures that all prospecting and monitoring operations are fully authorized by the Guyana EPA and GGMC.

### 3.5.2 *Environmental and Social Impact Assessment Process*

The second mechanism for ensuring compliance with the national legislative framework and IFC requirements is the environmental and social impact assessment process. The EPA in collaboration with the Environmental Assessment Board (EAB) has produced guidelines for conducting environmental impact assessments (EIA) for all mining projects in Guyana. The guidelines are intended to compliment those in Section IV of the Environmental Protection Act, 1996 (EP Act). Furthermore, where gaps exist between the national EIA requirements and IFC Performance Standards and EHS Guidelines, the project developer will comply with the standards set by the IFC. Together, these guidelines ensure that all mining projects comply with the applicable regulations of the policy, legal and administrative framework described above.

In Guyana, commencement of the environmental and social impact assessment process is preceded by an application for an environmental authorization and a summary of the project including information on the site, design and size of the project, possible effects on the environment, and a non-technical explanation of the project. The EPA will then determine whether an environmental and social impact assessment will be necessary prior to the issuance of an environmental authorization for the project.

#### *Public Consultation*

If an environmental and social impact assessment is needed, a draft Terms of Reference (ToR) must be prepared and submitted to the EPA. The EPA will then carry out a public consultation process, including public disclosure of the project proposal in the national media, and public consultation meetings. The results of the initial public consultation process are taken into account in the analysis and approval of the ToR for the project.

#### *Environmental and Social Impact Assessment Components*

Following the initial public consultation process, the project developer is required to prepare and submit an ESIA prior to implementation of the project. According to the guidelines, the ESIA for the mining sector must consist of three components:

1. *Environmental Baseline Study* to record the quality of the environment within the area of influence before the project is implemented. The data is analysed in the environmental assessment and is used to predict and quantify impacts;
2. *Environmental Assessment (EA)* to identify and assess potential impacts of the proposed project and its alternatives. The EA considers mitigation measures to offset negative impacts and assesses the impact of implementing these measures on the environment; and,
3. *Environmental Impact Statement* to summarize the findings of the environmental baseline study and the environmental assessment. The environmental impact statement includes an environmental management plan specifying the proposed actions to comply with all applicable national laws and regulations.

#### *Public Consultation and Disclosure*

The ESIA guidelines require that the development of the ESIA be carried out with significant public consultation and disclosure. This process must include:

- Public consultation, designed to give the public a voice in project planning and obtain local knowledge, information and ideas;
- Disclosure of project-related documents and information, especially regarding potential environmental, health and safety impacts; and,
- Submission of a draft ESIA to the EPA for comments and initial evaluation.

A final ESIA is then prepared to address the comments of the EPA, sector agencies, the public, and other stakeholders. The final ESIA is submitted to the EAB and the EPA for final approval. For approved projects, the EPA issues an Environmental Permit with the terms and conditions necessary to effectively manage the environment.

If an Environmental Permit is not granted, the developer may file an appeal within 28 days with the Environmental Appeals Tribunal (EAT). The EAT has the jurisdiction to hear and determine appeals against the refusal, requirement, cancellation or suspension of an Environmental Permit.

### **3.6**

#### ***REGULATORY REVIEW***

In conclusion, the following section provides additional details on specific components of the national and international policy, legal and administrative framework. *Table 3-1* provides a comprehensive review of all national legislation, codes, guidelines, and draft legislation applicable to the mining industry of Guyana. This table is provided to supplement the overview of national legislation provided above. The table also includes project-specific compliance recommendations.

*Table 3-2* provides a comprehensive description of the applicable IFC performance standards and references to EHS guidelines. This table is provided to supplement the overview of the IFC standards and guidelines provided above in relation to specific actions and compliance parameters.

**Table 3-1. National Legislative Framework and Checklist for Compliance**

	Legislation / Policy	Responsible Authority	Specific Provisions/ Citations	Checklist for Compliance
Relevant National Legislation				
1	<i>Environmental Protection Act, 1994 (amended in 2000)</i>	Central Government/ relevant State Government	<p>The Act establishes the Environmental Protection Agency and provides the administrative and legislative basis for:</p> <ul style="list-style-type: none"> <li>• Requirement of environmental impact assessments, approval or rejection of projects, environmental permitting, regulations and authorizations;</li> <li>• Prevention and control of pollution, including permitting, enforcement and prohibitions;</li> <li>• Establishment and jurisdiction of environmental appeals tribunal;</li> <li>• Procedures for investigations, prosecutions and civil proceedings;</li> <li>• Environmental trust fund finances; and,</li> <li>• Other administrative activities of the EPA.</li> </ul>	<p>Submit comprehensive environmental impact assessment to the EPA.</p> <p>Secure authorization prior to undertaking project development.</p> <p>Prepare and follow pollution prevention plan to ensure compliance with EPA pollution regulations.</p> <p>Provide appropriate financial assurance, if necessary.</p>
2	<i>Environmental Protection (Air Quality) Regulations 2000</i>	Environmental Protection Agency	<p>Outlines administrative and technical regulations related to air quality, including control of air emissions, national ambient air quality standards, permitting, and penalties. The regulations include the following list of contaminants for which specific emissions parameters will be set:</p> <ul style="list-style-type: none"> <li>• Smoke</li> <li>• Solid particles</li> <li>• Sulfuric acid mist or sulfuric trioxide</li> <li>• Fluoride compounds</li> <li>• Hydrogen chloride</li> <li>• Chlorine</li> <li>• Hydrogen sulfide</li> <li>• Nitric acid or oxides of nitrogen</li> <li>• Carbon monoxide</li> </ul>	<p>Submit application for authorization from EPA.</p> <p>Prepare and follow pollution prevention plan to ensure compliance with EPA air quality regulations.</p>

	Legislation / Policy	Responsible Authority	Specific Provisions / Citations	Checklist for Compliance
3	<i>Environmental Protection (Hazardous Wastes Management) Regulations 2000</i>	Environmental Protection Agency	<p>These regulations outline the rules, procedures and authorization process which apply to all operations that generate, transport, treat, store and dispose of hazardous wastes. The regulations include the following hazardous materials/wastes:</p> <ul style="list-style-type: none"> <li>• Explosives</li> <li>• Flammable liquids</li> <li>• Flammable solids or waste solids other than explosives which may be readily combustible</li> <li>• Oxidizing substances</li> <li>• Organic peroxides</li> <li>• Poisonous substances</li> <li>• Infectious substances</li> <li>• Corrosives</li> <li>• Toxic gases</li> <li>• Toxic substances which if inhaled or ingested may cause delayed or chronic effects</li> <li>• 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</li> <li>• Materials capable, after disposal, of yielding another material which possesses any of the characteristics specified above</li> </ul>	<p>Submit application for authorization from EPA.</p> <p>Prepare and follow emergency preparedness plan.</p> <p>Submit Waste Analysis Plan, if necessary.</p>
4	<i>Environmental Protection (Water Quality) Regulations 2000</i>	Environmental Protection Agency	<p>These regulations require registration and environmental authorization of any project which may 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. The EPA was mandated to establish specific parameter limits for the concentration of the following effluents:</p> <p>Ammonical Nitrogen, Sulfate, Chloride, Cobalt, Color, 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,</p>	<p>Submit application for authorization from EPA.</p> <p>Prepare and follow emergency preparedness plan.</p>

Legislation / Policy		Responsible Authority	Specific Provisions / Citations	Checklist for Compliance
			Fumigants or any other Biocides, any other chlorinated hydrocarbons, and any substance that either by itself or in combination with other waste or refuse may give rise to any gas, fume, odor or substance which causes or is likely to cause pollution.	
5	<i>Environmental Protection (Authorizations) Regulations 2000</i>	Environmental Protection Agency	These regulations further define the authorization process for all projects potentially having environmental impacts. The regulations define all administrative, design, licensing, monitoring, evaluation and documentation requirements.	Submit necessary applications for authorization from EPA.
6	<i>Environmental Protection (Noise Management) Regulations 2000</i>	Environmental Protection Agency	These regulations apply to operations that emit noise during construction, operations, transport, or other phases and require that all such activities be approved by the EPA. The EPA has published a draft standard on Noise Emissions which defines permissible noise levels for the following sectors: Residential, Institutional, Educational, Industrial, Commercial, Construction, Transportation and Recreational.	Submit application for authorization from EPA.  Adhere to EPA's permissible noise parameters in all operations.
7	<i>Forest Act 2008</i>	Guyana Forestry Commission	The Act consolidates and amends the law on forests, and governs all activities that are carried out in state forests including mining and associated activities. Under this Act, no person shall engage in the following unless a mineral prospecting or mining license has been granted under the Mining Act 1989: <ul style="list-style-type: none"> <li>• Enter and occupy state forest;</li> <li>• Cut, damage or take any forest produce or carry on any kind of forest operation; and,</li> <li>• Carry out any kind of exploratory operation in a state forest.</li> </ul>	Apply for and obtain prospecting and mining license.
8	<i>Wild Birds Protection Act Chapter 71:01</i>	Environmental Protection Agency	The Act pertains to hunting regulations for certain species of wild birds, including protection status, hunting season, sale of birds, etc.	There are no provisions for the protection of wild birds relative to mining operations.
9	<i>Pesticides and Toxic Chemicals Control Act No.</i>		The Act regulates the manufacture, importation, transportation, storage, sale, use and disposal of pesticides and toxic chemicals, and requires that regulations	Register all toxic chemicals.  Apply for and obtain license for import,

Legislation / Policy		Responsible Authority	Specific Provisions / Citations	Checklist for Compliance
	13		<p>be developed to:</p> <ul style="list-style-type: none"> <li>• Ensure the health and safety of works as well as mitigate risks associated with controlled products; and,</li> <li>• Impose duties or other fees related toxic chemicals.</li> </ul> <p>The Act resulted in the establishment of the Pesticides and Toxic Chemicals Control Board, whose functions include:</p> <ul style="list-style-type: none"> <li>• The registration of Pesticides and Toxic Chemicals;</li> <li>• The issuance of licenses to persons to import or manufacture registered pesticides and toxic chemicals; and,</li> <li>• All aspects of the importation, manufacture, storage, transportation, sale, preparation for sale, use and disposal of pesticides and toxic chemicals.</li> </ul>	manufacture or sale of toxic chemicals.
10	<i>Public Health Act Cap 145</i>	Ministry of Health	The Act includes a clause which enables the Minister of Health to make regulations pertaining to sanitation, health and welfare of inhabitants of mining districts. Revisions to the Public Health Act including draft regulations for mining have been made but not yet promulgated.	Prepare and implement appropriate OSH management plan.
11	<i>Code of Practice for Timber Harvesting 2002</i>	Guyana Forestry Commission (GFC)	This code provides guidelines and standards on sustainable forestry, forest harvesting practices, health and safety of forestry workers and other forestry related activities.	Comply with code of practice for timber harvesting in any removal or clearing of forested areas during mining operations.
12	<i>Town and Country Planning Act 20:01</i>	Central Housing and Planning Authority	The Act establishes provisions for the orderly and progressive development of land, cities, towns and other areas for their preservation and improvement and for other related matters. This act would regulate any new settlement associated with operations.	Where possible, coordinate with regional development plans, especially in the construction and use of roads and other infrastructure.
National Mining Sector Legislation				
1	<i>The Mining Act</i>	Guyana Geology and Mines Commission (GGMC)	<p>The Mining Act establishes the legal framework for the utilization of mineral resources in Guyana. Specifically, the Act makes provisions regarding:</p> <ul style="list-style-type: none"> <li>• Rights to and guardianship of minerals;</li> <li>• Large, medium and small scale prospecting and mining</li> <li>• Prospecting licenses</li> </ul>	<p>Apply for and secure prospecting license prior to conducting any prospecting activities.</p> <p>Apply for and secure mining license prior</p>

	Legislation / Policy	Responsible Authority	Specific Provisions / Citations	Checklist for Compliance
			<ul style="list-style-type: none"> <li>• Mining licenses</li> <li>• Royalties, penalties and other financial information</li> <li>• Mine safety, health and labor standards</li> <li>• Special provisions relating to Amerindians</li> <li>• And other requirements, provisions and information</li> </ul> <p>In addition, the Act makes provisions for the disposal of sanitary waste and the storage of poisonous substance in mining areas. The GGMC is also currently developing an additional document on occupational health and safety in mines.</p>	<p>to implementing all mining operations.</p> <p>Comply with all financial regulations and settle all accounts over royalties, taxes, fees or other transactions.</p> <p>Develop and implement environmental, health and safety management plans.</p> <p>Respect Amerindian clause (see below).</p>
2	<i>Amerindian Clause (Mining Act, Part VII)</i>	GGMC	Sec. 111 of the Mining Act states that “for the purposes of this Act, all land occupied or used by Amerindian communities and all land necessary for the quiet enjoyment by the Amerindians of any Amerindian settlements, shall be deemed to be lawfully occupied by them.”	Ensure that Amerindian communities in the vicinity of the project are in no way negatively impacted by the project.
3	<i>The Mining (Amendment) Regulations 2005</i>	GGMC	<p>This amendment to the Mining Act establishes increased regulatory control of poisonous substances such as cyanide and mercury in areas of key environmental concern, including:</p> <ul style="list-style-type: none"> <li>• Terms and agreement for mercury and cyanide use;</li> <li>• Management of tailings and mining waste;</li> <li>• Water quality;</li> <li>• Use and disposal of poisonous substances;</li> <li>• Closure and reclamation;</li> <li>• Management of the natural environment for restoration and mining;</li> <li>• Submission of environmental management plan in accordance with an environmental code of practice established by the GGMC; and,</li> <li>• Contingency and response plans.</li> </ul>	<p>Submit and implement environmental management plan in accordance with code of practice.</p> <p>Prepare and implement contingency and response plans.</p> <p>Plan in advance for closure and reclamation.</p>
4	<i>Gold Board Act 1981</i>	Guyana Gold Board	The Act established the Guyana Gold Board (GGB) and required that all gold produced in Guyana be purchased by and sold through the GGB to ensure the capture of mining royalties owed to the Guyanese Government.	Declare and sell all gold to the GGB.
5	<i>Mining Guidelines for</i>	Environmental Protection	The EPA has established guidelines requiring that water quality associated with both surface and groundwater associated with mining operations be analysed for pH, TDS, TSS, turbidity, conductivity, organic compounds (phenol and oil	Submit application for authorization from EPA.

Legislation / Policy		Responsible Authority	Specific Provisions / Citations	Checklist for Compliance
	<i>Water Quality</i>	Agency	<p>and grease), major anions (Ca, Mg, Na, K), nutrients (TKN, total ammonia, phosphate, nitrate + nitrite), and trace metals (Al, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Sb, Zn).</p> <p>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) and reserves the right to request analyses to determine bacteriological levels (i.e., coliforms, fecal coliforms and standard plate counts), rare earth elements, radioactive elements and other trace metals.</p>	Prepare and follow emergency preparedness plan.
6	<p><i>Draft Mining Occupational Safety and Health Regulation 2002</i></p> <p><i>and</i></p> <p><i>Occupational Health and Safety Act 1997</i></p>	Ministry of Labour, Human Services and Social Security	<p>The Occupational Health and Safety Act 1997 contains provisions applicable to the regulation of health and safety in mines, which may be expanded by the OSH draft regulations of 2002 specifying duties of employers and self-employed persons, owners of mines, manufacturers and workers, including:</p> <ul style="list-style-type: none"> <li>• Reporting of hazardous situations</li> <li>• Administration of monitoring and evaluation</li> <li>• Labor restrictions, minimum age, and duration of work shifts</li> <li>• Health and Safety procedures for mine operation</li> <li>• Employee training requirements</li> <li>• Provision of protective equipment</li> <li>• Emergency preparedness and fire prevention</li> <li>• Handling of explosive materials</li> </ul> <p><u>Note:</u> the extensive draft regulation has not yet been given legal effect by the Ministry of Labour, Human Services and Social Security.</p>	<p>Prepare and implement OSH management plan.</p> <p>Prepare and implement emergency preparedness plan.</p> <p>Carry out all necessary employee training requirements.</p> <p>Provide protective equipment and ensure proper handling of explosive or hazardous materials, as defined in the OSH management plan.</p>

*Table 3- 2: IFC Performance Standards, Provisions, and Related National Legislation*

IFC Performance Standard	Objectives	Specific Provisions	Applicable National Legislation
1	<p>The objectives of the social and environmental assessment and management systems are:</p> <ul style="list-style-type: none"> <li>To identify and assess social and environment impacts, both adverse and beneficial, in the project’s area of influence;</li> <li>To avoid, or where avoidance is not possible, minimize, mitigate, or compensate for adverse impacts on workers, affected communities, and the environment;</li> <li>To ensure that affected communities are appropriately engaged on issues that could potentially affect them; and,</li> <li>To promote improved social and environment performance of companies through the effective use of management systems.</li> </ul>	<ul style="list-style-type: none"> <li>Social and Environmental Impact Assessment</li> <li>Management Program</li> <li>Organizational Capacity and Training</li> <li>Community Engagement</li> <li>Monitoring and Reporting</li> <li>Use IFC EHS General Guidelines and Mining Sector guidelines in project development and Social and Environmental Impact Assessment</li> </ul>	<ul style="list-style-type: none"> <li>Environmental Protection Act 1994 (amended in 2000)</li> <li>Environmental Protection (Air Quality) Regulations 2000</li> <li>Environmental Protection (Hazardous Waste) Regulations 2000</li> <li>Environmental Protection (Water Quality) Regulations 2000</li> <li>Environmental Protection (Authorizations) Regulations 2000</li> <li>Environmental Protection (Noise Management) Regulations 2000</li> <li>Pesticides and Toxic Chemicals Control Act No. 13</li> <li>Public Health Act Cap 145</li> <li>Code of Practice for Timber Harvesting 2002</li> <li>Wildlife Management and Conservation Regulations (Draft)</li> <li>Town and Country Planning Act 20:01</li> <li>The Mining Act</li> <li>The Mining (Amendment) Regulations 2005</li> <li>Mining Guidelines for Water Quality</li> </ul>
2	<p>The objectives of the labor and working conditions performance standard are:</p> <ul style="list-style-type: none"> <li>To establish, maintain and improve the worker-management relationship;</li> <li>To promote the fair treatment, non-discrimination and equal opportunity of workers, and compliance with national labor and employment laws;</li> <li>To protect the workforce by addressing child labor and forced labour; and,</li> <li>To promote safe and healthy working conditions, and to protect and promote the health of workers.</li> </ul>	<ul style="list-style-type: none"> <li>Human Resources Policy and Training</li> <li>Grievance Mechanism</li> <li>Protection of Workforce</li> <li>Occupational Health and Safety Plan, including identification of hazards, provision of protective and preventive measures, training, documentation and reporting of occupational accidents, diseases and incidents, and emergency prevention, preparedness and response arrangement</li> <li>Use IFC EHS General Guideline on Occupational Health and Safety</li> </ul>	<ul style="list-style-type: none"> <li>Environmental Protection Act 1994 (amended in 2000)</li> <li>Pesticides and Toxic Chemicals Control Act No. 13</li> <li>Public Health Act Cap 145</li> <li>The Mining Act</li> <li>The Mining (Amendment) Regulations 2005</li> <li>Mining Guidelines for Water Quality</li> <li>Occupational Health and Safety Act 1997</li> <li>Draft Mining Occupational Safety and Health Regulation 2002</li> </ul>
3	<p>The objectives of the pollution prevention and</p>	<ul style="list-style-type: none"> <li>Use IFC EHS General Guidelines and Mining Sector guidelines to evaluate and</li> </ul>	<ul style="list-style-type: none"> <li>Environmental Protection Act 1994 (amended in 2000)</li> <li>Environmental Protection (Air Quality) Regulations 2000</li> </ul>

IFC Performance Standard	Objectives	Specific Provisions	Applicable National Legislation
	<p>abatement performance standard are:</p> <ul style="list-style-type: none"> <li>To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities; and,</li> <li>To promote the reduction of emissions that contribute to climate change.</li> </ul>	<p>select pollution prevention and control techniques</p> <ul style="list-style-type: none"> <li>An emergency preparedness and response plan that addresses training, responsibilities, communication, and procedures</li> <li>Consideration of existing and future land use, ambient conditions and proximity to ecologically sensitive areas</li> <li>Promote reduction in GHG emissions and quantify and monitor GHG emissions annually</li> </ul>	<ul style="list-style-type: none"> <li>Environmental Protection (Hazardous Waste) Regulations 2000</li> <li>Environmental Protection (Water Quality) Regulations 2000</li> <li>Environmental Protection (Authorizations) Regulations 2000</li> <li>Environmental Protection (Noise Management) Regulations 2000</li> <li>Pesticides and Toxic Chemicals Control Act No. 13</li> <li>Public Health Act Cap 145</li> <li>The Mining Act</li> <li>The Mining (Amendment) Regulations 2005</li> <li>Mining Guidelines for Water Quality</li> </ul>
4	<p>The objectives of the community health, safety and security performance standard are:</p> <ul style="list-style-type: none"> <li>To avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non routine circumstances; and,</li> <li>To ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security.</li> </ul>	<ul style="list-style-type: none"> <li>Use IFC EHS General Guidelines and Mining Sector Guidelines to evaluate and mitigate project related Community Health and Safety impacts</li> <li>Public disclosure of hazards, risks, or negative impacts of the project</li> <li>Adherence to IFC Security Personnel Requirements</li> </ul>	<ul style="list-style-type: none"> <li>Environmental Protection Act 1994 (amended in 2000)</li> <li>Environmental Protection (Air Quality) Regulations 2000</li> <li>Environmental Protection (Hazardous Waste) Regulations 2000</li> <li>Environmental Protection (Water Quality) Regulations 2000</li> <li>Environmental Protection (Authorizations) Regulations 2000</li> <li>Environmental Protection (Noise Management) Regulations 2000</li> <li>Pesticides and Toxic Chemicals Control Act No. 13</li> <li>Public Health Act Cap 145</li> <li>The Mining Act</li> <li>The Mining (Amendment) Regulations 2005</li> <li>Mining Guidelines for Water Quality</li> <li>Occupational Health and Safety Act 1997</li> <li>Draft Mining Occupational Safety and Health Regulation 2002</li> </ul>
6	<p>The objectives of the biodiversity conservation and sustainable natural resources management performance standard are:</p> <ul style="list-style-type: none"> <li>To protect and conserve biodiversity</li> </ul>	<ul style="list-style-type: none"> <li>Environmental Impact Assessment</li> <li>Implement mitigation measures such as post operation restoration of habitats, offsetting of ecological and biodiversity losses,</li> </ul>	<ul style="list-style-type: none"> <li>Environmental Protection Act 1994 (amended in 2000)</li> <li>Environmental Protection (Air Quality) Regulations 2000</li> <li>Environmental Protection (Hazardous Waste) Regulations 2000</li> <li>Environmental Protection (Water Quality) Regulations 2000</li> </ul>

IFC Performance Standard	Objectives	Specific Provisions	Applicable National Legislation
	<ul style="list-style-type: none"> <li>To promote the sustainable management and use of natural resources through the adoption of practices that integrate conservation needs and development priorities</li> </ul>	<ul style="list-style-type: none"> <li>Compensate direct users of biodiversity and respect ongoing usage of biodiversity by indigenous peoples or traditional communities</li> <li>No reduction in population of IUCN critically endangered or endangered species</li> <li>No introduction of new alien species</li> <li>Use IFC General Guidelines and Mining Sector Guidelines to avoid or mitigate environmental impacts</li> </ul>	<ul style="list-style-type: none"> <li>Environmental Protection (Authorizations) Regulations 2000</li> <li>Environmental Protection (Noise Management) Regulations 2000</li> <li>Wild Birds Protection Act Chapter 71:01</li> <li>Pesticides and Toxic Chemicals Control Act No. 13</li> <li>Code of Practice for Timber Harvesting 2002</li> <li>Wildlife Management and Conservation Regulations (Draft)</li> <li>Town and Country Planning Act 20:01</li> <li>The Mining Act</li> <li>The Mining (Amendment) Regulations 2005</li> <li>Mining Guidelines for Water Quality</li> <li>Forest Act 2008</li> </ul>
7	<p>The objectives of the performance standard on indigenous peoples are:</p> <ul style="list-style-type: none"> <li>To ensure that the development process fosters full respect for the dignity, human rights, aspirations, cultures and natural resource-based livelihoods of indigenous peoples;</li> <li>To avoid adverse impacts of the project on communities of indigenous peoples, or when avoidance is not feasible, to minimize, mitigate or compensate for such impacts, and to provide opportunities for development benefits in a culturally appropriate way;</li> <li>To establish and maintain an ongoing relationship with the affected indigenous peoples throughout the life of the project; and,</li> <li>To respect and preserve the culture, knowledge and practices of indigenous peoples.</li> </ul>	<ul style="list-style-type: none"> <li>Identify indigenous communities within the project area of influence and avoid or mitigate adverse impacts</li> <li>Disclosure, consultation and informed participation of indigenous peoples</li> </ul>	<ul style="list-style-type: none"> <li>The Mining Act</li> <li>Amerindian Clause (Mining Act, Part VII)</li> <li>The Mining (Amendment) Regulations 2005</li> <li>Mining Guidelines for Water Quality</li> <li>Forest Act 2008</li> </ul>

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**4.6.3 OFFSITE DISPOSAL OF HAZARDOUS MATERIALS..... 39**

The objective of the Aurora Project, being implemented by Guyana Goldfields, is “to develop and operate the Aurora Gold Mine as the centre of an emerging Northwest Guyana mining district in a sustainable and profitable manner that will be environmentally, socially and economically responsible and will recognize the rights and responsibilities of all stakeholders.” The project consists of the development of a gold mine with planned annual production averaging 250,000 ounces (Oz) over 16 years, or 4 Million Oz total. The construction and operation of the project requires the development of infrastructure and amenities. The description of the Aurora Project hereafter will be divided into three main components, as outlined below:

1. **Aurora Mine Site**- this is the immediate operational mine area, some 5,718.69 ha in area containing the mine area, processing facilities, tailings ponds, equipment storage and maintenance facilities, fuel and chemical storage, air strip, worker camp, offices and supporting ancillary facilities;
2. **Buckhall Port**- a wharf and staging area at Buckhall on the Essequibo River will serve as the port of entry and exit for equipment, goods and services and some workers for the Project; and,
3. **Access Road(s)** - connecting the Buckhall Port to the Aurora Mine Site. A portion of the extensive existing Barama Corporation forestry roads will be utilized to reach some 135 km from Buckhall to a point east of the Aurora site. From there, the Project will construct a new road extending some 10 km west to the Cuyuni River to a barge crossing/staging area on each bank called Tapir, and then an additional road (approximately 21 km) from the west bank barge crossing to the Aurora Mine Site.

This project description is based on the *NI 43-101 Technical Report on the Updated Preliminary Assessment* produced by AMEC Americas Limited (dated September 2009), which documents the results of an updated Preliminary Assessment (PA) of the proposed Aurora Mine project.

**It should be noted that this description is based on AMEC’s preliminary assessment and all the design elements are subject to change. Moreover, details on the design of mine infrastructure, specifications on equipment or machinery, and logistical plans for the project have not been finalized to date, nor has a preliminary closure plan been developed.**

### 4.1.1 *Project Location*

The site is located in northwestern Guyana in South America, approximately 170 km west of Georgetown, the capital of Guyana, and 130 km west-northwest of Bartica, a settlement at the junction of the Essequibo and Cuyuni Rivers (see Figure 4-1). The project is located within Region 7 in a largely uninhabited area of Guyana. There are no villages within 40 km of the site and few within the region; however, a number of artisanal and small scale miners (ASM) operate in the area.

Although there are a number of logging roads on the north side of the Cuyuni River, none allow direct access to the site. Currently the site can only be accessed via boat up the Essequibo River to Bartica, then by four wheel drive truck to a landing on the Cuyuni River, and finally upriver by boat to the proposed mine site, or by air to the Aurora airstrip.

The future port site is located on the Essequibo River just south of Buckhall in Region 3, a small community with an estimated population of 65-80 persons located on the west bank of the Essequibo River. Barama currently operates a saw mill and associated operations approximately 2 km to the north of Buckhall. As part of these operations, Barama has developed a network of service roads to access its forest concessions in the interior.

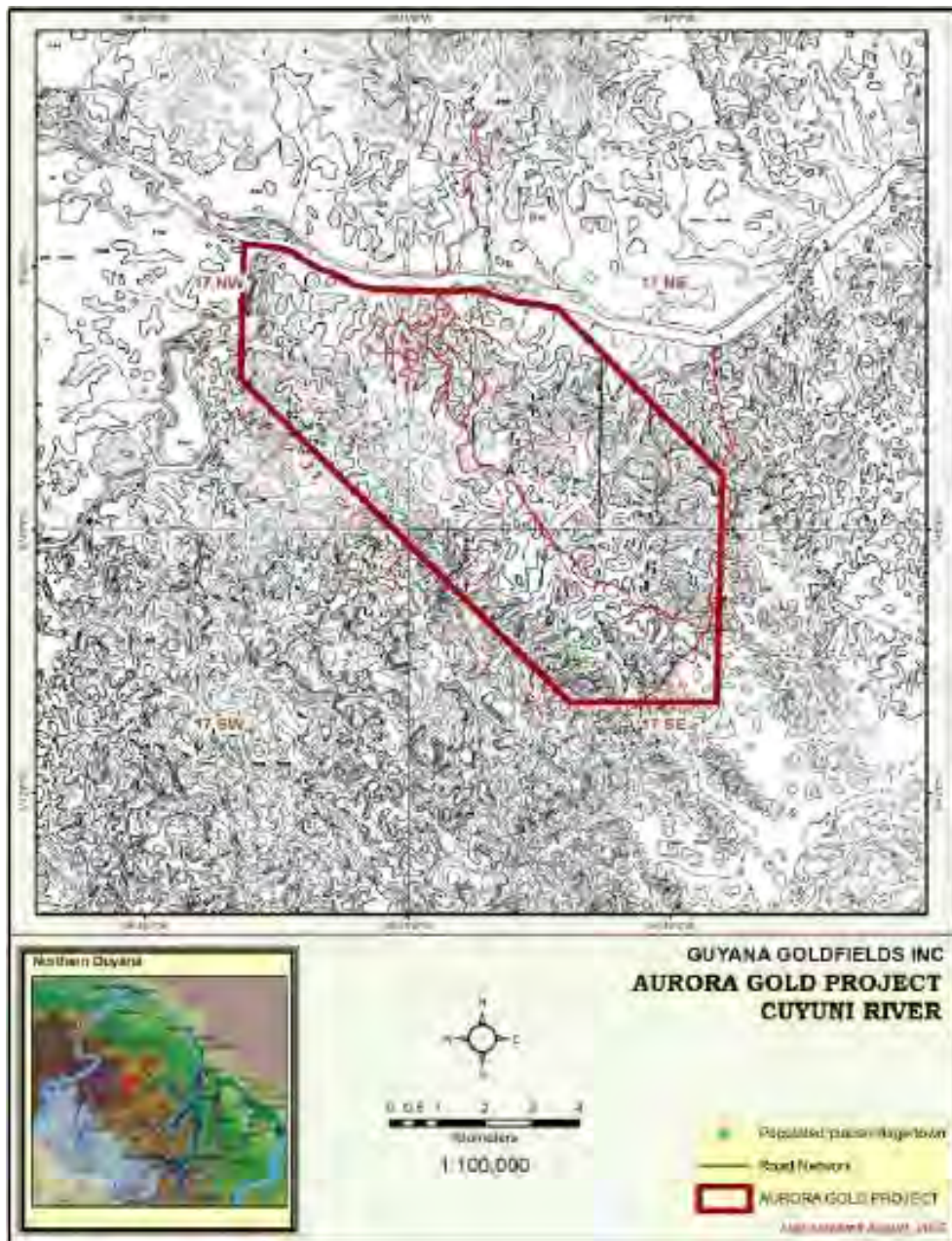
### 4.1.2 *Mineral Tenure*

Mineral tenure of the Aurora Project site has been secured through an A-1 prospecting license, which covers approximately 14,000 acres, and is held in the name of Guygold Inc., a wholly-owned subsidiary of Guyana Goldfield's (see Figure 4-1). The Aurora Project site has not been legally surveyed, nor is there any requirement for a legal survey under the laws of Guyana.

The license was granted on 29 June 2004 and has no definite expiration date as the Project has applied for a mining license. There is sufficient area within the A1 license to support the entire on-site infrastructure (i.e., mine, mill, tailings and waste rock facilities) proposed for the project. Mineral resources are confined within the A1 license to a zone approximately 2 km in strike length, known as the "Golden Square Mile", which has approximate coordinates of:

59°44.5' W, 6° 47.7' N  
59° 45.43' W, 6° 47.7' N  
59° 44.5' W, 6° 46.8' N  
59° 45.43' W, 6° 46.8' N

**Figure 4-1: Aurora Gold Project Claim**



Source: Guyana Goldfields, 2009.

At the time of this report, Guyana Goldfields held an additional ten prospecting licenses that are contiguous with the A1 license, totaling 96,093 acres. No advanced prospects were delineated on these licenses, and they were not considered part of the proposed Aurora Mine project. However, as presently designed, the tailings management area (TMA) would be located in the concessions lying immediately to the southwest of the Aurora Concession.

#### 4.1.3

#### *Surface Rights*

The Project's investigations to date have identified only one surface rights holder; however, some additional surface rights within the area of the

proposed project may be expected to be held by private individuals. Land access in these instances would therefore be subject to negotiation with individual land owners. Land access for the exploration programs completed to date has typically been negotiated without problems.

#### 4.1.4 *Royalties*

The proposed Aurora Mine project is subject to a 5% royalty payable to and determined at the discretion of the Guyana Geology and Mines Commission. An annual payment of US\$100,000 is payable to Alfro Alphonso (who acquired the property as a prospecting license in 1995) for as long as the Guyana Goldfields maintains an interest in the project, up to a maximum of US\$1.5 M. As of July 31, 2009, total payments of US\$500,000 have been made to Mr. Alphonso and a balance of US\$1 M remains.

#### 4.1.5 *Exploration and Development History*

The Aurora property is located in the Cuyuni greenstone belt of the Guyana Shield. Gold deposits have been known to exist in the area since 1911. The site and area have been subject to exploration since, and gold was produced from underground operations at the Aurora site (e.g., Aleck Hill and Mad Kiss) between 1940 and 1948. These gold deposits were characterized as residing in fracture-controlled mesothermal veins.

Throughout the late 1980's and 1990's, exploration for gold was conducted on and around the original Aurora Mine site. The Aurora site was acquired by Guyana Goldfield in 1998. Table 4-1 provides additional details regarding the exploration history at the Aurora Mine site.

**Table 4-1:** *Aurora Project Exploration History*

<b>Year</b>	<b>Exploration History</b>
1911	Discovery of gold at the Aurora site.
1934-1939	Solar Development Company Ltd., a subsidiary of Tech Cominco, Ltd., explored the area.
1940	Cuyuni Goldfields Company Ltd. (Cuyuni) acquired part of the area.
1940-1948	Cuyuni mined at Aleck Hill and explored Aleck Hill and Mad Kiss with underground openings and 30 DDH (2,088 m).
1963	Geological Survey of Guyana and the United Nations Development Program conducted a copper exploration program near Haimaralli Falls, northwest of the central Aurora area. This program included 19 DDH (2,515 m).
1989	South American Goldfields Ltd. acquired the property.
1989-1992	Denison Mines Ltd. optioned the property and carried out a three year exploration program which included 56 DDH (10,180 m). Denison dropped the option in 1992.
1992	Gold Star Resources Ltd. optioned the property from South American and carried out some geochemical exploration and trenching. Gold

Year	Exploration History
1995	Star dropped the option in 1993 and South American dropped its Prospecting License (PL). Mr. A. Alphonse acquired the property as a PL. He optioned the property to Coeur d'Alene Mines Ltd. which carried out a geochemical exploration program.
1998	Guyana Goldfields acquired a 100% option on the property from Mr. Alphonse.
2000	Guyana Goldfields conducted a small exploration program on the property which included 39 shallow DDH (1,067.1 m).
2004	A regional stream-silt survey was undertaken by Terraquest Ltd. which identified 62 geophysical anomalies.
2006	Preliminary baseline studies
2008	Completion of Preliminary Assessment (PA) based on core drilling, metallurgical test work, and mining, hydrological and geotechnical studies.

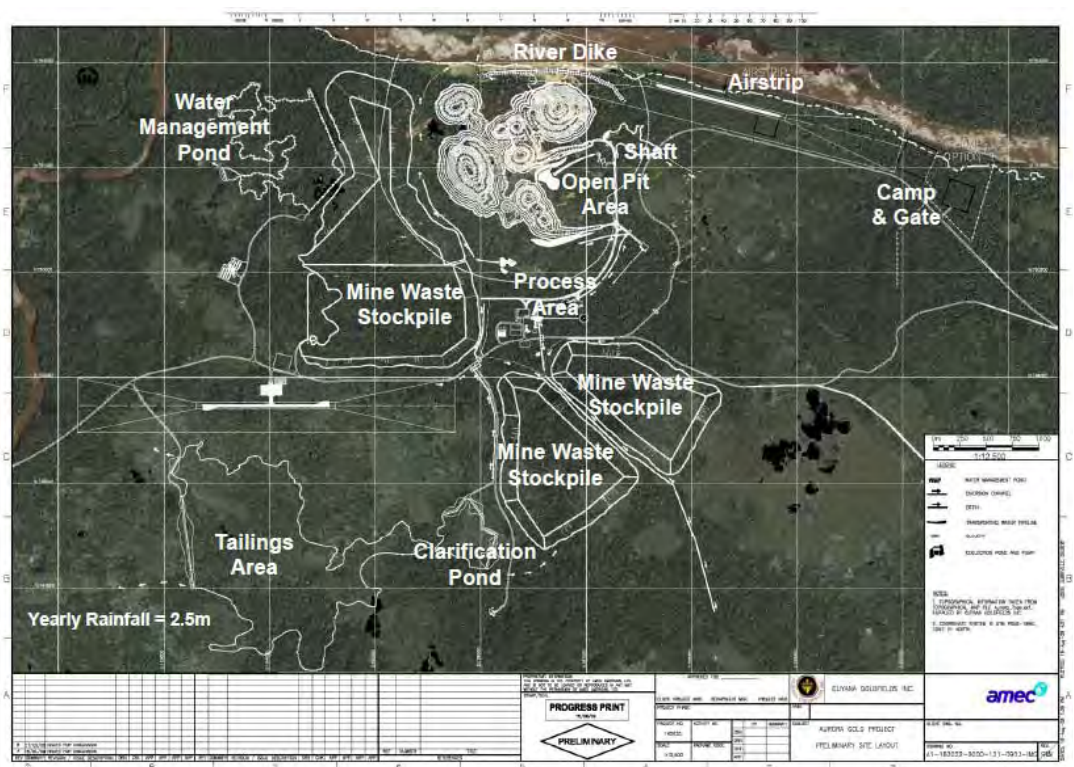
Source: Guyana Goldfields, 2009

#### 4.2

#### MINE SITE: MINE DESIGN, INFRASTRUCTURE AND OPERATION

The Aurora Project mine site will include open pit and underground mines, a processing mill, and related infrastructure. This section describes the mine site design, infrastructure and related operational plans. Figure 4-2 illustrates the proposed site layout for the mine site and infrastructure.

Figure 4-2: Conceptual Mine Site Plan



Source: AMEC, 2009.

#### 4.2.1

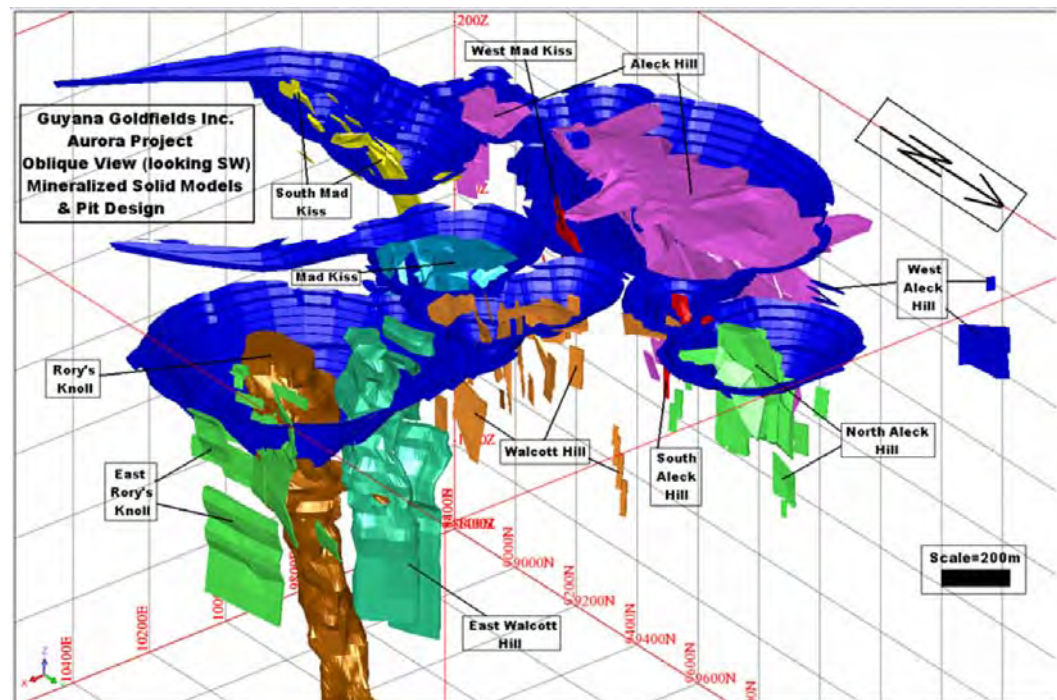
#### Open Pit

Conventional surface mining methods would be used to access the following geological areas within the Aurora concession: Rory's Knoll, East Rory's Knoll, Aleck Hill, South Aleck Hill, North Aleck Hill, Walcott Hill, East Walcott Hill, Mad Kiss, South Mad Kiss, and West Mad Kiss (Figures 4-2 and 4-3).

Pit production will begin at Rory's Knoll to create access to the underground portal development as soon as possible. Rory's Knoll will initially be mined for saprolite. Once all saprolite has been removed from Rory's Knoll, the other pit areas will be mined for saprolite while further mining of rock at Rory's Knoll continues. The same sequence will occur with Aleck Hill, then South Mad Kiss and North Aleck Hill. The final phase will develop the central Walcott Hill area in order to keep open haul access to the mill from North Aleck Hill open for as long as possible.

Overall pit slopes will vary from 43° to 51° in bedrock and 26° to 34° in saprolite, based on variable face slopes and berm widths for geotechnical zones. Ramps are designed to be 25 m wide for double lane access, narrowing to 15 m single lane access in the bottom 25 m depth of each pit area. There are no haul ramps on the north side of Rory's Knoll area by the river dike to reduce the slope angle and extend the pit bottom further.

**Figure 4-3: Three Dimensional Open Pit Design**



Source: AMEC, 2009.

The mine schedule is based on a 350-day year. Pre-production will begin 390 days prior to mill start up to fully utilize all equipment. Mill feed is targeted at 8,000 tons per day (t/d) for the first three years followed by a reduced rate of 5,000 t/d for the remainder of the open pit mine life. The life-of-mine for the open pit is 9.6 years including the pre-production waste removal. The projected major equipment requirements for the open pit operation include:

- 15 off highway end dump mining trucks
- 4 production shovels or loaders;
- 2 motor graders;
- 2 rubber tired dozers;
- 4 tracked dozers;
- 3 bench blast hole drills;
- 1 explosives bulk blending truck;
- 2 water tankers;
- 48 to 60 seat passenger busses; and
- 15 seat mini vans.

#### 4.2.2 *Underground Mining*

##### *Underground Mining Overview*

In addition to open pit mining, the project will operate an underground mine in the Rory's Knoll underground deposit. The Rory's Knoll underground deposit stretches from approximately 240 m to 1,350 m below ground surface. The primary access to the Rory's Knoll underground mine will be through a 5.8-m diameter shaft and a service ramp. Sublevel open stoping was selected as the preferred mining method based on a list of 15 criteria developed by AMEC and Guyana Goldfields, including mine access/haulage trade-off studies between shaft hoisting, decline trucking, and decline conveying.

The Rory's Knoll Underground deposit has been divided into three mining fronts, each producing 1,200 t/d (on average), for a total of 3,600 t/d. Stopes will be mined in a "primary-secondary" sequence starting at the bottom of the mining front and progressing upwards and "centre-out". Paste fill was selected as the preferred backfill method. The crown pillar immediately below Rory's Knoll open pit will be recovered near the end of mine life and has been assigned a lower mining recovery than other stopes.

A second underground deposit, known as the Satellites Underground mining zone (i.e., Aleck Hill Underground, North Aleck Hill Underground, Mad Kiss Underground, and South Mad Kiss Underground) will be utilized as a supplemental production source in addition to the Rory's Knoll Underground deposit. The Satellites Underground zone extends approximately from below the open pit bottoms (at an approximate depth of 30 m) to a depth of 140 m. For the Satellites Underground mining zone, the ramps are the primary access, and the mining method is the same as the Rory's Knoll Underground. The

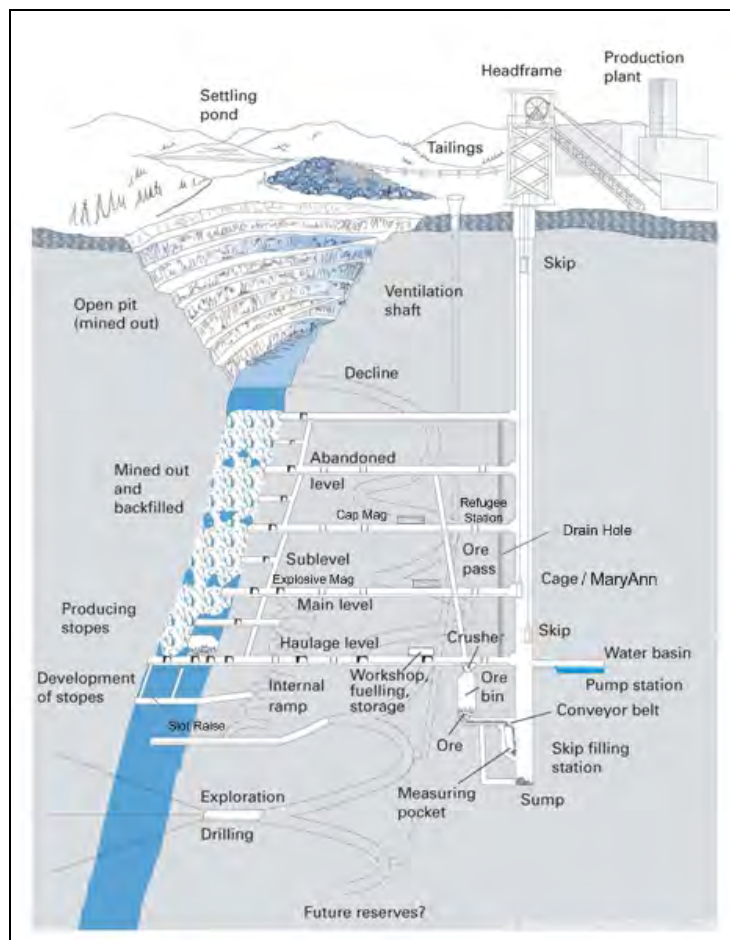
overall production rate from the Satellite Underground mining zone is expected to be 800 t/d.

Life-of-mine for the underground operation is approximately 17 years. The major equipment requirements for the underground operation include 2-boom jumbo drills, in-the-hole (ITH) production drills, load-haul-dump units (LHD), development and production haulage trucks, and service equipment.

#### *Rory's Knoll Underground Design*

The underground mine infrastructure will include access drives to sublevels, drifts for longhole drilling, loading drawpoints, and orepasses. Together, they will form an intricate network of underground openings (i.e., drifts, ramps, shafts, raises, etc.), each with its own function. *Figure 4-4* illustrates the conceptual underground mine at Aurora and basic required infrastructure. The figure also illustrates the conceptual spatial relationship between the open pit and underground mine.

**Figure 4-4:** Basic Conceptual Underground Mine Infrastructure



Source: AMEC, 2009.

Access to the Rory's Knoll Underground mine will be through a shaft and service ramp system (*Figure 4-5*). This system was selected based on a trade-off

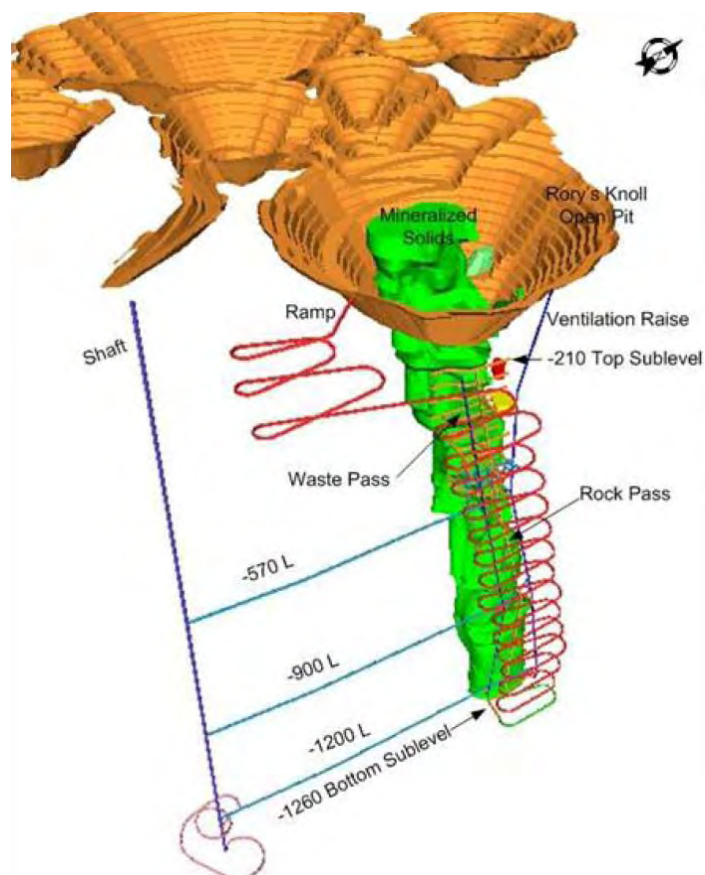
study completed by AMEC between shaft hoisting, ramp truck haulage, and conveyor haulage. Thus, the shaft will form the primary access to the underground levels, and would be the main artery for materials and personnel transport.

A 5.8-m inner diameter concrete lined shaft will extend to a depth of about 1,400 m, and a double-drum production hoist equipped with 12 t skips with slung cages on both sides will be installed.

Ramp dimensions are designed to be 4.5-m wide by 4.5-m high with a gradient of negative 17% to facilitate mobile equipment movement.

The shaft would be a long-lived installation which will be in operation for the life of mine. The hoist will provide the means to access the main underground levels. It is on these levels that load-haul-dump (LHD) mobile equipment, trucks, and other trackless mining equipment will operate. Skips would be used as it is the most efficient way to hoist ore from the underground mine to the surface.

**Figure 4-5:** *Rory's Knoll Underground mine shaft-ramp development system*



Source: AMEC, 2009.

Material will be handled by mobile equipment throughout the mine. Maintenance workshops will be located underground at convenient points on the main levels between ramp positions. Workshops will have floor drains

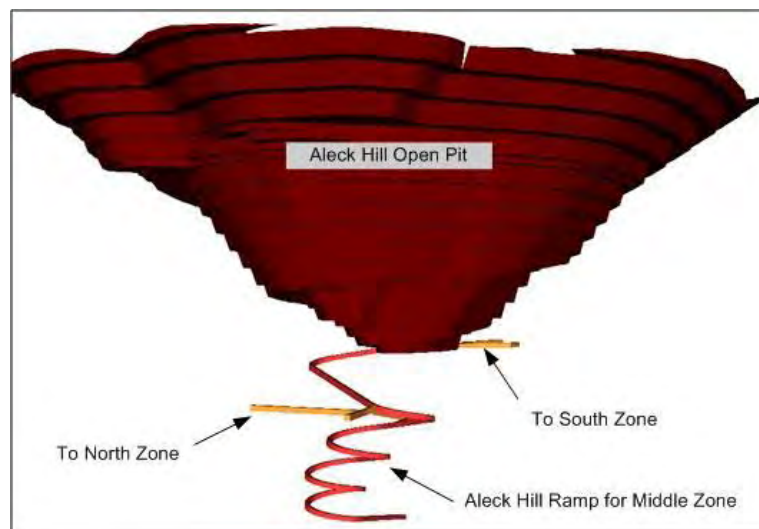
that channel all spillage to a sump, similar to the surface workshops. Each sump will be equipped with a water treatment system which will collect and remove oils via an oil-water separator. Used oils will be collected in containers and will be brought to the ground surface for disposal by an outside contractor. Used oil rags and filters will be collected in containers which will also be brought to the surface for disposal by an outside contractor.

The shaft will remain as the mine's main artery. However, both downwards and upward ramps will be developed to access the mineralized horizon. It is also likely that a ramp may be driven from surface while the shaft is being developed to more quickly access the deposit at deeper levels.

#### *Satellite Underground Design*

The Satellite Underground deposit (which includes Mad Kiss Underground, West Mad Kiss Underground, South Mad Kiss Underground, Aleck Hill Underground, and North Aleck Hill Underground) will be accessed by stand-alone ramp/adit systems with portals established near the pit bottoms. The ramp/adit access systems of the Satellite Underground mining zones will extend to depths ranging from 30 m for South Mad Kiss Underground to 170 m for Aleck Hill Underground below the open pit bottoms. *Figure 4-6* shows an example of the ramp development system.

**Figure 4-6:** *Example of Ramp Development System – Aleck Hill Underground*



Source: AMEC, 2009.

#### *Ventilation*

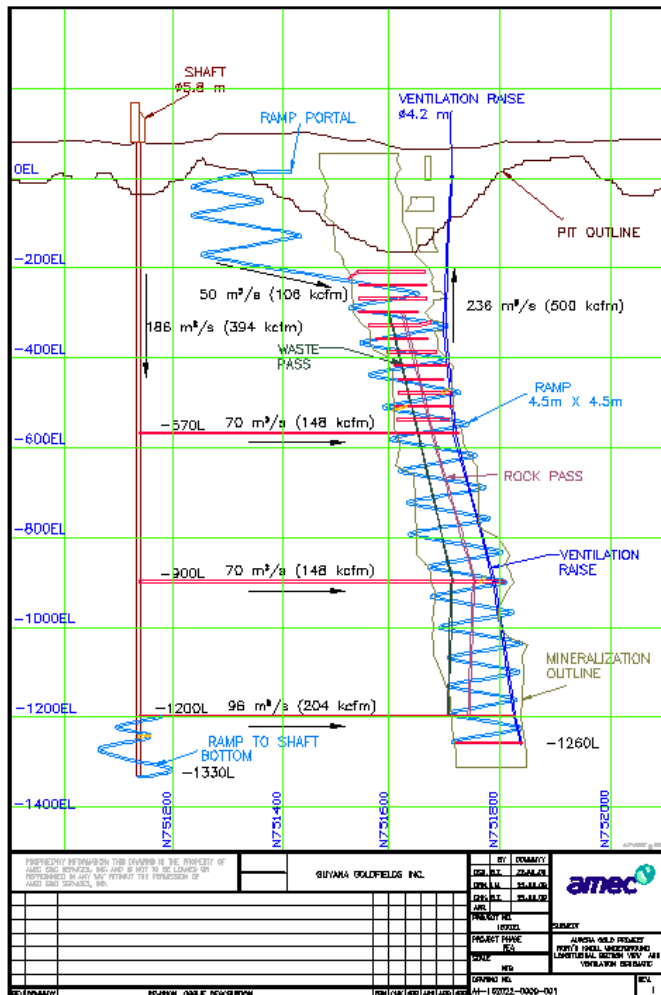
The underground mine will be provided with a ventilation system in order to remove smoke from blasting, exhaust gases from diesel-powered machines, and to provide fresh air for the workers (*Figure 4-7*). Air quality in the underground mine will be maintained to acceptable health standards. Due to lack of underground mining regulations in Guyana, the Canadian Ontario

Mining Regulations were referred to set an adequate volume of air for ventilating the mine (i.e., requirements are 0.06 m<sup>3</sup>/s of air per kW installed). An allowance of 10% for leakage was added to the total volume of air required.

*Proposed Mine Compressed Air*

Two compressors capable of delivering 4,000 cfm (at a pressure of 115 psi) were budgeted to power small equipment (i.e., pumps, jacklegs, etc.) for the Rory's Knoll Underground mine. Compressed air will be supplied from surface via a network of pipes down the shaft (250-mm diameter pipe) and throughout the mine (150-mm and 100-mm diameter pipes) on main levels, ramps, and sub-levels. On-board compressors will be also equipped for special equipment such as longhole drilling machines and explosive loaders.

**Figure 4-7: Longitudinal View of Rory's Knoll Underground Mine**



Source: AMEC, 2009.

*Dewatering*

Two-stage pumping is proposed for the Rory's Knoll Underground Mine. Pumping stations will be located on the bottom and top levels and positioned near the shaft. The main sumps will be located on the -1200 Level, with the secondary sumps installed on the -570 Level. Tertiary sumps will be developed on every sub-level. Drainage holes will connect levels down to the bottom of the mine (near the main conical sumps). Based on a preliminary hydrogeological study, a water inflow of 2,000 m<sup>3</sup>/d was estimated into the underground mine. As a result, the proposed pump capacity is anticipated to be 2,400 m<sup>3</sup>/d (or 6,700 L/min).

Daily water consumption is estimated to be 540 m<sup>3</sup>/d, including 450 m<sup>3</sup>/d of process water and 90 m<sup>3</sup>/d of paste fill pipeline flushing water. Groundwater and paste fill pipeline flushing water will flow to secondary or tertiary sumps, which would be situated near drain holes on the levels and sublevels. All water would flow by gravity to main sumps located on the bottom level. After clarification via settling and/or neutralizing, the water will then be pumped to surge ponds located on the surface for potential recycling and reuse as mill and underground process water. If water from the underground operations meets the water quality requirements for reuse, the extracted water will be used in the operations. If water from the underground operation does not meet the water quality requirements, the water will be discharged into the water management pond. No specific details are provided in the *AMEC NI 43-101 Technical Report on Updated Preliminary Assessment (dated June 2, 2009)*, hereinafter referred to as the AMEC report, regarding whether any treatment will be conducted in the water management pond.

#### *Communication*

Communications will be provided by a leaky feeder radio system that will be installed in the shaft, ramp, and main levels. The system will be capable of transmitting data and voice as well as high speed internet and telephone to the maintenance shops.

### **4.2.3**

#### ***Underground Mining Development and Production***

##### *Development*

Underground development will involve the excavation of shafts, drifts, ramps, steep raises, explosive magazines, fuel bays, refugee stations, pump houses and workshops. Based on the current known resources, a 1,400 m deep shaft will be drilled and is expected to last the life of mine. The shaft will be circular in profile.

Drifts and ramps would be dimensioned to accommodate equipment and services. Ramp grades will vary between 15% and 20%. A typical ramp will run in loops with a curve radius of 20 – 25 m and a grade of 17%. Drifts and

ramps will be mainly developed by using two-boom electro-hydraulic jumbos for fast and accurate drilling.

Raises will connect the levels and sublevels at different elevations and would be primarily used for ladderways, orepasses, slots or ventilation. The inclination of a raise is expected to vary from 70° to vertical, with cross-sections from 1.2 m<sup>2</sup> to 15 m<sup>2</sup>. A raiseboring machine (RBM) will provide a safe and efficient mechanized excavation of circular raises. Conventional raise borings will be used and consist of a pilot hole drilled to the target level where the bit would then be removed and replaced by a reaming head. The RBM would then ream back the hole to the final diameter by rotating and pulling the reaming head upward. The cuttings will fall to the lower level, and will be removed by LHD.

Waste rock will be produced from the development of the ramp, shaft and other underground workings. The total quantity of waste rock requiring storage was estimated at approximately 1.1 Mm<sup>3</sup>. Waste rock will be stored together in surface stockpile(s) with similar waste rock produced from open pit mining operations.

No temporary mill feed storage is necessary as the hoisted material will be transferred to the mill via conveyors. Mine development and production will employ mechanized mobile equipment such as hydraulic two-boom jumbo, 5 m<sup>3</sup> capacity load-haul-dump machines, and 50-t and 28-t capacity trucks.

### *Mining Method*

The planned mining sequence will be bottom-up vertically, centre-out with primary secondary stoping on strike, and retreat from hanging-wall to footwall transversely. Sublevel open stoping (SLOS), a large-scale open stoping mining method, or one of its many variations will be used to exploit the underground deposit. The orebody will be divided into a series of primary and secondary stopes. The primary stopes will be mined first, with the unblasted mineralized material between the primary stopes being left as a temporary pillar to support the hanging wall. These temporary pillars would be recovered at a later time as secondary stopes. Horizontal sections of ore may be also left as crown pillars or sill pillars.

Based on a list of 15 criteria along with a three-pass ranking scheme and a backfill trade-off study between paste fill and cemented rock fill, sublevel open stoping (SLOS) with delayed paste backfill was selected as the preferred mining method, with a typical stope dimensions of 20-m wide by 20-m long by 30-m high. The largest dimensions would normally be in the vertical direction. Mining activities such as drilling and blasting would be conducted in the sublevels with the mineralized material being collected through drawpoints on these levels.

### *Drilling*

Sublevel drifts would be strategically located within the orebody between main levels. These drifts would be driven to allow the longhole rigs to drill the blast patterns. Longhole drilling will be performed by either top hammer or in-the-hole (ITH) hammer longhole production rigs.

### *Blasting*

Production blasting would generally be carried out in single lifts and would be commonly initiated around a 1.2-m diameter raisebored slot raise located on the end of the stope. The slot raise initially may serve as a fill raise for the stope below, then as a slot for blasting. Blastholes would be charged with ammonium nitrate and fuel oil (ANFO) with the holes being “tied-in” immediately before the blast. Typical power factors for production blasts are expected to range between 0.6 – 0.9 kilogram per tonne (kg/t), and will depend on the stope size, drill pattern and hole diameter.

The frequency of blasting will depend on the stope size and production requirements. After each blast, the mine’s ventilation system will clear the mine of noxious gases. Before the mine is re-entered, trained personnel will use gas detection equipment to check air quality in all work areas to ensure the mine is clear of blasting gases.

Blasting operations will be undertaken by qualified persons using proper equipment and materials. Everyone involved in the blasting operations will be trained to ensure commitment to safe working practices and to ensure that every step of the operation is done in a manner which uses the correct methods and procedures.

The underground mine would only be evacuated for large-scale blasts. If the mine is evacuated, the blast would be detonated from the surface using electric-nonelectric combined blasting techniques. Refuge stations would be located at a minimum distance of 60 m from the explosive magazine, cap magazine, and storage container (Ontario Reg. 854 s. 126). Located in a crosscut or blind heading adjacent to the main travelling roadway with thick fire-proof stopping at each end, the refuge stations would be supplied with telephone, compressed air, food, and water.

Both permanent and portable refuge stations will be provided. Permanent refuge stations would be located on the main levels within 300 m of the shaft stations. Portable refuge stations would be mounted on skids and will be moved with the working face and would be sited within 300 – 500 m of the working face.

### *Mucking*

Mucking would be carried out at stope drawpoints on the level at the base of the stope. A minimum of one active mucking stope for the Satellite underground mining zone is required to meet the 800 t/d of supplemental mining. To ensure the safety of the workers, the LHD's would be operated by remote control in the stope once the brow of the drawpoint has been exposed. The mucked material may be dumped into an adjacent orepass, or into trucks if the distance to the orepass is excessive.

### *Backfilling*

To minimize ore loss, consolidated backfill techniques will be used to fill the open stopes. The mined-out stope will be backfilled with cemented paste fill and/or cemented rock fill (CRF). Cemented paste fill is a high density mixture of de-slimed tailings mixed with cement. The mixture would be prepared on the surface and pumped underground via a network of drill holes and pipes. CRF is a mixture of cement slurry and crushed rock or underground development waste. This mixture would be prepared underground and would be dumped into the stopes via fill raises.

The primary stopes would be mined first, then backfilled so that the secondary stopes can be safely extracted. The secondary stopes, in turn, would be backfilled with a lower ratio of cement content for paste fill or non-cemented waste rock, as the backfill does not require the same strength as for the primary stopes. Backfilling of stopes will allow for close to a 100% recovery rate of the ore.

## **4.2.4**

### *Processing Plant*

A conceptual flow diagram which covers all process units is illustrated in *Figure 4-8*. The major process units included in the on-site processing plant will include the following:

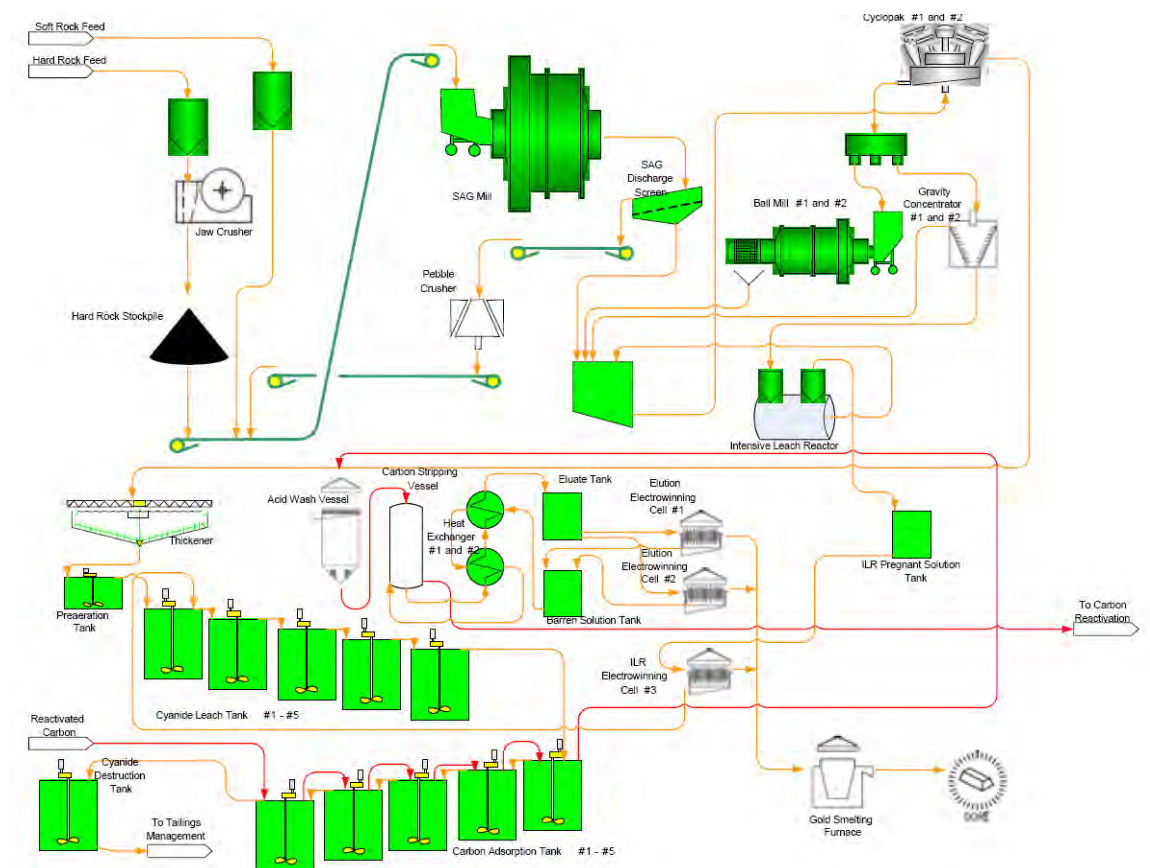
- primary crushing, ore handling and storage;
- grinding;
- classification;
- gravity circuit;
- thickening;
- cyanidation;
- elution;
- refining and smelting; and,
- cyanide destruction and tailings storage in TMA.

The following section provides further details on each process unit.

## Crushing/Material Handling

Two crushing circuits are proposed in the design to account for crushing oxide or sulfide mineralization types. The processing plant will treat a blend of the saprolite/transition rock and hard mineralized material at a rate of 8,000 t/d. The saprolite will require minimal crushing. AMEC has proposed the utilization of a mineral sizer as the primary crusher when handling saprolite. When the oxide layer is depleted, hard rock will be crushed using a jaw crusher. A mineral sizer will be incorporated in the circuit to possibly handle saprolitic material as it is encountered.

**Figure 4-8: Process Flow Diagram**



Source: AMEC, 2009.

## Grinding

The mineral sizer or the jaw crusher will feed a SAG mill, which is designed for a throughput of 8,000 t/d. A circulating load (20%) of the SAG mill discharge will be conveyed to a pebble crusher. A cone crusher rated at 70–100 t/h will be selected for pebble crushing. The SAG mill discharge will be feed two parallel ball mills in closed circuit with a cyclone pack. Cyanidation tests have been conducted at three grinds, ranging from a particle size (K80) of 95  $\mu\text{m}$  to 160  $\mu\text{m}$  and as expected higher recoveries (>96%) have been achieved at finer grinds. The grind will be optimized at a K80 of 75  $\mu\text{m}$ .

### *Gravity Recoverable Gold and Intensive Cyanidation*

To maximize recovery of gravity recoverable gold for the 8,000 t/d throughput, a portion of the cyclone underflow would be diverted to a Knelson concentrator. Based on preliminary metallurgical results, it is anticipated that at least 30-35% of the gold would be recovered by gravity.

The gravity concentrate would be treated in an Intensive Cyanidation Unit (ICU). In particular, the tabling of gravity concentrates offers very low recoveries often between 30% and 60%. The intensive cyanidation technology is attractive in that it would result in the following:

- Significant improvements in recovery of gravity gold (i.e., no recycle streams from the shaking table);
- Improved security; and,
- Capital cost reductions for increased leach throughput. The Knelson concentrator and intensive leach reactor (ILR) is normally supplied as a package.

### *Leaching*

To improve the cyanidation kinetics, the thickener underflow is proposed to feed a preaeration tank before the leach tanks. Leach tanks will be designed and sized for a pulp density of 45% solids and 24-36 hour residence time. The leach circuit will consist of six agitated tanks. Sodium cyanide would be metered into the first and second leach tank to maintain a nominal 0.5-0.8 g/L concentration. Air will be supplied to all tanks and the system will include a provision for bypassing of any one of the tanks, if necessary.

### *Carbon Circuits*

The slurry from the leach tanks will be pumped to the carbon in pulp (CIP) circuit, which conceptually would be a train of 5 or 6 agitated tanks. Each tank will be equipped with an inter-stage screen for carbon retention. Loaded carbon will be directed to the carbon stripping circuit. Stripped carbon from the carbon elution and activation kiln will be delivered to the last CIP tank. Slurry from the last CIP tank would be screened to ensure that no carbon is inadvertently lost. Loaded carbon from CIP would be transferred to a pressure vessel where gold is eluted using a weak caustic-cyanide solution at an elevated temperature. Stripped carbon will be screened and reactivated in a horizontal kiln.

### *Electrowinning and Gold Refining*

Pregnant strip solutions from the elution process would be accumulated in the pregnant solution tanks and fed continuously to the electrowinning cells for gold recovery. The electrowinning (EW) will be divided into two sections,

with one handling the pregnant solution coming from the ICU and the other dealing with the eluate from the carbon stripping vessel. Cathode gold would be periodically removed under tight security, refined to dore in a furnace, and cast into bars for shipment and sale.

### *Tailings*

Tailings from the last CIP tank will be discharged to a cyanide destruction plant. The leach circuit tailings will be discharged to a carbon safety screen and sampler for collection of a metallurgical accounting sample before entering the agitated cyanide destruction tank. In this tank, the residual cyanide content is reduced to concentrations below permissible levels through oxidation, using an SO<sub>2</sub>-air process. No information was provided in the AMEC report regarding what the permissible levels are for cyanide content in tailings. In addition, there are no details in the drawings/designs about how the tailings will be conveyed to the TMA.

## **4.2.5 Reagents Preparation System**

This section describes the preparation system for all reagents used in the proposed mining and processing operations.

### *Lime Preparation System*

Lime is envisaged as being delivered as fine quicklime (CaO) to the site in bulk via trucks. The trucks would discharge the fine quicklime into a 150-t capacity silo using an on-board compressor and a hose connected to a pipe riser, which delivers the quicklime to the top of the silo. The silo will be equipped with a bag house fitted with a mechanical shaker for dust control.

The slaked lime slurry will overflow the slaker at a solids density of 12% solids into an agitated holding tank. From this tank, the lime slurry will be distributed throughout the plant and delivered at the various addition points in the leach and cyanide destruction circuits through a pressurized close-circuit distribution loop.

### *Sodium Cyanide*

Cyanide is planned to be delivered to the site via bulk carriers as a 30% solution. The tanker truck will discharge the cyanide into a storage tank from where it can be distributed by metering pumps into the cyanidation circuits. No information was provided in the AMEC report regarding the location or configuration of the cyanide storage tank, including any secondary containment and/or spill control systems. The cyanide preparation area will reportedly have a sump pump that will be used to direct any spillage back to the holding tank.

### *Caustic Soda Preparation System*

Caustic soda is planned to be delivered to the site in a 1,000 kg isotainer as a 50% w/w solution. The caustic soda will be further diluted to 30% w/w strength in a mixing tank and then stored in a holding tank. For distribution, the caustic soda will be pumped in a pressurized loop from which individual control valves will bleed the required amounts at the addition points in the carbon circuits and at the wet scrubber servicing the gold refinery induction furnace off-take gases.

### *Hydrochloric Acid Preparation System*

Hydrochloric acid is planned to be delivered in bulk to the site at a 31.45% w/w solution concentration. The delivery truck will transfer the acid solution into a container provided by the acid supplier. From there, the acid will be drawn upon as required by a metering pump directly to the carbon acid wash solution tank.

### *Sulfur Dioxide Preparation System*

Sulfur dioxide is expected to be delivered to the site in pressurized tanker trucks and transferred into a pressurized storage tank. A control valve, operated in conjunction with a Coriolis flow meter indicating the mass flow of reagent, will regulate the addition of liquid sulfur dioxide in proportion to the amount of residual cyanide required for cyanide destruction.

### *Copper Sulfate Preparation System*

Copper sulfate will be received at the site in 1,000 kg bulk bags. A batch will be prepared by hoisting a bag on a bag breaker to release the solid copper sulfate pellets into the agitated mixing tank, which would previously be filled with fresh water. The target solution strength will be typically 15% w/w of copper sulfate. From the distribution tank, a series of metering pumps will provide the desired reagent flow rates to the cyanide destruction circuit.

## **4.2.6**

### ***Additional Mine Site Infrastructure Overview***

The mine site includes additional infrastructure to support the mining activities (*Figure 4-9*). Proposed on-site infrastructure includes the following:

- Hard rock offloading and crushing area
- Soft rock offloading and crushing area
- Mill building housing the process plant, maintenance areas, supervision offices, and laboratory
- Mine maintenance shops
- Warehouse

- Administrative offices
- Mine dry facilities
- Power generation facilities
- Emergency response building
- Construction/permanent camp accommodation complex
- Emergency power generator area
- Sewage treatment and waste disposal area
- Fuel storage facilities for heavy oil, diesel and other fuels
- Water supply and distribution including fire protection system
- On-site roads and drainage systems
- General outdoor laydown areas
- Explosives magazines
- General site vehicles (non-mine)
- Airstrip
- Tailings Management Area
- Waste Rock
- Water Management Area
- River Dike
- Security gatehouse
- Communications tower

The site layout for the project has been determined based on the existing topography as well as the location of the deposits. Condemnation drilling has determined that there are additional areas of mineralization to the southeast of the proposed open pit, precluding most of the works from being located on the easterly and southeast boundaries of the open pit.

The planned process facilities, administration center, and operational facilities are located on the south side of the open pit so as to be as close as possible to the open pit and headframe, while avoiding the east and southeast quadrants.

The proposed tailings management area and the waste rock facilities are located on the sides of a ridge located on the west side of the open pit. The use of the ridge minimizes the amount of dams and/or berms required. The tailings management area is located in an adjacent concession to the west of the Aurora Concession.

The accommodation complex is located close to the river on a westerly-trending ridge; however, if the selected site is within the riparian flood plain, a second site has been identified along the same ridge. The following sections provide additional details regarding significant on-site facilities.

#### **4.2.7 *Process and Material Handling Facilities***

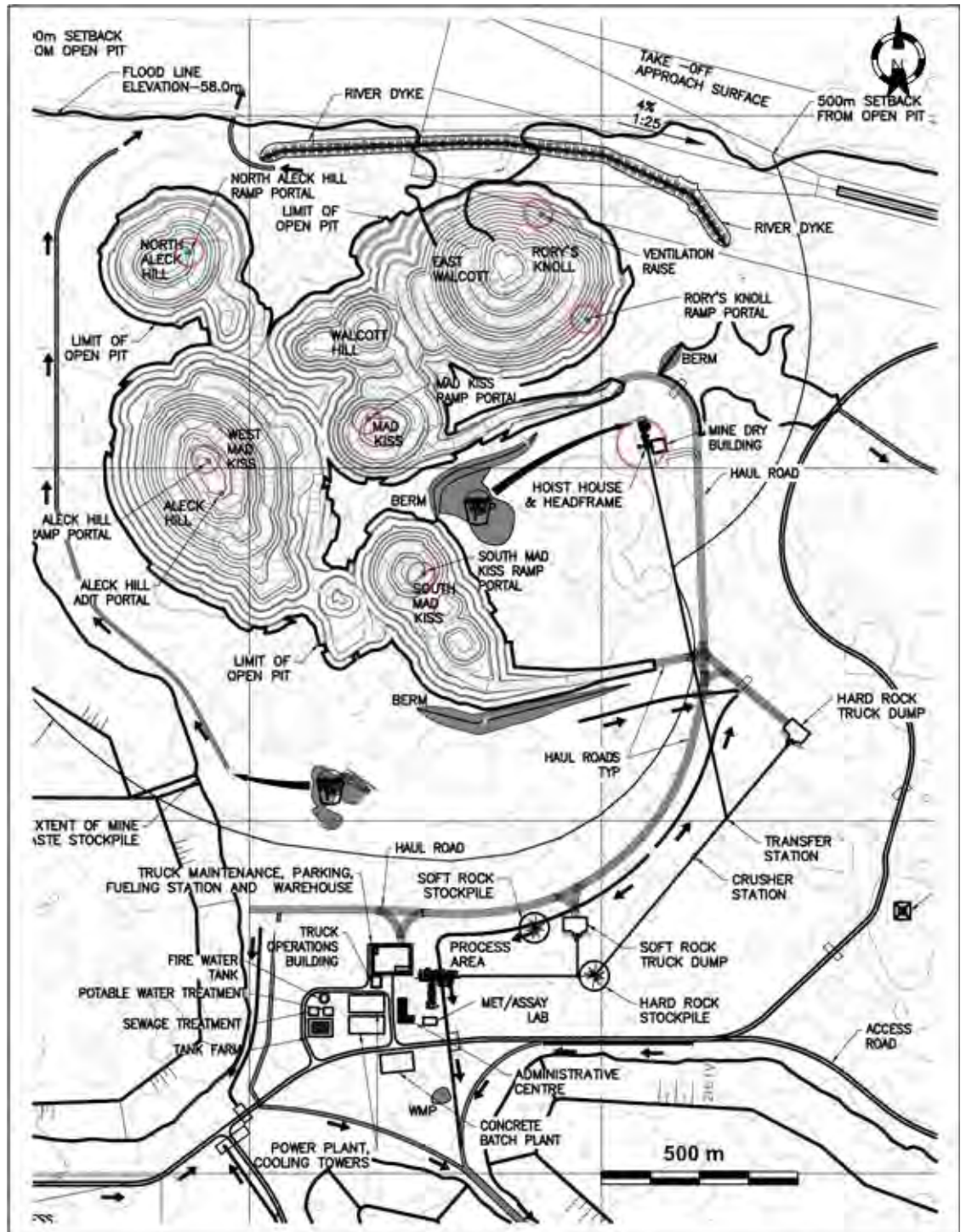
##### *Offloading and Crushing Area*

A hoist and conveyor system is planned to transport fresh-rock mineralized material from the mining operations to the process offloading area. Mineralization will be dumped into a hopper through a stationary grizzly, and then metered from the dump hopper by a vibrating feeder. Oversized material will be reduced using a rock breaker and discharged into a primary

jaw crusher. The fines passing through the feeder will combine with the crusher discharge and be transported by conveyor to a crushed ore stockpile.

Saprolitic mineralized material will be transported from the various pit locations by haul trucks to the offloading area. The mineralization will be dumped into a dump hopper through an opening stationary grizzly, and then metered from the dump hopper by an apron feeder to a sizer. The sized material will be fed through the SAG mill-feed conveyor.

**Figure 4-9: Proposed Mining Site Layout of Major Surface Infrastructure with Respect to Planned Open Pits and Mill Plant**



Source: AMEC, 2009.

### *Mill Building*

The mill building will house the process plant, where grinding, gravity separation and intensive cyanidation, leach, carbon circuits, gold refinery, and reagents preparation operations will be conducted. The building will be a pre-engineered steel building with an approximate 120 m x 30 m footprint, a clad roof, and  $\frac{3}{4}$  clad side walls to facilitate the use of natural ventilation within the building. No information was provided in the AMEC report regarding floor drains/sump systems and whether the building will be equipped with any secondary containment systems for the various processing areas.

The roof and walls will have translucent panels to maximize natural lighting within the building. Structures within the building will be self supported and not attached to the mill building steel structure. Steel platforms will be built to support elevated equipment and provide access to the surrounding facilities. Building foundations will be conventional type spread footings, unless additional geotechnical investigations require alternative foundations. Concrete pads and foundations will be provided to support the equipment.

## **4.2.8**

### *Ancillary Facilities*

#### *Maintenance Facilities*

A centralized maintenance facility will be provided to service the mine fleet and process plant equipment. The facility will be a steel-framed, fully-clad building (approximately 40 m x 15 m) accommodating the vehicle wash bay, vehicle repair bays, lubrication storage and distribution bay, plate shop, welding shop, machine shop, electrical shop, instrument shop, warehouse, wash facilities, tool crib and offices. A 50-t bridge crane will service the heavy vehicle repair bays and smaller 10-t bridge cranes will service the plate, welding, machine and electrical shops. The warehouse will be used for floor storage of heavy and large spares and rack storage of lighter smaller spares.

#### *Emergency Response Building*

The emergency response building will be a pre-engineered steel structure located next to the administration facilities. The building will house the medical clinic and garage bays for ambulance/rescue vehicles and a fire truck.

#### *Administration Facilities*

Office staff, including management, administration, purchasing, accounting, training, mine engineering, geology, planning, grade control, safety, security and payroll members, will be accommodated in the administrative facilities building.

### *Accommodation Facilities*

Two locations are being considered for the permanent accommodations facilities. The accommodation facility would be located either approximately 4 km to the northeast of the process plant or approximately 3 km to the west of the process plant on top of a ridge. The preferred location will be determined based on the results of the ongoing geotechnical and topographic survey programs.

The accommodation facilities will be constructed at the beginning of the project so that they can be used during the construction period. The facilities would include eight stand-alone one storey dormitories and a stand-alone, single storey core services building.

### *Airstrip and Terminal Building*

Two locations are also being considered for the location of the airstrip and associated terminal building. The airstrip would be located either to the east of the open pit along the banks of the Cuyuni River or on top of a ridge located 2km to the west of the process plant.

The airstrip is envisaged as having a length of 1,200 m, which is suitable for a Dash 8-300 airplane. The airstrip is intended to be used during daylight hours only. All aircraft maintenance and refueling activities will be done in Georgetown. The workers and staff would be flown to the site from Georgetown for their rotation and then flown out at the end of their rotation.

### *On-site Roads and Drainage*

Site roads will be designed with a minimum 7.5-m road width, which is suitable for small vehicles and for two-way traffic.

### *Explosives Plant and Magazine*

The explosives plant and magazine is currently planned to be located approximately 3 km to the south of the process plant. The explosives plant area will be fenced and access will be controlled. All works will be stored and handled in accordance with Guyanese explosives regulations. The magazines will be surrounded on three sides with berms for safety and leakage control.

### *Laydown Areas*

Temporary laydown areas will be provided for construction purposes. A permanent 22,500 m<sup>2</sup> laydown area is planned for operational use.

### *Mine Dry Building*

A mine dry building will be located adjacent to the shaft and designed for underground operations and maintenance.

### *Truck Operations Building*

A truck operations building will be located adjacent to the truck maintenance building. This building will be utilized for open pit operations, and include offices, a training room, lockers, a tool crib, a lunch room and a dispatch room.

## **4.2.9 Services and Utilities**

### *Water Systems*

The water system designed for this project includes a fresh water supply from the Cuyuni River (according to the AMEC report, a water supply well may be used as an alternative) for potable water treatment and distribution, sewage treatment and discharge, fire water, mill water, tailings water, seepage water from the pits and underground mine, and storm water. The AMEC report indicates both options; however, it is not clear whether one or the other option will be chosen or whether both will be used concurrently to meet the water needs of the project.

Fresh water will be sourced via a pump station either from the Cuyuni River or from a well within the project boundary. Fresh water will be supplied to a combination fresh and firewater tank. A water treatment plant (chlorination and filtration) will treat the fresh water to acceptable quality for potable water use. A potable water distribution system will supply potable water to the various users. A fire water distribution system (pumps, booster pump and emergency pump and associated piping, hoses, water spray nozzles, monitors) will ensure the facilities are adequately protected from fire damage as prescribed by regulations and insurers. A sewage treatment facility will treat all sewage produced by the facility before discharging the treated effluent to the environment. There are no details about the exact locations of these discharges available in the AMEC report.

The AMEC report indicates that there will be efforts made to reclaim water from the mining process and tailings system, thereby minimizing the requirement for additional fresh water. Open pit, underground, and storm water will be collected in a settling pond before discharge to the environment. There are no details about the settling pond and the exact locations of these discharges available in the AMEC report.

### *Fuel Storage and Distribution*

Fuels stored at the facility will include heavy oil, diesel and gasoline. All fuel will be supplied to the site by tanker trucks on a regular basis such that the amount stored on site is equal to 1 month's usage. A loading/unloading pump system will transfer the fuel from the supply vehicles to the storage tanks and also distribute the fuel to the different users. The storage tanks will be located within a tank farm with secondary containment (i.e., berm with high density polyethylene (HDPE) lining) of sufficient volume to contain twice the volume of the largest storage tank. Fuel piping will be single walled installed above grade.

#### *Power Plant*

Power will be supplied to the site by an in-house power plant with the capacity to be connected to a transmission line fed from a hydroelectric power plant located approximately 7 km from the proposed mining operation. Power generation will be provided by 13.8 kV (5.82 MW) generators running on heavy fuel oil (Bunker), one of which will be in standby mode as a backup. The generators will be sized so that the units can supply the site demand while running at 82-87% of their rated capacity. With the loss of one generator, the remaining generators shall be capable of handling the total load for a minimum of one (1) hour until the standby unit is brought on line.

In the initial five years of operation, only five (5) generators will be purchased (four units running and one unit functioning as a standby generator). After year five, two (2) additional generators of similar size will be added to satisfy the increased load from the underground mining operations. The heat passed out through the exhaust stacks will be recovered using an exhaust flue gas heat recovery system and will be used to heat the heavy fuel oil in the tank farm. The power plant will consist of a steel-framed, clad building with a footprint of approximately 80 m x 40 m. No information is provided in the AMEC report regarding whether the generators will be housed within this building.

#### *Emergency Diesel Generators*

Emergency generators will be provided to provide emergency power for the mining operations. The units will be sized to provide sufficient power for life safety, including the accommodation camp, and other critical loads.

In the initial five years of operation, only one (1) generator will be purchased and installed near the power plant. After year five, an additional generator will be added to support underground mining operations.

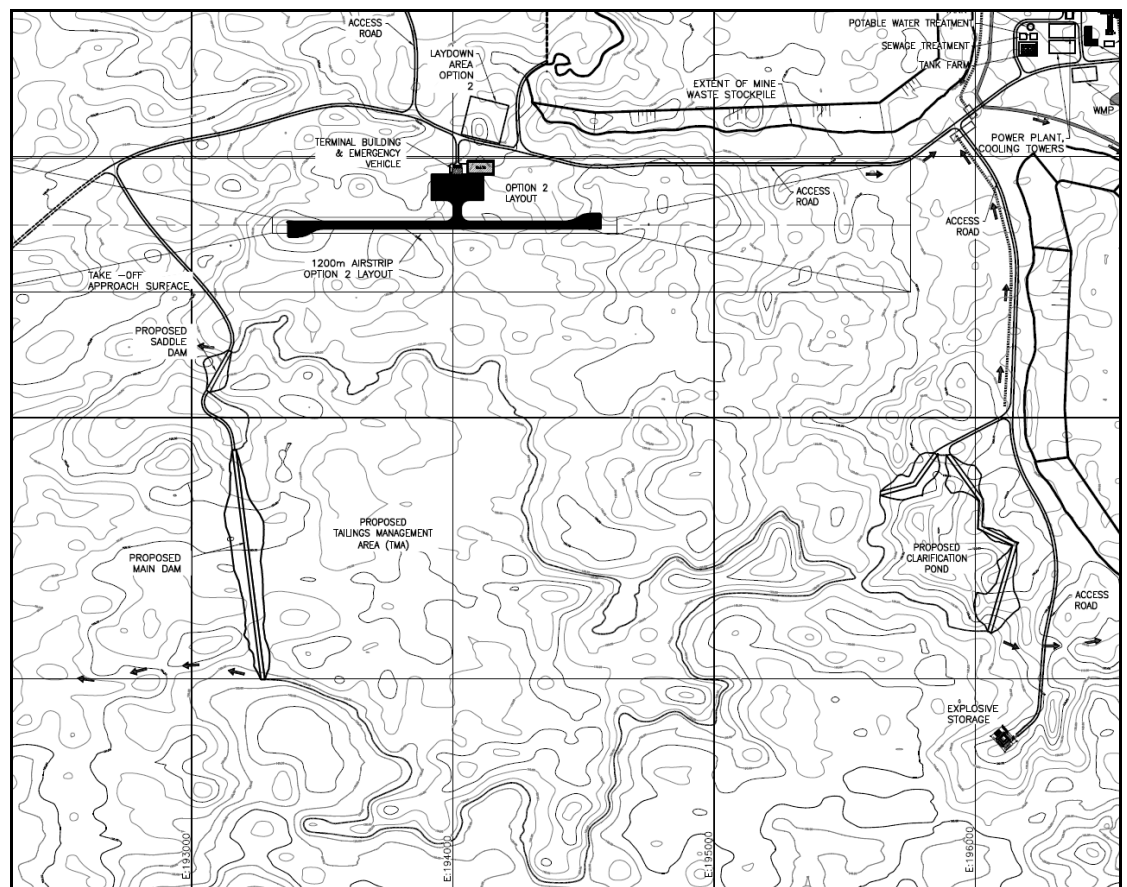
#### 4.2.10 Solid Waste Disposal

No information has been made available regarding the nature of the disposal of domestic and industrial solid wastes during the construction and operational phases of the Project.

#### 4.2.11 Tailings Management Area

Tailings will be disposed of as slurry in the Tailings Management Area (TMA), which is proposed to be located to the southwest of the open pit (Figures 4-10 and 4-11).

**Figure 4-10: Tailings Management Area Plan**



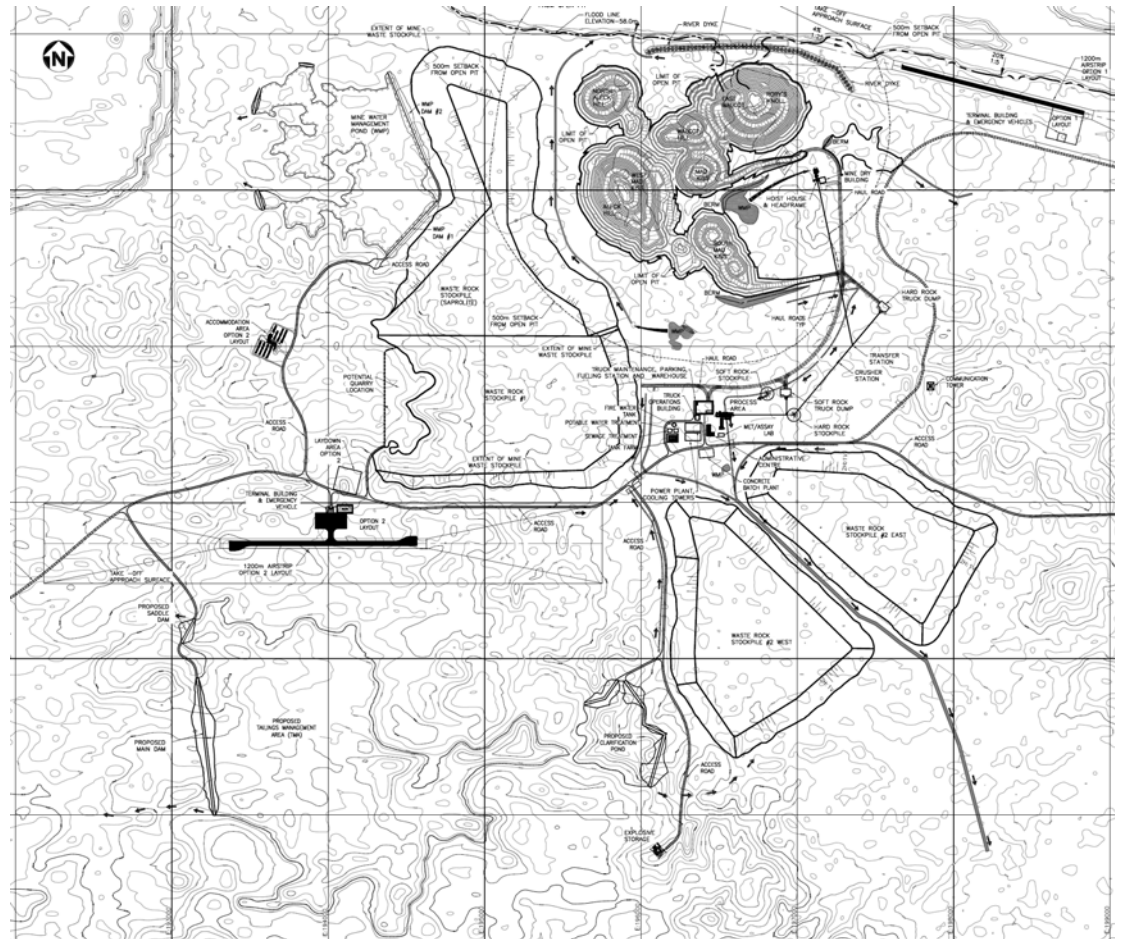
Source: AMEC, 2009.

The TMA is designed to contain the LOM tailings production of 25 Mt of dry solids. The tailings production rate is projected at 8,000 t/d dry solids, pumped at 45% solids content by weight, corresponding to 13,733 m<sup>3</sup>/d of slurry water. No information was provided in the AMEC report regarding the process for the transfer of tailings slurry from the processing area to the TMA.

Due to the uncertainty associated with the tailings geochemistry, the tailings will be discharged to the TMA under a permanent water cover of 1.5 m depth. The typical tailings pond operating level is expected to be about 121.2 m. The

cyanide associated with the processing will be destroyed in the process plant to a sufficiently low level. The large retention time and pond surface will enhance the natural degradation of the residual cyanide. No specific information was provided in the AMEC report regarding the expected average concentration of residual cyanide in the tailings waste stream or the natural cyanide degradation processes that will reportedly occur in the TMA.

**Figure 4-11: Water Tailings Management Layout Map**



Source: AMEC, 2009.

The TMA will be formed by the construction of two (2) perimeter dams: TMA Dam 1 (875 m in length and 30-m high) and TMA Dam 2 (170 m in length and 14-m high). Three perimeter dams will be required to form the clarification pond: Clarification Pond Dam 3 (330 m in length and 20-m high), Clarification Pond Dam 4 (320 m in length and 24-m high), and Clarification Pond Dam 5 (550 m in length and 34-m high). The TMA and clarification pond dams will reportedly be constructed to a 124.0-m crest elevation.

Excess water from the TMA will be discharged at the east edge of the facility through a connecting channel to the clarification pond, which will allow for settling of potential contaminants/suspended solids to enhance discharge water quality. The clarification pond will also be the source for process water

reclamation. Excess water from the clarification pond will be discharged through an overflow (stoplog) structure to a local receiving watercourse flowing easterly, eventually flowing to the Cuyuni River downstream of the site. The invert elevation of the overflow structure will be set to maintain a permanent water cover over the final tailings surface. The clarification pond is designed to provide a 5-day retention time for a 1-in-2-year 24-hour rainfall storm. Excess runoff from more intense storms will be discharged through the clarification pond overflow structure.

An emergency spillway will be located at the south abutment area of Dam 1 and will be set at an invert elevation above the 1-in-100-year 24-hour storm level. Runoff from events exceeding the 100-year flood event will be discharged through both the clarification pond overflow structure and TMA emergency spillway. The emergency spillway will be sized to convey the inflow design flood, and the dam crest elevation will provide a minimum 0.3 m freeboard above the maximum water level for this event.

#### *Geotechnical Conditions*

The geotechnical investigation of the area proposed for the TMA included the drilling of nine boreholes along the alignment of the TMA and clarification pond dams. The dams will be constructed of locally available fill materials, including silty clay to clayey silt (primarily saprolite), clean waste rock and overburden materials from the open pit excavation. Sand and gravel will be produced from crushing, if not available from a local or nearby source.

The TMA will include two dams on drainages that flow westward into the Julian Ross Itabu. The maximum TMA dam height will be approximately 30 m at the crest. No information is provided in the AMEC report indicating how the dams will be constructed (i.e., during initial project construction or via a phased approach during the life of the mine). It should be noted that the majority of the proposed TMA location is situated in Guyana Goldfield's adjacent A-22 concession outside of the limits of the Aurora Concession.

#### **4.2.12**      *Overburden and Mine Waste Stockpiles*

The development of the proposed open pit will generate excavated overburden and blasted waste rock. Excavated overburden (alluvium and saprolite) and waste rock materials will be stockpiled at the project site. The stockpile slopes will be designed to meet the required minimum factor of safety with respect to shear failure under long term and seismic loading conditions of 1.3 and 1.1, respectively.

The stockpile boundaries are constrained principally by:

1. A minimum setback of 200 m from the Cuyuni River;

2. A minimum setback of 100 m from the haul road to the proposed open pit;
3. A minimum setback of 100 m from the approach perimeter of the proposed airstrip; and,
4. A minimum setback of 30 m from any access roads or toes of proposed dams.

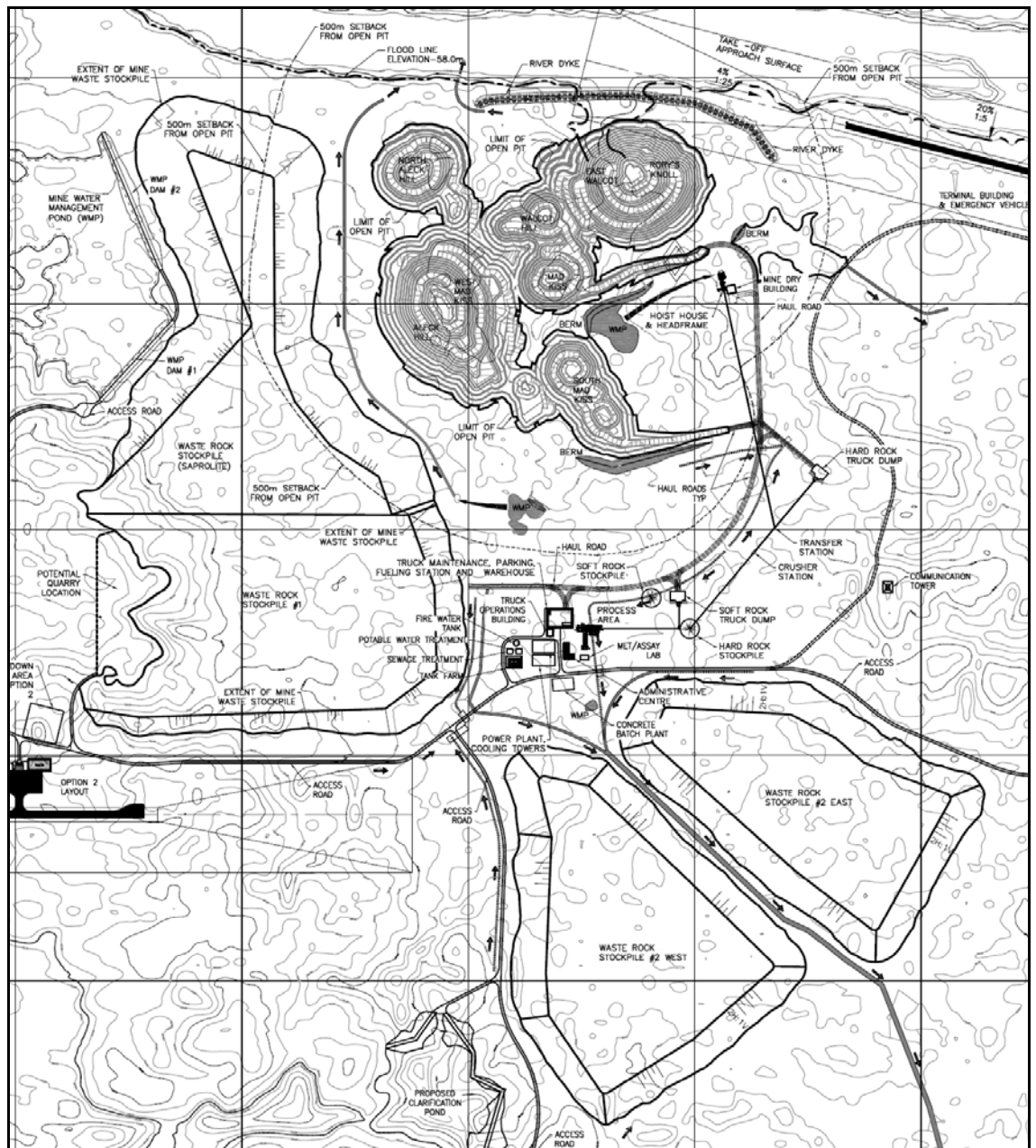
#### *Overburden Stockpile Area*

It is estimated that approximately 75 Mt of overburden (alluvial soil and saprolite) will be excavated from the open pit development. Total equivalent volume of overburden produced from the open pit at a placed density of 1.6 t/m<sup>3</sup> is 50 Mm<sup>3</sup>. A portion of the excavated saprolite will be used for the construction of dams and site infrastructure (i.e., airstrip and fill pads).

Based on the proposed plan in the AMEC report, overburden material will be stockpiled west of the proposed open pit perimeter (*Figure 4-12*). Total suspended solids (TSS) control measures will be provided for the runoff from the overburden stockpile. No additional information is provided in the AMEC report regarding what types of erosion and sediment control measures will be implemented at the project site. The project limitation for discharge of TSS off-site is 50 mg/L (IFC 2007). According to the AMEC report, the specific locations of the compliance monitoring points will be determined during feasibility level studies.

The design storage capacity of the proposed overburden stockpile is 56 Mm<sup>3</sup>, including a contingency volume of 6 Mm<sup>3</sup>. The stockpile has an overall design slope of 3H:1V, a top elevation of 150 m (maximum height of 65 m), and a footprint area of 154 ha. According to the AMEC report, the overall slope will require additional study prior to finalization. All stripped organic material will be stockpiled in segregated areas within the saprolite stockpile area for use in progressive reclamation.

**Figure 4-12: Planned Stockpile and Waste Dump Layout**



Source: AMEC, 2009.

### Waste Rock Stockpile Areas

An estimated 163 Mt of waste rock is expected to be produced from the mine development according to the AMEC report. The waste rock will be stored in three separate on-land stockpiles, each having its own water management system. This will provide the flexibility for storage of waste rock with different geochemical properties, if necessary, based on detailed geochemistry results. The total equivalent volume of waste rock expected to be produced at a placed density of 1.8 t/m<sup>3</sup> is 90 Mm<sup>3</sup>. Portions of the waste rock will be used for the construction of dams and site infrastructure (i.e., mine roads, airstrip

and fill pads). The waste rock quantities required for construction have not been excluded from the preliminary storage requirement calculations.

Three locations are proposed for the storage of waste rock: Waste Rock Stockpile 1 is located southwest of the open pit, and Waste Rock Stockpiles 2 and 3 are located southeast of the plant site area. *Figure 4-13* illustrates the locations and planned layout of the waste rock stockpiles.

Depending on the final mining plan, there may be opportunities for storage of mine rock within the completed area of the open pit to reduce on-land storage. This option may be considered at a later stage when a detailed mine plan is available.

Runoff from the stockpiles will be monitored for water quality. If the water quality is considered unsuitable, the runoff will be collected in a perimeter ditch system and directed to a mine water settling pond for removal of suspended solids and possible treatment prior to release to the environment. No specific information is provided in the AMEC report regarding the type of monitoring or treatment of runoff expected for the project.

The waste rock stockpiles will be designed for long term stability and to facilitate closure. Waste stockpile design parameters are summarized in *Table 4-2*.

**Table 4-2:** *Summary of Design Configuration for Waste Rock Stockpiles*

Stockpile	Storage Capacity		Footprint Area (ha)	Crest Elevation (m)	Maximum Height (m)	Overall Slope
	(Mm <sup>3</sup> )	(Mt*)				
Waste Rock Stockpile No 1	57	102.6	140	150	65	2H:1V
Waste Rock Stockpile No 2	15.3	27.5	116	150	60	2H:1V
Waste Rock Stockpile No 3	17.7	31.9	137	150	60	2H:1V
Total	90	162	393			

\*Note: Based on an assumed placed density of 1.8 t/m<sup>3</sup>

Source: AMEC, 2009.

As part of the site water management plan, diversion channels are proposed south of the plant processing area in the vicinity of Waste Rock Stockpiles 2 and 3. The diversion channels will discharge into a tributary of Gold Creek located southeast of the waste rock stockpiles.

The stockpiles will be developed with benches having a height of 22 m and a width of 15 m to achieve the design slope. The slopes of each bench are expected to be at an angle of repose of approximately 1.4H:1V.

#### *Surface Runoff*

According to the AMEC report, surface runoff from the stockpiles will be collected and conveyed by a perimeter ditch system for discharge into a

settling pond and discharge into tributaries of Gold Creek (Mine Waste Stockpiles 2 and 3) or the Cuyuni River (Overburden and Mine Waste Stockpile 1). No specific information was provided in the AMEC report regarding the perimeter ditch system, dust control measures, the potential risks associated with acid mine drainage from the mine waste stockpiles, and monitoring of the surface runoff.

#### 4.3 *MINE SITE MANAGEMENT PLANS*

The following section provides information regarding management plans related to the project site. The section includes the Mine Site Water Management Plan and the Environmental Closure Plan, as presented in the AMEC report. Additional management and action plans are included in Section 9 of this ESIA.

##### 4.3.1 *Mine Site Water Management Plan and Cuyuni River Flood Protection Dike*

A water management plan has been developed for the site to provide flood protection, handle potentially contaminated water, and manage site runoff. The main features of site water management plan include the following:

- An earthen river dike will be constructed alongside the Cuyuni River to mitigate flood risk to the project site. The dike will be designed using the very severe flood and earthquake criteria (i.e., the 1-in-10,000-year flood level and the maximum credible earthquake [MCE]). The proposed dike will be about 1,540 m long, with a 15 m crest width, 3H:1V slope on the upstream side, and a 2.5H:1V slope on the downstream side. A road surface with a bedding layer adequate for light vehicular traffic will be provided on the dike crest. Designs may be revised during more detailed studies (AMEC, 2009).
- A Water Management Pond (WMP) will be constructed and will serve as the central water management facility for the project site. The WMP will be formed by the construction of five earthen dams: WMP Dam 1 (710 m in length and 12.5 m high); WMP Dam 2 (500 m in length and 12 m high); WMP Dam 3 (143 m in length and 10 m high); WMP Dam 4 (231 m in length and 7 m high); and WMP Dam 5 (135 m in length and 2 m high). The WMP is designed to provide sufficient storage capacity for 5-day retention of the runoff volume from a 1-in-5-year 24-hour rainfall storm. This assumes a very high pumping capacity (7,000 m<sup>3</sup>/h), which would be needed to pump the open pit dry over a 24-hour period. The pond will discharge continuously through an overflow structure. For flood events exceeding the 1-in-100-year 24-hour storm, pond water will be allowed to spill through an emergency spillway. Contaminated water from the open pits, underground operations, and any other potentially-contaminated site water will be

pumped to the WMP for clarification or treatment, if required (AMEC, 2009). No specific information was provided in the AMEC report regarding the type of treatment and monitoring planned for the WMP.

- Pit dewatering requirements will be reduced by diverting site runoff away from the open pit in a progressive or staged manner to avoid accumulating large flows and volumes of surface water near the pit perimeter. This will be achieved by diverting site runoff that would normally reach the open pit into one of four diversion channels that will eventually be discharged into the Cuyuni River. The western and northern diversion channels will discharge directly to the Cuyuni River to the west of the river dike. The eastern diversion channel will discharge to an existing creek to the south of the proposed riverside airstrip and the southern diversion channel will discharge to an upper tributary of Gold Creek (AMEC, 2009). No specific information was provided in the AMEC report regarding the estimated discharge regimes for these channels.
- In general, runoff will be collected in ditches alongside the site access roads and haul roads, and routed to the diversion channels. Where topography and site layout make ditching impractical, runoff will be collected in topographic lows, which will be developed into two water management ponds. These will be equipped with a pump station able to route runoff over local high ground to a ditch or culvert (AMEC, 2009).
- In certain areas where runoff diversion, collection, and/or pumping are not practical due to topographical constraints, runoff in areas between the haul roads and the pit will be allowed to drain into the pit. This extra drainage has been considered in the initial design of pit dewatering. The site water management plan will be revised during feasibility-level studies and will be based on more detailed survey data, with the aim of further reducing the percentage of site runoff that reaches the pit (AMEC, 2009).

#### 4.3.2 *Environmental Closure Plan*

The current closure plan is a preliminary plan based on available project data. Review processes will determine the precise number of management plans required to address all aspects of the project to ensure compliance with environmental design and permit criteria. The objectives of the closure plan are to:

- Prevent, reduce or mitigate the adverse environmental effects associated with each phase of the project;
- Provide for the reclamation of all affected sites and landscapes to a stable and safe condition;

- Provide for the return of all affected ecosystems to healthy and sustainable functioning;
- Reduce the need for long-term monitoring and maintenance by designing for closure and instituting progressive reclamation;
- Provide for long-term monitoring and maintenance of the sites affected by the project, as required;
- Provide estimated costs for completing the work under the closure plan; and,
- Provide for mine closure using the most current available proven technologies in a manner consistent with sustainable development (AMEC, 2009).

The overall intent of the closure plan is to achieve Guyana Goldfield's objective for restoring the site and receiving aquatic environment to a high ecological value. As described in the AMEC report, the closure of the planned facilities will include progressive closure of unused components during the life of the mine. These may include portions of the stockpiles, water management structures, the laydown areas and some of the underground workings, as feasible (AMEC, 2009).

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 project is not warranted. In the early stage of the final closure, the following activities will be conducted, if not undertaken during progressive closure phases:

- All fuels, chemicals, waste hydrocarbon products, and any potentially hazardous materials will be removed from this site;
- The portal, vent raises, and openings will be sealed;
- Underground pumping and pit dewatering will cease; and,
- Water treatment will cease once runoff water no longer requires treatment (AMEC, 2009).

The following activities will be conducted during the second stage of the final closure:

- All equipment, machinery, and storage tanks will be removed for reuse or recycle and where such uses are not practical, any remaining such materials will be disposed of at a suitable storage site;
- All structures will be removed and/or demolished, with those materials that are suitable for reuse or recycling to be salvaged, and those not suitable for such use to be disposed of at a suitable storage site;
- TMA and other water management ponds will be closed (note: no specific information regarding the closure of the TMA and reclamation of the tailings was provided in the AMEC report);

- All disturbed areas will be reclaimed, with the exception of roads needed for monitoring access; and,
- All other closure works will be completed.

After the major closure activities are complete, some monitoring programs may be required including the site water quality monitoring and dam inspections. According to the AMEC report, an allocation of \$10M was recommended to cover closure costs.

#### 4.4

##### *PORT*

The Buckhall port location features 167 m of river waterfront with suitable draft for heavy lift vessels typical of those currently servicing the estuaries in the region. Barge access is available for large river and ocean going barge equipment.

The port will operate as the mine development and operations supply terminal for the life of the project. All cargo will be offloaded at these facilities for transportation by road to the Aurora site. The port is expected to operate on a 24/7 schedule.

A wharf and pier will be designed to allow for offloading of supplies for the project. A barge landing will be provided to meet barge cargo volume and shore discharge requirements. A large laydown area will be required. The port will include bulk fuel storage and a fuel transfer facility complete with appropriate secondary containment, emergency spill response, and fire fighting equipment.

Materials handling equipment with capabilities for containerized operations and a fleet of tractor trailer equipment will be based at the port. Repair and service capabilities will be available at the port facility. Communications, power, water and septic services will be required to support the operations. Camp and kitchen accommodations or housing arrangements will be required for the work force.

#### 4.5

##### *ACCESS ROADS*

Given the poor navigability of the Cuyuni River and the prohibitive costs associated with air transport, the project will require an overland transportation route from the Essequibo River to the Aurora Mine site.

Barama Company Limited has constructed a forest access road for its logging operations that is in close proximity to the Cuyuni River and within 31 km of the Aurora project (*Figure 4-13*). Portions of the 135-km long logging road from the Buckhall Port to the Cuyuni River will require upgrading and resurfacing. A new 31-km long road will be constructed from the western end

of the Barama road to the Aurora project site. The new road construction will feature barge landings and standard river barge equipment to transit the Cuyuni River.

Limited public use of the road is considered inevitable and will be contemplated as part of the design. The mine access road will feature typical two lane type construction as far as practical and limit single lane and pull out segments to single lane bridge or culvert installations. The construction technique will be primarily cut and fill.

Route selection will minimize disturbances and traverse the best possible surface, subsurface, and geotechnical conditions. Stream crossings will be minimized as far as practical. Corrugated culvert and bridges of log construction typical of the region will be installed, as practical.

**Figure 4-1:** Existing Road and Planned Addition



Source: Guyana Goldfields, 2010.

At the time of writing this report, no maps, plans or other information was available on the engineering design or logistics for the road upgrading and new road construction. Engineering plans of the new road will reportedly be available in May 2010.

#### 4.6 ASSOCIATED THIRD-PARTY FACILITIES AND ACTIVITIES

##### 4.6.1 Supply Chain and Logistics

Construction and operations supply will be substantially sourced from off shore. Guyana has little or no industrial base or manufacturing industries. Materials will be sourced within Guyana as available and as commercially competitive.

Cargo will be consolidated and stored at an off shore marine terminal in advance of the shipping schedule to ensure effective use of available shipping capacity. This provides opportunity to accomplish optimum load conditions and best passage.

Fuel delivery options to the mine site by a third party supplier will be examined in a trade-off study to determine the synergies of combining in-house cargo transport operations with fuel tanker services. Storage facility ownership and operation at all fuel storage locations will also be examined.

#### *Marine and Port*

The marine terminal and cargo consolidation point should be located at an international port. Good access to road and rail and available berthing, storage, security and materials handling capacity is important. The Port of Houston with close proximity to industrial facilities, industrial suppliers, and service providers, creates a significant advantage to operations supply for the project. The geographical location of Houston also offers a reduction in inland freight charges.

Marine cargo will be destined for the Buckhall Port (to be constructed as part the project). Delivery options include barging from Georgetown or transferring cargo from ocean going vessels to lighters at the Essequibo River mouth and barging to the port. The port laydown area will have adequate laydown space and materials handling capacity to accept ship load batches of cargo.

Truck and trailer access will be available to the dock and cargo operations. A shunt truck and trailer program will provide materials handling in and around the dock, dockside temporary laydown, and the cargo laydown storage areas.

#### *Inland Transport*

Truck and trailer programs will operate in two sectors with intersection at the Cuyuni River. Transport equipment based at Buckhall Port will haul cargo to the Cuyuni River barge crossing where a trailer yard and staging area will be provided.

Transport tractors in the port sector will drop their loaded trailers at this location and pick up an empty trailer for the return trip to the port base. Transport equipment based at the mine site will drop empty trailers at the Cuyuni River barge staging area and transport the loaded trailers to the mine site. The Aurora sector has the shortest distance and travel time. The Aurora based equipment will coordinate river crossings, including the barge

operations. The barge crossing operation constitutes a significant truck transport time constraint.

Cargo will be received by logistics personnel at the Aurora site and placed into storage. The materials will be issued from the warehouse or designated laydown area to users when required.

It is anticipated the 75-80% of the truck transport cargo will be of standard size, weight, and configuration. The 20-25% of constrained cargo will be scheduled as special deliveries. Explosives and hazardous materials are typical of this class.

#### *Air Cargo*

A freight forwarder based in Miami will be engaged to manage air cargo and associated documentation. The freight forwarder will be responsible for air shipping manifests and export documentation required to clear cargo at the destination.

#### *Materials Management*

Containerization of cargo is the preferred method of shipping. Materials and supplies will be expedited and shipped to the consolidation point designated by the project. Where possible, vendor orders will be containerized and documented prior to delivery to port. Part orders will be consolidated to container loads.

#### *Personnel Transportation*

Expatriate employees will travel by commercial carrier to Georgetown. Transportation to the project site will be by air from a designated consolidation point. Air service for all project personnel will be executed utilizing a charter air service provider. Flights will consist of a combination of passenger and freight as required by the project.

### **4.6.2** *Security Services*

It is estimated that a total of 33 security personnel are required for guarding the explosives magazine and emulsion plant. There are no details about whether security will be outsourced to private companies or managed in house by Guyana Goldfields.

### **4.6.3** *Offsite Disposal of Hazardous Materials*

No information has been made available regarding the offsite disposal of hazardous materials that may be required during the construction and operation phases of the project.

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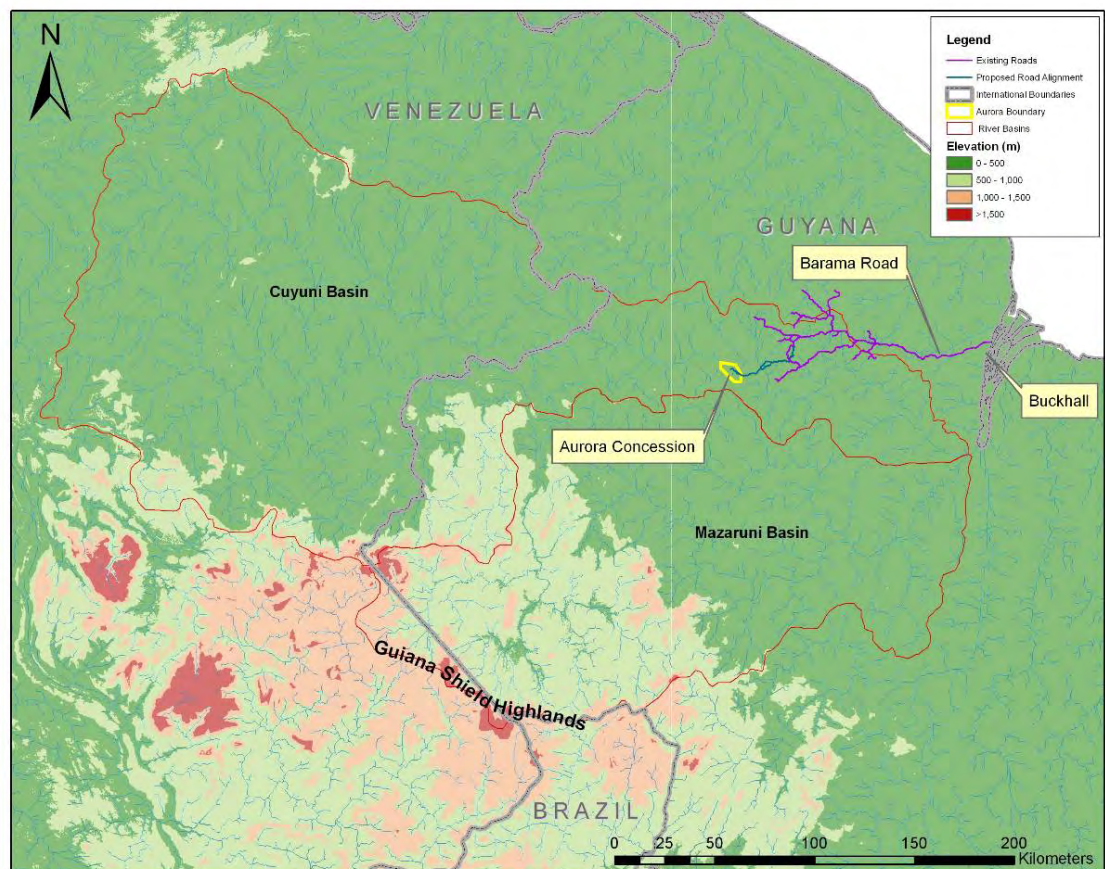
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## 5.1

## STUDY AREA AND SCOPE

The Environmental Baseline presents a characterization of the physical and biological environments within the Area of Influence of the Aurora Project. The biological environment section considers biodiversity in a regional context that includes the Area of Influence, as defined in *Section 1* of this report and the Landscape Area, the latter being defined as the lowlands (<500 masl<sup>1</sup>) of the Cuyuni and Mazaruni river basins (*Figure 5-1*). The biological assessment includes examination of the ecoregional and landscape contexts of the project as well as a site-specific assessment of the Aurora Concession.

*Figure 5-1. Regional Setting of the Aurora Concession within the Cuyuni and Mazaruni River Basins and in relation to the Guiana Shield Highlands.*



Source: ERM, 2009.

(1) Masl = meters above sea level.

## 5.2 *PHYSICAL ENVIRONMENT*

### 5.2.1 *Climate*

There are no long-term climate data available for the Aurora area. The closest historical station was located at Kamaria Falls on the Cuyuni River which is downstream of the Aurora concession. Daily rainfall and stream flow data from this station for the period 1971-1980 was reviewed to develop estimates of weather parameters prior to the commencement of detailed field monitoring at the mining concession. Data on evaporation and temperature for this station are not available.

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) within an area referred to as the Inter Tropical Convergence Zone (ITCZ). These factors result in seasonality of rainfall with a bimodal distribution. The maximum monthly rainfall recorded at Kamaria Falls was approximately 492 millimeters (mm), while the minimum monthly rainfall recorded over the same period was 10 mm. Formation of El Niño and La Niña weather patterns can disturb the regular location of the ITCZ and thus result in higher or lower than normal rainfall at specific locations. The El Niño/La Niña cycle is primarily responsible for inter-annual variation in rainfall. The maximum and minimum annual rainfall at Kamaria Falls for the period 1971-1980 was 2,710 and 1,956 mm, respectively.

An automated weather station was installed at the mining concession in June 2006 to collect baseline data, providing an automated record of minimum and maximum temperatures, total rainfall, rainfall rate, maximum and average wind speeds and directions, barometric pressure, humidity, solar radiation and several other parameters. Data has been collected at one-half hour intervals since installation in 2006. *Figures 5-2 through 5-5* are graphical representations of total daily rainfall, total daily evapotranspiration, daily solar radiation, and daily average wind speed for the period from June 2006 to February 2007.

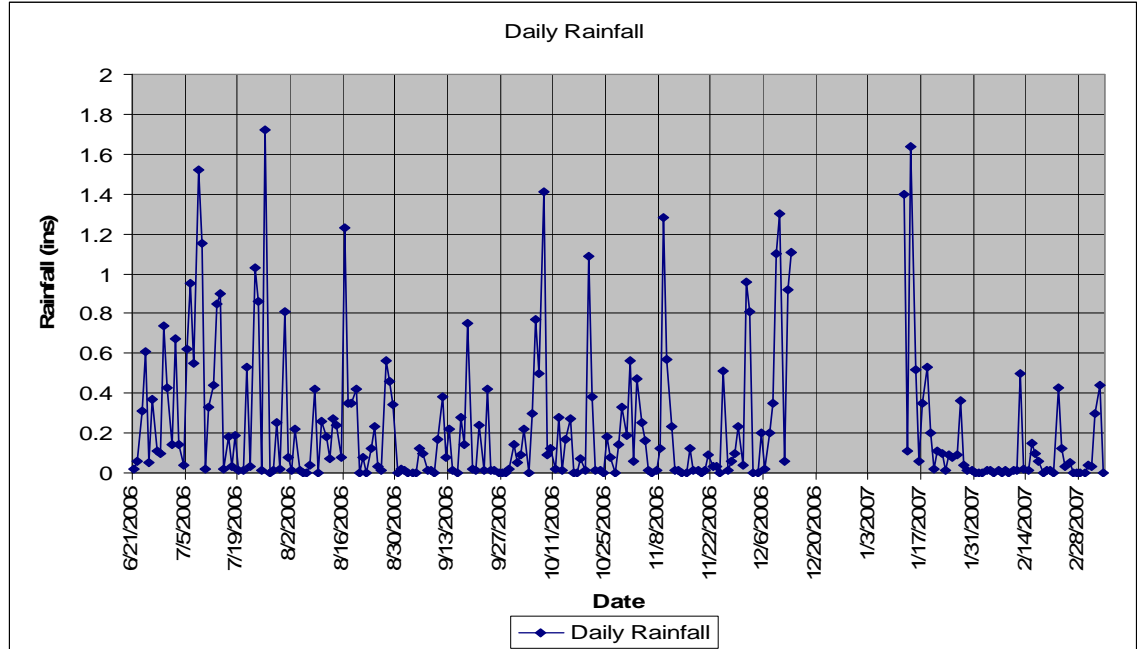


Figure 5-2 – Summary of Daily Rainfall at Aurora, June 2006-February 2007 (Source: GSEC, 2009)

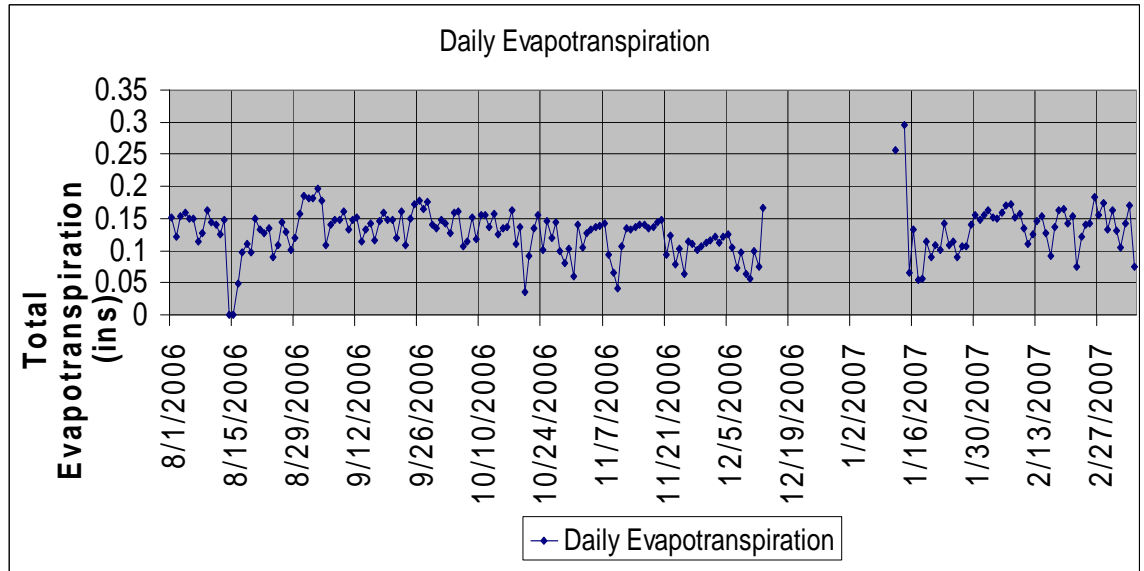


Figure 5-3 – Summary of Daily Evapotranspiration at Aurora, August 2006-February 2007 (Source: GSEC, 2009)

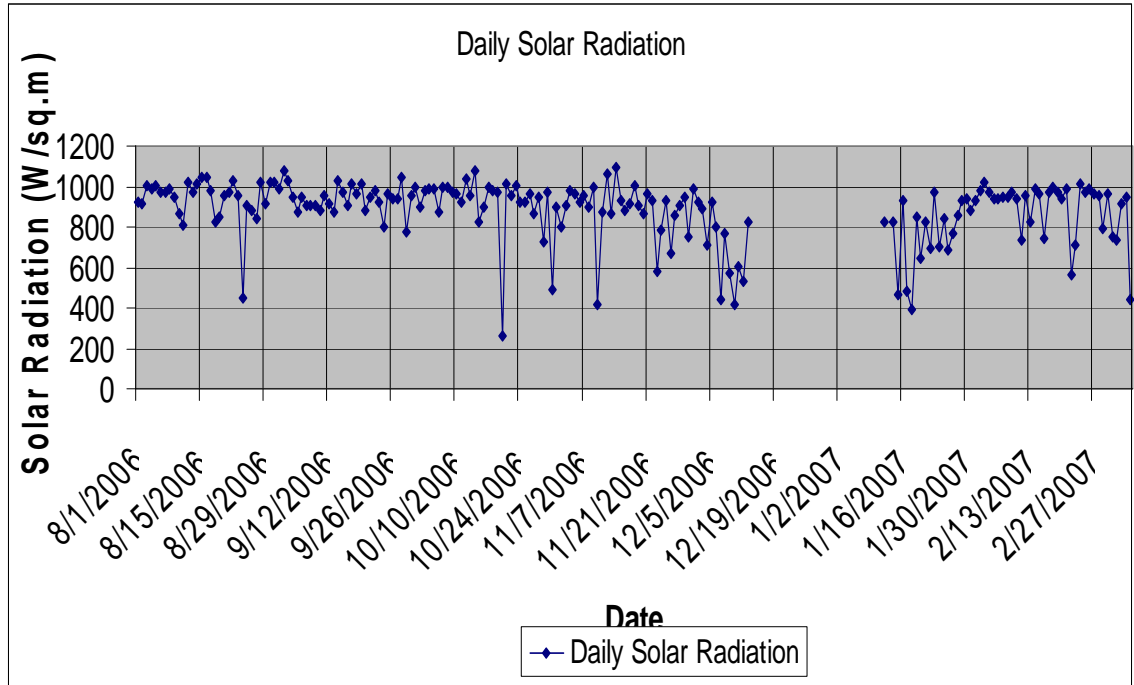


Figure 5-4 - Summary Of Daily Solar Radiation at Aurora, August 2006-February 2007 (Source: GSEC, 2009)

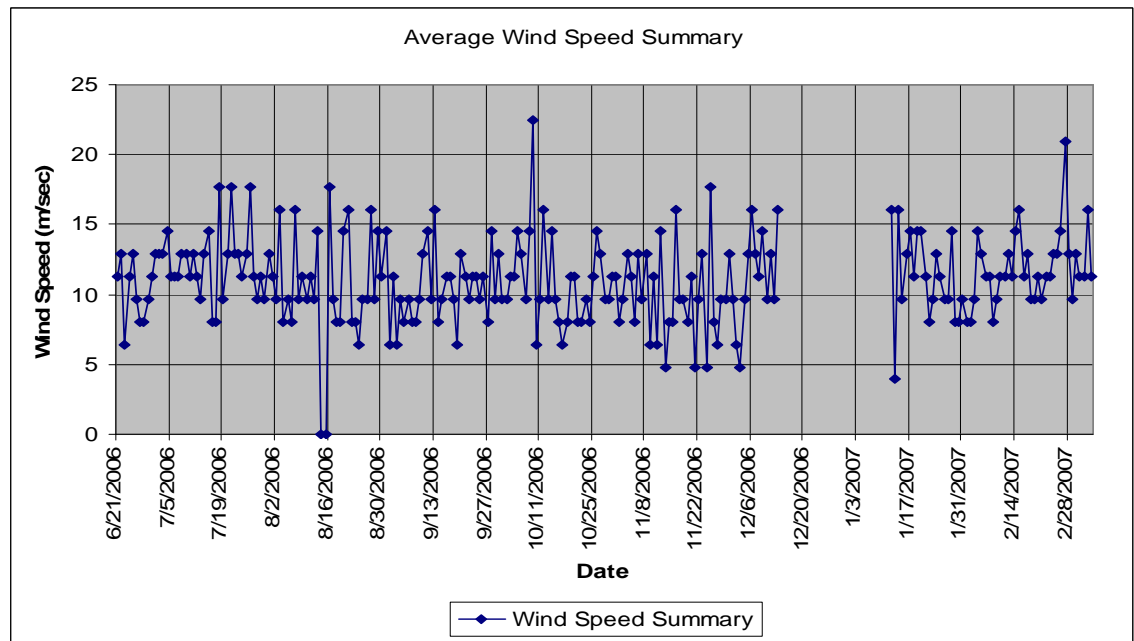


Figure 5-5 - Daily Wind Speed Summary at Aurora, June 2006-February 2007 (Source: GSEC, 2009)

The mining concession lies within the Precambrian Guiana Shield which extends across northern South America from east of the Andes to northeastern Brazil. The rocks in the concession area and its immediate vicinity can be classified into the three following units all of which appear to be of Precambrian age (Carter, 1963):

- Aurora Granite - Younger Granites;
- Cuyuni Formation - Barama-Mazaruni Assemblage; and
- Devil's Hole Gneisses.

The rocks of the Devil's Hole gneisses can be classified into two sets based on whether the rock are amphibole-rich or not. The sets are the (i) amphibolites and small basic bodies and (ii) the foliated biotite gneisses and minor quartzites. The foliated biotite gneisses and minor quartzites are comprised of a variety of rocks differing only slightly in composition and texture. Rocks of this unit are typically leucocratic with a foliation defined by aligned biotite. Hornblende may sometimes be present. Small basic bodies occurring in these rocks do not normally show an alignment of minerals though a later schistosity is often displayed. Locally, amphibole-rich bands are developed within the feldspar-rich rocks and here the banding is conformable with the dominant foliation direction. In the lower Labaria Creek, well foliated biotite gneisses are associated with very dense, fine-grained, amphibole-rich rocks which appear to represent former basic bodies in the gneisses. Here minor quartzites are also interbanded with the gneisses. Small bodies of gneissose biotite granites are also exposed, with biotite foliation again conformable with the regional foliation direction.

There are a minimum of three types of amphibolites and small basic bodies occurring in the area. The main development of these bodies exists in the Julian Ross Itabu above Haimaralli Falls. The hornblende-rich rocks in the Falls Creek area represent an extension of this main mass of amphibolites. The amphibolites in the northwestern portion of the Julian Ross Itabu area appear to be older than the mass exposed just above Falls Creek. The smaller lens-like bodies are considered to be of similar ages. The main amphibolites in Julian Ross Itabu consist of medium- to coarse-grained dark rocks composed essentially of hornblende and feldspars. This schistosity is usually restricted to narrow bands and therefore represent the effects of shearing. In both Falls Creek and Labaria Creek, the amphibolites display similar features and thus might be part of the same basic intrusive body. The contact between the biotite gneiss and this body of amphibolites is exposed in Julian Ross Itabu. Here the amphibolite becomes very fine grained and the contact between the two rock types runs generally north-south. The amphibolite in this vicinity is slightly sheared. At low water, the contact between the amphibolites and the gneisses is well exposed and can be

traced to the mouth of Labaria Creek. The main characteristic of this body of amphibolite is its lack of good orientation of amphibole crystals.

The Cuyuni Formation is a unit of rocks of great extent in the Cuyuni River area. The formation consists of laterally impersistent tongues predominantly of conglomerates, pebbly sandstones and porphyritic fine-grained igneous rocks. Some of the volcanic rocks in the Aurora Creek area carry abundant vesicles suggesting that they represent the tops of flows. Usually these fine-grained volcanic rocks are devoid of any observable schistosity. In thin section, all the rocks of the Cuyuni Formation display the characteristics of rocks subjected to a low grade of regional metamorphism approximately within the Greenschist facies. In most cases, the porphyritic volcanic flow rocks still preserve some original texture. These sometimes carry very large crystals of what was originally pyroxene set in very much finer-grained groundmass. Although the eight sided outlines of the pyroxenes remain unchanged, entire crystals have been replaced by an amphibole within the tremolite range of composition. Some original pyroxenes of the augite-aegerine group are still observable.

The Aurora Granite is an outcropping of granitic rocks immediately to the south of the former Aurora Gold Mine which forms a small copola intruding both the Cuyuni Formation and the Devil's Hole Gneisses. The rock is typically very leucocratic and in most instances it can be termed an aplite. Ferromagnesian are absent away from the margins or away from xenoliths. The granite often appears pinkish due to the color of feldspar and the quartz is usually smoky. In a few outcrops, particularly near to the former Aurora mine, the granite has a marked green appearance owing to chloritization of some of the feldspars. Typically, ferromagnesian are absent but a few patches of iron oxides are sometimes present. Quartz, orthoclase and microcline make up most of the rock but carbonates are sometimes prominent. The granite is often well strained as testified by the anomalous extinction of many minerals.

Close to the contacts between the granite and the Cuyuni Formation, shearing in both granite and sediments is usually well developed but there is seldom much reaction between the two rock types. The most characteristic feature of these contact areas is the presence of auriferous quartz veins in the sheared country rock. There is usually some reaction between the granite and the amphibole-rich rocks found to the south of Falls Creek. However, these effects are restricted to the regions close to the contacts. In places, the aplitic granite becomes rather rich in amphiboles and changes within a very short distance from an aplite into an amphibole-rich rock. At the contact between the granite and amphibolites, silicification is often well developed and granitic material is introduced as spots and seams in the amphibolite. Contact rocks have been observed in which granitic material pervades a rock which was dominantly amphibole rich. Some of the smaller creeks often flow between the contact of amphibolite and granite. In some

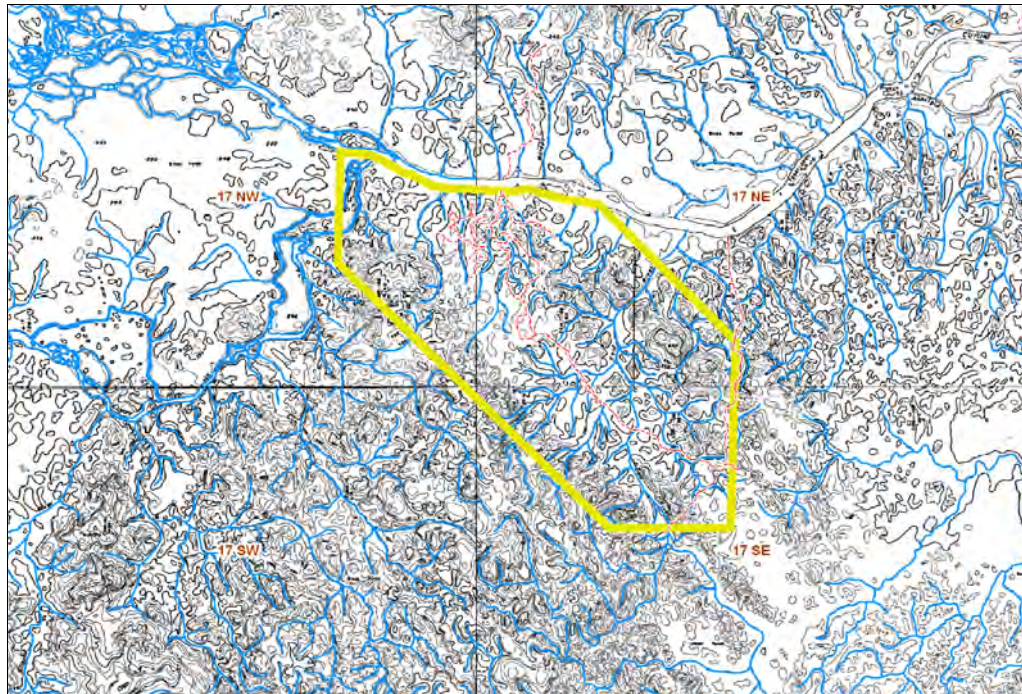
locations within Julian Ross Itabu, the contact between amphibolite and granite is sharp with little observable change within a few feet of the contact but in other places intense silicification is sometimes seen.

Most of the rocks occurring close to the granite margins have been intensely saussuritized and silicified. Here discrete patches rich in introduced quartzofeldspathic material are in evidence. In places highly altered plagioclases are replaced by large patches of quartz. Where saussuritization is well developed distinct crystals of epidote and zoisite are abundant. In the altered basic rocks near the granite margins tremolite, actinolite and hornblende are often abundant, usually associated with original pyroxene. As would be expected there is a diminishing of the effects away from the contacts with the granite. The plagioclase feldspars become less altered and the amount of introduced silica diminishes.

### 5.2.3 *Surface Hydrology*

The mine site area is drained by the Cuyuni River, which borders the site to the north, along with several associated tributaries, including the Gold River located to the east of the site. With a length of approximately 750 km, the Cuyuni River extends in a general west-east direction from its headwaters in Venezuela to the Essequibo River in Guyana. The basin covers an area of approximately 53,500 km<sup>2</sup> (AMEC, 2009). A hydrologic map showing the locations of the Cuyuni River and associated tributaries in relation to the project site is provided on *Figure 5-6*.

*Figure 5-6. Hydrologic map of the Aurora Concession (the polygon) and surrounding area.*



Source: Guyana Goldfields.

The portion of the site where surface and underground mining is planned (i.e., north-central portion of the concession near the Cuyuni River) has been partially cleared over the years to facilitate prior mining and exploratory drilling operations. Limited surface water runoff into the Cuyuni River is expected in this area. However, based on the presence of a thick forest canopy over much of the remaining portions of the site and general overall soil conditions, it is anticipated that infiltration of rainfall into the ground is a more significant process than storm water runoff into the Cuyuni River and its tributaries. As a result, flows within the streams and creeks traversing the site are more likely the result of groundwater discharge to surface water bodies than from surface water runoff.

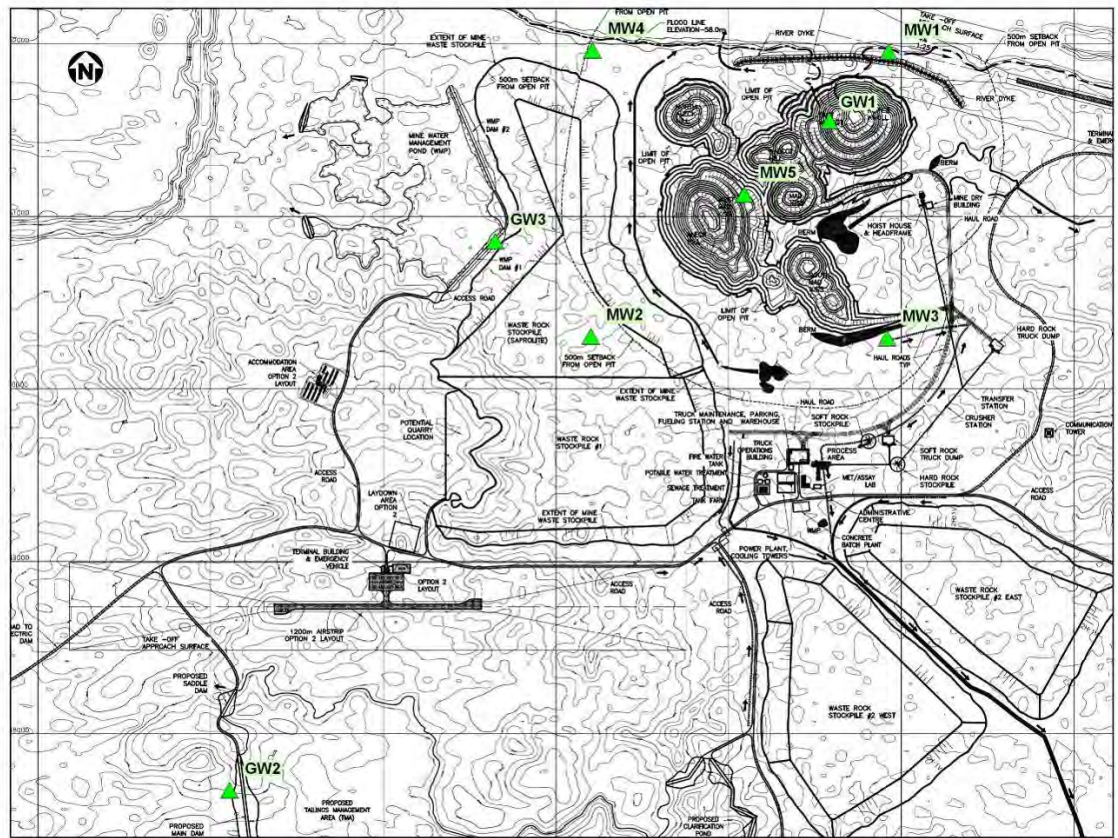
Historical daily flow records for the Cuyuni River are available for two hydrometric stations, referred to as Akarabisi and Kamaria Falls, which are separated by a distance of about 240 km and located along the Cuyuni River upstream and downstream of the site, respectively. Over the period in which readings were taken concurrently at both stations (i.e., 1967 to 1977), the mean annual flow at the upstream station (1,375 m<sup>3</sup>/s) exceeds the mean annual flow at the downstream station (1,259 m<sup>3</sup>/s). For some years, the mean annual flows at the upstream station exceed those at the downstream station by up to 40%. No specific explanations exist for this discrepancy based on the drainage pattern of the river basin. However, considering the low runoff coefficient implied by the downstream flow data, the mean annual flow data from the upstream station is

probably more representative of the actual flow conditions at the project site (AMEC, 2009).

## 5.2.4 Groundwater

Limited information is available regarding the local hydrogeology and groundwater conditions in the mining concession. A total of eight (8) groundwater monitoring wells are known to exist at the project site. The locations of the existing monitoring wells are illustrated in *Figure 5-7*.

*Figure 5-7. Groundwater monitoring well locations.*



Source: AMEC (Basemap) and ERM.

Installed in March 2006, five of the monitoring wells (MW-1 through MW-5) are located within an area referred to as the Golden Mile and extend to depths of approximately 6 m below grade (Guyana Goldfields, Inc., 2009). Monitoring wells were installed in 100-mm diameter borings and consist of 50-mm diameter PVC casing with 3 m of PVC No. 10 slotted screen surrounded by a sand pack. The geographic locations of these wells are as follows:

MW-1                      59°44.5'W, 6°47.7'N

MW-2	59°45.43'W, 6°46.8'N
MW-3	59°44.5'W, 6°46.8'N
MW-4	59°45.43'W, 6°47.7'N
MW-5	59°44.95'W, 6°47.25'N

During the feasibility studies conducted by AMEC, the approximate proposed footprints of the following facilities were established:

- River dike;
- Tailings management area; and,
- Water management pond.

Groundwater monitoring wells were installed below these areas to provide data on baseline groundwater quality. The groundwater monitoring wells in these areas were respectively designated as GW-1, GW-2 and GW-3 during the 2009 sampling event.

The monitoring wells sampled during 2009 were installed by drilling an NQ sized borehole to approximately 0.6m below the required depth of each well. The required depth of each well was based on the actual depth of the water table and the type of soils encountered. A sand bed was then placed in the lower 0.6 m of the borehole and a 3-m long 25-mm PVC No. 10 slotted screen was installed within the borehole annulus. The screen was then connected to a 25-mm diameter riser pipe which extended to 1 m above the ground surface. A sand pack was placed around the screen and was extended to a point approximately 0.6 m above the top of the screened interval. A bentonite/cement grout mix was then placed above this sand pack up to the ground level to prevent the migration of surface contaminants through the borehole annulus.

The depth to groundwater was measured in each well and recorded during the groundwater sampling activities. Clean dedicated bailers were used to collect groundwater samples from each well. In each instance, monitoring wells were purged of three volumes of standing water prior to sampling.

Based on groundwater monitoring conducted in 2006 and 2007, shallow groundwater exists within the unconsolidated overburden at depths ranging from approximately 1 to 4 m below grade. Groundwater level data for monitoring wells MW-1 through MW-5 along with monitoring dates are provided in *Table 5-1*. No information is provided regarding whether these monitoring wells have been surveyed to obtain relative well elevations. As a result, groundwater flow directions and gradients are not known at this time.

**Table 5-1. Depth to Groundwater (m)**

Well No.	January - February 2006	July 2006	October 2006	February - March 2007
MW-1	2.44	2.18	2.90	3.25
MW-2	2.15	1.09	3.10	3.52
MW-3	Dry	1.96	2.95	3.38
MW-4	Dry	2.03	3.15	3.76
MW-5	2.44	1.07	2.62	3.08

Source: Guyana Goldfields, Inc., 2009

Rising head in-situ hydraulic conductivity tests were also conducted in each of these wells during the 2006 and 2007 groundwater monitoring events. Based on the results of the aquifer testing, hydraulic conductivities range from  $3.49 \times 10^{-7}$  to  $8.36 \times 10^{-5}$  cm/s (AMEC, 2009). A summary of the hydraulic conductivities for each monitoring well is provided in Table 5-2.

**Table 5-2. Summary of Hydraulic Conductivities (cm/s)**

Well No.	January - February 2006	July 2006	October 2006	February - March 2007
MW-1	$7.9 \times 10^{-6}$	$1.34 \times 10^{-6}$	$5.3 \times 10^{-6}$	$3.8 \times 10^{-6}$
MW-2	$8.36 \times 10^{-5}$	$4.70 \times 10^{-7}$	$1.44 \times 10^{-5}$	$8.76 \times 10^{-6}$
MW-3	$1.35 \times 10^{-5}$ (Falling Head)	$9.28 \times 10^{-7}$	$6.8 \times 10^{-6}$	$3.8 \times 10^{-6}$
MW-4	$2.18 \times 10^{-5}$ (Falling Head)	$3.49 \times 10^{-7}$	$6.3 \times 10^{-6}$	$4.8 \times 10^{-6}$
MW-5	$9.7 \times 10^{-6}$	$2.71 \times 10^{-6}$	$1.5 \times 10^{-5}$	$9.7 \times 10^{-6}$

Source: Guyana Goldfields, Inc., 2009

As part of the conceptual design for the pit dewatering systems, seepage into the proposed open pit mine was estimated using a three-dimensional (3D) groundwater flow model (MODFLOW) that assumed inflow into the pits from three potential sources (i.e., groundwater flow from adjoining bedrock, leakage from saturated overburden/saprolite induced by the pit dewatering activities, and groundwater flow from the Cuyuni River under a losing stream scenario). The model assumed steady-state conditions, corresponding to long-term stabilized groundwater flow into a fully developed pit (AMEC, 2009).

Based on the modeling results, the estimated seepage rates into the open pit were approximately 4,000 m<sup>3</sup>/d under the base case scenario (i.e., assuming a bulk hydraulic conductivity of  $2 \times 10^{-4}$  cm/s) and about 14,000 m<sup>3</sup>/d under the simulated conservative scenario (i.e., assuming a bulk hydraulic conductivity of  $1 \times 10^{-3}$  cm/s). The estimated groundwater inflow to the proposed Rory's Knoll

underground mine workings (i.e., shaft, drifts, ramp and stopes) increases the predicted seepage rate by approximately 2,000 m<sup>3</sup>/d. Based on these estimates, the total seepage rate is expected to range from about 6,000 m<sup>3</sup>/d (base case scenario) to 16,000 m<sup>3</sup>/d (conservative scenario) (AMEC, 2009).

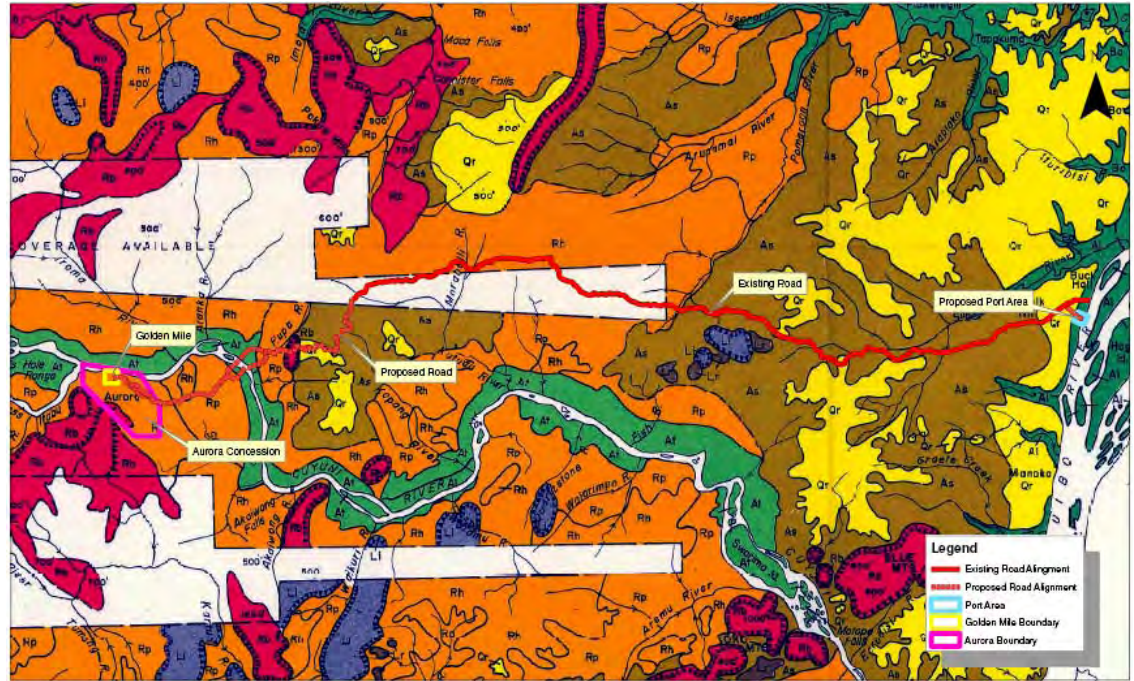
### 5.2.5 *Soils and Geomorphology*

The Indirect Area of Influence is largely undulating to hilly, with flat areas along the floodplain of the Cuyuni River. The elevation at Buckhall on the Essequibo River is only 10 meters above sea level (masl) and the Aurora Mine area on the Cuyuni River is located at an elevation of about 80 masl. The highest hill in the Aurora Concession has an elevation of approximately 200 masl.

The native soils of the proposed mine site, along the access road, and at the Buckhall Port area consist of residual material derived from weathered acidic crystalline rocks (i.e., granite, schist, dolerite, granodiorite, and phyllite), alluvial sediments derived from stratified and unconsolidated deposits of sand, silts, and clays. In the upland areas, the soils consist of deep, well-drained, yellow and reddish-brown sandy clay loams and gravelly clays. In the riverine and alluvial fan areas, the soils are also deep but range from poorly- to excessively well-drained brown to white clay loams and sands (Braun and Derting, 1964).

The soil types on the proposed project site include seven soil map units (see *Figure 5-8*). *Table 5-3* summarizes the major characteristics of the soil types.

Figure 5-8. Soil types within the Aurora Mine Area of Influence (See Table 5-3 below for description of soil types).



Source: Soils map from Braun and Dertin (1964).

Table 5-3. Major Characteristics of Soil Types Found on the Project Site

Major Characteristics of Soil Types Found on the Project Site				
Soil Map Unit	Soil Association Characteristics	Geomorphology/Landform	Parent Material	Land Capability Classification*
<b>Mine (Aurora Concession)</b>				
Rh	Deep, dominantly well drained, yellow and brown, sandy clay loam, clay, and gravelly clay-soils (red-yellow soils). Shallow, excessively drained, sandy loam and silt loam soils with occasional	Hilly to steep residual uplands.	Deeply, weathered, residual, acidic crystalline rocks, such as granite, schist, phyllite, and granodiorite.	III

**Major Characteristics of Soil Types Found on the Project Site**

<b>Soil Map Unit</b>	<b>Soil Association Characteristics</b>	<b>Geomorphology/Landform</b>	<b>Parent Material</b>	<b>Land Capability Classification*</b>
	gravel.			
Rb	Deep, well drained, brown, and red gravelly clay and clay soils (reddish-brown lateritic soils).	Step to hilly, hills and mountains.	Deeply weathered, residual, basic rocks (dolerite and amphibolite).	III
<b>Access Road</b>				
Rh	Deep, dominantly well drained, yellow and brown, sandy clay loam, clay, and gravelly clay-soils (red-yellow soils). Shallow, excessively drained, sandy loam and silt loam soils with occasional gravel.	Hilly to steep residual uplands.	Deeply weathered, residual, acidic crystalline rocks, such as granite, schist, phyllite, and granodiorite.	III
Rp	Deep, dominantly well drained, yellow and brown, sandy clay loam, clay and gravelly clay soils (red-yellow soils). Poorly drained, silty and clayey soils (low-humic gleyed soils).	Rolling pedimentry and residual uplands.	Unconsolidated pedimentary and alluvial deposits and residual materials derived from deeply weathered acid crystalline rocks (granite, schist, and phyllite).	I - II
At	Association of	Level to gently	Stratified,	I - II

**Major Characteristics of Soil Types Found on the Project Site**

<b>Soil Map Unit</b>	<b>Soil Association Characteristics</b>	<b>Geomorphology/ Landform</b>	<b>Parent Material</b>	<b>Land Capability Classification*</b>
	deep, dominantly poorly and moderately well drained, grey and brown silty and sandy soils. Excessively drained white sand and well drained sandy clay loam.	sloping river alluvium and terrace.	unconsolidated, recent and subrecent deposits of sand, silt, and clay.	
As	Association of deep, dominantly well drained, yellow and brown sandy clay loam and clay soils (red-yellow soils). Excessively drained brown and white sands, and shallow sandy loam soils.	Sloping to hilly dissected white sand plateau with crystalline exposures.	Stratified, unconsolidated, sandy deposits and residual acidic materials.	I - II
Qr	Deep, excessively or poorly drained white sand soils.	Gently sloping to sloping white sand plateau.	Stratified, unconsolidated, white quartz sand deposits.	IV
<b>Wharf / Dock</b>				
Qr	Deep, excessively or poorly drained white sand soils.	Gently sloping to sloping white sand plateau.	Stratified, unconsolidated, white quartz sand deposits.	IV
Al	Association of	Nearly level to	Stratified,	I - II

**Major Characteristics of Soil Types Found on the Project Site**

<b>Soil Map Unit</b>	<b>Soil Association Characteristics</b>	<b>Geomorphology/Landform</b>	<b>Parent Material</b>	<b>Land Capability Classification*</b>
	deep, grey and brown, poorly drained, clayey, silty and sandy soils (low-humic gleyed soils).	level river alluvium.	unconsolidated, recent alluvial deposits of silt, clay, and sand.	

Source: Environmental Resource Management, Inc. 2009 after Braun and Derting, 1964.

*\*Land Capability Classification: I - II = Good to moderate agricultural land (no to moderate limitations for general agricultural use); III = Poor agricultural land (severe limitations for general agricultural use); and IV = Nonagricultural land (very severe limitations for agricultural use).*

**5.2.6 Environmental Quality (Air, Noise, Water)**

**5.2.6.1 Air Quality**

There are no major industries in the area. Emissions in the project area are directly related to the emission of gases by rotting trees and other vegetative matter. Some aerial emissions are also related to the operation of dredges in the vicinity of the mining concession and from exploration equipment.

Airborne discharges and particulate matter have not been monitored in the area. However, IFC EHS guidelines for sulfur 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. Neither criterion was expected to be exceeded by current aerial emissions.

There were no settlements with significant fixed or mobile sources of atmospheric emissions in the area surrounding the Aurora Concession. The existing prospecting activities in the concession involve the use of ATVs, drill rigs, and generators. Fires were rare in the region, as there was almost no burning for agriculture or livestock in the region. Dust levels in the prospecting areas and along trails were low due to the high humidity and frequent rainfalls.

**5.2.6.2 Noise**

The baseline acoustic environment was affected by exploration and prospecting activities in the proposed mining areas. Generators and drilling activities generate noise 24 hours a day. Vehicle traffic was limited primarily to ATVs and a few larger tractors.

Motorized boat traffic on the Cuyuni River creates occasional noise events several times each day. Commercial aircraft rarely fly over the Area of Influence, except for planes serving the Aurora Camp.

During daylight hours, most of the forested areas was affected by the calls of various birds, especially the raucous red-throated caracara and the ubiquitous screaming piha. Nocturnal noise in the forest is generated primarily by insects and frogs.

### 5.2.6.3 *Surface Water Quality*

Surface water quality within the Cuyuni River has been impacted historically by upstream artisanal and small scale mining (ASM) activities, particularly in Venezuela. Mercury contamination of surface water, sediments, and fish has been documented in both the Cuyuni and Mazaruni river basins. The ASM activities have increased surface water turbidity and concentrations of suspended solids in the Cuyuni River and its tributaries.

In 2006 and 2007, surface water samples were collected from locations on the Cuyuni River, Gold River and from an unnamed tributary of the Cuyuni River immediately downstream of Devil's Hole. The sampling was conducted at times coincident with the four seasons in Guyana. The unnamed tributary of the Cuyuni River and Gold River are upstream and downstream of the project area, respectively. Cuyuni River samples were collected immediately north of the area identified as the Golden Mile. Surface water samples from the unnamed tributary are consequently indicative of background water quality for the project site. Surface water samples from both Gold River and Cuyuni River would be indicative of baseline water quality prior to the commencement of mining operations.

The surface water sampling results are provided in *Tables 5-4 through 5-7*. IFC EHS Guideline for Mining standards<sup>2</sup> for effluent from mining operations are also presented in the table for comparison purposes. Concentrations are provided in milligrams per liter (mg/L) unless specified otherwise.

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(2) Standards obtained from IFC/World Bank *Environmental, Health and Safety Guidelines for Mining*, December 10, 2007.

*Table 5-4. Surface Water Analytical Results, February 10, 2006*

Parameter	Units	Unnamed Creek	Cuyuni River	Gold River	IFC EHS Guideline for Mining Standards
Biochemical Oxygen Demand	mg/L	< 1	< 1	< 1	50
Cyanide (free)	mg/L	< 0.005	< 0.005	< 0.005	0.1
Cyanide (total)	mg/L	< 0.005	< 0.005	< 0.005	1
pH		7.23	7.3	7.63	6 to 9
Total Suspended Solids	mg/L	21	27	13	50
Arsenic	mg/L	< 0.001	< 0.001	< 0.001	0.1
Cadmium	mg/L	< 0.0001	< 0.0001	< 0.0001	0.05
Chromium	mg/L	< 0.001	0.002	0.001	NA
Copper	mg/L	< 0.001	< 0.001	< 0.001	0.3
Hexavalent Chromium	mg/L	< 0.05	< 0.05	< 0.05	0.1
Iron, Total	mg/L	1.65	9.11	3.08	2
Lead	mg/L	< 0.001	< 0.001	< 0.001	0.2
Mercury	mg/L	< 0.0001	< 0.0001	< 0.0001	0.002
Nickel	mg/L	< 0.005	< 0.005	< 0.005	0.5
Zinc	mg/L	0.01	0.01	< 0.01	0.5
Oil and Grease, Mineral	mg/L	< 1.0	< 1.0	< 1.0	NA
Oil and Grease, Non-Mineral	mg/L	< 4.0	< 4.0	< 4.0	NA
Oil and Grease, Total	mg/L	< 5.0	< 5.0	< 5.0	10

*Table 5-5. Surface Water Analytical Results, July 6, 2006*

Parameter	Units	Unnamed Creek	Cuyuni River	Gold River	IFC EHS Guideline for Mining Standards
Biochemical Oxygen Demand	mg/L	1	< 1	< 1	50
Cyanide (free)	mg/L	0.005	< 0.005	< 0.005	0.1
Cyanide (total)	mg/L	0.005	< 0.005	< 0.005	1
pH		--	7.38	7.48	6 to 9
Total Suspended Solids	mg/L	2	32	45	50
Arsenic	mg/L	0.001	< 0.001	< 0.001	0.1
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	0.05
Chromium	mg/L	0.001	< 0.001	0.002	NA
Copper	mg/L	0.001	< 0.001	< 0.001	0.3
Hexavalent Chromium	mg/L	0.05	< 0.05	< 0.05	0.1
Iron, Total	mg/L	0.03	2.01	8.67	2
Lead	mg/L	0.001	< 0.001	< 0.001	0.2
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	0.002

Nickel	mg/L	0.005	< 0.005	< 0.005	0.5
Zinc	mg/L	0.01	<0.01	<0.01	0.5
Oil and Grease, Mineral	mg/L	1	< 1.0	< 1.0	NA
Oil and Grease, Non-Mineral	mg/L	4	< 4.0	< 4.0	NA
Oil and Grease, Total	mg/L	1	< 1	< 1	10

*Table 5-6. Surface Water Analytical Results, October 12, 2006*

Parameter	Units	Unnamed Creek	Cuyuni River	Gold River	IFC EHS Guideline for Mining Standards
Biochemical Oxygen Demand	mg/L	<1	<1	<1	50
Cyanide (free)	mg/L	0.011	0.008	0.009	0.1
Cyanide (total)	mg/L	--	--	--	1
pH		6.63	6.49	6.42	6 to 9
Total Suspended Solids	mg/L	44	17	37	50
Arsenic	mg/L	<0.001	<0.001	<0.001	0.1
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	0.05
Chromium	mg/L	0.002	0.003	0.003	NA
Copper	mg/L	0.002	0.002	0.002	0.3
Hexavalent Chromium	mg/L	<0.05	<0.05	<0.05	0.1
Iron, Total	mg/L	0.50	0.55	0.68	2
Lead	mg/L	<0.001	<0.001	<0.001	0.2
Mercury	mg/L	<0.0001	<0.0001	<0.0001	0.002
Nickel	mg/L	<0.005	<0.005	<0.005	0.5
Zinc	mg/L	<0.01	<0.01	<0.01	0.5
Oil and Grease, Mineral	mg/L	<1	<1	<1	NA
Oil and Grease, Non-Mineral	mg/L	<4	<4	<4	NA
Oil and Grease, Total	mg/L	<5	<5	<5	10

*Table 5-7. Surface Water Analytical Results, March 4, 2007*

Parameter	Units	Unnamed Creek	Cuyuni River	Gold River	IFC EHS Guideline for Mining Standards
Biochemical Oxygen Demand	mg/L	1	1	1	50
Cyanide (free)	mg/L	<0.25	<0.25	<0.25	0.1
Cyanide (total)	mg/L	<0.25	<0.25	<0.25	1
pH		7.27	7.41	7.25	6 to 9
Total Suspended Solids	mg/L	37	24	18	50
Arsenic	mg/L	<0.001	<0.001	<0.001	0.1
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	0.05
Chromium	mg/L	0.001	0.003	0.001	NA

Copper	mg/L	0.003	0.003	0.001	0.3
Hexavalent Chromium	mg/L	<0.05	<0.05	<0.05	0.1
Iron, Total	mg/L	1.00	2.14	2.57	2
Lead	mg/L	<0.001	<0.001	<0.001	0.2
Mercury	mg/L	<0.0001	<0.0001	<0.0001	0.002
Nickel	mg/L	<0.005	<0.005	<0.005	0.5
Zinc	mg/L	<0.01	<0.01	<0.01	0.5
Oil and Grease, Mineral	mg/L	<1	<1	<1	NA
Oil and Grease, Non-Mineral	mg/L	<4	<4	<4	NA
Oil and Grease, Total	mg/L	<5	<5	<5	10

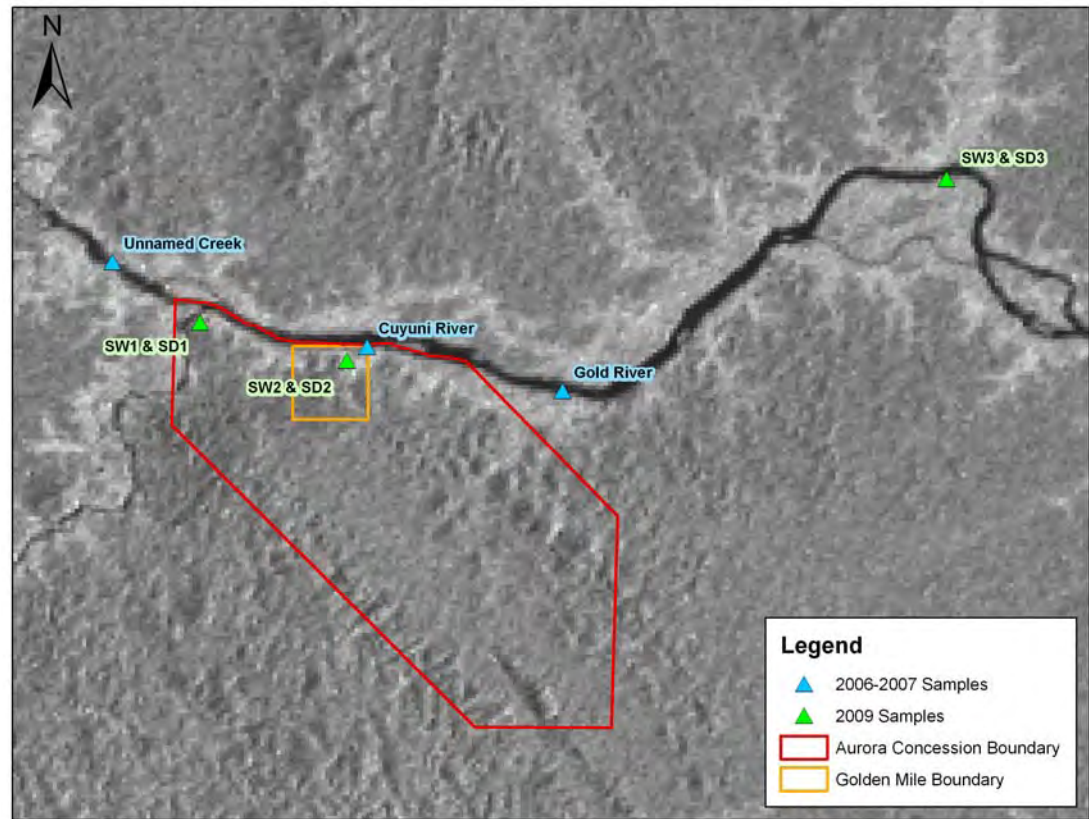
As shown in *Tables 5-4 through 5-7*, total iron is the only parameter that exceeded the standards. Total iron concentrations ranged from 0.5 to 9.11 mg/L.

In 2009, additional surface water and sediment sampling was conducted along the Cuyuni River to assess baseline surface water and sediment quality conditions. The samples were collected from the following locations:

- SW1/SD1 – Collected from the Julian Ross Itabu, approximately 500 m upstream of the Cuyuni River, upstream of the project site (E193105, N752493);
- SW2/SD2 – Collected in the vicinity of the Aurora Camp at the project site (E196438, N751628); and,
- SW3/SD3 – Collected in the vicinity of the mouth of Aranka Creek downstream of the project site (E210060, N755738).

Surface water and sediment sampling locations from 2009 are provided on *Figure 5-9*. Surface water and sediment analytical results from 2009 are provided in *Tables 5-8 and 5-9*. Surface water sampling results were compared to available IFC EHS standards. No IFC EHS Guidelines standards exist for sediment.

Figure 5-9. 2006-2007 and 2009 surface water and sediment sampling locations.



Source: ERM.

Table 5-8. 2009 Surface Water Analytical Results

Parameter	Units	SW1	SW2	SW3	IFC EHS Guideline for Mining Standards
Alkalinity as CaCO <sub>3</sub>	mg/L	7	12	11	NA
Chloride	mg/L	3	4	5	NA
Conductivity	uS/cm	25	26	28	NA
Cyanide (free)	mg/L	<0.10	<0.10	<0.10	0.1
Cyanide (total)	mg/L	<0.10	<0.10	<0.10	1
Fluoride	mg/L	<0.10	<0.10	<0.10	NA
N-NO <sub>2</sub> (Nitrite)	mg/L	<0.10	<0.10	<0.10	NA
N-NO <sub>3</sub> (Nitrate)	mg/L	0.11	0.13	0.13	NA
pH		6.93	6.72	6.74	6 to 9
Phenols	mg/L	<0.001	<0.001	<0.001	0.5
Sulphate	mg/L	<1	<1	<1	NA
Total Dissolved Solids (COND - CALC)	mg/L	16	17	18	NA
Total Kjeldahl Nitrogen	mg/L	0.55	0.52	0.33	NA

Total Phosphorus	mg/L	0.05	<0.1	0.35	NA
Total Suspended Solids	mg/L	22	50	264	50
Turbidity	NTU	46.0	67.4	>100	NA
HCO <sub>3</sub> as CaCO <sub>3</sub>	mg/L	7	12	11	NA
Calcium	mg/L	1	1	2	NA
Magnesium	mg/L	<1	<1	<1	NA
Potassium	mg/L	<1	<1	<1	NA
Sodium	mg/L	<2	<2	2	NA
Aluminum	mg/L	2.3	3.5	4.1	NA
Antimony	mg/L	<0.01	<0.01	<0.01	NA
Arsenic	mg/L	<0.05	<0.05	<0.05	0.1
Barium	mg/L	0.85	0.03	0.03	NA
Beryllium	mg/L	<0.01	<0.01	<0.01	NA
Boron	mg/L	<0.1	<0.1	<0.1	NA
Cadmium	mg/L	<0.01	<0.01	<0.01	0.05
Chromium	mg/L	<0.02	<0.02	<0.02	NA
Cobalt	mg/L	<0.005	<0.005	<0.005	NA
Copper	mg/L	<0.01	<0.01	0.02	0.3
Iron	mg/L	2.4	3.8	4.0	2
Lead	mg/L	<0.01	<0.01	<0.01	0.2
Manganese	mg/L	0.03	0.05	0.08	NA
Mercury	mg/L	<0.0001	<0.0001	<0.0001	0.002
Molybdenum	mg/L	<0.01	<0.01	<0.01	NA
Nickel	mg/L	<0.01	<0.01	<0.01	0.5
Selenium	mg/L	<0.05	<0.05	<0.05	NA
Silicon	mg/L	<1	<1	<1	NA
Silver	mg/L	<0.01	<0.01	<0.01	NA
Strontium	mg/L	<0.05	<0.05	<0.05	NA
Thallium	mg/L	<0.01	<0.01	<0.01	NA
Titanium	mg/L	<0.1	<0.1	<0.1	NA
Vanadium	mg/L	<0.05	<0.05	<0.05	NA
Zinc	mg/L	<0.05	<0.05	<0.05	0.5
Oil & Grease - Mineral	mg/L	<1	<1	<1	NA
Oil & Grease - Non-mineral	mg/L	<1	11	<1	NA
Oil & Grease - Total	mg/L	<1	11	<1	10

Table 5-9. 2009 Sediment Analytical Results

Parameter	Units	SD1	SD2	SD3
Cyanide (free)	µg/g	0.28	0.27	0.17
Loss on Ignition (@550C)	%	9.45	7.58	6.68
Total Organic Carbon	%	1.57	1.35	2.05
Calcium	µg/g	2020	1090	1070
Magnesium	µg/g	1140	741	344
Potassium	µg/g	300	207	222
Sodium	µg/g	<100	<100	122

Aluminum	µg/g	20400	16100	7010
Antimony	µg/g	<1	<1	<1
Arsenic	µg/g	<1.0	1.0	2.1
Barium	µg/g	88	69	47
Beryllium	µg/g	<1	<1	<1
Cadmium	µg/g	<0.5	<0.5	<0.5
Chromium	µg/g	87	71	74
Cobalt	µg/g	14	12	14
Copper	µg/g	21	18	49
Iron	µg/g	26000	23600	24300
Lead	µg/g	10	10	5
Manganese	µg/g	203	180	385
Mercury	µg/g	0.2	0.2	0.1
Molybdenum	µg/g	<1	<1	<1
Nickel	µg/g	20	15	8
Selenium	µg/g	<1	<1	<1
Silver	µg/g	<0.2	<0.2	<0.2
Strontium	µg/g	9	6	6
Thallium	µg/g	<1	<1	<1
Vanadium	µg/g	95	80	66
Zinc	µg/g	44	36	27
Oil & Grease - Mineral	µg/g	<100	<100	<100
Oil & Grease - Non-mineral	µg/g	580	<100	<100
Oil & Grease - Total	µg/g	580	<100	<100

As shown in *Table 5-8*, total suspended solids, iron, and oil and grease were detected in surface water samples at concentrations above the IFC standards. The detection of oil and grease at elevated levels in sample SW2 could be attributed to residual petroleum hydrocarbon impacts from the former gold exploration and drilling operations at the Aurora Camp.

#### 5.2.6.4 *Groundwater Quality*

In 2006 and 2007, groundwater sampling of monitoring wells MW-1 through MW-5 was conducted on a quarterly basis to assess seasonal variations in groundwater quality. During each sampling event, the depth to groundwater was measured in each well prior to the start of well purging activities. Clean and dedicated bailers were used to purge and sample each well. As part of sampling, approximately one well volume was purged from each well due to limited well yields and slow groundwater recovery as a result of the relatively impervious geologic conditions. Unfiltered groundwater samples were collected in accordance with procedures outlined in the USEPA RCRA Groundwater Monitoring Technical Enforcement Guidance Document. During the initial sampling period, no groundwater samples were collected from MW-3 and MW-4 since those wells were dry at the time of sampling.

The groundwater sampling results are provided in *Tables 5-10* through *5-13*. Guideline values published by the World Health Organization<sup>3</sup> for various chemicals are also presented in the table for comparison purposes. Concentrations are provided in milligrams per liter (mg/L) unless otherwise specified.

**Table 5-10. Groundwater Analytical Results, February 10, 2006**

Parameter	Units	MW-1	MW-2	MW-3	MW-4	MW-5	WHO Guideline Value
Biochemical Oxygen Demand	mg/L	< 1	10	--	--	--	NA
Cyanide (free)	mg/L	< 0.025	< 0.025	--	--	< 0.25	NA
Cyanide (total)	mg/L	< 0.025	< 0.025	--	--	< 0.025	0.07
pH		6.22	5.48	--	--	7.01	NA
Total Suspended Solids	mg/L	41,600	73,700	--	--	19,200	NA
Arsenic	mg/L	< 0.01	< 0.01	--	--	< 0.01	0.01
Cadmium	mg/L	0.005	0.008	--	--	< 0.001	0.003
Chromium	mg/L	0.025	0.048	--	--	0.012	0.05
Copper	mg/L	0.27	0.21	--	--	0.07	2
Hexavalent Chromium	mg/L	< 0.05	< 0.05	--	--	< 0.05	NA
Iron, Total	mg/L	19.9	245	--	--	6.7	NA
Lead	mg/L	0.07	0.06	--	--	0.02	0.01
Mercury	mg/L	< 0.0001	< 0.0001	--	--	< 0.0001	0.006
Nickel	mg/L	0.14	0.26	--	--	< 0.05	0.07
Zinc	mg/L	2.98	3.93	--	--	0.3	NA
Oil and Grease, Mineral	mg/L	< 1.0	< 1.0	--	--	6	NA
Oil and Grease, Non-Mineral	mg/L	< 4.0	< 4.0	--	--	4	NA
Oil and Grease, Total	mg/L	< 5.0	< 5.0	--	--	10	NA

(3) World Health Organization, *Guidelines for Drinking-water Quality Incorporating First and Second Addenda to Third Edition, Volume 1, Recommendations*, 2006.

*Table 5-11. Groundwater Analytical Result, July 6, 2006*

Parameter	Units	MW-1	MW-2	MW-3	MW-4	MW-5	WHO Guideline Value
Biochemical Oxygen Demand	mg/L	< 1	10	<1	1	46	NA
Cyanide (free)	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	NA
Cyanide (total)	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	0.07
pH		6.75	5.76	4.64	5.48	6.41	NA
Total Suspended Solids	mg/L	6432	7870	6930	15100	6110	NA
Arsenic	mg/L	< 0.001	< 0.001	<0.001	<0.001	<0.001	0.01
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.003
Chromium	mg/L	0.012	0.004	0.005	0.006	0.002	0.05
Copper	mg/L	0.29	0.27	0.007	0.004	<0.001	2
Hexavalent Chromium	mg/L	< 0.05	< 0.05	<0.05	<0.05	<0.05	NA
Iron, Total	mg/L	21.8	262	0.73	0.86	1.45	NA
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
Mercury	mg/L	< 0.0001	< 0.0001	<0.0001	<0.0001	<0.0001	0.006
Nickel	mg/L	0.18	0.32	0.005	<0.005	<0.005	0.07
Zinc	mg/L	3.03	3.28	0.02	0.01	<0.01	NA
Oil and Grease, Mineral	mg/L	< 1.0	< 1.0	<1	<1	3	NA
Oil and Grease, Non-Mineral	mg/L	< 4.0	< 4.0	<4	<4	<4	NA
Oil and Grease, Total	mg/L	< 5.0	< 5.0	<5	<5	<5	NA

*Table 5-12. Groundwater Analytical Results, October 12, 2006*

Parameter	Units	MW-1	MW-2	MW-3	MW-4	MW-5	WHO Guideline Value
Biochemical Oxygen Demand	mg/L	<1	<1	<1	<1	5	NA
Cyanide (free)	mg/L	0.015	0.007	0.19	0.385	0.014	NA
Cyanide (total)	mg/L	--	--	--	--	--	0.07
pH		5.85	6.23	5.56	5.35	6.43	NA
Total Suspended Solids	mg/L	633	10	8320	27500	2700	NA
Arsenic	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
Cadmium	mg/L	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	0.003
Chromium	mg/L	0.002	0.002	0.008	0.008	0.001	0.05
Copper	mg/L	0.001	0.002	0.008	0.007	0.002	2
Hexavalent Chromium	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	NA
Iron, Total	mg/L	0.27	0.54	1.36	0.79	1.49	NA
Lead	mg/L	<0.001	<0.001	0.001	<0.001	<0.001	0.01
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.006
Nickel	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	0.07

Zinc	mg/L	0.01	<0.01	0.03	0.02	<0.01	NA
Oil and Grease, Mineral	mg/L	3	--	<1	<1	<1	NA
Oil and Grease, Non-Mineral	mg/L	4	--	<4	<4	4	NA
Oil and Grease, Total	mg/L	7	--	<5	<5	<5	NA

*Table 5-13. Groundwater Analytical Results, March 4, 2007*

Parameter	Units	MW-1	MW-2	MW-3	MW-4	MW-5	WHO Guideline Value
Biochemical Oxygen Demand	mg/L	2	<1	<1	<1	7	NA
Cyanide (free)	mg/L	<0.25	<0.25	<0.5	<0.5	<0.25	NA
Cyanide (total)	mg/L	<0.25	<0.25	<0.5	<0.5	<0.25	0.07
pH		7.31	7.06	6.15	6.58	6.87	NA
Total Suspended Solids	mg/L	19	1690	8330	8670	16300	NA
Arsenic	mg/L	<0.001	<0.001	0.001	<0.001	<0.001	0.01
Cadmium	mg/L	0.0004	0.0002	<0.0001	<0.0001	<0.0001	0.003
Chromium	mg/L	0.003	0.004	0.007	0.003	0.002	0.05
Copper	mg/L	0.005	0.006	0.011	0.005	0.003	2
Hexavalent Chromium	mg/L	<0.05	<0.05	<0.05	<0.05	0.06	NA
Iron, Total	mg/L	0.34	3.40	0.88	1.52	0.26	NA
Lead	mg/L	<0.001	0.001	<0.001	<0.001	<0.001	0.01
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.006
Nickel	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	0.07
Zinc	mg/L	0.02	0.02	<0.01	<0.01	<0.01	NA
Oil and Grease, Mineral	mg/L	<1	<1	<1	--	<1	NA
Oil and Grease, Non-Mineral	mg/L	<4	<4	<4	--	4	NA
Oil and Grease, Total	mg/L	<5	<5	<5	--	<5	NA

As shown in *Tables 5-10 through 5-13*, several metals (i.e., cadmium, lead, and nickel) were detected during the first two sampling rounds at concentrations above the WHO guideline values for drinking-water quality. The majority of these exceedances occurred in monitoring wells MW-1 and MW-2.

In 2009, additional groundwater sampling was conducted to assess baseline groundwater quality conditions at locations in the vicinity of the proposed mining operations. Specifically, groundwater samples were collected from the following monitoring well locations:

- GW1 – located in the vicinity of the proposed river dike (N751555, E196582);

- GW2—located along the western end of the proposed TMA (N747672, E193108); and,
- GW3—located in the vicinity of the proposed Water Management Area (N750856, E94646).

Additional details regarding these groundwater sampling locations are provided below.

#### *River Dike*

A 1,540-m long dike is proposed along the southern bank of the Cuyuni River to protect the open surface mine pits from extreme floods. Six geotechnical groundwater monitoring wells were installed along the footprint of the proposed dike. Groundwater sampling was conducted from the well (GW1) located near the center of the entire length of the proposed dike. Topography at this location is generally flat. The average groundwater level was measured at about 3 m below ground surface. The type of soil encountered during drilling of this well was predominantly silty clay.

#### *Tailings Management Area*

This area has been allocated to contain the mine life tailings. Six geotechnical monitoring wells were installed along the footprint of the proposed tailings dam. Groundwater sampling was conducted from the well (GW2) with the lowest elevation. The average groundwater level was measured at about 3 m below ground surface. A creek is located approximately 60 m from this well and bedrock was encountered at a depth of less than 1 m below ground surface. The topography of the entire proposed tailings area is very hilly.

#### *Water Management Area*

This area is designated to serve as the central water management facility for the entire site. Six geotechnical groundwater monitoring wells were installed along the footprint of the proposed perimeter dam. Groundwater sampling was conducted at the well (GW3) with the lowest elevation. The average groundwater level was measured at about 1 m below ground surface. A swampy area is located about 50 m from this monitoring well. The type of soil encountered during drilling of this well was predominantly a sandy silty clay. Topography in this area is generally flat.

The groundwater sampling results are provided in *Table 5-14*. Guideline values published by the World Health Organization for various chemicals are also presented in the table for comparison purposes.

Table 5-14. 2009 Groundwater Analytical Results

Parameter	Units	GW1	GW2	GW3	WHO Guideline Value
Alkalinity as CaCO <sub>3</sub>	mg/L	25	238	1,491	NA
Chloride	mg/L	12	6	16	NA
Conductivity	uS/cm	88	378	6,060	NA
Cyanide (free)	mg/L	<0.10	<0.10	<0.10	NA
Cyanide (total)	mg/L	<0.10	<0.10	<0.10	0.07
Fluoride	mg/L	<0.10	0.17	<0.10	1.5
N-NO <sub>2</sub> (Nitrite)	mg/L	<0.10	<2.5	<0.10	3
N-NO <sub>3</sub> (Nitrate)	mg/L	<0.10	<2.5	<0.10	50
pH		6.20	8.50	12.4	NA
Phenols	mg/L	<0.001	<0.001	0.014	NA
Sulphate	mg/L	4	4	8	NA
Total Dissolved Solids (COND - CALC)	mg/L	57	246	3,940	NA
Total Kjeldahl Nitrogen	mg/L	0.13	1.67	8.17	NA
Total Phosphorus	mg/L	0.02	0.02	0.05	NA
Total Suspended Solids	mg/L	21,000	832	841	NA
Turbidity	NTU	>100	>100	>100	NA
HCO <sub>3</sub> as CaCO <sub>3</sub>	mg/L	25	231	<5	NA
Calcium	mg/L	3	77	535	NA
Magnesium	mg/L	1	3	<1	NA
Potassium	mg/L	<1	3	13	NA
Sodium	mg/L	9	12	51	NA
Aluminum	mg/L	3.6	5.0	0.76	NA
Antimony	mg/L	<0.0001	0.0003	0.0005	0.02
Arsenic	mg/L	<0.001	<0.001	<0.001	0.01
Barium	mg/L	0.89	1.4	3.9	0.7
Beryllium	mg/L	<0.001	<0.001	<0.001	NA
Boron	mg/L	0.01	0.01	0.01	0.5
Cadmium	mg/L	0.0003	0.0003	<0.0001	0.003
Chromium	mg/L	0.005	0.008	0.002	0.05
Cobalt	mg/L	0.103	0.0114	0.0028	NA
Copper	mg/L	0.051	0.071	0.008	2
Iron	mg/L	4.65	3.62	<0.03	NA
Lead	mg/L	0.032	0.005	<0.001	0.01
Manganese	mg/L	4.16	0.52	<0.01	0.4
Mercury	mg/L	<0.0001	<0.0001	<0.0001	0.006
Molybdenum	mg/L	<0.005	0.022	0.009	0.07
Nickel	mg/L	0.021	0.015	0.083	0.07
Selenium	mg/L	0.008	<0.001	0.003	0.01
Silicon	mg/L	14	20	0.7	NA
Silver	mg/L	<0.0001	0.0005	<0.0001	NA
Strontium	mg/L	0.051	0.139	4.17	NA

Thallium	mg/L	0.0001	<0.0001	<0.0001	NA
Titanium	mg/L	<0.01	0.03	<0.01	NA
Vanadium	mg/L	0.037	0.021	0.003	NA
Zinc	mg/L	0.16	0.09	<0.01	NA
Oil & Grease - Mineral	mg/L	<1	27	5	NA
Oil & Grease - Non-mineral	mg/L	1	57	14	NA
Oil & Grease - Total	mg/L	1	84	19	NA

As shown in *Table 5-14* above, several metals (barium, lead, manganese, and nickel) were detected in groundwater samples at concentrations above the WHO guideline values for drinking-water quality. Oil and grease was detected at elevated levels in groundwater samples GW2 and GW3; however, the sources of these contaminants were unknown. Groundwater collected from monitoring well GW3 also had an extremely elevated pH of 12.4, which could be attributed to the presence of residual drilling fluids or cement grout in the well.

### 5.3 *BIOLOGICAL BASELINE*

This biological baseline is based on the requirements of the IFC Performance Standards, the May 2009 ToR supplied by the IFC, and the Business and Biodiversity Offsets Programme (BBOP) Offsets Design Handbook. The emphasis of this baseline is to identify potentially sensitive habitats and species that could trigger a Critical Habitat Assessment and merit consideration of biodiversity offsets.

Consistent with the IFC's interpretative guidance on its Performance Standard 6, this baseline considers biodiversity at four levels of scale, listed below in increasing order of detail:

- Regions/Biogeographic Provinces;
- Landscapes/Ecosystems;
- Area of Direct Impact/Habitats; and
- Species.

#### 5.3.1 *Regional and Biogeographic Context*

The Aurora Concession is located in the tropical lowlands of northwestern Guyana, some 150 km inland from the Atlantic coast of northern South America. This low-lying area is considered to be part of the Guiana Shield region as defined by recent regional studies (e.g., Huber & Foster, 2003; Hollowell & Reynolds, 2005); however, it is biogeographically distinct from the Guiana Shield Highland centers of endemism. Biogeographically, the lowlands of the Guianas 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, despite the presence of some regional endemism. In contrast, the highlands of the Guiana Shield, especially at elevations greater than 1,500 m, are important as a center of endemism for various groups of plants and animals.

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. The Cuyuni River discharges into the lower Mazaruni River at a short distance from the Essequibo, and thus is connected to Amazonian aquatic ecosystems via the Rupununi savannas.

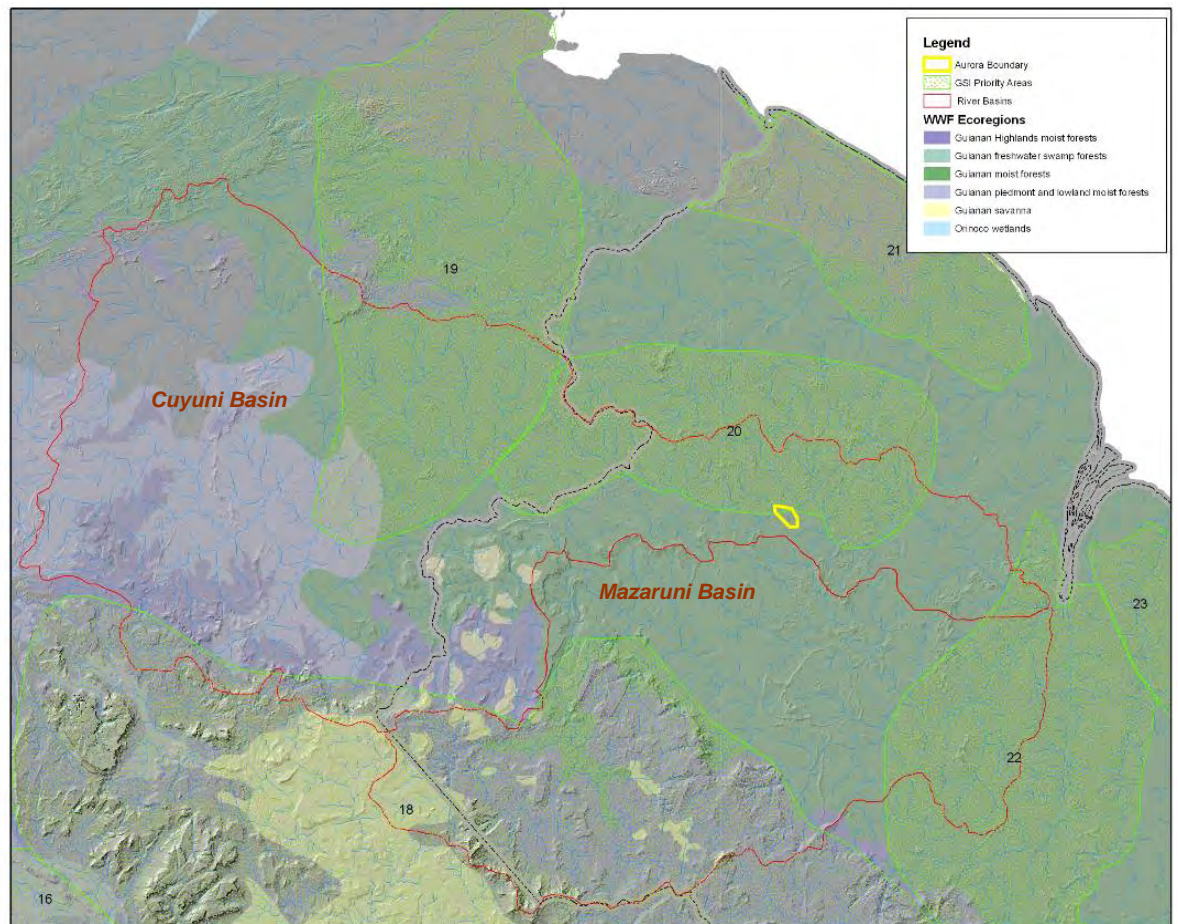
The vertebrate faunal diversity of the Guianan lowland forests is comprised largely of widespread species found across the lowland humid forests of the Amazon Basin and the Guianan Lowlands. Guianan vertebrate endemics are generally restricted to the highlands of the Guianan Shield or to the savanna and dry forest ecosystems.

Based on analyses of large-scale forestry inventories, ter Steege & Zondervan (2000) identify five preliminary divisions of the Guianan forest:

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

The Cuyuni Basin lies within the second division identified above. The upland forests of northwestern Guyana and bordering Venezuela are found on soils developed on the crystalline shield, consisting of granites and greenstones, as well as on smaller areas covered by Plio-Pleistocene sediments. The upland forests are characterized by a high abundance of *Eschweilera sagotiana*, *Alexa imperatricis*, *Catostemma commune*, *Licania* spp. and *Protium decandrum*. Most of these species belong to genera of the 'Lowland Guianas Dominants' identified by ter Steege & Zondervan. Upland forests dominated by *Alexa*, *Eschweilera*, *Licania* and *Catostemma* continue far into Venezuela. Poor mono-dominant stands of *M. gonggrijpii* are found on the (probably) more clayey soils between the Cuyuni and Mazaruni, as well as in the eastern parts of Venezuelan Guyana. Extraction of plywood species (mainly *Catostemma*, *Alexa* and *Mouriri*) has risen quite substantially over the last years in the area.

IFC biodiversity guidelines require consideration of areas of recognized global, national or local importance to biodiversity, such as legally protected areas, World Heritage sites, Ramsar sites, Important Bird Areas, Key Biodiversity Areas, community reserves, and natural reserves, as well as ecoregional planning. There has been no formal ecoregional planning by Guyana’s Ministry of the Environment and/or by any partnering organizations (e.g., WWF, CI). The “Guayana Shield Conservation Priority-setting Workshop” was held in April 2002 under the co-sponsorship of Conservation International (CI), the Guiana Shield Initiative of the Netherlands Committee for IUCN (GSI/NC-IUCN), the Caribbean Sub-regional Resource Facility of the United Nations Development Programme (UNDP), UNDP Suriname, and UNDP Guyana. One result of the workshop was a series of maps of biodiversity and conservation priority areas within the Guiana Shield region. Portions of four priority areas fall within the Cuyuni and Mazaruni basins (Figure 5-10, Table 5-15).



**Figure 5-10.** Guiana Shield Initiative (GSI) priority areas in the Cuyuni and Mazaruni river basins. Sources: ERM, WWF, GSI, and Jarvis et al. (2008).

**Table 5-15.** Description of Guiana Shield Initiative (GSI) priority areas in the Cuyuni and Mazaruni river basins.

No.	Area Name	BIR	BI	Biological Importance Description	OR	Opportunities Description	PR	Pressure Description
18	Eastern Tepui Upland Area	3	FL, PE, I, FW, A, R, B, M	Very high level of endemism with unique habitats in the eastern Guianan highlands.	2	Environmental education. Integration of local communities. Interconnection of the conservation policies of the three countries. Implementation of the only World Natural Heritage site in Venezuelan Canaima National Park. Historically important in the scientific knowledge of the Pantepui biogeographical region. Elaboration and implementation of management plans of the protected areas (national parks, natural monuments, etc.).	4	In the Gran Sabana uplands: uncontrolled tourism, infrastructure projects, small mining (serious problem increasing in importance), hydroelectric dams, access roads, settlements, hunting pressures, expansion of savanna and forest degradation. In the tepui highlands: uncontrolled tourism, introduction of alien taxa, burning.
19	Imataca-Southern Orinoco Delta	2	FL, PE, I, FW, A, R, B, M	Plant endemism. Some tree species with restricted geographical distribution. Some forest types with a determined floristic composition are unique in the Venezuelan Guayana.	2	Mariusa National Park at the northern edge of the area. The projected Delta del Orinoco biosphere reserve, and Canaima National Park in the south could be connected with a biological corridor through the Imataca forest reserve.	4	Agricultural frontier is advancing from north to south. Local fish fauna is under pressure from introduced African Cichlids (Tilapia). Allocated logging and mining concessions, some of them active, exist in the area. Uncontrolled small-scale mining. New construction planned.
20	Cuyuni	1	FL, R, M	Biogeographically distinctive.	2	Non-timber forest products (NTFPs)	3	Logging, hunting, wildlife trade, bushmeat.

No.	Area Name	BIR	BI	Biological Importance Description	OR	Opportunities Description	PR	Pressure Description
22	Lower Essequibo	2	PE, I, FW	High diversity of fish and other aquatic organisms. Monodominant forests. Rare and important ecological processes.	2	EPA is studying area. Conservation concessions. Collaboration with economic ventures in area.	3	Logging, agriculture, water pollution, hydro-electric exploitation, hunting, wildlife trade.

BIR = Biological importance rating: 3 = highest, 2 = high, 1 = moderate

Biological importance criteria: FL = floristics, PE = plant ecology, I = invertebrates, FW = fishes and freshwater ecology, A = amphibians, R = reptiles, B = birds, M = mammals, ND = not defined

OR = Opportunities rating: 3 = high, 2 = medium, 1 = low

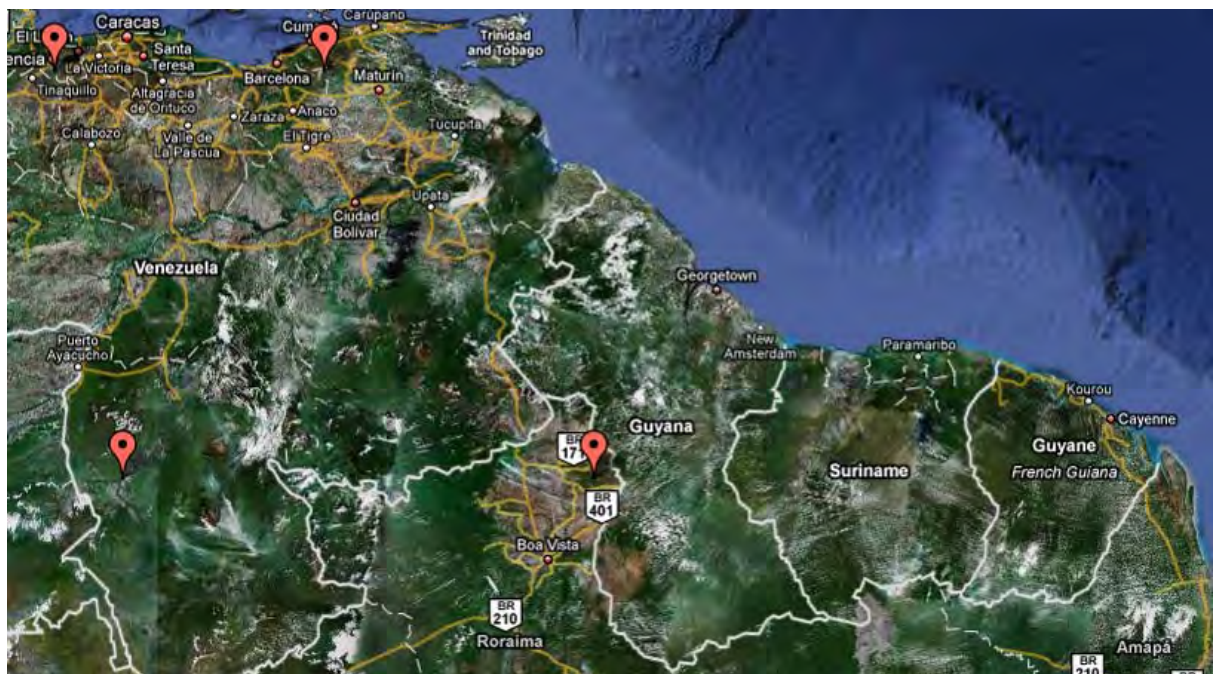
PR = Pressure rating: 4 = highest, 3 = high, 2 = moderate, 1 = low

Source: Adapted from Huber & Foster (2003).

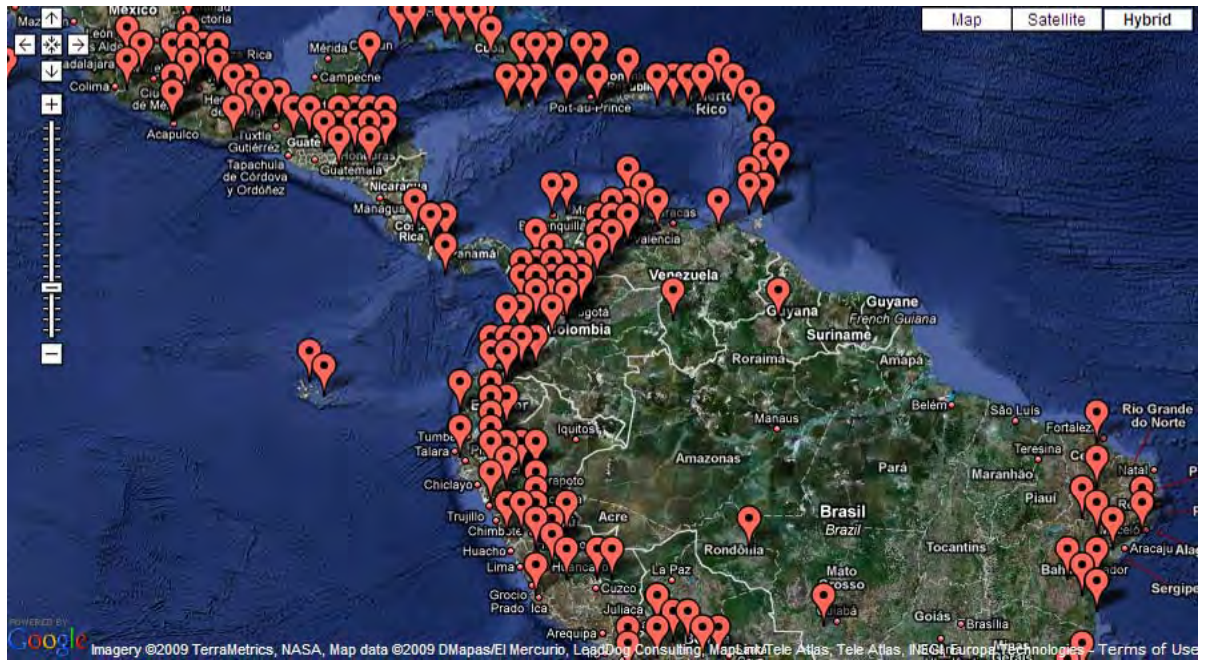
The Cuyuni Area (No. 20) is located to the north of the Aurora Concession and north of the Cuyuni River and traversed by the existing Barama Road. It is included for its importance for floristics, reptiles, and mammals; however, no specific information on its biogeographic distinctiveness is available in the GSI report. The other areas are remote from the Project Area of Direct Influence.

A 2005 Global Environment Facility (GEF) proposal for the Guyana Protected Areas System Project Phase I identifies the Upper Cuyuni River as an area of conservation interest. This area was characterized as relatively unexplored with many species from the Guiana Shield area. According to the proposal, recent expeditions gave evidence of a unique flora that was very poorly studied and a completely unsampled fauna. This area contains the headwaters of the Cuyuni River. The proposal also noted that there was considerable mining in this area. Based on the characterization of the area, this area does not include the Guyana Gold fields Area of Influence, which is centered on the lower Cuyuni and does not include the headwaters in the Guiana Shield highlands.

No High Conservation Value (HCV) areas, Alliance for Zero Extinction (AZE) sites, Important Bird Areas (IBAs), Key Biodiversity Areas (KBAs), or Important Plant Areas (IPAs) have been identified within Guyana to date (Figures 5-11 to 5-12).



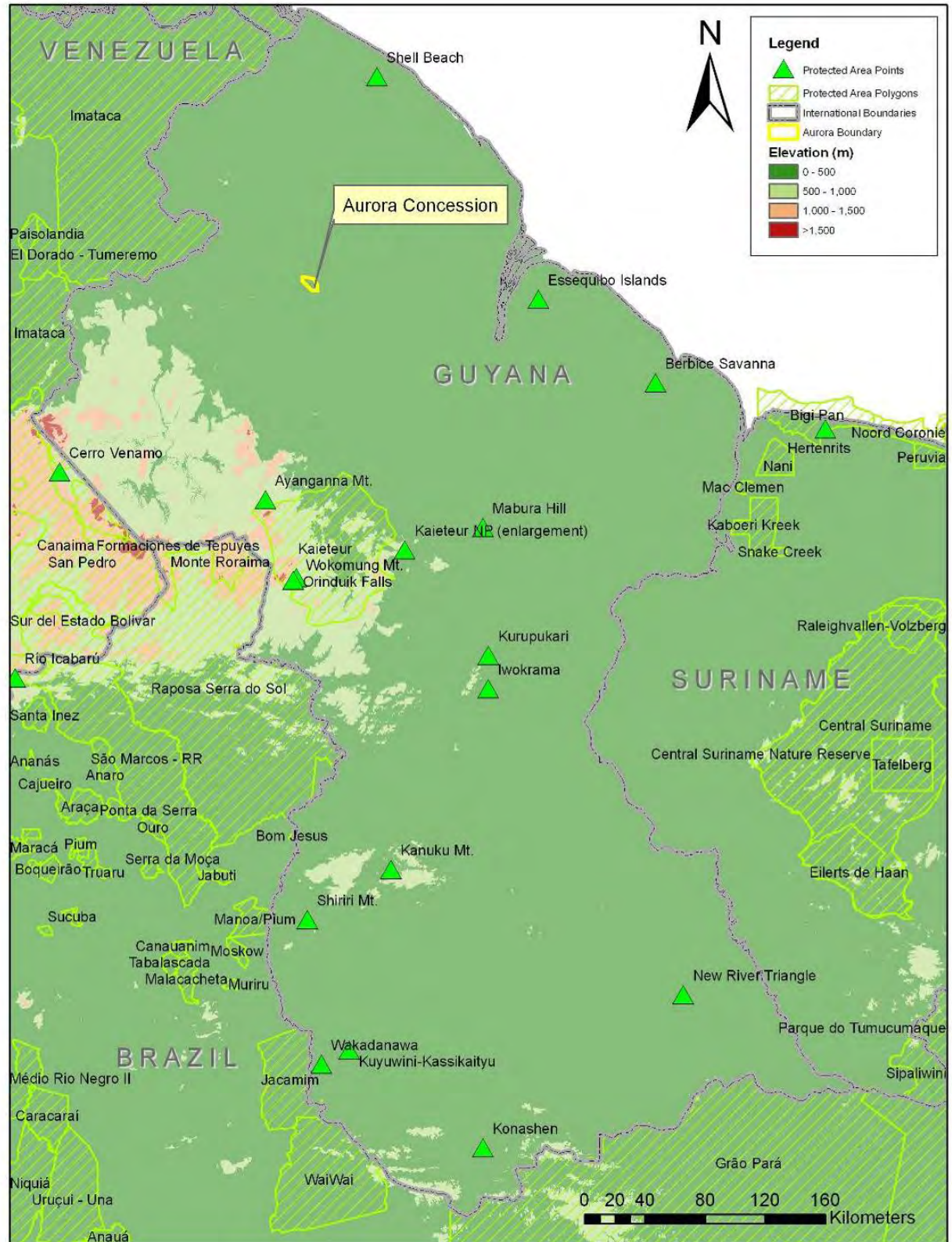
**Figure 5-11.** Alliance for Zero Extinction Sites in the Guiana Shield Region. Note: The Rio Tacutu site in Brazil near the Guyana border is a savanna ecosystem designated for the endangered hoary-throated spinetail (bird). Source: Downloaded from <http://www.zeroextinction.org/sitemap.htm>. 18 August 2009.



*Figure 5-12. Alliance for Zero Extinction Sites in northern South America, Mesoamerica, and the Caribbean. Note the paucity of sites in the Amazonian and Guianas regions in contrast with the Andes. Source: Downloaded from <http://www.zeroextinction.org/sitemap.htm>. 18 August 2009.*

No NGOs or governmental institutions have identified any area within the Concession itself as a priority for conservation interest. The conservation initiatives in Guyana are largely focused on the larger forested landscapes of central and southern Guyana or in the Rupununi Savannas region. Likewise, there are no established or proposed protected areas of any category in the Area of Influence (*Figure 5-13*).

Figure 5-13. Protected areas in Guyana and adjacent areas.



Source: Data from 2009 World Database of Protected Areas.

## 5.3.2 *Landscapes and Ecosystems*

### 5.3.3.1 *Delimitation of the Landscape*

The Aurora Concession lies within the lower Cuyuni River Basin in northwestern Guyana, entirely within the Guianan Moist Forests Ecoregion (as defined by Schipper *et al.*, 2001; *Figure 5-14*). This lowland ecoregion should not be confused with the Guiana Highlands which includes the tepui formations and is characterized by relatively high levels of endemism. The Guianan Moist Forest fauna is largely shared with other humid lowland ecoregions of the Amazon Basin.

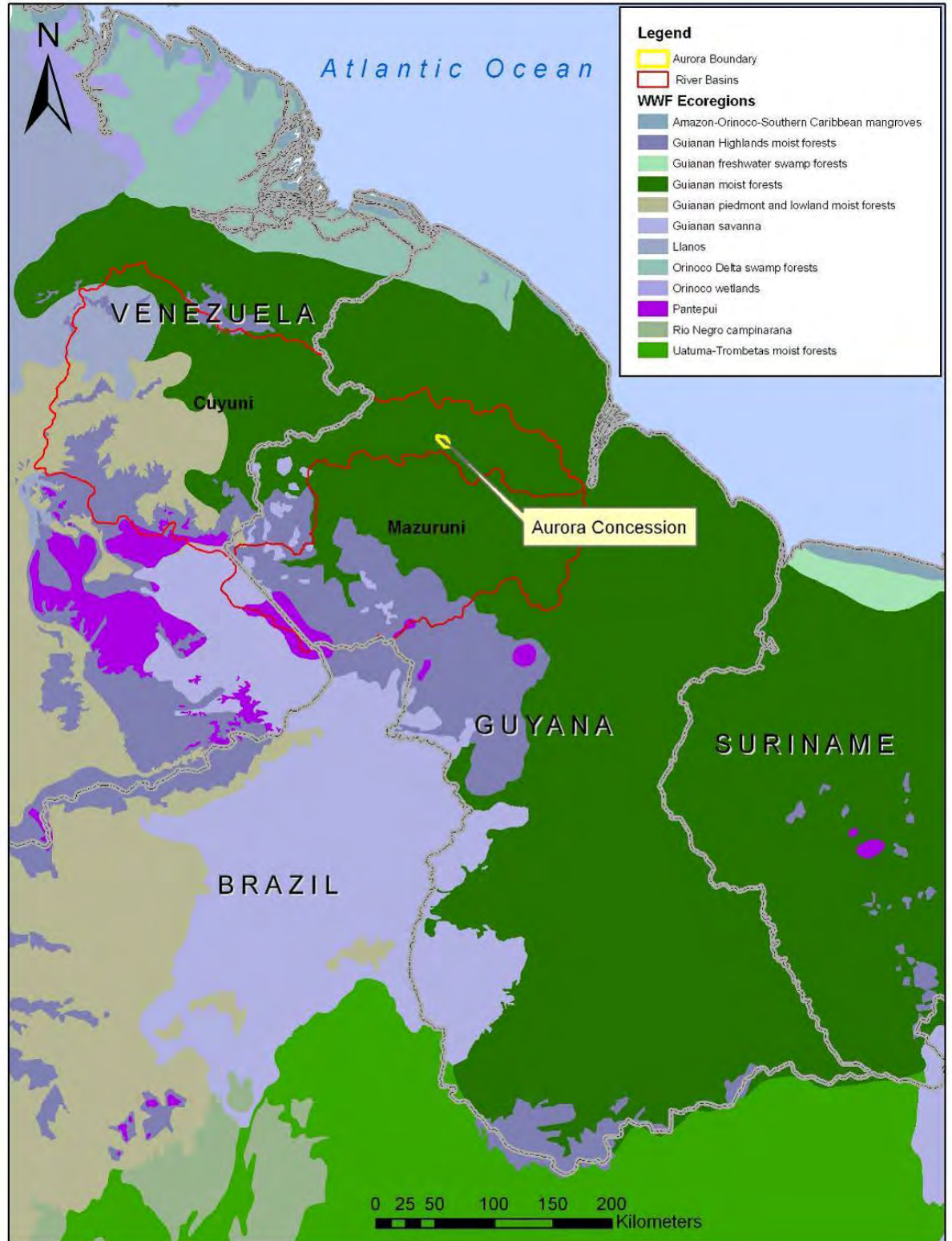
The Cuyuni River Basin is part of the Essequibo Freshwater Ecoregion (Abell *et al.*, 2008). The basin occupies an area of approximately 59,300 km<sup>2</sup>, of which approximately 51,800 km<sup>2</sup> lie upstream of the project site and some 42,100 km<sup>2</sup> are within the neighboring country of Venezuela. The Aurora Concession lies just to the north of the low-lying Cuyuni/Mazaruni watershed divide. The Mazaruni River basin occupies some 36,600 km<sup>2</sup>, almost entirely within Guyana. These two basins comprise a landscape region for the purposes of this analysis.

### 5.3.3.2 *Ecosystem Properties and Processes*

The ecosystems of the Cuyuni River basin are dominated by dense forests which are interdigitated among aquatic environments in the form of rivers and innumerable streams. Most of the bottomland forests along the rivers and in small stream valleys are seasonally flooded and support aquatic biota during the wet season. The valley slopes, hillslopes, and ridge-tops support forests with species intolerant of, or at least not requiring, seasonal flooding. Portions of these ecosystems that have only been disturbed slightly by human activity and support a large diversity of widespread humid forest fauna typical of the Neotropics generally (such as jaguars and peccaries), with other species typical of the greater Amazonian (such as lowland tapirs and black caiman) or Guianan Shield regions (such as Guiana red howler monkeys and black curassows).

The greater part of the Cuyuni River Basin is situated upstream in Venezuela, with only a small area in Guyana. Thus, the basin receives water from headwaters located in Venezuela before discharging to the Essequibo and ultimately to the Atlantic Ocean. The Cuyuni River serves as a biological corridor that links the Essequibo River with the Guianan Highlands of Venezuela; as such, it may have some significance for some migratory fish species such as *Prochilodus rubrotaeniatus*. There are also a few fish from coastal waters which reach the lower Cuyuni, such as the puffer fish (*Colomesus psittacus*).

The forest-river systems of the Cuyuni basin are integrated through surface and groundwater hydrological processes and the forests are important for the maintenance of hydrology and water quality. 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, and low conductivity and suspended sediments. Changes to the forest cover can adversely affect the quantity and quality of water.



*Figure 5-14. WWF ecoregions of the Guyana region, with location of Cuyuni and Mazuruni river basins and Aurora Concession. Source: Schipper et al., 2001*

### 5.3.3.3

#### *Human Impact on the Landscape and Ecosystems of the Project Area*

The biodiversity and environmental quality of the project area has been significantly and adversely affected by historical human activities, including logging and ASM. Despite its relatively remote location, the project area shows signs of environmental degradation and depletion of fauna.

Both the Cuyuni and Mazaruni basins have been historically affected by mining activities and these have resulted in contamination of rivers with mercury and increased turbidity. There has been some research on mining impacts in the Venezuelan portion of the Cuyuni basin (Nico & Taphorn, 1994; García-Sánchez *et al.*, 2008) as well as general studies in Guyana by WWF (Lowe, 2008). The fish abundance and diversity of the upper Cuyuni River basin in Venezuela has been adversely affected by historical artisanal mining (albeit some of which is considered to be large scale) due largely to impacts from accelerated sedimentation and increased turbidity. The Cuyuni River has experienced degradation of water quality since the 1980s from the discharge of sediment- and contaminant-laden waters from ASM into its tributaries (*Figure 5-15*). The river has become increasingly turbid and mercury has accumulated in the aquatic ecosystem.

*Figure 5-15. Cuyuni River and small-scale mining contaminated tributary with visibly high suspended sediment loads, April 2009.*



Source: ERM, 2009

Within the Aurora Project Area of Influence, the biodiversity has been affected to some degree by logging and mining activities during the 20<sup>th</sup> and 21<sup>st</sup> centuries. The Cuyuni River has served as a transportation corridor likely since the arrival of the first indigenous peoples to the basin. Construction of the Barama Road has led to increased human activity to the north of the Cuyuni River and to the west of the Essequibo River (*Figure 5-16*). The Aurora site was first developed in the 1930s and has been affected by mining activities ever since. Large fauna common in pristine habitats along similar types of rivers in the Guianas are absent or rare in the project area, presumably due to hunting, degradation of river quality, and disturbance by speedboats.

*Figure 5-16. Barama Road and associated small-scale mining activity to north of the Cuyuni River, March 2009.*



Source: ERM, 2009

### 5.3.3 *Species and Communities*

The biodiversity of the Guiana Shield Region has been the focus of concerted inventory efforts by the Smithsonian Institution's Biological Diversity of the Guiana Shield Program, resulting in recent checklists for vascular plants (Funk *et al.*, 2007), fish (Vari *et al.*, 2009), and terrestrial vertebrates (Hollowell & Reynolds, 2005). These data provide a valuable regional baseline on species richness.

There has been little focused biodiversity data collection in the Cuyuni River Basin of Guyana. Naturalist William Beebe produced a series of studies from his

base near Bartica in the 1930s. Lynne Gillespie collected a series of plants along the Cuyuni River around the Aurora camp in 1997. The fish of the Venezuelan portion of the Cuyuni Basin have been better studied by Machado-Allison and colleagues.

#### 5.3.4.1 *Species of Significance to Critical Habitat Assessment*

The decision for IFC to invest in development projects near or in critical habitats depends on the following factors:

- The relative vulnerability and irreplaceability of the particular habitat;
- The extent and quality of the biodiversity assessment, which should adhere to best practices;
- The capacity of the client to implement and ensure best practices in biodiversity management and monitoring for the long-term;
- The type of development (e.g., ecolodge, mining concession, oil palm plantation, wind turbines, etc.) and the related direct and indirect impacts on the critical habitat in question;
- The ability of the client to establish effective, long-term strategic partnerships with the government, academic institutions, local communities/stakeholders, and/or internationally recognized conservation organizations; and
- The regional cumulative impacts of this and other projects in the area.

IFC PS 6 identifies six criteria for the assessment of whether a given modified or natural habitat may be considered a critical habitat:

- Criterion 1: Critically Endangered and Endangered Species;
- Criterion 2: Endemic and Restricted-range Species;
- Criterion 3: Migratory and Congregatory Species;
- Criterion 4: Unique Assemblages of Species and Key Evolutionary Processes;
- Criterion 5: Key Ecosystem Services; and
- Criterion 6: Biodiversity of Significant Social, Economic or Cultural Importance to Local Communities.

These criteria were evaluated in the following sections.

#### *Critically Endangered (CR) / Endangered (EN) Species*

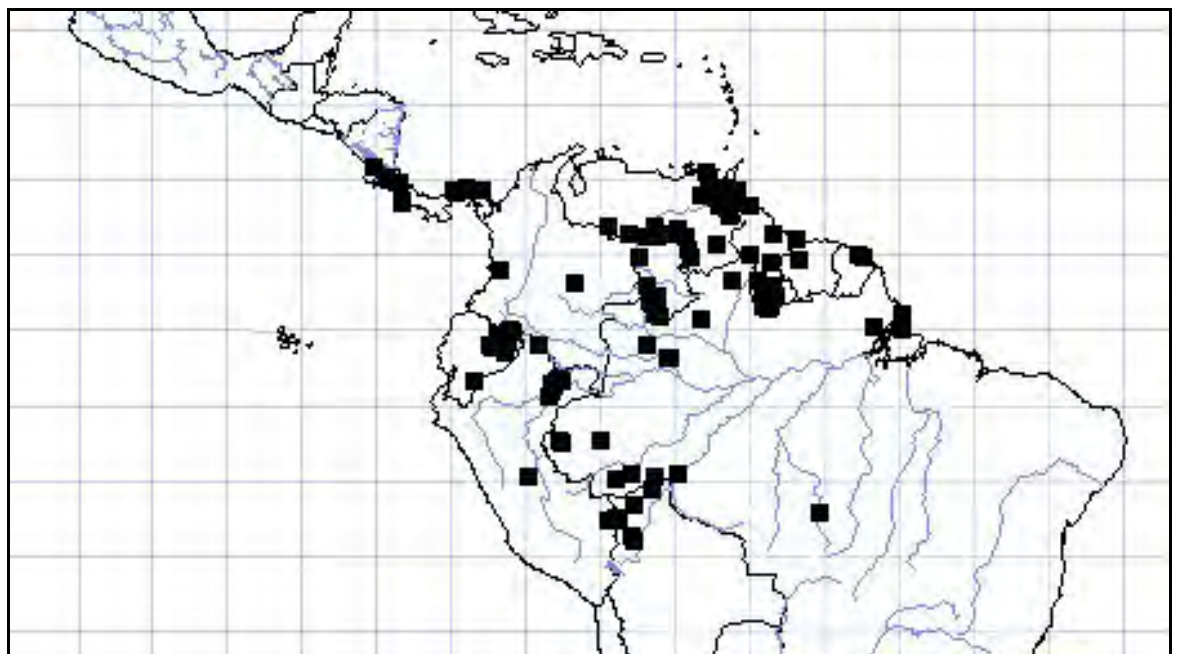
Guyana has no proposed or adopted list of threatened or endangered species; therefore, the 2009 IUCN Red List of Threatened Species was used in this analysis.

The only endangered or critically endangered plant species listed by the IUCN for Guyana are:

- *Aniba rosaedora* – EN
- *Trichilia surumuensis* – EN
- *Virola surinamensis* – EN
- *Vouacapoua americana* – CR

*Aniba rosaedora*, *Virola surinamensis*, and *Vouacapoua americana* are widespread species with hundreds or thousands of known localities. *Trichilia surumuensis* is restricted to the Roraima Highlands and is not likely to be present in the Aurora Area of Influence.

*Virola surinamensis* is a widely distributed swamp and riverine forest species that is locally abundant in the Guianas (Figure 5-17.) Known in Guyana as “swamp dalli”, it was reported as occurring in the project area in the October 2006 baseline data for the Aurora Concession. There is no evidence to support a threatened status for populations of this species within the Guianas, and its presence should not be grounds for a Critical Habitat Assessment given its widespread distribution and general abundance in swamp forests in the region.



**Figure 5-17.** Distribution of localities for Missouri Botanical Garden specimens of *Virola surinamensis* for which coordinates are available. *Source:* [http://mobot.mobot.org/cgi-bin/search\\_vast](http://mobot.mobot.org/cgi-bin/search_vast).

There are no endangered or critically endangered terrestrial or freshwater invertebrates listed by the IUCN for Guyana. 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 in the Cuyuni and Mazaruni basins. No endangered or critically endangered amphibians are known to occur in Guyana.

According to BirdLife International, only three endangered bird species are known to occur in Guyana:

- Sun parakeet (*Aratinga solstitialis*);
- Hoary-throated spinetail (*Synallaxis kollari*); and
- Red siskin (*Carduelis cucullata*).

All of these birds are associated primarily with savanna or dry forest landscapes (i.e., Rupununi and Sipalawini savannas within Guyana), none of which is present in the project area. The sun parakeet was reported by the 2006 field survey of the Aurora Concession, but has not been reported since. Its presence is unlikely due to the absence of its preferred habitats.

The only endangered mammal listed by the IUCN for Guyana is the giant otter (*Pteronura brasiliensis*). No critically endangered mammals are known to occur in Guyana. Individual Giant otters were sighted on the Cuyuni River in the Project Area of Influence during the 2006 and 2009 baseline studies. As a result of the 2009 sighting, a specialist survey was performed by internationally-recognized giant otter specialist Dr. Nicole Duplaix to determine whether there was a permanent population of giant otters in the Project Area of Influence, or whether these sightings represent lone individuals passing through the area. Her field survey did not reveal any signs of recent (i.e., within the last four years) inhabitation by giant otters in the survey area, which included both the upstream and downstream portions of the Cuyuni River and the Julian Ross Itabu.

#### *Endemic / Restricted-Range Species*

A preliminary list (Persaud, unpublished, cited by ter Steege, 2000a) of Guyana's endemic flora included 284 species, approximately 5% of which are found in Guyana. Guyana as a geographic unit is no phytogeographic entity in itself but part of the Guiana Shield area and therefore any endemism is either caused by accident (restricted-range species) or if a habitat containing endemics is confined to Guyana (ter Steege, 2000a). In a regional context, species endemic to the three Guianas are especially abundant in the central and northwest region of Guyana (which includes the Cuyuni Basin), where they usually amount to more than 50% of all trees with a trunk diameter > 30 cm in the forest (ter Steege, 2000b). Species endemic to Guyana itself are more narrowly confined with maximum densities in an area surrounding the Potaro River basin and a small area to the east in the central highlands (ter Steege, 2000b).

Ter Steege (2000b) concludes that central and northwestern Guyana have a lower diversity but a higher proportion of typical Guianan taxa and endemics. The low diversity could be the result of a long standing process of low disturbance and, as such, is possibly unique to South America. Because central and northwest Guyana are the main timber concession areas, he urges that swift action be taken to preserve a portion of this important area.

The following list of 84 freshwater fish species considered endemic to Guyana is based on data in the March 2009 version of FishBase ([www.fishbase.org](http://www.fishbase.org)), as compiled and published online by <http://Intreasures.com/guyanaff.html>, and updated according to Vari *et al.* (2009):

1. *Leporinus megalepis* OC (Anostomidae) Large-scaled Leporinus
2. *Bunocephalus chamaizelus* (Aspredinidae)
3. *Auchenipterus brevior* (Auchenipteridae)
4. *Centromochlus reticulatus* (Auchenipteridae)
5. *Tatia meesi* (Auchenipteridae)
6. *Trachelyichthys decaradiatus* (Auchenipteridae) Guyanan Pigmy Driftwood
7. *Corydoras potaroensis* (Callichthyidae)
8. *Cetopsidium roae* (Cetopsidae)
9. *Denticetopsis iwokrama* (Cetopsidae)
10. *Denticetopsis macilenta* (Cetopsidae)
11. *Acanthocharax microlepis* (Characidae)
12. *Aphyocharacidium melandetum* OC (Characidae)
13. *Aphyocharax erythrurus* OC (Characidae) Flametail Tetra
14. *Aphyodite grammica* OC (Characidae)
15. *Astyanax mutator* OC (Characidae)
16. *Bryconamericus hyphesson* OC (Characidae)
17. *Deuterodon potaroensis* (Characidae)
18. *Hemigrammus cylindricus* OC (Characidae)
19. *Hemigrammus erythrozonus* (Characidae) Glowlight Tetra
20. *Hemigrammus iota* (Characidae)
21. *Hyphessobrycon catableptus* (Characidae)
22. *Hyphessobrycon eos* (Characidae) Dawn Tetra
23. *Hyphessobrycon minimus* OC (Characidae) Mini Tetra
24. *Hyphessobrycon minor* OC (Characidae) White Minor

25. *Jupiaba essequibensis* OC (Characidae)
26. *Jupiaba mucronata* OC (Characidae)
27. *Jupiaba potaroensis* (Characidae)
28. *Microschemobrycon melanotus* (Characidae)
29. *Moenkhausia shideleri* OC (Characidae)
30. *Parapristella aubynei* (Characidae)
31. *Phenacogaster carteri* (Characidae)
32. *Phenacogaster megalostictus* OC (Characidae) Large-spot Glass Tetra
33. *Aequidens potaroensis* OC (Cichlidae) Guyana Aequidens
34. *Crenicichla wallacii* OC (Cichlidae) Slender Pike Cichlid
35. *Mazarunia mazarunii* (Cichlidae) Mazaruni Cichlid
36. *Ivanacara bimaculata* (Cichlidae) Potaro River Dwarf Cichlid
37. *Ammocryptocharax lateralis* OC (Crenuchidae)
38. *Characidium pteroides* OC (Crenuchidae)
39. *Poecilocharax bovalii* (Crenuchidae)
40. *Skiotocharax meizon* (Crenuchidae)
41. *Psectrogaster essequibensis* (Curimatidae)
42. *Rhinodoras armbrusteri* (Doradidae)
43. *Brachyglanis melas* (Heptapteridae)
44. *Brachyglanis phalacra* (Heptapteridae)
45. *Myoglanis potaroensis* (Heptapteridae)
46. *Pimelodella altipinnis* (Heptapteridae)
47. *Pimelodella wessellii* (Heptapteridae)
48. *Rhamdella leptosoma* (Heptapteridae)
49. *Derhamia hoffmannorum* (Lebiasinidae)
50. *Nannostomus espei* (Lebiasinidae) Barred Pencilfish
51. *Nannostomus harrisoni* OC (Lebiasinidae) Blackstripe Pencilfish
52. *Nannostomus minimus* (Lebiasinidae) Least Pencilfish
53. *Ancistrus leucostictus* OC (Loricariidae) Mana Ancistrus
54. *Ancistrus lithurgicus* (Loricariidae)
55. *Ancistrus nudiceps* (Loricariidae)
56. *Corymbophanes andersoni* (Loricariidae)
57. *Corymbophanes kaiei* (Loricariidae)

58. *Hypostomus hemiurus* (Loricariidae)
59. *Hypostomus macushi* (Loricariidae)
60. *Lasiancistrus schomburgkii* (Loricariidae)
61. *Lithogenes villosus* (Loricariidae)
62. *Lithoxus bovallii* OC (Loricariidae)
63. *Loricariichthys microdon* (Loricariidae)
64. *Parotocinclus collinsae* (Loricariidae)
65. *Peckoltia braueri* (Loricariidae)
66. *Peckoltia cavatica* (Loricariidae)
67. *Pseudacanthicus leopardus* (Loricariidae) Orange-trim Sucker Catfish
68. *Pseudancistrus guentheri* (Loricariidae)
69. *Pseudancistrus nigrescens* (Loricariidae)
70. *Sturisoma monopelte* (Loricariidae)
71. *Apareiodon agmatos* (Parodontidae)
72. *Cephalosilurus albomarginatus* OC (Pseudopimelodidae) Bee Catfish
73. *Austrofundulus rupununi* (Rivulidae)
74. *Rivulus breviceps* (Rivulidae) Shorthead Rivulus
75. *Rivulus holmiae* OC (Rivulidae) Goldentail Rivulus
76. *Rivulus lanceolatus* (Rivulidae)
77. *Rivulus mahdiaensis* (Rivulidae)
78. *Rivulus mazaruni* (Rivulidae) Mazaruni Rivulus
79. *Rivulus torrenticola* (Rivulidae)
80. *Rivulus waimacui* (Rivulidae) Waimacui Rivulus
81. *Henonemus taxistigmus* OC (Trichomycteridae)
82. *Ituglanis gracilior* OC (Trichomycteridae)
83. *Ochmacanthus flabelliferus* OC (Trichomycteridae)
84. *Trichomycterus conradi* OC (Trichomycteridae)

**Note:** OC = a FishBase occurrence record suggests a specimen from another country outside normal stated range.

The majority of the above-listed species are found in the highlands of the Guiana Shield, especially in the Potaro river basin, or in the Rupununi Savannas region. While some species are known only from the Essequibo basin, none of these species are known to be endemic to the Cuyuni river basin.

Similar to the fish, the endemic amphibians of the Guianas are largely restricted to the Guiana Shield Highlands; however, there are some species known only from a few localities in the lowlands, or from the edge of the Shield Uplands (Table 5-16). No amphibian species are known to be endemic to the Cuyuni River Basin or the lowlands of the Mazaruni River Basin.

**Table 5- 16.** *Amphibians Endemic to Lowland (<500 masl) Guyana, the Guianan Moist Forests Ecoregion (GMFE), or with Restricted-Ranges (<50,000 km<sup>2</sup>) that include the Lower Cuyuni-Mazaruni Basins (adapted from Frost, 2009; Señaris & MacCulloch, 2005; and <http://Intreasures.com/guyanaa.html>).*

Scientific Name	Distribution	GMFE Endemic?	2009 IUCN Red List
<b>Anurans</b>			
<i>"Hyla" helenae</i>	GU - Known only from type locality, "Valley of the Demerara River,...Dunoon, British Guiana".	Yes	DD
<i>Allobates spumaponens</i> Kok & Ernst, 2007	GU - Known only from Mabura Hill Forest Reserve, Upper Demerara-Berbice Region, Guyana (5°09N, 58°41W, occurs at elevation of about 100 m.	Yes	DD
<i>Anomaloglossus kaiei</i> (Kok, Sambhu, Roopsind, Lenglet, and Bourne, 2006)	GU - Known from Kaieteur National Park and the Pakaraima Mountains, Guyana, where it is known to occur in primary and disturbed forest. Also found along the Guyana-Brazil border and possibly present in Brazil. It occurs at elevations between 150-900 m.	No	VU
<i>Anomaloglossus kaiei</i> (Kok, Sambhu, Roopsind, Lenglet, and Bourne, 2006)	GU - Known from Kaieteur National Park and the Pakaraima Mountains, Guyana, where it is known to occur in primary and disturbed forest. Also found along the Guyana-Brazil border and possibly present in Brazil. It occurs at elevations between 150-900 m.	No	LC
<i>Dendrobates nubeculosus</i> Jungfer &	GU - Known only from	Yes	DD

Scientific Name	Distribution	GMFE Endemic?	2009 IUCN Red List
Böhme, 2004	"Rockstone, Essequibo River, Mazaruni Potaro District, Guyana . . . Rockstone (4° 58 N, 58° 32 W), a town on the Essequibo River at 7 m above sea level"		
<i>Dendropsophus grandisonae</i> (Goin, 1966)	GU - Type locality: "in the forest at Mazaruni, British Guiana". Believed to be a lowland species (Frost, 2009)	Yes	DD
<i>Hypsiboas liliae</i> Kok, 2006	GU - Known from Kaieteur Plateau (5 10'51" N, 59, 28'57" W), 400 m elevation, and vicinity of Elinkwa River (5 10' 06" N, 59 23' 41" W), 550 m elevation, Kaieteur National Park. The species has been heard calling at the Guyana-Brazil border. It is believed to be widespread in the Pakaraima Mountains of Guyana at elevations between 400-1200 masl (Kok, 2008).	No	LC
<i>Leptodactylus lutzi</i> (Heyer, 1975)	GU - Type locality "Guyana, Chinapoon R., upper Potaro (probably Chenapown River)".	Yes	DD
<i>Pristimantis inguinalis</i> (Parker, 1940)	GU SU FG - Not in W. Guyana	Yes	LC
<i>Scinax proboscideus</i> (Brongersma, 1933)	GU SU FG - Endemic to the Guianas, 200-600 m - NOT IN NORTHERN GUYANA	Yes	LC
<i>Stefania evansi</i> (Boulenger, 1904)	GU - Endemic to Guyana, 20-890 m	No	LC
<i>Stefania woodleyi</i> Rivero, 1968	GU - Eastern portion of the Pakaraima Mountain region, Guyana, at elevations of 100-900 m.	No	LC
<i>Tepuihyla talbergae</i> Duellman & Yoshpa, 1996	GU - Known only from "Kaieteur Falls, 366 m (05° 10 N, 59° 28 W), Mazaruni-Potaro District, Guyana".	No	LC
<i>Trachycephalus hadroceps</i> (Duellman and Hoogmoed, 1992)	GU [SU] FG - Endemic to	Yes	LC

Scientific Name	Distribution	GMFE Endemic?	2009 IUCN Red List
	extreme southern Guyana and French Guiana, 50-500 m - NOT IN NORTHERN GUYANA		

### Caecilians

<i>Caecilia pressula</i> Taylor, 1968	GU - Known only from Marudi Mountains, Guyana (250 m)	No	DD
<i>Osaecilia zweifeli</i> Taylor, 1968	GU FG? - Type locality: "a small creek tributary to Río Mazaruni, British Guiana [= Guyana]".	Yes	DD
<i>Rhinatrema bivittatum</i> (Guérin-Méneville, 1829)	AP GU SU FG	Yes	LC

Note: DD – data deficient

LC - least concern

VU - vulnerable

EN - endangered

CR - critically endangered

Distribution codes:

CG Colombian Guayana

VA Venezuela – Amazonas

BO Venezuela – Bolívar

DA Venezuela – Delta Amacuro

BA Brazil – Amazonas

RO Brazil – Roraima

PA Brazil – Pará

AP Brazil – Amapá

GU Guyana

SU Surinam

FG French Guiana

The toad *Rhaebo nasicus* (Figure 5-18) is endemic to western Guyana and the Bolívar State of Venezuela and is common at Aurora, although its known elevation range is stated as being from 500 to 1,350 masl (Hoogmoed & MacCulloch, 2004). With an estimated range of approximately 62,700 km<sup>2</sup> according to IUCN GIS data, it is not considered to have a restricted range. IUCN considers this species to be of least concern.

*Figure 5-18. Rhaebo nasicus toad at Aurora Concession, May 2009.*



Source: Langstroth/ERM, 2009

As with other vertebrate groups, most of the endemic non-avian reptiles<sup>4</sup> of Guyana are restricted to the highlands. The monotypic lizard genera *Kaieteurosaurus* and *Pantepuisaurus* are endemic to certain mountains of western Guyana, but these are not known from the lowlands of the Guianan Moist Forests Ecoregion. It should be noted that the state of knowledge regarding the squamate reptiles – lizards, amphisbaenids, and snakes – is far inferior to that of amphibians, birds, and mammals. No systematic assessments of their conservation status and distributions have been completed to date for South America, Amazonia, or the Guiana Shield region.

Avila-Pires (2005) provided a list of the Guiana Shield reptiles which indicates the species considered as endemic (defined by that work as “when distribution is restricted to relatively small areas within the region”). The Guiana Shield region endemics known to occur in Guyana are listed in the following table.

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(4) For purposes of scientific accuracy, the term “non-avian reptiles” to include the chelonians (turtles and tortoises), crocodylians, and squamata (lizards, snakes, amphisbaenia) is used here in recognition of the fact that birds are reptiles and represent the last living lineage of the dinosaurs.

**Table 5-17. Non-avian Reptiles Endemic to Guiana Shield Region and known to be present in Guyana (adapted and updated from Avila-Pires, 2005)**

Scientific Name	Distribution	GMFE Endemic?	2009 IUCN Red List
<i>Amphisbaena stejnegeri</i> Ruthven, 1922	GU - Known only from Demerara, Vreed en Rust (06°27'N, 58°19'W)	Yes	NE*
<i>Arthrosaura guianensis</i> MacCulloch & Lathrop, 2001	GU - Mount Ayanganna, Pakaraima Mountains	No	NE
<i>Atractus favae</i> (Filippi, 1840)	GU SU	Yes?	NE
<i>Atractus tamessari</i> Kok, 2006	GU - Known only from along a tributary of Elinkwa River, ESE Kaieteur National Park, 500 m elevation, Potaro-Siparuni District	No	NE
<i>Dipsas pakaraima</i> MacCulloch & Lathrop, 2004	GU - NE plateau of Mt. Ayanganna 5°24' N, 59°57' W, 1490 m elevation, Guyana	No	NE
<i>Echinosaura sulcarostrum</i> Donnelly, MacCulloch, Ugarte & Kizirian, 2006	GU - Known only from Baramita, approximately 1 km S airstrip, 07°22'N, 060°29'W, elevation 100 m	Yes	NE
<i>Gonatodes alexandermendesi</i> Cole & Kok, 2006	GU - Known only from drainage system of the Konawaruk River, Kaieteur National Park, on the Potaro River. Type locality: Magdalen's Creek Camp, near (275 m north) the northwest bank of the Konawaruk River (40 km [linear] WSW Mabura Hill), 120 m elevation, 5°13'07"N, 59°02'43"W	Yes?	NE
<i>Gymnophthalmus leucomystax</i> Vanzolini & Carvalho, 1991	RO GU - Rio Branco-Rupununi Savannas	No	NE
<i>Gymnophthalmus vanzoi</i> Carvalho, 1997	RO GU - Rio Branco-Rupununi Savannas	No	NE
<i>Kaieteurosaurus hindsi</i> Kok, 2005	GU - Edge of plateau 1,200 m north of Kaieteur Falls, 420 m elevation.	No	NE
<i>Pantepuisaurus rodriguesi</i> Kok, 2009	GU - Summit plateau of Mount Maringma, Cuyuni-Mazaruni District, Guyana (05° 12' 57"N, 060° 35' 07"W, 2,080 m).	No	NE
<i>Riolama leucosticta</i> (Boulenger, 1900)	RO GU - Highlands	No	NE

\*NE = Not Evaluated.

Note: Distribution codes:

CG Colombian Guayana  
 VA Venezuela – Amazonas  
 BO Venezuela – Bolívar  
 DA Venezuela – Delta Amacuro  
 BA Brazil – Amazonas  
 RO Brazil – Roraima  
 PA Brazil – Pará  
 AP Brazil – Amapá  
 GU Guyana  
 SU Surinam  
 FG French Guiana

The Cuyuni-Mazaruni lowlands are not included in either of Guyana’s Endemic Bird Areas, the Rio Branco Gallery Forests in the Rupununi Savannas near the Brazilian border, or the Tepuis in the Guiana Shield Highlands. While there are many bird species endemic to the Guiana Shield region, most of these are highland species and not endemic to the Guiana Moist Forests Ecoregion, as summarized in the following table (Table 5-18).

*Table 5-18. Guiana Shield Endemic Birds (after Milensky et al., 2005)*

Scientific Name	Common Name	Distribution	GMFE Endemic?	2009 IUCN Red List
<i>Crypturellus ptaritepui</i> Zimmer & Phelps, 1945	Tepui Tinamou	BO	No	LC
<i>Penelope marail</i> (Muller, 1776)	Marail Guan	BO RO-BA PA-AP GU SU FG	No	LC
<i>Mitu tomentosum</i> (Spix, 1825)	Crestless Curassow	VA BO RO-BA GU - ALSO COLOMBIA	No	LC
<i>Crax alector</i> Linnaeus, 1766	Black Curassow	VA BO RO-BA PA- AP GU SU FG	No	LC
<i>Aratinga solstitialis</i> (Linnaeus, 1758)	Sun Parakeet	BO? RO-BA GU? SU FG	No	EN
<i>Pyrrhura egregia</i> (Sclater, 1881)	Fiery-shouldered Parakeet	BO RO-BA GU	No	LC
<i>Nannopsittaca panychlora</i> (Salvin & Godman, 1883)	Tepui Parrotlet	VA BO GU	No	LC
<i>Pionites melanocephalus</i> (Linnaeus, 1758)	Black-headed Parrot	VA BO RO-BA PA- AP GU SU FG	No	LC
<i>Gypopsitta caica</i> (Latham, 1790)	Caica Parrot	BO RO-BA PA-AP GU SU FG	No	LC
<i>Neomorphus rufipennis</i> (Gray, 1849)	Rufous-winged Ground-Cuckoo	VA BO RO-BA PA- AP GU	No	LC

Scientific Name	Common Name	Distribution	GMFE Endemic?	2009 IUCN Red List
<i>Caprimulgus whitelyi</i> (Salvin, 1885)	Roraiman Nightjar	VA BO RO-BA GU	No	LC
<i>Streptoprocne phelpsi</i> Collins, 1972	Tepui Swift	VA BO RO-BA GU	No	LC
<i>Campylopterus hyperythrus</i> Cabanis, 1848	Rufous-breasted Sabrewing	BO RO-BA GU	No	LC
<i>Campylopterus duidae</i> Chapman, 1929	Buff-breasted Sabrewing	VA BO RO-BA	No	LC
<i>Lophornis pavoninus</i> Salvin & Godman, 1882	Peacock Coquette	VA BO RO-BA GU	No	LC
<i>Polytmus milleri</i> (Chapman, 1929)	Tepui Goldenthrout	VA BO RO-BA GU	No	LC
<i>Heliodoxa xanthogonyx</i> Salvin & Godman, 1882	Velvet-browed Brilliant	VA BO RO-BA GU	No	LC
<i>Galbula albirostris</i> Latham, 1790	Yellow-billed Jacamar	VA BO RO-BA PA- AP GU SU FG	No	LC
<i>Notharchus macrorhynchos</i> (J. F. Gmelin, 1788)	Guianan Puffbird	VA BO RO-BA PA- AP GU SU FG	No	LC
<i>Monasa atra</i> (Boddaert, 1783)	Black Nunbird	VA BO RO-BA PA- AP GU SU FG	No	LC
<i>Selenidera culik</i> (Wagler, 1827)	Guianan Toucanet	BO RO-BA PA-AP GU SU FG	No	LC
<i>Picumnus minutissimus</i> (Pallas, 1782)	Guianan Piculet	SU FG - ALSO GU (NatureServe)	Yes	LC
<i>Veniliornis sanguineus</i> (Lichtenstein, 1793)	Blood-colored Woodpecker	GU SU FG	Yes	LC
<i>Veniliornis cassini</i> (Malherbe, 1862)	Golden-collared Woodpecker	VA BO RO-BA PA- AP GU SU FG	No	LC
<i>Cranioleuca demissa</i> (Salvin & Godman, 1884)	Tepui Spinetail	VA BO RO-BA GU	No	LC
<i>Thripophaga cherriei</i> Berlepsch & Hartert, 1902	Orinoco Softtail	VA	No	VU
<i>Roraimia adusta</i> (Salvin & Godman, 1884)	Roraiman Barbtail	VA BO RO-BA GU	No	LC
<i>Frederickena viridis</i> (Vieillot, 1816)	Black-throated Antshrike	BO RO-BA PA-AP GU SU FG	No	LC
<i>Sakesphorus melanothorax</i> (Sclater, 1857)	Band-tailed Antshrike	PA-AP GU SU FG	No	LC

Scientific Name	Common Name	Distribution	GMFE Endemic?	2009 IUCN Red List
<i>Thamnophilus insignis</i> Salvin & Godman, 1884	Streaked-backed Antshrike	VA BO RO-BA GU	No	LC
<i>Myrmotherula guttata</i> (Vieillot, 1825)	Rufous-bellied Antwren	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Myrmotherula gutturalis</i> Sclater & Salvin, 1881	Brown-bellied Antwren	BO RO-BA PA-AP GU SU FG	No	LC
<i>Herpsilochmus sticturus</i> Salvin, 1885	Spot-tailed Antwren	BO PA-AP GU SU FG	No	LC
<i>Herpsilochmus stictocephalus</i> Todd, 1927	Todd's Antwren	BO PA-AP GU SU FG	No	LC
<i>Herpsilochmus roraimae</i> Hellmayr, 1903	Roraiman Antwren	VA BO RO-BA GU	No	LC
<i>Cercomacra carbonaria</i> Sclater & Salvin, 1873	Rio Branco Antbird	RO-BA GU	No	NT
<i>Percnostola rufifrons</i> (J. F. Gmelin, 1789)	Black-headed Antbird	VA RO-BA PA-AP GU SU FG	No	LC
<i>Gymnopithys rufigula</i> (Boddaert, 1783)	Rufous-throated Antbird	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Myrmothera simplex</i> (Salvin & Godman, 1884)	Tepui Antpitta	VA BO RO-BA GU	No	LC
<i>Elaenia dayi</i> Chapman, 1929	Great Elaenia	VA BO	No	LC
<i>Phylloscartes nigrifrons</i> (Salvin & Godman, 1884)	Black-fronted Tyrannulet	VA BO RO-BA GU	No	LC
<i>Phylloscartes chapmani</i> Gilliard, 1940	Chapman's Bristle-Tyrant	VA BO RO-BA GU	No	LC
<i>Phylloscartes virescens</i> Todd, 1925	Olive-green Tyrannulet	RO-BA GU SU FG	No	LC
<i>Hemitriccus josephinae</i> (Chubb, 1914)	Boat-billed Tody-Tyrant	RO-BA PA-AP GU SU FG	No	LC
<i>Poecilatriccus russatus</i> (Salvin & Godman, 1884)	Ruddy Tody-Flycatcher	BO RO-BA GU	No	LC
<i>Todirostrum pictum</i> Salvin, 1897	Painted Tody-Flycatcher	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Pipreola whitelyi</i> Salvin & Godman, 1884	Red-banded Fruiteater	BO GU	No	LC
<i>Lipaugus streptophorus</i> (Salvin & Godman, 1884)	Rose-collared Piha	BO RO-BA GU	No	LC

Scientific Name	Common Name	Distribution	GMFE Endemic?	2009 IUCN Red List
<i>Procnias albus</i> (Hermann, 1783)	White Bellbird	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Perissocephalus tricolor</i> (Muller, 1776)	Capuchinbird	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Rupicola rupicola</i> (Linnaeus, 1766)	Guianan Cock-of-the-Rock	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Xenopipo uniformis</i> Salvin & Godman, 1884	Olive Manakin	VA BO RO-BA GU	No	LC
<i>Corapipo gutturalis</i> (Linnaeus, 1766)	White-throated Manakin	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Pipra cornuta</i> Spix, 1825	Scarlet-horned Manakin	VA BO RO-BA GU	No	LC
<i>Lepidothrix suavisissima</i> (Salvin & Godman 1882)	Orange-bellied Manakin	VA BO RO-BA GU	No	LC
<i>Lepidothrix serena</i> (Linnaeus 1766)	White-fronted Manakin	RO-BA PA-AP GU SU FG	No	LC
<i>Tyrannetes virescens</i> (Pelzeln, 1868)	Tiny Tyrant-Manakin	BO RO-BA PA-AP GU SU FG	No	LC
<i>Neopelma chrysocephalum</i> (Pelzeln, 1868)	Saffron-crested Tyrant-Manakin	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Iodopleura fusca</i> (Vieillot, 1817)	Dusky Purpletuft	BO RO-BA GU SU FG	No	LC
<i>Hylophilus sclateri</i> Salvin & Godman, 1883	Tepui Greenlet	VA BO RO-BA GU	No	LC
<i>Troglodytes rufulus</i> Cabanis, 1849	Tepui Wren	VA BO RO-BA GU	No	LC
<i>Microcerculus ustulatus</i> Salvin & Godman, 1883	Fluting Wren	VA BO RO-BA GU	No	LC
<i>Microbates collaris</i> (Pelzeln, 1868)	Collared Gnatwren	VA BO RO-BA PA-AP GU SU FG	No	LC
<i>Cyanicterus cyanicterus</i> (Vieillot, 1819)	Blue-backed Tanager	BO RO-BA PA-AP GU SU FG	No	LC
<i>Diglossa major</i> Cabanis, 1849	Greater Flowerpiercer	BO RO-BA GU	No	LC
<i>Diglossa duidae</i> Chapman, 1929	Scaled Flowerpiercer	VA BO RO-BA	No	LC
<i>Mitrospingus oleagineus</i> (Salvin, 1886)	Olive-backed Tanager	BO RO-BA GU	No	LC

Scientific Name	Common Name	Distribution	GMFE Endemic?	2009 IUCN Red List
<i>Dolospingus fringilloides</i> (Pelzeln, 1870)	White-naped Seed-eater	VA RO-BA PA-AP GU	No	LC
<i>Atlapetes personatus</i> (Cabanis, 1848)	Tepui Brush-Finch	VA BO RO-BA GU	No	LC
<i>Emberizoides duidae</i> Chapman, 1929	Duida Grass-Finch	VA	No	NT
<i>Myioborus castaneocapillus</i> (Cabanis, 1849)	Tepui Redstart	VA BO RO-BA GU	No	LC
<i>Myioborus cardonai</i> Zimmer & Phelps, 1945	Saffron-breasted Redstart	BO	No	NT
<i>Myioborus albifacies</i> Phelps & Phelps, 1946	White-faced Redstart	VA	No	LC
<i>Macroagelaius imthurni</i> (Sclater, 1881)	Golden-tufted Grackle	VA BO RO-BA GU	No	LC
<i>Euphonia finschi</i> Sclater & Salvin, 1877	Finsch's Euphonia	BO RO-BA GU SU FG	No	LC
<i>Euphonia cayennensis</i> (J. F. Gmelin, 1789)	Golden-sided Euphonia	BO RO-BA PA-AP GU SU FG	No	LC

Note: DD – data deficient

LC - least concern

VU - vulnerable

EN - endangered

CR - critically endangered

NT - near threatened

Distribution codes:

CG Colombian Guayana

VA Venezuela – Amazonas

BO Venezuela – Bolívar

DA Venezuela – Delta Amacuro

BA Brazil – Amazonas

RO Brazil – Roraima

PA Brazil – Pará

AP Brazil – Amapá

GU Guyana

SU Surinam

FG French Guiana

The only bird species identified as Guiana Shield endemics by Milensky *et al.* (2005) that may be considered endemic to the Guianan Moist Forests Ecoregion are *Picumnus minutissimus* and *Veniliornis sanguineus*. Neither of these two species is considered to be threatened under the 2009 IUCN Red List. These two species are shown by NatureServe (2007) to occur in the easternmost portion of the

Cuyuni-Mazaruni District, but have not been reported within the Aurora Concession.

In their description of the Guianan Moist Forests Ecoregion, Schipper *et al.* (2001) state that the following mammal species are endemic to this ecoregion: *Marmosa lepida*, *Euphractus sexinctus*, *Saguinus midas*, *Pithecia pithecia*, *Ateles paniscus*, *Sciurillus pusillus*, *Oryzomys delicatus*, *Neacomys guianae*, *Sphiggurus insidiosus*, *Echimys chrysurus*, *Lophostoma schulzi*, and *Molossops neglectus*. However, based on the most recent distributional data from InfoNatura and the IUCN, none of these species should be considered endemic to the ecoregion, as summarized below.

*Marmosa lepida* is primarily an Andean species, but has an apparently disjunct population in Suriname. *Euphractus sexinctus* is found primarily in the open areas of central and southern South America, with only a small population in the savannas of Suriname. The primates *Ateles paniscus*, *Pithecia pithecia*, and *Saguinus midas* range from southern South America to the north bank of the Amazon River in Brazil and cannot be considered endemic to this ecoregion. *Sciurillus pusillus* has a wide but disjunct range in Amazonian Peru, Colombia, and Brazil, as well as the Guianas. *Oryzomys delicatus*, if a valid species, is a savanna species and cannot be considered endemic to the Guianan Moist Forests. *Sphiggurus insidiosus* is found only in the Atlantic forests and Caatinga of eastern Brazil; however, *Sphiggurus melanurus* is endemic to the Guianan Shield, but not to the GMFE. *Echimys chrysurus* is also found in southern South America to the Amazon River and to the south of the river in Marajó Island, Para and Maranhão, Brazil. *Molossops neglectus* has a poorly known distribution, but has been documented from scattered sites in southern Brazil, Peru, Colombia, Venezuela, Guyana, and Suriname.

Of the above listed species, the following two are most nearly endemic to the Guianan Moist Forests Ecoregion: the rat *Neacomys guianae*, which also occurs in the Guianan Piedmont and Lowland Moist Forests Ecoregion of Venezuela, and the bat *Lophostoma schulzi*, which also occurs in the Uatuma-Trombetas Moist Forests Ecoregion of northern Brazil. Neither of these two species has restricted-ranges and neither has been reported from the Project Area of Influence.

Lim *et al.* (2005) provided the most recent and comprehensive listing of the mammals considered endemic to the Guiana Shield, summarized in the following table.

**Table 5-19. Guiana Shield Endemic Mammals, after Lim et al. (2005)**

Scientific Name	Distribution	GMFE Endemic?	2009 IUCN Red List
<i>Didelphis imperfecta</i> Mondolfi & Pérez-Hernández, 1984	VA BO GU SU FG - ALSO BRAZIL	No	LC
<i>Marmosa tyleriana</i> Tate, 1931	VA BO - Highlands	No	DD
<i>Monodelphis breviceaudata</i> (Erxleben, 1777)	VA BO GU SU FG - ALSO BRAZIL	No	LC
<i>Monodelphis reigi</i> Lew & Pérez-Hernández, 2004	BO GU - Highlands	No	VU
<i>Philander</i> sp. Lew & Pérez-Hernández, ined.	DA	No	NE
<i>Lonchorhina fernandezi</i> Ochoa & Ibáñez, 1982	VA BO - Lowlands	No	EN
<i>Lophostoma schulzi</i> (Genoways & Williams, 1980)	GU SU FG - ALSO BRAZIL	No	LC
<i>Platyrrhinus aurarius</i> (Handley & Ferris, 1972)	VA BO GU SU - Highlands - ALSO BRAZIL	No	LC
<i>Lasiurus atratus</i> Handley, 1996	BO GU SU FG - Lowlands	No	LC
<i>Molossus barnesi</i> Thomas, 1905	FG	Yes	DD
<i>Ateles paniscus</i> (Linnaeus, 1758)	GU SU FG - Lowlands - ALSO BRAZIL	No	VU
<i>Pithecia pithecia</i> (Linnaeus, 1766)	VA BO DA GU SU FG - ALSO BRAZIL	No	LC
<i>Sciurus flammiifer</i> Thomas, 1904	BO - Lowlands	No	DD
<i>Neacomys dubosti</i> Voss et al., 2001	SU FG - Lowlands - ALSO BRAZIL	No	LC
<i>Neacomys guianae</i> Thomas, 1905	VA BO GU SU - ALSO BRAZIL	No	LC
<i>Neacomys paracou</i> Voss et al., 2001	BO GU SU FG - ALSO BRAZIL	No	LC
<i>Neusticomys oyapocki</i> (Dubost & Petter, 1978)	FG - Lowlands - ALSO BRAZIL	Yes	DD
<i>Oecomys auyantepui</i> Tate, 1939	BO GU SU FG - ALSO BRAZIL	No	LC
<i>Oecomys rex</i> Thomas, 1910	BO GU SU? FG - ALSO BRAZIL	No	LC
<i>Oecomys rutilus</i> Anthony, 1921	BO GU SU FG - ALSO BRAZIL	No	LC
<i>Podoxymys roraimae</i> Anthony, 1929	BO GU - Highlands	No	VU
<i>Rhipidomys macconnelli</i> de	VA BO GU - Highlands -	No	LC

Scientific Name	Distribution	GMFE Endemic?	2009 IUCN Red List
Winton, 1900	ALSO BRAZIL		
<i>Rhipidomys wetzeli</i> Gardner, 1990 (1989)	VA BO GU - Highlands	No	LC
<i>Sphiggurus melanurus</i> (Wagner, 1842)	VA BO DA GU SU FG - ALSO BRAZIL	No	LC
<i>Dasyprocta guamara</i> Ojasti, 1972	DA	No	NT
<i>Isithrix sinnamariensis</i> Vié et al., 1996	GU FG - Lowlands	Yes	LC
<i>Proechimys hoplomyoides</i> (Tate, 1939)	VA BO GU - Highlands - ALSO BRAZIL	No	DD

Note: DD – data deficient

LC - least concern

VU - vulnerable

EN - endangered

CR - critically endangered

NT - near threatened

Distribution codes:

CG Colombian Guayana

VA Venezuela – Amazonas

BO Venezuela – Bolívar

DA Venezuela – Delta Amacuro

BA Brazil – Amazonas

RO Brazil – Roraima

PA Brazil – Pará

AP Brazil – Amapá

GU Guyana

SU Surinam

FG French Guiana

Based on the distributions mapped by the IUCN and NatureServe, none of the three mammal species that are endemic to the Guianan Moist Forests Ecoregion - *Molossus barnesi*, *Neusticomys oyapocki*, and *Isithrix sinnamariensis* - are expected to occur in or near the Cuyuni and Mazaruni basins.

#### *Migratory and Congregatory Species*

While the Atlantic coastline of northwestern Guyana (i.e., Shell Beach) is an important area for nesting congregations of sea turtles, the interior lowlands of northern Guyana are not known to be critical habitats for any migratory or congregatory species. The Project Area of Influence does not include any significant areas of open wetland habitats where congregatory species are known to assemble.

The Cuyuni River itself is a migration corridor for some fish species, including *Phractocephalus hemiliopterus*, *Prochilodus rubrotaeniatus*, *Pseudoplatystoma* sp., and *Sorubim elongatus*. However, there is no information available on the ecology, conservation status, or socioeconomic importance of the migratory fish species in the Cuyuni River in Guyana. It is known that the Venezuelan portion of the Upper Cuyuni Basin has been severely degraded in many areas due to mining activities that have released sediments and mercury into the river systems (Machado-Allison *et al.*, 2000).

#### *Unique Assemblages of Species and Key Evolutionary Processes*

The IFC's ToR requires the discussion of the importance of the landscape study area and the particular habitats in which the project concession may be sited with respect to the following phenomena:

- Transitional (ecotone) habitat or other landscape features of potential importance to speciation;
- Unique assemblages of species associated with this altitude including those of very unique phylogeny;
- Other landscape features of importance to evolutionary processes;
- Wildlife corridors; and,
- Any other outstanding ecological features or functions of the landscape and/or the project concession site of critical importance to maintaining regional biodiversity.

The habitats present in landscape containing the Project Area of Influence are rather uniform and, as a result, there are no significant transitional habitats or ecotones that are of potential importance to speciation. This region of Guyana does not have pockets or belts of herbaceous wetlands, savannas, or dry forest formations. While there is some heterogeneity in the nature of the soils due to variations in geologic parent materials, such as granitic outcrops versus recent alluvium, these features are present across the regional landscape mosaic and there are no known edaphically restricted plant assemblages or micro-endemic species in the region.

In contrast to the Guiana Shield Highlands that support unique assemblages of endemic species, especially above 1,500 m, the Aurora Concession and the surrounding landscape are lowland ecosystems with elevations not exceeding 200 m and which are characterized by the dominance of widespread Guianan-Amazonian biota.

There are no recognized unique assemblages or species of unique phylogeny associated with the landscape of the Aurora Concession. This absence of unique assemblages and lineages reflects the absence of isolated landscape features of importance to evolutionary processes, such as caves, plateaus, springs, barrens, or lagoons, as well as the absence of major barriers to dispersal such as high mountain ranges, expansive open vegetation formations, or larger rivers.

The Cuyuni River itself is an important ecological and biogeographic corridor for aquatic and riverine terrestrial biota, linking the eastern Venezuelan Guayana highlands with the lower Essequibo Basin, as well with Amazonia via the Rupununi flood savannas mixing zone. Guyana is unique among the three Guianan countries for the presence of numerous Amazonian fishes absent from Suriname and French Guiana, such as the giant *Arapaima gigas*.

There are no outstanding terrestrial ecological features or functions of the landscape and/or the project concession site of critical importance to maintaining regional biodiversity. The ecological features and functions of the Aurora Concession and the surrounding area are replicated across the Cuyuni and Mazaruni lowlands and the rest of the Guianan Lowland Moist Forests ecoregion.

#### *Species of Significant Social, Economic or Cultural Importance to Local Communities*

Given that there are no local communities in the Area of Direct Impact, with the exception of the households in the Buckhall area, the species present in the area are not of current social, economic, or cultural importance. While there are species of potential commercial and subsistence value in the Project Area of Influence, these are not present within the zones of traditional use by any known communities other than hunting and fishing by small-scale miners or individuals involved in the supplying of fish and bushmeat to the small-scale miners.

### **5.3.4**

#### ***Ecosystem Services***

The habitats of the study area provide the types of ecosystem services associated with forested lands, including sequestration of carbon, aquifer recharge, watershed regulation, and provision of timber and non-timber forest products. Given the absence of significant human settlements in the vicinity of the Aurora Concession, there are few direct beneficiaries for the ecosystem services associated with habitats in the Area of Direct Impact. None of the ecosystem services associated with the Aurora Concession is unique to the concession nor is any of these services of any disproportionately greater magnitude than in surrounding areas.

The only settlements in the vicinity (<30 km) of the Aurora Concession consist of small-scale mining camps and service centers. While inhabitants of these settlements likely practice some hunting and fishing activities to supplement their diet with fresh bushmeat and fish, none of these settlements are known to utilize any natural resources within the Aurora Concession itself, let alone the mined portions of the concession site.

### 5.3.5 *Biodiversity Characterization of the Area of Direct Impact*

An initial baseline of the Aurora Concession was performed by local biologists in cooperation with WWF-Guyana in 2006 and 2007. A subsequent assessment was made in 2009 by a team of Guyanese biologists, which included an aquatic biologist, a herpetologist, an ornithologist, and a mammals and vegetation specialist. The data from these field surveys are presented in Annex 2 and are summarized in the following sections. An experienced Guianas wildlife biologist and giant otter specialist, Dr. Nicole Duplaix, performed an additional field survey along the Cuyuni River in October 2009. The findings of Dr. Duplaix's independent assessment are presented in full in Annex 3, *Bio-Assessment of the Cuyuni River near Aurora, Guyana, Environmental and Economic Implications*.

The sites contemplated for potential hydropower developments upriver of the Aurora Concession in the Devil's Hole area and the Julian Ross Itabu have not been surveyed in detail under the scope of the present ESIA. If Guyana Goldfields decides to pursue these developments in the future, the respective ESIA's must be performed.

Field survey data on the access road alignment and the wharf area are provided in Sections 5.3.7 and 5.3.8, respectively.

#### 5.3.6.1 *Vegetation and Flora*

The Aurora Concession, as well as the wharf and access road areas, was completely forested prior to initiation of mining and logging activities in the region. This part of Guyana does not support appreciable natural open or herbaceous formations such as savannas or marshes. Species identified within this area are common to fairly common to this area and within the brown sand/swamp forest biogeographic province of Guyana. None of the plant species identified in the Aurora concession are known to be endangered, locally endemic, or of significance to any local human communities.

The variations in natural forest composition are related to the topographic position in the local landscape (*see Figures 5-19 to 5-21*). Four basic units may be

identified: riverine forests along the Cuyuni River and its narrow floodplain; riparian forests along the small streams and stream valley floors; hillslope forests; and ridge and hilltop forests. None of these forest types are geographically restricted within the greater landscape region. An exceptional type of vegetation with more restricted distribution in the area is the manicole palm (*Euterpe oleracea*) swamp. The riverine forests along the Cuyuni River are dominated by flood-tolerant species, especially various species of *Inga*, *Mora*, and *Triplaris*. The mora tree (*Mora excelsa*), a large legume with buttress roots, is typical of the floodplain forests. On the hillslopes, it is replaced by its congener *M. gonggrijpii*. The largest trees overall tend to be found on the more stable ridge and hilltop forests.

**Figure 5-19.** Secondary vegetation in Golden Mile area of the Aurora Concession, March 2009. Source: Langstroth/ERM, 2009



*Figure 5-20. Streamside floodplain forest with Mora excelsa trees, Aurora Concession, March 2009. Source: Langstroth/ERM, 2009*



*Figure 5-21. Ridgetop forest in Aurora Concession, March 2009. Source: Langstroth/ERM, 2009.*



### 5.3.6.2

#### *Fish*

No previous systematic fish sampling had been done at the Cuyuni River in Guyana prior to the 2006-2007 surveys. However, in Venezuela, 135 species of fish were documented occurring along the Cuyuni and its tributaries in lowland Venezuela (Machado-Allison *et al.*, 2000). A photograph of a typical fish within the Cuyuni River is provided in *Figure 5-22*.

*Figure 5-22. Hoplias malabaricus (haimara) caught by small-scale miners at camp near Alligator Creek in concession adjacent to the Aurora Concession, April 2009. Source: Langstroth/ERM, 2009*



A total of fish 59 species were reported by the 2006, 2007, and 2009 surveys (Annex 2). None of the species reported are known to be endemic to Guyana or the Cuyuni river basin.

Although 45 species of fish were collected in 2009, only a few individuals were collected per species. The sampled tributaries of the Julian Ross Itabu were heavily contaminated from tailings runoff and oil from operations further upstream, which resulted in significant sedimentation and possibly depleted water quality. At one particular creek, the sedimentation was so severe that no species were collected during sampling. A photograph of a sediment-laden stream in the vicinity of the project site is provided in *Figure 5-23*.

*Figure 5-23. Fine sediment along lower reach of Alligator Creek, affected by upstream small-scale mining, April 2009. Source: Langstroth/ERM, 2009*



### 5.3.6.3

#### *Amphibians*

A total of 31 species of amphibians from eight families were reported by the 2006, 2007, and 2009 surveys. All of the species encountered are common to the wider geographic area of Guyana and many are found across the entire Guianan-Amazonian lowlands region. None of the species reported are endemic to Guyana or categorized as threatened. A photograph of a typical amphibian found within the Aurora Concession is provided in *Figure 5-24*.

*Figure 5-24. Allobates femoralis, an abundant forest floor frog in the Aurora Concession, April 2009. Source: Langstroth/ERM, 2009*



#### 5.3.6.4 *Non-Avian Reptiles*

A total of 46 species of non-avian reptiles within 17 families were reported by the 2006, 2007, and 2009 surveys. All of the species identified are common to the wider geographic area of Guyana and most are found across the entire Guianan-Amazonian lowlands region. The presence of savanna species (e.g. *Kentropyx* cf. *borckiana*, *Kentropyx striata*, *Cnemidophorus* spp.) reported by the 2006 and 2007 surveys was not validated by the 2009 survey team. None of the species reported are endemic to Guyana or categorized as threatened. A photograph of a typical non-avian reptile found within the Aurora Concession is provided in *Figure 5-25*.

*Figure 5-25. Anolis nitens, a common forest floor lizard in the Aurora Concession, April 2009. Source: Langstroth/ERM, 2009*



#### 5.3.6.5

##### *Birds*

A total of 215 bird species from 50 families were reported by the 2006, 2007, and 2009 surveys. The 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. Point counts and opportunistic mist netting were also conducted.

The 2006 and 2007 field data (Annex 2) indicated the presence of the sun parakeet (*Aratinga solstitialis*), an endangered species under the 2009 IUCN Red List. However, this species is not known to inhabit the Cuyuni River Basin and is associated with dry forest hills surrounding the Rupununi Savannas and areas of adjacent Brazil. No sun parakeets were observed during the 2009 surveys.

The only other species with an IUCN category other than “least concern” reported by the surveys was the harpy eagle (*Harpia harpyja*). An adult and juvenile were reported by the 2009 survey in the vicinity of the proposed TMA.

A total of ten migratory species was reported from the 2006, 2007, and 2009 surveys (see Table 5-20). Of these, five are austral migrants, four are Nearctic migrants, and one has a complex migration pattern.

**Table 5- 20.** Migratory bird species reported from the Aurora Concession during the 2006, 2007, and 2009 field surveys. Source: Braun et al., 2000

Scientific Name	Common Name	IUCN Category	Migratory Pattern
<i>Elanoides forficatus</i>	Swallow-tailed Kite	LC	COMPLEX
<i>Coccyzus americanus</i>	Yellow-billed Cuckoo	LC	NEARCTIC
<i>Progne tapera</i>	Brown-chested Martin	LC	AUSTRAL
<i>Actitis macularius</i>	Spotted Sandpiper	LC	NEARCTIC
<i>Tringa solitaria</i>	Solitary Sandpiper	LC	NEARCTIC
<i>Legatus leucophaeus</i>	Piratic Flycatcher	LC	AUSTRAL
<i>Tyrannus albogularis</i>	White-throated Kingbird	LC	AUSTRAL
<i>Tyrannus dominicensis</i>	Gray Kingbird	LC	NEARCTIC
<i>Tyrannus melancholicus</i>	Tropical Kingbird	LC	AUSTRAL
<i>Tyrannus savana</i>	Fork-tailed Flycatcher	LC	AUSTRAL

Note: LC - least concern

In addition, eight species were recorded as endemics to the Guianan Shield (per Milensky et al., 2005), none of which is considered to be threatened or range-restricted (i.e., range of less than 50,000 km<sup>2</sup>) (Table 5-21).

**Table 5-21.** Guianan Shield endemic bird species reported from the Aurora Concession during the 2006, 2007, and 2009 field surveys. Source: Milensky et al., 2005

Scientific Name	Common Name	IUCN Category	Estimated Range Size
<i>Cyanocorax cayanus</i>	Cayenne Jay	LC	1,160,000 km <sup>2</sup>
<i>Perissocephalus tricolor</i>	Capuchinbird	LC	1,660,000 km <sup>2</sup>
<i>Crax alector</i>	Black Curassow	LC	2,100,000 km <sup>2</sup>
<i>Pionites melanocephalus</i>	Black-headed Parrot	LC	2,920,000 km <sup>2</sup>
<i>Pyrilia caica</i>	Caica Parrot	LC	1,290,000 km <sup>2</sup>
<i>Pteroglossus viridis</i>	Green Aracari	LC	1,560,000 km <sup>2</sup>
<i>Myrmotherula gutturalis</i>	Brown-bellied Antwren	LC	1,090,000 km <sup>2</sup>

Note: LC - least concern

### 5.3.6.6

#### **Mammals**

A total of 37 mammalian species from 20 families were reported by the 2006, 2007, and 2009 surveys (Annex 2). The methodologies used for the identification of mammals were visual encounter surveys (VES), track and scat identification, mist netting for bats and opportunistic sightings.

While the 2006/2007 surveys reported four or five species of primates, the 2009 surveys indicated only low numbers of howlers and capuchins. In undisturbed regions of the Guianas with similar habitats, primates are generally abundant. A

photograph of a typical mammal found within the Aurora Concession is provided in Figure 5-26.

**Figure 5-26.** Guiana red howler monkeys (*Alouatta macconnelli*) along Cuyuni River across from Aurora Concession, May 2009. Source: Langstroth/ERM, 2009



As mentioned above, a single giant otter (*Pteronura brasiliensis*) was observed swimming in the Cuyuni River in front of the Aurora Concession in the May 2009 field surveys. An otter sighting was also reported in the 2006/2007 baseline surveys. No additional individuals or any otter dens were identified within the survey area. It is possible that the individual observed was a lone male that was passing through the area. None of the persons interviewed at the Aurora camp or the adjacent garimpeiro camp had observed giant otters in the project area. This otter is classified as an endangered species on the IUCN Red List. It was recommended that further studies be done to determine whether there were any resident populations within the project area, identify the location of any dens, estimate the population size, and assess potential impacts of the mining on this species, if present.

As a result, internationally-recognized giant otter specialist Dr. Nicole Duplaix was retained to provide a field assessment for the giant otter in the Project Area of Influence (Annex 3). The field assessment was performed 13-22 October 2009. No evidence for recent inhabitation by giant otters was found. Previous reports (2006/2007, 2009) are interpreted as transient males.

It is believed that the presence of small-scale mining and logging in the Project Area of Influence has led to a reduction in the abundance of large mammals due to hunting and disturbance (see Annex 3 for detailed discussion). The presence of exploration activities in the Aurora Concession has also likely led to the retreat of more sensitive species due to noise and activity (such as frequent use of ATVs on trails).

### 5.3.7 *Biodiversity Characterization of the Area of the Access Road Area*

#### 5.3.7.1 *General Methodology*

A rapid biodiversity assessment was undertaken of the access road alignment over a five day period commencing on February 08, 2010. The survey was undertaken to compile information on floral and faunal resources on the access road alignment.

Prior to the commencement of field work, a literature review was conducted on the flora and fauna of the Cuyuni- Mazaruni area of Guyana. Field surveys were conducted at 5 km intervals on the access road alignment and progressed to distance of 0.5 km on either side of the access road. During the survey particular emphasis was placed on species of conservation interest or sites of conservation value. Direct observations were used to determine the species composition in areas along the proposed road.

Surveys were conducted at the following points determined by GPS:

1. E 0196369 N 0751118
2. E 0199202 N 0748023
3. E 0203204 N 0745806
4. E 0205983 N0745128
5. N06° 53 14.5 W058° 34 51.8
6. N06° 53 14.5 W058° 34 51.8
7. N06° 44 44.8 W059° 32 59.2
8. N06° 45 09.4 W059° 34 01.0

#### 5.3.7.2 *Flora*

Biogeographically, the Aurora/Cuyuni Area lies within the Brown Sand Forest and Swamp Forests with mora (*Mora excelsa*) being the dominant species. The Mora forests are located on alluvial silt, clay or loam along rivers and on riverine flats throughout the lowland region. Generally, the area is considered as Mixed Lowland Forests with morabukea (*Mora gonggripii*) forest found on laterite areas,

less frequently it is encountered on sandy loam or on brown sand. It occurs on undulating terrain with slopes in the near interior, east of the Cuyuni River.

The methodologies used for floral survey included 1 km transects, with 50m x 50m subplots at every 100m, creating a herring bone formation. Within the 50m x 50m main plots, sub plot measuring 10m x 10m square were also established. In the main plots (50m x 50m), all trees measuring 20 cm DBH and above were recorded. In the sub plots all trees and saplings measuring 19.9 cm DBH and less were recorded. Species identified within this area are common to fairly common to this area and within the brown sand/swamp forest biogeographic province of Guyana.

The floral survey was designed to identify the various plant communities and species on the access road alignment. Plants that were unidentifiable in the field were collected as voucher specimens and bark, stem, fruits and floral parts were also collected for trees, vines or shrubs that were unidentifiable. The collected specimens were subsequently identified, after the survey team returned to Georgetown, by comparison with herbarium material at the Guyana Forestry Commission and the Centre for the Study of Biological Diversity, University of Guyana, and available literature. Plant species identified during the survey were recorded in a notebook. Observations were also made of the ecosystems present within the area of influence.

A total of sixty five species of plants representing thirty (30) families were documented along the access road area. The most dominant family in terms of species diversity was Caesalpiniaceae. This family was represented by six species. Plants along the proposed road alignment are common throughout the area and little variation was seen in the ecosystems except those that occurred in swampy areas. Palms and sedges were abundant around swampy areas. Baromali, countaballi, morabukea, wallaba and trysil were common at plots along the access road. These were also abundant in the survey area. No endemic species were recorded. The forest is intact in most of the areas surveyed, except in those areas cleared for the construction of the road.

Shrubs, small trees, vines and grasses were particularly abundant at the sample plot closest to the right bank of the Cuyuni River. Two *Cecropia* species were plentiful in this area and a large number of manicole and turu palm were also observed. The subsequent transects were characterised by predominately undisturbed forests, except for the small area that was cleared for the access road. Plants in the overstory had an estimated height of 30 m. A few species of fungi were observed growing on fallen trees. Epiphytes were observed to be associated with a number of trees in the sample plots

Some tree species were either fruiting or flowering. The seeds of *Licania alba* were especially plentiful on the forest floor. A few monkey pot and crabwood seeds and tonka bean pods were observed. The survey period was characterised by dry sunny days. The soil was very dry indicating the lack of rainfall over an extensive period of time. A list of plant species recorded along the access road is presented in (Table 5-22).

**Table 5-22. Plant species recorded along the Access Road Alignment**

Common Name	Scientific Name	Family
Epiphytes	Unidentified	-
Duka	<i>Tapirira obtusa</i>	Anacardiaceae
Yarri Yarri (black)	<i>Unonoposis glaucopetala</i>	Annonaceae
Yarri-yarri	<i>Duguettia pycnasteria</i>	Annonaceae
Dukali	<i>Parabancomia fasciculata</i>	Apocynaceae
Gum tree	<i>Sapium paucinerivium</i>	Apocynaceae
Nibi	<i>Heteropsis flexuosa</i>	Araceae
Batric palm	Unidentified	Arecaceae
Manicole	<i>Euterpe edulis</i>	Arecaceae
Turu palm	<i>Jessenia bataua</i>	Arecaceae
Fuiti	<i>Jacaranda copaia</i>	Bignoniaceae
Baromalli	<i>Catostemma commune</i>	Bombacaceae
Kurokai	<i>Protium decandrum</i>	Bursерaceae
Mora	<i>Mora excelsa</i>	Caesalpiniaceae
Morabukea	<i>Mora gonggripii</i>	Caesalpiniaceae
Purple Heart	<i>Peltogyne venosa</i>	Caesalpiniaceae
Wallaba (Ituri)	<i>Eperua grandiflora</i>	Caesalpiniaceae
Wallaba (soft)	<i>Eperua falcata</i>	Caesalpiniaceae
Monkey ladder	<i>Bauhinia suranamensis</i>	Caesalpinioideae
Kabukalli	<i>Goupia glabra</i>	Celastraceae
Burada	<i>Parinari rodolphii</i>	Chrysobalanaceae
Counta ( fine leaf)	<i>Licana alba</i>	Chrysobalanaceae
Countaballi	<i>Licania alba</i>	Chrysobalanaceae
Kautaballi	<i>Licania alba</i>	Chrysobalanaceae
Fukadi	<i>Buchenavia fanshawei</i>	Combretaceae
Sedge	Unidentified	Cyperaceae
Fern	<i>Touroulia guianensis</i>	Dryopteridaceae
Fern	<i>Polybtrya caudata</i>	Dryopteridaceae
Bara bara	<i>Diospyros ierensis</i>	Ebenaceae
Bread and cheese	<i>P. unguis</i>	"Fabaceae"
Wild tamarind	Unidentified	"Fabaceae"
Blood wood	<i>Vismia guianensis</i>	Guttiferae
Clusia	<i>Clusia amazonica</i>	Guttiferae
Kufa	<i>Clusia grandiflora</i>	Guttiferae
Wild mango	<i>Tovomita obovata</i>	Guttiferae
Heliconia	<i>Heliconia pendula</i>	Heliconiaceae

Yuruwe	<i>B. humilis</i>	Lauraceae
Kakaralli (common black)	<i>Eschweilera sagotiana</i>	Lecythidaceae
Kakaralli (Fine leaf)	<i>Eschweilera wachenheimii</i>	Lecythidaceae
Karakalli (black)	<i>Eschweilera pedicellata</i>	Lecythidaceae
Karakalli (smooth leaf)	<i>Eschweilera</i>	Lecythidaceae
Monkey pot	<i>Lecythis zabucajo</i>	Lecythidaceae
Mukru	<i>Ischnoiphon arouma</i>	Marantaceae
Mukuru	<i>Miconia guianensis</i>	Melastomataceae
Waraia	<i>Merianja urceolata</i>	Melastomataceae
Crabwood	<i>Carapa guianensis</i>	Meliaceae
Trysil	<i>Pentaclethra macroloba</i>	Mimosaceae
Maporkon	<i>Inga alba</i>	Mimosaceae
Conga pump (common)	<i>Cecropia obtusa</i>	Moraceae
Conga pump(long leaf)	<i>Cecropia sciadophylla</i>	Moraceae
Dalli	<i>Virola elongata</i>	Myristicaceae
Duru	<i>Annona symphyocarpa</i>	Myristicaceae
Wild guava	<i>Myrcia rufipila</i>	Myrtaceae
Aromata	<i>Clathrotropis macrocapa</i>	Papilionaceae
Parakusan	<i>Swartzia jenmanii</i>	Papilionaceae
Tonka bean	<i>Dipteryx odorata</i>	Papilionaceae
Wamara	<i>Swartzia leiocalycina</i>	Papilionaceae
Cork Wood	<i>Pterocarpus sp.</i>	Papilionaceae
-	Unidentified	Rubiaceae
Bird Vine	<i>Phoradendron racemosum</i>	Santalaceae
Ascepoko	<i>Pouteria guianensis</i>	Sapotaceae
Bullet wood/balata	<i>Manikara bidentata</i>	Sapotaceae
Buru buru	<i>Solanum stramonifolium</i>	Solanaceae
Maho	<i>Sterculia guianensis</i>	Sterculiaceae
Fowl cup	Unidentified	Unknown
Wild ginger	Unidentified	Zingiberaceae

### 5.3.7.3

#### *Fauna*

##### *Methodology*

The methodologies used for the identification of mammals were visual encounter surveys (VES), track and scat identification, and opportunistic sightings. Mammal traps were also set up in some of the sample plots. There were baited with meat and checked periodically for the presence of mammals.

The faunal survey focused on the major vertebrate group namely, mammals, birds, fishes, amphibians and reptiles and macro-invertebrates. All faunal components within the area surveyed were characterized including vertebrate and invertebrate fauna, habitats for wildlife. Particular interest was placed on

threatened or endangered species in the area. The Faunal survey also entailed activities such as leaf litter searches, habitat assessment, bird surveys, and routine checks of traps for wildlife presence. Birds were identified using their vocalization, visual encounter and opportunistic sightings.

Transects were established at 5km intervals along the 31 km stretch allocated for the construction of the access road. Each transect was 0.5 km long and was laid out on opposite sides of the proposed road. A total of eight transects were set up along the access road. Sampling were done in quadrats or sample plots along transects. Each sample plot measured 200mx100m. Sample plots were clearly demarcated using flagging tapes. During the survey the team walked the length of the quadrats and collected information on fauna with the plots.

Fishes were collected using tangle seines, dip nets and hook and line methods. Amphibians and reptiles were identified using visual encounter and by their vocalization. Macro-invertebrates were collected using dip nets where possible.

*Mammals*

A total of thirteen (13) species of mammals were documented along the access road. Capybaras were encountered in large numbers early in the morning in the section of access road close to the Aurora mine site. These mammals were observed feeding close to the Cuyuni River. Additionally, howler monkeys were very vocal during the night and early in the morning. These were not seen but were heard regularly along the access road. None of the mammals documented are endangered, threatened or given special protection status. (Table 5-23) identifies the mammals recorded along the access road.

**Table 5-23. Mammals encountered along the Access Road Alignment**

Common Name	Scientific Name	Comments
Agouti	<i>Dasyprocta leporina</i>	Seen, prints common
Anteater	<i>Mymecophaga tridactylus</i>	Seen
Bats	Unidentified	Seen
Capybara	<i>Hydrochoeris hydrochaeris</i>	Seen
Collard Peccary	<i>Pecari tajacu</i>	Tracks and bathing pools
Common Porcupine	<i>Coendou prehensilis</i>	Smell
Forest rat	Rodentia	Seen
Giant armadillo	<i>Priodontes maximus</i>	Prints
Grey deer	<i>Mazama gouazoubira</i>	Prints common
Howler monkey	<i>Alouatta macconnelli</i>	Heard
Labba or Paca	<i>Agouti paca</i>	Prints common
Nine-banded Armadillo	<i>Dasypus novemcinctus</i>	Reports from workers
Red Brocket deer	<i>Mazama americana</i>	Prints common

## Avifauna

The Cuyuni area is known to support rich avifauna populations. Bird species were observed either hovering above the ground, in the middle canopy or in the understory regions of the forest. A few were observed on the ground. The canopy provides birds with food, shelter and nesting sites. Thirty seven (37) bird families representing 114 species were recorded along the access road. Seven families were represented by at least five species.

Eleven (11) species were recorded in the family Psittacidae, while the Tyrannidae and Tharupidae families were represented by nine and eight species respectively. The yellow oriole and pairs of red-and-green and blue-and-yellow macaws were frequently seen along the access road within the vicinity of the Aurora Mine site.

Two migrants, notably *Elanoides forficatus* and *Ictinia plumbea*, were identified along the access road, with nine species of Guianan endemics, namely *Cyanicterus cyanicterus*, *Tyranneutes virescens*, *Corapipo gutturalis*, *Myrmeciza ferruginea*, *Ramphastos tucanus*, *Monasa atra*, *Gypopsitta caica*, *Ara ararauna*, and *Myrmotherula guttata*. (Table 5-24) lists the bird species encountered along the access road alignment.

**Table 5-24.** Bird Encountered along the Access Road Alignment

Family	Scientific Name	Common Name
Tinamidae	<i>Tinamus major</i>	Great tinamou
	<i>Crypturcellus soui</i>	Little tinamou
Cathartidae	<i>Coragyps atratus</i>	Black Vulture
	<i>Cathartes aura</i>	Turkey Vulture
	<i>Buteogallus</i> sp.	Hawk
Accipitridae	<i>Elanoides forficatus</i>	Swallow-tailed Kite
	<i>Ictinia plumbea</i>	Plumbeous Kite
Falconidae	<i>Micrastur semitorquatus</i>	Collared Forest-Falcon
	<i>Ibycter americanus</i>	Red-throated Caracara
	<i>Caracara plancus</i>	Crested caracara
	<i>Milvago chimachima</i>	Yellow-headed caracara
	<i>Falco ruficularis</i>	Bat Falcon
Cracidae	<i>Ortalis motmot</i>	Little Chachalaca
	<i>Crax alector</i>	Black Curassow
Psophidae	<i>Psophia crepitans</i>	Gray-winged Tropicbird
Columbidae	<i>Patagonenas speciosus</i>	Scaled Pigeon
	<i>Patagonenas cayennensis</i>	Pale-vented pigeon
	<i>Columbina passerina</i>	Common ground dove
	<i>Leptotila verreauxi</i>	White-tipped dove
	<i>Patagonenas subvinacea</i>	Ruddy pigeon
Psittacidae	<i>Forpus passerinus</i>	Green-rumped Parrotlet

	<i>Brotogeris chrysoptera</i>	Golden-winged Parakeet
	<i>Ara ararauna</i>	Blue and yellow Macaw
	<i>Pionites melanocephalus</i>	Black-headed Parrot
	<i>Gypopsitta caica</i>	Caica Parrot
	<i>Ara chloropterus</i>	Red- and- Green Macaw
	<i>Pionus fuscus</i>	Dusky Parrot
	<i>Amazona ochrocephala</i>	Yellow-crowned Parrot
	<i>Amazona amazonica</i>	Orange winged Parrot
	<i>Amazona farinosa</i>	Mealy Parrot
	<i>Deroptylus accipitrinus</i>	Red- fan Parrot
Cuculidae	<i>Piaya cayana</i>	Squirrel Cuckoo
	<i>Tapera naevia</i>	Striped Cuckoo
Tytonidae	<i>Megascops choliba</i>	Tropical Screech-owl
Caprimulgidae	<i>Chordeiles acuptipennis</i>	Lesser Nighthawk
	<i>Nyctidromus albicollis</i>	Common Pauraque
	<i>Caprimulgus cayennensis</i>	White-tailed Nightjar
	<i>Caprimulgus parvulus</i>	Little Nightjar
Nyctibccdae	<i>Nyctibius granndis</i>	Great Potoo
Apodidae	<i>Chaetura brachyura</i>	Short-tailed Swift
	<i>Sterptoprocne zonaris</i>	White-collared Swift
Trochilidae	<i>Phaethornis supercilliosus</i>	Long-tailed Hermit
	<i>Phaethornis ruber</i>	Reddish Hermit
	<i>Campylopterus laripennis</i>	Gray-breasted Sabrewing
	<i>Amazilia brevirostris</i>	White - chested Emerald
	<i>Amazilia sp.</i>	Hummingbird
Trogonidae	<i>Trogon viridis</i>	White - tailed Trogon
	<i>Trogon violaceus</i>	Violaceous Trogon
	<i>Trogon melanurus</i>	Black - tailed Trogon
Momotidae	<i>Momotus momota</i>	Blue - crowned Motmot
Bucconidae	<i>Monasa atra</i>	Black Nunbird
	<i>Chelidoptera tenebrosa</i>	Swallow-wing Puff Bird
Galbulidae	<i>Galbula dea</i>	Paradise Jacamar
Ramphastidae	<i>Pteroglossus aracari</i>	Black - necked Aracari
	<i>Ramphastos vitellinus</i>	Channel - billed Toucan
	<i>Ramphastos tucanus</i>	Red-billed Toucan
Picidae	<i>Melanerpes cruentatus</i>	Yellow-tufted Woodpecker
	<i>Celeus flavus</i>	Cream-colored Woodpecker
	<i>Celeus torquatus</i>	Ringed Woodpecker
	<i>Campephilus rubricollis</i>	Red-necked Woodpecker
Dendrocolaptidae	<i>Dendrocincla fuliginosa</i>	Plain-brown Woodcreeper
	<i>Glyphorhynchus spirurus</i>	Wedge-billed Woodcreeper
	<i>Xiphorhynchus picus</i>	Straight-billed Woodcreeper
Thamnophilidae	<i>Taraba major</i>	Great Antshrike
	<i>Sakesphorus Canadensis</i>	Black-chested Antshrike
	<i>Thamnophilus doliatus</i>	Barred Antshrike
	<i>Myrmotherula guttata</i>	Rufous-bellied Antwren

	<i>Hypocnemis cantator</i>	Warbling Antbird
	<i>Pithys albifrons</i>	White-plumed Antbird
Formicariidae	<i>Hylopezus macularius</i>	Spotted Antpitta
Tyrannidae	<i>Atalotriccus pilaris</i>	Pale-eyed Pygmy-Tyrant
	<i>Myiozetetes luteiventris</i>	Dusky-chested Flycatcher
	<i>Myiozetetes cayanensis</i>	Rusty-margined Flycatcher
	<i>Myiodynastes maculatus</i>	Streaked Flycatcher
	<i>Legatus leucophaeus</i>	Piratic Flycatcher
	<i>Myiarchus tuberculifer</i>	Dusky-capped Flycatcher
	<i>Myiarchus tyrannulus</i>	Brown-crested Flycatcher
	<i>Pitangus sulphuratus</i>	Great Kiskadee
	<i>Tyrannus melancholicus</i>	Tropical Kingbird
Incertae Sedis	<i>Pachyramphus rufus</i>	Cinereous Becard
	<i>Tityra cayana</i>	Black-tailed Tityra
	<i>Attila cinnamomeus</i>	Cinnamon Attila
Cotingidae	<i>Querula purpurata</i>	Purple-throated Fruitcrow
	<i>Lipaugus vociferans</i>	Screaming Piha
Pipridae	<i>Corapipo gutturalis</i>	White-throated Manakin
	<i>Chiroxiphia pareola</i>	Blue-backed Manakin
	<i>Pipra pipra</i>	White-crowned Manakin
	<i>Pipra erythrocephala</i>	Golden-headed Manakin
	<i>Tyranneutes virescens</i>	Tiny Tyrant-Manakin
	<i>Neopelma chrysocephalum</i>	Saffron-crested Tyrant-Manakin
Vireonidae	<i>Vireo olivaceus</i>	Red-eyed Vireo
Hirundinidae	<i>Progne tapera</i>	Brown-chested Martin
	<i>Tachycineta albiventer</i>	White-winged Swallow
	<i>Atticora fasciata</i>	White-banded Swallow
Troglodytidae	<i>Thryothorus coraya</i>	Coraya Wren
	<i>Thryothorus leucotis</i>	Buff-breasted Wren
	<i>Troglodytes musculus</i>	Southern House-Wren
	<i>Cyphorhinus arada</i>	Musician Wren
Turdidae	<i>Turdus nudigensis</i>	Bare-eyed Thrush
	<i>Turdus albicollis</i>	White-necked Thrush
Tharupidae	<i>Tachyphonus luctuosus</i>	White-shouldered Tanager
	<i>Ramphocelus carbo</i>	Silver-beaked Tanager
	<i>Thraupis episcopus</i>	Blue-gray Tanager
	<i>Tanagra mexicana</i>	Turquoise Tanager
	<i>Thraupis palmarum</i>	Palm Tanager
	<i>Cyanicterus cyanicterus</i>	Blue-backed Tanager
	<i>Chlorophanes spiza</i>	Green Honeycreeper
	<i>Cyanerpes caeruleus caeruleus</i>	Purple Honeycreeper
	<i>Cyanerpes cyaneus</i>	Red-legged Honeycreeper
	<i>Coereba flaveola</i>	Bananaquit
Fringillidae	<i>Euphonia violacea</i>	Violaceous Euphonia
Cardinalidae	<i>Caryothraustes canadensis</i>	Yellow-green Grosbeak

	<i>Cyanocompsa cyanoides</i>	Blue-black Grosbeak
Icteridae	<i>Psarocolius decumanus</i>	Crested Oropendola
	<i>Icterus nigrogularis</i>	Yellow oriole

### Herpetofauna

The Cuyuni area is known to support rich populations of amphibians and non-avian reptiles. Previous studies have documented a number of species within the area. A total of seventeen (17) species of herpetofauna were documented during this assessment, thirteen reptiles and four amphibians. Species were identified by visual encounter surveys (VES), vocalization for frogs and opportunistic sightings.

The area in which the general survey was conducted was dry and therefore amphibian species were not present in abundance. Forest clearance produced light gaps which were frequently use by reptilian species such as *Ameiva* and *Kentropyx*. Yellow foot tortoises (*Geochelone denticulata*) were encountered in two sample plots close to the Aurora project site. Salipenters or tegus (*Tupinambus teguixin*) were also plentiful in some sample plots. None of the species identified were listed as threatened or endangered. A list of herpetofauna observed along the access road is provided in (Table 5-25).

**Table 5-25. Herpetofauna along the Access Road Alignment**

Common Name	Scientific Name
Anaconda	<i>Eunectes murinus</i>
Bushmaster	<i>Lachesis muta</i>
Emerald tree boa	<i>Corallus caninus</i>
Frog	Hylidae
Giant gladiator treefrog	<i>Hypsiboas boans</i>
Green- garden Lizard	<i>Ameiva ameiva</i>
Green Iguana	<i>Iguana iguana</i>
Green Labaria	<i>Bothriopsis sp.</i>
Land Boa	<i>Boa constrictor</i>
Lizard	<i>Anolis fuscoauratus</i>
Rainbow boa*	<i>Epicrates cenchría</i>
Salipenter	<i>Tupinambis teguixin</i>
Skink	<i>Gymnophthalmus underwoodi</i>
Snake	Unknown
Toad	<i>Rhinella sp.</i>
Werner's Toad	<i>Rhaebo nasicus</i>
Yellow foot tortoise	<i>Geochelone denticulata</i>

### Ichthyofauna

The Cuyuni River and several creeks outside the concession footprint were sampled and 18 species were documented, as detailed by (Table 5-26).

**Table 5-26. Fishes along the Access Road Alignment**

Scientific Name	Common Name
<i>Ageneiosus inermis</i>	Dawala
<i>Brachyplatystoma filamentosum</i>	Kumakuma
<i>Cichlasoma bimaculatum</i>	Common Patwa
<i>Crenicichla alta</i>	Sunfish
<i>Crenicichla reticulata</i>	Sunfish
<i>Hassar</i> sp.	Zipfish
<i>Hemiodopsis thayeria</i>	Unknown
<i>Hoplias macrophthalmus</i>	Haimara
<i>Hoplias malabaricus</i>	Huri
<i>Hydrolycus scomberoides</i>	Biara
<i>Hypostomus</i> sp.	(Suckermouth catfish)
<i>Moenkhausia oligolepis</i>	Silverfish
<i>Myleus pacu</i>	Pacu
<i>Pimelodella</i> sp.	(Catfish)
<i>Plagioscion squamissimus</i>	Basha
<i>Pygocentrus nattereri</i>	Perai
<i>Rhamdia holomelas</i>	Kassie
<i>Serrasalmus rhombeus</i>	Perai

#### *Macro-invertebrates*

More than ninety five percent of the macro invertebrate recorded along the access road existed above the forest floor. Litter searches recorded less than 5% of the total invertebrate life observed. A total of twenty two (22) families/orders of macro-invertebrates were identified. Orders or families were identified using visual encounter surveys, and litter searches. Dip nets were also used to capture macro-invertebrates. Dragonflies were especially plentiful near ponds. Further, only species from the orders/families Aranae, Hymenoptera and Lepidoptera, were abundant due to the prevailing dry weather. Little fruiting and flowering occurred in some areas and this may explain the lack of abundance of these species. Nocturnal surveys indicated a large population of spiders in the surrounding vegetation. (Table 5-27) list macro-invertebrates observed along the access road alignment.

**Table 5-27. Macro-invertebrates observed along the Access Road Alignment**

<b>Common Name</b>	<b>Family/Order</b>
<i>Ants-leaf cutters, Redants, army ants, bullet ant</i> <i>Bees and wasps</i>	Hymenoptera
Beetles	Coleoptera
Black crabs	Decapoda-Brachyura
Butterfly and moths	Lepidoptera Riodinidae - <i>Helicopsis cupido</i> Lycaenidae-hairstreak <i>Satyrium, Pierella</i> <i>hyalinus</i> <i>Heliconius</i> <i>Dismorphia</i> Moths
Millipedes	Diplopoda
Cockroach and mantids	Dictyoptera
Damsel flies Dragon flies ( <i>Anax</i> sp)	Odonata
Earwig	Thysanoptera
Fire flies	Lampyridae
Grasshoppers and crickets	Orthoptera
True Bugs	Hemiptera
Hydrometridae	Water threaders
Katydids	Tettigoniidae
Mosquito ( <i>Anopheles</i> sp.)	Diptera
Scorpion	Scorpionida
Segmented worms	Annelida (Oligocheta)
Snails ( <i>Pomacea</i> sp.)	Mollusca-Gastropoda
Spiders	Aranea
Termites	Isoptera
Tick	Ixodida
True Flies (cow fly)	Diptera
Walking Stick	Plasmida

### 5.3.8 *Biodiversity Characterization of the Wharf Area*

The findings of the biodiversity survey of the wharf area are provided below. The methodologies used mirrored that used for the access road survey.

#### 5.3.8.1 *Flora*

A total of twenty nine (29) species of plants were recorded in areas along the wharf. These belong to eighteen families. Caesalpinaceae and Lecythidaceae

were the most dominant families recorded. In some plots secondary forest comprising mainly of dukali, small wallaba, malbotine, kookrite, turu and manicole palm were observed. Wild mangrove was noted along the rivers. No tree species was endemic to the area around the wharf. A list of plant species encountered in the wharf area is provided in (Table 5-28).

**Table 5-28. Plant species observed in the Wharf Area**

<b>Common Name</b>	<b>Scientific Name</b>	<b>Family</b>
Yarri Yarri (black)	<i>Unonopsis glaucopetala</i>	Annonaceae
Yarri-yarri	<i>Duguetia pycnasteria</i>	Annonaceae
Dukali	<i>Parabancomia fasciculata</i>	Apocynaceae
Nibi	<i>Heteropsis flexuosa</i>	Araceae
Kookrite	<i>Maxmiliania maxima</i>	Arecaceae
Manicole	<i>Euterpe edulis</i>	Arecaceae
Turu palm	<i>Jessenia bataua</i>	Arecaceae
Baromalli	<i>Catostemma commune</i>	Bombacaceae
Kurokai	<i>Protium decandrum</i>	Burseraceae
Morabukea	<i>Mora gonggrijpii</i>	Caesalpiaceae
Wallaba (soft)	<i>Eperua falcata</i>	Caesalpiaceae
Monkey ladder	<i>Bauhinia suranamensis</i>	Caesalpinioideae
Kabukalli	<i>Goupia glabra</i>	Celastraceae
Burada	<i>Parinari rodolphii</i>	Chrysobalanaceae
Countaballi	<i>Licania alba</i>	Chrysobalanaceae
Clusia	<i>Clusia amazonica</i>	Guttiferae
Baradan	<i>Ocotea tomentella</i>	Lauraceae
Kakaralli (common black)	<i>Eschweilera sagotiana</i>	Lecythidaceae
Karakalli (black)	<i>Eschweilera pedicellata</i>	Lecythidaceae
Karakalli (smooth leaf)	<i>Eschweilera sp.</i>	Lecythidaceae
Monkey pot	<i>Lecythis zabucajo</i>	Lecythidaceae
Mukuru	<i>Miconia guianensis</i>	Melastomataceae
Trysil	<i>Pentaclethra macroloba</i>	Mimosaceae
Maporkon	<i>Inga alba</i>	Mimosaceae
Dalli	<i>Virola elongata</i>	Myristicaceae
Parakusan	<i>Swartzia jenmanii</i>	Papilionaceae
Cork Wood	<i>Pterocarpus sp.</i>	Papilionaceae
Asepoko	<i>Pouteria guianensis</i>	Sapotaceae
Maho	<i>Sterculia guianensis</i>	Sterculiaceae

### 5.3.8.2

#### *Fauna*

##### *Mammals*

Five mammalian species were encountered within the Wharf Area, as detailed in (Table 5-29) below. These species were also encountered along the access road. No threatened or endangered mammalian species were recorded within this area.

**Table 5-29. Mammals observed in the Wharf Area**

Common Name	Scientific Name	Comments
Agouti	<i>Dasyprocta leporina</i>	Seen, prints common
Howler monkey	<i>Alouatta macconnelli</i>	Heard
Labba or Paca	<i>Agouti paca</i>	Prints common
Nine-banded Armadillo	<i>Dasyplus novemcinctus</i>	
Squirrel monkeys	<i>Saimiri sciureus</i>	Seen

*Ichthyofauna*

Six species of fish were documented in the Wharf Area as listed by (Table 5-30).

**Table 5-30. Fishes observed in the Wharf Area**

Scientific Name	Common Name
<i>Aequidens tetramerus</i>	(Cichlid)
<i>Ageneiosus inermis</i>	Dawala
<i>Crenicichla alta</i>	Sunfish
<i>Hoplias malabaricus</i>	Huri
<i>Pimelodella</i> sp.	(Catfish)
<i>Rhamdia holomelas</i>	Kassie

*Avifauna*

Bird 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. Surveys were done along plots while doing point counts along the way.

A total 46 avifaunal species from 20 families were recorded within the Wharf Area (Table 5-31). One migrant, *Elanoides forficatus* and one Guianan endemic *Tyrannetes virescens* were observed at the wharf area. Three waterbirds were identified within this area, *Megarynchus pitangua*, *Tachycineta albiventer* and *Atticora fasciata*.

**Table 5-31. List of bird species observed in the Wharf Area**

Family	Scientific Name	Common Name
Cathartidae	<i>Coragyps atratus</i>	Black Vulture

	<i>Cathartes aura</i>	Turkey Vulture
Accipitridae	<i>Elanoides forficatus</i>	Swallow-tailed Kite
Falconidae	<i>Micrastur semitorquatus</i>	Collared Forest-Falcon
	<i>Caracara plancus</i>	Crested caracara
	<i>Milvago chimachima</i>	Yellow-headed caracara
	<i>Herpetotheres cachinnans</i>	Laughing Falcon
	<i>Falco rufigularis</i>	Bat Falcon
Cracidae	<i>Ortalis motmot</i>	Little Chachalaca
Columbidae	<i>Patagionenas cayennensis</i>	Pale-vented pigeon
	<i>Columbina passerine</i>	Common ground dove
Cuculidae	<i>Crotophaga ani</i>	Smoothed-billed Ani
Caprimulgidae	<i>Chordeiles acutipennis</i>	Lesser Nighthawk
	<i>Sterptoprocne zonaris</i>	White-collared Swift
Trochilidae	<i>Amazilia brevirostris</i>	White - chested Emerald
Bucconidae	<i>Chelidoptera tenebrosa</i>	Swallow-wing Puff Bird
Thamnophilidae	<i>Taraba major</i>	Great Antshrike
	<i>Thamnophilus doliatus</i>	Barred Antshrike
Tyrannidae	<i>Elaenia flavogaster</i>	Yellow-bellied Elaenia
	<i>Capseimpis flaveola</i>	Yellow Tyrannulet
	<i>Todirostrum cinereum</i>	Common Tody-Flycatcher
	<i>Megarynchus pitangua</i>	Boat-billed Flycatcher
	<i>Myiozetetes cayanensis</i>	Rusty-margined Flycatcher
	<i>Myiodynastes maculatus</i>	Streaked Flycatcher
	<i>Pitangus sulphuratus</i>	Great Kiskadee
	<i>Tyrannus melancholicus</i>	Tropical Kingbird
Cotingidae	<i>Lipaugus vociferans</i>	Screaming Piha
Pipridae	<i>Neopelma chrysocephalum</i>	Saffron-crested Tyrant-Manakin
	<i>Tyranneutes virescens</i>	Tiny Tyrant-Manakin
Hirundinidae	<i>Progne tapera</i>	Brown-chested Martin
	<i>Tachycineta albiventer</i>	White-winged Swallow
Troglodytidae	<i>Thryothorus coraya</i>	Coraya Wren
Tharupidae	<i>Tachyphonus luctuosus</i>	White-shouldered Tanager
	<i>Tachyphonus rufus</i>	White-lined Tanager
	<i>Ramphocelus carbo</i>	Silver-beaked Tanager
	<i>Thraupis episcopus</i>	Blue-gray Tanager
	<i>Tanagra Mexicana</i>	Turquoise Tanager
	<i>Thraupis palmarum</i>	Palm Tanager
	<i>Coereba flaveola</i>	Bananaquit
Emberizidae	<i>Volatina jacarina</i>	Blue-black Grassquit
	<i>Sporophila minuta</i>	Ruddy-breasted Seedeater
	<i>Sporophila castaneiventris</i>	Chestnut-bellied Seedeater
Cardinalidae	<i>Salator maximus</i>	Buff-throated Saltator
	<i>Caryothraustes canadensis</i>	Yellow-green Grosbeak
Icteridae	<i>Psarocolius decumanus</i>	Crested Oropendola
	<i>Psarocolius viridis</i>	Green Oropendola

### Herpetofauna

At the Wharf Area, two amphibians and four reptilian species were recorded (Table 5-32).

**Table 5-32. Herpetofauna observed in the Wharf Area**

Common Name	Scientific Name
Anaconda	<i>Eunectes murinus</i>
Giant gladiator treefrog	<i>Hypsiboas boans</i>
Green Labaria	<i>Bothriopsis</i> sp.
Snake	Unidentified
Spectacled Caiman	<i>Caiman crocodilus</i>
Werner's Toad	<i>Rhaebo nasicus</i>

### Macro-Invertebrates

Species of three invertebrate orders were abundant at the wharf area surveyed. Hymenopterans were especially abundant at this site. Small numbers of individuals were recorded for eleven orders. The lack of large numbers of invertebrate species is associated with the non flowering phase of trees and persistent dry weather conditions. See (Table 5-33) for list of invertebrates encountered.

**Table 5-33. Macro-invertebrates observed in the Wharf Area**

Common Name	Family/Order
Ants-leaf cutters, Red ants, army ants, bullet ant Bees and wasps	Hymenoptera
Beetles	Coleoptera
Black crabs	Decapoda-Brachyura
Butterfly and moths	Lepidoptera Riodinidae - <i>Helicopsis cupido</i> Lycaenidae-hairstreak <i>Satyrrium</i> , <i>Pierella hyalinus</i> <i>Heliconius</i> <i>Dismorphia</i> Moths
Millipedes	Diplopoda
Cockroach and mantids	Dictyoptera
Damsel flies Dragon flies ( <i>Anax sp</i> )	Odonata
Earwig	Thysanoptera
Fire flies	Lampyridae

Grasshoppers and crickets	Orthoptera
True Bugs	Hemiptera
Hydrometridae	Water threaders
Katydid	Tettigoniidae
Mosquito ( <i>Anopheles sp.</i> )	Diptera
Scorpion	Scorpionida
Segmented worms	Annelida (Oligocheta)
Snails ( <i>Pomacea sp.</i> )	Mollusca-Gastropoda
Spiders	Aranea
Termites	Isoptera
Tick	Ixodida
True Flies (cow fly)	Diptera
Walking Stick	Plasmida

### 5.3.9 Identification of Key Biodiversity Components

#### Criteria

Following the BBOP methodology, the identification of key biodiversity components that may require offsets is one of the first steps in the offset planning process. The criteria taken into consideration under the BBOP methodology are:

- Intrinsic Values
  - Vulnerability – The vulnerability of a biodiversity component is a measure of sensitivity to impacts and environmental change. Species may be naturally vulnerable due to having highly specialized ecological adaptations or low reproductive rates, for example. An ecosystem may be highly vulnerable when it has low resiliency due to having a limited number of species or severe physical constraints such as limited availability of moisture or nutrients;
  - Irreplaceability – The irreplaceability of a biodiversity component is inversely proportional to its geographic distribution. If a particular component is widespread and occurs in numerous locations over a broad geographic area, then each occurrence of the component can be considered replaceable by occurrences at other locations. In contrast, the habitat of narrowly endemic restricted-range species known only from one or two localities would be considered highly irreplaceable;
- Utilitarian Values; and,
- Cultural Values.

### *Intrinsic Values*

Initial reports of endangered giant otters and sun parakeets have not been confirmed by the 2009 surveys and literature reviews. The only other species of potential conservation interest is the harpy eagle, which is categorized as near threatened by the IUCN. The home range size of the harpy is large (approximately 30 km<sup>2</sup> or greater) and the Aurora Concession is not likely to support many individuals. Also, the observed primate population along the Cuyuni River and within the concession is low in comparison with similar habitats elsewhere in the Guianas, which suggests that that area is not a prime harpy eagle habitat. Therefore, none of the species or habitats present in the Project Area of Influence can be considered especially vulnerable to the impacts associated with the Project.

Given the common and widespread occurrence of the species and habitats present, the absence of any narrowly endemic restricted-range species, and the absence of any unique habitats or species assemblages, there are no biodiversity components in the Project Area of Influence that can be considered to have medium or high irreplaceability.

### *Utilitarian Values*

Given that no communities, with the exception of itinerant small-scale miners, make direct use of the biodiversity components that would be affected by the Project, there are no components of significant utilitarian value from a local perspective. The forestry resources to be lost in the Area of Direct Impact by clearing for construction and mining are widespread and abundant in the Area of Influence as well as in the remainder of the Cuyuni River Basin.

While providing the standard ecosystem services associated with forested ecosystems, the habitats of the Project Area of Influence do not have any special significance and are largely already affected by historic human activities in the region. Similar and higher-quality habitats are widespread in the Cuyuni Basin. Therefore, they have low vulnerability and low irreplaceability. The watersheds to be affected by the project are small and all discharge into the Cuyuni River. None of them is inhabited or utilized by any local community except for itinerant small-scale miners.

### *Cultural Values*

Likewise, no stakeholders have identified any cultural, spiritual, or religious values associated with the biodiversity components that would be affected by the Project.

### *Conclusions*

Based on the present assessment of the biodiversity of the Project Area, it is concluded that the Project impacts will not affect any key biodiversity components that merit specific biodiversity offsets due to unavoidable losses of high-value habitats or impacts to sensitive species. Given that the Project will take place in a historic mining and logging district that has already subjected the habitats along and adjacent to the Cuyuni River and the Barama Road to significant disturbance and degradation of habitat, the biodiversity components to be affected by the Project are largely modified habitats. The Project will implement the required international best practice environmental management practices to control impacts during construction and operation of the Project as well as to promote the ongoing biorestitution and reinstatement of disturbed areas. One of the key environmental issues in the Guianas is the impact of unregulated artisanal or small-scale mining, and efforts towards improving environmental management of these operations would constitute a significant positive development in regards to the conservation of biodiversity in the region.

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## 6.1

## INTRODUCTION

There were no formal or established communities or settlements in the immediate vicinity of the Aurora mine-site, and very few communities in proximity to associated project components. Hence, due to its remote location, the Aurora Project does involve the types of direct socio-economic effects characteristic of most mining projects.

Artisanal and small-scale mining (ASM) were a key activity in the Project region, in particular in the immediate vicinity of the proposed mine site and along the Cuyuni River. Small and seasonal mining camps represented the main habitations in the immediate Project area. The miners move frequently and establish small exploration camps wherever they go. They were not included in the Government's census and very little data or records were available to document their presence.

However, due to the importance of ASM in the Project region, a separate Health Impact Assessment for the ASM communities in the region was carried out by NewFields, which contains further information on those communities.

**Additionally, a detailed report on the baseline status, locations and socio-economic conditions of ASM within the Project region is presented in Annex 1 of this report (Part A, Artisanal Mining Management Plan).**

Given the lack of communities in the area of direct influence of the project, the social baseline was developed looking at a broader area where possible interactions and impacts of the Project on formal settlements/communities were likely to occur, even if relatively far from the three main Project components. The zone of indirect influence for the socio-economic baseline study was determined using this logic. For example, there are certain towns which are likely to serve as entry points to the Aurora site for project logistics and the transport goods, services and workers. Hence, the villages or towns of Buckhall, Parika, Itaballi and Bartica were also considered to be in the area of indirect influence. Similarly, potentially vulnerable communities, such as the Amerindian community of Kurutuku, were also included, as it was considered appropriate that the Project should consider such communities in its Community Investment Program. Aranka, an informal ASM settlement was also included in the Area of Indirect Influence.

The baseline study focused on relevant socio-economic characteristics of these communities with particular emphasis on: (i) socio-economic statistics and census data related to demographics, health, education, employment; (ii) land use and natural resource use for subsistence and livelihood activities, such as farming, fishing, hunting and mining practices; (iii) social infrastructure such as schools, medical facilities, communications network/transport networks and markets; (iv) public health; (v) local institutional capabilities; (vi) land ownership patterns; (vii)

identification and characterization of community cohesion and management; and (vii) identification of concerns and issues which may affect the project and vice versa.

The baseline relied on three data collection methods:

- Focused consultations with the public officials, NGOs and representatives of important groups (i.e. Ministry of Amerindian Affairs, Guyana Organization of indigenous Peoples, Amerindian Peoples Association and The Association of Amerindians of Guyana);
- Review and analysis of secondary data (reports, census data, legislation, etc.); and
- Site visits and consultations with communities/villages.

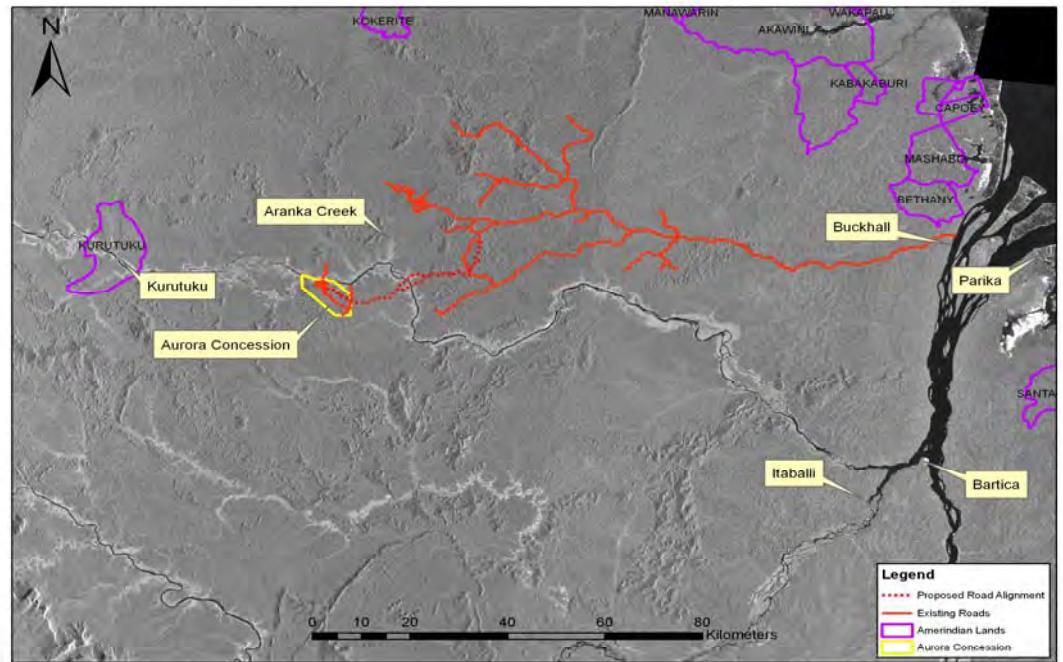
## 6.2 COMMUNITIES STUDIED IN THE BASELINE

The socio-economic baseline study focused on six settlements or communities considered to be in the Area of Indirect Influence listed in *Table 6-1* below. The locations are illustrated in *Figure 6-1*. The project and its associated components as well as the six communities studied were located in Regions 3 and 7 of Guyana’s administrative divisions.

**Table 6-1** *Communities and administrative regions.*

Name of Settlement/Town/Village	Administrative Region
Aranka	7
Bartica	7
Itaballi	7
Kurutuku	7
Buckhall	3
Parika	3

Figure 6-1. Communities studied in the Baseline



Source: ERM 2009

### Aranka

Aranka is an informal ASM camp located approximately 30 km downstream of the Aurora mine site along the Cuyuni River. It has a significant number of independent and transient artisanal and small-scale miners and significant commercial activity. Aranka has a history of mining activity and was the site of an initial Guyana Gold exploration camp. Infrastructure in Aranka is limited and access is mainly via the Cuyuni River. The Aurora project will have little or no direct impact on Aranka, but, as a community within the project region, it was included in the baseline analysis.



### Bartica

Bartica is located along the Essequibo River at the confluence of the Cuyuni and Mazaruni Rivers. Its strategic location makes it a regional commercial hub, serving as a gateway to the interior. Bartica is also the administrative



headquarters of the Regional Democratic Council of Region 7 and houses the Region 7 hospital and other regional administrative offices. Although Guyana Gold has no formal presence in Bartica and the Aurora Project is unlikely to cause direct impacts to Bartica, it was included in the area of indirect influence due to its regional economic and political importance.

### **Itaballi**

Itaballi is located approximately six miles from Bartica on the West Bank of the Mazaruni River. There was a Guyana Goldfields dormitory located in Itaballi, a two story building with beds, kitchen, restrooms and other facilities. This was being used to house employees or project personnel en route to or from the Project site. During the construction of the Aurora Project, at least in the early days, it is likely that workers may pass through Itaballi in greater numbers. Itaballi was therefore included in the project area of influence and a baseline developed.



### **Kurutuku**

Kurutuku is a titled Amerindian community of roughly 120 persons located in the Upper Cuyuni River approximately 90 km from Eterinbang, the closest town, and 50 km upstream from the Aurora site. Due to its remote location upstream from the project site, it is unlikely to suffer any impacts as a result of the Project. However, given its importance as a titled Amerindian community which is closest to the Project, Kurutuku should be considered for community investment programs of the Projects.



### **Buckhall**

Buckhall is located in Region 3 along the Essequibo River and is the site of the proposed port facilities for the Aurora Project. Buckhall will serve as an entry point for project goods and cargo to be transported to the Aurora site via the Barama road and other access roads. Currently Buckhall has few inhabitants and minimal infrastructure, but is an important entry/exit point for small scale and artisanal miners active in the region. For these reasons, Buckhall was included in the area of direct influence.



## **Parika**

Parika is located in Region 3, roughly 65 km downstream from Bartica on the east bank of the Essequibo River and at the terminus of the main national road to Georgetown.

Parika is a busy port town and has seven villages located within its administrative borders. Parika is a source of goods (especially fuel) and services for the interior.

Parika could be impacted by the project, as it forms an important part of the transportation corridor between the project site and Georgetown and was therefore included in the area of indirect influence.



## **Communities or Settlements along the Barama Road or Access Roads**

Based on secondary sources, available maps and route surveys carried out by the Project, no established villages, communities or settlements were reported to be located along the Barama road or the proposed access road corridor to the Cuyuni River. However, there are isolated structures/outposts with limited commercial activity, including sale of alcohol and alleged sex workers. As mentioned, these areas are also periodically inhabited by small scale and artisanal miners. Despite the lack of official socio-economic data related to these remote areas, they were considered to within the area of indirect influence and included in the baseline analysis.

## **6.3**

### ***BRIEF NATIONAL PROFILE***

Due to the remote location of the Project and the extended area of indirect influence, it was necessary to consider national and regional socio-economic characteristics in the development of the socio-economic baseline study. National and regional information illustrated important trends, highlights key demographic characteristics of the zone of indirect influence, and provided an analytical framework to understand the trends and issues in each particular settlement and community within the area of indirect influence.

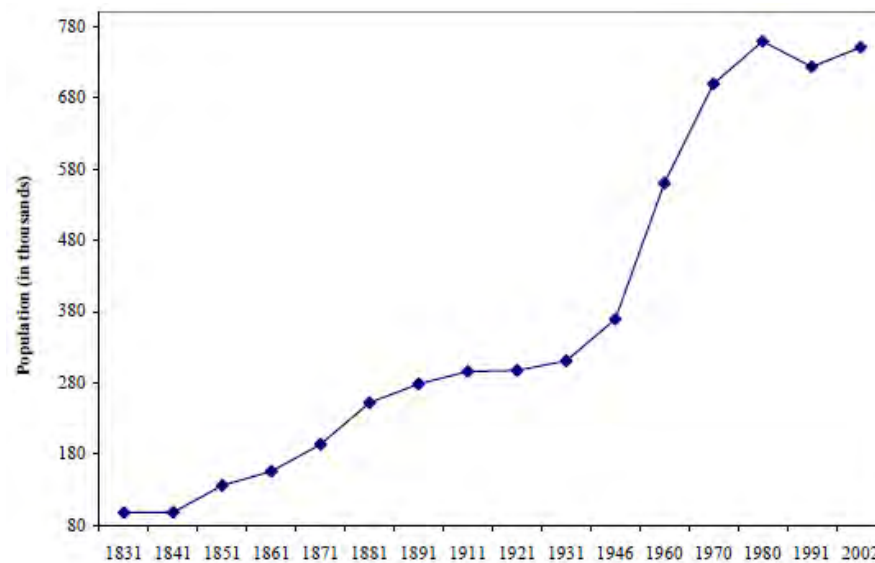
Guyana is one of the poorest countries in the world and is ranked 114th in the 2007 Human Development Report of UNDP. The ranking is based on the Human Development Index, which takes into consideration a wide range of national socio-economic characteristics.

The average life expectancy at birth in Guyana is 63 years (in 2004), total fertility rate is 2.3, and the annual rate of natural increase of the population is roughly 1.0%.

Over the last two decades, the economy of Guyana has slowly increased, showing an annual growth rate in GDP per capita of 2.9%. However, despite overall economic growth, it is estimated that 35% of the population lives below the national poverty line and 16.8% live on less than US\$2 a day. For many Guyanese, remittances are an important part of the Guyanese economy, contributing roughly US\$377 per capita and totaling nearly US\$278 million in 2007.

The high rate of remittances per capita, the 17<sup>th</sup> highest national rate in the world, reflects the high emigration rates of Guyanese to work in other countries. The Human Development Report states that Guyana has an emigration rate of 33.5%, with the majority of migrants residing in North America.

*Figure 6.2. Population Trends of Guyana, 1831-2002*



Source: Guyana Census 2002

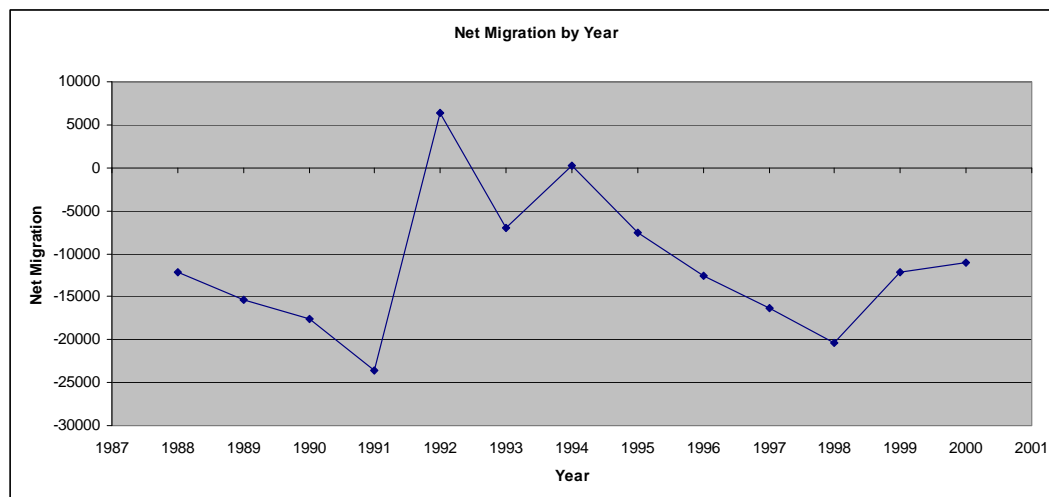
Additional information from the Guyana census of 2002 illustrate that national population trends have shown overall steady growth over the last two centuries (*Figure 6-2*), with only a slight decrease in the growth rate in the years leading up to the 1992 census. The increasing trend is attributed mainly to population growth, increasing life expectancy, decreasing fertility rates, and improved healthcare.

However, these general characteristics hide several pertinent details related to the slight fluctuations in the national growth rate over the last twenty years. For example, consideration of the relation between net migration rates and national growth rates reveals an important socio-economic dynamic related to the national mining industry.

Analysis of net migration rates over the last two decades suggest that the decrease in population leading up to the census of 1992 is related to an increase in emigration rates (*Figure 3*). Furthermore, the sharp increase in net migration in the years just after the 1991 suggests immigration to Guyana outpaced emigration from

Guyana. Both of these dynamics may be attributed to an increase in employment opportunities within Guyana during these years, which likely corresponds to the construction and initial operations phase of the Omai Mine Project in Region 7, which began construction in 1991 and operation in 1992-1993.

*Figure 6-3. National Net Migration by Year*



Source: Guyana Census 2002

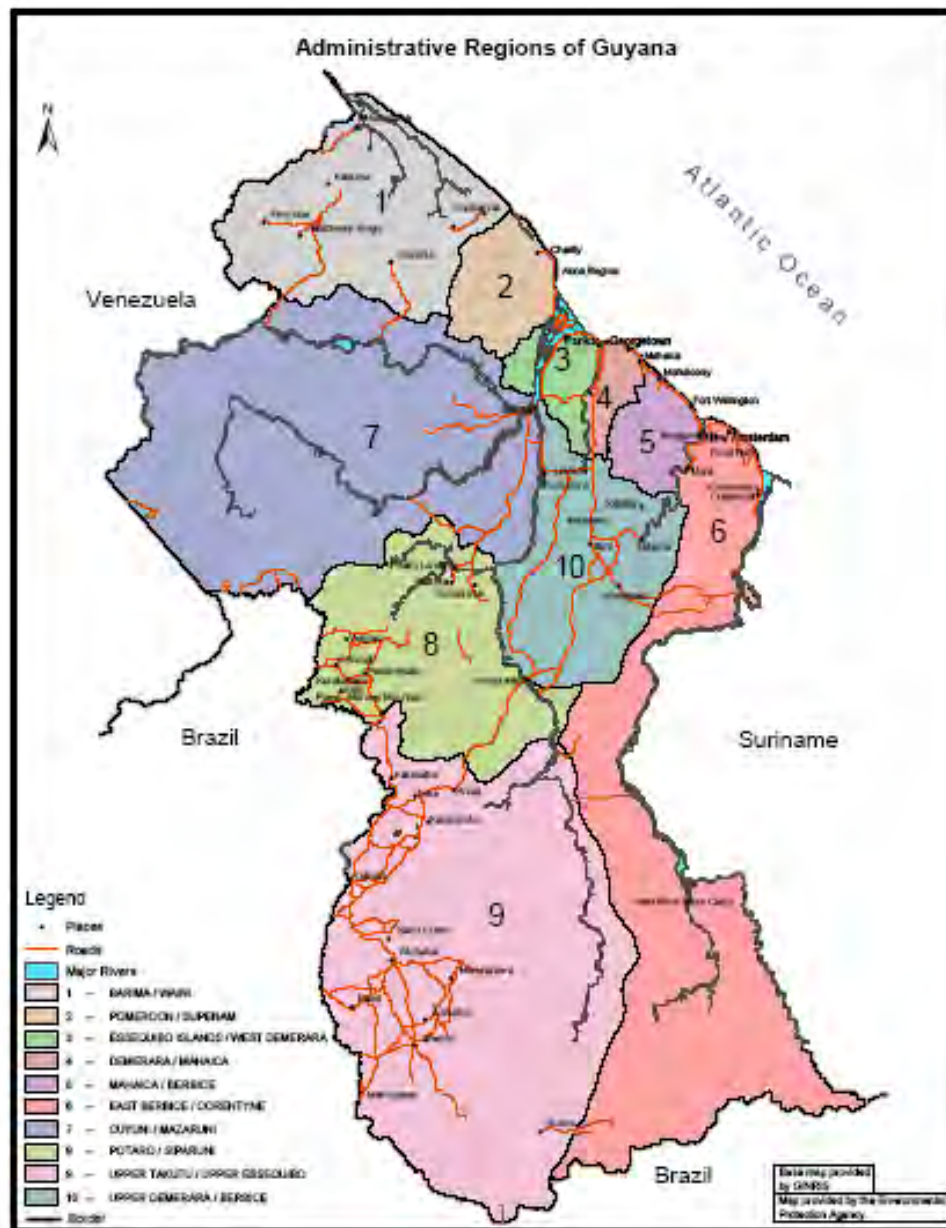
Thus, it is important to consider not only regional socio-economic characteristics, but to compare them to national trends to understand underlying issues.

The baseline studies provide information for Region 7 and Region 3 and analyze trends and comparisons relevant to the project area and communities within the zone of indirect influence.

### 6.3.1 Regional Administration

Guyana is divided into ten administrative regions, each of which has a Regional Democratic Council (RDC) and a regional chairman. This system of local government is designed to decentralize government functions and provide each region with administrative responsibilities to serve the interest of that region. As noted above, the Aurora Project site and most associated facilities, including the access roads, are located in Region 7 while the port facilities and part of the Barama road traverses Region 3.

Figure 6-4. Administrative Regions of Guyana



## 6.4

### PROFILE OF REGION 7

Region 7 is the second largest administrative region of Guyana and covers the majority of the communities studied, including Aranka, Bartica, Itaballi and Kurutuku. Due to its large geographic size and difficult accessibility, Region 7 is divided into three administrative sub-regions: Upper, Middle and Lower Mazaruni. The Regional Democratic Council and Regional administrative headquarters are located in Bartica, while each sub-region has a separate District

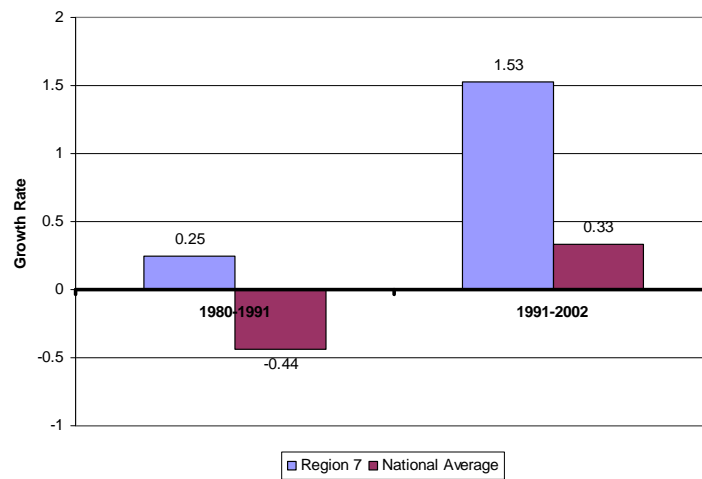
Administrative Center. At the local level, Village Councils, or other legally appointed representatives, administer each community.

The project area of influence straddles the Middle and Lower Mazaruni Sub-regions of Region 7. The mine site is located within the Middle Mazaruni Sub-region and is closest to the District Administrative Centre of the Middle Mazaruni sub-region located at Kamarang.

### 6.4.1 Demographic Profile

The total population of Region 7 in 2002 was approximately 17,600 people<sup>1</sup> and accounted for 2.3 per cent of the total population of Guyana. Analysis of general demographic information reveals two key characteristics of Region 7. First, over the last quarter century growth rates in Region 7 have been significantly higher than the national average (see Figure 6-5). As mentioned, this is primarily due to the increased migration to interior regions owing to increased activity of the mining sector, high birth rates, and low interregional migrations.

Figure 6-5. Comparison of Region 7 Growth Rates with National Average



Source: Guyana Census 2002

Second, the region is the second largest geographic region in the country, covering 47,213 sq km. but has the second lowest population density per sq km, at just .4 persons per sq km, compared with 139 persons per sq km in Region 4 (Georgetown), and 27.5 sq km in Region 3, surrounding the capital. These differences in population density illustrate the potential variation in land use, natural resource use, economic activity and proximity to social and physical infrastructure.

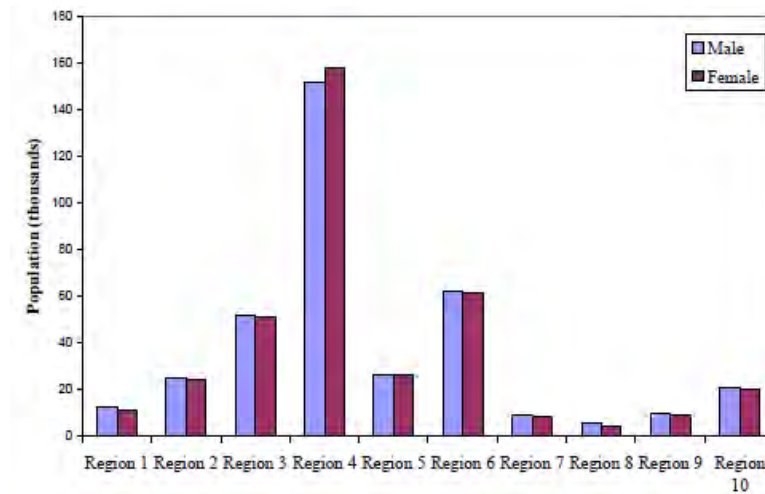
(1) Guyana Census Report, 2002

## 6.4.2

### *Gender and Age Distribution Profile*

Regional demographic information suggests that there is overall gender parity between regions and that the national male to female ratio is 1.00. *Figure 6-6* illustrates the population differences between the administrative regions, and shows that there is a minimal gender gap in Region 7. Based on the most recent census data there are 9,373 males and 8,224 females in Region 7, a male to female ratio of 1.14. This is due to a higher proportion of males migrating to Region 7 to work in mining and quarrying jobs and a reverse emigration of females from Region 7 to urban areas for social and economic reasons.

*Figure 6-6. Population, by Gender and Administrative Region*

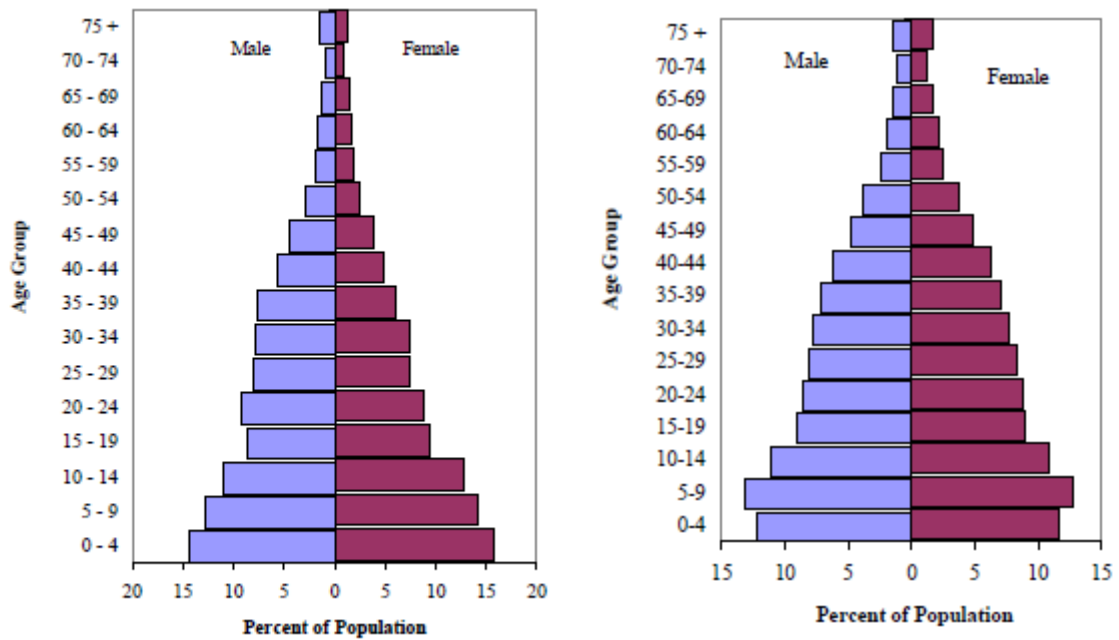


Source: Guyana Census 2002

In addition to gender, age distribution is an important demographic characteristic with wide-ranging socio-economic implications. *Figure 6-7*, below, compares the population pyramids of Region 7 (left) and the national average (right) by both age and gender. These figures correspond to the conclusions made in the previous section and reveal several additional socio-economic characteristics and trends, explained below.

First, the age distribution graphically illustrates the median age of the population, and shows that the Region 7 age distribution generally mirrors the national averages. Further statistical analysis reveals that the national population has been gradually maturing, with the median age increasing to 22.6 in 2002 from 18.4 in 1980. Overall Region 7 has a young population and mostly in the working age of 18 to 50.

Figure 6-7. Age and Gender Distribution of Region 7 (left) and National Avg. (Right)<sup>2</sup>



Source: Guyana Census 2002

Second the comparison of age and gender distributions confirm the migrational dynamics noted above; mainly that men are more likely to be migrating to Region 7 from other areas of the country, while working age women are more likely to be moving out of the region, presumably to look for employment in urban areas, or other social reasons.

### 6.4.3 Ethnic Composition

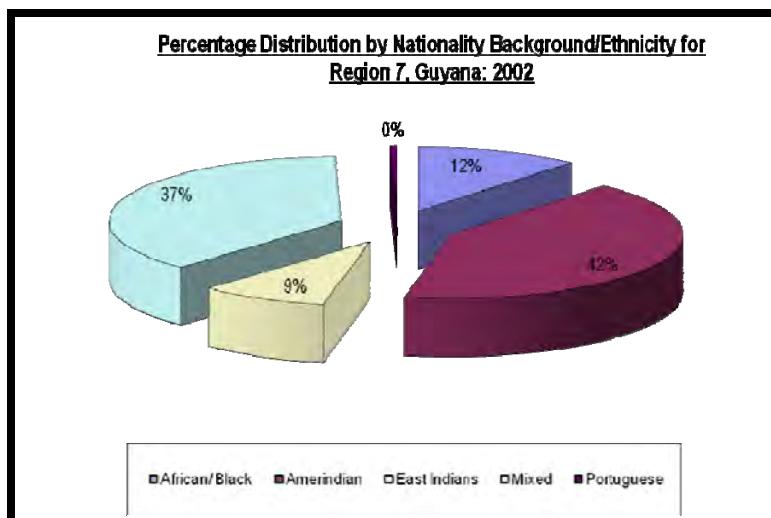
The current population of Guyana is heterogeneous and is comprised by both indigenous Amerindian populations and descendants of groups with European/Portuguese, African, Chinese, and Indian heritage. These groupings are complicated by the dynamics of intermarriage and mixed heritage, which is facilitated in part by the use of English as the common language. Nationally, groups of East Indian, African, and mixed decent are most common, comprising 43%, 30% and 16%, respectively, of the national population in 2002. Ethnic and racial issues are important throughout Guyana, and their affects on education, health and other socio-economic variables must be considered.

The ethnic composition in interior areas is significantly different than national averages, with a much higher percentage of Amerindians, African/Black and mixed decent, with minimal presence of immigrant populations common in coastal

(2) 2002 Guyana Census

areas of Guyana. *Figure 6-8* illustrates the ethnic composition of Region 7 and the high proportion of Amerindians in the region (42%).

**Figure 6-8.** *Percentage Distribution by Nationality Background/Ethnicity for Region 7, Guyana: 2002*



Source: Guyana Census 2002

The high proportion of Amerindians in Region 7 compared to other areas of the country required particular consideration. While nationally, Amerindians are the fourth largest ethnic group, accounting for 9.2% of the population in 2002, Amerindians account for 42% of the population of Region 7. Given their importance in the socio-economic context of Region 7, the status of Amerindians in Region 7 is discussed in *Section 6.4.8*.

#### 6.4.4 Migration Patterns

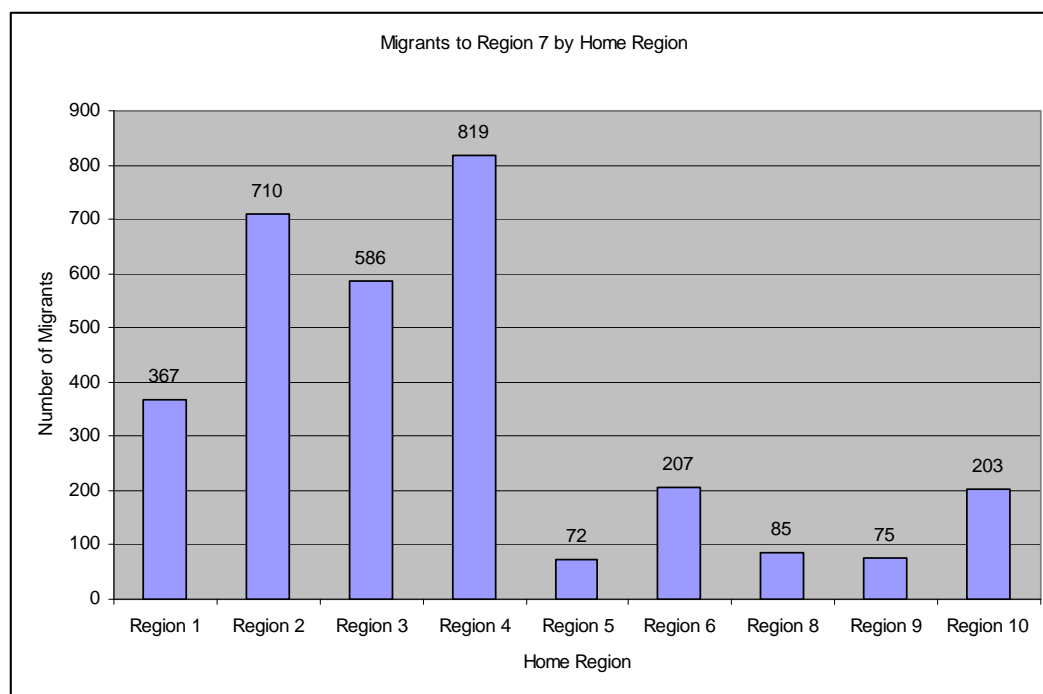
Migration is an important socio-economic dynamic in Region 7, as it is throughout Guyana. The 2002 census shows that 27.3% of foreign born persons currently in Guyana are from Suriname, 12.6% are from Brazil and 12.4% are from Venezuela. While the effects of immigration varies in each region, the economy and culture of Region 7 is being significantly influenced by the influx of Brazilian laborers working in the small scale mining industries of the interior regions.

In addition to international migration, inter-regional migration is an important socio-economic characteristic in Region 7. It is estimated that roughly 20% of those born in Region 7 reside outside of Region 7, which is comparatively lower than other Regions of Guyana.

As noted, migration away from interior areas such as Region 7 typically involves youth and working age females who move to urban areas. Thirteen percent of migrants leaving Region 7 were residing in Region 4 (where the capital city of Georgetown is located) during the 2002 census. This dynamic is attributed to the fact that most of the employment opportunities in Region 7 are highly male-

dominated and usually associated with mining, while there are more opportunities for women in urban areas like Georgetown.

**Figure 6-9.** Migrants to Region 7 by Home Region



Source: Guyana Census 2002

Furthermore, inter-regional migration to Region 7 from other regions of Guyana is important, even if the scale is comparatively limited. According to the 2002 census there were 3,124 persons residing in Region 7 from other regions of the country. *Figure 6-9* shows the percentage of migrants to Region 7 by home region, which illustrates the dual dynamic of urban to interior migration. Migrants to Region 7 are predominantly from urban areas, and mostly working age males in search of employment opportunities in the interiors.

#### 6.4.5 Health

According to international organizations such as the Pan American Health Organization, public health in Guyana is of significant socio-economic concern. Health characteristics have been adversely affected by weak public health infrastructure and capacity, unequal access to health care, poverty, inequity and ethnic disparities<sup>3</sup>. Nationally, the main causes of morbidity are maternal and pediatric diseases such as diarrhea, acute respiratory infections, and nutritional deficiencies. The prevalence of communicable diseases, including malaria, tuberculosis, dengue, and sexually transmitted diseases, are also high. The national

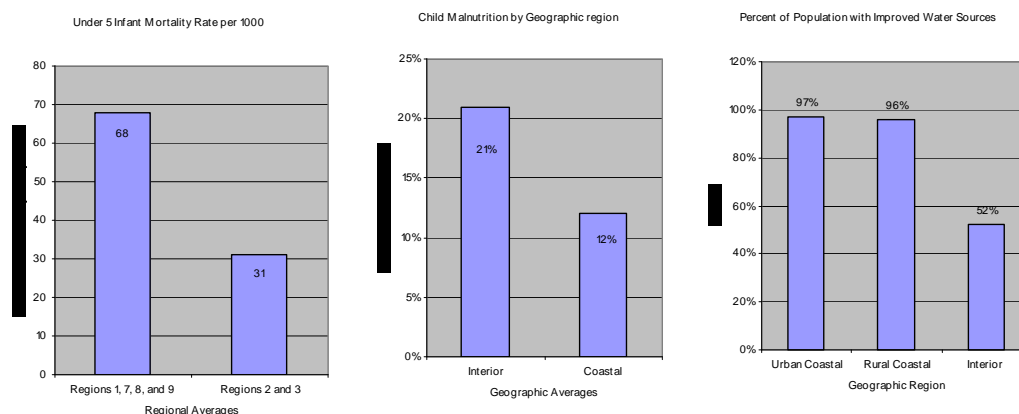
(3) World Health Organization, Country Cooperation Strategy Brief, Guyana, 2006. [http://www.who.int/countryfocus/cooperation\\_strategy/ccsbrief\\_guy\\_en.pdf](http://www.who.int/countryfocus/cooperation_strategy/ccsbrief_guy_en.pdf)

life expectancy at birth is correspondingly low, (63 years in 2004) and under-5 mortality rates are high, but slowly decreasing<sup>4</sup>.

The majority of measurable health parameters show decreases in the level of public health in interior regions of Guyana, including Region 7, compared with coastal and urban areas. *Figure 6-10* illustrates three key parameters: under-5 infant mortality, child malnutrition, and percent of population with improved water sources. These parameters illustrate the relationship between lack of public health facilities, and the corresponding decreases in public health.

The lack of access to improved water sources is related to the high prevalence of diarrhea and intestinal complications in interior areas. These issues are further compounded by the lack of public health centers in interior areas. In Region 7 there is only one hospital for Region 7, which is located in Bartica and is not easily accessible by residents throughout Region 7.

**Figure 6-10. Regional Comparison of Key Health Parameters, 2006<sup>5</sup>**



Source: Guyana Multiple Indicator Cluster Survey, 2006

Furthermore, the prevalence of communicable diseases and related complications is much higher in Region 7 and other interior Regions compared with urban areas. In Region 7, Malaria is the most prevalent disease. In 2004, 8,253 cases were reported in Region 7, which is considered a high-risk malaria area. Other ailments that are significant in the region include respiratory tract infections (1,666 cases); skin disorders (993 cases) acute diarrheal diseases (914 cases), hypertension (688), and worm infestation (668).

(4) Ibid

(5) Multiple Indicator Cluster Survey, Summary Report, 2006, Guyana.  
[http://www.statisticsguyana.gov.gy/pubs/Guyana\\_MICS\\_Summary\\_Report\\_2006.pdf](http://www.statisticsguyana.gov.gy/pubs/Guyana_MICS_Summary_Report_2006.pdf)

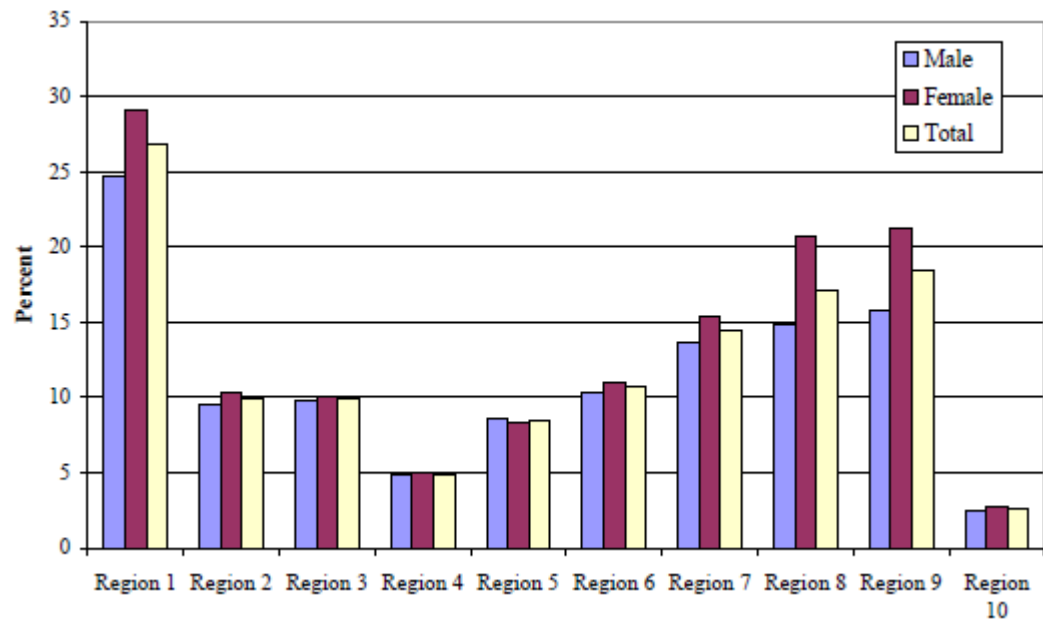
### 6.4.6

### Education Levels

Education is compulsory for all children in Guyana once they reach the age of five years. The Government of Guyana provides public education throughout the country, including nursery, primary, secondary, and post secondary institutions, and the national literacy rate was estimated to be 92% according to the 2002 census. However, as with all other socio-economic characteristics, there are significant differences between the educational characteristics of interior and urban/coastal areas.

While national literacy rates are comparable to other Latin American and Caribbean countries, interior regions - such as Region 7 - have significantly lower literacy rates, as *Figure 6-11* illustrates. The increased illiteracy rates in interior regions may be associated with multiple dynamics, as explained below.

**Figure 6-11.** *Percent Illiterate by Region and Gender*



Source: Guyana Ministry of Education

There is only one secondary school in Region 7, which is located in Bartica, and no tertiary level institutions. *Table 6-2* provides further information regarding the education system in Region 7. The increasing student-teacher ratio is associated with the lack of secondary and post-secondary institutions throughout Region 7. The lack of upper level educational institutions is also related to the decreasing enrollment rates of school age children, as shown in *Table 6-2*.

*Table 6-2. Overview of Region 7 Education System*

Overview of Region 7 Education System						
Type	Number of Institutions	Number of Students	Total Teachers	Trained Teachers	Student to All Teacher Ratio	Student to Trained Teacher Ratio
Nursery	25	802	56	20	14	40
Primary	24	2,704	102	48	27	56
Primary - Tops	15	383	25	9	15	43
Community High Schools	1	512	11	7	47	73
General Secondary	1	269	14	13	19	21
<b>Total</b>	<b>66</b>	<b>4,670</b>	<b>208</b>	<b>97</b>	<b>-</b>	<b>-</b>

*Source: Guyana Ministry of Education*

As Table 6-3 illustrates, there is a significant decrease in the percentage of school age population enrolled for each progressive age group. This may be attributed to the lack of educational facilities, but also may be related to other socio-economic dynamics such as the need for employment, migration etc. However, regardless of the cause, the effects of the declining enrollement rates are also apparent in data related to the highest education reached among Region 7 population over 15 years, as illustrated in Table 6-4.

*Table 6-4. Region 7 Percentage of School Age Population Enrolled in School*

Region 7 Percentage of School Age Population Enrolled in School					
	5 - 9 yrs	10 - 14 yrs	15 - 19 yrs	20 - 24 yrs	Total
Males	94.9	90.9	30.4	2.7	61.5
Females	93.0	92.7	33.5	4.8	62.9
Combined Average	93.9	91.8	31.9	3.7	62.2

*Table 6-5. Highest Education Reached Among Population 15 years and Above*

Region 7 Highest Education Reached Among Population 15 Years and Above							
	None/ Nursery	Primary	Secondary	Post Secondary	University/ Tertiary	Other	Number
Males	6.5	28.7	61.2	1.4	1.8	0.4	5047
Females	8.7	25.2	61.9	1.4	2.3	0.5	4548
Combined Average	7.6	26.95	61.55	1.4	2.05	0.45	9595 (total #)

*Source: Guyana Ministry of Education*

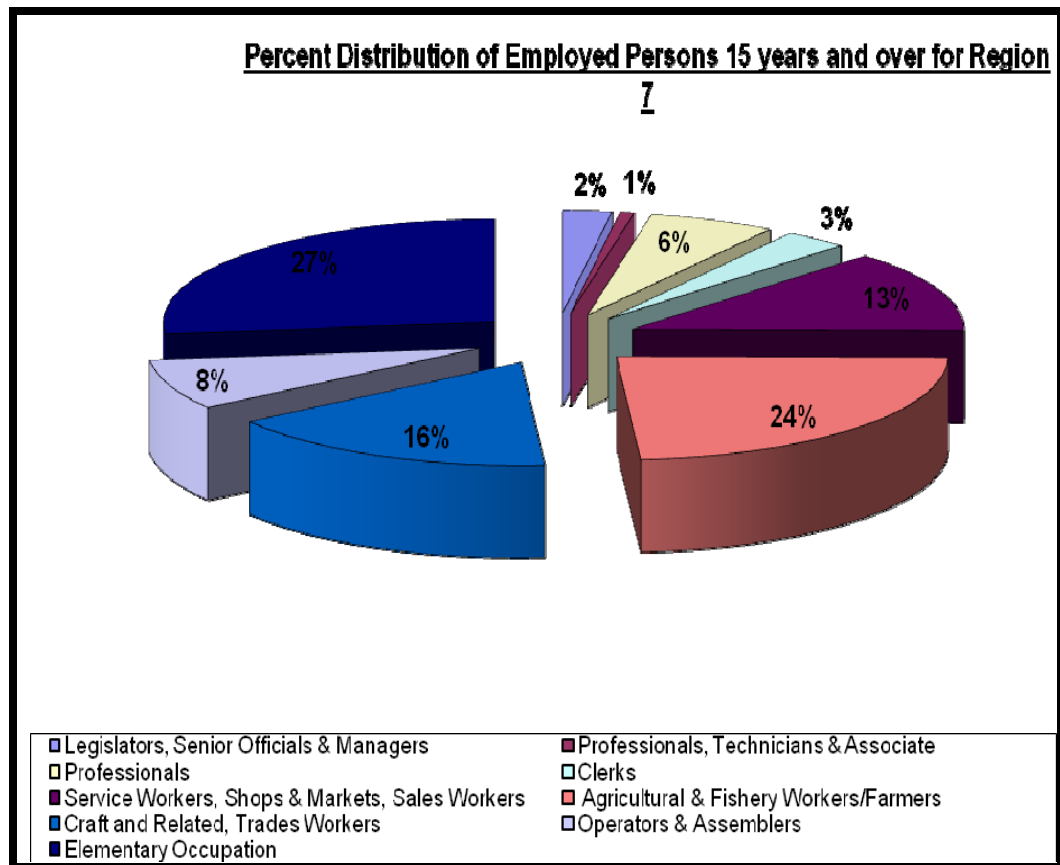
6.4.7

*Occupation and Livelihoods*

Region 7 is well known for its gold mining activities. Historically, gold mining has been an economic pillar for Guyana. Region 7 was the site of the largest gold mine project, the Omai Mine, which began construction in 1991, and continues to be a region with significant small scale mining activity. However, despite the activity of the mining sector in Region 7, the region has not significantly benefited from the profits of such projects.

Subsistence farming, fishing, hunting, and employment in logging and mining businesses are the main sources of livelihoods in Region 7. The percent distribution of general occupation categories is depicted in *figure 6-12* below, which shows that the majority of employed persons perform skilled and unskilled labor in the agricultural/fishing sector, construction, small scale mining and other trades.

*Figure 6-12. Percent Distribution of Employed Persons 15 years and over, Region 7*



Source: Guyana Census 2002

*Figure 6-12* illustrates that the majority of employed persons are performing menial and general labor, a characteristic related both to education level and experience. Furthermore, residents of region 7 are less likely than the national average to hold professional occupations, management or technical positions.

Unemployment rates in Region 7 reflect the nature of available jobs throughout the region. Region 7 unemployment rates are estimated at 7.2% for males and 16.1% for females. Unemployment rates for men are therefore much lower than the national average, while female unemployment rates are higher than the national average, a factor which contributes to the inter-regional migration. Furthermore, unemployment is exacerbated by the influx of Brazilians, who actively look for employment in the mining sector in interior communities throughout Region 7.

The cost of living in Region 7 is also comparatively high, and is estimated to be almost one and a half times that on the coast<sup>6</sup>. One of the root causes of the high cost of living is the high cost of transporting goods due to the relative geographic isolation of the area and difficulty of traversing the terrain. This high cost of living has negatively impacted the availability of government officers (teachers, health workers, nurses, etc.) and most government employees are not adequately compensated to remain for long periods in the area.

The Amerindian population has also been greatly affected by the socio-economic issues in the region. Traditional occupations and lifestyles have slowly been abandoned. Many men have neglected their traditional occupations and have sought employment in the commercial mining or forestry sectors. Food insecurity is also rising in the region, leading some Amerindian populations to require supplements to their diet of traditional staple-foods (flour, rice, etc.), which has led to further increases in the cost of living<sup>7</sup>.

Over time, these socio-economic dynamics and the development of the mining and logging sectors in Region 7 have transformed Region 7 from a subsistence based economy into the current cash based economy.

#### 6.4.8 *The status of Amerindians*

Based on information obtained from the Ministry of Amerindian Affairs, there are twenty-three (23) Amerindian communities (mainly Akawaio and Arecuna) in Region 7. These communities are scattered throughout the three sub-regions of Upper, Middle and Lower Mazaruni.

**Table 6-6. Amerindian Communities in Region 7**

<b>Village</b>	<b>Sub-Region</b>	<b>Population</b>
Arau	Upper Mazaruni	140
Chinoweng	Upper Mazaruni	540

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(6) Guyana Living Standards Survey, 1999

(7) UNDP Report, 1999

Jawalla	Upper Mazaruni	1200
Kaikan	Upper Mazaruni	296
Kako	Upper Mazaruni	511
Kambaru	Upper Mazaruni	219
Kurutuku	Upper Mazaruni	127
Paruima	Upper Mazaruni	730
Phillipai	Upper Mazaruni	1098
Quebanang	Upper Mazaruni	-
Waramadong	Upper Mazaruni	875
Warawatta/Kamarang	Upper Mazaruni	594
Isseneru	Middle Mazaruni	260
Tassarene	Middle Mazaruni	230
Kaburi/72 Miles	Middle Mazaruni	295
Kangaruma/Falls Top	Middle Mazaruni	-
Batavia	Lower Mazaruni	132
Dogg Point	Lower Mazaruni	-
Falmouth	Lower Mazaruni	-
Goshen/Rivers View	Lower Mazaruni	330
Karrau	Lower Mazaruni	276
Kartabo	Lower Mazaruni	-
Rockstone	Lower Mazaruni	375

Source: Ministry of Amerindian Affairs 2008

Amerindian communities are governed by Village Councils made up of Toshaos and Councilors. Elections are held every two years, and are supervised by Officers in 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 established by the Amerindian Act (2005) are to:

- represent the Community;
- act in the best interest of the Community
- provide advice and strategic direction to the Community; hold for the benefit and use of the Community all rights, titles and interests in or over Community lands;
- manage and regulate the use and occupation of Community lands;
- promote the sustainable use, protection and conservation of Community lands and the resources on those lands;
- encourage the preservation and growth of Amerindian culture;

- ensure that places and artifacts located which hold sacred or cultural values to the Community are protected and cared for;
- protect and preserve the Community's intellectual property and traditional knowledge;
- nominate Councilors or other members of the Community to accompany the Tasha to meetings of the Regional Democratic Council, or to attend meetings on behalf of the Community; and
- ensure that proper accounts and financial records are kept.

Unfortunately, many Amerindian Councils are plagued by poor administration and lack of law enforcement. The Captain is the only member of the village council, and receives a small stipend from the Government. Most Amerindian leaders have identified the need for leadership and other training as a priority for their development<sup>8</sup>.

Interior Amerindian communities have traditionally been dependent on agricultural production, hunting and fishing. The advent of mining particularly ASM in the interior regions has disrupted traditional Amerindian life. Amerindian males are increasingly being hired as laborers for mining operations. This has had impacts on agriculture and subsistence farming, leaving women to tend to plantations in the villages. High migration of males has also resulted in an increase in women headed families in these villages. However, the increase of wealth from remittances in the Amerindian economies has led to increased consumerism. Items such as televisions, radios, imported food and beverages are now commonly seen in villages. Despite these symbols of greater affluence, lack of education and higher skills are significant barriers preventing Amerindians from participating in the advancing economy.

Overall, the constraints faced by Amerindians in Region 7 include access to land, lack of physical and social infrastructure, income poverty, limited sustainable livelihood alternatives, low literacy level, and lack of capacity to monitor activities taking place adjacent to their communities.

## 6.5

### *BRIEF PROFILE OF REGION 3*

Region 3 is a predominantly coastal regional with close proximity to urban areas and the national capital of Georgetown. Parts of the project zone of indirect influence cover areas of Region 3, such as Parika, and the proposed wharf site is located in Buckhall. Region 3 is highly populated, contains several urban areas and is divided into 14 active Neighbourhood Democratic Councils (NDC's).

Parika is an active town, with its own NDC, whereas Buckhall is much smaller and has limited infrastructure and accessibility.

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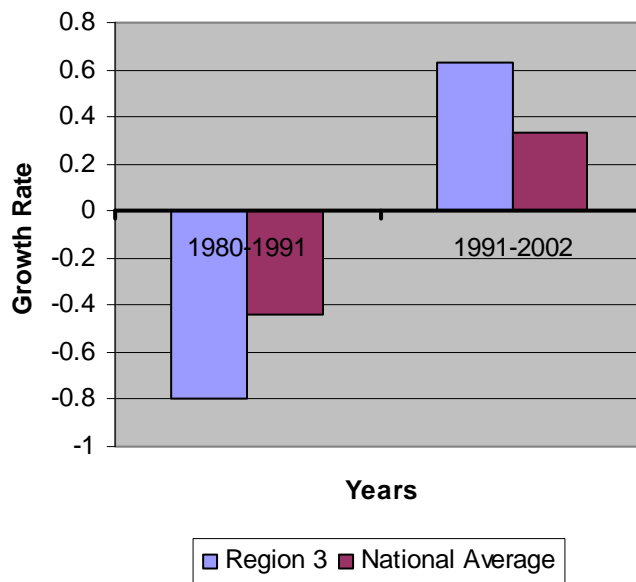
(8) Guyana National Development Strategy 2001-2010

### 6.5.1 Demographic Profile

The total population of Region 3 is 103,061 people, which accounts for 13.2% of the national population<sup>9</sup>. Region 3 is the third most populated region in Guyana, after Region 4, which includes Georgetown, and Region 6, a large coastal and inland Region.

Region 3 is the second smallest region in the country, covering only 3,755 sq km, but is also one of the most densely populated. Region 3 has a population density of 27.5 persons per sq km, compared to the national average of 3.5 persons per sq. km.

Figure 6-13. Comparison of Region 3 Growth Rates with National Average



Source: Guyana Census 2002

The average growth rates over the past two decades appear to follow the same overall trend as the national averages, but are more pronounced, as shown in Figure 6-13.

### 6.5.2 Gender and Age Distribution Profile

As noted above, the national male to female ratio is 1.00 and there is overall gender parity between regions, with only Region 4, the capital city, showing a slightly higher percentage of females. Figure 6-6 (Sec 6.4.2) shows the population, by gender and administrative region for comparative purposes.

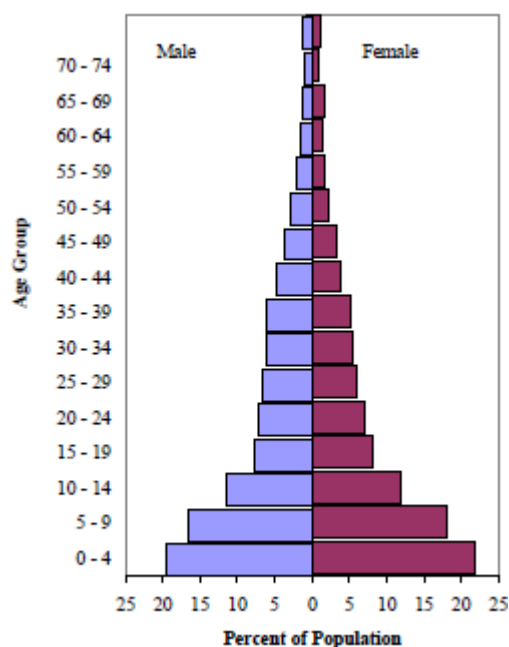
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(9) Guyana Census Report, 2002

In addition to gender, age distribution is an important demographic characteristic with wide-ranging socio-economic implications. *Figure 6-14* illustrates the population pyramids of Region 3. These figures correspond to the conclusions made in regards to the gender and age distribution in Region 7, above, and reveal several additional socio-economic characteristics and trends specific to Region 3, explained below.

The age distribution shows that the population of Region 3 is particularly young, with a high rate of migration after school age years. Migrational dynamics appear to be much more prevalent in Region 3, most likely due to its proximity to both urban areas in Georgetown and interior areas where there are additional employment opportunities.

**Figure 6-14.** *Age and Gender Distribution of Region 3*

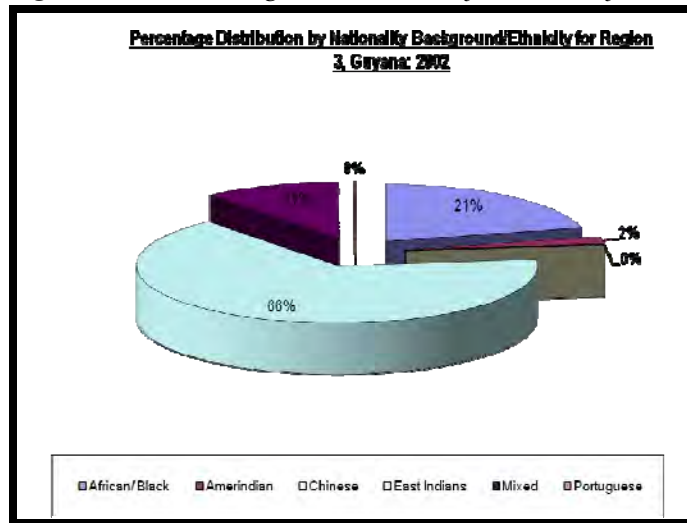


Source: Guyana Census 2002

### 6.5.3 Ethnic Composition

As opposed to Region 7 and other interior areas, Region 3 is comprised of a higher percentage of East Indians, mixed, and other nationalities. *Figure 6-15* illustrates the ethnic composition of Region 3 and shows that East Indians are the dominant ethnic group, comprising 66% of the population, followed by Africans/Blacks comprising 21%, and persons of mixed decent comprising approximately 11% of the population. The higher proportion of ethnic diversity is due largely to the urban and coastal nature of Region 3.

Figure 6-15. Percentage Distribution by Nationality/Ethnicity for Region 3



Source: Guyana Census 2002

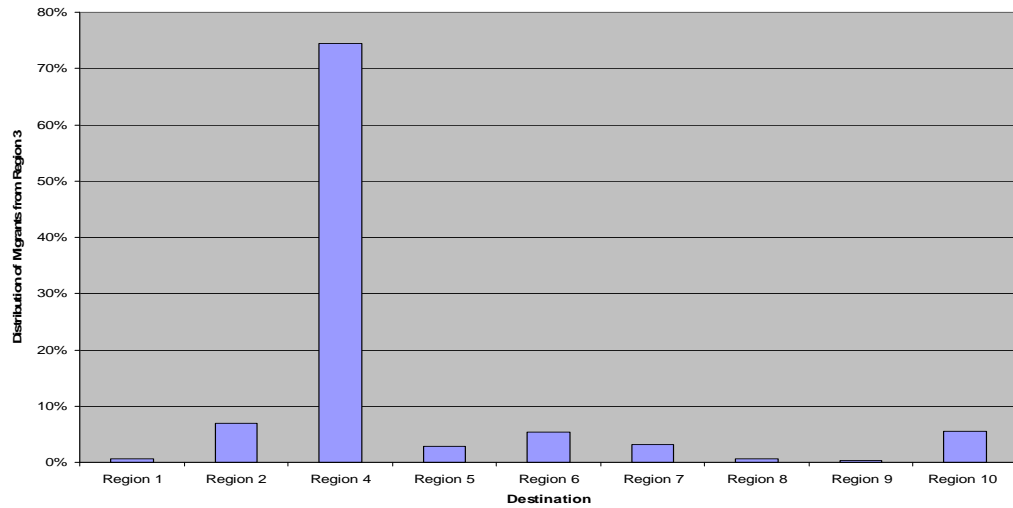
#### 6.5.4 Migration Patterns

Due its geographic location, Region 3 illustrates two of the major inter-regional migrational dynamics within Guyana; it is both a source of migrants and a destination for migrants of other regions.

First, Region 3 is a significant source of inter-regional migrants to other regions of Guyana. Region 3 has no major urban areas, and its close proximity to Georgetown and the urban areas of Region 4 results in a high rate of migration to Region 4.

Figure 6-16 shows the destination of migrants from Region 3, and illustrates that 74% of all migrants from Region 3 are residing in Region 4. Additionally, it is not uncommon for residents of Region 3 to commute to employment opportunities in Region 4. Both these dynamics underscore the differences in economic opportunity in urban areas of Guyana as compared to rural and interior areas.

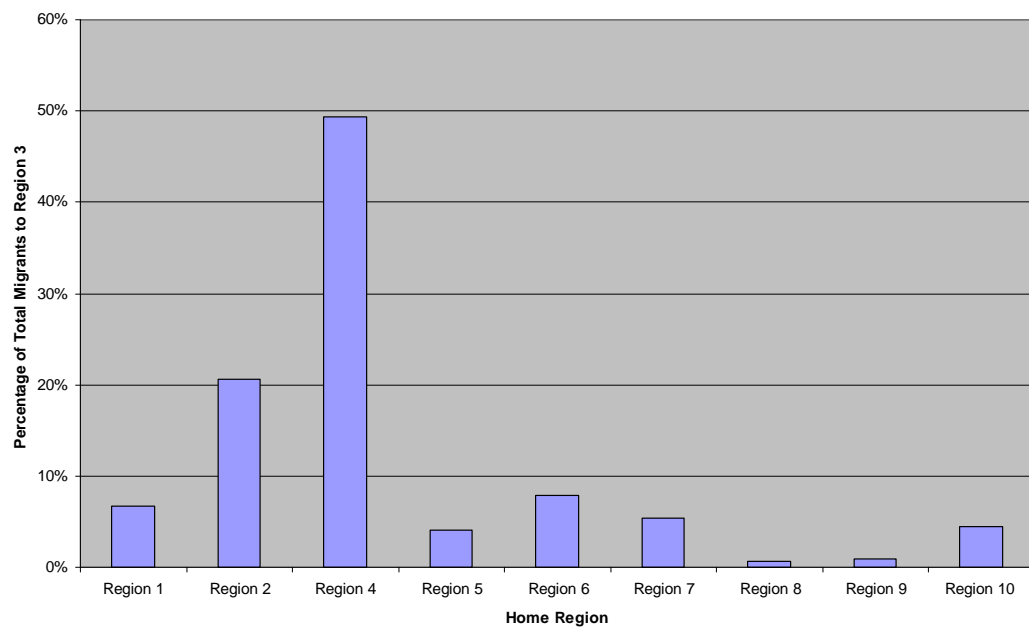
**Figure 6-16. Destination of Migrants from Region 3**



Source: Guyana Census 2002

While Region 3 is a significant source of migrants to urban areas, it is also a major destination for migrants from other regions. *Figure 6-17*, below, illustrates the composition of migrants to Region 3 by their home region, and shows that nearly half of all migrants to Region 3 are from Region 4. This supports the conclusion that there is a significant level of inter-regional migration between Region 3 and Region 4, and that such migration is not limited only to migration to urban areas from rural areas of the country.

**Figure 6-17. Home Region of Migrants to Region 3**



Source: Guyana Census 2002

### 6.5.5

#### *Health*

Public health dynamics in Region 3 are similar to Region 7. Public health institutions are more numerous and more accessible in urban and coastal areas of Guyana, and have comparatively higher levels of public health.

Public health indicators show the four main health concerns in Region 3 are (i) diarrhoeal-related diseases (ii) worm-infestation (iii) common cold & fever and (iv) pneumonia.

Region 3 has a comparatively high amount of health institutions and a correspondingly high level of access to public health care institutions. The major regional hospital in Region 3 is the Vreed-en-hoop West Demerara regional Hospital which provides basic inpatient and outpatient care, diagnostic services and specialist services. Only four other regions have regional hospitals, and the only National hospital is located in Region 4.

While there are no private hospitals in Region 3, there are 10 public health centers and 21 public health posts. Census data show that public health indicators in Region 3 are higher than interior areas, such as Regions 7 and 8, where there is a lack of public health institutions and existing institutions are not easily accessed by the entire population served.

One issue, however, which requires particular attention in urban and coastal areas, is HIV/AIDS. By the end of 2001, there were 2,173 known cases of AIDS in Guyana, 83.7% of which were documented in Region 4, 5.2% in Region 6, 4.3% in Region 10, and 4.2% in Region 3<sup>10</sup>. In response, the Government of Guyana initiated a national HIV/AIDS program to control the spread of HIV/AIDS and provide additional health service for affected persons. Recent data suggest that the HIV prevalence rate in the general population has stabilized and may be decreasing. Data shows that the HIV prevalence rate was 3.1 percent in 2003, 2.5 percent in 2004, 2.2 percent in 2005, and 1.6 percent in 2006<sup>11</sup>.

### 6.5.6

#### *Education Levels*

Education levels and literacy rates vary significantly by region, with urban and coastal regions showing much higher literacy rates, higher enrollment rates, higher educational levels reached, and greater coverage and access to institutions of public education. Such differences in education levels may be correlated to a variety of factors, one of the most important being the availability of educational

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(10) Pan American Health Organization (PAHO) and World Health Organization (WHO). Health Sector Analysis - Guyana, 2003.

(11) IBID.

infrastructure. *Table 6-7* provides details regarding the education infrastructure of Region 3.

*Table 6-7. Region 3- Educational Infrastructure*

Region 3 Educational Infrastructure						
Type	Number of Institutions	Number of Students	Total Teachers	Trained Teachers	Student to All Teacher Ratio	Student to Trained Teacher Ratio
Nursery	62	5,092	312	115	16	44
Primary	61	13,670	511	255	27	54
Primary Tops	38	1,499	95	57	16	26
Community High Schools	5	1,798	83	47	22	38
General Secondary	7	4,347	198	123	22	35
Total	173	26,406	1,199	597		

Source: Guyana Ministry of Education

However, despite the increased coverage of the public education system in Region 3, enrolment rates follow the same general pattern as other regions of the country. The percentage of school age children enrolled in school decreases for each progressive age group, as shown in *Table 6-8*. However, the number of students advancing to higher levels of education is slightly higher in Region 3 than in other rural or interior areas, as shown in *Table 6-9*.

*Table 6-8. Region 3- Percentage of School Age Population Enrolled in School*

Region 3 Percentage of School Age Population Enrolled in School					
	5 - 9 yrs	10 - 14 yrs	15 - 19 yrs	20 - 24 yrs	Total
Males	97	91.8	36.3	5.9	64.1
Females	97.7	92.4	39.3	7	64.3
Total	97.35	92.1	37.8	6.45	64.2

Source: Guyana Ministry of Education

*Table 6-9.. Region 3- Highest Education Reached*

Region 3 Highest Education Reached Among Population 15 Years							
	None/ Nursery	Primary	Secondary	Post Secondary	University/ Tertiary	Other	Number
Males	3.1	34.1	57.2	1.7	3.5	0.4	33473
Females	3.8	30	60.7	1.6	3.4	0.5	33414
Total	3.45	32.05	58.95	1.65	3.45	0.45	66887 (total #)

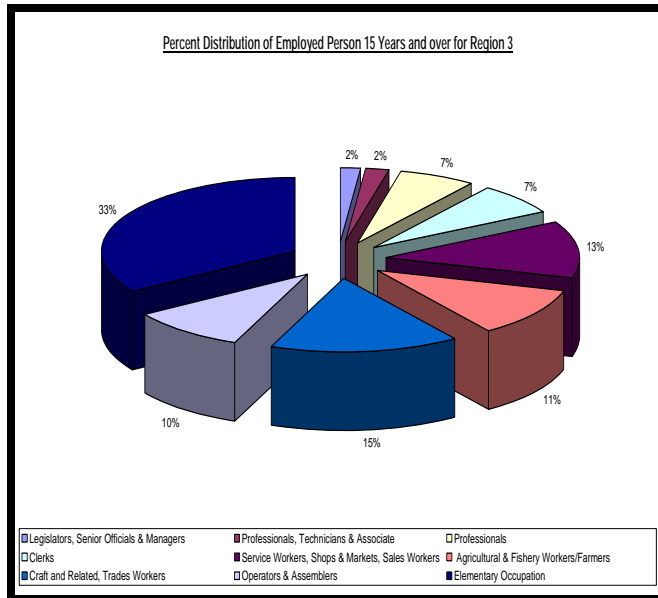
Source: Guyana Ministry of Education

6.5.7

**Occupation and Livelihoods**

As noted above, Region 3 is a coastal region with close ties to urban areas, commercial centers, and agricultural and fishing activities. Region 3 also has several commercial centers, with shops, markets and transportation centers. *Figure 6-18*, below, illustrates the distribution of employed persons in Region 3, and shows that the majority of occupations available in the region consist of elementary/manual labor (33%), craft and trade (15%) and occupations in the commercial or service sectors.

**Figure 6-18. Percent Distribution of Employed Persons – Region 3**



Source: Guyana Census 2002

Both male and female unemployment rates are below the national average of 11.7% unemployment. According to the 2002 census, the male unemployment rate in Region 3 was 7%, which follows the general trends discussed in section 1.4.7.

6.6

**SOCIO-ECONOMIC BASELINE OF THE COMMUNITIES/SETTLEMENTS IN THE PROJECT ZONE OF INDIRECT INFLUENCE**

This section presents the baseline of the six settlements and communities studied as a part of the project zone of influence. This baseline draws on community consultations held in each community as well as all available secondary data and national census data.

### 6.6.1

#### *Bartica*

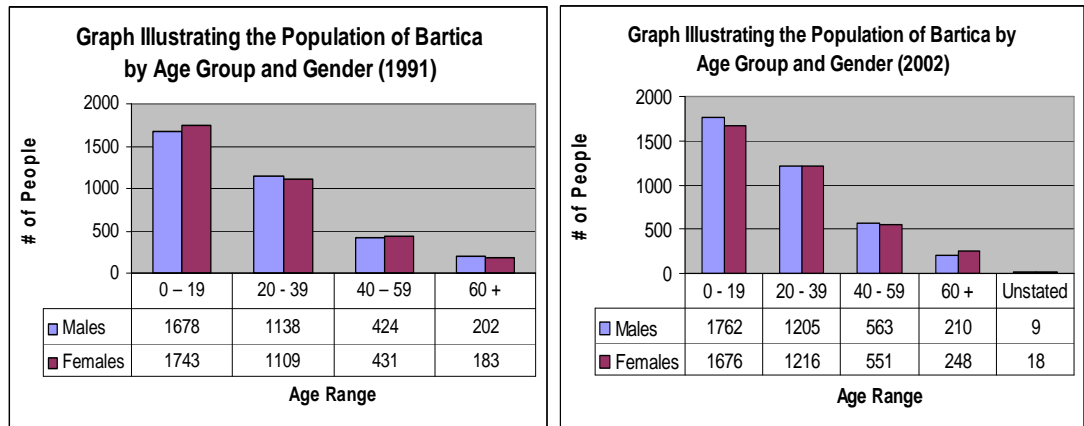
Bartica is located along the Essequibo River at the confluence of the Essequibo and Mazaruni Rivers. Its strategic location makes it a regional commercial hub, serving as a gateway to the interior. The community sits on the site of the old “Vryheid” Dutch Plantation that was established in 1678 by the Dutch West India Company. The first permanent structure was established in 1829 by the Church Missionary Society to carry out missionary work among the Amerindians housed the Bartica Mission Station. However, due to the soil’s unsuitability for agriculture, the mission moved eastwards for about a mile to Bartica Grove (the current site of Bartica), at the confluence of the Essequibo and Mazaruni Rivers, and a short distance from the mouth of the Cuyuni River.

In 1887, the land was repossessed with permission from the Court of Policy to lay the foundation for a future town in the hinterland and several lots were laid out and sold at a public auction. However, it was the rise of the gold industry in the 1880's which really give impetus to the development and growth of Bartica as it was an ideal location in terms of accessibility to the Georgetown, as well as the gold fields and the timber grants. Bartica also served as a major recruitment point for laborers and a number of service oriented businesses sprang up in the town to cater for the needs of the miners and woodcutters. Finally, government departments were established to monitor and control the gold industry.

#### *Population*

Bartica had a total population of 7,458 in 2002 according to census information. The population grew by approximately 8% since 1991. In 2002, there were 1,664 households of varying sizes, and Bartica had an average household size of 5. Furthermore, according to the 2002 census the population has remained predominantly young with a high proportion of the population below 20 years of age. *Figure 6-19* compares the population of Bartica in 1991 and 2002, and reflects slight changes in the gender balance over persons 0-19 and the number of persons aged 40-59. These changes are most likely due to interregional migrational dynamics, as discussed above.

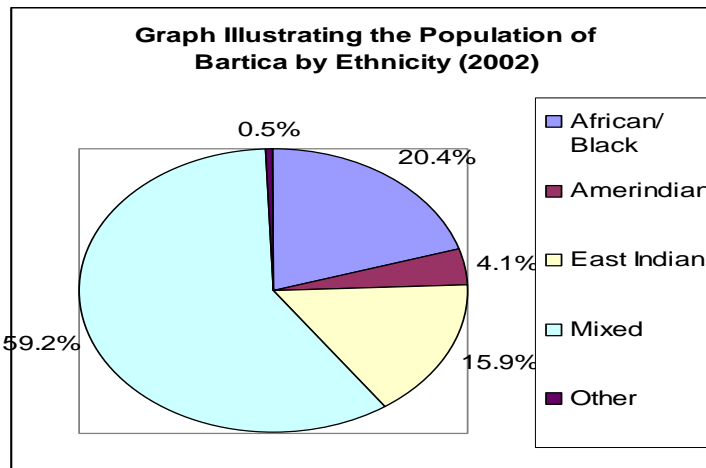
Figure 6-19. Population of Bartica, 1991 and 2002



Source: Guyana Census 2002

Bartica's population is similar to other coastal regions of Guyana and is comprised of multiple ethnic groups. The 2002 census found that 20.4% of the population is of African/Black lineage, 15.9% are of East Indian lineage, 4.1% are Amerindian, and the remaining 59.2% are a mix of these ethnic groups, with additional influence from Brazilian and other nationalities present in Guyana (Figure 6-20).

Figure 6-20. Ethnic Composition of Bartica, 2002



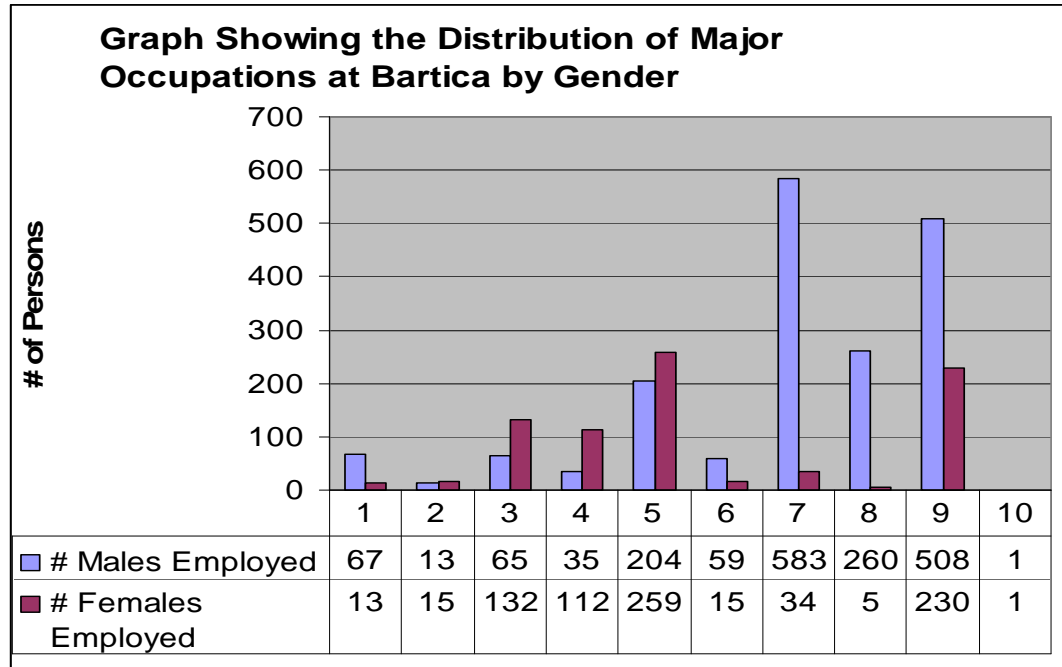
Source: Guyana Census 2002

### Employment and Economy

Employment and economic characteristics of Bartica are similar to the regional characteristics discussed in section 6.4.6. The dominant economic activities for males in Bartica are related to common crafts and trades, general physical labor, machine operators and assemblers, and service and market sales workers and shops, respectively (Figure 6-21). Females in the labor force are employed in

occupations related to commercial services and sales, manual or unskilled labor, and limited numbers of professional, secretarial and clerk positions. Bartica is also known to have a significant population of female sex workers who are not registered in the employment status classifications. Details regarding employment status by gender are illustrated in Figure 6-22.

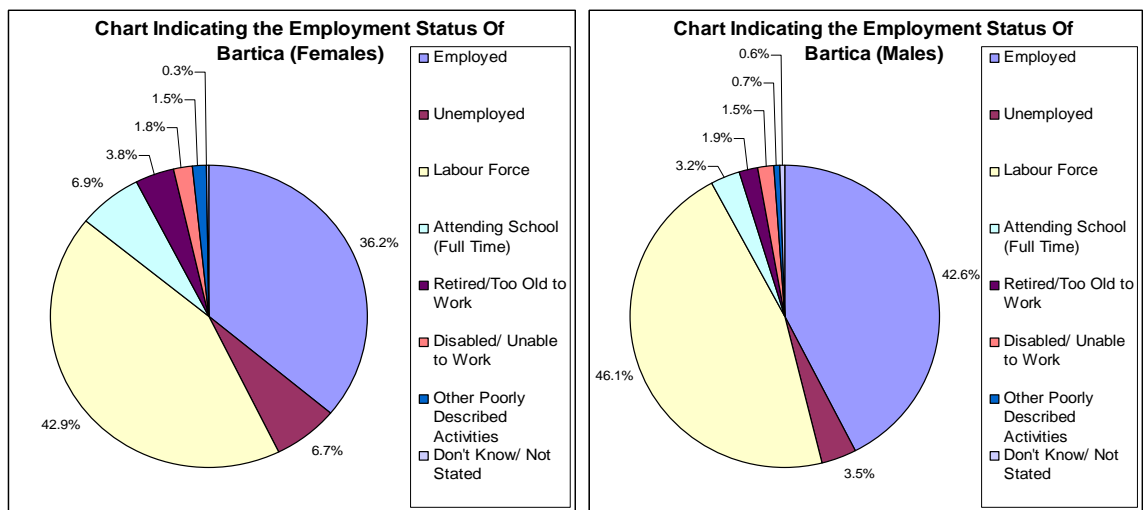
Figure 6-21. Distribution of Occupations in Bartica



Source: Guyana Census 2002

\*Occupation Key: 1.) Legislators, Senior Officials & Managers; 2.) Professionals; 3.) Technicians & Associate Professionals; 4.) Clerks  
5.) Service & Market Sales, Workers & Shops; 6.) Skilled Agricultural & Fishery Workers/Farmers; 7.) Craft and Related Trades  
Workers; 8.) Plant & Machine Operators & Assemblers; 9.) Elementary Occupation; 10.) Not Stated

Figure 6-22. Employment Status of Bartica by Gender



Source: Guyana Census 2002

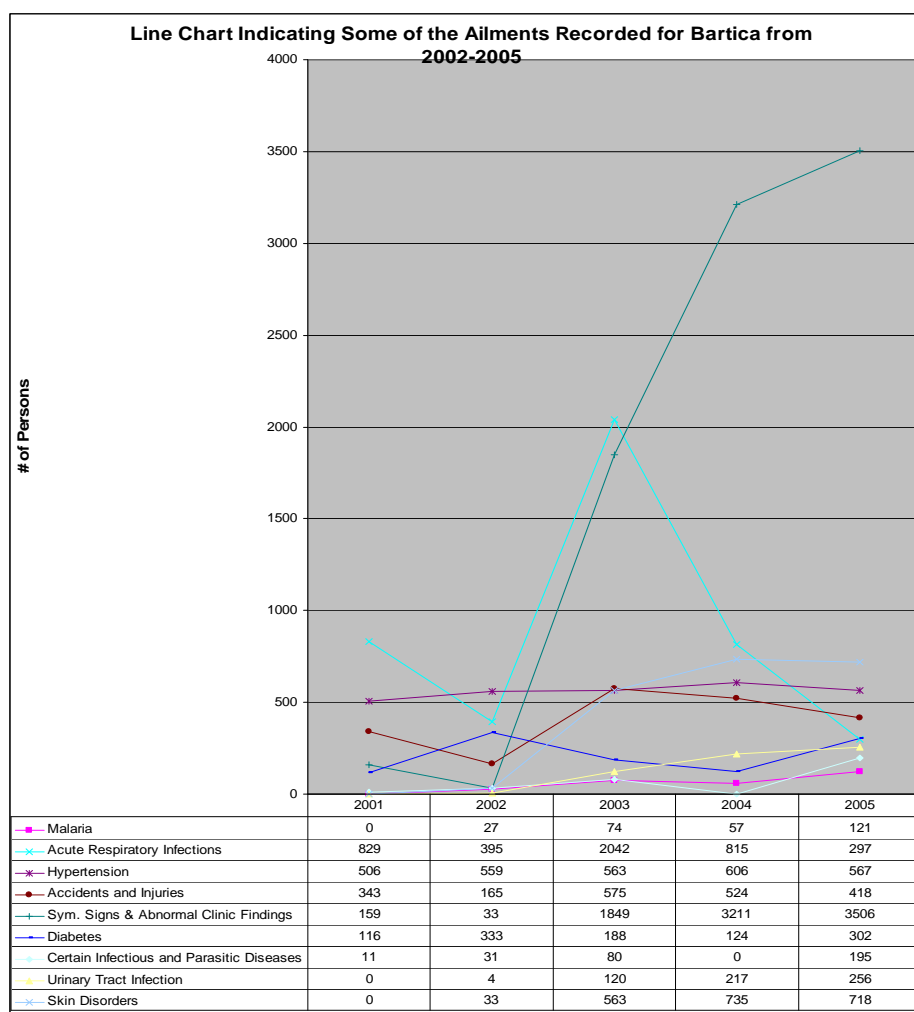
Unemployment rates in Bartica also correspond to the Region 7 unemployment rates. While most of the male population appears to be productively employed, the unemployment rates remain especially high among women. The unemployment rate in Bartica is approximately 7.6 % for males and 15.6 % for females.

### Health

The health issues in Bartica are similar to the general health issues throughout Region 7, as described in section 6.4.5. However, residents of Bartica have greater access to health care services than do other residents of outlying areas of Region 7 due to the services of the Regional Hospital in Bartica.

The principal ailments in Bartica are related to typhoid and paratyphoid fevers, asthma, and sexually transmitted diseases, as shown in *Figure 6-23*. Trends show that there was a marked decrease in typhoid and paratyphoid fevers between 2003 and 2005, occurrences of asthma and sexually transmitted diseases have fluctuated significantly.

**Figure 6-23. Ailments Recorded in Bartica, 2002-2005**



Source: Guyana Census 2002

### *Infrastructure and Amenities*

As the administrative headquarters of Region 7, Bartica is home to a comparatively high amount of infrastructure and amenities. Currently, the social infrastructure of Bartica includes:

- one secondary school;
- six primary schools;
- several nursery schools;
- a community centre;
- a police station;
- a library; and
- a hospital.

Others amenities include:

- a regional transportation workshop;
- the office of the Regional Democratic Council of Region 7;
- two commercial banks; and
- several places of worship.

Bartica is also home to several NGOs and other organizations active in the region, such as The Hope Foundation, an HIV/AIDS NGO which provides education and public awareness on HIV/AIDS and related issues.

### *Other Related Issues*

Bartica has historically been considered as low crime community, with crimes in the area being predominantly petty crimes (for examples, stealing) with few isolated cases of rape and murder. However, on February 16<sup>th</sup> 2008, Bartica was attacked by a heavily-armed gang. The attack resulted in the death of twelve persons, including three policemen. To commemorate this horrific attack, the community is seeking assistance to erect a monument to represent the lost lives of the innocent civilians that were victims of this massacre.

Brazilians who reside in Bartica are allowed to operate a number of establishments (shops and restaurants) which promote the use and abuse of alcohol. The Brazilian culture has been adopted by many of the youths of Bartica, which is slowly changing the overall culture of Bartica.

## **6.6.2** *Itaballi*

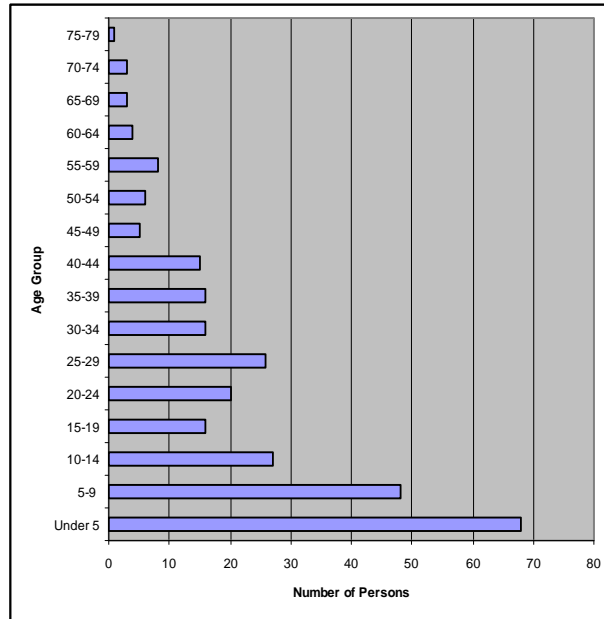
Itaballi is located approximately six miles from Bartica on the west bank of the Mazaruni River and houses a Guyana Gold camp. The camp is used to house employees or project personnel on their way to interior locations.

### *Population*

According to the 2002 census, the population of Itaballi was 282 people and comprised of approximately 84 households. *Figure 6-24* illustrates the population

demographic by age, which corresponds to the age distributions common throughout Region 7, but shows a large proportion of young and working age persons. This has positive implications on the demand for labor in the mining and logging industries operating within proximity of the area. It has been noted that there has been a gradual increase in the population since the 2002 census which is attributed to the growth of the mining/logging industry in the past few years and the associated development of the area.

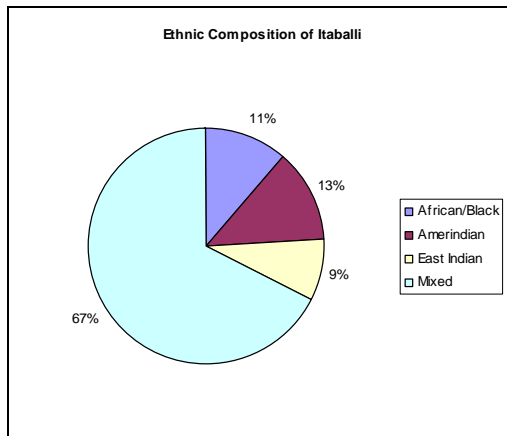
**Figure 6-24.** Population of Itaballi, by Age



Source: Guyana Census 2002

Similarly, the ethnic composition of Itaballi reflects the same general trends as that of Region 7. In Itaballi, Amerindians are the most prevalent ethnic group, comprising 13% of the population, while the majority of the population is of mixed ethnic background (Figure 6-25).

**Figure 6-25.** Ethnic Composition of Itaballi

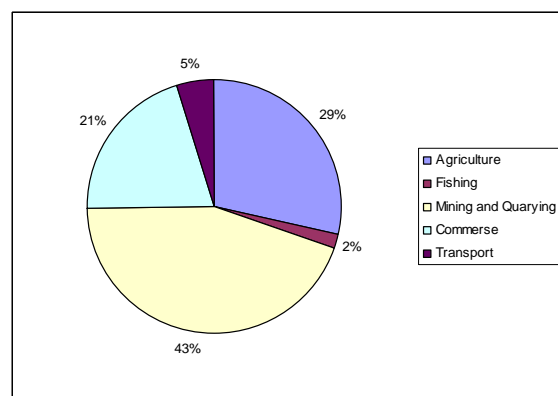


Source: Guyana Census 2002

### *Employment and Economy*

There is limited economic and commercial activity in Itaballi and subsistence farming appears to be the main non-income household activity. The 2002 census recorded only 63 gainfully employed individuals in Itaballi. Of those, 43% were employed in the mining and quarrying sector, 29% in wage earning agricultural activities, and 21% in the general commerce sector, as shown in Figure 6-26.

**Figure 6-26.** Occupation of Employed Residents of Itaballi, 2002



Source: Guyana Census 2002

Further analysis has confirmed that the major economic activities in Itaballi are associated with gold/diamond mining, shop keeping, quarrying and logging, and agricultural produce such as bananas, pears, and ground provisions.

In the recent years, there has been an increase in the number of occupations not related directly to mining/logging, which may be an indicator economic development in the village. Itaballi also provides fuel depots which provide fuel to vehicles travelling to the interiors areas. As a result shops and services including tire and automotive repair, bars etc., have sprung up to cater to truckers and vehicular traffic. It has also been noted that female sex workers are present in large numbers in Itaballi.

The recent economic development of Itaballi may be related more to speculation rather than sustainable development. It has been noted that Itaballi is attracting attention due to potential economic opportunities associated with the development of the area, and community consultations confirm that people come here looking to set up shops and provide new services.

### *Infrastructure and Amenities*

Itaballi has the following infrastructure:

- a community centre;
- a library;
- a primary school;
- a recently constructed health centre/post;

- two churches; and
- a play field and pavilion.

Itaballi has no secondary school; however, children from the community can and have, over the years, accessed secondary education in Bartica. A recently constructed health facility provides the community with basic health services, such as medical supplies, medical checks and testing for hypertension. A medic is stationed at this health post every other day; the medic provides services to both Bartica and Itaballi. With malaria being a major health concern in this area, malaria smears are sent to be analysed at the Bartica Regional Hospital.



In 2003, a security check-point was established at Itaballi with the aim of reducing the high incidence of crime at interior locations. Two officers of the Guyana Police Force and two GGMC mining officers are stationed at the check-point. These officers monitor persons and vehicles entering and leaving the mining district.

#### *Other Issues and Concerns*

Community consultations with residents of Itaballi revealed the following concerns:

- high unemployment, especially among young people;
- absence of technical training facilities for youths and limited opportunities for self actualization and improved self esteem;
- poor health care system;
- poor water supply;
- land erosion and destruction of forests and vegetation;
- discrimination among different races/lack of social cohesion;
- drug and alcohol abuse;
- strangers entering the community and being involved in crime;
- a high prevalence of malaria among residents;
- a high incidence of diarrhoea, typhoid and vomiting due to unsanitary conditions and the domestic use of contaminated water from nearby rivers;
- the influence of alcohol in the community where all the shops in the area appeared to market the substance- alcohol has been seen as a major cause of spousal abuse and the lack of social cohesion within homes;

- more focus desired on the primary school by the Ministry of Education, due to lack of teachers, overcrowding, and inadequate teaching quarters;
- the expense and difficulty of travelling to Bartica for medical emergencies and for children to attend the secondary school; and
- the need for a public restroom as a means to provide outsiders/visitors with a place to relieve themselves rather than in the nearby rivers that the community uses to bathe, cook and drink.

### 6.6.3 *Aranka*

Aranka has been a mining community for over 100 years and contains a large community of transient miners. Aranka is located on a stream of the same name with its mouth approximately 30 km downstream from the Aurora mine site. Aranka is quite remote and access is mainly from several points along the Cuyuni River or by tractor/ATV through the interior. A boat trip from the Project Site to Aranka takes about 2-3 hours when the water level is high and 6-7 hours when the water level is low.

#### *Population*

Since Aranka is not an incorporated village, no official demographic surveys have been conducted for Aranka; however, it has been estimated that the total population is roughly 500-1000 persons. The population is approximately 75% male and 25% female, due to the high proportion of mining related activities. Observations and community responses indicate the age of the population is generally lower than 40. The area predominantly consists of Black African-Guyanese (90%), Brazilians 9%, and other ethnicities (1%).

#### *Employment and Economy*

Aranka is predominantly a transient/artisanal mining community. Very little farming occurs in the community and only a small number of individuals cultivate commercial crops or livestock. Diets are also supplemented by fishing.

Basic consumer goods and supplies are transported from Georgetown and sold at increased prices due to the high cost of transportation and infrequent replenishment of goods.

Women employed in Aranka are mostly service workers. They run shops, food services, laundry services, and some participate in the sex trade. Petty trade also exists among the residents of the community.

There are very few, if any, traditional households. During



consultations, the women in Aranka indicated that they came from throughout Guyana and remain in Aranka for approximately three month periods. While most have at least one child, none of the women brought the children to Aranka, primarily due to the lack of security in the community. The women all claimed to be single and fully independent of male companions and expressed some fear over the presence of many firearms and the greater number of men in the community. Women claim to be paid for their services in gold, with monthly incomes ranging between 2-8 oz <sup>12</sup> of gold.

Men in the community who were participated in the consultation also stated that they refused to bring their partners or families to the community for fear of the dangerous environment. However, on average the men earned a much higher monthly income, claiming that an average annual income can amount to over \$400,000. However, due to the lack of shops, many of the men complained about the high prices for food and goods in the community.

#### *Infrastructure and Amenities*

The only official sign of infrastructure is the presence of a small Guyana and Geology Mines Commission (GGMC) office. The Guyana Geology and Mines Commission (GGMC) is the lead institution in charge of providing reconnaissance, exploration, prospecting guidelines and mining licenses. Despite the presence of the office, the GGMC representative is not always on site and a great majority of the artisanal miners in the community do not possess licenses to undertake mining activities.

The remainder of the infrastructure is very basic and consists of a few bars, shops, and an overnight facility. Housing and living conditions are basic and similar to that of transient mining camps.

#### *Other Issues and Concerns*

Mercury amalgamation is the primary means of beneficiation exercised by miners in the vicinity of Aranka. The common use of mercury combined with frequent discharges to streams in the area is thought to negatively impact the water quality of the area. Nevertheless, the river is still used to bathe and, when rain water is insufficient, is at times still used as a source of drinking water. This poses a serious health risk to the residents of the community. There is also a lack of latrines, with only about 10-15 personal latrines within the entire community.

There is no health post or medics to support the community. In the event of a medical emergency, those in need of treatment must secure boat transportation to the Aurora mining campsite for assistance. In past cases the Aurora site medic has

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(12) 1 oz of gold is estimated at approximately \$124,000 GUY (\$620USD)

attempted to provide medical services, if appropriate, and when necessary has referred patients to seek further medical assistance and helped arrange transportation.

Other general concerns expressed in the consultations include:

- lack of security;
- high risk of HIV/AIDS due to sex trade practices;
- lack of potable water;
- lack of transport facilities;
- high malaria and dengue fever risk;
- absence of health post/medic; and
- high cost of living.

#### 6.6.4

#### *Kurutuku*

Kurutuku is a titled Amerindian community which is located in the Upper Cuyuni River and is approximately 90 km from Eterinbang, in the Administrative Region # 7. According to the Old Amerindian Act, Kurutuku is *a tract of State Land situated on the right bank of the Cuyuni River, commencing at the mouth of Otomung River, right bank of Cuyuni River, thence up to the Otomung River for four miles, thence northwest for five miles, thence north east to the mouth of Otomung River, the point of commencement.* Its closest neighbour is San Martin, Venezuela. Currently, the community is accessed directly (only) by water transportation. The mining concession at Aurora is located approximately 53 km downstream of the community.

Kurutuku was established in 1966 after the Guyana Defense Force had constructed an airstrip in Kurutuku. After some time, a Priest of the Bartica Anglican Church visited Bamboo Landing, what is referred to as “Old Kurutuku”, and established a church in that area. In the past, many residents of Old Kurutuku depended mainly on subsistence farming as their main source of livelihood. However, the rocky soil in the area was not conducive for farming; thus, many households migrated due to difficult socio-economic circumstances. Consequently, a community was formed five (5) miles from Old Kurutuku, and in close proximity to the airstrip. This community is known today as Kurutuku.

Kurutuku was once a community with potential to expand and improve the quality of life of the residents. The land was more fertile and conducive to farming activities, and the presence of the airstrip provided a good opportunity for trading activities. The area was also once renowned for its mineral wealth and the associated establishment of several small businesses.

However, the Regional Democratic Council closed the trading operation due to alleged drug trafficking activities taking place between Guyana and Venezuela. That decision significantly affected the Kurutuku community and mining

operations ceased and small businesses closed and residents gradually migrated to Venezuela in search of employment opportunities<sup>13</sup>. Consequently, many skilled persons, including the health workers, teachers and others took up residence in Venezuela, with few remaining in Kurutuku.

### *Population*

According to the 2002 census, the population of Kurutuku was about 120 persons comprising 25 households. Of this total, 110 are Amerindians<sup>14</sup>, 7 are mixed, while 3 did not state their ethnicity. There are 66 males and 54 females. Households sizes vary, with the majority (10) having 4 to 6 persons and (6) 2-4 persons (*Table 6-10*).

**Table 6-10. Household Size Group - Kurutuku**

Size	Frequency (Number of households)
1 person	3
2-3 persons	6
4-6 persons	10
7-9 persons	4
10-14 persons	2
Total	25

*Source: 2002 Guyana Census*

The most recent figures made public by the Ministry of Amerindian Affairs (2005) indicates that Kurutuku has a population of 127 persons.

### *Employment and Economy*

Currently, members of the Kurutuku community are involved in subsistence activities (farming, fishing and hunting), in addition to forestry, artisanal gold mining and dredging for gold mining operations.

Farms are located between one and two miles from residences and are accessed by water and canoe. Produce from the farms range from ground provisions to an assortment of fruits and vegetables, and account for the staple diet of residents. The main crops grown on the farms are yam, sweet cassava, sugarcane, watermelon, pumpkin, sweet potato, eddo, banana and papaw. Basic and elementary agricultural implements such as cutlasses, shovels and forks are used to prepare the land. Shifting cultivation is practiced when land is unsuitable to support crops year after year.

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(13) Information obtained form SIMAP.

(14) Akawaios are the dominant tribe, while the Arekunas are the minority in Kurutuku.

Fishing activities occur mainly at Powis Falls and Stop-off Falls and on rivers and creeks within proximity of the village and sometimes as far away as Devils Hole in the Cuyuni River. Fishes caught include bum bum, blinker, pacu, basha, kuma kuma, skeet, piranhas, haimara, dawala, maripac and lou lou.

Hunting is done approximately once a week using traditional arrow and bow or a shotgun. Hunting grounds are in the areas surrounding the village, in hilly areas on the south bank of the Cuyuni River, along creeks such as the Arenasi, and Takutu, as well as on the trail to Barama. Animals hunted include deer, agouti, acouri, white-lipped peccary, collared peccary, paca (labba), tapir (bush cow), capybara, curassows (powis), marudi, mam and yacy. Birds are also trapped in areas around the village by the residents for food.

Some residents of the community are involved in gold mining operations. Gold mining is done mainly in the North West District, about 65 miles from the village. This two-day journey is completed on foot at least once a year. A metal detector is used to prospect for gold. Those who are unable to acquire this device, seek employment with other miners.

#### *Land Use and Utilization of Aurora Concession area*

Today, Amerindians hold land collectively, although individual/family parcels are identified and generally accepted at the community level. In some communities, the Village Council has identified parcels for activities such as housing, farming, etc.

As mentioned earlier in this report, Kurutuku is a titled community and therefore there is communal ownership of resources. All decisions concerning the utilization of resources must be made by the Village Council, which has legal jurisdiction to govern all the affairs of the community. The village council therefore acts as a private landowner, subject to the approval of the Community, and has the right to lease areas of its lands for the benefit of the Community. The Government of Guyana has initiated a process to have communal lands surveyed, demarcate the boundaries and issue full titles to Amerindian communities.

Amerindian communities are known to use the Cuyuni River to access areas both upstream and downstream of the village. The downstream areas are accessible only during the high water periods. During these periods villagers, may from time to time stop at the Aurora Project Site during their travels or to seek limited medical assistance.

#### *Public Health*

The major health issues in Kurutuku are similar to those of Region 7 as a whole and include malaria, water borne diseases such as diarrhoea, gastroenteritis, and typhoid. Others issues with particularly high incidences in Kurutuku include tuberculosis, worm infestation, and anemia. There is also a growing threat of

increased occurrences of HIV/AIDS related to widespread female prostitution in Bartica and on the Venezuela border.

### *Infrastructure*

While there is one school building in Kurutuku education is limited by the lack of qualified teachers. There are no certified teachers within the community and no teachers outside of Kurutuku are willing to go into the area due to the absence of appropriate accommodation. However, the situation may improve due to the completion of a teachers' living quarters. As a result, Kurutuku has high illiteracy rates.

There is also a health post in the village, but it lacks certified health workers. Health workers from Kaikan or Arau visit the village periodically. The community owns a radio set; however, it is sometimes difficult to get signals in and out of Georgetown. Residents use pit latrines and have no access to potable water or electricity.

### *Other Concerns and Issues*

Other key concerns and issues expressed in recent consultations include:

- Malaria smears take a long time to confirm disease;
- Lack of employment which results in residents opting to migrate away from area as a survival strategy;
- Migration affects households' and families' structure, as well as community social cohesion;
- Lack of education due to the absence of school teachers. Illiteracy is claimed as being partly responsible for alleged 'exploitation' of Amerindian employees by mining operators and owners of logging concessions;
- Transportation costs associated with exorbitant travel costs make accessibility almost prohibitive;
- Amerindian employees do not maintain steady employment. Information provided by the Ministry of Amerindian Affairs reveal that workers are changed every two months since persons migrate to Venezuela (and may return after a few years), due to the socio-economic realities of Kurutuku; and
- Lack of specialized skills among the adult and younger population. The National Development Strategy (2001-2010) notes that only 0.1 percent of the interior population has received post-secondary education; hence the urgent need for upgrading basic skills among the adult population has been identified by indigenous people representatives. Skills training will prepare Amerindians to manage the resource base in their villages, as well as to take fuller advantage of job openings within the developing economy in the Guyana interior.

### 6.6.5

#### *Buckhall*

Buckhall is located on the west bank of the Essequibo River. Buckhall was originally a farming community but has been significantly impacted by the development of commercial forestry related activities.

Barama Company Limited (Barama), a commercial forestry company, obtained a large forestry concession and began operations in Buckhall in 2002. The company operates a saw mill, an operations department, a log pond, and living quarters for their employees in Buckhall. Barama has also developed a network of roads that service the forest concession. The primary road within the network, referred to as M1, is utilized by Guyana Gold and others to gain road access to mining and forestry areas further west.

#### *Population*

The current population of Buckhall is estimated to be 65-70 persons. Long term residents claim the population of Buckhall has been declining significantly in recent years, decreasing from a high of roughly 150-200 persons. The population is considered mixed-race with no significant ethnic groups. Average household sizes in the area are 5 persons, and there are approximately 8-10 households in the area close to the landing in Buckhall.

#### *Employment and Economy*

Following the commencement of Barama operations in Buckhall, economic activities have shifted from small scale agriculture to forestry and artisanal mining. Most gainfully employed residents of Buckhall are employed by Barama. However, there are also several small stores and bars, and there is some economic activity associated with the sex trade.

Small scale farming and fishing also contribute to the subsistence of some Buckhall residents, including the rearing of poultry and sheep, and fishing for personal consumption and occasional sale.

#### *Health*

Health issues in Buckhall are similar to other rural areas of Region 7 and region 3. Health care is limited by the lack of health care institutions. Some basic first aid services are provided at Barama facilities, both for employees and local residents, however anyone with more than minor injuries requiring basic first aid are referred to the nearest public medical facilities, which are located in Parika.

#### *Infrastructure*

There is no governmental school in Buckhall. The nearest public primary school is located on Great Troolie Island. Due to the lack of nearby schools there is rate of absenteeism and low literacy rates.

Residents of Buckhall have criticized Barama for not complying with a previous promise to provide an educational facility for the community. Residents have petitioned government officials to intervene, since their children are disadvantaged by not having access to formal education.

### 6.6.6 *Parika*

#### *Population*

According to the 2002 census, the population of Parika was 4,081. The population has increased by 40% since 1991, when the population was estimated to be 2,913, as shown in *Table 6-11*. Parika is a well developed town and the overall increase in population is attributed to the development of the port facilities over the last decade and the corresponding increase in economic activity.

Despite the increase in population, however, the general age and gender composition of the population have remained unchanged. The 2002 male to female sex ratio was fairly equal at 1.03, according to the Guyana Census, which is similar to the overall sex ratio of Region 3.

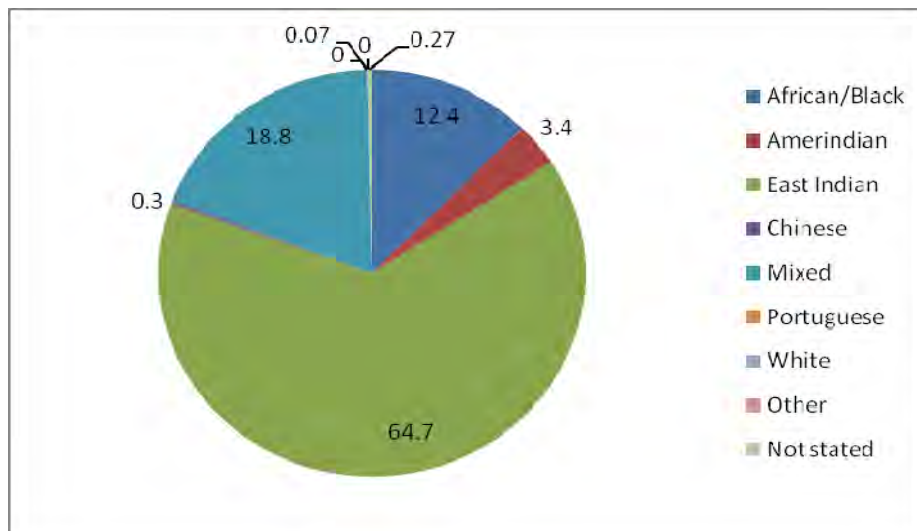
**Table 6-11.** Comparison of Parika's Population in 1991 and 2002, by age

Age Group	1991 Guyana Census	2002 Guyana Census
0-5	404	572
5-9	321	548
10-14	352	474
15-19	340	383
20-24	337	359
25-29	293	337
30-34	226	346
35-39	165	294
40-44	104	254
45-49	87	201
50-54	76	120
55-59	51	73
60-64	45	64
65 & Above	112	110
Not Stated	0	6
Total	2913	4081

Source: Guyana Census 1991 & 2002

According to the Mora-Parika Neighbourhood Democratic Council, East Indians are the dominant ethnic group in Parika, comprising approximately 64.7% of the population. *Figure 6-27* illustrates the major ethnic groups in Parika, including African/Black, Mixed, and Amerindian populations. As the figure shows, the ethnic composition of Parika is similar to the overall ethnic composition of Region 3, described above.

**Figure 6-27.** *Ethnic Composition of Parika, 2002*



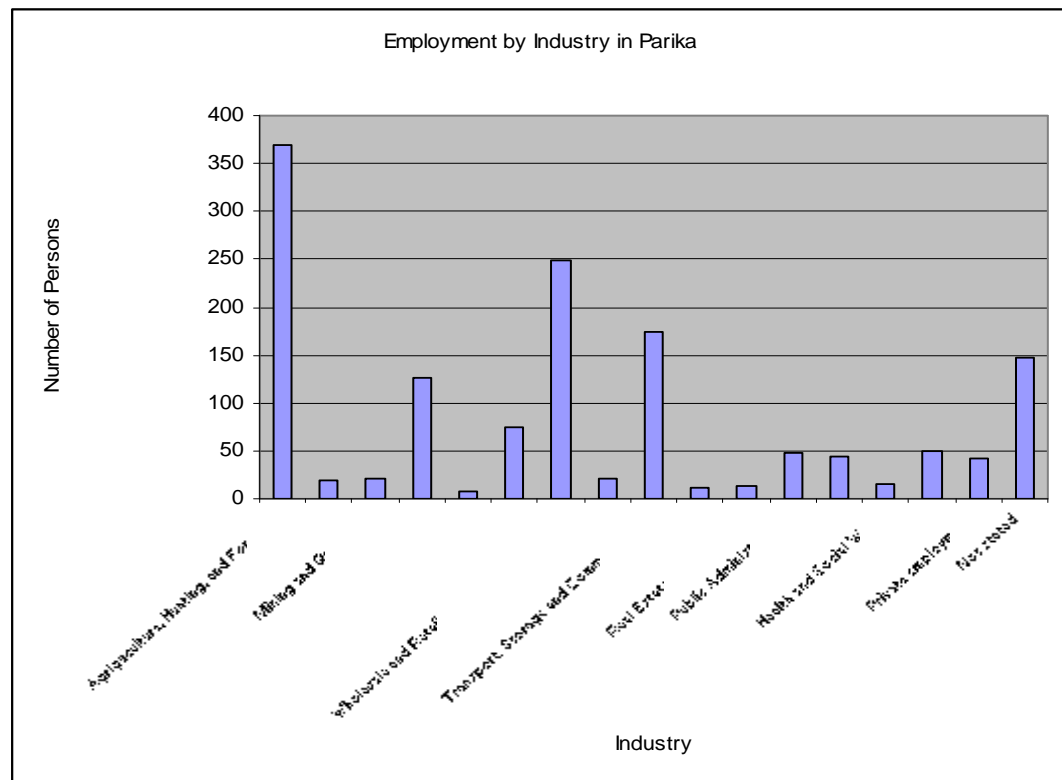
Source: Guyana Census 2002

### *Employment and Economy*

Parika is primarily a port township with a ferry service to and from the Essequibo Islands and West Demerara area. The economic activity is therefore dependent on the port and other commercial activities. The Parika port area also houses a popular Sunday market. Parika has recently developed due to investments by the private sector, and contains more banks there than anywhere else in the region.

According to the 2002 census the unemployment rate in Parika was 10.6%, with 1,282 gainfully employed persons, and 152 unemployed persons of working age. Unemployment rates in Parika are just below the national average. While the economy of Parika supports several banks and professional services, most employed persons are involved in agriculture, hunting and forestry, general commerce, and the transportation sector. There is also a small manufacturing scale industrial sector and limited construction and small scale mining, as shown in *Figure 6-28*.

Figure 6-28. Occupations of Employed Persons in Parika



Source: Guyana Census 2002

### Child Labor

The rapid economic and demographic growth in Parika has contributed to an increase in child labor. In 2004 the Guyana Bureau of Statistics undertook a baseline survey of child labor in Parika as a pilot study for a national project funded by the ILO. The survey identified 133 child laborers in Parika; most were involved in itinerant vending, and other small scale enterprises<sup>15</sup>. The survey found that child labor is caused by economic and social conditions which lead many children to drop out of school and seek work to survive. Issues related to child labor are compounded by poverty, gangs, and crime.

Despite the hazards to health, safety and morals of the children, the survey found that the children perceived their participation in the labor market offered greater opportunities to meet their material needs than did participation in the public education system.

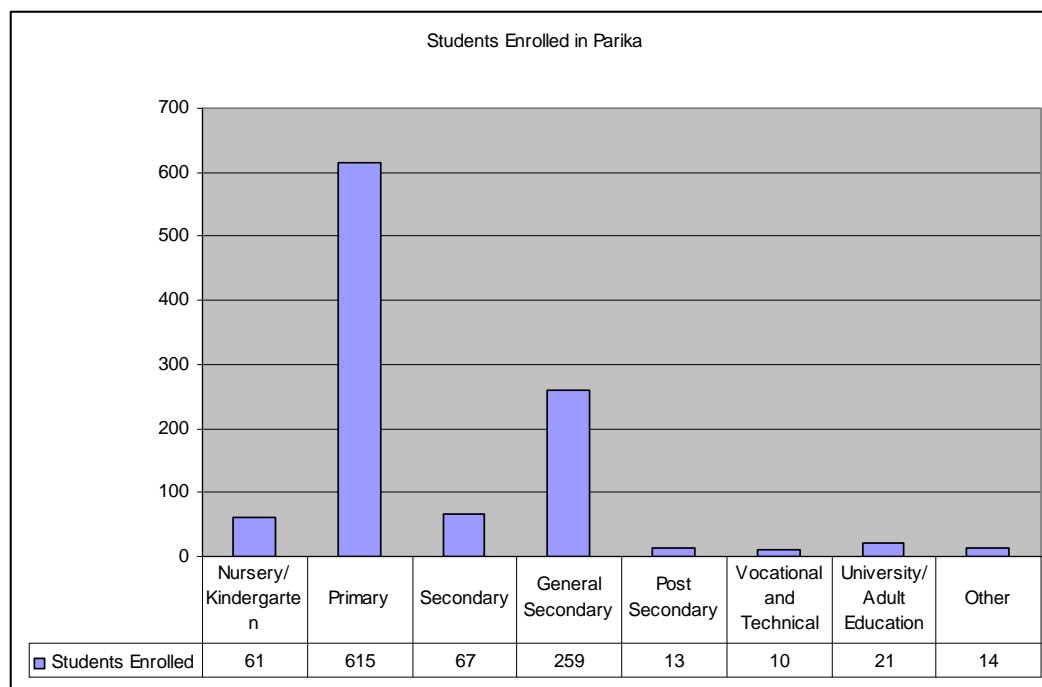
(15) Guyana Bureau of Statistics, ILO/CIDA. Child Labor Survey in Parika. 2004. <http://www.statisticsguyana.gov.gy/surveys.html>

The results of the ILO funded survey are intended to provide recommendations for local and national level programs to address child labor and form national policy on child labor.

### Education

Parika has 2 nursery schools, 2 primary schools, 1 public high school and 1 private educational complex offering both primary and secondary school. *Figure 6-29* shows the distribution of students enrolled in school in Parika, and illustrates the decreasing enrolment rates in school at each successive grade level.

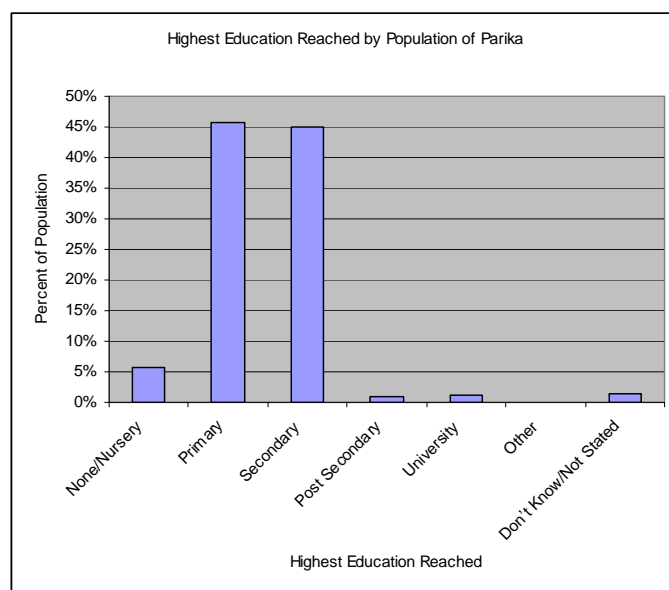
**Figure 6-29. Students Enrolled in Parika, 2002**



Source: Guyana Census 2002

The overall education level for the population of Parika reflects a similar trend. *Figure 6-30* shows the highest education level reached by the population of Parika, and illustrates that roughly half of the population (46%) has received only a primary education, while 45% of the total population has continued to secondary school. There are very few individuals in Parika with any type of post secondary schooling, and, due to the lack of post-secondary schools in Parika, these individuals were required to travel to other areas of the country, such as the capital city, to receive their educations.

**Figure 6-30.** Highest Education Reached by Population of Parika, 2002



Source: Guyana Census 2002

### Health Issues

Health issues in Parika are similar to other commercial areas of Region 3 and Region 7. There is one main health center located within the port district of Parika, which provides quality health care services to the population of Parika and surrounding areas.

One underlying difference between the incidence of preventable illnesses such as diarrhoea and intestinal problems common in interior regions of Guyana, are related to the availability of improved water sources and sanitation. Households in Parika have much greater access to sources of clean drinking water, with only 2% lacking access to clean drinking water, as shown in *Table 6-12*.

**Table 6-12.** Sources of Drinking Water for Households in Parika, 2002

Main source of drinking	Total	
	%	Count
Piped Into Dwelling	3	26
Piped into Yard or Plot	5	48
Public Standpipe	1	9
Bottled Water	2	16
Rain water Collection	88	878
Unprotected Dug well	0	1
Pond/River/Stream	2	21
Not Stated/Don't Know	0	2
<b>Total</b>	<b>100</b>	<b>1001</b>

Source: Child Labor Survey in Parika. 2004

Similarly, households in Parika have much greater access to household level sanitation facilities, such as latrines, septic tanks, and sewer systems, as shown in

Table 6-13. The presence and use of such facilities decreases the likelihood of preventable diseases common in other interior areas, as described in the section 1.4.5, above.

**Table 6-13. Type of Household Level Sanitation Facility in Parika, 2002**

Type of toilet facility	Total	
	%	Count
Water closet linked to sewer	0	2
Water closet, cesspit or septic tank	17	170
Pit – latrine	82	819
None	1	9
Not stated/don't know	0	1
<b>Total</b>	<b>100</b>	<b>1001</b>

Source: Child Labor Survey in Parika, 2004

#### *Infrastructure and Amenities*

As a regional center and significant commercial town, Parika has a comparatively high concentration of social infrastructure and administrative offices. Currently, Parika has the following amenities:

- two nursery schools;
- two primary school;
- one secondary school;
- one private school with primary and secondary levels;
- a police station;
- a post office;
- a health centre
- 1,243 residential buildings;
- 90 commercial buildings;
- a library;
- multi-purpose centre;
- community centre;
- forestry building;
- four commercial banks; and
- several places of worship

#### *Other Concerns and Issues*

General concerns and issues documented during participatory consultation in Parika include:

- The need for more compliant educational measures for young children. There were several complaints over the numerous disadvantaged children hanging around the port carrying out menial labour and begging. People feel this leads to a lot of petty theft in the area and illegal child labour;
- An increased level of employment opportunities;

- A higher level of police security at this port. Residents feel that a lot of illegal activity takes place at this major trading and transportation point; and
- Placing a cap on the number of taxi drivers, mini bus drivers and boat transporters. The high level of competition makes these transportation workers more aggressive towards potential customers and reckless on the road and on the water. This leading to an increased number of accidents.

## 6.7

### *SUMMARY OF KEY FINDINGS*

The stakeholder consultations in the six settlements and other findings of the baseline study revealed the following issues and concerns:

1. There were the expected significant differences between the socio-economic characteristics of towns and rural settlements in Region 7. The towns of Region 7, especially Bartica, offer greater social infrastructure and economic opportunity. The availability of medical and educational facilities, transportation, police and other governmental services contributes to a higher standard of living, while smaller, interior and rural communities understandably lack such services. In a relatively poor, emerging market country such as Guyana, these differences are dramatic;
2. Region 7 has the highest concentration of Amerindian communities in Guyana. These interior Amerindian communities have traditionally been dependent on agricultural production, hunting and fishing. The advent of mining particularly ASM in the interior regions has disrupted traditional Amerindian life. Amerindian males are increasingly being hired as laborers for mining operations. This has had impacts on agriculture and subsistence farming, leaving women to tend to plantations in the villages. High migration of males has also resulted in an increase in women headed families in these villages. However, the increase of wealth from remittances in the Amerindian economies has led to increased consumerism. Items such as televisions, radios, imported food and beverages are increasingly seen in these villages. Despite these symbols of greater affluence, lack of education and higher skills are significant barriers preventing Amerindians from participating in the advancing economy;
3. Both regions 7 and 3 suffer from lack of infrastructure and amenities such as roads and health facilities in the interior. The interior communities report health problems and the need for health facilities to be the top most priority;
4. The advent of mining in the interiors, especially ASM, has affected traditional villages. There is increasing influx of Brazilian and Venezuelan miners which is creating conflict with local communities and security issues due to alleged drug trafficking or smuggling;
5. Stakeholder consultations in each of the six settlements revealed that the need for employment and expectation of economic opportunities from this Project was a common view;
6. Prime health concerns amongst the communities were the high rates of malaria and HIV and the lack of health centers in the interior. Coupled with this was the need for better education, well staffed schools and job opportunities;

7. A common apprehension amongst communities was a repetition of the Omai tailing dam failure and cyanide poisoning of the river; and
8. Overall, the communities studied desired benefits from the project and not to be burdened with impacts such as deforestation, silting of rivers and environmental degradation.

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## 7.1

## INTRODUCTION

This section provides an assessment of the key potential environmental and social impacts and risks related to the Aurora Project. Potential impacts and risks for each of the major project components (i.e., the mine, the access road, and the Buckhall port) have been assessed for the construction, operation, and closure phases, as applicable. For the purposes of this assessment, it was assumed that the access road and port site will remain operational after the Aurora Mine is decommissioned as the port will likely serve other mining operations in the area and the access road will continue to be used as a public thoroughfare.

The primary intent of this assessment was to identify the potential impacts and risks that will require protective management and mitigation actions during each of the project phases so that these actions can be incorporated in the Aurora Project's Social and Environmental Management Program. For the purposes of this assessment, "impacts" are consequences likely to occur in the normal mode of an activity, while "risks" are the more unlikely adverse results of a system failure or accident. For example, the loss of habitat resulting from clearing for construction is an impact, while a spill of fuel resulting from a tanker truck accident is a risk.

As a preface to the discussion of impacts, it is important to reiterate the physical and biological context of the Project Area of Direct Influence as described in the baseline section. The environment in the vicinity of the Aurora Project has been significantly impacted by historical mineral exploration, mining and logging activities, as well as the intensive use of the Cuyuni River as an important transportation corridor. Likewise, the environments along the Cuyuni River and the existing roads have been significantly affected by historic and ongoing small-scale mining activities (i.e., Guyanese "pork-knockers" or Brazilian "garimpeiros"), which has had an impact on the ecology of the area along with the quality of habitats and therefore the biodiversity. However, the proposed large-scale mining project could result in additional direct and indirect environmental impacts, such as increased contamination of water bodies. In this section, the potential impacts and risks are segregated by project component and phase (wherever appropriate) and the impacts rated according to the rating criteria as presented in *Section 2, Approach and Methodology*.

The Area of Indirect Influence was largely focused on potential dispersed socio-economic effects of the Aurora Project, and there was no likely impact on the physical and biological environments in this larger area of influence as the Aurora Project is currently conceived. The primary social impacts and risks are influx to

the area and economic impacts (e.g., the “boom and bust” cycle of mining development).

The great majority of the potential impacts on the physical, biological and social environments will take place during the construction phase. During operations, the principal potential environmental impacts will be related to water that will be discharged to the TMA, the water management pond, and the diversion channels, along with traffic to and from the mine site. During operations, the primary social risks are the economic effects of post-construction loss of jobs and the unwinding of influx.

## 7.2 *POTENTIAL ENVIRONMENTAL IMPACTS RELATED TO MINE CONSTRUCTION*

### 7.2.1 *Noise*

Construction activities will produce noise levels above the WHO industrial/commercial noise level guideline value of 70 decibels (dBA) from heavy earthmoving machinery operation. Elevated noise levels may also be generated during blasting operations as part of the construction of the TMA and water management pond. Maintenance operations in workshops will generate noise levels in the vicinity of 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. Tired workers are prone to accidents which may contribute to an increase in work-related accidents. These are moderate impacts (medium severity, medium likelihood). There are no human receptors within 25 km of the site and the only human noise receptors will be individuals involved in construction activities at the site.

Construction phase noise will also have an adverse effect on many species of wildlife that are sensitive to increased noise levels. However, many species will also become habituated to frequent noise events or continuous levels and may return to the area. The most sensitive fauna have likely long abandoned the areas of the Aurora Concession where there is frequent disturbance from noise.

These impacts 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,

- Provide personal protective equipment (PPE) to employees and contractors, and requiring their usage under the health and safety plan.

Implementation of these measures would reduce the likelihood and impacts of noise occurrences. Noise impacts to receptors would as a result be minor (low severity; medium likelihood).

### 7.2.2 *Increased Atmospheric Emissions and Dust*

Construction activities will result in an increase in dust generation from the movement of vehicles and machinery, and the generation of atmospheric emissions from vehicles, machinery, and electrical generators. Fugitive dust emissions will result from land clearing, vehicle movements on earthen roads, excavation, grading and loading and unloading of earth, rock, gravel, etc. Dust generation, transport and deposition would be a function of construction activities, soil type, moisture content, wind speed, frequency of precipitation, vehicle traffic and vehicle type. Fugitive emissions would be greater during dry periods.

Combustion emissions would result from chainsaw operations, diesel- and/or gasoline-fired heavy duty equipment usage, and power generation from diesel generators. Products of combustion will include: benzene, PM<sub>10</sub>, PM<sub>2.5</sub>, carbon monoxide, NO<sub>x</sub>, SO<sub>2</sub>, VOCs – a precursor of ozone, and hydrocarbons. These emissions would be short-term and would be elevated only in the vicinity of construction operations. Burning of waste would also generate emissions.

The impacts to air quality would be moderate (low severity; high likelihood). These impacts will be mitigated by employing the following measures:

- Covering trucks to minimize dust particulate emission;
- Minimizing drop heights from vehicles;
- Scheduling land clearing activities on less windy days;
- Limiting vehicle speed during construction to a maximum 30 km/hr;
- Employing dust suppression techniques such as wetting earthen roads with water or non-toxic chemicals;
- Avoiding open burning of wastes at the construction site; and,
- Maintaining construction equipment according to manufacturer's specifications.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

### 7.2.3 *Impacts on Soils*

There are numerous impacts to soils associated with construction activities. Land clearing and earthmoving activities during construction will lead to an increased potential for erosion of soils. Soil compaction will occur in work areas and temporary access routes. Organic matter and topsoil will be removed from areas

subject to any grading activities. Spills of fuels, lubricants, and other hazardous substances can lead to contamination of soils.

In the absence of mitigation, the collective impacts to soils are rated as major, with high severity and high likelihood. The mitigation measures for soils should include the following:

- Implementation of best management practices for erosion control;
- Topsoil and organic matter stockpiling;
- Respreading, decompaction, and revegetation; and,
- Spill control and cleanup.

Implementation of these measures will result in minor residual impacts.

#### **7.2.4 *Solid Waste Generation***

The construction of the mine will generate large volumes of solid wastes, including spoils, trash, scrap, rubble, domestic wastes, and hazardous wastes. If not properly managed, these wastes could lead to contamination of soils and water, as well as generate odors, attract vermin, and create human health and safety hazards.

This impact is rated as moderate with medium severity and high likelihood. The Aurora Project will mitigate these issues by developing and implementing the respective waste management plans for each type of solid waste anticipated to be generated by the construction phase of the project. Reuse and recycling should be preferred over disposal to the extent practicable. Under proper management, the residual impact associated with solid waste generation would be considered to be minor.

#### **7.2.5 *Impacts to Surface Water***

Land clearing and earthmoving activities associated with the construction of mine infrastructure, including the river dike system, will lead to an increased potential for erosion, sediment transport, and sedimentation of water bodies in the vicinity of the Aurora Project site. While many streams in the Areas of Direct and Indirect Influence have already been adversely impacted by sedimentation from artisanal miners and from ongoing exploration activities at the Aurora Project site, there are additional streams that would be affected by the construction of the Aurora Project.

The potential for sediment loading of surface water as a result of construction activities is considered to be a moderate impact (medium severity, medium likelihood). Implementation of a sediment and erosion control plan as a mitigation measure during construction activities will minimize impacts associated with sediment loading of the Cuyuni River and its tributaries. The likelihood of soil erosion and sedimentation will be minimized or avoided by the implementation of the following mitigation measures:

- Implementation of best management practices in the Storm Water Management Plan for soil erosion, storm water runoff, and sedimentation control (e.g., optimization/ minimization of vegetation clearance (just in time approach as opposed to large scale clearance), revegetation of disturbed areas (even if temporary), storm runoff retention ponds, silt fences, etc.);
- Develop channel control structures;
- Develop an Interim Reclamation Plan following clearance activities; and,
- Implementation of a long-term Reclamation Plan for disturbed areas.

Implementation of these measures will result in minor impacts (low severity, low likelihood).

Surface spills and releases of fuels, oils and grease during refueling and/or maintenance of on-site earthmoving equipment during the construction phase are considered to be moderate impacts (medium severity, medium likelihood). Spill containment, control and prevention measures should be implemented during the refuelling and maintenance of equipment during construction activities.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

#### **7.2.6** *Groundwater Contamination*

Groundwater dewatering activities will likely be required during construction of the river dike and possibly during construction of foundations for other project infrastructure. Surface spills of fuels in the vicinity of the excavations may result in localized impacts to shallow groundwater at the project site via runoff into the open excavations. However, because groundwater dewatering activities would essentially capture any petroleum-related releases into groundwater, the potential impact to groundwater during the construction phase is considered to be minor (low severity; medium likelihood). Potential mitigation measures include the use of secondary containment structures around ASTs containing fuel oil and the maintenance of spill containment equipment in the vicinity of the refueling areas. Implementation of these mitigation measures will result in minor impacts (low severity; low likelihood) to groundwater quality.

**Note:** groundwater effects related to the mine pit aspects are discussed under *Section 7.3, Potential Environmental Impacts related to Mine Operations.*

#### **7.2.7** *Loss of Aquatic Habitats*

The construction of the mine and associated infrastructure will result in the loss of various stream and swamp habitats within the Aurora Concession. Many of these habitats have already been affected by historical exploration and mining activities at the Aurora Project site since the 1940s as well as by ASM activities in the area. Surveys have not identified any of the aquatic habitats to be critical habitats based on the criteria of IFC PS6. Similar aquatic habitats are common in the region. No

human communities make use of the Aurora Project site aquatic habitats or their resources.

Loss of aquatic habitats in the open pit area, TMA, water management pond, and other areas where major conversion of the land surface is required will be unavoidable due to the nature of the activities. Upstream and downstream segments of streams will be affected, and there are no plans to construct diversions, for example in the stream catchment of the future TMA.

Mine site engineering will require the construction of diversion channels for stormwater runoff, and these channels will discharge to existing surface waters (streams and the Cuyuni River). In particular, the diversion channel that will receive stormwater from the mine waste stockpile areas and process area will discharge to the tributaries of Gold Creek, the largest stream in the Aurora Concession. Retention ponds and other detention storage/sedimentation facilities must be installed to ensure that stormwater discharges do not degrade the water quality and habitat structure of the natural receiving bodies.

None of the aquatic fauna identified in the streams or creeks within Area of Direct Influence is known to be threatened or restricted-range endemic. Based on the October 2009 giant otter specialist survey, the sighting of an individual giant otter in the Cuyuni River during both the 2006 baseline survey and the April 2009 biodiversity field survey was considered to be attributed to transient individuals travelling through the area. No evidence of giant otter presence could be found during the October 2009 survey by giant otter expert Nicole Duplaix (see *Annex 3*).

The loss of aquatic habitat in the Aurora Concession is considered to be a potential major impact with high likelihood and high severity. With the application of the mitigations for surface water impacts (see 7.2.5, *Impacts to Surface Water*), the impact rating is considered to be minor.

### 7.2.8 *Loss of Terrestrial Habitat and Flora*

The estimated area of land to be cleared and graded for the construction of the mine and associated infrastructure was approximately 1,300 ha or 13 km<sup>2</sup>, as detailed in *Table 7-1*.

**Table 7-1** *Estimated Footprint of Proposed Aurora Mine*

<b>Component</b>	<b>Footprint Area (ha)</b>
Open Pit Area (including Underground Mine entrance)	148
Tailings Management Area and Clarification Pond	257

Water Management Pond	77
Mine Waste Dumps	393
Saprolite and Overburden Storage	158
Accommodations Area	6
Airstrip	186
General Industrial Area	41
Explosives Area	1.0
Laydown Area	2.3
River Dike	18
Quarry Area	14.3
<b>Total Footprint</b>	<b>1,301.6 ha</b>

*Source: ERM, based on GIS measurements from AMEC Site Plan.*

The loss of terrestrial habitats and flora is unavoidable within the direct footprint areas identified in the table above. With the exceptions of the open pit area and the river dike, most of the areas listed above are currently forested. In particular, the proposed TMA lies largely in a relatively intact forested area outside of the area that has been surveyed during the two baseline field studies and beyond the ends of the existing roads within the concession. However, it is likely that artisanal miners may have been hunting in the area, as a camp was observed at a distance of 1.5 km from the proposed TMA.

None of the terrestrial habitats in the Area of Direct Influence have been identified as critical habitat per the criteria of IFC PS6. None of the plant species known to be present in Area of Direct Influence are known to be threatened locally or to be restricted-range endemic. However, two sightings of harpy eagles were reported by the 2009 biodiversity survey, and this species is of interest to Guyanese stakeholders due to its emblematic status and supposed value as an indicator species. The loss of habitats in the Aurora Concession are unlikely to have a significant impact on the local population of harpy eagles, and even less significant impact at regional, national, and global levels. To the extent practicable, special mitigations should be employed in the event an active harpy eagle nest is encountered in an area scheduled for clearing, such as relocating the activity or postponing the activity to a non-nesting season.

The loss of terrestrial habitats in the Area of Direct Influence is considered to be a major impact with high likelihood and high severity. With appropriate mitigations such as strict minimization of clearing and progressive restoration, the impact rating is considered to be moderate.

### **7.2.9**      *Loss of Terrestrial Fauna*

Some loss of small and/or slow-moving fauna is inevitable under any land clearing earthmoving activity. None of the invertebrate, amphibian, non-avian reptile or small mammal species known to be present in the Area of Direct Influence is known to be threatened or endemic. More mobile fauna including large mammals and adult birds are likely to flee the area well in advance of clearing of habitats. How absorptive the receiving habitat may be is an unknown, but it is generally presumed that natural predation and mortality would allow at least partial absorption.

The loss of terrestrial fauna in the Area of Direct Influence is estimated to be a moderate impact with high likelihood and low severity, at least in part because much of the area has been disturbed by prior mining and transport activities. As discussed above, active harpy eagle nests should demand special mitigation to avoid loss of reproductive efforts. With appropriate mitigations such as strict minimization of clearing, the impact rating will be minor.

### **7.2.10**      *Introduction or Promotion of Alien Invasive Species*

The movement of vehicles, equipment, and materials between the Buckhall port site and the Aurora mine along the access road will have the potential to cause the introduction of alien invasive species of both plants and animals. The disturbance and clearing of natural habitats can also promote the growth or colonization of alien invasive species.

This impact is rated as moderate with medium severity and medium likelihood. Mitigation should include monitoring of biodiversity, general prohibition of the importation of any invasive species which may be identified, control and awareness raising, and bio restoration of disturbed areas and spoils. With these mitigations, this impact should be minor.

### **7.2.11**      *Increased Human Population and Activity in the Area of Influence*

The construction works will lead to increased human population and increased levels of general activity in the Aurora Mine area. The increased human presence has the potential to lead to increased impacts on flora and fauna through harvesting, collecting, hunting, fishing, disturbance, and other activities by construction workers.

This impact is considered moderate with medium likelihood and medium severity. With enforcement of a strict Code of Conduct that includes prohibitions of all use and disturbance of flora and fauna, the impact will be minor.

### 7.3 *POTENTIAL ENVIRONMENTAL IMPACTS RELATED TO MINE OPERATIONS*

#### 7.3.1 *Increased Noise Levels*

During the 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 surface pit and underground mining operations. Maintenance operations in workshops and the process plant area will generate noise levels in the vicinity of 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 moderate impacts (medium severity, medium likelihood). There are no receptors within 25 km of the site, and the only noise receptors should be workers at the site during the project operational phase. These impacts will be mitigated by implementation 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.

Operations phase 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 preadapted to higher noise levels. Implementation of these measures would reduce the likelihood and severity of impacts of noise generated. Noise impacts to receptors would as a result be minor (low severity; medium likelihood).

7.3.2

*Increased Atmospheric Emissions and Dust*

Operations associated with the Aurora Project will require a substantial supply of electrical energy. ERM’s understanding was that the onsite power plant will require four 5.8-MW diesel generators for the first five years of operation (five generators will be installed, with one as a back-up). An additional two generators will be added after five years to satisfy power needs for the facility at full operational capacity. 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 generator assumptions, ERM conducted air quality screening modeling for the proposed power generating facility. Equipment specifications were not available; therefore the specifications – including physical stack dimensions and exhaust characteristics – were estimated based on a similar sized (5,000 kw-h) diesel generators. We also assumed that the exhaust would be combined into a single, 30-meter stack and that the effect of pre-heating the fuel would reduce the exhaust temperature from 767 Kelvin (K) to 460 K. Stack characteristics for the single stack, for both 4 and 6 units, are shown in *Table 7-2*.

**Table 7-2** *Estimated Stack Parameters for Generators*

Description	Height (m)	Inner Diameter (m)	Exhaust Velocity (m/s)	Exhaust Flow (m <sup>3</sup> /s)	Exhaust Flow (acfm)	Exhaust Temperature (K)	Exhaust Flow (Nm <sup>3</sup> /s)	Heat Input (MMBTU/hr)
4 Units	30.00	1.568	37.87	73.09	154,869	460.00	40.36	188.40
6 Units	30.00	1.568	56.80	109.64	232,304	460.00	60.54	282.60

This 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 (dated 30 April 2007)<sup>1</sup>. In accordance with the general guidelines, we 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 (as specified in *Table 1.1.2* of the IFC Environmental, Health, and Safety General Guidelines, dated 30 April 2007). This table contains a range of emissions limits and modeling was conducted for both ends of the ranges. Emissions calculated for SO<sub>2</sub>, NO<sub>x</sub>, and PM, for both 4 and 6 units and the low and high range of the IFC guidelines, are shown in *Table 7-3*.

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(1) International Finance Corporation (IFC) Environmental, Health, and Safety Guidelines - GENERAL EHS GUIDELINES. April 30, 2007.

**Table 7-3 Modeled Emission Rates for Generators**

Description	Exhaust Flow (Nm <sup>3</sup> /s)	Units	PM Low	PM High	NOx Low	NOx High	Units	SO2 Low	SO2 High
4 Units	40.36	mg/Nm3	50	100	1460	1850	% S	1.50	3.00
		g/s	2.018	4.036	58.930	74.672	g/s	35.96	71.93
6 Units	60.54	mg/Nm3	50	100	1460	1850	% S	1.50	3.00
		g/s	3.027	6.054	88.395	112.008	g/s	53.95	107.89

The modeling was conducted using the U.S. EPA screening model SCREEN3, which has been used widely in the U.S. as a conservative estimate of the maximum impacts of air pollution sources. 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 the purpose of this assessment, modeled impacts were compared to the WHO Air Quality Guidelines; additionally, all PM emissions were assumed to be PM2.5. 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 7-4 presents the results of the modeling and demonstrates that the maximum impacts of the power generating units (4 and 6 units, both low and high emission rates) meet all of the WHO guideline values except for SO<sub>2</sub>, 24-hour averages. However, modeled impacts do comply with the SO<sub>2</sub> 24-hour average interim guideline. Compliance with the interim guideline is generally considered acceptable. It should be noted that equipment specifications and emission rates will need to match the specifications used in the modeling in order to support these conclusions.

Since the approvability of any given project is a function of many different factors, we would like to note the following issues in particular with respect to the proposed power generating units. The modeling was conducted with a screening (conservative) model. Lenders may require additional refined modeling (for example, AERMOD) to strengthen the conclusions on air quality. Additionally, ambient air monitoring may also be required, either in support of an ESIA or post-construction to measure actual air quality and emissions. While this additional analysis would require resources and time, it is ERM's belief that ultimately the conclusion regarding the approvability of the project would not change as long as the modeled impacts of the power generating units do not change.

**Table 7-4 Model Results-- Emission Rates for Generators**

**SO<sub>2</sub>**

Avg. Period	Number of Units	Description	Model Prediction	WHO Guidelines	WHO Interim Target
1-hr	4	Low	92.4	350	-
		High	184.7		
	6	Low	113.2		
		High	226.4		
24-hr	4	Low	36.9	20	125
		High	73.9		
	6	Low	45.3		
		High	90.5		

**NO<sub>2</sub>**

Avg. Period	Number of Units	Description	Model Prediction	WHO Guidelines
1-hr	4	Low	113.5	200
		High	143.8	
	6	Low	139.1	
		High	176.2	
Annual	4	Low	9.1	40
		High	11.5	
	6	Low	11.1	
		High	14.1	

**PM**

Avg. Period	Number of Units	Description	Model Prediction	WHO Guidelines - PM10	WHO Guidelines - PM25
24-hr	4	Low	2.1	50	25
		High	4.1		
	6	Low	2.5		
		High	5.1		
Annual	4	Low	0.4	20	10
		High	0.8		
	6	Low	0.5		
		High	1.0		

Operations would generate dust and combustion emissions from:

- Vehicles traversing site roads ;

- Wind erosion of stockpiles and spoil piles ;
- The operation of heavy duty equipment ; and,
- The operation of bunker-fired electrical generators.

Dust emissions from haul roads would occur over the duration of the operation. The Aurora Project area is noted for elevated levels of rainfall throughout the year. This would reduce dust emissions during wet periods. The impacts to air quality would therefore be minor (low severity, medium likelihood). These impacts will be mitigated by employing the following measures:

- Covering trucks to minimize particulate emission;
- Minimizing drop heights from vehicles;
- 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; and,
- Providing goggles and eye wash lotion for dust-induced eye irritation for workers on site.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

### **7.3.3 *Impacts on Soils***

During operations, additional areas will be cleared, graded, mined, and covered, which will result in expansion of the area of impacted soils. Spills of fuels, lubricants, and other hazardous substances can lead to contamination of soils.

In the absence of mitigation, the collective impacts to soils during operations are rated as major, with high severity and high likelihood. The mitigation measures for soils should include the continued implementation of the following:

- Implementation of best management practices for erosion control;
- Topsoil and organic matter stockpiling;
- Respreading, decompaction, and revegetation; and,
- Spill control and cleanup.

Implementation of these measures will result in minor residual impacts.

### **7.3.4 *Generation of Solid Wastes***

The operation of the mine will generate large volumes of solid wastes, including spoils, trash, scrap, rubble, domestic wastes, and hazardous wastes. If not properly managed, these wastes could lead to contamination of soils and water, as well as generate odors, attract vermin, and create human health and safety hazards.

This impact is rated as moderate with medium severity and high likelihood. The Aurora Project will minimize and mitigate these potential impacts by developing and implementing the respective waste management plans for each type of solid waste anticipated to be generated by the operation phase of the Aurora Project. Reuse and recycling should be preferred over disposal to the extent practicable. Under proper management, the residual impact associated with solid waste generation would be considered to be minor.

### 7.3.5 *Impacts to Surface Water*

Several types of potential surface water impacts are attributed to gold mining activities, including sediment loading and low pH due to acid mine drainage (AMD). Metals such as mercury, cyanide, chlorine and other caustic chemicals are typically used during the mining operations and can impact surface water bodies via accidental spills, releases, or leachate associated with waste rock stockpiles from the gold processing operations.

Several chemicals including cyanide and lime will be used during mineral processing. Potential spills or discharges of cyanide and other chemicals used in the mineral processing operations may result in major impacts to surface water (high severity, medium likelihood). The implementation of Best Management Practices (BMPs) during the transportation, handling, storage, use of and destruction/safe disposal of these chemicals is recommended during mine operations to minimize these potential impacts. Implementation of these mitigation measures (i.e., BMPs) will result in minor impacts (low severity, low likelihood) to surface water.

Precipitation may induce leaching of chemicals from waste rock and saprolite stockpiles at the Aurora 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 major impacts (high severity, medium likelihood). Based on review of the AMEC report, it is unclear whether the waste rock and saprolite stockpiles will be equipped with an impermeable liner and/or leachate collection systems. However, perimeter drainage channels will reportedly be installed around the waste rock stockpiles to collect stormwater runoff. Stormwater from the perimeter drainage system will be reportedly discharged to the water management pond before final discharge to surface water. Recommended mitigation measures include the following:

- Installation of an impermeable liner as part of a leachate collection system to minimize potential impacts to surface water; and,
- 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 minor impacts (low severity, medium likelihood).

Several streams/creeks are located in the vicinity of tailings and water management ponds. Flow into stream/creek beds downstream of the tailings and water management ponds will be altered and/or reduced after these facilities become operational, resulting in significantly reduced flows in the downstream stream/creek beds. The modification of hydrologic flow patterns within these streams/creeks is considered a major impact (high severity, high likelihood). Mitigation of this impact may be achieved by directing discharge from the water management pond, assuming that they meet effluent discharge limits and water quality standards, to these stream/creek beds at points downstream of the tailings and water management ponds. Mitigation measures will result in minor impacts (medium severity, low likelihood).

Breaches and overtopping of the TMA and/or water management pond will result in major impacts (high severity, medium likelihood) 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 moderate impacts (high severity, low likelihood).

No detailed information was provided in the AMEC pre-feasibility report regarding the proposed stormwater management system for the Aurora Project site. Reportedly, the system will include a series of diversion channels that would convey stormwater to existing natural receiving bodies, including the upper tributaries of Gold Creek. Potential runoff of impacted stormwater is considered to be a major impact (high severity, high likelihood). Recommended mitigation measures include the following:

- Runoff from mine processing areas, waste stockpiles, roadways, etc. must be collected, retained, and treated to acceptable water quality standards prior to discharge to the natural environment; and,
- Due to differences in elevation across the project site, it is not likely that all stormwater will be discharged to the water management pond, as this could require substantial pumping. Design of the stormwater management pond must include sufficient retention (capacity of settling ponds) and treatment (i.e., oil/water separators, debris removal, etc.) to ensure that natural surface waters are not affected by discharges of untreated stormwater.

Implementation of these mitigation measures along with the proper design of the stormwater management system will result in minor impacts (medium severity, low likelihood).

No information has been made available regarding domestic and industrial wastewater loads, flows, treatment, and discharge. 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. Due to the lack of information on the wastewater discharge control and treatment systems, these potential wastewater discharges were considered to be moderate impacts (medium severity, medium likelihood). Recommended mitigation measures 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 should be designed in accordance with the new Guyanese septic tank standards 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 will also be conducted 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 minor impacts (low severity, low likelihood).

Wastewater during operations will consist of groundwater extracted from the mine dewatering operations and slurry/tailings from the mineral processing operations. Groundwater from the mine dewatering operations will be discharged to surface water after passing through the water management pond to ensure the attainment of discharge effluent/water quality standards. The extracted groundwater will also 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 groundwater from the pit dewatering activities is considered to be a minor impact (low severity, low likelihood). No mitigation measures are proposed.

Wastewater from the gold processing operations (i.e., slurry/tailings) will be transferred to the TMA; however, no specific information was provided in the AMEC report regarding the mechanism (i.e., pumps and piping) for transferring the process wastes to the TMA. In addition, no information was provided regarding whether the TMA will be constructed with an impermeable liner system to minimize potential leakage to surface or groundwater. Based on these unknowns, potential release of tailings water from the TMA is considered to be a major impact (high severity, high likelihood). The installation of an impermeable liner as part of a leachate collection system is recommended for the TMA during mine operations to minimize potential impacts. Proper implementation of these mitigation measures will result in minor impacts (low severity, moderate likelihood).

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 considered to be moderate impacts (medium severity, medium likelihood). Recommended mitigation measures include the following:

- Spill containment, control and prevention measures should be implemented during transport and refuelling operations as well as during all vehicle and mining equipment maintenance and repair; and,
- Stormwater discharge from fuel storage areas should be channeled to an oil-water separator prior to being discharged to surface water.

Proper implementation of these mitigation measures will result in minor impacts (low severity, low likelihood) on surface water quality during operation.

Surface water will initially be withdrawn from the Cuyuni River and nearby streams/creeks for the mineral processing operations. The region receives approximately 2.5 m of precipitation annually, so it is anticipated that this loss of surface water will be compensated for by the increased expected runoff due to site clearance and earthwork activities. Therefore, the withdrawal will result in minor impacts (low severity, low likelihood). Once the mine enters into full operational mode, the amount of surface water withdrawal is expected to diminish due to recycling of process wastewater.

No engineering plans or details were provided in the AMEC report regarding the construction of the river dike. Based on the proximity of the Cuyuni River, short circuiting of surface water around or under the river dike may result in surface water infiltration into the open pit and/or underground mine during groundwater dewatering activities. The stability of the river dike may also be impacted as a result of surface water flow and erosion around the base/foundation of the dike system. The potential infiltration of surface water from the Cuyuni River into the open pit mine is considered to be a moderate impact (medium severity, medium likelihood). Installation of an impermeable barrier below grade and extension of the dike to the west are recommended to further protect the mine from potential surface water infiltration. Implementation of these mitigation measures will result in minor impacts (low severity, low likelihood).

#### *Spill Modeling Results*

To evaluate the severity and extent of potential impacts to surface water, surface water modelling of two hypothetical accidental spills of fuel oil (diesel) and cyanide into the Cuyuni River was conducted as part of the ESIA. The CORMIX model was used to quantify the near-field dilution of the spills, while GEMSS was used for a far-field impact assessment. A mean flow rate of 1,000 m<sup>3</sup>/s was used for the Cuyuni River for all model simulations.

#### Scenario No. 1--Fuel Oil Spill

The fuel oil spill scenario assumed a spill of 200,000 gallons of diesel fuel from an AST at the Aurora Mine located adjacent to the river. The scenario also assumed that the diesel fuel breached the containment facility and that all 200,000 gallons

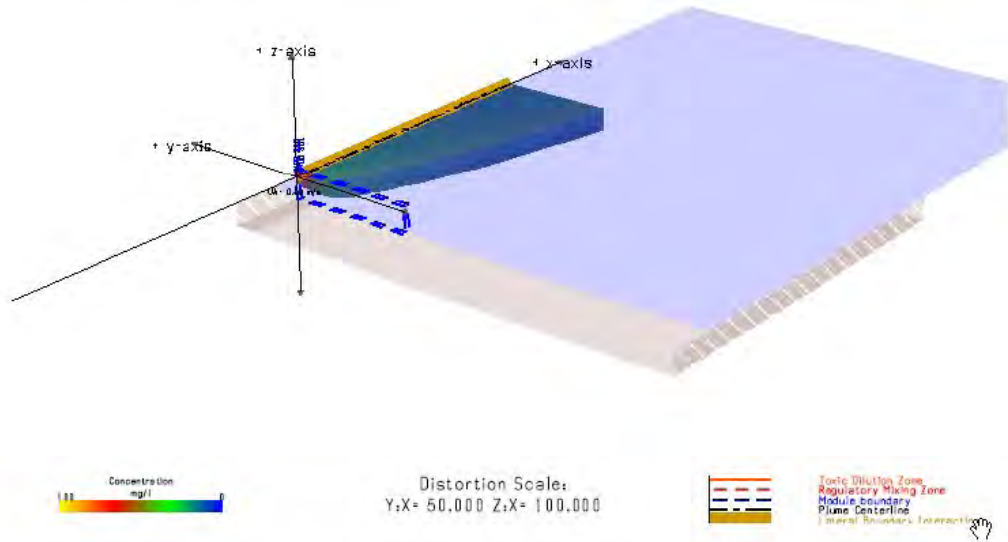
spilled over the bank into the river within a one hour period. When diesel was modeled as a conservative substance (i.e., no losses due to decay or evaporation), the CORMIX model of the spill predicted that diesel concentrations would be diluted to approximately 20% of the initial concentration at a distance of approximately 100 m from the spill location. At distances of approximately 1 and 10 km downstream of the spill area, the spill diluted to 10% and to less than 1% of its initial concentration, respectively. As illustrated in *Figure 7-1*, the CORMIX model showed minimal lateral dispersal of the diesel plume; however, the CORMIX model assumes an idealized, straight river section. In reality, as the plume reaches river bends and cataracts downstream of the spill site, the plume can be expected mix laterally across the entire width of the river.

The GEMSS model of the diesel spill included evaporation and decay of the diesel fuel. Diesel typically loses approximately 50% of its mass in one day as a result of evaporation. As illustrated in *Figure 7-2*, the GEMSS model showed that a diesel spill of 200,000 gallons over a one hour period diluted to a concentration of 0.006 mg/L at a distance of 10 km downstream from the spill site, and even lower concentrations further downstream.

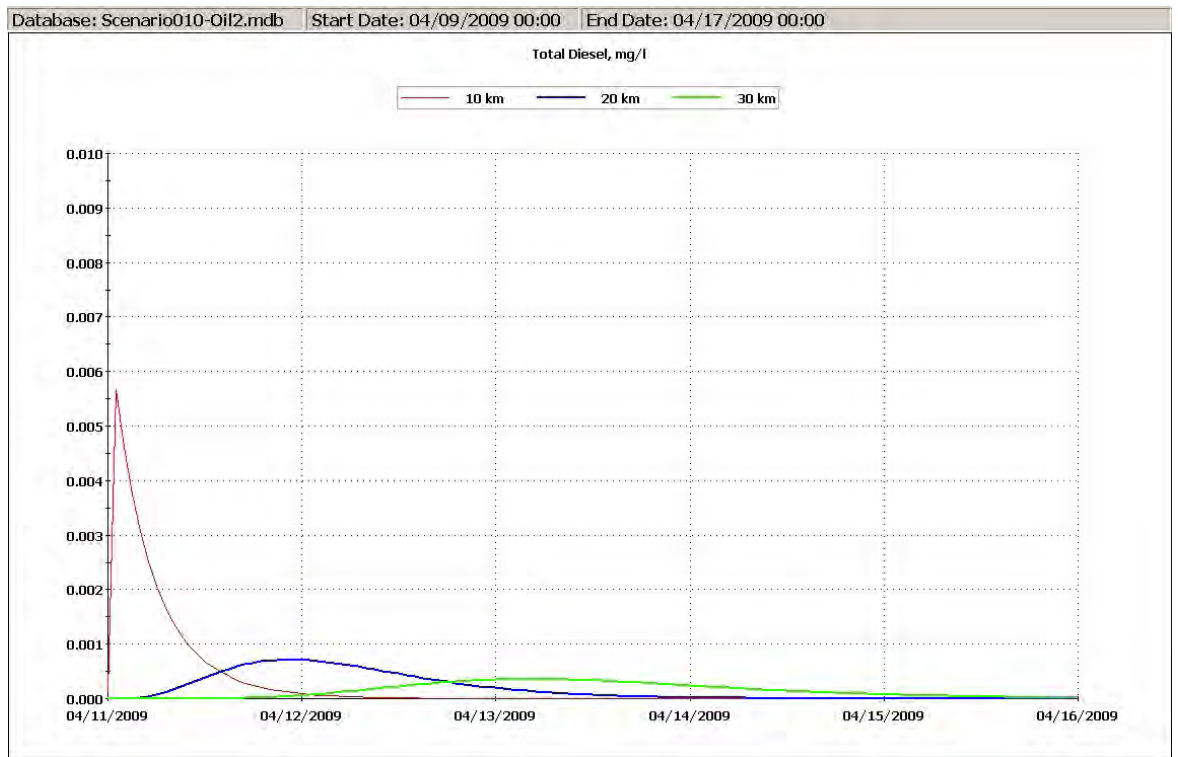
A diesel oil spill into the river may have an effect on shorelines (where staining may coat plants or be ingested by wildlife), on the benthos (where sediments may become contaminated and organisms become physically fouled), on the water surface (where birds and aquatic creatures may become contaminated by contacting the oil), and in 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, the Cuyuni River would experience concentrations as high as 36 mg/L at the initial spill location and 0.006 mg/L at a location 10 km downstream of the spill area. At these concentrations, humans, fish, invertebrates, mammals, and birds in the river may be at risk. These are considered to be minor impacts (medium severity, low likelihood). These impacts will be mitigated by strict adherence to the Environmental Monitoring Plan, which would include frequent monitoring of hydrocarbons in the TMA and water management pond and inspection of fuel storage tanks (and their containment systems). Implementation of these mitigation measures will result in minor impacts (low severity, low likelihood) to surface water.

Guyana  
Guyana-pipe  
Time of Run: Thu May 14 09:28:47 2009

Cormix3 Simulation  
MyFiles\Guyana\Guyan:  
Flow Class: WJ1



**Figure 7-1** CORMIX Output – Dilution Factors from Hypothetical Spill

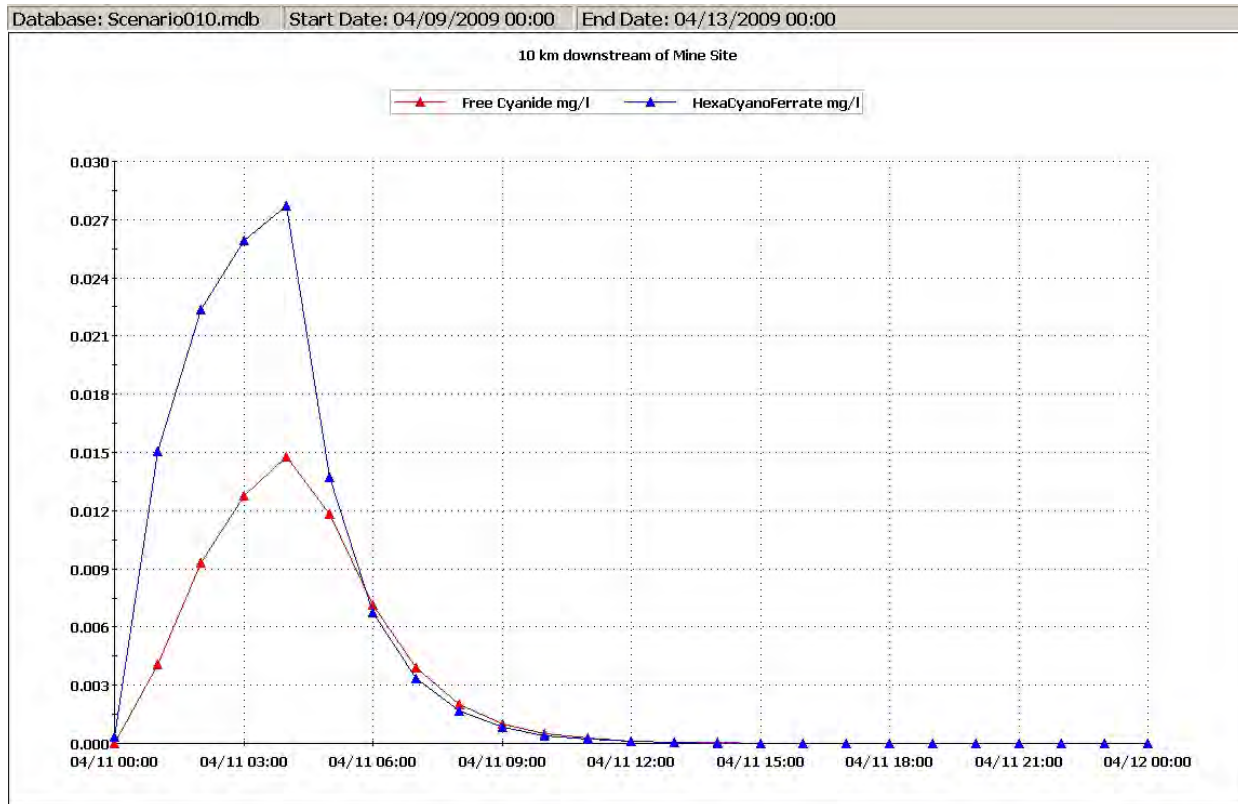


**Figure 7-2** GEMSS Output - Concentration of Diesel in Cuyuni River Downstream of Mine Site after Hypothetical Spill of 200,000 Gallons

## Scenario No. 2 – Cyanide Spill

Cyanide will be present at the Aurora Project site at several locations, including within the process tanks, storage tanks, TMA, and water management pond. The worst-case scenario for a cyanide spill event at the project site would involve a catastrophic release from six 400 m<sup>3</sup> vat tanks. Cyanide in the tanks is assumed to have a concentration of 800 mg/L (800,000 µg/L). The modelling of an accidental spill assumed that the cyanide breached the containment facility and all 2,400 m<sup>3</sup> of solution spilled into the river within a 4-hour period. The GEMSS model included speciation into free cyanide and a rapid decay rate. The GEMSS model showed that a cyanide spill of 2,400 m<sup>3</sup> over 4 hours produced a maximum concentration of 0.015 mg/L (15 µg/L) at a location 10 km downstream from the spill site. The GEMSS model results showing concentrations of free cyanide and hexacyanoferrate for the hypothetical spill over time at a location 10 km downstream of the spill are shown on *Figure 7-3*.

Cyanide is acutely toxic to humans and other organisms. Liquid and gaseous cyanide can enter the body via inhalation, ingestion, or absorption through the skin. Lethal dose standards (50% lethality) provided by the International Cyanide Management Institute are shown in *Table 7-5*. Contact with free cyanide at a concentration of 1 mg/L (or 1 part per million or 1,000 µg/L) would be lethal to a



**Figure 7-3** GEMSS Output - Concentration of Cyanide in Cuyuni River 10 km Downstream of Mine Site after Hypothetical Spill of 2400 m<sup>3</sup> of 800 mg/l Cyanide

**Table 7-5** *Surface Water Cyanide Standards – International Cyanide Management Institute*

<b>Parameter</b>	<b>Value</b>
LD50 for human ingestion	50 – 200 mg or 1 – 3 mg / kg of body weight
LD50 for human contact	100 mg / kg of body weight
LD50 for fish	200 µg/L
LD50 for invertebrates	20 to 76 µg/L
LD50 for birds via ingestion	0.8 to 11.1 mg / kg of body weight
LD50 for mammals via ingestion	2 to 10 mg / kg of body weight

100 kg man. Cyanide has low persistence in the environment and does not bioaccumulate, so chronic exposure to sub-lethal concentrations does not result in acute toxicity. Chronic cyanide poisoning has been observed and is a potential risk to those with continuous exposure, but this analysis is based on a single accidental cyanide spill event leading to potential acute exposures.

Fish and aquatic invertebrates are also very sensitive to cyanide exposure. Adverse effects are observed at a concentration of 5 µg/L, with death of many species observed at concentrations of 20 to 76 µg/L of free cyanide. At levels exceeding 200 µg/L, free cyanide is rapidly toxic to most species of fish. Birds and mammals are also susceptible to cyanide toxicity at concentrations from 0.8 to 11.1 mg/kg of body weight. These values, shown in *Table 7-5*, are provided by the International Cyanide Management Institute ([www.cyanidecode.org](http://www.cyanidecode.org)).

If the assumed cyanide spill occurred into the Cuyuni River, free cyanide concentrations as high as 800,000 µg/L would result at the initial spill location and 15 µg/L at a location 10 km downstream of the spill area. At these concentration levels, humans, fish, invertebrates, mammals, and birds in the river would be in danger for several kilometers downstream of the mine site. These impacts merit the rating of moderate (high severity, low likelihood) and will be mitigated by strict adherence to the Environmental Monitoring Plan, specifically to include frequent monitoring of cyanide in the TMA and water management pond, maintenance and monitoring of the cyanide storage tank integrity, and containment of cyanide in ore processing and mining operations. Implementation of the proposed mitigation measures will contain and localize potential impacts, resulting in a minor impact rating (medium severity, low likelihood).

### **7.3.6** *Groundwater Contamination*

Precipitation may induce leaching of chemicals from waste rock and saprolite stockpiles at the project site. The AMEC report doesn't specify if the waste rock

and saprolite stockpiles will be equipped with an impermeable liner and/or leachate collection systems. Leaching of the waste rock and saprolite stockpiles can potentially result in degradation of groundwater quality. Based on these unknowns and the presence of groundwater at shallow depths (i.e., 1 to 4 m below grade), potential leaching of contaminants into groundwater is considered a major impact (high severity, medium likelihood). The installation of an impermeable liner as part of a leachate collection system is recommended during mine construction to minimize potential impacts to groundwater. These mitigation measures will result in minor impacts (low severity, moderate likelihood).

Infiltration of wastewater from the TMA, water management pond, and waste management areas along with leaching of minerals into solution in the mine can have potential negative impacts on groundwater quality. These are considered to be major impacts (high severity, high likelihood). Mitigation of these potential impacts can be achieved by installing impervious liners below the TMA, water management pond, and waste management areas and directing water from the mine to the water management pond. Implementation of these mitigation measures will result in minor impacts (low severity, low likelihood).

Extensive groundwater dewatering estimated at 6,000 m<sup>3</sup>/d (base case scenario) to 16,000 m<sup>3</sup>/d (conservative scenario) will be required to facilitate surface pit and underground mining 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 Cuyuni River because the river may be hydraulically contacted to shallow groundwater in the vicinity of 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 (low severity, high likelihood). No mitigation measures are proposed.

Several chemicals including cyanide and lime will be used during mineral processing. Potential spills or discharges of cyanide and other chemicals used in the mineral processing operations may result in major impacts to groundwater (high severity, medium likelihood). The implementation of Best Management Practices (BMPs) during the transportation, handling, storage, and use of these chemicals is recommended during mine operations to minimize these potential impacts. Implementation of these mitigation measures (i.e., BMPs) will result in minor impacts (low severity, low likelihood) to groundwater.

Spills of fuel and oils from mining equipment, fuel storage areas (i.e., tank farm), and service areas can infiltrate into the subsurface and potentially impact groundwater quality in the underlying aquifer. This will result in moderate impacts (medium severity, medium likelihood). Spill containment, control and prevention measures should be implemented during the transport and refuelling operations as well as during all vehicle and mining equipment maintenance and repair. Implementation of these mitigation measures will result in minor impacts (low severity, low likelihood) on groundwater quality during operation.

### 7.3.7 *Loss of Aquatic Habitats*

The operation of the mine and associated infrastructure will impact various stream and swamp habitats within the Aurora Concession. 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 TMA, the water management pond, and other areas where major conversion of the land surface is required will be unavoidable due to the nature of the activities. Upstream and downstream segments of streams will be affected and there are no plans to construct diversions, for example in the catchment area of the TMA. 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 Aurora Concession is considered to be a major impact with high likelihood and high severity. With appropriate mitigations discussed above for surface waters and groundwater, the impact rating will be minor.

### 7.3.8 *Loss of Terrestrial Habitats and Flora*

After the initial build out during the construction phase, additional land areas will be occupied by the mining project during operations, including the open pit, the mine waste areas, and the TMA. The additional loss of habitats and flora will not affect any threatened or restricted-range endemic species of flora and fauna. 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 with low severity and high likelihood. Recommended mitigation measures include the following:

- Minimization of the Aurora Project footprint; and,
- Initiating restoration as soon as practicable in temporary work areas.

Implementation of these measures will result in minor impacts (low severity, low likelihood).

### 7.3.9 *Loss of Terrestrial Fauna*

During the operation of the mine, 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. 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 having minor significance of low severity and medium likelihood. Recommended mitigation measures include the following:

- Minimization of the Aurora Project footprint; and,
- Performance of preclearance surveys for harpy eagle nests in suspected nesting habitats.

Implementation of these measures will result in minor impacts (low severity, low likelihood).

### **7.3.10** *Introduction or Promotion of Alien Invasive Species*

The movement of vehicles, equipment, and materials to the mine, along the access road, and to the Buckhall port will have the potential to cause the introduction of alien invasive species of both plants and animals. The disturbance and clearing of natural habitats can also promote the growth or colonization of alien invasive species.

This impact is rated as moderate with medium severity and medium likelihood. Recommended mitigation measures include the following:

- Monitoring of biodiversity; and,
- Control of invasive species.

Implementation of these measures will result in minor impacts (low severity, low likelihood).

## **7.4** *POTENTIAL ENVIRONMENTAL IMPACTS RELATED TO MINE CLOSURE*

### **7.4.1** *Surface Water/Groundwater/Soil*

Failure of the two perimeter dams associated with the TMA and the three perimeter dams associated with the clarification/water management pond may significantly impact surface waters in the vicinity of the Aurora Project site as well as groundwater quality in the underlying aquifer. The potential failure of these dams after completion of mining activities is considered to be a potential major impact (high severity, medium likelihood). Recommended mitigation measures include the following:

- Post-closure monitoring of the stability of the dams; and,
- Periodic monitoring of surface and groundwater conditions in the vicinity of the dams.

Implementation of these measures will result in moderate impacts (high severity, low likelihood).

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 surface water and/or groundwater, as well as soils. Potential spills associated with these closure activities are considered to be moderate impacts (medium severity, medium likelihood). Mitigation of these potential impacts can be achieved by adhering to a mine closure plan that specifies

appropriate and specific procedures for dismantling/decommissioning mining infrastructure.

## 7.5 *POTENTIAL ENVIRONMENTAL IMPACTS RELATED TO ACCESS ROAD IMPROVEMENT AND CONSTRUCTION*

Given that the Cuyuni River is not navigable for larger vessels that would be required to transport equipment, machinery, and materials to the Aurora Mine site and air transport would be prohibitively expensive, the use of road transport is essential to the implementation of the Aurora Project. The existing roads are not of sufficient grade to enable heavy traffic throughout the year (e.g., the rainy seasons); therefore, improvements to the existing roads will be required. In addition, the existing roads do not reach the Aurora Mine site; therefore, construction of some 40 km of new roads will be necessary to connect the existing road network to the Aurora Mine site. A barge crossing and staging area will also be required at the Cuyuni River.

### 7.5.1 *Increased Noise Levels*

Improvement of the existing road and construction of the new road segments will result in short-term increases of ambient noise levels associated with construction activities. Access road construction will require the use of heavy machinery. Most activities will be intermittent and localized; however, those activities will contribute to sustained noise levels during equipment operation hours. Noise generated by construction activities may prevent animals from approaching or crossing the access road corridor because of fear. Noise may potentially reduce the success of these species and contribute to changed behaviour and consequent effects on the ecology of affected species. These were rated as potentially minor impacts (low severity, medium likelihood). Noise impacts can be mitigated by:

- Maintaining equipment in accordance with manufacturer's specifications; and
- Maintaining/installing mufflers on vehicle and equipment exhaust systems.

The mitigation measures will result in minor residual impacts (low severity, low likelihood).

### 7.5.2 *Increased Atmospheric Emissions and Dust*

Construction and improvements works would generate dust and combustion emissions from vehicles and machinery, as well as generators, pumps, and other equipment. Emissions and dust reduce air quality and can result in adverse health impacts for workers. Dust can coat the leaves of roadside vegetation and decrease photosynthesis. The impacts from increased atmospheric emissions and dust are considered to be major (high severity, high likelihood).

Recommended mitigation measures include the following:

- Regular vehicle and machinery maintenance to reduce emissions; and,
- Regular road surface wetting during dry periods to reduce dust generation.

Implementation of these measures will result in minor impacts (low severity, low likelihood).

### 7.5.3 *Impacts on Soils*

Land clearing and earthmoving activities during access road construction and improvement will lead to an increased potential for erosion of soils. Soil compaction will occur in work areas and temporary access routes. Organic matter and topsoil will be removed from areas subject to any grading activities. Spills of fuels, lubricants, and other hazardous substances can lead to contamination of soils.

In the absence of mitigations, the collective impacts to soils were rated as major, with high severity and high likelihood. The mitigation measures for soils should include the following:

- Implementation of best management practices for erosion control;
- Topsoil and organic matter stockpiling;
- Respreading, decompaction, and revegetation; and,
- Spill control and cleanup.

Implementation of these measures will result in minor impacts (low severity, low likelihood).

### 7.5.4 *Impacts to Surface Water*

Access road upgrading and new road construction will likely involve installation of bridges or culverts at a number of stream crossings. Construction of bridges and culverts can modify the natural flow of surface water, concentrating flows at certain points and/or increasing the surface water flow rates/velocities. These flow modifications may potentially result in flooding, bank and bed erosion, and increased sediment discharge downstream, which are considered major impacts (high severity, moderate likelihood). Recommended mitigation measures include the following:

- Design of bridges or culverts with adequate spans or diameters such that natural surface water flows are passed without significant alteration; and,
- Culverts shall be lined with grass and/or riprap, where necessary, to control flow rates/velocities and minimize erosion. Flow volumes will be determined as part of the hydrological monitoring program to be undertaken during design of bridges and culverts.

Implementation of these mitigation measures will result in minor residual impacts (low severity, low likelihood).

The potential impact to surface water bodies resulting from surface spills and releases of fuels, oils and grease during refueling and/or maintenance of on-site road construction equipment is also a concern during the construction phase. These are considered to be moderate impacts (medium severity, medium likelihood). Recommended mitigation measures include the following:

- Spill containment, control and prevention measures should be implemented during the refuelling and maintenance of construction equipment during road construction activities;
- Identify specific areas along the road alignment for equipment storage and maintenance activities. These areas will be equipped with sumps and oil traps to control and contain potential spills. Chemicals and oils collected from sumps and oil traps will be stored in drums for disposal at proper off-site locations; and,
- Development of emergency response stations at select locations along the access road.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

Removal of vegetative cover over the access road alignment during construction may potentially increase surface runoff volumes and alter drainage patterns locally in the vicinity of the alignment. These are considered to be minor impacts (low severity, high likelihood) and will not be mitigated.

#### **7.5.5 *Impacts to Groundwater***

The access road alignment is located in a groundwater recharge area for the coastal aquifers. Because the proposed road will be covered by a lateritic clayey gravel surface that may be less permeable than the surrounding ground surface, construction of the access road can potentially result in reduced infiltration to groundwater. However, since the area covered by the road will be a very small fraction of the area potentially available for recharge, this is anticipated to be a minor impact (low severity, medium likelihood) that will not require any mitigation.

#### **7.5.6 *Loss and Degradation of Aquatic Habitats***

Clearing of vegetation and earthmoving activities for the improvement of the existing road and construction of the new road will lead to the loss and alteration of aquatic habitats, primarily as the result of increased sedimentation and alteration of water quality. This impact is rated as major with high severity and high likelihood. The mitigations discussed above for impacts to soils and surface water will reduce the rating of this impact to minor.

### 7.5.7 *Loss and Alteration of Terrestrial Habitats*

Clearing of vegetation and earthmoving activities for the improvement of the existing road and construction of the new road will lead to the loss and alteration of terrestrial habitats. Assuming a nominal right-of-way of 20 m, the estimated area of land to be cleared and graded for the new access road construction is approximately 80 ha, without taking into consideration areas need for cuts, fill, and borrow pits. These areas have not been significantly disturbed by human activity to date relative to more accessible areas along waterways and existing tracks.

There is no information available on the requirements for additional clearing and disturbance along the existing roadway. However, the habitats to be cleared for road improvement have already been altered by exposure to edge effects and proximity to the existing Barama road. The Aurora Project will result in an expansion of the existing road's zone of influence, exposing new areas to direct edge effects and increasing the width of the open habitat barrier for small forest species.

The loss and alteration of habitats and flora resulting from the construction and improvement of access roads is rated as a major impact with medium severity and high likelihood. Recommended mitigation measures include the following:

- Minimizing the area required for clearance to permit safe operating conditions of the road; and,
- Ensuring that trees are felled towards the interior of the right-of-way such that trees outside of the cleared area are not damaged.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

### 7.5.8 *Increased Susceptibility to Forest Fires*

Clearing of vegetation along the access road will create conditions that will increase the susceptibility of the surrounding forests to fires. This is the result of the drying that occurs along the forest edge and the potential increase in fine fuels within the open right-of-way, as well as the increase in potential sources of ignition such as smoking, sparks, and campfires.

This impact is rated as major with high severity and medium likelihood (especially during the dry seasons and during dry years). Recommended mitigation measures include the following:

- Maintaining a strict Code of Conduct for drivers that raises awareness of high fire risk periods;
- Control of smoking and fires; and,
- Mowing the vegetative growth in the right-of-way to reduce potential fuel loads.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

### **7.5.9** *Introduction or Promotion of Alien Invasive Species*

The movement of vehicles, equipment, and materials to the mine, along the access road, and to the Buckhall port will have the potential to cause the introduction of alien invasive species of both plants and animals. The disturbance and clearance of natural habitats can also promote the growth or colonization of alien invasive species.

This impact is rated as moderate with medium severity and medium likelihood. Recommended mitigation measures include the following:

- Monitoring of biodiversity; and,
- Control of identified invasive species.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

## **7.6** *POTENTIAL ENVIRONMENTAL IMPACTS RELATED TO ACCESS ROAD OPERATION AND MAINTENANCE*

### **7.6.1** *Increased Noise*

During operations and maintenance of the access road, there will be an increase in noise generation in comparison with baseline levels due to increased activity of vehicles related to the Aurora Project and increased frequency of maintenance required to maintain safe road conditions for the transport of hazardous materials. Vehicle passage over the access road will be intermittent; therefore the impact would be minor (low severity, high likelihood). These impacts will be mitigated by employing the following measures:

- Limiting vehicle speed;
- Maintaining equipment in accordance with manufacturer's specifications; and,
- Maintaining/installing mufflers on vehicle and equipment exhaust systems.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

### **7.6.2** *Increased Atmospheric Emissions, and Dust*

Dust would be emitted from the access road surface and from unsurfaced areas within the Buckhall port facility during operation. Equipment traversing the road will have combustion emissions. Equipment passage over the access road will be intermittent. The impacts to air quality would therefore be minor (low severity,

medium likelihood). These impacts will be mitigated by employing the following measures:

- Maintaining equipment in accordance with manufacturer's specifications;
- Limiting vehicle speed;
- Employing dust suppression techniques; and
- Providing facemasks with dust removal filters.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

### **7.6.3** *Impacts on Soils*

Spills of fuels, lubricants, and other hazardous substances can lead to contamination of soils. In the absence of mitigations, the collective impacts to soils were rated as major, with high severity and high likelihood. Recommended mitigation measures include the following:

- Ensure that the trucking companies utilized for transport of hazardous and petroleum-related materials have spill contingency plans in place that may include provision of spill kits on the trucks for the cleanup of minor spills; and,
- Development of emergency response stations at select locations along the access road.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

### **7.6.4** *Impacts to Surface Water*

Surface water quality may potentially be impacted by spills of fuel and other chemicals during transport between the Aurora Mine site and Buckhall port. These spills and/or releases may be catastrophic if caused by a vehicular accident. Based on the remote location of the access road, spill response may not be sufficient, both in terms of response time and capacity, to contain and clean up large spills before impacting surface waters. As a result, the potential for spills along the access road is considered a major impact (high severity, low likelihood). Recommended mitigation measures include the following:

- Ensure that the trucking companies utilized for transport of hazardous and petroleum-related materials have spill contingency plans in place that may include provision of spill kits on the trucks for the cleanup of minor spills; and,
- Development of emergency response stations at select locations along the access road.

Implementation of the mitigation measures will result in moderate impacts (medium severity, low likelihood).

### **7.6.5** *Groundwater Contamination*

Groundwater quality can potentially be impacted by spills of fuels, oil and other chemicals on the ground surface and the migration of spilled material to groundwater underlying the area. These are considered to be moderate impacts (medium severity, low likelihood). Recommended mitigation measures include the following:

- Ensure that the trucking companies utilized for transport of hazardous and petroleum-related materials have spill contingency plans in place that may include provision of spill kits on the trucks for the cleanup of minor spills; and,
- Development of emergency response stations at select locations along the access road.

Implementation of these measures will result in minor impacts (low severity, low likelihood).

### **7.6.6** *Commercial Logging Activity to the South of the Cuyuni River*

The Barama Company has logging rights to the area to the south of the Cuyuni River, but it has not constructed access roads in that area to date. The construction of an all-weather road to the south of the Cuyuni River could lead to the feasibility of logging in an area that is presently inaccessible to logging operations. This is considered a moderate impact (medium severity, medium likelihood). No mitigation is planned since Guyana Goldfields has no control over activities in logging concessions.

### **7.6.7** *Increased Susceptibility to Forest Fires*

The maintenance of an open corridor for the access road will create conditions that will increase the susceptibility of the surrounding forests to fires. This is the result of the drying that occurs along the forest edge and the potential increase in fine fuels within the open right-of-way, as well as the increase in sources of ignition such as smoking, sparks, and campfires.

This impact is rated as major with high severity and medium likelihood (especially during the dry seasons and during dry years). Recommended mitigation measures include the following:

- Maintaining a strict Code of Conduct for drivers that raises awareness of high fire risk periods;
- Control of smoking and fires; and,
- Mowing the vegetative growth in the right-of-way to reduce potential fuel loads.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

### **7.6.8** *Increased Pressure on Forest Resources and Wildlife*

Increased traffic on the roads will increase the number of people passing through and thereby increasing the potential that individuals may engage in unauthorized activities such as hunting or cutting of timber. Also, the road improvements and new roads could facilitate additional influx of small-scale or medium-scale miners. This is rated to be a moderate impact with medium likelihood and medium severity. The enforcement of a Code of Conduct in partnership with the Government and other users will reduce the impact to minor.

### **7.6.9** *Introduction or Promotion of Alien Invasive Species*

The movement of vehicles, equipment, and materials along the access road has the potential to introduce alien invasive species of aquatic plants and animals. Invasive sun-tolerant plant species could be promoted by clearance and disturbance within the road right-of-way. This is rated to be a moderate impact with medium likelihood and medium severity. Recommended mitigation measures include the following:

- Monitoring of biodiversity;
- Control of identified invasive species; and,
- Right-of-way vegetation management and monitoring.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

## **7.7** *POTENTIAL ENVIRONMENTAL IMPACTS RELATED TO BUCKHALL PORT DEVELOPMENT*

### **7.7.1** *Increased Noise*

Construction of the Buckhall port and related facilities will include pile driving operations and the use of other heavy machinery. Operational activities will include loading/unloading of equipment and supplies for the Aurora Mine site. Most activities will be intermittent and localized; however, activities will contribute to sustained noise levels during equipment operation. 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. Tired workers are prone to accidents which may contribute to an increase in work-related accidents. These are considered to be moderate impacts (medium severity, medium likelihood). There are few receptors within 2 km of the site and the only noise receptors will be individuals working at the site. These impacts will be mitigated by implementation of the following:

- Installation of sound suppression devices (such as mufflers) on construction equipment;
- Implementing best available work practices on-site to minimize occupational noise levels;
- Using acoustic insulating materials such as silencers on exhaust systems;
- Issuing ear plugs or ear muffs to employees exposed to high noise levels;
- Periodically monitoring noise levels to ensure compliance with recommended threshold levels; and,
- Posting visible warning signs in areas of high noise levels instructing employees to wear ear protection.

Implementation of the mitigation measures will result in minor impacts (low severity, medium likelihood).

### **7.7.2 *Increased Atmospheric Emissions and Dust***

Dust would be emitted from work areas within the Buckhall port facility during operation. Equipment and machinery will also emit products of combustion. The impacts to air quality are expected to be minor (low severity, medium likelihood). These impacts will be mitigated by employing the following measures:

- Maintaining equipment in accordance with manufacturer's specifications;
- Limiting vehicle speed;
- Employing dust suppression techniques; and
- Providing facemasks with dust removal filters.

Implementation of the mitigation measures will result in minor impacts (low severity, low likelihood).

### **7.7.3 *Impacts on Soils***

There are numerous impacts to soils associated with construction activities. Land clearing and earthmoving activities during construction will lead to an increased potential for erosion of soils. Soil compaction will occur in work areas and temporary access routes. Organic matter and topsoil will be removed from areas subject to any grading activities. Spills of fuels, lubricants, and other hazardous substances can lead to contamination of soils.

In the absence of mitigations, the collective impacts to soils are rated as major, with high severity and high likelihood. The mitigation measures for soils should include the following:

- Implementation of best management practices for erosion control;
- Topsoil and organic matter stockpiling;
- Respreading, decompaction, and revegetation; and,
- Spill control and cleanup.

Implementation of these measures will result in minor impacts (low severity, low likelihood).

#### **7.7.4**      *Generation of Solid Wastes*

The construction of the Buckhall port and associated facilities will generate solid wastes, including spoils, trash, scrap, rubble, domestic wastes, and hazardous wastes. If not properly managed, these wastes could lead to contamination of soils and water, as well as generate odors, attract vermin, and create human health and safety hazards.

This impact is rated as moderate with medium severity and high likelihood. The Aurora Project will mitigate these issues by developing and implementing the respective waste management plans for each type of solid waste anticipated to be generated by the operation phase of the Aurora Project. Reuse and recycling should be preferred over disposal to the extent practicable. Under proper management, the impact would be reduced to minor (low severity, low likelihood).

#### **7.7.5**      *Impacts to Surface Water*

Surface water quality may potentially be impacted by sediment loading due to runoff from cleared areas and by oils and fuel spilled during construction. These are considered to be moderate impacts (medium severity, medium likelihood). Recommended mitigation measures include the following:

- Implementation of an Erosion and Sediment Control Plan;
- Collecting site discharge within an oil-water separator; and,
- Implementation of spill containment, control and prevention measures during the refuelling and maintenance of construction equipment.

These mitigation measures will effectively remove any potential impacts to surface water quality and residual impacts will consequently be minor (low severity, low likelihood).

#### **7.7.6**      *Groundwater Contamination*

Groundwater quality can potentially be impacted by spills of fuels, oil and other chemicals and the migration of spilled material to groundwater underlying the area. These are considered to be moderate impacts (medium severity, low likelihood). Spill containment, control and prevention measures should be implemented during the refuelling and maintenance of construction equipment. Residual impacts will consequently be minor (low severity, low likelihood).

#### **7.7.7**      *Alteration of Aquatic Habitats*

The construction of the Buckhall port and associated facilities will require the disturbance of aquatic habitats within the Essequibo River along a 650-m front. This impact is considered minor (low severity, medium likelihood). Mitigations

should include implementation above mitigations for surface water impacts and minimization of the Aurora Project footprint to the extent practicable.

#### **7.7.8 *Loss of Terrestrial Habitats***

The estimated area of land to be cleared and graded for the Buckhall port and accessory areas is approximately 25 ha. The existing vegetation consists of secondary forests and fallow areas subject to cultivation and timber harvesting by local residents. This impact is considered minor (low severity, low likelihood). Mitigations should include minimization of the Aurora Project footprint to the extent practicable.

#### **7.7.9 *Introduction or Promotion of Alien Invasive Species***

The movement of vessels and materials to the Buckhall port has the potential to introduce alien invasive species of plants and animals that may arrive in materials reaching the port, attached to the vessels, or in ballast water. This impact is rated as minor with low severity and low probability, as the vessels arriving at the wharf will largely be of local origin. Mitigation should include monitoring of biodiversity and control of invasive species as necessary.

### **7.8 *POTENTIAL ENVIRONMENTAL IMPACTS RELATED TO BUCKHALL PORT OPERATIONS***

#### **7.8.1 *Impacts to Soils***

Use of the onshore port facilities will result in compaction of soils beneath them. Also, the storage and maintenance of vehicles can result in soil contamination. Throughout the lifetime of the mining operations, various types of hazardous materials, including fuels and chemicals, will be offloaded from vessels arriving at the Buckhall port for transfer to trucks for overland transport to the Aurora Mine site. Spills of these materials could result in contamination of soils.

This is rated as a moderate impact with medium severity and low likelihood. Recommended mitigation measures include the following:

- Develop and follow a Spill Prevention and Control procedure, which should include criteria for paving or otherwise making the vehicle storage and maintenance areas impervious;
- Fuel storage tanks should be located in secondary containment areas with impervious floors, preferably with a roof or overhead canopy to prevent rain water from accumulating in the containment areas and mixing with spilled fuel; and,
- Drains from the secondary containment areas should be equipped with oil/water separators.

Implementation of these measures will result in minor impacts (low severity, low likelihood).

### 7.8.2 *Generation of Solid Wastes*

The operation of the port and the associated facilities will generate solid wastes, including trash, scrap, domestic wastes, and hazardous wastes. If not properly managed, these wastes could lead to contamination of soils and water, as well as generate odors, attract vermin, and create human health and safety hazards.

This impact is rated as moderate with medium severity and high likelihood. The Aurora Project will mitigate these issues by developing and implementing the respective waste management plans for each type of solid waste anticipated to be generated by the operation phase of the Aurora Project. Reuse and recycling should be preferred over disposal to the extent practicable. Under proper management, the impact would be reduced to minor (low severity, low likelihood).

### 7.8.3 *Impacts to Surface Water*

Loading/unloading activities along with fueling and maintenance of vessels at the Buckhall port have the potential to cause spills of contaminants directly and indirectly into the Essequibo River. Surface water quality may potentially be impacted by spills of fuel and other chemicals being loaded/unloaded at the port. These are considered to be major impacts (high severity, low likelihood). Spill containment, control and prevention measures should be implemented during the refuelling and maintenance of vessels and during loading/unloading activities. Implementation of these measures will result in minor impacts (low severity, low likelihood).

Surface water quality may also be negatively impacted by accidental discharges of fuels, oils and grease from equipment and/or as a result of the failure of fuel containment facilities. These are considered to be major impacts (high severity, low likelihood). The potential for accidental spills of fuels, oils and grease and the associated contamination of surface waters will be minimized by implementation of spill containment, control and prevention measures at the port facility. Implementation of these mitigation measures will result in minor impacts (low severity; low likelihood) on surface water quality during operation.

The Buckhall port will include permanent accommodations and offices which will result in the generation of domestic wastewater, which, if inadequately treated and disposed of, could result in surface water contamination. No information has been made available regarding domestic wastewater loads, flows, treatment, and discharge for the port facility. Discharge of domestic wastewater to surface water may impair surface water quality by causing changes to physical, chemical and biological properties within the receiving waters. Based on the lack of information on the wastewater discharge control and treatment systems, these potential wastewater discharges are considered to be moderate impacts (medium severity, medium likelihood). Potential impacts associated with discharges from domestic wastewater will be mitigated through the use of septic tank systems, which include

septic tanks and leach fields consisting of granular filter beds. Residual impacts will be minor (medium severity, low likelihood). Septic tanks should be designed in accordance with the new Guyanese septic tank standards developed in 2008.

#### **7.8.4** *Groundwater Contamination*

Groundwater quality can potentially be impacted by spills of fuels, oil and other chemicals on the ground surface and the migration of spilled material to groundwater underlying the area. These are considered to be moderate impacts (medium severity, low likelihood). Spill containment, control and prevention measures should be implemented during loading/unloading activities and vessel refuelling and maintenance at the port facility. Residual impacts will consequently be minor (low severity, low likelihood).

#### **7.8.5** *Introduction or Promotion of Alien Invasive Species*

The movement of vessels and materials to the Buckhall port has the potential to introduce alien invasive species of plants and animals that may arrive in materials reaching the port, attached to the vessels, or in ballast water. This impact is rated as minor with low severity and low probability, as the vessels arriving at the Buckhall port will largely be of local origin. Mitigation should include monitoring of biodiversity and control of invasive species as necessary.

#### **7.9** *POTENTIAL SOCIAL IMPACTS OF THE PROJECT*

As highlighted in the socio-economic baseline, there were very few communities located in proximity to any of the project components, and thus the direct impacts on human populace in settlements/villages/towns was likely to be quite limited.

An indirect area of influence was considered for the social impacts. The indirect area of influence mainly traced the project footprint, meaning the area beyond the specific operating areas including the sources and logistics corridors for goods and services including labor, or certain settlements/communities indirectly affected by interaction with the project or its activities although they are physically far from the project sites.

Some of the social issues are risks that may arise due to the Aurora Project. For example, influx to remote areas due to building of access roads for the project or influx of ASM into the Aurora Project area may occur due to better infrastructure. These issues are mainly scenario-based risks that provide the company the bigger picture and recommendations on how to be proactive in managing them.

The potential social impacts and risks are identified and segregated by project component and phase wherever appropriate.

## 7.10

### *POTENTIAL SOCIAL IMPACTS ON NATIONAL SOCIO-ECONOMIC CONDITIONS*

Guyana is one of the poorest countries in the world, ranked 103 in the 2006 Human Development Report of UNDP and considered the second poorest in the hemisphere, ranked only second to Haiti. Guyana has an unemployment rate of 11.7%, and unemployment has been exacerbated in the last decade by the closure of the Omai Mine as well as the bauxite industry. The need for employment and economic opportunity is the biggest concern in the country.

The Aurora Project can be compared in size and economic potential to the Omai Mine project. Omai was a large employer, and with the shut down of the mine the employment rates in Guyana were greatly affected. Stakeholder consultations revealed that the closure of the Omai mine in 2005 affected the national economy and employment conditions in Guyana.

As with Omai, the Aurora Project could be a major contributor to the national economy and a significant employer, but also as with Omai, the eventual closure of the Aurora Mine could have negative effects. Optimizing the benefits and minimizing the adverse impacts should be the primary goals of the Aurora Project's social management plan given the lack of direct impacts on communities.

#### 7.10.1

##### *Impacts on National Socio-economic Conditions during Project Construction*

The construction phase of the project was projected to last two to three years. Construction will occur in the mine site, roads and port facility. During this time, the project is likely to impact the overall economic conditions of the larger country in a positive manner.

Some of the likely impacts of the project on the larger socio-economic conditions of the country include:

- **Generation of employment** - Although the precise workforce requirements of the Aurora Project were not established at the time of this report, early estimates suggest that during peak construction time, the Aurora Project can employ as many as 450 workers at a time. These are direct hires by the company. However there could be contractors and subcontractors who bring their own workers for construction. Therefore, the total employment generated during the construction phase of the Aurora Project will be significant. It is expected that the Aurora Project will be the largest employer since Omai because the scale of the Aurora project is similar to that of Omai. It is understood that the workforce for the construction and operations of the Aurora Project will be sourced nationally. Guyana Goldfields currently centralizes recruitment in Georgetown and candidates from all over the country apply for employment in their exploration activities. The plan for the Aurora Project is similar. Inadvertently some areas of Guyana may benefit more than others. For example the village of

Linden is the home of the former Omai workers, and the Aurora Project anticipates that Linden will be the most likely source of skilled workers for the project construction phase.

- **Stimulus to national economy due to the requirements for goods and services (Induced economic benefit)** - The logistics and service needs of the Aurora Project are likely to be significant during the construction phase. This includes needs for trucks, tankers, vans and other vehicles for movement of goods, materials and workforce. A number of contractors and related businesses including transport/truck companies and road works/construction companies in Guyana should potentially benefit from the Aurora Project depending on their quality and competitiveness. Moreover, food and other supplies to the Aurora Project worker camps are likely to be at least in part sourced from Georgetown, Parika or other towns in Guyana.
- **Taxes and Royalties to the Government** - The project is likely to pay taxes and royalties to the Government. This will contribute to the overall GDP of the country.

The overall impact on the national socio-economic conditions during the construction phase is considered to be a major beneficial impact with high level of enhancement and medium likelihood.

#### **7.10.2** *Impacts on National Socio-economic Conditions during Project Operations*

Mining projects often have a 'boom and bust' economic cycle. During the construction phase the demand for workforce, goods and services is very high and the demand comes down significantly during the operations phase.

In the case of the Aurora Project, although estimates of the workforce required by phase or scale of logistics have not yet been determined fully some early estimates suggest that during operations a total of 600 workers will be required including on and off rotation workers. At this time, the number of workers hired by contractors and sub contractors are also likely to go down because operations may not require many contractors and sub contractors at the mine or port. Thus there is likely to be a significant drop in demand for labor, goods and services during the operations phase of the Aurora Project.

As mentioned, the construction phase of the Aurora Project could benefit some areas more than others but during operations there could be a reversal of these benefits. For example, if workers are sourced from Linden or there are many suppliers/contractors from Georgetown they could be economically vulnerable when their services are not required during operations. Similarly, at the Buckhall port there could be employment of daily skilled or unskilled labor for construction or loading/unloading. Such workers are likely to come from Parika rather than

other places in Guyana simply due to their proximity to Buckhall port and the fact that Parika already has skilled dock workers because it's a developed port town. During the operations phase, some areas such as these could be more affected economically than others as there could be widespread and sudden unemployment, loss of supply and contracts and assured source of business.

During the operations, the following types of impacts are likely:

- **Employment-** There is likely to be a decline in the demand for construction workers as the Aurora Project shifts over to operations and skilled mining workers are required. Typically, the number of workers needed during operations is far less than during construction; and,
- **Requirements for goods and services and impacts on local suppliers/business-** The requirements for service providers and contractors such as construction companies are also likely to decline significantly once construction is complete. Similarly, the sourcing of goods such as food, electrical goods, camp equipment, etc. from Georgetown is likely to decline, impacting the livelihoods and incomes of many who had benefited from the construction boom.

This is judged to be a major impact with medium likelihood and high severity. Careful planning will be required to manage the 'boom and bust' cycle and mitigate the potential secondary negative impacts. Measures such as diversifying workforce skills (so that they can work in other industries) or targeting the worker's families for income generation projects can be successful mitigation measures to reduce these impacts.

### **7.10.3** *Impacts on National Socio-economic Conditions due to Closure of the Project*

Based on the AMEC report, the Aurora Project currently has a projected total mine life of 17.5 years from the start of production. Closures of projects of such scale typically have significant impacts on the national socio-economic conditions. This can be illustrated by the Omai Mine example, and its possible effects on the national economy.

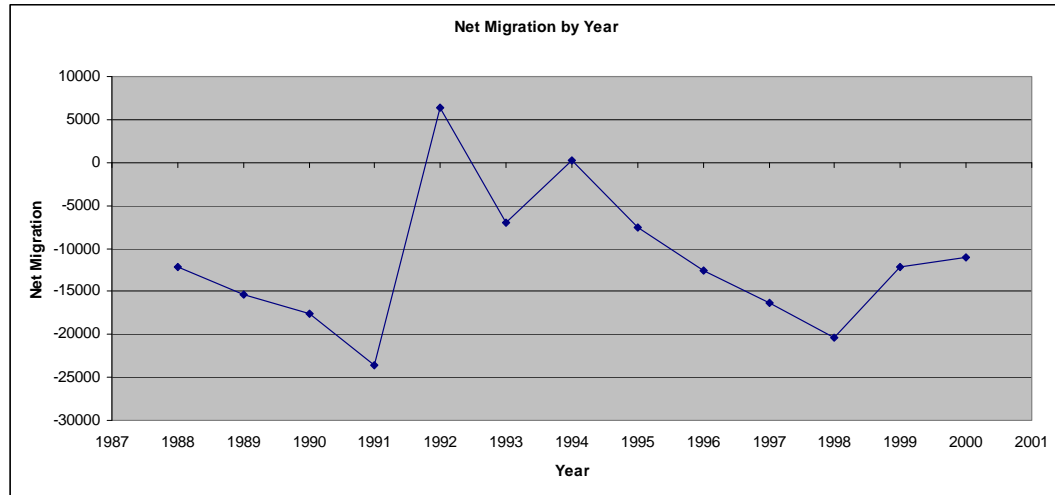
Omai construction began in 1991 and operation/ production of gold began in 1992-1993. The mine went into the closure phase in 2005.

Drawing from national statistics and demographic information related to migration and unemployment rates and mapping them to the Omai Project life cycle, the following scenarios can be identified.

Analysis of net migration rates over the last two decades for Guyana indicates that from 1991 to 1992 there was a sharp increase in positive net migration, which can be attributed at least in part to the increase in employment due to the start up of the Omai mines construction phase in 1991-1992. After 1992, when the Omai operations

phase began, net migration rates began to decline, in particular after the tailings dam failure in 1995. There has been a steady negative downward trend of net migration ever since. This correlation between mine phases and net migration into Guyana is illustrated in *Figure 7-4*.

*Figure 7-4 National Net Migration by Year*

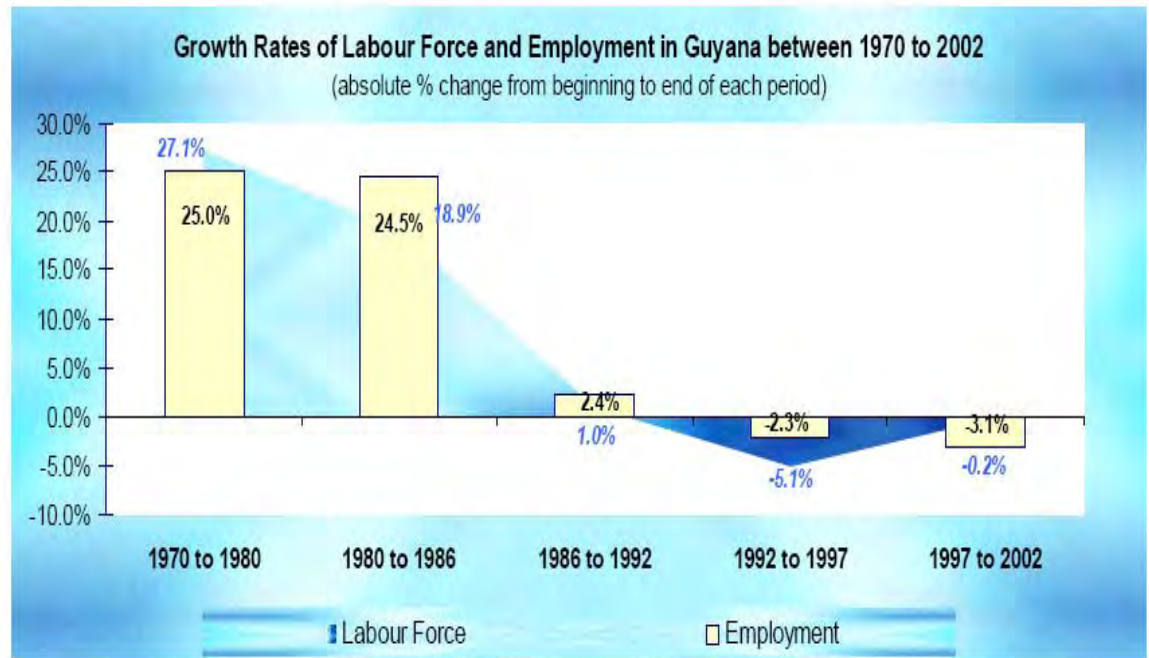


Source: *Guyana Census 2002*

Similarly a report on *Labor Force and Employment in Guyana published by the Private Sector Commission in April 2007* illustrates an overall decline of employment and labor force over the Omai period (see *Figure 7-5*). During the period 1986 to 1992, 5,677 jobs were created, which was more than twice the number of peoples who entered the labor force. This resulted in a lowering of the unemployment rate. From 1992 to 1997, the labor force declined by 5.1%, and the employment rate showed a steady negative trend of -2.3%.

This trend can be mapped against the project phases of Omai where the operations phase began from 1992 onwards. Over the years as production declined so did available employment.

**Figure 7-5 Growth Rates of Labor Force and Employment in Guyana, 1970 to 2002**



Source: *Labor Force and Employment in Guyana* published by the Private Sector Commission in April 2007

The above example of Omai and its impacts on the employment status and migration rates in Guyana can be used to predict similar potential effects for the Aurora Project.

Typically, impacts due to closure of such projects include:

- Loss of employment** - Depending on the scale of total employment provided by the Aurora Project over its lifecycle, there could be a dramatic decrease in employment due to project closure. This may disproportionately affect one area of the country over another. For example, if the bulk of the mine operation workforce is sourced from Linden, the incomes and livelihoods of this town could be severely affected by the closure of the Aurora Project;
- Loss of economic opportunities** - All of the service providers and suppliers to the Aurora Project, especially in Georgetown, could be severely impacted, especially if the bulk of their business came from the Aurora Project; and,

- **Loss of taxes and royalties** - With the closure of the project, the Government could lose a major source of revenue and this in turn can impact GDP of the country.

The impacts of closure are therefore considered to be potentially major. The project proponents in partnership with the Government and its workforce along with suppliers/contractors need to carefully plan for eventual closure. A carefully formulated forward looking closure plan should be commissioned to address the socio-economic impacts of closure.

## 7.11 *POTENTIAL SOCIAL IMPACTS RELATED TO MINE CONSTRUCTION*

### 7.11.1 *Potential Influx into the Aurora Concession due to Mine Area Development and Related Risks*

The Aurora Mine site is located in a remote interior area that has a very small, scattered population. The development of the Aurora Project and potential employment opportunities could attract people to the site for work or other economic opportunities which could have adverse social and environmental consequences if not controlled. The fact that the government would like to see additional development in the area is potentially a problem as well.

At the time of the ESIA, there was an exploration camp at the Aurora Mine site with up to 100 workers. As mentioned, the construction phase of the Aurora Project will require a much larger workforce, but as the logistics planning and feasibility studies for the Aurora Project are still underway and the exact numbers have not yet been finalized. Early estimates suggest 450 directly hired workers at peak construction period which will be supplemented by workforce brought in by various construction contractors and sub contractors. These numbers could vary depending on the construction sites, mine, port or roads.

Given the above numbers of workers, there are several factors that could potentially result in a significant influx situation to the Aurora Project area:

- As has been the experience in many mining projects, once large worker camp(s) are established in a remote area, local people migrate to sell goods and services to the workers. Guyana is a very poor country, and in such economies people tend to flock to where the opportunities are. There is thus a strong possibility that the development of the mine may attract local vendors and service providers including sex workers to the area;
- People could also migrate to the site expecting employment. Currently, all hiring is done out of the Guyana Goldfields office in Georgetown, and there is no recruitment at the Aurora Mine site. However, if the centralized hiring policy is not well disseminated, and even if it is, an influx of people seeking jobs is likely;

- Consultations with Government departments have revealed that there is a general expectation that the Aurora Project should be a stimulus to development in the interior and perhaps even a mining town should develop around it. It is therefore important for the project developers to manage these expectations especially if there is a mixed message from various stakeholders;
- Guyana Goldfields, as a part of its community investment, has been exploring the possibility of establishing a health clinic in the mine area to service the interior. The lack of health facilities is an acute problem in the interior, and there are little or no emergency or first aid services available for artisanal miners or remote communities such as Kurutuku. The location of this health facility is critical, as it is extremely likely that such a facility will be a magnet for influx, attracting those seeking health services as well as those seeking economic gain by providing goods and services to the former. Guyana Goldfields needs to be cognizant that establishing the clinic anywhere near the Aurora Project site could compound the influx problem.

An influx situation could have a variety of impacts including:

- Environmental impacts - the site is in a remote area which lacks infrastructure or services. Rapid development of informal settlements may significantly degrade the local environment (water quality), impact biodiversity (forest clearance, bush meat hunting), etc.;
- Social impacts - influx is likely to lead to an increase in alcohol and drug abuse, prostitution and crime;
- Health impacts - the influx of people from outside could possibly create health risks to the Aurora workers and vice versa. Very often the introduction of new people into the area is often accompanied by transmission of contagious and other diseases. Influx of sex workers often leads to rise in HIV and other STD rates; and,
- Security issues- any influx can create security issues and increase crime leading to impacts on the Aurora Project.

This is judged to be a major potential impact with medium likelihood and high severity. With appropriate mitigations such as planned development or implementation of a focused influx management plan, the impact rating will be minor.

### **7.11.2**      *Obstruction to River Traffic*

The Cuyuni River is the primary means of transportation in the area. Communities situated upstream and downstream of the Aurora Mine site use the river. Current information available indicates that all goods will be carried from the port using the

Barama road after which it will connect to the new road built by Guyana Goldfields. At the point where the new access road ends, a barge will be used to transport construction materials and equipment across the river to the Aurora Mine site. The frequent movement of the barges and high number of trips increases the risk of accidents and incidents with the local communities travelling along the river.

This is a moderate impact with medium severity and medium likelihood. Appropriate mitigation measures such as a well enforced traffic management plan to control site-related river traffic will reduce the impact rating to minor.

### **7.11.3** *Expectation of Employment and Economic Opportunities*

Consultations with the communities, particularly in Kurutuku, revealed that unemployment and lack of economic opportunities are the primary concerns, and there is an expectation that the Aurora Project will provide them some benefits.

As ERM currently understands it, the Aurora Project does not anticipate changing their centralized Georgetown hiring program, and reaching Georgetown for many of the Region 7 inhabitants is a major challenge. In addition, the Region 7 inhabitants are unlikely to have the requisite skills for working in the construction or operational phases of the Aurora Project. Disappointing the expectation for job opportunities could engender antipathy towards the Aurora Project, possibly resulting in sabotage or other criminal acts.

This is a moderate impact with medium likelihood and medium severity. With appropriate mitigation and management, such as an aggressive outreach and engagement program with local communities to identify means to satisfy at least some of their expectations and perhaps help the communities in other ways, could reduce the impact to minor.

### **7.11.4** *Potential Issues with Artisanal Mining*

Artisanal and small scale mining (ASM) is widespread in the region and considerable numbers of artisanal/small scale miners are operating along the Cuyuni River and in the Aurora Mine area. Small and seasonal artisanal mining camps are the main habitations in the area as well. These miners move frequently and establish small exploration camps wherever they go.

It is estimated that roughly 1,200 small scale and artisanal miners are operating in the Aurora Project area. These include miners operating with permits from the GGCM as well as illegal miners from Brazil and possibly Venezuela. During the field surveys undertaken for the ESIA, two ASM camps were observed adjacent to the Aurora Concession.

There are environmental, health & safety impacts typically associated with ASM that include mercury contamination, turbidity in streams, the creation of stagnant pools of water which serve as breeding places for mosquitoes, alteration of river channels from hydraulic mining of alluvial sediments, tailings heaps, deforestation, destruction of habitat, and land degradation. Typical social issues due to ASM are impacts on Amerindian communities, influx of sex workers, increase in crime, and increase of HIV/AIDS and STDs.

The building of the 40-km long access road that will join the Barama transport corridor to the Aurora Mine site could potentially serve as access for artisanal miners to new areas including the south bank of the Cuyuni River. This could lead to security risks and possible conflicts if they trespass on the Aurora Concession. Coupled with the influx of artisanal miners around the Aurora Concession comes the complexities of environmental pollution caused by small scale mining. Any activities by the miners that pollute the river and/or negatively impact biodiversity or surrounding environment could be wrongfully attributed to Guyana Goldfields. Guyana Goldfields could thus bear reputational risks and liability issues especially if international NGOs get involved.

ASM and possible influx caused by the new Aurora Mine infrastructure, primarily the access road, is a key potential issue for the project. It is a major impact with high severity and medium likelihood. With measures including community engagement, implementation of an artisanal mining management plan and active patrolling of the concession boundaries, the risk can be reduced to minor.

#### **7.11.5 *Potential Impact on Itaballi***

Itaballi is located approximately six miles from Bartica and is an entry point to the interior as it has a number of roads that lead to the forest areas in Region 7. Moreover, Itaballi is located near an industrial quarrying project and many of its inhabitants work there. Itaballi also has a fuelling depot for trucks travelling to the interior and in recent years has seen a great influx of sex workers and others to set up small businesses like tire repair, vehicle maintenance and bars. In Itaballi, there are reported issues of increase in HIV/STD rates, lack of infrastructure, security concerns and lack of educational and health facilities for the residents.

There is a Guyana Goldfields worker camp located in Itaballi, consisting of a two storey house with beds, kitchen, restrooms and other facilities. This is currently used to house employees or project personnel on their way to Guyana Goldfield's exploration sites. During the construction of the Aurora Project, workers may be transported by river with stopovers in Itaballi.

The footfall and worker presence in Itaballi is currently limited to a short time but it is possible that during the construction period of the Aurora Project, more workers could be housed here and frequently.

The increase of Guyana Goldfields workers in an already emerging influx situation in Itaballi may have the following impacts:

- Health - There could be health risks posed to the incoming workforce staying in the accommodations from the resident population and vice versa. Risks could include spread of communicable diseases including influenzas, HIV, and STDs;
- Attract more influx in Itaballi – More activity in Itaballi on the part of the Aurora Project will likely result in more influx to provide goods and services; and,
- Security issues - Any influx can create security issues and increase crime.

Overall the potential impact on Itaballi is considered to be moderate with medium severity and medium likelihood of occurrence. Careful logistics planning, which would consist of minimizing the presence of large number of workers in Itaballi for a long duration, will reduce the risks and the rating of the impact to minor.

#### **7.12 POTENTIAL SOCIAL IMPACTS RELATED TO CONSTRUCTION OF BARAMA ROAD AND CONNECTING ACCESS ROAD**

As mentioned, Guyana Goldfields is proposing to upgrade the Barama road and use it as the main transport corridor connecting the Buckhall port to the Aurora Mine site. A new access road will be built to connect the Barama road to the Cuyuni River, where a barge crossing operation will transfer vehicles across the river to another new road spur connected to the Aurora Mine site. Staging areas will also be created on both banks of the river for temporary storage of vehicles and trailers, etc.

Based on secondary sources, available maps and route surveys done by Guyana Goldfields, no established villages, communities or settlements occur along the Barama road or the proposed new access road to the Aurora Mine site. The only populations in the area are related to ASM activities. In addition, there are scattered small shanties/shops selling groceries and some bars that also house sex workers at some points along the Barama road.

At the time of preparation of this report, no maps, plans or other information was available on the engineering design or logistics for the road upgrading and new road construction other than that the Aurora Project was in discussion with the Barama Company regarding partnering to carry out the works. Engineering plans of the new road will reportedly be available in January 2010.

### **7.12.1** *Potential Influx due to Presence of Workforce for Upgrading and Constructing the Roads*

Although the exact estimates of the required workforce for upgrading the existing Barama road and construction of the new spur has not yet been established, it is assumed that a significant number of workers will be required for the effort. Overall, the Barama road is a narrow dirt road that passes through rocky, sloping and uneven terrain that is prone to landslides in the monsoon season. The widening of this road will require significant effort as will the construction of the new access road. It is not known whether Guyana Goldfields will partner with Barama on this effort or will subcontract the assignment to road works contractors. Nevertheless, Guyana Goldfields needs to be aware of the impacts that can occur during the construction phase of the roads.

Despite the topographic variability of the terrain and impenetrability of the interior regions, artisanal miners and small shanty shops/sex workers are present along the Barama road demonstrating the tendency of seeking opportunities. The presence of a large construction workforce (possibly camping along the roads) during construction may attract people from other parts hoping to set up shops to provide to these workers. Further it may attract more sex workers into the area. As mentioned, influx typically creates risks of health, security, conflict between various groups, and unplanned development in a region.

Such an impact is considered as a moderate impact with medium severity and medium likelihood. Recommended mitigation measures include the following:

- Careful logistics planning;
- Ensuring that builders or subcontractors follow the policies of the company and the provisions of the influx management plan; and,
- Implementation of an influx management plan.

Implementation of these mitigation measures will result in minor impacts (low severity, low likelihood).

## **7.13** *POTENTIAL SOCIAL IMPACTS RELATED TO DEVELOPMENT/OPERATIONS OF THE ACCESS ROAD*

### **7.13.1** *Potential Influx due to Easier Access to the Interior*

Upgrade of the Barama road and construction of the new access road will open up new and better routes to the interior. Despite the traditional dependence on the rivers for access to the interior in Region 7, it was reported by several sources during the baseline field surveys that despite the rough conditions of the current Barama road network, ASMs and others make use of the roads for access. Hence, improvement of the main road and creation of the new road from the Barama M3

variant to the Cuyuni River and ultimately to the Aurora Mine site will likely facilitate additional influx, in particular for ASMs for exploration and mining. While the ability of the developer to charge a toll for use may be somewhat of a deterrent, it was reported that the ASMs are willing to pay the toll to Barama for use of the road network (Barama was unwilling to release any data on usage or tolls collected).

The planned creation of the barge crossing and associated staging areas may also attract influx, though this will be dependent on the types of facilities the Aurora Project decides to place there. No details were available at the time of preparation of this report, but any concentration of people, even if transitory day traffic, will likely attract vendors of goods and services.

This is rated a potential major impact with high severity and medium likelihood. A variety of mitigation measures and a carefully implemented influx management plan could reduce the risk to minor.

### **7.13.2 *Increased Traffic and Safety Risks***

Although the exact traffic estimates are not known, the construction and operations phase of the mine is likely to significantly increase movement of vehicles such as big trucks or other vehicles carrying equipment, materials and workforce along the Barama road. It is anticipated that fuel in large quantities will be transported to meet the energy requirements of the mine. Similarly, the operation of the mine will require significant transport of cyanide on these roads. Information from Guyana Goldfields indicates that there will be a 24-hour movement of trucks along the road corridors.

As the road is a public road, it is likely that Barama, and possibly other companies or ASMs, will also use the improved and new roads. The traffic volume due to Guyana Goldfield's activities could greatly increase overall traffic movement in this corridor increasing dust, noise, and vehicular emissions as well as increase risks of accidents and incidents.

This is rated to be a moderate impact with medium likelihood and medium severity. The enforcement of a traffic management plan in partnership with Barama and the Government and other users will reduce the impact to minor.

## **7.14 *POTENTIAL SOCIAL IMPACTS RELATED TO CONSTRUCTION OF BUCKHALL PORT***

### **7.14.1 *Potential Influx into Buckhall Port due to Port Construction and Related Risks***

Although the exact estimates are not available, the information to date suggests that the construction of the Buckhall port will require a significant amount of workers. There is a small Guyana Goldfields camp currently on the site. Future plans indicate that camp facilities will be built to house workers at the Buckhall port, with

approximately 50 workers housed at the Buckhall camp. This camp will also house truck drivers and other vehicular drivers who will be moving materials along the road corridor to the Aurora Mine site.

Barama already has existing worker housing and office facilities and it is likely that the construction and development of the Buckhall port site for the Aurora Project can attract influx, both persons seeking jobs as well as vendors of goods and services, in particular dock workers, possibly from Parika and Bartica.

Influx could potentially create:

- Environmental impacts – Buckhall port is a remote area which lacks infrastructure or services. Rapid development of informal settlements will may significantly degrade the local environment (water quality) and impact biodiversity (forest clearance, bush meat hunting), etc.;
- Pressure on existing resources - The influx of any local population and increase of workers may place additional pressure on the already limited shared resources, such as land, water, forest use, goods, and services;
- Fence line development - It is often seen that incoming migrants tend to occupy a perimeter area around any development, such as the Buckhall port. They could set up houses and shops and squat around or near the Buckhall camp. Development of a port and other facilities can provide more incentive for people to come in especially since river and boats are the usual mode of travel. Such unplanned growth is literally called fence line development;
- Security issues - Any influx can create security issues and increase crime leading to impacts on the Aurora Project workforce;
- Impacts on worker health - The influx of people from outside could possibly create health risks for the Guyana Goldfields workers, the inhabitants of Buckhall port and vice versa. Very often the introduction of new people into the area is often seen to be accompanied by transmission of contagious and other diseases. Influx of sex workers often leads to a rise in HIV and other STDs; and,
- Social interaction between groups could bring about an increase in alcohol and drug abuse, prostitution and crime. The circulation of money from wages and salaries would sustain all of the workers leisure activities. This may increase the demand for alcohol, drugs and sexual services especially for those migrant and expatriate workers.

This is rated to be a major impact with medium likelihood and high severity. With appropriate mitigations, including planned development or discouraging influx, the impact rating will be minor.

***SUMMARY AND RATING OF IMPACTS AND MANAGEMENT PLAN ELEMENTS***

Each of the environmental and social impacts identified in this section are presented in the following tables which summarize the impacts, rating of the impacts, recommended mitigation measures, and ratings of the residual impacts after implementation of mitigation measures.

This will help the reader understand impacts at a glance and also prioritize mitigation or action items based on ratings of the impacts. The mitigations provided here are a part of the Aurora Project's Social & Environmental Management Plans and should be read in conjunction with *Sections 9, 10, 11, 12 and 13* and the stand alone management plans provided in *Annex 1*.

## Environmental Impacts Summary and Ranking Table

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
<b>Project Component-Mine</b>			
<i>Construction Phase</i>			
Increased Noise Levels	Moderate	<p>Installation of sound suppression devices (such as mufflers) on earthmoving equipment, generators etc.</p> <p>Avoiding unnecessary idling of vehicles and machinery that are used intermittently.</p> <p>Employing best available work practices on-site to minimize occupational noise levels.</p> <p>Provide personal protective equipment (PPE) to employees and contractors, and requiring their usage under the health and safety plan.</p>	Minor
Increased Atmospheric Emissions and Dust	Moderate	<p>Covering trucks to minimize dust particulate emission.</p> <p>Minimizing drop heights from vehicles.</p> <p>Scheduling land clearing activities on less windy days.</p> <p>Limiting vehicle speed during construction to a maximum 30 km/hr.</p> <p>Employing dust suppression techniques such as wetting earthen roads with water or non-toxic chemicals.</p> <p>Avoiding open burning of wastes at the construction</p>	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
		<p>site.</p> <p>Maintaining construction equipment according to manufacturer's specifications.</p>	
Impacts to Soils	Major	<p>Implementation of best management practices for erosion control.</p> <p>Topsoil and organic matter stockpiling.</p> <p>Respreading, decompaction, and revegetation.</p> <p>Spill control and cleanup.</p>	Minor
Solid Wastes Generation	Moderate	<p>Implementation of the respective waste management plans for each type of solid waste anticipated to be generated by the operation phase of the Aurora Project.</p> <p>Reuse and recycling should be preferred over disposal to the extent practicable.</p>	Minor
Sediment loading of surface water	Moderate	<p>Implementation of best management practices in the Storm Water Management Plan for soil erosion, storm water runoff, and sedimentation control (e.g., optimization/ minimization of vegetation clearance (just in time approach as opposed to large scale clearance), revegetation of disturbed areas (even if temporary), storm runoff retention ponds, silt fences, etc.).</p> <p>Develop channel control structures.</p> <p>Develop an Interim Reclamation Plan following clearance activities.</p> <p>Implementation of a long-term Reclamation Plan for disturbed areas.</p>	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
Surface spills and releases to surface water	Moderate	Implementation of spill containment, control and prevention measures.	Minor
Surface spills into open pit excavations and groundwater	Minor	Use of secondary containment structures around ASTs containing fuel oil and the maintenance of spill containment equipment in refueling and maintenance areas.	Minor
Loss of Aquatic Habitats	Major	Implementation of above mitigations for surface water and groundwater impacts.	Minor
Loss of Terrestrial Habitat and Flora Loss	Major	To the extent practicable, special mitigations should be employed in the event an active harpy eagle nest is encountered in an area scheduled for clearing, such as relocating the activity or postponing the activity to a non-nesting season.  Strict minimization of clearing  Progressive restoration.	Moderate
Loss of Terrestrial Fauna	Moderate	Minimize Project footprint.  Perform Preclearance Survey for Harpy Eagle Nests in areas suspected nesting habitats.	Minor
Introduction or Promotion of Alien Invasive Species	Moderate	Monitoring of biodiversity  Prohibition of the importation of any invasive species  Control and awareness raising  Biorestitution of Disturbed Areas and Spoils.	Minor
Increased Human Population and Activity in the	Moderate	Enforcement of a strict Code of Conduct that includes	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
Area of Influence		prohibitions of all use and disturbance of flora and fauna.	
<i>Operations Phase</i>			
Increased Noise Levels	Moderate	<p>Installation of sound suppression devices (such as mufflers) on earthmoving equipment and generators, as necessary;</p> <p>Employing best available work practices on-site to minimize occupational noise levels;</p> <p>Isolation of noise source from employees' living and dining area;</p> <p>Using acoustic insulating materials such as silencers on exhaust systems;</p> <p>Issuing/ requiring use of PPE (e.g., ear plugs or ear muffs) especially in high noise locations;</p> <p>Posting visible warning signs in areas of high noise levels instructing employees to wear ear protection;</p> <p>Periodically monitoring noise levels to ensure compliance with recommended threshold levels; and,</p> <p>Conducting regular hearing tests and maintaining records of results for workers exposed to high noise levels.</p>	Minor
Increased Atmospheric Emissions and Dust	Moderate	<p>Covering trucks to minimize particulate emission;</p> <p>Minimizing drop heights from vehicles;</p>	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
		<p>Limiting vehicle speed to a maximum 30 km/hr;</p> <p>Employing dust suppression techniques such as applying water or non-toxic chemicals;</p> <p>Maintaining construction equipment according to manufacturer's specifications;</p> <p>Providing facemasks with dust removal filters;</p> <p>Conducting periodic medical checks of employees for effects of dust exposure; and,</p> <p>Providing goggles and eye wash lotion for dust-induced eye irritation for workers on site.</p>	
Impacts to Soils	Major	<p>Implementation of best management practices for erosion control.</p> <p>Topsoil and organic matter stockpiling.</p> <p>Respreading, decompaction, and revegetation.</p> <p>Spill control and cleanup.</p>	Minor
Solid Wastes Generation	Moderate	<p>Implementation of the respective waste management plans for each type of solid waste anticipated to be generated by the operation phase of the Aurora Project.</p> <p>Reuse and recycling should be preferred over disposal to the extent practicable.</p>	
Potential spills or discharges of cyanide and other chemicals into surface water	Major	Implementation of Best Management Practices (BMPs) during the transportation, handling, storage,	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
		and use of cyanide and other chemicals.	
Leaching of chemicals from waste rock and saprolite stockpiles into surface water	Major	Installation of an impermeable liner as part of a leachate collection system.	Minor
Slope failure of waste rock and saprolite stockpiles causing discharge into surface water	Major	Periodic monitoring of the physical integrity of the waste rock and saprolite stockpiles.	Minor
Modification of hydrologic flow patterns within streams/creeks due to TMA and water management ponds	Major	Direct discharge from the water management pond, assuming that they meet effluent discharge limits and water quality standards, to stream/creek beds at points downstream of the tailings and water management ponds.	Minor
Breaches and overtopping of the TMA and/or water management pond	Major	Utilization of BMPs during design, construction and operation of these facilities, including monitoring of dam integrity.	Moderate
Potential runoff of impacted stormwater into surface water	Major	Proper design of the stormwater management system, including sufficient retention (capacity of settling ponds) and treatment (i.e., oil/water separators, debris removal, etc.) to ensure that natural surface waters are not affected by discharges of untreated stormwater.  Runoff from mine processing areas, waste stockpiles, roadways, etc. must be collected, retained, and treated to acceptable water quality standards prior to discharge to the natural environment.	Minor
Wastewater discharges from the onsite sewer system, domestic wastewater, and/or by stormwater runoff from developed areas into surface water	Moderate	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).	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
		<p>Proper disposal of sludge (i.e., in a secure landfill).</p> <p>Monitoring of the effluent from the oil-water separators will also be conducted to ensure that the discharged stormwater meets effluent discharge/water quality standards prior to discharge into surface water.</p>	
Potential discharge of groundwater from the pit dewatering activities into surface water	Minor	None	Minor
Potential runoff of wastewater from the TMA into surface water	Major	Installation of an impermeable liner as part of a leachate collection system.	Minor
Surface spills and releases to surface water	Moderate	Implementation of spill containment, control and prevention measures. Stormwater discharges from fuel storage areas should be channeled to an oil-water separator prior to being discharged to surface water.	Minor
Withdrawal of surface water from the Cuyuni River and streams/creeks for the mineral processing operations	Minor	None	Minor
Diesel oil spill into the Cuyuni River	Minor	Strict adherence to the Environmental Monitoring Plan, which would include frequent monitoring of hydrocarbons in the TMA and water management pond and inspection of fuel storage tanks (and their containment systems).	Minor
Cyanide spill into the Cuyuni River	Moderate	Strict adherence to the Environmental Monitoring Plan, specifically to include frequent monitoring of cyanide in the TMA and water management pond, maintenance and monitoring of the cyanide storage tank integrity, and containment of cyanide in ore	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
		processing and mining operations.	
Leaching of chemicals from waste rock and saprolite stockpiles into groundwater	Major	Installation of an impermeable liner as part of a leachate collection system.	Minor
Infiltration of wastewater from the TMA, water management pond, and waste management areas along with leaching of minerals into solution in the mine	Major	Installation of impervious liners below the TMA, water management pond, and waste management areas and directing water from the mine to the water management pond.	Minor
Groundwater dewatering	Moderate	None.	Minor
Infiltration of potential spills or discharges of cyanide and other chemicals into groundwater	Major	Implementation of Best Management Practices (BMPs) during the transportation, handling, storage, and use of cyanide and other chemicals.	Minor
Surface spills and releases to groundwater	Moderate	Implementation of spill containment, control and prevention measures.	Minor
Potential infiltration of surface water from the Cuyuni River into the open pit mine	Moderate	Installation of an impermeable barrier below grade and extension of the dike to the west are recommended to further protect the mine from potential surface water infiltration.	Minor
Loss and Degradation of Aquatic Habitats and Fauna	Major	Implement mitigations discussed above for surface waters and groundwater.	Minor
Loss of Terrestrial Habitat and Flora	Moderate	Minimize Project footprint.  Initiate restoration as soon as practicable in temporary work areas.	Minor
Loss of Terrestrial Fauna	Minor	Minimize Project footprint.  Perform Preclearance Survey for Harpy Eagle Nests	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
		in areas suspected nesting habitats.	
Introduction or Promotion of Alien Invasive Species	Minor	Biodiversity Monitoring. Control of Invasive Species.	Minor
<i>Mine Closure Phase</i>			
Potential failure of the TMA and water management pond dams after completion of mining activities	Major	Post-closure monitoring of the stability of these dams along with periodic monitoring of surface and groundwater conditions in the vicinity of these dams.	Moderate
<b>Project Component - Buckhall-Aurora Access Road</b>			
<i>Construction and Improvement Phase</i>			
Increased Noise Levels	Minor	Maintaining equipment in accordance with manufacturer's specifications. Maintaining/installing mufflers on vehicle and equipment exhaust systems.	Minor
Increased Atmospheric Emissions and Dust	Moderate	Perform maintenance on vehicles and machinery.	Minor
Impacts to Soils	Major	Implementation of best management practices for erosion control. Topsoil and organic matter stockpiling. Respreading, decompaction, and revegetation. Spill control and cleanup.	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
Installation of culverts at stream crossings	Major	Design culvert sizes to properly handle natural surface water flows. Culverts shall also be lined with grass and/or riprap, where necessary, to control flow rates/ velocities and minimize erosion.	Minor
Surface spills and releases to surface water	Moderate	Implementation of spill containment, control and prevention measures. Identification and use of equipment storage and maintenance areas that will be equipped with sumps and oil traps to control and contain potential spills.  Development of emergency response stations at select locations along the access road.	Minor
Reduced infiltration into groundwater recharge area	Minor	None.	Minor
Loss and Degradation of Aquatic Habitats	Major	Mitigations listed above for soils, culverts, and surface spills and releases.	Minor
Loss and Alteration of Terrestrial Habitats	Major	Minimizing the area required for clearance to permit safe operating conditions of the road.  Ensuring that trees are felled towards the interior of the right-of-way such that trees outside of the cleared area are not damaged.	Minor
Increased Susceptibility to Forest Fires	Major	Maintaining a strict Code of Conduct for drivers that raises awareness of high fire risk periods.  Control of smoking and fires.  Mowing the vegetative growth in the right-of-way to	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
		reduce potential fuel loads.	
Introduction or Promotion of Alien Invasive Species	Minor	Monitoring of biodiversity. Control of identified invasive species.	Minor
<i>Operation Phase</i>			
Increased Noise Levels	Moderate	Limiting vehicle speed. Maintaining equipment in accordance with manufacturer's specifications. Maintaining/installing mufflers on vehicle and equipment exhaust systems.	Minor
Increased Atmospheric Emissions and Dust	Moderate	Maintaining equipment in accordance with manufacturer's specifications. Limiting vehicle speed. Employing dust suppression techniques. Providing facemasks with dust removal filters.	Minor
Impacts to Soils	Major	Ensure that the trucking companies utilized for transport of hazardous and petroleum-related materials have spill contingency plans in place that may include provision of spill kits on the trucks for the cleanup of minor spills; and, Development of emergency response stations at select locations along the access road.	Minor
Spills of fuel and other chemicals during transport	Major	Require that the trucking companies utilized for transport of hazardous and petroleum-related	Moderate

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
between the Aurora Mine site and Buckhall port.		materials have spill contingency plans in place that may include provision of spill kits on the trucks for the cleanup of minor spills.  Development of emergency response stations at select locations along the access road.	
Spills of fuels, oil and other chemicals on the ground surface and the migration of spilled material to groundwater underlying the area.	Moderate	Require that the trucking companies utilized for transport of hazardous and petroleum-related materials have spill contingency plans in place that may include provision of spill kits on the trucks for the cleanup of minor spills.  Development of emergency response stations at select locations along the access road.	Minor
Facilitation of Commercial Logging Activity to the South of the Cuyuni River	Moderate	Guyana Goldfields has no control over activities in logging concessions.	Moderate
Increased Susceptibility to Forest Fires	Major	Maintaining a strict Code of Conduct for drivers that raises awareness of high fire risk periods.  Control of smoking and fires.  Mowing the vegetative growth in the right-of-way to reduce potential fuel loads.	Minor
Increased Pressure on Forest Resources and Wildlife	Moderate	Enforcement of a Code of Conduct in partnership with the Government and other users.	Minor
Introduction or Promotion of Alien Invasive Species	Moderate	Monitoring of biodiversity.  Control of identified invasive species.	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
		Right-of-way vegetation management and monitoring.	
<b>Project Component- Buckhall Port</b>			
<i>Construction Phase</i>			
Increased Noise Levels	Moderate	<p>Installation of sound suppression devices (such as mufflers) on construction equipment.</p> <p>Employing best available work practices on-site to minimize occupational noise levels.</p> <p>Using acoustic insulating materials such as silencers on exhaust systems.</p> <p>Issuing ear plugs or ear muffs to employees exposed to high noise levels.</p> <p>Periodically monitoring noise levels to ensure compliance with recommended threshold levels.</p> <p>Posting visible warning signs in areas of high noise levels instructing employees to wear ear protection.</p>	Minor
Increased Atmospheric Emissions and Dust	Moderate	Perform maintenance on vehicles and machinery.	Minor
Impacts to Soils	Major	<p>Implementation of best management practices for erosion control.</p> <p>Topsoil and organic matter stockpiling.</p> <p>Respreading, decompaction, and revegetation.</p> <p>Spill control and cleanup.</p>	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
Solid Wastes Generation	Moderate	Implementation of the respective waste management plans for each type of solid waste anticipated to be generated by the operation phase of the Aurora Project.  Reuse and recycling should be preferred over disposal to the extent practicable.	Minor
Sediment loading due to runoff from cleared areas and oils and fuel spilled during construction	Moderate	Implementation of an Erosion and Sediment Control Plan and collection of site discharges within an oil-water separator. Spill containment, control and prevention measures should also be implemented during the refuelling and maintenance of construction equipment.	Minor
Spills of fuels, oil and other chemicals and the migration of spilled material to groundwater underlying the area.	Moderate	Spill containment, control and prevention measures should be implemented during the refuelling and maintenance of construction equipment.	Minor
Alteration of Aquatic Habitats	Minor	Implementation above mitigations for surface water impacts.  Minimization of the Project footprint to the extent practicable.	Minor
Loss of Terrestrial Habitats	Minor	Minimization of the Project footprint to the extent practicable.	Minor
Introduction or Promotion of Alien Invasive Species	Minor	Monitoring of biodiversity.  Control of invasive species as necessary.	Minor
<i>Operations Phase</i>			
Impacts to Soils	Moderate	Develop and follow a Spill Prevention and Control	Minor

Impact	Rating	Mitigation Measure /SEMP Section	Residual Impact
		<p>procedure, which should include criteria for paving or otherwise making the vehicle storage and maintenance areas impervious.</p> <p>Fuel storage tanks should be located in secondary containment areas with impervious floors, preferably with a roof or overhead canopy to prevent rain water from accumulating in the containment areas and mixing with spilled fuel.</p> <p>Drains from the secondary containment areas should be equipped with oil/water separators.</p>	
Solid Wastes Generation	Moderate	Implementation of Wastes Management Plans	Minor
Spills of fuel and other chemicals being loaded/unloaded at the port	Major	Spill containment, control and prevention measures should be implemented during the refuelling and maintenance of vessels and during loading/unloading activities.	Minor
Accidental discharges of fuels, oils and grease from equipment and/or as a result of the failure of fuel containment facilities	Major	Implementation of spill containment, control and prevention measures at the port facility.	Minor
Discharge of domestic wastewater to surface water	Moderate	Installation and use of septic tank systems.	Minor
Spills of fuels, oil and other chemicals on the ground surface and the migration of spilled material to groundwater underlying the area.	Moderate	Implementation of spill containment, control and prevention measures during loading/unloading activities and vessel refuelling and maintenance at the port facility.	Minor
Introduction or Promotion of Alien Invasive Species	Minor	<p>Monitoring of biodiversity.</p> <p>Control of invasive species as necessary.</p>	Minor

**Social Impacts Summary and Ranking Table**

Impact	Rating	Mitigation Measure	Residual Impact
<b>Overall Macro impacts of the project</b>			
Beneficial impact on socio-economic conditions of the nation during construction phase	Major	NA	NA
Impact on socio-economic conditions of the nation during operations phase especially areas like Linden, Parika, Georgetown and Buckhall	Major	<p>Train and build capacities of the workers &amp; service providers to find economic opportunities with other industries in Guyana</p> <p>Diversify skills of workers so that they can work in other industries beyond the life of this project</p> <p>Target worker’s families for income generation projects</p> <p>Implement Community Development Plan</p> <p>Formulate a Closure plan that that addresses the economic impacts of the ‘boom &amp; bust’ phenomena along with measures to manage these impacts addresses socio-economic impacts</p>	Moderate
Impact on socio-economic conditions of the nation due to closure	Major	Implement the closure plan addressing socio-economic impacts of project closure	Moderate
<b>Project Component-Mine</b>			
<i>Construction Phase</i>			

<p>Potential influx into the Aurora concession leading to health, security and conflict related risks</p>	<p>Major</p>	<p>Actively discourage influx into the area and not allow outsiders to settle in the periphery of the camp</p> <p>Guyana Goldfields is signatory to the Voluntary Principles on Human Rights and the company should train the security forces on site to handle influx sensitively without conflict or security issues</p> <p>Promote and run health awareness campaigns especially on HIV and STD amongst the workers as well as local communities upstream and downstream of project site</p> <p>Implement Influx Management Plan</p>	<p>Minor</p>
<p>Increase in river traffic creating risks of accidents and incidents</p>	<p>Moderate</p>	<p>Estimate the exact numbers, volumes and frequency of traffic per day</p> <p>Formulate a Traffic Management Plan that addresses issues like safety training for boat/barge transport, timing of movement of river traffic to and from the site and identification of accident risk areas.</p>	<p>Minor</p>
<p>Expectation of Employment and Economic Opportunities</p>	<p>Moderate</p>	<p>Dialogue with the local communities especially Kurutuku to understand their expectations</p> <p>Create strategies to generate local employment upstream/downstream of Aurora site. See Community Development Plan.</p> <p>Promote community development projects that enhance local benefits and create skills, capacities,</p>	<p>Minor</p>

		improve education, health and infrastructure of the local communities. See Community Development Plan.	
Potential issues with artisanal mining	Major	Consult and engage with artisanal miners who come into the concession  Patrol concession boundaries  Implement the Artisanal Mining Management Plan in Annex A	Minor
Potential Impact on Itaballi	Moderate	Carefully plan logistics to minimize frequency and duration of stay of Guyana Goldfields workers in Itaballi  In addition see Community Development Plan	Minor
<b>Project Component- Barama Road and Access Roads</b>			
<i>Construction Phase</i>			
Potential Influx due to presence of workforce for upgrading and constructing the roads	Moderate	Careful Logistics planning  Ensuring that builders or subcontractors follow the policies of the company and the provisions of the influx management plan  Implement Influx Management Plan	Minor
<i>Operations Phase</i>			

Potential Influx due to Easier Access to the Interiors	Major	<p>Partner with Barama and the Government to patrol the roads and manage influx issues</p> <p>Consult with the Government on issues such as promotion of planned regional development</p> <p>Implement the Influx Management Plan &amp; Artisanal Mining Management Plan</p>	Minor
Increased Traffic and Safety Risks	Moderate	<p>Estimate the volume of traffic during construction and operations phase</p> <p>Partner with government and other companies like Barama that use the road to promote safety and reduce risks</p> <p>Formulate a detailed Traffic Management Plan that addresses measures like driver safety training, identification of risk zones and timing of movement of traffic</p>	Minor
<b>Project Component-Buckhall Port</b>			
<i>Construction Phase</i>			
Potential influx into Buckhall due to wharf development and related risks	Major	<p>Partner with the Government and/or Barama to plan sustainable development/growth of Buckhall</p> <p>Actively discourage influx into the area and not allow outsiders to settle in the periphery of the camp</p> <p>Guyana Goldfields is signatory to the <i>Voluntary Principles on Human Rights</i> and the company should train the security forces on site to handle influx sensitively without conflict or security issues</p>	Minor

		<p>Promote and run health awareness campaigns especially on HIV and STD amongst the workers as well as local communities</p> <p>Implement the Influx Management Plan</p>	
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## 8 CUMULATIVE IMPACTS

### 8.1 INTRODUCTION

The IFC defines cumulative impacts as the combination of multiple impacts from existing projects, the proposed project, and/or anticipated future projects that may result in significant adverse and/or beneficial impacts that would not be expected in the case of a stand-alone project. This chapter describes and analyzes the potential cumulative impacts of the Project and past, existing, or future actions/projects on the natural environment, social and economic conditions, and community health.

#### 8.1.1 *Scope of the Cumulative Impacts Assessment*

For cumulative impacts assessment (CIA) to be a useful tool to decision-makers and stakeholders, it must be limited to effects that can be meaningfully evaluated, rather than explore infinite possibilities. Three important aspects that require consideration prior to the evaluation of cumulative impacts are listed below:

- Identifying the resources and/or receptors at risk or likely to experience interactions with the Project;
- Determining the appropriate spatial and temporal boundaries for evaluation; and
- The identification of relevant past, existing, and future actions/projects for consideration.

### 8.2 POTENTIAL CUMULATIVE IMPACTS

In the context of the Aurora project, the following potential cumulative impacts were identified. These are listed in relative order of importance.

#### 8.2.1 *Gold Rush Effect*

Guyana is a poor, natural resource rich country, and the future of Region 7, given the gold and mineral resources in the area, is likely to be one of exploitation and rapid change. Reportedly, the numbers of ASM in the area has increased significantly over the last year, no doubt due in part to the rising price of gold.<sup>1</sup> As the Aurora project begins construction and the scale of the development becomes

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(1) Personal communication, Guyana Goldfields December 2009 re findings of the fall 2009 Newfields survey of the Aurora Mine area.

visually apparent (e.g., the works at the Aurora site, the works at the Buckhall port), it is likely that word will spread through the region that a major gold strike has been found, attracting more ASM from outside Region 7. 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 has prepared a National Development Strategy and a National Environmental Action Plan (see *Section 3.2.1 National Development Strategy*) to guide and manage development, but implementation and enforcement are weak. The Aurora Project should contribute to the gold mining industry-related goals of the NDS, advance the general principles of the NEAP, and participate in the economic and social development of the country by supporting and encouraging sustainable development in Region 7 (see *Section 8.3, Managing Cumulative Effects* below).

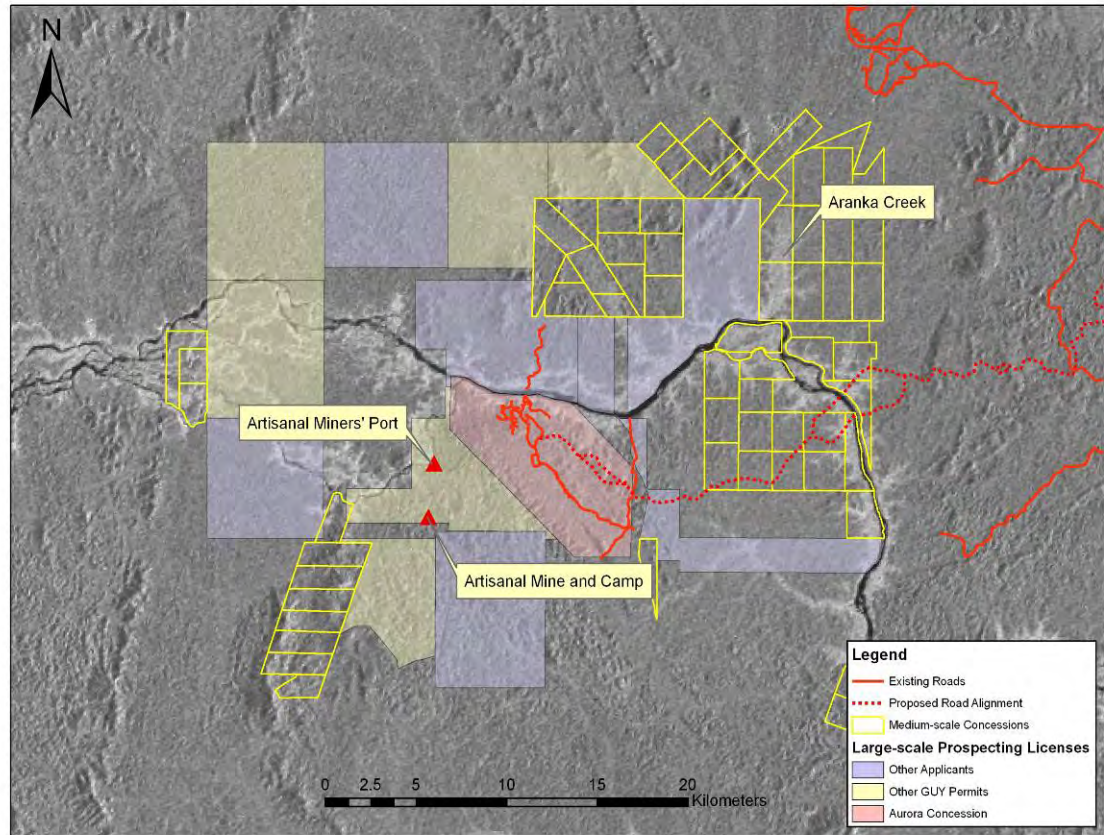
### 8.2.2 *Other Guyana Goldfields Concessions, ASM and Other Mining Projects in region 7*

There are significant current and potential future mining developments in Region 7 based on the existing concessions, exploration activities and ASM.

- Guyana Goldfields' concessions include additional area in the Aurora concession as well as Aranka and Peters Mine (*Figure 8-1*). The Aurora area concessions total 110,224 acres (44,625 ha), the Aranka concession includes 307,589 acres (124,530 ha), and the Peters Mine concession encompasses 8,358 acres (3,384 ha). Only exploration activities were underway at these sites. Depending on the results of exploration, Guyana Goldfields may decide to leverage their investments in the access road and Buckhall to develop these other sites.
- There are also other large-scale and medium-scale concessions held by other individuals and firms in Region 7 as illustrated in *Figure 8-2*. The completed Aurora Mine transportation infrastructure could facilitate the development of these projects to some degree.
- The government has no detailed statistics or GIS data documenting the extent of ASM in Region 7. Secondary sources such as the WWF report, *Situational Analysis of Small Scale Gold Mining in Guyana, 2008I*, estimates that roughly 1,200 artisanal and transient miners live in makeshift camps and are active in the region. There has also been an observed increase in Brazilian miners, described by WWF as using higher risk gold extraction methods. The Aurora project infrastructure and subsequent development will provide improved access to the interior and could potentially result in increased ASM activity. (*For more information see the NewFields ASM Health Impact Assessment and Annex 1: Part A, Artisanal Mining Management Plan*)



**Figure 8-2.** *Aurora Properties and Adjoining Prospecting Licenses/Concessions.*



Source: Guyana Goldfields/ERM, 2009

### 8.2.3

#### *Cumulative Impacts of the Potential Cuyuni River Hydropower Project*

Feasibility studies are underway for a 40 MW run-of-river hydropower project on the Cuyuni River upstream of the Aurora Mine (Guyana Goldfields, 2009). Given that the projected total energy demand for the Aurora Mine is approximately 30 MW, the excess capacity could be used to supply power/electricity for potential future developments in the region. However, it is not clear whether the hydropower would completely replace the onsite generators for the Aurora Mine or whether a portion of the energy might be used for other developments.

The availability of excess energy due to the proposed hydropower project could result in increased development in the vicinity of the Aurora Mine, including expansion of the Aurora Mine, development of other Guyana Goldfields properties, or developments by third-party mining operations on adjacent and nearby mining concessions, leading to additional impacts on the social and natural environment in Regions 7 and 3.

#### 8.2.4

#### *Cumulative Impacts Relating to future Planned Road/Infrastructure Projects like IIRSA*

The Initiative for the Integration of Regional Infrastructure in South America (IIRSA) is a continental scheme involving the governments of South America and regional development banks to construct a new infrastructure network for the continent, including roads, waterways, ports, and energy and communications interconnections. The overall aim of IIRSA is to improve transportation infrastructure and trade and to increase exports of primary materials such as soybeans and other grains, timber, and minerals.

The IIRSA Venezuela -Guyana -Suriname (Paramaribo) Road project is in the conceptual phase. This road would connect Ciudad Guayana, Venezuela with Paramaribo, Suriname, via Georgetown. The currently proposed route would pass through Region 7 to the south of the Cuyuni River, close to the Aurora Concession, and connect the towns of San Martín Turumbang (Venezuela) and Bartica. Preliminary studies are underway, and the Caribbean Development Bank has entertained financing the project. While the likelihood and timing of this project being implemented was unknown, the improvements of the existing Barama Road could affect the decision regarding the route of this road through the region between the Aurora Concession and the Essequibo River. However, it was considered unlikely that the IIRSA road would cross the lower Essequibo due to the potentially enormous expense of constructing bridges across the 22 mile wide estuary. The project as currently envisioned includes bridges over the Mazuruni River in the vicinity of Bartica and over the Essequibo River in the vicinity of Rockstone.

If completed during the lifetime of the Aurora Mine, this road could significantly alter the population and socioeconomic dynamics of the Aurora Mine Area of Influence by creating a new overland transportation corridor between the Bartica area, the Aurora area, and the Venezuelan frontier. The potential for new settlements and influx of populations in the Aurora area and in Region 7 generally would be increased by combination of the new road and the economic activity associated with the Aurora Mine.

#### 8.2.5

#### *Cumulative Impacts on Regional Socioeconomic Conditions*

The Aurora Mine project is the only large-scale mining project currently under development in Guyana and it will be a nationally-significant source of employment and revenue. The success of the Aurora Mine project could facilitate the development of additional mining concessions by Guyana Goldfields, or other mining companies, and this could lead to greater levels of employment and extend the duration of the increased employment as well. The secondary socioeconomic impacts would extend nationwide, as discussed in Section 7.

## 8.3 *MANAGING CUMULATIVE IMPACTS*

### 8.3.1 *Regional Planning*

While the Aurora Project was likely to be the major development in the region in the short term, the possible future development of the Aranka property and the hydro-power facility would dramatically increase the scale of effects in the region going forward. And, at the time of this report, the pressure of ASM, already a very significant impact on the regional environment, specifically biodiversity and water quality, and the few communities in the region, was growing dramatically with the rise in gold prices and is likely to continue to grow in the near term. Last, the Government of Guyana is supportive of development in the region to take advantage of the natural resources in order to benefit the national economy, and while the regulatory framework is well structured, enforcement is weak due to limited capacity and resources.

Management of potential cumulative impacts in Region 7 will require a long term, multi-stakeholder regional planning program. Such planning should be done by building consensus, collaboration and partnerships between the affected and responsible parties. Key stakeholders who should be included in the process are:

- Government of Guyana particularly authorities of region 7 and 3;
- Amerindian Peoples Association;
- Residents of the region; including Kurutuku;
- Barama Company;
- Aurora Project and Guyana Goldfields;
- Artisanal Miners Associations;
- Local WWF and CI conservation NGO offices; and
- Other regional stakeholder organizations.

As noted in *Section 8.2.1, the Gold Rush Effect*, above, the National Development Strategy and NEAP provide an excellent framework for managing development in Guyana and in the mining sector in particular, and is recommended that these frameworks serve as the basis for a broadly consultative and collaborative process.

### 8.3.2 *Post Construction Cumulative Effects Study*

In addition, it is recommended that a Cumulative Effects Study be commissioned and carried out at the end of the construction phase of the Aurora Mine Project to assess the effects to date, predict the likely future effects and recommend management measures for optimizing positive benefits and controlling adverse impacts.

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The Social & Environmental Management System (SEMS) provides the management framework or the systemic aspects for implementation of the Social and Environmental Management Plan (SEMP) presented in *Section 10, Environmental Management Plan, Section 11, Social Management Plan and Section 12, Health, Safety, and Emergency Response Plan*.

This SEMS is the backbone of the SEMP and the adoption of this SEMS is critical for the implementation of the SEMP presented in this report.

The SEMS is a systemic framework that will be applicable throughout the life cycle of the project and to every phase from feasibility and construction to operations and closure.

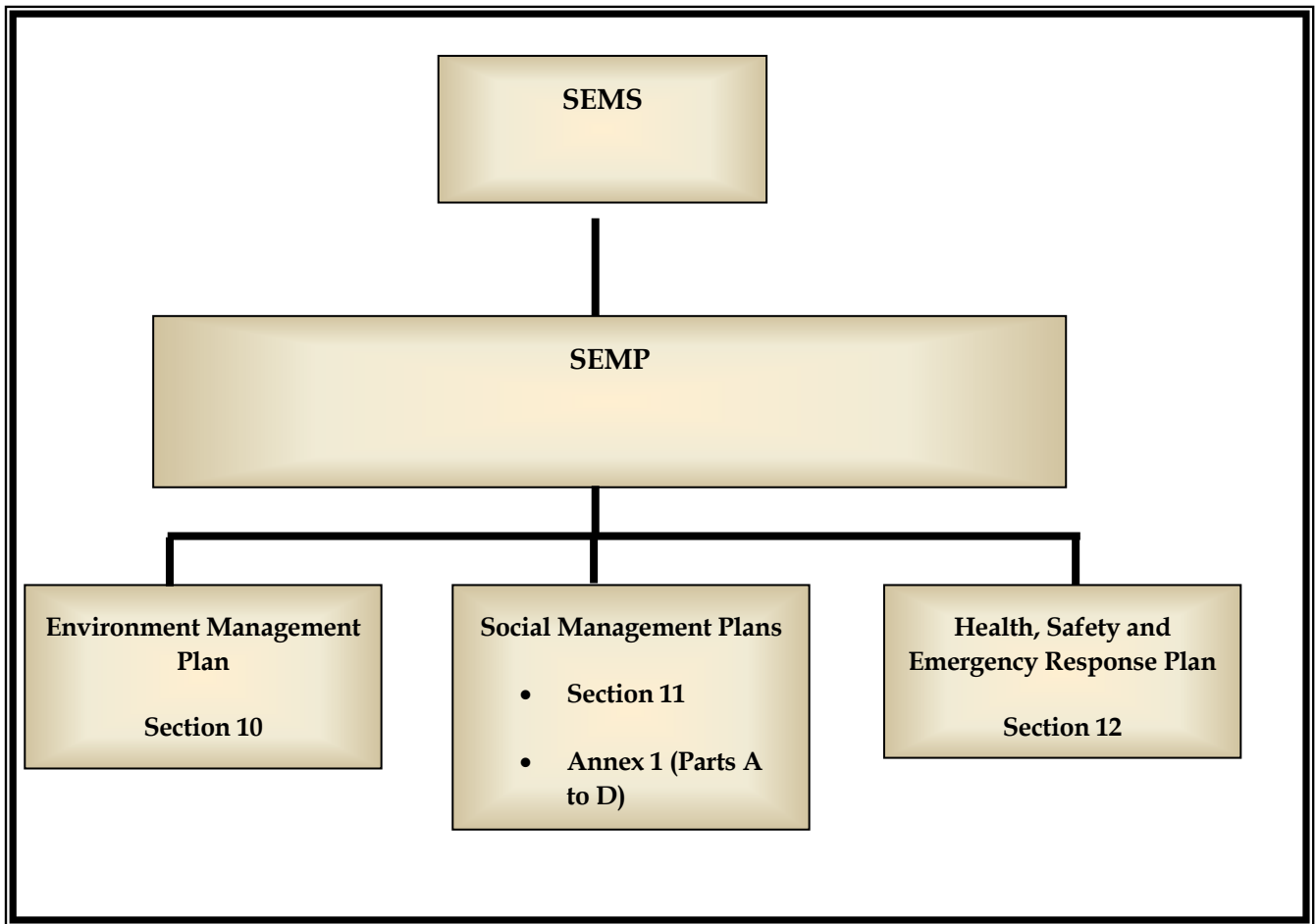
While the SEMP presented in *sections 10, 11 and 12* are mainly plans/mitigations to address specific impacts identified by this ESIA, the SEMS goes beyond the SEMP and forms an independent and adaptive system of checks and balances that ensures that all possible environmental & social risks/impacts 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:

- Policy framework;
- Organizational Structure and Responsibilities for the implementation of the SEMP;
- Monitoring and Audits Process;
- Change Management; and
- Reporting and Disclosure.

*Figure 9-1* illustrates the organization of the SEMS, the SEMP, and its component plans.

**Figure 9-1:** Organization of the SEMS and SEMP.



## 9.1

### *POLICY FRAMEWORK*

Guyana Goldfields and its contractors should adhere to all applicable laws, regulations, and codes of practice of Guyana, the applicable *IFC Performance Standards on Social and Environmental Sustainability*, and the applicable *IFC EHS Guidelines*. In the event that Guyana Goldfields deems full compliance with a particular standard or guideline not to be technically or economically feasible, the IFC, EPA, and GGMC should be consulted proactively such that alternative standards or practices may be developed.

A policy framework is an integral part of a management system. It is very important for a company to have written policies on environmental social and health & safety issues. Such policies should clearly outline the mission, vision and aim of the company and the standard operating procedures (SOP) that detail how these policies will be implemented throughout the Project.

An integral part of the policy framework is the establishment of a code of conduct. The code of conduct ensures that the intent of the policies of the company and SOPs percolate to all levels like the employees, contractors and subcontractors of the Project.

#### **9.1.1**

#### ***Written Management Policies***

Although Guyana Goldfields has not yet adopted a set of formal policies, it should adhere to the entire environment, social, health & safety and labor legislation and regulatory framework of Guyana as well as the applicable *IFC Performance Standards* and *EHS Guidelines*. Each of these compliance requirements have been discussed in *Section 3* of this ESIA report.

Guyana Goldfields will develop written policies for each of the applicable *IFC PS* discussed in *Section 3*. 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.

### 9.1.2 *Guyana Goldfields Code of Conduct*

All Guyana Goldfields employees, contractors, and site visitors will be required to comply with a Company Code of Conduct. A code of conduct ensures 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.

A sample code of conduct has been provided in *Annex 4* as a guidance, which has 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.

**Guyana Goldfields needs to develop their own code of conduct to reflect their own vision and objectives.**

## 9.2 *ORGANIZATIONAL STRUCTURE AND RESPONSIBILITIES*

Guyana Goldfields is currently 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 Guyana Goldfields functions in a skeletal capacity with managers and staff taking on multiple functions;
- Personnel who can take management decisions are based in primarily in Toronto and 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.

For a project of this magnitude and particularly to be able to implement the SEMP of this ESIA, Guyana Goldfields needs a team of trained and dedicated resources.

The primary responsibility of these staff should be to oversee the implementation of the SEMP and take ownership of the systems and processes of this SEMS.

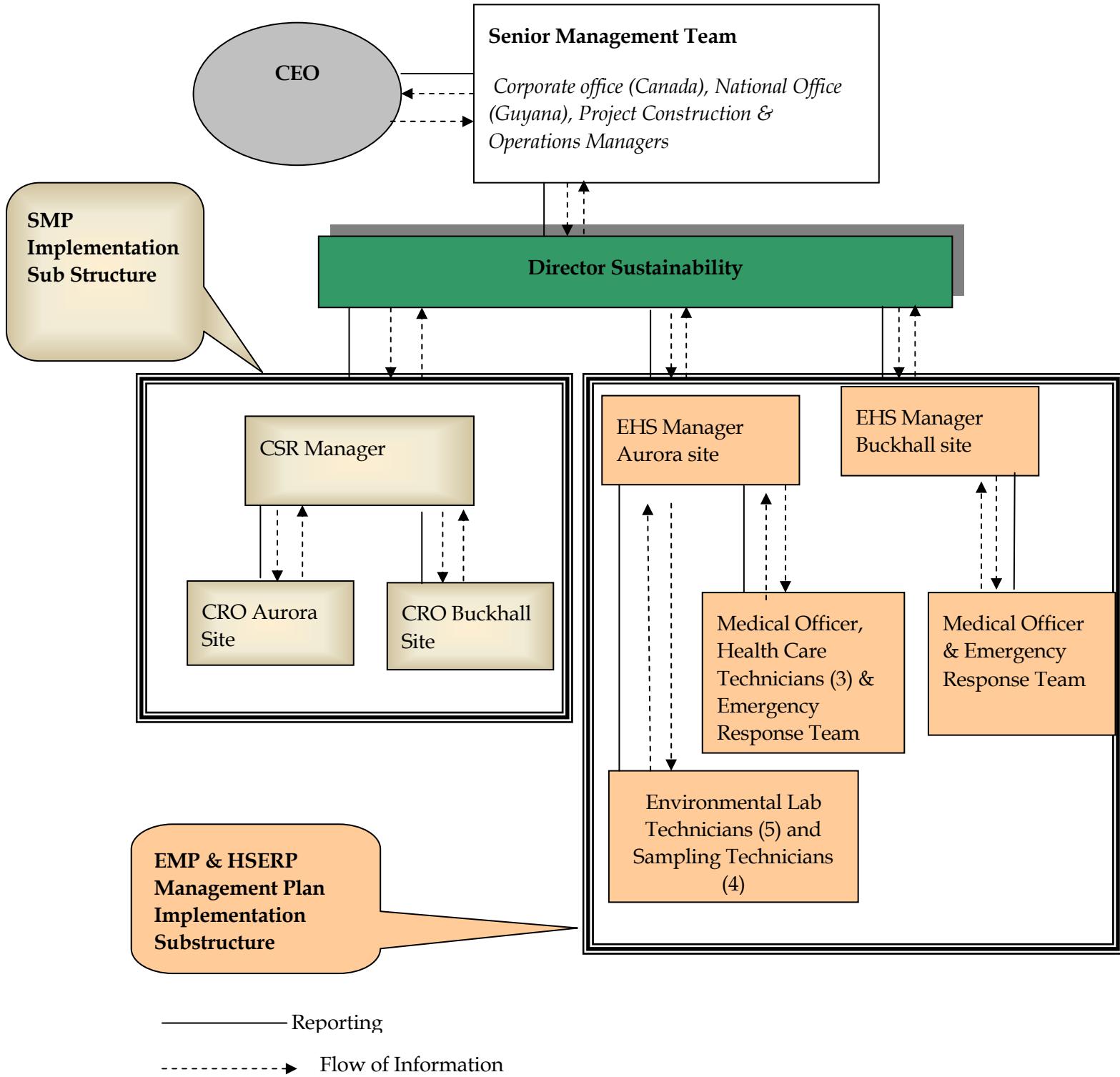
Hence organization, staffing, training and capacity building are urgent needs, critical for ensuring that the SEMP is correctly implemented and functional.

*Figure 9-2* depicts the organizational structure and personnel required for the implementation of the SEMP. The organization structure also depicts the specific sub-structures showing the divisions between social and environment teams that will manage and implement the SEMP.

The overall implementation will be done by placing environmental and community managers at both the Aurora and Buckhall sites. This will ensure adequate geographic coverage of the project components and also divide the tasks of implementation amongst qualified personnel.

The larger responsibility of the SEMP rests with the Director of Sustainability and the Senior Management team while the sub teams should perform the field functions. Guyana Goldfields needs to hire or place specialists who have experience in environmental and social issues and implementing management plans for each of these proposed positions in *Figure 9-2*.

Figure 9-2: Proposed Organization & Implementation Structure for the SEMP



### **9.2.1**      *Director Sustainability*

The Director of Sustainability will be responsible for implementation of the SEMP. The Director will manage and lead the Environment and Social/Community teams and ensure that the SEMP implementation occurs properly. The Corporate Social Responsibility (CSR) Manager responsible for social/community aspects of the SEMP and the Environmental Health & Safety (EHS) Managers will report directly to the Director.

The Director will also be the conduit of information and will report to the Senior Management team of Guyana Goldfields. The Senior Management team could include all senior staff in Georgetown, Corporate office at Canada and Project Managers and other staff as appropriate. The Director should regularly report to the Senior Management on the implementation issues of the SEMP, information on arising social & environmental issues and management of the SEMS. The Director should have powers to take organizational and resourcing decisions at the country level 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 SEMP will be the responsibility of the Director.

The Director will be responsible for compiling yearly reports on the status of the SEMP implementation and manage the internal monitoring activities. The Director should be responsive to the environmental and social issues arising (if any) should be proactive in identifying risks and managing these issues through the lifecycle of the Aurora project.

### **9.2.2**      *Corporate Social Responsibility (CSR) Manager*

The CSR Manager is the second level of management and will head the Community relations department. The CSR Manager will be the owner of the Social Management Plan presented in *Section 11* and responsible for its effective implementation. The CSR manager will be the head of the Community Relations/Social team. The CSR Manager should report to the Director Sustainability on all matters related to the Community Relations Team and the social aspects of the project. Further details of the roles and responsibilities and specific tasks of the CSR Manager have been presented in *Section 11, Social Management Plan*.

### **9.2.3**      *Community Relations Officer (CRO) Aurora Site*

There should be a dedicated CRO stationed in Aurora camp. The main responsibilities of this CRO is to implement, manage and report on stakeholder/community issues and perform the specific tasks of the SMP. The CRO will report to the CSR Manager and facilitate the flow of information from the

Aurora site to the senior management teams. The CRO will serve as the primary contact and face of the company to the local communities. The CRO will be responsible for maintaining relations with the communities that fall in the zone of the mine site particularly Aranka and Kurutuku and ASM camps. The CRO will be responsible for maintaining the Grievance Redressal mechanism specific to the Aurora site. Further details of the roles and responsibilities and specific tasks of the CRO stationed at the Aurora camp have been presented in *Section 11, Social Management Plan*.

#### **9.2.4 *Community Relations Officer (CRO) Buckhall Site***

There should be a dedicated CRO stationed in Buckhall camp. The main responsibilities of this CRO is to implement, manage and report on stakeholder/community issues and perform the specific tasks of the SMP. The CRO will report to the CSR Manager and facilitate the flow of information from the Buckhall site to the senior management teams. The CRO will serve as the primary contact and face of the company to the local communities. The CRO will be responsible for maintaining relations with the communities that fall in the zone of the port particularly Buckhall, Parika, Itaballi and Bartica. This CRO will be responsible for identifying and managing any community issues that may arise along the Barama and access roads. Further details of the roles and responsibilities and specific tasks of the CRO stationed at the Buckhall camp have been presented in *Section 11, Social Management Plan*.

#### **9.2.5 *Environmental, Health, and Safety Manager Aurora Site***

An Environmental, Health, and Safety (EHS) Manager shall be assigned to full-time onsite duty at the Aurora Site. In addition, his or her geographic area of responsibility will include the Access Road between the Cuyuni River and the Aurora Site. The EHS Manager will report directly to the Director of Sustainability and will have direct responsibility for EHS 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)*.

The Mines Manager will support the EHS Manager by providing additional expertise and resources on an as needed basis to satisfy operational, maintenance and emergency response needs. Guyana Goldfields will retain a qualified firm to provide support to the EHS 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 EPA and GGMC will review plans prepared by the operations to ensure that all concerns are appropriately addressed.

The Aurora EHS 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.

#### **9.2.6 *Environmental, Health, and Safety Manager Buckhall Site***

An Environmental, Health, and Safety (EHS) Manager shall be assigned to full-time onsite duty at Buckhall. In addition, his or her geographic area of responsibility will include the Access Road between the Cuyuni River and Buckhall. The EHS Manager will report directly to the Director of Sustainability and will have direct responsibility for EHS aspects of the construction and operations, including emergency response, and will be the primary authority for day-to-day enforcement of the EMP and HSERP.

The Buckhall Port Manager will support the EHS Manager by providing additional expertise and resources on an as needed basis to satisfy operational, maintenance and emergency response needs. Guyana Goldfields will retain a qualified firm to provide support to the EHS 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 EPA and GGMC will review plans prepared by the operations to ensure that all concerns are appropriately addressed.

The Buckhall EHS 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.

#### **9.2.7 *Environmental Staff***

The EHS Department will have 4 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 five individuals will be located on Aurora 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.

### 9.2.8 *Health, Safety, and Emergency Response Staff*

Medical Officers will be assigned to the Aurora and Buckhall and they will oversee the respective onsite health facilities that will be equipped to attend to the needs of site residents, workers, and visitors. At the Aurora Site, there will be three full time Health Care Technicians to attend to minor injuries and basic first aid. At each site, Emergency Response Teams 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. Either Emergency Response Team may be mobilized to attend to incidents along the Access Road, depending on the distance from the sites and the availability of the teams.

### 9.3 *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 society and the environment, 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. The monitoring plans described in this chapter encompass two distinct categories, environmental and operational. The environmental aspect is structured to monitor the physical, biological and socioeconomic changes in the environment, if any, and includes the mitigation measures. The operational monitoring will include those variables important for day-to-day operations such as processing

methods and camp facilities. Specific requirements for environmental monitoring are presented in *Section 10*.

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 legislative norms, 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. Guyana Goldfields 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 should also have a system of internal and external monitoring. The internal monitoring should be done in house by the Community Relations Team led by the CSR Manager. Quarterly monitoring should be done of the implementation of the SMP and of all community projects being funded by the company. External third party monitoring and/or audits should be facilitated by the company to ensure that the SMP and its activities are meeting indicators. All issues and corrective actions raised by third party audits should be implemented.

#### **9.4**            *REPORTING AND DISCLOSURE*

Guyana Goldfields senior management will receive periodic assessments of the effectiveness of the SEMP, based on systematic data collection and analysis resulting from the monitoring and auditing programs.

Guyana Goldfields will also report externally on the implementation, monitoring, and auditing of the SEMP. The SEMP, monitoring reports, and external auditing reports will be disclosed to any interested party requesting a copy. In addition, these will be posted on the Guyana Goldfields public website.

#### **9.5**            *CHANGE MANAGEMENT*

Guyana Goldfields recognizes that the Project design, specification, 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 are to be considered in the same manner as permanent changes.

The SEMP 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 SEMP and the need for modification in light of 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 SEMP.

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## 10.1

*SCOPE AND APPLICABILITY*

The Environmental Management Plan (EMP) provides recommendations and preliminary plans that should be further developed and implemented by Guyana Goldfields and their Contractors to achieve compliance with international best practice in environmental protection for gold mining projects.

Given that the Aurora Project ESIA and its SEMP were developed during the pre-feasibility phase of the Project, the present EMP presents only Preliminary Plans which serve as guidelines and models for development of final plans by Guyana Goldfields during the Feasibility and Final Design phases of Project development. In addition, it is anticipated that many of the mitigations and requirements present here should be incorporated as elements of final project design.

The Final EMP should be applicable to all phases of the Project, including construction, operations, and closure, and should include the following major sections:

- Environmental Management Requirements for Construction and Operations;
- Spill Prevention and Control;
- Cyanide Management Plan;
- Biodiversity Protection;
- Mine Reclamation and Closure; and
- Environmental Monitoring.

## 10.2

*CONTRACTOR RESPONSIBILITIES*

The Construction Contractor(s) should develop a detailed *Contractor Environmental Implementation Plan (CEIP)* to be submitted to Guyana Goldfields not less than 90 days prior to the start of construction. This plan should establish the organizational structure for ensuring proper management of all environmental issues which may arise during construction.

The Contractor is responsible for understanding the detailed requirements of all applicable Guyanese laws, regulations, and codes of practice and the IFC Performance Standards and EHS Guidelines. The *CEIP* should be designed to

meet these requirements in addition to those specified by the *Aurora Project SEMP*.

The *CEIP* should include at least the following content:

- Contractor Environmental Policy Statement;
- Contractor Environmental Management Organization;
- Contractor Environmental Training;
- Contractor Environmental Plans and Procedures; and
- Contractor Environmental Assurance.

The Contractor should adhere fully to the *Aurora Project Code of Conduct* and Guyana Goldfields reserves the right to dismiss Contractor personnel and management for violations of the *Code of Conduct*.

### 10.3

#### *FINAL AURORA PROJECT ENVIRONMENTAL MANAGEMENT PLAN*

Based on the recommendations of this document, Guyana Goldfields or a specialized environmental firm should develop a detailed *Aurora Project Environmental Management Plan (APEMP)* as the Project enters the Feasibility and Final Design stages of development. Not less than 60 days prior to the start of construction, Guyana Goldfields should submit the *APEMP* to the IFC, the EPA, and the GGMC in order to assure alignment of the Plan with these entities requirements and guidelines. The *APEMP* should reflect the final design of the Project and contain fully implementable procedures for managing the foreseeable environmental impacts of all phases of the Project, including construction, operation, and closure.

## 10.4 GENERAL ENVIRONMENTAL MANAGEMENT REQUIREMENTS FOR CONSTRUCTION AND OPERATION

### 10.4.1 *Scope and Applicability*

The requirements contained within this section are intended to provide minimum requirements for the Aurora Project's environmental performance and compliance with national and international best practice. The requirements should be operationalized and implemented through the *CEIP* and the *APEMP* to be developed by the Construction Contractor and Guyana Goldfields, respectively.

These requirements are applicable to the construction and operation of all Project components (i.e., the Mine, the Access Road, and the Port)

The requirements for reclamation and closure are presented in *Section 10.7* and the requirements for monitoring are presented in *Section 10.8*.

The Construction Contractor should develop implementation plans which detail the methods and procedures to be put in place to meet these requirements.

### 10.4.2 *Noise*

The Guyana National Bureau of Standards (GNBS), along with the EPA and other relevant agencies, has developed the draft standard on Noise Emissions into the Environment which is currently being finalized. This interim standard is applied to regulate noise emissions into the environment.

Good practice in the prevention and control of noise sources should be established based on the prevailing land use and the proximity of noise receptors such as communities or community use areas. Recommended management strategies include:

- Noise levels at the nearest sensitive receptor should meet the noise guidelines in the General EHS 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
- 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

The most significant vibrations are usually associated with blasting activities; however vibrations may also be generated by many types of equipment. Mines should minimize significant sources of vibration, such as through adequate design of crusher foundations.

For blasting-related emissions (e.g. vibration, airblast, overpressure, or fly rock), the following management practices are recommended:

- Mechanical ripping should be used, 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.

Noise emissions should be limited by appropriate soundproofing of individual pieces of equipment. Equipment exhaust systems should be fitted with mufflers. The electrical generators should be housed in a closed structure with acoustic insulation that should reduce external noise levels.

Additionally, all workers with potential chronic or acute noise exposures should be required to wear appropriate personal noise-protection gear.

#### **10.4.3**      *Atmospheric Emissions and Dust*

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

Recommended dust management strategies include:

- 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;
- Exposed soils and other erodible materials should be revegetated or covered promptly;
- New areas should be cleared and opened-up only when absolutely necessary;
- Surfaces should be re-vegetated or otherwise rendered non-dust forming when inactive;

- Storage for dusty materials should be enclosed or operated with efficient dust suppressing measures;
- Loading, transfer, and discharge of materials should take place with a minimum height of fall, and be shielded against the wind, and consider use of dust suppression spray systems ; and
- Conveyor systems for dusty materials should be covered and equipped with measures for cleaning return belts.

Water should be periodically sprinkled on roads, other conveying routes, stock piles and spoil piles to control dust emissions.

Other emissions to air should include NO<sub>x</sub>, CO, VOCs, SO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, and hazardous air pollutants (HAPs) from the operation of gasoline- and diesel-fired equipment. These emissions should be reduced to minimum levels by following the protocols of the manufacturer for equipment use and maintenance.

Recommended emissions reduction and control strategies for stationary power generation activities from sources with a capacity equal to or lower than 50 Megawatt thermal (MWth) and from mobile sources are addressed in the General EHS Guidelines.

General recommendations related to smelting and refining may be found in the EHS Guidelines for Base Metal Smelting and Refining. However, there are a few issues which are specific to the roasting and smelting of precious metals. Recommended management strategies include:

- Operations at controlled temperature (higher temperature roasters generally cause more problems of contaminant control); and
- Inclusion of an appropriate gas scrubbing system.

#### **10.4.4**      *Soils Management*

Soils should be protected from contamination and erosion during all Project activities. Soil erosion measures are detailed in *Section 10.5.5* below. At the same time, soil must not be allowed to become a contaminant itself by entrainment in runoff or wind.

Topsoil and organic matter should be separated from subsoils and should not be intermixed. Topsoil and organic matter should be stockpiled and protected from rainfall and sunlight. Stockpiled materials should be reutilized in progressive restoration works as soon as practicable to avoid losses of organic matter through oxidation. No topsoil should be removed from any area outside the mining limits unless approved by the EPA.

Soils in temporary work areas should be decompacted by means of disking, plowing, ripping, or other mechanical means.

Soils must be protected from contamination as detailed in the Spill Prevention and Control Plan to be finalized in accordance with *Section 10.7*. Any soil contamination should be remediated by in situ or ex situ means as appropriate.

#### **10.4.5**      *Erosion and Sediment Control Plan*

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

Site clearing operations should progress in a gradual and phased manner to ensure there are no large increases in sediment discharge. Sediment control structures should be used to prevent the inflow of sediment to surface water. These control practices should 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 should be installed as soon as possible. Adequate provision should be made for long-term maintenance of permanent erosion and sediment control structures and vegetation. Runoff from the stockpiled area should be controlled to prevent erosion and resultant sedimentation of receiving waters. Runoff should 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 should be disposed of in spoil stockpiles located in the vicinity of the mined out areas. All spoil stockpiles should be surrounded by a soil containment berm to prevent and/or minimize the runoff of surface water and sediment from stockpiles. Erosion and sediment control structures should be utilized to ensure that surface water runoff from these stockpiles meets the IFC/World Bank effluent discharge limits (e.g., TSS of 50 mg/L). The height and slope of each spoil stockpile should be such that foundation and slope failures do not occur.

Stormwater runoff and water from the mining operations should both be channeled to the water management pond, which should be designed to provide a detention time of 48 hours. Discharge from the water management pond should be via a spillway with a sediment control structure (i.e., matrix of stone, sand and grass) to remove sediment prior to discharge to surface water bodies in the site area.

Mining should 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 should be used to prevent the inflow of sediment to surface water. These control practices should include sediment traps or screens to control run-off and sedimentation. Surface runoff from maintenance workshops and other vehicle service areas should be channeled to an oil/water separator. All water from the oil/water separators should be skimmed prior to discharge. Discharges from the oil/water separators must meet effluent discharge limitations, as specified in Section 8.1.2.3.

Sumps should be excavated along the floor of the mine and all groundwater flow and precipitation should be channeled into the sumps. Engineered controls and measures, including berms, diversion channels, or other structures, should be implemented to prevent surface runoff from entering the open pit mine.

Installation of erosion control systems should be performed under favorable weather conditions and should be conducted prior to the start of the rainy season. When excessive moisture or other unsatisfactory conditions prevail, the installation should be stopped. Erosion control systems should not be installed in adverse weather conditions which could affect their performance. Erosion control should be accomplished by using one or more of the following:

- Erosion control blankets;
- Geotextile fabric; or
- Seeding.

Before placement of the erosion control blankets or geotextile fabrics, the subgrade should be graded smooth with no depressions, voids, and obstructions (such as tree roots, projecting stones or other foreign matter). No vehicles should be permitted directly on the blankets. Seeding should then be applied to the areas.

Erosion and sediment control procedures should be implemented during both the construction and operation phases of the mining project. Guyana Goldfields should be responsible for implementation during both phases. The costs incurred for implementation of these measures are part of the EMP. Since enforcement of these measures are part of the construction and

operation, the costs for their implementation is a part of the overall project cost and no additional specific costs should be incurred.

#### 10.4.6 *Mine Waste Stockpiles Management*

As part of the construction phase and mining operations, subsoil (e.g., alluvium and saprolite) and blasted waste rock should be removed from the mining areas and stored in three proposed mine waste stockpiles. The stockpiles slopes should be designed to meet the required minimum factor of safety under long-term and seismic loading conditions of 1.3 and 1.1, respectively.

The following actions should be taken in order to properly manage the mine waste stockpiles:

- The overburden is planned to be stockpiled in waste stockpile No. 1, located west of the open pit perimeter. Rock waste should be stockpiled in all of the three stockpiles. During stockpiling operations, all waste stockpiles should be watered periodically, as needed, to minimize dust emissions;
- The waste stockpiles should be engineered with appropriate geochemical, geotechnical, and hydraulic engineering specifications based on the nature of the overburden materials and waste rock and local geotechnical considerations to minimize environmental, erosion, and reduce safety risks. The stockpiles should be constructed with benches having a height of 22 m and a width of 15 m to achieve the design overall slope. The slopes of each bench are expected to be at an angle of repose approximately 1.4 H:1V;
- The waste stockpiles should be designed for long-term stability and to facility closure;
- To control water runoff and sedimentation each stockpile should have its own water management system. This should also provide flexibility for storage of waste rock with different geochemical properties, if judged necessary when detailed geochemistry results are available. As part of the on site water management plan, a diversion channel should be constructed south of the plant site area extending toward southeast. This south diversion channel should divide waste stockpiles No.2 and No. 3;
- Construction, waste blending, grade control, and survey procedures should be used to mitigate and monitor potential environmental effects. A comprehensive geochemical testing/ mapping and management program should be implemented to assess and manage potentially acid generating (PAG) materials, acid rock drainage (ARD), and metals leaching (ML);

- Mining operations should implement ore and waste geochemical characterization for proper routing of PAG materials and ARD management programs that include the following elements:
  - Conducting a comprehensive series of accelerated leaching tests to evaluate the potential for ARD in all formations foreseen 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.
  - 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:
  - Isolating PAG materials above the water table with an impermeable cover to limit infiltration and exposure to air.
  - Blending of PAG materials with non-PAG can to neutralize acid generation, as appropriate.
  - The operating and final surfaces of stockpiles should be graded to promote runoff;
- Stockpiles should be protected from runoff by upstream diversions;
- Drains should be constructed to convey runoff from stockpile surfaces to downstream sediment control structures in a controlled manner;
- Diversion ditches should be constructed around the base of stockpiles as required;
- Sediment traps or check dams should be constructed within stockpile diversion ditches. The total suspended solids (TSS) control measures should be provided for the runoff from the stockpiles. Project criteria for discharge of TSS is 50 mg/L;

- Erosion control BMPs should be implemented to protect side slopes from erosion;
- Stockpile toes should not encroach into watercourses;
- Drainage controls should be maintained as needed, and sediment capture structures should be cleaned regularly; and
- Stockpiles should be reclaimed and revegetated immediately upon completion of use.

#### **10.4.7 Access Roads Management**

In order to minimize the impacts of access road construction and maintenance on the environment, the following actions should be taken:

- Access roads should be regularly watered and vehicle speeds controlled to minimize dust emissions.
- Where the roadway crosses streams/creeks, timber bridges would be constructed where spans are in excess of 3 m. In those instances where the spans are less than 3 m, the stream crossing should be made using High Density Polyethylene (HDPE) culverts.
- During construction activities, all temporary construction tracks and laydown areas should be removed and rehabilitated when construction is completed.
- To properly manage stormwater discharges, the new access road should be drained by excavating several pits adjacent to the roadway at discrete intervals on the alignment. Runoff from the roadway should be channeled to these pits, and should include the following:
  - Adequate crown or slope to promote drainage to roadside ditches and pits.
  - Adequately sized roadside ditches, i.e. sized for the appropriate design storm event, adequately spaced relief culverts.
- Roadside ditches and discharge structures should be protected from erosion with rock lining, concrete or shotcrete, riprap, grouted rock lining, drop pools,
- Sediment control structures should be maintained and cleaned out regularly.
- Keeping access roads free of mud build up on sides and drains, and cleaning out sediment traps is important to the overall sediment management plan.
- Stormwater run-on that has not been impacted should be diverted away from/around roads.
- Roads should be constructed of non-acid generating materials.

- Regular maintenance of vegetation within the access road right-of-way should be implemented to avoid interference with vehicle travel and to control invasive plant species. Maintenance methods should include mechanical mowing and hand pruning.
- Stormwater ditches, culverts, and other water management structures should be maintained in proper function at times by removing sediments and other materials from these structures as needed.

#### 10.4.8 *General Water Management and Quality*

Management of water use and quality, in and around mine sites should be a significant element of the Project's overall environmental performance. Mining activities should include adequate monitoring and management of water use, in addition to treatment of effluent streams including stormwater run-off from the mine property. All mines should focus on appropriate management of their water balance.

Given the insufficient data and studies available during the Pre-Assessment phase when the ESIA was conducted to determine whether groundwater and surface water quality would be significantly adversely impacted by the Project, the EMP approach is to require best management practices that should, if properly designed, installed, and maintained, be protective of water resources.

Table 1 presents IFC effluent guideline values for the mining sector. guideline values for process effluents in this sector are indicative of good international industry practice as reflected in relevant standards of countries with recognized regulatory frameworks. These guidelines should be achievable under normal operating conditions in appropriately designed and operated facilities through the application of pollution prevention and control techniques.

*Table 1. IFC effluent guideline values for the mining sector.*

<b>Pollutant</b>	<b>Units</b>	<b>IFC Guideline Value</b>
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.		

Effluent guidelines should be applicable for site runoff and treated effluents to surface waters for general use. If discharged directly to surface waters, site-specific discharge levels may be established based on the receiving water use classification as described in the *IFC General EHS Guidelines*. 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. Deviation from these levels in consideration of specific, local project conditions should be justified in the environmental assessment.

Recommended practices for water management include the following:

- Establishing a water balance (including probable climatic events) for the mine and related process plant circuit and incorporate this data into the mine infrastructure design;
- Developing a Sustainable Water Supply Management Plan to minimize impact to natural systems by managing water use, avoiding depletion of aquifers, and minimizing impacts to water users;
- Minimizing the amount of make-up water;
- Consider reuse, recycling, and treatment of process water where feasible (e.g., return of supernatant from tailings pond to process plant);
- Consider the potential impact to the water balance prior to commencing any dewatering activities; and
- Consultation with key stakeholders (e.g., government, civil society, and potentially affected communities) to understand any conflicting water use demands and the communities' dependency on water resources and/or conservation requirements that may exist in the area.

Recommended practices to manage impacts to water quality include the following:

- The quality and quantity of mine effluent streams discharged to the environment, including stormwater, leach pad drainage, process effluents, and overall mine works drainage should be managed and treated to meet the applicable IFC EHS effluent discharge guideline values for the mining sector.

- In addition, discharges to surface water should not result in contaminant concentrations in excess of local ambient water quality criteria outside a scientifically established mixing zone. Receiving water-body use and assimilative capacity, including the impact of other sources of discharges to the receiving water, should be considered with respect to acceptable contaminant loadings and effluent discharge quality as described in the General EHS Guidelines;
- Efficient oil and grease traps, oil-water separators, or sumps should be installed and maintained at refueling facilities, workshops, fuel storage depots, and containment areas, and spill kits should be available along with an emergency response plan and a Spill Prevention and Control Plan (SPCP);
- Water quality in open storage systems (e.g., leachate areas, solution ponds, and tailings ponds or impoundments) should be based on the results of a site-specific risk assessment with appropriate control measures to mitigate the risk or meet the IFC EHS effluent guideline values for the mining sector; and,
- Sanitary wastewater should be managed via reuse or routing into septic or surface treatment as described in the IFC General EHS Guidelines.

All contaminated water should be directed to the water management pond for treatment prior to discharge to off-site surface water receptors. Process wastewater should be channeled to the tailings pond. All water retention facilities should be provided with adequate capacity to contain the design rainfall event and to eliminate the likelihood and reduce the frequency of spills that may impact downstream waters and groundwater quality.

The Mining Regulations require that information in relation to the disposal of effluent should be provided by the applicant to the GGMC on the following: the site of the disposal, the amount of the disposal and the possible effects on the environment.

As required by the GGMC, all channels discharging from settling ponds used as part of the mine drainage system will be culverted and the slopes of the culverts should be protected from erosion. The GGMC also requires the removal of settleable solids in tailings discharges using approved devices, chemical procedures or settling/clarification ponds. Ponds are required to 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 during any continuous two hour period. Discharges from the ponds must meet effluent discharge limitations, as specified in Section 8.1.2.3.

The disposal 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 should be prohibited. Surface runoff from the workshop and other

vehicle service areas should be channeled to oil/water separators, where the water should be skimmed prior to discharge. Discharges from these oil/water separators should be monitored to ensure that the effluent from the oil/water separators meet effluent discharge limitations, as specified in Section 8.1.2.3.

No direct discharge to surface water should be permitted from any of the ponds that constitute a part of the process circuit. Seepage controls should also be provided in the TMA design to maintain embankment stability, decrease water losses, and maintain water quality at the site. Drains should be provided for seepage collection and all seepage collected in these drains should be pumped back into the process stream.

Precipitation data, topographic maps and stream flow measurements should be used during the design of the ponds to prepare hydrographs and frequency curves for use in estimating volumes of precipitation. Precipitation data from wet and dry years should be used to provide minimum, average, and maximum precipitation rates and volumes to determine storage capacities for the ponds. Surface runoff from other areas of the site should be channeled away from the tailings pond.

The mine should be developed to ensure minimum disturbance to streams and creeks in the area. However, the construction of open pits, the water management pond, and the TMA should likely eliminate flow in some streams/creeks. In instances where this cannot be avoided, the stream or creeks should be diverted to ensure flow to downstream sections. Information on the size, flow volumes, and level of dependence must be provided to the local regulatory agency for approval of any stream/creek diversions.

#### **10.4.9 Stormwater**

Key issues associated with management of stormwater include separation of contaminated and uncontaminated water, minimizing run-off, avoiding erosion of exposed ground surfaces, avoiding sedimentation of drainage systems, and minimizing exposure of polluted areas to stormwater. Recommended stormwater management strategies have been broadly categorized into phases of operation (although several measures span more than one phase including the decommissioning and closure phase).

From exploration onwards, stormwater management strategies include:

- Reducing exposure of sediment-generating materials to wind or water through proper stockpiling of saprolite and waste rock;
- Divert run-off from undisturbed areas around disturbed areas including areas that have been graded, seeded, or planted. Drainage from these areas should be treated for sediment removal;

- Reducing or preventing off-site sediment transport (e.g., use of settlement ponds, silt fences, and other erosion and sediment control measures);
- Stormwater drains, ditches, and stream channels should be protected against erosion through a combination of adequate design and construction, including the use of rip-rap and lining to minimize erosion;
- Temporary drainage installations should be designed, constructed, and maintained for recurrence periods of at least a 25-year/24-hour event, while permanent drainage installations should be designed for a 100-year/24-hour recurrence period; and
- Design requirements for temporary drainage structures should be developed using a risk-based approach considering the intended life of diversion structures, as well as the recurrence interval of any structures that drain into them.

From construction onwards, recommended stormwater management strategies include:

- Establishing riparian zones;
- Timely implementation of an appropriate combination of contouring techniques, terracing, slope reduction/minimization, and appropriate drainage installations to reduce erosion in both active and inactive areas;
- Access and haul roads should have gradients or surface treatment to limit erosion, and road drainage systems should be provided;
- Facilities should be designed for the full hydraulic load, including contributions from upstream catchments and non-mined areas;
- Stormwater settling facilities should be designed and maintained according to internationally accepted good engineering practices, including provisions for capturing of debris and floating matter;
- Sediment control facilities should be designed and operated to ensure that discharges are below the IFC/World Bank guideline values (e.g., 50 mg/L for TSS) for the mining sector taking into consideration background conditions and opportunities for overall improvement of the receiving water body quality, as discussed in the IFC General EHS Guidelines; and
- Discharge water quality should also be consistent with the receiving water body use.

From operations onwards, recommended stormwater management strategies include:

- Final grading of disturbed areas, including preparation of overburden before application of the final layers of top soil, in a safe and practical manner; and
- Revegetation of disturbed areas should be performed immediately following application of the top soil to avoid erosion.

Total suspended solids in stormwater discharges must not exceed 50 mg/L or 50 NTU. No discharges should be made to a water body with greater than 30 NTU.

All storm water runoff should be channeled to the water management pond. Discharge from the water management pond should be via a spillway and should be channeled through a sediment control structure to remove sediment prior to discharge to surface water bodies in the site area. Discharges from the water management pond must meet effluent discharge limitations, as specified in *Section 10.5.8.1*.

#### **10.4.10**      *Catchment Area Management*

The concession should be managed to minimize potential impacts to the watershed. The objective of the catchment management plan should be to maintain the pre-project hydrological runoff characteristics of the watershed to the extent reasonably possible. 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 should also ensure that water quality and security of water supply is provided to transient people who use the waters of the Cuyuni River.

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

Guyana Goldfields should provide the EPA and GFC with information on logging operations within the project area. The responsible national statutory authority should ensure that a formal Environmental Impact Assessment is conducted where any new forestry exploitation project is proposed. If the company determines that uncontrolled logging is occurring in the area covered by this ESIA report, both the EPA and GFC should be informed. If timber concessions are granted by the responsible national statutory authority, the developer should review the draft ESIA report prepared for logging in the area to ensure implementation of the following during the life of these operations:

- Appropriate use and choice of cutting implements and machinery;
- Selective felling;
- Establishment of buffer areas around the mine;
- Road construction in accordance with sustainable practices;
- Closure of roads after completion of logging activities; and,
- Regular monitoring of the logging areas to ensure no encroachment.

Guyana Goldfields should report to the EPA instances of clearing for small scale agricultural operations along access routes and within forested areas that could prove detrimental to the environment if left uncontrolled. The developer should implement methods to curb or mitigate these problems, in consultation with the responsible national statutory authority.

Since Guyana Goldfields has no legal authority, the responsible national statutory authority should be required to establish clear demarcation between the areas of different land-use potential and promote awareness of the consequences of encroachment within areas identified for specific land use. The responsible national statutory authority should also provide training on environmentally-friendly methods of agriculture such as selective clearing (in lieu of slash and burn methods), terracing, mulching, crop rotation or strip cropping. The authority should also provide guidance on adopting proper land tenure procedures. The responsible national statutory authority should further be required to ensure that any type of land development meets all relevant legal requirements and be in accordance with any land use plan prepared by the local authorities.

In those instances where Guyana Goldfields has legal authority, travel along access roads by the public should be controlled. Where this is not the case, the developer should report levels of use and incidents of encroachment to the responsible national statutory authority,

The management of the concession to minimize impacts to the watershed is an ongoing process which commenced prior to exploration activities. These activities should continue throughout the construction, operation and closure phases. Guyana Goldfields should be responsible for implementation of the measures outlined above. Since enforcement of these measures is part of the operation, the costs for their implementation are a part of the overall project cost and no additional specific costs should be incurred.

#### **10.4.11**      *Acid Rock Drainage (ARD), Potentially Acid Generating (PAG) materials, and Metals Leaching (ML)*

Management of PAG, ARD and ML should extend for as long as there is a need to maintain water quality to the levels required to protect the local environment, including into the post-closure phase of the mine if necessary.

#### **10.4.12**      *Groundwater Protection*

In addition to the prevention and control of effluents, wastes, and potential releases of hazardous materials, additional recommendations for the management of potential sources of groundwater contamination include the following:

- Infiltration of toxic solutions should be prevented through the provision of appropriate liners and sub- drainage systems to collect or recycle solution for treatment, and minimize ground infiltration;
- Pipeline systems carrying pregnant solutions should be designed with secondary banded containment;
- Leak detection equipment should be installed for pipeline and plant systems with appropriate leak response systems in place; and
- Process solution storage ponds and other impoundments designed to hold non-fresh water or non-treated process effluents should be lined, and be equipped with sufficient wells to enable monitoring of water levels and quality.

#### **10.4.13**      *Domestic and Industrial Wastewater Treatment and Dispersal*

The Mining Regulations stipulate that any area of water containing poisonous or injurious chemical solutions used in the treatment of gold must be fenced in any effective form to prevent inadvertent access thereto, and notice boards should be erected in suitable places warning persons from making use of such water and in no case should 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.

The design of the onsite sewage treatment facilities should be in compliance with the applicable requirements of the 2008 Guyanese septic tank standards.

Although not specific to mining, the GNBS and EPA have jointly developed interim industrial effluent standard which should be met by the Project.

#### **10.4.14**      *Open Pit Management*

In order to prevent slope failure and threats to workers health and safety, open pit mine walls should be designed based on the results of detailed geotechnical and geohydrological investigation with slopes to preclude slopes failures and slides. Excavated materials should not be stored at the crest of slopes. Ramps into the mine pit and roads within the pit should be wide enough to allow for the passage of two vehicles with slopes generally acceptable for the operation of those vehicles.

To avoid discharge of contaminated water through the floor of the mine, equipment should not generally be serviced in the mine pit. Vehicle and equipment servicing should be restricted to emergency repairs only. In the event of emergency repairs, work should be undertaken to ensure there are no oil and/or fuel spills in the pit.

Sumps should be excavated in mined out areas on the floor of the mine and all groundwater flow and precipitation should be channeled into the sumps. Pumps should be provided for mine dewatering based on the results of the hydrological analyses undertaken for the project. Berms should be maintained at the edge of open mine pits to prevent surface runoff from entering the open pit and from adding to the volume of groundwater inflow and direct precipitation.

The geotechnical and hydrogeological investigation and design of the mines pits should be undertaken by AMEC during the project design phase. Guyana Goldfields should be responsible for implementation of the measures to preclude groundwater contamination and flooding of the mine pit. These measures should be enacted immediately upon commencement of stripping operations for the mines and for the duration of the mining operation. The costs for implementation of these measures are included in the project costs.

#### **10.4.15**      *Waste Rock*

Large quantities of overburden or waste rock should need to be removed to expose the mineral to be mined. The overburden and waste rock should be disposed of in constructed waste rock dumps. Management of these dumps during the mine life cycle is important to protect human health, safety and the environment. Recommendations for management of waste rock dumps include the following:

- Dumps should be planned with appropriate terrace and lift height specifications based on the nature of the material and local geotechnical considerations to minimize erosion and reduce safety risks;

- Management of Potentially Acid Generating (PAG) wastes should be undertaken as described in the guidance below; and
- Potential change of geotechnical properties in dumps due to chemical or biologically catalyzed weathering should be considered. This can reduce the dumped spoils significantly in grain size and mineralogy, resulting in high ratios of clay fraction and a significantly decreased stability towards geotechnical failure. These changes in geotechnical properties (notably cohesion, internal angle of friction) apply especially to facilities which are not decommissioned with a proper cover system, which should prevent precipitation from percolating into the dump's body. Design of new facilities has to provide for such potential deterioration of geotechnical properties with higher factors of safety. Stability / safety assessments of existing facilities should take these potential changes into account.

Improper management of overburden spoils could increase sediment discharge to surface water and result in acid mine drainage after closure.

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

#### **10.4.16** *Tailings Management Guidelines and Recommendations*

An internationally recognized expert firm with extensive experience and a positive track record in tailings management should undertake the geotechnical investigation and design the tailing and water management ponds prior to the commencement of construction activities at the site. In addition, an internationally recognized expert firm should provide quality control/quality assurance (QA/QC) services to Guyana Goldfields during the construction phase and supervise the installation of embankment and foundation monitoring instrumentation.

Guyana Goldfields should develop a site-specific Tailings Management Plan as part of the final design phase of the Aurora Project. The tailings management strategies should consider how tailings should be handled and disposed of during operation, in addition to permanent storage after

decommissioning. Strategies must 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).

In particular, the Tailing Management Plan (TMP) development should 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 should include a synthesis of these lessons and the steps to be taken to avoid these weaknesses of the Omai management system.

The TMP should 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 should include an Operating Manual and Contingency Plan, both written in clear and concise language.

Recommended tailings management strategies 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 should 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 should 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 should 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 should thus 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 should be built to the flood event recurrence interval standards outlined elsewhere in this Section;
- Seepage management and related stability analysis should 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 should 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 should 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 should 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 should be designed, constructed and operated according to internationally recognized geotechnical safety standards;
- Thickening or formation of paste for backfilling of pits and underground workings during mine progression; and
- Riverine (e.g. rivers, lakes, and lagoons) disposal is not considered good international industry practice and should not be considered by the Project.

In order to reduce the use of the TMA by wildlife, the following criteria should be applied (after Donato *et al.*, 2007):

- Reduce supernatant area;
- Thicken tailings to prevent supernatant formation;
- Screen decant ponds;
- Line dam walls with steep-sloping high-density polyethylene;
- 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 should be designed for the critical rainfall event. The top of the TMA should be situated above surrounding ground level to prohibit runoff

from the surrounding area from entering the pond. The TMA should be provided with a minimum operating freeboard of 3 m which should allow for adequate containment of precipitation associated with the design rainfall event.

The Mining Regulations stipulate that any area of water containing poisonous or injurious chemical solutions used in the treatment of gold must be fenced in any effective form to prevent inadvertent access thereto, and notice boards should be erected in suitable places warning persons from making use of such water and in no case should 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.

The Mining Regulations mandate operators of land operations 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 a dredges into any river or creek should 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 should 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) readings in the grab sample of the discharge and such readings of the daily record should be approximately twenty four hours after the previous reading.

Under the Mining Regulations, approved devices, chemical procedures or ponds are required to be used to remove settleable solids from tailings discharges from on-land mines and every settling pond is required to 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.

#### **10.4.17** *Tailings Dams Safety Design and Review*

The World Bank OP 4.37 – Safety of Dams requirements for design and review should be applied to the design, construction, operation, instrumentation and

monitoring of all dams constructed in the Project, including the tailings dams. In addition, the initial design of the tailings dam and other earth structures should be submitted to the EPA for review. The final design of the tailings pond and cyanide destruction ponds should be submitted to both GGMC and the EPA for approval of these structures prior to project start up and the use of these facilities.

The tailings ponds should be designed to ensure stability of its embankment. Stability analysis should 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 should 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 flow through porous media and is used to show 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 should consider the following failure modes:

- rotational slide;
- overtopping;
- foundation failure;
- erosion;
- piping; and
- liquefaction.

Data for the analyses should be generated by conducting a detailed geotechnical investigation in the area proposed for siting of the tailings pond and on materials identified for use as fill for tailings pond construction. Soil samples should be recovered during a field investigation and should be tested to determine the soils' index, hydraulic conductivity, strength, and deformation parameters. If bedrock is encountered in the tailings pond area, the rock quality should be determined and the fracture pattern should be analyzed to assess the likelihood of migration from the tailings pond to the underlying rock.

The Mining Regulations require that tailings dam or water retaining dams higher than 16 feet or six meters 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 inspection are required to be kept on file and be available for review by inspectors of the Commission and every tailings pond should be equipped with emergency spillways that pass the flows from the probable maximum flood so as to prevent overtopping of dams under extreme rainfall or runoff rainfall.

#### 10.4.18

#### *Non-Hazardous Solid Waste*

Non-hazardous solid wastes such as household and non-process related industrial waste should be managed according to the recommendations presented in the IFC General EHS Guidelines.

Non-hazardous solid waste should be collected for recycling or disposal at an approved sanitary landfill. External landfills should be audited by the mine to ensure appropriate waste management practices. If such a facility is not available within a feasible distance, the mine should establish and operate its own with appropriate regulatory permits and scientifically defensible studies that can demonstrate that the disposal of the hazardous waste should not impact human health and the environment.

No other solid wastes or liquid wastes should be mixed or disposed of together with waste rock or overburden.

The following waste will be generated by the project:

- overburden during mining;
- tailings from the processing operation;
- solid waste, including food waste from the camp operations; and
- septic waste from the camp operations.

Overburden should be placed in spoil piles in the mined out area. All tailings and other process waste should be placed in the tailings pond. The coarse fraction of the tailing waste, recovered from the gravity circuit, may be used as hard capping for access roads only when laboratory analyses have been performed to demonstrate it to be innocuous to the environment.

Solid waste from the operation of the camp should be disposed of in secure areas designed in accordance with guidelines provided by the Guyana EPA.

All food waste and organic matter should be composted and the composted material should be used as fertilizer for revegetation of the spoil piles after closure. Food waste should be stored such as not to attract vermin or generate odors that affect work or residential areas.

Septic waste should be managed by a series of septic tanks on site. Discharge from the septic tanks should be channeled through a granular filter bed prior to discharge. Septic tanks contents should be emptied as dictated by capacity constraints, by a licensed operator and should be trucked to Georgetown for disposal in accordance with EPA guidelines.

The non-hazardous solid wastes management procedure should be implemented at the start of construction and throughout the duration of mining operations until final site closure has been achieved. Guyana

Goldfields should be responsible for implementation. The costs for waste management are included in the project costs.

#### 10.4.19 *Mine Waste Geochemical Characterization*

Mining operations should prepare and implement ore and waste geochemical characterization methods for proper routing of Potentially-Acid-Generating (PAG) materials and 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 foreseen 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. Covers are typically less of a concern in arid climates where there is limited precipitation, and should be appropriate for local climate and vegetation (if any); and
  - Blending of PAG materials with non-PAG or alkaline materials can also be employed to neutralize acid generation, as appropriate. Blending should 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.

#### **10.4.20**      *General Requirements for Hazardous Materials*

The Mining Regulations require that all poisonous substances used in any mining or milling process are to be kept in a separate compartment specially set aside for the storage of such poisonous substances with the compartment being locked and in the care of a person duly authorized by the manager and no person is authorized to remove from a claim or mine any poisonous substances without having obtained the written permission of the manager. Further all holders of licenses and permits as granted under the Mining Act, are required to adhere to the provisions of the current Code of Practice on Use and Handling of Poisonous Chemicals as published jointly by the GGMC and Environmental Protection Agency.

The Mining Regulations further stipulate that any area of water containing poisonous or injurious chemical solutions used in the treatment of gold must be fenced in any effective form to prevent inadvertent access thereto, and notice boards should be erected in suitable places warning persons from making use of such water and in no case should 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.

Hazardous materials should be handled, stored, and transported so as to avoid leaks, spills or other types of accidental releases into soils, surface water, and groundwater resources. Hazardous materials management, including spill prevention and control planning for the handling, storage, and transport of such materials as fuels and chemicals, should generally follow the recommendations of the IFC General EHS Guidelines.

In order to minimize the risk associated with accidental spills from storage tanks and pipelines (e.g. tailings pipelines), mitigation measures should include providing secondary containment to restrict movement into receiving water bodies (e.g. sumps, holding areas, impermeable liners), for example, constructing pipelines with double-walled or thick-walled sections at critical locations (e.g. large stream crossings) and installing shutoff valves to minimize spill volumes and to isolate flow in critical areas

Hazardous materials at the mine site are expected to include cyanide, tailings with various percentages of cyanide, waste oils and grease from workshop operations and from vehicles.

Hazardous materials should be located in secure storage facilities on-site to prevent accidental release and protect against rainfall that may result in

contaminated run-off and leaching. All storage areas for hazardous material should be concreted to provide an impervious surface and to prevent uncontrolled discharges to groundwater.

Material Safety Data Sheets (MSDS) should be kept on site and all measures to contain spills of hazardous materials should be in accordance with the procedures therein.

No rainfall should be allowed to percolate through areas where hazardous materials are stored and no uncontrolled run-off should be permitted from these areas. Stormwater from areas around storage facilities should be channeled to the water management pond.

Incompatible substances that can react upon mixing to generate heat, fire, gas, explosion, or violent polymerization should not be located within proximity of each other.

Hazardous materials facilities should be constructed before the commencement of shipment of these materials to the mine. Guyana Goldfields should be responsible for constructing the impervious bases and containment facilities for hazardous materials and for managing the facilities. The costs for design and construction are included in the project costs.

#### **10.4.21 Hazardous Wastes**

Hazardous wastes should be disposed of in accordance with guidelines established by the Guyana EPA. Cyanide and cyanide waste should be managed in accordance with the Cyanide Management Plan detailed below.

The Mining Regulations require that all hazardous waste earmarked for disposal whether recovered from prior workings or from the current operations should be sealed in barrels which are made of or lined with plastic, marked and sealed and conveyed to an area set aside or facility set up for the disposal of hazardous waste. The accumulated waste should be brought to the GGMC Commissioner's attention for treatment as appropriate and where facilities for disposal are not available, a miner should burn all waste products including batteries using fuel such as kerosene or similar substances of high flash point in an area set aside for such purposes or, where appropriate should use the said waste products.

Recommended practices for the management of hazardous waste include the following:

- Hazardous waste, including waste oils and chemicals, spent packaging materials and containers, should be managed as described in the IFC General EHS Guidelines;

- Hazardous waste should be handled by specialized providers (in accordance with regulatory permits) of hazardous waste management facilities specifically designed and operated for this purpose. When such services are unavailable within a feasible distance of the mine, the mine should establish and operate its own waste facility with the necessary permits; and
- Combustion of waste oils should preferably be undertaken as a supplementary fuel in power generation facilities and in accordance with emissions guidelines applicable to combustion sources (see the IFC General EHS Guidelines and the IFC EHS Guidelines for Thermal Power).

The management of wastes containing cyanide is addressed by the Cyanide Management Plan.

#### **10.4.22** *Fuel and Waste Oil Management*

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

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

Implementation of these measures should be coincident with the commencement of construction activities and should extend through to the project closure phase. Guyana Goldfields should be responsible for its implementation and the costs for implementation are part of the project costs.

#### **10.4.23** *Energy Use*

In accordance with IFC EHS Guidelines, the Project should seek to minimize energy use and consider the application of energy conservation measures whenever possible, such as:

- Use of non-invasive technologies such as remote sensing and ground-based technologies to minimize exploratory digging and drilling; and
- Correctly sizing motors and pumps used in the excavation, ore moving, ore crushing, and ore handling process, as well as using adjustable speed drives (ASDs) in applications with highly varying load requirements.

#### **10.4.24**      *Visual Impacts*

Mining operations should prevent and minimize negative visual impacts through consultation with local communities about potential post-closure land use, incorporating visual impact assessment into the mine reclamation process.

Reclaimed lands should, to the extent feasible, conform to the visual aspects of the surrounding landscape. The reclamation design and procedures should take into consideration the proximity to public viewpoints and the visual impact within the context of the viewing distance.

Mitigation measures may include strategic placement of screening materials including trees and use of appropriate plant species in the reclamation phase as well as modification in the placement of ancillary facilities and access roads.

### **10.5**              *CYANIDE MANAGEMENT REQUIREMENTS*

#### **10.5.1**            *Cyanide Management Plan Development*

Guyana Goldfields should develop a specific *Aurora Project Cyanide Management Plan* based on final Project design to operationalize and implement the requirements of Guyanese legislation, the International Cyanide Code, and other applicable best practice. This plan should clearly document the lessons learned from an examination of the Omai Mines experience. This plan should also include an executive summary in plain language that can be understood by stakeholders with basic literacy levels.

#### **10.5.2**            *Authorizations and Registers*

Before commencing any use of cyanide, Guyana Goldfields must apply to the GGMC for a cyanide permit, providing a description in summary of the activities in respect of which cyanide is to be used including information on:

- the site, design or process and amount of cyanide to be used; site characteristics and layout; distance to water bodies; ground water regime and mode of tailings disposal;
- possible effects on the environment;

- a simplified description of the activity; and
- activities for minimizing the use of cyanide in the long-term.

According to the Mining Regulations, the owner or manager of any claim or mine, in which cyanide or any preparation containing cyanide or any other poisonous substance is used for any purpose is mandated to enter or cause to be entered in a register to be kept for that purpose, the quantities of cyanide and other poisonous substances received and issued. The record of each poisonous substance should be kept separately and should show the date of receipt, the date of issue, quantities received or issued and the balance of stock on hand, and the signature of the receiver or issuer, as the case may be. The owner or manager of any claim or mine should have the said register available at all times for inspection by a mines officer.

Guyana Goldfields should regularly provide the GGMC with updated information related to cyanide permits issued, including:

- the name of the person to whom the cyanide permit is granted;
- the date that the permit was granted, expiration and renewal dates;
- the date and reason for revocation and suspension of the license or permit and in respect of suspension the period thereof;
- the number of the license or permit; and
- the amount of cyanide purchased; and any relevant remarks

Guyana Goldfields should make its information on cyanide open for inspection by the public at their Georgetown office during office hours, free of charge.

### 10.5.3 *General Best Practice for Cyanide*

The transportation, storage, use and disposal of cyanide at the mine can be hazardous both to human health and the environment. Cyanide use should be consistent with the principles and standards of practice of the International Cyanide Management Code. The Cyanide Code includes principles and standards applicable to several aspects of cyanide use including its purchase (sourcing), transport, handling / storage, use, facilities decommissioning, worker safety, emergency response, training, and public consultation and disclosure. The Code is a voluntary industry program developed through a multi-stakeholder dialogue under the auspices of the United Nations Environment Programme and administered by the International Cyanide Management Institute.

Best Management Practice (BMP) techniques should be adopted to minimize the risk of environmental damage from accidental cyanide release. The main goals of the BMP should be to:

- Minimize the amounts of cyanide required for gold recovery;
- monitor all operations, discharges and the environment to detect any escape of cyanide and subsequent impacts of that release;
- ensure a full understanding of the actual and potential hazards and environmental impacts of cyanide use;
- maximize the recovery of cyanide or to ensure its destruction;
- construct physical containment facilities to control spills or leaks of cyanide;
- to dispose of cyanide in a way that minimizes environmental impacts; and
- to keep adequate records of cyanide use.

Clear responsibility should be established for all phases of cyanide use, including transportation, storage, use and disposal. Cyanide levels in the tailings should be reduced by passage through an agitated cyanide destruction tank. In this tank the residual cyanide content should be reduced below permissible levels through oxidation, using SO<sub>2</sub>-air process.

The Mining Regulations also specify the following requirements for use of cyanide:

- All vessels or plants used for the cyanide process should be fitted with mechanical agitators and hoods or other appliances of such a nature that the fumes generated in such vessels should be carried directly to the external air at a distance approved by the GGMC;
- Cyanide facilities should be located downwind or in any other wind of all residences so that such residences are not unduly disturbed;
- An adequate supply of wholesome drinking water is to be provided in each premises or place where cyanide or any preparation containing cyanide is used, and this supply should be distinctly labeled Drinking Water; and
- Cyanide used in any mining or milling process is required to be kept in a separate compartment specially set aside for the storage of cyanide with the compartment being locked and in the care of a person duly authorized by the manager and no person is authorized to remove from a claim or mine any cyanide without having obtained the written permission of the manager.

#### **10.5.4 Cyanide Transport**

The transport of cyanide should be performed to ensure protection of all

communities and the environment during transport. Clear lines of responsibility should 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 should identify personnel responsible for each aspect of cyanide transport. The transport aspects should 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; and
- emergency response during transport.

The Emergency Response Plan (*Section 12.7*) should address spill response scenario during transport to the site. All personnel involved in cyanide transport should be trained prior to the commencement of operations and should also be given periodic refresher training in the use of the equipment and in the implementation of the Emergency Response Plan.

Warning signs should be posted on all transport equipment alerting workers of the presence of cyanide and that smoking, open flames, eating and drinking are prohibited. In addition, workers should be required to wear cyanide-specific personal protective equipment. Security measures, such as lockouts on valves and fenced and locked storage of solids, should be provided at all transshipment points and at interim storage sites.

Storage of both solid and liquid cyanide should be separate from incompatible materials such as acids, strong oxidizers and explosives. All contact with low- and neutral-pH water should be prevented during shipping. Storage facilities should have spill containment capacity at least equal to 120% of the capacity of the storage area and personal protective equipment and clean-up materials appropriate for the type and amount of cyanide stored should 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, should be identified and evaluated to determine the need for special precautions in these areas. Communities in the area should be consulted and all applicable governmental/EPA transportation related and emergency response procedures should be considered to prevent and respond to any releases during cyanide transport.

The company road safety program for all cyanide transport vehicles should include, but 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 should retain records to document that these activities have been conducted. The company should also implement inventory and/or chain of custody documentation procedures to identify the loss of any cyanide material during transport.

All transport vehicles should be provided with emergency communications capability to ensure timely communication. Any spills/releases should be immediately reported to the Mines Manager who should immediately inform all potentially impacted communities, relevant government agencies and the company's designated emergency response team.

### **10.5.5**      *Cyanide Handling and Storage*

The company should design and construct unloading, storage and mixing facilities consistent with sound and accepted engineering practice and should employ quality control/quality assurance procedures and spill prevention and containment measures to protect workers and the environment during cyanide handling and storage.

To the extent practicable, all unloading and storage areas for liquid and solid cyanide should 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 should be evaluated and the operation should implement protective measures to prevent or minimize these potentials. The protective measures should include automatic sensors and alarms for hydrogen cyanide gas, additional containment structures, and specific emergency procedures for evacuation and response.

Unloading of all cyanide should be done on a concrete surface that can prevent leaks from coming in contact with the environment. An automatic level indicator, high-level alarm, or integrated tank and tanker valve-shutdown device should be provided on all cyanide storage tanks to prevent overfilling. Direct observation of tank levels or use of a manual gauging rod should not be done to prevent overfilling of cyanide storage tanks.

Storage areas for cyanide should be well ventilated to prevent the build-up of hydrogen cyanide gas. Measures should be put in place to minimize the potential for contact of cyanide with water. These measures should include storage in covered enclosures and off the ground or in secure containers.

The public and workers not directly involved in cyanide operations should be prohibited from accessing cyanide storage areas by a fenced boundary or by storing cyanide within a separate fenced and locked area of the plant. Cyanide should be stored separately from incompatible materials such as acids, strong oxidizers and explosives with berms, bunds, walls or other barriers that

should prevent mixing.

Cyanide storage and mixing tanks should be located on a concrete surface to prevent seepage to the subsurface. Secondary containment should be employed to contain releases from these tanks as well as any precipitation that may come in contact with cyanide. The secondary containment should allow for recovery and return to the cyanidation process or proper disposal. Secondary containments used for this purpose should be constructed of concrete, plastic or other materials demonstrated to provide a competent barrier to leakage. All containments should be sized to hold 120 % of the volume of the largest tank within the containment and any piping that drains back into the containment.

Cyanide storage and mixing tanks and related pipeline should be constructed or coated with materials that are compatible with cyanide and high pH conditions. Tanks and pipelines should be clearly identified as containing cyanide. The direction of flow should also be indicated on pipelines. Cyanide-specific first aid and emergency response equipment should be readily available for use at unloading, storage and mixing locations, including high-pH water for decontamination of exposed workers, oxygen and a resuscitator and appropriate personal protective equipment. An antidote for cyanide poisoning should also be available. Workers involved with unloading, storage and mixing of cyanide should be trained in the use of emergency rescue equipment and in the first aid procedures for responding to cyanide exposures.

Spill neutralization and clean-up equipment should be available for use at unloading, storage and mixing locations. This should include water for cleaning spills of liquid cyanide, shovels for cleaning up spills of solid cyanide, and chemicals to treat or neutralize cyanide and cyanide-contaminated soils, as well as cyanide-specific personal protective equipment. Personnel engaged in unloading, storage and mixing activities should be trained in the operation's procedures to respond to cyanide spills, including notifications, clean up and detoxification.

Storage areas, pipelines, pumps, valves and tanks should be inspected regularly for evidence of leakage, presence of solution in secondary containments and integrity of the containment. Deficiencies should be noted and records should be retained documenting the inspection and the implementation of necessary corrective measures.

Empty cyanide containers should not be reused on or off the mine site for any purpose other than holding cyanide. Prior to their disposal or reuse, cyanide drums should be rinsed with high-pH water three times, and the rinse water should be added to the cyanidation process. The rinsed drum should then be crushed and placed in the onsite landfill. Plastic bags and liners should also be triple-rinsed prior to disposal. Wooden container should be burned or

disposed of in the spoil pile area.

### 10.5.6 *Cyanide-related Operations*

All cyanide related facilities should be inspected on an established frequency sufficient to assure and document that they are functioning within design parameters. Tanks holding process solutions should be inspected for structural integrity and signs of corrosion and leakage. Secondary containments should 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 leach pads and ponds should be inspected as required. Pipelines, pumps and valves should be inspected for deterioration and leakage. Ponds should be periodically inspected to ensure available freeboard and the integrity of embankment.

Facility inspections should be documented on inspection forms and in log books and should include the date of the inspection, the name of the inspector, and any observed deficiencies. The nature and date of corrective actions also should be documented.

Preventive maintenance programs should be implemented to assure the continuous functioning of equipment and devices that are necessary for cyanide management. Pumps, pipelines, and cyanide treatment, destruction and regeneration equipment should be regularly maintained so that failures do not result in worker exposure or releases to the environment. Preventive maintenance activities should be documented.

The operations should have a source of emergency power for pumps and other equipment when their primary power supply is interrupted to prevent unintentional cyanide releases and worker exposures. Back-up power generating equipment should be maintained and tested to ensure its availability if needed.

The operations should use bottle roll or another test procedure to determine the optimal rate of cyanide addition for the process. The rate of addition should be reevaluated and adjusted as necessary when changes in ore type or processing plant practices occur that effect cyanide requirements.

Unintentional releases should be prevented by maintaining adequate freeboard in tailings storage facilities. All facilities should be inspected and monitored to determine the accuracy of the water balance and to assure the facilities operates as designed. This should 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 such as leaching vessels, CIP/CIL tanks and

cyanide tanks associated with cyanide regeneration activities should be located on concrete to restrict seepage of spilled solution or leakage to the subsurface. Secondary containment should be provided for a potential failure of cyanide process solution tanks, with provisions for recovery of released solution such that adverse impacts on surface or ground water are prevented.

Spill prevention or containment measures should be provided for pipelines transporting process solution. These measures should include secondary containment ditches, differential pressure sensing with alarms and/or automatic shutoff systems, or preventive maintenance programs with pipe thickness measurements. Cyanide process tanks and pipelines should be constructed or coated with materials that are compatible with cyanide and high pH conditions. Tanks and pipelines should be clearly identified as containing cyanide. The direction of flow should be indicated on pipelines.

Facilities for the management of cyanide should be constructed according to accepted engineering standards and specifications. Quality control and quality assurance programs should 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 should 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 should also be implemented for installation of synthetic membrane liners used in ponds, for pipes, pipe fittings, for welds and bolts on cyanide storage and process tanks, and for any other equipment containing cyanide. Records should be retained to document that the specified quality control and quality assurance procedures have been followed.

Holding facilities and compounds should be designed and maintained to ensure the storage areas is adequately ventilated to disperse any build up of hydrogen cyanide gas to minimize the possibility of contact with water. In addition all storage areas should be bunded and should be located well away from natural drainage channels. Cyanide should be stored separately from corrosive, acidic and explosive materials. The storage area should be fence and locked to prevent accidental entry or access by unauthorized individuals. The storage area should also be designed to be fire resistant and should be provided with adequate fire fighting capability. In addition, all vegetation should be cleared from the storage area to decrease the likelihood of fires.

An inventory should be maintained of all quantities stored and any loss should be immediately reported to the mines manager and to GGMC.

The company should deploy a system to enable rapid determination of cyanide concentration in any waste water discharged from the site. One of the

following systems should be deployed:

- Cyanide Ion Specific Electrode;
- Canfield Cyanide Testing System; and
- Basic Color-Disc Field-Test Kits.

### 10.5.7 *Cyanide Emergency Procedures*

Emergency procedures for cyanide-related incidents are detailed in *Section 12.5.2*.

## 10.6 *SPILL PREVENTION AND CONTROL*

Guyana Goldfields should develop a *Spill Prevention and Control Plan (SPCP)* should become effective coincident with the commencement of construction activities at the mine. Emergency Response Coordinators should have authority to expend funds and recruit employees to implement the *SPCP*. The *SPCP* should address the following:

- Operating procedures to prevent oil spills;
- Control measures which should 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.

The *SPCP* should also set 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 *SPCP* Plan should be implemented for on-site, as well as off-site releases that could threaten human health and the environment. The Plan should deal 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 should be appended to the *SPCP*. The appended information should include contact list and phone numbers for the Emergency Response Coordinator(s), the EPA, cleanup contractors, and other appropriate national and local agencies who should be contacted in case of a discharge. The *SPCP* should also be expanded to include a prediction of the direction, rate of flow, and total quantity of fuel oil/cyanide/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 should be maintained at the mine and at Buckhall together with

device capable of summoning external assistance (telephone or two-way radio). Portable fire extinguishers, fire control equipment, spill control equipment, and decontamination equipment should also be maintained at these two locations.

All fuel storage areas should 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 should be directed into gutters which flow to oil-water separators prior to release to the environment. End-of-pipe water quality should 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 should respond to that discharge and an alternate source of water should be provided to persons located downstream of the discharge.

Spills of fuel oils should be cleaned by mechanical methods, chemical dispersants, gelling agent or biological agents. The specific method to be used should depend on the quantity and location of the spill.

A berm should be constructed around the spill area to control runoff to surface water. All soils impacted by the spills should 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 should be trapped and should be relocated to areas within close proximity of the site, which are the same ecologically as the spill area. Fishes should be trapped with nets and animals should 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 should have insignificant impacts on the areas to which the fauna is relocated. Spills of fuel oil should 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 should be allowed to naturally degrade by dilution and dispersion. During the degradation process water quality should be monitored in the spilled area. After monitoring determines that water quality has attained acceptable standards, sensitive fauna should be allowed to naturally reenter the area.

Mechanical cleanup, using booms and skimmers, should be used to recover spills to surface water. Containment booms should 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 should be used to divert and channel oil slicks along desired paths, making them easier to remove from the surface of the water. Skimmers should be used to recover spilled oil from the surface of the water. Skimmers should be either self-propelled or operated from the bank of streams/creeks. Chemicals dispersants should be used to accelerate the breakup of fuel oil and refined product spills to surface water.

Dispersants should be applied immediately following a spill, before the lightest materials in the oil have evaporated. The use of dispersants in freshwater should be authorized by the Emergency Response Coordinator only if it does not pose any threat to human health or the environment. Gelling agent should be used to respond to small spills of fuel oil. Gelling agents should be applied by hand to small spills and should be left to mix on their own. The gelled oil should be removed from surface water using skimmers. Biological agents should be used to mitigate the impacts of spills of crude oil and refined products to surface water and to soils.

Surface water and soil samples should 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 should be removed from the spill area until the residual levels fall below tolerable limits. The soil excavated from the area should be disposed in accordance with the Hazardous Waste Management protocol. If surface water quality has not been attained, monitoring should be continued. Persons downstream of the spill should 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 should be conducted to define the contaminant plume. A plan to clean-up the aquifer should be prepared after the delineation of the plume. The contaminated groundwater should be treated and should be re-injected into the aquifer. Treatment should cease when analyses of groundwater samples indicate acceptable groundwater quality.

During the emergency control phase, the emergency coordinator should take all reasonable steps necessary to ensure that explosions and releases do not occur, recur, or spread to other areas. These steps should include, where applicable, stopping operations. The emergency coordinator should monitor for leaks, pressure buildup, gas generation, or ruptures in valves, pipes, or other equipment, wherever appropriate. Details should be provided to emergency personnel concerning the types of on-site emergency equipment to be used and the need for personnel protection equipment.

Immediately after an emergency, the emergency coordinator should provide for treating, storing, or disposing of recovered waste, contaminated soil or surface water, or any other material. The recovered material should be handled as a hazardous waste unless it is a characteristic hazardous waste only, which is analyzed and determined not to be hazardous. The emergency coordinator should ensure that in the affected areas, no waste which may be incompatible with the released material is treated, stored, or disposed of until cleanup procedures are completed. All emergency equipment should be cleaned and made fit for its intended use before operations are resumed.

The *SPCP* should 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; or
- the list of emergency equipment changes.

## **10.7**            ***BIODIVERSITY PROTECTION***

### **10.7.1**        ***General Prohibitions***

As part of the Project *Code of Conduct*, Guyana Goldfields should develop and enforce prohibitions that apply to all employees and contractors during all phases of the project:

- No native flora or fauna or their products may be captured, fished, hunted, harassed, harvested, collected, possessed, transported, bought, bartered, or sold while within the Project Area of Influence;
- No pets may be kept within the Project Area of Influence, including caged songbirds; and
- Bushmeat may not be purchased, bartered, possessed, or transported within the Project Area of Influence.

The prohibitions on capture, collection, possession, and transport of flora and fauna would not apply to personnel or consultants involved in biodiversity-related work.

### **10.7.2**        ***Terrestrial Habitats***

Temporary and permanent alteration of terrestrial habitats should be minimized to the extent feasible and be consistent with the requirement to protect and preserve critical habitat.

Recommended management strategies include:

- Siting access routes 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;
- 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 should be considered;
- Where topsoil is pre-stripped, it should be stored for future site rehabilitation activities. Topsoil management should include maintenance of soil integrity in readiness for future use. Storage areas should 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 should be consistent with surrounding undisturbed areas and future land use; and
- Manage vegetation growth along access roads and at permanent above-ground facilities. Remove invasive plant species and replant native species. Vegetation control should 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 access roads or at facilities, then personnel should be trained in their use. Herbicides that should be avoided include those listed under the World Health Organization (WHO) recommended Classification of Pesticides by Hazard Classes 1a and 1b, the WHO recommended Classification of Pesticides by Hazard Class II (if the project host country lacks restrictions on distribution and use of these chemicals, or if they are likely to be accessible to personnel without proper training, equipment, and facilities to handle, store,

apply, and dispose of these products properly), and Annexes A and B of the Stockholm Convention, except under the conditions noted in the convention.

New vegetation should be planted around production facilities and along access roads to mitigate the impact on terrestrial resources. Deep trenches, which were dug during the exploration phase, should be refilled to eliminate barriers to the passage of animals. Vegetated corridors should be maintained and gradually removed during construction to enable wildlife present in the area to relocate to adjacent areas.

The Project footprint should optimize the use of areas which were previously cleared for earlier exploration and mining operations and clearing should be minimized to the extent practicable.

The company should 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, should be restricted and the workforce should be educated about the consequences of hunting. Guyana Goldfields should also establish a reporting mechanism for hunting incidents within the concession.

The area should be revegetated with indigenous species after completion of mining as part of the Closure Plan. Primary and secondary site roads should be identified and site roads no longer needed should be closed to employees. The revegetation program should be tested on these closed roads to develop an appropriate revegetation program.

The location of site facilities in previously worked areas and design of the ponds and pits to minimize their footprints should be undertaken by AMEC. Clearing operations should be undertaken by Guyana Goldfields during both construction and operational phases. These activities should take place during the design, construction and operation phases and Guyana Goldfields should be responsible for implementation. The costs for implementation of these measures are included in the project costs.

### **10.7.3** *Species of Special Interest*

The baseline studies have indicated the presence of various species considered to be of special interest to the EPA, EAB, and conservations organizations, such as the harpy eagle and the giant otter.

In the event that active harpy eagle nests or resident giant otters are encountered within the Aurora Concession or other Project sites, all activities should cease in that location and the EPA Biodiversity Unit should be notified. Further actions should then be coordinated with the EPA Biodiversity Unit and any conservation partners identified by Guyana Goldfields.

#### 10.7.4

#### *Aquatic Habitats*

The Mining Regulations mandate that mining and quarrying activities may not be conducted in the areas within 20 meters of the low water mark of a river bank, except for access of dredges from the river or in specified nature reserves and parks where resource extraction is prohibited or in buffer areas, without the express approval of the Commission and the notification of parties likely to be affected by the activity. In addition, no dry mining or excavation should be conducted in any watershed without prior permission from the GGMC Commissioner.

Recommended management strategies for the protection of aquatic habitats include the following:

- Minimizing the creation and extent of new access corridors;
- Decommissioning and re-vegetating exploration access routes, and installing barricades to limit access;
- Maintaining, to the extent possible, natural drainage paths and restoring them if they are disrupted;
- Maintaining water body catchment areas equal or comparable to pre-development conditions;
- Protecting stream channel stability by limiting in-stream and bank disturbance, and employing appropriate setbacks from riparian zones;
- Attenuating surface runoff from high precipitation events using on-site storage and water management infrastructure (e.g. storage ponds, sumps, low gradient ditches, clean water diversions);
- Designing temporary and permanent bridges and culverts to manage peak flows depending on the associated potential risk; and
- Constructing, maintaining, and reclaiming watercourse crossings that are stable, safe for the intended use, and that minimize erosion, mass wasting and degradation of the channel or lake bed.

Construction of the tailings and water management ponds should progress in the direction of stream flow to enable aquatic organisms to move downstream and vacate the area.

If monitoring indicates significant occurrences of deaths associated with ingestion of water from the tailing pond and related water management facilities, wildlife access to cyanide-solution ponds should be restricted by erecting fences at strategic locations. In addition, all discharges from these facilities should be monitored to ascertain that discharges are safe for fish, as well as people.

### **10.7.5** *Invasive Alien Species*

Guyana Goldfields and its Contractors should not utilize invasive alien species in its revegetation or reclamation programs.

Biodiversity monitoring should pay special attention to the presence of invasive alien species.

In the event of the proliferation of any new alien species in the Project's area of direct influence, Guyana Goldfields should develop an immediate action plan to control and eradicate the species.

### **10.7.6** *Biodiversity Monitoring*

See *Sections 10.8.10* and *10.8.11* for recommendations on biodiversity monitoring.

## **10.8** *CONCEPTUAL MINE RECLAMATION AND CLOSURE PLAN*

The following conceptual Mine Reclamation and Closure is a suggested approach based on international best practice and the case of the Omai Gold Mines, the only major mine reclamation and closure in Guyana to date.

### **10.8.1** *Reclamation and Closure Objectives*

In accordance with the *IFC EHS Guideline for Mining*, the general objective of the MRCP is to leave the mine area in a functioning ecological (to the extent possible), and physically-chemically stable, state, thereby making it available for future land uses.

The overall intent of the closure plan is to achieve Guyana Goldfield's objective for restoring the site and aquatic environment to a high ecological value. In addition closure would 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 mechanism are in place to protect water resources and the receiving environment thereby providing chemical stability (Chemical Stability).

Criteria 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; and
- 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 would provide systems that minimize environmental damage by:

- Maximizing retention time within the system by use of detention ponds
- Minimizing increases in surface runoff flow and volume
- Channeling 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 would 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

### **10.8.2      *Reclamation and Closure Approach***

The facilities would be progressively reclaimed and closed over the duration of the mine site operations. Progressive reclamation and closure would reduce the costs since closure would be integrated with the production operations. In addition, progressive closure would result in the development of expertise on the most appropriate reclamation methods. Progressive closure would be undertaken, however without posing impediments to day-to-day operations of the site.

Final reclamation and closure of the mine site would be undertaken following completion of all mining operations, once treatment of site waters is no longer

required, and indications that further mining of the Aurora Mine is not warranted.

Final reclamation and closure of the facility would occur in two stages. The first stage would entail the following activities, if not undertaken during progressive closure phases:

- All fuel, chemicals, waste hydrocarbon products, and any potentially hazardous materials would be removed from this site;
- The portal, vent raises, and openings would be sealed;
- Underground pumping and pit dewatering would cease; and,
- Water treatment would cease once runoff water no longer requires treatment.

During the second stage of the final closure, all equipment, machinery, and storage tanks would be removed for reuse or recycle. Where such uses are not practical, any remaining such materials would be disposed of at a suitable storage site. All structures would be removed and/or be demolished. Structures that are suitable for reuse or recycling would be salvaged. Structures not suitable for use would be disposed.

The Tailing Management Area (TMA) and other water management ponds would be closed and all disturbed areas would be reclaimed, with the exception of roads needed for monitoring access.

After the major closure activities are complete, a monitoring program may be implemented including the site water quality monitoring and dams inspections.

Historical information for the site indicates that the site has been the subject of mining and mineral exploration for close to 100 years. Those activities have resulted in significant disturbance to the area, including excavations, road building, construction of infrastructure and forest clearing. Previous operations have used steam powered water pumps, and wood-fired boilers. 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 and ponded areas indicative of former operations at the site.

The conceptual closure is intended to ensure the “return to nature” of the mine site. At the conclusion of the closure process, no buildings or supporting infrastructure or facilities would remain at the site. The areas would be fully replaced by a sustainable environment comprised of productive and diverse lake and pond ecosystems. Spoil piles, stockpiles, borrow areas etc would be vegetated with general sustainable grass as well as emerging forest (primarily early stages in rainforest succession are expected to dominate the period immediately following closure). The site would be monitored for success of

the closure plan. A few routes would be left for access to points of interest for the monitoring program. These routes would be closed after successful reclamation.

### 10.8.3 *Reclamation and Closure Concept*

Borrow pits used to source material for embankment construction would be profiled and partially vegetated with grass. Grass shoots shall be manually harvested from other areas and would be transplanted at borrow pits locations.

A containment berm would be constructed around the perimeter of each spoil pile to control erosion and the migration of solids. The spoil pile would then be graded to blend with the natural topography. A layer of saprolite would be applied to selected areas of the dump face where waste rock only is exposed. Soil would then be applied over the spoil piles and vegetated 'islands' would be planted and observed. If the "islands" indicate that the soils are adequately fertile to develop a diverse community of plants, no additional action would be taken and the vegetation would be allowed to naturally spread. If observations of the "island" indicate very little development and spreading of vegetation, seedlings from a nursery plot at the site would be transplanted into the spoil pile.

Each mine pit would be provided with a spillway to enable discharge to surface water features around the pits. The discharge spillway would be sloped and would be covered with geotextile and rip rap (waste rock) to minimize the possibility of erosion. All power and water line would be disconnected and would be removed from the site.

All stockpile areas would be excavated back to original ground level, profiled and covered with natural organic-rich soils to encourage natural revegetation. The water management pond would be breached to reduce the pond to one-half of its designed height and a spillway would link the pond to nearby surface water features. The spillway would be covered with geotextile and rip rap (waste rock) to minimize the possibility of erosion. All haul and access roads would be regraded, reclaimed, and closed except for agreed upon access routes.

To match adjacent slopes and roads material would be pulled from the fill portion of the roads and placed in the cut portion to aid in regrading. All exploration roads at the mine site would be reclaimed in a similar manner to haul and access roads. This would include all areas outside the active mining area.

The process plant and its associated treatment facilities would be removed from the site. Concrete slabs and footings would be broken up and placed into open facilities such as ponds or would be placed on waste rock dumps in such

a manner that the concrete would be incorporated into anticipated reclamation.

Facility sites would be graded to blend in with existing topography, and compacted areas would be ripped and the whole area would be covered with topsoil and revegetated. All topsoil areas would 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 would 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, would 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 would increase water storage capacity and provide a good substrate for rooting and maximize the likelihood of long-term vegetative success.

The closure plan would lead to the re-establishment of ecological processes that would 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 would include native species appropriate for the area. Non-invasive introduced vegetation species would be considered for their benefits to add organic matter to soils.

#### **10.8.4**      *Implementation, Responsibility, and Funding*

The costs associated with mine closure and post-closure activities, including post-closure care, should be included in business feasibility analyses during the final planning and design stages. Minimum considerations should include the availability of all necessary funds, by appropriate financial instruments, to cover the cost of closure at any stage in the mine life, including provision for early, or temporary closure.

Funding should be by either a cash accrual system or a financial guarantee. The two acceptable cash accrual systems are fully funded escrow accounts (including government managed arrangements) or sinking funds. An acceptable form of financial guarantee must be provided by a reputable financial institution. Mine closure requirements should be reviewed on an annual basis and the closure funding arrangements adjusted to reflect any changes.

The Mining Regulations require Guyana Goldfields to lodge an Environmental Bond in favor of the GGMC, for an amount to be determined by the Commissioner. The Environmental Bond or part thereof, should be used by the GGMC to restore the environment where restoration of the said area was not done to the satisfaction of the Commissioner provided that the

GGMC should 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.

## **10.9 ENVIRONMENTAL MONITORING**

### **10.9.1 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.

The IFC recommends that environmental monitoring programs should be implemented to address all activities that have been identified to have potentially significant impacts on society and the environment, during both normal operations and unexpected conditions. Social and environmental monitoring activities should be based on direct and indirect indicators of emissions, effluents, and other potential sources of impacts associated with the project. IFC guidelines recommend that monitoring should extend for a minimum period of five years after closure.

Monitoring frequency for each parameter should be sufficient to provide representative data for the parameter being monitored. Specific monitoring frequencies are specified in the following sections.

Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed/compared against operating standards so that any necessary corrective actions can be taken.

The environmental monitoring program for the mine should serve as an integral part of the operation and would be implemented to generate information for environmental management and environmental information dissemination. The monitoring plans described in this chapter encompass two distinct categories, environmental and operational. The environmental aspect is structured to monitor the physical, biological and socioeconomic changes in the environment, if any, and includes the mitigation measures. The operational monitoring should include those variables important for day-to-day operations such as processing methods and camp facilities.

Monitoring should be conducted during all phases of the project; specifically, the design, construction, operation and closure phases. The monitoring program should play a pivotal role in ensuring that the trends for specific parameters are tracked and should provide information on compliance with

legislative norms, set guidelines or desirable operational limits. Review of the monitoring data should provide a basis for corrective actions and modification of activities if necessary. Sampling intensity during monitoring should depend on the time and location of the development activities and results derived from monitoring data.

### **10.9.2**      *Noise Monitoring*

Per *IFC General EHS Guidelines*, the noise monitoring program should be designed and conducted by trained specialists. Monitoring periods should be sufficient for statistical analysis and may last 48 hours with the use of noise monitors that should be capable of logging data continuously over this time period, or hourly, or more frequently, as appropriate (or else cover differing time periods within several days, including weekday and weekend workdays). The type of acoustic indices recorded depends on the type of noise being monitored, as established by a noise expert. Monitors should 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 is represented by the background or ambient noise levels that would be present in the absence of the facility or noise source(s) under investigation.

### **10.9.3**      *Air Quality & Dust Monitoring*

Vehicles and non-stationary equipment should be visually monitored to identify any vehicles or equipment with visible particulate emissions that should be inspected to identify need for repair or maintenance.

Emissions from the generator house stack should be tested annually for NO<sub>x</sub> and PM, with fuel testing for SO<sub>2</sub>, to ensure IFC 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 should be monitored to ensure that excessive dust is not emitted by vehicle traffic, construction, and maintenance activities.

In addition, Guyana Goldfields should establish an automated meteorological station to measure rainfall, temperature (maximum and minimum), humidity, evaporation, wind speed and direction, and hours of sunshine.

### **10.9.4**      *Soils Monitoring*

The removal, storage, and reutilization of topsoil and organic matter should be registered and documented.

The removal, storage, treatment, and final disposition of contaminated soils should be registered and documented.

### 10.9.5 *Water Quality Monitoring*

Sampling of any discharge points downstream of the tailings and water management ponds should be conducted weekly for the first year of operation and twice per month after that time. The sampling results should be used to determine the effectiveness of the cyanide destruction circuit.

Effluent from the sewage treatment systems (e.g., Mine and Buckhall) should be sampled weekly at the discharge point(s) and tested for total coliform bacteria, BOD<sub>5</sub>, 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 should also be conducted weekly to ensure that discharged stormwater meets effluent discharge/water quality standards prior to discharge into surface water.

Surface water samples should be collected in streams/creeks in proximity of the operations and from each of the diversion channels on a quarterly basis (i.e., four times each year). Statistical evaluation of the data should be performed to determine if sampling should be conducted at more frequent intervals. Stream flow data should be collected at each surface water sampling event as part of the sampling protocol. Surface water monitoring data should be compared to the IFC/World Bank Standards (IFC/World Bank *Environmental, Health and Safety Guidelines for Mining*, December 10, 2007) listed in *Table 1* to assess for potential impacts from 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 should be installed both up-gradient and down-gradient of the tailings and water management pond. Samples should be collected from these wells on a monthly basis and analyzed for the presence of heavy metals and cyanide. Three additional permanent groundwater monitoring wells should be installed on the perimeter of the operations area. Groundwater sampling should be conducted at each perimeter well on a yearly basis and samples should 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 ( $p < 0.05$ ) increase over the baseline levels.

### 10.9.6 *Tailings and Water Management Dam Integrity Monitoring*

Monitoring and preventive maintenance should be undertaken to assure optimal performance of the tailings and water management ponds.

Monitoring should consist of visual observation of the tailings embankment, and the monitoring of piezometers and other instrumentation installed to assess the performance of these facilities. Guyana Goldfields should retain an independent expert firm to monitor the performance of the TMF during the project operation phase.

The tailings and water management dams should be monitored on a weekly basis, at a minimum, or as dictated by the EPA/GGMC to visually determine their structural integrity. The ponds should 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 should 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 should 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 should also be factored into the periodic evaluation of the impoundment stability.

Preventive maintenance should be undertaken at all potential trouble spots observed during visual inspection. The preventative maintenance should be geared primarily to ensure the stability of the structure and to control seepage through the embankment cross-section. A beach should also 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 should 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 TMA 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 should therefore be undertaken from the beginning of deposition throughout the life of the dam. Through careful monitoring, areas of concern should be noted and quickly repaired, thereby preventing failure.

Visual monitoring should 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 should 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 should be used to show developing trends in the behavior of the tailings and water management

ponds.

The instrumentation should be installed in the embankment and its foundation to monitor changes which are critical to the embankment stability, and to predict unstable conditions. Instruments should be installed to measure pore water pressures, seepage flows, embankment movements, and total pressures. Pore water pressure in soils should be measured with piezometers. Seepage flow emerging downstream from the embankment, should be collected and directed to a weir for flow measurements. Seepage flows should be used to indicate when significant changes occur and to permit an evaluation of potential problems from piping.

Markers should be installed on the embankment surface and should 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 should also be used to measure horizontal movement of the embankment. The slope indicators works 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 should be measured by leveling of temporary benchmarks.

The frequency of monitoring should depend on previous observations and on the critical nature of the parameters. The frequency of monitoring should be more pronounced during and immediately after construction. When records indicate that conditions are relatively stable, the frequency of monitoring should be extended. Monitoring auditing should include water balance, freeboard, and deposition plans in order to determine the validity of the Operating Manual and its procedures.

#### **10.9.7 *Mine Waste Stockpiles Monitoring***

The waste rock stockpiles should be monitored on a weekly basis to determine the integrity of the containment berm around the perimeter of the stockpiles. The monitoring events should include an evaluation of the height and slopes of the stockpiles to ensure that they do not exceed the tolerable limits.

Potential geotechnical changes in the stockpiles should be monitored to assess potential changes that can significantly decrease the stability of the stockpiles. In accordance with the *IFC EHS Guidelines for Mining*, modern topographical 3D deformation measurements and related specific processing and evaluation software should be the standard method for stability monitoring.

Dust emissions from the stockpiles should be visually monitored and corrective action implemented, if required. Corrective actions may include wetting down or covering the stockpiles to reduce dust emissions.

Runoff from the stockpiles should be monitored for water quality. Samples should be collected from the leachate collection/perimeter drainage system and analyzed for parameters outlined in *Table 1* 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. If the water quality is considered unsuitable to release, the runoff should be collected in the perimeter ditch system and directed to a mine settling pond for removal of suspended solids and possible treatment prior to release to the environment.

Potential changes in geotechnical properties due to chemical or biologically catalyzed weathering should be considered and monitored as these can reduce the geotechnical stability of the stockpiles.

#### **10.9.8**      *Hazardous Material Monitoring*

Inventories of hazardous material should be monitored to ensure all material is used for the purposes intended. Waste containment areas should be monitored to ensure that the impervious surface upon which they are sited is not breached. The area should 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, including cyanide-containing substances, should be reported to the GGMC and made available to interested stakeholders.

#### **10.9.9**      *Solid Waste Monitoring*

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

#### **10.9.10**    *Aquatic Ecology Monitoring*

In addition to the monitoring of the physical and chemical quality of water in streams and rivers, Guyana Goldfields should perform periodic sampling to assess trends in the abundance and diversity of the aquatic biota in all of the streams affected by the Project. Special attention should be given to the detection of invasive alien species.

### **10.9.11** *Terrestrial Ecology Monitoring*

Guyana Goldfields should contract a firm or NGO to develop and implement a Biodiversity Monitoring Plan. This plan should identify the appropriate indicators, protocols, and frequencies to be followed. The results of the Biodiversity Monitoring should be reported to all interested stakeholders.

Monitoring should begin during the pre-construction phase and should continue throughout construction, operations, 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 should be conducted concurrently with the vegetation monitoring. Observations should be recorded in a wildlife-sighting logbook and these should be periodically examined to determine if there have been any significant changes in species abundance and/or distribution. All collisions with wildlife on the access and/or haul roads should be recorded. The record should note the proximity to cleared areas, the animal involved in the collision and the time of that collision etc. These records should be used to evaluate the success of the measures outlined in the Management Plan.

In particular, Guyana Goldfields should monitor any population of harpy eagles found in the Aurora Concession, as this species is an indicator of habitat quality and disturbance. If harpy eagle nests are found, these should be carefully monitored and protected from disturbance.

In the event that endangered species, such as giant otters and sun parakeets that were reported previously for the site, are observed at any time during construction or operations, special monitoring plans should be developed to track these occurrences.

A record should 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 should be among the parameters recorded. Additional fencing around the ponds should be installed as needed based on the results of this monitoring.

Special attention should be given to the detection of invasive alien species in order to preemptively identify areas where control measures are required.

### **10.9.12** *Progressive Reclamation Monitoring*

As part of the reclamation program, a record should be maintained of all spontaneous and natural regrowth after clearing and the conditions contributing to that regrowth. The record should note plant species, soil type, weather conditions during the period, drainage conditions etc. The

records should be used to examine parameters considered necessary for the successful establishment of plant cover after reclamation.

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

### **10.9.13** *Post-Closure Monitoring*

Post closure monitoring of the TMA should 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 TMA. The cyanide concentration and water content of tailings should be monitored to determine when these parameters are within acceptable limits (<0.1 mg/L for free cyanide, <0.5 mg/for WAD cyanide; acceptable tailings water content to be determined by TMA engineering team during final design).

Post closure monitoring of the TMA should also include the collection of surface water and groundwater samples from locations in the vicinity of the TMA on a quarterly basis. Parameters to be analyzed should include those in *Table 1*. Sampling should 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.

Monitoring of the tailings should be discontinued only after both cyanide 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.

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## 11.1

## INTRODUCTION

The social management plan is a practical document designed to help Guyana Goldfields implement and operationalize the management and mitigation measures identified during the impact assessment process. These measures are designed to reduce or remove potential negative impacts, enhance potential positive impacts and reduce community related risks to the project.

The social management plan forms a framework within which the company can manage Project based impacts/risks as well as the future issues/concerns of the local communities and stakeholders beyond the scope of this ESIA. The social management plan and its specific sub parts are designed to address the social impacts and risks identified in *Section 7*. A proper implementation of all these measures will ensure that the project manages all possible social issues and risks.

The social management plan has the following components:

1. **Internal Capacity Building/Implementation Framework-** Guyana Goldfields currently lacks a proactive system for managing social/community issues. There is lack of resources and dedicated personnel who can deal with social and community issues. Currently they are a small exploration unit and function in skeletal capacity with managers and staff taking on multiple functions. In order to implement the overall social management plan and the specific sub plans Guyana Gold needs to build its internal capacity and designate responsibilities. The SMP Implementation/organization structure presented here is a sub part specifying the structure of the social/community team. It is a part of the larger SEMP organizational structure as presented in *Section 9*

2. **Detailed Plans to Address Findings of the ESIA in Annex 1**

Annex 1 contains detailed plans for managing the identified issues or impacts in the ESIA study. It has the four following parts (A to D).

**Part A: Artisanal Mining Management Plan-** This plan articulates the issues of artisanal and small scale mining which could affect the project and provides recommendations on how the project should manage such issues

**Part B: Influx Management-**the potential of attracting influx into the remote and interior regions of Guyana has been identified as a key issue in the ESIA. The influx management plan provides

recommendations on pro-actively managing and mitigating such issues

**Part C: Stakeholder Engagement Plan**-Continuous engagement and consultation is key to creating stakeholder acceptance and favorable public opinion for the project. Stakeholders should be continuously engaged and included in the entire project life cycle; construction, operations and closure. This plan provides recommendations on how Guyana Gold should consult with stakeholders on project activities and disclose project information, using methods of communication that are inclusive (i.e., accommodating various levels of vulnerability), culturally appropriate, and adapted to the communities' language needs and decision-making, such that members of these communities fully understand how the project will affect their lives. The plan also highlights the mechanisms for setting up a grievance system for stakeholders

**Part D: Community Development Plan**-As a part of its strategic planning, Guyana Gold should invest in community development. Partly this has already begun whereby Guyana Gold is sponsoring community projects in certain areas in Guyana. However a more strategic and stakeholder focused approach is required if community investment has to be done in a meaningful and sustainable manner. This plan provides strategic direction and recommendations for successful community development initiatives that the company could get involved in.

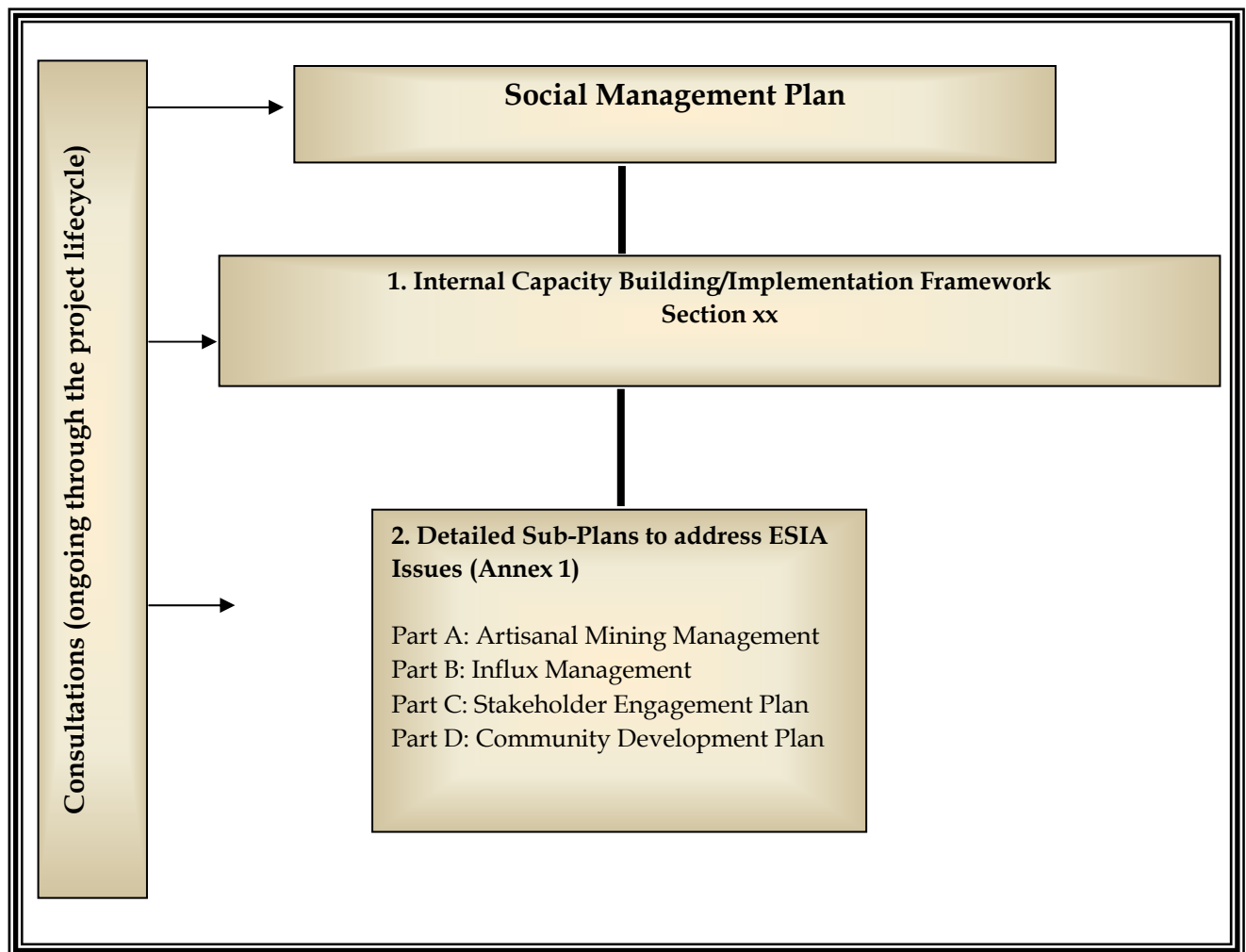
### 11.1.1 *How to Read the Social Management Plan*

The Social Management plan comprises of two parts, the Implementation Framework that is presented here and four separate stand alone documents (Parts A to D) presented in *Annex 1*.

**The SMP has been divided such that each detailed plan, such as the Artisanal Mining Management or Community Development plan can be read as stand alone documents.**

The Implementation and Capacity Building Framework presented here is the backbone of the Social Management Plan and all aspects of Management Plans; A to D should be implemented using this framework.

Figure 11-1. Social Management Plan Structure and Components



## 11.2 INTERNAL CAPACITY BUILDING AND IMPLEMENTATION FRAMEWORK FOR THE SOCIAL MANAGEMENT PLAN

Guyana Gold is currently an exploration unit and has been exploring at the Aurora site since 2000. The ESIA consultations within the company revealed certain issues:

- There is lack of dedicated resources to manage community/social aspects. By virtue of being a small exploration unit Guyana Gold functions in a skeletal capacity with managers and staff taking on multiple functions. There is one Corporate Social Responsibility (CSR) officer based in Georgetown but for a project of this magnitude Guyana Gold needs a team of trained and dedicated resources to overlook social/community aspects especially to implement the Social Management Plan;
- Several studies were commissioned by the company prior to the ESIA including a baseline study in 2006 which assessed communities and

stakeholders. Although the company has established relationships with stakeholders and communities in areas like Bartica, Buckhall and Itaballi, these interactions are mostly ad hoc and on a need to need basis;

- On the whole Guyana Gold currently lacks a proactive stakeholder engagement strategy and has no systematic procedure in place to interact or engage with the local communities;
- Stakeholder interactions are managed by various personnel mostly located in the Georgetown office; some that are responsible for liaising with Government departments and others that interact with communities. However these duties/functions are not formalized and there is no documentation of stakeholder issues/grievances

In order to implement the social management plan, Guyana Gold needs to build its internal capacity and designate responsibilities to manage social/community issues in an organized and systematic manner. This requires building of a social/community relations team that has trained experts to manage such issues. The Implementation/Capacity building structure presented here is a sub part of the larger SEMP organization structure presented in section 9. This sub part specifies the composition, roles and responsibilities of the Social/Community relations team required to implement the SMP.

### **11.2.1 *Building a Community Relations Team***

It is important that a dedicated community relations team be constituted for the project. The main role of this team is to:

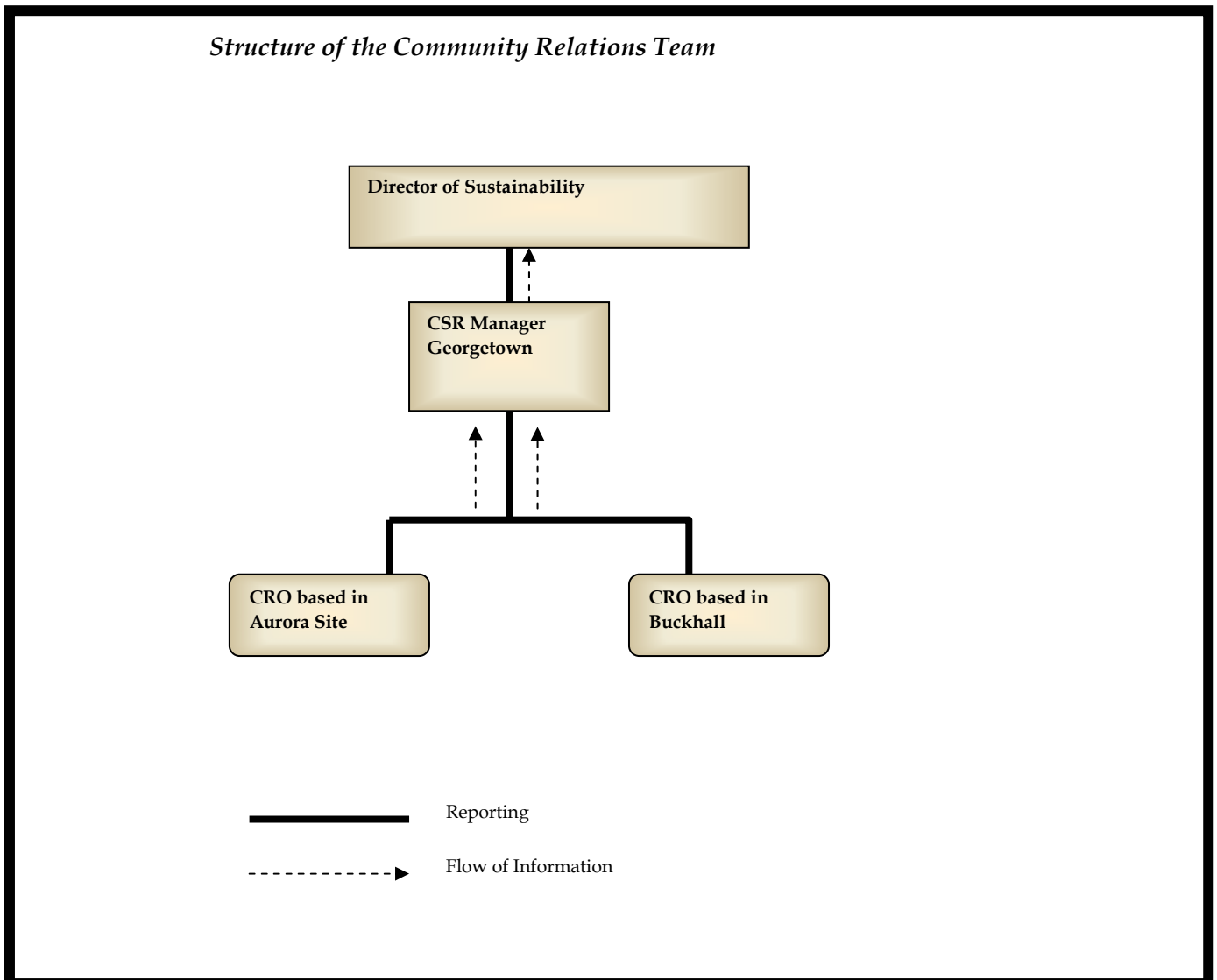
- Be the company point of contact to manage social/community issues;
- Liaise with senior management to pro-actively identify social risks for e.g. concerns amongst stakeholders that can lead to future conflicts or reputational implications for the project;
- Be a trained resource group well versed in working with communities especially Amerindians and be the 'ears' of the senior decision makers within Guyana Gold;
- Implement the recommendations of the Social Management plan especially the sub plans from Part A to D;
- Conduct meaningful consultations with the communities in the project zone of influence and other stakeholders;
- Formulate, implement and manage the Grievance Redressal Process;
- Identify, implement and monitor community development programmes;
- Monitor the implementation of the Social Management Plan and provide corrective actions and adaptive strategies whenever required.

The members of this team should be selected carefully and should have prior experience of working with communities and understanding of social/communities issues as well as larger CSR context.

It is important that this team is well spread out and physically based at important locations in the project sites. This will enable comprehensive coverage of all communities identified in the project zone of influence and also a steady flow of information to the central office in Georgetown.

We recommend that as a start up for this department at least two Community Relations Officers (CROs) are hired. They should report to the CSR Manager based in Georgetown who in turn reports to the Director Sustainability who is overall in charge of environmental and social issues.

*Figure 11-2. Structure of the Community Relations Team*



### 11.2.2 *Roles and Responsibilities of the CSR Manager*

The CSR Manager should head the Community relations department. Key function of the CSR Manager is to:

- Be the owner of the Social Management plan and all its components and responsible for its implementation;
- Report to the Director Sustainability who is the overall in charge of environmental & social aspects of the project (*see section 9*)
- Work with the other departments especially senior management team to implement all aspects of the Social Management Plan
- Identify, manage and monitor social/community/stakeholder issues using inputs from the CROs;
- Facilitate and coordinate between the CROs;
- Develop a Strategic Approach to Community relations
- Be the conduit for the flow of information and reporting from the sites to Georgetown;
- Ensure that regular reports on the implementation of the SMP measures and their effectiveness, are circulated to senior management
- Maintain the effectiveness of the Grievance Redressal process;
- Discuss risk issues with the senior management;
- Maintain responsibility for effective implementation of the community investment strategy and programmes run by Guyana Gold;
- Select, manage and monitor community development programmes

### 11.2.3 *Roles and Responsibilities of the CRO(s)*

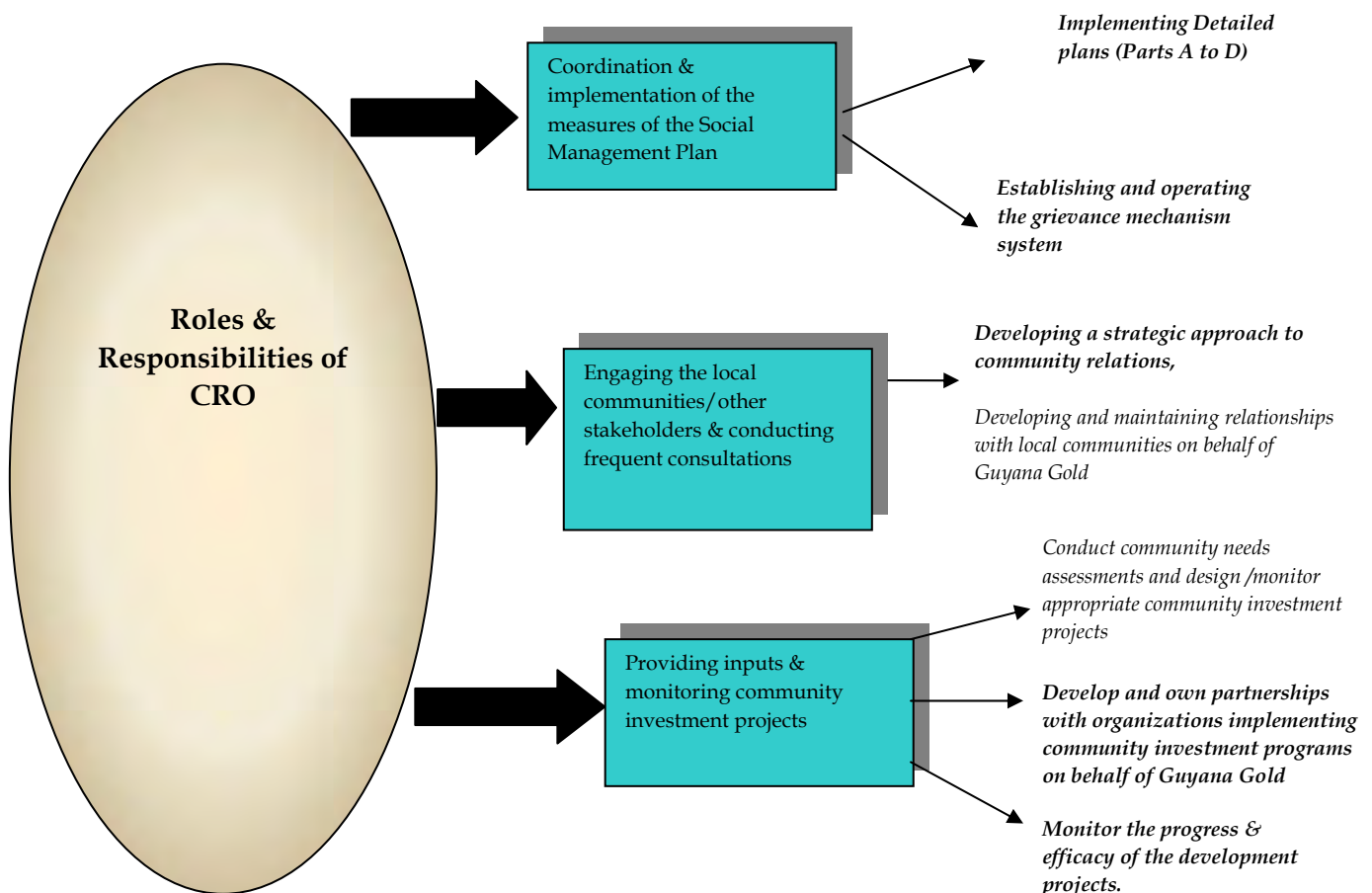
The CRO's should be stationed in at least two locations, Aurora site and Buckhall. This ensures that there is adequate coverage of the six settlements identified in the project zone of influence and at least one CRO will represent Guyana Gold to these communities. It is understood that the geographical and physical distances between these six locations may render regular interaction difficult. However the frequency and schedule of CRO visits to each of these places could vary depending on the needs of the project, the concerns of the stakeholders and issues (if any) to manage.

Overall the CROs will:

- Serve as the primary contact and face of the company to the local communities especially in the six settlements;
- Serve as the designated contact to handle all project related queries. For this the CRO will have to work closely with the project team on the field and have daily interaction and status reporting with the Project Manager and any other personnel;
- Implement all the measures recommended in plans A to D;

- Conduct consultations with the communities and inform them about proposed activities in construction and operations phases of the project;
- Undertake community engagement with an objective to form partnerships, collaborations and solicit the local community's support in project related and other company activities. Use best practice tools of community engagement such as participatory appraisal, focus group discussions and community meetings;
- Record the grievances of the local communities and liaise with other departments and senior management as necessary;
- Conduct consultations using PRA techniques like Needs Assessment to identify what community projects are appropriate for which settlement;
- Provide inputs to the design and implementation of a community investment program focused on local communities;
- Regularly report community issues to the CSR Manager;
- Monitor and supervise the implementation of the community projects invested in by Guyana Gold.

*Figure 11 - 3. Proposed Roles & Responsibilities of the CROs*



### 11.3

#### SUMMARY

The Implementation and Capacity building framework presented here is the main aspect of managing the social risks and impacts of the project as identified by the ESIA studies. This framework is necessary to implement detailed plans presented in *Annex 1 (Parts A to D)* effectively. Coordination between the activities of each plan and the consistency of the roles/responsibilities of the Guyana Gold team is critical to the success of the overall social management plan.

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**12.1** *SCOPE AND APPLICABILITY*

The Health, Safety and Emergency Response Plan (HSERP) provides recommendations and preliminary plans that should be further developed and implemented by Guyana Goldfields and their Contractors to achieve compliance with international best practice in health, safety, and emergency response for gold mining projects.

**Given that at the time of development of the ESIA the Aurora Project was in the Pre-Assessment phase, the present HSERP presents only Preliminary Plans which serve as guidelines and models for development of final plans by Guyana Goldfields during the Feasibility and Final Design phases of Project development.**

The final HSERP should be applicable to all phases of the Project, including construction, operations, and closure and should include the following major components:

- Health and Safety Plan;
- Explosives Management Plan; and
- Emergency Response Plan, including Cyanide Exposure.

**12.2** *POLICY, LEGAL, AND ADMINISTRATIVE REQUIREMENTS*

Guyana Goldfields and its contractors shall adhere to all laws, regulations, and codes of practice of Guyana, the applicable IFC Performance Standards on Social and Environmental Sustainability, and the applicable IFC EHS Guidelines. In the event that Guyana Goldfields deems full compliance with a particular standard or guideline not to be technically or economically feasible, the IFC and GGMC shall be consulted proactively.

**12.3** *CONTRACTOR RESPONSIBILITIES*

The Construction Contractor(s) shall develop a detailed *Contractor Health, Safety, and Emergency Response Plan (Contractor HSERP)* to be submitted to Guyana Goldfields not less than 90 days prior to the start of construction. This plan shall establish the Contractor's organizational structure, policies, plans, and procedures for ensuring proper management of all health, safety, and emergency response (HSER) issues which may arise during construction.

The Contractor is responsible for understanding the detailed requirements of all applicable Guyanese laws, regulations, and codes of practice and the IFC Performance Standards and EHS Guidelines. The *Contractor HSERP* should be designed to meet these requirements in addition to those specified by the Aurora Project SEMP. In particular, the *Contractor HSERP* shall reflect a clear understanding of the requirements and responsibilities of employers at construction sites under the Guyana *Occupational Health and Safety Act*.

The *Contractor HSERP* shall include at least the following content:

- Contractor HSER Policy Statement;
- Contractor HSER Management Organization;
- Contractor HSER Training;
- Contractor HSER Plans and Procedures; and
- Contractor HSER Assurance.

The Contractor shall adhere fully to the *Aurora Project Code of Conduct* and Guyana Goldfields reserves the right to dismiss Contractor personnel and management for violations of the *Code of Conduct*.

#### 12.4

##### ***DEVELOPMENT OF THE FINAL AURORA PROJECT HEALTH, SAFETY AND EMERGENCY RESPONSE PLAN***

Based on the recommendations of this document, Guyana Goldfields or a specialized HSER firm should develop a detailed *Aurora Project Health, Safety, and Emergency Response Plan (APHSERP)* as the Project enters the Feasibility and Final Design stages of development. Not less than 60 days prior to the start of construction, Guyana Goldfields should submit the final *APHSERP* to the IFC, the Guyanese Occupational Health and Safety Authority, and the GGMC for review and comment in order to assure that the Plan is in alignment with the requirements of these entities. This plan shall reflect the final design of the Project and contain fully implementable procedures for managing the foreseeable environmental impacts of the construction phase. In particular, the plan shall reflect a clear understanding of the requirements and responsibilities of owners, occupiers, and employers under the Guyana *Occupational Health and Safety Act*.

## 12.5 *PRELIMINARY HEALTH AND SAFETY PLAN*

### 12.5.1 *Organization and Infrastructure*

During the all phases of the Project, an emphasis should be placed on providing a safe and healthy environment for the workers. A Health and Safety Plan should be implemented to ensure strict compliance with the Guyanese *Occupational Health and Safety Act* and the IFC's Performance Standards on Social and Environmental Sustainability and EHS Guidelines. Occupational Safety & Health plans should be implemented in the following areas:

- Industrial Accident prevention and management;
- Hazard monitoring and prevention;
- Training and education; and
- Occupational hygiene.

An onsite Health, Safety and Emergency Response Manager should be responsible for implementation of the Health and Safety Plan. An onsite Health Care Facility should be in place to attend to standard first aid and worker health care, with capacity to attend to a workforce of approximately 600 persons.

### 12.5.2 *Industrial Accident Prevention and Management*

Industrial accident prevention and management should be effected via the company safety program. This should commence during the construction phase of the new facility and last through the operating phase until the cessation of operations. The program should 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.
- Hazard Identification and Control

As part of the final design and preconstruction phase of the Project, Guyana Goldfields should perform a full health and safety hazard assessment of each

of the Project components of the construction, operations, and closure phases. For each hazard identified, Guyana Goldfields should identify the preventative and remedial activities necessary for their elimination and control. In addressing these hazards, the first priority should 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 should be provided with the necessary safety protective gear to prevent any injuries during the work process.

Hazard identification and reporting should constitute an ongoing activity in which the employees' participation should be considered an integral part of their work functions. The clearly stipulates the responsibilities of employees and supervisor/management in this regard. In accordance with the OHS Act 1997, the HSER Manager be responsible for ensuring that:

- All work scenarios, machines, and equipment are inspected for the existence of potential hazards and ensure that they are in working order;
- All workers are informed of any hazards present in their workplaces;
- All employees receive instruction in correct and safe work procedures to prevent injuries and ensure that those instructions are followed; and
- All workers are provided with safety and protective gear required to safely perform his or her specific tasks and duties.

In accordance with OSH Act 1997, all Guyana Goldfield employees shall:

- Cease work immediately once a health or safety hazard is perceived;
- Immediately report the hazard to their supervisor who should, in company with the HSER Manager or designee, inspect the condition or circumstance and determine its validity;
- Obey instructions to perform alternative work or cease work completely as directed by their supervisor; and
- Return to their workplace or proceed with their activities only when authorized by their supervisor and the hazard has been adequately dealt with or eliminated.

Guyana Goldfield's approach should integrate behavioral considerations into health and safety management, including on- the-job behavioral observation and feed-back processes.

**12.5.3 Hazard Monitoring and Reporting**

A Safety Representative, elected from among the workers, should monitor hazards and work conditions. He or she should do the following:

- Perform Safety Inspections on and off the operations site 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 1* 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 1. Accident Report Format*

ACCCIDENT 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.....		

**12.5.4 Training & Education of Employees**

The company should run periodic training program in:

- Basic first aid programs (all employees).
- Advanced first aid programs
- Accident investigation & reporting seminars (supervisory personnel & safety reps.)

In addition to the abovementioned, all employees should be educated about their responsibility to participate in the creation of a healthy and safe environment by:

- reporting unsafe and hazards conditions when detected
- performing work in a safe manner by following the correct work procedure.

The basic first aid program should be extended to all employees and should be geared to ensure that in the event of an accident or injury, someone with first aid knowledge should always be present to render initial assistance until further medical attention can be made available. Qualified personnel should run seminars to impart the necessary theoretical as well as practical skills required. These courses should be scheduled depending on employee strength and attrition.

The advanced first aid program should constitute an upgrading course from the basic first aid program in which selected employees including supervisors and the Safety representative should be exposed to advanced first aid knowledge and techniques which should 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.

#### 12.5.5 *Industrial Accident Protocol*

Serious injuries should be referred to a medical practitioner and medical institution. The medical institution and practitioner should preferably be chosen from the nearest Town/Village to the operations and contact should be maintained by radio/ radiophone at all times. In the event of an industrial accident the following protocol should be followed:

- A basic first aider should be summoned if not already present at scene of accident.
- The basic first aider should render first aid care.
- The basic first aider should summon an advanced first aider who should administer further care if necessary and evaluate the necessity for removal to the first aid centre.
- The advanced first aider should 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 should be informed. He should:
  - 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 should record the accident in the Industrial accident register.

A vehicle should be available at all times to respond to accidents. That vehicle should be equipped with a four wheel drive and should 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.

### 12.5.6 *Occupational Hygiene*

The main environmental occupational hazards to which employees should be exposed during the operations phase of the mining entity are:

- Dust;
- Noise;
- Heat;
- Cyanide; and
- Vectors.

#### *Dust Exposure*

The following measures should be implemented in order 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 should 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 should be exposed to wind blown/fugitive dust being blown into the eyes and causing eye irritation and conjunctivitis. These employees should be provided with clear goggles and eye wash lotion should at all times be available for washing the affected eyes.

#### *Noise Exposure*

The following measures should be implemented to address worker health and safety related to noise associated with the operation:

- Control of noise levels at source via installation of silencers on exhaust system of power generating plant.
- Provision of hearing protection to employees exposed to high noise levels: ear muffs for employees in the maintenance shops and generating plant areas.
- Earplugs for employees who operate heavy-duty machines.
- Siting of power generating plant and mining operations in location away from the living quarters of employees.
- Warning signs in areas of high noise levels instructing employees to wear earmuffs or earplugs as required.
- Hearing conservation program for employees exposed to noise. This should 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.

#### *Heat Exposure*

Measures to decrease the effect of increased exposure to heat should include:

- Measurement of ambient temperature levels in vicinity of generating plant: and
- Provision of heat shields - coating of surface of generating plant by high reflective material such as polished aluminum

## *Vectors*

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. Malaria is known to be frequent in the region, particularly in association with artisanal/small-scale mining camps.

An integrated vector control program for Aurora Project facilities should be implemented, which should include:

- Engineering design reviews including careful scrutiny of roads, water storage and control facilities and surface water management strategies;
- Collaboration and exchange of in-kind services with other control programs in the project area to maximize beneficial effects, particularly distribution of treated bed nets;
- Development of the “A-B-C-D” program for all project workers where A= awareness, B=bite control, C=chemoprophylaxis for non-immune personnel and D=diagnosis and treatment;
- Selective use of indoor residual spraying (IRS) for project housing, involving careful design review, particularly a clear understanding of the local mosquito vectors and their pre-existing resistance to available insecticides;
- Development of an effective short and long- term monitoring and evaluation program

### **12.5.7**      *Electrical Safety*

Electrical safety devices shall be installed on all final distribution circuits, and appropriate testing schedules should be applied to these safety systems. All sources of hazardous energy should have written procedures for isolation, identifying how the system, plant or equipment can be made and kept safe.

### **12.5.8**      *Illumination Requirements*

Illumination systems should be adequate and safe (considering the need to avoid such things as glare or potential sources of ignition, for example) for the planned working conditions in travel paths, mine working areas, and within and around surface facilities and dumpsites of mines (see the illumination guideline values presented in Section 2.0).

Additional illumination guidance includes adherence to local standard requirements for illumination for mobile equipment operating above ground and on public roads. As a general rule, mobile equipment should produce an illumination level of 50 Lux across the passage at a distance of 1.5 times the stopping distance.

### **12.5.9**      *Occupational Health Assessments and Recordkeeping*

Occupational health assessments should be conducted for employees on a regular basis, based on exposure to risk. Medical records should be retained for at least 20 years.

### **12.5.10**     *Signage*

Signage should be installed in hazardous and risky areas, installations, materials, safety measures, emergency exits, and other such areas, including the access roads. All signage should be in accordance with international standards, including standards of cleanliness, visibility and reflectance in areas of potentially poor illumination or sources of dust and pollution. Signage should be known and easily understood by workers, visitors, and, as appropriate the general public.

### **12.5.11**     *Implementation Schedule, Responsibility and Costs*

Implementation of the management program for health and safety of employees should coincide with the commencement of construction activities and should last through work on site closure. Guyana Goldfields should be responsible for its implementation and the costs for implementation are part of the project costs.

## 12.6 *PRELIMINARY EXPLOSIVES MANAGEMENT PLAN*

### 12.6.1 *Requirements, Objectives, and Content*

Blasting activities that may result in safety impacts are typically related to accidental explosion and poor coordination and communication of blasting activities.

The use, handling, and transport of explosives should be carried out in accordance with Guyanese explosives and safety regulations.

- Specific personnel training on explosives handling and safety management should be conducted;
- Blasting-permit procedures should be implemented for all personnel involved with explosives (handling, transport, storage, charging, blasting, and destruction of unused or surplus explosives);
- Specific audited procedures should be implemented for all activities related to explosives (handling, transport, storage, charging, blasting, and destruction of unused or surplus explosives) in accordance with relevant national or internationally recognized fire and safety codes;

### 12.6.2 *Explosive Transportation*

Transport vehicles should be escorted by qualified security personnel.

### 12.6.3 *Explosives Storage*

The explosives storage area should be patrolled by qualified security personnel.

### 12.6.4 *Blasting Operations*

Blasts should be conducted only by certified blasters or explosives experts and should be accompanied by qualified security personnel.

Blasting activities should be proactively managed in terms of loading, priming, and firing explosives, drilling near explosives, misfired shots and disposal.

Consistent blasting schedules should be adopted and blast- time changes should be minimized. Blasting schedules and any changes should be communicated to all onsite personnel and visitors.

Specific warning devices (e.g. horn signals, flashing lights) and procedures should be implemented before each blasting activity to alert all workers and third parties in the surrounding areas. Warning procedures may need to include traffic limitation along local roadways.

Prior to resumption of work, blasting sites should be checked post-blast by qualified personnel for malfunctions and unexploded blasting agents.

## **12.7 PRELIMINARY EMERGENCY RESPONSE PLAN**

### **12.7.1 Requirements, Objectives, and Content**

The Mining Regulations require holders of Prospecting and Mining Licenses to prepare a contingency and response plan in accordance with the Code of Practice. The contingency and emergency response plan must set out provisions for hazards in mining operations including practical mechanisms for responding to cyanide and fuel spills and spills of other poisonous or hazardous substances and breaches of tailings ponds. License holders are also 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.

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 should be needed for as follows:

- Spills of fuel oil, cyanide or other hazardous material during road transport to the site

- Releases of fuel oil, cyanide or other hazardous material during unloading and mixing,
- Releases of fuel oil, cyanide or other hazardous material during fires and explosions,
- Release of fuel oil, cyanide 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 and potentially affected communities 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.

In accordance with IFC EHS Guidelines, the final ERP should be developed in accordance with the UNEP APELL for Mining, Awareness and Preparedness for Emergencies at Local Level, Technical Report No. 41. The report provides a framework for preparation of an Emergency Response Plan involving the mine, emergency response agencies, local authorities and communities.

The ERP consists of the following elements:

- Cyanide Safety and Response Plan
- Hazardous Material Spill Prevention and Response Plan
- Tailings and Water Management Facilities Response Plan
- Fire Response Plan
- Evacuation Plan
- Emergency Communications and Coordination Plan
- Training

Job functions and tasks should be evaluated to determine possible exposure scenarios and pathways. Process changes or engineering controls should be developed and implemented to eliminate these exposures where practicable and to reduce or control them when they cannot be eliminated. The operations should develop and document procedures for performing cyanide related tasks such as unloading, mixing, plant operations, entry into confined spaces, and equipment decontamination prior to maintenance in a manner that minimizes worker exposures.

These procedures address the use of cyanide-specific personal protective equipment such as respirators, eye protection and protective gloves, coveralls or suits, pre-work inspections, emergency response, cyanide monitoring and communications and documentation. Personnel involved in cyanide management should be trained in handling cyanide in a manner that protects their safety and the safety of their co-workers. Training should also include the proper use of personal protective equipment, emergency rescue equipment, and cyanide first aid equipment.

As mandated by the Mining Regulations, no operation in which cyanide or any preparation containing cyanide may be commenced until the necessary buildings, structures, rooms, appliances and other arrangements to carry on these operations have been inspected and approved by a mines officer. In addition, at every location where cyanide is used, an approved cyanide antidote shall be kept in a conspicuous and convenient place in a box labeled "Cyanide Antidote". Explicit directions for the use of such antidote shall be affixed inside the lid of the box and the mines manager shall ensure that all persons working in any place where the cyanide is used familiarize themselves with the location of the box and the directions for use of the antidote.

The plant should implement procedures to review process and operational changes and modifications for their potential impacts on worker health and safety, and to incorporate the necessary worker protection measures. Worker input through safety meetings, suggestion boxes, or other methods should be factored into the development and evaluation of health and safety procedures.

Process changes and engineering or administrative controls should be used to limit worker exposure to hydrogen cyanide gas and sodium and potassium cyanide to the American Conference of Governmental Industrial Hygienists (ACGIH) Ceiling Limit Value of 4.7 parts per million (5 mg/m<sup>3</sup>) as cyanide. Where the potential exists for significant worker exposure to hydrogen cyanide gas or sodium or potassium cyanide dust, the operation should monitor hydrogen cyanide concentrations with ambient and/or personal monitoring devices and evaluate the results to confirm that controls are

adequate.

Cyanide monitoring equipment should be maintained, tested and calibrated as directed by the manufacturer, and records should be retained for at least one year. Warning signs should be placed where cyanide is used and should alert workers that cyanide is present, that smoking, open flames, eating and drinking are not allowed and that the necessary cyanide-specific personal protective equipment must be worn. Showers, low-pressure eye wash stations and dry powder or non-acidic sodium bicarbonate fire extinguishers should be located at strategic locations throughout the operation where cyanide is present. This equipment should be maintained and be inspected or tested on a regular basis, and records should be retained, to assure that it is in good working order if and when needed. Tanks and piping containing cyanide should be identified by color code, signs, labels, tags, decals or other means to alert workers of their contents. The direction of cyanide flow in pipes should also be labeled, marked or otherwise designated.

Cyanide first aid equipment including medical oxygen and a resuscitator should be provided and should be inspected regularly to assure that it is available when needed. At every place where cyanide is used or stored, an approved cyanide antidote shall be kept in a conspicuous and convenient place in a box labeled "Cyanide Antidote". Explicit directions for the use of such antidote shall be affixed inside the lid of the box and the Mines Manager shall ensure that all persons working in any place where the cyanide is used familiarize themselves with the location of the box and the directions for use of the antidote.

Antidotes should be stored and/or tested as directed by their manufacturer and replaced on a schedule that assures their effectiveness. In general, the procedures for responding to inhalation of cyanide gas or skin contact with liquid or gaseous cyanide should include the following elements:

- Activate alarm or call for help to notify the appropriate site personnel (through alarms, radio, telephone) so that medical assistance is available as soon as possible.
- Call for assistance before responding to the emergency ("buddy-system"). Never try to rescue a cyanide victim on your own.
- The responder must put on the personal protective equipment necessary to safely enter the area and come in contact with the exposed individual.
- If possible, the responder must move the exposed individual to a safe area away from continued exposure. If removing the exposed individual from the area is not possible, the responder must attempt to prevent further exposure to the victim or seek assistance in moving the victim from the area of exposure.

- All contaminated clothing must be removed from the exposed individual, and the exposed individual should be decontaminated by washing with water. Safety shower and eye wash station using low pressure water are recommended.
- Oxygen must be administered, and medical help must be sought. Where authorized by the applicable jurisdiction, treatment with amyl nitrite is recommended along with oxygen. A resuscitator should be used if the exposed individual is not breathing.

If cyanide is ingested the response to such exposure should include the following elements:

- Notify the appropriate site personnel and put on personal protective equipment, as above.
- An exposed individual who is conscious should spit or be made to vomit, and the mouth should be rinsed with water.
- Continue with decontamination and administration of oxygen and amyl nitrite if permitted, or if the exposed individual is not breathing, a resuscitator should be used.
- An exposed individual that is not conscious, or has impaired consciousness should be treated with oxygen and amyl nitrite if permitted.

Workers who may be called upon to respond to cyanide exposures should be trained in the operation's response procedures and should take part in routine drills to test and improve their response skills. The operations should develop its own on-site capability to provide first aid or medical assistance to workers exposed to cyanide.

Formalized arrangements should be made with local hospitals so health workers are aware of the potential need to treat patients for cyanide exposure. In making these arrangements, the operation should ensure that the medical facility has adequate, qualified staff, equipment and expertise to be able to respond effectively. The operation should assist local medical providers with training and equipment to enhance its capabilities.

Mock emergency drills based on likely cyanide release/exposure scenarios should be conducted periodically to test response procedures. Lessons learned from the drills should be incorporated into response planning

Operators undertaking operations involving cyanide use should wear appropriate protective clothing. For respirable forms of cyanide, a full face respirator should be worn. Since cyanide can be absorbed through skin, for liquid cyanides, worker should wear disposable coveralls, PVC gloves and waterproof boots. Workers should wash their hands before eating, drinking or

smoking. Contaminated protective gear and clothing should be securely discarded, or washed before being stored and re-used. Operators should be protected through a monitoring and sampling program for airborne contaminants in confined spaces. Sampling for hydrogen cyanide gas should either be undertaken continuously, using electronic detection equipment, or batch sampling should be done using air pumps and sampling tubes.

Operators should work in pairs with one acting as a 'sentry' during all operations. The role of a sentry should be clearly defined and should be primarily to act as a passive observer of any cyanide handling process. The sentry should participate in the handling process only in the event of an emergency. Cyanide handling operations should include the following:

- opening storage containers;
- dissolving sodium cyanide pellets; and
- cleaning-up cyanide spillages.

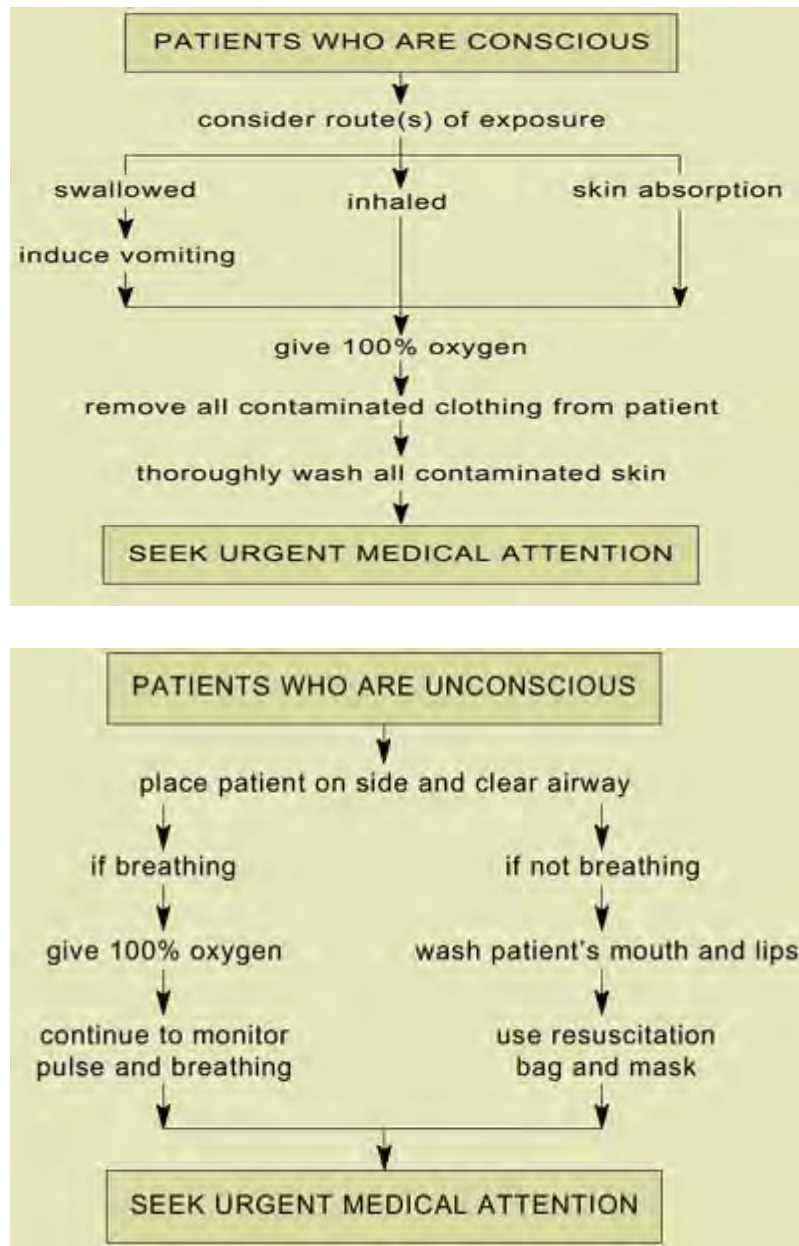
Should an operator be exposed to cyanide, effective and timely medical care should be provided. All personnel should be required to be familiar with the treatment procedures for personnel affected by cyanide exposure presented in the box below. The treatment of cyanide poisoning should fall into two categories.

- Patients who are conscious
- Patients who are unconscious

Treatment for both categories should be undertaken swiftly and efficiently by well trained and properly equipped personnel.

The general first aid treatment procedures for cyanide exposures are diagrammed in (*Figure 12-1*) below.

**Figure 12-1.** First Aid Treatment Immediately Following A Cyanide Exposure Incident



### 12.7.3

#### *Tailings and Water Management Facilities Response Plan*

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, 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 should be quickly observed. The EPA, GGMC and OPM should 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 should 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 should be immediately implemented. A close watch should be kept on the facilities for the next two to four weeks as some damage may not show up immediately after the quake.

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 downstream from the site should be notified immediately and efforts should be coordinated with others downstream to try and reduce impacts, if applicable. The EPA, the GEA and OPM should be immediately notified. The Emergency Response Center should assign an Emergency Response Coordinator to respond to the emergency. Emergency response procedures should replicate those for a spill during transportation of fuel oil, cyanide or other hazardous materials to the site.

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

- contact EPA, GEA and OPM;
- 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; and
- provide water to residents downstream of the discharge until water quality in the receiving waters returns to an acceptable standard.

#### **12.7.4**      *Transport Vehicle Emergency Response*

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

#### **12.7.5**      *Fire Response Plan*

If there is a fire which results in release of toxic fumes and if the fire spreads and is likely to ignite materials at other locations at the site or can cause heat-induced explosions, water and/or chemical fire suppressant shall be used as fire suppressant.

In addition to fires, if an explosion has occurred which poses an imminent danger that can result in a safety hazard due to flying fragments or shock waves or if an imminent danger exists that an explosion could result in release of toxic material, the EPA, the GEA and OPM should be immediately notified. The Emergency Response Center should assign an Emergency Response Coordinator (ERC) to respond to the emergency. The ERC shall determine whether the situation warrants evacuation of employees and persons within proximity of the fire or explosion.

#### **12.7.6**      *Mine Evacuation Plan*

If evacuation is required, all employees shall be picked up from designated assembly points and should be evacuated along pre-planned evacuation routes. Previously identified alternate evacuation routes shall be used if primary exit routes are blocked by releases of toxic substances or fires.

Medical emergency evacuations should be performed by aircraft.

#### **12.7.7**      *Emergency Response Organization and Equipment*

The company should maintain Emergency Response Centers; one at the mine and at the other at Buck Hall. Primary and alternate Emergency Response

Coordinators should be located at each center. Each coordinator should have explicit authority to commit the resources necessary to implement the ERP. Emergency response teams should be identified and should 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.

Operations teams should be charged with responsibilities for emergency process shutdown and firewater pump/emergency generator operation. Maintenance teams should supply labor, equipment and tools as needed to assure all support required to handle any emergency situation is available and in good working condition.

The following list of equipment and supplies should be provided for response to emergencies:

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

### **12.7.8      *Emergency Communications and Coordination***

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 Office of the Prime Minister (OPM) should be notified. The Regional Democratic Council of Region 7 should be notified of the potential problem and should be kept advised of the situation. During these contacts, the agencies should 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 should be implemented. An Emergency Response Coordinator should 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 7 and nationally should be alerted to inform residents of surrounding area and steps should be initiated to immediately advise persons in the vicinity of the emergency to evacuate due to the potential release. The EPA, GGMC and OPM should be notified. A single Emergency Response Coordinator should be tasked with responding to the potential release to minimize disparate utilization of resources. Equipment and personnel should be deployed to the maximum extent necessary to prevent the potential release to the environment.

If there is a release of fuel oil, cyanide or other hazardous material, all persons downstream and downwind from that release should be notified immediately and efforts should be coordinated with others to reduce impacts associated with the release. The EPA, the GGMC and OPM should be immediately notified. If a spill of fuel oil, cyanide or other hazardous material/waste enters waters adjacent to the access/haul roads, Guyana Water Inc. (GWI) should be added to the entities notified.

#### **12.7.9**      *Emergency Response Plan Training*

All employees and contractors should be trained in emergency response procedures.

All relevant information of the Contingency and Emergency Response Plan shall be communicated to employees and independent contractors. This information 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.

All personnel involved in mineral processing and process chemical management should be trained to recognize and respond to situations which can result in releases to the environment. The training should 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.